MULLER

MEMORANDUM

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PROJECT: **Cherry Creek Improvements at the Cherry Creek Ecological Park**
MEC #09-031.01

RE: **Preliminary Design Summary**

The Urban Drainage and Flood Control District (UDFCD) in partnership with Southeast Metro Stormwater Authority (SEMSWA), have initiated a stream reclamation project for a one-mile reach of Cherry Creek within the Cherry Creek Ecological Park (Eco Park). Muller Engineering Company, Valerian, and The Restoration Group have completed a preliminary design for this project. This report summarizes the preliminary design effort completed for the project improvements. The proposed improvements include channel reclamation measures along Cherry Creek, improvements to a series of tributaries entering Cherry Creek within the project reach, and recreational and educational amenities within the Eco Park open space. All aspects of the design process are discussed in the sections that follow.

A preliminary design drawing package containing initial layouts of the proposed drainage improvements has also been prepared to compliment this memorandum. This drawing package is submitted as a stand-alone document.

GENERAL LOCATION AND DESCRIPTION

The project reach extends approximately one mile from just south of Broncos Parkway to a point about 3,000 feet upstream of Arapahoe Road. The project reach abuts the Parker-Jordan Open Space to the south and the Cornerstar development to the north. This reach of Cherry Creek is located west of Parker Road and east of Jordan Road in Arapahoe County, Colorado. The project site is located within the southwest quarter of Section 29, Township 5 South, Range 66 West.. A vicinity map showing the project area can be found in Appendix A.

Cherry Creek is a sand-bed stream characterized by a 15-foot to 25-foot wide and 5-foot to 8-foot deep degraded active channel situated within a wider densely vegetated primary channel. The primary channel ranges in width from 100 feet to 150 feet with a depth that typically extends about 5 feet above the top of the active channel banks.

Vegetation along the primary channel is composed mainly of sandbar willows, peach leaf willows, cottonwood trees, and weeds. The primary channel meanders through a broad floodplain varying from approximately 700 feet wide at its narrowest point to 1100 feet at its widest point. The upland areas of the floodplain consist mainly of disturbed dry-prairie grassland.

Due to residential and commercial development within the watershed, base flow and storm flow volumes have been increasing over the last several years. As a result, the active channel has been steadily down-cutting, forming an incised channel. The current slope of the active channel is approximately 0.34%, but it is continuing to decrease as it seeks a flatter long-term equilibrium slope. Down-cutting of the active channel has lowered the water table and reduced the amount of water supplied to existing riparian vegetation in the primary channel. In addition to down-cutting of the active channel, bank erosion has occurred in a number of locations along the project reach. Areas of bank erosion at the Broncos Parkway bridge are of greatest concern due to the active channel's close proximity to the adjacent bridge foundation and trail.

Happy Canyon Creek is a west bank tributary to Cherry Creek with a confluence approximately 200 feet south of Broncos Parkway. Prior to a major realignment of the tributary channel that occurred between 1975 and 1976, the confluence of Happy Canyon Creek with Cherry Creek was located approximately 2000 feet downstream of its current location. At its current confluence, the Happy Canyon Creek invert is perched approximately ten feet above the invert of Cherry Creek. This has resulted in severe erosion and head cutting at this location, with potential impacts to underground utilities and a box culvert trail crossing approximately 300 feet upstream of the confluence. Immediately west of the confluence is an offline detention facility that provides detention for adjacent development. The pond outfalls into the Happy Canyon Creek channel just upstream of the confluence.

An east bank tributary to Cherry Creek has a confluence with Cherry Creek approximately 2700 feet north of Broncos Parkway. This east tributary has been constructed as a straight trapezoidal channel that is approximately 10 feet wide and 5 feet deep. The tributary channel contains a grade control structure located at the eastern edge of the Cherry Creek floodplain, which stabilizes the upstream reach. A four foot by two foot box culvert conveys tributary flows under the Cherry Creek regional trail. A detention facility located south of the tributary, providing detention for the Red Hawk Ridge Elementary School and Creek View at River Run developments, outfalls into this tributary channel.

At the downstream limit of the project reach there is a west bank tributary to Cherry Creek at Fremont Drive, which discharges into the Cherry Creek primary channel. This western tributary is a v-shaped channel with flows that spread out in the Cherry Creek overbank.

Two additional water quality/detention facilities are located adjacent to Cherry Creek. The first is a water quality pond located south of the Eco Park pond within the Courtney Downs multi-family development and the second is a water quality facility that treats runoff from commercial developments west of Eco Park parking lot.

A small feature pond with a fishing pier and adjacent boardwalk and trail exists within the limits of the Eco Park. The pond boundary is isolated from the Cherry Creek primary/active channel; however, the water level of the pond is largely influenced by the water level in the active channel. As the Cherry Creek active channel has lowered due to channel degradation, the pond water surface has also lowered, leaving a depressed pond footprint. Although the pond perimeter is currently supporting wetland vegetation, the lack of circulation within the pond has resulted in stagnant water with large amounts of algae.

The Cherry Creek corridor provides a valuable recreational amenity to the public with a regional trail that traverses through the project reach along with amenities associated with the Eco Park. The parking lot for the park also serves as a trailhead for the regional trail. The existing trail system consists of a paved concrete trail on the east side of the creek. The trail system also includes an existing pedestrian bridge located approximately 500 feet north of Broncos Parkway, where the regional trail crosses to the west side of the channel and connects to the trail network which parallels Happy Canyon Creek. Recently, a reach of trail was constructed on the east side of Cherry Creek from the pedestrian bridge to a proposed trailhead parking lot on the south side of Broncos Parkway. A meandering network of crusher fines trails along with the pond boardwalk traverses the Eco Park and provides access to the regional trail network.

Several utilities exist within the project reach. A 12-inch and 16-inch irrigation main and 24-inch water main, which are owned by Arapahoe County Water and Waste Water Authority (ACWWA) cross the active channel just south of Broncos Parkway. A 21" encased sanitary main, also owned by ACWWA, crosses Cherry Creek approximately 300 upstream of Broncos Parkway. Due the above mentioned channel degradation, the top of this existing pipe is exposed. An existing underground cable line crosses Cherry Creek just south of the pedestrian bridge. An additional water line of unknown size, which is owned by ACWWA, crosses Cherry Creek approximately 1200 feet upstream of the downstream limits of the project. Within the project area, there are also two well outfalls owned by ACWWA that discharge into Cherry Creek. Both are east bank outfalls located north of Broncos Parkway. The existing ground adjacent to these outfalls exhibits a distinct orange color as a result of iron deposits.

Photos showing existing site conditions can be found in Appendix A.

BASE MAPPING

Western States Surveying and Synergy Mapping were contracted to complete a survey that completely covers the project reach. Synergy Mapping generated aerial mapping in January 2010. Their survey included 1-foot contour intervals, street geometries, structure foot prints, fence lines, and vegetation within the study area. The mapping was then merged with a detailed ground survey completed by Western States Surveying.

Western States/Synergy's survey and all design/floodplain modeling associated with this project has been completed on the NAVD88 vertical datum.

HYDROLOGY

A Flood Hazard Area Delineation (FHAD) Study (URS, 2003) and Major Drainageway Planning Report (URS, 2004) have been completed for this portion of Cherry Creek. Table 1 presents the flow rates reported in these studies at Broncos Parkway.

Table 1: Cherry Creek Peak Discharges

Return Period	Peak Discharges at Broncos Parkway (cfs) *(from Major Drainageway Planning Report)*
2-year	1799
5-year	5033
10-year	9,367
50-year	28,107
100-year	45,973

The discharges documented in the FHAD and Major Drainageway Planning studies do not account for an unusual phenomenon termed the "sponge effect" that appears to play a significant role in the upper Cherry Creek basin. Based on gage data from the Parker gage at Main Street and the Franktown gage located 13 miles upstream as well as personal accounts during storm events, flood waves seem to diminish as they make their way downstream. It is suspected that the wide, sandy alluvium below the upper Cherry Creek floodplain provides for notable infiltration of flood flows, resulting in decreased peaks at the Parker gage. Recent storm events that seem to support this theory include those listed below:

- Storm of 8/23/1996; Franktown peak of 1460 CFS, down to 80 CFS at the Parker gage.
- Storm of 4/30/1999; Franktown peak of 1290 CFS, down to 450 CFS at the Parker gage.
- Storm of 8/27/2002; Franktown peak of 5310 CFS, down to 163 CFS at the Parker gage. *(Once the magnitude of this event had been recorded at the Franktown gage, emergency warnings went out to the Town of Parker to brace for the impending flood. Town of Parker personnel have noted that by the time the event passed under the Main Street bridge, the event was almost undetectable to the naked eye, and registered as only a minor deviation at the Parker gauging station.)*
- Storm of 7/2/2006; Franktown peak of approximately 6000 CFS, down to 300 CFS at the Parker gage.

USGS stream flow data on Cherry Creek at the Town of Parker gage contains 19 years of data, indicating a maximum recorded peak discharge of 900 CFS on July 30, 1998.

FUNCTIONS AND THREATS TO THE CORRIDOR

Hydraulics

One of the primary functions of Cherry Creek is the hydraulic conveyance of water and sediment during base flow conditions and storm events. When the channel is healthy and stable, it conveys water and sediment in a manner that does not cause major changes to its dimension, pattern, or profile. Another important component of hydraulic stability in Cherry Creek relates to floodwater having access to a wide floodplain. As water spreads over the floodplain, velocities and erosion potential are reduced.

These hydraulic functions are currently being threatened by the incised low flow channel that has developed. The incised low flow channel has created an unstable hydraulic condition where storm flows remain concentrated and cannot spread out into the wide primary channel and floodplain. This is creating higher velocities and more erosion along the channel bed and banks.

Riparian Ecology

Ecology is another important element in the stability and overall health of Cherry Creek. The existing riparian vegetation is relatively dense within the primary channel and includes thick stands of sandbar willows along with cottonwood trees and peachleaf willow trees. This dense vegetation can provide significant erosion protection during larger storms by slowing flood velocities, providing protective coverage of the underlying soil, and reinforcement of the soil with root systems. This dense vegetation also sustains a variety of wildlife including beaver, waterfowl, raptors, foxes, coyotes, rabbits, mice, and deer.

The incised low flow channel has lowered the water table, which the riparian vegetation is dependent upon. Prolonged low water table conditions will dry-out the vegetation and make the primary channel more vulnerable to erosion during larger storms.

Water Quality

The Cherry Creek corridor, when it is stable, provides significant water quality benefits, which are of value to the creek itself and also beneficial in nutrient reduction to the downstream Cherry Creek Reservoir. The riparian vegetation provides filtering and nutrient uptake. Spreading of flow into the wide, sandy floodplain provides infiltration and filtering of storm flows during larger events.

The incised low flow channel condition in the project reach that has lowered the water table threatened the health of the riparian vegetation, and impaired the spreading and infiltration of flows during larger storms also has a detrimental water quality impact.

CHERRY CREEK CHANNEL RECLAMATION IMPROVEMENTS

As mentioned earlier, a Major Drainageway Planning Report was completed by URS for the *Cherry Creek Corridor from Cherry Creek Reservoir to Scott Road* in January of 2004. This report identified areas of channel instability throughout the Cherry Creek corridor and recommended channel stabilization improvements consisting primarily of 3 to 4 foot high grade control structures providing a stable longitudinal slope of 0.22% and

riprap protection for selected channel banks. This report was used as a guide for development of the reclamation and stabilization improvements for the Cherry Creek channel through the project reach. However, the project improvements were tailored to meet a broader range of goals identified by the project stakeholders, summarized below.

- Restore and stabilize the channel and its hydraulic function, allowing larger flows to spread out into its wide floodplain.
- Preserve and enhance riparian vegetation to provide erosion protection during larger storms.
- Stabilize actively eroding banks near critical infrastructure.
- Restore and enhance the water quality function of the mainstem creek corridor and tributaries. Improve the health of the Park's feature pond.
- Preserve the natural character of the reach.
- Pursue opportunities to create educational places and experiences for park users.

The primary channel reclamation improvements include a series of 9 drop structures to raise the incised active channel bottom approximately 4 to 6 feet to the pre-incised geometry that existed in the 1970s. The drop structures will be arranged to provide a stable channel slope of 0.22%. These drop structures will consist of 5 riffle drop structures, a sculpted concrete anchor drop structure, a sculpted concrete splitter drop structure, a sculpted concrete drop structure at a proposed trail crossing, and a terminal drop structure at the downstream end of the project. In addition, two secondary channels and isolated areas of bank protection are proposed to be incorporated into the design. Detailed descriptions of each type of improvement are provided in the following paragraphs. An overall layout of these improvements is presented on the site plan in Appendix B.

Riffle Drop Structures

The proposed riffle drop structures will be located along the active channel, covering a footprint that is approximately 100-feet in width by 60-feet in length. Each riffle will provide a drop height of 12 inches. The riffle drops will be constructed with "riffle rock", a mixture comprised of riprap, varying sizes of crushed rock, river cobbles, gravel, sand, and topsoil intended to replicate natural river-bed material. The riffle material keeps base flows on the surface and supports riparian vegetation, making it a good candidate for a "natural" grade control structure. The riffle rock is placed at a 5% slope down the face of the structure. The side slopes of the riffles will be buried with topsoil and revegetated. Native grasses and shrubs, willow stakes, and cottonwood poles will be planted along the banks of the riffle structures to further reinforce the stability of the rock installation and reclaim disturbed portions of the primary channel and overbank areas.

It is the intent of the riffle drop design to minimize disturbance to riparian vegetation and stabilize only the incised active channel, but do so in a manner that will raise the water table. This will maintain and enhance the existing vegetative stand beyond the riffle limits. The riffles will have a capacity of approximately 150 cfs before flow starts to spread beyond the limits of the void-filled riprap. The surrounding vegetation, in conjunction with wide, shallow flow conditions, will be relied on for erosion protection outside the riffle drop structure limits.

Anchor Drop Structure
A sculpted concrete anchor drop structure proposed immediately downstream of Broncos Parkway, will extend across the entire width of the primary channel to provide protection during larger storms. Sheet pile associated with this structure will span the full width of the Broncos Parkway bridge opening. The sheet pile will reinforce the overbanks and reduce bridge scour through the Broncos Parkway structure.

The anchor drop structure will be constructed downstream of Broncos Parkway, where a larger drop structure is warranted to protect the existing bridge crossing and overbanks. This structure will consist of a 2.5-foot drop height. At larger storm events, the structure will be designed to submerge such that there will be no hydraulic drop in water surface through the structure once the structure capacity is exceeded.

This location was determined to be an area visible to recreational users and as such, additional measures will be taken to focus on the aesthetic value of the drop structure. Sculpted concrete will be used to mimic natural rock outcroppings characteristic of the region. Also, a portion of the drop will contain a step-pool arrangement to satisfy fish passage requirements.

Splitter Drop Structure
A splitter drop structure will be constructed at the upstream end of a proposed secondary channel (secondary channels will be discussed later in this memorandum). This structure will provide grade control for both the primary channel and the secondary channel as well as provide a means of distributing flows between the two channels. A 15-foot deep sheet pile cutoff wall will extend across the two channels and adjacent overbanks to control the crest. Sculpted concrete structures will be constructed on the downstream side of the sheet pile for both the primary and secondary channels. The sculpted concrete drop structures will provide a drop height of 1.0 and 2.5 feet for the primary and secondary channels, respectively.

The crest of the secondary channel structure will be set approximately 1-foot above the primary channel crest to direct base flows and small storm flows through the primary channel prior to overtopping the secondary channel crest. However, notches will be carved into the secondary channel structure crest to allow a small portion of the base flow to be leaked into the secondary channel, assuming Cherry Creek base flows are present.

Trail Crossing Drop Structure
A drop structure will be incorporated into the upstream side of a proposed trail crossing that will provide access to the regional trail (the trail crossing is discussed later in this memorandum). Combining the drop structure and trail crossing structures is an ideal way to disturb as little as possible during construction and allow for a smaller structure footprint. Since this drop structure will be highly visible to recreational trail users, a sculpted concrete drop structure emulating a natural bedrock outcropping was chosen for its aesthetic qualities and its ability to blend well with the trail improvements. The sculpted concrete drop structure will have a 2.0-foot drop height and will contain a flow capacity that is equivalent to the capacity of the trail crossing culvert.

Terminal Drop Structure
A 3.5-foot high drop structure is required to transition the proposed raised channel bed to the existing incised channel at the downstream project limit. This drop structure is anticipated to be temporary due to a future channel stabilization project downstream that is anticipated to raise the downstream invert elevation and ultimately reduce the drop height of the terminal, or tie-in drop structure. The proposed terminal drop structure will consist of a sheet pile cutoff wall with a loose boulder rundown on the downstream side of the sheet pile. Riprap will be placed downstream of the boulders to help protect the structure from future down-cutting of the downstream channel. The sheet pile spans the entire width of the primary channel.

Secondary Channels
Two secondary channels will be incorporated into the Cherry Creek corridor and run parallel to the primary channel in the Cherry Creek overbanks. One secondary channel will be located immediately upstream of Broncos Parkway within the eastern overbank. This secondary channel, in combination with lowering the overall elevation of the eastern overbank under the Broncos Parkway bridge, will increase flood conveyance and mitigate the concentrated flow condition that currently exists at the west bridge abutment, as well as expand the riparian corridor. This secondary channel will be graded with a 0.22% longitudinal slope and will tie into grade control structures along the primary channel at the upstream and downstream ends.

The second secondary channel will be located along the Eco Park pond. This secondary channel will provide a flow path for Cherry Creek flows through the pond, increasing flood conveyance, expanding the riparian corridor, and improving circulation within the pond. This secondary channel will be graded with a 0.22% longitudinal slope and the pond will be reshaped. Flow will be diverted into the secondary channel at the splitter drop discussed earlier and a riffle drop structure will be located downstream of the pond to re-establish the pond water surface elevation and transition the secondary channel invert back to the primary channel. The proposed raised invert along the primary channel will also help to re-establish the former pond water surface elevation.

These secondary channels will also provide an opportunity to divert flows around improvement areas during construction.

Bank Protection
Eroded banks near residential properties and infrastructure will be stabilized. Other eroded banks in areas where infrastructure is not threatened and in areas where owners are not concerned with the possibility of additional erosion will be left alone. Bioengineering methods will be used when possible. All bank protection measures will incorporate different combinations of buried soil riprap, temporary erosion control blanket, willow stakes, willow fascines, and wetland seed.

TRIBUTARY CHANNEL IMPROVEMENTS

As mentioned previously, several sources contribute flow to Cherry Creek within the project reach. Improvements associated with these tributaries are described in the

following paragraphs. An overall layout of these improvements is presented on the site plan in Appendix B.

Happy Canyon Creek
To mitigate the headcutting that is currently being experienced at the Happy Canyon Creek confluence, it is proposed that a drop structure be constructed at this location. A drop structure height of 3.5 feet will be required to transition from the stable Happy Canyon Creek channel invert to the proposed raised active channel invert of Cherry Creek. The structure will be constructed of sculpted concrete to mimic natural rock outcroppings characteristic of the region.

West Tributary at Abandoned Happy Canyon Creek Confluence
Additional water quality will be provided within the abandoned Happy Canyon Creek confluence. Improvements include the construction of a berm along with a water quality outlet structure to capture and treat runoff from the adjacent development south of the Eco Park parking lot. The outlet structure will discharge into the Cherry Creek primary channel where flows will spread before entering the active channel.

West Tributary at Fremont Drive
The existing v-shaped channel will be widened and flattened creating a smooth transition into the Cherry Creek primary channel. Grading will be limited within the lower primary channel as a natural depression will be utilized to lengthen the flow path prior to entering the active channel. The wide, flat channel alignment will provide additional water quality through infiltration and wetland filtering and will offer improved aesthetics at this outfall.

East Tributary
As previously discussed, the existing outfall from this east tributary to Cherry Creek is a straight trapezoidal channel which is conveyed underneath the regional trail via a two foot by four foot box culvert. The proposed design includes widening and flattening the existing channel by meandering it through the Cherry Creek overbank area. The existing box culvert trail crossing will be maintained to convey flows under the Cherry Creek regional trail. The outlet of the culvert and downstream channel will be regraded and protected with riffle rock to stabilize the transition to the Cherry Creek active channel.

The intent of this improvement is to promote additional riparian vegetative growth within the overbank areas and increase infiltration and wetland filtering of storm runoff. The wide, flat realigned tributary channel will provide water quality benefits, diversify the overbank vegetation, and offer improved aesthetics to enhance the natural character of the corridor.

ACWWA Well Outfalls
Earthen settling basins are proposed to promote deposition of iron contained in the well discharge flows prior to entering the Cherry Creek primary channel. The basin outfalls will be designed to spread flows out to create a sheet flow condition through the primary channel. This will encourage infiltration and prevent erosion before entering the Cherry Creek active channel.

EDUCATIONAL AND RECREATIONAL IMPROVEMENTS

An exhibit that summarizes the educational and recreational aspects of this project is presented in Appendix C. A brief overview of these components is discussed in the following paragraphs.

Education

Many of the activity nodes presented in the preliminary plan contain areas designed for group gatherings. The council ring and amphitheater are rustic outdoor classrooms for environmental lectures, heritage craft demonstration and wildlife education. The children's exploratory garden creates an area for creative play and scientific observation of plants, gardening practices and team/group cooperative task completion. For small groups, willow bowers; a living, growing shade structure of small willow saplings create child sized structures for outdoor learning opportunities. Another item which supports the project's educational goals is signage. Outside of standard park wayfinding and directional signage, educational signage will convey the intent and function of the stream reclamation work, highlighting water quality and ecological features of the park for visiting school groups and the general public.

Trails

The park activity nodes are linked by 8' wide soft-surface trails. A large component of the internal trail system is a one mile loop which begins and ends at the adjacent elementary school. Along the loop, the trail user will experience a wide variety of plant associations from wetland areas to upland native grasslands and various ecological niches and wildlife habitat. All the internal trails connect to the Cherry Creek Regional Trail providing a site visitor with access to over 39 miles of regional area trails.

Trail Crossings

A low flow crossing is proposed across the Cherry Creek active channel to make a secondary trail connection to the regional trail. This crossing will consist of a 20-foot wide by 2.5-foot high concrete box culvert. The top-of-trail in the vicinity of the crossing will be situated in close proximity to the existing surrounding overbank elevation. This arrangement will reduce the amount of flow obstruction and allow overtopping flows to smoothly transition to the downstream channel. Also, sheet pile will be installed along the downstream face of the structure along the entire length of the primary channel. The sheet pile will add strength to the crossing and allow it to serve as a hard point during large storm events. A combination of riprap, clayey topsoil, temporary erosion control blanket, and plantings will be installed in the overbanks just downstream of trail crossing to help protect against erosion when overtopping flows occur.

An informal crossing is planned to make a secondary/dirt trail connection from the nearby school site to the Eco Park pond area. The crossing will be incorporated into the sculpted concrete splitter drop structure. A layout for this crossing has not yet been developed.

Lastly, a boardwalk crossing is planned to provide an ADA crossing of the secondary channel in the vicinity of the Cherry Creek Eco Park pond. This crossing will replace the existing at grade crusher fines trail that runs along the east side of the existing pond.

Park Amenities

The reclamation improvements have been designed to serve a dual role. As noted in this document, the primary role is the improvement of the area's water quality, the riparian ecology, bank stabilization and the overall watershed base flow; however, they also perform or support recreational activities. The features will be sculpted to form atheistically pleasing trail crossings and water access points that are focal points of an interconnected "naturalized" soft surface trail system. Activity nodes located along the trails, provide natural play opportunities, such as climbing, jumping, balancing, hopping, and digging. Loosely structured play area will be built out of logs, trees, boulders, gravel and sand immersing the site visitor in a naturalistic setting with active free play opportunities.

Due to the fact that the majority of the project area is located within the Cherry Creek floodway, any proposed fencing locations will need to be coordinated with SEMSWA. SEMSWA's floodplain regulations prohibit fences from being installed within the floodway to prevent obstruction of flood flows. Floodplain information is discussed in further detail later in this memorandum.

WATER QUALITY AND ECOLOGICAL BENEFITS

As discussed in the preceding sections, there is a strong water quality enhancement component associated with the proposed improvements. Stabilizing the creek and its tributaries will reduce the amount of sediment and attached phosphorus that is eroded and conveyed downstream. Raising the degraded invert and creating a shallow baseflow channel will re-establish a high water table that will help to maintain healthy, dense overbank vegetation along with incorporating wetland terraces. This will also encourage large runoff events to spread out in the vegetated overbanks, promoting infiltration and filtering of the runoff (preserving the "sponge effect"). Tributary improvements will create additional opportunities for runoff to be detained, settled, infiltrated, and filtered prior to entering the Cherry Creek channel.

An exhibit that summarizes the stream reclamation improvements and depicts the vegetative cover is presented in Appendix C.

FLOODPLAIN IMPACTS

A Flood Hazard Area Delineation (FHAD) study completed by URS was completed in May of 2003 for the *Cherry Creek Corridor from the Reservoir to Scott Road.* A Letter of Map Revision (LOMR) was issued by FEMA, which established the results of the FHAD study as the regulatory floodplain. The FHAD reports a 100-year peak discharge of 45,471 cfs at the upstream end (cross section 49) and 47,733 cfs at the downstream end of the project (cross section 35). At the time of this study, Broncos Parkway had not been constructed; however, the Broncos Parkway bridge deck and piers were incorporated into the study based on preliminary design information. Also, the pedestrian bridge crossing downstream of Broncos Parkway was not included in the FHAD study. Since the completion of the FHAD study additional developments within the study area have impacted the regulatory 100-year floodplain.

- A LOMR was prepared by Vision Land Consultants, Inc as a part of the Cornerstar Subdivision, case number 08-08-0536 P, which extended from downstream of Arapahoe Road (cross section 18) to just upstream of the Eco Park pond (cross section 39). This study also included updates to the floodplain associated with the development of The Landing at Cherry Creek and Coyote Ranch, which are both east bank developments. LOMR's were prepared for these developments; however, they were prepared based on FIS cross sections. This LOMR updated the FHAD study by incorporating these east bank developments.

- As a part of the DFIRM process, Icon Engineering provided additional updates to the effective floodplain for Cherry Creek within the study area. The analysis incorporated improvements associated with the Creek View at River Run development located east of Cherry Creek and north of Broncos Parkway. This study extended from cross section 38 to just downstream of Broncos Parkway (cross section 43). It should be noted that this analysis only modified east overbank geometry as a part of Creek View at River Run and did not account for improvements completed as a part of Broncos Parkway at cross section 43.

A figure showing the effective floodplain and floodway boundaries and cross section locations is presented in Appendix D along with a preliminary water surface comparison table.

Duplicate Effective Model

As part of this preliminary design evaluation, a duplicate effective model was prepared to create a continuous model that represents the regulatory floodplain. This model is a compilation of the FHAD study, Cornerstar Subdivision LOMR, and the DFIRM updates listed above. The Cornerstar Subdivision model was utilized from cross section 35 to cross section 38. The Icon DFIRM model was used from cross section 39 up to cross section 43. Cross section 44 through cross section 49 from the FHAD study encompasses the upstream limit of this analysis. This duplicate effective model yielded results that were within 0.10 feet for the 100-year water surface. The greatest discrepancy is at cross section 44 where there is a 0.07 foot rise. This rise is attributed to the fact that there is a rise at cross section 43 between the effective DFIRM analysis and the superseded FHAD study. The upstream limit of the DFIRM analysis is cross section 43 and the rise is propogated upstream, creating a rise at cross section 44, the downstream limit of the FHAD model.

A discrepancy was found in the effective model at cross section 38 as a part of the DFIRM model. Geometry from FHAD cross section 38 was utilized as a part of the DFIRM analysis as opposed to cross section 38 from the Cornerstar Subdivision. The Cornerstar Subdivision geometry for cross section 38 includes a detention pond facility and Red Hawk Ridge Elementary School. Therefore this analysis utilized Cornerstar Subdivision LOMR cross section 38.

Corrected Effective Model

A corrected effective model was generated to update the duplicate effective model with improved information. The following revisions were made:

- The cross sectional geometry was modified from cross section 35 to cross section 48 using the base mapping prepared for this project and portions of the LIDAR mapping. New geometry was spliced into the effective cross sections where topography was available.
- Four interpolated cross sections between cross sections 46 and cross section 48 were eliminated from the corrected effective model. These interpolated sections were included in the effective FHAD model and remain in the duplicate effective model.
- Modifications were made to the Broncos Parkway Bridge geometry based on provided construction plans and new topography.
- The pedestrian bridge deck and pier downstream of Broncos Parkway were added at cross section 40.1 in the existing conditions model as a lid based on survey information and field observation. Additional analysis will be required at this location based on a review of the construction plans as a part of final design.
- Two cross sections were added to account for proposed improvements associated with the low flow box culvert trail crossing and drop structure (cross sections 36.1 and 36.2).
- Ineffective flow areas were added at cross sections 45 and 46 to reflect contractions at Broncos Parkway.
- Ineffective flow stations were modified at cross sections 39, 43, and 44 based on current topography.

In comparing the geometry of the duplicate effective model and corrected effective model, some differences were identified. At each cross section, the channel inverts are consistently between one and three feet lower in the corrected effective model due to more accurate topography, smaller contour intervals, and channel degradation. While the duplicate effective model included the Broncos Parkway Bridge, the upstream and downstream cross sections (43 through 46) do not reflect the roadway embankments. These embankments were included in the corrected effective model. The regional trail and wall improvements underneath Broncos Parkway were also incorporated to the corrected effective model at cross sections 43 and 44. Cross sections 43, 44, 45, and 46 upstream of the DFIRM analysis do not incorporate fill being placed as a part of the Creek View at River Run development. At these locations the spliced in geometry does not cleanly transition into the effective model sections and therefore, additional topography may need to be obtained in these locations.

The 100-year water surface elevations produced by the corrected effective model are contained within the new topography; however, additional information will need to be obtained to complete a 500-year analysis. An unexplained fill on the right overbank of approximately three feet has been identified at cross section 36. This fill is located in undeveloped land at the northern limits of the Coyote Ranch development.

Rises in the 100-year water surface between the corrected and duplicate effective models appear to be minor in the downstream reaches of the study area; however, the addition of the pedestrian bridge deck and piers at cross section 40.1 generates a rise of 1.79 feet at cross section 41. The backwater propagates upstream creating a rise in subsequent upstream cross sections. The addition of ineffective flow areas and embankment grading at Broncos Parkway has also created a rise at the upstream cross sections with the greatest rise being 1.16 feet at cross section 47.

Post Project Model

A post project model was created by incorporating the proposed Eco Park improvements into the corrected effective model from cross section 36 to cross section 46. The following items were completed:

- To model the fill that is being placed within the low flow channel, fixed channel invert elevations have been added within the study area matching the anticipated elevation based on the stable slope of 0.22%.
- Proposed grading within overbank areas from upstream of Broncos Parkway to the pedestrian bridge, at split flow locations upstream of Broncos Parkway, at split flow locations at the Eco Park pond, and at the east tributary channel have been included into the post project channel geometry.
- The proposed 20'(S) x 2.5'(R) box culvert at the low flow trail crossing has been modeled at cross section 36.1 as a lid.

In comparing the corrected effective model and post project model, small rises have been identified in the 100-year event. The greatest increase, 0.31 feet, is at cross section 36.1. The overbank grading at the pedestrian bridge and Broncos Parkway has reduced the 100-year floodplain from the existing condition; however, the 100-year water surface is still higher than the effective 100-year water surface. Increases in the 100-year water surface between the post project model and corrected effective model at cross sections 47 and 48 are attributed to the six feet of fill being placed in the low flow channel at cross section 46. Further coordination will be required as a part of the upstream Parker Jordan Open Space Project to finalize the floodplain impacts at the upstream end of the project.

As a part of final design, further evaluation of the proposed improvements will be required to determine if the 100-year water surface can be reasonably mitigated to show a "no rise" condition between the corrected effective and post project models. If this cannot be achieved without compromising the design of the proposed improvements, then a Conditional Letter of Map Revision (CLOMR) will be required prior to constructing the improvements. It is anticipated that there will be a rise from the post project 100-year water surface to the effective 100-year water surface. This rise is due primarily to the incorporation of the pedestrian bridge and the Broncos Parkway embankment grading into the corrected effective and post project models. It is anticipated that any changes in the effective 100-year water surface will be contained within the public right-of-way and will not impact any additional structures.

PERMITTING

Due to the project's proximity and impacts to Cherry Creek, 404 Permitting through the US Army Corps of Engineers (USCOE) is required prior to constructing the proposed improvements. It is anticipated that this project will be permitted through an Individual Permit.

ERO Resources has been tasked with completing all environmental permitting for the proposed project during final design.

CONSTRUCTION COSTS

An engineer's opinion of probable construction costs has been completed and is presented in Appendix E. The preliminary design probable construction cost for all project improvements is $3,895,375. The costs were divided into four categories to provide stakeholders with additional funding information when establishing project budgets. These four categories are: Cherry Creek Stabilization, Tributary Stabilization, Water Quality, and Education.

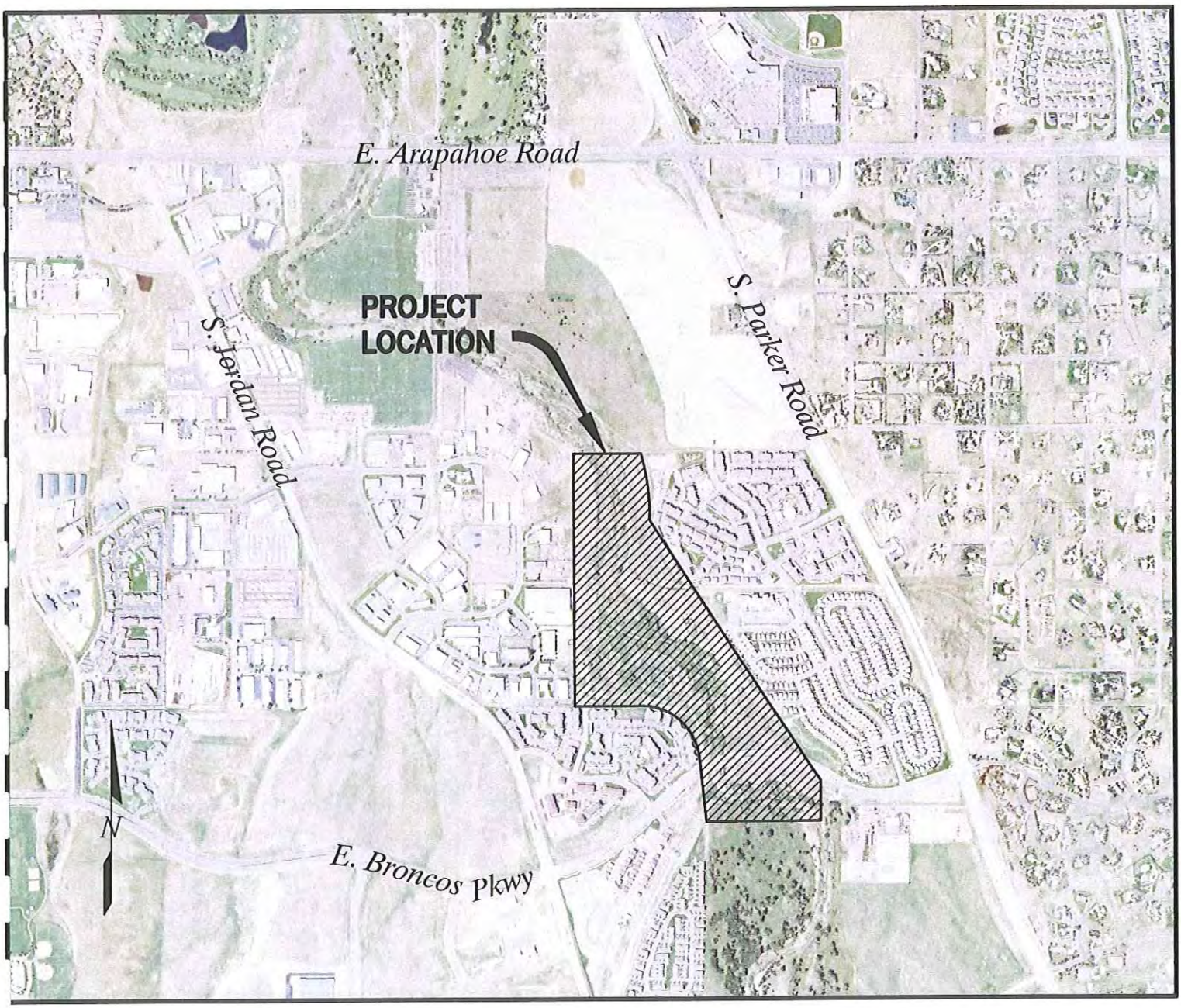
A portion of the project (mainly the riffle drop structures) contain low capacity, low disturbance improvements. These improvements contain less of a structural component than conventional improvements and rely on the surrounding vegetation to reinforce the stabilization measures. This design philosophy is effective in reducing project costs, but comes with added risk. Although the project improvements will be designed with large storm events in mind, they are more susceptible to damage than high capacity grade control structures consisting of long runs of sheet pile. As such, it should be recognized that some risk of damage and repair work will inherently exist with the proposed project improvements.

SUMMARY

The project improvements consist of installing a series of grade control structures, bank protection measures, and secondary channels to help restore and stabilize the Cherry Creek channel. The project will also involve improvements to a series of tributary channels as well as expanding educational and recreational opportunities. The Cherry Creek Corridor provides a number of ecological, educational, recreational, water quality, and wildlife benefits. All project improvements were designed to preserve and enhance these valuable benefits, while avoiding major areas of disturbance to existing riparian vegetation and minimizing impacts to the floodplain.

APPENDIX A

Vicinity Map and Existing Conditions Photos



VICINITY MAP

PHOTO 1 – HAPPY CANYON CREEK CONFLUENCE

PHOTO 2 – CHERRY CREEK BANK EROSION AT CONFLUENCE
WITH HAPPY CANYON CREEK

PHOTO 3 – CHERRY CREEK BANK EROSION UPSTREAM OF BRONCOS PARKWAY

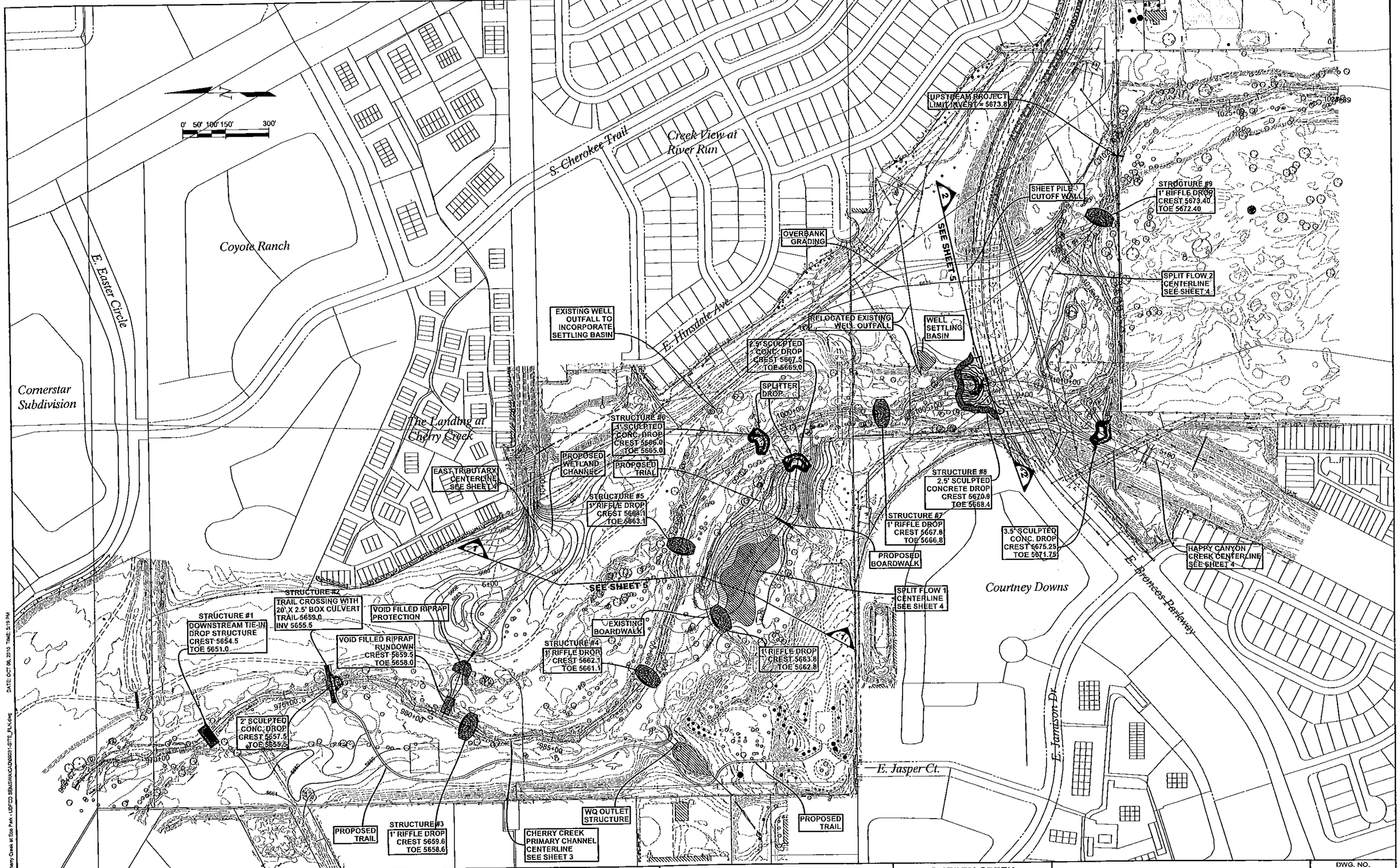
PHOTO 4 – CHERRY CREEK AT BRONCOS PARKWAY

PHOTO 5 – CHERRY CREEK OVERBANK AT BRONCOS PARKWAY

PHOTO 6-ECO PARK POND

APPENDIX B

Preliminary Drainage Design Site Plan



MULLER ENGINEERING CO., INC.
CONSULTING ENGINEERS
1803 GATE 4, SUITE 100
777 SOUTH WADSWORTH BLVD.
LAKEWOOD, COLORADO 80226
(303) 985-8979

PROJECT NO. 09-031.01

DESIGN JRS
DRAWN NJM
CHECK JPJ

SOUTHEAST METRO STORMWATER AUTHORITY

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

CHERRY CREEK IMPROVEMENTS AT ECO PARK

SITE PLAN

DWG. NO.

SHEET 2 OF 21

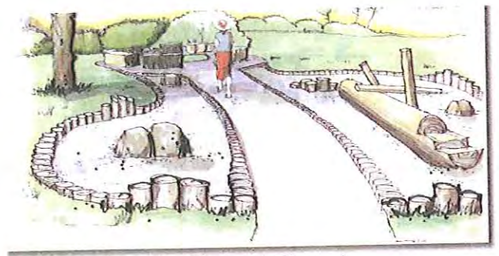
No.	DATE	REVISIONS	APPR.

DATE: OCT 06, 2010 TIME: 5:19 PM

NAME: P:\09-031.01 Cherry Creek at Eco Park - UDFCD SEMS\WA\CAD\09031-SITE_PLN.dwg

APPENDIX C

Valerian Exhibits



Concept Sketch - Natural Play at Existing Council Ring

Concept Sketch - Children's Exploratory Garden

Concept Sketch - Willow Bower

Concept Sketch - Water Access at Sculpted Drop

Cherry Creek Valley Ecological Park - Stream Reclamation and Amenities Improvements

Preliminary Master Plan - Enhanced Amenities Improvements

777 South Wadsworth Boulevard, Suite 4-100
Lakewood, Colorado 80226
Phone 303 988 4939
Fax 303 988 4969

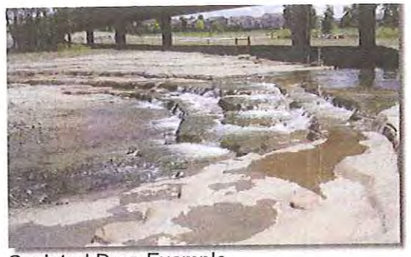
Cross Section 2 - Sculpted Drop at Broncos Bridge

See Cross Section Legend for for area descriptions

Cross Section Legend

A - Shortgrass
B - Midgrass
C - Tallgrass
D - Wetlands/Moist Meadow
E - Trail
F - Sculpted Drop Structure
G - Shrub Edge

Riffle Drop Structure



Sculpted Drop Example

Trail Crossing and Drop Structure

Secondary Channel

See Cross Section Legend for for area descriptions

Cross Section 1 - Cherry Creek and Pond

Cherry Creek Valley Ecological Park - Stream Reclamation and Amenities Improvements

Preliminary Master Plan - Stream Reclamation Improvements

September 8, 2010

777 South Wadsworth Boulevard Suite 4-100
Lakewood, Colorado 80226
Phone 303 988 4939
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MULLER

2734 West 28th Avenue Denver CO 80211
p 303 477 7202 f 303 247 9261

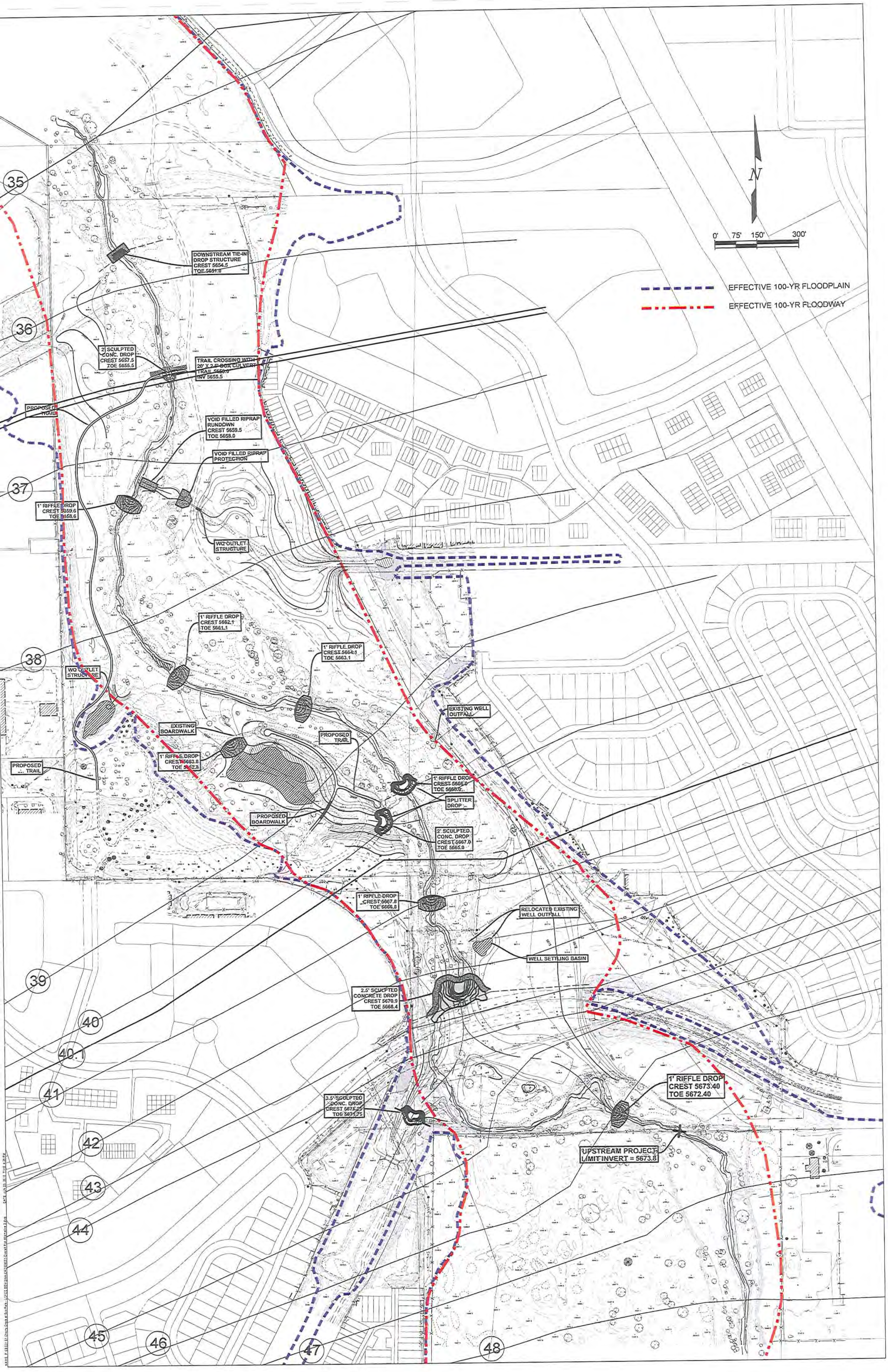
Landscape Architecture
Master Planning
Urban Design

North

Scale: 1" = 100'

APPENDIX D

Floodplain Information



EFFECTIVE 100-YR FLOODPLAIN
EFFECTIVE 100-YR FLOODWAY
0' 75' 150' 300'
N
DOWNSTREAM TIE-IN DROP STRUCTURE CREST 5654.5 TOE 5651.0
2' SCULPTED CONC. DROP CREST 5657.5 TOE 5655.5
TRAIL CROSSING WITH 20' X 2.5' BOX CULVERT INV 5655.5
PROPOSED TRAIL
VOID FILLED RIPRAP RUNDOWN CREST 5659.5 TOE 5658.0
VOID FILLED RIPRAP PROTECTION
WQ OUTLET STRUCTURE
1' RIFFLE DROP TOE 5658.6
1' RIFFLE DROP CREST 5662.1 TOE 5661.1
1' RIFFLE DROP CREST 5664.1 TOE 5663.1
WQ OUTLET STRUCTURE
EXISTING BOARDWALK
1' RIFFLE DROP CREST 5663.8
PROPOSED TRAIL
PROPOSED TRAIL
PROPOSED BOARDWALK
EXISTING WELL OUTFALL
1' RIFFLE DROP
SPLITTER DROP
2' SCULPTED CONC. DROP CREST 5667.0 TOE 5665.0
1' RIFFLE DROP CREST 5667.8 TOE 5666.8
RELOCATED EXISTING WELL OUTFALL
WELL SETTLING BASIN
2.5' SCULPTED CONCRETE DROP CREST 5670.9 TOE 5668.4
3.5' SCULPTED CONC. DROP
1' RIFFLE DROP CREST 5673.40 TOE 5672.40
UPSTREAM PROJECT LIMIT INVERT = 5673.8
35
36
37
38
39
40
40.1
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42
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48

CHERRY CREEK AT ECO PARK WATER SURFACE COMPARISON TABLE

	FHAD STATIONS		FIS INFO	URS FHAD*	Cornerstar LOMR**	River Run DFirm*	Duplicate Effective Model (1)	Existing Condition Model (4)	Post Project Model (11)	Model Comparison		
	Cross Section (FHAD)	Station (FHAD)	Cross Section (FIS)	100 YR WS (From Model) (NAVD)	100 YR WS (From Model) (NAVD)	100 YR WS (From Model) (NAVD)	100 YR WS (From Model) (NAVD)	100 YR WS (From Model) (NAVD)	100 YR WS (From Model) (NAVD)	11-1	11-4	4-1
Cornerstar LOMR	35	96762.38	P	5664.45	5664.72		5664.72	5664.67	5664.67	-0.05	0.00	-0.05
	36	97309.89	Q	5666.99	5666.65		5666.65	5666.53	5666.56	-0.09	0.03	-0.12
	36.1	97653.13	Low Flow Crossing					5668.67	5668.98		0.31	
	36.2	97673.14						5668.75	5669.05		0.30	
	37	97989.06	R	5670.02	5669.98		5669.98	5670.09	5670.15	0.17	0.06	0.11
	38	98604.21	S	5672.35	5672.31	5672.35	5672.31	5672.38	5672.47	0.16	0.09	0.07
	39	99597.60	T	5675.72	5675.69	5675.66	5675.63	5675.78	5675.64	0.01	-0.14	0.15
	40	99902.58		5677.09		5676.71	5676.70	5677.00	5676.60	-0.10	-0.40	0.30
River Run Dfirm	40.1	100093.24	Pedestrian Bridge					5681.04	5679.98		-1.06	
	41	100259.70	U	5681.67		5680.17	5680.17	5681.96	5682.09	1.92	0.13	1.79
	42	100528.60	V	5683.01		5683.17	5683.17	5683.52	5683.57	0.40	0.05	0.35
	43	100739.80		5683.27		5683.42	5683.42	5684.46	5683.83	0.41	-0.63	1.04
Cherry Creek FHAD	43.1	100804.90	Bridge (Broncos Parkway)									
	44	100869.00		5684.70		5684.77	5684.77	5684.98	5684.27	-0.50	-0.71	0.21
	45	101249.70		5685.90		5685.94	5685.94	5685.84	5684.78	-1.16	-1.06	-0.10
	46	101845.80	W	5687.08		5687.10	5687.10	5687.76	5687.06	-0.04	-0.70	0.66
	47	102419.80	X	5689.55			5689.55	5690.71	5690.91	1.36	0.20	1.16
	48	102810.90		5691.25			5691.25	5691.59	5691.71	0.46	0.12	0.34
	49	103582.60	Y	5694.14			5694.14	5694.10	5694.10	-0.04	0.00	-0.04

APPENDIX E

Construction Cost Information

PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COSTS

CHERRY CREEK AT ECO PARK

October 15, 2010

Cost Estimate						Cost Breakdown				Percentage Breakdown				
BID ITEM NO.	DESCRIPTION OF BID ITEM	QUANTITY	PAY UNIT	UNIT PRICE	TOTAL COST OF BID ITEM	Cherry Ck Channel Stabilization	Tributary Channel Stabilization	Water Quality	Education	% Cherry Ck Channel Stabilization	% Tributary Channel Stabilization	% Water Quality	% Education	% Total
1	Mobilization	1	LS	$50,000.00	$50,000.00	$17,500.00	$12,500.00	$15,000.00	$5,000.00	35%	25%	30%	10%	100%
2	Water Control and Dewatering	1	LS	$50,000.00	$50,000.00	$17,500.00	$12,500.00	$15,000.00	$5,000.00	35%	25%	30%	10%	100%
3	Traffic / Pedestrian Control	1	LS	$5,000.00	$5,000.00	$1,750.00	$1,250.00	$1,250.00	$750.00	35%	25%	25%	15%	100%
4	Clearing and Grubbing	1	LS	$30,000.00	$30,000.00	$18,000.00	$4,500.00	$7,500.00	$0.00	60%	15%	25%	0%	100%
5	Topsoil Removal, Stockpiling, & Replacement	25,000	CY	$5.00	$125,000.00	$50,000.00	$37,500.00	$31,250.00	$6,250.00	40%	30%	25%	5%	100%
6	Earthwork (cut)	55,000	CY	$10.00	$550,000.00	$220,000.00	$165,000.00	$137,500.00	$27,500.00	40%	30%	25%	5%	100%
7	Vehicle Tracking Control	2	EA	$2,500.00	$5,000.00	$2,000.00	$1,250.00	$1,250.00	$500.00	40%	25%	25%	10%	100%
8	Rock Check Dam	3	EA	$2,500.00	$7,500.00	$3,000.00	$1,875.00	$1,875.00	$750.00	40%	25%	25%	10%	100%
9	Silt Fence	2,000	LF	$2.00	$4,000.00	$1,600.00	$1,000.00	$1,000.00	$400.00	40%	25%	25%	10%	100%
10	Construction Fence	20,000	LF	$2.00	$40,000.00	$16,000.00	$10,000.00	$10,000.00	$4,000.00	40%	25%	25%	10%	100%
11	Concrete Washout Area	2	LS	$3,000.00	$6,000.00	$2,400.00	$1,500.00	$1,500.00	$600.00	40%	25%	25%	10%	100%
12	Muck Excavation	400	CY	$40.00	$16,000.00	$6,400.00	$4,800.00	$4,800.00	$0.00	40%	30%	30%	0%	100%
13	1' Riffle Drop Structure	5	EA	$32,000.00	$160,000.00	$112,000.00	$0.00	$48,000.00	$0.00	70%	0%	30%	0%	100%
14	Splitter Drop - Main Channel with Informal Crossing (less sheet pile)	1	EA	$90,000.00	$90,000.00	$45,000.00	$0.00	$36,000.00	$9,000.00	50%	0%	40%	10%	100%
15	Splitter Drop - Secondary Channel (less sheet pile)	1	EA	$85,000.00	$85,000.00	$59,500.00	$0.00	$25,500.00	$0.00	70%	0%	30%	0%	100%
16	Splitter Drop - Steel Sheet Pile Cutoff Wall	5,700	SF	$30.00	$171,000.00	$119,700.00	$0.00	$51,300.00	$0.00	70%	0%	30%	0%	100%
17	4-ft Sculpted Concrete Drop Structure (Happy Canyon Ck.)	1	EA	$130,000.00	$130,000.00	$0.00	$97,500.00	$32,500.00	$0.00	0%	75%	25%	0%	100%
18	2-ft Sculpted Concrete Drop Structure (large drop at Broncos Parkway bridge at confluence with Happy Canyon Ck.)	1	EA	$300,000.00	$300,000.00	$210,000.00	$0.00	$90,000.00	$0.00	70%	0%	30%	0%	100%
19	Sheet Pile at Broncos Parkway Bridge	9,750	SF	$30.00	$292,500.00	$263,250.00	$0.00	$29,250.00	$0.00	90%	0%	10%	0%	100%
20	Trail Crossing - Box Culvert (Structural Concrete & Sheet Pile)	1	LS	$81,000.00	$81,000.00	$24,300.00	$0.00	$24,300.00	$32,400.00	30%	0%	30%	40%	100%
21	Trail Crossing - Trail Reinforced Concrete	90	SY	$45.00	$4,050.00	$405.00	$0.00	$1,215.00	$2,430.00	10%	0%	30%	60%	100%
22	Trail Crossing - Sculpted Concrete Drop	1	LS	$25,000.00	$25,000.00	$17,500.00	$0.00	$7,500.00	$0.00	70%	0%	30%	0%	100%
23	Tie-In Drop Structure	1	LS	$81,000.00	$81,000.00	$56,700.00	$0.00	$24,300.00	$0.00	70%	0%	30%	0%	100%
24	Water Quality Outlet Structure	2	EA	$15,000.00	$30,000.00	$0.00	$15,000.00	$15,000.00	$0.00	0%	50%	50%	0%	100%
25	24-Inch Reinforced Concrete Pipe	50	LF	$65.00	$3,250.00	$0.00	$1,625.00	$1,625.00	$0.00	0%	50%	50%	0%	100%
26	24-Inch Reinforced Concrete Pipe FES and Outlet Protection	1	LS	$5,000.00	$5,000.00	$0.00	$2,500.00	$2,500.00	$0.00	0%	50%	50%	0%	100%
27	Well Outfall Protection	1	LS	$50,000.00	$50,000.00	$0.00	$0.00	$50,000.00	$0.00	0%	0%	100%	0%	100%
28	6' Bench - Recycled Content	7	EA	$1,200.00	$8,400.00	$0.00	$0.00	$0.00	$8,400.00	0%	0%	0%	100%	100%
29	6' ADA Accessible Picnic Table - Recycled Content	5	EA	$2,500.00	$12,500.00	$0.00	$0.00	$0.00	$12,500.00	0%	0%	0%	100%	100%
30	Trash Receptacle - Recycled Content	5	EA	$1,200.00	$6,000.00	$0.00	$0.00	$0.00	$6,000.00	0%	0%	0%	100%	100%
31	Bike Rack - Recycled Content	1	EA	$900.00	$900.00	$0.00	$0.00	$0.00	$900.00	0%	0%	0%	100%	100%
32	Pet Waste Station	2	EA	$1,000.00	$2,000.00	$0.00	$0.00	$1,000.00	$1,000.00	0%	0%	50%	50%	100%
33	Existing CCRT (at Broncos Parkway) Remove and Dispose	9,700	SF	$1.50	$14,550.00	$0.00	$7,275.00	$4,365.00	$2,910.00	0%	50%	30%	20%	100%
34	Proposed CCRT (at Broncos Pkwy, Replace, 10' width, 6" depth)	9,000	SF	$4.50	$40,500.00	$0.00	$20,250.00	$12,150.00	$8,100.00	0%	50%	30%	20%	100%
35	Secondary Concrete Path (8' width, 6" depth)	12,800	SF	$4.50	$57,600.00	$0.00	$0.00	$17,280.00	$40,320.00	0%	0%	30%	70%	100%

Cost Estimate						Cost Breakdown				Percentage Breakdown				
BID ITEM NO.	DESCRIPTION OF BID ITEM	QUANTITY	PAY UNIT	UNIT PRICE	TOTAL COST OF BID ITEM	Cherry Ck Channel Stabilization	Tributary Channel Stabilization	Water Quality	Education	% Cherry Ck Channel Stabilization	% Tributary Channel Stabilization	% Water Quality	% Education	% Total
36	Secondary Crusher Fines Path (6' width, 6" depth)	9,600	SF	$3.00	$28,800.00	$0.00	$0.00	$8,640.00	$20,160.00	0%	0%	30%	70%	100%
37	Secondary Crusher Fines Path (Adjacent to Regional)	27,600	SF	$3.00	$82,800.00	$0.00	$0.00	$24,840.00	$57,960.00	0%	0%	30%	70%	100%
38	Boardwalk	1	LS	$75,000.00	$75,000.00	$0.00	$37,500.00	$22,500.00	$15,000.00	0%	50%	30%	20%	100%
39	Educational Signage	8	EA	$2,000.00	$16,000.00	$0.00	$0.00	$4,800.00	$11,200.00	0%	0%	30%	70%	100%
40	Basic Nature Play Area with Educational Components	5	EA	$20,000.00	$100,000.00	$0.00	$0.00	$30,000.00	$70,000.00	0%	0%	30%	70%	100%
41	Enhanced Nature Play Area with Educational Components	3	EA	$50,000.00	$150,000.00	$0.00	$0.00	$45,000.00	$105,000.00	0%	0%	30%	70%	100%
42	24" Waterline Relocation	600	LF	$110.00	$66,000.00	$39,600.00	$0.00	$26,400.00	$0.00	60%	0%	40%	0%	100%
43	16" Irrigation Line Relocation	600	LF	$80.00	$48,000.00	$28,800.00	$0.00	$19,200.00	$0.00	60%	0%	40%	0%	100%
44	12" Irrigation Line Relocation	600	LF	$55.00	$33,000.00	$19,800.00	$0.00	$13,200.00	$0.00	60%	0%	40%	0%	100%
45	Type H Void Filled Riprap Rundown	200	CY	$70.00	$14,000.00	$0.00	$7,000.00	$7,000.00	$0.00	0%	50%	50%	0%	100%
46	Type H Void Filled Riprap Outlet Protection	180	CY	$70.00	$12,600.00	$0.00	$6,300.00	$6,300.00	$0.00	0%	50%	50%	0%	100%
47	Bank Protection No. 1 (riprap and blanket)	850	LF	$90.00	$76,500.00	$34,425.00	$22,950.00	$19,125.00	$0.00	45%	30%	25%	0%	100%
48	Coir Mat (not including Bank Protection No. 1)	15,000	SY	$8.00	$120,000.00	$54,000.00	$36,000.00	$30,000.00	$0.00	45%	30%	25%	0%	100%
49	Project Sign	2	EA	$600.00	$1,200.00	$300.00	$300.00	$300.00	$300.00	25%	25%	25%	25%	100%
50	Construction Survey	1	LS	$25,000.00	$25,000.00	$8,750.00	$6,250.00	$6,250.00	$3,750.00	35%	25%	25%	15%	100%
51	Upland/Riparian Seed and Mulch	27	AC	$2,000.00	$54,000.00	$21,600.00	$16,200.00	$16,200.00	$0.00	40%	30%	30%	0%	100%
52	Wetland Seed and Mulch	7	AC	$2,800.00	$19,600.00	$7,840.00	$5,880.00	$5,880.00	$0.00	40%	30%	30%	0%	100%
53	Wetland Plantings (willows, grass plugs, cottonwood poles)	1	LS	$50,000.00	$50,000.00	$20,000.00	$15,000.00	$15,000.00	$0.00	40%	30%	30%	0%	100%
54	Tree and Shrub Plantings	1	LS	$30,000.00	$30,000.00	$12,000.00	$9,000.00	$9,000.00	$0.00	40%	30%	30%	0%	100%
	SUBTOTAL					$3,541,250.00	$1,511,620.00	$560,205.00	$1,011,345.00	$458,080.00				
	CONTINGENCY (10%)					$354,125.00	$151,162.00	$56,020.50	$101,134.50	$45,808.00				
	TOTAL					**$3,895,375.00**	**$1,662,782.00**	**$616,225.50**	**$1,112,479.50**	**$503,888.00**	**43%**	**16%**	**29%**	**13%**	**100%**

Notes:

1. Cost estimate accounts for some exporting of excess material.
2. Proposed 6' wide crusher fines path adjacent to CCRT, from Broncos Pkwy Trailhead to northern Eco Park boundary.