South Platte River Restoration Design and Demonstration Project Final Report (April – June 2013)

Initiated and Implemented By:

Urban Drainage and Flood Control District
South Suburban Parks and Recreation
City of Littleton
Denver and Cutthroat Chapters of Trout Unlimited
Ecological Resource Consultants, Inc
Naranjo Civil

April 3, 2015

Prepared By:
Ecological Resource Consultants, Inc

Table of Contents

1.0 Project Summary

The 2013 South Platte Park (SPP) South Platte River Restoration Design and Demonstration Project was a river enhancement project completed by Urban Drainage and Flood Control District (UDFCD), South Suburban Parks and Recreation (SSPR), City of Littleton, Denver and Cutthroat Chapters of Trout Unlimited, Colorado Parks and Wildlife, the Colorado Water Conservation Board, and the U.S. Army Corps of Engineers. The goal of the plan was to improve aquatic habitat, river health and water quality by creating a unique unchannelized section of river with healthy aquatic and riparian systems connected to natural flood terraces. This included a design for river enhancement for a 2.5 mile stretch of the South Platte River within SPP and three demonstration projects. The demonstration projects included:

1. Instream Habitat and Bank Stabilization: 1,300 linear feet of instream improvements including two riffle-pool-glide sequences with constructed point bar, streamside riparian vegetation and bank stabilization

2. Stream-Lake Connection and Wetland Associations: approximately 4,000 square feet of constructed wetland in Cooley Lake and 3,000 square feet of constructed wetland in Redtail Lake. The work in Redtail Lake also included an improved stream-lake interface for fish refugia and wetland associations for stream-lake complex

3. Bank Stabilization and Flood terracing: 1,270 linear feet off bank stabilization of actively eroding cut banks

The detailed design and permitting effort began in 2011. The permits that obtained included:

1. U.S. Army Corps of Engineers 404 Permit
2. U.S. Army Corps of Engineers Floodplain Permit
3. City of Littleton Floodplain Permit
4. State of Colorado Construction Stormwater Permit

Funding came from Urban Drainage and Flood Control District, South Suburban Parks and Recreation, the City of Littleton, and Colorado Watershed Conservation Board ($46,118 WRSA Grant).

In-stream work on the demonstration projects began in April 2013 and was completed by June 2013. Because the work was a design-build project, minor changes were implemented during construction. As an example, Type A bank stabilization near Redtail Lake was originally set for 600 linear feet. It was increased to 720 linear feet after noticing additional bank erosion.

During the summer of 2013, revegetation efforts were implemented to further stabilize the streambanks and improve riparian habitat. The demonstration projects improved the riparian and upland habitat by increasing species diversity, willow and riparian vegetation cover as well as reduced sediment loading by stabilizing the streambanks, and enhanced the fishery.

2.0 Background

The project focused on the portion of the 2.5 miles of South Platte River that runs through South Platte Park. The park is an 878-acre parcel of land owned by the City of Littleton, Colorado and managed by South Suburban Parks and Recreation. A site map is provided in **Figure 2.1**.

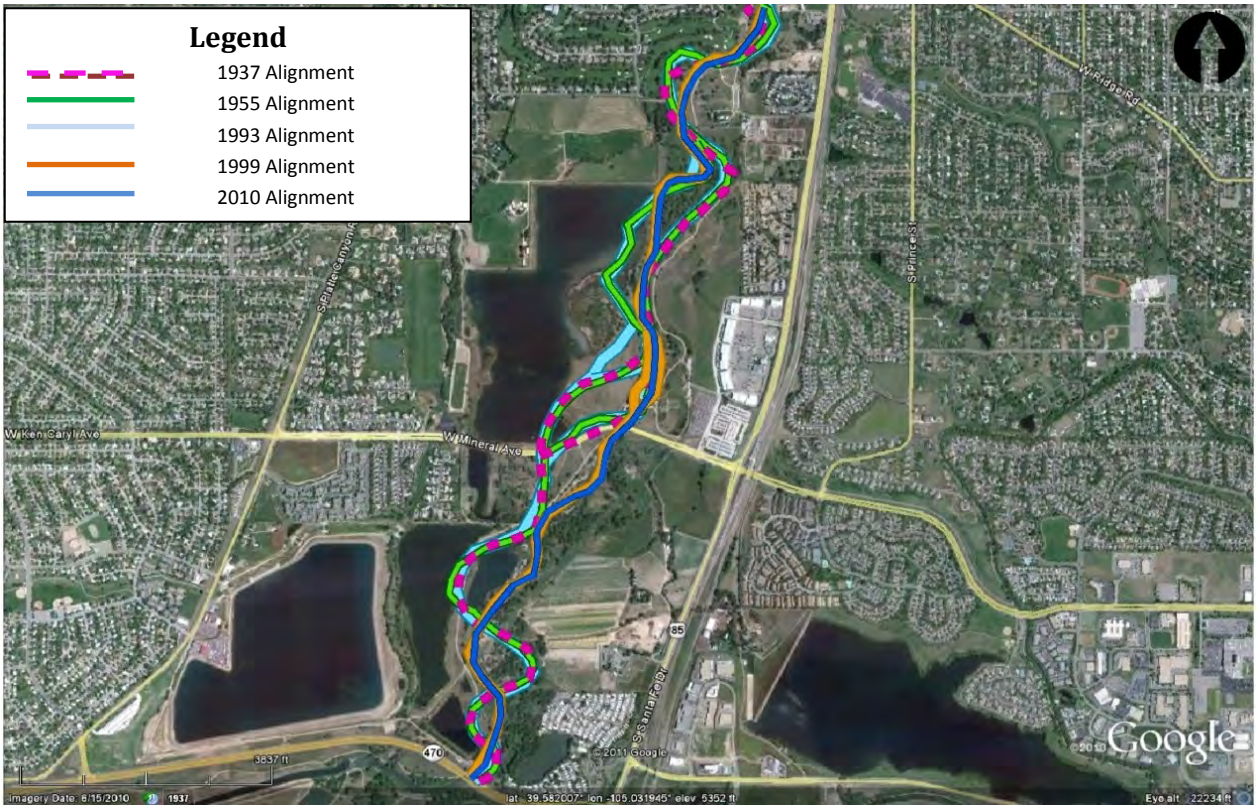
Figure 2.1. South Platte Park Site Map

The project area has been significantly impacted by the construction of the Chatfield Dam, past land use practices and water usage. After a significant flood in 1965, the US Corps of Engineers decided to construct Chatfield Dam and channelize much of the South Platte River through the Denver metropolitan area for the purpose of flood control. Flows in the South Platte River through the project area are controlled primarily by release from Chatfield Reservoir and are significantly reduced from natural, pre-dam flow conditions. During low flow periods which persist below the dam, limited flow is spread out over the wide channel resulting in low flow conditions. These conditions are not conducive to aquatic habitat and reduced peak flows are not in balance with the channel size.

In addition to peak flood events, operations of the reservoir as both a flood control facility and for water supply have altered the historic flow hydrograph and effectively cut off the natural sediment inflow to the project area. As a result, the sediment starved stream began downcutting. To arrest the active downcutting, grade control structures were constructed previously through the project area. These grade control structures altered the profile of the channel by converting the stream from a natural bend/pool morphology to a system where a majority of the elevation is lost at distinct vertical drops. This change resulted in the loss of natural habitat variety and the drop structures create migration barriers to aquatic life.

While the park is intended to be a natural floodplain park, historical land use practices within what is now SPP have also had a significant impact on the stream. Historic aerial photos show the river to be a meandering stream that was free to migrate laterally across the valley. After formation of SPP in 1974, formal development was prohibited in the park. However past gravel operations had a significant effect on the stream and riparian corridor. From the 1930s to its current conditions, channel encroachment effectively reduced the stream sinuosity, as shown in **Figure 2.2**. The figure illustrates the alignment of the South Platte River through South Platte Park at different points in time from 1937 to 2010. The straightened channel has lost characteristics of a natural stream, impacting aquatic habitat and the adjacent riparian zone.

Figure 2.2. South Platte River Channel Alignment (1937-2010)



The combined impacts of the altered flow and sediment regime along with past channel encroachment have resulted in a stream system that is no longer functioning naturally.

On December 22, 2010 an agreement was signed by the project partners to begin planning for the river enhancement. Ecological Resource Consultants, Inc (ERC) was retained by UDFCD to prepare the design drawings and supervise a design-build approach to the demonstration projects.

Preliminary design work included a review previous studies and an assessment of existing hydrology, geomorphology and aquatic and riparian habitat. Based on initial assessments, detailed grain-analysis and flow modeling was conducted as a precursor to detailed design. The results addressed bank erosion at key locations and informed the design of river features such as riffle-pool sequences, bank stabilization, and riparian planting zones.

The enhancement plan for the river and adjacent areas was completed in 2012. To construct the project, UDFCD selected Naranjo Civil as a design-build contractor. Construction began on April 1, 2013 and was complete by June 6, 2013. Revegetation efforts began during construction and were completed by mid-summer of 2013.

3.0 Project Goals

The intent of the project was to improve the ecological health of the stream and riparian system by developing a riverine system that mimics a more natural condition taking into account current flow conditions, land constraints and existing infrastructure.

The restoration plan used a holistic approach to rehabilitate the intended natural function of the stream and adjacent riparian areas while maintaining the flood control characteristics of the property. The main goals of the enhancement design included:

1. Adjust the channel profile through the construction of riffle-pool-glide sequences to restore the natural balance that typically exists between flows and channel geometry

2. Narrow the stream to an appropriate bankfull width of 40-60 feet by creating vegetated constructed point bars in order to increase flow depth and improve aquatic habitat

3. Stabilize eroding banks by installing soil-filled riprap and native riparian vegetation

4. Increase riparian habitat by replicating the natural characteristics of typical local riparian corridors including the re-establishment of a regularly flooded willow dominated midstory and herbaceous understory

5. Increase biodiversity through shoreline enhancement along Redtail and Cooley Lake by creating more natural landforms, near water planting shelves and a gentler, irregular transition side slope

4.0 Project Approach and Implementation

The project team developed an Enhancement Plan to identify key project components and design elements that would improve the natural and ecological condition of the stream system while helping to offset past decades of impacts. The ideas and designs identified in the plan were intended to provide a "roadmap" that could be followed as interest and funding allowed improvements to be implemented. Phase I of the Plan included the design and demonstration projects covered by the CWCB WSRA Grant. Phases II and III will include the remaining sections of South Platte River in SPP.

A natural-based restoration approach was taken for proposed improvements whenever possible. The guiding principle of the natural restoration approach is that an enhanced stream system should mimic a natural channel in appearance and function. Recreating the natural form and function within the stream system restores the previously lost natural balance. The plan was approached with a design that will allow the stream to maintain its basic form without significant aggradation or degradation. This approach will allow the restored resources to function as naturally as possible given the modern day physical constraints of the site.

5.0 Budget

Given the high cost of the overall plan it was anticipated that the Enhancement Plan would not be undertaken all at once but rather implemented in phases as funding became available. The final budget reflecting all work performed on this project as part of Phase I of the Enhancement Plan (including CWCB WRSA Grant funds) is presented in **Table 5.1.**

Table 5.1. Final Budget for Project

Item	Cost
In-stream Improvements	$309,936
Bank Stabilization	$67,602
Revegetation	$86,347
Miscellaneous	$172,613
TOTAL	**$636,498**

Miscellaneous costs include construction BMPs, water control, design, permitting and construction management. It is worth noting that diversions and water control account for a significant portion of the overall cost of the project. This was necessary to implement the enhancement strategies using means that minimized downstream turbidity.

6.0 Construction Approach and Implementation

The project was implemented as a design-build project by ERC and Naranjo Civil. ERC produced design drawings and provided construction oversight in the field to assist Naranjo as they constructed river features and graded the channel. The revegetation efforts were also developed by ERC and implemented by UDFCD with their subcontractor Arrowhead Landscaping.

Several of the key techniques used in the design and construction are described below.

The project incorporated the fundamental principles of fluvial morphology and aquatic biology. ERC conducted a detailed technical evaluation as part of design development. This evaluation included flow analysis, sediment transport modeling and ecological field study.

The proposed channel was designed to function at a wide range of flows, be stable at peak flow rates and maintain flood conveyance for the jurisdictional flood event. A flow frequency analysis determined three flow values that guided the design process: low flow, bankfull flow and the regulatory 100-year flow. The low flow value was used to ensure sufficient water depth for fish to migrate through the constructed riffles the majority of time. A low flow value of 20 cfs was selected as that is the average daily median flow value from September through March. Bankfull flow occurs about once every 1.5 years is the flow that is generally responsible for the morphology of a channel. Bankfull flow, estimated as 650 cfs for the project area, was used to determine channel widths and elevations for riparian terraces and bank stabilization. Using the bankfull stage to set design elevations allows water to occasionally flow out of the designed channel and onto riparian terraces. This mimics the flow processes of a natural stream. Other design considerations, such as channel stability, depend on peak design flows while maintenance of the channel profile is dependent on sediment transport. The regulatory 100-year flood flow was used to evaluate potential impacts on the floodplain and obtain floodplain permits.

A sediment transport model was generated and run in conjunction with the hydraulic model to evaluate material transport through the project reach. This model was used to define the channel maintenance flow and determine the flow rate and corresponding frequency at which sediment of different sizes is transported. This information was used to ensure that the appropriate size riprap was used in channel improvements and that it would remain stable over time.

ERC used the hydraulic modeling software HEC-RAS, version 4.1, a one dimensional computer model developed by the Army Corps of Engineers, to calculate water surface elevations, energy grade elevations and other hydraulic parameters produced by the design flows. Design drawings were produced in AutoCAD based on the results of ERC's technical analysis. Naranjo Civil provided initial surveying, ensured stormwater and erosion control compliance and coordinated directly with Park personnel for mobilization and staging.

Construction progressed simultaneously at two separate locations: downstream, where the riffle-pool-glide sequences were built, and upstream, where Type A bank stabilization and Redtail Lake wetland

work occurred. This approached allowed the majority of work to be completed prior to the seasonal increase in river flows.

Construction of the riffle-pool-glide sequences generally progressed from upstream to downstream except where river access required the opposite. Instream grading and rock placement was completed with a large tracked excavator. Work took place in dry areas while the river was diverted into natural side channels or divided using sheet piling. Approximately 5,200 cubic yards of native material from the existing channel was repositioned in the floodplain to help achieve a stable longitudinal profile and cross section and build instream habitat features. Approximately 2,540 tons of riprap was imported and placed within the main channel to form the two riffle-pool sequences. Another 3,400 tons of riprap was used to create two riparian terraces. For bank stabilization, approximately 650 tons of soil-filled riprap was placed along 540 linear feet of eroding bank near the downstream end of the project. Bank armoring in this section consisted of 9-inch (median diameter) soil-filled riprap placed along the bank after the removal of unstable soil. Planting benches were prepared at the bankfull crest above the riprap for native grass and shrub development. The need for bank protection along this section was identified during construction and the flexibility of the design-build process allowed the work to be completed with no delays or cost overruns.

Riffle-pool-glide sequences were constructed by excavating native material to design elevations then placing riprap as channel armoring. Twelve-inch riprap was placed on side slopes and 9-inch riprap was placed on the channel invert. At the downstream end of the riffle, at the headin to the pool, 18-inch riprap was used to account for the increased velocity on steeper slopes. Pools were excavated about 2.5 feet below the bottom of the riffle. The higher flow velocities of the riffle sections provide the energy required to continually scour the pools and maintain quality pool habitat. Glides were constructed downstream of pools by grading the channel invert with a mild adverse slope to the next riffle. Glides have a well-defined thalweg that contain flow to a defined channel during low flow periods. Because the top of the downstream riffle acts as grade control, the flow in the upstream glide remains slower and deeper. Habitat boulders were placed in the deepest sections of glides and pools and also on terraces to provide aquatic habitat, diversify flows and create aesthetic appeal. The habitat boulders were recycled from existing drop structures that were removed.

Two point bars were constructed in the downstream section of the project. The bars were built on inside bends along pools and glides. The point bars increase channel sinuosity and reduce channel width. To maintain the design width, point bar slopes were built at 8H:1V with soil riprap to the elevation of bankfull flow. Above bankfull elevation, the bars are constructed with native soil and include riprap veins to reduce the scour potential of high flows. Riprap veins were built as 3-foot deep by 10-foot wide pits filled with 9-inch riprap. They extend perpendicular to the direction of flow from the top of bankfull to the outside edge of the point bar.

Some of the spoils excavated during the creation of the riffle-pool-glide sequences were hauled to the northeast corner of Cooley Lake and placed just above the permanent outlet elevation to create a planting bench. South Platte Park facilitated the creation of this additional feature by identifying an area of shore erosion where fill could be placed. This opportunity helped the park preserve the habitat in

and around Cooley Lake, developed a unique natural habitat pocket and also saved the project the cost of hauling and disposing of excess material.

Upstream, near Redtail Lake, 720 linear feet of Type A bank stabilization was constructed. Type A bank stabilization was constructed from 9-inch soil-filled riprap and included a reinforced toe and a 5-foot wide planting bench at bankfull elevation for native grass and shrubs. Type A bank stabilization was designed to maintain the upper portion of the eroding bank, at the Park's request, for wildlife habitat (cut banks are used as nesting areas by bird species such as the kingfisher).

Finally, fill material excavated from the existing channel was placed in Redtail Lake to create approximately 3,000 square feet of wetland. The fill material came from spoils excavated from both upstream and downstream work areas. Spoils were hauled by truck and placed using an excavator. A riprap grade control structure was placed at the entrance to Redtail Lake to establish a specific lake minimum outlet elevation.

Construction was substantially complete by the end of May 2013 - just before the seasonal period of high flow releases from Chatfield Dam. Punch-list items were generated during a final walk-through inspection with project members. The punch-list items were completed during the next few weeks as Naranjo demobilized. During and following construction operations, landscape crews completed reclamation efforts with the installation of seed mixes, erosion control blanket and nursery stock plantings.

7.0 Revegetation Effort

There were four areas targeted for revegetation: Redtail Lake wetland, bank stabilization, Cooley Lake wetland, and constructed point bars. In addition, all disturbed areas including staging areas, access roads and river access ramps were reclaimed following completion of construction.

In Redtail Lake, 15,300 nursery stock wetland plugs were planted along a newly constructed shoreline wetland area. The plugs were protected from geese and other wildlife using chicken wire and wooden stakes. Wetland plugs where installed at various shallow water depths.

Along bank stabilizations, on site harvested willow stakes were installed one per liner foot for a total of 550 downstream and 720 upstream. On the Type A planting bench, sixty # 5 shrubs were planted about 1 every 10 feet. Fifty # 5 shrubs were planted on the planting benches above the downstream bank protection.

In Cooley Lake, enough spoils were placed to create a small planting bench. Thirty # 5 shrubs and 1,000 square feet of upland seed were planted. Erosion control blanket (C125BN) and coir logs (1-foot diameter) were used to stabilize the area and prevent wave action erosion.

On each of the constructed point bars, ten irregularly-shaped, 25-foot diameter planting pockets were located above the bankfull elevation. Each pocket was excavated two feet deep and filled with 18 inches of topsoil. Fifteen #5 nursery stock shrubs were planted into each planting pocket. Each pocket was surrounded by temporary fencing for protection from wildlife and park visitors. In addition to planting pockets, terraces were seeded with a native seed mix and covered with C125BN erosion control blanket.

The primary natural habitat type or vegetation community which is locally native and appropriate for the environmental setting within the SPP is the Western Great Plains Woodland and Shrubland. This vegetation community was used as a reference in developing constructed point bar riparian vegetation. Ideally planted communities would have focused on establishing more of cottonwood tree overstory, however tree development within the active channel was prohibited as part of floodplain management. Specialized native seed mix and nursery plant stock were utilized to replicate the naturally occurring habitat commonly and historically found along the South Platte River in the local region. The list of nursery plant stock installed as part of the project is provided in **Table 7.1.**

Table 7.1. List of Shrub Species and Quantities

Scientific Name	Common Name	Quantity
Populus deltoides	cottonwood	20
Symphoricarpos albus	white snowberry	45
Salix exigua	sandbar willow	109
Salix amygdaloides	peachleaf willow	10
Prunus virginiana	chokecherry	81
Prunus americana	Wild Plum	57
Cornus sericea	Redtwig dogwood	37
	TOTAL:	359

8.0 Lessons Learned

The South Platte Park South Platte River Restoration Design and Demonstration Project was the first phase of three projects designed to improve aquatic habitat, river health and water quality in the 2.5 miles stretch of river through South Platte Park. The dedicated project team members on this project learned a tremendous amount throughout the design and construction phases. The following points should be considered by any organization attempting to undertake a similar project:

1. A design-build approach with the project contractor is a very helpful and labor saving methodology. This approach also offers flexibility to seamlessly deal with challenges faced by unforeseen circumstances on the ground. However, it is critical that the selected contractor be thoroughly vetted, trustworthy, and have experience in river restoration.

2. Permitting can be a tedious process. It is best to allow months of lead time to secure all required permits. It is also advantageous to partner with project team members who have experience navigating the permitting process.

3. Funding a project such as this can be done through grants and private-public partnerships between local governments, municipalities and non-profit organizations.

4. Provide plenty of notice to inform the public about the project and its benefits. An undertaking such as this is this one is important to stream health and provides many benefits to the park and the surrounding community. During construction, informative signs were posted at park headquarters as well as along trails and adjacent to active work. News releases were provided. Many people were curious about the project but were very supportive upon hearing about the project goals. Park visitors, especially fishermen, have been very pleased with the results. Demonstration projects such as this one can give the public a chance to see how river enhancement benefits the stream and the community. Managing public expectations ad highlighting the benefits will help generate support for future projects.

5. Seeding and planting of native vegetation requires close coordination with construction operations and time of year. Seed and plant material should be secured well in advance and contract-grow agreements made to ensure well developed and optimal species are available. When possible native seeding should occur in later fall and winter before spring emergence. Planted nursery stock should be installed in early spring and often requires routine watering during the first and second growing season. A maintenance program should be anticipated during any revegetation project to ensure plant establishment and minimize weed development. Willow staking should be completed during the dormant season and must be installed at proper depth through the riprap and must be located at specific elevations on the bank in relation to anticipated water depths.

6. Water control is extremely important from a water quality and aesthetic perspective. Inevitably, a project like this will disturb sediment and increase stream turbidity. However,

proper planning can reduce the impacts of increased sediment loading on the stream habitat and reassure the public that work is being done in accordance with best management practices (BMPs). Some of the techniques used by the project team include:

a. Developing and understanding the river hydrograph. This allowed the team to anticipate periods of high flow and schedule work accordingly.
b. Seek opportunities to work in the dry. Naranjo created dry areas to work by dividing the river longitudinally using sheet piling or plastic-lined berms. When possible, they also used existing side channels to divert water. Afterwards, they sealed off these side channels by reinforcing the inlets with riprap and building buried grade control structures.
c. Use realistic estimates to budget time and money for water control efforts. Naranjo enter the construction phase with a well-developed plan for working in the dry. The plan accounted for the cost and time to construct diversions and install the necessary BMPs. For example, Naranjo built rock check dams downstream of work areas to contain sediment and limit downstream turbidity. Also, when pumping to maintain dry work areas while diverting the river, they constructed sediment basins to limit disturbance and turbidity at the pumping outlet.

9.0 Conclusion

The South Platte Park South Platte River Restoration Design and Demonstration Project resulted in a major improvement in aquatic habitat, river health and water quality to approximately 2,000 linear feet of the South Platte River in South Platte Park. Deep pools for fish habitat have made the river much more suitable for trout spawning and fish survival during periods of minimum flows is now highly probable. Recreational access for anglers and park visitors is much improved in all areas, especially along the constructed point bars at the downstream end of the project. River health has improved from increased sinuosity and channel depth. The blooming upland vegetation also contributes to a more balanced riparian ecosystem. Finally, water quality benefits are evident from the bank protection and stabilization efforts that have reduced degradation and erosion. Overall, the design and demonstration projects have been a wonderful success for the river, the park and the community. Hopefully, this project will serve as a showcase for the ability of private-public partnerships to improve the natural environment and also encourage and facilitate future projects.

APPENDIX A: BEFORE AND AFTER PHOTOS

<u>Top</u>: Looking downstream at overly wide channel (before).

<u>Bottom</u>: Constructed low flow channel and vegetated point bar (after).

<u>Top</u>: Looking downstream from fishing pier at braided channel clogged with debris (before).

<u>Bottom</u>: Constructed low flow channel and vegetated point bar (after).

<u>Top</u>: Looking upstream from fishing pier at overly wide channel (before).

<u>Bottom</u>: Constructed low flow channel and vegetated point bar (after).

<u>Top</u>: Looking upstream at braided channel (before).

<u>Bottom</u>: Constructed low flow channel and vegetated point bar (after).

<u>Top</u>: Looking downstream towards at unstable bank littered with concrete rubble (before).

<u>Bottom</u>: Constructed low flow channel and bank stabilization (after).

<u>Top</u>: Looking downstream towards at unstable bank littered with concrete rubble (before).

<u>Bottom</u>: Constructed low flow channel and bank stabilization (after).

<u>Top</u>: Looking upstream at caving bank near Redtail Lake just after construction began (before).

<u>Bottom</u>: Type A bank stabilization installed to protect cut bank habitat (after).

<u>Top</u>: Stage I of constructed point bar revegetation: point bar constructed and top soiled (Apr 2013).

<u>Bottom</u>: Stage II of constructed point bar revegetation: planting pockets and seed placed (Aug 2013).

<u>Top</u>: Stage III of constructed point bar revegetation: bankfull flows flood point bar (Jun 14).

<u>Bottom</u>: Stage IV of constructed point bar revegetation: shrubs and grasses established (Aug 14).

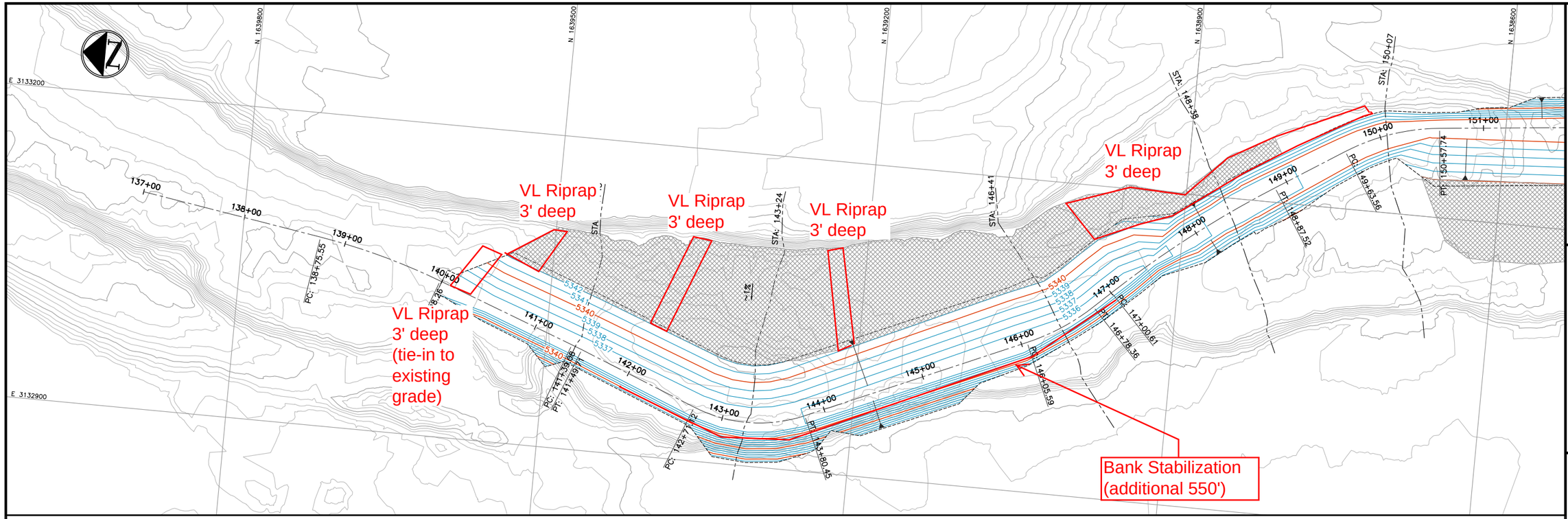
<u>Top</u>: Area of Redtail Lake marked for wetland creation (spoils staged).

<u>Bottom</u>: Wetland plugs established.

<u>Top</u>: Area of Cooley Lake marked for wetland creation (spoils staged).

<u>Bottom</u>: Seed and shrubs established.

APPENDIX B: AS-BUILT DRAWINGS



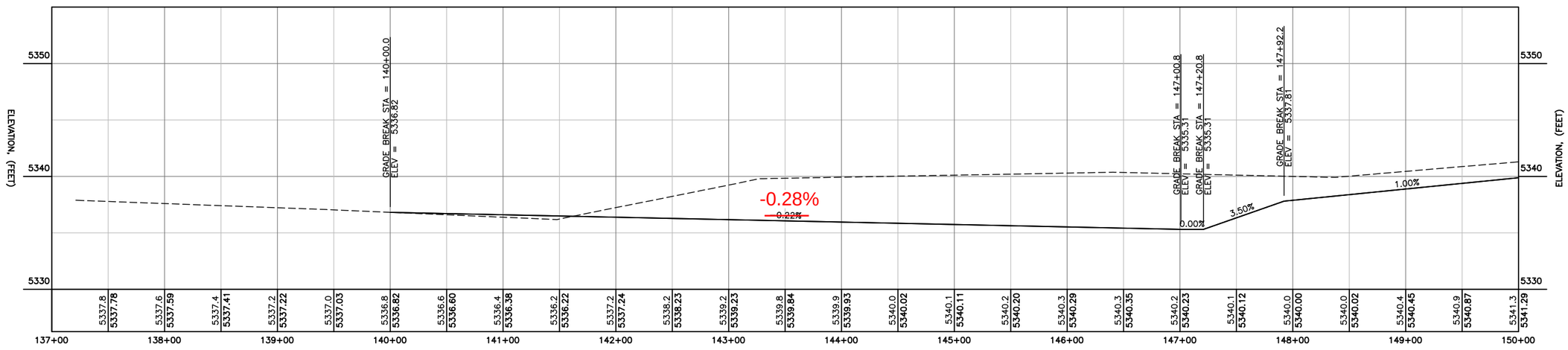
LEGEND:

EXISTING GROUND CONTOURS

CONSTRUCTED POINT BAR (includes ten 10-foot diameter planting pockets and native seeding)

SURVEYED CROSS SECTION LINES

0 50' 100'



0 50' 100'
HORIZONTAL SCALE

0 5' 10'
VERTICAL SCALE

NOTES:

1. MATCH EXISTING GRADE AT APPROXIMATELY STATION 140+00
2. EXISTING CONTOUR DATA BASED ON AERIAL SURVEY MAPPING. CROSS SECTIONAL DATA BASED ON JUNE 2012 SITE SURVEY.
3. FOR CENTERLINE HORIZONTAL ALIGNMENT DATA REFER TO SHEET 3
4. APPROXIMATE EARTHWORKS: CUT = 14,500 YDS^3
   FILL = 2,200 YDS^3
   NET CUT = 14,300 YDS^3

South Platte Park
South Platte River Proposed Enhancement Plan

AS-BUILT
PLAN AND PROFILE
Sta: 137+00 to 150+00
SHEET 1 OF2

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REVISIONS

No	Date	By	Chk	Description

Job #	825-111
Date	8/13/11
Drawn By	DS
Designed By	LJS
Checked By	TT/TB
File	P-SITE-SECTIONS
Scale	AS NOTED

Sheet: 1 Of: n

Channel thalweg moved 10' east
to be closer to ADA fishing piers
(STA 156+50 to 156+00)

VL Riprap
3' deep

VL Riprap
check dam

VL Riprap
check dam

VL Riprap
armored bank

VL Riprap
check dam

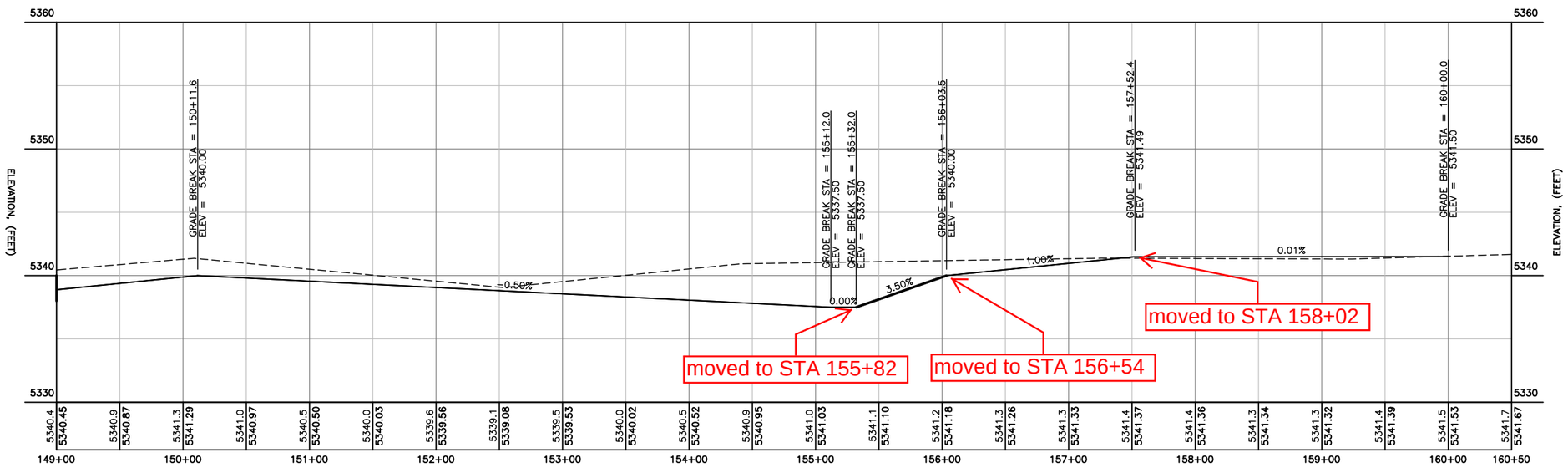
LEGEND:

EXISTING GROUND CONTOURS

CONSTRUCTED POINT BAR (includes five 10-foot diameter planting pockets)

SURVEYED CROSS SECTION LINES

0 50' 100'



0 50' 100'
HORIZONTAL SCALE

0 5' 10'
VERTICAL SCALE

NOTES:

1. MATCH EXISTING GRADE AT APPROXIMATELY STATION 160+00
2. EXISTING CONTOUR DATA BASED ON AERIAL SURVEY MAPPING. CROSS SECTIONAL DATA BASED ON JUNE 2012 SITE SURVEY.
3. FOR CENTERLINE HORIZONTAL ALIGNMENT DATA REFER TO SHEET 3.

South Platte Park
South Platte River Proposed Enhancement Plan

AS-BUILT
PLAN AND PROFILE
Sta: 149+00 to 160+50
SHEET 2 OF 2

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REVISIONS

No	Date	By	Chk	Description

Job #	825-111
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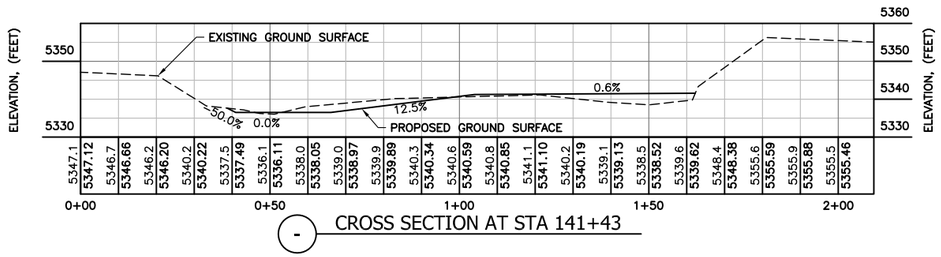
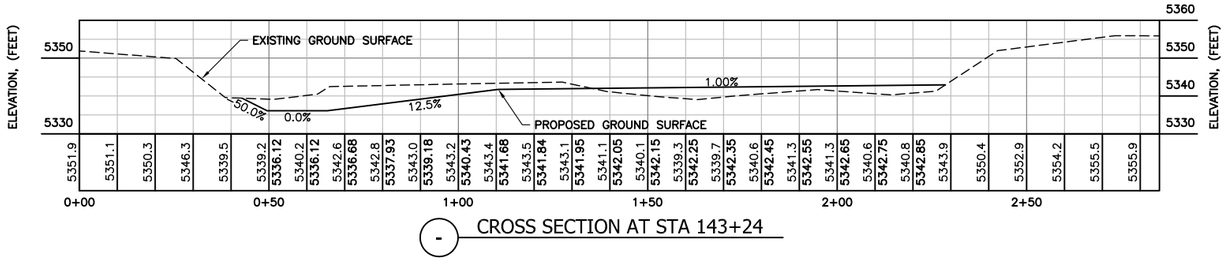
Scale	AS NOTED

Sheet: 2 Of: n



CROSS SECTION AT STA 141+43



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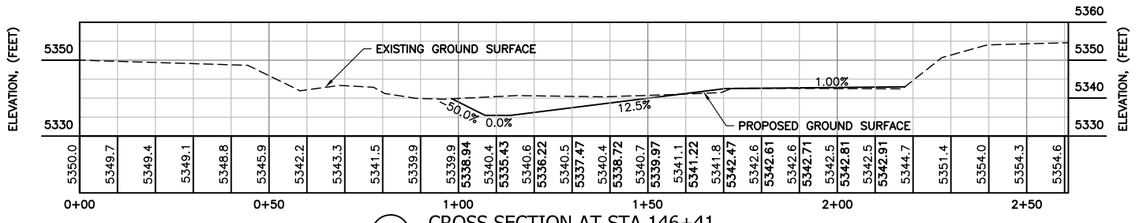
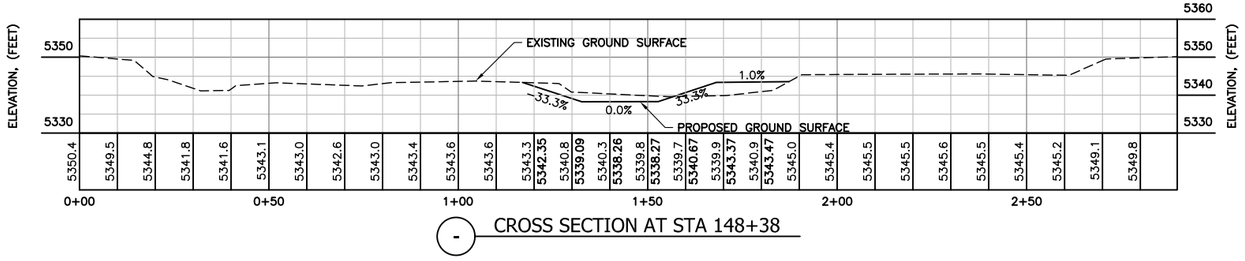


CROSS SECTION AT STA 146+41



CROSS SECTION AT STA 148+38

DESCRIPTION	POINT	STATION	INVERT ELEV. (FT)	BOTTOM WIDTH (FT)	LEFT SLOPE (X:1)	RIGHT SLOPE (X:1)
RIFFLE BEGIN	RB–1	140+00	MATCH EXISTING	25.0	3.0	3.0
GLIDE	G–2	141+43	5336.5	15.0	8.0	2.0
GLIDE	G–2	143+24	5336.1	15.0	8.0	2.0
GLIDE	G–2	146+41	5335.4	15.0	8.0	2.0
POOL	P–2	147+21	5335.3	5.0	8.0	2.0
RIFFLE END	RE–2	147+92	5337.8	20.0	3.0	3.0
RIFFLE	R–2	148+38	5338.2	21.0	3.0	3.0
RIFFLE	R–2	150+07	5339.9	25.0	3.0	3.0
RIFFLE BEGIN	RB–2	150+12	5340.00	25.0	3.0	3.0
GLIDE	G–3	152+50	5338.8	15.0	2.0	8.0
GLIDE	G–3	154+37	5337.9	15.0	2.0	8.0
POOL	P–3	155+22	5337.5	5.0	2.0	8.0
RIFFLE END	RE–3	156+04	5340.00	20.0	3.0	3.0
RIFFLE	R–3	157+26	5341.2	24.0	3.0	3.0
RIFFLE BEGIN	RB–3	157+52	5341.49	25.0	3.0	3.0

158+02

156+54

155+82

SOUTH PLATTE PARK HORIZONTAL ALIGNMENT DATA

	STATION	NORTHING	EASTING	DELTA (D–M–S)	RADIUS	LENGTH
PI	137+00.00	1,639,898.51	3,133,108.44			
PC	138+75.55	1,639,725.12	3,133,080.92			
				11–27–39.95	613	123
PT	139+98.26	1,639,606.66	3,133,049.73			
PC	141+39.08	1,639,474.74	3,133,000.46			
				01–13–05.34	500	11
PT	141+49.71	1,639,464.82	3,132,996.64			
PC	142+71.12	1,639,352.01	3,132,951.75			
				45–18–15.28	138	109
PT	143+80.45	1,639,245.52	3,132,953.52			
PC	146+05.59	1,639,039.23	3,133,043.68			
				19–46–24.60	211	73
PT	146+78.36	1,638,978.84	3,133,083.64			
PC	147+00.61	1,638,962.67	3,133,098.92			
				10–42–32.12	1,000	187
PT	148+87.52	1,638,815.65	3,133,213.89			
PC	149+63.56	1,638,751.64	3,133,254.94			
				26–58–56.30	200	94
PT	150+57.75	1,638,663.50	3,133,285.60			
PC	152+78.19	1,638,444.14	3,133,307.45			
				17–43–14.45	1,000	309
PT	155+87.47	1,638,136.56	3,133,290.40			
PC	156+25.39	1,638,099.47	3,133,282.50			
				29–15–20.42	750	383
PT	160+08.35	1,637,760.94	3,133,112.53			
PI	160+92.03	1,637,698.06	3,133,057.31			

NOTES:

1. CROSS SECTIONS BASED ON JUNE 2012 SITE SURVEY.

South Platte Park
South Platte River Proposed Enhancement Plan

STREAM CROSS SECTIONS
(1 OF 2)
AS-BUILT

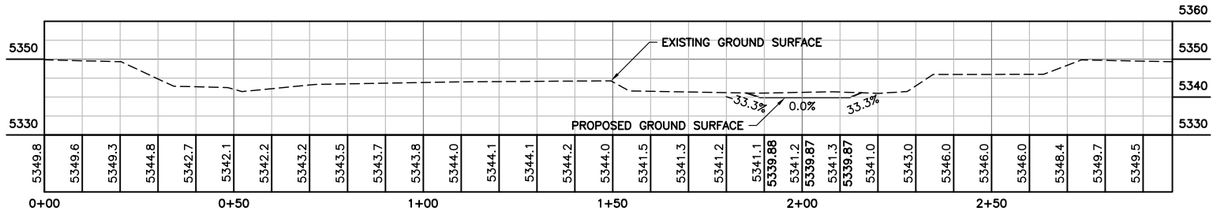
Ecological Resource Consultants, Inc.
25715 US Hwy 40
Evergreen, CO 80439
303–679–4820
www.ercolorado.net

REVISIONS

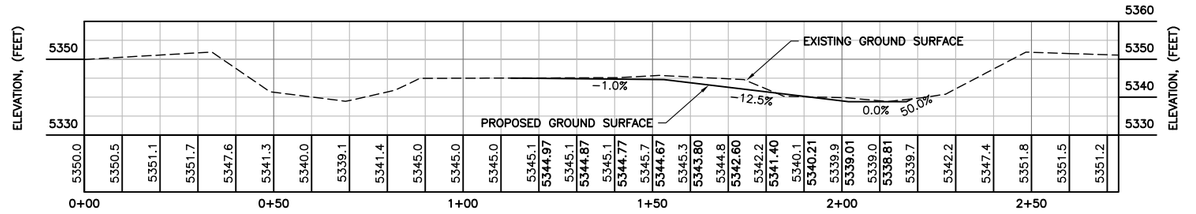
No	Date	By	Chk	Description

Job #	825-111
Date	8/13/11
Drawn By	DS
Designed By	LJS
Checked By	TT/TB
File	P-SITE-SECTIONS
Scale	AS NOTED

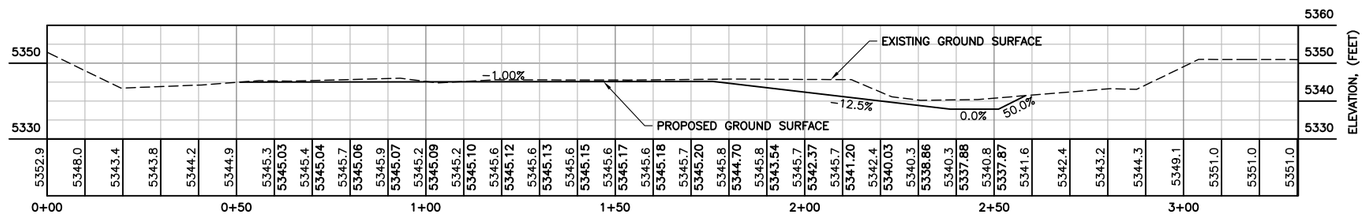
Sheet: 3 Of: n



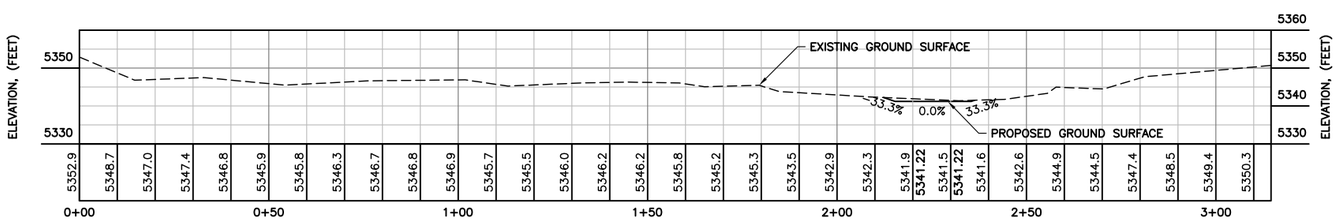
CROSS SECTION AT STA 150+07



CROSS SECTION AT STA 152+50



CROSS SECTION AT STA 154+37



CROSS SECTION AT STA 157+26

NOTES:

1. CROSS SECTIONS BASED ON JUNE 2012 SITE SURVEY.

South Platte Park
South Platte River Proposed Enhancement Plan

STREAM CROSS SECTIONS (2 OF 2)

AS-BUILT

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REVISIONS

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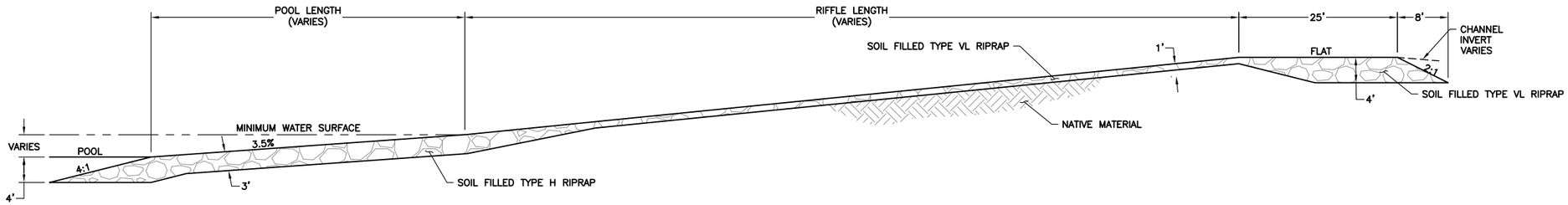
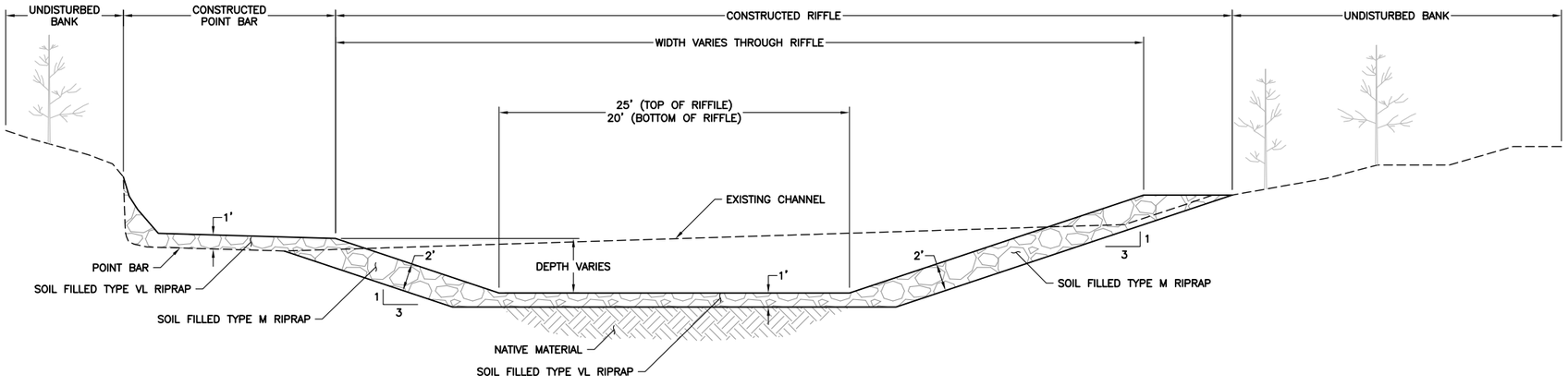
Checked By	TT/TB
File	P-SITE-SECTIONS
Scale	AS NOTED

Sheet: 4 of n



RIFFLE PROFILE

0 10' 20'



RIFFLE SECTION

0 5' 10'

SOIL FILLED RIPRAP THICKNESS	
SOIL FILLED RIPRAP TYPE	THICKNESS
TYPE VL	1'
TYPE M	2'
TYPE H	3'

NOTES:

1. RIFFLE LENGTH WILL EXTEND APPROXIMATELY 100 FEET.
2. SOIL FILLED RIPRAP SHOULD CONSIST OF A MIXTURE OF RIPRAP AND NATIVE SOIL.

South Platte Park
South Platte River Proposed Enhancement Plan

RIFFLE DETAILS
AS-BUILT

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REVISIONS

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Designed By	LJS
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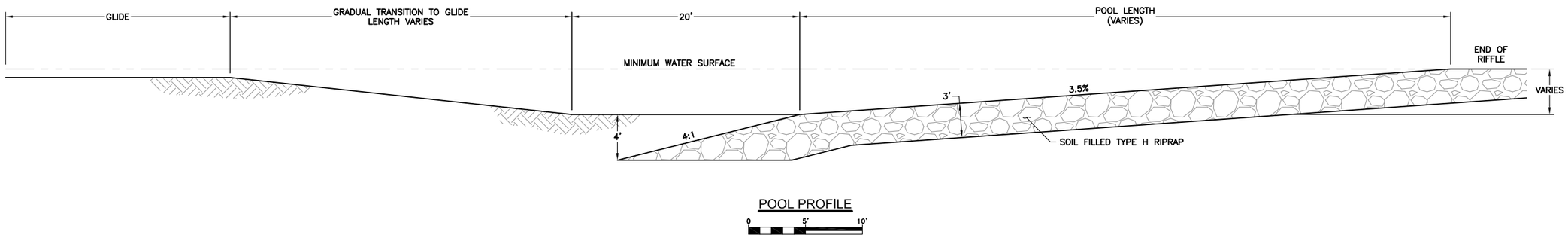
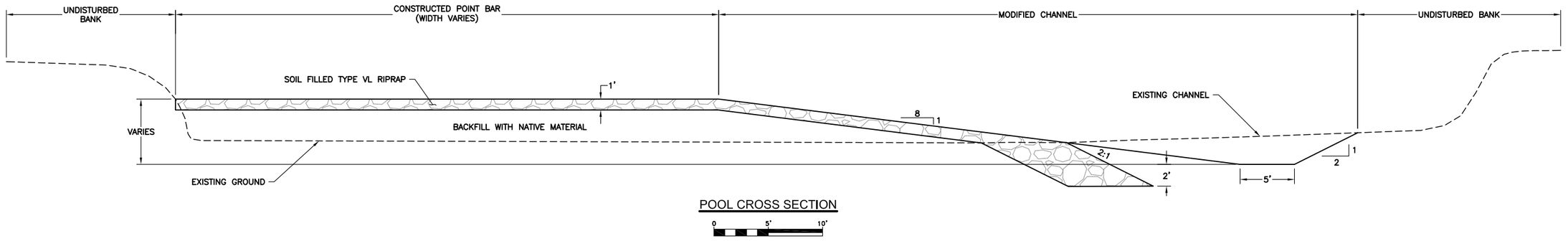
File	P-SITE-DETAILS
Scale	1" = 100'h/10'v

Sheet: 5 Of: n



POOL PROFILE

0 5' 10'



POOL CROSS SECTION

0 5' 10'

NOTES:

1. MINIMUM CONSTRUCTED POOL DEPTH IS 4 FEET.
2. DIMENSIONS OF COBBLE TERRACES WILL VARY WITH EXISTING CHANNEL GEOMETRY
3. BANK SIDE OF CONSTRUCTED POINT BAR SHOULD TIE INTO EXISTING BANK BELOW EXISTING AND DESIGN BANKFULL ELEVATION.
4. CONSTRUCTED POINT BARS SHOULD SLOPE TOWARDS CHANNEL.
5. SOIL FILLED RIPRAP SHOULD CONSIST OF A MIXTURE OF RIPRAP AND NATIVE SOIL.

South Platte Park
South Platte River Proposed
Enhancement Plan

POOL DETAILS
AS-BUILT

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REVISIONS

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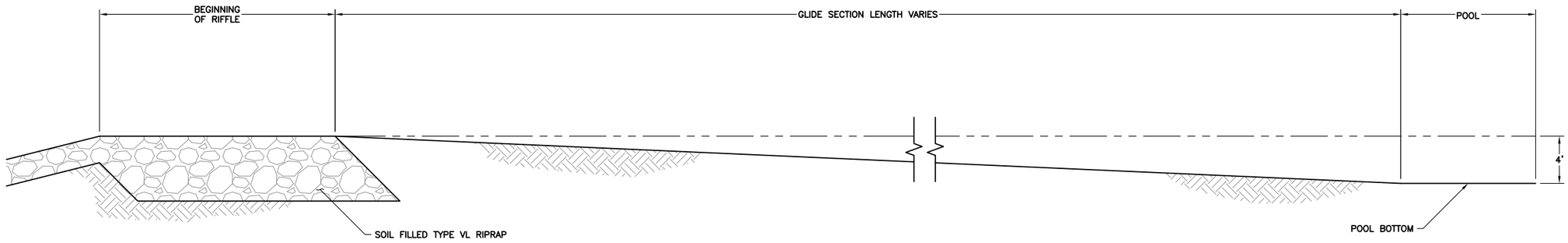
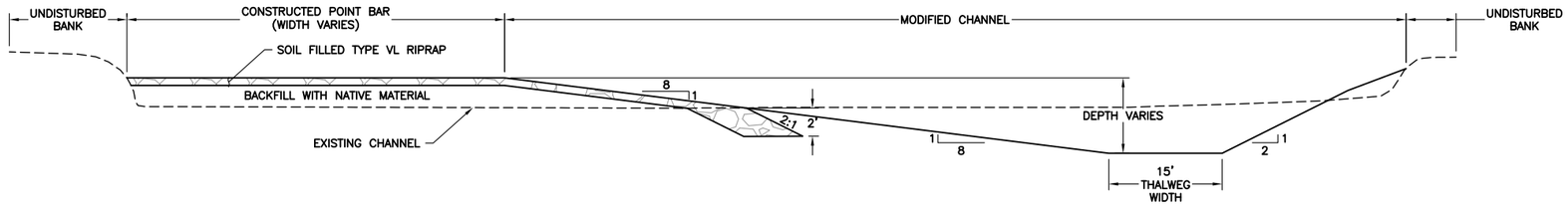
Scale	1" = 100'h/10'v

Sheet: 6 Of: n



GLIDE PROFILE

0 5' 10'



GLIDE CROSS SECTION

0 10' 20'

NOTES:

1. GLIDE WIDTH AND DEPTH WILL VARY WITH EXISTING GEOMETRY.
2. SOIL FILLED RIPRAP SHOULD CONSIST OF A MIXTURE OF RIPRAP AND NATIVE SOIL.

South Platte Park
South Platte River Proposed Enhancement Plan

GLIDE DETAILS
AS-BUILT

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REVISIONS

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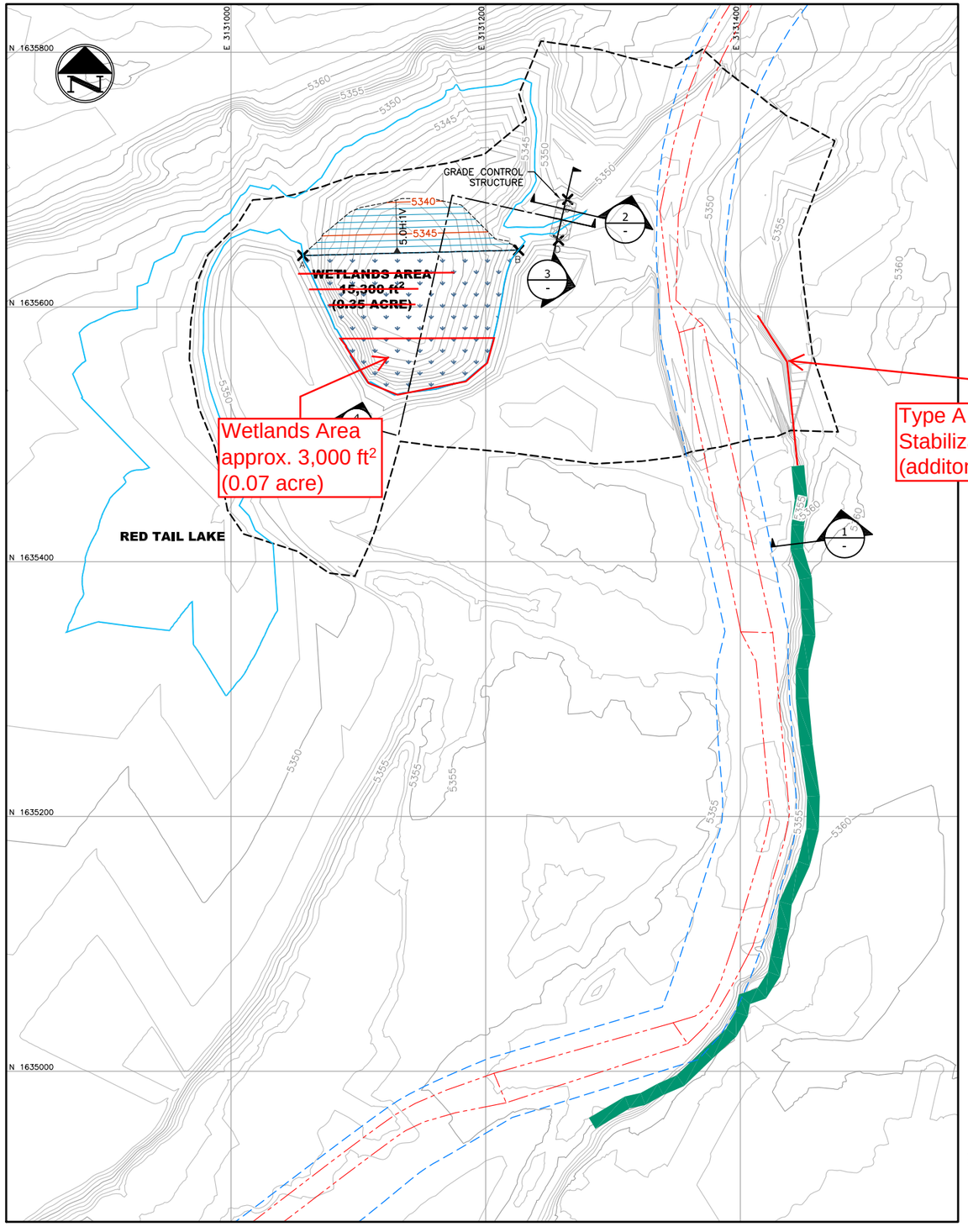
Scale	1" = 100'h/10'v

Sheet: 7 Of: n



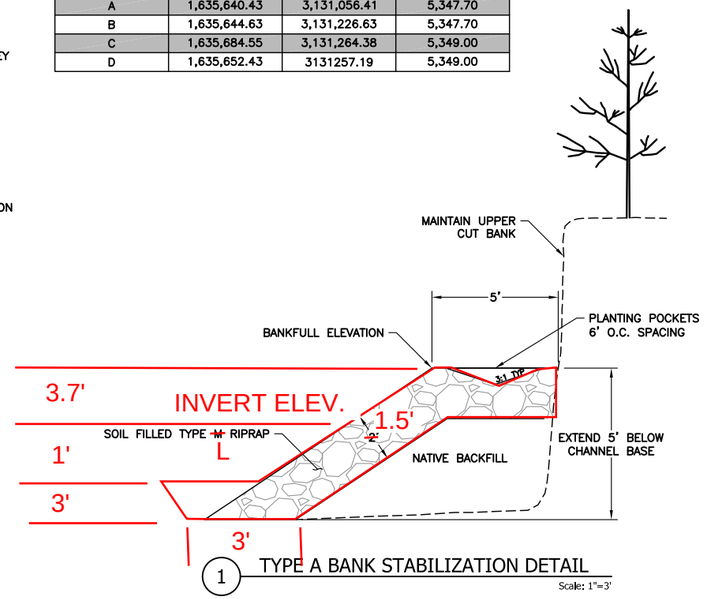
PLAN

0 50' 100'

LEGEND:

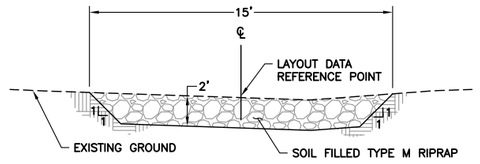
- EXISTING GROUND CONTOURS
- THALWAG LOCATION
- LIMITS OF GROUND SURVEY
- TYPICAL BANKFULL WIDTH
- RED TAIL LAKE
- PROPOSED WETLANDS
- TYPE A BANK STABILIZATION

LAYOUT DATA			
CONTROL POINT	NORTHING	EASTING	ELEVATION
A	1,635,640.43	3,131,056.41	5,347.70
B	1,635,644.63	3,131,226.63	5,347.70
C	1,635,684.55	3,131,264.38	5,349.00
D	1,635,652.43	3131257.19	5,349.00



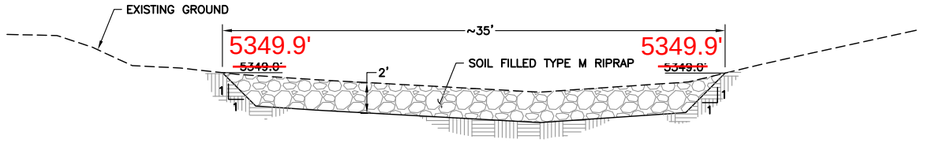
1 TYPE A BANK STABILIZATION DETAIL

Scale: 1"=3'



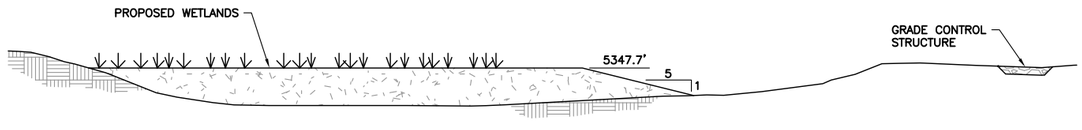
2 GRADE CONTROL STRUCTURE CROSS SECTION

Scale: 1"=5'



3 GRADE CONTROL STRUCTURAL PROFILE

Scale: 1"=5'



4 WETLANDS CROSS SECTION

Scale: 1"=20'

South Platte Park
South Platte River Proposed Enhancement Plan

WETLANDS AREA
AS-BUILT

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Sheet: 8 Of: n