Log Drop Evaluations at Timbers Creek and Rock Creek

Mile High Flood District

October 08, 2021

Contents

Document history and status

Revision	Date	Description
0	08-Oct-2021	Original Report

Executive Summary

The Mile High Flood District (District), formerly the Urban Drainage Flood Control District (UDFCD), is committed to advancing the practice of science, engineering, and management of watersheds and streams through research, innovation, and education. The installation of engineered drop structures on streams is a common practice to stabilize the vertical profile of an unstable stream reach. Typically, drop structures are constructed of sculpted concrete, grouted boulders, or mixed rock to mimic natural riffles. The District has pursued two pilot projects along Timbers Creek (Douglas County) and Rock Creek (Boulder County) utilizing natural logs as the primary drop structure. The initial project on Timbers Creek was documented in *Case Study – Log Drop Structures for UDFCD* by CH2M Hill (now Jacobs) in 2011; see **Appendix F**. That case study establishes a basis for the concept of log drops and provides considerations from both design and construction perspectives.

This report is indented to be a living document with periodic updates for the District. The document history table and the executive summary will be updated with each revision. The original Rock Creek and Timbers Creek reports have been grouped together in this document to capture lessons learned from both projects related to the design and installation of log drops within the District's service area.

A. <u>Timbers Creek Updates</u>

July 26, 2021 – Log Drop Evaluation

In 2021, an evaluation was performed to determine the health and performance of the log drop structure after a decade in use. The cedar logs have performed well with no signs of decay, damage, or other failure modes. Riparian and wetland vegetation have established throughout the drop structure, supporting water quality, reducing water velocity, and minimizing erosion. The outer bark on the logs is no longer present, leaving the inner wood fully exposed. The outer bark was primarily left on during installation for aesthetic reasons and was never expected to remain. The downstream-most log in the structure is completely covered by sedimentation and vegetative cover. The structure appears to be performing well. In the future, it is recommended that the outer bark be removed from those sections of the logs that are to be buried and/or tied into a hard, engineered feature such as grouted boulders. As noted in the report, the grout was installed over the outer bark and as the outer bark has deteriorated with time, a small gap between the grout and the inner wood is evident at Log #5's northern connection to the grouted boulders.

JULY 18, 2013 – Repair of Flood Damage

In 2013, repairs to the log drop structure were completed in response to flood damage incurred during 2012, which was soon after construction before vegetation had fully established. The logs and their anchors were in good condition and were not modified. The repairs focused on channel bottom erosion prevention. The outer log bark had partially deteriorated at this time.

AUGUST 25, 2010 – Final Walkthrough of Original Design and Construction

In 2010, construction of the pilot project at Timbers Creek using cedar logs was completed, and a final walkthrough was performed. The outer log bark was left on the logs for aesthetics. The logs were anchored in place with buried concrete blocks and chains. The logs delivered to the site for installation were significantly larger than the design diameter and required cutting the bottom of the log with a chain saw to achieve the appropriate crest height. In the future, it is recommended that a tighter minimum and a maximum allowable log diameter be defined in the project specifications.

B. Rock Creek Updates

SEPTMEBR 13, 2019 – Log Drop Evaluation

In 2019, an evaluation was performed to determine the health and performance of the log drop structures after nearly a decade in use. All three species of tree have performed well with no significant signs of decay, damage, or other failure modes.

SEPTEMBER 11, 2013 – Colorado 2013 Floods

In 2013, major floods along the Colorado Front Range occurred. The improvements on Rock Creek remained intact and no damage was discovered.

FALL 2012 – Seepage Control

In 2012, it was found that some of the creek flow was being conveyed under the log drops, passing through the compacted native material and rock mixture that was provided for seepage control. The seepage control improvements included the installation of a geotextile fabric anchored to the upstream face of the logs and buried under clay material, and the District's newly developed void-filled riprap mixture was placed upstream.

NOVEMBER 2011 – Final Walkthrough of Original Design and Construction

In 2011, construction of the log drop pilot project at Rock Creek was completed, and a final walkthrough was performed. The installations included log drops using pine, cottonwood, and cedar logs ranging in diameter from 18" to 30". During construction, the contractor placed the buoyancy anchors too low in relation to the variable log diameters and used rock shims to install the logs at the correct elevation. In the future, the contractor should account for each log's specific diameter prior to installing foundation components.

SECTION 1 – TIMBERS CREEK

1. Introduction

The intent of this report is to evaluate the performance of an engineered drop structure containing six natural log drops within Timbers Creek in Douglas County, CO after nearly a decade in operation. This drop structure represents the first such installation by the District. These structures were installed in the Winter of 2010 to address vertical instability issues of the creek and were repaired in the Winter of 2013 to correct flood damage. The project reach is bounded by Fox Sparrow Road on the west and Sage Thrasher Road on the east.

Timbers Creek is a sandy ephemeral stream in The Pinery, Colorado approximately 30 miles southeast of downtown Denver. The creek is utilized as a greenspace and hiking path for the surrounding single-family residential developments and is home to abundant wildlife.

Figure 1: Vicinity Map of Project Area

Figure 2: Drop Structure Locations

2. History

2.1 2010 Timbers Creek Channel Improvements

In 2010, Timbers Creek was chosen as the District's first pilot project area to explore the efficacy of natural logs in an engineered stream drop structure, see Figures 3 & 4. The channel was eroding both laterally and vertically, requiring stabilization. The design incorporated six cedar logs with a design diameter of 18-inches, with Log #1 at the downstream end of the structure and Log #6 is at the upstream end. If found to be resilient and effective, log drop structures could prove to be fiscally and environmentally beneficial in future stream restoration projects.

The logs were attached to concrete anchors for buoyancy resistance and the ends were buried under soil, with the channel bottom forming a traditional trapezoidal shape. Standard soil riprap was used upstream, downstream, and on the sides of the drop structure (see Figure 3). Cobbles were added to the soil riprap to provide a more natural cobble appearance. The upstream and downstream logs incorporated sheetpile with a concrete cap, which were integrated into the concrete anchors. Please refer to the 2011 Case Study, found in **Appendix F**, for additional information including the basis for the concept, a summary of design elements, a summary of construction efforts, and recommendations for future log drop structure installations.

2.2 2013 Repairs to Flood Damage

In 2012, the project site received flood damage before vegetation could be established in the very sandy soils. The logs themselves were not damaged nor undermined, but there was significant scour and riprap transportation. In response, the site was repaired in 2013. The areas between logs were filled with 4-foot boulders, grouted to two-thirds the height of the boulder to allow for sediment deposition and vegetation. The four interior logs received sheetpile to provide additional seepage protection. The low flow channel was lined with grouted boulder walls as well (see Figure 4). Due to the dry, sandy nature of Timbers Creek, revegetation of the channel was a challenge and it took several growing seasons to properly establish.

Figure 3: Original Design

Figure 4: Post Flood Repairs

3. 2021 Log Drop Evaluation

An evaluation of the log drops was conducted to investigate the physical integrity of the logs and the stability of the stream's vertical profile. Photos of the log drops are included in **Appendix A**.

Vegetation and Wildlife

Riparian and wetland vegetation has firmly established within the limits of the log drop structure as well as the immediate areas. A variety of grasses fill the spaces in the grouted boulder channel bottom between Log #5 and Log #2, and cattails cover the channel bottom from Log #2 to the downstream tie-in to the natural channel bottom, covering Log #1. Please see Photos G.1 – G.4 as well as **Appendix B**.

Wildlife is supported in this space in a number of ways. Several micropools have formed throughout the log-drop structure supporting mosquito larvae, brown snails, and leeches. A variety of predatory bird species were observed in the area with non-predatory bird species seeking shelter in the cattails. Additionally, a number of deer were observed, and the Jacobs team stumbled across a bedding site where a young fawn was startled by our presence. The design has also unintentionally created game trails where the concrete headers exist; vegetation has difficulty establishing itself here and animal signs were abundant.

Log Integrity

The site visit revealed that each log has held up well with no significant evidence of biodegradation, debris impact damage, insect infestation, or fungal growth. The ephemeral nature of the stream was an early concern for the logs as it was unclear how the seasonal dry-wet cycles would affect the logs. The effects of Ultra-Violet (UV) radiation, or sun-burn, on the logs should be considered in future evaluations, however there is no evidence to suggest this is an issue at the present time. Typically sun-burn is a concern for living trees as it can lead to insect infestation and fungal growth, which are elements already under consideration.

The logs used on this project had the outer bark intact upon installation, however most of the outer bark has since eroded away. The inner wood that remains appears to be in good condition. There is evidence that suggests minor debris impact damage (i.e. small dents in the wood) was sustained at Log #4 and Log #5, see photos 4.4 and 5.5, however the damage appears to be insufficient to have facilitated further complications to the logs' condition.

The physical integrity of each log was tested by mechanical sounding with a rubber mallet. Mechanical sounding is a well-established forestry method of tapping a tree trunk with a wooden or rubber mallet to listen for the tell-tale drumming response indicating an interior hollow. No such hollows were detected.

Channel Stability - Vertical Profile

The original design and construction intended for a 0.5% slope within the limits of the log drop structure with a downstream tie-in to the proposed natural channel bottom with a design slope of 1.0%. However, it was noted that Log #1 is covered by sediment deposition and wetland growth (cattails), forming a completely new slope that is nearly level with the top of Log #2. Please see **Appendix B** for a comparison. It is unclear if this is evidence of the channel downstream of the drop structure naturally establishing a stable channel slope, or simply an instance of sediment transport and deposition that has self-propagated with the establishment of dense vegetation. For the moment stability appears to have been achieved in this stream bed, which was the original goal of this rehabilitation project.

Notable Observations

The interface between the logs and the grouted boulder channel edging appear to be in good condition throughout the structure. However, the north end of Log #5, as seen in photos 5.1 and 5.5, shows evidence of a small gap in the grout. The grout was installed over the outer bark and as the outer bark has deteriorated with time, a gap between the grout and the inner wood is evident.

4. Conclusions and Recommendations

The Timbers Creek log drop structure has proven to be successful and resilient after nearly a decade. As a pilot project, a few hurdles were expected and indeed encountered as evidenced by the revegetation challenges, 2012 flood, and subsequent repairs. The channel in the vicinity of the structure appears to be stable and well vegetated. The following recommendations and lessons learned based on this evaluation are provided for consideration during future projects using log drops as well as on-going care of this drop structure.

- Cedar was chosen for its natural decay resistance and it has proven to be successful over the course of a decade. Future observation is recommended to determine the applicable engineering life-span of this tree species. At this time cedar remains a desirable species for this application if it can be sourced at the appropriate diameter and length for a given project.

- Logs can be obtained in a milled form with the outer bark removed, or in their native form with the outer bark intact. The outer bark provides some natural and aesthetic values. If it is determined that the outer bark should remain, it is recommended that the outer bark be removed from those sections of the logs that are to be buried and/or tied into a hard, engineered feature such as grouted boulders. This work should be done on-site by the contractor. This course of action serves to minimize issues encountered at the interface.

    - **Action –** For Log #5 it is advised that a crew remove the remaining outer bark from the grout interface and seal the annular gap that has formed with additional grout or an appropriate sealant.

- Grouted boulders can be effective in certain applications as channel bottoms and channel edging as evidenced by this project. To support desirable sedimentation and vegetation establishment in the channel bottom application, the grout should be limited to two-thirds or three-quarters of the boulder height to provide a space for this natural action.

- As indicated in the 2011 case study, the logs delivered to the site in the original design were significantly larger than the design diameter and required cutting with a chain saw to achieve the appropriate crest height. We recommend identifying a minimum and a maximum allowable log diameter in the project specifications.

- The channel slope between Log #2 and Log #1 appears to have found a natural stable condition with the aggradation of sediment and establishment of vegetation, see **Appendix B**. We recommend that, for the moment, the vegetation be left alone as channel stability has been achieved and an ecosystem has established. At the same time, we recommend continued observation and evaluation of the vegetation advancement as it relates to stream stability and function within the drop structure.

- Consideration should be given in future designs to facilitate the development of features that support the local ecosystem. Though the sedimentation and vegetation were largely part of the design intent, the establishment of game trails, animal shelter, and micropools were coincidental. Designing for these elements would improve the interface between the built and natural spaces.

SECTION 2 – ROCK CREEK

1. Introduction

The intent of this white paper is to evaluate the performance of five natural log drop structures and two sculpted concrete log drop structures located within Rock Creek in the Town of Superior, CO. These structures were installed in the Winter of 2011 to address vertical instability issues of the creek and this evaluation was conducted in 2019/2020. The project reach is bounded by West Flatiron Crossing Drive on the east and Autrey Park on the West, and is within an open space area for public use that includes the Autrey Dog Park, Superior Skate Park, Superior Bike Park, Superior Yard Waste Recycling Facility, and the Superior Wastewater Treatment Plant.

2. History

2.1 2011 Rock Creek Channel Improvements

In 2011, Rock Creek was chosen as another pilot project area to explore alternative, natural, and resilient log drop structure options. The design incorporates five natural logs drops using on-site logs and imported logs to aid in determining the resiliency of the different species. Two sculpted concrete log drop structures were constructed to simulate natural log drops but be more durable with a longer life span. If found to be resilient and durable, natural log drops could prove to be fiscally and environmentally beneficial in future stream restoration projects.

The seven drop structures are shown in **Figure 1**, including Drop 1 and Drop 7 constructed with sculpted concrete and Drops 2 through 6 constructed with natural logs.

Figure 1: Drop Structure Locations

The five natural log drop structures consist of cottonwood, pine, and cedar logs. These three log types were selected based on the differences related to local availability, wood density, and anticipated longevity due to biodegradation. As noted in the 2011 Case Study, logs have the following approximate densities:

- Cedar: 20 to 24 pounds per cubic foot (pcf)
- Pine: 25 to 44 pcf
- Cottonwood: 30 pcf
- Ash: 40 pcf
- Oak: 40 to 60 pcf

It is also known that cottonwood trees typically have a soft inner core or hollow trunk, which could lead to a shorter lifespan. However, cottonwood trees are very common in Colorado and could provide a cost effective and natural solution for log drops as opposed to importing logs from the Colorado mountains or from out of state.

Consideration also needs to be given to importing logs due to invasive species such as the pine beetle and emerald ash borer.

The two sculpted concrete log drop structures were constructed by Colorado Hardscapes using cast-in-place concrete with concrete stamps to mimic cottonwood tree bark, and were colored and stained to match the natural tree colors. The furthest upstream drop, Drop 7, also serves as a flow splitting structure, allowing high flows in the creek to be conveyed by the right overbank of the creek parallel to Drop 1 to Drop 6. This was a design feature to allow the preservation of many large trees along the corridor while stabilizing the creek and decreasing the erosive forces in the low flow channel during high flows. **Table 1** summarizes the seven log drops and the diameters represent the average diameter for the section of log to be exposed in the creek, not the buried sections. **Appendix D** includes photos of each drop structure.

Table 1: Log Drop Summary

Log Drop:	1	2	3	4	5	6	7
Material	Concrete	Cottonwood	Pine	Cedar	Cedar	Cedar	Concrete
Diameter	30"	24"	18"	18"	18"	24"	30"

The natural log drops on Rock Creek were stabilized using concrete anchors to resist buoyancy forces. It was known at the time that steel cable with duck bill anchors or other methods could be used in the future as an alternative approach, but a more robust approach was selected for this pilot project.

After construction was completed in the Winter of 2011, record drawings were developed in January of 2012 to summarize the as-built conditions. The log drop structure related plan, profile, and detailed drawings from the Rock Creek Channel Improvements Project are included in **Appendix E**.

2.2 2012 Log Drop Revisions and 2013 Floods

After construction, the flows in Rock Creek started to flow underneath the logs at some of the natural log drops. The original construction included compacted soil riprap upstream and downstream of the drops. The cause of the flow traveling under some of the logs is not known, but a couple of scenarios are possible. The first is that the natural soil material was piped out of the soil riprap mixture, allowing the creek flows to travel through the voids in the riprap. The second scenario may be that the logs were not placed on adequately compacted soil riprap subgrade. During construction it was found that the contractor placed the buoyancy anchors too low, and rock shimming was used to place the logs on the anchors. Thus, the subgrade below the logs may not have been ideal.

Keeping the logs saturated is a goal of the project to decrease the biodegradation processes that could lead to log deterioration over time. In order to bring the flow back to the surface and over the logs, geotextile fabric was anchored to the upstream face of the log and buried under clay material. The District's newly developed "void-filled riprap" mixture was placed upstream of the logs. The result was the flows returned to the surface and over the tops of the logs.

In September of 2013, major floods along the Colorado Front Range occurred. The floods caused significant damage on many streams in northern Colorado, but the improvements on Rock Creek remained intact and no major damage occurred.

3. 2019 Log Drop Evaluation

A log drop evaluation was conducted to investigate the physical integrity of the logs and the stability of the stream's vertical profile. The site visit was conducted in September of 2019 and the evaluation of survey data was completed in 2020. Photos of the log drops as seen in 2019 are included in **Appendix D**.

Log Integrity

The site visit revealed that each log has held up well with no significant evidence of biodegradation or deterioration. The physical integrity of each log was tested by applying point pressure with a steel rod. At each log, healthy resistance was met with less than approximately 1/8-inch of give. The flows in Rock Creek are traveling over each of the logs. The channel banks adjacent to the drops are well vegetated and no signs of log movement were seen. The exposed log lengths, as measured between the adjoining boulders, were collected due to a lack of as-built data and the dimensions are in-line with the design and can be used for monitoring in the future; see **Table 2**.

Table 2: Exposed Log Length in Creek Channel

Log Drop:	1	2	3	4	5	6	7
Exposed Log Length	n/a	8′	8′	8′	7′	8′	n/a

The pine and cedar log drops are performing well and the log integrity appears strong. The log drop to monitor more closely is Drop 2, which used a cottonwood log. Due to the irregular shape of the log, during low-flow conditions a portion of the log is exposed to the air and can dry out. This can accelerate the biodegradation activity and could decrease the longevity of the log. As part of this pilot project, it was known that cottonwood logs are more susceptible to biodegradation and the center of the trunk is often hollow. The fact that part of the log will experience wetting and drying cycles will be informative to determine if the longevity of the log is compromised. Jacobs recommends that this drop be monitored more closely to determine if it experiences deterioration faster than the other logs. This information will be especially important since cottonwood trees would be the most likely species to be used by the District on future projects.

Vertical Profile Stability

The vertical profile of the channel was stabilized through the construction of the seven log drop structures. The vertical channel stability was measured as part of this assessment by capturing four vertical survey points at each log drop (upstream of the log, log crest, toe below the log, and downstream of the log) and compared to the as-built elevations. The upstream and downstream measurements were located between 15 and 20 feet away from the drops to attempt to avoid local sediment aggradation or degradation immediately adjacent to the drops.

A direct comparison to as-built conditions is not possible because the exact log elevations were not captured in the as-built drawings. However, the logs were installed per the design drawings as best as possible given the nonuniformity of the logs and typical creek construction practices. The changes in channel elevation from construction in 2011 to this assessment in are presented below in **Table 3**.

Table 3: Change in Channel Elevation

Survey Point Location:	Upstream of Drop (inches)	Log Crest (inches)	Log Toe (inches)	Downstream of Drop (inches)
Drop 1	-10.5	3.9	14.4	8.6
Drop 2	3.10	7.3	9.20	5.8
Drop 3	-11.8	5.2	-1.10	3.0
Drop 4	0.20	8.0	3.70	-3.0
Drop 5	3.50	7.6	9.40	3.0
Drop 6	4.00	4.3	7.20	6.3
Drop 7	17.5	4.5	7.10	6.5

The results show that the current channel profile is typically within 3 inches to 12 inches of the as-built profile. The minor differences are assumed to be consistent with natural geomorphic process and movement of sediments during low and high flows. The consistency in the profile after having experienced the flood flows in 2013 is another sign that the log drops and flow splitting structure performed well. It is noted that Drop 7 at the upstream end of the project was constructed with a crest elevation that would intentionally cause sedimentation upstream of the crest. It is also noted that Drop 1 was shifted approximately 5 feet to the northeast during construction. Overall, the logs are performing well, the channel profile has remained intact, and no items of concern are noted.

4. Conclusions and Recommendations

The Rock Creek log drop structures have proven to be successful and resilient after nearly a decade, including resiliency to the 2013 floods. The presence of minor scour and sedimentation upstream and downstream of the drop structures is noted but the overall profile of the creek has not significantly changed since the post-construction conditions. The following recommendations and lessons learned based on this pilot project are provided for consideration during future projects using logs:

- All three species of the natural logs are performing well. The cottonwood log showed slight signs of flexing during testing, but this could be due to the hollow core of the trunk at the time of construction or due to the drying and wetting cycles that are occurring on a portion of the log. Future observation is recommended to determine the useful life of each log type, which can then be compared to the sculpted concrete log drops and other types of drops constructed by the District.

- Flow cutoff measures should be included in design and construction to ensure flows are conveyed over the tops of the logs. Cutoff measures could include well graded void-filled rock, clay fill, geotextile fabrics, or other methods. At a minimum, a geotextile cutoff securely fastened to the upstream side of the log and buried below the channel invert and banks is recommended.

- There is a maximum practical log length that is able to be obtained from natural logs, due the changing diameter of the tree trunk. Thus, there is a maximum stream width that can be addressed through the use of only one log to not have to contend with seams between multiple logs. Ensuring that adequate log length is buried into the bank is important to make sure the log is not laterally bypassed by creek flows.

- Log buoyancy must be considered to make sure that logs are not mobilized during high flows. The concrete anchors in this project proved to work well in the 2013 floods and to date. Alternative methods such as steel cable and duck bill anchors could be considered but would need to be sized appropriately for the buoyancy forces and soil conditions.

- The sculpted concrete log drops have functioned well and mimic the natural cottonwood trees very well. However, given the cost of these structures, they would be best used in areas where the public would benefit from the unique and artistic features of the logs. These logs could create excellent nature-play areas.

- The logs on Rock Creek should continue to be monitored to determine the ultimate longevity and durability of the logs.

- The District should consider the use of logs on additional projects and continue to refine design and construction procedures based on lessons learned from each project.

Appendix A. Timbers Creek Photos

GENERAL SITE PHOTOS


Photo G.1


Photo G.2


Photo G.3


Photo G.4


Photo G.5


Photo G.6

LOG DROP 1

No Photos. Log Drop 1 has been completely covered by sediment and wetland vegetation.

LOG DROP 2

Photo 2.1

Photo 2.2

Photo 2.3

Photo 2.4

LOG DROP 3

Photo 3.1

Photo 3.2

Photo 3.3

Photo 3.4

LOG DROP 4


Photo 4.1


Photo 4.2


Photo 4.3


Photo 4.4

LOG DROP 5

Photo 5.1

Photo 5.2

Photo 5.3

Photo 5.4

Photo 5.5

LOG DROP 6

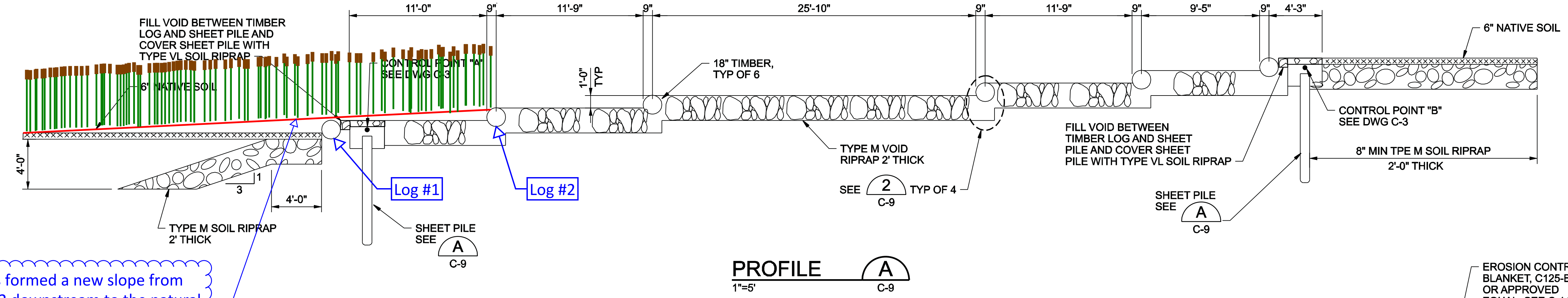
Photo 6.1

Photo 6.2

Photo 6.3

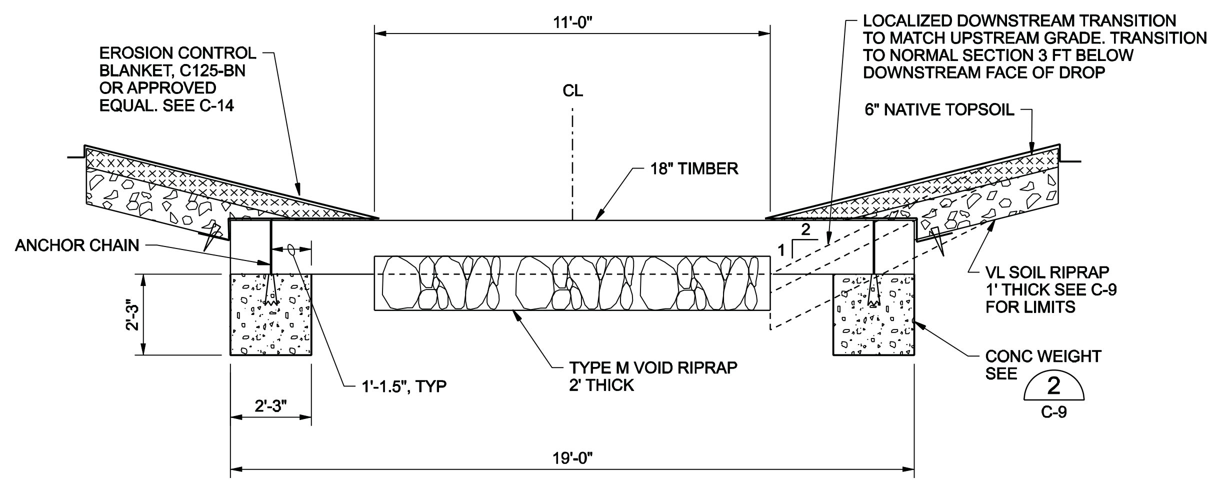
Photo 6.4

Appendix B. Timbers Creek Channel Bottom Exhibit

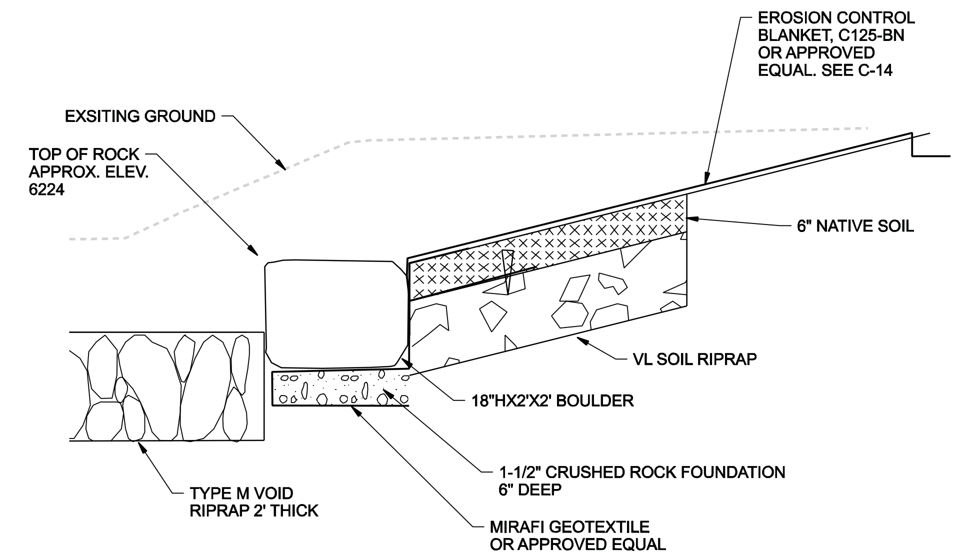


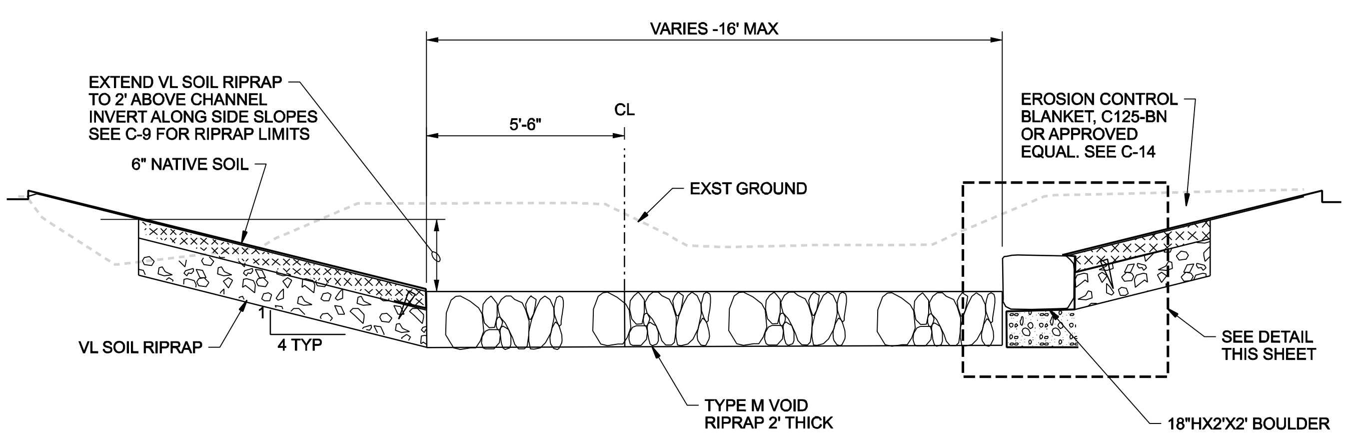
The channel has formed a new slope from the top of Log #2 downstream to the natural channel bottom. The extent of this revised channel bottom is unclear.

PROFILE A
1"=5' C-9



SECTION B
1/4"=1'-0" C-9





SECTION C
3/8"=1'-0" C-9

VOID RIPRAP NOTES:

1. ROCK REQUIREMENTS ARE TO COMPLY WITH TYPE M RIPRAP.
2. THE COLOR OF RIPRAP AND VOID-FILL MATERIALS USED TO FILL THE RIPRAP VOIDS SHALL BE LIGHT GRAY OR TAN AND SHALL BE UNIFORM. SAMPLES OF RIPRAP AND VOID-FILL MATERIALS SHALL BE SUBMITTED FOR REVIEW AND APPROVAL OF THE ENGINEER PRIOR TO CONSTRUCTION.
3. WHERE "TYPE M VOID-FILLED RIPRAP" IS DESIGNATED ON THE CONTRACT DRAWINGS, RIPRAP SHALL BE MIXED WITH THE MATERIALS AND ASSOCIATED PROPORTIONS LISTED IN THE TABLE BELOW TO FILL THE VOIDS 0F THE RIPRAP:

Approximate Proportions (loader buckets)	Material Type	Material Description
6	Riprap	Type M Riprap
3	Void-fill material	7-inch minus crushed rock surge (100% passing 7-inch sieve, 80-100% passing 6-inch sieve, 35-50% passing 3-inch sieve, 10-20% passing 1.5-inch sieve)
1	Void-fill material	2 to 4-inch cobble (round washed river rock that is well-graded, 100% passing 6-inch sieve, 35-50% passing 3-inch sieve, 5-20% passing 2-inch sieve)
1	Void-Fill material	4-inch minus pit run surge (round river rock and sand, well graded, 90-100% passing 4-inch sieve, 70-80% passing 1.5-inch sieve, 40-60% passing 3/8-inch sieve, 10-30% passing #16 sieve)
1	Void-fill material	Type II bedding
½ to 1	Void-fill material	Native topsoil
Top layer	Top dressing	Additional 4 to 12-inch cobbles (round washed river rock that is well graded, 80-100% passing 12-inch sieve, 35-50% passing 6-inch sieve, 5-20% passing 4-inch sieve) shall be mixed in on the surface of the void-filled riprap (covering approximately 40% of the surface) prior to compaction of the void-filled riprap. Cobbles shall be fully embedded into the mass of the void-filled riprap.

NOTE: MIX PROPORTIONS AND MATERIAL GRADATIONS ARE APPROXIMATE AND ARE SUBJECT TO ADJUSTMENT BY THE ENGINEER. NO ADJUSTMENT IN UNIT PRICE FOR VOID-FILLED RIPRAP WILL BE ALLOWED BASED ON MODIFICATION TO THE MIX PROPORTIONS.

DSGN	C BUTLER					
DR	M MONAHAN					
CHK	C BUTLER					
APVD	K HAMILTON	NO.	DATE	REVISION	BY	APVD

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

CH2MHILL
9193 S JAMAICA ST
ENGLEWOOD, CO 80112
CONTACT: MARK GLIDDEN
720-286-5135

DOUGLAS COUNTY COLORADO

TIMBERS CREEK CHANNEL STABILIZATION

TIMBER DROP STRUCTURE SECTIONS

SHEET	15
DWG	C-10
DATE	APRIL 2010
PROJ	328175

FILENAME: timcDT02rev1.dgn PLOT DATE: 4/2/2010 PLOT TIME: 1:09:30 PM

Appendix C. Timbers Creek As-Builts (2014)

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT AND DOUGLAS COUNTY, COLORADO
CONTRACT DRAWINGS FOR CONSTRUCTION OF

TIMBERS CREEK CHANNEL STABILIZATION PROJECT

APRIL 2010

RECORD DRAWINGS

Revisions Drawn By B SCHAFROTH Date 9/2014

THESE RECORD DRAWINGS HAVE BEEN PREPARED, IN PART, ON THE BASIS OF INFORMATION COMPILED BY OTHERS. THEY ARE NOT INTENDED TO REPRESENT IN DETAIL THE EXACT LOCATION, TYPE OF COMPONENT NOR MANNER OF CONSTRUCTION. THE ENGINEER WILL NOT BE RESPONSIBLE FOR ANY ERRORS OR OMISSIONS WHICH HAVE BEEN INCORPORATED INTO THE RECORD DRAWINGS.

RECORD DRAWING NOTES:

1. THESE DRAWINGS WERE ORIGINALLY PREPARED IN 2010 FOR THE CONSTRUCTION OF IMPROVEMENTS ON TIMBERS CREEK.
2. CONSTRUCTION PER THE ORIGINAL DRAWINGS WAS COMPLETED IN 2010.
3. AS-CONSTRUCTED DRAWINGS FOR THE ORIGINAL CONSTRUCTION PROJECT WERE COMPLETED IN NOVEMBER 2010.
4. A LARGE FLOOD OCCURRED ON TIMBERS CREEK IN 2012, PRIOR TO ESTABLISHMENT OF VEGETATION IN THE VERY SANDY SOILS, AND SOME CHANNEL EROSION OCCURRED.
5. NARANJO CIVIL CONSTRUCTORS CONSTRUCTED POST-FLOOD CHANNEL RESTORATION IMPROVEMENTS IN 2013.
6. THESE RECORD DRAWINGS, DATED 9/2014 IN THE REVISION SECTION OF THE SHEET BORDER, REFLECT THE AS-CONSTRUCTED CONDITIONS AFTER REPAIR OF THE STORM DAMAGED AREAS.
7. SOME OF THE INFORMATION IN THESE DRAWINGS WAS NOT UPDATED TO REFLECT AS-CONSTRUCTED CONDITIONS, AS REQUESTED BY UDFCD. THE ITEMS THAT HAVE BEEN UPDATED PER THE 2013 CONSTRUCTED IMPROVEMENTS ARE NOTED ON EACH SHEET.

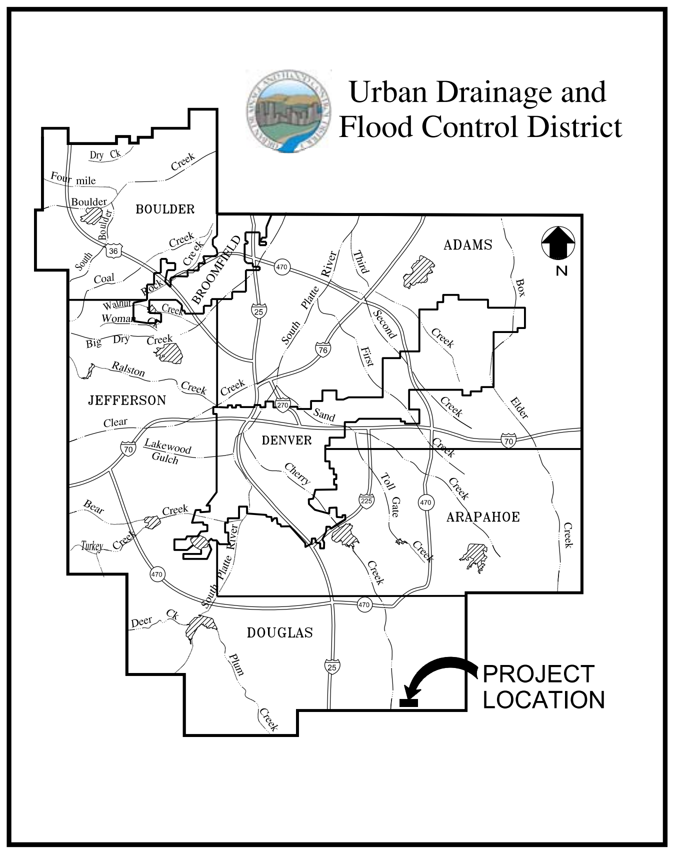


IMAGE BY: GOOGLE EARTH

PROJECT LOCATION

LOCATION MAP: DOUGLAS COUNTY
NTS

INDEX OF DRAWING

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

PAUL A HINDMAN, EXECUTIVE DIRECTOR — DATE

DAVE BENNETTS, MANAGER DESIGN, CONSTRUCTION AND MAINTENANCE — DATE

LAURA A KROEGER, SR. PROJECT ENGINEER — DATE

CH2M HILL

MARK GLIDDEN P.E., PROJECT MANAGER — DATE 4/2/2010

DOUGLAS COUNTY

ENGINEERING SERVICES DIRECTOR — DATE

DSGN	C BUTLER
DR	M MONAHAN
CHK	C BUTLER
APVD	M GLIDDEN

NO.	DATE	REVISION	BY	APVD
1	9/2014	RECORD DRAWINGS	BS	KH

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

CH2MHILL
9193 S JAMAICA ST
ENGLEWOOD, CO 80112
CONTACT: MARK GLIDDEN
720-286-5135

DOUGLAS COUNTY COLORADO

TIMBERS CREEK CHANNEL STABILIZATION

COVER SHEET AND INDEX OF DRAWINGS

SHEET	1
DWG	G-1
DATE	APRIL 2010
PROJ	328175

FILENAME: timcG001.dgn PLOT DATE: 2014\11\03 PLOT TIME: 7:49:21 AM

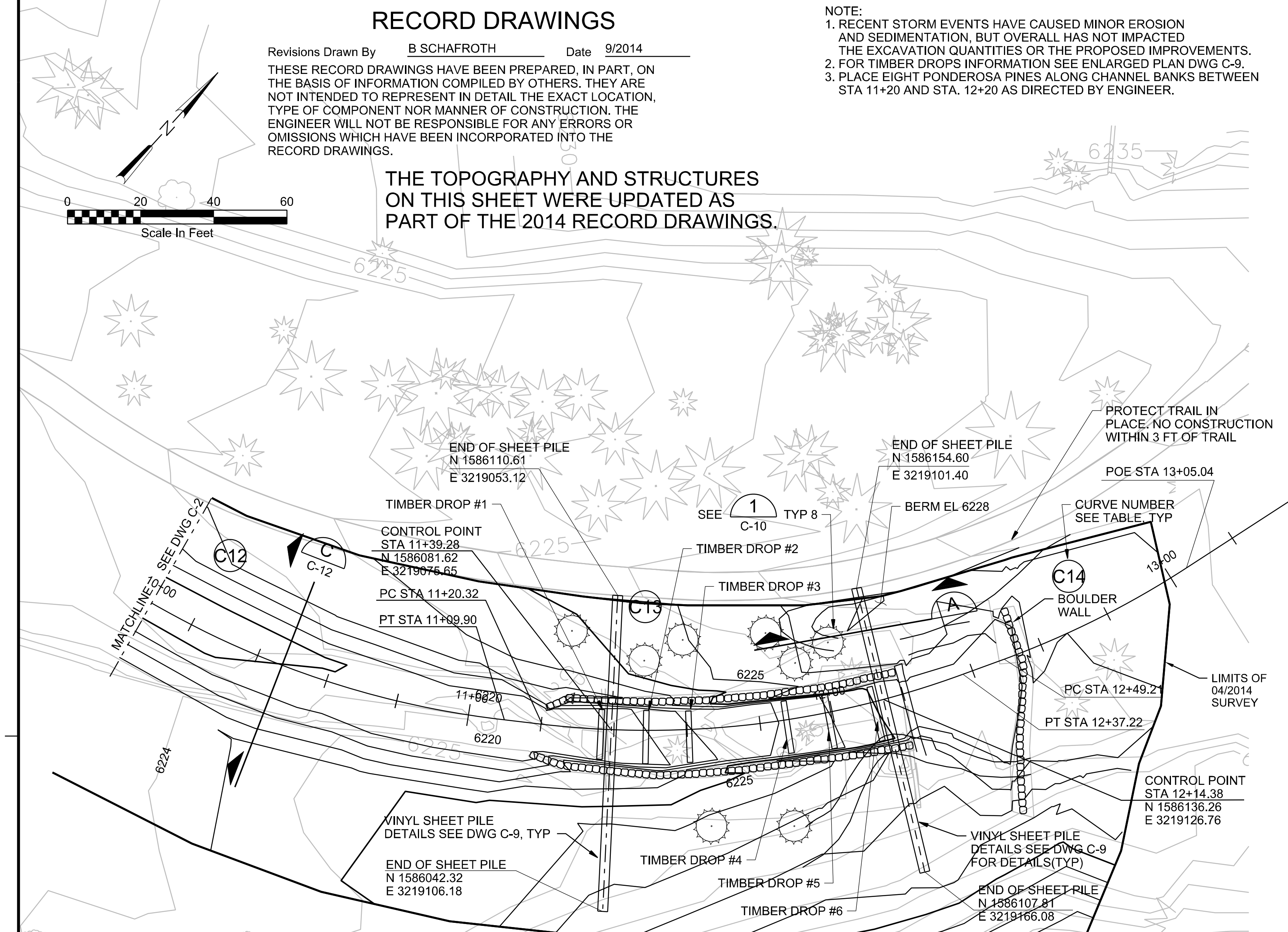
RECORD DRAWINGS

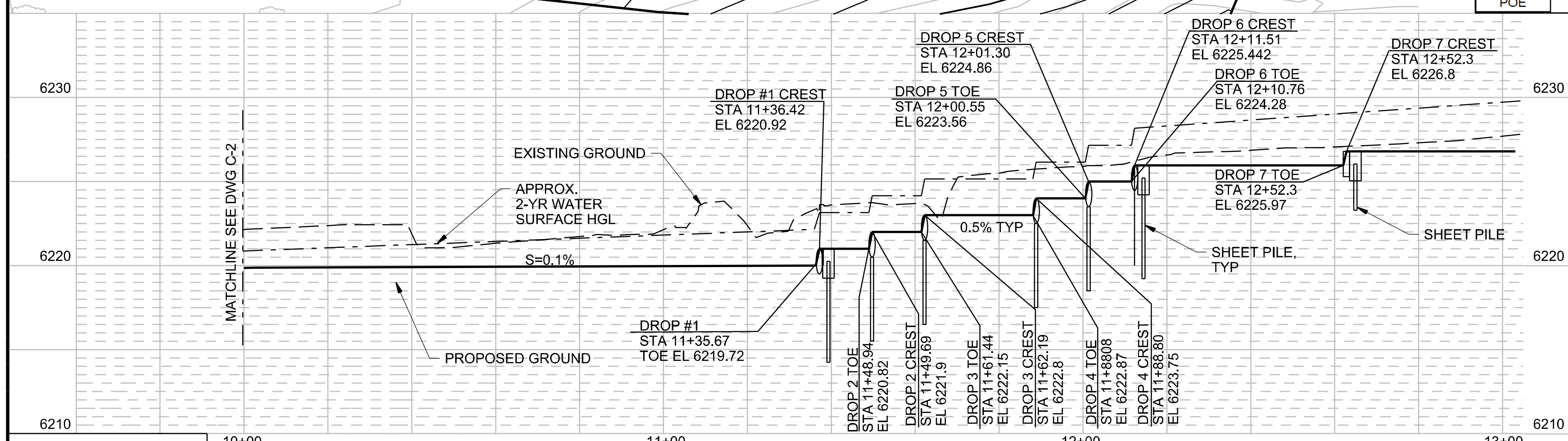
Revisions Drawn By B SCHAFROTH Date 9/2014

THESE RECORD DRAWINGS HAVE BEEN PREPARED, IN PART, ON THE BASIS OF INFORMATION COMPILED BY OTHERS. THEY ARE NOT INTENDED TO REPRESENT IN DETAIL THE EXACT LOCATION, TYPE OF COMPONENT NOR MANNER OF CONSTRUCTION. THE ENGINEER WILL NOT BE RESPONSIBLE FOR ANY ERRORS OR OMISSIONS WHICH HAVE BEEN INCORPORATED INTO THE RECORD DRAWINGS.

THE TOPOGRAPHY AND STRUCTURES ON THIS SHEET WERE UPDATED AS PART OF THE 2014 RECORD DRAWINGS.

NOTE:
1. RECENT STORM EVENTS HAVE CAUSED MINOR EROSION AND SEDIMENTATION, BUT OVERALL HAS NOT IMPACTED THE EXCAVATION QUANTITIES OR THE PROPOSED IMPROVEMENTS.
2. FOR TIMBER DROPS INFORMATION SEE ENLARGED PLAN DWG C-9.
3. PLACE EIGHT PONDEROSA PINES ALONG CHANNEL BANKS BETWEEN STA 11+20 AND STA. 12+20 AS DIRECTED BY ENGINEER.



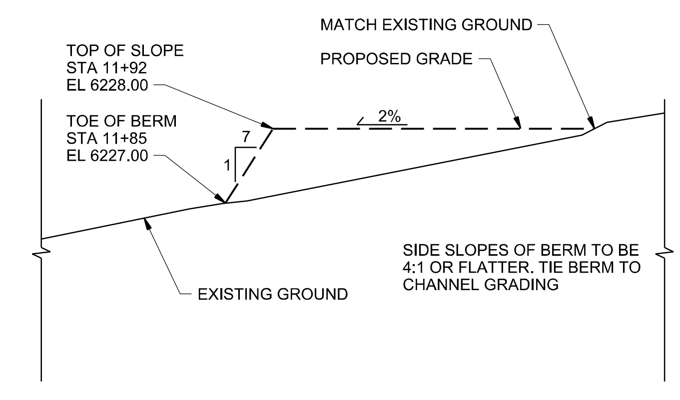


NORTH BANK STABILIZATION CONTROL LINE TABLE

TYPE	CURVE	STATION	NORTHING	EASTING	RADIUS	LENGTH	DELTA	DIRECTION
POB		0+00.00	1586119.30	3218134.77				
PC	G1	0+02.07	1586119.28	3218136.83				
PI		0+04.67	1586119.26	3218139.44	10	5.1	29°12'26"	Right
PT		0+07.17	1586117.97	3218141.70				
PC	G2	0+10.73	1586116.20	3218144.80				
PI		0+14.79	1586114.19	3218148.33	7	7.36	60°16'19"	Right
PT		0+18.09	1586110.12	3218148.33				
PC	G3	0+39.10	1586089.12	3218148.33				
PI		0+88.80	1586039.41	3218148.33	21	49.18	134°11'35"	Left
PT		0+88.28	1586074.06	3218183.96				
PC	G4	1+05.89	1586086.34	3218196.59				
PI		1+11.50	1586090.25	3218200.61	17	10.85	36°33'50"	Right
PT		1+16.73	1586091.00	3218206.18				
PC	G5	1+40.34	1586093.09	3218229.69				
PI		1+48.68	1586093.83	3218238.00	50	16.54	18°57'07"	Right
PT		1+56.87	1586091.83	3218246.10				
POE		1+77.16	1586086.93	3218265.79				

CHANNEL CONTROL LINE TABLE

TYPE	CURVE	STATION	NORTHING	EASTING	RADIUS	LENGTH	DELTA	Direction
POB		0+00.00	1586045.65	3218019.96				
PC	C1	0+07.12	1586046.53	3218027.03				
PI		0+39.51	1586050.55	3218059.17	200	64.22	18°23'49"	Right
PT		0+71.34	1586044.22	3218090.93				
PC	C2	1+18.64	1586034.97	3218137.32				
PI		1+62.05	1586026.49	3218179.89	100	81.91	46°56'01"	Left
PT		2+00.55	1586051.8	3218215.16				
PC	C3	2+05.06	1586054.42	3218218.82				
PI		2+49.15	1586080.13	3218254.65	100	83.06	47°35'34"	Right
PT		2+88.12	1586071.02	3218297.8				
PC	C4	3+01.23	1586068.3	3218310.62				
PI		3+41.33	1586060.01	3218349.86	100	76.28	43°42'14"	Right
PT		3+77.51	1586026.91	3218372.5				
PC	C5	4+01.49	1586007.11	3218386.04				
PI		5+03.87	1585922.6	3218443.83	150	179.67	68°37'47"	Left
PT		5+81.17	1585945.62	3218543.58				
PC	C6	6+13.82	1585952.96	3218575.4				
PI		6+21.83	1585954.77	3218583.2	45	15.86	20°11'32"	Left
PT		6+29.67	1585959.15	3218589.91				
PC		6+43.39	1585966.66	3218601.39				
PI		6+51.49	1585971.09	3218608.17	45	16.03	20°24'29"	Right
PT		6+59.42	1585972.88	3218616.06				
PC	C8	6+60.89	1585973.21	3218617.5				
PI		6+66.99	1585974.56	3218623.45	45	12.14	15°27'24"	Right
PT		6+73.03	1585974.27	3218629.55				
PT		6+73.03	1585974.27	3218629.55				
PC	C9	7+04.58	1585972.8	3218661.07				
PI		7+11.88	1585972.46	3218668.36	60	14.54	13°52'50"	Left
PT		7+19.11	1585973.88	3218675.53				
PC	C10	7+86.28	1585986.93	3218741.41				
PI		8+03.43	1585990.26	3218758.24	250	34.25	7°51'01"	Left
PT		8+20.53	1585995.86	3218774.46				
PC	C11	8+58.31	1586008.19	3218810.17				
PI		8+99.82	1586021.74	3218849.4	250	82.27	18°51'14"	Right
PT		9+40.58	1586021.89	3218890.91				
PC	C12	9+62.56	1586021.96	3218912.9				
PI		10+38.44	1586022.23	3218988.77	250	147.33	33°45'59"	Left
PT		11+09.90	1586064.62	3219051.7				
PC	C13	11+20.32	1586070.44	3219060.35				
PI		11+79.86	1586103.71	3219109.72	250	116.9	26°47'26"	Left
PT		12+37.22	1586155.65	3219138.81				
PC	C14	12+49.21	1586166.12	3219144.67				
PI		12+77.24	1586190.57	3219158.36	250	55.83	12°47'43"	Left
POE		13+05.04	1586217.46	3219166.3				



BERM DETAIL A
NTS

DSGN	C BUTLER				
DR	M MONAHAN				
CHK	C BUTLER	1	9/2014	RECORD DRAWINGS	BS	KH
APVD	K HAMILTON	NO.	DATE	REVISION	BY	APVD

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

CH2MHILL
9193 S JAMAICA ST
ENGLEWOOD, CO 80112
CONTACT: KYLE HAMILTON
720-286-5240

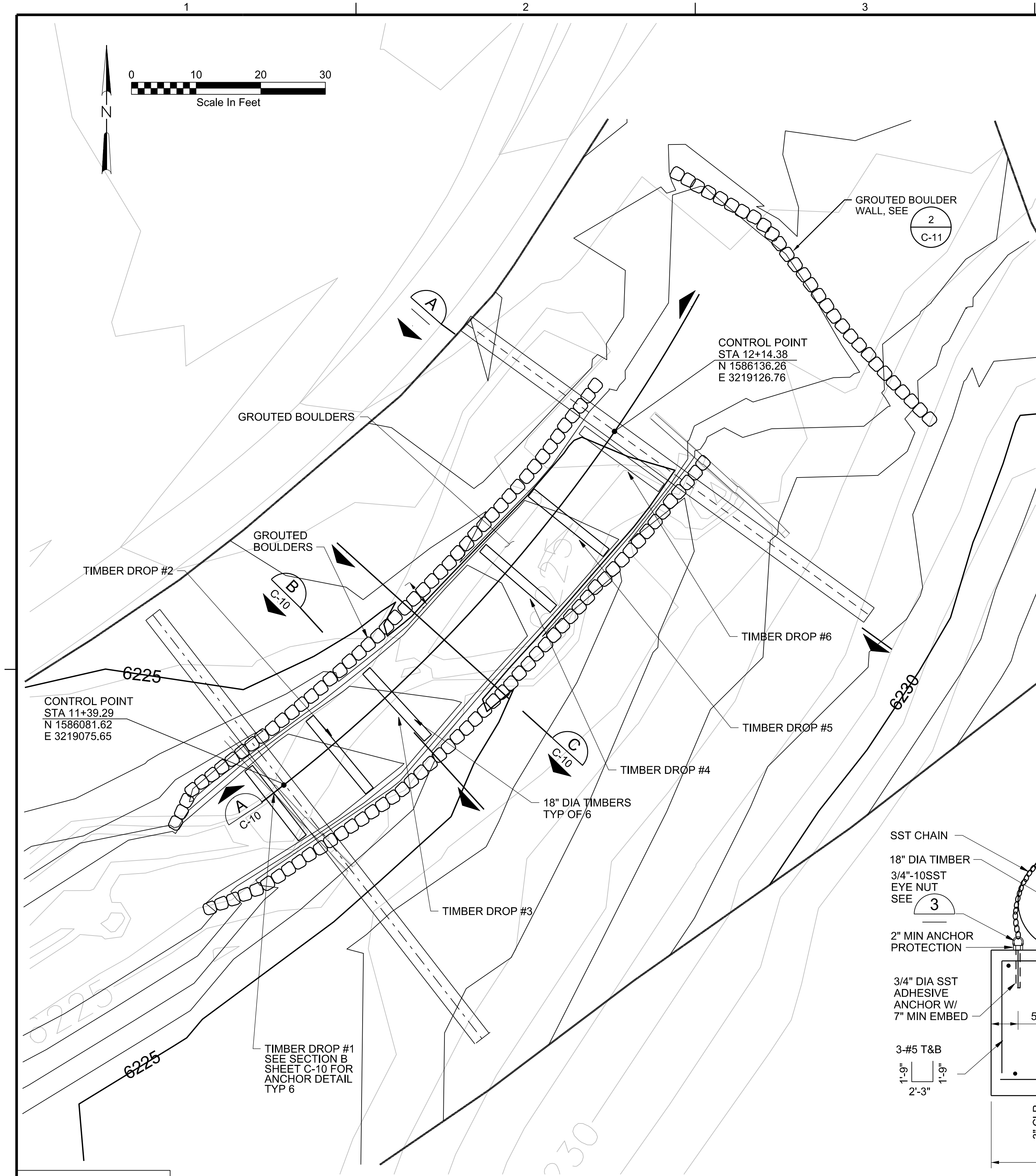
DOUGLAS COUNTY COLORADO

TIMBERS CREEK CHANNEL STABILIZATION

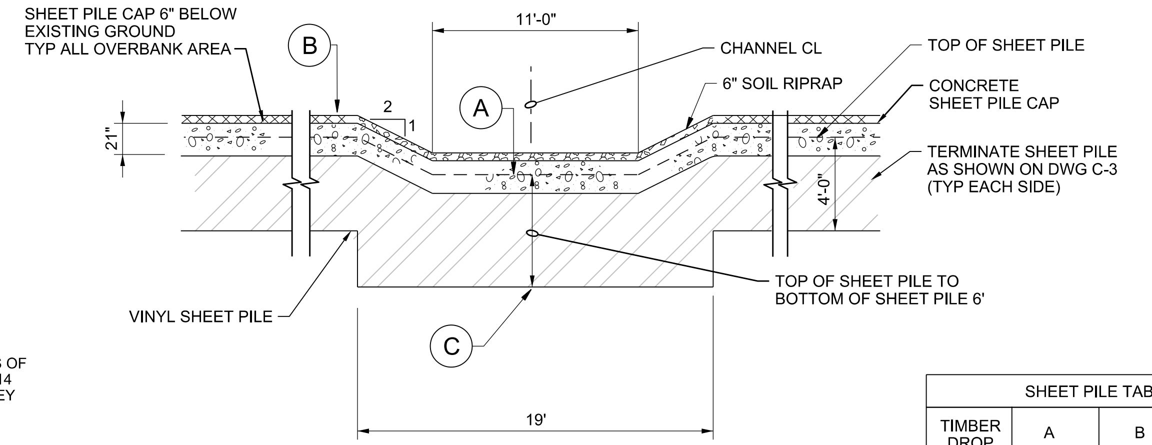
PLAN AND PROFILE
STATION 10+00 TO 13+05

SHEET	8
DWG	C-3
DATE	MARCH 2010
PROJ	328175

FILENAME: timcC003.dgn PLOT DATE: 2014\11\11 PLOT TIME: 1:38:16 PM

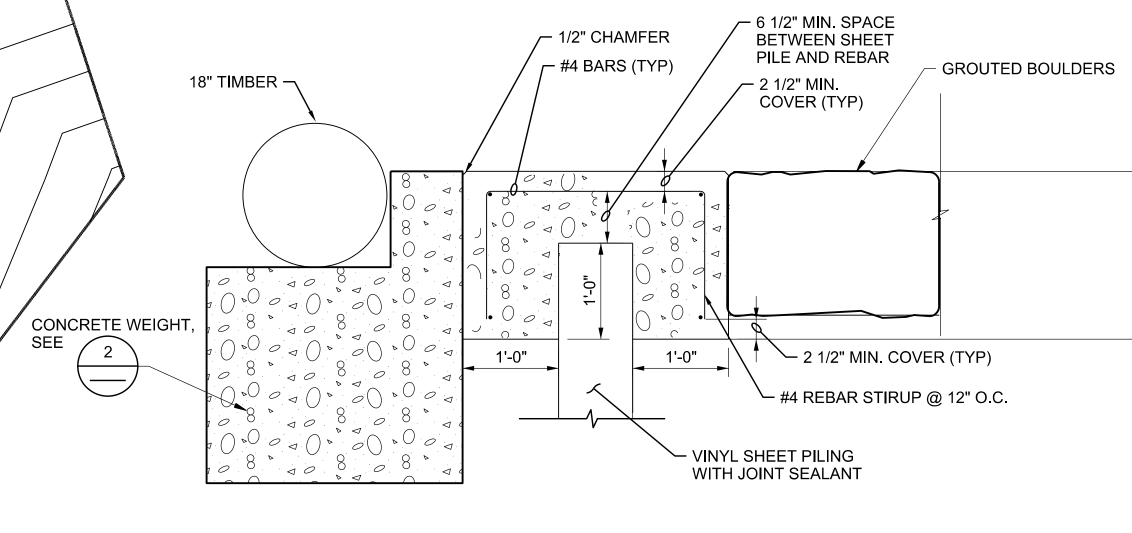


ENLARGED PLAN
1"=10'

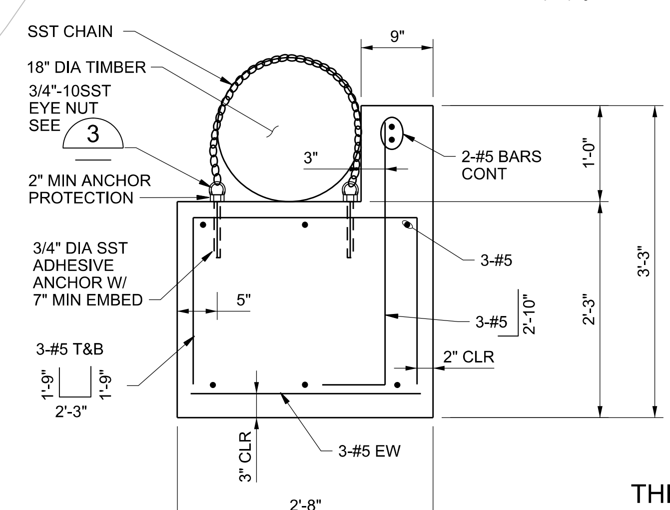


LOG DROP SHEET PILE PROFILE A
3/16"=1'-0"

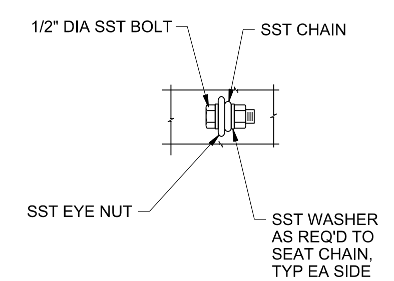
SHEET PILE TABLE			
TIMBER DROP	A	B	C
1	6219.75	6223.00	6213.75
6	6224.80	6228.26	6218.80



SHEET PILE AND SHEET PILE CAP DETAIL 1
1"=1'-0"



CONCRETE WEIGHT DETAIL 2
1"=1'-0"



DETAIL 3
3"=1'-0"

NOTES
1. SST BOLTS AND THREADED ANCHOR STUDS: ASTM F593, AISI 316, CONDITION CW. SST NUTS AND WASHERS: ASTM F594, AISI 316, CONDITION CW
2. SST CHAIN:3/8" AISI 316L, GRADE 50, WORKING LOAD LIMIT 4,000 LB MIN. MCMASTER-CARR PART NUMBER 33645T53 OR EQUAL.
3. SST EYE NUT: AISI TYPE 316, ¾" - 10 OVAL EYE, WORKING LOAD LIMIT 4,000 LB MIN. MCMASTER-CARR PART NUMBER 3061T23 OR EQUAL.
4. CONCRETE:
   a. CONCRETE SHALL HAVE A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 4000 PSI AND SHALL CONFORM TO ASTM C94 OPTION A. WATER TO CEMENT RATIO SHALL NOT EXCEED 0.44.
   b. AGGREGATES SHALL BE 3/4 INCH AND SMALLER CONFORMING TO ASTM C33. COARSE AGGREGATE SHALL BE SIZE NO. 57 NO. 67.
   c. SLUMP SHALL BE 4 INCHES +/- 1 INCH. PROVIDE WATER REDUCING ADMIXTURES AS REQUIRED. AIR CONTENT SHALL BE 6% +1% / -2%
   d. WET CURE CONCRETE FOR A MINIMUM OF 3 DAYS AFTER PLACEMENT; ALTERNATIVELY, APPLY CURING COMPOUND MEETING REQUIREMENTS OF ASTM C309.

THE TOPOGRAPHY AND STRUCTURES ON THIS SHEET WERE UPDATED AS PART OF THE 2014 RECORD DRAWINGS

RECORD DRAWINGS

Revisions Drawn By B SCHAFROTH Date 9/2014

THESE RECORD DRAWINGS HAVE BEEN PREPARED, IN PART, ON THE BASIS OF INFORMATION COMPILED BY OTHERS. THEY ARE NOT INTENDED TO REPRESENT IN DETAIL THE EXACT LOCATION, TYPE OF COMPONENT NOR MANNER OF CONSTRUCTION. THE ENGINEER WILL NOT BE RESPONSIBLE FOR ANY ERRORS OR OMISSIONS WHICH HAVE BEEN INCORPORATED INTO THE RECORD DRAWINGS.

DSGN	C BUTLER					
DR	M MONAHAN					
CHK	C BUTLER	1	9/2014	RECORD DRAWINGS	BS	KH
APVD	K HAMILTON	NO.	DATE	REVISION	BY	APVD

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

CH2MHILL
9193 S JAMAICA ST
ENGLEWOOD, CO 80112
CONTACT: MARK GLIDDEN
720-286-5135

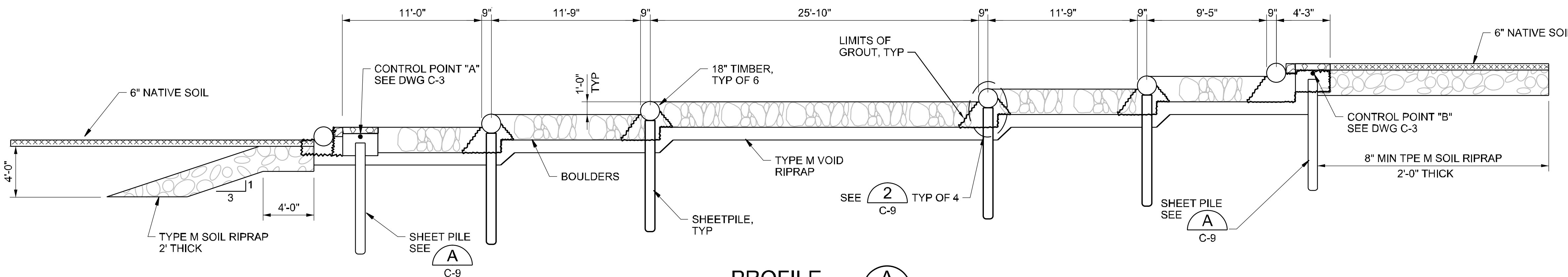
DOUGLAS COUNTY COLORADO

TIMBERS CREEK CHANNEL STABILIZATION

TIMBER DROP STRUCTURE
PLAN, SECTIONS, AND DETAILS

SHEET	14
DWG	C-9
DATE	APRIL 2010
PROJ	328175

FILENAME: timcDT01rev1.dgn PLOT DATE: 2014\11\03 PLOT TIME: 8:57:13 AM



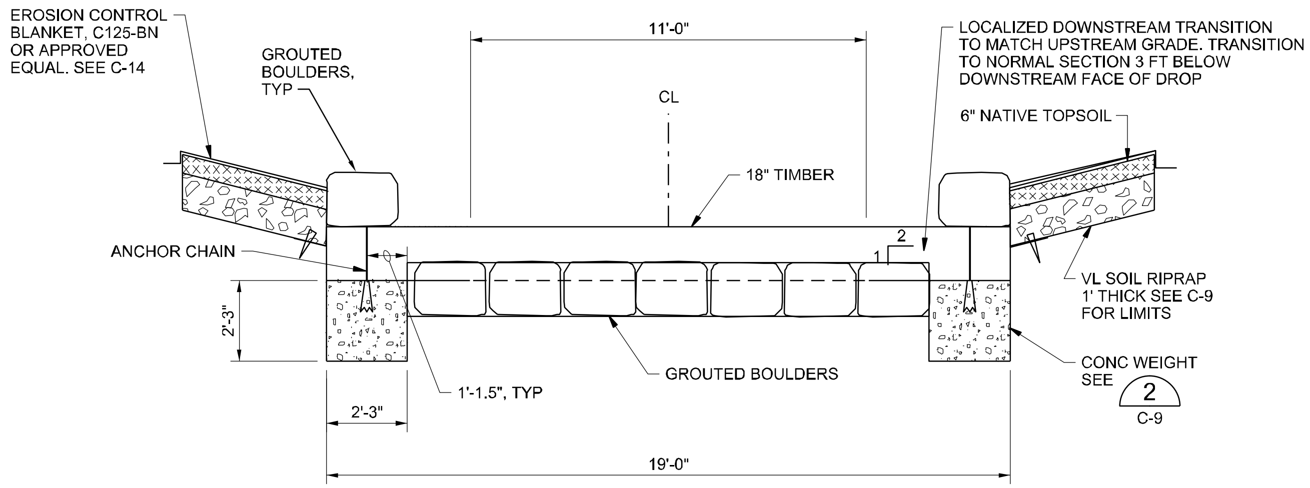
PROFILE A
1"=5' C-9

RECORD DRAWINGS

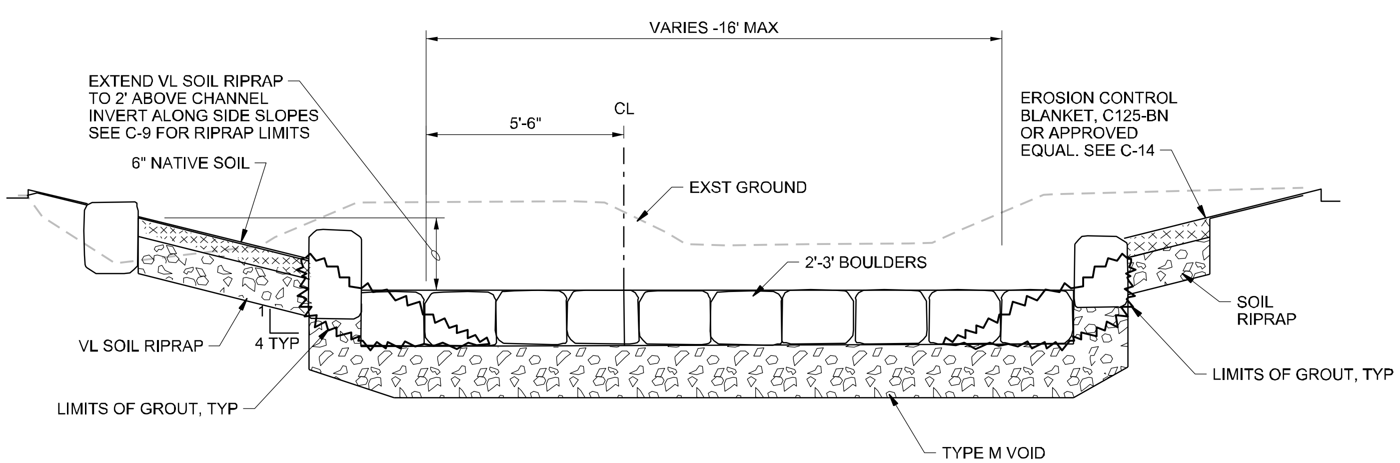
Revisions Drawn By B SCHAFROTH Date 9/2014

THESE RECORD DRAWINGS HAVE BEEN PREPARED, IN PART, ON THE BASIS OF INFORMATION COMPILED BY OTHERS. THEY ARE NOT INTENDED TO REPRESENT IN DETAIL THE EXACT LOCATION, TYPE OF COMPONENT NOR MANNER OF CONSTRUCTION. THE ENGINEER WILL NOT BE RESPONSIBLE FOR ANY ERRORS OR OMISSIONS WHICH HAVE BEEN INCORPORATED INTO THE RECORD DRAWINGS.

THE GROUTED BOULDERS IN THE TIMBER DROP STRUCTURES ON THIS SHEET WERE UPDATED AS PART OF THE 2014 RECORD DRAWINGS.



SECTION B
1/4"=1'-0" C-9



SECTION C
3/8"=1'-0" C-9

VOID RIPRAP NOTES:

1. ROCK REQUIREMENTS ARE TO COMPLY WITH TYPE M RIPRAP.
2. THE COLOR OF RIPRAP AND VOID-FILL MATERIALS USED TO FILL THE RIPRAP VOIDS SHALL BE LIGHT GRAY OR TAN AND SHALL BE UNIFORM. SAMPLES OF RIPRAP AND VOID-FILL MATERIALS SHALL BE SUBMITTED FOR REVIEW AND APPROVAL OF THE ENGINEER PRIOR TO CONSTRUCTION.
3. WHERE "TYPE M VOID-FILLED RIPRAP" IS DESIGNATED ON THE CONTRACT DRAWINGS, RIPRAP SHALL BE MIXED WITH THE MATERIALS AND ASSOCIATED PROPORTIONS LISTED IN THE TABLE BELOW TO FILL THE VOIDS 0F THE RIPRAP:

Approximate Proportions (loader buckets)	Material Type	Material Description
6	Riprap	Type M Riprap
3	Void-fill material	7-inch minus crushed rock surge (100% passing 7-inch sieve, 80-100% passing 6-inch sieve, 35-50% passing 3-inch sieve, 10-20% passing 1.5-inch sieve)
1	Void-fill material	2 to 4-inch cobble (round washed river rock that is well-graded, 100% passing 6-inch sieve, 35-50% passing 3-inch sieve, 5-20% passing 2-inch sieve)
1	Void-Fill material	4-inch minus pit run surge (round river rock and sand, well graded, 90-100% passing 4-inch sieve, 70-80% passing 1.5-inch sieve, 40-60% passing 3/8-inch sieve, 10-30% passing #16 sieve)
1	Void-fill material	Type II bedding
½ to 1	Void-fill material	Native topsoil
Top layer	Top dressing	Additional 4 to 12-inch cobbles (round washed river rock that is well graded, 80-100% passing 12-inch sieve, 35-50% passing 6-inch sieve, 5-20% passing 4-inch sieve) shall be mixed in on the surface of the void-filled riprap (covering approximately 40% of the surface) prior to compaction of the void-filled riprap. Cobbles shall be fully embedded into the mass of the void-filled riprap.

NOTE: MIX PROPORTIONS AND MATERIAL GRADATIONS ARE APPROXIMATE AND ARE SUBJECT TO ADJUSTMENT BY THE ENGINEER. NO ADJUSTMENT IN UNIT PRICE FOR VOID-FILLED RIPRAP WILL BE ALLOWED BASED ON MODIFICATION TO THE MIX PROPORTIONS.

DSGN C BUTLER						
DR M MONAHAN						
CHK C BUTLER						
APVD K HAMILTON	1	9/2014	RECORD DRAWINGS	BS	KH	
	NO.	DATE	REVISION	BY	APVD	

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

CH2MHILL
9193 S JAMAICA ST
ENGLEWOOD, CO 80112
CONTACT: MARK GLIDDEN
720-286-5135

DOUGLAS COUNTY COLORADO

TIMBERS CREEK CHANNEL STABILIZATION

TIMBER DROP STRUCTURE SECTIONS

SHEET	15
DWG	C-10
DATE	APRIL 2010
PROJ	328175

FILENAME: timcDT02rev1.dgn PLOT DATE: 2014\11\04 PLOT TIME: 6:34:41 AM

Appendix D. Rock Creek Photos

LOG DROP 1 – SCULPTED CONCRETE LOG DROP

LOG DROP 2 – NATURAL LOG DROP (Cottonwood)

LOG DROP 3 – NATURAL LOG DROP (Pine)

LOG DROP 4 – NATURAL LOG DROP (Cedar)

LOG DROP 5 – NATURAL LOG DROP (Cedar)

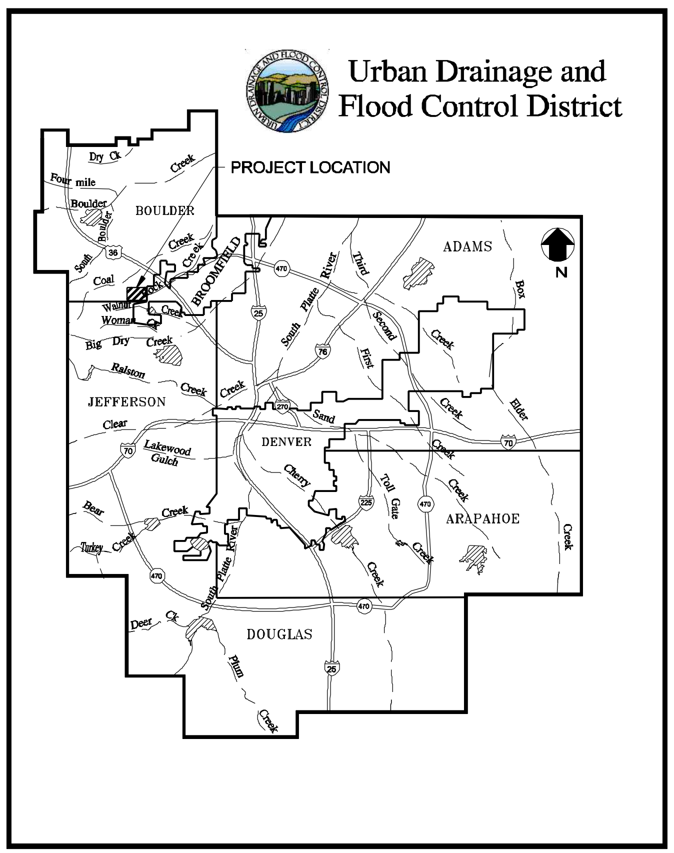
LOG DROP 6 – NATURAL LOG DROP (Cedar)

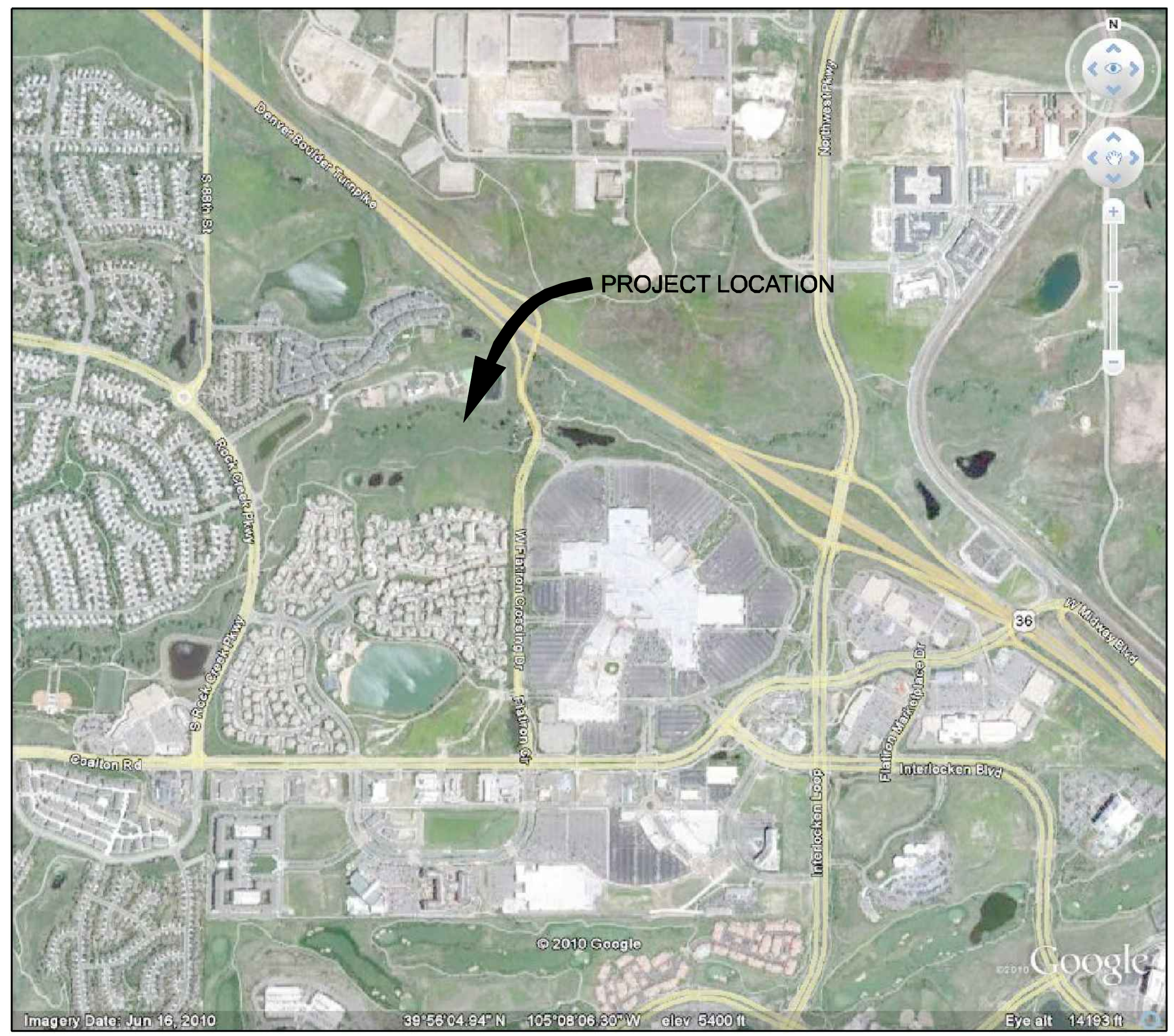
LOG DROP 7 – SCULPTED CONCRETE LOG DROP / FLOW SPLITTER (including artistic stump)

Appendix E. Rock Creek As-Builts (2012)

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
CONTRACT DRAWINGS FOR CONSTRUCTION OF
ROCK CREEK CHANNEL IMPROVEMENTS BETWEEN
WEST FLATIRON CIRCLE AND SOUTH ROCK CREEK PARKWAY

JUNE 2011





LOCATION MAP: BOULDER COUNTY
NTS
SOURCE: GOOGLE EARTH

INDEX OF DRAWINGS

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

MANAGER DESIGN, CONSTRUCTION AND MAINTENANCE, DAVID BENNETTS — DATE

SENIOR PROJECT ENGINEER, DAVID SKUODAS — DATE

TOWN OF SUPERIOR

DIRECTOR OF PUBLIC WORKS AND UTILITIES, KURT KOWAR — DATE

CH2M HILL

SENIOR PROJECT MANAGER, KYLE HAMILTON — DATE

RECORD DRAWINGS

THIS RECORD DRAWING IS A COMPILATION OF INFORMATION RECEIVED FROM THE CONTRACTOR(S)/ SUPPLIER(S). THE INFORMATION SHOWN ON THIS DRAWING HAS NOT BEEN VERIFIED FOR ACCURACY OR COMPLETENESS.

DSGN	A. COOK
DR	J. WALKER
CHK	C. HOOPER
APVD	K. HAMILTON

NO.	DATE	REVISION	BY	APVD
1	1/12	RECORD DRAWINGS	AC	KH

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

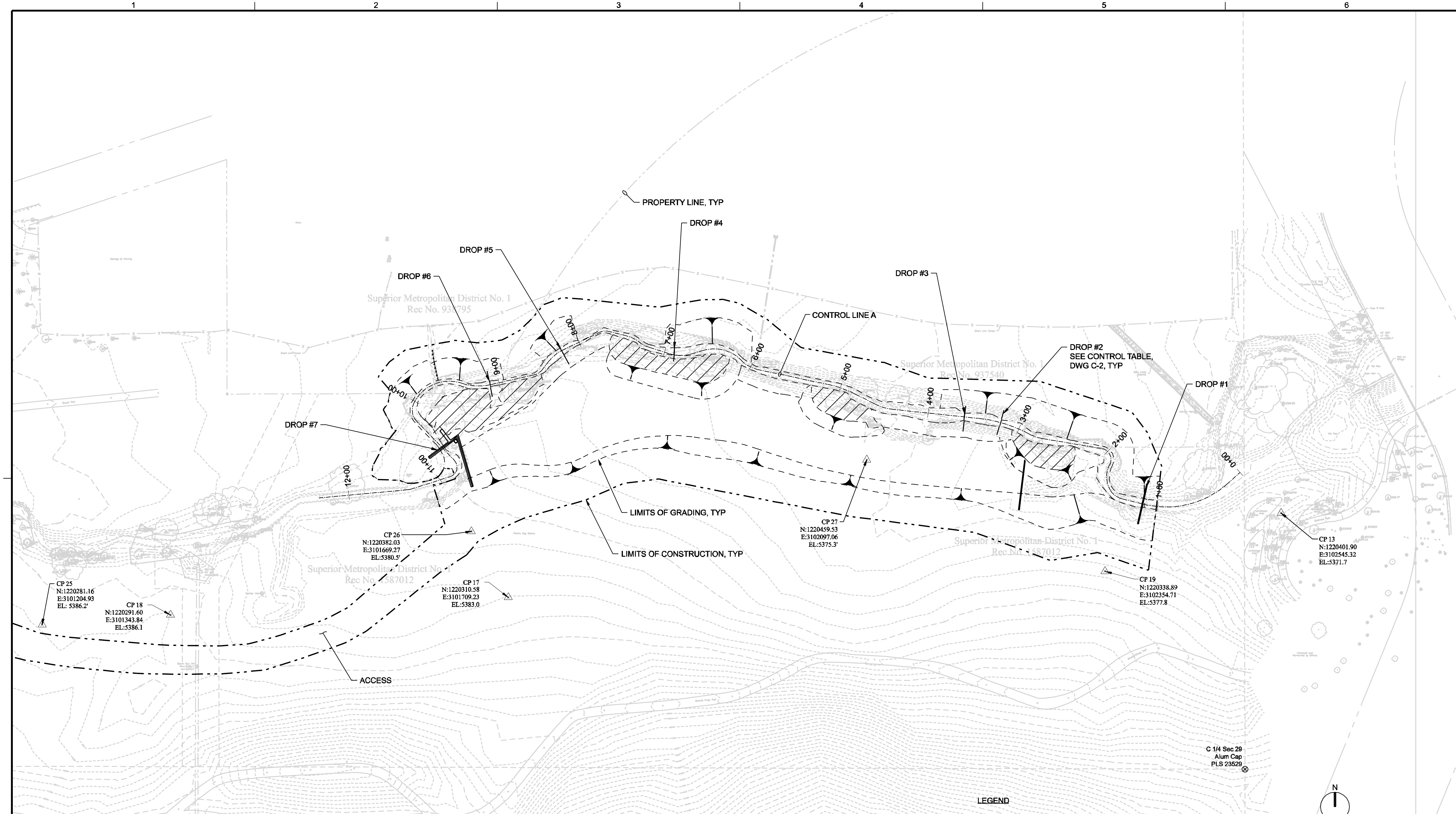
CH2MHILL
9193 SOUTH JAMAICA STREET
ENGLEWOOD, CO 80112
KYLE HAMILTON: (720) 286-5240

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
TOWN OF SUPERIOR
ROCK CREEK IMPROVEMENTS BETWEEN
W FLATIRON CIR AND S ROCK CREEK PARKWAY

ROCK CREEK CHANNEL IMPROVEMENTS
COVER SHEET

SHEET	1
DWG	G-1
DATE	JUNE 2011
PROJ	392516

FILENAME: RC01ng001_AB.dgn PLOT DATE: 1/13/2012 PLOT TIME: 1:36:32 PM



RECORD DRAWINGS

THIS RECORD DRAWING IS A COMPILATION OF INFORMATION RECEIVED FROM THE CONTRACTOR(S)/ SUPPLIER(S). THE INFORMATION SHOWN ON THIS DRAWING HAS NOT BEEN VERIFIED FOR ACCURACY OR COMPLETENESS.

LEGEND

TREE PROTECTION AREA, NO GRADING ALLOWED UNLESS SHOWN ON PLAN.

DSGN A. COOK	1	1/12	RECORD DRAWINGS	AC	KH	VERIFY SCALE	
DR J. WALKER						BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1" IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.	
CHK C. HOOPER							
APVD K. HAMILTON	NO.	DATE	REVISION	BY	APVD		

CH2MHILL
9193 SOUTH JAMAICA STREET
ENGLEWOOD, CO 80112
KYLE HAMILTON: (720) 286-5240

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
TOWN OF SUPERIOR
ROCK CREEK IMPROVEMENTS BETWEEN
W FLATIRON CIR AND S ROCK CREEK PARKWAY

ROCK CREEK CHANNEL IMPROVEMENTS

SURVEY CONTROL PLAN

SHEET	3
DWG	C-1
DATE	JUNE 2011
PROJ	392516

FILENAME: RC05c004_AB.dgn PLOT DATE: 1/13/2012 PLOT TIME: 1:38:15 PM

CONTROL LINE A

POINT TYPE	STATION	NORTHING	EASTING	RADIUS (FT)	LENGTH (FT)	DELTA / THETA	ROTATION DIRECTION
POB	0+00.00	1220445.84	3102500.78				
PC	0+17.48	1220434.14	3102487.79				
PC	0+17.48	1220434.14	3102487.79				
PI	0+71.09	1220398.26	3102447.96	100	98.42	56°23'22"	RIGHT
CC		1220508.44	3102420.86				
PT	1+15.90	1220411.57	3102396.03				
PT	1+15.90	1220411.57	3102396.03				
PC	1+40.08	1220417.58	3102372.60				
PC	1+40.08	1220417.58	3102372.60				
PI	1+48.32	1220419.62	3102364.63	20	15.62	44°44'50"	RIGHT
CC		1220436.95	3102377.57				
PCC	1+55.70	1220426.69	3102360.41				
PCC	1+55.70	1220426.69	3102360.41				
PI	1+71.55	1220440.29	3102352.28	28	28.84	59°00'17"	RIGHT
CC		1220441.06	3102384.44				
PRC	1+84.54	1220454.26	3102359.75				
PRC	1+84.54	1220454.26	3102359.75				
PI	2+01.22	1220468.97	3102367.61	12	22.74	108°33'25"	LEFT
CC		1220459.92	3102349.16				
PT	2+07.27	1220471.75	3102351.16				
PT	2+07.27	1220471.75	3102351.16				
PC	2+71.80	1220482.48	3102287.53				
PC	2+71.80	1220482.48	3102287.53				
PI	2+79.93	1220483.83	3102279.52	50	16.11	18°27'50"	RIGHT
CC		1220531.79	3102295.85				
PRC	2+87.91	1220487.65	3102272.34				
PRC	2+87.91	1220487.65	3102272.34				
PI	3+17.10	1220501.37	3102246.58	150	57.65	22°01'14"	LEFT
CC		1220355.26	3102201.83				
PT	3+45.56	1220504.43	3102217.56				
PT	3+45.56	1220504.43	3102217.56				
PC	4+37.46	1220514.07	3102126.17				
PC	4+37.46	1220514.07	3102126.17				
PI	4+48.44	1220515.22	3102115.25	60	21.71	20°43'44"	RIGHT
CC		1220573.74	3102132.46				
PT	4+59.17	1220520.16	3102105.45				
PT	4+59.17	1220520.16	3102105.45				
PC	4+83.41	1220531.07	3102083.81				
PC	4+83.41	1220531.07	3102083.81				
PI	4+99.04	1220538.10	3102069.85	120	31.08	14°50'30"	LEFT
CC		1220423.90	3102029.80				
PT	5+14.49	1220541.32	3102054.56				
PT	5+14.49	1220541.32	3102054.56				
PC	5+90.01	1220556.90	3101980.67				
PC	5+90.01	1220556.90	3101980.67				
PI	6+01.96	1220559.37	3101968.97	40	23.24	33°17'06"	RIGHT
CC		1220596.04	3101988.92				
PRC	6+13.24	1220567.85	3101960.54				
PRC	6+13.24	1220567.85	3101960.54				
PI	6+36.76	1220584.53	3101943.97	40	42.52	60°54'14"	LEFT
CC		1220539.66	3101932.17				
PT	6+55.76	1220578.17	3101921.33				
PT	6+55.76	1220578.17	3101921.33				
PC	6+71.00	1220574.04	3101906.67				

POINT TYPE	STATION	NORTHING	EASTING	RADIUS (FT)	LENGTH (FT)	DELTA / THETA	ROTATION DIRECTION
PC	6+71.00	1220574.04	3101906.67				
PI	6+82.91	1220570.81	3101895.20	40	23.16	33°10'18"	RIGHT
CC		1220612.54	3101895.83				
PT	6+94.16	1220574.39	3101883.83				
PT	6+94.16	1220574.39	3101883.83				
PC	7+18.20	1220581.60	3101860.90				
PC	7+18.20	1220581.60	3101860.90				
PI	7+23.69	1220583.25	3101855.66	30	10.87	20°45'10"	RIGHT
CC		1220610.22	3101869.90				
PRC	7+29.06	1220586.64	3101851.34				
PRC	7+29.06	1220586.64	3101851.34				
PI	7+37.61	1220591.93	3101844.63	40	16.84	24°07'23"	LEFT
CC		1220555.22	3101826.60				
PT	7+45.90	1220594.01	3101836.34				
PT	7+45.90	1220594.01	3101836.34				
PC	7+64.74	1220598.60	3101818.07				
PC	7+64.74	1220598.60	3101818.07				
PI	7+70.17	1220599.92	3101812.80	15	10.42	39°48'38"	LEFT
CC		1220584.05	3101814.42				
PT	7+75.16	1220597.56	3101807.91				
PT	7+75.16	1220597.56	3101807.91				
PC	8+18.64	1220578.69	3101768.74				
PC	8+18.64	1220578.69	3101768.74				
PI	8+28.89	1220574.24	3101759.50	45	20.17	25°40'42"	LEFT
CC		1220538.15	3101788.27				
PT	8+38.81	1220566.22	3101753.10				
PT	8+38.81	1220566.22	3101753.10				
PC	8+50.91	1220556.76	3101745.55				
PC	8+50.91	1220556.76	3101745.55				
PI	8+56.19	1220552.64	3101742.26	15	10.15	38°45'23"	RIGHT
CC		1220566.12	3101733.82				
PT	8+61.06	1220551.48	3101737.11				
PT	8+61.06	1220551.48	3101737.11				
PC	9+08.92	1220541.00	3101690.40				
PC	9+08.92	1220541.00	3101690.40				
PI	9+25.48	1220537.38	3101674.25	60	32.31	30°51'28"	RIGHT
CC		1220599.55	3101677.27				
PRC	9+41.24	1220542.55	3101658.52				
PRC	9+41.24	1220542.55	3101658.52				
PI	9+77.94	1220554.03	3101623.65	42.5	60.55	81°37'54"	LEFT
CC		1220502.18	3101645.23				
PCC	10+01.79	1220521.20	3101607.23				
PCC	10+01.79	1220521.20	3101607.23				
PI	10+14.14	1220510.15	3101601.70	17.5	21.51	70°26'04"	LEFT
CC		1220513.37	3101622.88				
PT	10+23.30	1220501.25	3101610.26				
PT	10+23.30	1220501.25	3101610.26				
PC	10+81.69	1220459.14	3101650.70				
PC	10+81.69	1220459.14	3101650.70				
PI	10+99.08	1220446.60	3101662.76	10.85	21.98	116°05'34"	RIGHT
CC		1220451.63	3101642.88				
PT	11+03.67	1220441.29	3101646.19				
PT	11+03.67	1220441.29	3101646.19				
PC	11+46.09	1220428.36	3101605.79				
PC	11+46.09	1220428.36	3101605.79				
PI	11+49.37	1220427.36	3101602.67	30	6.54	12°29'17"	RIGHT
CC		1220456.93	3101596.64				
PT	11+52.63	1220427.05	3101599.40				
PT	11+52.63	1220427.05	3101599.40				
POE	12+48.16	1220418.27	3101504.27				

SURVEY CONTROL

1. SURVEY CONDUCTED BY GEOSURV INC. 2010.
2. PROJECT IS MODIFIED COLORADO STATE PLANE NORTH ZONE, SCALED FROM 0,0, NAD 83.
3. SCALE FACTOR = 0.999713798934
4. PROJECT BENCHMARK IS NGS KK1556 (Q 413) NAVD 88 = 5296.02
5. GENERAL GRADING TOLERANCE SHALL BE 0.2'. GRADING TOLERANCE FOR THE BOTTOM OF THE WETLAND AREA SHALL BE 0.1'.
6. CONTROL LINE A CORRESPONDS TO THE CHANNEL INVERT AND PROFILES ON DWGS C-4 AND C-5. CONTROL LINE A DOES NOT REPRESENT THE CENTER OF THE CHANNEL BOTTOM, WHICH VARIES PER THE PLANS.
7. THE FOLLOWING INFORMATION WILL BE PROVIDED TO THE CONTRACTOR FOR SURVEY CONTROL:
   - A. INFORMATION CONTAINED IN THE CONSTRUCTION CONTRACT DOCUMENTS HEREIN.
   - B. ELECTRONIC FILES AS FOLLOWS:
     - I. FINISHED GRADE CAD TOPOGRAPHY LAYER, AND CORRESPONDING TOPS AND TOES OF SLOPES.
     - II. DIGITAL ELEVATION MODEL OF THE FINISHED GRADE.
   - C. THE DIGITAL ELEVATION MODEL IS PROVIDED FOR ROUGH GRADING.
   - D. THESE DRAWINGS SHALL TAKE PRECEDENCE OVER CONFLICTING ELECTRONIC DATA.
8. CONTRACTOR SHALL COMPLETE AND VERIFY GRADING ELEVATIONS PRIOR TO MOBILIZATION BY THE RESTORATION CONTRACTOR.
9. CONSTRUCTION FENCE SHALL BE PLACED AROUND THE TREE PROTECTION AREAS AT THE TOP OF THE SLOPE.

EXISTING CONTROL POINT LIST

PNT	NORTHING	EASTING	ELEV	DESCRIPTION
10	1220132.74	3101534.57	5403.8	2" ALUM CAP
11	1220135.95	3100485.17	5403.5	2" ALUM CAP
12	1219292.79	3100509.98	5413.1	2" ALUM CAP
13	1220401.90	3102545.32	5371.7	SPIKE
14	1219348.21	3100376.24	5410.3	SPIKE
15	1219871.75	3101984.85	5439.9	2" ALUM CAP
17	1220310.58	3101709.23	5383.0	SPIKE
18	1220291.60	3101343.84	5386.1	SPIKE
19	1220338.89	3102354.71	5377.8	SPIKE
20	1219609.65	3100434.17	5404.6	SPIKE
21	1219841.16	3100470.56	5401.1	SPIKE
22	1220013.31	3100530.29	5396.8	SPIKE
23	1220168.51	3100805.95	5393.6	SPIKE
24	1220278.06	3100747.99	5393.0	SPIKE
25	1220281.16	3101204.93	5386.2	SPIKE
26	1220382.03	3101669.27	5380.5	SPIKE
27	1220459.53	3102097.06	5375.3	SPIKE

DROP DETAILS

1

				BANK SLOPE AT LOG	BANK SLOPE AT LOG	BURY LENGTH	BURY LENGTH	
DROP NO.	MATERIAL	LOG DIAMETER	DROP HEIGHT	NORTH	SOUTH	NORTH (DIMENSION A)	SOUTH (DIMENSION B)	LOG LENGTH (DIMENSION C)
		(INCHES)	(FT)	(XH:1V)	(XH:1V)	(FT)	(FT)	(FT)
1	CONCRETE	30	1.84	4	4	11.36	11.36	30.72
2	COTTONWOOD	24	1.50	4	4	10	10	28 (USE EXST TREE)
3	PINE	18	0.99	4	6	8	12	28
4	CEDAR	18	0.71	4	4	6.84	6.84	21.68
5	CEDAR	18	1.01	4	6	8	12	28
6	CEDAR	24	1.50	4	4	10	10	28
7	CONCRETE	30	1.00	4	4	N/A - LOGS FOLLOW THE SLOPE OF THE BANK		

NOTE: SEE DWG C-8.

DROP CONTROL TABLE

END OF LOG CONTROL POINT TABLE				
TIMBER DROP	NORTH CONTROL POINT		SOUTH CONTROL POINT	
NO.	N	E	N	E
1	1220428.99	3102399.80	1220396.30	3102392.03
2	1220513.36	3102245.40	1220486.41	3102237.84
3	1220517.93	3102203.96	1220490.09	3102201.03
4	1220587.64	3101889.52	1220566.05	3101888.08
5	1220587.47	3101761.75	1220562.85	3101775.09
6	1220555.45	3101686.37	1220528.04	3101691.94

NOTE: SEE B / C-8

RECORD DRAWINGS

THIS RECORD DRAWING IS A COMPILATION OF INFORMATION RECEIVED FROM THE CONTRACTOR(S)/ SUPPLIER(S). THE INFORMATION SHOWN ON THIS DRAWING HAS NOT BEEN VERIFIED FOR ACCURACY OR COMPLETENESS.

DSGN A. COOK	1	1/12	RECORD DRAWINGS	AC	KH
DR J. WALKER					
CHK C. HOOOPER					
APVD K. HAMILTON	NO.	DATE	REVISION	BY	APVD

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

CH2MHILL
9193 SOUTH JAMAICA STREET
ENGLEWOOD, CO 80112
KYLE HAMILTON: (720) 286-5240

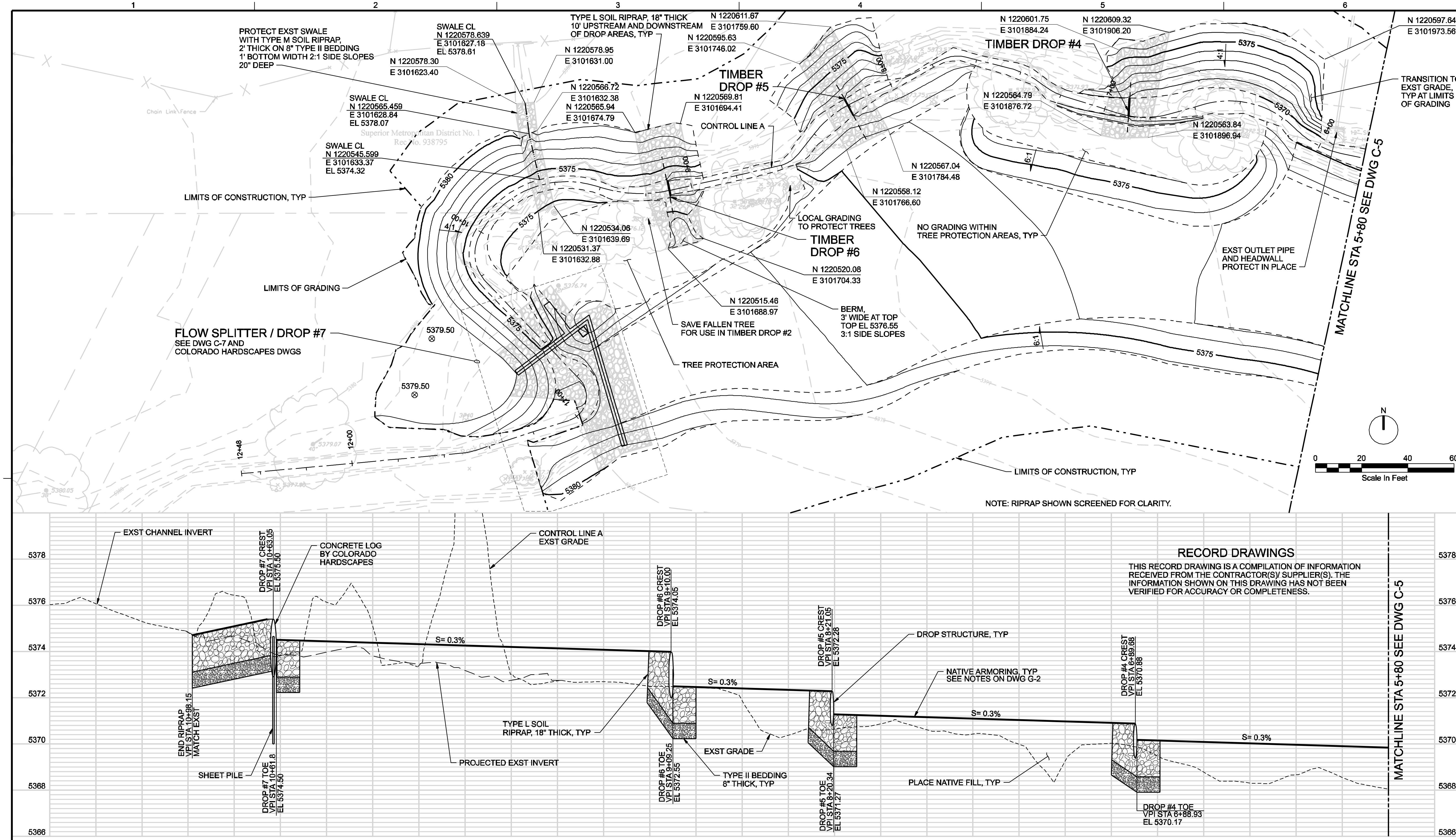
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
TOWN OF SUPERIOR
ROCK CREEK IMPROVEMENTS BETWEEN
W FLATIRON CIR AND S ROCK CREEK PARKWAY

ROCK CREEK CHANNEL IMPROVEMENTS

SURVEY CONTROL TABLES AND NOTES

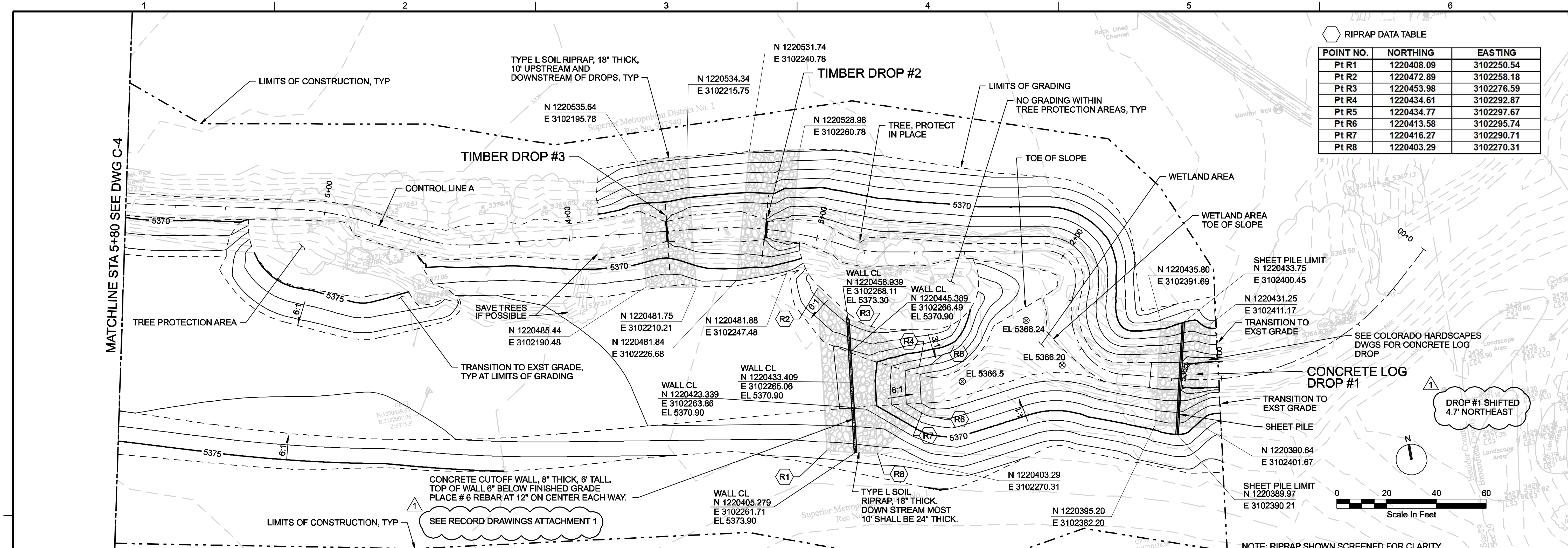
SHEET	4
DWG	C-2
DATE	JUNE 2011
PROJ	392516

FILENAME: rc05c002_AB.dgn PLOT DATE: 1/13/2012 PLOT TIME: 4:02:01 PM



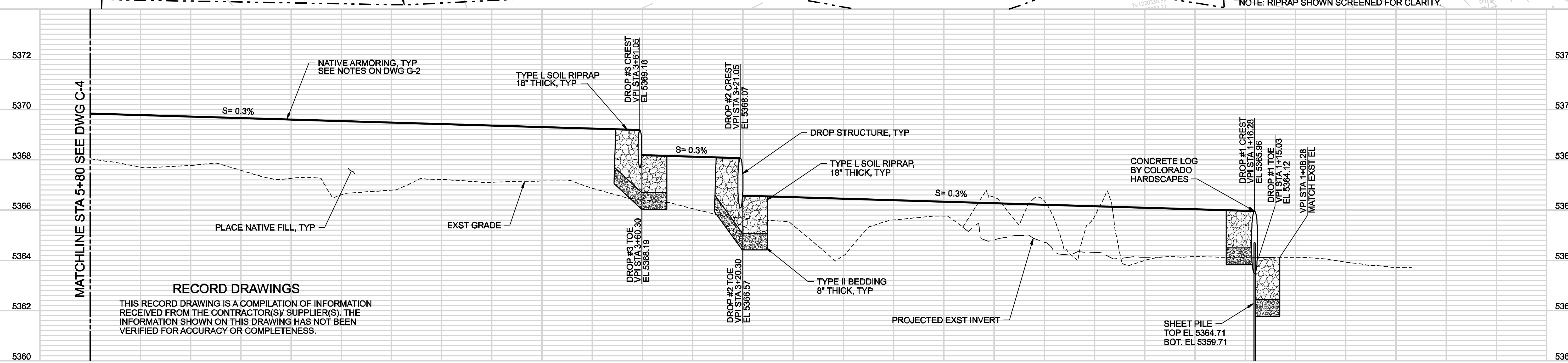
DSGN A. COOK	1	1/12	RECORD DRAWINGS	AC	KH	VERIFY SCALE BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1" IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY	CH2MHILL 9193 SOUTH JAMAICA STREET ENGLEWOOD, CO 80112 KYLE HAMILTON: (720) 286-5240	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT TOWN OF SUPERIOR ROCK CREEK CHANNEL IMPROVEMENTS W FLATIRON AND S ROCK CREEK PARKWAY	ROCK CREEK CHANNEL IMPROVEMENTS PLAN AND PROFILE	SHEET	6
DR J. WALKER										DWG	C-4
CHK C. HOOPER										DATE	JUNE 2011
APVD K. HAMILTON	NO.	DATE	REVISION	BY	APVD					PROJ	392516

FILENAME: RC05pp01_AB.dgn PLOT DATE: 1/20/2012 PLOT TIME: 2:29:28 PM



RIPRAP DATA TABLE

POINT NO.	NORTHING	EASTING
Pt R1	1220408.09	3102250.54
Pt R2	1220472.89	3102258.18
Pt R3	1220453.98	3102276.59
Pt R4	1220434.61	3102292.87
Pt R5	1220434.77	3102297.67
Pt R6	1220413.58	3102295.74
Pt R7	1220416.27	3102290.71
Pt R8	1220403.29	3102270.31



RECORD DRAWINGS

THIS RECORD DRAWING IS A COMPILATION OF INFORMATION RECEIVED FROM THE CONTRACTOR(S)/ SUPPLIER(S). THE INFORMATION SHOWN ON THIS DRAWING HAS NOT BEEN VERIFIED FOR ACCURACY OR COMPLETENESS.

DSGN A. COOK	1	1/12	RECORD DRAWINGS	AC	KH
DR J. WALKER					
CHK C. HOOPER					
APVD K. HAMILTON	NO.	DATE	REVISION	BY	APVD

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

CH2MHILL
9193 SOUTH JAMAICA STREET
ENGLEWOOD, CO 80112
KYLE HAMILTON: (720) 286-5240

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
TOWN OF SUPERIOR
ROCK CREEK CHANNEL IMPROVEMENTS
W FLATIRON AND S ROCK CREEK PARKWAY

ROCK CREEK CHANNEL IMPROVEMENTS

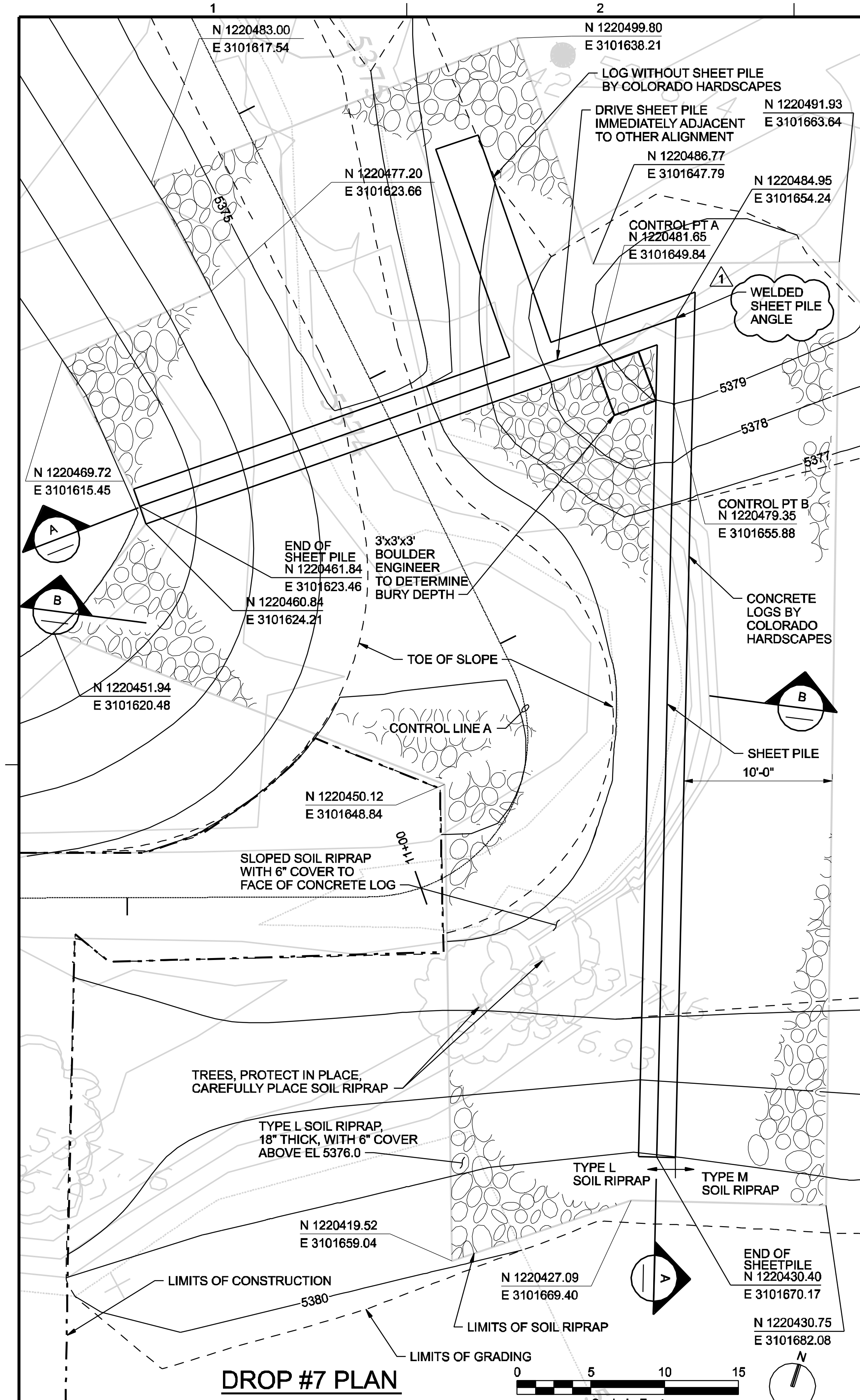
PLAN AND PROFILE

SHEET	7
DWG	C-5
DATE	JUNE 2011
PROJ	392516

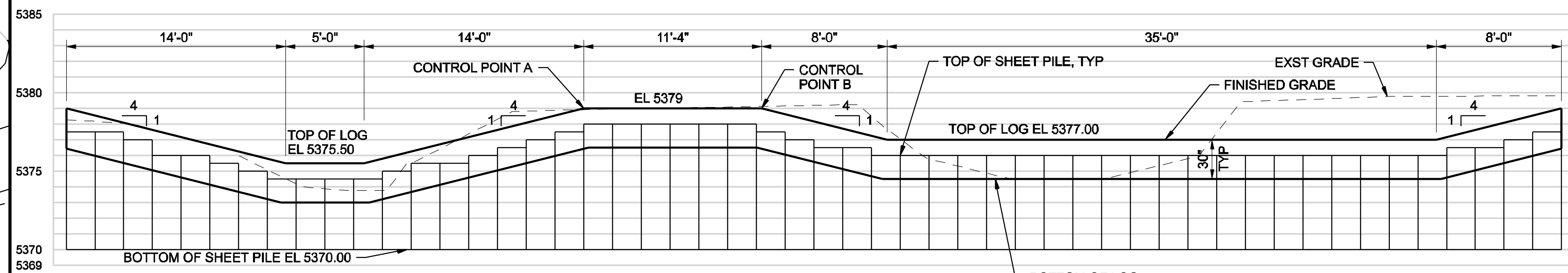
FILENAME: RC05pp02_AB.dgn PLOT DATE: 1/20/2012 PLOT TIME: 2:29:56 PM

RECORD DRAWINGS

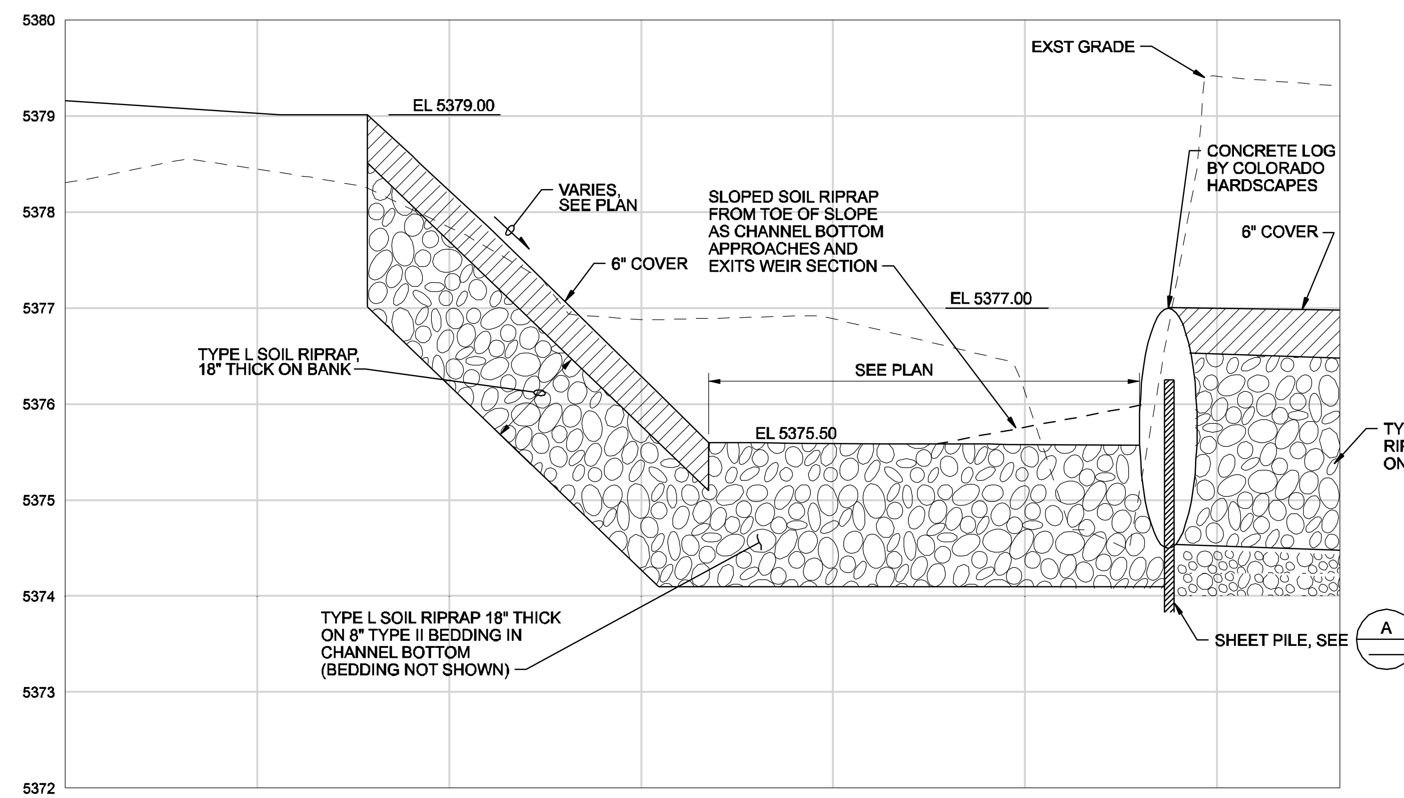
THIS RECORD DRAWING IS A COMPILATION OF INFORMATION RECEIVED FROM THE CONTRACTOR(S)/ SUPPLIER(S). THE INFORMATION SHOWN ON THIS DRAWING HAS NOT BEEN VERIFIED FOR ACCURACY OR COMPLETENESS.



DROP #7 PLAN



A SHEET PILE PROFILE
H:1"=5'-0"
V:1"=1'-0"



B WEIR SECTION
H:1"=5'-0"
V:1"=1'-0"

DSGN A. COOK	1	1/12	RECORD DRAWINGS	AC	KH	
DR J. WALKER						
CHK C. HOOPER						
APVD K. HAMILTON	NO.	DATE	REVISION	BY	APVD	

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

CH2MHILL
9193 SOUTH JAMAICA STREET
ENGLEWOOD, CO 80112
KYLE HAMILTON: (720) 286-5240

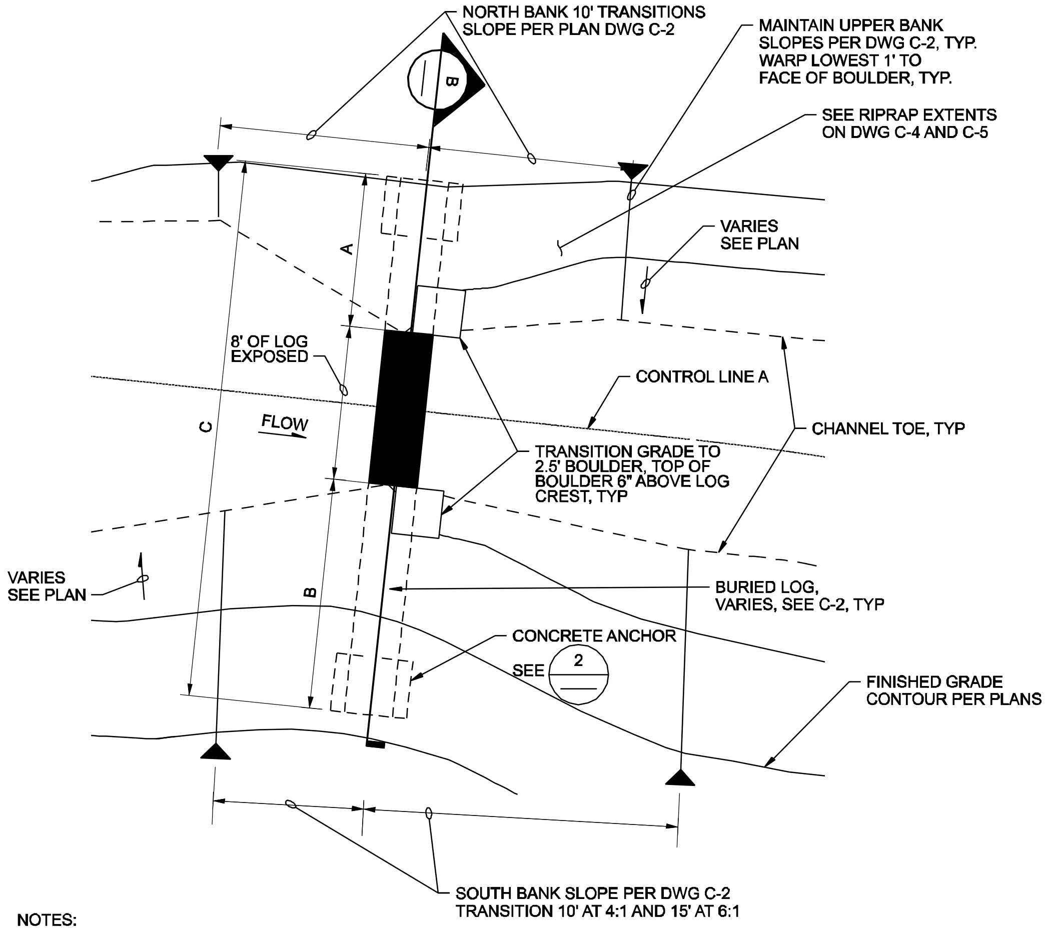
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
TOWN OF SUPERIOR
ROCK CREEK IMPROVEMENTS BETWEEN
W FLATIRON CIR AND S ROCK CREEK PARKWAY

ROCK CREEK CHANNEL IMPROVEMENTS

FLOW SPLITTER DETAILS

SHEET	9
DWG	C-7
DATE	JUNE 2011
PROJ	392516

FILENAME: RC05c003_AB.dgn PLOT DATE: 1/20/2012 PLOT TIME: 2:43:03 PM



NOTES:

1. SEE DWGS C-4 AND C-5 FOR INDIVIDUAL DROP PLANS.
2. THIS PLAN PROVIDED TO ILLUSTRATE GRADING SLOPES (TRANSITIONS AND WARPING) AND BOULDER LOCATIONS.
3. SLOPES VARY, SEE DWG C-2.

A TYPICAL DROP STRUCTURE PLAN (DROP #3 SHOWN)

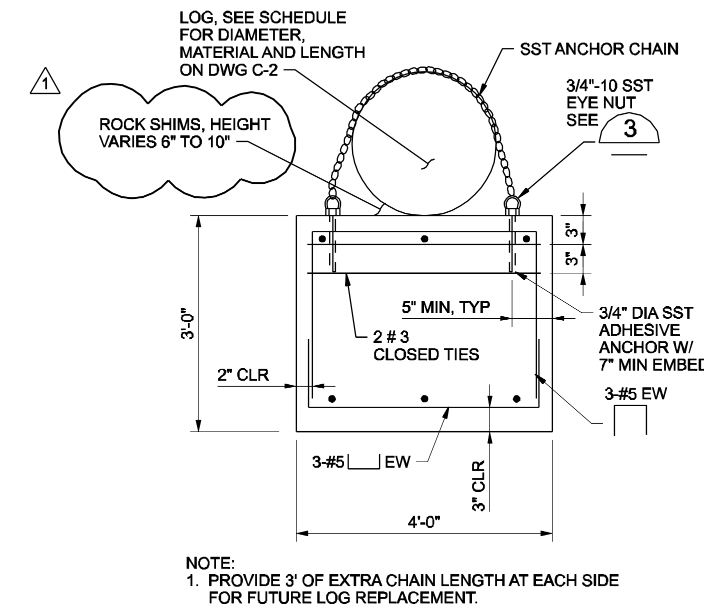
1"=5'

C-4, C-5

N

GENERAL NOTES

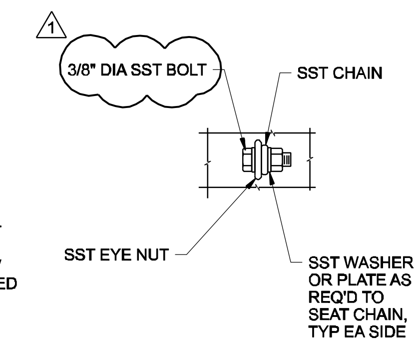
1. CLEARANCE FOR REINFORCEMENT BARS, UNLESS SHOWN OTHERWISE, SHALL BE:
   "WHEN PLACED ON GROUND: ———— 3"
   "ALL OTHER CONCRETE SURFACES: ———— 2"
2. ALL BENDS, UNLESS OTHERWISE SHOWN, SHALL BE A 90 DEGREE STANDARD HOOK AS DEFINED IN LATEST EDITION OF ACI 318.
3. CONCRETE PLACEMENT SHALL CONFORM TO ACI 301 "SPECIFICATIONS FOR STRUCTURAL CONCRETE FOR BUILDINGS".
4. ITEMS TO BE EMBEDDED IN CONCRETE SHALL BE CLEAN AND FREE OF OIL, DIRT AND PAINT.
5. ADHESIVE DOWEL SYSTEM FOR REINFORCING INSTALLATION SHALL BE HILTI HY-150 OR APPROVED EQUAL. ALL DOWELS SHALL BE INSTALLED ACCORDING TO MANUFACTURER INFORMATION.
6. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL WORK RELATING TO CONSTRUCTION ERECTION METHODS, BRACING, SHORING FORMWORK AND OTHER WORK AIDS REQUIRED TO SAFELY PERFORM THE WORK SHOWN.
7. SST BOLTS AND THREADED ANCHOR STUDS: ASTM F593, AISI 316, CONDITION CW. SST NUTS AND WASHERS: ASTM F594, AISI 316, CONDITION CW.
8. SST CHAIN:3/8" AISI 316L, GRADE 50, WORKING LOAD LIMIT 4,000 LB MIN. MCMASTER-CARR PART NUMBER 33645T53 OR EQUAL.
9. SST EYE NUT: AISI TYPE 316, ¾" - 10 OVAL EYE, WORKING LOAD LIMIT 4,000 LB MIN. MCMASTER-CARR PART NUMBER 3061T23 OR EQUAL.
10. CONCRETE:
    a. CONCRETE SHALL HAVE A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 4500 PSI AND SHALL CONFORM TO ASTM C94 OPTION A. WATER TO CEMENT RATIO SHALL NOT EXCEED 0.44.
    b. AGGREGATES SHALL BE 3/4 INCH AND SMALLER CONFORMING TO ASTM C33. COARSE AGGREGATE SHALL BE SIZE NO. 57 NO. 67.
    c. SLUMP SHALL BE 4 INCHES +/- 1 INCH. PROVIDE WATER REDUCING ADMIXTURES AS REQUIRED. AIR CONTENTSHALL BE 6% +1% / -2%
    d. WET CURE CONCRETE FOR A MINIMUM OF 3 DAYS AFTER PLACEMENT; ALTERNATIVELY, APPLY CURING COMPOUND MEETING REQUIREMENTS OF ASTM C309.
    e. REINFORCING STEEL SHALL CONFROM TO ASTM A615, GRADE 60
    f. CEMENTITIOUS MATERIAL SHALL BE SUITABLE FOR SULFATE EXPOSURE CLASS S2 ACCORDING TO ACI 318.
    g. ANCHOR BOLTS SHALL BE CENTERED ON CONCRETE BLOCK IN THE LONGITUDINAL DIRECTION OF THE LOG.



NOTE:
1. PROVIDE 3' OF EXTRA CHAIN LENGTH AT EACH SIDE FOR FUTURE LOG REPLACEMENT.

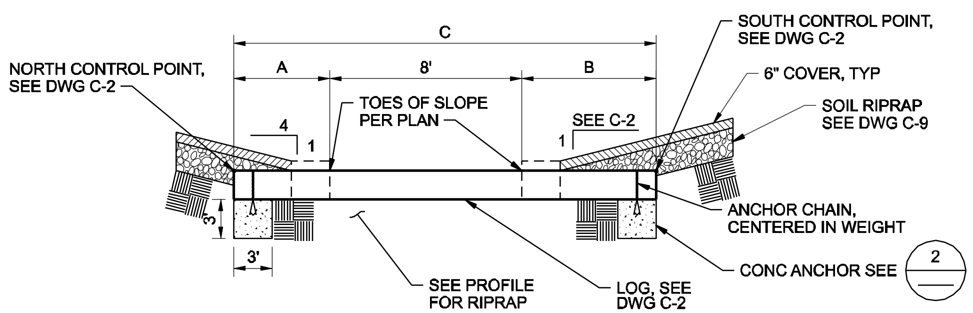
2 CONCRETE ANCHOR DETAIL

NTS



3 DETAIL

3"=1'-0"



B TIMBER DROP TYPICAL SECTION

NTS

C-4, C-5

NOTES:

1. SOUTH ANCHOR LOCATIONS TO BE FIELD VERIFIED BY CONTRACTOR DUE TO EXISTING TREE ROOTS AT SEVERAL LOCATIONS.
2. SEE TABLE ON DWG C-2 FOR DIMENSIONS A, B, AND C AND SLOPES.

RECORD DRAWINGS

THIS RECORD DRAWING IS A COMPILATION OF INFORMATION RECEIVED FROM THE CONTRACTOR(S)/ SUPPLIER(S). THE INFORMATION SHOWN ON THIS DRAWING HAS NOT BEEN VERIFIED FOR ACCURACY OR COMPLETENESS.

DSGN A. COOK	1	1/12	RECORD DRAWINGS	AC	KH
DR J. WALKER					
CHK C. HOOPER					
APVD K. HAMILTON	NO.	DATE	REVISION	BY	APVD

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

CH2MHILL
9193 SOUTH JAMAICA STREET
ENGLEWOOD, CO 80112
KYLE HAMILTON: (720) 286-5240

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
TOWN OF SUPERIOR
ROCK CREEK IMPROVEMENTS BETWEEN
W FLATIRON CIR AND S ROCK CREEK PARKWAY

ROCK CREEK CHANNEL IMPROVEMENTS

TIMBER DROP STRUCTURE DETAILS

SHEET	10
DWG	C-8
DATE	JUNE 2011
PROJ	392516

FILENAME: Rc95dt003_AB.dgn PLOT DATE: 1/13/2012 PLOT TIME: 1:44:46 PM

Appendix F. Timbers Creek Case Study – Log Drop Structures (2011)

Case Study - Log Drop Structures

Prepared for: Urban Drainage and Flood Control District

Prepared by: CH2M HILL

April 13, 2011

Introduction

The Urban Drainage and Flood Control District (UDFCD) and CH2M HILL recently implemented a stream stabilization project using log (wood) grade control structures (log drops). The project is located on Timbers Creek in Douglas County, Colorado. This case study documents the basis for the concept, a summary of the design elements, a construction summary, and recommendations for future log drop installations.

Photo 1: Natural Log Drop, Frying Pan River, CO

Basis for Concept

UDFCD has been constructing grade control structures for stream stabilization purposes for many years. In decades past, concrete was often used. More recently, grade control structures have used grouted boulders, sculpted concrete, and fiberglass reinforced panels.

In nature, logs are used to create beaver dams, and fallen trees inadvertently serve several purposes from drop structures in streams to small sediment traps on hill slopes. Manmade structures made from wood timbers have historically been used for various types of projects in and around water, including for fish habitat structures, flow redirection, grade control for fisheries purposes (spawning habitat), bridges and piers, docks, etc.

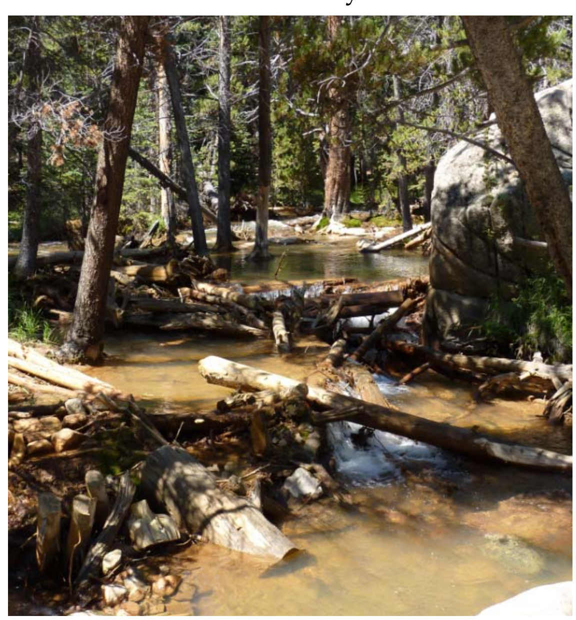


Photo 2: Natural Log Jam, S. Platte Tributary, CO

The concept for the timber drop structure was to build on these natural concepts and mimic a tree that has fallen across a stream, thereby becoming a grade control feature.

Design Elements

Timbers Creek is a sandy ephemeral stream. The channel was eroding both laterally and vertically, and stabilization was needed. Design elements typical of all UDFCD projects were determined, including flow rate, longitudinal slope, typical channel geometry, and erosion control methods. The difference between the existing longitudinal slope and the design slope resulted in the need for drop structures. During the planning stages of the Timbers Creek project, it was decided to use logs for some of the grade control elements of the project. Since this project would be the first of its kind, log drops were used for six feet of vertical grade control and sculpted concrete drops were used for the remainder of the grade control. Initially, a project goal was to have all drop structures be approximately 3 feet in height. This was applied to both the sculpted concrete drops and timber drops.

Drop Geometry

The initial geometry concepts were developed under the project assumption that drops would be approximately three feet in height. **Table 1** provides a summary of geometry options that were considered.

TABLE 1
Geometry Options

Option	Concept	Pros / Cons
1	Stack Logs Vertically	This geometry does not mimic nature very closely. Not desired due to safety concerns and the U.S. Army Corps of Engineers desire to have sloped drop structures.
2	Overlapping Logs at a Set Angle	Allows flexibility with the invert slope along the drop, but creates some bank transition difficulties. There was a concern that a sloped bank interfacing with a series of sloped logs could create a weak interface. Boulders could be placed at the toe of the slope, but sliding of the boulders on the logs was also a concern.
3	Single Log Structure	Mimics nature well. Avoids sloped log geometry concerns, but increases the number of drops required.

The buoyancy resistance method, discussed previously, has an impact on the geometric options. By selecting the concrete anchor buoyancy resistance method, several geometry constraints were avoided. For example, if using boulders as buoyancy resistance, the number and size of boulders for each log would need to meet the requirements of the buoyancy calculations. It can become difficult to fit the number of needed boulders into the channel and bank geometry on top of the corresponding log. Having the ability to set the dimensions of the concrete anchor, such that the log and channel geometry did not need to change, was advantageous.

Several alternatives were investigated for Option 2, including using very flat slopes, and using boulders or additional logs for transition areas. After consideration of these options, Option 3 – Single Log Structure was selected for design. Thus the two three-feet high structures became six one-foot high structures.

Log Selection

Different types of wood vary in strength, hardness, stiffness, density, and resistance to decay. Although local trees, such as pine trees and cottonwood trees, may be readily available, cedar logs were selected for this project due to their decay resistance properties. Cedar is commonly used for outdoor purposes, such as for roof shingles, fence posts, and dock planks. The cedar logs were imported to the site. Cottonwoods trees are very fibrous and are known to rot more quickly than cedar or pine, and were not selected for this project. Decay resistance and longevity were determined to be the most improtant factors for log type selection, resulting in the selection of cedar logs instead of pine logs.

Logs can be obtained in a milled form with the bark removed, or in their native form with the bark intact. The bark provides some natural and aesthtic values. A milled log allows the log to meet tighter dimensional criteria. The logs used on this project had the bark intact.

The diameter of the logs were determined by the required drop heights and embedment into the channel invert. The length of logs was based on the creek width and embedment into the creek bank.

The density of the log impacts the buoynacy of the log. A denser wood would allow the buoyancy resistance system to be smaller. The following list shows the varying densities of wood:

- Cedar: 20 to 24 pounds per cubic foot (pcf)
- Pine: 25 to 44 pcf
- Cottonwood: 30 pcf
- Ash: 40 pcf
- Oak: 40 to 60 pcf

Buoyancy Resistance

A design factor associated with timber drops is the buoyancy of the timbers. Since these structures will be partially or fully submerged, the buoyancy effect needs to be countered. It is realized that beaver dams, natural logs jammed in rivers, and other similar occurrences do not have buoyancy resistant elements. However, the interlocking of beaver dam branches, the tree root ball that is still attached to a creek bank, and similar conditions provide some level of buoyancy resistance and stability to the natural structures. For this project, a conservative approach was taken that uses engineering principles and calculations to determine the density of the wood and buoyancy force acting upward on the logs.

The buoyancy resistance options that were considered, including pros and cons, are listed in **Table 2**. For all options, it was desired to have a simple way to remove the log from the buoyancy resistance system and replace it, if needed.

TABLE 2
Buoyancy Resistance Options

Option	Buoyancy Resistance Method	Pros / Cons
1	Place Soil on Ends of Logs	Given a reasonable embedment length (the log into the channel bank), the weight of soil alone does not provide adequate buoyancy resistance.
2	Place a Boulder on Top of the Ends of the Logs	A project goal was to not use boulders, and attaching the boulder(s) to the log would be difficult. Also, the buoyancy resistance needed for each log can result in the need for more than one boulder, which can be geometrically difficult to place over the end of each log and secure.
3	Wrap Cable Around Log, Attach Cable Ends to Soil Anchors	This system is feasible; however, Timbers Creek is in very sandy, non-cohesive soil. To be conservative and due to soil conditions, the use of soil anchors was avoided.
4	Buried Concrete Anchors	By using concrete, the needed dimensions and corresponding buoyancy resistance could be provided. Standard concrete embeds allow flexibility for connecting the log to the concrete anchor. Depending on the final structure geometry, the concrete anchor could be a continuous block under several logs (similar to a footing) with embeds spaced as needed.

After considering the buoyancy options, Option 4 - Buried Concrete Anchors was selected for design. This approach provided conservatism and flexibility.

Buoyancy Resistance Calculations

After the type and size of logs and the associated anchoring system were determined, buoyancy resistance calculations were performed to address the buoyancy forces acting on those components. The buoyancy calculations addressed the following assumptions and factors:

- Density of water, and the assumption that the logs and concrete anchor are fully submerged by the design depth at the log.
- Density, dimensions, and depth of soil on each end of the log.
- Density, dimensions, and buoyancy force acting on the log.
- Density, dimensions, and buoyancy resistance force provided by the concrete anchor.
- Forces acting on each anchor bolt, chain, and other hardware.
- Application of appropriate factors of safety.

The results of the calculations are the dimension of the concrete anchor and dimensions of the anchoring hardware. All metal used was stainless steel.

Attaching the Log to the Anchor

The options for attaching the log to the concrete anchor included the following:

- Use an all-thread bolt placed through the log and secured with a washer and nut.
- Wrap steel cable around the log and secure it to the concrete anchor with an eye-bolt (or equivalent) and cable locks.
- Wrap steel chain around the log and secure it to the concrete anchor with removable chain links or bolts, washers, and nuts.

After considering these options, Option 3 – Steel Chain was selected. However, the other two options remain feasible.

Other Design Considerations

Sheet Pile

Similar to other drop structures, sheet pile can be incorporated into the drop structure in order to provide additional groundwater and head cut control (for both the invert and overbanks, as needed). It was decided that the upstream and downstream log drops would incorporate sheet pile, and the middle drops would not. The sheet pile and concrete sheet pile cap were integrated into the concrete anchors.

Erosion Control at the Log Drops

Standard UDFCD buried soil riprap was used upstream, downstream, and on the sides of the drop structure. Cobbles were added to the soil riprap mix in order to provide a more natural cobble appearance. The voids of the riprap need to be chinked well in order to minimize piping potential below the log. The soil on the banks was seeded with a native seed mix and the surface was covered with erosion control blanket. Due to the dry, sandy nature of the channel, it was anticipated that revegetation of the channel would be difficult and may take several growing seasons.

Construction Summary

The following sections summarize the construction materials used, the installation procedures, and contractor feedback.

Materials and Equipment

The following materials and equipment were used for the installation of the log drops.

- Logs: Cedar (with bark), provided by united Wood Products, Longmont, Colorado.
- Chain: Stainless steel.
- Anchors: Stainless steel eye bolts, bolts, washers, and nuts.
- Concrete: 4,000 psi structural concrete.
- Major Equipment: Excavator, chain saw (for cutting timbers), and metal saw (for cutting chain).

Construction Sequencing

The following photos illustrate the construction elements and sequencing.

Photo 3: Place Sheet Pile and Form Cap

Photo 4: Place Concrete Cap

Photo 5: Form and Pour Concrete Anchor

Photo 6: Place Embeds in Wet Concrete

Photo 7: Notch Log for Level Crest

Photo 8: Place Log on Concrete Anchors

Photo 9: Cut Anchor Chain to Length

Photo 10: Prepare Anchoring Hardware

Photo 11: Attach Chain to Eye Bolt

Photo 12: Finished Log on Anchor with Chain

Photo 13: Install Next Log

Photo 14: Finish Grading and Place Riprap

Photo 15: Install Seed and Erosion Control

Photo 16: Completed Project

Construction Costs

The following costs, per log drop, were provided by the contractor:

Excavation/Set-up:	$668
Concrete Anchor:	$744
Anchor Chains:	$350
Timber Log:	$1755
Total:	$3,517

Lessons Learned and Recommendations

The contractor stated that construction of the log drops went well and no field modifications were made to the design. However, some lessons were learned throughout the project, as described below. Recommendations based on those lessons learned are identified for consideration during the next log drop project.

Log Diameter

The logs delivered to the site were larger than the design diameter and required cutting with a chain saw in order to provide the appropriate crest height.

> Recommendation: Provide both a minimum and maximum allowable log diameter.

The large log diameters resulted in some of the logs being wider than the concrete anchor.

> Recommendation: Adjust the anchor bolt locations to allow greater anchoring flexibility. However, if the logs delivered to the site are within the specified diameter, the existing anchor bolt locations are sufficient.

Concrete Anchor Geometry

When sheet pile doesn't need to be interconnected with the concrete anchor, the concrete anchor geometry can be simplified.

> Recommendation: When no sheet pile is used, modify the concrete anchor to be a simple block shape.

Chain Tightening

The anchor chain is cut to length, but the exact chain length is limited by the size of the last chain link.

> Recommendation: In order increase the tightness of the chain, consider adding a turnbuckle between the eye bolt and the chain. However, the chains used on this project were able to be connected tightly without a turnbuckle. Also, a small notch can be cut into the log to result in a very tight chain.

Project Location

It is recommended that the next installation be in a location that will allow comparison of the log structures in differing conditions, such as a site with a base flow and rockier soil. This will allow the logs to be tested in a continuously saturated environment with larger bed load and abrasive forces acting on the logs.

Log Type

It is recommended that the next installation include the use of a local cottonwood tree and / or pine tree in order to compare the longevity of readily available local logs with imported cedar logs.

Minimize the Use of Concrete Trucks

It is recommended that soil anchors be considered in lieu of the concrete anchors, if the soil conditions allow. The use of soil anchors would eliminate the need to bring concrete trucks on site, minimizing the impact to the project site. The effort required to install the soil anchors, including required equipment, would need to be considered.

Another recommendation is to use the concrete anchor blocks, but have the contractor form, pour, and place embeds off site. The anchors could then be brought to the site by the contractor, eliminating the need to have concrete trucks on site. It is anticipated that an excavator or other piece of equipment would be on site that could move the concrete blocks.

Limitations

This case study is for use by UDFCD only and should not be used as a design guide. Log drops are not an approved drop structure type at this time.

Acknowledgements

- Project Lead: UDFCD, Denver, Colorado
- Partnering Agency: Douglas County, Colorado
- Design Engineer: CH2M HILL, Denver, Colorado
- Contractor: Naranjo Civil Constructors, Denver, Colorado

Attachments

The following attachments are included:

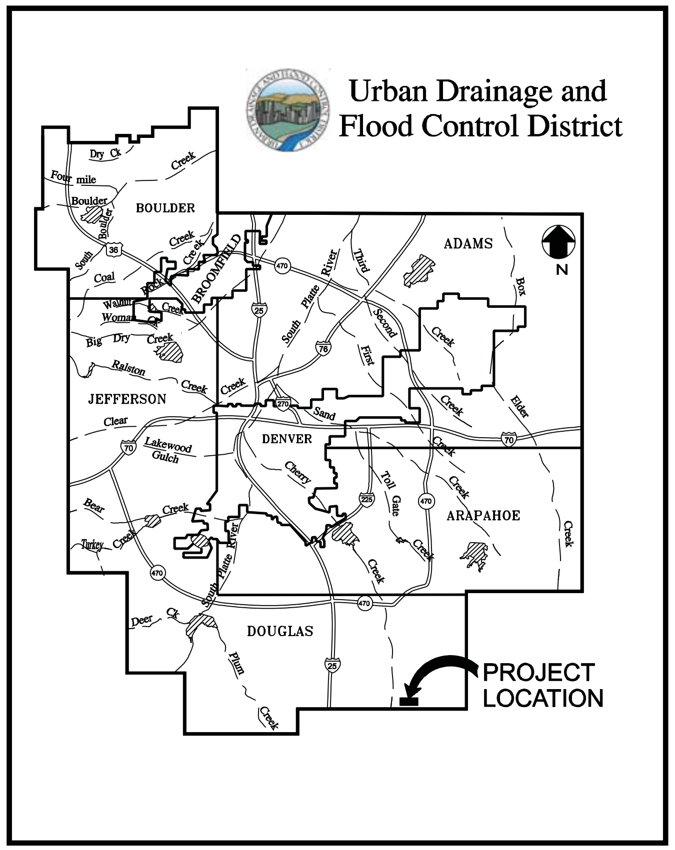
- **Attachment A:** Relevant Construction Drawings

Attachment A
Relevant Construction Drawings

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
AND DOUGLAS COUNTY, COLORADO
CONTRACT DRAWINGS FOR CONSTRUCTION OF

TIMBERS CREEK CHANNEL STABILIZATION PROJECT

APRIL 2010



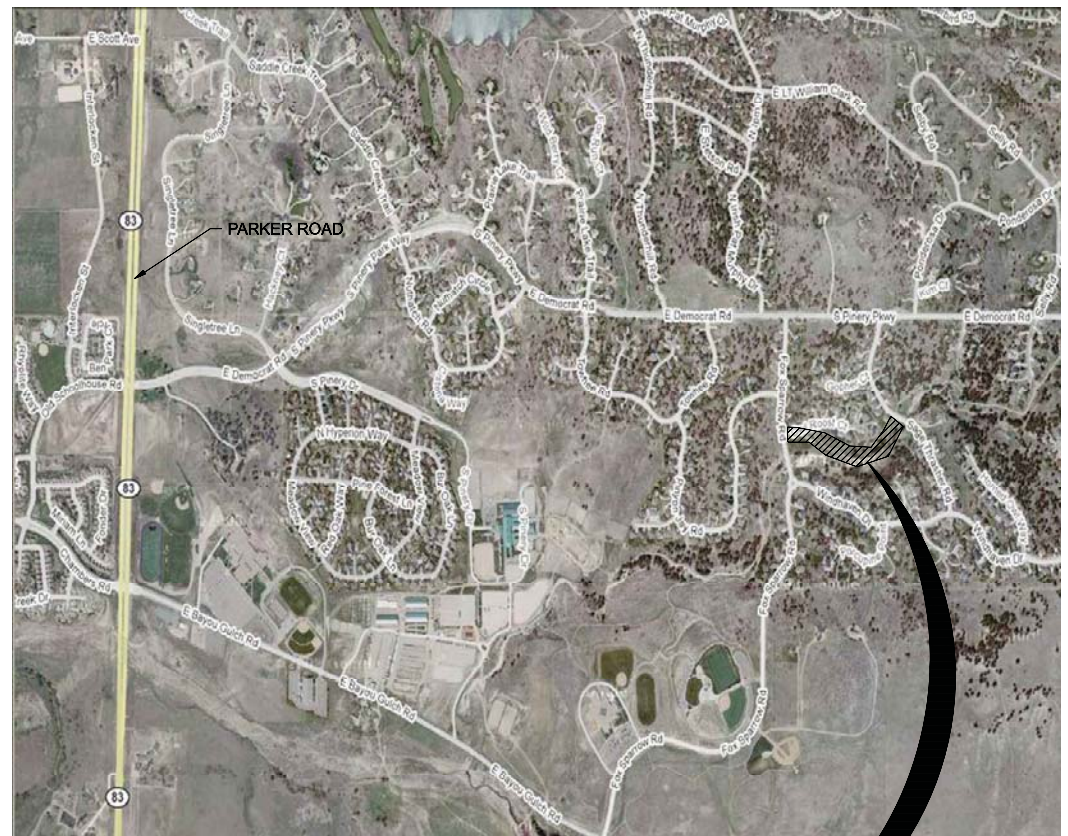


IMAGE BY: GOOGLE EARTH

PROJECT LOCATION

LOCATION MAP: DOUGLAS COUNTY
NTS

INDEX OF DRAWING

SHEET NO	DWG NO	SHEET TITLE
1	G-1	COVER SHEET AND INDEX OF DRAWINGS
2	G-2	PROJECT GENERAL NOTES
3	G-3	SITE, SURVEY, DEMOLITION AND GEOTECHNICAL PLAN
4	EC-1	EROSION AND SEDIMENT CONTROL PLAN
5	EC-2	EROSION AND SEDIMENT CONTROL PLAN
6	C-1	PLAN AND PROFILE STATION 0+00 TO 5+00
7	C-2	PLAN AND PROFILE STATION 5+00 TO 10+00
8	C-3	PLAN AND PROFILE STATION 10+00 TO 13+05
9	C-4	CHANNEL CROSS SECTIONS STATION 2+97 TO STA 5+50
10	C-5	CHANNEL CROSS SECTIONS STATION 6+00 TO STA 9+00
11	C-6	CHANNEL CROSS SECTIONS STATION 9+50 TO STA 12+00
12	C-7	SCULPTED CONCRETE DROP STRUCTURE PLAN AND DETAILS
13	C-8	SCULPTED CONCRETE DROP STRUCTURE SECTIONS
14	C-9	TIMBER DROP STRUCTURE PLAN, SECTIONS, AND DETAILS
15	C-10	TIMBER DROP SECTIONS
16	C-11	CONTROL WALL MODIFICATIONS
17	C-12	SECTIONS AND DETAILS
18	C-13	EROSION AND SEDIMENT CONTROL DETAILS
19	C-14	EROSION AND SEDIMENT CONTROL DETAILS
20-33	GESC-1 THRU GESC-14	GRADING EROSION AND SEDIMENT CONTROL SHEETS

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

PAUL A HINDMAN, EXECUTIVE DIRECTOR — DATE

DAVE BENNETTS, MANAGER DESIGN, CONSTRUCTION AND MAINTENANCE — DATE

LAURA A KROEGER, SR. PROJECT ENGINEER — DATE

CH2M HILL

MARK GLIDDEN P.E., PROJECT MANAGER — DATE 4/2/2010

DOUGLAS COUNTY

ENGINEERING SERVICES DIRECTOR — DATE

DSGN	C BUTLER						
DR	M MONAHAN						
CHK	C BUTLER						
APVD	M GLIDDEN	NO.	DATE	REVISION	BY	APVD	

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

CH2MHILL
9193 S JAMAICA ST
ENGLEWOOD, CO 80112
CONTACT: MARK GLIDDEN
720-286-5135

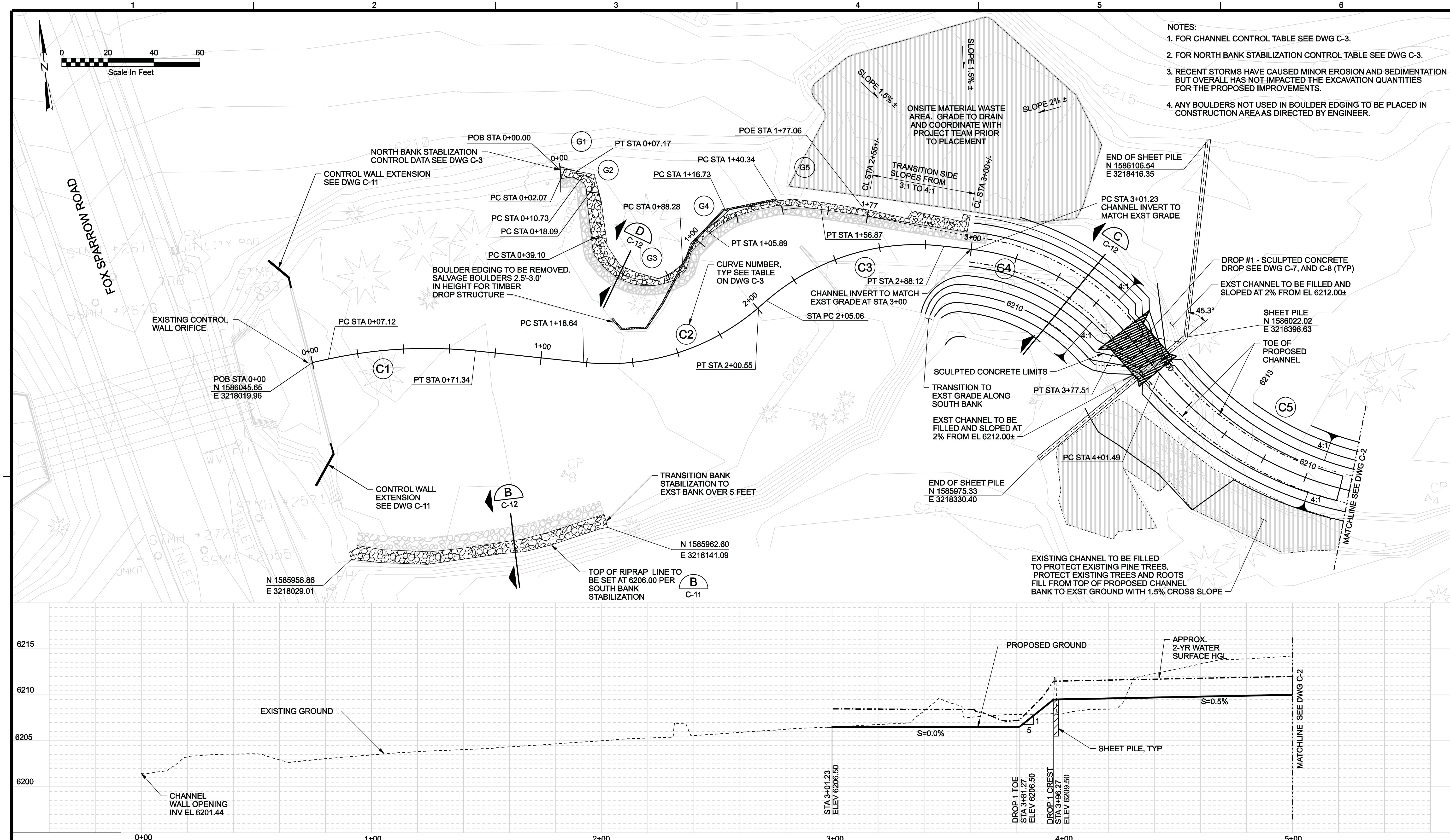
DOUGLAS COUNTY COLORADO

TIMBERS CREEK CHANNEL STABILIZATION

COVER SHEET AND INDEX OF DRAWINGS

SHEET	1
DWG	G-1
DATE	APRIL 2010
PROJ	328175

FILENAME: timcG001.dgn PLOT DATE: 4/2/2010 PLOT TIME: 9:47:14 AM



DSGN C BUTLER						
DR M MONAHAN						
CHK C BUTLER	NO	DATE	DESCRIPTION	APVR	N	
APVD K HAMILTON	NO.	DATE	REVISION	BY	APVD	

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

CH2MHILL
9193 S JAMAICA ST
ENGLEWOOD, CO 80112
CONTACT: KYLE HAMILTON
720-286-5240

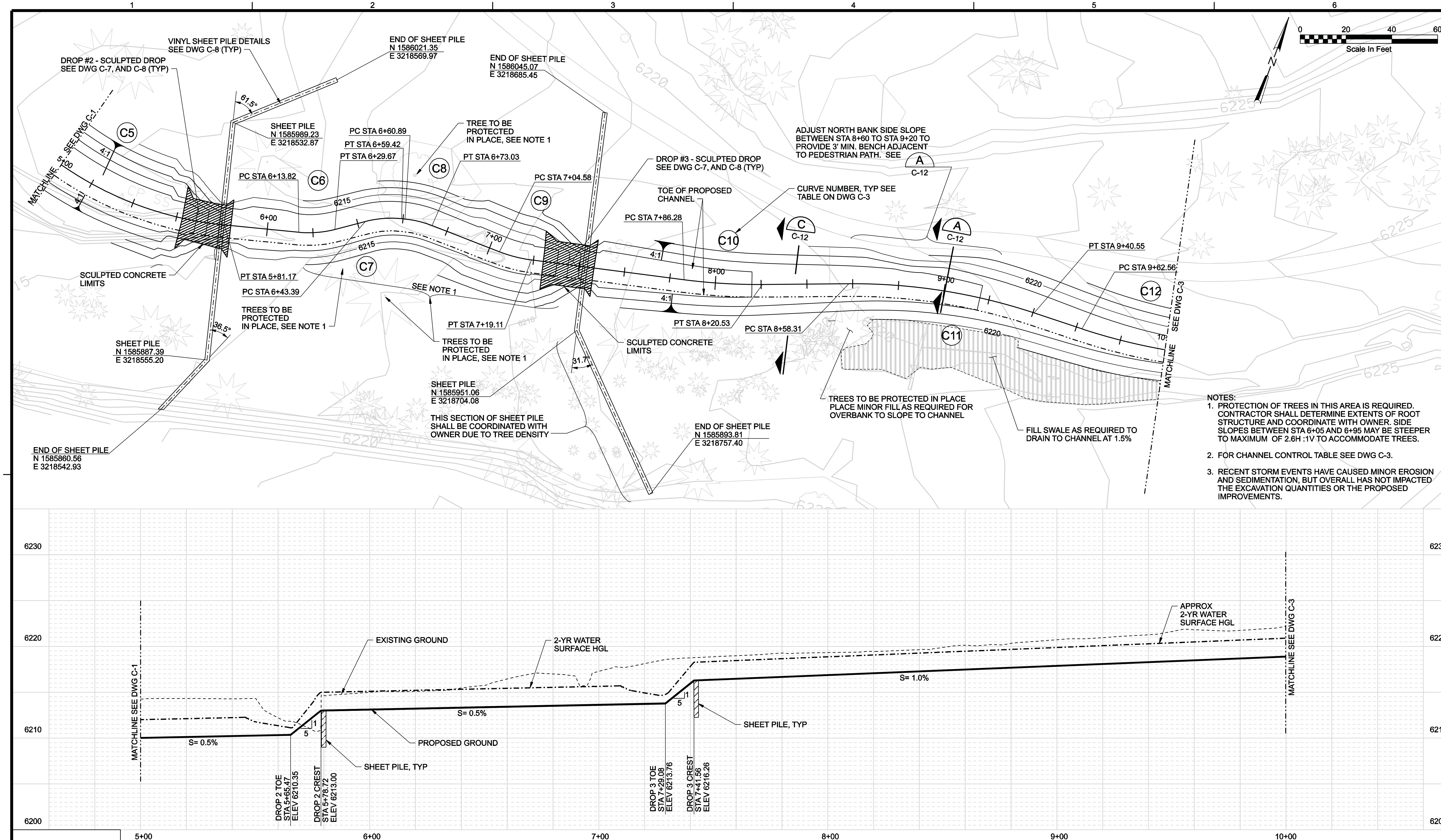
DOUGLAS COUNTY
COLORADO

TIMBERS CREEK CHANNLE STABILIZATION

PLAN AND PROFILE
STATION 0+00 TO 5+00

SHEET	6
DWG	C-1
DATE	APRIL 2010
PROJ	328175

FILENAME: timcC001.dgn PLOT DATE: 4/2/2010 PLOT TIME: 10:49:23 AM



NOTES:
1. PROTECTION OF TREES IN THIS AREA IS REQUIRED. CONTRACTOR SHALL DETERMINE EXTENTS OF ROOT STRUCTURE AND COORDINATE WITH OWNER. SIDE SLOPES BETWEEN STA 6+05 AND 6+95 MAY BE STEEPER TO MAXIMUM OF 2.6H :1V TO ACCOMMODATE TREES.
2. FOR CHANNEL CONTROL TABLE SEE DWG C-3.
3. RECENT STORM EVENTS HAVE CAUSED MINOR EROSION AND SEDIMENTATION, BUT OVERALL HAS NOT IMPACTED THE EXCAVATION QUANTITIES OR THE PROPOSED IMPROVEMENTS.

DSGN C BUTLER						
DR M MONAHAN						
CHK C BUTLER	NO	DATE	DESCRIPTION	APVR	N	
APVD K HAMILTON	NO.	DATE	REVISION	BY	APVD	

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

CH2MHILL
9193 S JAMAICA ST
ENGLEWOOD, CO 80112
CONTACT: KYLE HAMILTON
720-286-5240

DOUGLAS COUNTY COLORADO

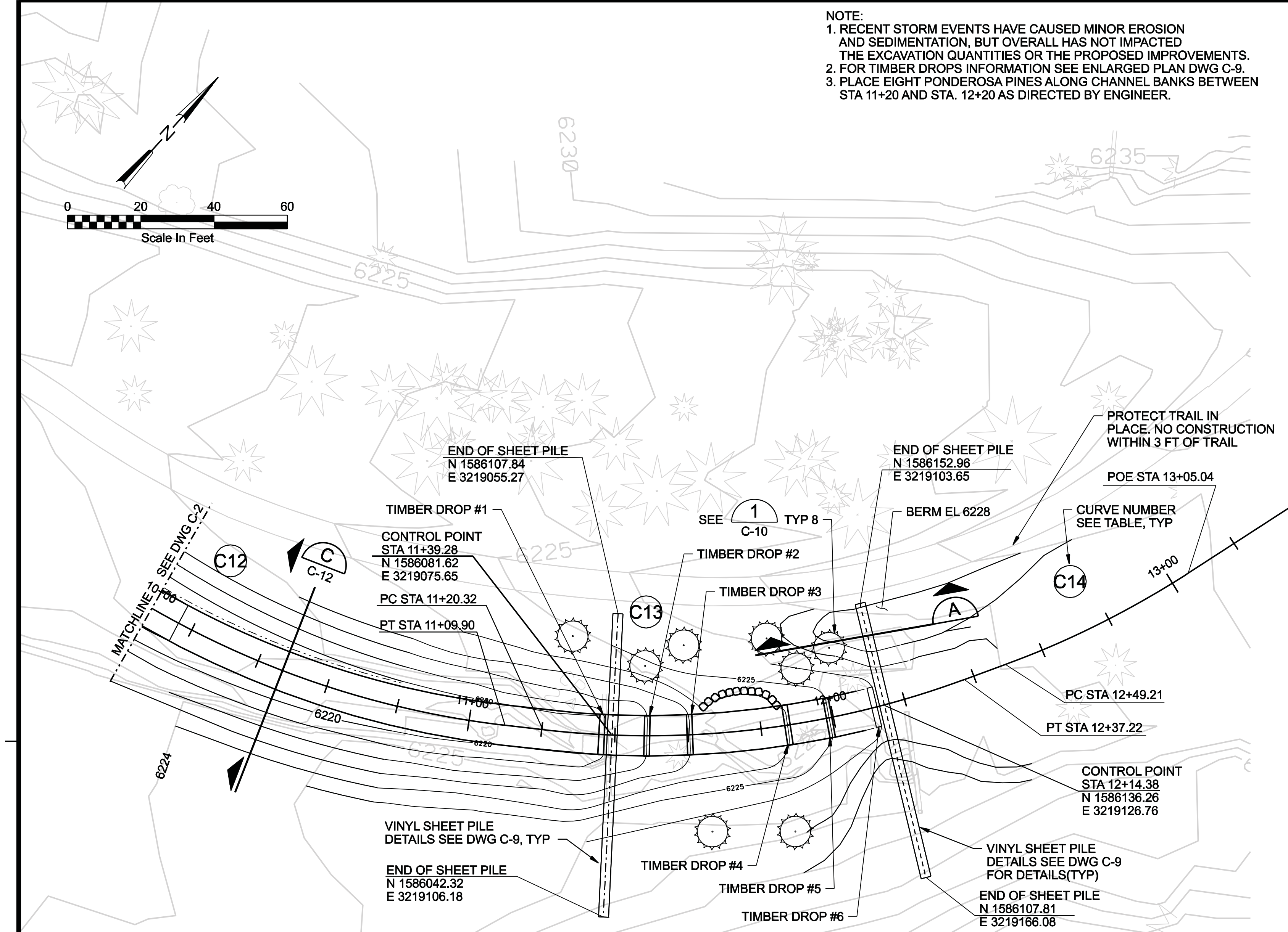
TIMBERS CREEK CHANNEL STABILIZATION

PLAN AND PROFILE
STATION 5+00 TO 10+00

SHEET	7
DWG	C-2
DATE	APRIL 2010
PROJ	328175

FILENAME: timcC002.dgn PLOT DATE: 4/2/2010 PLOT TIME: 10:58:01 AM

NOTE:
1. RECENT STORM EVENTS HAVE CAUSED MINOR EROSION AND SEDIMENTATION, BUT OVERALL HAS NOT IMPACTED THE EXCAVATION QUANTITIES OR THE PROPOSED IMPROVEMENTS.
2. FOR TIMBER DROPS INFORMATION SEE ENLARGED PLAN DWG C-9.
3. PLACE EIGHT PONDEROSA PINES ALONG CHANNEL BANKS BETWEEN STA 11+20 AND STA. 12+20 AS DIRECTED BY ENGINEER.

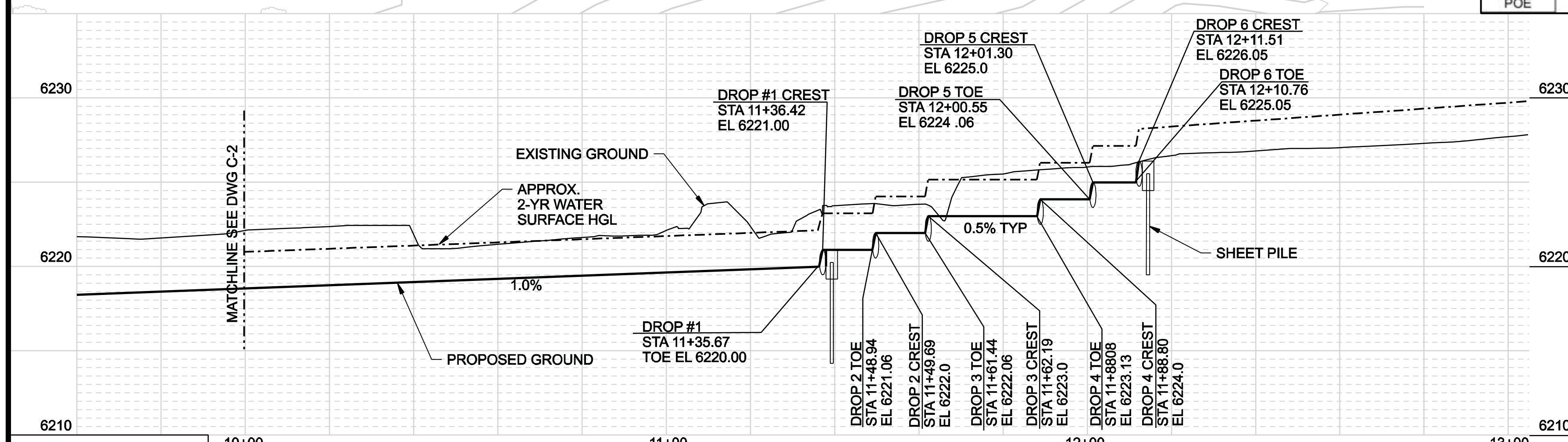


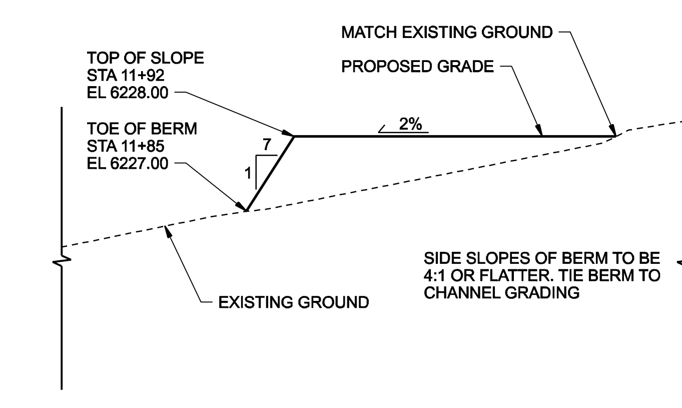
NORTH BANK STABILIZATION CONTROL LINE TABLE

TYPE	CURVE	STATION	NORTHING	EASTING	RADIUS	LENGTH	DELTA	DIRECTION
POB		0+00.00	1586119.30	3218134.77				
PC	G1	0+02.07	1586119.28	3218136.83				
PI		0+04.67	1586119.26	3218139.44	10	5.1	29°12'26"	Right
PT		0+07.17	1586117.97	3218141.70				
PC	G2	0+10.73	1586116.20	3218144.80				
PI		0+14.79	1586114.19	3218148.33	7	7.36	60°16'19"	Right
PT		0+18.09	1586110.12	3218148.33				
PC	G3	0+39.10	1586089.12	3218148.33				
PI		0+88.80	1586039.41	3218148.33	21	49.18	134°11'35"	Left
PT		0+88.28	1586074.06	3218183.96				
PC	G4	1+05.89	1586086.34	3218196.59				
PI		1+11.50	1586090.25	3218200.61	17	10.85	36°33'50"	Right
PT		1+16.73	1586091.00	3218206.18				
PC	G5	1+40.34	1586093.09	3218229.69				
PI		1+48.68	1586093.83	3218238.00	50	16.54	18°57'07"	Right
PT		1+56.87	1586091.83	3218246.10				
POE		1+77.16	1586086.93	3218265.79				

CHANNEL CONTROL LINE TABLE

TYPE	CURVE	STATION	NORTHING	EASTING	RADIUS	LENGTH	DELTA	Direction
POB		0+00.00	1586045.65	3218019.96				
PC	C1	0+07.12	1586046.53	3218027.03				
PI		0+39.51	1586050.55	3218059.17	200	64.22	18°23'49"	Right
PT		0+71.34	1586044.22	3218090.93				
PC	C2	1+18.64	1586034.97	3218137.32				
PI		1+62.05	1586026.49	3218179.89	100	81.91	46°56'01"	Left
PT		2+00.55	1586051.8	3218215.16				
PC	C3	2+05.06	1586054.42	3218218.82				
PI		2+49.15	1586080.13	3218254.65	100	83.06	47°35'34"	Right
PT		2+88.12	1586071.02	3218297.8				
PC	C4	3+01.23	1586068.3	3218310.62				
PI		3+41.33	1586060.01	3218349.86	100	76.28	43°42'14"	Right
PT		3+77.51	1586026.91	3218372.5				
PC	C5	4+01.49	1586007.11	3218386.04				
PI		5+03.87	1585922.6	3218443.83	150	179.67	68°37'47"	Left
PT		5+81.17	1585945.62	3218543.58				
PC	C6	6+13.82	1585952.96	3218575.4				
PI		6+21.83	1585954.77	3218583.2	45	15.86	20°11'32"	Left
PT		6+29.67	1585959.15	3218589.91				
PC		6+43.39	1585966.66	3218601.39				
PI		6+51.49	1585971.09	3218608.17	45	16.03	20°24'29"	Right
PT		6+59.42	1585972.88	3218616.06				
PC	C8	6+60.89	1585973.21	3218617.5				
PI		6+66.99	1585974.56	3218623.45	45	12.14	15°27'24"	Right
PT		6+73.03	1585974.27	3218629.55				
PT		6+73.03	1585974.27	3218629.55				
PC	C9	7+04.58	1585972.8	3218661.07				
PI		7+11.88	1585972.46	3218668.36	60	14.54	13°52'50"	Left
PT		7+19.11	1585973.88	3218675.53				
PC	C10	7+86.28	1585986.93	3218741.41				
PI		8+03.43	1585990.26	3218758.24	250	34.25	7°51'01"	Left
PT		8+20.53	1585995.86	3218774.46				
PC	C11	8+58.31	1586008.19	3218810.17				
PI		8+99.82	1586021.74	3218849.4	250	82.27	18°51'14"	Right
PT		9+40.58	1586021.89	3218890.91				
PC	C12	9+62.56	1586021.96	3218912.9				
PI		10+38.44	1586022.23	3218988.77	250	147.33	33°45'59"	Left
PT		11+09.90	1586064.62	3219051.7				
PC	C13	11+20.32	1586070.44	3219060.35				
PI		11+79.86	1586103.71	3219109.72	250	116.9	26°47'26"	Left
PT		12+37.22	1586155.65	3219138.81				
PC	C14	12+49.21	1586166.12	3219144.67				
PI		12+77.24	1586190.57	3219158.36	250	55.83	12°47'43"	Left
POE		13+05.04	1586217.46	3219166.3				





BERM DETAIL A
NTS

DSGN	C BUTLER					
DR	M MONAHAN					
CHK	C BUTLER	NO	DATE	DESCRIPTION	APVR	N
APVD	K HAMILTON	NO.	DATE	REVISION	BY	APVD

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

CH2MHILL
9193 S JAMAICA ST
ENGLEWOOD, CO 80112
CONTACT: KYLE HAMILTON
720-286-5240

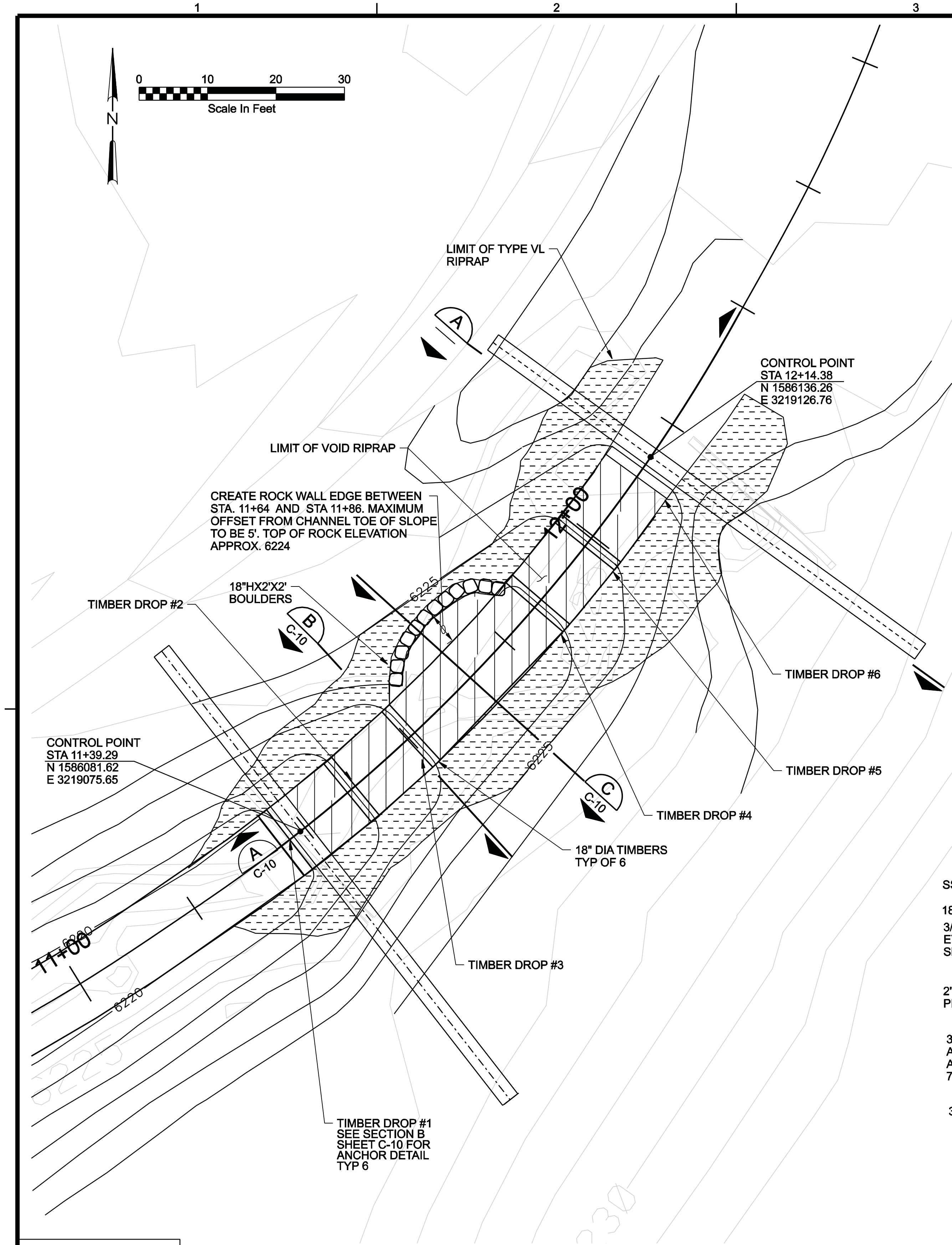
DOUGLAS COUNTY
COLORADO

TIMBERS CREEK CHANNEL STABILIZATION

PLAN AND PROFILE
STATION 10+00 TO 13+05

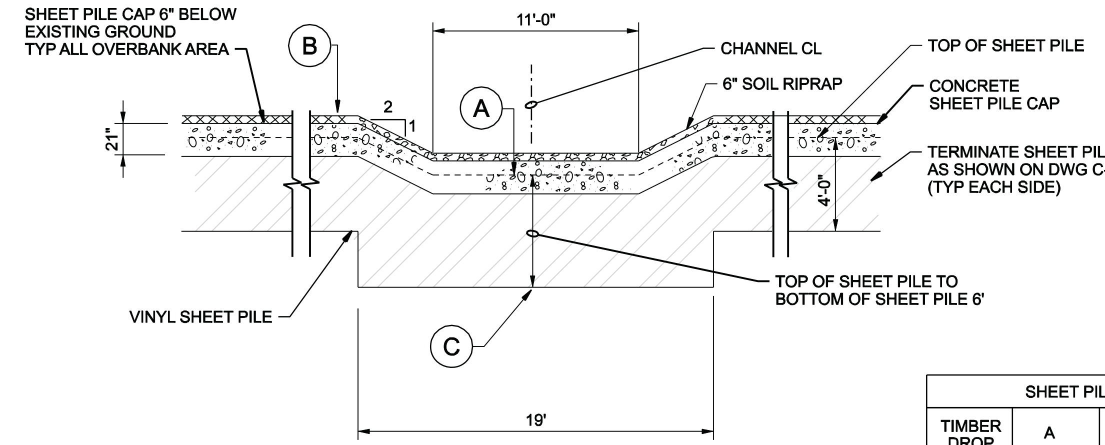
SHEET	8
DWG	C–3
DATE	MARCH 2010
PROJ	328175

FILENAME: timcC003.dgn PLOT DATE: 4/2/2010 PLOT TIME: 11:17:54 AM



ENLARGED PLAN

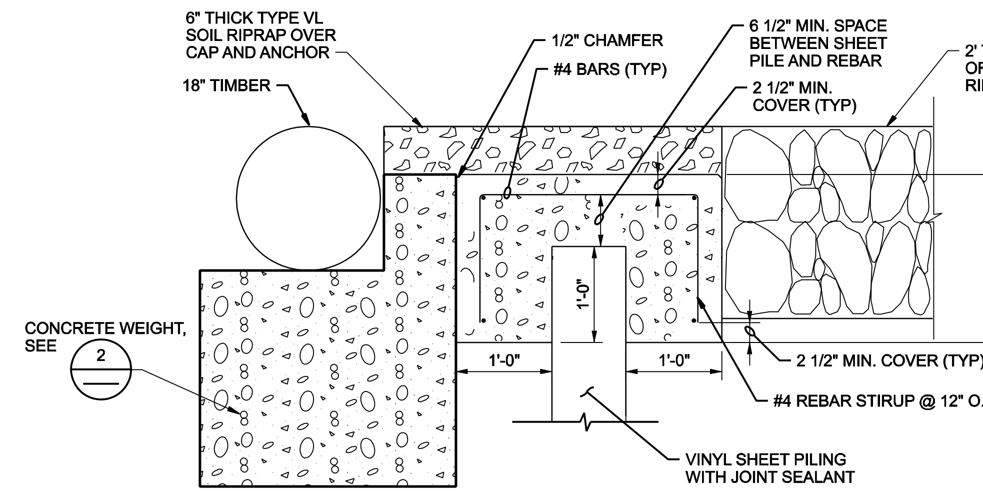
1"=10'



LOG DROP SHEET PILE PROFILE (A)

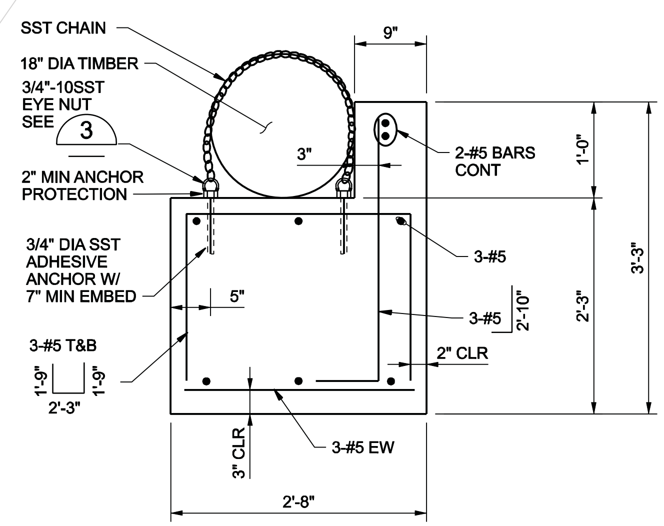
3/16"=1'-0"

SHEET PILE TABLE			
TIMBER DROP	A	B	C
1	6219.75	6223.00	6213.75
6	6224.80	6228.26	6218.80



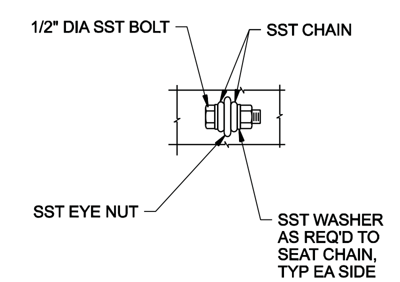
SHEET PILE AND SHEET PILE CAP DETAIL (1)

1"=1'-0"



CONCRETE WEIGHT DETAIL (2)

1"=1'-0"



DETAIL (3)

3"=1'-0"

NOTES
1. SST BOLTS AND THREADED ANCHOR STUDS: ASTM F593, AISI 316, CONDITION CW. SST NUTS AND WASHERS: ASTM F594, AISI 316, CONDITION CW
2. SST CHAIN:3/8" AISI 316L, GRADE 50, WORKING LOAD LIMIT 4,000 LB MIN. MCMASTER-CARR PART NUMBER 33645T53 OR EQUAL.
3. SST EYE NUT: AISI TYPE 316, ¾" - 10 OVAL EYE, WORKING LOAD LIMIT 4,000 LB MIN. MCMASTER-CARR PART NUMBER 3061T23 OR EQUAL.
4. CONCRETE:
   a. CONCRETE SHALL HAVE A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 4000 PSI AND SHALL CONFORM TO ASTM C94 OPTION A. WATER TO CEMENT RATIO SHALL NOT EXCEED 0.44.
   b. AGGREGATES SHALL BE 3/4 INCH AND SMALLER CONFORMING TO ASTM C33. COARSE AGGREGATE SHALL BE SIZE NO. 57 NO. 67.
   c. SLUMP SHALL BE 4 INCHES +/- 1 INCH. PROVIDE WATER REDUCING ADMIXTURES AS REQUIRED. AIR CONTENT SHALL BE 6% +1% / -2%
   d. WET CURE CONCRETE FOR A MINIMUM OF 3 DAYS AFTER PLACEMENT; ALTERNATIVELY, APPLY CURING COMPOUND MEETING REQUIREMENTS OF ASTM C309.

		NO.	DATE	REVISION	BY	APVD
DSGN	C BUTLER					
DR	M MONAHAN					
CHK	C BUTLER					
APVD	K HAMILTON					

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

CH2MHILL
9193 S JAMAICA ST
ENGLEWOOD, CO 80112
CONTACT: MARK GLIDDEN
720-286-5135

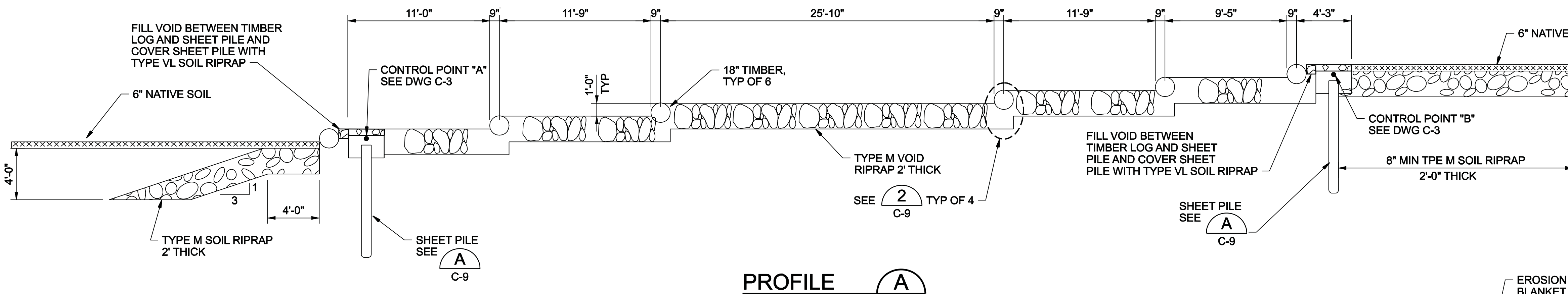
DOUGLAS COUNTY COLORADO

TIMBERS CREEK CHANNEL STABILIZATION

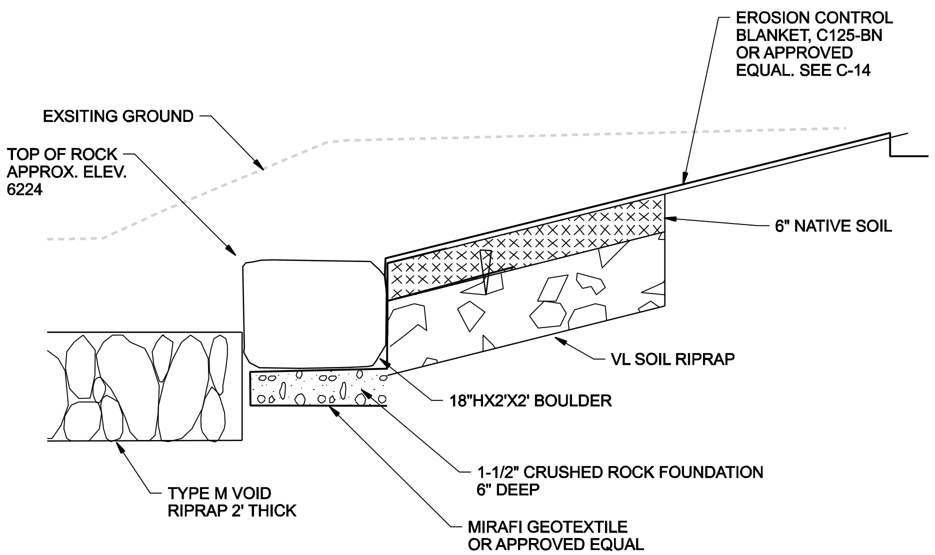
TIMBER DROP STRUCTURE
PLAN, SECTIONS, AND DETAILS

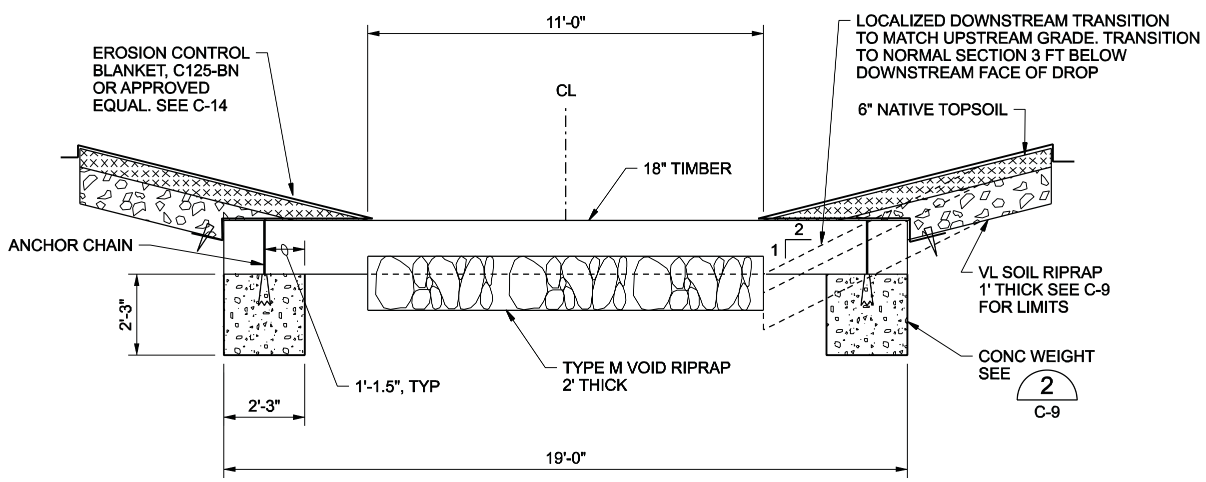
SHEET	14
DWG	C-9
DATE	APRIL 2010
PROJ	328175

FILENAME: timcDT01rev1.dgn PLOT DATE: 4/2/2010 PLOT TIME: 2:32:43 PM

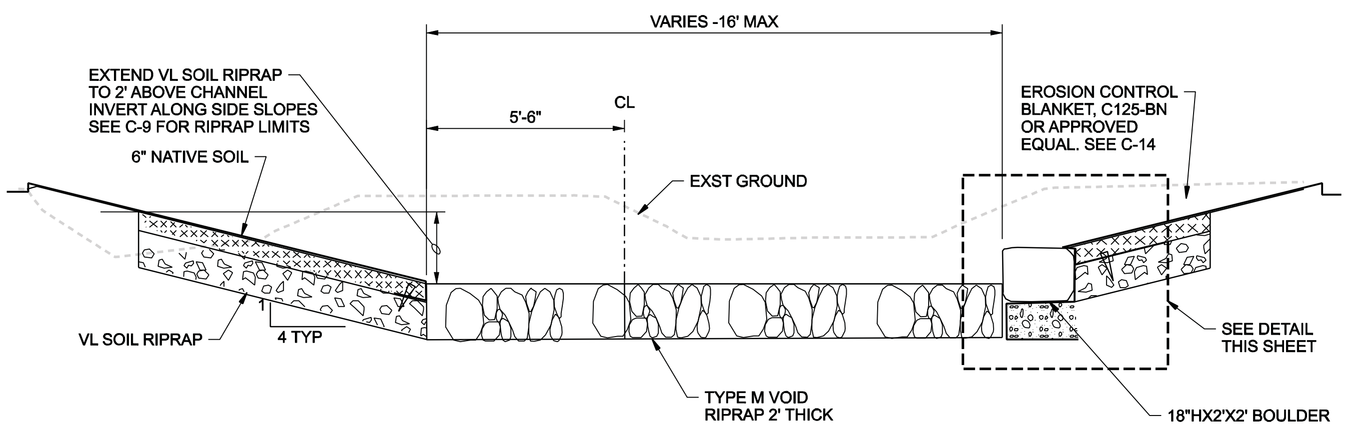


PROFILE A
1"=5' C-9





SECTION B
1/4"=1'-0" C-9



SECTION C
3/8"=1'-0" C-9

VOID RIPRAP NOTES:

1. ROCK REQUIREMENTS ARE TO COMPLY WITH TYPE M RIPRAP.
2. THE COLOR OF RIPRAP AND VOID-FILL MATERIALS USED TO FILL THE RIPRAP VOIDS SHALL BE LIGHT GRAY OR TAN AND SHALL BE UNIFORM. SAMPLES OF RIPRAP AND VOID-FILL MATERIALS SHALL BE SUBMITTED FOR REVIEW AND APPROVAL OF THE ENGINEER PRIOR TO CONSTRUCTION.
3. WHERE "TYPE M VOID-FILLED RIPRAP" IS DESIGNATED ON THE CONTRACT DRAWINGS, RIPRAP SHALL BE MIXED WITH THE MATERIALS AND ASSOCIATED PROPORTIONS LISTED IN THE TABLE BELOW TO FILL THE VOIDS 0F THE RIPRAP:

Approximate Proportions (loader buckets)	Material Type	Material Description
6	Riprap	Type M Riprap
3	Void-fill material	7-inch minus crushed rock surge (100% passing 7-inch sieve, 80-100% passing 6-inch sieve, 35-50% passing 3-inch sieve, 10-20% passing 1.5-inch sieve)
1	Void-fill material	2 to 4-inch cobble (round washed river rock that is well-graded, 100% passing 6-inch sieve, 35-50% passing 3-inch sieve, 5-20% passing 2-inch sieve)
1	Void-Fill material	4-inch minus pit run surge (round river rock and sand, well graded, 90-100% passing 4-inch sieve, 70-80% passing 1.5-inch sieve, 40-60% passing 3/8-inch sieve, 10-30% passing #16 sieve)
1	Void-fill material	Type II bedding
½ to 1	Void-fill material	Native topsoil
Top layer	Top dressing	Additional 4 to 12-inch cobbles (round washed river rock that is well graded, 80-100% passing 12-inch sieve, 35-50% passing 6-inch sieve, 5-20% passing 4-inch sieve) shall be mixed in on the surface of the void-filled riprap (covering approximately 40% of the surface) prior to compaction of the void-filled riprap. Cobbles shall be fully embedded into the mass of the void-filled riprap.

NOTE: MIX PROPORTIONS AND MATERIAL GRADATIONS ARE APPROXIMATE AND ARE SUBJECT TO ADJUSTMENT BY THE ENGINEER. NO ADJUSTMENT IN UNIT PRICE FOR VOID-FILLED RIPRAP WILL BE ALLOWED BASED ON MODIFICATION TO THE MIX PROPORTIONS.

DSGN	C BUTLER	NO.	DATE	REVISION	BY	APVD
DR	M MONAHAN					
CHK	C BUTLER					
APVD	K HAMILTON					

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

CH2MHILL
9193 S JAMAICA ST
ENGLEWOOD, CO 80112
CONTACT: MARK GLIDDEN
720-286-5135

DOUGLAS COUNTY
COLORADO

TIMBERS CREEK CHANNEL STABILIZATION

TIMBER DROP STRUCTURE
SECTIONS

SHEET	15
DWG	C-10
DATE	APRIL 2010
PROJ	328175

FILENAME: timcDT02rev1.dgn PLOT DATE: 4/2/2010 PLOT TIME: 1:09:30 PM