South Platte River
Sportsman's Paradise & Happy Meadows
Reaches 20, 21 & 22
River Assessment & Restoration Plan
2011



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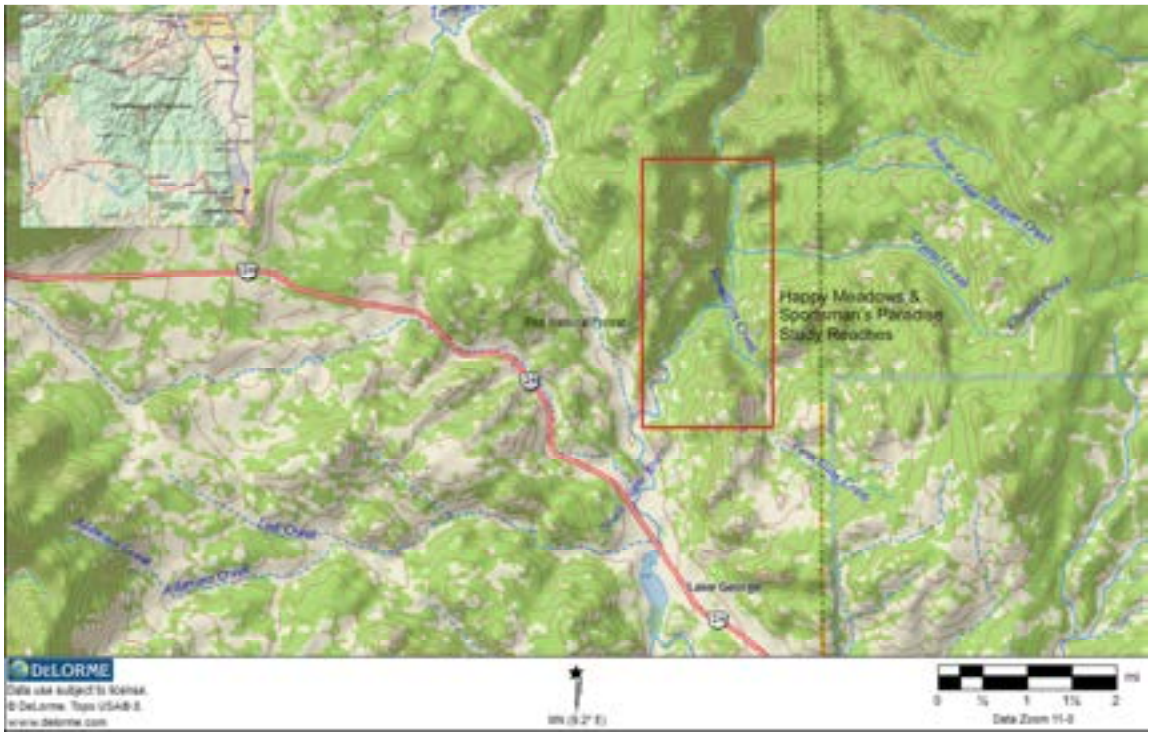
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South Platte River
Happy Meadows – Sportsman's Paradise
River Restoration Plan
2011

The following document describes the treatments to be implemented on the South Platte River in the area known as Happy Meadows and Sportsman's Paradise. The segment of the river is mixed ownership. The upstream reach, designated Reach 22, is located on U.S. Forest Service lands in Park County, Colorado. The river is under management by the Pike & San Isabel National Forests, Cimarron & Comanche National Grasslands, and is within the South Park Ranger District. The downstream reaches, Reach 20 & 21, are located on private lands immediately downstream of the USFS Happy Meadows Reach. This segment of the river is managed as a put-and-take fishery by the Sportsman's Paradise Home Owners Association (SPHOA), for the benefit and enjoyment of their members.

The project reaches begin approximately 2.5 miles NW of the town of Lake George, CO, and are a combined length of four miles. The river is accessible by Park County Road #112, which follows the river throughout the reach on the left (west) bank. The project area is bounded by private property upstream and USFS lands downstream. .

Project Reaches:
The project has been broken out into three distinct reaches, based upon land ownership and channel morphology. The reaches are numbered consecutively, beginning at the downstream boundary of the project area. Reach 20 begins at the downstream boundary of the Sportsman's Paradise property, 420 feet downstream of the confluence of the South Platte River and Beaver Creek, and extends 5,834 feet upstream to the confluence with Crystal Creek. The river channel throughout Reach 20 is classified as Rosgen Type C4, with a few segments exhibiting more of a C3 form.



Map 1: Vicinity Map of the Study Reaches – Happy Meadows Sportsman's Paradise Project

Reach 21 begins at the confluence with Crystal Creek, and extends 3,655 feet upstream to the confluence with Vermillion Creek. The river channel throughout this reach is also classified as Rosgen Type C4. Reach 22 begins at the Sportsman's Paradise / USFS property boundary, and extends 11,440 feet upstream to the upstream USFS / private property boundary. The river channel throughout Reach 22 is classified as Rosgen Type C4, with a few segments exhibiting more of a C3 form.

Purpose & Need:
The South Platte River throughout the project reaches is limited by excess sediment from sources upstream, and from inputs from the adjacent county road (CR 112). This segment of the river was designated by the State of Colorado as impaired by sediment under Section 303(d) of the Federal Clean Water Act of 1972, and a total maximum daily load (TMDL) analysis was conducted between 1996 -2002. The channel is classified as Rosgen C throughout the project reaches, and is over-wide in many segments, exhibiting shallow depth, laminar flow, limited habitat complexity, and poor sediment transport. The downstream segment of Reach 22 is affected by a large low-head diversion structure on the Sportsman's Paradise property that has dramatically over-widened the river. In 2002, the Hayman wildfire burned a large portion of the watershed on the eastern side of the project reaches, further increasing sediment input into the river.

Downstream of the low head dam on the Sportsman's Paradise property, roads exist on both sides of the river, with numerous homes and other structures constructed along both sides of the valley. Extensive "informal" habitat enhancement efforts, mostly in the form of large boulder structures and channel modifications, have been constructed by the SPHOA over the years. While these efforts likely represented the best of intentions by their sponsors to improve the fishery, they have had an unfortunate and unintended consequence of dramatically reducing the river's natural capacity to transport sediment. The river channel throughout the reach is over-wide in many segments, exhibiting shallow depth, laminar flow, limited habitat complexity, and poor sediment transport. Over-widening is especially apparent near the existing boulder structures.

For the most part, the valley bottom, water influence zone, and riparian meadows within the project reaches have remained mostly undeveloped and intact. Soil condition in the riparian zone appears to be relatively poor, however, and is likely due to historic agricultural practices, including extensive potato cultivation in the years before the Sportsman's Paradise housing development began. Upland regions consist mostly of ponderosa pine and spruce forest, with soils comprised of decomposed granite, with a thin layer of duff and sparse vegetation. Throughout the project reaches, large gullies have formed on the large alluvial fans on the right (burned) side of the river, and have contributed significant quantities of sediment to the reach, dramatically effecting habitats downstream.

Base Line Aquatic Habitat and Channel Data:
Aquatic monitoring has been conducted by the US Forest Service throughout the Happy Meadows Reach 22, including basin-wide aquatic habitat inventories (1993 & 2002), and extensive channel morphology surveys in 2006 and 2008. In 2009 and 2010, a rapid aquatic habitat and existing structure assessment and a channel morphology survey was conducted within the Sportsman's Paradise reaches by the Coalition for the Upper South Platte (CUSP), Fin-Up Habitat Consultants, Inc., Crane Associates, the US Forest Service, and volunteers from the SPHOA. This information has been utilized to develop the current habitat assessment and enhancement proposal.

Within Sportsman' Paradise Reach 20, low gradient riffles are the dominant meso-habitat form in the reach, and comprise 46% of the wetted area of the reach. Pool habitats occupy 34% of the reach, with the remaining 20% comprised of poorer quality glides. Glide habitats are typically

associated with disturbed areas and segments where previous habitat enhancement attempts have been undertaken. River bank rock composition (BRC) is heavily dominated by gravel or smaller sized particles consisting mostly of decomposed granite. Given the composition of BRC in the reach, the stream banks in Reach 20 are relatively stable and are well vegetated with sedge and willow. 12% of the east (right) river banks and 5% of the left (west) banks exhibit some signs of instability, and 330 feet of bank was found to be actively eroding materials into the river.

In Sportsman' Paradise Reach 21, low gradient riffles are once again the dominant meso-habitat form in the reach, and comprise 51% of the wetted area of the reach. Pool habitats are less frequent than in Reach 20, and occupy only 25% of the reach, with the remaining 24% comprised of poorer quality glides. As was the case in Reach 20, glide habitats are closely associated with disturbed areas. BRC is almost entirely dominated by gravel or smaller sized particles consisting decomposed granite. The stream banks in Reach 21 exhibit similar stability and vegetation characteristics to the reach downstream, and are relatively stable and vegetated with sedge and willow. 7% of the east (right) river banks and 15% of the left (west) banks exhibit some signs of instability, and 200 feet of bank was found to be actively eroding materials into the river. Most of the unstable left bank is directly associated with the fill slope forming the diversion ditch that feeds the lake on the west side of the reach.

Within Happy Meadows Reach 22, low gradient riffles are once again the dominant meso-habitat form in the reach, and comprise 51% of the wetted area of the reach. Pool habitats occupy 21% of the reach, with the remaining 28% comprised of poorer quality glides. River bank rock composition (BRC) is heavily dominated by gravel or smaller sized particles consisting mostly of decomposed granite. Given the composition of BRC in the reach, the stream banks in Reach 20 are relatively stable and are well vegetated with sedge and willow. 16% of the east (right) river banks and 28% of the left (west) banks exhibit some signs of instability, and 2,950 feet of bank was found to be actively eroding materials into the river.

Hydrology & HEC RAS

The hydrology for the South Platte River at Happy Meadows was evaluated using stream gage information to perform a flood frequency analysis. Annual maximum flows were determined from the monthly peak discharge information available for the South Platte River near Lake George (PLAGEOCO) gage operated by the Colorado Division of Water Resources.

The gage is located at latitude 38 54'19" and longitude 105 28'22", on the left bank approximately 700 feet downstream of Eleven Mile Canyon Reservoir. The contributing drainage area at the gage is 963 mi2 and the gage has been operated continuously since October 3, 1929. However, the Eleven Mile Canyon Dam construction was completed in 1932, therefore the period of record used for analysis for this project is the post-dam period, 1932 to 2009.

The USGS program, PEAKFQ, was used to analyze the yearly peak flow. This program is based on the methods outlined in "Guidelines for Determining Flood Flow Frequency, Bulletin 17B of the Hydrology Subcommittee" of the USGS. This method utilizes a Log Pearson Type III distribution with a regional and station weighted skew to evaluate peak flow data and perform the frequency analysis. The results of the analysis at the gage are summarized in Table 1 and shown in Figure 1.

The results are representative of flows at the gaging station. However, this is approximately 12.5 miles upstream of the project site. To determine flows at the Happy Meadows project, the following equation was applied:

$$QT(u) = QT(g)\ (Au/Ag)x$$

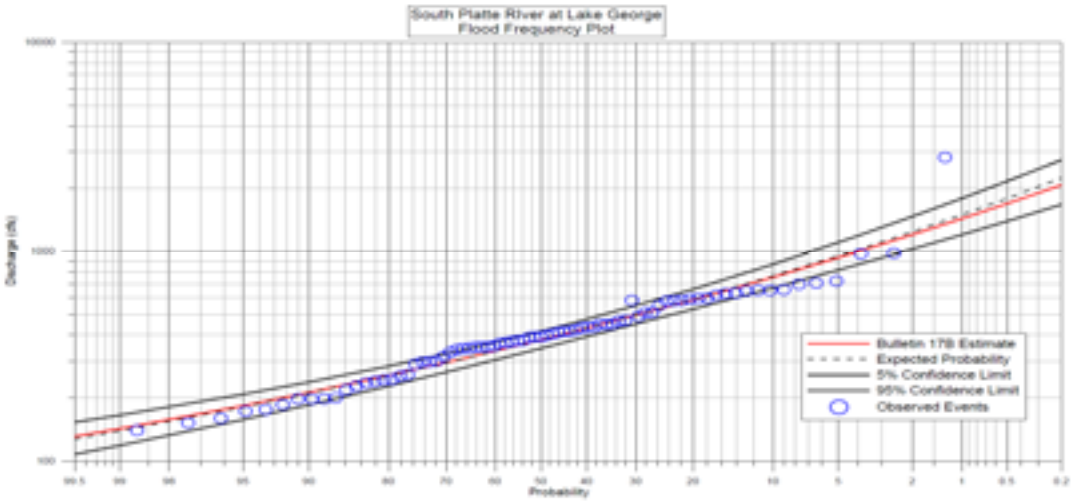


Figure 1: Flood Frequency for the South Platte River at Lake George

Where QT(u) is the peak discharge in cfs at the ungaged station for the T-year recurrence interval
QT(g) is the peak discharge in cfs at the gaged station for the T-year recurrence interval
Au is the contributing drainage area for the ungaged station
Ag is the contributing area for the gaged station
X = the average exponent for drainage area for each flood region,
= 0.69 for the Mountains region

The equation and methodology are described in the USGS Water-Resources Investigation Paper 99-4190 titled "Analysis of the Magnitude and Frequency of Floods in Colorado".

To determine the watershed area between the gaged site and the downstream end of the project site, a series of USGS quads were assembled to evaluate the contributing watersheds. Figure 1 depicts the area (outlined in red) that drains to the South Platte River and tributaries that all reach the project site. This area is 181.7 mi2. The watershed area at the PLAGEOCO gage is 963 mi2.

A HEC RAS sediment transport model has been developed for the project to verify the sediment transport goals of the design. HEC RAS prediction modeling is included in the Appendix to this document.

Frequency Analysis Results for PLAGEOCO 1934-2009

Percent Chance Exceedance	Computed Flow (cfs)	Confidence Limits (Flow in cfs) 0.05	0.95
0.2	2072	1671	2731
0.5	1686	1389	2157
1	1429	1198	1787
2	1199	1023	1464
4	992.5	862	1182
10	750.4	667.2	864.2
20	585.4	528.9	657.6
50	377.6	343.5	414.6
80	255.2	226.8	282.7
90	211.6	184.6	237.3
95	183	157	207.5
99	142.2	118.2	164.9

Area Gaged = 963 mi²
Area Ungaged = 1145 mi²
Au/Ag = 1.19
QT(u) = QT(g) (Au/Ag)^0.69

Frequency Analysis Results for Happy Meadows Site

Percent Chance Exceedance	Return Period (yrs)	Predicted Flow in cfs
0.2	500	2,335
0.5	200	1,900
1	100	1,610
2	50	1,351
4	25	1,118
10	10	846
20	5	660
50	2	426
80	1.25	288
90	1.11	238
95	1.05	206
99	1.01	160

Table 1: Flood Frequency Analysis Results for the PLAGEOCO gage andHappy Meadows Project Site

Goals & Objectives:
In 2004, biologists and watershed specialists from the US Forest Service, Colorado Division of Wildlife, and the Coalition for the Upper South Platte identified the Happy Meadows reach as an ideal location to begin assessing the potential for river restoration in a moderately burned area of the Hayman burn. The goal of the project would be to demonstrate different techniques to reduce sediment loads from the burned areas, improve sediment transport within the river channel, and restore lost habitat. In 2006, the CUSP secured 319 program funding to begin design and implementation of the project. In 2008, the project scope was enlarged to include the removal and replacement of the Sportsman's Paradise Dam and restoration of the privately owned reaches immediately downstream.

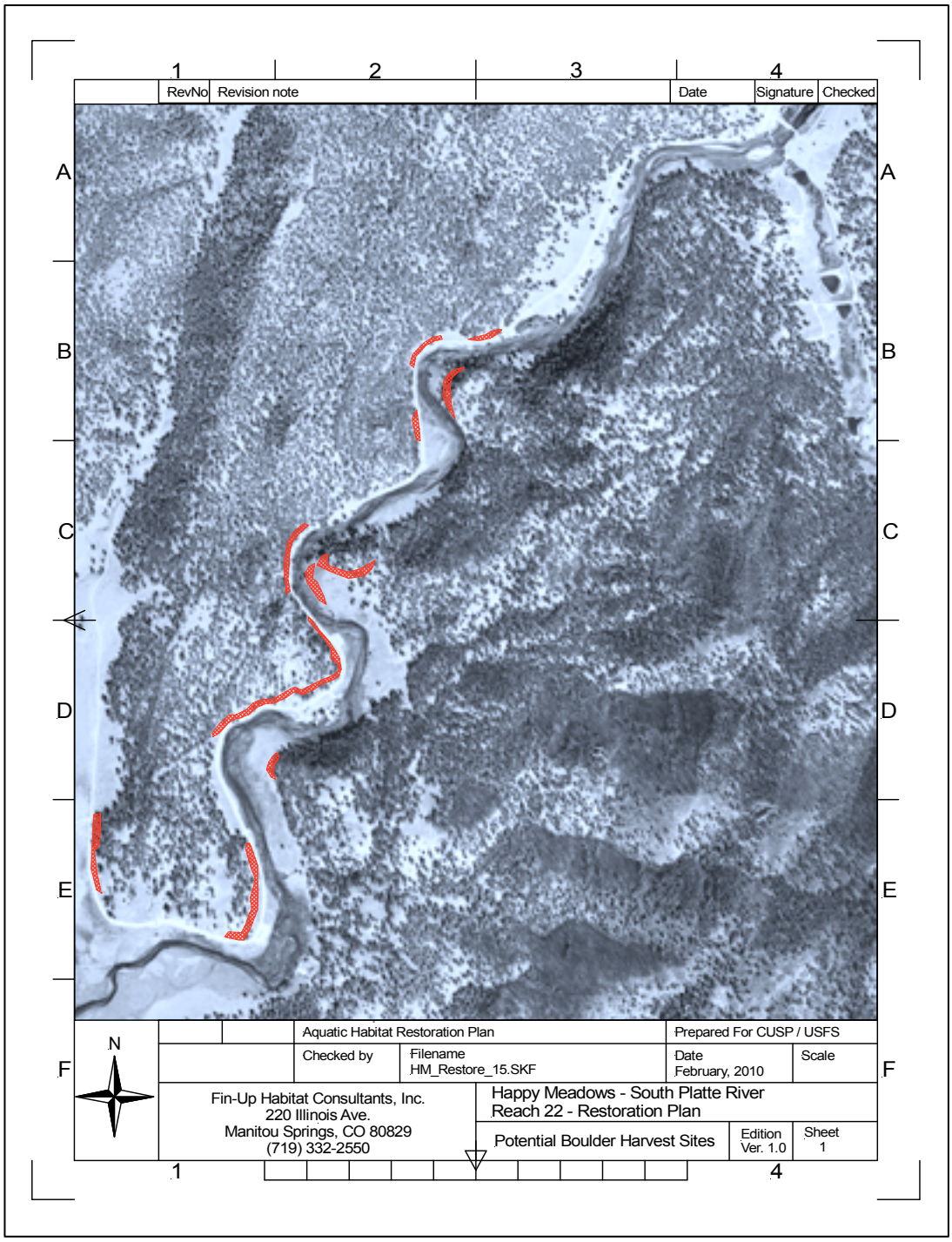
The project will address the sedimentation issues presented by the gullies on the burned side of the river actively contributing sediment to the system. These gullies will be stabilized to cut off the sediment supply to the main stem of the channel. The low-head diversion structure at Sportsman's Paradise will be re-configured, allowing for restoration of the channel upstream on Forest lands, and to improve aquatic organism passage through the project reaches. Downstream on the Sportsman' Paradise property, the first priority will be to reconfigure or remove the problematic existing structures that are continuing to degrade channel stability and integrity. In this segment, the in-channel and river bank enhancement effort will focus on reducing the width/depth ratio of the channel to improve sediment transport. Work in the project reaches will include many features and techniques that will improve habitat complexity and quality for resident rainbow and brown trout.

Project Monitoring:
The project reaches will be monitored to determine how proposed treatments affect stream stability and habitat compared to pre-treatment conditions. Most of the base-line sample data has already been collected, with the remainder expected to be collected before project construction begins. Post project monitoring will continue after treatments are completed. Photo-points will be established in the treatment areas to monitor the vegetation and channel over time. Habitat mapping survey and a channel morphology surveys may be repeated five to ten years following completion of the project.

To measure the effectiveness of the proposed treatments for reducing sediment impacts, the monitoring objectives will seek to answer the following:
• Did the percentage of unstable stream bank decrease after treatments?
• Did the width to depth ratio of the stream decrease after treatments?
• Did percentage of fine sediment decrease after treatments?
• Did pool habitat increase after treatments?
• Did stream stability ratings improve after treatment?
• Did the percentage of stream bank with vegetation cover increase after treatments?
• Did sediment transport capacity change after treatment?
• Did benthic macroinvertbrate abundance and diversity increase after treatments?

Project Materials Harvest Sites:
450 to 500 large trees will need to be harvested from the surrounding National Forest and private lands to provide the large wood required to implement the restoration plan. It is expected that these trees will come from existing active timber sales on the South Park and Pikes Peak Ranger District, recent blow-down sites in the vicinity of Lake George and the Manitou Experimental Forest, and from Sportsman's Paradise.

Several hundred cubic yards of boulders will be required, and represent a significant cost to complete the project reach. Several sites immediately adjacent to County Road 112 and the project reach have been identified during the planning phase of the project that could supply the necessary boulders for the project. In the Sportsman's Paradise reaches, substantial quantities of boulders are



already available on site in the existing structures, however, a few hundred cubic yards of additional boulders will still be required to complete these segments. There are a few sites within the SPHOA property that may be suitable for boulder collection that could supply the necessary boulders for the project.

Using low impact boulder harvest techniques demonstrated during the 2005 Eleven-mile Canyon River Restoration "Centennial" Project and the 2009 Camp Alexander Restoration Project, boulders for this restoration may be harvested with little disturbance from these areas. Using local boulders not only substantially reduces the overall cost of the work, but is esthetically desirable to enhance the natural appearance and reduce the visual impact of the project. Ideally, the project should be relatively "invisible" to the untrained eye three years following completion of the work. The use of native materials greatly increases the probability of achieving this goal. The boulder harvest sites identified during the planning phase of the project are shown in the map on the following page of this document.

Native coyote and sand bar willow is relatively abundant in the project area, and will allow for quick and easy transplant by backhoe, excavator or front loader. Sedge is less abundant in the project reach, and will likely have to be harvested from areas outside of the project reach. A large source of sedge has been identified on private property adjacent to the large lakes in the town of Lake George, and the owners have agreed to allow harvest of sedge necessary for the project from this nearby site. Additionally, they may be able to provide additional trees for the effort due to the recent tornado / blow-down event that occurred last fall. Areas where sod mats can be taken to restore river banks are abundant in the project area, but noxious weed survey and mapping will need to be conducted before project implementation to assure that sod mats are not infested with undesirable vegetation. Sod mat harvest areas will need to be reclaimed and re-seeded following project implementation to assure that these disturbed areas do not become additional sources of week infestation. Extensive hand planting of bare root stock willow by volunteers will require purchase of these plants from the Colorado State Forest Service. As many as 16,000 bare root stock plants may eventually be planted to fully revegetate the restored river banks in the project reaches.

Prioritization and Implementation:
If time and budgets allow, the project should be fully implemented, in order to take advantage of the economies of scale of a larger effort in the basin, and to quickly address some of the significant issues identified in this assessment. The reality of limited budget, resources, and timing, however, may dictate that the work be implemented over an extended period of time. If this is indeed the case, the treatments outlined in this document may be prioritized for implementation over a period of years. Project implementation will begin with the removal of the low head dam, and reconstruction of the Sportsman's Paradise diversion and the river channel extending approximately 600 feet upstream onto the National Forest. Following this work, channel and habitat restoration may proceed on the project reaches. While it is ideal to begin the work at the upstream boundary of Reach 22 and proceed downstream, this may not be feasible given the NEPA requirement for work on this Reach. If this is the case, work will begin on Reach 21, continuing downstream to Reach 20, with Reach 22 completed the following year.

The project will require the use of heavy equipment to complete the treatments as prescribed. At a minimum, we recommend the following equipment be contracted to implement the project. A large excavator (200 series or greater) with a functional hydraulic "thumb" will be necessary. Excavators utilizing a fixed "thumb" are not suitable for work of this complexity, and are not recommended. A large loader will be required, with a minimum bucket size of 4 yd^3, and equipped with a hardened steel cutting edge on the bucket to allow for efficient harvest of vegetation mats from the islands and surrounding meadows. The loader may be either tracked or wheeled, but ifwheel driven, it should have large balloon style tires to minimize compression of riparian soils. Tandem dump trucks and/or a side dump truck will be required to move materials to the project sites. While not absolutely required, a second excavator can be very useful, particularly with the

log toe-slope and riparian bank-full bench work, and can significantly reduce the time necessary to build these features.

Project Development & Design Team:

Pete Gallagher – River Assessment & Restoration Planning
FIN-UP Habitat Consultants, Inc. Manitou Springs, CO

Dana Butler – Forest Hydrologist
USFS– Pike & San Isabel National Forests, Cimarron and Comanche National Grasslands

Jeff Crane – Restoration Plan Review and HEC RAS Model Development
Crane Associates, Hotchkiss, CO

Molly Purnell – Forest Hydrology Technician
USFS– Pike & San Isabel National Forests, Cimarron and Comanche National Grasslands

Additional Project Development, Design Planning, and Assistance:

Steve Culver – Fisheries Biologist
USFS– Pike & San Isabel National Forests, Cimarron and Comanche National Grasslands

Craig Hansen – Biologist
USFS– Pike & San Isabel National Forests, Cimarron and Comanche National Grasslands

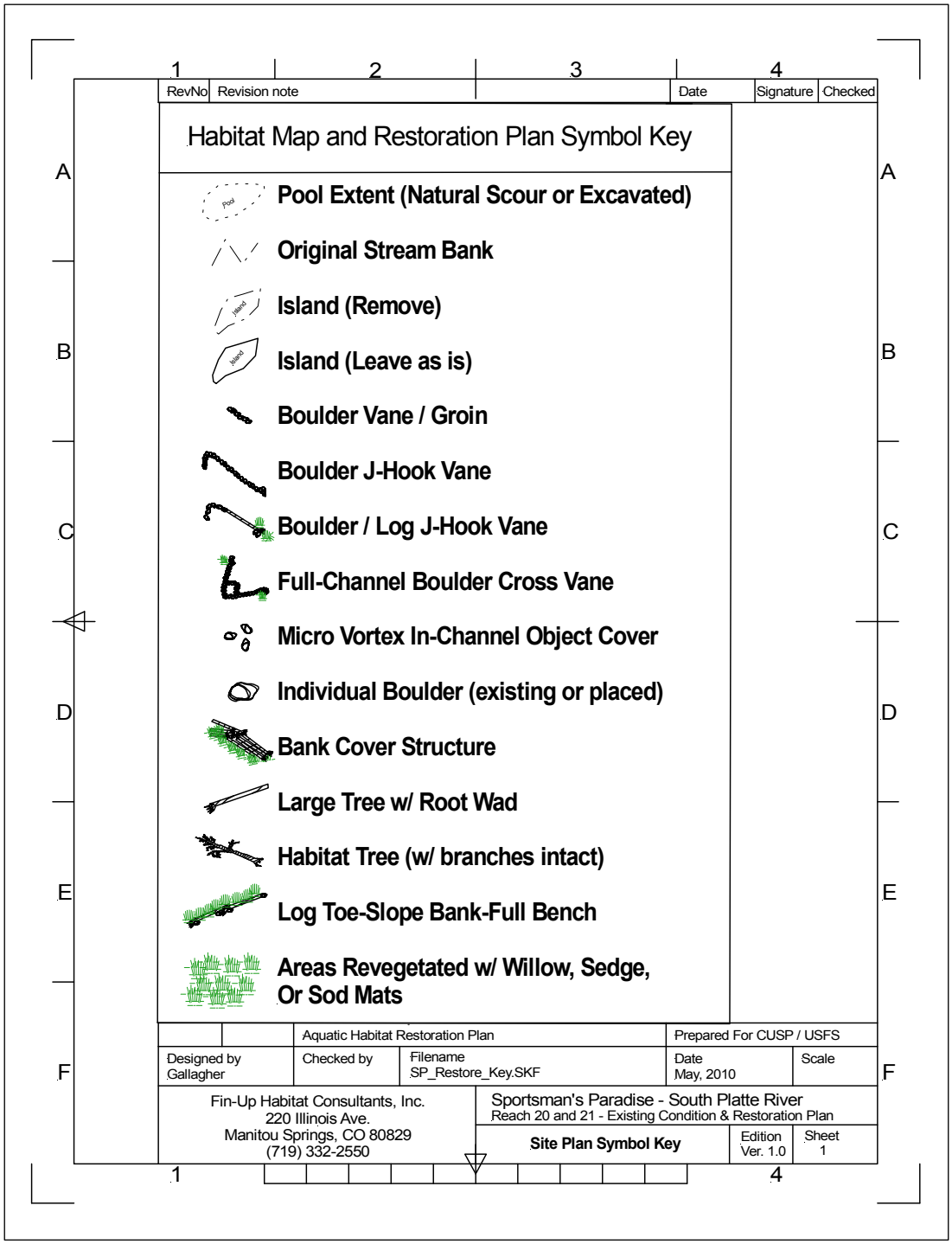
Sarah Lykens - AmeriCorps*VISTA Planning and Development Coordinator
Coalition for the Upper South Platte

Ted Stiles – Home Owner
Sportsman's Paradise Home Owners Association

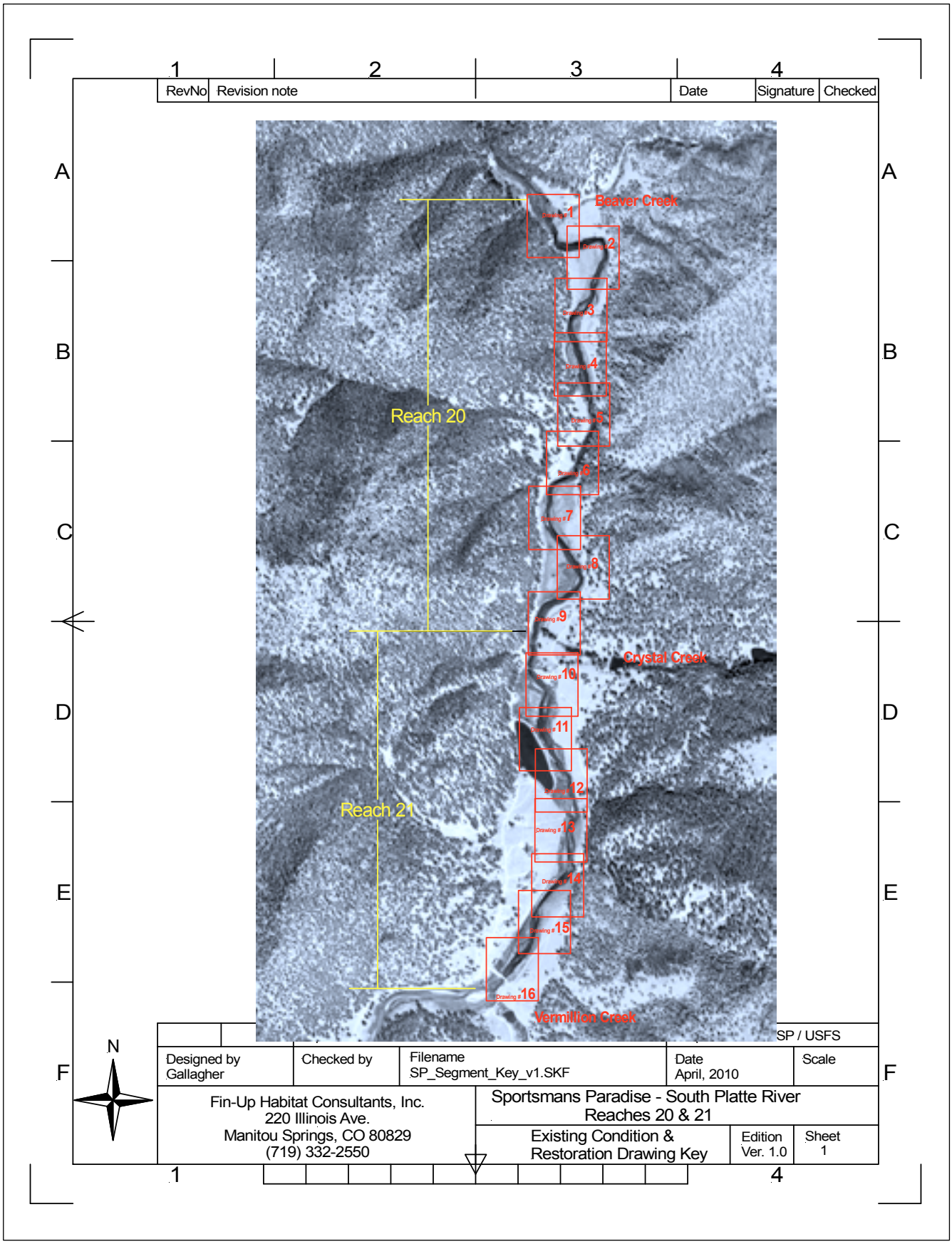
Restoration Plans:
An aquatic and riparian enhancement plan has been developed for Reach 20 and 21 on the SPHOA property, and Reach 22 on USFS lands. The plan is principally based on the existing condition assessments and river channel surveys conducted by the USFS and CUSP. The existing condition assessments indicate that the principal limiting factors to the fishery are poor pool and in-channel pocket-water habitat due to insufficient sediment transport. The channel is over-wide in many areas, and is particularly poor in those associated with previous in-channel habitat structure efforts. The numerous large mid-channel islands and sediment bars found in the South Platte River within Sportsman's Paradise and Happy Meadows appear to indicate that the river has lost much of it's capacity to move the current sediment load. These islands are creating additional shear on the river banks, further exasperating the over-widening issue. If left in the current condition, it is expected that the river will continue laterally migrate and over-widen, with much of the remaining pool and pocket-water habitats eventually filling with fines, further reducing the habitat capacity for trout. The enhancement project outlined in this document will address the sedimentation and channel morphology issues identified in the assessment. The first priority will be to remove and replace the existing low-head diversion structure at Sportsman's Paradise will be re-configured, allowing for improved sediment transport capacity and restoration of the channel upstream on National Forest lands. The next priority will focus on reducing the width/depth ratio of the channel to improve sediment transport. This work will also include many features and techniques that will improve habitat complexity and quality for resident rainbow and brown trout. The problematic existing structures in the Sportsman's Paradise reaches that are continuing to degrade channel stability and integrity will be reconfigured or removed from the channel. The gullies on the burned side of the

river actively contributing sediment to the river will be stabilized to cut off the sediment supply to the main stem of the channel.

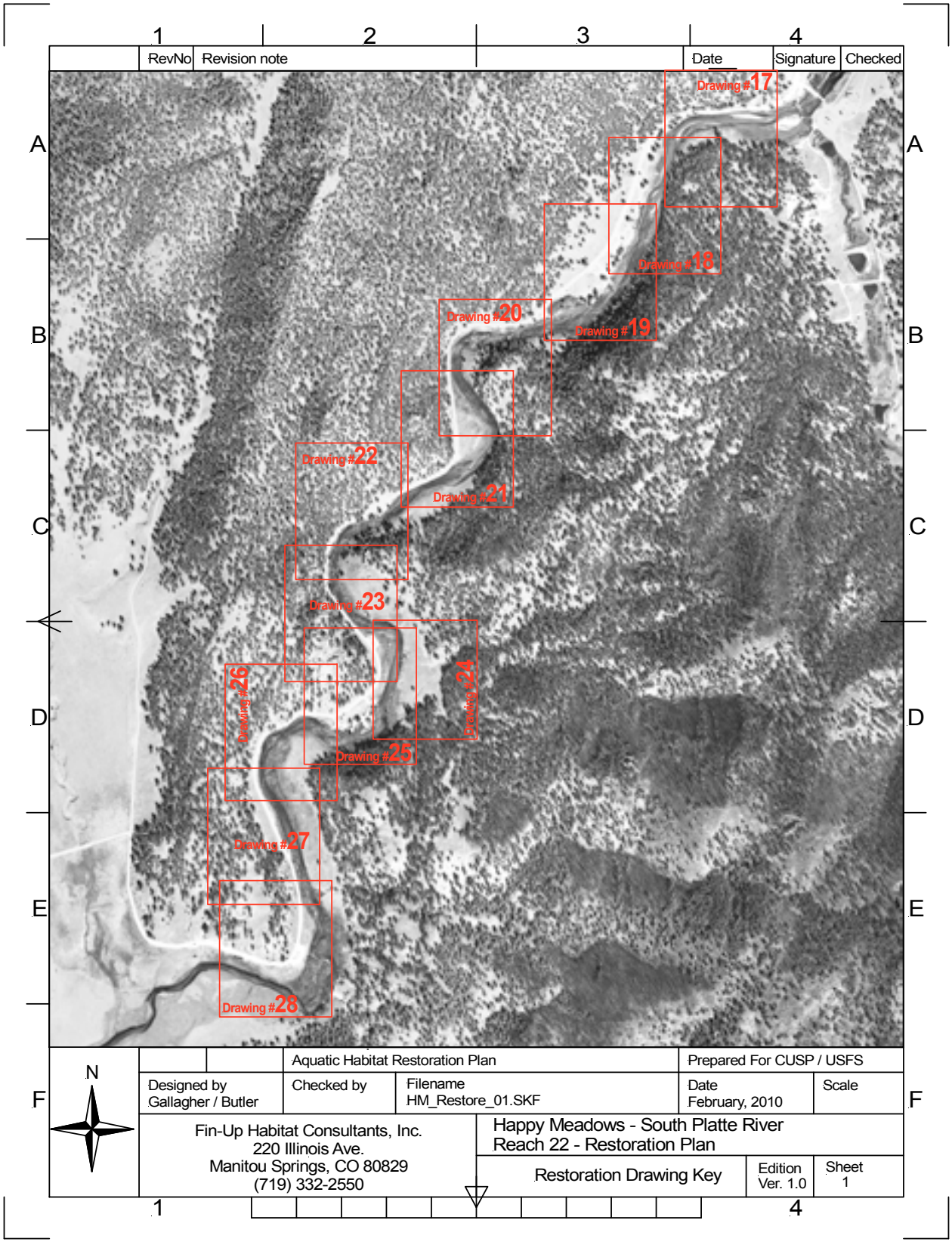
The specific project treatments are described in the following chapters, beginning with Reach 20 at the downstream boundary of the project area, and proceeding upstream through the Happy Meadows Reach. The drawings on the following pages show the locations of the proposed treatments. Accompanying each drawing is a narrative of the specific proposed treatment. Treatment locations are described based on grid location on each drawing.



Sportsman's Paradise Reaches 20 & 21



Happy Meadows Reach 22



Reach 20 – Enhancement Plan Drawing #1:

This drawing shows the downstream (northern) most segment of Reach 20, from the USFS/SPHOA property boundary at 0ft upstream to 0+600ft along the longitudinal axis of the river.

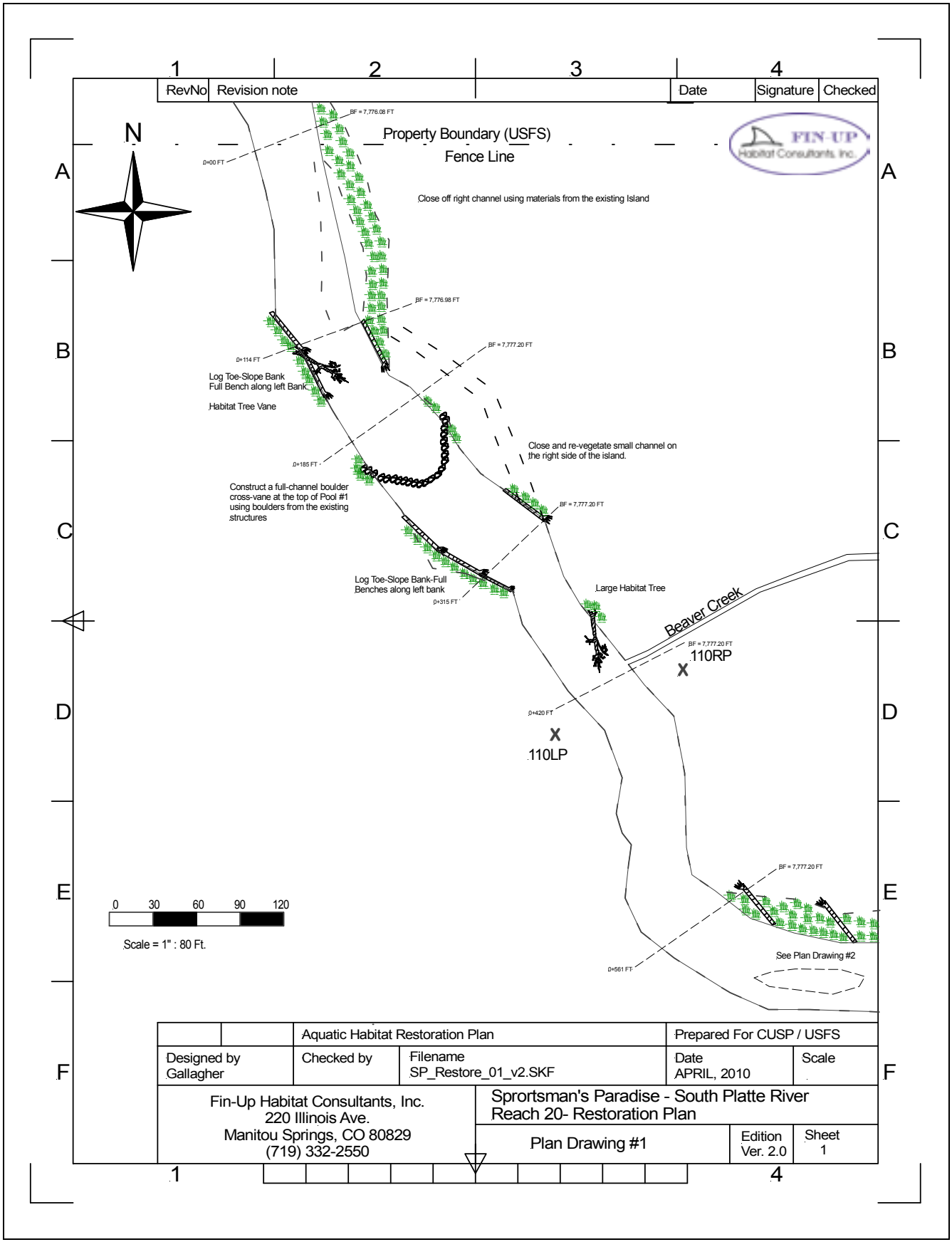
The five structures identified in the condition assessment should be removed, and the boulders utilized to build a full-channel boulder cross-vane at 0+200ft (Grid C-2). This cross-vane will improve scour and depth through the center the existing pool downstream. The vanes forming the structure will be tied into the existing river banks at the bank-full elevation, and the center of the structure will be constructed to an elevation of ½ bank-full or less. The riffle upstream is armored to the point that some small gaps may be left between boulders in the center of the structure to create greater velocity complexity and better feeding stations for trout immediately downstream.

Upon removal of structures #1 and #2, the smaller right channel at 0+114 ft (Grid A\B-2) will be closed off using large wood to create a bank-full riparian bench along the upstream boundary of the channel. The right (island) bank of the left channel will be reconstructed to a bank-full channel width of approximately 70 ft to create a width/depth ratio in the riffle of 30 or less. Vegetation from this river bank will be transplanted to the right channel to re-vegetate this feature.

The small channel on the right side of the large island at 0+315ft will be closed off using large wood and boulder, similar to the side channel downstream. After removal of Structures #4 & #5, the left river bank from 0+ 220ft to 0+330ft will be reconstructed using large wood bank-full benches and willow transplanted from nearby sites upstream.

A large ponderosa pine tree will be installed as a vane along right river bank downstream of the confluence with Beaver Creek. This feature should improve scour and velocity complexity in Glide #1. It is expected that sediment entering the river from Beaver Creek will gradually form a bar upstream of the tree; further reducing the width of the channel at this point and enhancing scour along the left third of the glide habitat. Eventually, this may form a trench pool within this currently habitat limited segment of the river.

The large pool at the meander bend at 0+500 ft (Grid E-3) will be left undisturbed. This feature is currently one of the best pools in the study reaches and does not require any further enhancement. Upstream of this pool, the river becomes significantly over-wide. This segment of the river, from 0+561 ft to 0+968, (see Plan Drawing #2) will be treated using river narrowing techniques developed and demonstrated in Eleven-mile Canyon in 2004 and 2006 (Photo 18). Large wood will be placed low in the channel along the river banks to capture sediment moving through the system and aggrade the bed. Extensive plantings of sedge and sod mats will be utilized. The goal of this work will be to reduce the width/depth ratio of this segment to between 35 – 30. In addition to the channel narrowing work, two log/boulder J-Hook vanes and one large habitat tree will be installed along the outside left bank of the river meander, creating additional complexity and protecting the bank from increased shear.


RevNo
Revision note
Date
Signature
Checked
N
Property Boundary (USFS)
Fence Line
FIN-UP Habitat Consultants, Inc.
Close off right channel using materials from the existing Island
BF = 7,776.08 FT
0+00 FT
BF = 7,776.98 FT
BF = 7,777.20 FT
0+114 FT
Log Toe-Slope Bank
Full Bench along left Bank
Habitat Tree Vane
Close and re-vegetate small channel on
the right side of the island.
0+185 FT
Construct a full-channel boulder
cross-vane at the top of Pool #1
using boulders from the existing
structures
BF = 7,777.20 FT
Log Toe-Slope Bank-Full
Benches along left bank
0+315 FT
Large Habitat Tree
Beaver Creek
BF = 7,777.20 FT
110RP
0+420 FT
110LP
BF = 7,777.20 FT
See Plan Drawing #2
0+561 FT
0
30
60
90
120
Scale = 1" : 80 Ft.
Aquatic Habitat Restoration Plan
Prepared For CUSP / USFS
Designed by
Gallagher
Checked by
Filename
SP_Restore_01_v2.SKF
Date
APRIL, 2010
Scale
Fin-Up Habitat Consultants, Inc.
220 Illinois Ave.
Manitou Springs, CO 80829
(719) 332-2550
Sprortsman's Paradise - South Platte River
Reach 20- Restoration Plan
Plan Drawing #1
Edition
Ver. 2.0
Sheet
1

Reach 20 – Enhancement Plan Drawing #2:



Large wood installed low in the channel to reduce width/depth ratio - South Platte River, Elevenmile Canyon, IFIM Springer Gulch Middle Station. 2004 "*Trees for Trout*" Demonstration Project

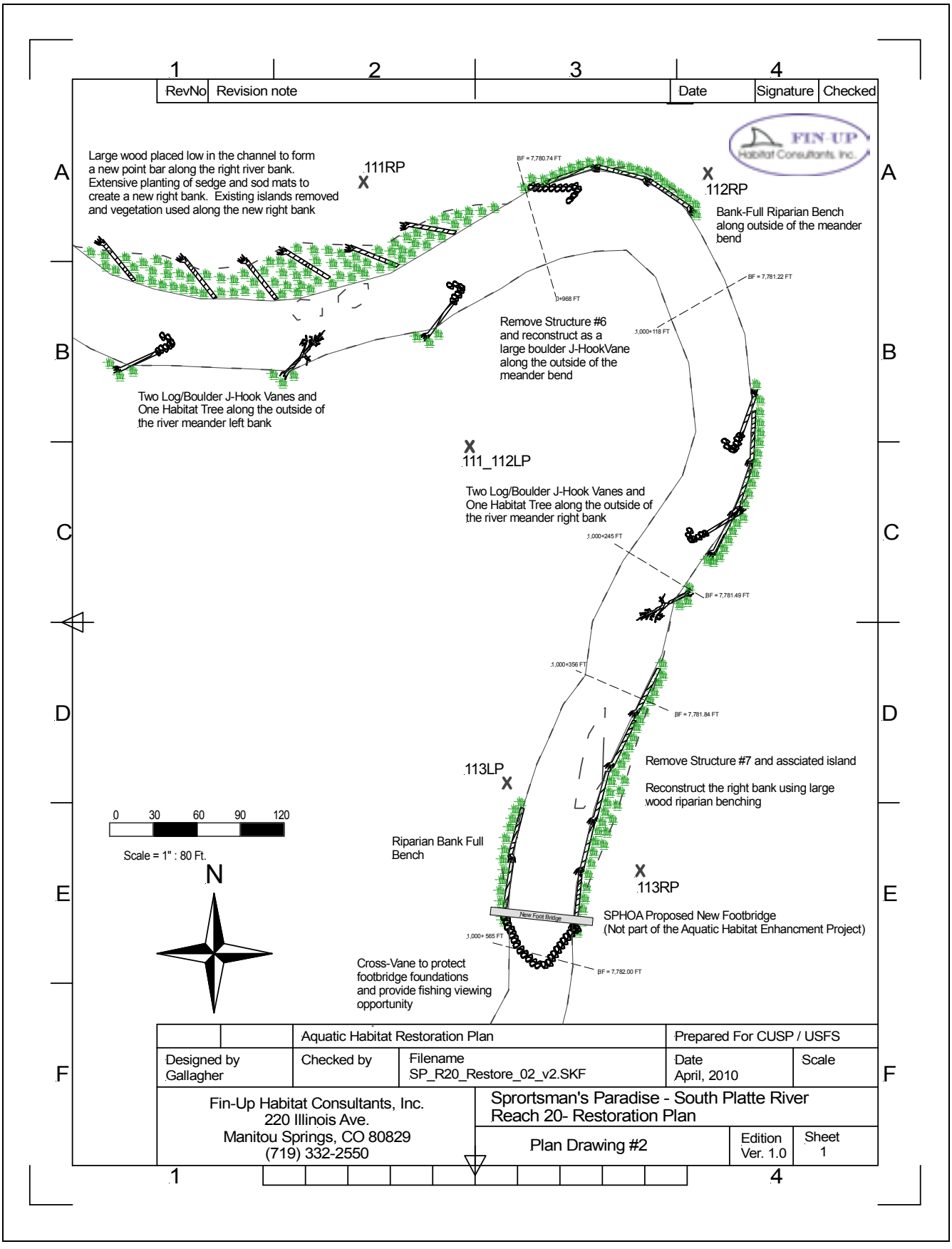
The two structures identified in the condition assessment should be removed, and the boulders utilized to build a large J-Hook vane at 0+968 (Grid A-3), and other features in the segment as described below. The J-Hook vane will anchor the riparian bench work along the right bank of Pool #3, immediately upstream along the outside of this meander bend. Very large wood should be used to form the toe of this feature, in order to effectively capture material and stabilize the deposition fan formed by the gully that enters the stream from the northeast.

The small island and gravel bar at Riffle #4 (Grid C-4) will be removed, and these materials will be incorporated into the new log toe-slope bank-full benches constructed along the right bank of this habitat. Two log/boulder J-Hook vanes will be installed along the right bank to protect the bank from erosion. These features will also provide additional in-channel object cover, and young-of-the-year rearing habitat along the edge of the river.

One large ponderosa pine or spruce tree will be utilized as a habitat tree along the right river bank at Glide #2 (Grid D-3). The tree will provide additional complexity in this otherwise habitat limited segment. Every effort should be utilized to keep all of the tree branches intact, in order to provide as much velocity shelter and cover as possible.

Once Structure #7 is removed, the bank-full width of the river at Cross-Section #113 and Riffle 5 can be reduced to approximately 70 ft utilizing bank-full riparian benching on the right bank along the entire length of the riffle. Vegetation from the island that has formed in the center of the channel downstream of the structure will be transplanted along the riparian benches. A small avulsion on the left bank, near the top of the riffle, may also be treated with bank-full riparian benching.

The SPHOA has proposed building a small footbridge at 0+550ft (Grid E-3). While not a part of the aquatic enhancement project, this structure may require some in-channel work to protect the bridge foundation supports. We recommend that a boulder cross-vane be installed upstream of the structure to address this need, and to provide fish-viewing opportunity as well.


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Large wood placed low in the channel to form a new point bar along the right river bank. Extensive planting of sedge and sod mats to create a new right bank. Existing islands removed and vegetation used along the new right bank
111RP
112RP
Bank-Full Riparian Bench along outside of the meander bend
BF = 7,780.74 FT
BF = 7,781.22 FT
Remove Structure #6 and reconstruct as a large boulder J-HookVane along the outside of the meander bend
Two Log/Boulder J-Hook Vanes and One Habitat Tree along the outside of the river meander left bank
111_112LP
Two Log/Boulder J-Hook Vanes and One Habitat Tree along the outside of the river meander right bank
BF = 7,781.49 FT
BF = 7,781.84 FT
113LP
Remove Structure #7 and assciated island
Reconstruct the right bank using large wood riparian benching
Riparian Bank Full Bench
113RP
New Foot Bridge
SPHOA Proposed New Footbridge (Not part of the Aquatic Habitat Enhancment Project)
BF = 7,782.00 FT
Cross-Vane to protect footbridge foundations and provide fishing viewing opportunity
0 30 60 90 120
Scale = 1" : 80 Ft.
N
Aquatic Habitat Restoration Plan
Prepared For CUSP / USFS
Designed by Gallagher
Checked by
Filename SP_R20_Restore_02_v2.SKF
Date April, 2010
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Reach 20 – Enhancement Plan Drawing #3:

This drawing shows the segment of Reach 20 from 0+1,425ft to 0+2,200 ft along the longitudinal axis of the river. The segment up to the new cross-vane at 0+565 has been described in the previous section.

Structure #8 and the large mid-channel island downstream will be removed. The left bank downstream of Structure #8 will be reconstructed using large wood and riparian bank-full benches, utilizing vegetation taken from the mid-channel island. The eroding bank on the right (Grid C/D-2) will also be stabilized using log toe-slope riparian benches. The target bank-full width of the channel through this segment is 80 ft. Boulders from the structure will be utilized to build a full-channel boulder cross-vane at 0+1,765 ft (Grid C-2). This cross-vane will improve scour and depth through the center of the pool downstream. The vanes forming the structure will be tied into the restored river banks at the bank-full elevation, and the center of the structure will be constructed to an elevation of ½ bank-full or less.

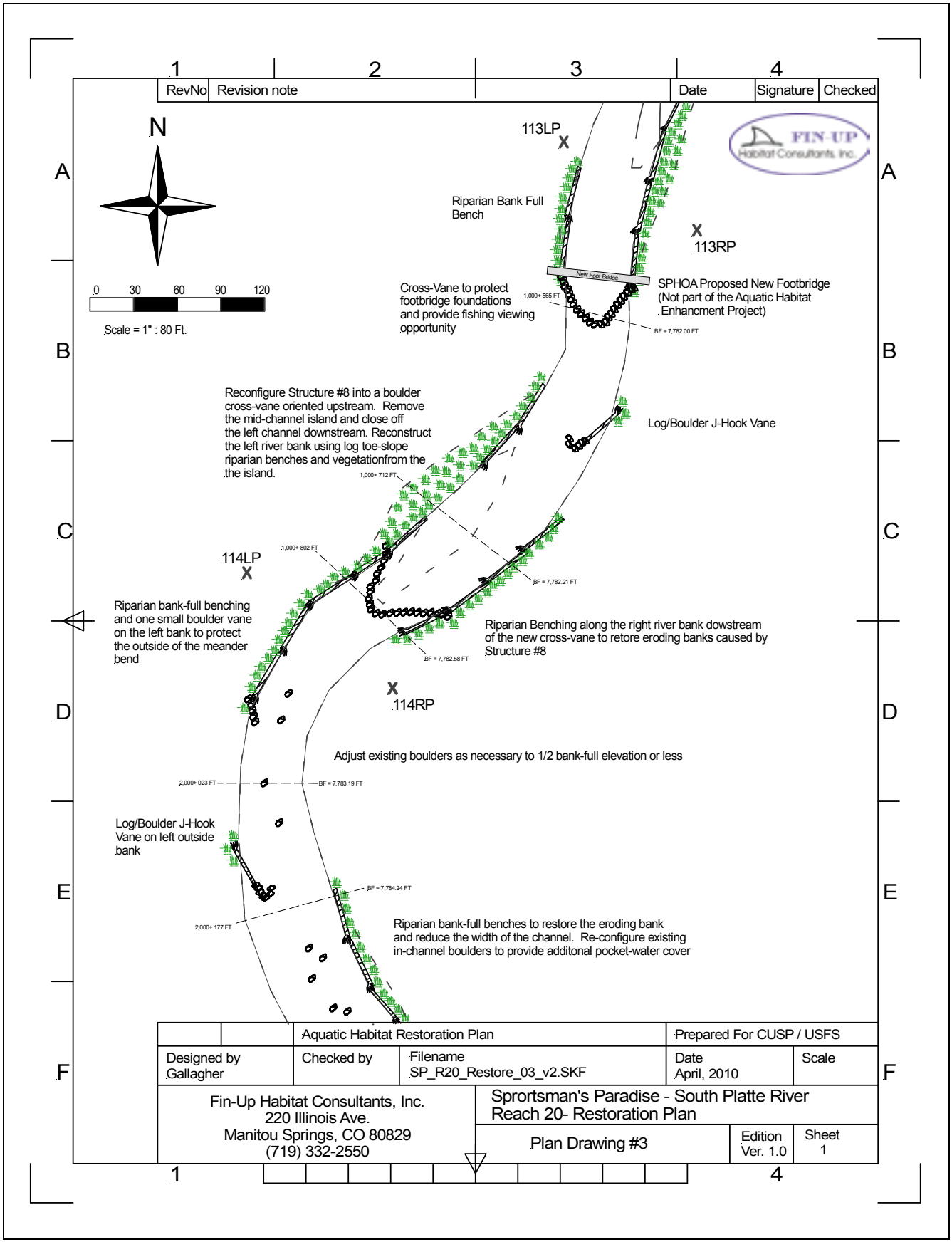
Upstream of the new boulder cross-vane, riparian bench treatments will be continued along the left bank to protect this area from shear along the outside of the meander bend of the river. A small boulder vane will be installed on the upstream side of the riparian benching to protect this feature, and to provide additional velocity shelter in the channel.

Two large log/boulder J-Hook vanes will be installed within this segment. The first will be located along the outside meander bend in Glide #3, at approximately 0+1,740 ft (GridB/C-3). This feature will provide protection to the right river bank along this habitat unit; create additional rearing habitat along the bank for juvenile trout. The second log/boulder J-Hook vane will be installed on the left bank in Riffle #6 at approximately 0+2,070 ft (Grid E-1), to create similar habitat and additional pocket water in this riffle. Several existing boulders in the riffle may be utilized to construct this feature.

The actively eroding right river bank along the downstream half of Riffle #7 will be treated with riparian benching to slightly reduce the width of the channel, creating a more desireable width/depth ratio in the habitat and improving sediment transport through the channel. The target bank-full width of the river through this segment will be 75-80 feet, with a width\depth ratio of 35 or less.


Micro-Vortex Structure – Elevenmile Canyon.

There are numerous existing in-channel boulders in the segment that may be re-aligned or re-positioned to improve object cover and scour along these features. Within Riffle #7, these boulders may be used to create several micro-vortex structures along the thalweg of the river in this habitat.


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Revision note
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Signature
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0 30 60 90 120
Scale = 1" : 80 Ft.
113LP
Riparian Bank Full Bench
113RP
New Foot Bridge
Cross-Vane to protect footbridge foundations and provide fishing viewing opportunity
SPHOA Proposed New Footbridge (Not part of the Aquatic Habitat Enhancment Project)
1,000+ 565 FT
BF = 7,782.00 FT
Reconfigure Structure #8 into a boulder cross-vane oriented upstream. Remove the mid-channel island and close off the left channel downstream. Reconstruct the left river bank using log toe-slope riparian benches and vegetationfrom the the island.
Log/Boulder J-Hook Vane
1,000+ 712 FT
1,000+ 802 FT
114LP
BF = 7,782.21 FT
Riparian bank-full benching and one small boulder vane on the left bank to protect the outside of the meander bend
Riparian Benching along the right river bank dowstream of the new cross-vane to retore eroding banks caused by Structure #8
BF = 7,782.58 FT
114RP
Adjust existing boulders as necessary to 1/2 bank-full elevation or less
2,000+ 023 FT
BF = 7,783.19 FT
Log/Boulder J-Hook Vane on left outside bank
BF = 7,784.24 FT
2,000+ 177 FT
Riparian bank-full benches to restore the eroding bank and reduce the width of the channel. Re-configure existing in-channel boulders to provide additonal pocket-water cover
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Reach 20 – Enhancement Plan Drawing #4:

This drawing shows the segment of Reach 20 from 0+2,100 ft to 0+2,650 ft along the longitudinal axis of the river. The log/boulder J-Hook vane on the left bank at 0+2,070 ft has already been described in the previous segment.

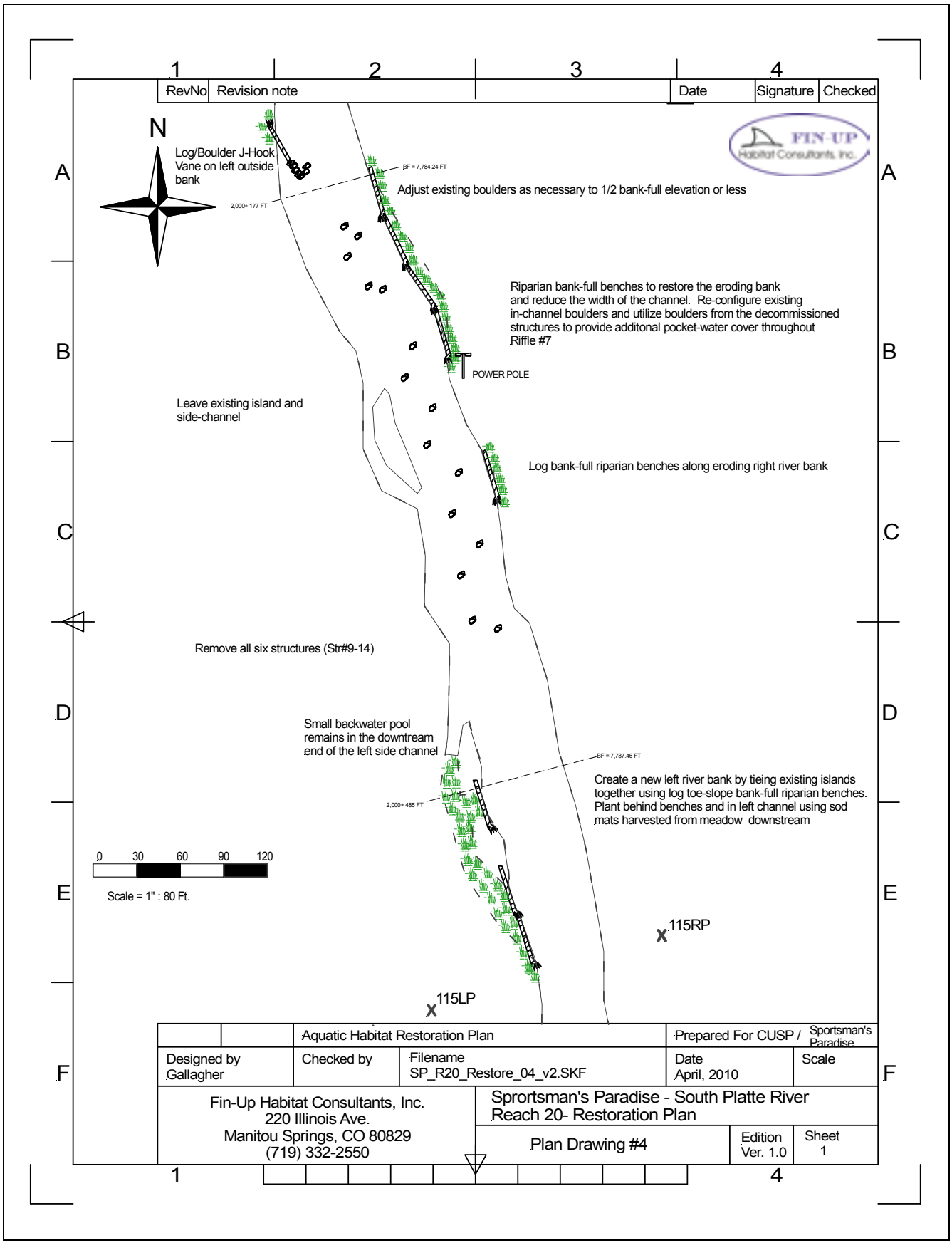
The actively eroding right river bank along the downstream half of Riffle #7 will be treated with riparian benching to slightly reduce the width of the channel, creating a more desirable width/depth ratio in the habitat and improving sediment transport through the channel. The target bank-full width of the river through this segment will match the existing channel immediately upstream, with a width\depth ratio of 35 or less. The unstable right river bank at 0+2,300 ft (Grid C-3), adjacent to the location of Structures #10-12, will also be treated with logs along the toe of the bank and bank-full riparian benches.

All six of the existing structures in this segment will be removed from the channel, and the materials utilized to create up to 15 micro-vortex structures and random in-channel boulder object cover structures along the thalweg of the river from 0+2,177 ft to 0+2,400 ft. There are several existing in-channel boulders in the segment that may also be re-aligned or re-positioned to improve object cover and scour along these features.

The left river bank at the top of Riffle #7 and through the lower half of Glide #4 will be reconstructed to eliminate the islands on the left side of the channel, and to reduce the bank-full width in these habitats. This work will be accomplished by closing off the small channels on the left side of the islands, and tying the two islands together using logs and bank-full benches to create the new river bank. The small closed off channels may then be re-vegetated using willow harvested from the left bank and sod-mats harvested from the meadow immediately downstream. Depending on the availability of willow clumps and sod mats, a small backwater pool may be left on the downstream left side of the lowest island (Grid D-2), to provide additional refugia from high flows for juvenile and young-of-the-year trout.



Backwater Pool and Log/Boulder J-Hook Vane. South Platte River at Lake George, CO.


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Log/Boulder J-Hook Vane on left outside bank
BF = 7,784.24 FT
2,000+ 177 FT
Adjust existing boulders as necessary to 1/2 bank-full elevation or less
Riparian bank-full benches to restore the eroding bank and reduce the width of the channel. Re-configure existing in-channel boulders and utilize boulders from the decommissioned structures to provide additonal pocket-water cover throughout Riffle #7
POWER POLE
Leave existing island and side-channel
Log bank-full riparian benches along eroding right river bank
Remove all six structures (Str#9-14)
Small backwater pool remains in the downtream end of the left side channel
BF = 7,787.46 FT
2,000+ 485 FT
Create a new left river bank by tieing existing islands together using log toe-slope bank-full riparian benches. Plant behind benches and in left channel using sod mats harvested from meadow downstream
0 30 60 90 120
Scale = 1" : 80 Ft.
115RP
115LP
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F
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Reach 20 – Enhancement Plan Drawing #5

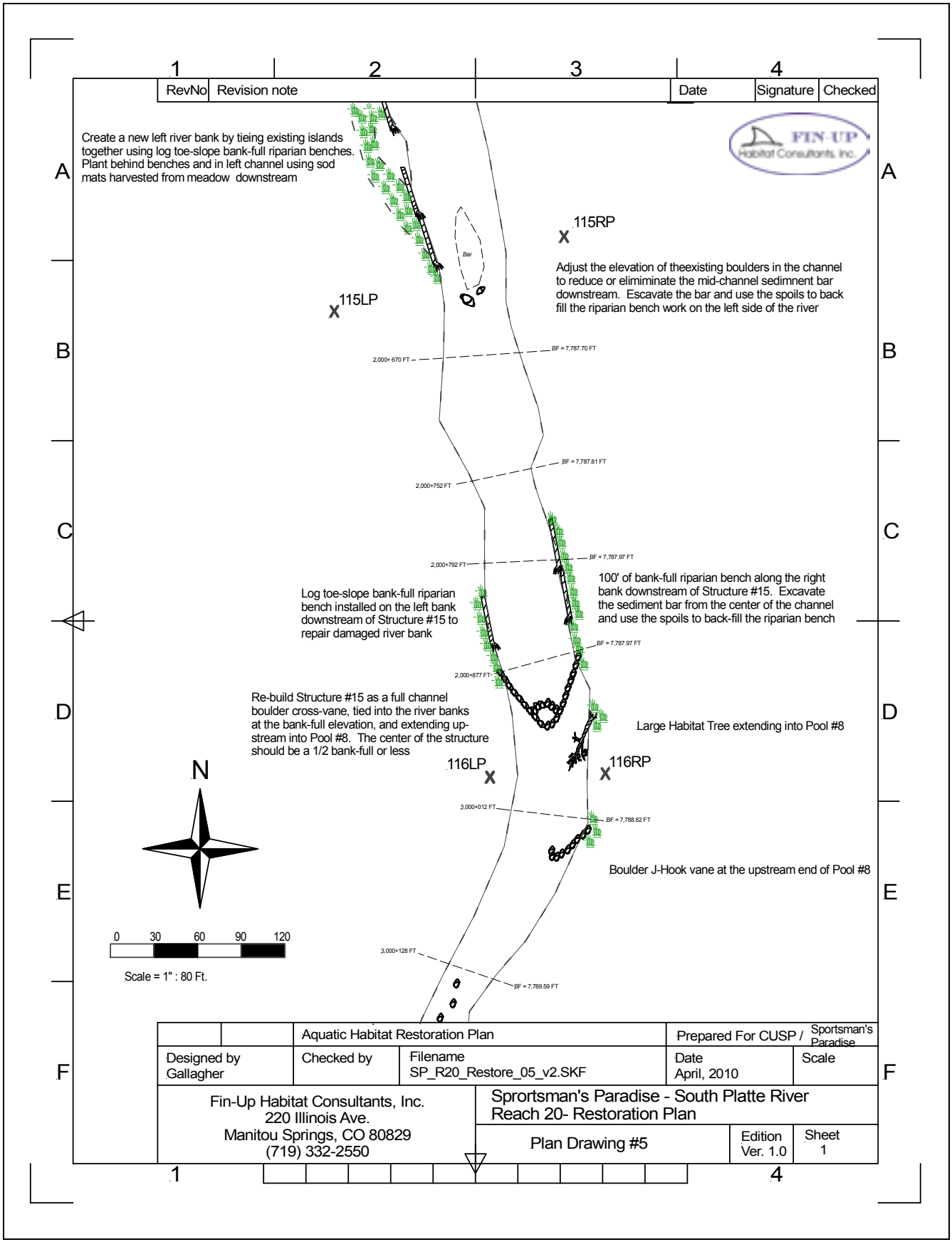
This drawing shows the segment of Reach 20 from 0+2,500 ft to 0+3,150 ft along the longitudinal axis of the river. The large sediment bar that has formed in the upstream half of Glide #4 (Grid B-2) will be eliminated by re-positioning the existing boulders upstream of the bar so that they do not exceed ½ of the bank-full elevation at this point along the river. The bar will be excavated down to the level of the original cobble bed, and this material will be utilized to back-fill the riparian benching on the left side of the channel downstream.

Structure #15 will be completely removed from the channel, and the boulders will be re-used to construct a full-channel boulder cross-vane at 0+2,877 ft (Grid D-3). This cross-vane will improve scour and depth through the center of the pool downstream, and should be low enough in the center to effectively pass sediment through the feature. The vanes forming the structure will be tied into the river banks at the bank-full elevation, and the center of the structure will be constructed to an elevation of ½ bank-full or less. Downstream of the cross-vane, the bank avulsion on the left side and the unstable banks on the right will be treated using riparian bench techniques. The large mid-channel sediment bar will be excavated down to the level of the original cobble bed, and this material will be utilized to back-fill the riparian benching on either side of the river.

Approximately 30 feet upstream of the new cross-vane, a large habitat tree will be installed along the right river bank to improve habitat complexity and cover in Pool #8. At the top this pool, at 0+3,012 ft, a boulder J-Hook vane will also be installed along the right bank. This structure should protect the right bank both upstream and downstream, and create better initial scour in the top of the pool.



Full Channel Boulder Cross-vane. South Platte River at Lake George, CO.


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Create a new left river bank by tieing existing islands together using log toe-slope bank-full riparian benches. Plant behind benches and in left channel using sod mats harvested from meadow downstream
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115RP
Adjust the elevation of theexisting boulders in the channel to reduce or eliminate the mid-channel sedimnent bar downstream. Escavate the bar and use the spoils to back fill the riparian bench work on the left side of the river
Bar
115LP
2,000+ 670 FT
BF = 7,787.70 FT
2,000+752 FT
BF = 7,787.81 FT
2,000+792 FT
BF = 7,787.97 FT
100' of bank-full riparian bench along the right bank downstream of Structure #15. Excavate the sediment bar from the center of the channel and use the spoils to back-fill the riparian bench
Log toe-slope bank-full riparian bench installed on the left bank downstream of Structure #15 to repair damaged river bank
BF = 7,787.97 FT
2,000+877 FT
Re-build Structure #15 as a full channel boulder cross-vane, tied into the river banks at the bank-full elevation, and extending up-stream into Pool #8. The center of the structure should be a 1/2 bank-full or less
Large Habitat Tree extending into Pool #8
116LP
116RP
3,000+012 FT
BF = 7,788.62 FT
Boulder J-Hook vane at the upstream end of Pool #8
N
0 30 60 90 120
Scale = 1" : 80 Ft.
3,000+128 FT
BF = 7,789.59 FT
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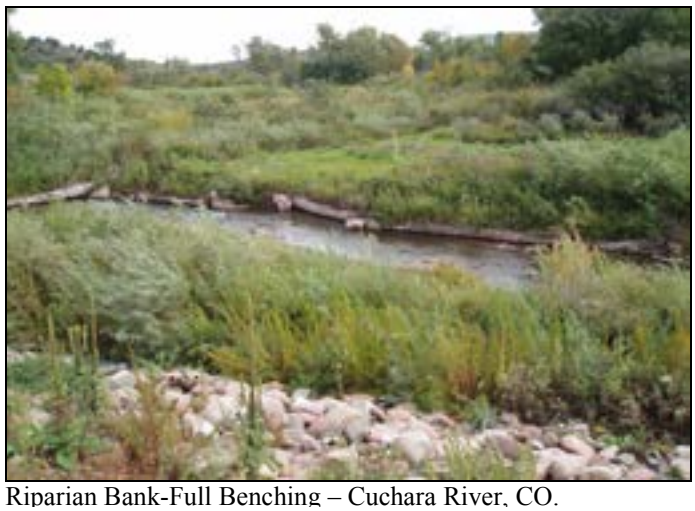
Reach 20 – Enhancement Plan Drawing #6

This drawing shows the segment of Reach 20 from 0+3,000 ft to 0+3,800 ft along the longitudinal axis of the river. The deposition fan from the large gully entering the river on the right (Grid C-3) will be stabilized using large wood to form the toe of a new right river bank. This wood, and extensive riparian plantings, will re-define the channel along the deposition fan and cut off sediment from the gully. The large mid-channel bar that has formed downstream of this gully will be removed, and the material will be used in combination with riparian bank-full benching to effectively reduce the width of the channel in Riffle #9 to approximately 70 -75 ft. Several of the existing boulders in this riffle will be adjusted to less than ½ bank-full to improve scour and increase pocket water cover in the habitat. Additionally, several micro-vortex structures may be installed along the thalweg of the river, adjacent to the gully deposition fan, to further increase pocket-water habitat in the riffle.

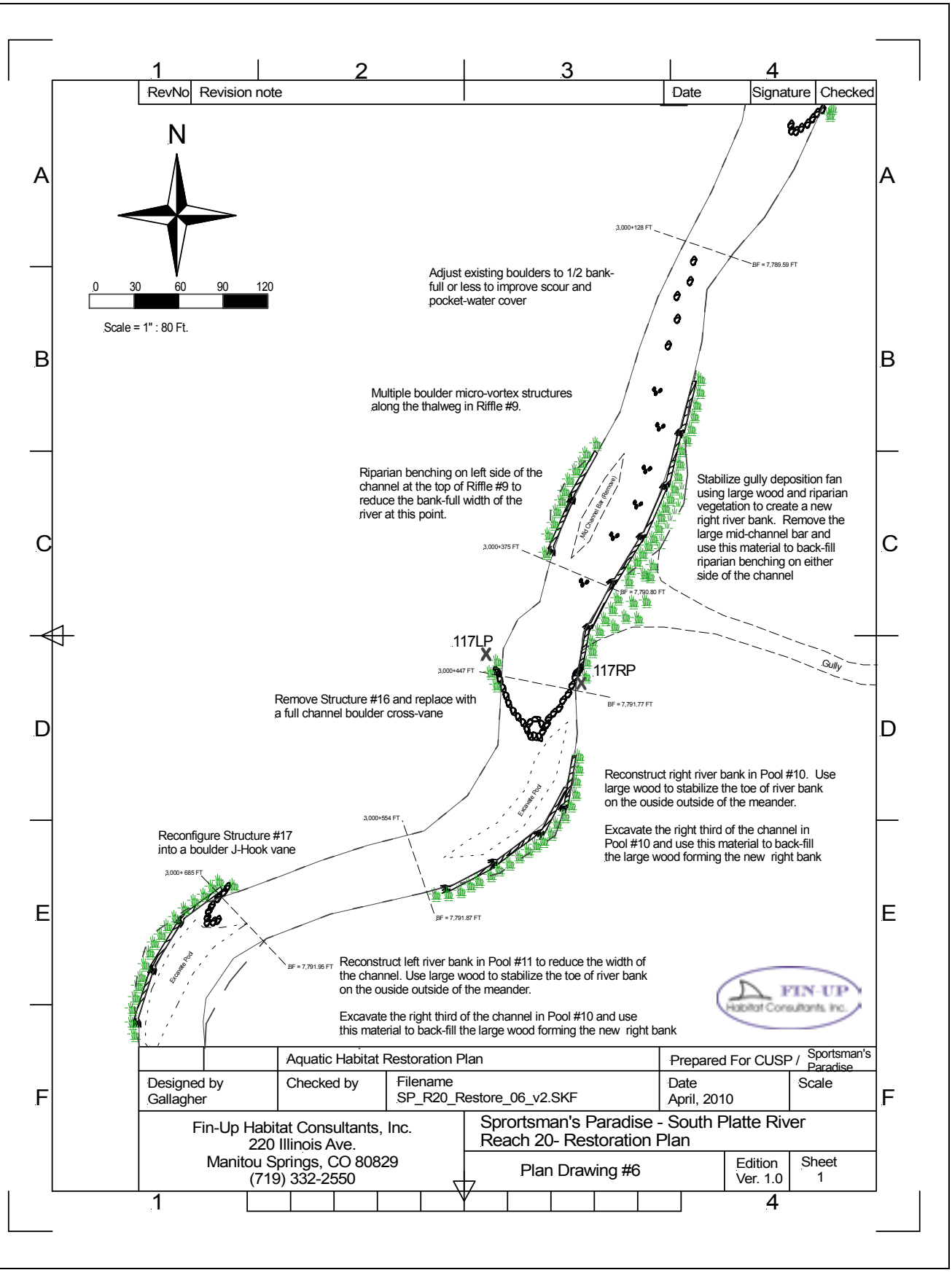
Structure #16 will be removed. The right bank downstream of Structure #16 will be reconstructed using large wood and riparian bank-full benches, tying into the bank work done to stabilize the gully deposition fan. The eroding bank on the right side of the structure will also be stabilized using transplanted willow. Boulders from the structure will be utilized to build a full-channel boulder cross-vane at 0+3,447 ft (Grid D-3). This cross-vane should improve scour, depth, and the overall length through the center of the pool downstream. The vanes forming the structure will be tied into the restored river banks at the bank-full elevation, and the center of the structure will be constructed to an elevation of ½ bank-full or less in order to efficiently pass sediment through the feature.

The right river bank upstream of Structure #16 has been damaged by previous dreding efforts in Pool #10. This unstable bank will be rehabilitated using large wood to redefine the toe of the stream bank along this outside meander bend. Accumulated sediment will be excavated from the right third of the channel in Pool #10, and this material will be used to back-fill the large wood. While riparian plantings will be used extensively along this bank, it will be necessary to provide some hardened access points to the river to provide for the heavy recreation use this pool receives.

Structure #17 currently provides little if any velocity shelter or conver for trout, and will be reconfigured into a boulder J-Hook vane. This reconfigured structure should increase pocket water cover, as well as protecting the river bank on this outside meander bend.


Riparian Bank-Full Benching – Cuchara River, CO.

The left river bank upstream of this structure (Grid E-1) will be redefined using log bank-full benches to reduce the width of the river and create a buffer between the river and the steep slope above. Accumulated sediment will be excavated from the left third of the channel in Pool #11, and this material will be used to back-fill the riparian bank-full benches, and to build the point bar on the right, inside bend of the river meander.


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120
Scale = 1" : 80 Ft.
Adjust existing boulders to 1/2 bank-full or less to improve scour and pocket-water cover
3,000+128 FT
BF = 7,789.59 FT
Multiple boulder micro-vortex structures along the thalweg in Riffle #9.
Riparian benching on left side of the channel at the top of Riffle #9 to reduce the bank-full width of the river at this point.
Mid Channel Bar (Remove)
Stabilize gully deposition fan using large wood and riparian vegetation to create a new right river bank. Remove the large mid-channel bar and use this material to back-fill riparian benching on either side of the channel
3,000+375 FT
BF = 7,790.80 FT
117LP
117RP
3,000+447 FT
BF = 7,791.77 FT
Gully
Remove Structure #16 and replace with a full channel boulder cross-vane
Reconstruct right river bank in Pool #10. Use large wood to stabilize the toe of river bank on the ouside outside of the meander.
Excavate the right third of the channel in Pool #10 and use this material to back-fill the large wood forming the new right bank
Excavate Pool
3,000+554 FT
BF = 7,791.87 FT
Reconfigure Structure #17 into a boulder J-Hook vane
3,000+ 685 FT
BF = 7,791.95 FT
Excavate Pool
Reconstruct left river bank in Pool #11 to reduce the width of the channel. Use large wood to stabilize the toe of river bank on the ouside outside of the meander.
Excavate the right third of the channel in Pool #10 and use this material to back-fill the large wood forming the new right bank
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Reach 20 – Enhancement Plan Drawing #7

This drawing shows the segment of Reach 20 from 0+3,700 ft to 0+4,500 ft along the longitudinal axis of the river. Structures #18 and #19 will be removed, and the boulders may be used to construct a boulder J-Hook vane on the left bank at the upstream end of Pool #12. This structure will improve scour and depth through the pool, and protect the left river bank from shear.

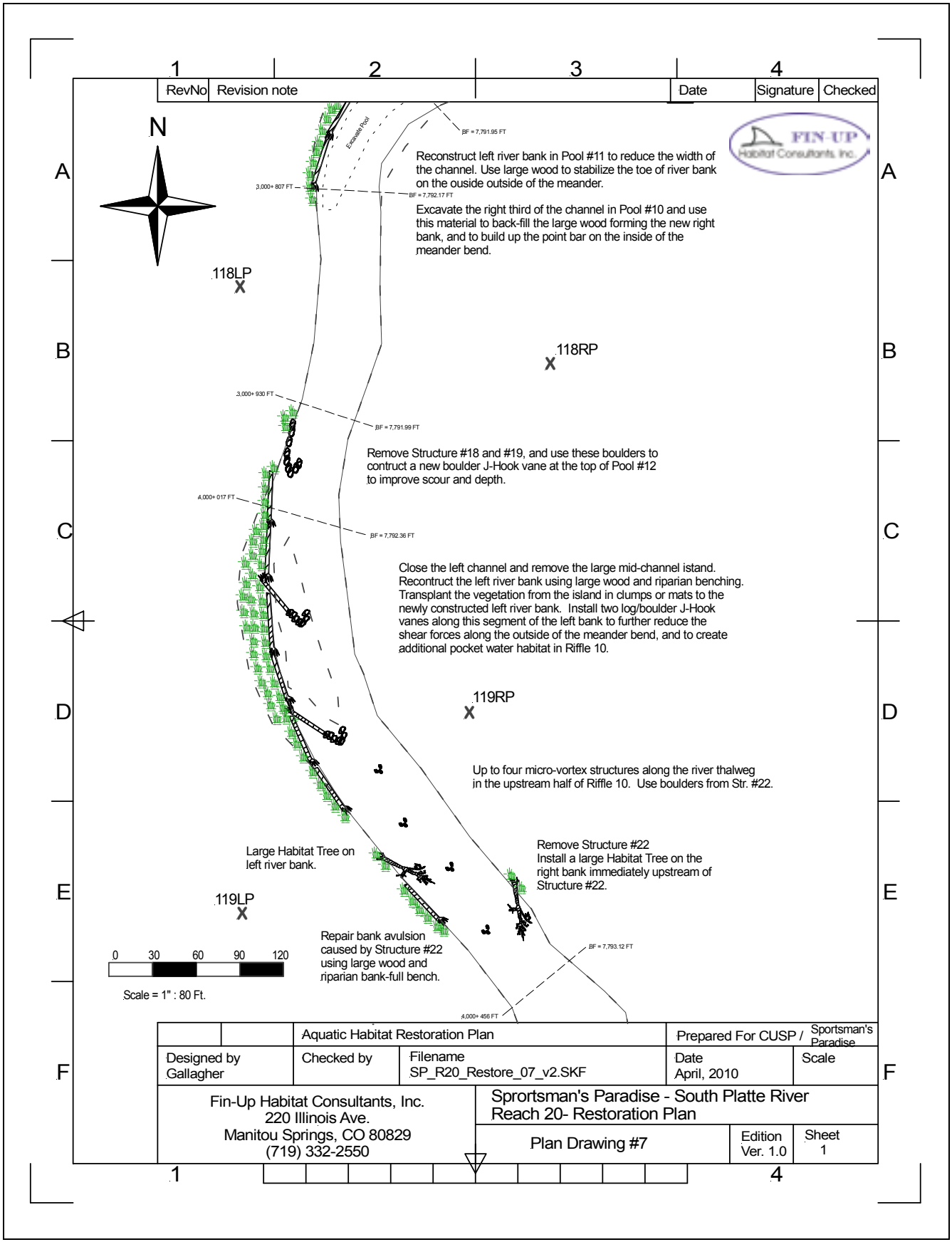
Structures #20, #21, and the large island upstream of)+4,020 ft will be removed. The river channel will be reconfigured into a single thread, with a target bank-full width of 75 – 80 ft and a width/depth ratio of 35 or less. Vegetation from the island will be used in conjunction with large wood riparian benching to reconstruct the left of bank the river between 0+4,020 and 0+4,300 ft. Two large wood/boulder J-Hook vanes will be installed along the new left bank to direct the thalweg away from the left bank; providing additional protection from high flows, as well as additional holding cover and pocket-water habitat within Riffle 10.

At the current location of Structure #22, near the upstream boundary of Riffle 10, a large habitat tree will be installed along the right river bank. Another large habitat tree will be installed on the left bank, approximately 75 feet downstream, functioning as a vane to redirect the thalweg away from the left bank. Structure #22 will be completely removed, and the gravel bar that has formed immediately downstream will be excavated down to the original cobble bed of the river. The avulsion on the left bank immediately opposite of Structure #22 will be repaired using a log toe-slope riparian bank-full bench. Some material from the bar excavation may be used to back-fill behind this structure.

In addition to the river bank treatments described above, up to four in-channel boulder micro-vortex structures may be installed along the thalweg in Riffle 10 from 0+4275 ft to 0+4,456 ft. These structures may be constructed of boulders left over from the existing structures in this segment.



Large wood / boulder J-Hook Vanes - South Platte River, Elevenmile Canyon, IFIM Springer Gulch Middle Station. 2004 "*Trees for Trout*" Demonstration Project.


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FIN-UP
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Excavation Pool
BF = 7,791.95 FT
3,000+ 807 FT
BF = 7,792.17 FT
Reconstruct left river bank in Pool #11 to reduce the width of the channel. Use large wood to stabilize the toe of river bank on the ouside outside of the meander.
Excavate the right third of the channel in Pool #10 and use this material to back-fill the large wood forming the new right bank, and to build up the point bar on the inside of the meander bend.
118LP
118RP
3,000+ 930 FT
BF = 7,791.99 FT
Remove Structure #18 and #19, and use these boulders to contruct a new boulder J-Hook vane at the top of Pool #12 to improve scour and depth.
4,000+ 017 FT
BF = 7,792.36 FT
Close the left channel and remove the large mid-channel istand. Recontruct the left river bank using large wood and riparian benching. Transplant the vegetation from the island in clumps or mats to the newly constructed left river bank. Install two log/boulder J-Hook vanes along this segment of the left bank to further reduce the shear forces along the outside of the meander bend, and to create additional pocket water habitat in Riffle 10.
119RP
Up to four micro-vortex structures along the river thalweg in the upstream half of Riffle 10. Use boulders from Str. #22.
Large Habitat Tree on left river bank.
Remove Structure #22
Install a large Habitat Tree on the right bank immediately upstream of Structure #22.
119LP
Repair bank avulsion caused by Structure #22 using large wood and riparian bank-full bench.
BF = 7,793.12 FT
4,000+ 456 FT
0
30
60
90
120
Scale = 1" : 80 Ft.
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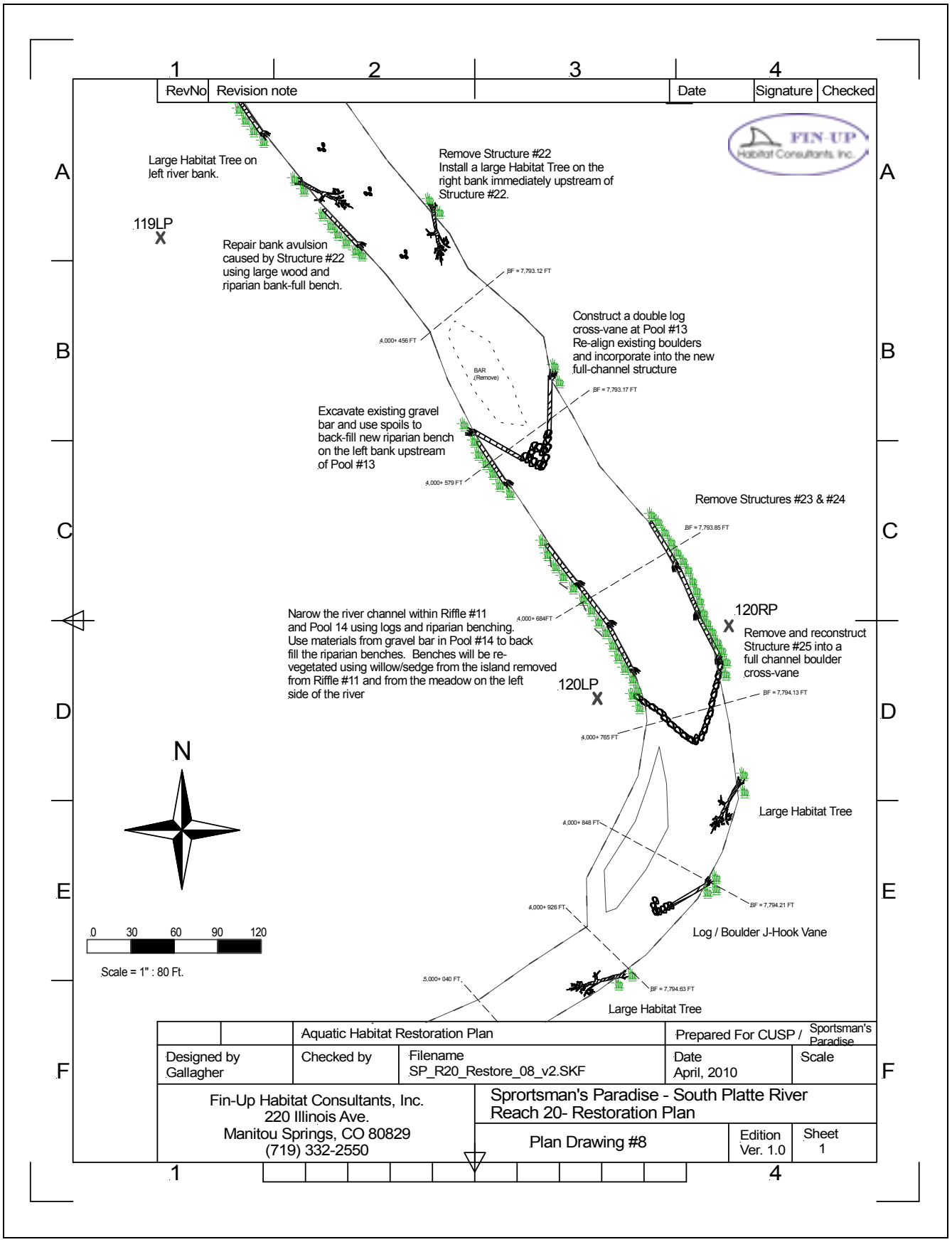
Reach 20 – Enhancement Plan Drawing #8

This drawing shows the segment of Reach 20 from 0+4,250 ft to 0+5,050 ft along the longitudinal axis of the river. The habitat tree and bank work in Riffle #10 (Grid A-2) was described in the previous segment. Upstream, in Pool #13, the existing boulders in the pool will be re-aligned and incorporated into a new double log/boulder cross-vane, spanning the bank-full width of the channel at 0+4,565 ft. This structure will consist of two large ponderosa pines anchored into the river banks at the bank-full elevation (7,793.17ft), extending upstream into the river channel. The center of the structure will consist of large boulders, placed at ½ bank-full or less. Structures #23 and #24 will be removed, and may be used to construct the center of the double log cross-vane structure downstream. Riparian benching will be installed along 40 ft of the left bank immediately upstream of this structure to stabilize this eroding bank. The gravel bar that has formed along the left third of the channel within this pool habitat will be removed down to the original cobble bed elevation, and this material will be utilized to back-fill the riparian bench on the left and the additional benches upstream.
Structure #25 will be completely removed, and reconstructed as a full channel boulder cross-vane. The cross-vane will not exceed the bank elevation where it ties into the river banks, and will be at ½ bank-full or less in the center. The river channel downstream of this structure, within Riffle #11 and Pool #14, will be effectively narrowed using large wood and riparian benches on both sides of the river. The target bank-full width through this segment should not exceed 80 ft, with a width depth ratio not exceeding 35. The large bar that has formed on the right side of Pool #14 will be removed from the active channel, and these materials will be utilized to back-fill the riparian benches. Sod-mats and willow from the meadow on the left side of the river will be used to re-vegetate these features.

A large habitat tree will be installed along the outside of the meander bend on the right bank of Pool #15, providing additional velocity shelter and cover within this habitat. A log/boulder J-Hook vane will be installed near the top of Pool #15 to provide initial scour and re-align the thalweg into this habitat. Another habitat tree will be installed along the right banks of Glide #8 as well.



Double Log /Boulder Cross-vane Structure - Eagle Rock Ranch, Tarryall River, Park Co., CO


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Revision note
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Large Habitat Tree on left river bank.
119LP
Repair bank avulsion caused by Structure #22 using large wood and riparian bank-full bench.
Remove Structure #22
Install a large Habitat Tree on the right bank immediately upstream of Structure #22.
BF = 7,793.12 FT
4,000+ 456 FT
Construct a double log cross-vane at Pool #13
Re-align existing boulders and incorporate into the new full-channel structure
BAR (Remove)
BF = 7,793.17 FT
Excavate existing gravel bar and use spoils to back-fill new riparian bench on the left bank upstream of Pool #13
4,000+ 579 FT
Remove Structures #23 & #24
BF = 7,793.85 FT
4,000+ 684FT
120RP
Remove and reconstruct Structure #25 into a full channel boulder cross-vane
Narow the river channel within Riffle #11 and Pool 14 using logs and riparian benching. Use materials from gravel bar in Pool #14 to back fill the riparian benches. Benches will be re-vegetated using willow/sedge from the island removed from Riffle #11 and from the meadow on the left side of the river
120LP
BF = 7,794.13 FT
4,000+ 765 FT
N
Large Habitat Tree
4,000+ 848 FT
BF = 7,794.21 FT
4,000+ 926 FT
Log / Boulder J-Hook Vane
5,000+ 040 FT
BF = 7,794.63 FT
Large Habitat Tree
0 30 60 90 120
Scale = 1" : 80 Ft.
Aquatic Habitat Restoration Plan
Prepared For CUSP / Sportsman's Paradise
Designed by Gallagher
Checked by
Filename SP_R20_Restore_08_v2.SKF
Date April, 2010
Scale
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Reach 20 – Enhancement Plan Drawing #9

This drawing shows the segment of Reach 20 from 0+4,250 ft to 0+5,050 ft along the longitudinal axis of the river. The large habitat tree installed along the right banks of Glide #8 (Grid A-4) will function like a vane on the outside of the meander bend on the right bank of the glide, protecting the bank from high flows, and providing additional cover and velocity shelter in this otherwise limited habitat.

Upstream, near the transition from Riffle #13 to Glide #9, a large log / boulder J-Hook vane will be installed along the outside left bank of the meander bend. The boulders that are forming a gravel bar at this locations may be used to create this structure, which will improve depth of the habitat upstream, protect the left bank from erosion, and provide energy to scour the channel downstream and eliminate the bar.

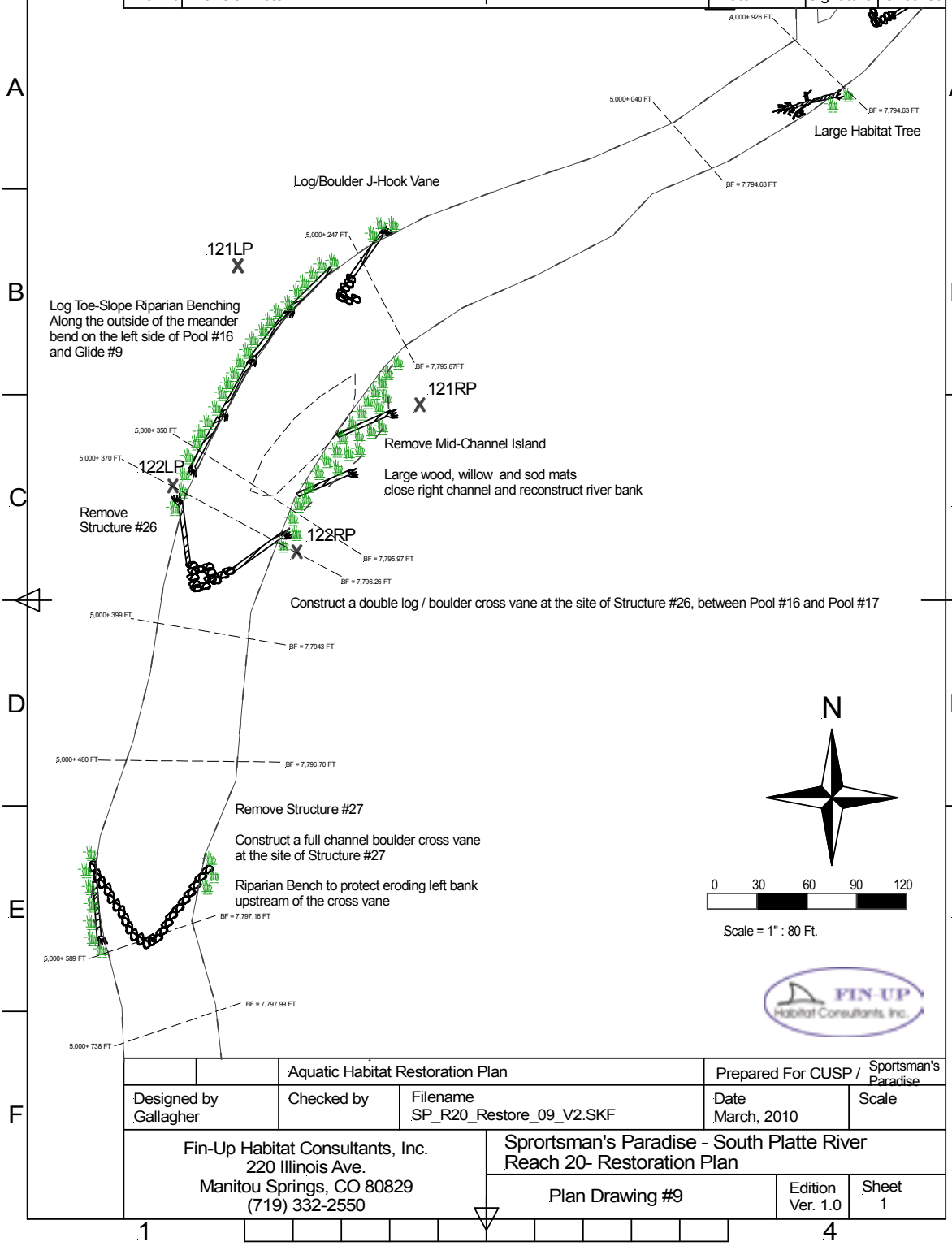
The boulder drop at Structure #26 that forms the boundary between Pool #16 and Pool #17 should be completely removed, and the boulders used to construct a double log / boulder cross-vane in its place. Once this feature is reconstructed, the large mid-channel island that has formed downstream in Pool #16 and Glide #9 can be removed and a new right river bank and point bar constructed between 0+5,247 ft and 0+5,370 ft. The target bank-full width of the channel through Pool #16 and Glide #9 should be 85 ft or less.

Pool #16 may be restored and enhanced by excavating a scour along the left third of the channel downstream into Glide #9 to create a lateral scour pool along the outside of the meander bend. The bottom half of Glide #9 will form the new tail-out and riffle crest between Pool #16 and Riffle #13, and this area should be left reasonably undisturbed.

The boulder drop and associated mid-channel boulder vane at Structure #27 should be removed, and the boulders utilized to construct a new boulder cross-vane between Pool #18 and Pool #19. Approximately 40 ft of riparian benching will need to be installed along the left river bank upstream of this structure to stabilize the eroding bank that has developed due to increased shear from the miss-aligned existing structure.



Looking Downstream through Riffle #14 & Pool #19 towards Structure #27. Reach 20.


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4,000+ 926 FT
5,000+ 040 FT
BF = 7,794.63 FT
Large Habitat Tree
Log/Boulder J-Hook Vane
5,000+ 247 FT
121LP
Log Toe-Slope Riparian Benching
Along the outside of the meander
bend on the left side of Pool #16
and Glide #9
BF = 7,795.87FT
121RP
5,000+ 350 FT
5,000+ 370 FT
122LP
Remove Mid-Channel Island
Large wood, willow and sod mats
close right channel and reconstruct river bank
Remove
Structure #26
122RP
BF = 7,795.97 FT
BF = 7,796.26 FT
Construct a double log / boulder cross vane at the site of Structure #26, between Pool #16 and Pool #17
5,000+ 399 FT
BF = 7.7943 FT
5,000+ 480 FT
BF = 7,796.70 FT
Remove Structure #27
Construct a full channel boulder cross vane
at the site of Structure #27
Riparian Bench to protect eroding left bank
upstream of the cross vane
BF = 7,797.16 FT
5,000+ 589 FT
BF = 7,797.99 FT
5,000+ 738 FT
N
0 30 60 90 120
Scale = 1" : 80 Ft.
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Prepared For CUSP / Sportsman's Paradise
Designed by
Gallagher
Checked by
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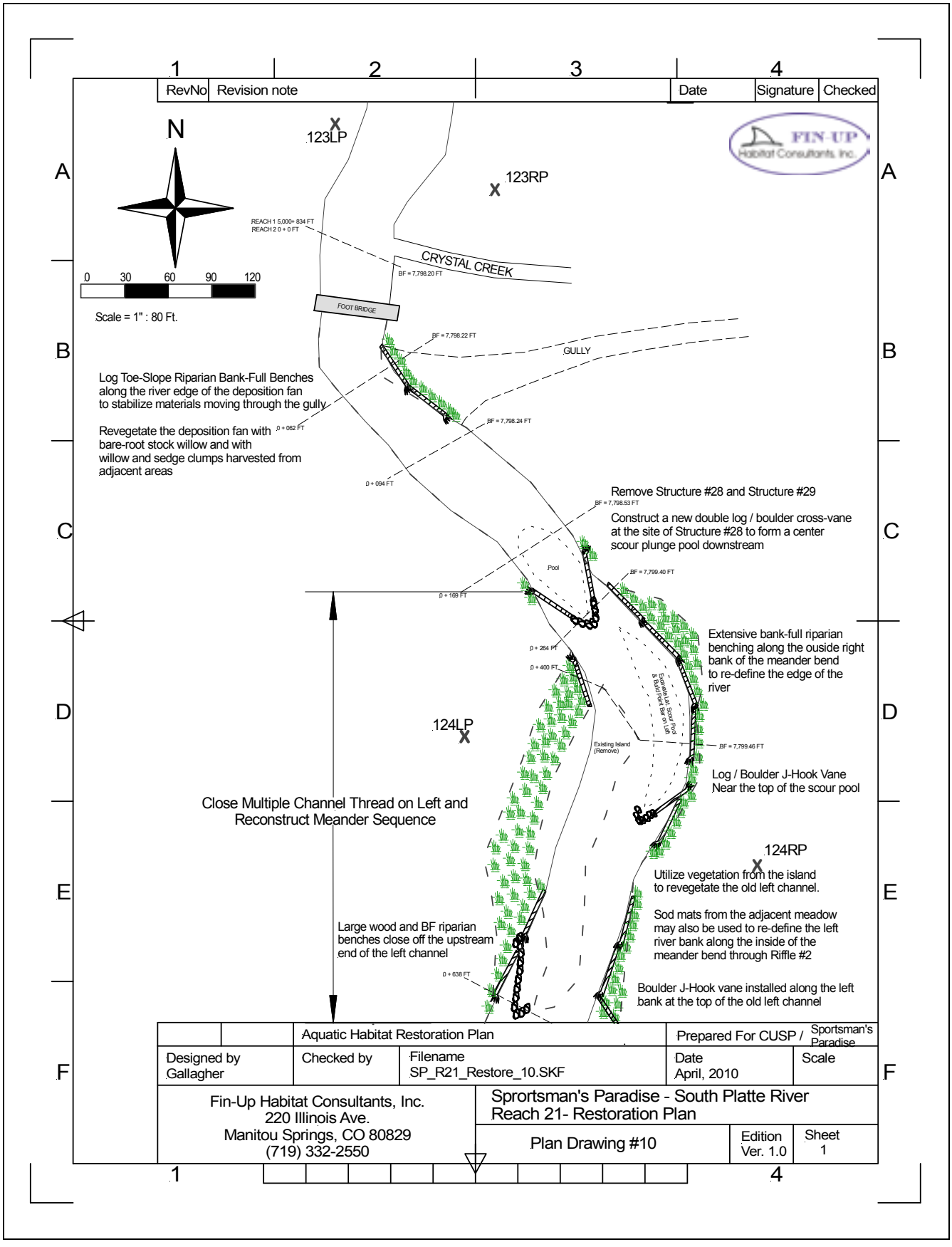
Reach 21 – Enhancement Plan Drawing #10 & #11

Enhancement Plan Drawing #10 shows the segment of Reach 20 from 0+5,050 ft to the end of the reach at the confluence of the South Platte River and Crystal Creek; at 0+5,384 ft., and the beginning segment of Reach 21, extending upstream from the confluence with Crystal Creek to 0+638 ft. Enhancement Plan Drawing #11 continues upstream to 0+1,250ft. No additional work is planned in Reach 20 within this segment. Immediately upstream in Reach 21, the gully that enters the river on the right will be treated to reduce of eliminate sediment entering the stream from this source. The deposition fan along the edge of the river will be removed to the point of the original river bank to return the channel to it's original bank-full width in Riffle #1. The edge of the deposition fan will be stabilized using large wood along the toe of the bank, and the deposition bar will be planted with willow clumps, sedge mats, and bare-root stock willow. Some directional felling of small trees to create rolling vanes in the gully may be utilized to reduce movement of sediment in this channel.

Upstream, beginning at the partially failed Structure #28, the river begins to exhibit some of the worst over-wide and habitat limited characteristics within the entire project area. A reconfiguration of the river channel meander sequence between 0+265ft and 0+850 ft is the best alternative for addressing the problems of habitat and sediment transport in this segment. First, all of the existing structures should be removed from the channel (Str #28 - #32) along this segment. Additionally, the large mid-channel island that has formed downstream of Structure #30 should be eliminated, and the willow/sedge vegetation preserved for use as mats in the bank restoration that follows. The new meander sequence will start at Pool #3, and extend upstream to the top of the current Riffle #4. The new meander channel sequence will follow a typical C channel scour pool/riffle transition form, with new pools created along the outside bend of each meander. Bank-full width of the channel through this segment should not exceed 80 ft, and the width/depth ratio within the riffle transition habitats should be 35 or less, however, channel narrowing through this segment may be limited by the available vegetation on hand. Large wood along the toe of the bank on the



Island removal and river narrowing project. South Platte River - Elevenmile Canyon PG - 2006


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123LP
123RP
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REACH 1 5,000+ 834 FT
REACH 2 0 + 0 FT
CRYSTAL CREEK
BF = 7,798.20 FT
0 30 60 90 120
Scale = 1" : 80 Ft.
FOOT BRIDGE
BF = 7,798.22 FT
GULLY
Log Toe-Slope Riparian Bank-Full Benches along the river edge of the deposition fan to stabilize materials moving through the gully
Revegetate the deposition fan with bare-root stock willow and with willow and sedge clumps harvested from adjacent areas
0 + 062 FT
BF = 7,798.24 FT
0 + 094 FT
Remove Structure #28 and Structure #29
BF = 7,798.53 FT
Construct a new double log / boulder cross-vane at the site of Structure #28 to form a center scour plunge pool downstream
Pool
BF = 7,799.40 FT
0 + 169 FT
0 + 264 FT
0 + 400 FT
Extensive bank-full riparian benching along the ouside right bank of the meander bend to re-define the edge of the river
Existing Lat. Scour Pool & Bar/Point Bar on Left
124LP
Existing Island (Remove)
BF = 7,799.46 FT
Log / Boulder J-Hook Vane Near the top of the scour pool
Close Multiple Channel Thread on Left and Reconstruct Meander Sequence
124RP
Utilize vegetation from the island to revegetate the old left channel.
Sod mats from the adjacent meadow may also be used to re-define the left river bank along the inside of the meander bend through Riffle #2
Large wood and BF riparian benches close off the upstream end of the left channel
0 + 638 FT
Boulder J-Hook vane installed along the left bank at the top of the old left channel
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outside bend of each meander, along with riparian bank-full benches and transplanted willow, will be utilized to provide stable banks along these features, and to create over-hanging combination cover for brown trout. Approximately 600 ft of this bank treatment will be required along this segment. Large wood and bank-full benching will also be utilized to close off the old left channel in Riffle #2. Along the inside bends of the meander sequence, large wood will be placed low in the channel, and extensive sedge and willow will be planted to form a stable inside river bank and point bar. Substrates excavated from the new pools will be utilized to form the point bars along the inside of the meander bend in the pool habitats.

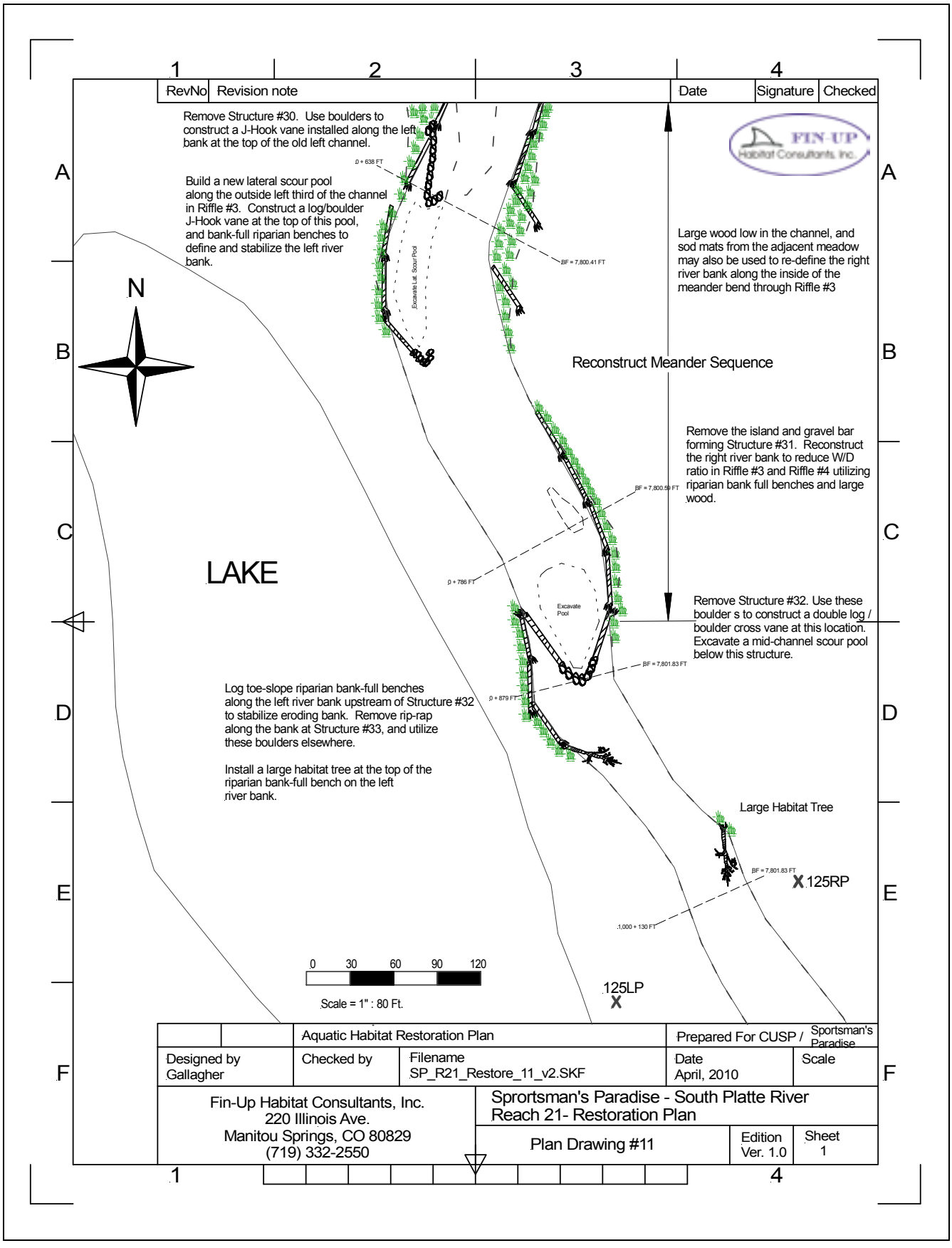
Several in-channel structure types will be employed to assure vertical channel bed stability in the reconstructed segment, protect newly constructed river banks, and provide initial scour for the meander bend pools. A double log / boulder cross-vane will be constructed at the downstream end of the new meander sequence at the location of the existing structure #28. The cross-vane will provide a stable tail-out for the new lateral scour pool upstream, as well as additional pool habitat immediately downstream of this feature. Immediately upstream of the initial scour point of the first pool in the sequence, a log / boulder J-Hook vane will be installed along the right river bank, at approximately 0+450 ft, to create initial scour for the new pool, and to reduce shear along the new river bank immediately upstream and downstream.

At 0+638 ft, near the top of the old left channel formed by the large island, a large boulder J-Hook vane will be installed along the outside, left river bank to direct the thalweg away from the closed channel, and reduce the shear at high flows along the newly constructed river bank immediately downstream. The structure will be constructed in a manner not to exceed the bank-full elevation (7,800.41ft) so not to limit the floodplain function of the closed channel. An additional log / boulder J-Hook vane will be installed 100 ft further upstream along the left river bank at the initial scour point of the second new lateral scour pool. This feature will provide benefit similar the log/boulder J-Hook vane on the right bank in the new scour pool downstream.

At the upstream boundary of the newly reconfigured meander, another double log / boulder cross-vane will be installed to create the upstream pool in the sequence, and to provide protection from head-cutting in the channel upstream of this segment. The rip-rap toe forming Structure #33 will be removed , and the actively eroding left river bank between this structure and the double log / boulder cross-vane will be stabilized, utilizing riparian benching techniques described previously. In addition to the bank-full bench work, a large habitat tree will be anchored into the left bank at the upstream end of the bank treatments, and will extend upstream into the channel to form a vane that may reduce shear along the restored bank. A second large habitat tree may also be installed along the right bank at the top of Glide #2, 30 ft downstream of Cross-Section 125 at approximately 0+1,100ft, to provide additional habitat complexity and cover for resident trout.



South Platte River - Elevenmile PG project, immediately following completion in 2006.


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Remove Structure #30. Use boulders to construct a J-Hook vane installed along the left bank at the top of the old left channel.
Build a new lateral scour pool along the outside left third of the channel in Riffle #3. Construct a log/boulder J-Hook vane at the top of this pool, and bank-full riparian benches to define and stabilize the left river bank.
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Large wood low in the channel, and sod mats from the adjacent meadow may also be used to re-define the right river bank along the inside of the meander bend through Riffle #3
N
Reconstruct Meander Sequence
Remove the island and gravel bar forming Structure #31. Reconstruct the right river bank to reduce W/D ratio in Riffle #3 and Riffle #4 utilizing riparian bank full benches and large wood.
LAKE
Remove Structure #32. Use these boulder s to construct a double log / boulder cross vane at this location. Excavate a mid-channel scour pool below this structure.
Log toe-slope riparian bank-full benches along the left river bank upstream of Structure #32 to stabilize eroding bank. Remove rip-rap along the bank at Structure #33, and utilize these boulders elsewhere.
Install a large habitat tree at the top of the riparian bank-full bench on the left river bank.
Large Habitat Tree
125RP
125LP
0 30 60 90 120
Scale = 1" : 80 Ft.
Aquatic Habitat Restoration Plan
Prepared For CUSP / Sportsman's Paradise
Designed by Gallagher
Checked by
Filename SP_R21_Restore_11_v2.SKF
Date April, 2010
Scale
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Plan Drawing #11
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Reach 21 – Enhancement Plan Drawing #12

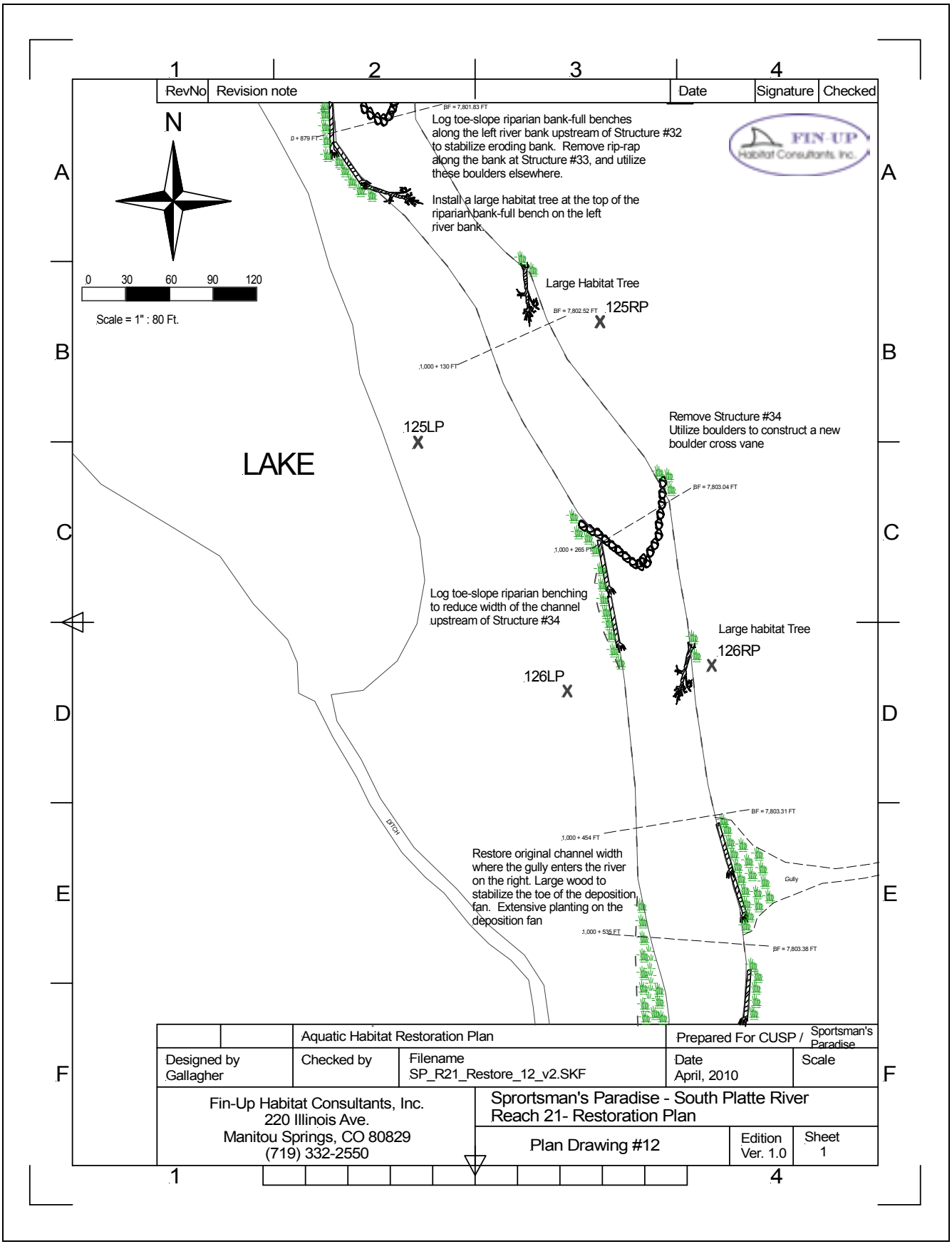
This drawing shows the segment of Reach 21 from 0+880 ft to 0+1,600 ft along the longitudinal axis of the river. The prescribed restoration work downstream of Cross-Section #125 has been described in the previous section. Upstream of Cross-Section 125, the existing full-channel boulder drop structure identified as Structure #34 will need to be re-configured into a boulder cross-vane extending upstream into the rive channel. As with the other cross-vanes described in this project, the elevations of this structure will be critical to its successful function of creating pool habitat while sufficiently transporting the sediment load through the feature.

Upstream of the boulder cross-vane, the unstable left river bank will be treated with large wood and riparian benches, slightly reducing the width of the river channel through the downstream half of Pool #4. A large habitat tree may be installed as a vane on the right bank within Pool #4 to provide additional habitat complexity and cover. The branches should be left intact in order to maximize cover and velocity shelter in this feature.

The gully that enters the river on the right at 0+1,464 ft (Grid E-4), will be treated to reduce of eliminate sediment entering the stream from this source. The existing deposition fan is significantly confining the river channel within Glide #3, and has greatly reduced the channel cross-section throughout this habitat. The edge of the deposition fan extending into the river will be removed to the point of the original river bank, in order to return the channel to the pre-fire, original bank-full width in Glide #3. Following the re-definition of this deposition fan edge, the new river bank will be stabilized using large wood along the toe of the bank, and the deposition bar will be planted with willow clumps, sedge mats, and bare-root stock willow. As with the other gullies entering the river from the burned areas to the east, some directional felling of small trees to create rolling vanes and velocity reducing structure may be utilized to reduce movement of sediment in these ephemeral channels.



Example of river over-widening due to poorly configured drop structures. Wigwam Club, CO


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0 30 60 90 120
Scale = 1" : 80 Ft.
Log toe-slope riparian bank-full benches along the left river bank upstream of Structure #32 to stabilize eroding bank. Remove rip-rap along the bank at Structure #33, and utilize these boulders elsewhere.
Install a large habitat tree at the top of the riparian bank-full bench on the left river bank.
Large Habitat Tree
125RP
125LP
LAKE
Remove Structure #34
Utilize boulders to construct a new boulder cross vane
Log toe-slope riparian benching to reduce width of the channel upstream of Structure #34
Large habitat Tree
126RP
126LP
Restore original channel width where the gully enters the river on the right. Large wood to stabilize the toe of the deposition fan. Extensive planting on the deposition fan
DITCH
Gully
Aquatic Habitat Restoration Plan
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Reach 21 – Enhancement Plan Drawing #13

Enhancement Plan Drawing #13 shows the segment of Reach 21 from 0+1,450 ft to 0+2,100 ft along the longitudinal axis of the river. The treatments for the gully entering the river at 0+1,454 ft have been described in the previous section. Upstream of this point, the over-wide channel in Riffle #6 will be treated by removing Structure #35, and excavating the large mid-channel gravel/sediment bar down to the cobble bed of the river. This material will be utilized to back-fill the bank-full riparian bench structures that will be constructed along the right river bank in this riffle. The left bank will also be reconstructed to reduce the overall bank-full width of the riffle, using sedge and sod mats harvested from the adjacent meadow. Some large wood may be placed low in the channel as vanes along the left bank to further stabilize the new vegetation treatments.

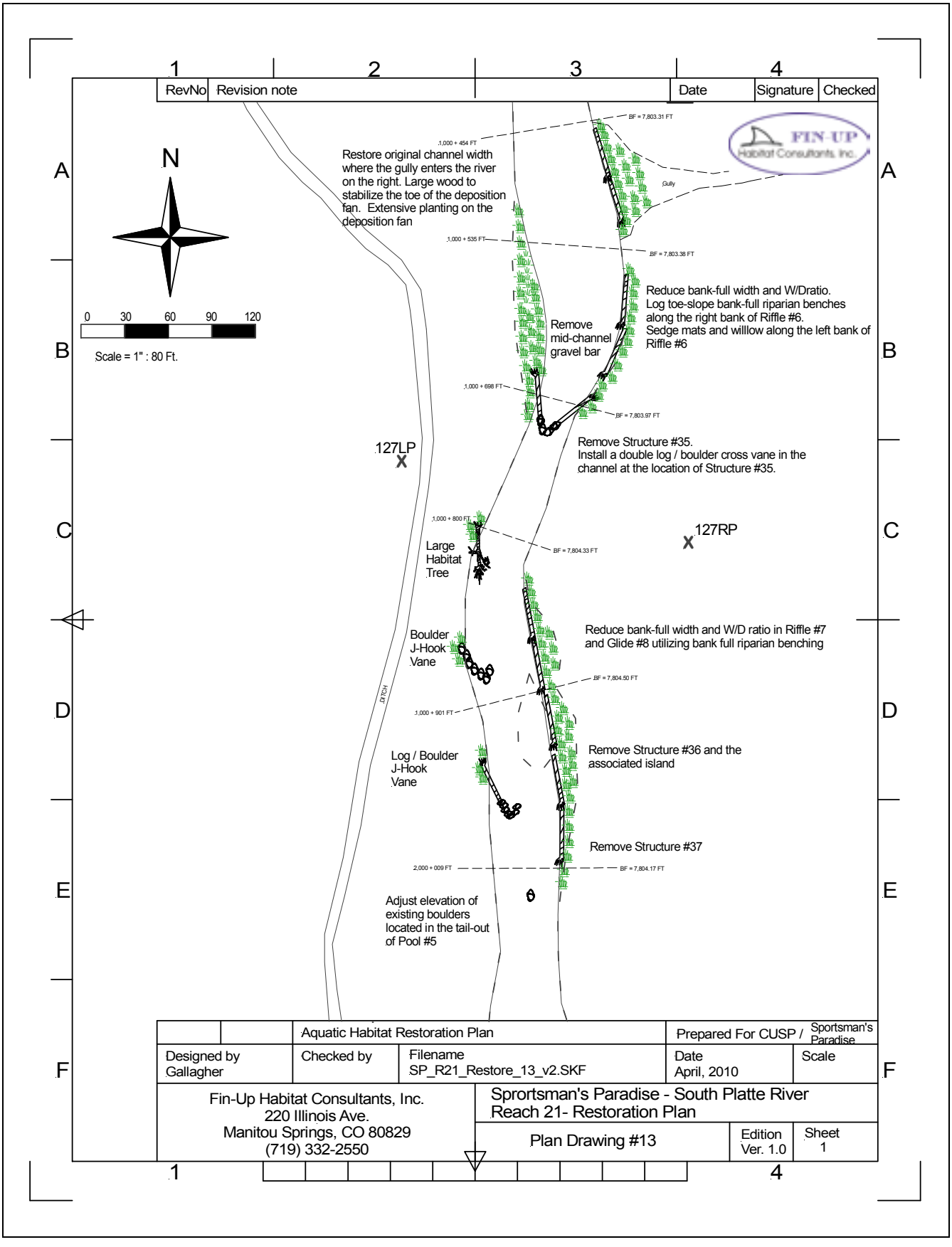
Another double log / boulder full channel cross-vane will be installed at 0+1,698 ft, at the former location of Structure #35, to create a new pool at this location. This structure will also serve to reduce erosion and shear forces along the restored river banks on either side of the channel downstream, and will also provide vertical channel and river bed stability upstream in Glide #4.

Upstream of Cross-Section 127, the boulder cluster at Structure #36, and the associated island, will be removed from the channel. Structure #37 is also not currently functioning, and will be removed as well. The width of the channel through Riffle #7 and Glide #5 will be reduced by re-constructing the right river bank using riparian bank-full benches. Vegetation mats preserved from the island and harvested from the adjacent meadow will be used to plant behind these structures.

Reducing the bank-full channel width through Glide #5 should covert this habitat to more of a riffle-like form. In order to increase pocket-water habitat throughout the increased length of the riffle, several features will be added along the left bank of the channel in this segment. Near the downstream left side of Riffle #7, a large habitat tree may be installed as a vane to provide habitat complexity and cover along this section of the bank. Directly across from where the island currently exists in the channel, a boulder J-Hook vane will provide in-channel object cover and velocity shelter, as well as protection of the left river bank from high flow events. Approximately 75 ft upstream, a log/boulder J-Hook vane will serve a similar purpose, as well as providing refugia for juvenile and young-of-the-year trout.



Example of a boulder J-Hook Vane. Tarryall River – Eagle Rock Ranch, Park County, CO


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120
Scale = 1" : 80 Ft.
Restore original channel width where the gully enters the river on the right. Large wood to stabilize the toe of the deposition fan. Extensive planting on the deposition fan
1,000 + 454 FT
BF = 7,803.31 FT
Gully
1,000 + 535 FT
BF = 7,803.38 FT
Reduce bank-full width and W/Dratio. Log toe-slope bank-full riparian benches along the right bank of Riffle #6. Sedge mats and willlow along the left bank of Riffle #6
Remove mid-channel gravel bar
1,000 + 698 FT
BF = 7,803.97 FT
127LP
Remove Structure #35. Install a double log / boulder cross vane in the channel at the location of Structure #35.
1,000 + 800 FT
BF = 7,804.33 FT
127RP
Large Habitat Tree
Boulder J-Hook Vane
Reduce bank-full width and W/D ratio in Riffle #7 and Glide #8 utilizing bank full riparian benching
DITCH
BF = 7,804.50 FT
1,000 + 901 FT
Log / Boulder J-Hook Vane
Remove Structure #36 and the associated island
Remove Structure #37
2,000 + 009 FT
BF = 7,804.17 FT
Adjust elevation of existing boulders located in the tail-out of Pool #5
A
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D
E
F
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Prepared For CUSP / Sportsman's Paradise
Designed by Gallagher
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Reach 21 – Enhancement Plan Drawing #14

This drawing shows the segment of Reach 21 from 0+2,000 ft to 0+2,700 ft along the longitudinal axis of the river. The elevation and orientation of the boulders in the tail-out of Pool 5 (Grid A-4) will be adjusted so that sediment will not deposit behind these features, forming small mid-channel bars. The elevations of these boulders should be set no higher than ½ of the bank-full stage of the channel at this location. Habitat in Pool #5 may be further enhanced, and sediment transport improved, by installing a double log / boulder cross-vane at the initial scour point of the riffle at 0+2,108 ft. This structure will also provide an anchor point along the right bank for the new right bank in Riffle #8 described below.

The over-wide channel at Riffle #8 (Grid B-4) can be treated by removing Structure #38, Structure #39, and the two islands that have formed in the channel between the two structures. The right river bank can then be re-constructed to reduce the bank-full width of the channel through the riffle to 70 – 80 ft, with a consequent reduction of width/depth ratio to less than 35. The right river bank will be constructed utilizing large wood and riparian bank-full benching, vegetation taken from the islands removed from the channel, and sod / sedge mats from the adjacent meadow. To further protect the new right river bank from high flow shear forces, two log / boulder J-Hook vanes will be installed at intervals along the outside of the meander bend. These vanes will provide useable slow-water habitat immediately adjacent to the new bank both upstream and downstream of the structure, and additional pocket-water habitat and in-channel object cover within the small scour zones downstream of the "hook".

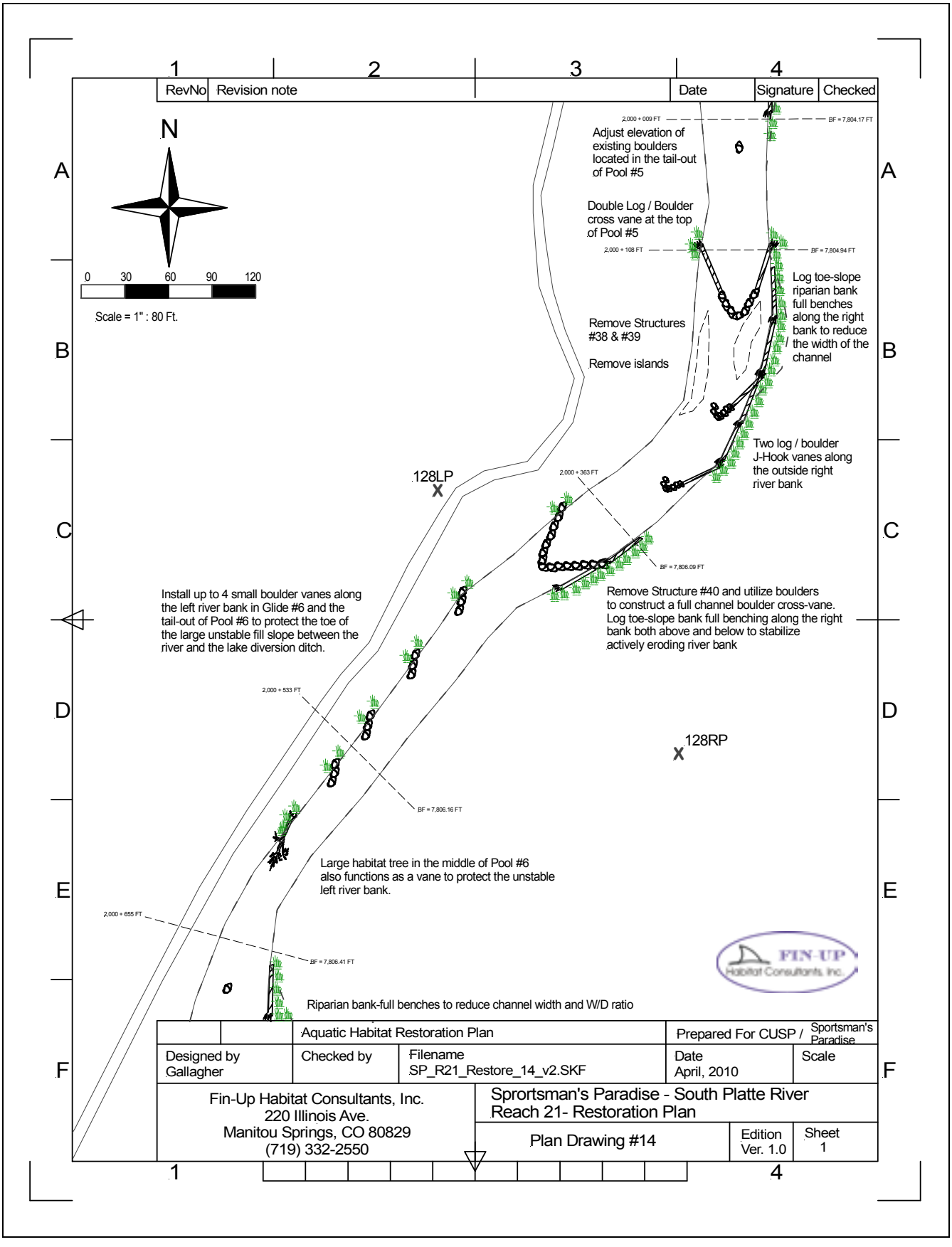
The mostly failed boulder vane/drop structure between Riffle #8 and Glide #6 (Structure #40 / Grid C-3) and the associated mid-channel sediment bar immediately downstream, will be completely removed from the channel. In it's place, a full channel boulder cross-vane may be installed 65-75 ft upstream in Glide #6 to form a new pool in the channel extending downstream to the existing riffle crest at the top of Riffle #8. The blown out right bank will be restored using the large wood and riparian benching techniques previously described.

The generally unstable left river bank formed by the fill slope of the diversion ditch throughout Glide #5 and Pool #6 (Grid D-2) will be treated using small boulder vanes and groins at intervals along the bank to flatten the water surface slope and reduce bank shear forces along the "at-risk" river bank. The river is already relatively narrow through this segment, and these small features should reduce pressure along the bank without significantly affecting the overall cross-sectional area and capacity of the channel. Up to four of these structures will be utilized within this segment. In addition to protecting the river bank, these features will provide additional velocity shelter, holding and feeding areas for resident fish.

Following construction of the boulder vanes, bare-root stock willow should be planted along the toe of the fill slope throughout the entire length of the right bank from 0+2,375 ft to 0+2,650 ft. Additionally, a large habitat tree may be installed as a vane along the left bank in Pool #6 (Grid E-2) to provide additional bank protection and habitat complexity.



TU volunteers planting bare-root stock willow – Arkansas River – Canon City, CO.


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0 30 60 90 120
Scale = 1" : 80 Ft.
Adjust elevation of existing boulders located in the tail-out of Pool #5
2,000 + 009 FT
BF = 7,804.17 FT
Double Log / Boulder cross vane at the top of Pool #5
2,000 + 108 FT
BF = 7,804.94 FT
Log toe-slope riparian bank full benches along the right bank to reduce the width of the channel
Remove Structures #38 & #39
Remove islands
Two log / boulder J-Hook vanes along the outside right river bank
128LP
2,000 + 363 FT
BF = 7,806.09 FT
Remove Structure #40 and utilize boulders to construct a full channel boulder cross-vane. Log toe-slope bank full benching along the right bank both above and below to stabilize actively eroding river bank
Install up to 4 small boulder vanes along the left river bank in Glide #6 and the tail-out of Pool #6 to protect the toe of the large unstable fill slope between the river and the lake diversion ditch.
2,000 + 533 FT
BF = 7,806.16 FT
128RP
Large habitat tree in the middle of Pool #6 also functions as a vane to protect the unstable left river bank.
2,000 + 655 FT
BF = 7,806.41 FT
Riparian bank-full benches to reduce channel width and W/D ratio
FIN-UP Habitat Consultants, Inc.
Aquatic Habitat Restoration Plan
Prepared For CUSP / Sportsman's Paradise
Designed by Gallagher
Checked by
Filename SP_R21_Restore_14_v2.SKF
Date April, 2010
Scale
Fin-Up Habitat Consultants, Inc.
220 Illinois Ave.
Manitou Springs, CO 80829
(719) 332-2550
Sprortsman's Paradise - South Platte River
Reach 21- Restoration Plan
Plan Drawing #14
Edition Ver. 1.0
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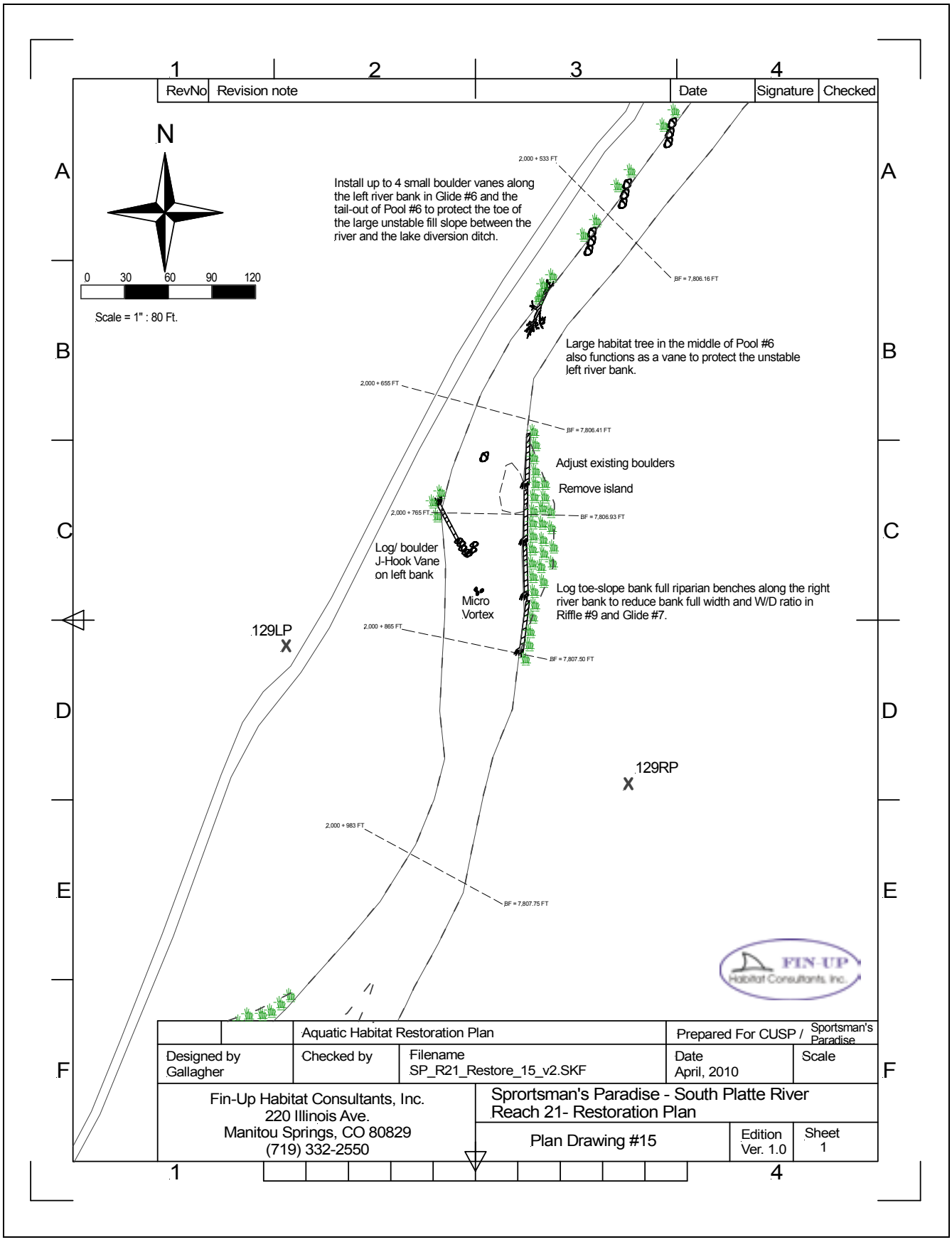
Reach 21 – Enhancement Plan Drawing #15

Habitat Map Drawing #15 shows the segment of Reach 21 from 0+2,450 ft to 0+3,100 ft along the longitudinal axis of the river. The treatments proposed for Glide #6 and Pool #6 were described in the previous section. The only other area within this segment that is proposed for treatment is the over-wide channel within Riffle #9 and Glide #7 (Grid C-3).

The channel over-widening in this segment is directly associated with Structure #41, and this feature will be removed, and the boulders salvaged for use elsewhere. The small island that has formed downstream of the structure will also be removed, and the vegetation preserved for use along the right river bank. The right river bank throughout Riffle #9 and Glide #7 will be re-built to reduce the bank-full width of the river to 80 ft or less. Large wood should be used along the toe of the bank to protect the transplanted vegetation on the new bank-full riparian benches. We anticipate that the reduction of bank-full channel width should convert Glide #7 back to more of a riffle like form, and several in channel treatments have been identified to create additional useable habitat in this expanded riffle habitat. Several existing boulders in this segment can be adjusted to function more efficiently in creating useable habitat in the riffle. Modification of elevation and orientation will result in better scour and deeper in-channel object cover in these existing features. Additional micro-vortex in-channel object cover structures may be added in the former glide to create additional habitat complexity and to break up the laminar flow along this segment of river channel. A log / boulder J-Hook vane will also be installed on the left bank at 0+2,765 ft to reduce the added shear along this outside bank caused by reducing the width of the channel. This feature will also provide additional pocket-water habitat and combination cover along the left bank in the riffle.



River over-widening due to miss-aligned boulder vanes. Swayback Ranch, CO


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Scale = 1" : 80 Ft.
Install up to 4 small boulder vanes along the left river bank in Glide #6 and the tail-out of Pool #6 to protect the toe of the large unstable fill slope between the river and the lake diversion ditch.
2,000 + 533 FT
BF = 7,806.16 FT
Large habitat tree in the middle of Pool #6 also functions as a vane to protect the unstable left river bank.
2,000 + 655 FT
BF = 7,806.41 FT
Adjust existing boulders
Remove island
2,000 + 765 FT
BF = 7,806.93 FT
Log/ boulder J-Hook Vane on left bank
Micro Vortex
Log toe-slope bank full riparian benches along the right river bank to reduce bank full width and W/D ratio in Riffle #9 and Glide #7.
129LP
2,000 + 865 FT
BF = 7,807.50 FT
129RP
2,000 + 983 FT
BF = 7,807.75 FT
FIN-UP
Habitat Consultants, Inc.
Aquatic Habitat Restoration Plan
Prepared For CUSP / Sportsman's Paradise
Designed by Gallagher
Checked by
Filename SP_R21_Restore_15_v2.SKF
Date April, 2010
Scale
Fin-Up Habitat Consultants, Inc.
220 Illinois Ave.
Manitou Springs, CO 80829
(719) 332-2550
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Reach 21- Restoration Plan
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Reach 21 – Enhancement Plan Drawing #16

Habitat Map Drawing #16 shows the final segment of Reach 21, from 0+2,900 ft to the end of the reach at the confluence with Vermillion Creek at 0+3,655 ft. The channel is severely impacted throughout this segment, and will require significant treatment to restore river function and enhance habitat.

The six existing structures, and the large wood that is associated with these features, are no longer providing any habitat benefit and in most cases are contributing the degradation of the channel throughout this segment. These structures should be removed, and the boulders salvaged for use in the re-configured channel described below. The large island that has formed in Riffle #10 (Grid B-4 and C-3) will be removed from the channel, and the vegetation preserved for use along the restored stream banks in this habitat.

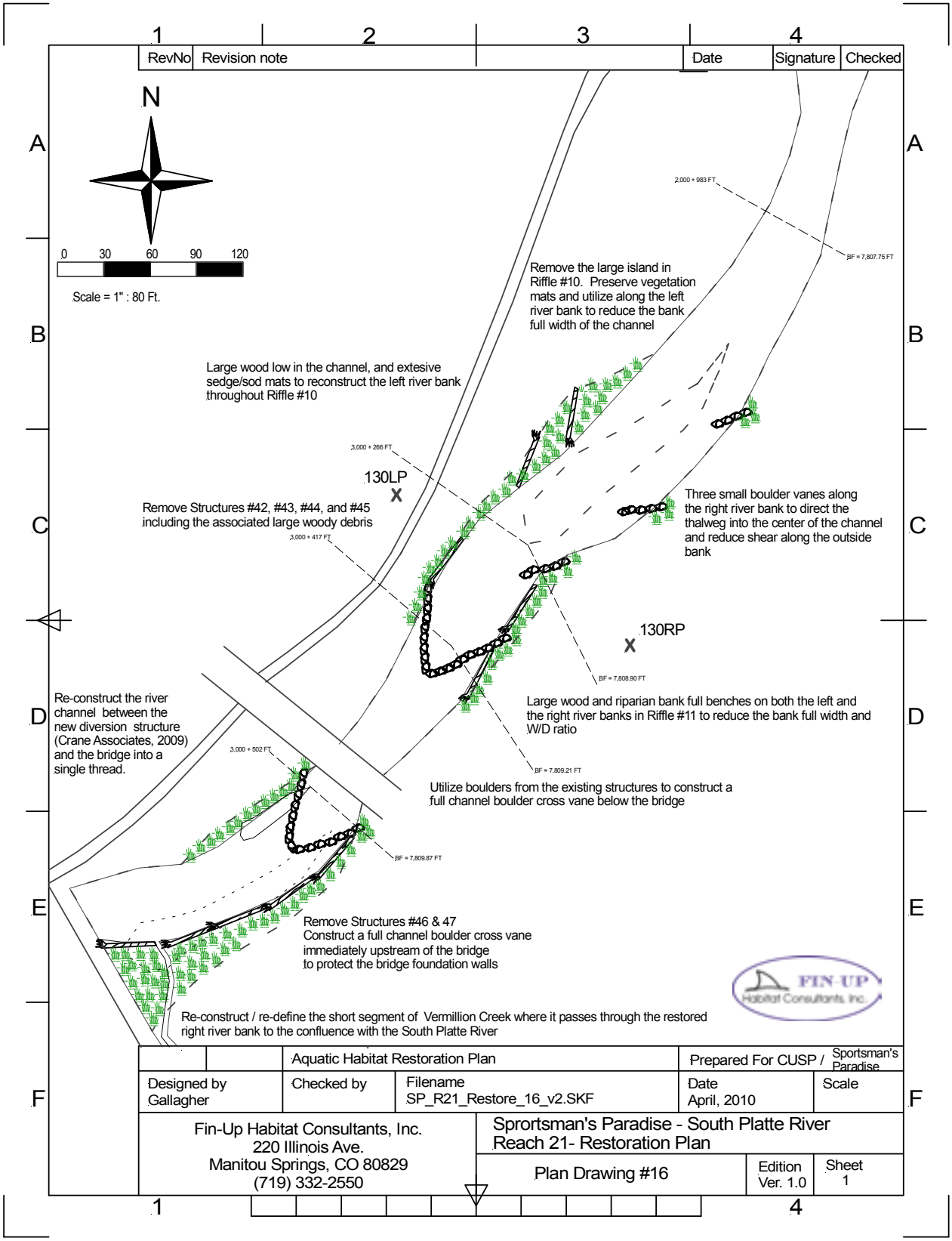
The bank-full width of Riffle #10 may be reduced to 75 ft - 85 ft by reconstructing the left river bank utilizing large wood as vanes, low in the channel, and sedge plantings and sod mats to re-form the river bank on the inside of this gradual meander bend. Although the outside right river bank is relatively well vegetated with willow through this habitat, we recommend that three boulder vanes be installed at intervals along the bank reduce water surface slope and any additional shear along the bank that may result from reducing the bank-full width of this riffle. These features should also provide some additional pocket-water habitat and fishing opportunities along this bank.

Upstream in Riffle #11, both river banks will need to be restored in order to address the severe over-wide condition of the channel in this habitat. Log toe-slope bank-full riparian benching will be used throughout this segment of the channel, with the goal of reducing the bank-full width to 70 ft and the width/depth ratio to 35 or better. A full channel boulder cross-vane recommended near the top of this habitat. This structure will allow us to define the thalweg through the restored channel below, as well as protect the newly restored river banks in Riffle #11. The structure will provide vertical stability in the river channel, protecting critical infrastructure (a bridge) immediately upstream, as well as creating some additional pool cover in the center scour immediately downstream of the structure. A boulder cross-vane is also recommended immediately upstream of the bridge to protect the bridge foundation supports, and to enhance scour and sediment transport through the pool downstream.

The segment of the river from the bridge upstream to the diversion structure at the SPHOA property boundary will be reduced to a single th read channel, with extensive riparian planting on both banks to significantly reduce the width of the channel through this segment. At the confluence with Vermillion Creek, a new channel for Vermillion Creek will be constructed through the river bank and floodplain restoration. This segment is part of a separate project to replace the diversion structure. A detailed design has been completed Crane Associates (2009) for the SPHOA and the Coalition for the Upper South Platte.



One possible definition of successful restoration.


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Scale = 1" : 80 Ft.
2,000 + 983 FT
BF = 7,807.75 FT
Remove the large island in Riffle #10. Preserve vegetation mats and utilize along the left river bank to reduce the bank full width of the channel
Large wood low in the channel, and extesive sedge/sod mats to reconstruct the left river bank throughout Riffle #10
3,000 + 266 FT
130LP
Remove Structures #42, #43, #44, and #45 including the associated large woody debris
Three small boulder vanes along the right river bank to direct the thalweg into the center of the channel and reduce shear along the outside bank
3,000 + 417 FT
130RP
BF = 7,808.90 FT
Large wood and riparian bank full benches on both the left and the right river banks in Riffle #11 to reduce the bank full width and W/D ratio
Re-construct the river channel between the new diversion structure (Crane Associates, 2009) and the bridge into a single thread.
3,000 + 502 FT
BF = 7,809.21 FT
Utilize boulders from the existing structures to construct a full channel boulder cross vane below the bridge
BF = 7,809.87 FT
Remove Structures #46 & 47
Construct a full channel boulder cross vane immediately upstream of the bridge to protect the bridge foundation walls
FIN-UP Habitat Consultants, Inc.
Re-construct / re-define the short segment of Vermillion Creek where it passes through the restored right river bank to the confluence with the South Platte River
Aquatic Habitat Restoration Plan
Prepared For CUSP / Sportsman's Paradise
Designed by Gallagher
Checked by
Filename SP_R21_Restore_16_v2.SKF
Date April, 2010
Scale
Fin-Up Habitat Consultants, Inc.
220 Illinois Ave.
Manitou Springs, CO 80829
(719) 332-2550
Sprortsman's Paradise - South Platte River
Reach 21- Restoration Plan
Plan Drawing #16
Edition Ver. 1.0
Sheet 1
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Reach 22 – Enhancement Plan Drawing #17:

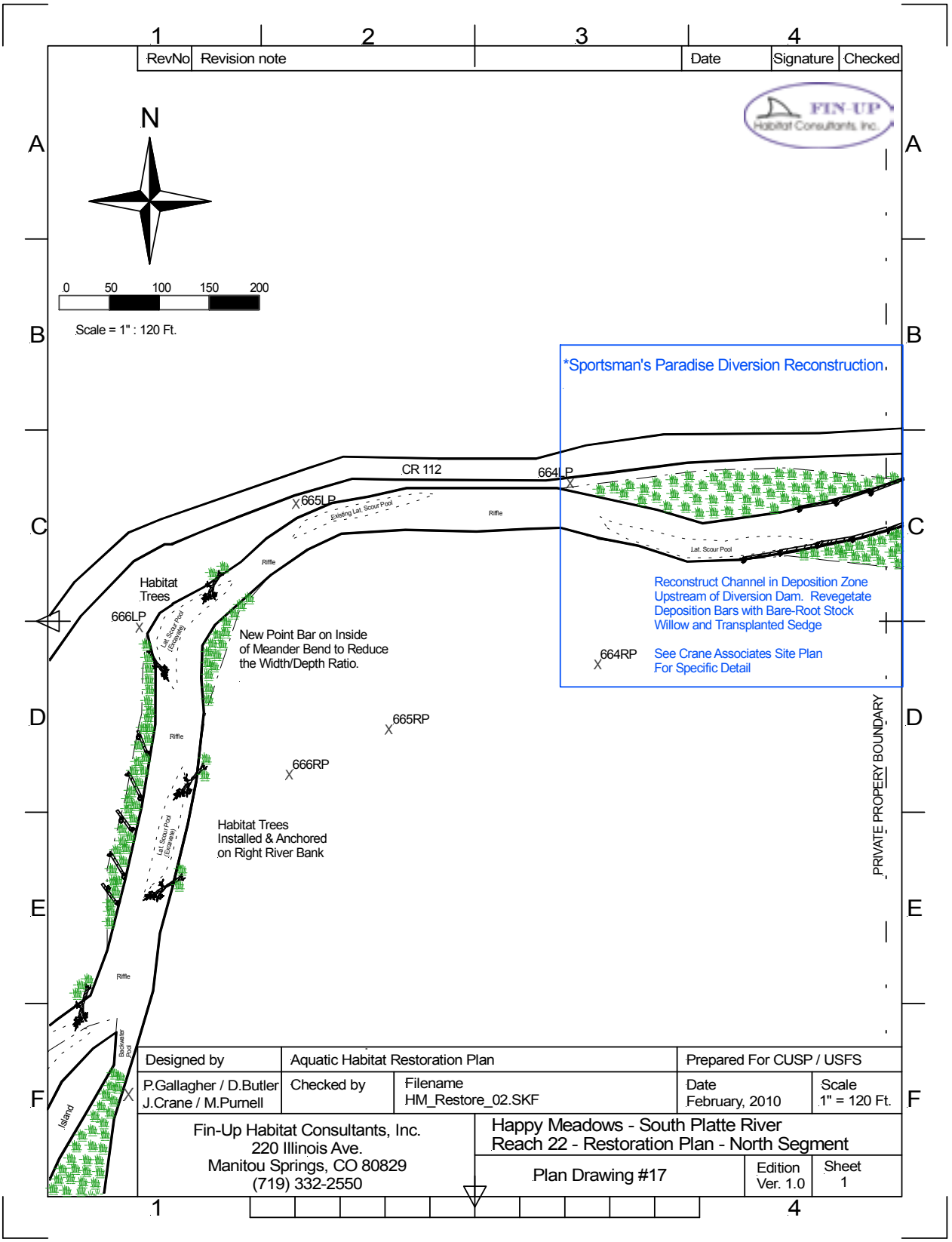
This drawing shows the segment of the river from 0ft to 1,300 ft along the longitudinal axis of the project reach. The river in this segment exhibits the most severe effects of sediment deposition due to the low head diversion structure downstream at the Sportsman's Paradise property boundary. The channel is characterized by very low gradient, shallow depth and laminar flow and high width/depth ratio. The river bed is comprised mostly of gravel and smaller materials. The road returns to the river, and is immediately adjacent to the channel along several hundred feet this segment, and appears to be a direct source of sediment.



The river channel between cross-section #667 and #666 will be narrowed and the W/D ratio reduced through the use of large wood placed low in the channel along the left river bank to create a new point bar. Extensive planting of sedge will be completed by volunteers. The goal of this work will be to reduce the width/depth ratio of this segment to less than 35.

Downstream of cross-section #666, an existing lateral scour pool will be excavated and enhanced through the installation of large tree vanes upstream and downstream of the channel habitat feature. Spoils excavated from the pool will be used to create a point bar on the inside (right bank) of the meander bend to further reduce the width/depth ratio, improving scour and sediment transport through the pool.

Downstream of cross-section #664, the river channel will be completely re-configured through the large sediment detention zone upstream of the diversion structure. A 70 – 80 ft wide, meandering C channel will be constructed between XS #664 and the diversion structure, which will be lowered and reconfigured to allow normal sediment transport through the newly constructed channel upstream. A detailed plan and drawings of the new diversion structure, and the reconstructed river channel, extending upstream from the low head dam to cross-section #664, has been developed by by Crane Associates of Hotchkiss, CO for the Coalition for the Upper South Platte, Sportsman's Paradise, and the USFS, and is separate from this document.


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Habitat Consultants, Inc.
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Scale = 1" : 120 Ft.
*Sportsman's Paradise Diversion Reconstruction.
Reconstruct Channel in Deposition Zone
Upstream of Diversion Dam. Revegetate
Deposition Bars with Bare-Root Stock
Willow and Transplanted Sedge
See Crane Associates Site Plan
For Specific Detail
CR 112
664LP
665LP
666LP
664RP
665RP
666RP
Existing Lat. Scour Pool
Lat. Scour Pool
Riffle
Habitat
Trees
New Point Bar on Inside
of Meander Bend to Reduce
the Width/Depth Ratio.
Habitat Trees
Installed & Anchored
on Right River Bank
Backwater Pool
Island
PRIVATE PROPERY BOUNDARY
Designed by
P.Gallagher / D.Butler
J.Crane / M.Purnell
Aquatic Habitat Restoration Plan
Checked by
Filename
HM_Restore_02.SKF
Prepared For CUSP / USFS
Date
February, 2010
Scale
1" = 120 Ft.
Fin-Up Habitat Consultants, Inc.
220 Illinois Ave.
Manitou Springs, CO 80829
(719) 332-2550
Happy Meadows - South Platte River
Reach 22 - Restoration Plan - North Segment
Plan Drawing #17
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Reach 22 – Enhancement Plan Drawing #18:

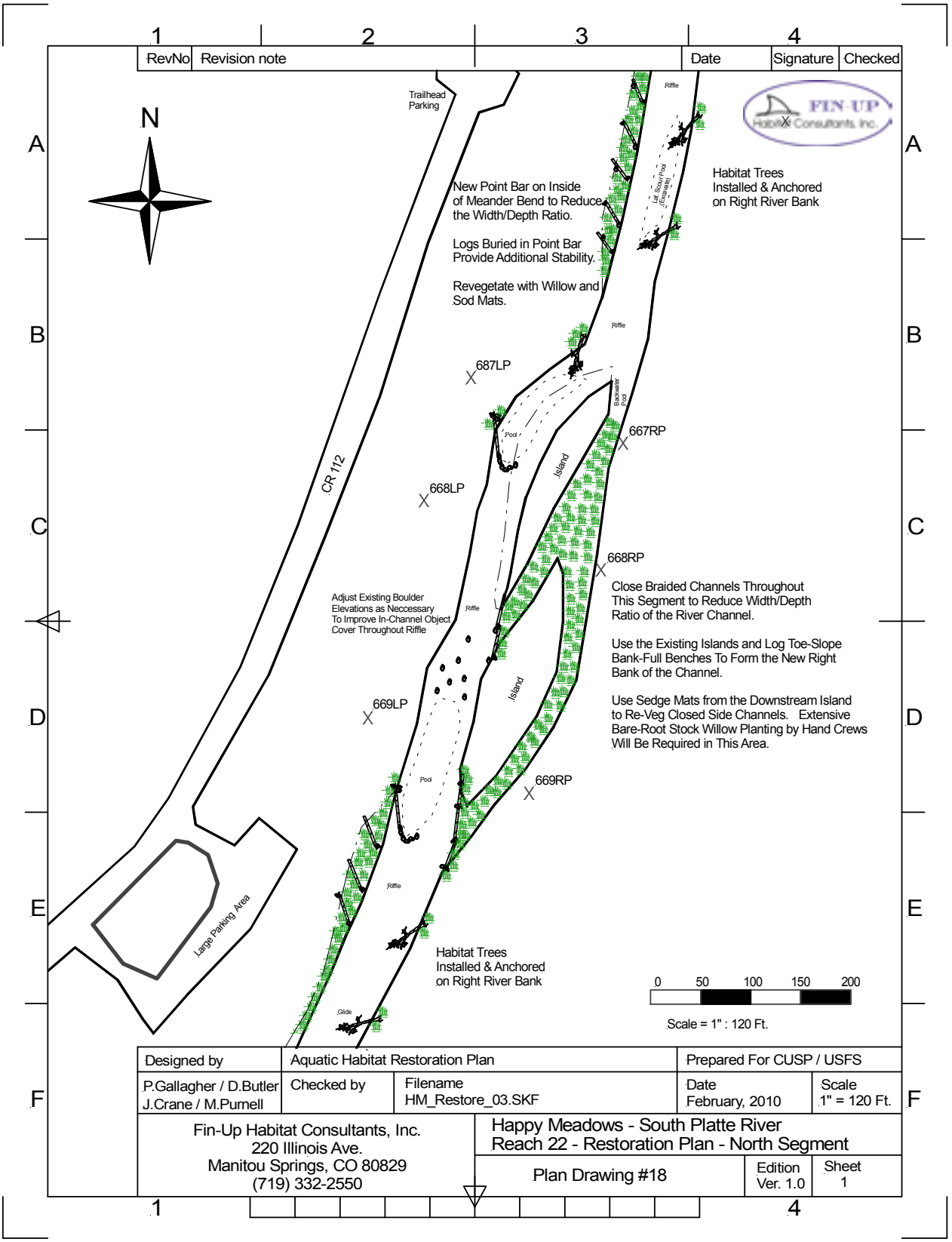
This drawing shows the segment of the river from 990ft to 1,900 ft along the longitudinal axis of the project reach. The river exhibits many of the effects of sediment deposition due to the low head diversion structure downstream at the Sportsman's Paradise property boundary. The river throughout this segment appears to be evolving from a C channel to a multi-thread braided DA channel. The channel is characterized by shallow depth and laminar flow, and the bed is comprised mostly of gravel and smaller materials. The road is removed from the river throughout this segment, and does not appear to impact the river at this point. Recreational use is high, and the left stream bank is in generally poor condition. This segment will be one of the most difficult challenges for restoration in the project reach, and will require considerable effort to complete.



A pool / riffle sequence will be constructed along the left side of the channel from cross-section #669 downstream to cross-section #666. The right side channels will be closed off throughout the segment, utilizing large wood, boulder and vegetation harvested from the islands. Volunteers will be utilized to complete extensive sedge and bare root stock willow planting throughout these closed channels.

The left channel will be slightly widened by harvesting vegetation along the right bank of the islands, to maintain a bank-full width/depth ratio of 30-35 throughout the segment. A large log/boulder J-Hook vane will be installed along the left bank, fifty feet upstream of cross-section #669, to create a lateral scour pool on the left side of the channel. Existing boulders in the riffle downstream of this pool may be adjusted to improve scour and create additional pocket-water object cover.

Another lateral scour pool will be created along the existing meander bend between cross-section #668 and #667, utilizing a large log/boulder J-hook vane at the top of the pool, and a habitat tree near the tail-out of this habitat. These trees will also help to reduce expected shear forces along this bank due to the concentrating the entire flow of the river into the left channel.


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Trailhead Parking
CR 112
New Point Bar on Inside of Meander Bend to Reduce the Width/Depth Ratio.
Logs Buried in Point Bar Provide Additional Stability.
Revegetate with Willow and Sod Mats.
Habitat Trees Installed & Anchored on Right River Bank
687LP
667RP
668LP
668RP
669LP
669RP
Riffle
Pool
Island
Backwater Pool
Adjust Existing Boulder Elevations as Necessary To Improve In-Channel Object Cover Throughout Riffle
Close Braided Channels Throughout This Segment to Reduce Width/Depth Ratio of the River Channel.
Use the Existing Islands and Log Toe-Slope Bank-Full Benches To Form the New Right Bank of the Channel.
Use Sedge Mats from the Downstream Island to Re-Veg Closed Side Channels. Extensive Bare-Root Stock Willow Planting by Hand Crews Will Be Required in This Area.
Large Parking Area
Habitat Trees Installed & Anchored on Right River Bank
Glide
0
50
100
150
200
Scale = 1" : 120 Ft.
Designed by
P.Gallagher / D.Butler
J.Crane / M.Purnell
Aquatic Habitat Restoration Plan
Checked by
Filename
HM_Restore_03.SKF
Prepared For CUSP / USFS
Date
February, 2010
Scale
1" = 120 Ft.
Fin-Up Habitat Consultants, Inc.
220 Illinois Ave.
Manitou Springs, CO 80829
(719) 332-2550
Happy Meadows - South Platte River
Reach 22 - Restoration Plan - North Segment
Plan Drawing #18
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Reach 22 – Enhancement Plan Drawing #19:

This drawing shows the segment of the river from 1,600ft to 2,700 ft along the longitudinal axis of the project reach. The river throughout this segment consists of a long meander bend turning back to the north. The road is far removed from the river throughout this segment. Several large parking areas exist along the segment, and recreational use is relatively intense. The river consists mostly of low gradient boulder and cobble riffle habitat, with occasional scour features along the outside (right side) of the meander bend. A Colorado Division of Wildlife electrofishing monitoring station exists in this segment, extending from a point adjacent to the large parking area on the north (Dwg #19 Grid C4) upstream to the obvious natural boulder riffle crest at Grid E3. Near the downstream end of this segment, the river begins to exhibit effects from the low head diversion structure downstream at the Sportsman's Paradise property boundary.

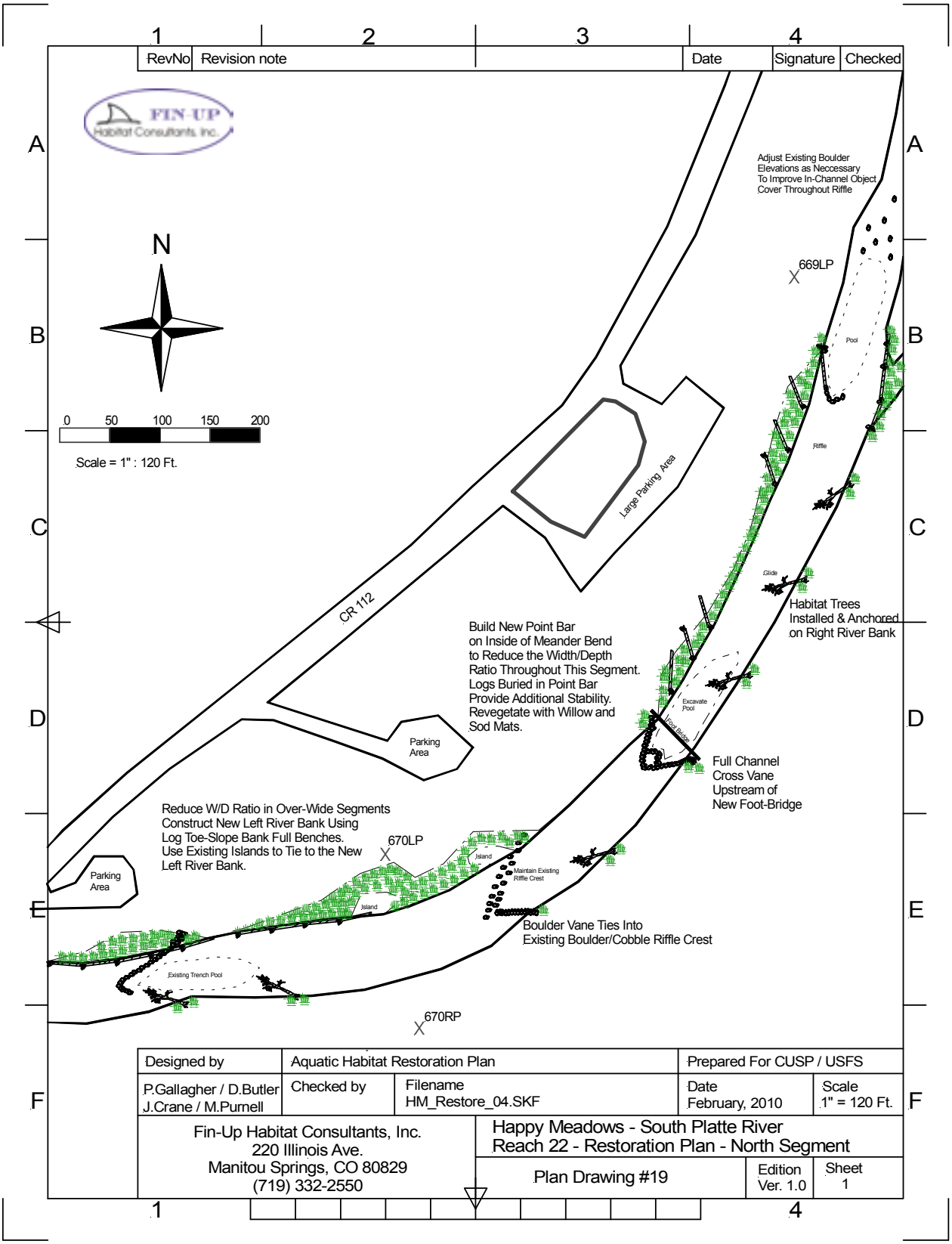
The boulder pocket-water riffle beginning at the upstream boundary of this segment is somewhat over-wide, with considerable sediment deposition occurring behind many of the in channel boulders. This segment, as well as another boulder pocket-water riffle downstream, will be narrowed using log toe-slope bank full benches along the left bank. Where possible, these structures will tie into existing islands for added stability. The trench pool between these two riffles may be further enhanced by constructing a boulder J-Hook vane near the initial scour point of the pool, and two habitat trees will be installed on the opposite bank to further increase habitat complexity and velocity shelter in the pool.

The existing boulder/cobble riffle crest that defines the upstream boundary of the CDOW electrofishing station will be left undisturbed. A small boulder vane may be installed on the right bank and tied into the existing riffle crest to protect the outside of the meander bend from shear at high flow. Additionally, a habitat tree will be installed approximately 100 ft downstream to further protect the meander bend outside bank, and to provide additional habitat and pocket water in the riffle.

A full channel boulder cross-vane will be installed in the channel at approximately 2,100ft along the longitudinal axis of the project reach, just upstream of south end of the large parking area (Dwg#19 Grid D4). The cross vane will be necessary to provide grade control along the river and protection for the foundation supports for a new foot-bridge that will eventually be installed immediately downstream of this feature. The cross-vane will improve scour and depth in the existing pool downstream, providing additional fish viewing opportunity from the foot bridge. This pool will be excavated to improve residual pool depth, and a large habitat tree will be installed along the right bank upstream of the tail-out of the pool.

The river downstream of the proposed footbridge location becomes significantly over wide throughout the remainder of the project reach. Large wood will be placed low in the channel along inside of the meander bend below the bridge site to capture sediment and create a new point bar, creating a new left bank. Extensive planting of sedge will be completed by volunteers. The goal of this work will be to reduce the width/depth ratio of this segment to less than 35.

To increase habitat complexity throughout this limited segment of the river, two large habitat trees will be installed and anchored on the outside (right bank) of the meander bend, within the glide and riffle habitats downstream of the footbridge pool. These features will also function as vanes, protecting the stream bank from high flow shear stress.


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FIN-UP
Habitat Consultants, Inc.
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Scale = 1" : 120 Ft.
Adjust Existing Boulder Elevations as Neccessary To Improve In-Channel Object Cover Throughout Riffle
669LP
Pool
Riffle
Large Parking Area
CR 112
Glide
Habitat Trees Installed & Anchored on Right River Bank
Build New Point Bar on Inside of Meander Bend to Reduce the Width/Depth Ratio Throughout This Segment. Logs Buried in Point Bar Provide Additional Stability. Revegetate with Willow and Sod Mats.
Excavate Pool
Foot Bridge
Parking Area
Full Channel Cross Vane Upstream of New Foot-Bridge
Reduce W/D Ratio in Over-Wide Segments Construct New Left River Bank Using Log Toe-Slope Bank Full Benches. Use Existing Islands to Tie to the New Left River Bank.
670LP
Island
Maintain Existing Riffle Crest
Parking Area
Island
Boulder Vane Ties Into Existing Boulder/Cobble Riffle Crest
Existing Trench Pool
670RP
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Designed by
P.Gallagher / D.Butler
J.Crane / M.Purnell
Aquatic Habitat Restoration Plan
Checked by
Filename
HM_Restore_04.SKF
Prepared For CUSP / USFS
Date
February, 2010
Scale
1" = 120 Ft.
Fin-Up Habitat Consultants, Inc.
220 Illinois Ave.
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Reach 22 – Enhancement Plan Drawing #20:

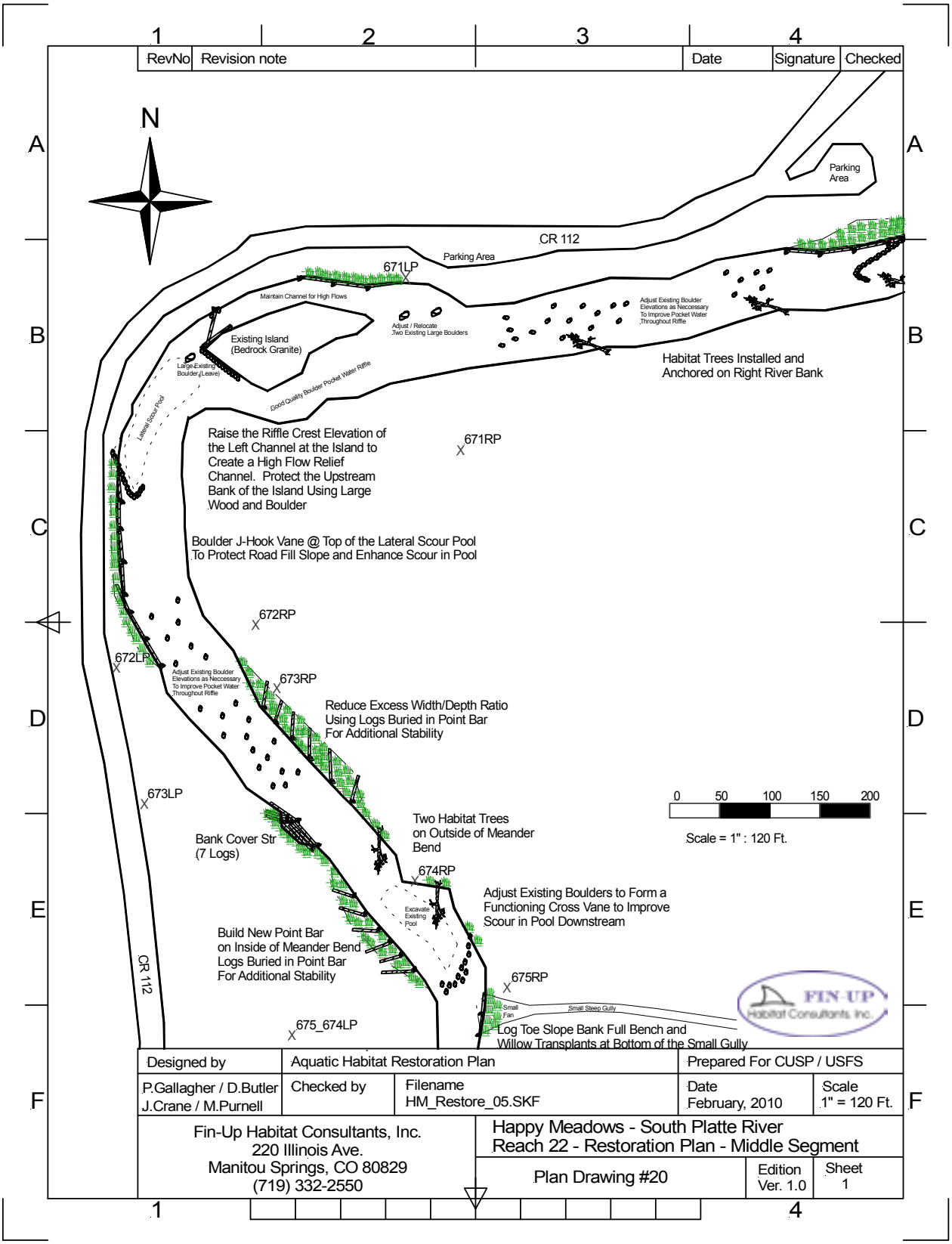
This drawing shows the segment of the river from 2,700ft to 3,800 ft along the longitudinal axis of the project reach. The river throughout this segment consists of a long, low gradient, boulder dominated riffle, followed by a large meander bend turning back to the east. County Road 112 confines the river throughout most of the length of the meander bend, between cross-sections #672 and #671. The river through this section exhibits similar characteristics to the meander bend upstream in Drawing 7.



The low gradient boulder riffle is very wide and relatively shallow, exhibiting W/D ratios <50. This segment will be treated using river narrowing techniques developed and demonstrated in Eleven-mile Canyon and utilized upstream. Large wood will be placed low in the channel along the river banks to capture sediment moving through the system and aggrade the bed. Extensive planting of sedge will be completed by volunteers from Trout Unlimited, the Rocky Mountain Field Institute's Pikes Peak Youth Corps, and the Coalition for the Upper South Platte. The goal of this work will be to reduce the width/depth ratio of this segment to approximately 30. In several segments, log toe-slope bank full benches may be employed to provide additional bank stability. In conjunction with the channel narrowing work in this segment, boulder elevations may be adjusted to improve scour behind these features, and a river bank cover structure may be installed on the left bank (Dwg.#20 Grid E2), using 6 to 7 large trees.

Downstream at the meander bend, a marginal lateral scour pool will be enhanced by constructing a large boulder J-Hook vane near the initial scour point of the pool. Downstream of this pool, a large island splits the channel in two, with the primary flow going into the right channel. While a single thread channel might be desirable here, the island is composed mostly of parent bedrock granite, making a single thread impractical. We propose to raise the riffle crest at the top of the left channel, using large wood and boulder to create a vane across the channel. This will effectively close this channel during base flows, but allow high flows to pass, reducing shear on the banks of the main channel and providing important cover and velocity shelter during peak flows. The upstream bank of the island is currently exhibiting some stress from high flows, and will be reinforced using log bank-full benching and boulders.

Downstream of the island, two habitat trees will be installed along the right bank of the pocket-water boulder dominated riffle. Minor adjustments of in-channel boulders will be accomplished, as necessary, to improve pocket water depth and quality in the riffle.


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Parking Area
CR 112
Parking Area
671LP
Maintain Channel for High Flows
Existing Island (Bedrock Granite)
Large Existing Boulder (Leave)
Adjust / Relocate Two Existing Large Boulders
Adjust Existing Boulder Elevations as Neccessary To Improve Pocket Water Throughout Riffle
Habitat Trees Installed and Anchored on Right River Bank
Good Quality Boulder Pocket Water Riffle
Lateral Scour Pool
Raise the Riffle Crest Elevation of the Left Channel at the Island to Create a High Flow Relief Channel. Protect the Upstream Bank of the Island Using Large Wood and Boulder
671RP
Boulder J-Hook Vane @ Top of the Lateral Scour Pool To Protect Road Fill Slope and Enhance Scour in Pool
672RP
672LP
Adjust Existing Boulder Elevations as Neccessary To Improve Pocket Water Throughout Riffle
673RP
Reduce Excess Width/Depth Ratio Using Logs Buried in Point Bar For Additional Stability
673LP
0 50 100 150 200
Scale = 1" : 120 Ft.
Two Habitat Trees on Outside of Meander Bend
Bank Cover Str (7 Logs)
674RP
Adjust Existing Boulders to Form a Functioning Cross Vane to Improve Scour in Pool Downstream
Excavate Existing Pool
Build New Point Bar on Inside of Meander Bend Logs Buried in Point Bar For Additional Stability
CR 112
675RP
Small Fan
Small Steep Gully
675_674LP
Log Toe Slope Bank Full Bench and Willow Transplants at Bottom of the Small Gully
FIN-UP Habitat Consultants, Inc.
Designed by
P.Gallagher / D.Butler
J.Crane / M.Purnell
Aquatic Habitat Restoration Plan
Checked by
Filename
HM_Restore_05.SKF
Prepared For CUSP / USFS
Date
February, 2010
Scale
1" = 120 Ft.
Fin-Up Habitat Consultants, Inc.
220 Illinois Ave.
Manitou Springs, CO 80829
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Happy Meadows - South Platte River
Reach 22 - Restoration Plan - Middle Segment
Plan Drawing #20
Edition
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Reach 22 – Enhancement Plan Drawing #21:

This drawing shows the segment of the river from 3,400ft to 5,200 ft along the longitudinal axis of the project reach. The river throughout this segment consists of a long low gradient meander bend turning back to the northwest. County Road 112 significantly confines the channel along 200 ft of the river in the upstream portion of this segment. Once the road departs from the river, the channel becomes over-wide, exhibiting poor scour, shallow depth and limited cover for trout.

A full channel boulder cross vane will be installed at the point where County Road 112 begins to encroach on the left side of the river (Dwg. #21 Grid E1). This structure will help to protect the road fill slope downstream, direct the thalweg back into the center of the channel, and improve the scour pool immediately downstream. Log toe-slope bank full benches will be installed along the left river bank to form a narrow riparian buffer between the road and the river. At some point, the road facet slope should be changed from "out-slope" to "in-slope" with the addition of an in-board drainage ditch and culvert to drain run-off from the road away from the river.

Downstream of cross-section #680, the river dramatically widens, with a large vegetated island forming two broad, shallow channels. The left (road side) channel will be closed by extending the bank-full benching downstream and tying into the island. A small sliver of the right bank of the island will be removed to create a single thread channel on the right. The target width of this channel will be approximately 70 ft. A small backwater pool will remain near the downstream boundary of the closed channel to provide habitat and high flow protection for juvenile trout.

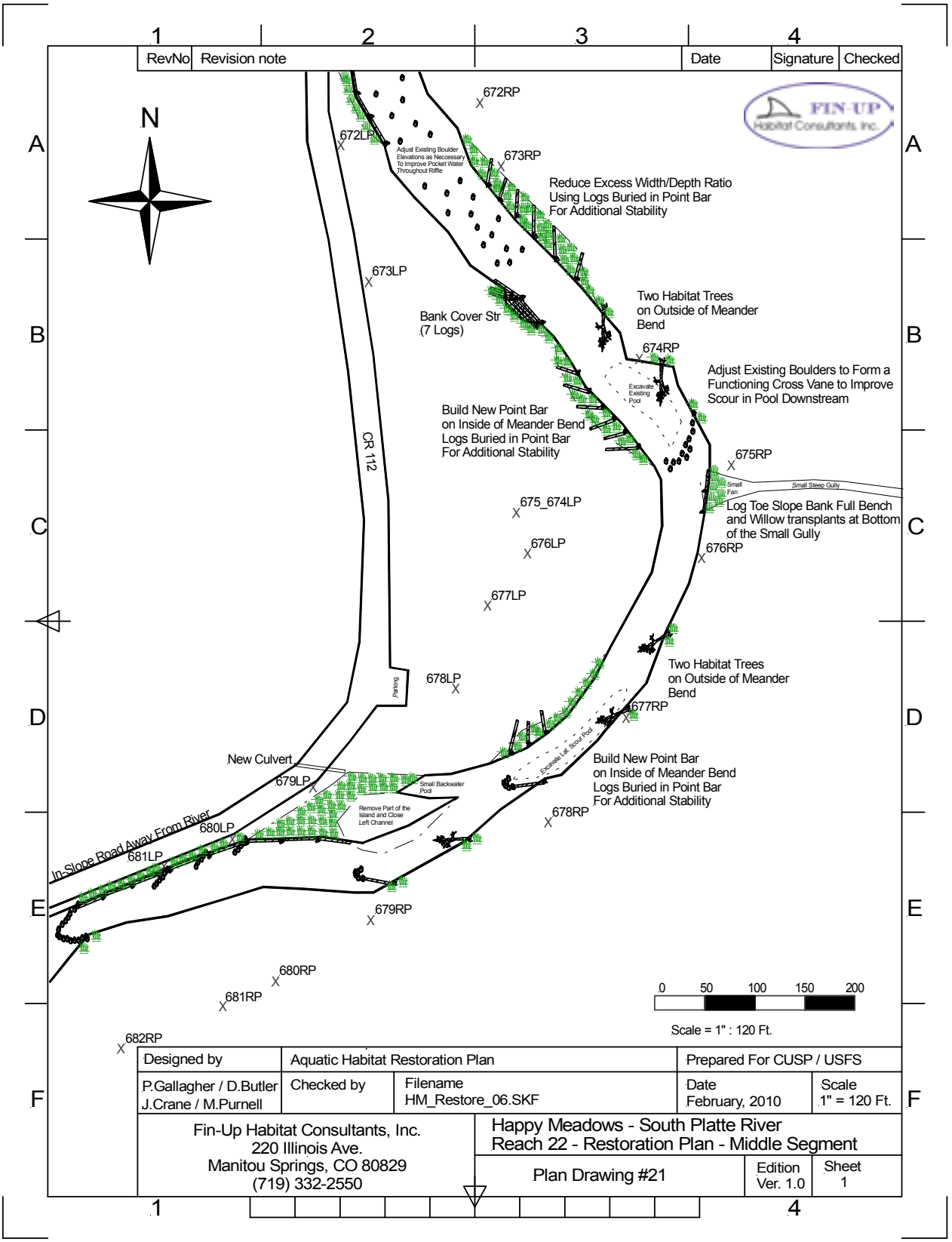
A large log / boulder J-Hook vane will be installed on the right bank near the top of the right channel to protect the river bank along this segment, and to provide pocket water cover within the riffle. An additional habitat tree may be placed approximately 75 ft downstream to provide additional habitat complexity and to act as a vane along the outside of the meander bend.

A very marginal lateral scour pool exists between cross-sections #678 and #677. A large boulder J-Hook vane will be installed on the right bank at the upstream initial scour point of the pool in order to focus the thalweg into the habitat feature.

The left stream bank is adjacent to a major parking area, and is in generally poor condition, and has resulted in over-widening of the channel at this point. A new left river bank will be constructed using large wood and riparian plantings to reduce the width of the river. The existing pool will be excavated, and this material will be used to fill behind the toe-slope logs to bring the grade of the river bank up to the bank full elevation. Additional willow and sedge transplants will be required to recover this area, and may be harvested from the meadow between the road and river (Dwg #21 Grid C3). At the tail-out of the lateral scour pool, and at a point approximately 100 ft downstream, habitat trees will be installed and anchored along the outside (right) bank of the meander bend.

A small gully enters the river from the steep slopes on the right near cross-section #675. This gully has eroded down to the parent bedrock, and does not appear to be continuing to contribute sediment to the system. The toe of the deposition fan will be stabilized using log bank full benches, and the small deposition fan will be planted with willow to form a vegetative barrier between the gully and the river.

Downstream of the gully, existing boulders will be re-configured to form a cross-vane or J-Hook vane to enhance the existing scour pool below. The scour pool will be excavated, and this material will be used to build a new point bar on the inside (left) bank of the meander bend.


RevNo
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672RP
672LP
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673LP
Adjust Existing Boulder Elevations as Necessary To Improve Pocket Water Throughout Riffle
Reduce Excess Width/Depth Ratio Using Logs Buried in Point Bar For Additional Stability
Two Habitat Trees on Outside of Meander Bend
Bank Cover Str (7 Logs)
674RP
Adjust Existing Boulders to Form a Functioning Cross Vane to Improve Scour in Pool Downstream
Excavate Existing Pool
Build New Point Bar on Inside of Meander Bend Logs Buried in Point Bar For Additional Stability
CR 112
675RP
Small Fan
Small Steep Gully
675_674LP
Log Toe Slope Bank Full Bench and Willow transplants at Bottom of the Small Gully
676LP
676RP
677LP
Two Habitat Trees on Outside of Meander Bend
678LP
Parking
677RP
New Culvert
679LP
Small Backwater Pool
Excavate Lat. Scour Pool
Build New Point Bar on Inside of Meander Bend Logs Buried in Point Bar For Additional Stability
Remove Part of the Island and Close Left Channel
678RP
680LP
In-Slope Road Away From River
681LP
679RP
680RP
681RP
682RP
0 50 100 150 200
Scale = 1" : 120 Ft.
Designed by
P.Gallagher / D.Butler
J.Crane / M.Purnell
Aquatic Habitat Restoration Plan
Checked by
Filename
HM_Restore_06.SKF
Prepared For CUSP / USFS
Date
February, 2010
Scale
1" = 120 Ft.
Fin-Up Habitat Consultants, Inc.
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(719) 332-2550
Happy Meadows - South Platte River
Reach 22 - Restoration Plan - Middle Segment
Plan Drawing #21
Edition
Ver. 1.0
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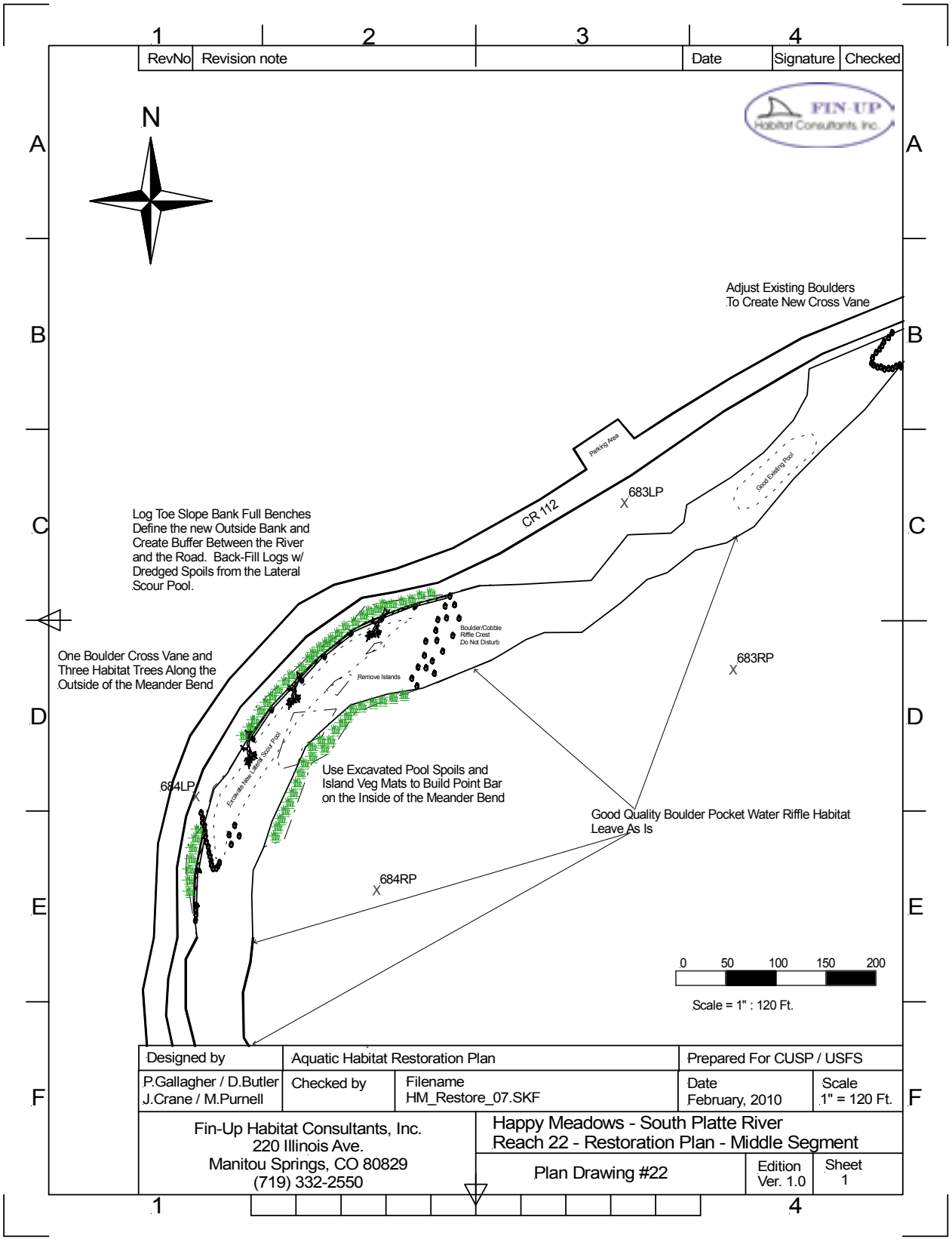
Reach 22 – Enhancement Plan Drawing #22:

This drawing shows the segment of the river from 5,200ft to 6,100 ft along the longitudinal axis of the project reach. The river throughout this segment consists of a long meander bend to the east, and is dominated by boulder pocket-water riffle habitat. County Road 112 confines the channel throughout much of this segment, particularly in the upstream half. Where the road is not immediately adjacent to the river, the channel is very stable, and exhibits some of the highest quality habitat within the project reach.

The only work proposed within this section is the three hundred foot segment of channel extending from immediately upstream of cross-section #684 downstream to a natural riffle crest forming the upstream boundary of a long boulder dominated pocket-water riffle. The road is perched approximately 10 – 20 feet above the river along this segment, with the road fill slope extending directly to the river's edge. Previous habitat surveys (USFS 1993) indicate that a relatively good quality lateral scour pool once existed here, and the proposed work will seek to re-create this habitat form. Extensive log toe-slope bank full bench structures will be utilized to create a vegetative buffer between the river and the road toe-slope. The three mid-channel vegetated islands that have formed in the river will be removed. The lateral scour pool will be excavated, with the spoils being used to back-fill the bank full bench structures, and to create a new point bar on the inside (right) bank of the meander. A large boulder J-Hook vane will be installed at the upstream initial scour point of the pool in order to focus the thalweg into the habitat feature, as well as protect the adjacent river banks and fill slope from high flows. Several existing boulders near this feature are currently forming sediment bars downstream, and will be adjusted or removed to eliminate deposition in these areas. Finally, three habitat trees will be installed and anchored along the left bank, extending into the scour pool, to provide additional habitat complexity and cover.



Example of bank full bench structures and a habitat tree along the outside of a meander bend.


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FIN-UP
Habitat Consultants, Inc.
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Adjust Existing Boulders
To Create New Cross Vane
Parking Area
CR 112
683LP
Good Existing Pool
Log Toe Slope Bank Full Benches
Define the new Outside Bank and
Create Buffer Between the River
and the Road. Back-Fill Logs w/
Dredged Spoils from the Lateral
Scour Pool.
Boulder/Cobble
Riffle Crest
Do Not Disturb
One Boulder Cross Vane and
Three Habitat Trees Along the
Outside of the Meander Bend
Remove Islands
683RP
Excavate New Lateral Scour Pool
684LP
Use Excavated Pool Spoils and
Island Veg Mats to Build Point Bar
on the Inside of the Meander Bend
Good Quality Boulder Pocket Water Riffle Habitat
Leave As Is
684RP
0
50
100
150
200
Scale = 1" : 120 Ft.
Designed by
P.Gallagher / D.Butler
J.Crane / M.Purnell
Aquatic Habitat Restoration Plan
Checked by
Filename
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Prepared For CUSP / USFS
Date
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Scale
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Happy Meadows - South Platte River
Reach 22 - Restoration Plan - Middle Segment
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Reach 22 – Enhancement Plan Drawing #23:

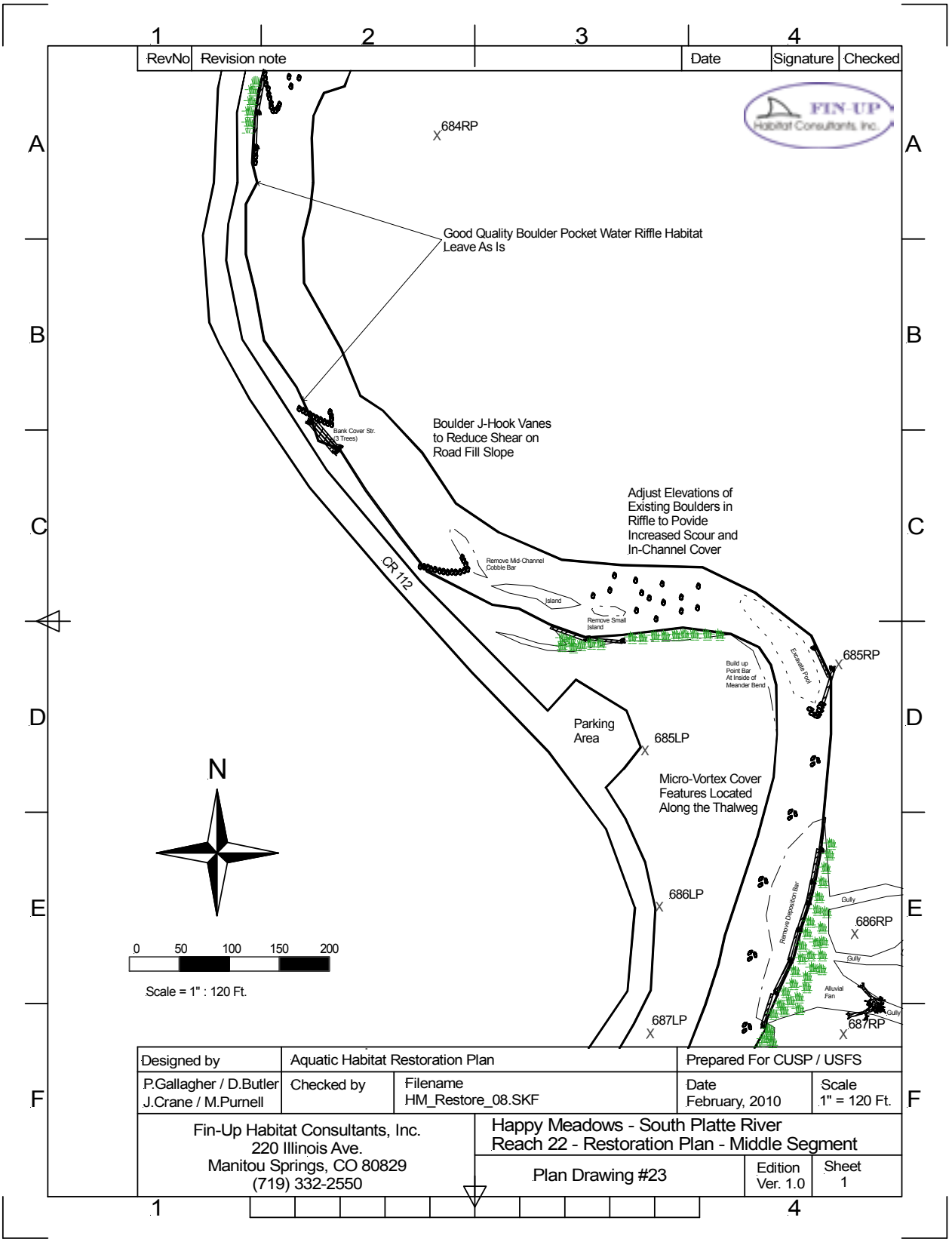
This drawing shows the segment of the river from 6,100ft to 7,060 ft along the longitudinal axis of the project reach. The river throughout this segment is dominated by boulder pocket-water riffle habitat. A large parking area is found in the middle of the segment, and the river exhibits impacts from intense recreational use within this area.

The existing lateral scour pool on the meander bend immediately downstream of the large gully (Dwg.#23 Grid D4) have been severely impacted by sediment from the gully, and currently exhibits characteristics more akin to a glide habitat. The work in the gully, described on the previous page, should effectively cut off the sediment entering this habitat, and allow the pool to be restored. A large log/boulder J-Hook vane will be installed along the right river bank immediately upstream of the lateral scour pool to redirect the thalweg of the river and improve scour through the pool, and to provide protection from high flow erosion on the stream bank downstream. The lateral scour pool will be excavated, and the spoils will be used to create a new point bar on the inside (left) bank of the meander.

The boulder riffle downstream of the lateral scour pool is significantly over-wide, with several mid-channel vegetated islands. Additionally, the left stream bank adjacent to the parking area is in extremely poor condition. A new left river bank will be constructed using large wood and riparian bank-full benching techniques to effectively reduce the width of the river at this point. Spoils from the excavation of the lateral scour pool upstream will be used to fill behind the toe-slope logs to bring the grade of the river bank up to the bank full elevation. The smaller, upstream island will be removed, and vegetation will be transplanted to the left stream bank. Additional willow and sedge transplants will be required to recover this area. Additionally, the surface elevations of several existing boulders in the riffle will be adjusted to ½ bank-full or less to improve scour and depth behind these features.

Downstream of this area, the river enters a very stable boulder dominated riffle. At this point, County Rd 112 begins to confine the stream on the left, with a very narrow, but robust willow dominated riparian buffer separating the road from the river. Immediately below a long narrow willow covered island (Dwg. #23 Grid C3), a natural cobble/boulder mid channel bar is deflecting the thalweg of the river directly into the road fill slope, and may at some future point cause a failure at this point. We propose to adjust this bar, using material from the bar to construct a boulder J-Hook vane to protect the road fill slope at this point. This feature will also provide a useful pocket-water and velocity shelter within the riffle at this point.

Approximately 150 ft downstream (Dwg#23 Grid B2) there is an opportunity to create an effective bank cover structure using several pieces of large wood anchored into the left river bank. To further enhance this feature by increasing depth, and to protect the narrow riparian buffer between the river and the road at this point, a boulder J-Hook vane will be installed immediately downstream of the bank cover structure.


RevNo
Revision note
Date
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684RP
Good Quality Boulder Pocket Water Riffle Habitat
Leave As Is
Boulder J-Hook Vanes
to Reduce Shear on
Road Fill Slope
Bank Cover Str.
(3 Trees)
Adjust Elevations of
Existing Boulders in
Riffle to Povide
Increased Scour and
In-Channel Cover
Remove Mid-Channel
Cobble Bar
CR 112
Island
Remove Small
Island
Build up
Point Bar
At Inside of
Meander Bend
Excavate Pool
685RP
Parking
Area
685LP
Micro-Vortex Cover
Features Located
Along the Thalweg
686LP
Remove Deposition Bar
Gully
686RP
Gully
Alluvial
Fan
Gully
687LP
687RP
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0
50
100
150
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Scale = 1" : 120 Ft.
Designed by
P.Gallagher / D.Butler
J.Crane / M.Purnell
Aquatic Habitat Restoration Plan
Checked by
Filename
HM_Restore_08.SKF
Prepared For CUSP / USFS
Date
February, 2010
Scale
1" = 120 Ft.
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Reach 22 - Restoration Plan - Middle Segment
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Reach 22 – Enhancement Plan Drawing #24

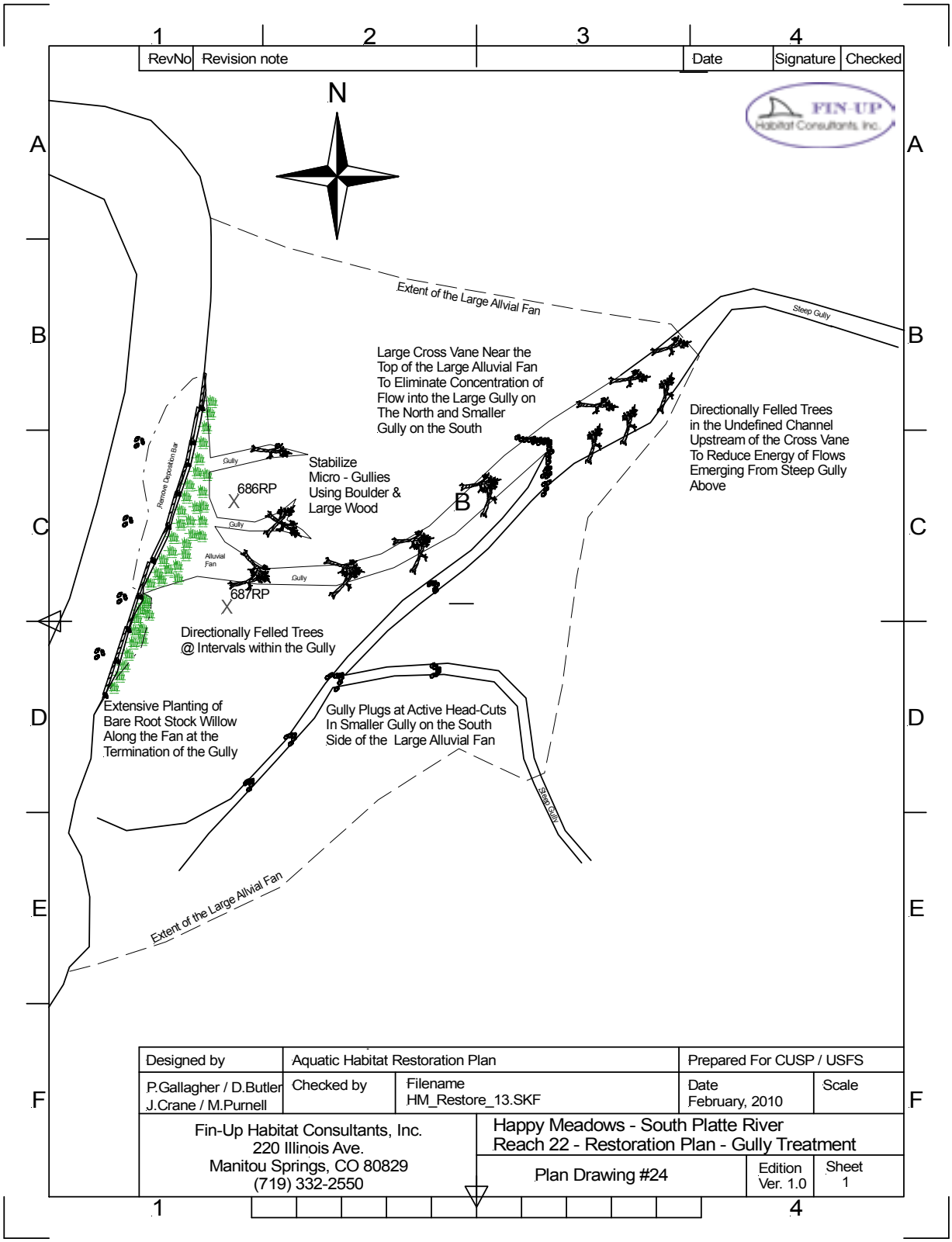
The segment downstream of the campground is affected by sediment inputs from the largest of the erosion gullies from the Hayman burn, which enters the river between cross-sections #687 and #686. Work will include require re-connecting the ephemeral drainages to the historic alluvial fans near the upper end of these features, at the point where the gullies emerge from the steep surrounding hill slopes. A large boulder cross-vane will be installed in the channel at this point (see photo below) to create a sediment detention area upstream, and to allow flows from the gully above to spread out over the alluvial fan instead of concentrating in the down-cut gully below

Downstream of the cross-vane, the gully will be plugged at several intervals using large wood placed in the gully to reduce energy and create additional roughness in the channel. These features should capture some of the material moving through the channel and help to aggrade the bed back to the original elevation of the surrounding alluvial fan. Upstream, between the cross-vane and the point where there is a significant increase in channel gradient, several trees may be dropped in a staggered pattern to reduce the energy of flood flows emerging from the steeper segment of the gully.

Extensive toe-slope stabilization and planting where the gully meets the river will be undertaken to create a vegetative buffer between the gully and the river. A deposition bar extending into the river below this gully will be excavated back to the natural channel width (approx. 70 ft) and a new bank full bench constructed to stabilize the toe of the deposition fan. Several micro-vortex in-channel object structures will be added along this segment to provide cover and velocity shelter for resident trout.

A smaller gully exists immediately to the south of the major gully, and exhibits several active head-cuts throughout its length. The head-cuts will be stabilized through the installation of small boulder gully plugs in the channel. Additionally, two small “micro” gullies immediately downstream (north) of the primary gully will be treated using large wood and tree tops in the active eroding areas of these features.




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FIN-UP
Habitat Consultants, Inc.
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Extent of the Large Allvial Fan
Steep Gully
Large Cross Vane Near the
Top of the Large Alluvial Fan
To Eliminate Concentration of
Flow into the Large Gully on
The North and Smaller
Gully on the South
Directionally Felled Trees
in the Undefined Channel
Upstream of the Cross Vane
To Reduce Energy of Flows
Emerging From Steep Gully
Above
Stabilize
Micro - Gullies
Using Boulder &
Large Wood
686RP
687RP
Remove Deposition Bar
Gully
Alluvial Fan
Directionally Felled Trees
@ Intervals within the Gully
Extensive Planting of
Bare Root Stock Willow
Along the Fan at the
Termination of the Gully
Gully Plugs at Active Head-Cuts
In Smaller Gully on the South
Side of the Large Alluvial Fan
Steep Gully
Extent of the Large Allvial Fan
Designed by
P.Gallagher / D.Butler
J.Crane / M.Purnell
Aquatic Habitat Restoration Plan
Checked by
Filename
HM_Restore_13.SKF
Prepared For CUSP / USFS
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Happy Meadows - South Platte River
Reach 22 - Restoration Plan - Gully Treatment
Plan Drawing #24
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Reach 22 – Enhancement Plan Drawing #25:

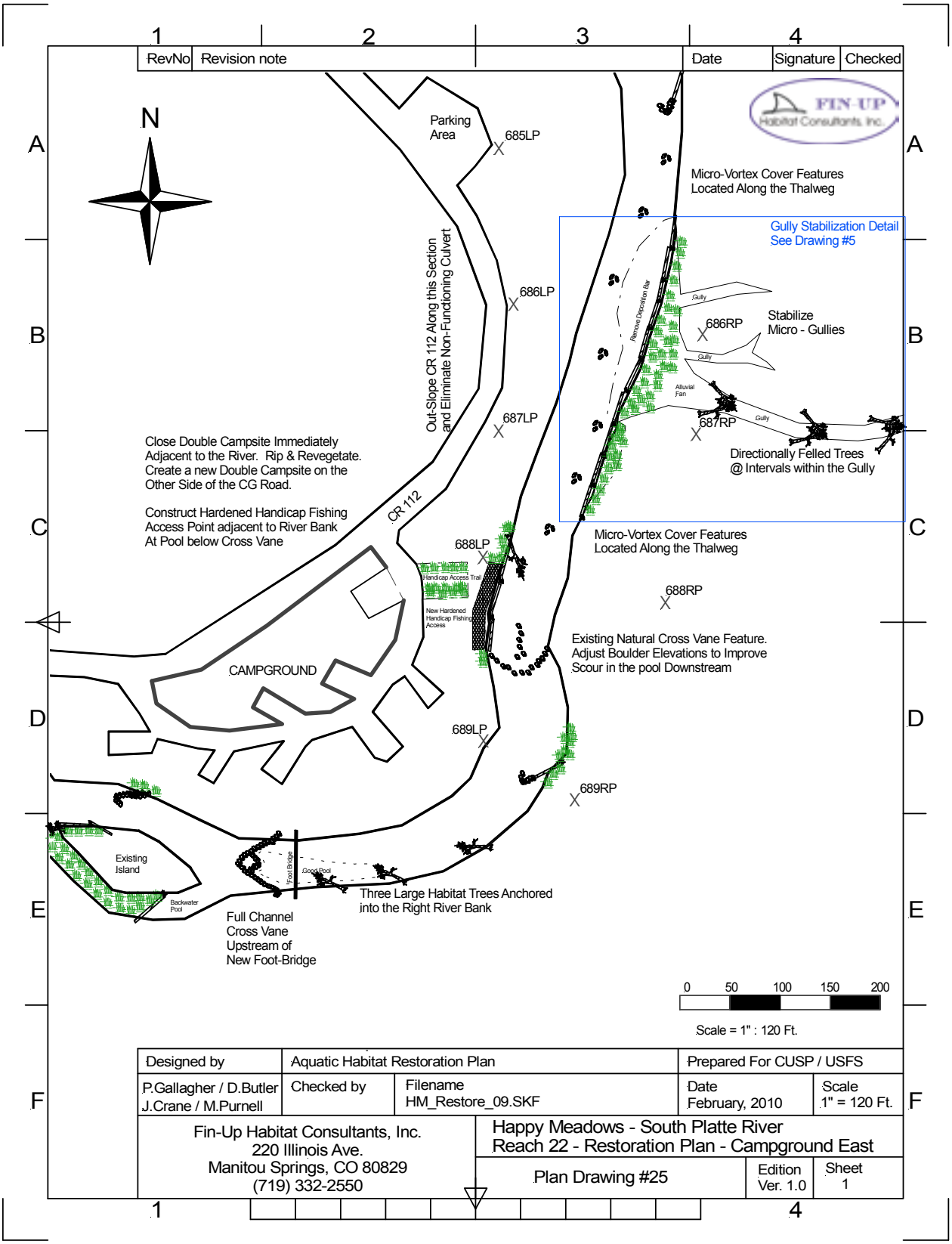
This drawing shows the segment of the river from 7,060ft to 8,000 ft along the longitudinal axis of the project reach. The river throughout this segment is characterized by a meander bend to the north (left). Happy Meadows Campground is located on the left river bank at the upstream part of this segment. The largest of the erosion gullies from the Hayman burn enters the river near the downstream boundary of this segment.

A full channel boulder cross-vane will be installed downstream of the point where the closed channel enters the main thread (Dwg.#25 Grid E2). This feature will provide improve depth at base flow of the backwater pool feature at the bottom of the closed side channel. The cross vane will also be necessary to provide an important grade control along the river and protection for the foundation supports for a new foot-bridge that will eventually be installed immediately downstream of this feature. The cross-vane will improve scour and depth in the existing pool downstream, providing additional fish viewing opportunity from the foot bridge.



Three large habitat trees will be installed and anchored along the right bank downstream of the footbridge. One of these trees should extend into the existing pool, and another should be installed near the tail-out of the pool to function as a vane and velocity shelter. A third tree will be installed in the riffle downstream. A large tree / boulder J-Hook structure will be installed at cross-section #689 to further enhance the existing pocket water in this area, and to protect the eroded river bank on the right side of the channel.

A natural boulder cross vane feature exists just upstream of cross-section #668 (Dwg.#25 Grid D3). This feature may be re-configured to provide better scour along the left side of the channel in the pool immediately downstream. This will create quality holding habitat for trout, providing an ideal location to construct a handicap accessible, hardened fishing site along the left stream bank within Happy Meadows Campground. The existing left stream bank is in poor condition here, due to intense recreation use. Large trees and boulders will be used to construct a solid toe along the bank. These structures will be lined with geo-textile fabric and back-filled to form a level platform for wheel-chair bound users. The double campsite immediately adjacent is too close to the river and should be eliminated. A handicap accessible trail can be constructed through this site, with the remainder being ripped and re-seeded with native grasses. We recommend that a new double site be constructed immediately across the campground access road from the current site to mitigate the loss of the streamside campsite, and that this site be designated for handicapped use and parking.


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Parking Area
685LP
686LP
687LP
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686RP
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689RP
Out-Slope CR 112 Along this Section and Eliminate Non-Functioning Culvert
CR 112
Micro-Vortex Cover Features Located Along the Thalweg
Gully Stabilization Detail See Drawing #5
Stabilize Micro - Gullies
Directionally Felled Trees @ Intervals within the Gully
Close Double Campsite Immediately Adjacent to the River. Rip & Revegetate. Create a new Double Campsite on the Other Side of the CG Road.
Construct Hardened Handicap Fishing Access Point adjacent to River Bank At Pool below Cross Vane
Micro-Vortex Cover Features Located Along the Thalweg
Existing Natural Cross Vane Feature. Adjust Boulder Elevations to Improve Scour in the pool Downstream
CAMPGROUND
Handicap Access Trail
New Hardened Handicap Fishing Access
Existing Island
Backwater Pool
Foot Bridge
Good Pool
Three Large Habitat Trees Anchored into the Right River Bank
Full Channel Cross Vane Upstream of New Foot-Bridge
0 50 100 150 200
Scale = 1" : 120 Ft.
Designed by
P.Gallagher / D.Butler
J.Crane / M.Purnell
Aquatic Habitat Restoration Plan
Checked by
Filename
HM_Restore_09.SKF
Prepared For CUSP / USFS
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Reach 22 - Restoration Plan - Campground East
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Reach 22 – Enhancement Plan Drawing #26:

This drawing shows the segment of the river from 8,000ft to 9,300 ft along the longitudinal axis of the project reach. The river throughout this segment is characterized by a long meander bend to the east (right). The river has formed several mid-channel islands throughout this meander bend. These areas exhibit shallow depths, laminar flows and limited habitat. Happy Meadows Campground is located on the left river bank at the downstream part of this segment.

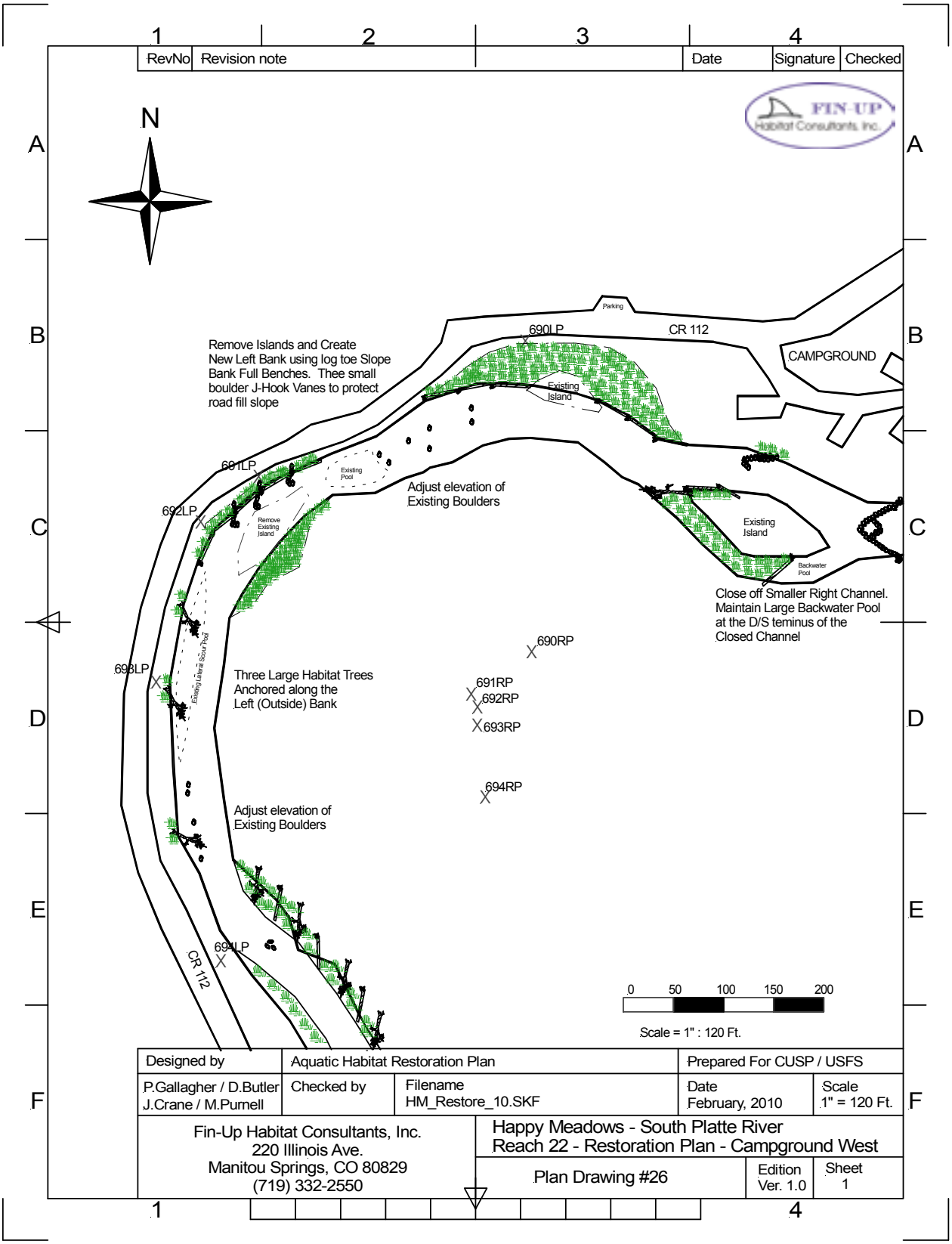
Three large "habitat" trees will be installed and anchored along the outside (left) bank near the beginning of the meander bend (Dwg.#26 Grid D1) to provide cover and velocity for trout and reduce shear along the bank. The surface elevations of several existing boulders in the channel will be adjusted to ½ bank-full stage elevation or less to improve scour and depth behind these features.



The large mid-channel island at Grid C2 will be removed. Vegetation from the island will be used to form a new point bar along the inside (right) bank of the meander bend adjacent to the island. Log toe-slope bank-full benching will be constructed along the outside (left) bank of the meander bend to create a buffer between County Road 112 and the river. Additionally, three small boulder vanes will be installed along the bank to further reduce shear forces on the bank full bench and road fill slope.

The segment of the river immediately upstream of the campground (Dwg.#26 Grid B3) is braided and extremely wide. A new left river bank will be constructed using large wood and riparian bank-full benching techniques. The existing island will be utilized as an anchor point for the new river bank, and the left channel will be revegetated using transplanted sedge and willow. The surface elevations of several existing boulders in the riffle upstream of this area will be adjusted to ½ bank-full or less to improve scour and depth behind these features.

The right channel formed by the island at Grid C4 will be closed off using large wood and willow. A small backwater pool will be maintained at the downstream end of the closed side channel to support habitat for young-of-the-year and juvenile trout. The upstream segment of the island will be protected from additional shear by installing a single log toe-slope bank full bench at the upstream side of the island. A small boulder J-Hook structure will be installed on the left bank of the main thread to create velocity shelter and protect the river bank adjacent to the campground.


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Date
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N
FIN-UP
Habitat Consultants, Inc.
Parking
690LP
CR 112
CAMPGROUND
Remove Islands and Create New Left Bank using log toe Slope Bank Full Benches. Thee small boulder J-Hook Vanes to protect road fill slope
Existing Island
691LP
Existing Pool
Adjust elevation of Existing Boulders
692LP
Remove Existing Island
Existing Island
Backwater Pool
Close off Smaller Right Channel. Maintain Large Backwater Pool at the D/S teminus of the Closed Channel
690RP
693LP
Existing Lateral Scour Pool
Three Large Habitat Trees Anchored along the Left (Outside) Bank
691RP
692RP
693RP
694RP
Adjust elevation of Existing Boulders
694LP
CR 112
0
50
100
150
200
Scale = 1" : 120 Ft.
Designed by
P.Gallagher / D.Butler
J.Crane / M.Purnell
Aquatic Habitat Restoration Plan
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Filename
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Reach 22 - Restoration Plan - Campground West
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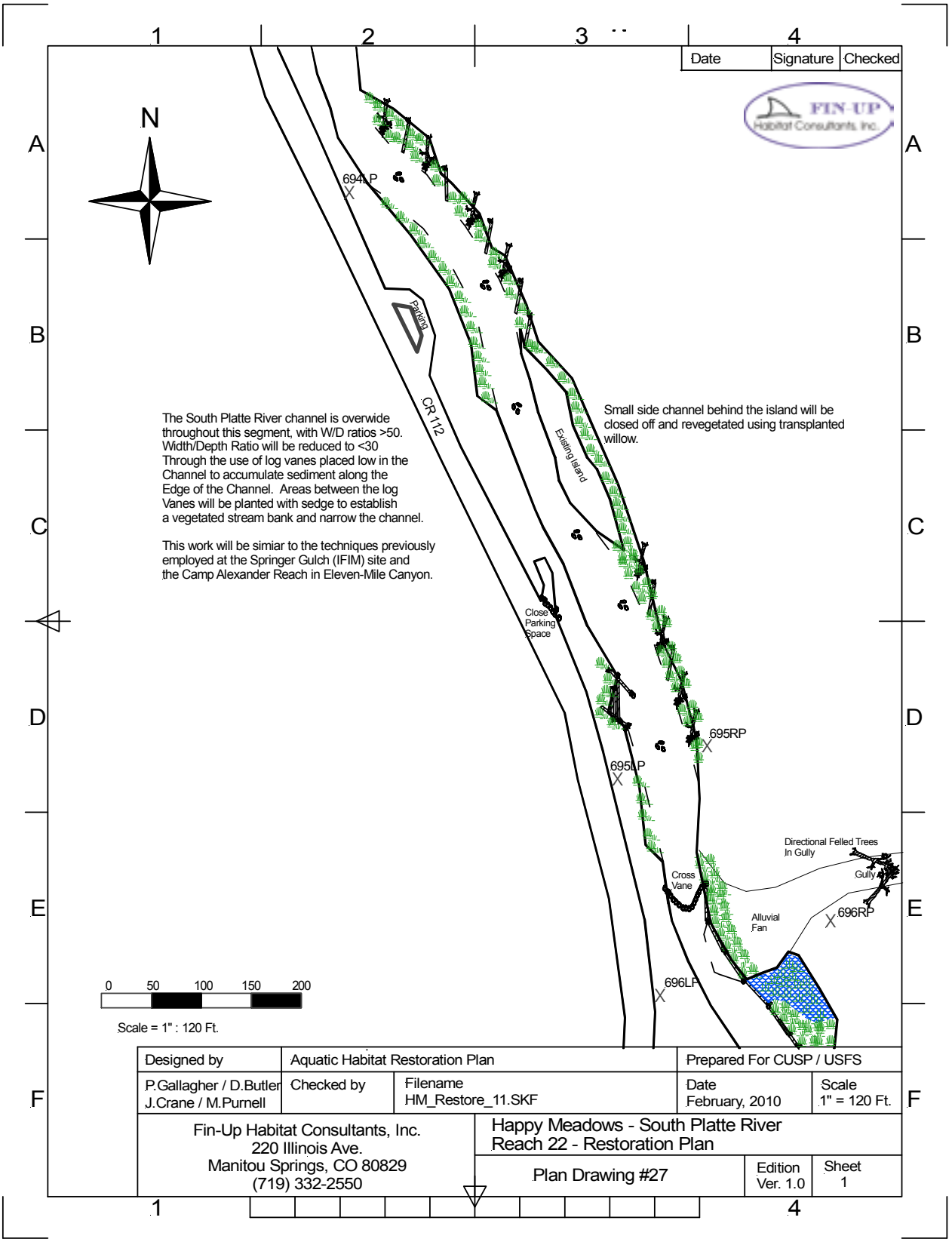
Reach 22 – Enhancement Plan Drawing #27:

This drawing shows the segment of the river from 9,300 ft to 10,100ft along the longitudinal axis of the project reach. The river throughout this segment is straight, shallow, and over-wide, with few holding areas for trout. A large gully / deposition fan enters the river near the upstream limit of the segment (Dwg. #27 Grid E4). A small portion of the deposition bar extending into the river below this gully will be excavated and a new bank full bench constructed to stabilize the toe of the deposition fan. Extensive willow planting will completed on the bank-full bench and deposition fan. Large wood will be placed in the gully above in a manner consistent with the directional felling techniques used for burned area emergency rehab to reduce energy and create additional roughness in the channel. These features should capture some of the material moving through the channel and help to aggrade the bed back to the original elevation of the surrounding alluvial fan.

A boulder or double log cross vane may be installed in the channel immediately downstream of the gully to provide vertical stability in the river bed, and to create scour to form a pool immediately below. A river bank cover structure can be installed downstream of this point (Dwg.#27 Grid D3) on the left bank, using 5 to 6 large trees.

The parking area at Grid C3 will b closed, ripped, and re-seeded. This particular parking spot is too close to the stream, and has very poor drainage, resulting in it frequently becoming a mud bog. Access to the parking spot will be closed using large boulders.

The remaining over-wide segment of the river, downstream to cross section #694, will be treated using river narrowing techniques developed and demonstrated in Eleven-mile Canyon in 2004 and 2006. Large wood will be placed low in the channel along the river banks to capture sediment moving through the system and aggrade the bed. Extensive planting of sedge will be completed by volunteers from Trout Unlimited, the Rocky Mountain Field Institute's Pikes Peak Youth Corps, and the Coalition for the Upper South Platte. The goal of this work will be to reduce the width/depth ratio of this segment to between 25 – 30. In addition to the channel narrowing work, 6 -8 small micro vortex in-channel object cover features will be installed along the thalweg within this segment to provide velocity shelter through the riffle.


1
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A
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C
D
E
F
Date
Signature
Checked
FIN-UP
Habitat Consultants, Inc.
N
694LP
Parking
CR 112
Existing Island
Close Parking Space
695RP
695LP
Directional Felled Trees In Gully
Gully
Cross Vane
Alluvial Fan
696RP
696LP
The South Platte River channel is overwide throughout this segment, with W/D ratios >50. Width/Depth Ratio will be reduced to <30 Through the use of log vanes placed low in the Channel to accumulate sediment along the Edge of the Channel. Areas between the log Vanes will be planted with sedge to establish a vegetated stream bank and narrow the channel.
This work will be simiar to the techniques previously employed at the Springer Gulch (IFIM) site and the Camp Alexander Reach in Eleven-Mile Canyon.
Small side channel behind the island will be closed off and revegetated using transplanted willow.
0 50 100 150 200
Scale = 1" : 120 Ft.
Designed by
P.Gallagher / D.Butler
J.Crane / M.Purnell
Aquatic Habitat Restoration Plan
Checked by
Filename
HM_Restore_11.SKF
Prepared For CUSP / USFS
Date
February, 2010
Scale
1" = 120 Ft.
Fin-Up Habitat Consultants, Inc.
220 Illinois Ave.
Manitou Springs, CO 80829
(719) 332-2550
Happy Meadows - South Platte River
Reach 22 - Restoration Plan
Plan Drawing #27
Edition
Ver. 1.0
Sheet
1

Reach 22 – Enhancement Plan Drawing #28:

This drawing shows the upstream (southern) most segment of the project reach, from 10,100ft to 11,294ft along the longitudinal axis of the river. The proposed treatments are described working downstream from the private property boundary.

Two log/boulder J-Hook vanes will be installed along the right bank at the existing pool at the top of the reach. These features will reduce shear along the right bank, improve scour in the pool, and add velocity shelter and cover for trout.

A boulder cross vane will be installed near the top of the alluvial fan formed at the bottom of the gully (Dwg.#28 Grid E4) on the right side of the river to reduce flow energy and sediment from this source. The deposition bar extending into the river will be excavated and a new bank full bench constructed to stabilize the toe of the deposition fan. Extensive willow planting will completed on the bank-full bench and alluvial fan.

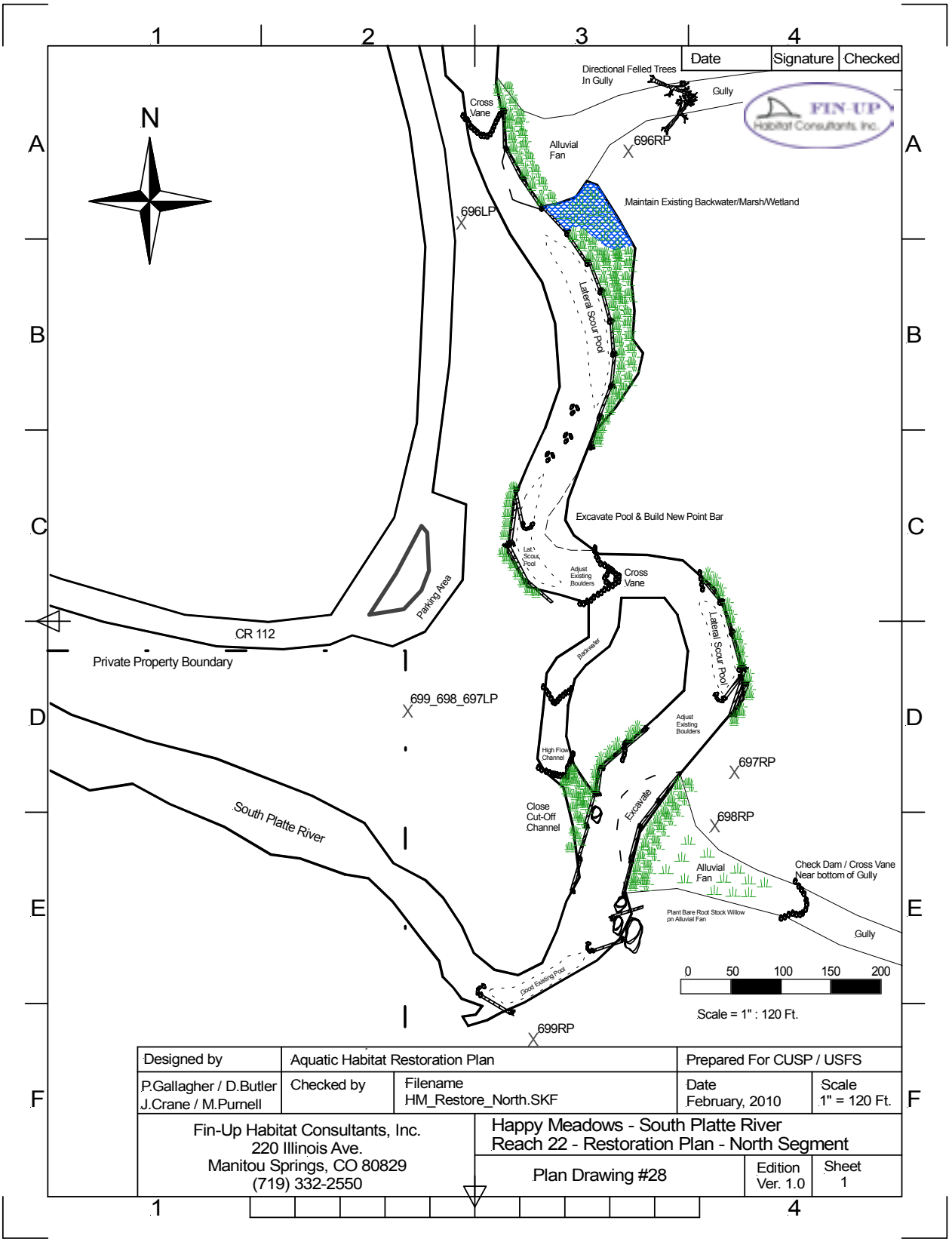
The ox-bow cut-off channel on the left side of the river, which was likely created by channel encroachment from the aforementioned gully, will be closed and revegetated. If the channel cannot be completely closed off, two boulder cross-vanes will be installed to control vertical stability of the channel, preventing further degrading of the river bed and preventing this channel from becoming the primary channel in this segment. The downstream terminus of the side channel will be preserved as a backwater pool to provide habitat and velocity shelter for young-of-the-year and juvenile trout.

The lateral scour pool along the right bank of the river (Dwg.#28 Grid D4) will be enhanced by installing a log/boulder J-Hook vane upstream of the initial scour point of this habitat. Immediately upstream of the J-Hook, a bank cover feature can be constructed using 2 -3 large trees. The unstable stream bank forming the left bank of the pool will be treated using log toe-slope bank full benching. A small boulder vane near the downstream tail of the pool will further reduce shear along the outside of the meander bend of the river.

A full channel boulder cross-vane can be installed downstream of the point where the ox-bow cut-off channel enters the main thread, mostly by reconfiguring existing boulders in the river. This feature will provide an important grade control along the river at this point, and improve depth at base flows of the backwater pool feature at the bottom of the closed side channel.

The left stream bank along the meander bend adjacent to the parking area (Dwg.#28 Grid C3) receives intense recreation use, and is in very poor condition. Bank full benching will be completed along the outside of the meander bend, and the pool will be excavated, with spoils used to build a new point bar on the inside of the meander bend. A log vane will be installed near the downstream tail of the pool to further protect the left stream bank and create additional complexity.

The river in Grid B3, downstream to the next large gully on the right, is very shallow and over-wide. Extensive log toe-slope bank-full benching will be used to reduce the width of the channel. Sedge and willow mats will be planted behind the bank full benches. The wetland feature upstream of the deposition fan of the gully at Grid A3 will not be disturbed. Micro vortex in-channel cover features will be installed along the thalweg within this segment to provide velocity shelter through the riffle.


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A
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E
F
Date
Signature
Checked
N
Directional Felled Trees In Gully
Gully
Cross Vane
Alluvial Fan
696RP
696LP
Maintain Existing Backwater/Marsh/Wetland
Lateral Scour Pool
Excavate Pool & Build New Point Bar
Lat. Scour Pool
Adjust Existing Boulders
Cross Vane
Parking Area
CR 112
Private Property Boundary
699_698_697LP
Backwater
Lateral Scour Pool
Adjust Existing Boulders
High Flow Channel
697RP
Close Cut-Off Channel
Excavate
698RP
South Platte River
Alluvial Fan
Check Dam / Cross Vane Near bottom of Gully
Plant Bare Root Stock Willow on Alluvial Fan
Gully
Good Existing Pool
699RP
0
50
100
150
200
Scale = 1" : 120 Ft.
Designed by
P.Gallagher / D.Butler
J.Crane / M.Purnell
Aquatic Habitat Restoration Plan
Checked by
Filename
HM_Restore_North.SKF
Prepared For CUSP / USFS
Date
February, 2010
Scale
1" = 120 Ft.
Fin-Up Habitat Consultants, Inc.
220 Illinois Ave.
Manitou Springs, CO 80829
(719) 332-2550
Happy Meadows - South Platte River
Reach 22 - Restoration Plan - North Segment
Plan Drawing #28
Edition
Ver. 1.0
Sheet
1

Sportsman's Paradise Diversion Dam Removal and Reconfiguration:

The following drawings detail the existing low head dam and diversion structure on the Sportsman's Paradise / Forest Service property boundary. The existing dam will be removed, and the river channel reconfigured to allow for aquatic organism passage between Reach 21 and Reach 22. A new diversion structure, and an additional cross vane will be installed in the channel to tie the different grades together, and assure continued delivery of water to the Sportsman's Paradise pond on the west side of the river approximately ½ mile downstream.

The demolition of the existing dam will be done in a manner to assure that there is not a significant movement of stored sediments above the structure downstream into Reach 21 and 20. The newly configured channel upstream of the new diversion structure will be defined using large wood and boulder to create a stable river bank toe slope. These riparian benches will be established at the bank-full elevation, with extensive plantings of willow clumps behind the log toe-slope features. The mud flats that have formed behind the existing structure will be planted with sedge and willow. It is expected that these areas will be periodically inundated during high flow events, and a high flow relief channel will remain along the south side of the mud flat to provide over-flow capacity in the channel. Downstream of the existing dam, the outlier threads of the multi-braided channel will be closed off and revegetated. Additionally, a short segment (<100ft) of Vermillion Creek, from the road to the confluence of the South Platte River, will be re-aligned and restored.



The diversion structure at the upstream boundary of Reach 21 on the S. Platte River in Sportsman's Paradise.

SPORTMEN'S PARADISE

IRRIGATION DIVERSION RECONSTRUCTION & HABITAT ENHANCEMENT PROJECT

PRELIMINARY–NOT FOR CONSTRUCTION

PREPARED FOR:

COALITION for the UPPER SOUTH PLATTE
PO BOX 726
LAKE GEORGE, CO 80627

PROJECT LOCATION:

SOUTH PLATTE RIVER
NE 1/4; NE 1/4 Section 8, T12S, R71W
PARK COUNTY, COLORADO
LAT: 39.0266 / LONG:105.3507

INDEX OF DRAWINGS:

1. OVERALL PLAN VIEW
2. CHANNEL PROFILE
3. TYPICAL CROSS SECTIONS
4–11 CROSS SECTIONS
12–14 DETAILS

PREPARED BY:

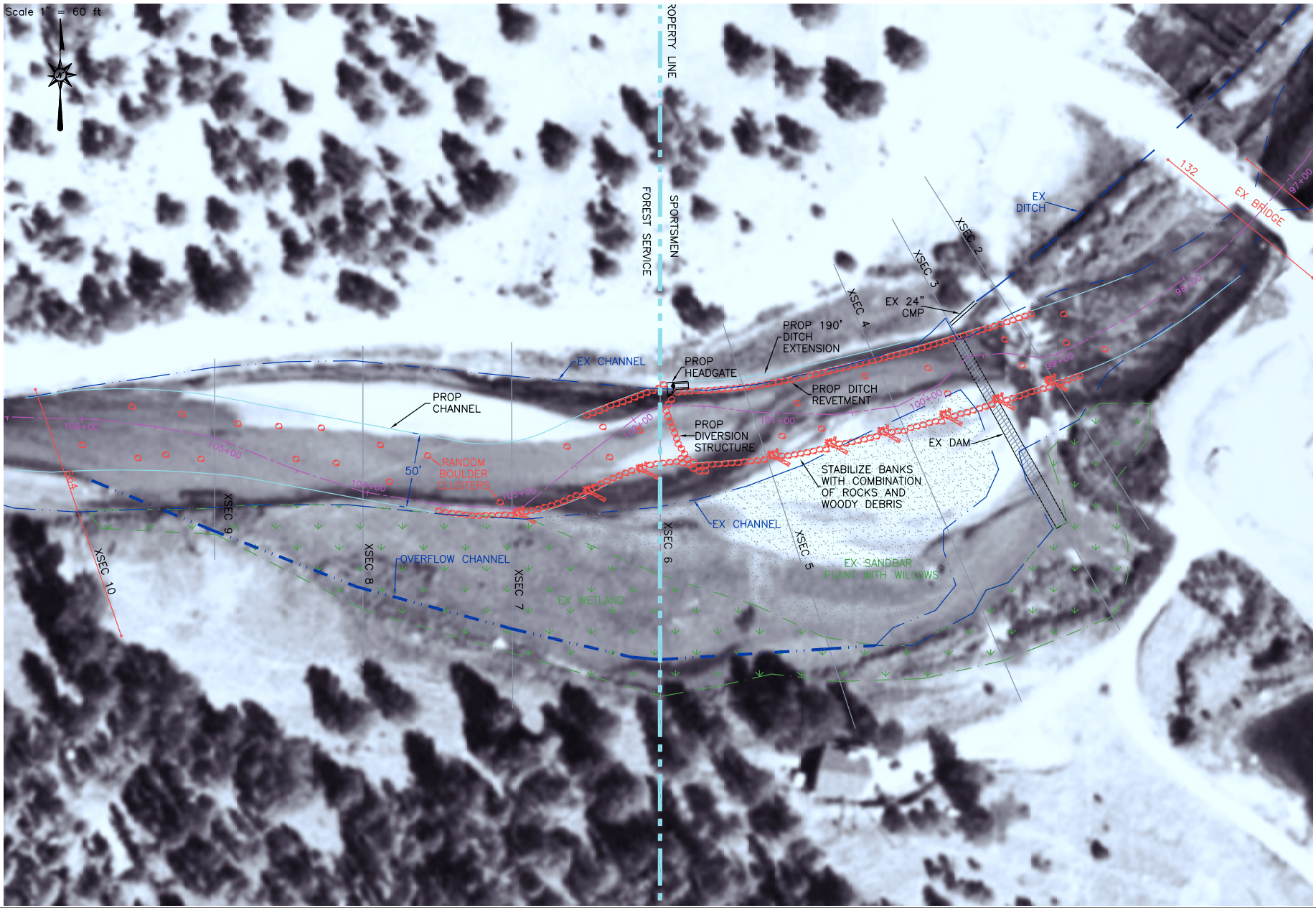
CRANE ASSOCIATES

29163 STINGLEY GULCH ROAD
HOTCHKISS, CO 81419
(970) 872–2433

MAY 2009

NOTES:

1. Existing stream cross section data was obtained on site on March 20, 2009
2. Flow data for the site was obtained from the "South Platte River near Lake George" gage (PLAGEOCO) operated by the Colorado Division of Water Resources.
3. These plans are conceptual in nature and intended to be used for comments by stakeholders.



Rev.	Description	Date
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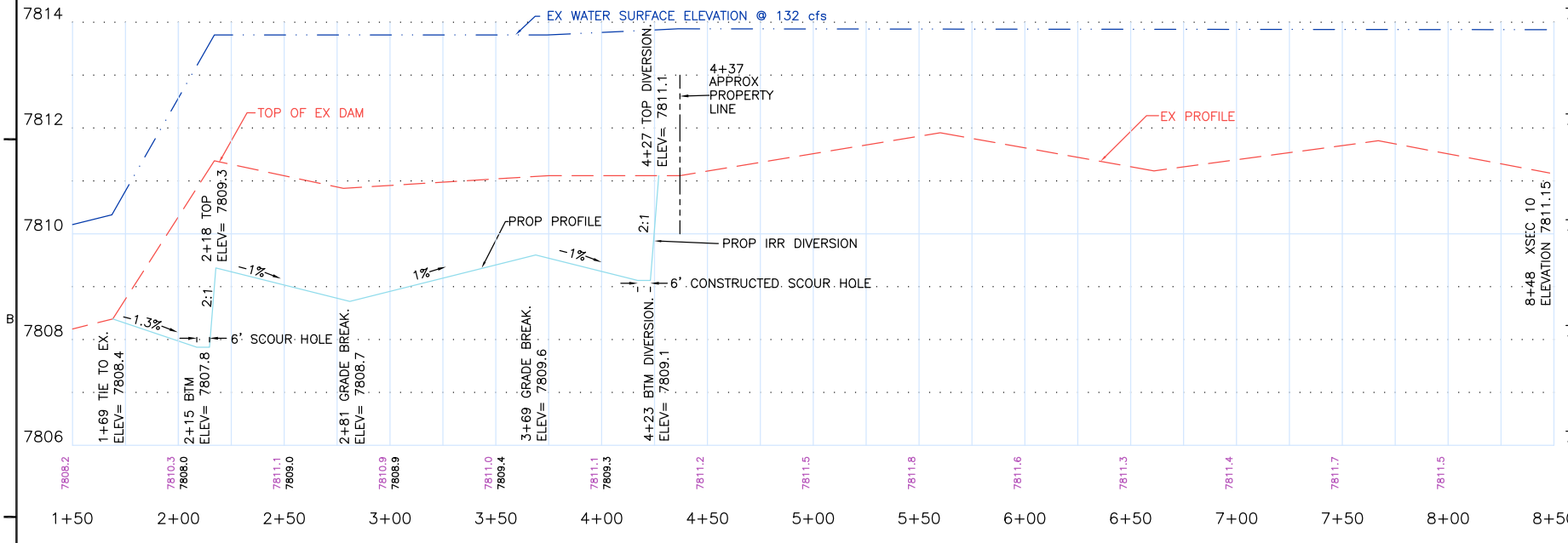
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Drawn by: JPC
Checked by:
Reviewed by:
Submitted by:
Design file no:
Drawing Code:
File name:
Plot date:
Plot scale:

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29163 Stingly Gulch Road
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Phone (970) 872-2433

SPORTSMAN'S PARADISE
IRRIGATION RELOCATION & HABITAT ENHANCEMENT PROJECT
PARK COUNTY, COLORADO
PLAN VIEW

Sheet reference number:

Sheet 1 of 14



CHANNEL PROFILE

HORIZONTAL SCALE:1"=50'
VERTICAL SCALE:1"=2'

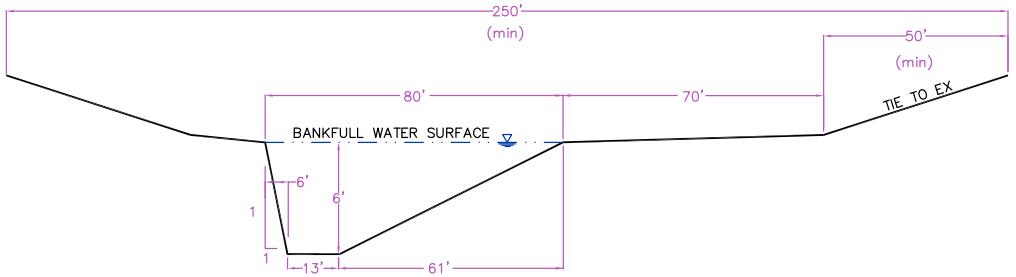
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Submitted by:
Old by:
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Plot scale:

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HABITAT ENHANCEMENT PROJECT
PARK COUNTY, COLORADO
CHANNEL PROFILE

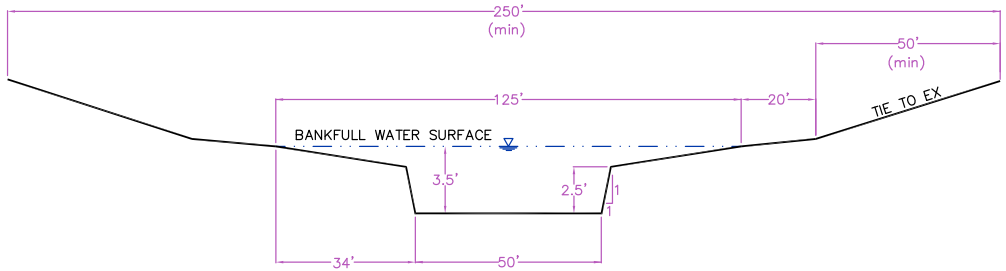
Sheet reference number:
Sheet 2 of 14



Q=700 cfs
A=280 sq ft
P=83 ft
R=3.37 ft
W=80 ft
V=2.50 ft/sec
S=.001 ft/ft

TYPICAL POOL CROSS SECTION

NTS



Q=700 cfs
A=165.3 sq ft
P=67.9 ft
R=2.43 ft
W=125 ft
V=4.23 ft/sec
S=.005 ft/ft

TYPICAL RIFFLE CROSS SECTION

NTS

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	REVISIONS PER HOMEOWNERS MEETING	6/15/09	6/09

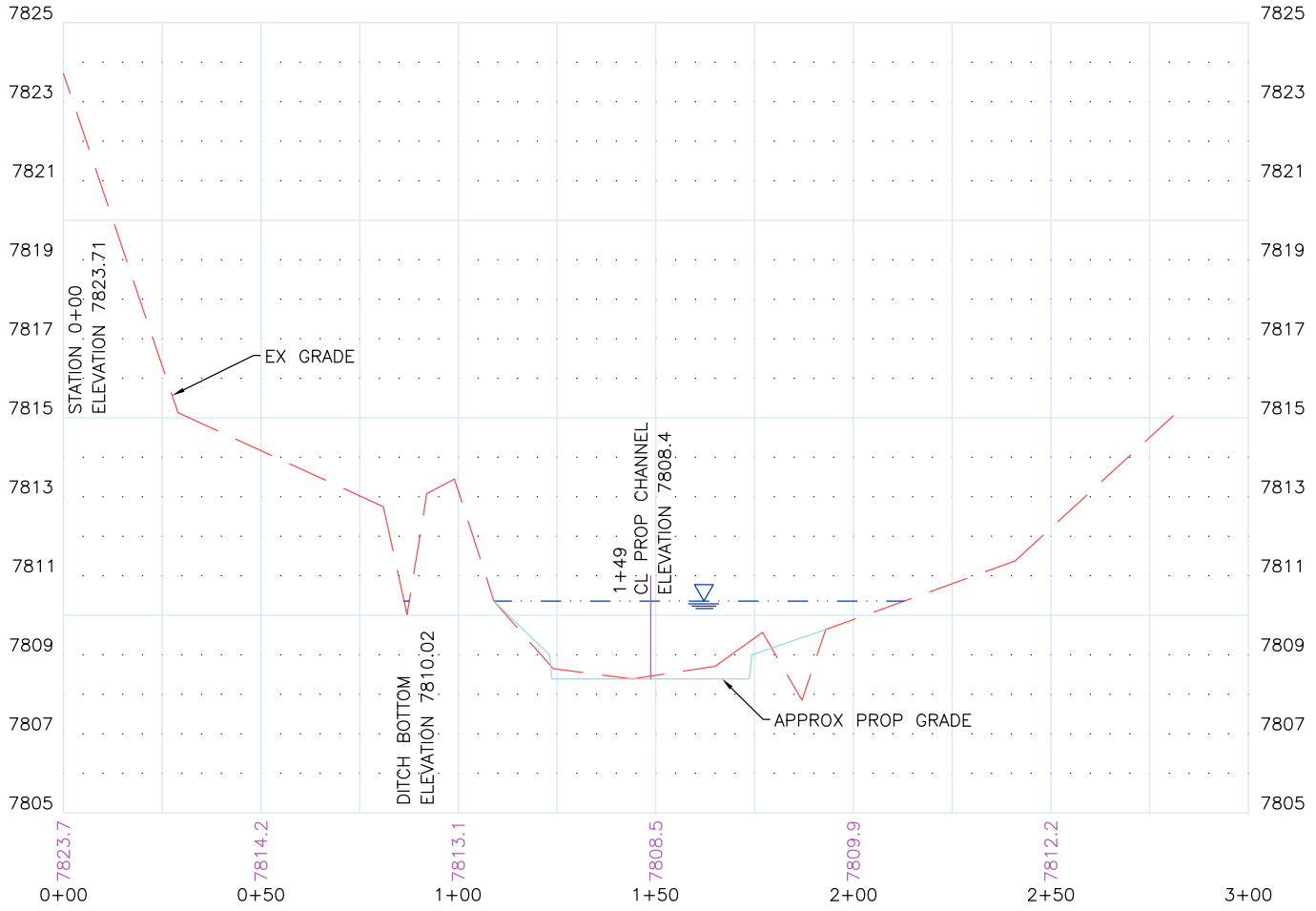
CRANE ASSOCIATES
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Phone (970) 872-2433

Designed by: JEFF CRANE
Drawn by: JPC
Reviewed by:
Submitted by:
Date: May, 2009
Design file no:
Drawing Code:
File name:
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Plot scale:

SPORTSMAN'S PARADISE
IRRIGATION RELOCATION &
HABITAT ENHANCEMENT PROJECT
PARK COUNTY, COLORADO
PROP TYPICAL CROSS SECTIONS

Sheet reference number:

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CROSS SECTION 2

1+69

HORIZONTAL SCALE:1"=30'

VERTICAL SCALE:1"=3'

Symbol	REVISIONS PER HOMEOWNERS MEETING 6/15/09 Description	6/09 Date Approved

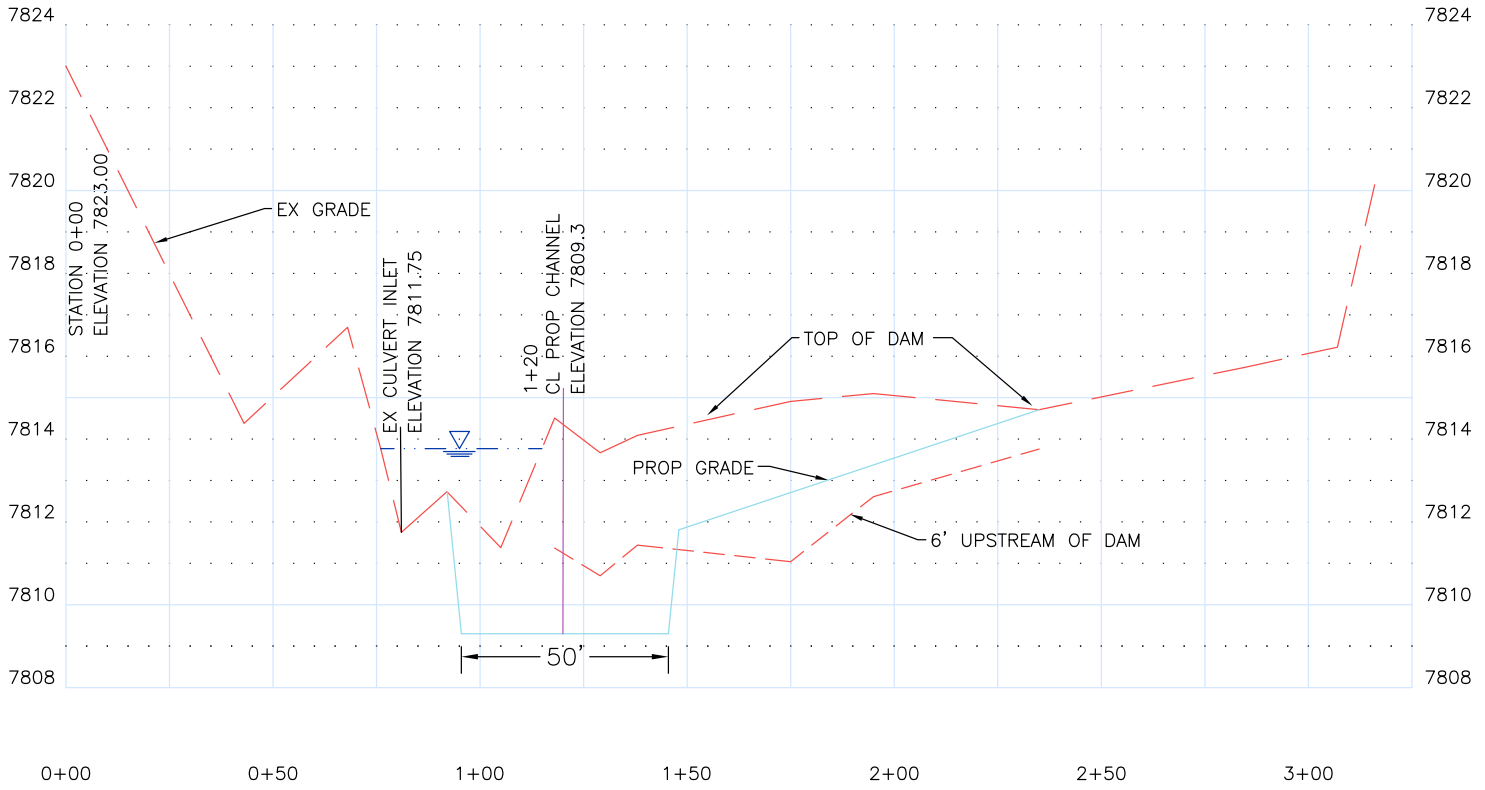
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Hotchkiss, Colorado 81419
Phone (970) 872-2433

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Dwn by: JPC	Design file no:	
Chkd by:	Drawing Code:	
Reviewed by:		
Submitted by:	File name:	
	Plot date:	
	Plot scale:	

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PARK COUNTY, COLORADO
CHANNEL CROSS SECTIONS

Sheet reference number:

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CROSS SECTION 3

2+17

HORIZONTAL SCALE:1"=30'
VERTICAL SCALE:1"=3'

Symbol	Description	Date Approved
	REVISIONS PER HOMEOWNERS MEETING 6/15/09	6/09

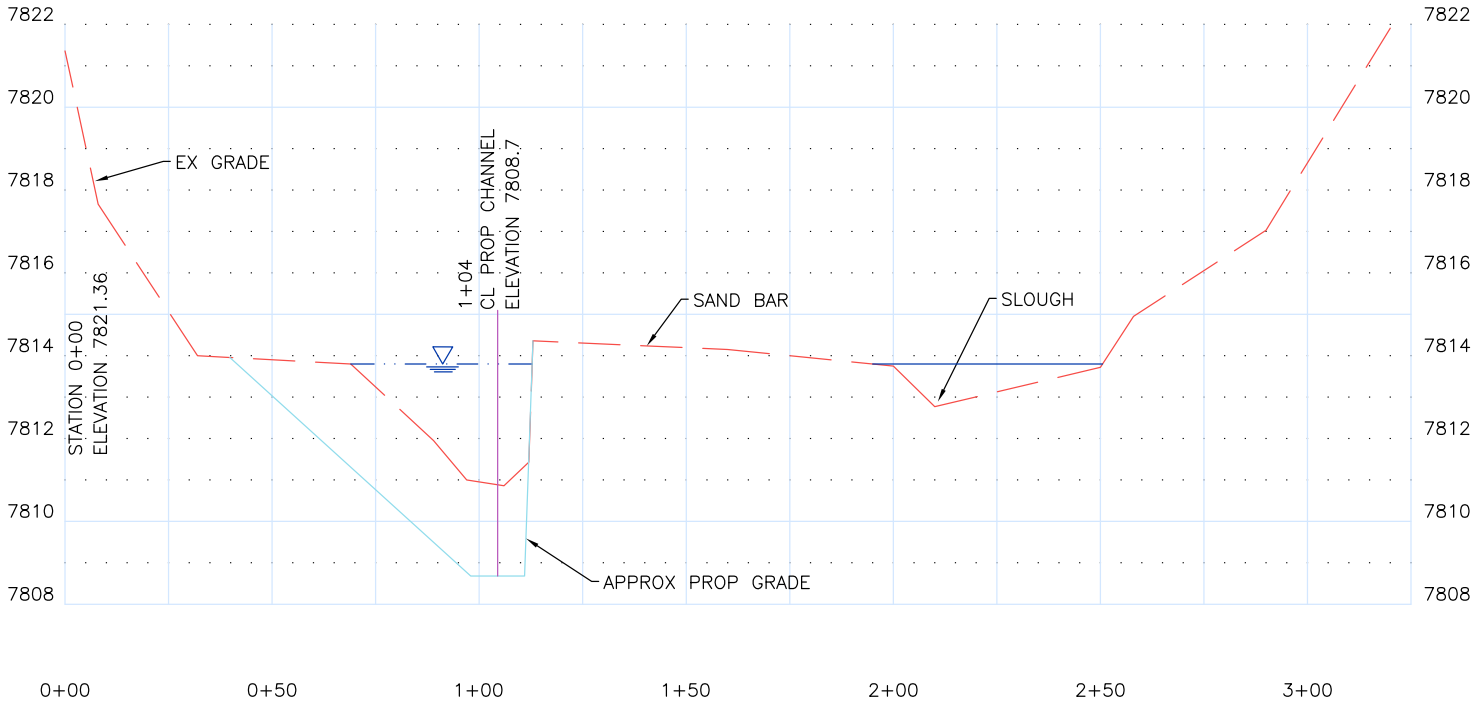
CRANE ASSOCIATES
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Designed by: JEFF CRANE
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Checked by:
Reviewed by:
Submitted by:
Date: May, 2009
Design file no:
Drawing Code:
File name:
Plot date:
Plot scale:
Rev.

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IRRIGATION RELOCATION & HABITAT ENHANCEMENT PROJECT
PARK COUNTY, COLORADO
CHANNEL CROSS SECTIONS

Sheet reference number:

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CROSS SECTION 4

2+78

HORIZONTAL SCALE:1"=30'
VERTICAL SCALE:1"=3'

Rev.	Description	Date	Approved
	REVISIONS PER HOMEOWNERS MEETING	6/15/09	

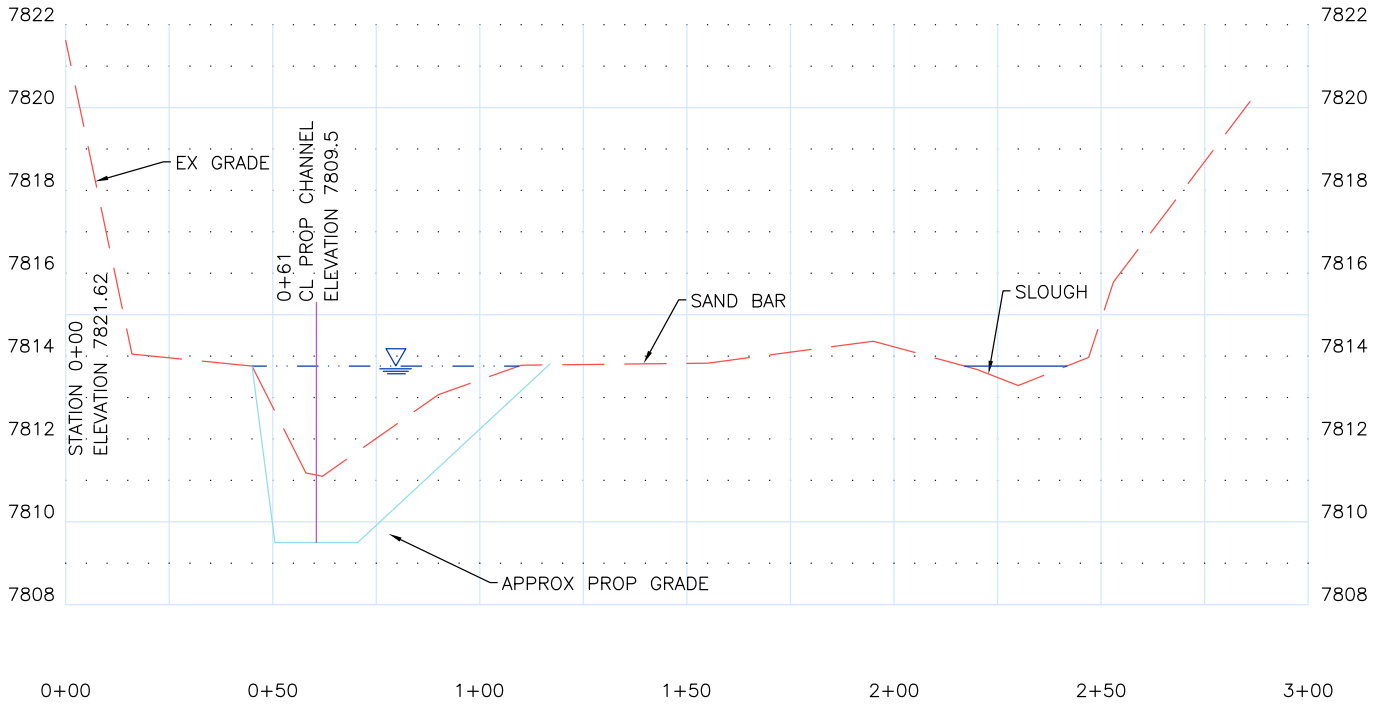
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Phone (970) 872-2433

Designed by: JEFF CRANE
Drawn by: JPC
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Submitted by:
Date: May, 2009
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File name:
Plot date:
Plot scale:

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PARK COUNTY, COLORADO
CHANNEL CROSS SECTIONS

Sheet reference number:

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CROSS SECTION 5

3+75

HORIZONTAL SCALE:1"=30'

VERTICAL SCALE:1"=3'

Symbol	Description	Date	Approved
	REVISIONS PER HOMEOWNERS MEETING	6/15/09	6/09

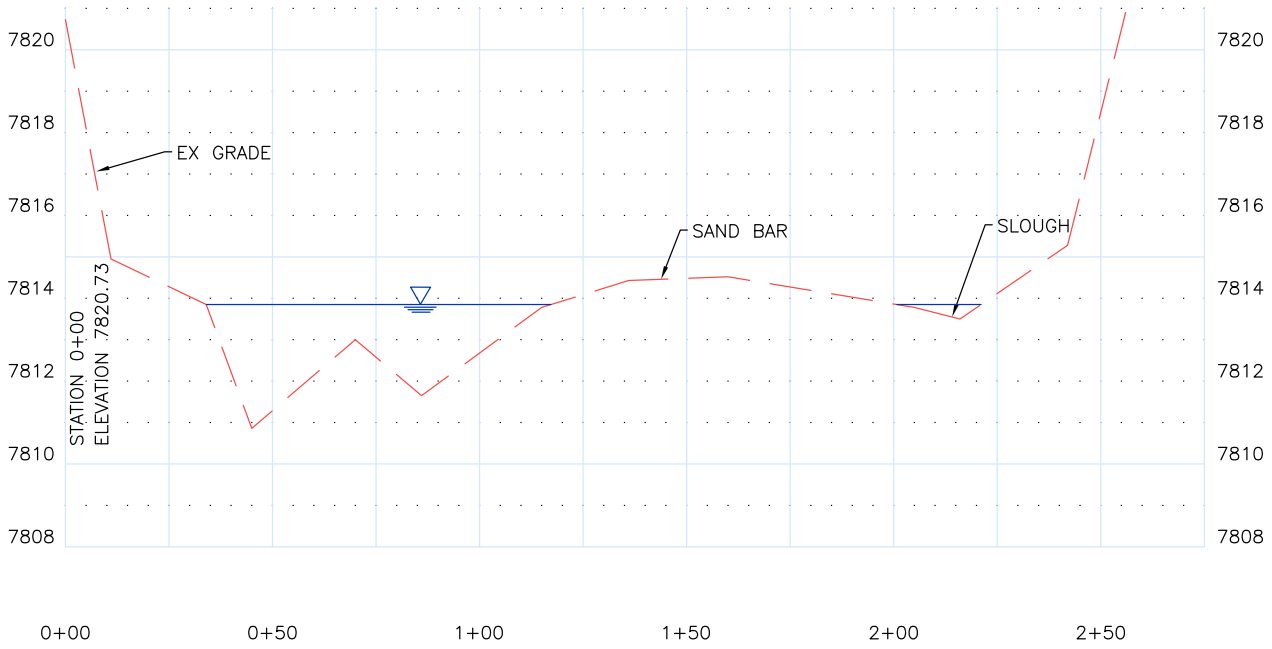
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Submitted by:
Date: May, 2009
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PARK COUNTY, COLORADO
CHANNEL CROSS SECTIONS

Sheet reference number:

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CROSS SECTION 6

4+37 (ON PROPERTY LINE)

HORIZONTAL SCALE:1"=30'

VERTICAL SCALE:1"=3'

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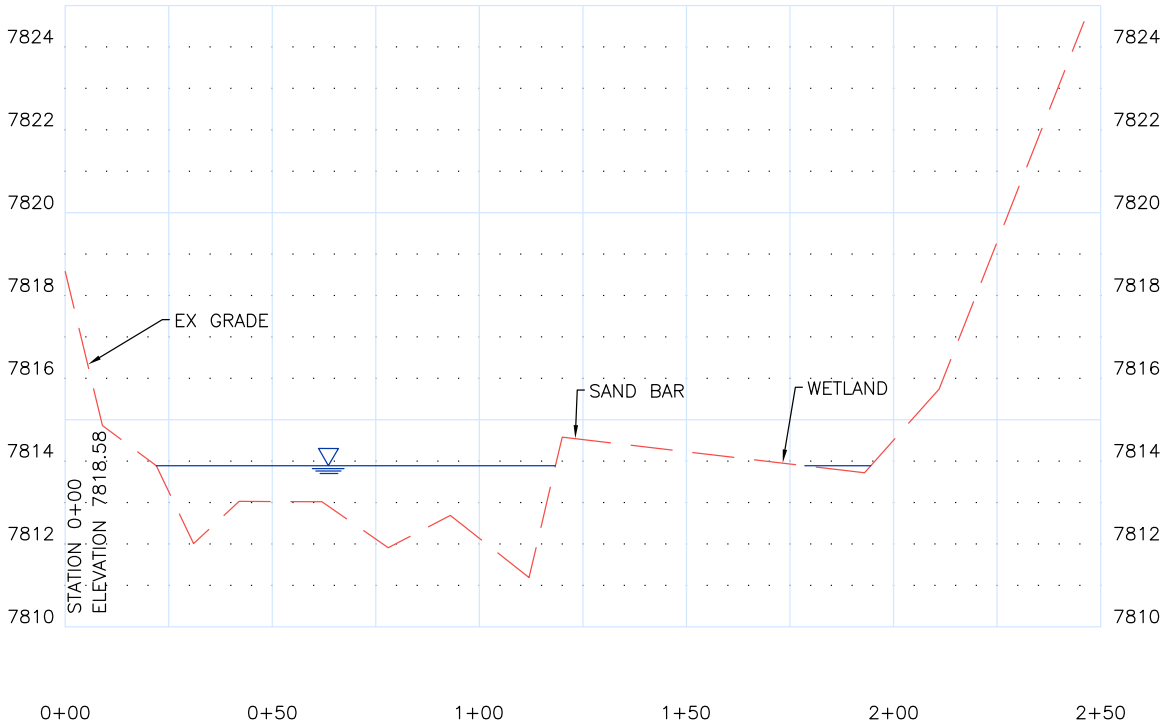
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Drawn by: JPC
Reviewed by:
Checked by:
Submitted by:

Date: May, 2009
Design file no:
Drawing Code:
File name:
Plot date:
Plot scale:
Rev.

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IRRIGATION RELOCATION & HABITAT ENHANCEMENT PROJECT
PARK COUNTY, COLORADO
CHANNEL CROSS SECTIONS

Sheet reference number:

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CROSS SECTION 7

5+60

HORIZONTAL SCALE:1"=30'
VERTICAL SCALE:1"=3'

Symbol	REVISIONS PER HOMEOWNERS MEETING 6/15/09 Description	6/09 Date Approved

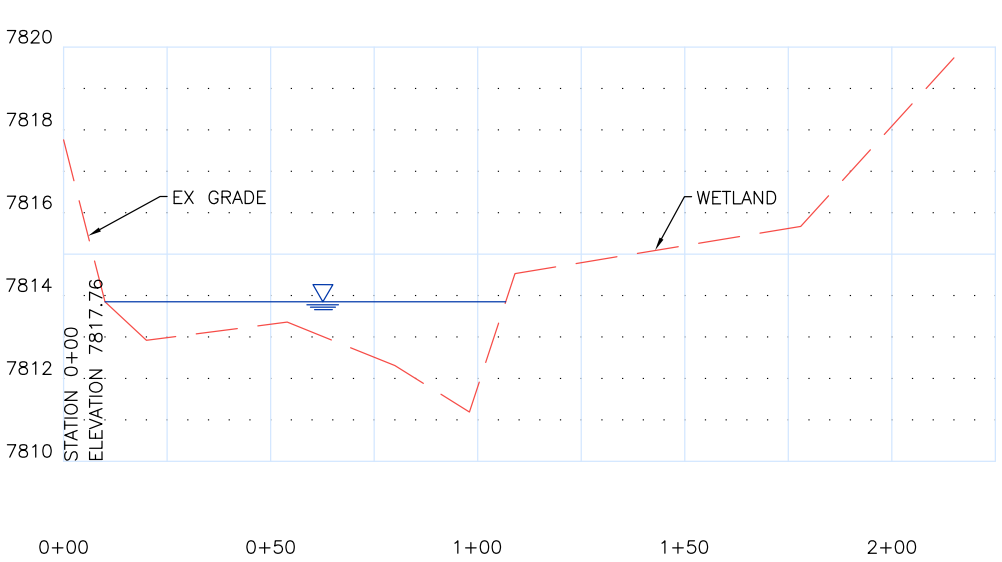
CRANE ASSOCIATES
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Phone (970) 872-2433

Designed by: JEFF CRANE
Drn by: JPC
Chkd by:
Reviewed by:
Submitted by:
Date: May, 2009
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File name:
Plot date:
Plot scale:
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PARK COUNTY, COLORADO
CHANNEL CROSS SECTIONS

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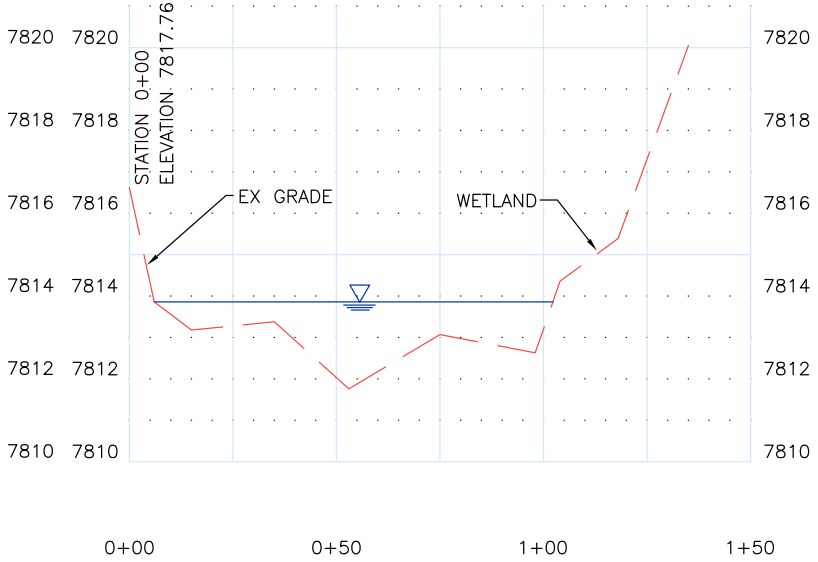
Sheet 9 of 14



CROSS SECTION 8

6+61

HORIZONTAL SCALE:1"=30'
VERTICAL SCALE:1"=3'



CROSS SECTION 9

7+67

HORIZONTAL SCALE:1"=30'
VERTICAL SCALE:1"=3'

REVISIONS PER HOMEOWNERS MEETING 8/15/09

CRANE ASSOCIATES
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Hotchkiss, Colorado 81419
Phone (970) 872-2433

SPORTSMAN'S PARADISE
IRRIGATION RELOCATION &
HABITAT ENHANCEMENT PROJECT
PARK COUNTY, COLORADO
CHANNEL CROSS SECTIONS

Sheet reference number:

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CROSS SECTION 10

8+48

HORIZONTAL SCALE:1"=30'

VERTICAL SCALE:1"=3'

Symbol	Description	Date	Approved
	REVISIONS PER HOMEOWNERS MEETING 6/15/09	6/09	

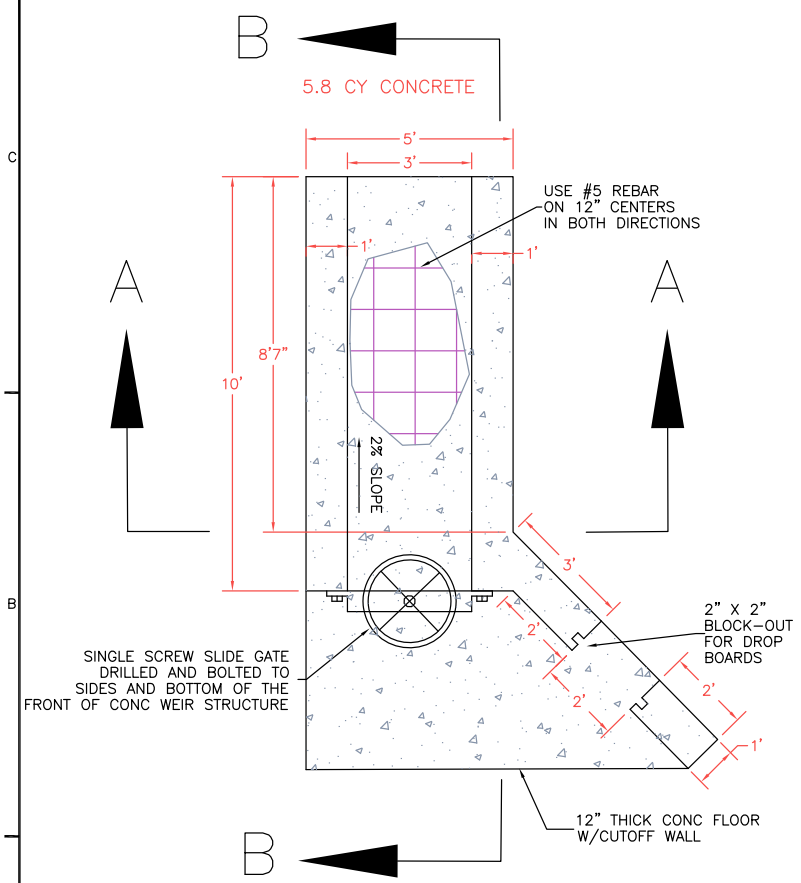
CRANE ASSOCIATES
29163 Stingly Gulch Road
Hotchkiss, Colorado 81419
Phone (970) 872-2433

Designed by: JEFF CRANE
Drn by: JPC
Chkd by:
Reviewed by:
Submitted by:
Date: May, 2009
Design file no:
Drawing Code:
File name:
Plot date:
Plot scale:
Rev.

SPORTSMAN'S PARADISE
IRRIGATION RELOCATION & HABITAT ENHANCEMENT PROJECT
PARK COUNTY, COLORADO
CHANNEL CROSS SECTIONS

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Sheet 11 of 14



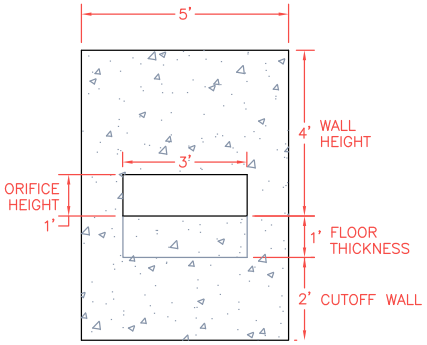
PLAN VIEW

1"=3'

NOTES:

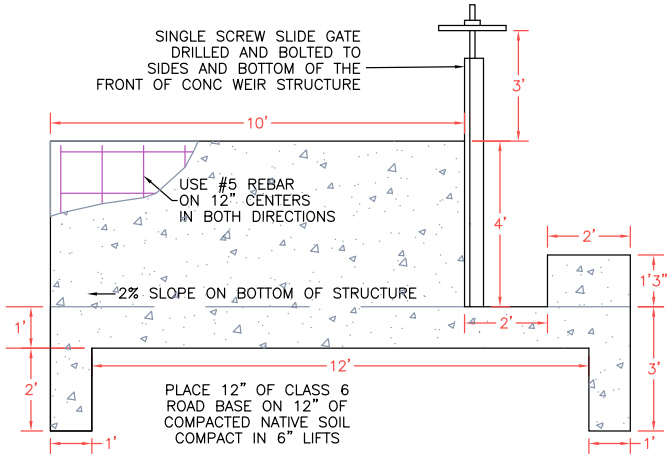
All work shall conform to Construction Specicfications 32, Concrete. In addition, the following is required:

1. The concrete shall a 28 day compressive strength of 4000 psi and contain a minimum of 6 sacks of Type II (or equal) cement per cubic yard with a 5%–8% air entraining and slump between 3"–5".
2. Reinforcing bar spacing is center to center of bars. Double mat reinforcing bars shall have a bar cover clear distance between the surface of the bars and the surface of the concrete of 2 inches for formed and top surfaces and 3 inches for surfaces placed against earth.
3. Reinforcing bars shall be continuous or spliced from floors, walls, and footers into adjacent walls, floors, and/or footers. Splice lengths shall be 19" for #5 bars and 23" for #6 bars.
4. Snap cone ties (3/4") shall be used for forming. All forms shall be removed prior to placing backfill.
5. All exposed edges shall be chamfered 3/4". All concrete shall be finished straight, smooth, clean, and neat.
6. All concrete shall be consolidated with a concrete mechanical vibrator.
7. All backfill material shall be minus 3" sands and gravels obtained from river excavations compacted in 12" lifts with a hand directed vibrating plate compactor.
8. The rock for riprap and for the weir structure shall be sound and angular with a minimum density of 2.5. The maximum dimension of the rock shall be no more than 2.5 times its least dimension. The rock shall be well graded and range in size from 6" min diameter to 60" max diameter. At least 60% of the rock shall be larger than 24" diameter.
9. The concrete shall be housed or blanketed and at no time shall the temperature of the concrete get below 40 degrees F.



SECTION A–A

1"=3'



SECTION B–B

1"=3'

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	REVISIONS PER HOMEOWNERS MEETING	6/15/09	6/09

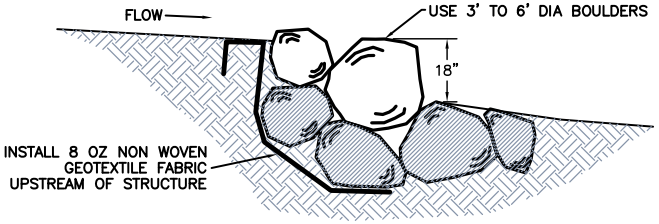
CRANE ASSOCIATES
29163 Stingly Gulch Road
Hotchkiss, Colorado 81419
Phone (970) 872-2433

Designed by: JEFF CRANE
Drawn by: JPC
Reviewed by:
Old by:
Submitted by:
Date: May, 2009
Design file no:
Drawing Code:
File name:
Plot date:
Plot scale:

SPORTSMAN'S PARADISE
IRRIGATION RELOCATION &
HABITAT ENHANCEMENT PROJECT
PARK COUNTY, COLORADO
HEADGATE DETAILS

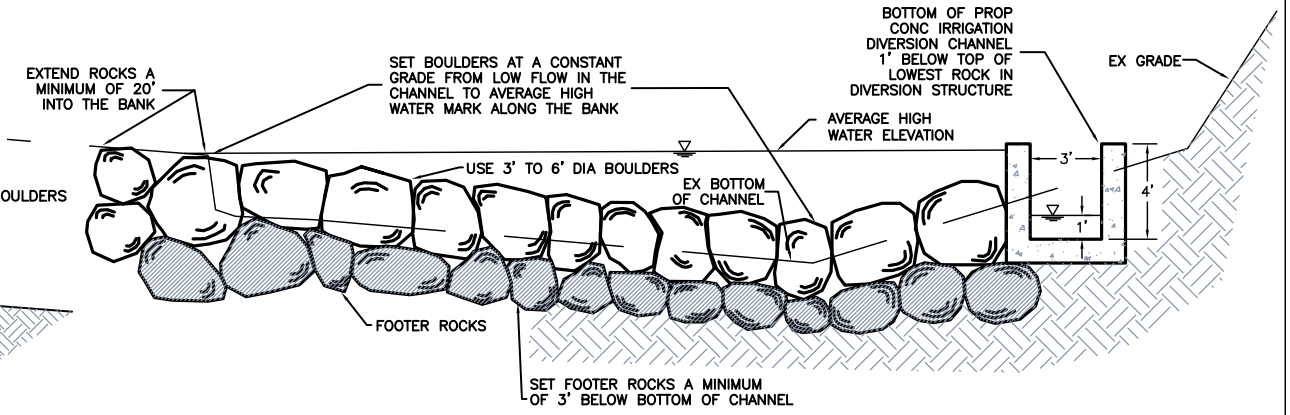
Sheet reference number:

Sheet 12 of 14



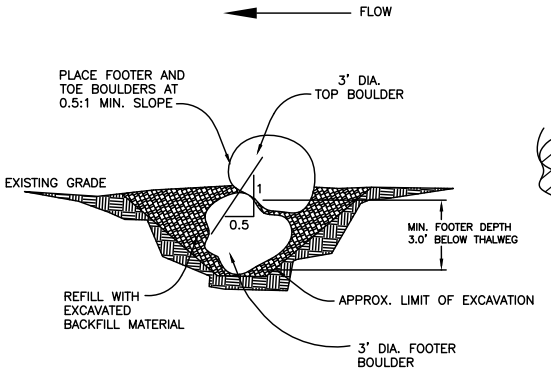
DIVERSION STRUCTURE PROFILE

NTS

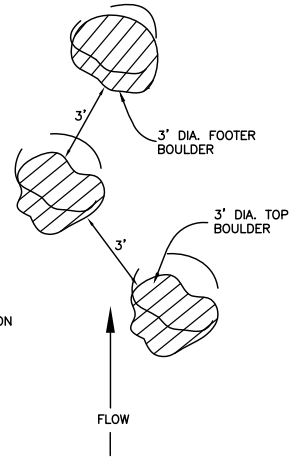


DIVERSION STRUCTURE CROSS SECTION

NTS



NOTE: OFFSET FOOTER BOULDER IN THE DOWNSTREAM DIRECTION, PERPENDICULAR TO FLOW



NOTE: SPACE BOULDERS A MIN. OF 1 BOULDER WIDTH IN DIAMOND OR TRIANGLE PATTERN.
NOTE: OFFSET BOULDERS FROM FLOW LINE.

BOULDER CLUSTER DETAIL

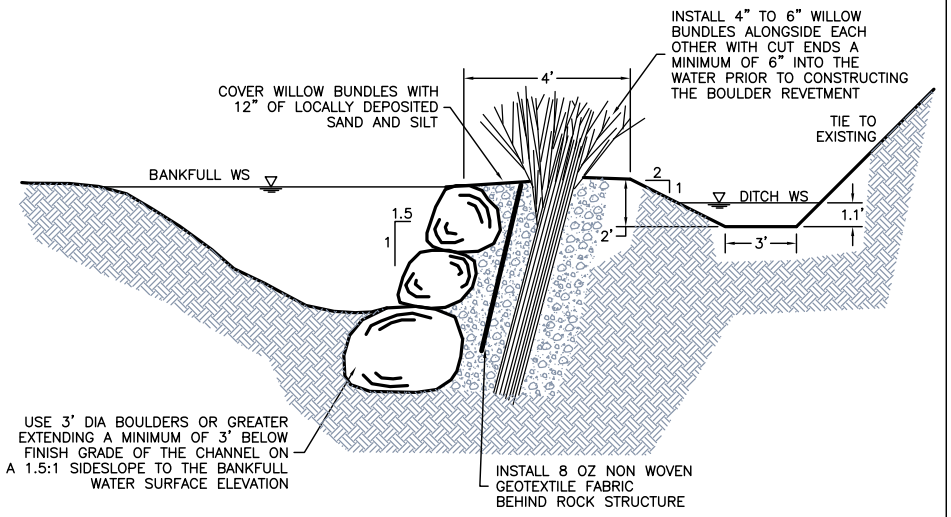
NTS

BOULDER CLUSTER PLAN VIEW DETAIL

NTS

TYPICAL BOULDER CLUSTER

NTS



DITCH & BANK REVETMENT DETAIL

NTS

Symbol	Description	Date Approved
	REVISIONS PER HOMEOWNERS MEETING 6/15/09	6/09

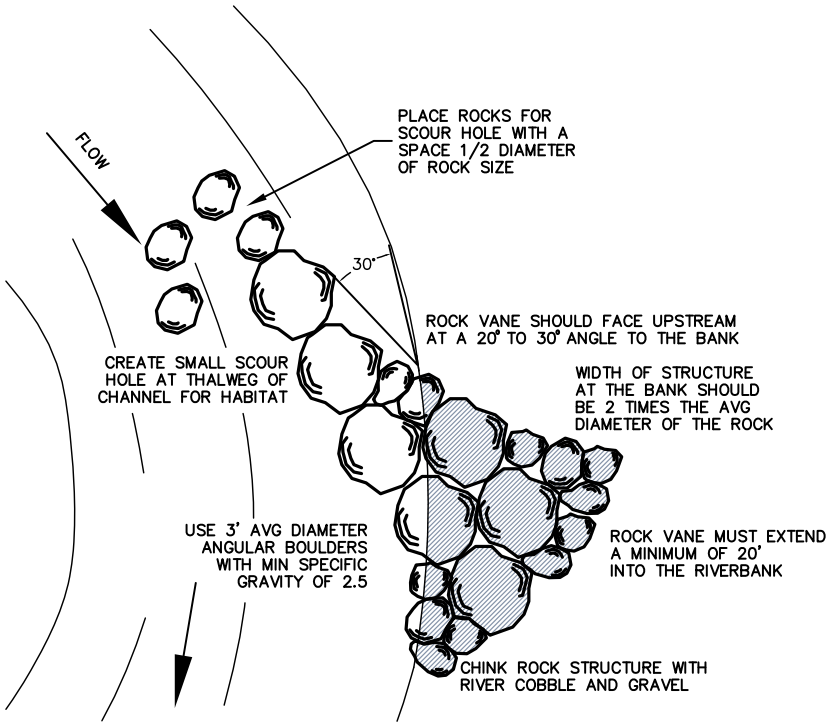
CRANE ASSOCIATES
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Designed by: JEFF CRANE
Drawn by: JPC
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Date: May, 2009
Design file no:
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File name:
Plot date:
Plot scale:
Rev.

SPORTSMAN'S PARADISE
IRRIGATION RELOCATION & HABITAT ENHANCEMENT PROJECT
PARK COUNTY, COLORADO
DIVERSION STRUCTURE DETAILS

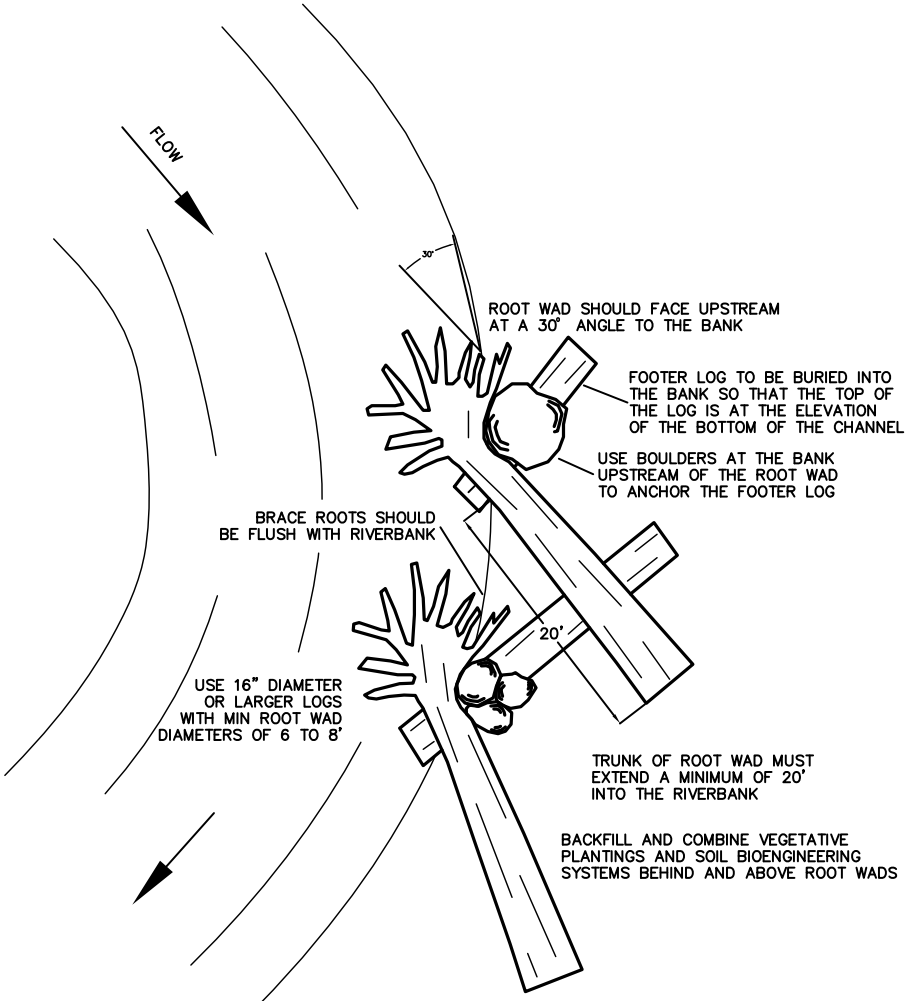
Sheet reference number:

Sheet 13 of 14



J–HOOK DETAIL

NTS



ROOT WAD REVETMENT DETAIL

NTS

Symbol	Description	Date Approved
	REVISIONS PER HOMEOWNERS MEETING 8/15/09	9/09

CRANE ASSOCIATES
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Designed by: JEFF CRANE
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Design file no:
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Rev.

SPORTSMAN'S PARADISE
IRRIGATION RELOCATION & HABITAT ENHANCEMENT PROJECT
PARK COUNTY, COLORADO
REVETMENT DETAILS

Sheet reference number:

Sheet 14 of 14

Glossary of Terms:

Benthic Zone - The benthic zone is the lowest level of a body of water. It is inhabited mostly by organisms that tolerate cool temperatures and low oxygen levels, called benthos or benthic organisms.

Cascade - A meso-habitat type. Cascades are the steepest riffle habitat types, in terms of gradient, in streams. These riffles consist of alternating small waterfalls and shallow pools. These habitats may appear to have the characteristics of a Step-pool system. Cascades are characterized by swift current flows and often have exposed rocks and boulders above the water surface, which creates considerable turbulence and surface agitation. The substrate normally found in cascades is bedrock or accumulations of boulders.

Cover - Locations where fish prefer to rest, hide and feed are called cover. Cover serves to visually isolate fish, which increases the number of territories in the same space. Additionally, cover can create areas of reduced velocities providing critical resting and feeding stations for fish. The amount of cover available in a stream can influence the production of a number of fish and invertebrate species.

Cross-Vane - A structure spanning the entire width of the channel, constructed of large boulders and/or large wood, that provides vertical stability, increased scour, increased stage upstream, and reduced stream power. This structure type is commonly used as a diversion structure for irrigation ditches, as well as for treating active down cutting and head cuts in the stream channel.

Embeddedness - The degree to which the interstitial spaces between larger substrate particles are filled with finer sediments. Embeddedness tends to armor the substrate, thus limiting available habitat for benthic dwelling macroinvertebrates and spawning habitat for salmonids.

Glide - A meso-habitat type. Glides are those portions of streams which have relatively wide uniform bottoms, low to moderate velocity flows, lack pronounced turbulence, and have substrates usually consisting of either cobble, gravel or sand. Glides are usually described as stream habitat with characteristics intermediate between those of pools and riffles. These habitats are commonly found in the transition between a pool and the head of a riffle, however they are occasionally found in low gradient stream reaches with stable banks and no major flow obstructions.

Head-Cut - An area of active down-cutting in the channel where a river or stream is eroding down to a new, lower flood plain.

Intermittent - An intermittent stream is one that only flows for part of the year.

Lotic - Of, relating to, or living in moving water such as streams and rivers.

Meso-Habitat - A channel scale habitat form. Typically a pool, riffle, rapid, cascade or glide habitat. A meso-habitat occupies the entire width of the stream channel, and with few exceptions (most notably plunge pools in high gradient step-pool systems) is at least as long as the channel is wide.

Micro-Habitat - Micro habitats are small, site specific habitats within a meso-habitat form, and may include spawning redds, in-stream or overhead cover, and velocity shelters.
Micro-Vortex - A small rock cluster structure that replicates pocket water habitat in riffles, rapids and cascades.

Over-Wintering Habitat - Areas of a stream or water body exhibiting depths that may sustain a population through the winter months.

Perennial - A perennial stream is one that flows year round.

Pocket Water - A micro-habitat type. Pocket water habitats are typically found in higher gradient riffles, rapids, and cascades with large cobble, boulder, and large woody debris. These pocket water habitats provide small areas for velocity shelter and cover within these fast-water habitat forms.

Pool - A meso-habitat type. Pools are channel segments exhibiting areas of scour and deposition where the water is deeper and slower moving.

Primary Producers - Primary producers are those organisms in an ecosystem that produce biomass from inorganic compounds. In almost all cases these are photosynthetically active organisms.

Rapid - A meso-habitat type. Rapids are riffles associated with high gradients (greater than 4%) with swiftly flowing (greater than 1.5 ft/sec), moderately deep, and highly turbulent waters. These riffles are generally associated with boulder substrates, which protrude through the surface of the water.

Residual Pool Depth (RPD) - Residual pool depth is estimated as the depth of water which would be retained in a pool under highly reduced flows or the stoppage of flows in the stream. This area of pools would be utilized by fish in low flow conditions. Residual pools would also provide habitat for overwintering of fish when ice buildup restricts movement in riffles or glides between pools. Residual pool depth is calculated by locating and measuring the greatest depth of the pool at the riffle crest (deepest point of the downstream boundary cross-section of the pool), and subtracting this value from the greatest measured depth of the pool habitat. The difference in these measurements is described as the RPD. RPD may be difficult to determine in some habitats, particularly dam pools with woody debris structural associations. In many of these habitat units, the RPD may actually be a very low value or zero due to water flowing through these debris dams.

Riffle - A meso-habitat type. Riffles are those areas of the stream in which turbulence in the water column is the major identifying characteristic, as a result of relatively high gradients. These units contain moderately deep to shallow, swift flowing water, and are characterized by boulder or cobble substrates. Riffles are very important for macroinvertebrate production, due to the availability of light and oxygen, and the corresponding vegetative growth on the bottom substrate. The quality of riffles, including low sediment deposition and resulting embeddedness can have a direct impact on fish populations. The cleaner and healthier the vegetative growth and benthic macroinvertebrate community, the more food there is for the fish population.

Salmonids - Salmonidae is a family of ray-finned fish, the only family of order Salmoniformes. It includes the well-known salmons and trouts; the Atlantic salmons and trouts of genus Salmo give the family and order their names.

Subfamily - Salmoninae
Brachymystax - lenoks
Oncorhynchus - Pacific salmon and trout
Salmo - Atlantic salmon and trout
Salvelinus - Char and trout (Brook trout, Lake trout)

Substrate - Stream substrate (sediment) is the material that rests at the bottom of a stream.

Thermal Refugia - Micro habitats found in streams and lakes that provide thermal protection for cold water species such as trout. These may include shaded areas, cool water springs, and deep water habitats.

Toe-Slope - The foot, or bottom, of the sloping bank of a stream. This is the area of the highest sheer stress and erosion potential on a stream bank, and is typically the point of failure leading to mass wasting and collapse.

References:

Azuma, David and David Fuller, 1994. Repeatability of the USFS Pacific SW Region Habitat Classification Procedure. USFS Pacific Southwest Experiment Station, Berkely, CA. Presentation Paper for the 1994 National American Fisheries Society Meeting.

Bisson, P.A., J.L. Nielson, R.A. Palmason, and L.E. Grove. 1981. A system for mapping habitat types in small streams, with examples of habitat utilization by salmonids during low stream flow. p. 62-73. In: N.B. Armantrout (ed.). Acquisition and utilization of aquatic habitat. Western Div. Amer. Fish. Soc., Portland, OR 376pp.

Bovee, K.D. 1982. A guide to stream habitat analysis using the Instream Flow Incremental Methodology. Instream Flow Information Paper '12. U.S. Fish and Wildlife Service. FWS/OBS-82/26.

Gallagher, J. P., et al, 2010. South Platte River - Happy Meadows – Reach 22 River Restoration Plan. Prepared for the Coalition for the Upper South Platte and the Pike National Forest. Fin-Up Habitat Consultants, Inc. – unpublished, 42pp.

Gallagher, J. P., 2008. Aquatic Assessment & Habitat Enhancement Plan - The South Platte River - Lake George Company, Park County – Colorado. Unpublished assessment for the Lake George Company prepared by Fin-Up Habitat Consultants, Inc., 36pp.

Gibbons, D.R., W.R. Meehan, M.D. Bryant, M.L. Murphy, S.T. Elliot. 1990. Fish in the Forest. Large Woody Debris in Streams, A New Management Approach to Fish Habitat. USDA-Forest Service, R10-MB-86. 21pp.

Hamilton, K. and E.P. Bergersen. 1984. Methods to Estimate Habitat Variables. CSU, CO Coop. Fish. Res. Unit, Environ. Eval., BOR Project No. DPTS-35-9.

Hankin, D.G. and G.H. Reeves. 1988. Estimating total fish abundance and total habitat area in small streams based upon visual estimation methods. Can. J. Fish. Aquat. Sci,, 45: 834-S44.

Helm, W.T., P. Brouha, M. Aceituno, C. Armour, P. Bisson, J. Hall, G. Holton, and M. Shaw. 1983. Aquatic habitat inventory. Glossary and Standard Methods. West.. Div. A.F.S., Portland, OR. 34pp.

Lisle, T.E. 1987. Using residual depths to monitor pool depths independently of discharge. USDA-FS Rsch. Note, PSW-394. 4pp.

McCain, Mike, David Fuller, Lynn Decker and Kerry Overton. 1990. Stream Habitat Classification and Inventory Procedures for Northern California. Region 5 FHR Currents Technical Bulletin #1, USDA-Forest Service, Pacific Southwest Region. Arcata CA. 15pp.

Ohlander, Coryell A. 1996. Clean Water Act - Monitoring and Evaluation, Part 7. Stream Reach Monitoring - T-Walk Training - Syllabus to Establish Background and Rationale. USDA Forest Service, Rocky Mountain Region, Denver, CO. 141pp.

Pacific Southwest Region Habitat Typing Field Guide (USDA-USFS)

Pfankuch, D.J. 1975. Stream reach inventory and channel stability evaluation. USDA-FS Northern Region Rl-75-002. 22pp.

Platts, W.S. 1974. Geomorphic and aquatic conditions influencing salmonids and stream classification. USDA-FS, Surface Environment and Mining Report, Washington, D.C.

Platts, W. S., W.F. Megahan and G.W. Minshall. 1983. Methods for evaluating stream riparian and biotic conditions. USDA-FS Forest Range Exp. Stn., Gen. Tech. Rept. INT-13S. 70 pp.

Rosgen, D.L. 1985. A stream classification system. IN: Riparian ecosystems and their management; reconciling conflicting uses. Proceedings of the First North American Riparian Conference, April 16-18, Tucson, AZ. GTR-RM120, pp. 91-95.

Schmal, R.N., S.J. Kozel, and S.S. Marsh. 1988. A Basin-Wide Inventory Approach Using a Channel Type and Habitat Type Classification System for Resident Trout. USDA-FS. Medicine Bow National Forest, 16pp with illustrations.

USDA-Forest Service. 1975. Stream Reach Inventory and Channel Stability Evaluation: A Watershed Management Procedure. USDA-Forest Service, Northern Region. Rl-75-002. 26pp.

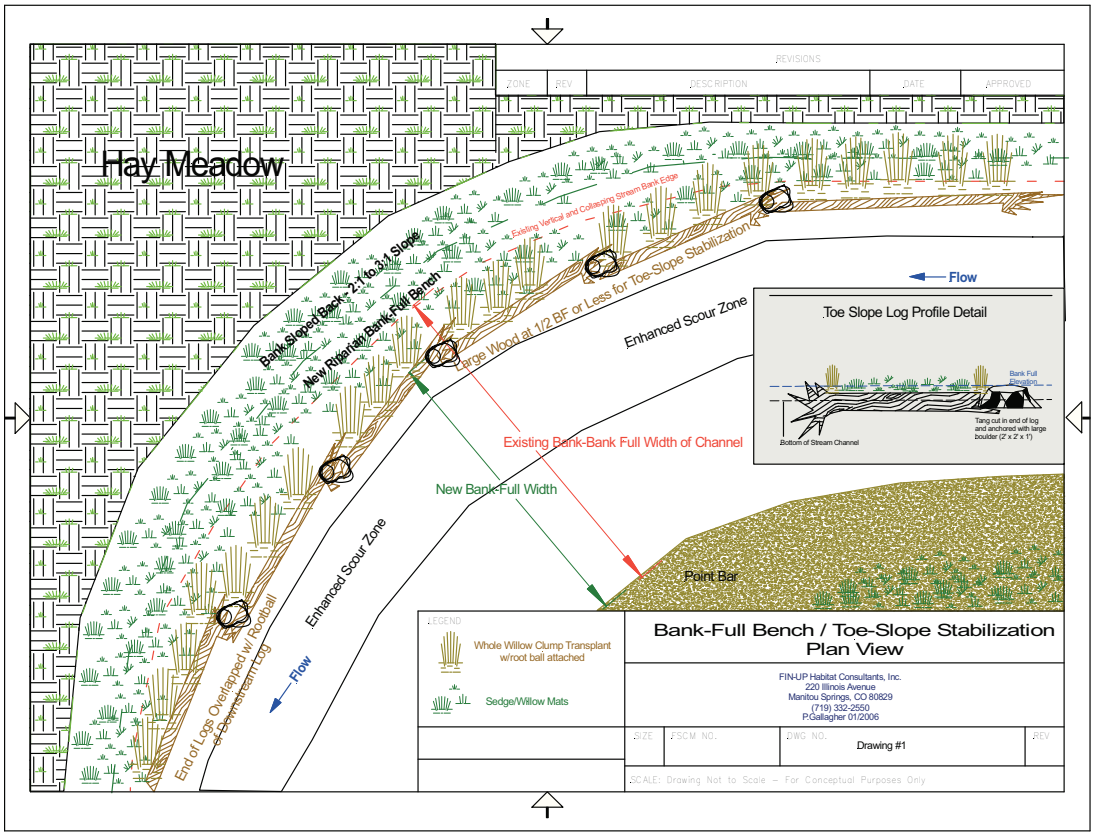
Winters, D.S. and J.P.Gallagher. - USDA-Forest Service. 1997. Basinwide Stream Habitat Inventory - A Protocol for the Pike and San Isabel National Forests and the Cimarron and Comanche National Grasslands. 41pp.

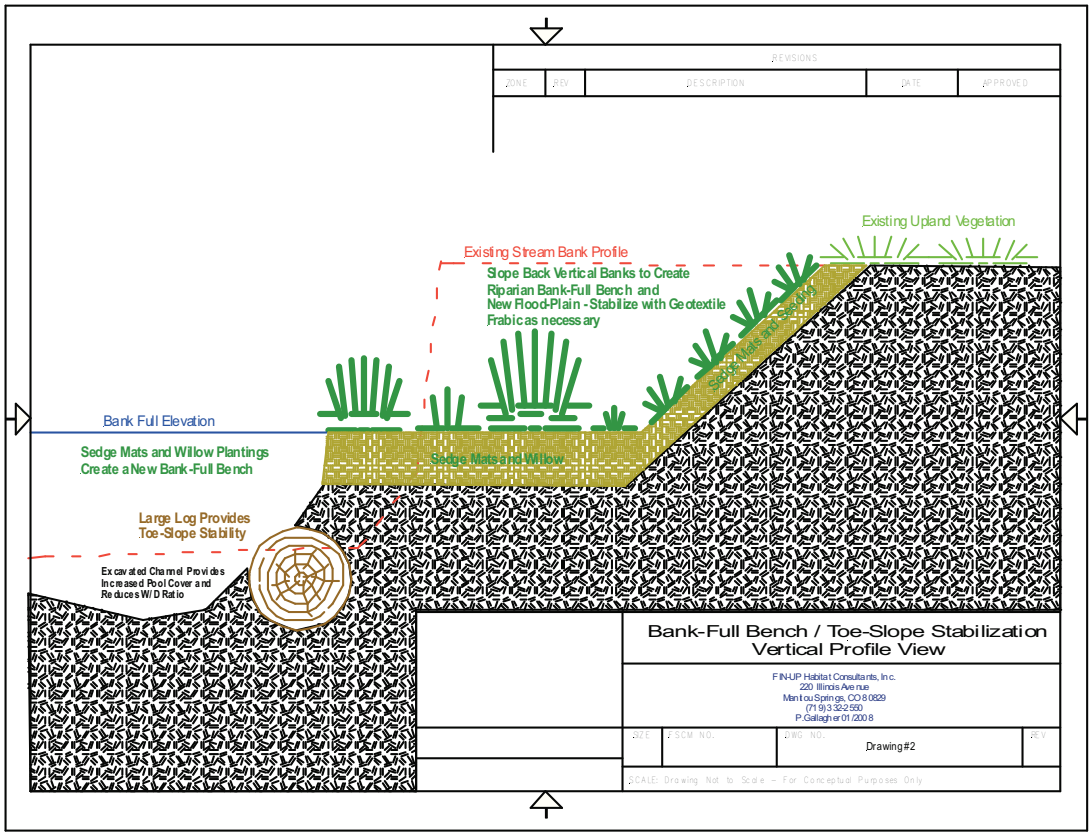
Winters, D.S., T. Wagner and J.P.Gallagher. - USDA-Forest Service. 2007. Developing Monitoring Plans for Structure Placement in the Aquatic Environment – ElevenMile Canyon Demonstration Project, San Dimas Technology Center, San Diego, CA.

Ariel Photography provided by the US Forest Service. Topographical maps created using USGS and Delorme TOPO 8.0

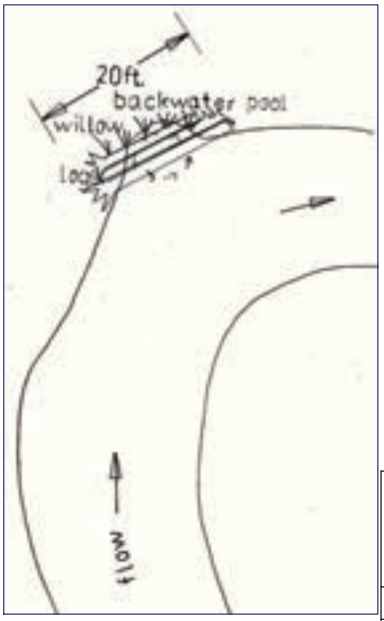
APPENDICES:

Drawings and Photos of Treatment Types

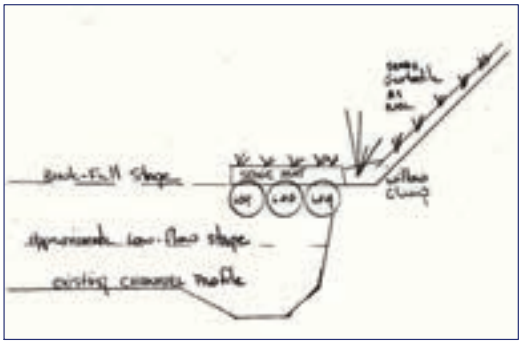




Plan View



Profile View



REVISIONS

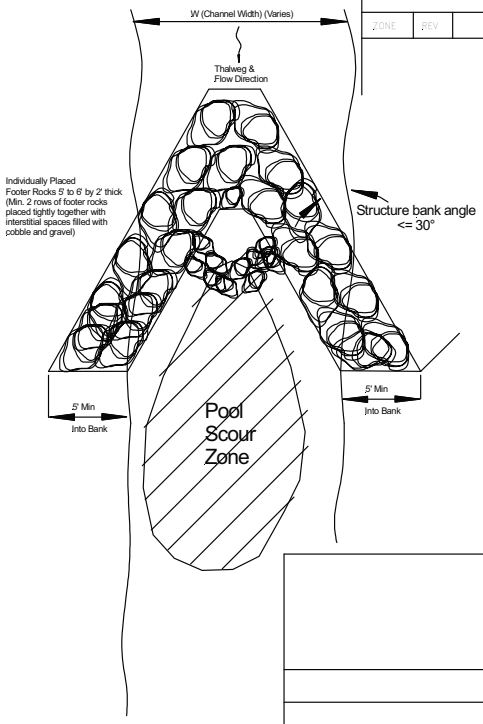
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LUNKER Bench / Bank Stabilization Plan and Profile View

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Manitou Springs, CO 80829
(719) 332-2550
P.Gallagher 01/2008

SIZE	FSCM NO.	DWG NO.	REV
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REVISIONS

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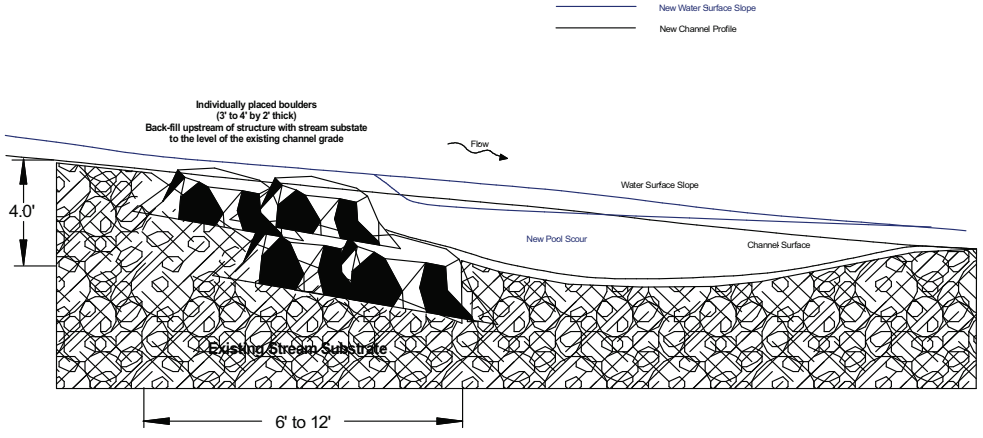
Cross-Vane Plan View

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SIZE	FSCM NO.	DWG NO.	REV
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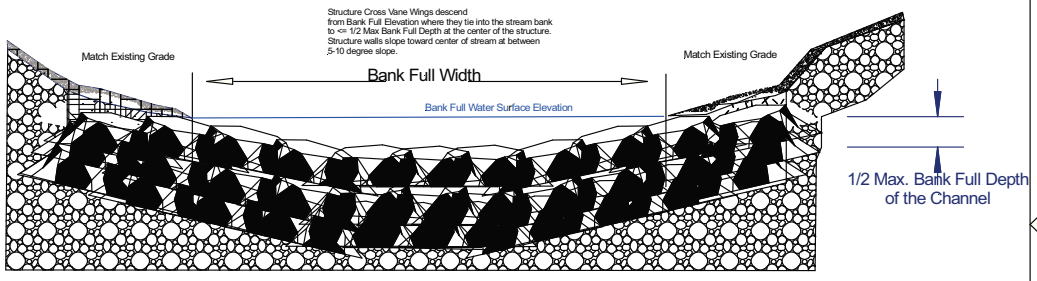
Cross-Vane Vertical Profile (Center of Structure)

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Manitou Springs, CO 80829
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SIZE	FSCM NO:	DWG NO:	REV
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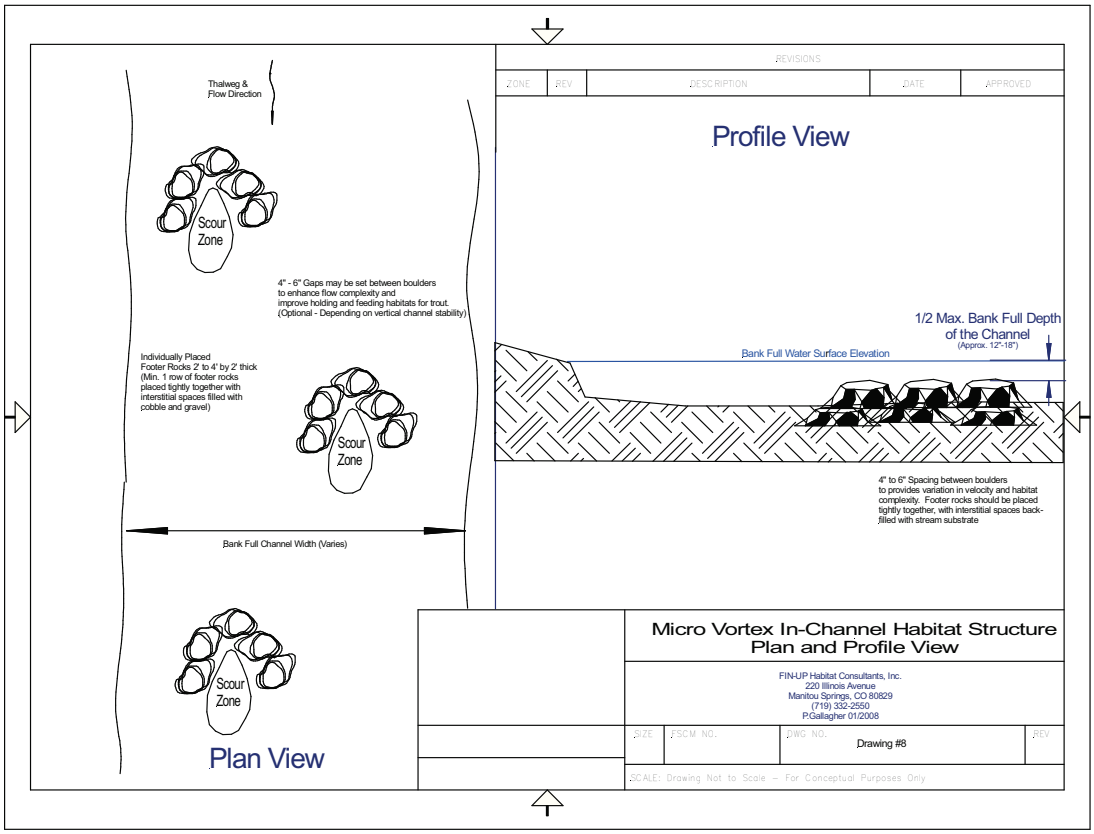


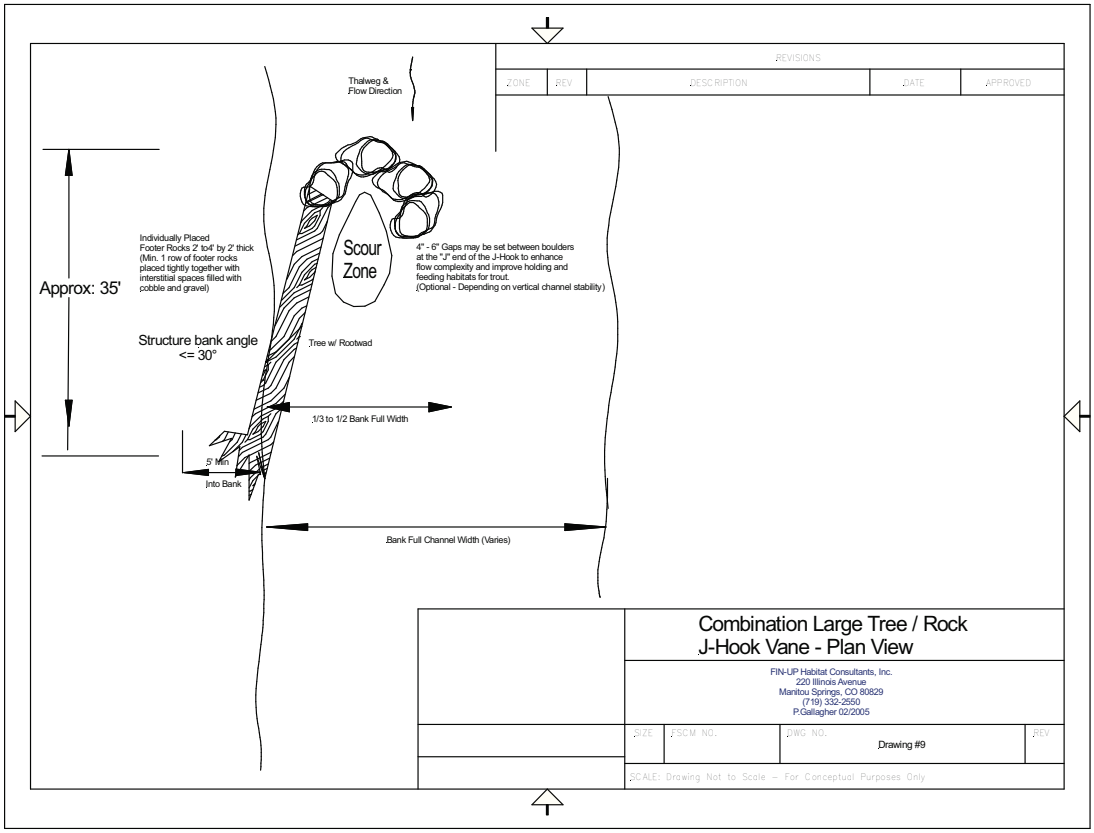
Cross-Vane Vertical Profile Cross Section Elevations)

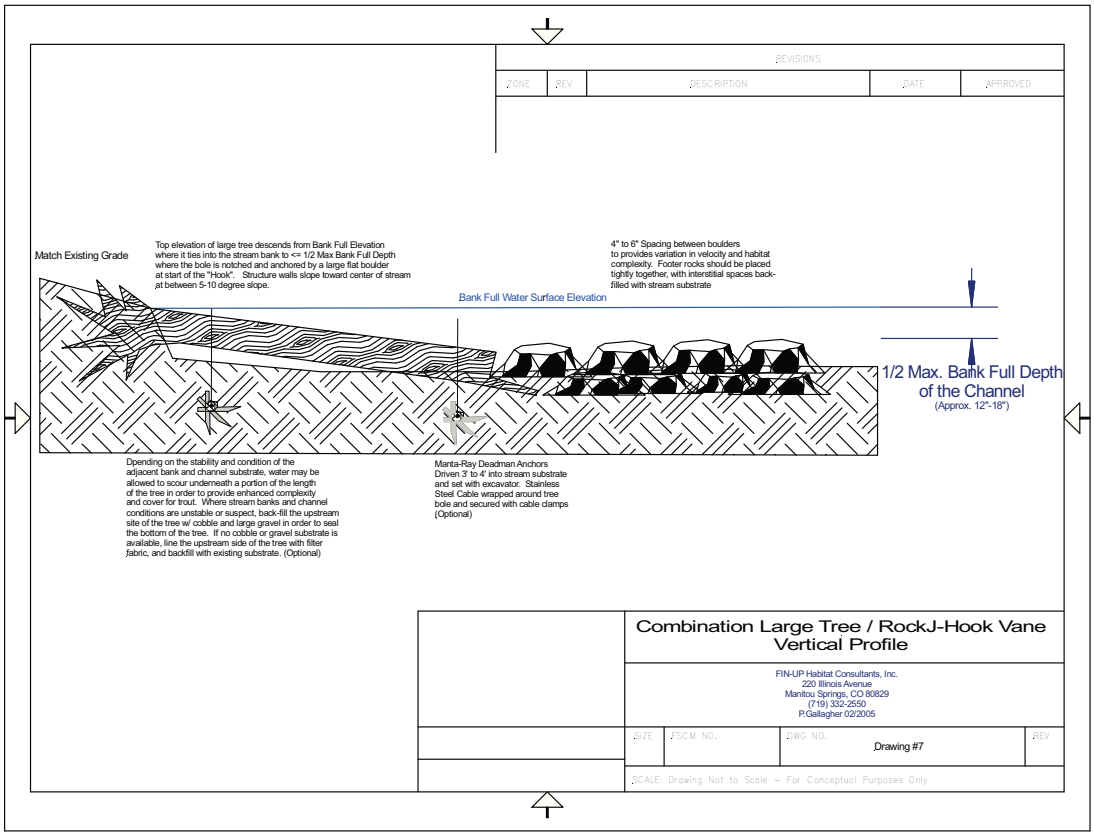
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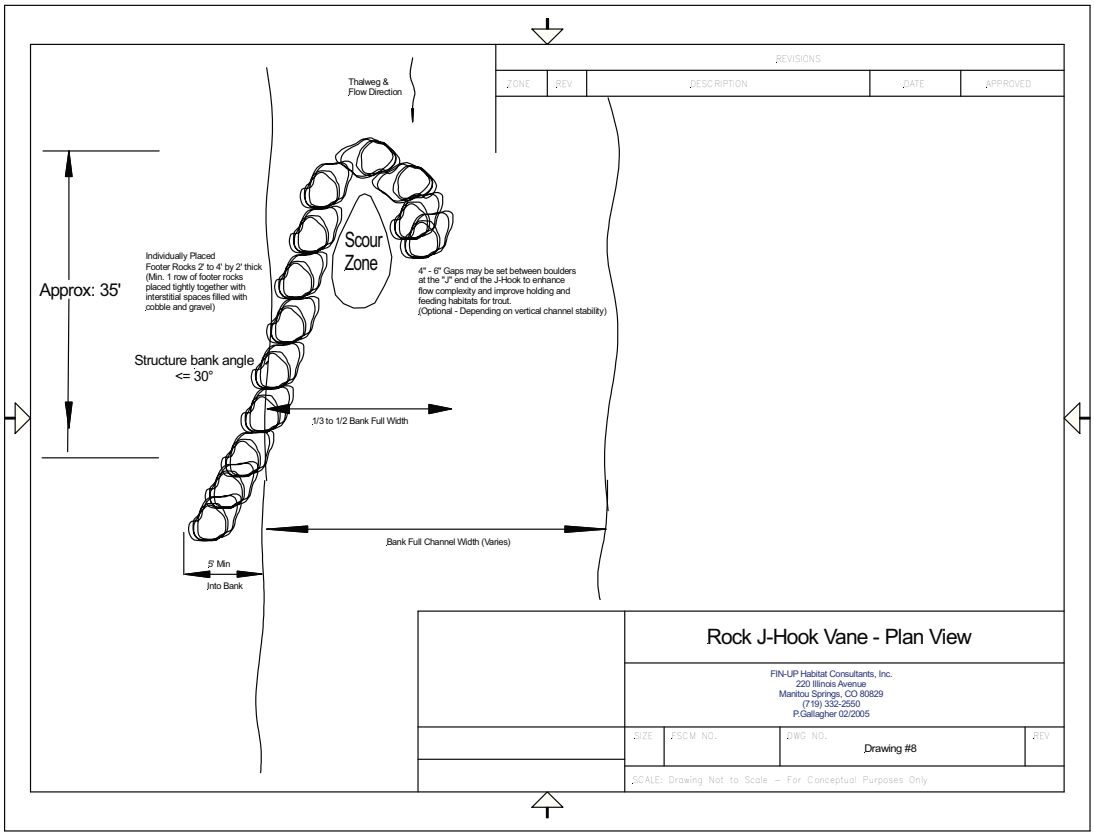
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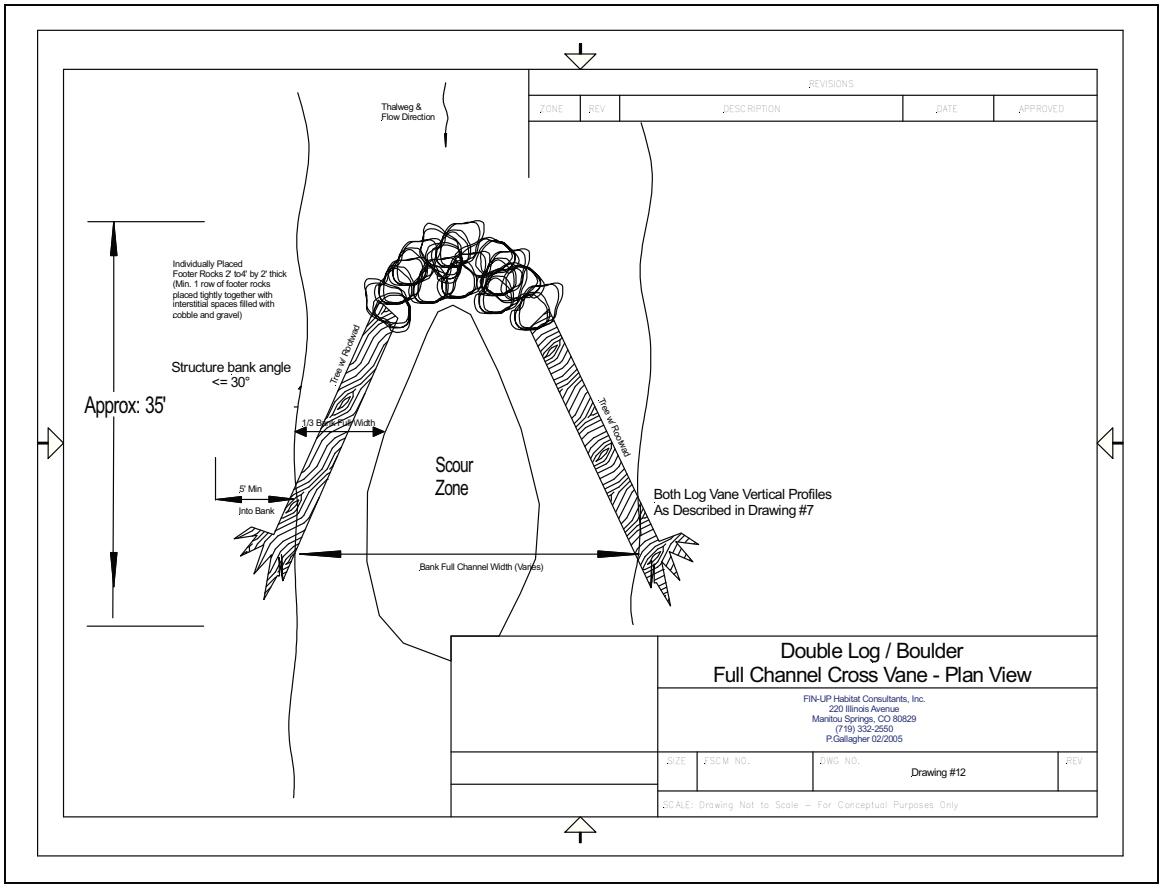
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Thalweg &
Flow Direction
Scour
Zone
4" - 6" Gaps may be set between boulders
to enhance flow complexity and
improve holding and feeding habitats for trout.
(Optional - Depending on vertical channel stability)
Individually Placed
Footer Rocks 2' to 4' by 2' thick
(Min. 1 row of footer rocks
placed tightly together with
interstitial spaces filled with
cobble and gravel)
Scour
Zone
Bank Full Channel Width (Varies)
Scour
Zone
Plan View
REVISIONS
ZONE
REV
DESCRIPTION
DATE
APPROVED
Profile View
1/2 Max. Bank Full Depth
of the Channel
(Approx. 12"-18")
Bank Full Water Surface Elevation
4" to 6" Spacing between boulders
to provides variation in velocity and habitat
complexity. Footer rocks should be placed
tightly together, with interstitial spaces back-
filled with stream substrate
Micro Vortex In-Channel Habitat Structure
Plan and Profile View
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SIZE
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ZONE
REV
DESCRIPTION
DATE
APPROVED
Thalweg &
Flow Direction
Approx: 35'
Individually Placed
Footer Rocks 2' to4' by 2' thick
(Min. 1 row of footer rocks
placed tightly together with
interstitial spaces filled with
cobble and gravel)
Scour
Zone
4" - 6" Gaps may be set between boulders
at the "J" end of the J-Hook to enhance
flow complexity and improve holding and
feeding habitats for trout.
(Optional - Depending on vertical channel stability)
Structure bank angle
<= 30°
Tree w/ Rootwad
1/3 to 1/2 Bank Full Width
5' Min
Into Bank
Bank Full Channel Width (Varies)
Combination Large Tree / Rock
J-Hook Vane - Plan View
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SIZE
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DWG NO:
Drawing #9
REV
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REVISIONS
ZONE
REV.
DESCRIPTION
DATE
APPROVED
Match Existing Grade
Top elevation of large tree descends from Bank Full Elevation where it ties into the stream bank to <= 1/2 Max Bank Full Depth where the bole is notched and anchored by a large flat boulder at start of the "Hook". Structure walls slope toward center of stream at between 5-10 degree slope.
4" to 6" Spacing between boulders to provides variation in velocity and habitat complexity. Footer rocks should be placed tightly together, with interstitial spaces back-filled with stream substrate
Bank Full Water Surface Elevation
1/2 Max. Bank Full Depth of the Channel
(Approx. 12"-18")
Depending on the stability and condition of the adjacent bank and channel substrate, water may be allowed to scour underneath a portion of the length of the tree in order to provide enhanced complexity and cover for trout. Where stream banks and channel conditions are unstable or suspect, back-fill the upstream site of the tree w/ cobble and large gravel in order to seal the bottom of the tree. If no cobble or gravel substrate is available, line the upstream side of the tree with filter fabric, and backfill with existing substrate. (Optional)
Manta-Ray Deadman Anchors Driven 3' to 4' into stream substrate and set with excavator. Stainless Steel Cable wrapped around tree bole and secured with cable clamps (Optional)
Combination Large Tree / RockJ-Hook Vane
Vertical Profile
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DWG NO.
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REVISIONS
ZONE
REV.
DESCRIPTION
DATE
APPROVED
Thalweg & Flow Direction
Approx: 35'
Individually Placed Footer Rocks 2' to 4' by 2' thick (Min. 1 row of footer rocks placed tightly together with interstitial spaces filled with cobble and gravel)
Scour Zone
4" - 6" Gaps may be set between boulders at the "J" end of the J-Hook to enhance flow complexity and improve holding and feeding habitats for trout. (Optional - Depending on vertical channel stability)
Structure bank angle <= 30°
1/3 to 1/2 Bank Full Width
Bank Full Channel Width (Varies)
5' Min Into Bank
Rock J-Hook Vane - Plan View
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SIZE
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DWG NO.
Drawing #8
REV
SCALE: Drawing Not to Scale – For Conceptual Purposes Only





Cross Vane Structure on Fountain Creek below 21st Street Bridge, El Paso County, CO.

South Platte River - Sportsman's Paradise &
Happy Meadows Aquatic Enhancement Project - 2011

Estimate of Fill Below the Ordinary High Water Mark of the River for Treatments

Reach 20

Treatment Type	Number of Structures	Est. Fill below Bank Full Each (yd^3)	Total (yd3)
Cross Vanes	7	100	700
2x Log / Boulder Cross Vanes	2	80	160
Boulder Vanes / Groins / Spurs	1	10	10
Boulder J-Hook Vanes	4	20	80
Log/Boulder J-Hook Vanes	10	20	200
Micro-Vortex Structure	33	3	99
Habitat Trees	9	10	90
Log Toe-Slope Bank Full Riparian Benches	3,200 ft.	0.20/ft	460
Low Elevation Log Revetment Treatments	950 ft.	0.15/ft	143

Reach 21

Treatment Type	Number of Structures	Est. Fill below Bank Full Each (yd^3)	Total (yd3)
Cross Vanes	4	100	400
2x Log / Boulder Cross Vanes	4	80	320
Boulder Vanes / Groins / Spurs	7	10	70
Boulder J-Hook Vanes	2	20	40
Log/Boulder J-Hook Vanes	6	20	120
Micro-Vortex Structure	<10	3	30
Habitat Trees	5	10	50
Log Toe-Slope Bank Full Riparian Benches	2,200 ft.	0.20/ft	440
Low Elevation Log Revetment Treatments	1,250 ft.	0.15/ft	188

Reach 22

Treatment Type	Number of Structures	Est. Fill below Bank Full Each (yd^3)	Total (yd3)
Cross Vanes	7	100	700
Boulder Vanes / Groins / Spurs	6	10	60
Boulder J-Hook Vanes	9	20	180
Log/Boulder J-Hook Vanes	10	20	200
Bank Cover (lunker) Structures	3	10	30
Micro-Vortex Structure	22	3	66
Habitat Trees	28	10	280
Log Toe-Slope Bank Full Riparian Benches	4960 ft.	0.20/ft	992
Low Elevation Log Revetment Treatments	1600 ft.	0.15/ft	240

Cross Vanes	18
2x Log / Boulder Cross Vanes	6
Boulder Vanes / Groins / Spurs	14
Boulder J-Hook Vanes	15
Log/Boulder J-Hook Vanes	26
Bank Cover (lunker) Structures	3
Micro-Vortex Structure	65
Habitat Trees	42
Log Toe-Slope Bank Full Riparian Benches	10360
Low Elevation Log Revetment Treatments	3800

BWSHI Habitat Survey Results

Reach 20

STREAMNAME	SOUTH PLATTE RIVER	CHANNEL TYPE	C
REACH NO.	20	MIN. TEMP.	
DATE	9/22/2009	MAX. TEMP	
PERSONNEL	GALLAGHER, NUSS	DISTRICT	SPORTSMANS PARADISE
DESCRIPTION			

	HABITAT UNIT TYPE		LENGTH	WIDTH	RESIDUAL DEPTH	AVE. DEPTH	MAX. DEPTH	COVER TYPES				BANK STABILITY		BANK ROCK CONTENT		ERODING BANKS		
NO.	TYPE	SA	(FT.)	(FT.)	(FT.)	(FT.)	(FT.)	2	3	4	5	LEFT	RIGHT	LEFT	RIGHT	(FT.)	LOD	COMMENTS
R1	10	O	114.00									1	1	7	7	20.00		
P1	7	SA	71.00									1	1	7	7			
R2	11	O	130.00									1	1	7	7			
G1	1		105.00									1	1	7	7			
P2	6	M	141.00									1	1	8	7			STRUCTURE @ TOP / VANE
R3	11	O	407.00									1	1	6	6			
P3	6	M	150.00									1	1	6	6	50.00		BOULDER CLUSTER @ 4321FT
R4	11	O	127.00									1	1	6	6	40.00		
G2	1		111.00									1	1	6	6			BOULDER CLUSTER @ 4633FT
R5	10	O	209.00									1	1	6	6			LOCATED ON MEANDER
G3	1		147.00									1	1	5	5			DROP STRUCTURE
P4	5	SA	90.00									1	1	7	7			
P5	7	SA	221.00									1	1	7	7			
R6	11	O	154.00									1	1	7	7			
R7	10	P	308.00									1	1	5	5			
G4	1		185.00									1	1	4	4			
P6	4	D	82.00									1	1	4	4			
R8	10	O	40.00									1	1	4	4			
P7	5	SA	85.00									1	2	4	6	50.00		
P8	7	SA	135.00									1	1	7	7			
G5	1		116.00									1	1	7	6			
R9	10	P	247.00									1	1	4	6			
P9	5	SA	72.00									4	1	4	6	40.00		
P10	7	S/D	107.00									2	1	7	7			
G6	1		131.00									1	1	7	7			
P11	6	M	122.00									1	1	7	7			
G7	1		123.00									1	1	7	7			
P12	6	M	87.00									1	1	7	7			
R10	12	O	439.00									1	2	7	7	100.00		
P13	4	B	123.00									1	1	4	7			
R11	12	O	105.00									1	1	7	7			
P14	6	S	81.00									2	1	7	7			
P15	7	S	83.00									2	1	7	7			
R12	11	O	78.00									2	1	7	7			
G8	1		114.00									1	1	7	7			
R13	11	O	207.00									1	1	7	7			
G9	1		103.00									1	1	7	7			
P16	5	S	20.00									1	1	7	7			
P17	7	S	64.00									1	1	7	7			
G10	1		46.00									1	1	4	2	30.00		
P18	4	S	139.00									1	1	4	2			
P19	7	S	119.00									1	1	7	7			
R14	12	O	96.00									1	1	4	4			END OF REACH @ CONFLUENCE W/ CRYSTAL CREEK

BWSHI Habitat Survey Results (cont.)

Reach 21

STREAMNAME	SOUTH PLATTE RIVER	CHANNEL TYPE	C
REACH NO.	21	MIN. TEMP.	
DATE	9/22/2009	MAX. TEMP	
PERSONNEL	GALLAGHER / NUSS	DISTRICT	SPORTSMANS PARADISE
DESCRIPTION			

HABITAT UNIT NO.	TYPE	SA	LENGTH (FT.)	WIDTH (FT.)	RESIDUAL DEPTH (FT.)	AVE. DEPTH (FT.)	MAX. DEPTH (FT.)	COVER TYPES 2	3	4	5	BANK STABILITY LEFT	RIGHT	BANK ROCK CONTENT LEFT	RIGHT	ERODING BANKS (FT.)	LOD	COMMENTS
P1	6	SA	62.00									1	1	6	2			FOOTBRIDGE
R1	11	O	32.00									2	1	4	7			
G1	1		75.00									1	1	7	7			
P2	6	SA	94.00									1	2	7	6	30.00		
P3	7	SA	137.00									1	1	7	7			
R2	11	O	238.00									1	1	7	7			BRAIDED CHANNEL BOULDER VANE @ 587FT OUTLET OF POND
R3	12	O	148.00									1	1	7	7			
R4	10	P	93.00									1	1	7	7			BELOW STRUCTURE
G2	1	SA	251.00									1	2	7	6	80.00		ABOVE STRUCTURE - SOME POOL POCKETS @ 1000FT
R5	10	P	134.00									1	7	7				BELOW STRUCTURE
P4	7	SA	190.00									1	1	7	7			
G3	1		81.00									1	1	7	7			
R6	11	O	163.00									1	1	7	7			STRUCTURE AT TOP ON RIGHT
G4	1	SA	102.00									1	2	7	7			
R7	11	O	101.00									1	2	7	7	6.00		STRUCTURE AT TOP
G5	1	SA	108.00									1	1	7	7			
P5	4	G	99.00									1	1	7	7			GULLY ON LEFT @ 2068FT
R8	11	O	255.00									2	1	7	7	80.00		STRUCTURE @ 2190FT
G6	1	SA	170.00									1	1	7	7			STRUCTURE AT BOTTOM
P6	6	M	132.00									1	1	7	7			
R9	11	O	100.00									1	1	7	7			
G7	1		100.00									1	1	7	7			
P7	6	M	118.00									1	1	7	7			
R10	11	P	283.00									1	1	5	5			
R11	12	O	151.00									1	1	7	7			SERIES OF STRUCTURES CAUSING OVERWIDENING OF RIVER
P8	4	SA	85.00									1	1	7	7			BRIDGE POOL
R12	11	O	153.00									1	1	4	4			END OF REACH BELOW DIV DAM @ CONFL W/ VERMILLION CREEK

BWSHI Habitat Survey Results (cont.)

Reach 22

STREAMNAME	south platte river - happy meadows	CHANNEL TYPE	A4
REACH NO.	22	MIN. TEMP.	
DATE	10/27-28/1998	MAX. TEMP	
PERSONNEL	t.saulters, p.gallagher	DISTRICT	south park
DESCRIPTION	begin @ sportsman paradise bndry		
	flow approx 50cfs		

	HABITAT UNIT TYPE		LENGTH	WIDTH	RESIDUAL DEPTH	AVE. DEPTH	MAX. DEPTH	COVER TYPES				BANK STABILITY		BANK ROCK CONTENT		ERODING BANKS		
NO.	TYPE	SA	(FT.)	(FT.)	(FT.)	(FT.)	(FT.)	2	3	4	5	LEFT	RIGHT	LEFT	RIGHT	(FT.)	LOD	COMMENTS
G1	1		1293.00	75.00							250	1	2	8	8	520.00		
R1	11	O	494.00	76.00				1				1	1	8	8	250.00		
G2	1		200.00	73.00				40				1	1	8	8	30.00		
P1	4	B	105.00	66.00	1.30		2.30	11			2	1	1	4	8			
R2	10	O	447.00	77.00				4			100	1	1	4	3			
P2	4	B	145.00	67.00	1.70		2.70	15			7	1	1	3	3			
R3	10	P	155.00	70.00				8			300	1	1	4	4			
P3	5	B	53.00	61.00	1.50		3.50	5			5	1	1	4	3			
P4	7	B	56.00	50.00	1.60		3.10					1	1	2	2			
R4	10	P	301.00	65.00				250				1	1	4	4	50.00		
R5	8	O	110.00	25.00								1	2	3	3	50.00		
P5	2	A	90.00	25.00						100		1	2	4	8	90.00		
P6	7	E	166.00	65.00	1.20		2.70					1	2	8	8			
R6	10	O	405.00	73.00				3				1	1	5	5	90.00		
P7	6	B/M	133.00	75.00	2.00	1.76	4.00	500			1000	1	1	3	8	20.00		
G3	1		133.00	70.00				7				2	1	8	8	80.00		
P8	6	M	83.00	50.00	1.00	2.48	3.90	8			41	2	1	8	8	20.00		
G4	1		183.00	55.00				25				2	1	8	8	100.00		
R7	12	O	200.00	87.00				20				2	1	8	8	80.00		
G5	1		208.00	72.00				25				2	2	8	5	100.00		WILLOW CUT PHOTO#5
R8	10	O	178.00	54.00				30				1	2	7	5	45.00		
P9	4	A/B	178.00	50.00	2.50	2.35	4.00	17			90	1	1	4	4			
P10	4	B	118.00	44.00	1.00	2.89	4.00	11			70	1	1	4	4	30.00		
R9	10	P	240.00	69.00				12				1	1	4	4	20.00	2	PHOTO#6
P11	6	M	185.00	75.00	4.00	2.46	5.00	18			9	1	2	4	4	85.00	2	FILLED W/ SEDIMENT
R10	10	P	780.00	62.00				440				1	2	3	4	300.00	2	
P12	6	M	232.00	61.00	3.00	2.43	4.00	35			58	2	1	8	8	60.00		
G6	1		120.00	57.00								1	1	8	8	5.00		
R11	12	O	310.00	62.00								1	1	8	8	10.00		AT C.G.
P13	4	B	90.00	63.00	1.50	1.69	2.50	5			5	1	2	5	8	50.00		
R12	10	O	40.00	60.00								1	1	4	3			
P14	6	M	165.00	63.00	2.50	1.70	3.50	8			8	1	1	6	8	50.00		
G7	1		215.00	58.00								1	1	8	8	5.00		
R13	12	O	258.00	75.00								1	1	8	8	10.00		
P15	6	A	127.00	40.00	3.00	1.30	3.50	12			55	1	2	8	8	100.00		
R14	8	A	65.00	34.00								1	1	8	8			
G8	1		104.00	70.00								1	2	8	4	50.00	1	
R15	10		240.00	70.00				100				1	2	8	6	180.00		
P16	6	M	264.00	52.00	3.00		3.60	24			132	1	2	8	8	170.00		
R16	11	O	232.00	61.00								1	2	8	8	115.00		
G9	1		305.00	73.00								1	1	8	8			PHOTO#7
P17	4	B	177.00	69.00	1.50	1.78	3.00	17			34	1	1	8	8			
R17	11	O	210.00	75.00								1	1	6	3			
G10	1		133.00	79.00								1	1	6	7			
R18	11	O	350.00	59.00								1	1	6	6	40.00		
R19	8	O	200.00	30.00								1	1	8	8			
P15	6	M	130.00	48.00	2.10	2.06	2.70	13			39	1	1	8	8	15.00		
R20	11	O	293.00	57.00				150				1	1	7	8	70.00		
P19	6	M	111.00	38.00	2.00	1.74	3.50	13			55	2	1	6	8	30.00		
R21	11	O	98.00	44.00								2	1	8	8	30.00		END OF REACH FENCE

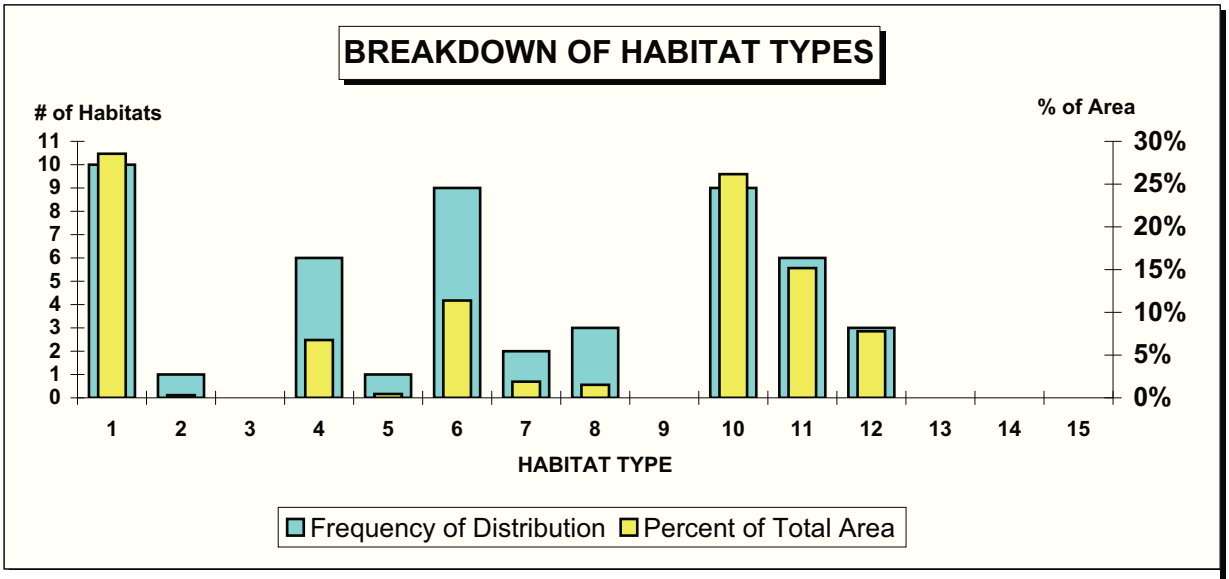
south platte river - happy meadows - REACH 22

10/27-28/1998

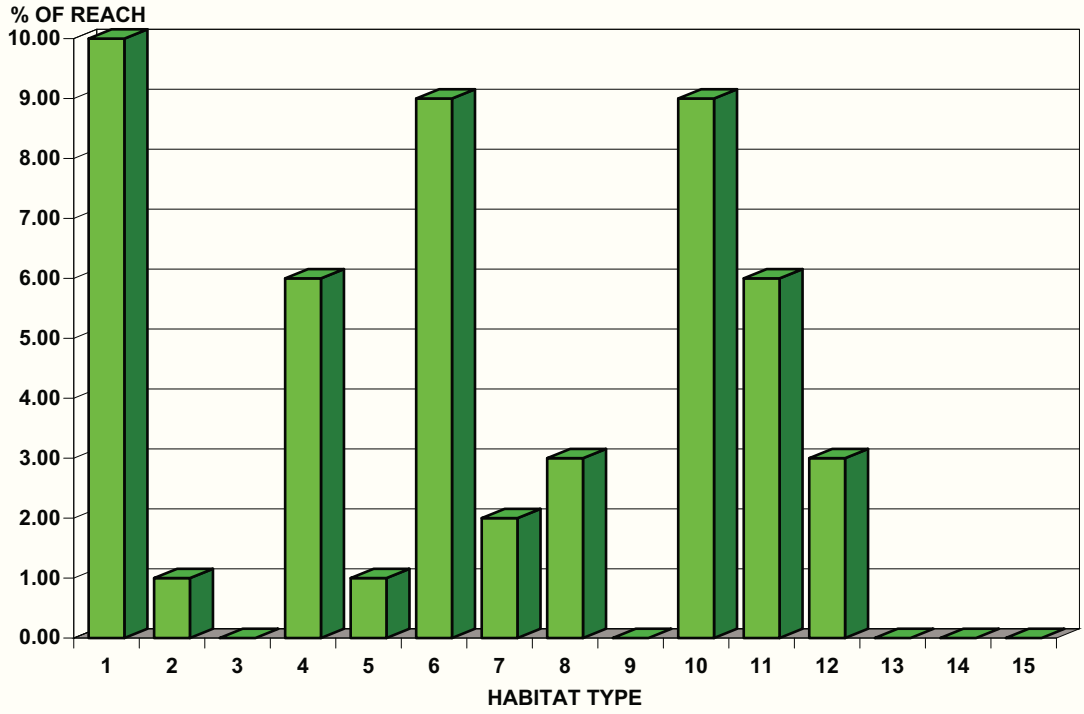
	POOL	RIFFLE	GLIDE	REACH TOTAL
TOTAL LENGTH OF HA	2608.00	5606.00	2894.00	11108.00
AVERAGE WIDTH OF I	55.89	61.19	68.20	61.76
AVERAGE RESIDUAL	2.02	0.00	0.00	2.02
AVERAGE DEPTH (ft.	2.05	0.00	0.00	2.05
TOTAL COVER TYPE 2	711.45	1018.00	96.65	1826.10
AVE. TYPE 2 COVER I	37.44	48.48	9.67	0.25
TOTAL COVER TYPE 3	0.00	0.00	0.00	0.00
AVE. TYPE 3 COVER I	0.00	0.00	0.00	0.00
TOTAL COVER TYPE 4	100.00	0.00	0.00	100.00
AVE. TYPE 4 COVER I	5.26	0.00	0.00	0.01
TOTAL COVER TYPE 5	1610.00	400.00	250.00	2260.00
AVE. TYPE 5 COVER I	84.74	19.05	25.00	0.31
% BANK STABILITY TYPE 1				
LEFT BANK	84.21	90.48	70.00	84.00
RIGHT BANK	68.42	76.19	70.00	72.00
% BANK STABILITY TYPE 2				
LEFT BANK	15.79	9.52	30.00	16.00
RIGHT BANK	31.58	23.81	30.00	28.00
% BANK STABILITY TYPE 3				
LEFT BANK	0.00	0.00	0.00	0.00
RIGHT BANK	0.00	0.00	0.00	0.00
% BANK STABILITY TYPE 4				
LEFT BANK	0.00	0.00	0.00	0.00
RIGHT BANK	0.00	0.00	0.00	0.00
TOTAL OF ERODING B	720.00	1340.00	890.00	2950.00
TOTAL LRG. ORGANIC	2.00	4.00	1.00	7

	POOL	RIFFLE	GLIDE	REACH TOTAL
TOTAL AREA OF HABI	149506.00	364170.00	205288.00	718964.00
% OF TOTAL NUM. OF	38.00	42.00	20.00	100.00
HABITAT TYPE	20.79	50.65	28.55	100.00
AS A % OF TOTAL AREA				
% OF TOTAL COVERS	1.62	0.39	0.17	0.58
TO TOTAL HABITAT				
% OF CVR 2 TO TOTAL	0.48	0.28	0.05	0.25
% OF CVR 3 TO TOTAL	0.00	0.00	0.00	0.00
% OF CVR 4 TO TOTAL	0.07	0.00	0.00	0.01
% OF CVR 5 TO TOTAL	1.08	0.11	0.12	0.31
% BANK ROCK CONTENT				
TYPE 2				
LEFT BANK	5.26	0.00	0.00	2.00
RIGHT BANK	5.26	0.00	0.00	2.00
TYPE 3				
LEFT BANK	10.53	9.52	0.00	8.00
RIGHT BANK	10.53	19.05	0.00	12.00
TYPE 4				
LEFT BANK	31.58	23.81	0.00	22.00
RIGHT BANK	15.79	19.05	10.00	16.00
TYPE 5				
LEFT BANK	5.26	4.76	0.00	4.00
RIGHT BANK	0.00	9.52	10.00	6.00
TYPE 6				
LEFT BANK	10.53	9.52	10.00	10.00
RIGHT BANK	0.00	9.52	0.00	4.00
TYPE 7				
LEFT BANK	0.00	9.52	0.00	4.00
RIGHT BANK	0.00	0.00	10.00	2.00
TYPE 8				
LEFT BANK	36.84	42.86	90.00	50.00
RIGHT BANK	68.42	42.86	70.00	58.00

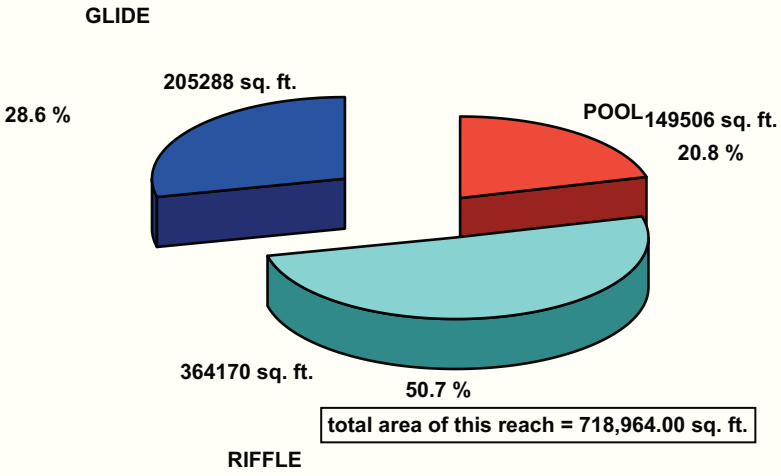
HABITAT TYPE ANALYSIS									
				TOTAL					TOTAL
NUMBER OF TYPE 2 H	1.00	0.00	0.00	1.00	NUMBER OF TYPE 9 H	0.00	0.00	0	0.00
% OF HABITAT	1.50	0.00	0.00	2.00	% OF HABITAT	0.00	0.00	0	0.00
NUMBER OF TYPE 3 H	0.00	0.00	0.00	0.00	NUMBER OF TYPE 10 H	0.00	9.00	0	9.00
% OF HABITAT	0.00	0.00	0.00	0.00	% OF HABITAT	0.00	51.66	0	18.00
NUMBER OF TYPE 4 H	6.00	0.00	0.00	6.00	NUMBER OF TYPE 11 H	0.00	6.00	0	6.00
% OF HABITAT	32.52	0.00	0.00	12.00	% OF HABITAT	0.00	29.96	0	12.00
NUMBER OF TYPE 5 H	1.00	0.00	0.00	1.00	NUMBER OF TYPE 12 H	0.00	3.00	0	3.00
% OF HABITAT	2.16	0.00	0.00	2.00	% OF HABITAT	0.00	15.37	0	6.00
NUMBER OF TYPE 6 H	9.00	0.00	0.00	9.00	NUMBER OF TYPE 13 H	0.00	0.00	0	0.00
% OF HABITAT	54.72	0.00	0.00	18.00	% OF HABITAT	0.00	0.00	0	0.00
NUMBER OF TYPE 7 H	2.00	0.00	0.00	2.00	NUMBER OF TYPE 14 H	0.00	0.00	0	0.00
% OF HABITAT	9.09	0.00	0.00	4.00	% OF HABITAT	0.00	0.00	0	0.00
NUMBER OF TYPE 8 H	0.00	3.00	0.00	3.00	NUMBER OF TYPE 15 H	0.00	0.00	0	0.00
% OF HABITAT	0.00	3.01	0.00	6.00	% OF HABITAT	0.00	0.00	0	0.00
TOTAL NUMBER OF H	19.00	21.00	10.00	50.00	NUMBER OF GLIDES	0.00	0.00	10	10.00
TOTAL % OF HABITAT	100.00	100.00	100.00	100.00		0.00	0.00	100.00	20.00



BREAKDOWN OF HABITAT TYPES

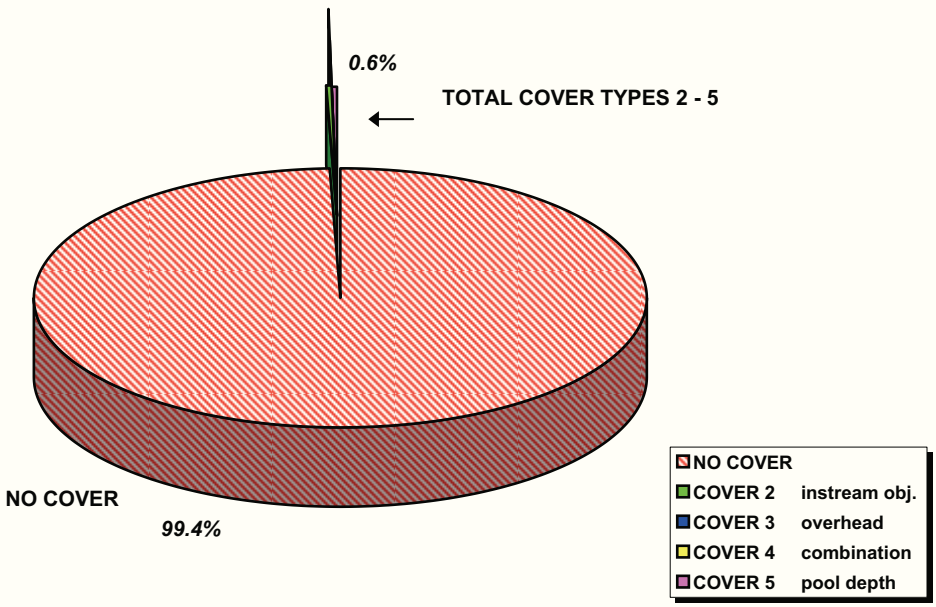


TOTAL AREA OF REACH

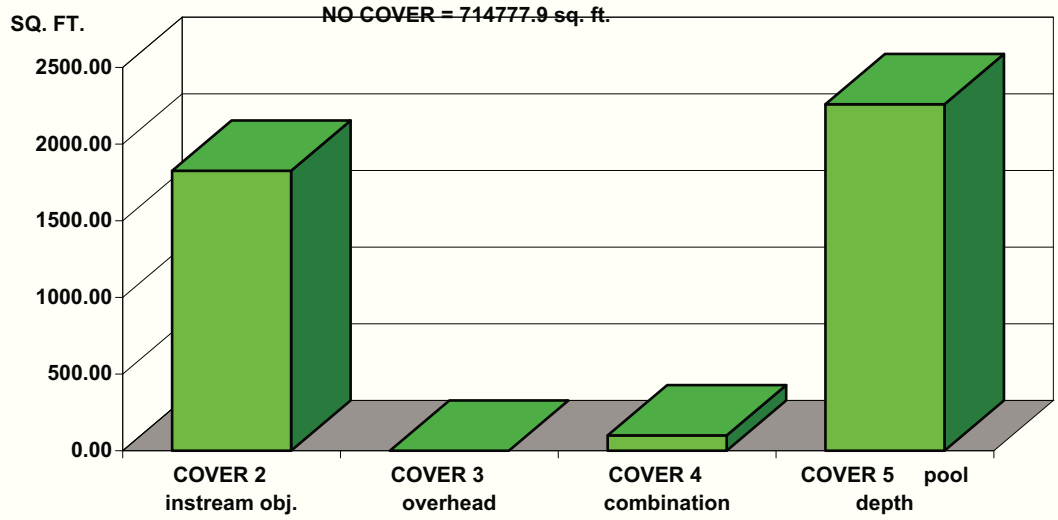


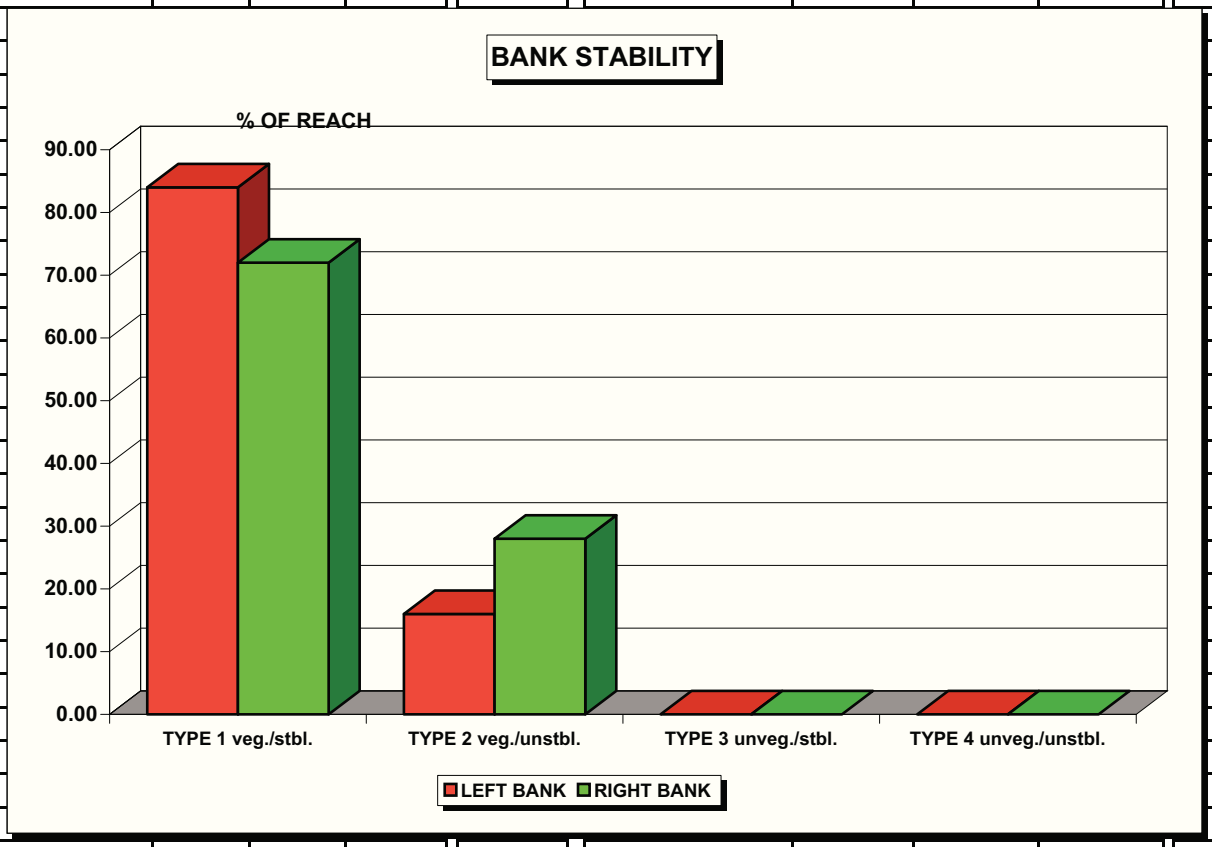
total area of this reach = 718,964.00 sq. ft.

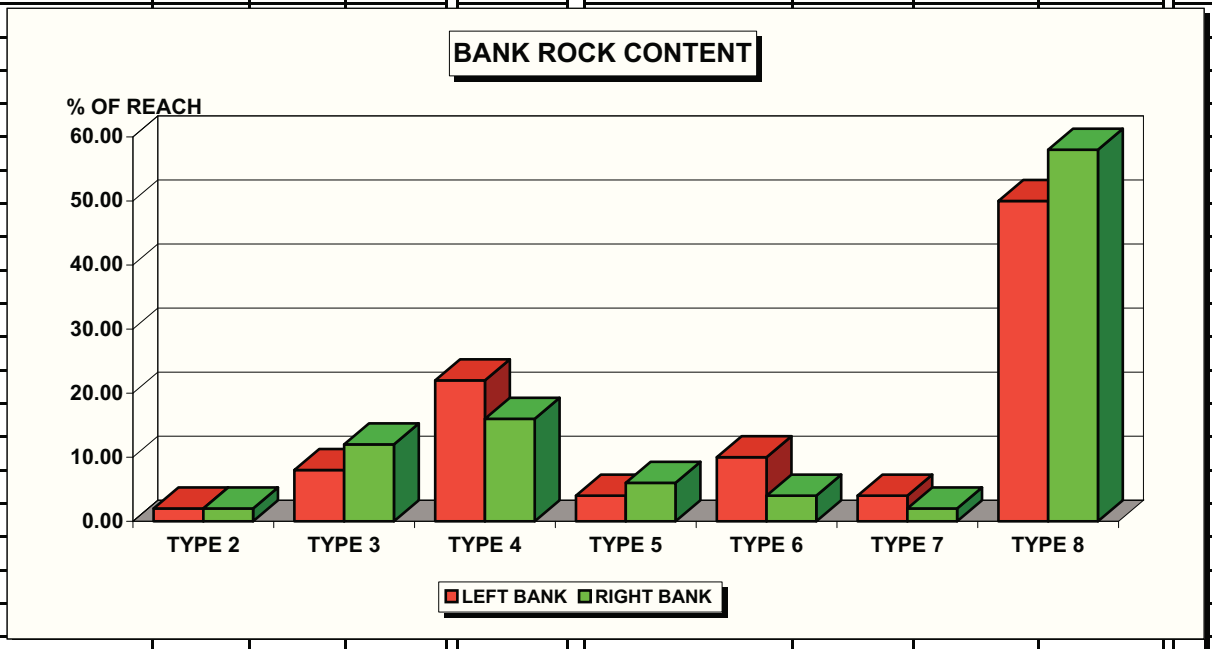
% OF COVER TYPES TO TOTAL AREA OF REACH



TOTAL SQ. FT. OF COVER TYPES




BANK STABILITY
% OF REACH
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
TYPE 1 veg./stbl.
TYPE 2 veg./unstbl.
TYPE 3 unveg./stbl.
TYPE 4 unveg./unstbl.
LEFT BANK
RIGHT BANK


BANK ROCK CONTENT
% OF REACH
60.00
50.00
40.00
30.00
20.00
10.00
0.00
TYPE 2
TYPE 3
TYPE 4
TYPE 5
TYPE 6
TYPE 7
TYPE 8
LEFT BANK
RIGHT BANK

south platte river - hab	POOLS						RIFFLES							
REACH 2 page 1	TYPE 2	TYPE 3	TYPE4	TYPE5	TYPE 6	TYPE 7	TYPE 8	TYPE 9	TYPE 10	TYPE 11	TYPE 12	TYPE 13	TYPE 14	T
TOTAL LENGTH OF	90.00	0.00	813.00	53.00	1430.00	222.00	375.00	0.00	2786.00	1677.00	768.00	0.00	0.00	
AVERAGE WIDTH (	25.00	0.00	59.83	61.00	55.78	57.50	29.67	0.00	66.67	62.00	74.67	0.00	0.00	
AVERAGE DEPTH (	0.00	0.00	2.18	0.00	1.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
RESIDUAL DEPT	0.00	0.00	1.58	1.50	2.51	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL AREA OF H	2250.00	0.00	48620.00	3233.00	81813.00	13590.00	10960.00	0.00	188131.00	109109.00	55970.00	0.00	0.00	
% OF TTL # OF HAI	0.02	0.00	0.12	0.02	0.18	0.04	0.06	0.00	0.18	0.12	0.06	0.00	0.00	
HAB. TYPE AS A PI	0.00	0.00	0.07	0.00	0.11	0.02	0.02	0.00	0.26	0.15	0.08	0.00	0.00	
OF TOTAL AREA OF REACH														
COVER														
TOTAL COVER TYP	0.00	0.00	75.00	5.00	631.45	0.00	0.00	0.00	847.00	151.00	20.00	0.00	0.00	
AVE. COVER 2 per	0.00	0.00	12.50	5.00	70.16	0.00	0.00	0.00	105.88	75.50	20.00	0.00	0.00	
% OF COVER 2 TO	0.00	0.00	0.15	0.15	0.77	0.00	0.00	0.00	0.45	0.14	0.04	0.00	0.00	
TOTAL COVER TYP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
AVE. COVER 3 per	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
% OF COVER 3 TO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL COVER TYP	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
AVE. COVER 4 per	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
% OF COVER 4 TO	4.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL COVER TYP	0.00	0.00	208.00	5.00	1397.00	0.00	0.00	0.00	400.00	0.00	0.00	0.00	0.00	
AVE. COVER 5 per	0.00	0.00	34.67	5.00	155.22	0.00	0.00	0.00	200.00	0.00	0.00	0.00	0.00	
% OF COVER 5 TO	0.00	0.00	0.43	0.15	1.71	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.00	
SUBSTRATA														
PLANT DEBRIS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
SAND \ SILT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
GRAVEL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
RUBBLE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
BOULDERS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
BEDROCK	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

south platte river - hab	POOLS	RIFFLES

REACH 2 page 2	TYPE 2	TYPE 3	TYPE4	TYPE5	TYPE 6	TYPE 7	TYPE 8	TYPE 9	TYPE 10	TYPE 11	TYPE 12	TYPE 13	TYPE 14
BANK STABILITY													
% OF BANK STABILITY TYPE 1													
LEFT BANK	100.00	0.00	100.00	100.00	66.67	100.00	100.00	0.00	100.00	83.33	66.67	0.00	0.00
RIGHT BANK	0.00	0.00	83.33	100.00	66.67	50.00	66.67	0.00	66.67	83.33	100.00	0.00	0.00
% OF BANK STABILITY TYPE 2													
LEFT BANK	0.00	0.00	0.00	0.00	33.33	0.00	0.00	0.00	0.00	16.67	33.33	0.00	0.00
RIGHT BANK	100.00	0.00	16.67	0.00	33.33	50.00	33.33	0.00	33.33	16.67	0.00	0.00	0.00
% OF BANK STABILITY TYPE 3													
LEFT BANK	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RIGHT BANK	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% OF BANK STABILITY TYPE 4													
LEFT BANK	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RIGHT BANK	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NK ROCK CONTENT													
TYPE 2													
LEFT BANK	0.00	0.00	0.00	0.00	0.00	50.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RIGHT BANK	0.00	0.00	0.00	0.00	0.00	50.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TYPE 3													
LEFT BANK	0.00	0.00	16.67	0.00	11.11	0.00	33.33	0.00	11.11	0.00	0.00	0.00	0.00
RIGHT BANK	0.00	0.00	16.67	100.00	0.00	0.00	33.33	0.00	22.22	16.67	0.00	0.00	0.00
TYPE 4													
LEFT BANK	100.00	0.00	50.00	100.00	11.11	0.00	0.00	0.00	55.56	0.00	0.00	0.00	0.00
RIGHT BANK	0.00	0.00	33.33	0.00	11.11	0.00	0.00	0.00	44.44	0.00	0.00	0.00	0.00
TYPE5													
LEFT BANK	0.00	0.00	16.67	0.00	0.00	0.00	0.00	0.00	11.11	0.00	0.00	0.00	0.00
RIGHT BANK	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.22	0.00	0.00	0.00	0.00
TYPE 6													
LEFT BANK	0.00	0.00	0.00	0.00	22.22	0.00	0.00	0.00	0.00	33.33	0.00	0.00	0.00
RIGHT BANK	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.11	16.67	0.00	0.00	0.00
TYPE7													
LEFT BANK	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.11	16.67	0.00	0.00	0.00
RIGHT BANK	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TYPE 8													
RIGHT BANK	0.00	0.00	16.67	0.00	55.56	50.00	66.67	0.00	11.11	50.00	100.00	0.00	0.00
FT BANK	100.00	0.00	50.00	0.00	88.89	50.00	66.67	0.00	0.00	66.67	100.00	0.00	0.00
OTHER													
TOTAL OF ERODIN	90.00	0.00	80.00	0.00	550.00	0.00	50.00	0.00	685.00	505.00	100.00	0.00	0.00
TOTAL LRG. ORG.	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00

SOUTH PLATTE RIVER RESTORATION PROJECT HYDROLOGIC ANALYSIS

Prepared for:

Carol Ekarius, Director
Coalition for the Upper South Platte
PO Box 726
Lake George, CO 80827
(719) 748-0033

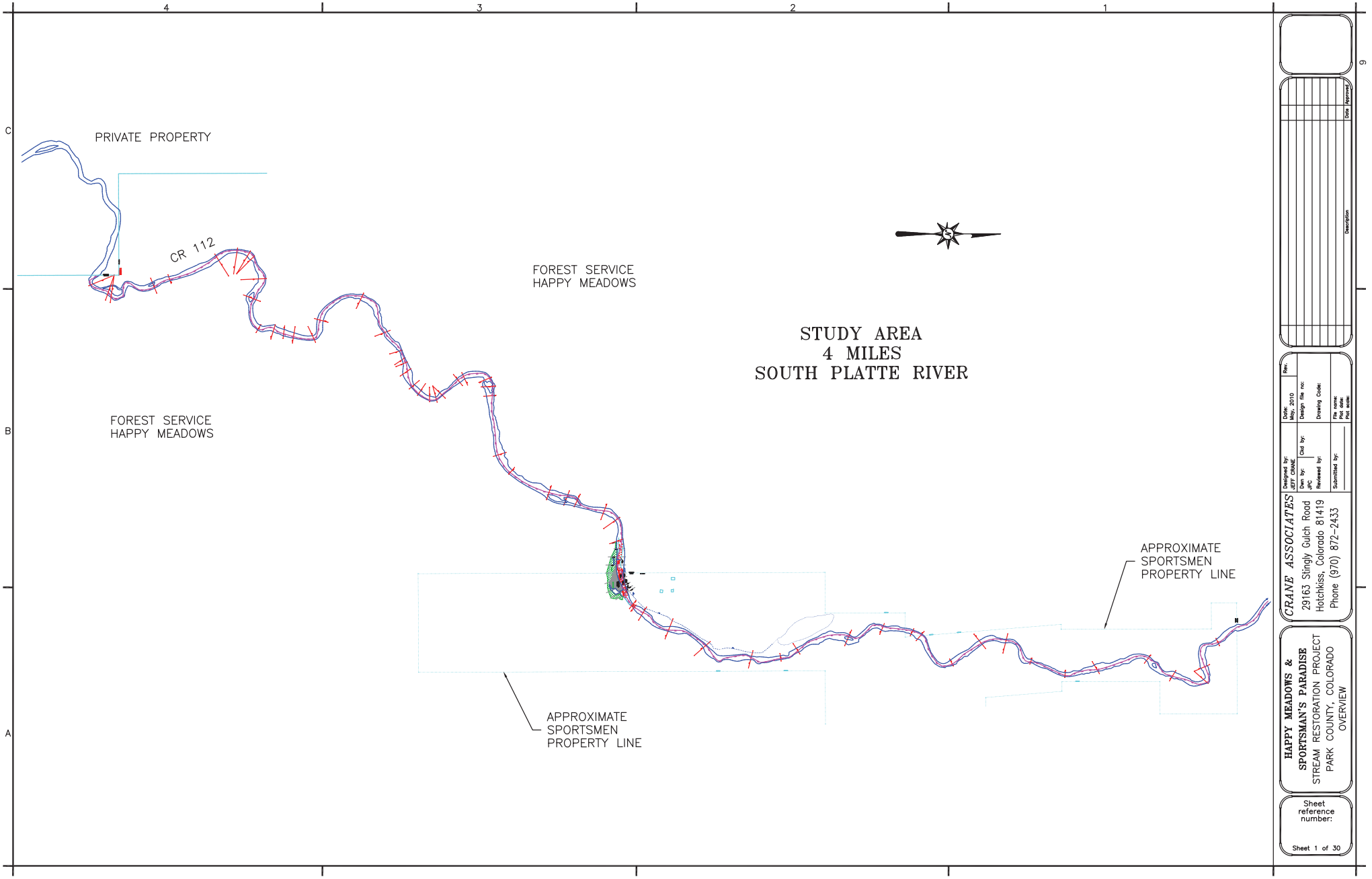
Prepared by:

Jeff Crane

140 Ash Lane
Carbondale, CO 81623
(970) 510-7026
jeffcrane@paonia.com

July 2011

PLAN VIEWS
CROSS SECTION LOCATIONS

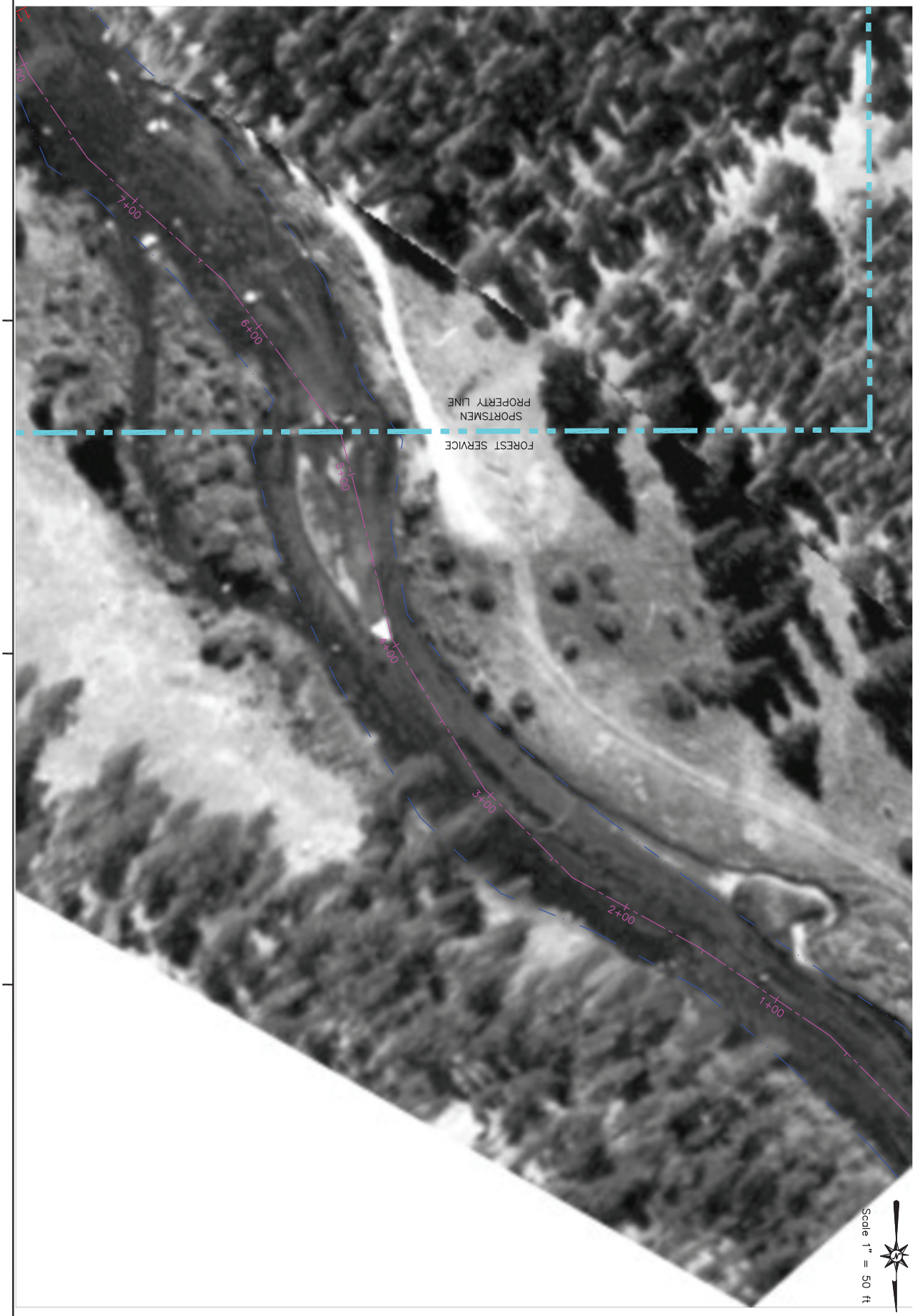


HAPPY MEADOWS & SPORTSMAN'S PARADISE
STREAM RESTORATION PROJECT
PARK COUNTY, COLORADO
OVERVIEW

Sheet reference number:
Sheet 1 of 30

CRANE ASSOCIATES
29163 Stingly Gulch Road
Hotchkiss, Colorado 81419
Phone (970) 872-2433

Designed by: JEFF CRANE
Drawn by: JPC
Checked by:
Reviewed by:
Submitted by:
Date: May, 2010
Design file no:
Drawing Code:
File name:
Plot date:
Plot scale:
Rev.
Description
Date Approved

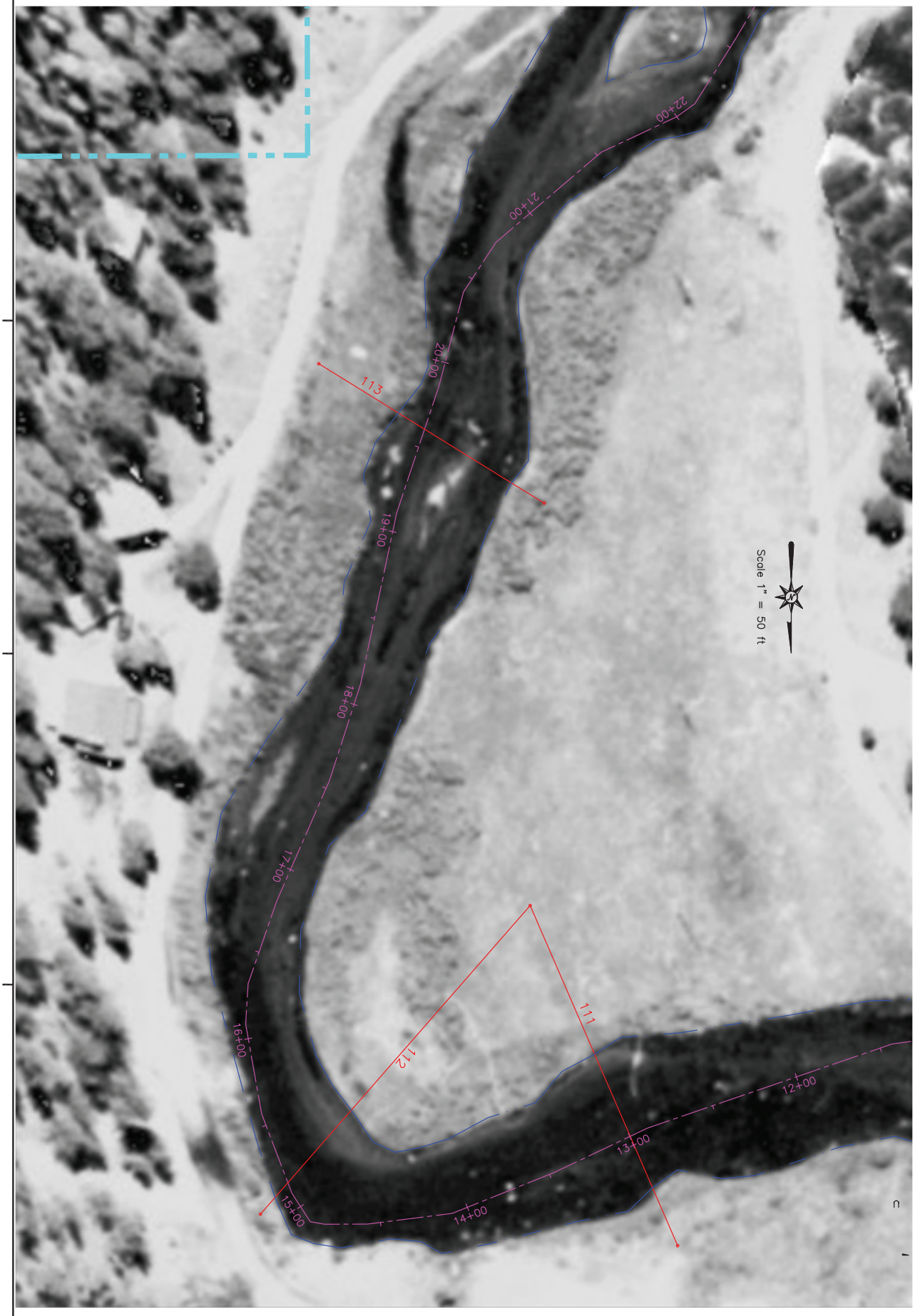


Scale 1" = 50 ft

Sheet reference number: Sheet 2 of 30	**HAPPY MEADOWS & SPORTSMAN'S PARADISE** STREAM RESTORATION PROJECT PARK COUNTY, COLORADO PLAN VIEW	*CRANE ASSOCIATES* 29163 Stingly Gulch Road Hotchkiss, Colorado 81419 Phone (970) 872-2433	Designed by: JEFF CRANE; Date: May, 2010; Rev. Dwn by: JPC; Ckd by: Reviewed by: Submitted by: Design file no: Drawing Code: File name: Plot date: Plot scale:	Description; Date; Approved



Sheet reference number: Sheet 3 of 30	HAPPY MEADOWS & SPORTSMAN'S PARADISE STREAM RESTORATION PROJECT PARK COUNTY, COLORADO PLAN VIEW	CRANE ASSOCIATES 29163 Stingly Gulch Road Hotchkiss, Colorado 81419 Phone (970) 872-2433	Designed by: JEFF CRANE Dwn by: JPC Ckd by: Reviewed by: Submitted by:	Date: May, 2010 Rev. Design file no: Drawing Code: File name: Plot date: Plot scale:	Description / Date / Approved



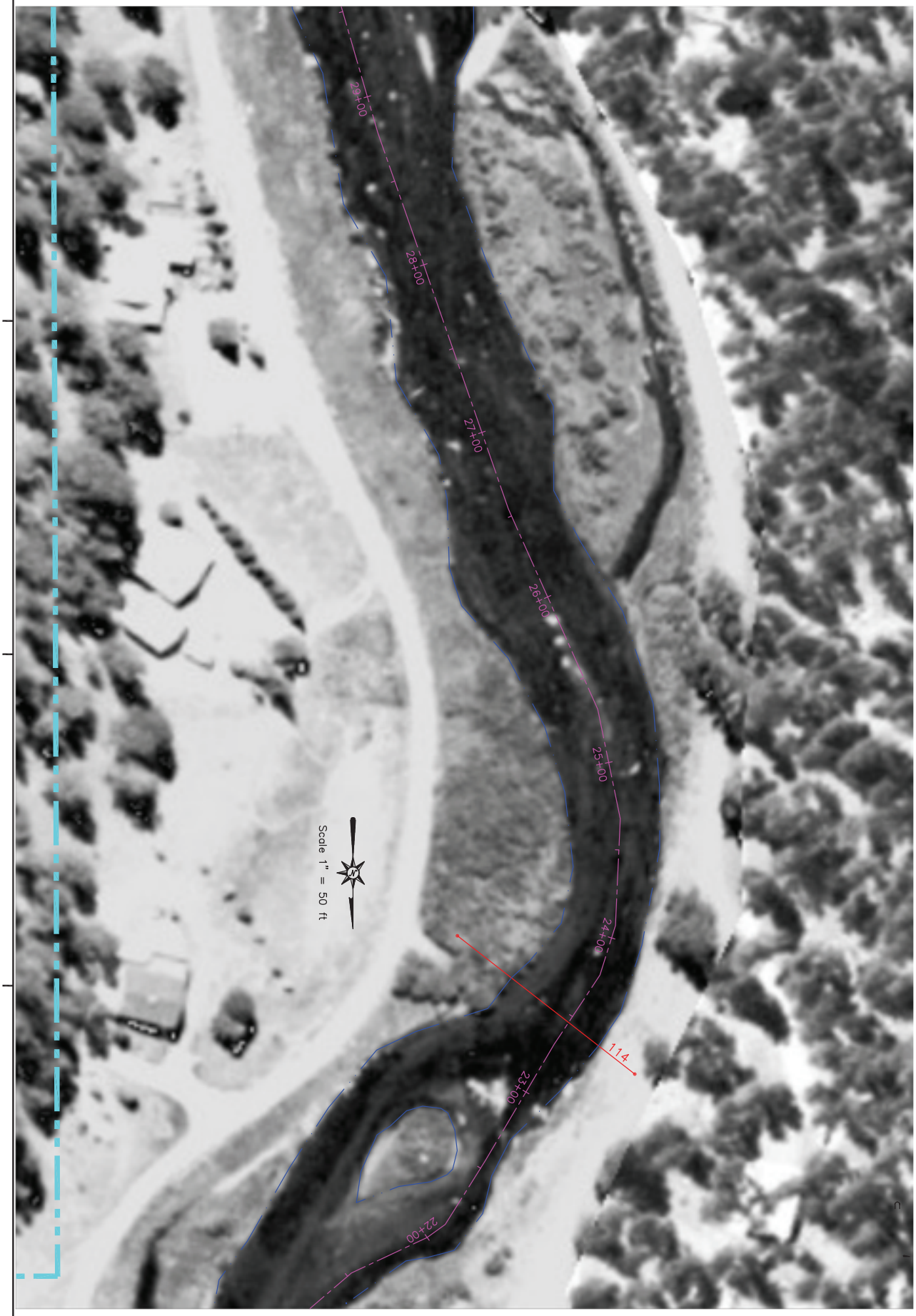
Sheet reference number: Sheet 4 of 30

HAPPY MEADOWS & SPORTSMAN'S PARADISE
STREAM RESTORATION PROJECT
PARK COUNTY, COLORADO
PLAN VIEW

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Dwn by: JPC / Ckd by:	Design file no:	
Reviewed by:	Drawing Code:	
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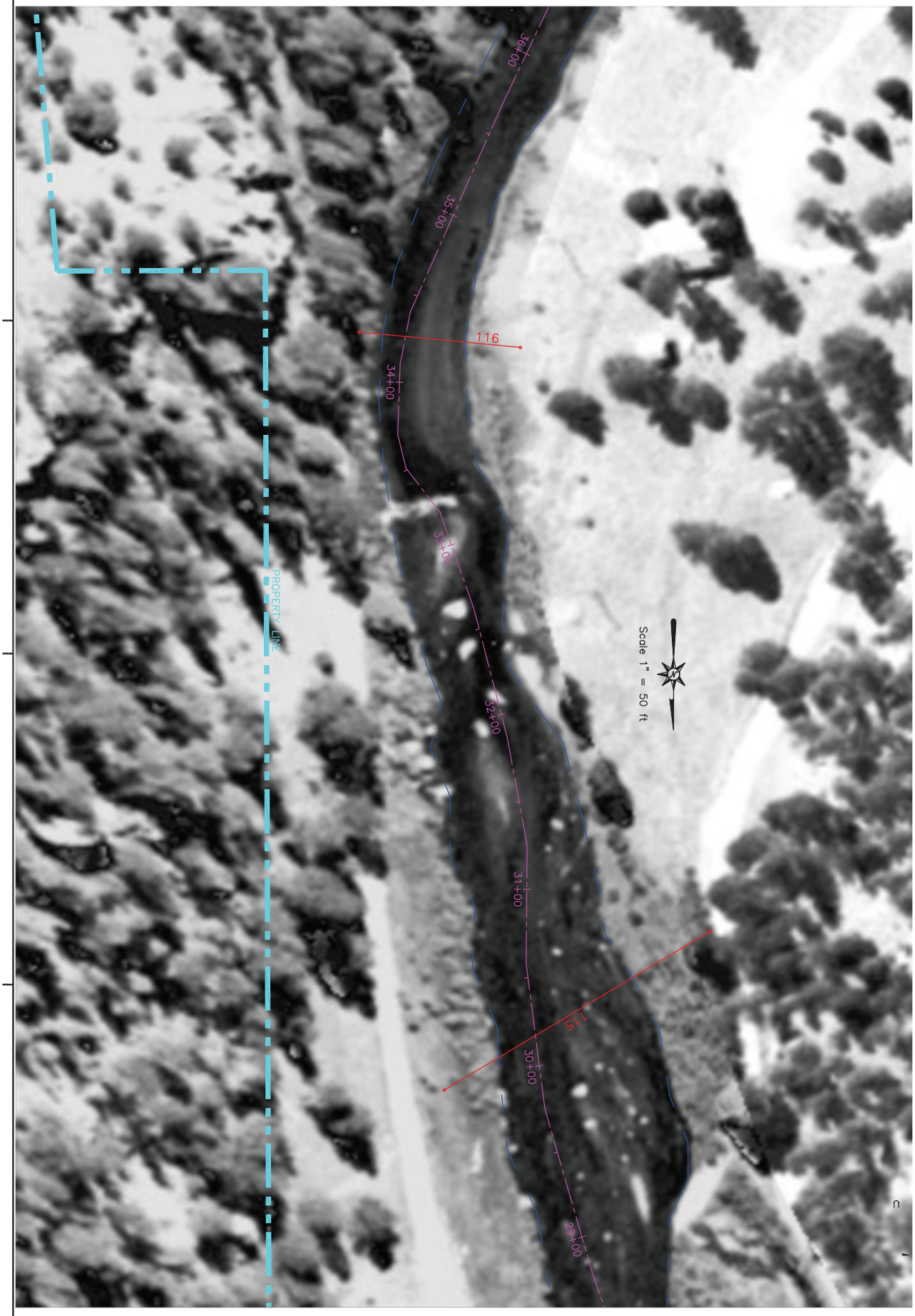
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HAPPY MEADOWS & SPORTSMAN'S PARADISE
STREAM RESTORATION PROJECT
PARK COUNTY, COLORADO
PLAN VIEW

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Reviewed by:	Drawing Code:	
Submitted by:	File name: / Plot date: / Plot scale:	

Description	Date	Approved



Sheet reference number: Sheet 6 of 30	**HAPPY MEADOWS & SPORTSMAN'S PARADISE** STREAM RESTORATION PROJECT PARK COUNTY, COLORADO PLAN VIEW	*CRANE ASSOCIATES* 29163 Stingly Gulch Road Hotchkiss, Colorado 81419 Phone (970) 872-2433	Designed by: JEFF CRANE Dwn by: JPC Ckd by: Reviewed by: Submitted by:	Date: May, 2010 Rev. Design file no: Drawing Code: File name: Plot date: Plot scale:	Description / Date / Approved



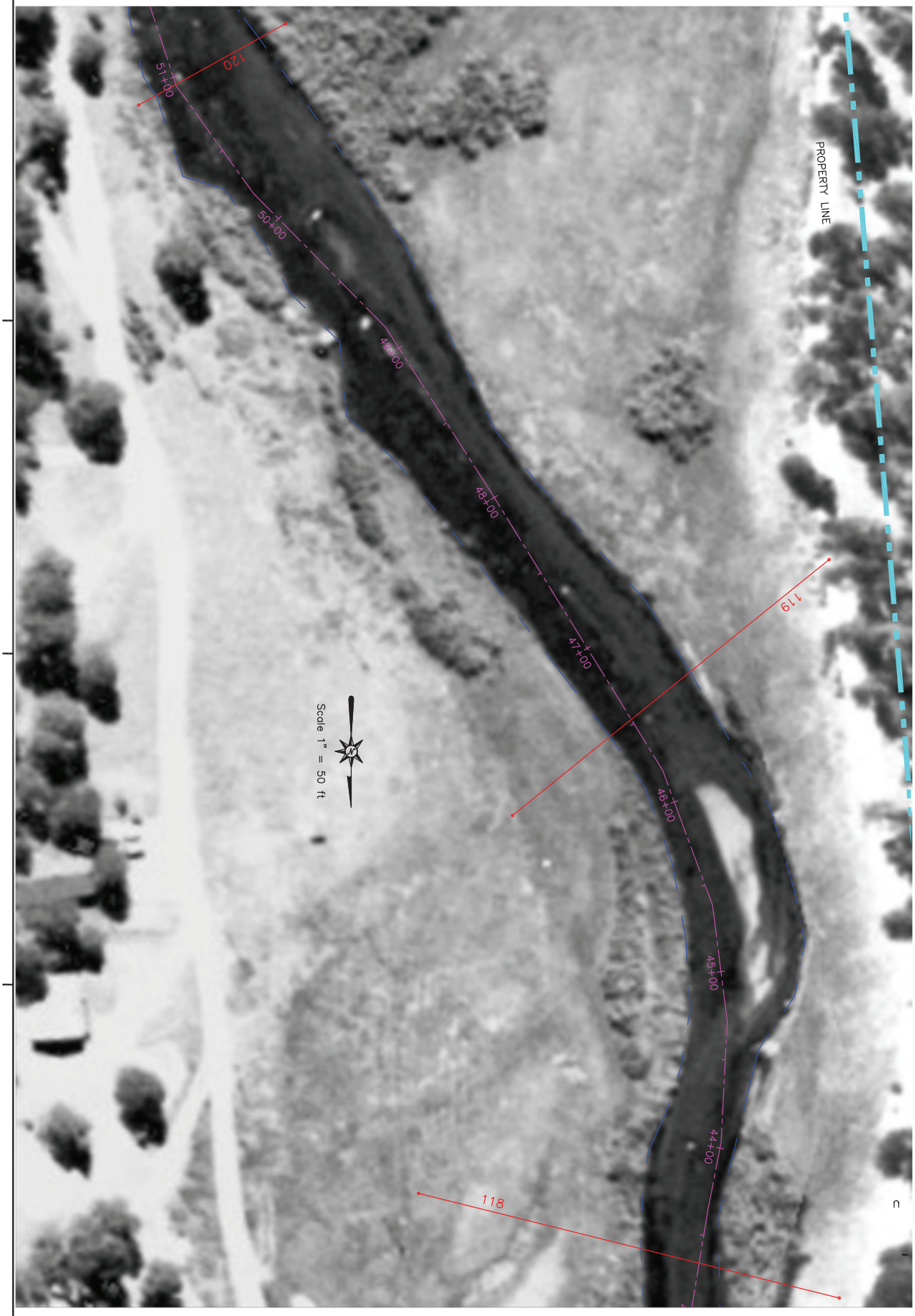
Sheet reference number: Sheet 7 of 30

HAPPY MEADOWS & SPORTSMAN'S PARADISE
STREAM RESTORATION PROJECT
PARK COUNTY, COLORADO
PLAN VIEW

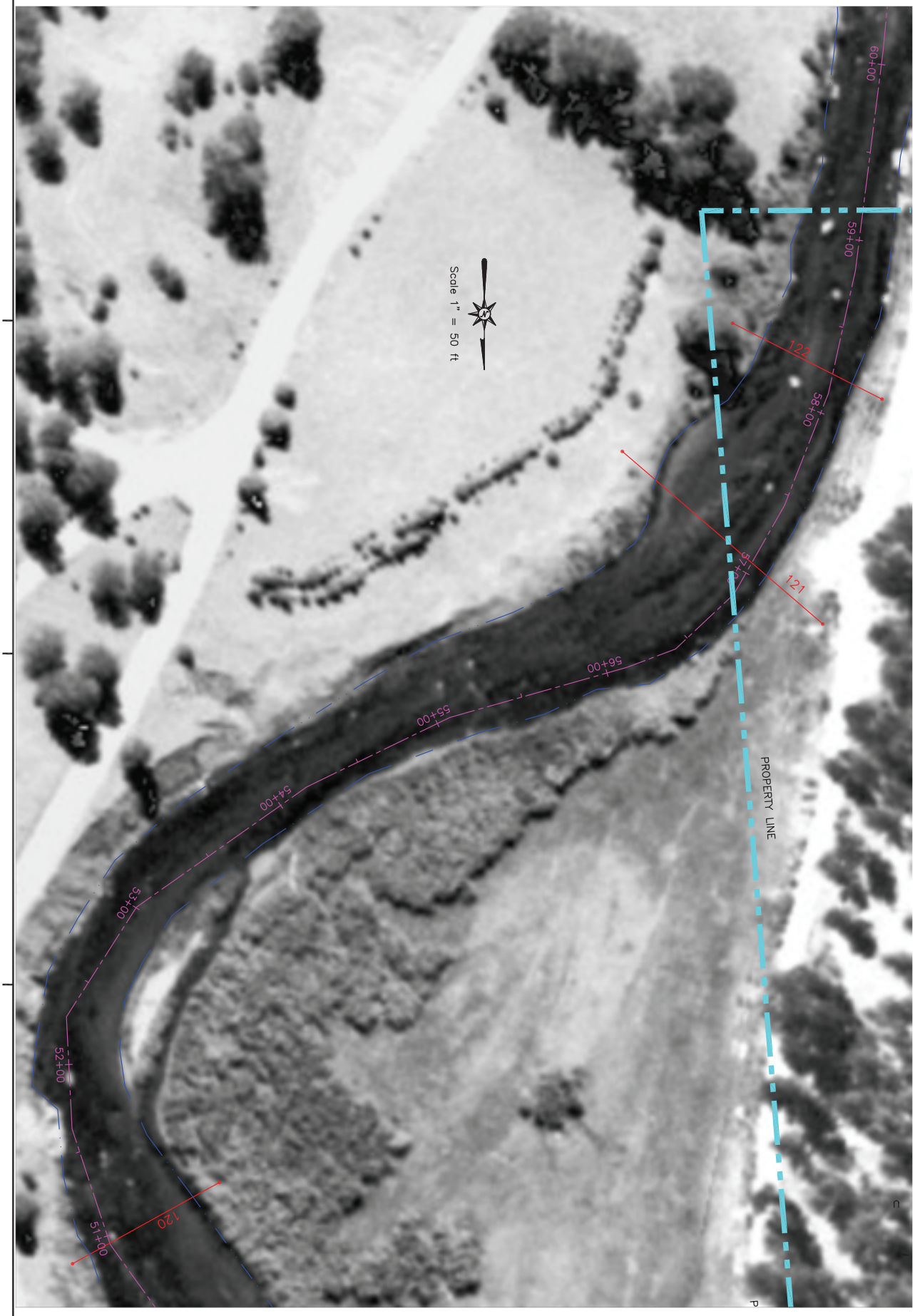
CRANE ASSOCIATES
29163 Stingly Gulch Road
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Dwn by: JPC / Ckd by:	Design file no:	
Reviewed by:	Drawing Code:	
Submitted by:	File name: / Plot date: / Plot scale:	

Description	Date	Approved



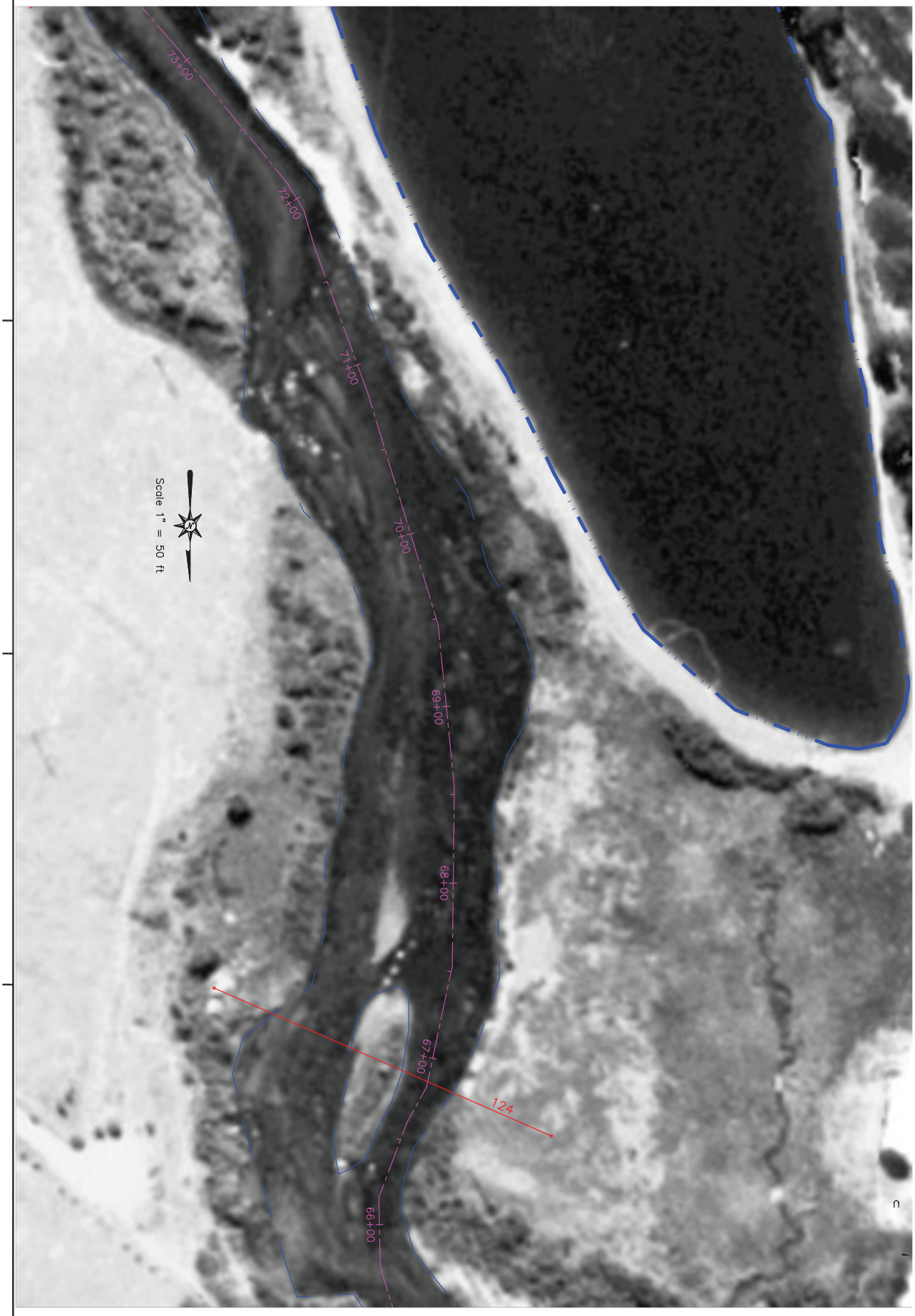
Sheet reference number: Sheet 8 of 30	**HAPPY MEADOWS & SPORTSMAN'S PARADISE** STREAM RESTORATION PROJECT PARK COUNTY, COLORADO PLAN VIEW	*CRANE ASSOCIATES* 29163 Stingly Gulch Road Hotchkiss, Colorado 81419 Phone (970) 872-2433	Designed by: JEFF CRANE Dwn by: JPC Ckd by: Reviewed by: Submitted by:	Date: May, 2010 Rev. Design file no: Drawing Code: File name: Plot date: Plot scale:	Description Date Approved



Sheet reference number: Sheet 9 of 30	**HAPPY MEADOWS & SPORTSMAN'S PARADISE** STREAM RESTORATION PROJECT PARK COUNTY, COLORADO PLAN VIEW	*CRANE ASSOCIATES* 29163 Stingly Gulch Road Hotchkiss, Colorado 81419 Phone (970) 872-2433	Designed by: JEFF CRANE Dwn by: JPC Ckd by: Reviewed by: Submitted by:	Date: May, 2010 Rev. Design file no: Drawing Code: File name: Plot date: Plot scale:	Description / Date / Approved



Sheet reference number: Sheet 10 of 30	**HAPPY MEADOWS & SPORTSMAN'S PARADISE** STREAM RESTORATION PROJECT PARK COUNTY, COLORADO PLAN VIEW	*CRANE ASSOCIATES* 29163 Stingly Gulch Road Hotchkiss, Colorado 81419 Phone (970) 872-2433	Designed by: JEFF CRANE Dwn by: JPC Ckd by: Reviewed by: Submitted by:	Date: May, 2010 Rev. Design file no: Drawing Code: File name: Plot date: Plot scale:	Description / Date / Approved



Sheet reference number: Sheet 11 of 30

HAPPY MEADOWS & SPORTSMAN'S PARADISE
STREAM RESTORATION PROJECT
PARK COUNTY, COLORADO
PLAN VIEW

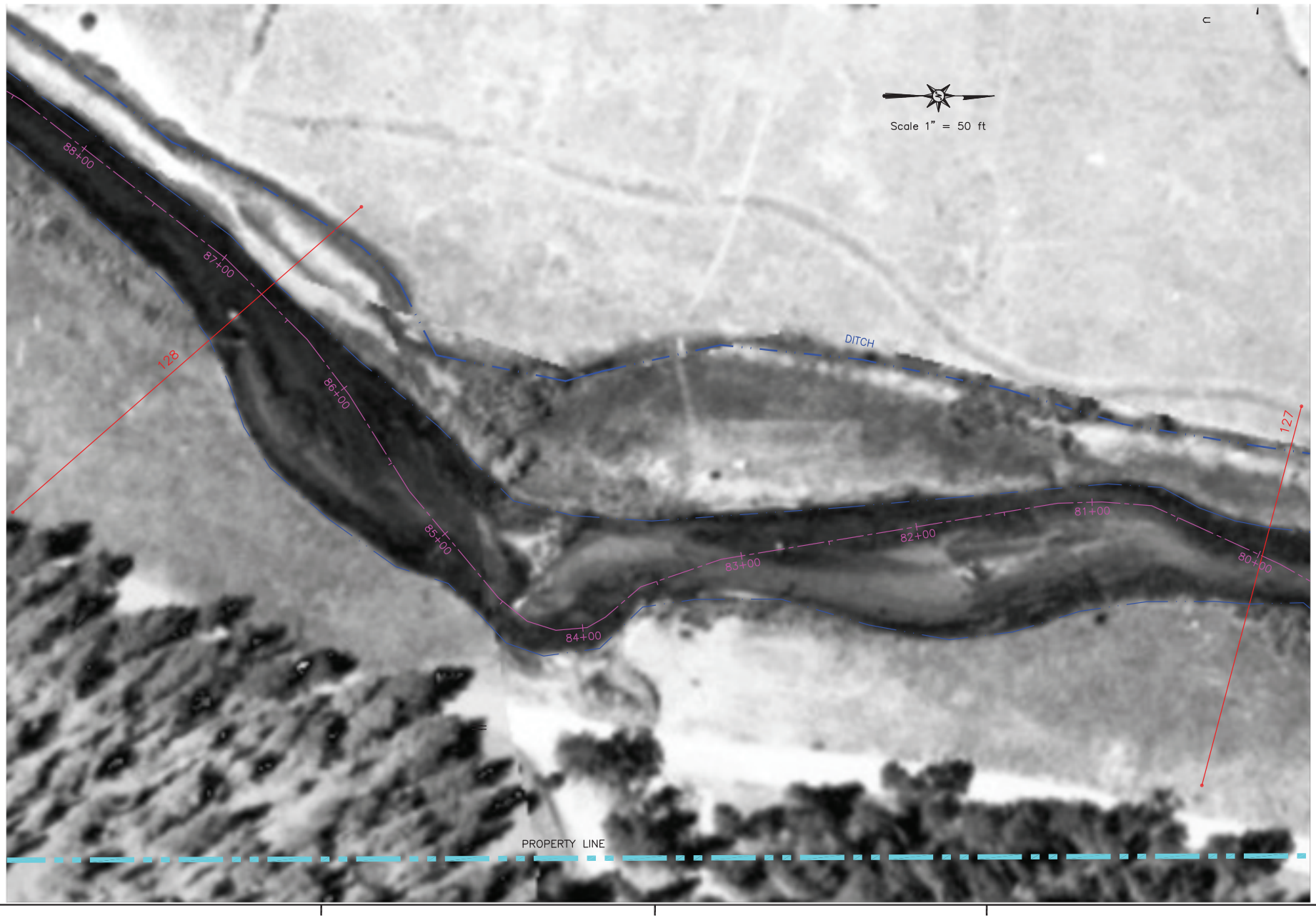
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Designed by: JEFF CRANE	Date: May, 2010	Rev.
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Sheet reference number: Sheet 12 of 30	**HAPPY MEADOWS & SPORTSMAN'S PARADISE** STREAM RESTORATION PROJECT PARK COUNTY, COLORADO PLAN VIEW	*CRANE ASSOCIATES* 29163 Stingly Gulch Road Hotchkiss, Colorado 81419 Phone (970) 872-2433	Designed by: JEFF CRANE Dwn by: JPC Ckd by: Reviewed by: Submitted by:	Date: May, 2010 Rev. Design file no: Drawing Code: File name: Plot date: Plot scale:	Description / Date / Approved



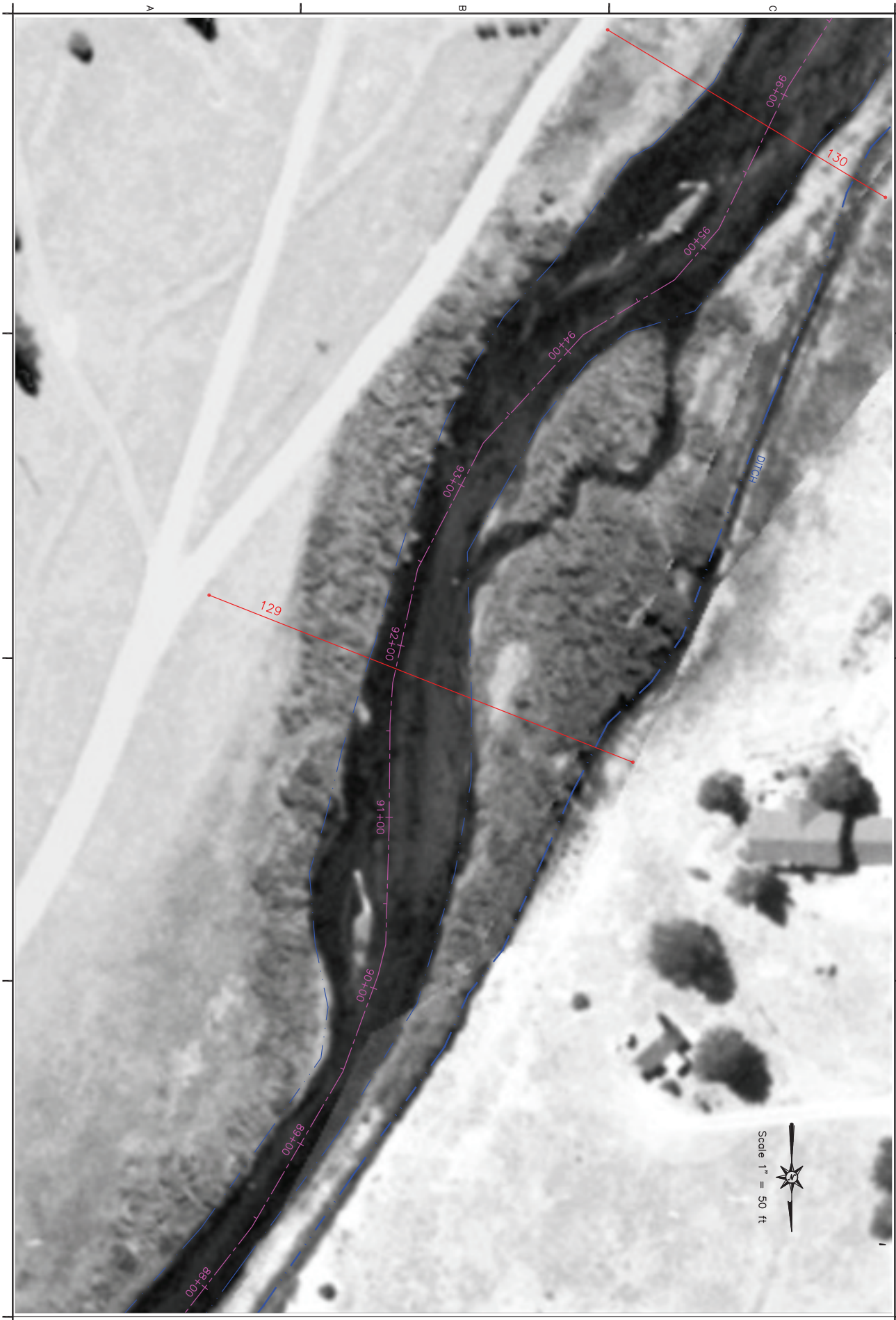
HAPPY MEADOWS & SPORTSMAN'S PARADISE
STREAM RESTORATION PROJECT
PARK COUNTY, COLORADO
PLAN VIEW

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Designed by: JEFF CRANE
Drawn by: JPC
Checked by:
Reviewed by:
Submitted by:
Date: May, 2010
Design file no:
Drawing Code:
File name:
Plot date:
Plot scale:
Rev.
Description
Date
Approved

Sheet reference number:
Sheet 13 of 30

21



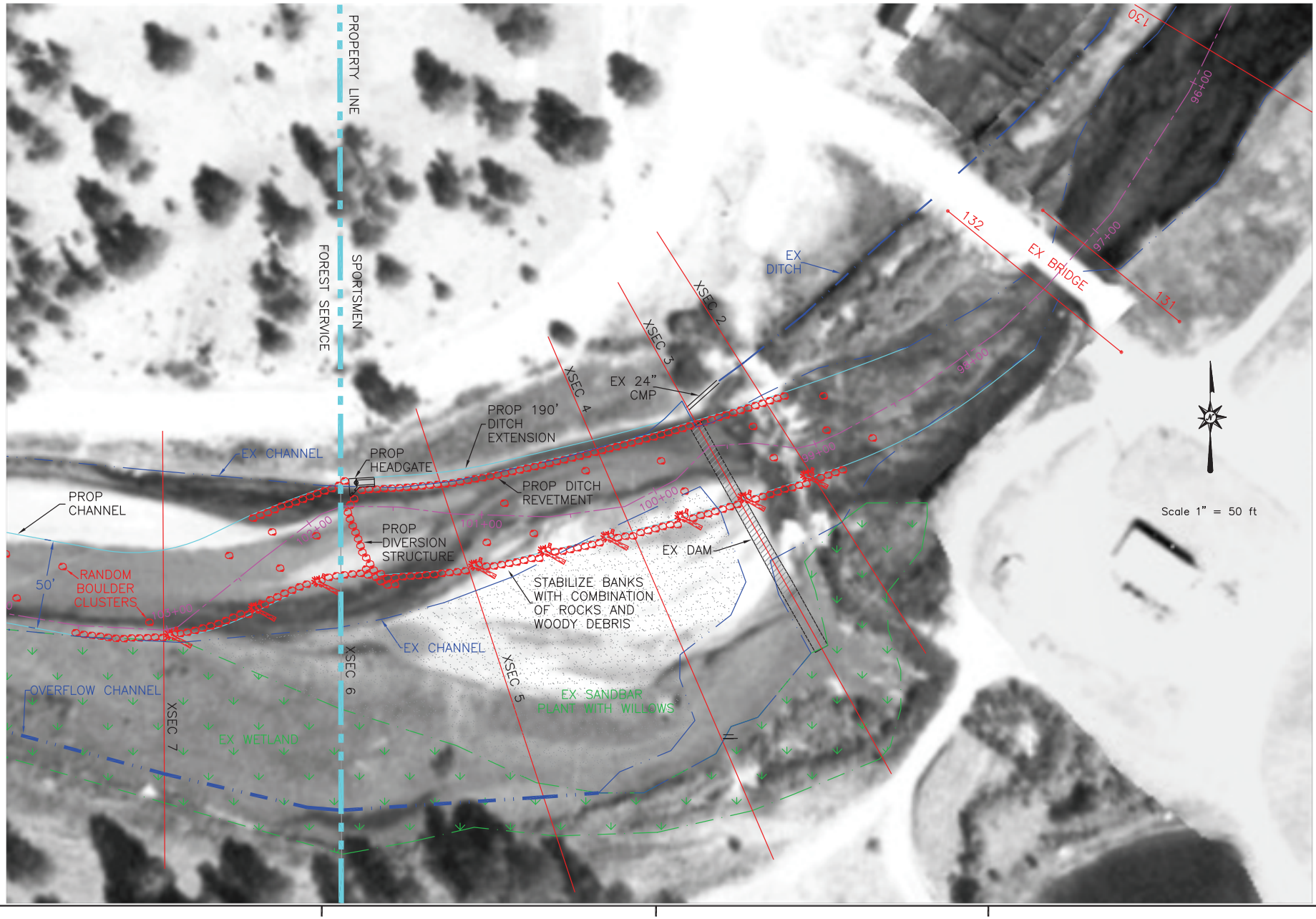
Sheet reference number: Sheet 14 of 30

HAPPY MEADOWS & SPORTSMAN'S PARADISE
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Reviewed by:	Drawing Code:	
Submitted by:	File name: / Plot date: / Plot scale:	

Description	Date	Approved

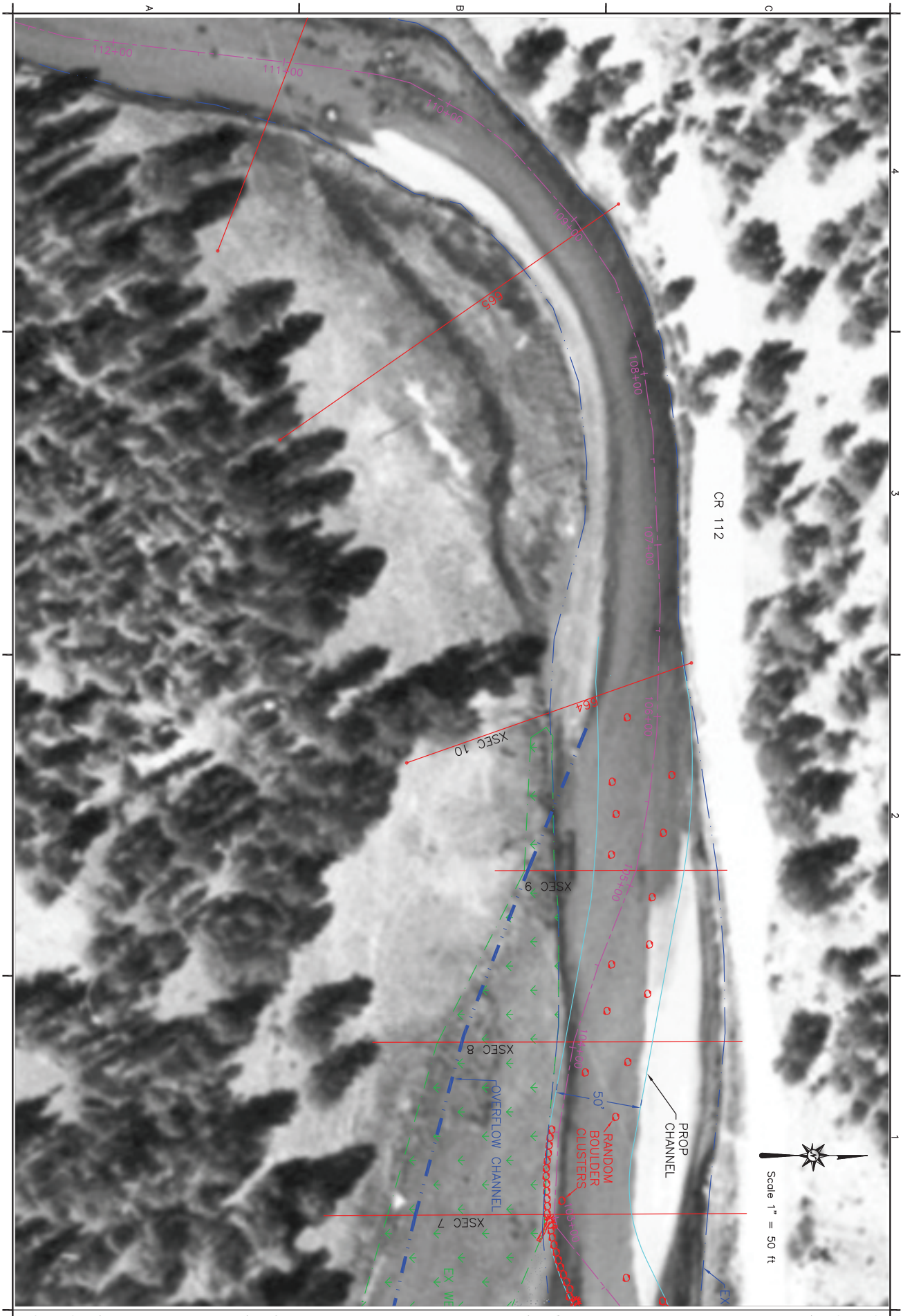


Designed by: JEFF CRANE	Dwn by: JPC	Chd by:	Rev.
Date: May, 2010	Design file no:	Drawing Code:	
Submitted by:	Reviewed by:	File name: Plot date: Plot scale:	

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HAPPY MEADOWS & SPORTSMAN'S PARADISE
STREAM RESTORATION PROJECT
PARK COUNTY, COLORADO
PLAN VIEW

Sheet reference number:
Sheet 15 of 30



Sheet reference number: Sheet 16 of 130	**HAPPY MEADOWS & SPORTSMAN'S PARADISE** STREAM RESTORATION PROJECT PARK COUNTY, COLORADO PLAN VIEW	*CRANE ASSOCIATES* 29163 Stingly Gulch Road Hotchkiss, Colorado 81419 Phone (970) 872-2433	Designed by: JEFF CRANE Dwn by: JPC Ckd by: Reviewed by: Submitted by:	Date: May, 2010 Rev. Design file no: Drawing Code: File name: Plot date: Plot scale:	Description / Date / Approved



Sheet reference number: Sheet 17 of 30	**HAPPY MEADOWS & SPORTSMAN'S PARADISE** STREAM RESTORATION PROJECT PARK COUNTY, COLORADO PLAN VIEW	*CRANE ASSOCIATES* 29163 Stingly Gulch Road Hotchkiss, Colorado 81419 Phone (970) 872-2433	Designed by: JEFF CRANE Dwn by: JPC Ckd by: Reviewed by: Submitted by:	Date: May, 2010 Rev. Design file no: Drawing Code: File name: Plot date: Plot scale:	Description / Date / Approved



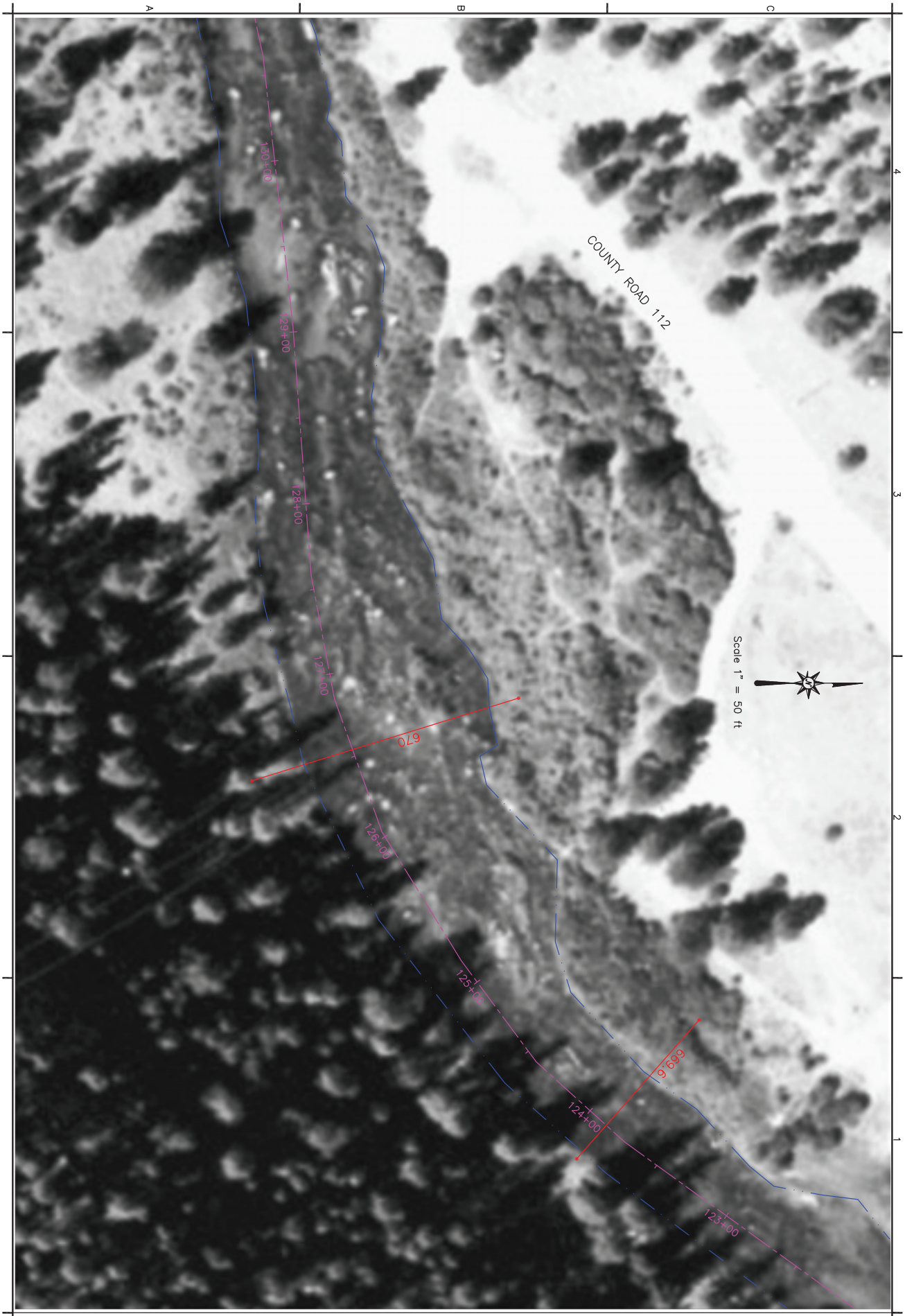
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HAPPY MEADOWS & SPORTSMAN'S PARADISE
STREAM RESTORATION PROJECT
PARK COUNTY, COLORADO
PLAN VIEW

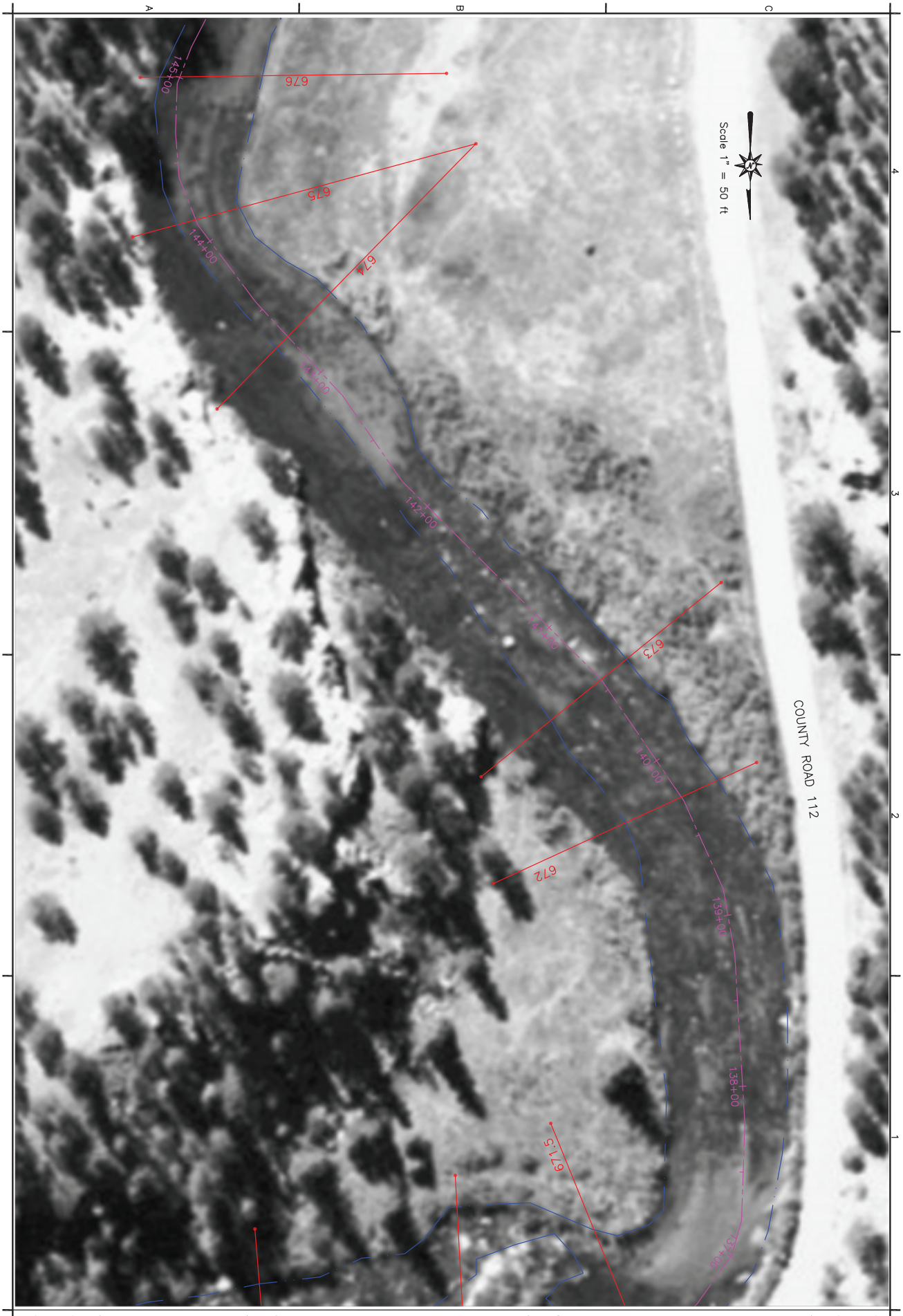
CRANE ASSOCIATES
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Designed by: JEFF CRANE	Date: May, 2010	Rev.
Dwn by: JPC / Ckd by:	Design file no:	
Reviewed by:	Drawing Code:	
Submitted by:	File name: / Plot date: / Plot scale:	

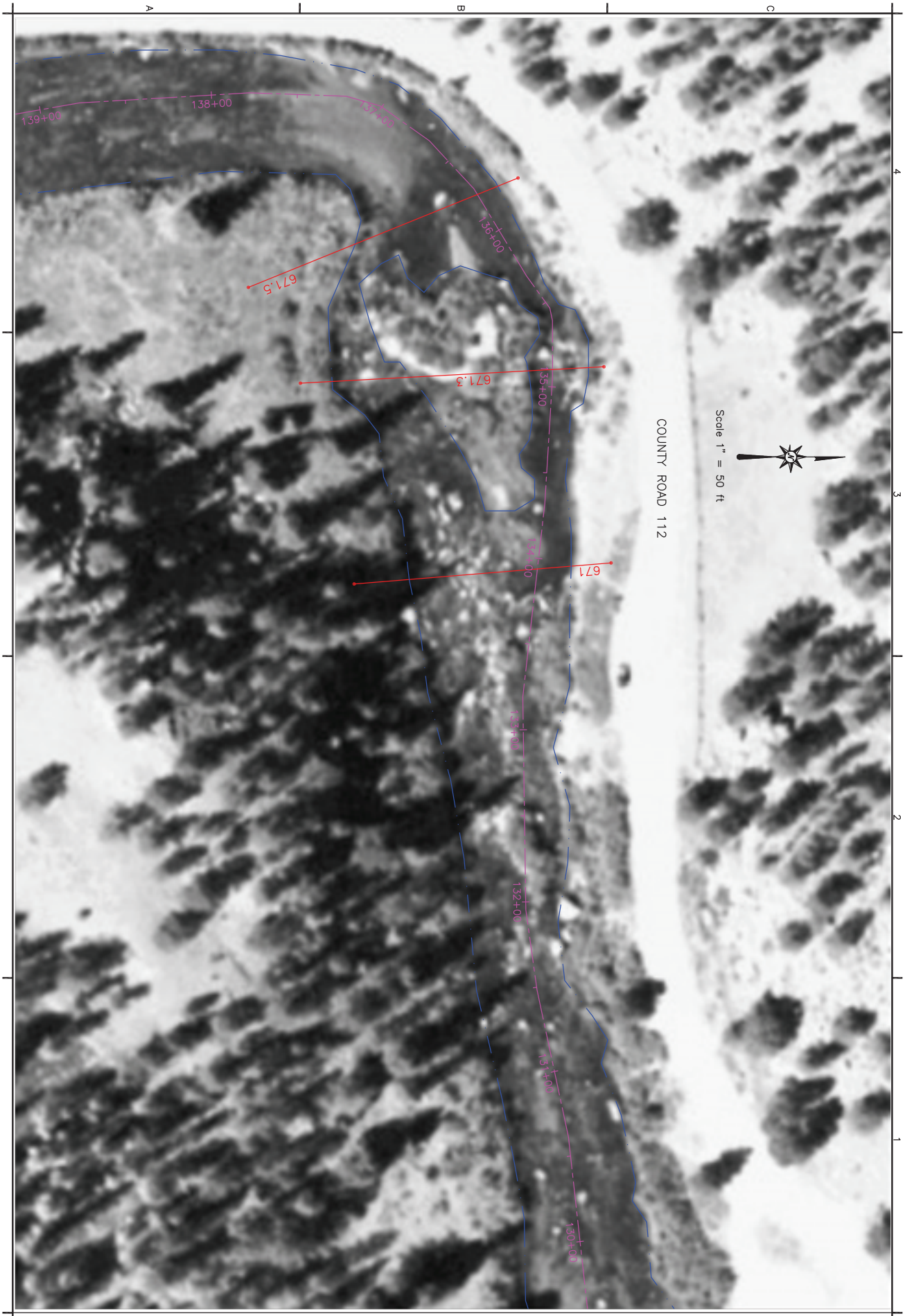
Description	Date	Approved



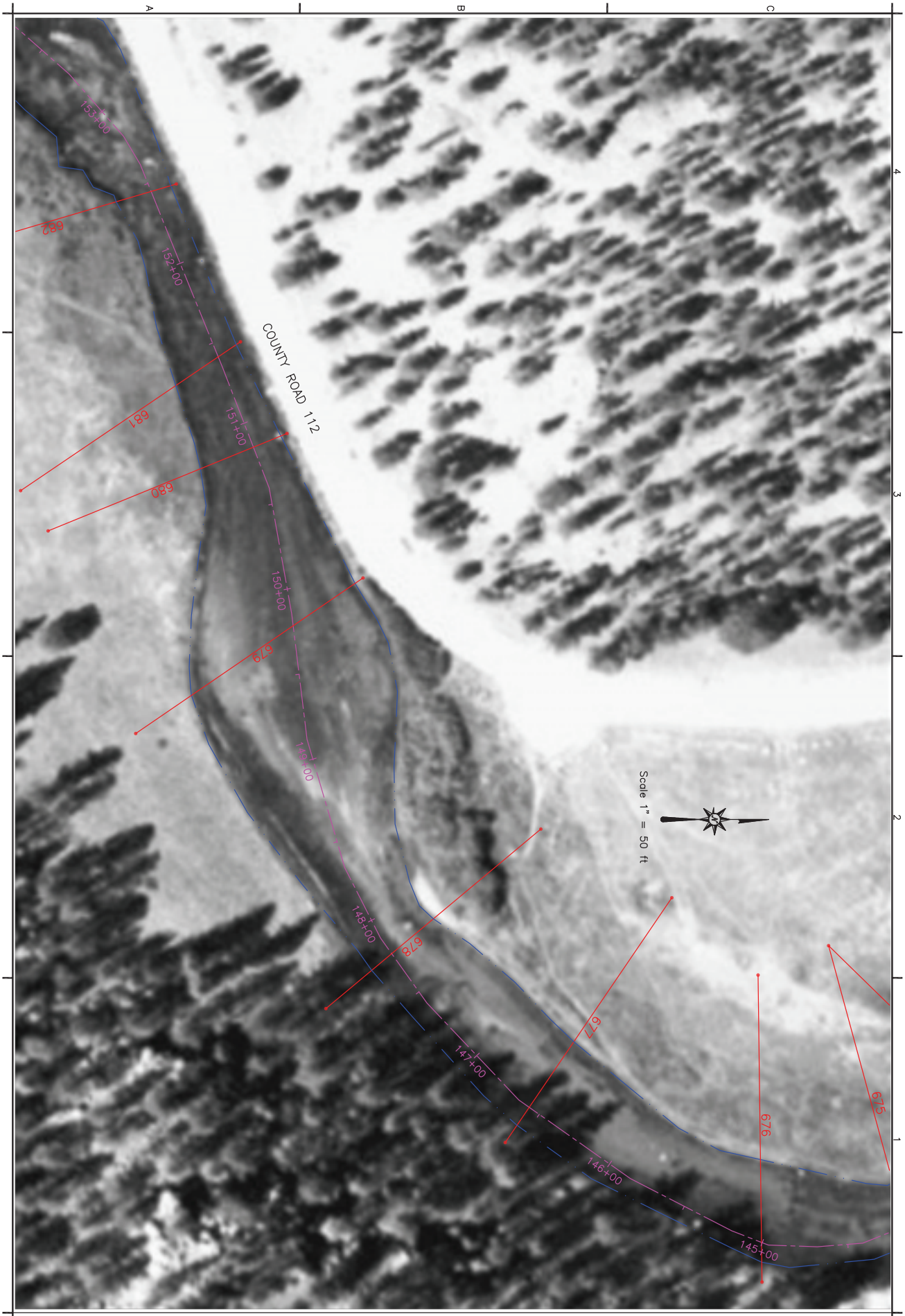
Sheet reference number: Sheet 19 of 30	**HAPPY MEADOWS & SPORTSMAN'S PARADISE** STREAM RESTORATION PROJECT PARK COUNTY, COLORADO PLAN VIEW	*CRANE ASSOCIATES* 29163 Stingly Gulch Road Hotchkiss, Colorado 81419 Phone (970) 872-2433	Designed by: JEFF CRANE Dwn by: JPC Ckd by: Reviewed by: Submitted by:	Date: May, 2010 Rev. Design file no: Drawing Code: File name: Plot date: Plot scale:	Description / Date / Approved



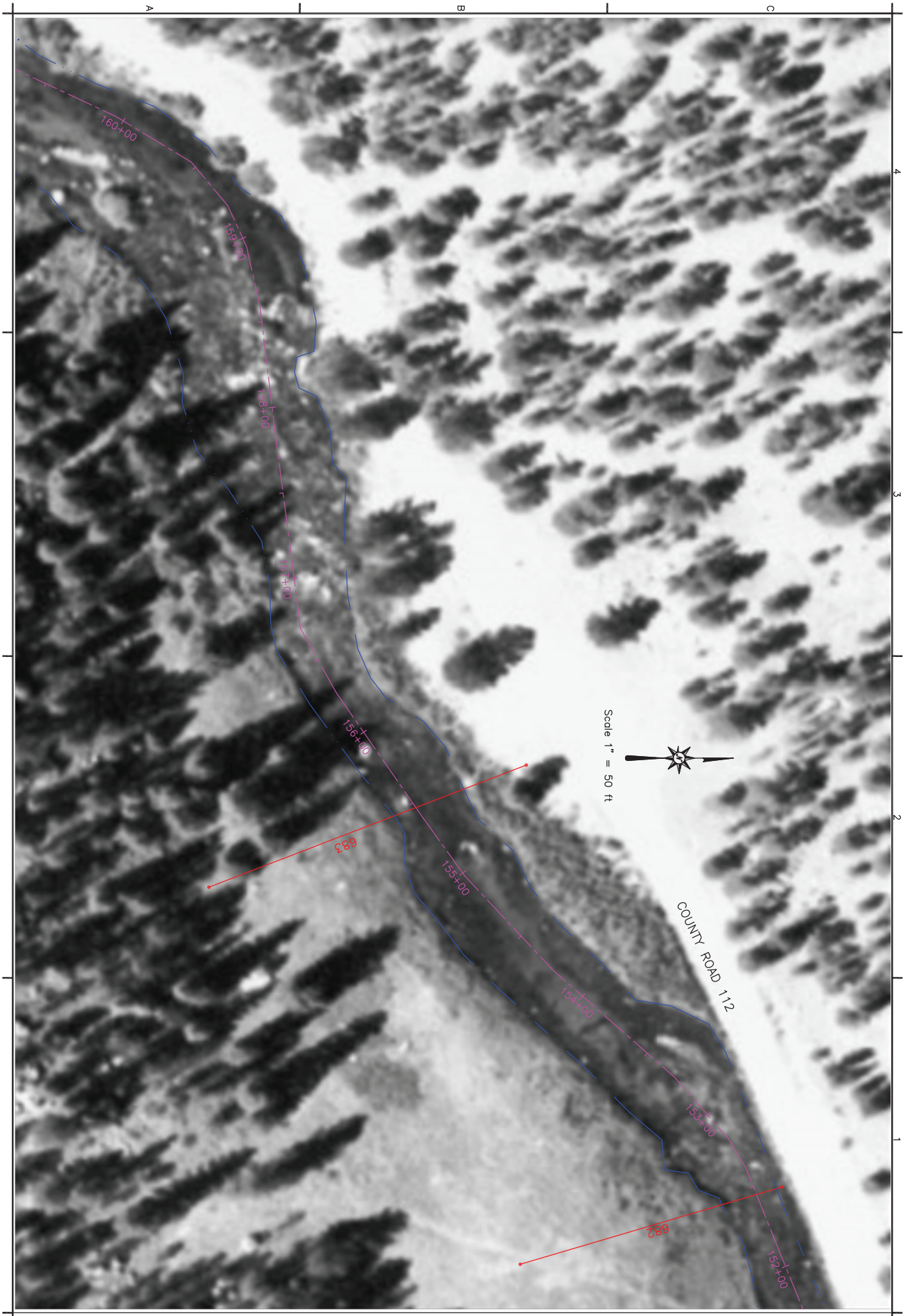
Sheet reference number: Sheet 21 of 30	**HAPPY MEADOWS & SPORTSMAN'S PARADISE** STREAM RESTORATION PROJECT PARK COUNTY, COLORADO PLAN VIEW	*CRANE ASSOCIATES* 29163 Stingly Gulch Road Hotchkiss, Colorado 81419 Phone (970) 872-2433	Designed by: JEFF CRANE Date: May, 2010 Rev. Dwn by: JPC Ckd by: Design file no: Reviewed by: Drawing Code: Submitted by: File name: Plot date: Plot scale:	Description Date Approved



Sheet reference number: Sheet 20 of 30	**HAPPY MEADOWS & SPORTSMAN'S PARADISE** STREAM RESTORATION PROJECT PARK COUNTY, COLORADO PLAN VIEW	*CRANE ASSOCIATES* 29163 Stingly Gulch Road Hotchkiss, Colorado 81419 Phone (970) 872-2433	Designed by: JEFF CRANE Dwn by: JPC Ckd by: Reviewed by: Submitted by:	Date: May, 2010 Rev. Design file no: Drawing Code: File name: Plot date: Plot scale:	Description / Date / Approved



Sheet reference number: Sheet 22 of 30	**HAPPY MEADOWS & SPORTSMAN'S PARADISE** STREAM RESTORATION PROJECT PARK COUNTY, COLORADO PLAN VIEW	*CRANE ASSOCIATES* 29163 Stingly Gulch Road Hotchkiss, Colorado 81419 Phone (970) 872-2433	Designed by: JEFF CRANE Dwn by: JPC Ckd by: Reviewed by: Submitted by:	Date: May, 2010 Rev. Design file no: Drawing Code: File name: Plot date: Plot scale:	Description / Date / Approved



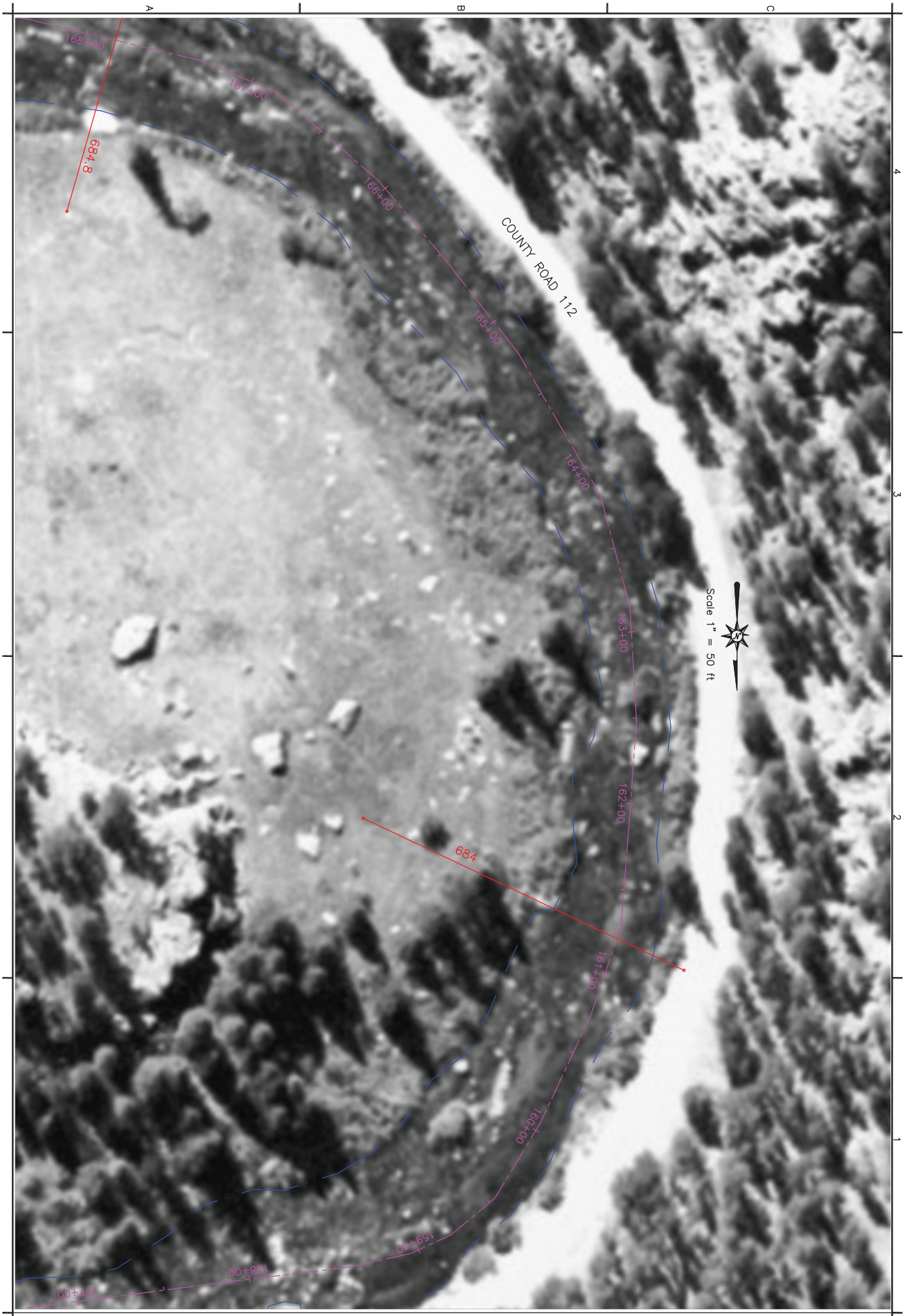
Sheet reference number: Sheet 23 of 30

HAPPY MEADOWS & SPORTSMAN'S PARADISE
STREAM RESTORATION PROJECT
PARK COUNTY, COLORADO
PLAN VIEW

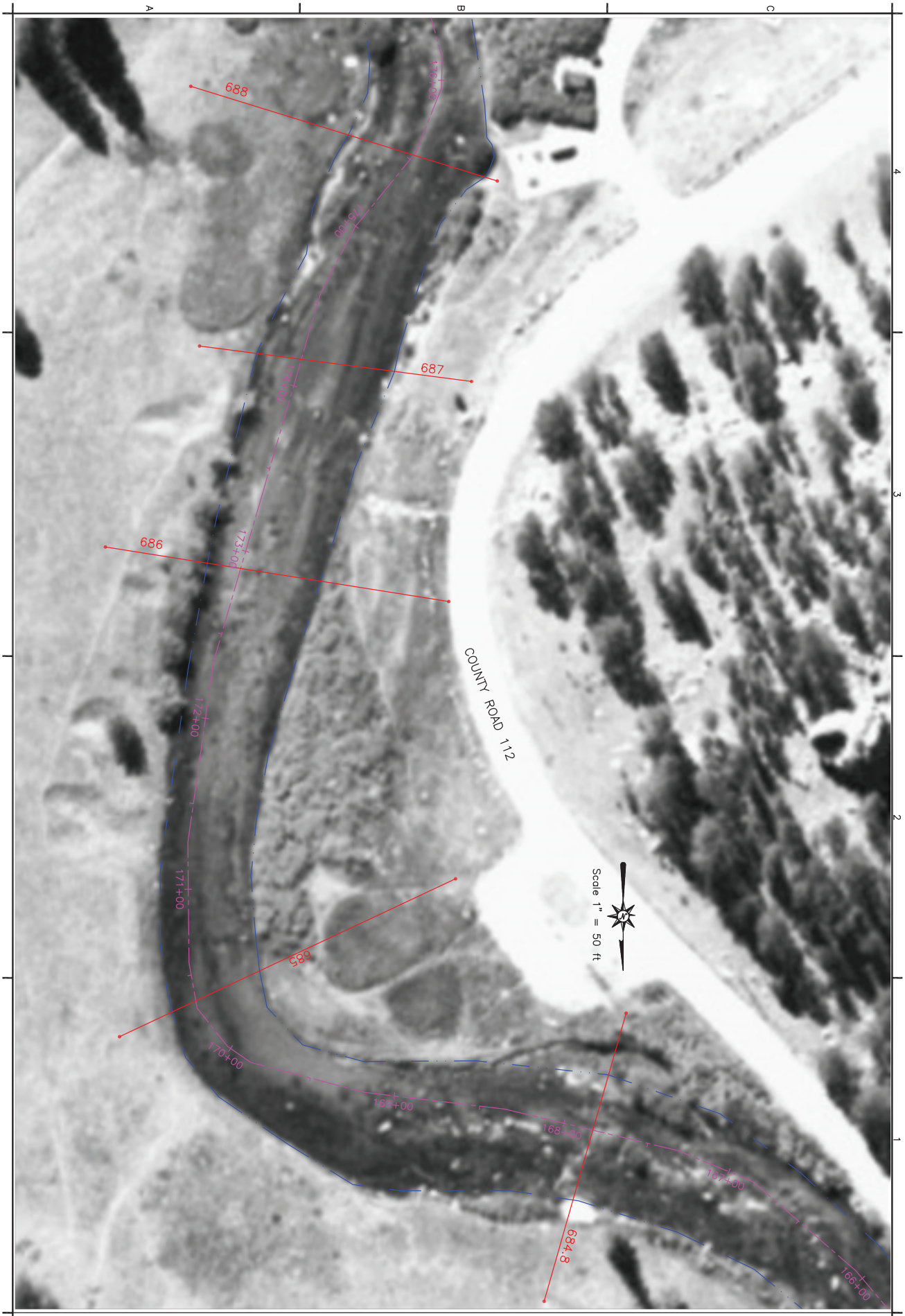
CRANE ASSOCIATES
29163 Stingly Gulch Road
Hotchkiss, Colorado 81419
Phone (970) 872-2433

Designed by: JEFF CRANE	Date: May, 2010	Rev.
Dwn by: JPC / Ckd by:	Design file no:	
Reviewed by:	Drawing Code:	
Submitted by:	File name: / Plot date: / Plot scale:	

Description	Date	Approved



Sheet reference number: Sheet 24 of 30	**HAPPY MEADOWS & SPORTSMAN'S PARADISE** STREAM RESTORATION PROJECT PARK COUNTY, COLORADO PLAN VIEW	*CRANE ASSOCIATES* 29163 Stingly Gulch Road Hotchkiss, Colorado 81419 Phone (970) 872-2433	Designed by: JEFF CRANE Dwn by: JPC Ckd by: Reviewed by: Submitted by:	Date: May, 2010 Rev. Design file no: Drawing Code: File name: Plot date: Plot scale:	Description / Date / Approved



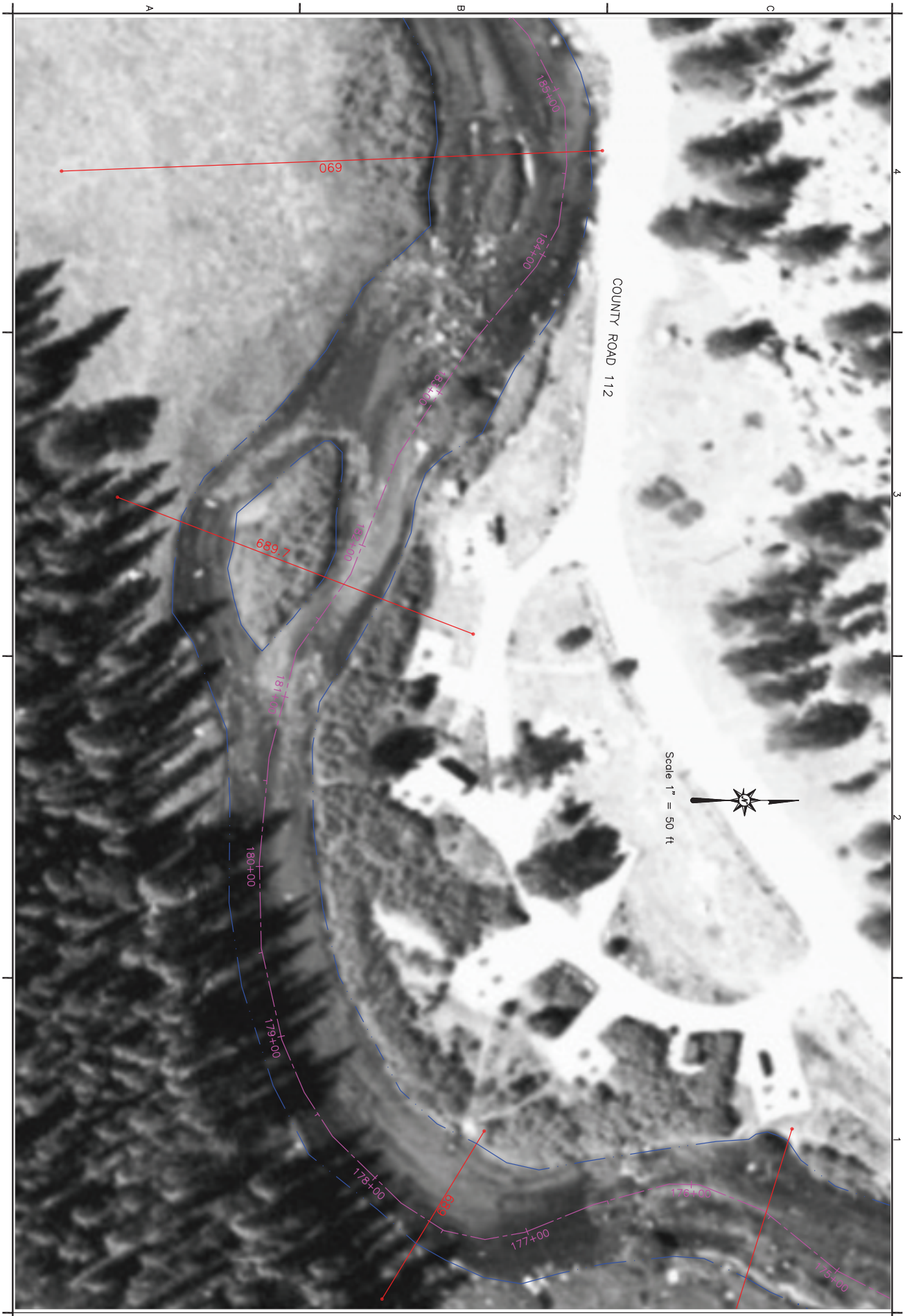
Sheet reference number: Sheet 25 of 30

HAPPY MEADOWS & SPORTSMAN'S PARADISE
STREAM RESTORATION PROJECT
PARK COUNTY, COLORADO
PLAN VIEW

CRANE ASSOCIATES
29163 Stingly Gulch Road
Hotchkiss, Colorado 81419
Phone (970) 872-2433

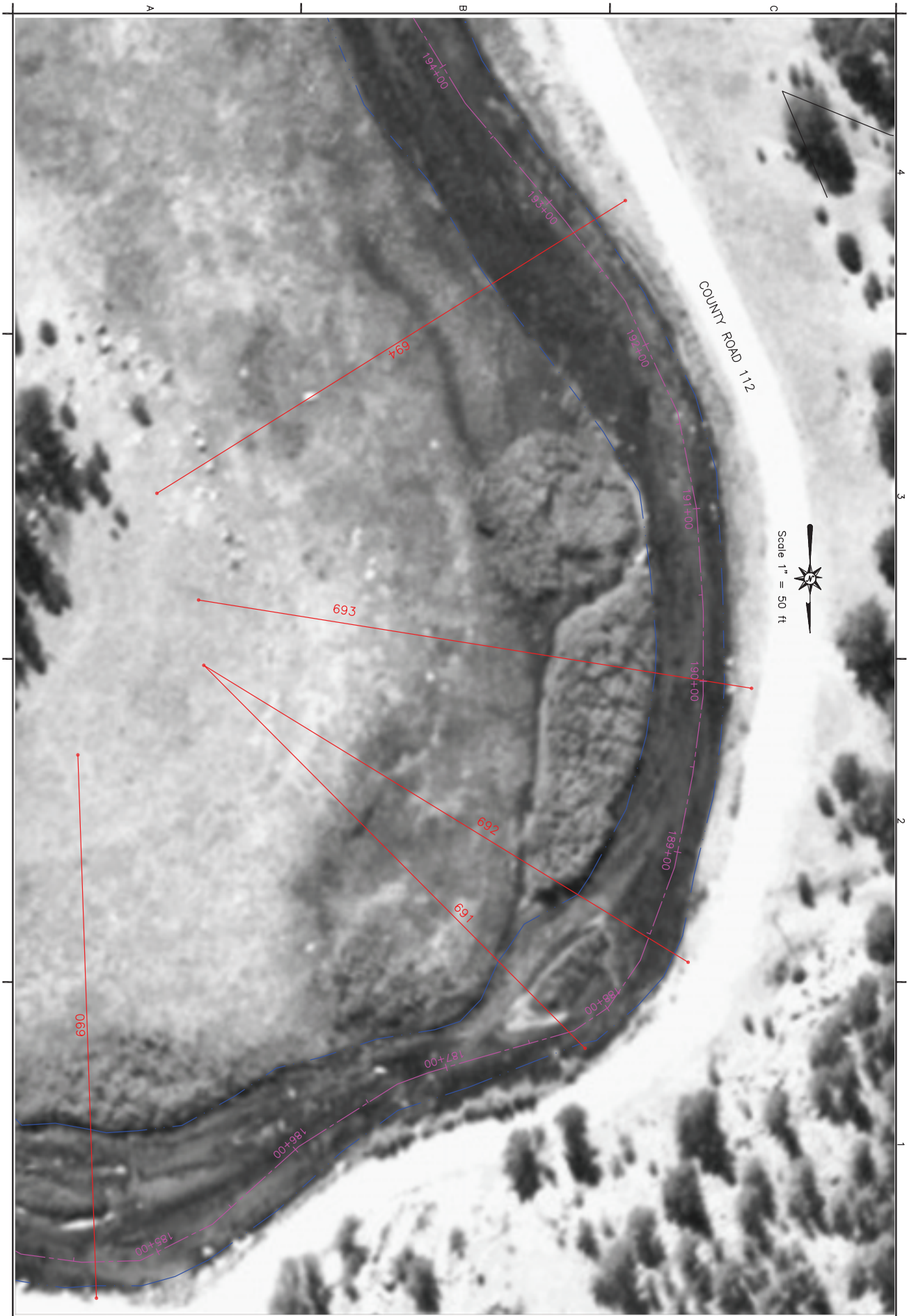
Designed by: JEFF CRANE	Date: May, 2010	Rev.
Dwn by: JPC / Ckd by:	Design file no:	
Reviewed by:	Drawing Code:	
Submitted by:	File name: / Plot date: / Plot scale:	

Description	Date	Approved



Sheet reference number:	HAPPY MEADOWS & SPORTSMAN'S PARADISE STREAM RESTORATION PROJECT PARK COUNTY, COLORADO PLAN VIEW	CRANE ASSOCIATES 29163 Stingly Gulch Road Hotchkiss, Colorado 81419 Phone (970) 872-2433	Designed by: JEFF CRANE Drn by: JPC Ckd by: Reviewed by: Submitted by: Date: May, 2010 Rev. Design file no: Drawing Code: File name: Plot date: Plot scale:	Description / Date / Approved

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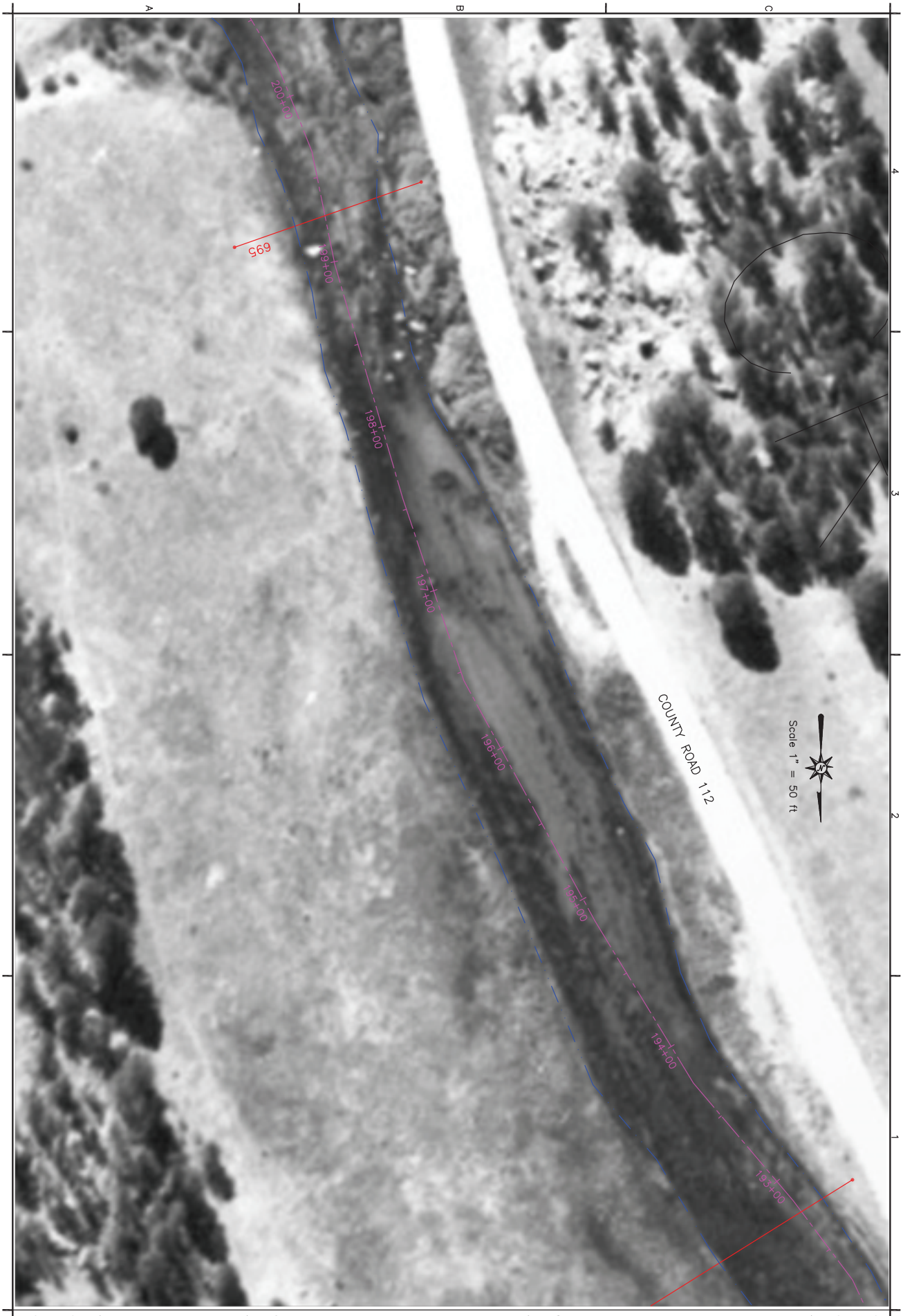
Sheet reference number: Sheet 27 of 30

HAPPY MEADOWS & SPORTSMAN'S PARADISE
STREAM RESTORATION PROJECT
PARK COUNTY, COLORADO
PLAN VIEW

CRANE ASSOCIATES
29163 Stingly Gulch Road
Hotchkiss, Colorado 81419
Phone (970) 872-2433

Designed by: JEFF CRANE		Date: May, 2010	Rev.
Dwn by: JPC	Ckd by:	Design file no:	
Reviewed by:		Drawing Code:	
Submitted by:		File name: Plot date: Plot scale:	

Description	Date	Approved



Sheet reference number: Sheet 28 of 30

HAPPY MEADOWS & SPORTSMAN'S PARADISE
STREAM RESTORATION PROJECT
PARK COUNTY, COLORADO
PLAN VIEW

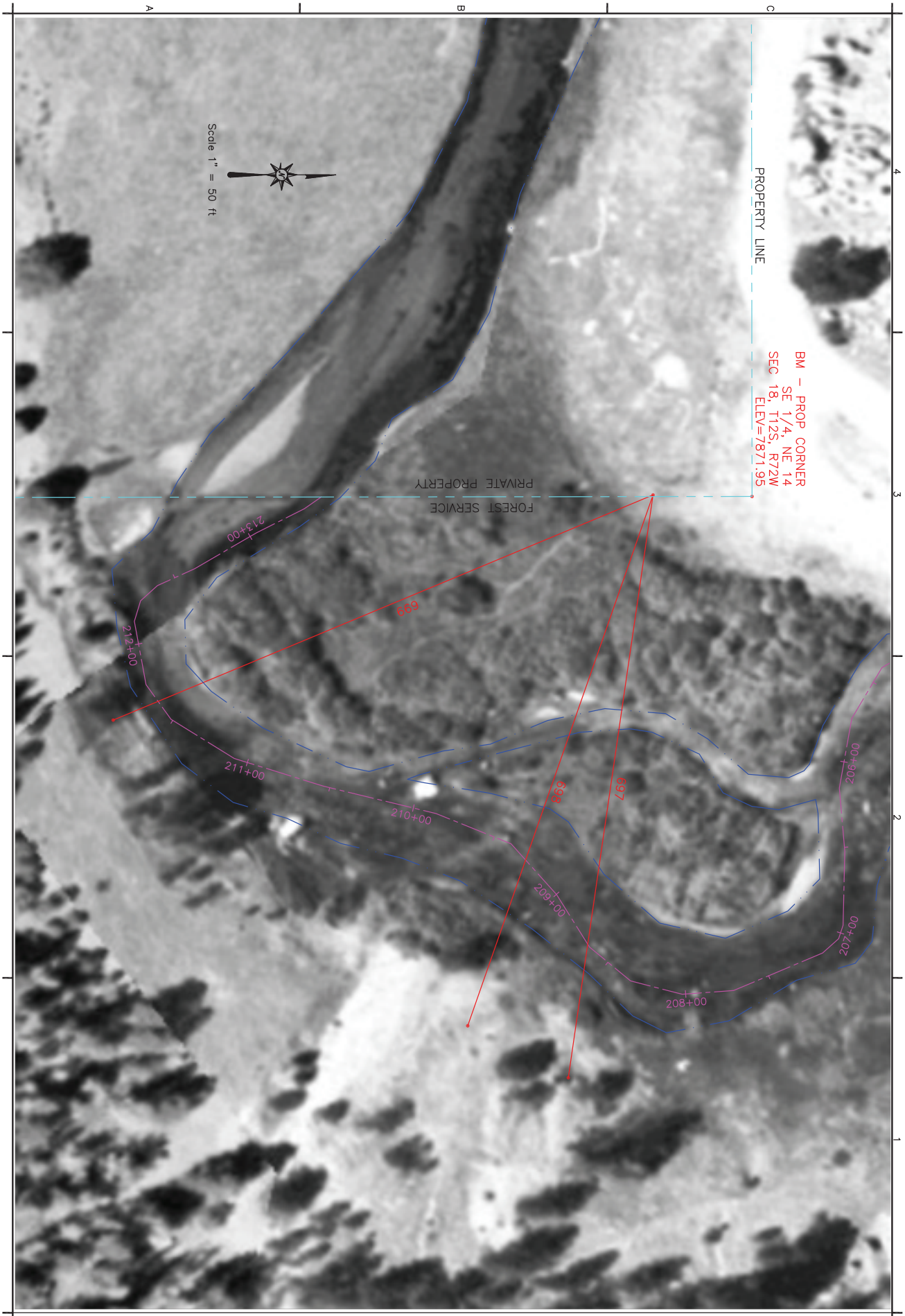
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Phone (970) 872-2433

Designed by: JEFF CRANE	Date: May, 2010	Rev.
Dwn by: JPC / Ckd by:	Design file no:	
Reviewed by:	Drawing Code:	
Submitted by:	File name: / Plot date: / Plot scale:	

Description	Date	Approved



Sheet reference number: Sheet 29 of 30	**HAPPY MEADOWS & SPORTSMAN'S PARADISE** STREAM RESTORATION PROJECT PARK COUNTY, COLORADO PLAN VIEW	*CRANE ASSOCIATES* 29163 Stingly Gulch Road Hotchkiss, Colorado 81419 Phone (970) 872-2433	Designed by: JEFF CRANE Dwn by: JPC Ckd by: Reviewed by: Submitted by:	Date: May, 2010 Rev. Design file no: Drawing Code: File name: Plot date: Plot scale:	Description Date Approved



Sheet reference number: Sheet 30 of 30	**HAPPY MEADOWS & SPORTSMAN'S PARADISE** STREAM RESTORATION PROJECT PARK COUNTY, COLORADO PLAN VIEW	*CRANE ASSOCIATES* 29163 Stingly Gulch Road Hotchkiss, Colorado 81419 Phone (970) 872-2433	Designed by: JEFF CRANE Dwn by: JPC Ckd by: Reviewed by: Submitted by:	Date: May, 2010 Rev. Design file no: Drawing Code: File name: Plot date: Plot scale:	Description / Date / Approved

EXISTING CONDITIONS
OUTPUT REPORT
PROFILE
CROSS SECTIONS

HEC-RAS Plan: Plan 01 River: South Platte Reach: Happy Meadows

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Happy Meadows	699	min	32.00	7864.61	7866.99		7867.01	0.000808	1.28	24.98	19.46	0.20
Happy Meadows	699	1-yr	160.00	7864.61	7867.97		7868.12	0.003884	3.13	51.10	34.22	0.45
Happy Meadows	699	2-yr	426.00	7864.61	7868.99		7869.34	0.005220	4.76	89.42	39.20	0.56
Happy Meadows	699	5 yr	660.00	7864.61	7869.61		7870.12	0.005724	5.75	119.51	74.16	0.60
Happy Meadows	699	10-yr	846.00	7864.61	7869.84	7869.14	7870.52	0.007063	6.69	139.70	119.67	0.67
Happy Meadows	699	50-yr	1351.00	7864.61	7870.75		7871.12	0.003789	5.80	382.15	312.19	0.51
Happy Meadows	699	100 yr	1610.00	7864.61	7871.08		7871.38	0.003083	5.51	486.01	325.47	0.47
Happy Meadows	699	500-yr	2335.00	7864.61	7871.82		7872.06	0.002208	5.20	739.57	353.20	0.41
Happy Meadows	698	min	32.00	7865.01	7866.91		7866.92	0.000239	0.54	59.62	70.82	0.10
Happy Meadows	698	1-yr	160.00	7865.01	7867.74		7867.77	0.000720	1.25	127.53	96.22	0.19
Happy Meadows	698	2-yr	426.00	7865.01	7868.86		7868.91	0.000726	1.69	252.89	127.69	0.21
Happy Meadows	698	5 yr	660.00	7865.01	7869.61		7869.65	0.000659	1.81	397.88	245.81	0.20
Happy Meadows	698	10-yr	846.00	7865.01	7869.93		7869.99	0.000670	1.98	478.87	250.86	0.21
Happy Meadows	698	50-yr	1351.00	7865.01	7870.66		7870.73	0.000685	2.33	665.42	264.33	0.22
Happy Meadows	698	100 yr	1610.00	7865.01	7870.94		7871.03	0.000723	2.52	741.48	276.55	0.23
Happy Meadows	698	500-yr	2335.00	7865.01	7871.64		7871.75	0.000792	2.95	944.83	313.88	0.24
Happy Meadows	697	min	32.00	7865.53	7866.90	7866.44	7866.91	0.001507	0.89	35.97	79.23	0.23
Happy Meadows	697	1-yr	160.00	7865.53	7867.72		7867.75	0.001150	1.47	108.71	90.72	0.24
Happy Meadows	697	2-yr	426.00	7865.53	7868.83		7868.89	0.000982	1.98	220.03	150.62	0.24
Happy Meadows	697	5 yr	660.00	7865.53	7869.59		7869.64	0.001006	1.93	380.34	258.17	0.24
Happy Meadows	697	10-yr	846.00	7865.53	7869.92		7869.98	0.000915	2.04	466.93	267.24	0.24
Happy Meadows	697	50-yr	1351.00	7865.53	7870.65		7870.72	0.000813	2.31	669.78	288.48	0.23
Happy Meadows	697	100 yr	1610.00	7865.53	7870.93		7871.01	0.000824	2.47	752.45	298.80	0.24
Happy Meadows	697	500-yr	2335.00	7865.53	7871.63		7871.73	0.000843	2.83	972.51	332.44	0.25
Happy Meadows	696	min	32.00	7862.90	7863.78	7863.78	7864.07	0.026666	4.28	7.47	13.30	1.01
Happy Meadows	696	1-yr	160.00	7862.90	7864.84	7864.84	7865.53	0.021084	6.64	24.11	17.83	1.01
Happy Meadows	696	2-yr	426.00	7862.90	7866.19	7866.19	7866.94	0.020280	6.93	61.47	42.33	1.01
Happy Meadows	696	5 yr	660.00	7862.90	7866.70	7866.70	7867.66	0.018506	7.86	84.29	46.68	1.01
Happy Meadows	696	10-yr	846.00	7862.90	7867.08	7867.08	7868.16	0.016303	8.35	103.11	52.52	0.98
Happy Meadows	696	50-yr	1351.00	7862.90	7868.15	7868.15	7869.21	0.010162	8.52	182.37	107.76	0.82
Happy Meadows	696	100 yr	1610.00	7862.90	7868.64	7868.64	7869.58	0.007955	8.26	249.46	157.85	0.75
Happy Meadows	696	500-yr	2335.00	7862.90	7869.27	7869.27	7870.28	0.007710	9.01	355.90	177.59	0.75
Happy Meadows	695	min	32.00	7861.34	7863.04	7862.19	7863.05	0.000571	0.78	41.00	53.31	0.16
Happy Meadows	695	1-yr	160.00	7861.34	7864.06		7864.10	0.000855	1.50	106.99	70.37	0.21
Happy Meadows	695	2-yr	426.00	7861.34	7864.97		7865.06	0.001296	2.47	173.59	77.52	0.28
Happy Meadows	695	5 yr	660.00	7861.34	7865.50		7865.65	0.001565	3.11	216.45	85.37	0.32
Happy Meadows	695	10-yr	846.00	7861.34	7865.90		7866.09	0.001640	3.47	253.15	94.93	0.34
Happy Meadows	695	50-yr	1351.00	7861.34	7866.76		7867.04	0.001827	4.27	341.22	110.20	0.37
Happy Meadows	695	100 yr	1610.00	7861.34	7867.08		7867.40	0.001976	4.67	377.33	115.96	0.39
Happy Meadows	695	500-yr	2335.00	7861.34	7867.76		7868.23	0.002459	5.71	459.37	128.08	0.44
Happy Meadows	694	min	32.00	7861.26	7861.72	7861.72	7861.89	0.030206	3.26	9.81	29.49	1.00
Happy Meadows	694	1-yr	160.00	7861.26	7862.20	7862.20	7862.47	0.027166	4.22	37.90	71.40	1.02
Happy Meadows	694	2-yr	426.00	7861.26	7863.03		7863.31	0.008316	4.24	100.40	76.59	0.65
Happy Meadows	694	5 yr	660.00	7861.26	7863.84		7864.09	0.004049	4.05	163.73	81.34	0.49
Happy Meadows	694	10-yr	846.00	7861.26	7864.13		7864.45	0.004304	4.55	189.33	98.93	0.52
Happy Meadows	694	50-yr	1351.00	7861.26	7864.76		7865.22	0.004652	5.54	278.84	208.28	0.56
Happy Meadows	694	100 yr	1610.00	7861.26	7865.02		7865.51	0.004605	5.82	334.41	221.99	0.57
Happy Meadows	694	500-yr	2335.00	7861.26	7865.67		7866.18	0.004153	6.23	488.49	249.15	0.55
Happy Meadows	693	min	32.00	7858.31	7860.39		7860.40	0.000181	0.61	52.17	41.14	0.10
Happy Meadows	693	1-yr	160.00	7858.31	7861.31		7861.36	0.000872	1.71	93.61	51.33	0.22
Happy Meadows	693	2-yr	426.00	7858.31	7862.17		7862.31	0.001892	3.04	139.94	56.01	0.34
Happy Meadows	693	5 yr	660.00	7858.31	7862.82		7863.00	0.003731	3.41	194.01	114.43	0.45
Happy Meadows	693	10-yr	846.00	7858.31	7863.15		7863.36	0.003440	3.68	232.22	118.10	0.45
Happy Meadows	693	50-yr	1351.00	7858.31	7863.95		7864.20	0.002731	4.07	368.86	220.16	0.42
Happy Meadows	693	100 yr	1610.00	7858.31	7864.27		7864.53	0.002528	4.20	440.85	229.98	0.41
Happy Meadows	693	500-yr	2335.00	7858.31	7865.01		7865.30	0.002265	4.57	621.68	269.26	0.41
Happy Meadows	692	min	32.00	7858.99	7860.14	7860.14	7860.29	0.036731	3.17	10.09	36.29	1.06
Happy Meadows	692	1-yr	160.00	7858.99	7861.04		7861.12	0.004057	2.22	72.25	85.34	0.42
Happy Meadows	692	2-yr	426.00	7858.99	7861.81		7861.95	0.003458	2.99	143.60	98.32	0.43
Happy Meadows	692	5 yr	660.00	7858.99	7862.32		7862.50	0.003195	3.43	196.40	110.89	0.43
Happy Meadows	692	10-yr	846.00	7858.99	7862.70		7862.91	0.002840	3.64	241.70	128.12	0.42
Happy Meadows	692	50-yr	1351.00	7858.99	7863.60		7863.84	0.002266	4.03	388.15	232.93	0.39
Happy Meadows	692	100 yr	1610.00	7858.99	7863.96		7864.19	0.002040	4.10	473.53	242.89	0.38
Happy Meadows	692	500-yr	2335.00	7858.99	7864.75		7865.00	0.001778	4.37	678.94	275.13	0.37
Happy Meadows	691	min	32.00	7858.20	7859.92		7859.94	0.000943	1.01	31.74	40.94	0.20
Happy Meadows	691	1-yr	160.00	7858.20	7860.89		7860.94	0.001653	1.86	86.18	67.40	0.29
Happy Meadows	691	2-yr	426.00	7858.20	7861.58		7861.73	0.002847	3.21	132.91	68.72	0.41

HEC-RAS Plan: Plan 01 River: South Platte Reach: Happy Meadows (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Happy Meadows	691	5 yr	660.00	7858.20	7862.01		7862.27	0.003477	4.06	163.25	70.46	0.46
Happy Meadows	691	10-yr	846.00	7858.20	7862.36		7862.68	0.003619	4.53	187.97	72.55	0.48
Happy Meadows	691	50-yr	1351.00	7858.20	7863.20		7863.63	0.003532	5.35	280.78	150.91	0.50
Happy Meadows	691	100 yr	1610.00	7858.20	7863.53		7863.99	0.003499	5.65	336.24	182.94	0.50
Happy Meadows	691	500-yr	2335.00	7858.20	7864.34		7864.82	0.003107	6.04	510.53	244.55	0.49
Happy Meadows	690	min	32.00	7858.25	7858.97	7858.97	7859.10	0.037347	2.94	10.88	43.97	1.04
Happy Meadows	690	1-yr	160.00	7858.25	7859.40	7859.40	7859.65	0.028527	4.07	39.35	79.42	1.02
Happy Meadows	690	2-yr	426.00	7858.25	7860.24		7860.46	0.007204	3.73	114.30	91.91	0.59
Happy Meadows	690	5 yr	660.00	7858.25	7861.00		7861.20	0.003635	3.56	185.23	94.99	0.45
Happy Meadows	690	10-yr	846.00	7858.25	7861.50		7861.71	0.002813	3.64	232.92	97.44	0.41
Happy Meadows	690	50-yr	1351.00	7858.25	7862.56		7862.80	0.002031	3.93	376.20	188.47	0.37
Happy Meadows	690	100 yr	1610.00	7858.25	7862.94		7863.19	0.001903	4.08	450.11	199.69	0.36
Happy Meadows	690	500-yr	2335.00	7858.25	7863.83		7864.10	0.001701	4.42	647.64	248.15	0.36
Happy Meadows	689.7	min	32.00	7855.89	7857.48		7857.50	0.001340	1.00	32.00	54.14	0.23
Happy Meadows	689.7	1-yr	160.00	7855.89	7858.52		7858.56	0.001002	1.57	102.48	76.62	0.24
Happy Meadows	689.7	2-yr	426.00	7855.89	7859.84		7859.90	0.000791	2.07	210.03	92.08	0.24
Happy Meadows	689.7	5 yr	660.00	7855.89	7860.70		7860.77	0.000698	2.16	317.75	149.57	0.25
Happy Meadows	689.7	10-yr	846.00	7855.89	7861.26		7861.33	0.000628	2.21	402.19	154.69	0.23
Happy Meadows	689.7	50-yr	1351.00	7855.89	7862.38		7862.47	0.000576	2.47	605.37	200.79	0.22
Happy Meadows	689.7	100 yr	1610.00	7855.89	7862.76		7862.86	0.000600	2.64	683.32	211.50	0.22
Happy Meadows	689.7	500-yr	2335.00	7855.89	7863.64		7863.77	0.000659	3.06	882.56	241.02	0.23
Happy Meadows	689	min	32.00	7854.98	7856.81		7856.84	0.001874	1.43	22.39	28.55	0.28
Happy Meadows	689	1-yr	160.00	7854.98	7858.04		7858.09	0.001288	1.73	92.33	66.19	0.26
Happy Meadows	689	2-yr	426.00	7854.98	7859.47		7859.55	0.000885	2.24	190.99	72.86	0.24
Happy Meadows	689	5 yr	660.00	7854.98	7860.35		7860.45	0.000827	2.61	259.81	85.18	0.24
Happy Meadows	689	10-yr	846.00	7854.98	7860.90		7861.03	0.000825	2.86	309.71	94.88	0.25
Happy Meadows	689	50-yr	1351.00	7854.98	7861.98		7862.17	0.000911	3.51	423.64	117.07	0.27
Happy Meadows	689	100 yr	1610.00	7854.98	7862.31		7862.53	0.001032	3.89	462.97	124.80	0.29
Happy Meadows	689	500-yr	2335.00	7854.98	7863.05		7863.38	0.001340	4.81	561.51	142.08	0.34
Happy Meadows	688	min	32.00	7854.14	7856.82		7856.82	0.000014	0.21	149.89	81.19	0.03
Happy Meadows	688	1-yr	160.00	7854.14	7858.04		7858.04	0.000064	0.64	253.33	90.52	0.06
Happy Meadows	688	2-yr	426.00	7854.14	7859.47		7859.48	0.000119	1.13	403.04	142.87	0.09
Happy Meadows	688	5 yr	660.00	7854.14	7860.35		7860.38	0.000141	1.38	542.44	169.41	0.11
Happy Meadows	688	10-yr	846.00	7854.14	7860.91		7860.94	0.000154	1.54	640.93	180.81	0.11
Happy Meadows	688	50-yr	1351.00	7854.14	7862.01		7862.06	0.000191	1.93	849.83	200.16	0.13
Happy Meadows	688	100 yr	1610.00	7854.14	7862.34		7862.40	0.000222	2.15	917.59	205.65	0.14
Happy Meadows	688	500-yr	2335.00	7854.14	7863.10		7863.19	0.000307	2.70	1081.84	223.30	0.17
Happy Meadows	687	min	32.00	7854.80	7856.82		7856.82	0.000056	0.33	96.64	79.22	0.05
Happy Meadows	687	1-yr	160.00	7854.80	7858.02		7858.03	0.000143	0.83	193.89	83.08	0.09
Happy Meadows	687	2-yr	426.00	7854.80	7859.43		7859.46	0.000210	1.37	319.81	96.19	0.12
Happy Meadows	687	5 yr	660.00	7854.80	7860.31		7860.35	0.000245	1.69	415.54	135.30	0.14
Happy Meadows	687	10-yr	846.00	7854.80	7860.86		7860.92	0.000264	1.89	494.56	147.76	0.15
Happy Meadows	687	50-yr	1351.00	7854.80	7861.94		7862.02	0.000320	2.36	665.01	168.39	0.17
Happy Meadows	687	100 yr	1610.00	7854.80	7862.26		7862.36	0.000372	2.63	720.12	174.64	0.18
Happy Meadows	687	500-yr	2335.00	7854.80	7862.99		7863.14	0.000510	3.31	852.24	188.78	0.21
Happy Meadows	686	min	32.00	7855.41	7856.73		7856.79	0.003331	1.94	16.53	20.48	0.38
Happy Meadows	686	1-yr	160.00	7855.41	7857.70		7857.95	0.006308	3.98	40.16	26.99	0.58
Happy Meadows	686	2-yr	426.00	7855.41	7858.78		7859.33	0.007449	5.97	72.72	35.97	0.68
Happy Meadows	686	5 yr	660.00	7855.41	7859.40		7860.19	0.007955	7.19	98.36	46.62	0.73
Happy Meadows	686	10-yr	846.00	7855.41	7859.74	7859.45	7860.72	0.008892	8.15	114.88	53.18	0.78
Happy Meadows	686	50-yr	1351.00	7855.41	7860.91	7860.91	7861.83	0.006328	8.38	223.21	140.18	0.69
Happy Meadows	686	100 yr	1610.00	7855.41	7861.20	7861.20	7862.15	0.006347	8.75	265.72	148.10	0.70
Happy Meadows	686	500-yr	2335.00	7855.41	7861.82	7861.82	7862.89	0.006703	9.75	363.22	164.64	0.74
Happy Meadows	685	min	32.00	7854.75	7856.27		7856.28	0.001304	0.97	33.04	57.81	0.23
Happy Meadows	685	1-yr	160.00	7854.75	7857.33		7857.37	0.001012	1.68	95.52	59.57	0.23
Happy Meadows	685	2-yr	426.00	7854.75	7858.50		7858.60	0.001154	2.56	168.72	70.14	0.27
Happy Meadows	685	5 yr	660.00	7854.75	7859.21		7859.36	0.001238	3.09	231.65	127.64	0.29
Happy Meadows	685	10-yr	846.00	7854.75	7859.65		7859.81	0.001259	3.37	297.42	169.72	0.30
Happy Meadows	685	50-yr	1351.00	7854.75	7860.52		7860.71	0.001225	3.80	471.03	210.65	0.31
Happy Meadows	685	100 yr	1610.00	7854.75	7860.89		7861.08	0.001199	3.95	548.79	216.37	0.31
Happy Meadows	685	500-yr	2335.00	7854.75	7861.74		7861.95	0.001173	4.32	737.94	230.44	0.31
Happy Meadows	684.8	min	32.00	7852.95	7853.93		7854.02	0.006504	2.37	13.52	20.61	0.52
Happy Meadows	684.8	1-yr	160.00	7852.95	7855.18	7854.51	7855.37	0.007778	3.52	45.42	42.63	0.60
Happy Meadows	684.8	2-yr	426.00	7852.95	7855.98	7855.61	7856.31	0.008946	4.61	92.42	63.38	0.67
Happy Meadows	684.8	5 yr	660.00	7852.95	7856.38	7856.01	7856.86	0.010002	5.59	119.12	70.05	0.73
Happy Meadows	684.8	10-yr	846.00	7852.95	7856.65	7856.30	7857.24	0.010491	6.18	139.06	73.81	0.76
Happy Meadows	684.8	50-yr	1351.00	7852.95	7857.36	7856.99	7858.13	0.011359	7.10	195.11	89.19	0.81

HEC-RAS Plan: Plan 01 River: South Platte Reach: Happy Meadows (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Happy Meadows	684.8	100 yr	1610.00	7852.95	7857.63	7857.32	7858.50	0.011733	7.57	220.78	101.21	0.84
Happy Meadows	684.8	500-yr	2335.00	7852.95	7858.17	7858.09	7859.34	0.012672	8.83	278.85	109.72	0.90
Happy Meadows	684	min	32.00	7844.82	7845.86	7845.86	7846.00	0.030000	3.02	10.59	35.32	0.97
Happy Meadows	684	1-yr	160.00	7844.82	7846.32	7846.32	7846.60	0.027389	4.24	37.76	70.87	1.02
Happy Meadows	684	2-yr	426.00	7844.82	7846.81	7846.81	7847.29	0.023127	5.55	76.79	84.60	1.03
Happy Meadows	684	5 yr	660.00	7844.82	7847.14	7847.14	7847.76	0.020018	6.29	104.94	85.68	1.00
Happy Meadows	684	10-yr	846.00	7844.82	7847.37	7847.37	7848.09	0.018976	6.81	124.26	86.37	1.00
Happy Meadows	684	50-yr	1351.00	7844.82	7847.88	7847.88	7848.87	0.017474	7.98	169.41	87.85	1.01
Happy Meadows	684	100 yr	1610.00	7844.82	7848.12	7848.12	7849.24	0.016866	8.47	190.49	88.71	1.01
Happy Meadows	684	500-yr	2335.00	7844.82	7848.76	7848.76	7850.16	0.015145	9.51	247.30	90.99	1.00
Happy Meadows	683	min	32.00	7835.71	7838.71		7838.72	0.000219	0.71	44.82	31.55	0.11
Happy Meadows	683	1-yr	160.00	7835.71	7840.06		7840.10	0.000592	1.55	103.36	47.86	0.19
Happy Meadows	683	2-yr	426.00	7835.71	7841.43		7841.53	0.000824	2.51	171.89	54.78	0.24
Happy Meadows	683	5 yr	660.00	7835.71	7842.28		7842.43	0.000941	3.09	225.68	84.87	0.26
Happy Meadows	683	10-yr	846.00	7835.71	7842.84		7843.02	0.000967	3.40	278.44	99.55	0.27
Happy Meadows	683	50-yr	1351.00	7835.71	7844.15		7844.36	0.000947	3.93	431.29	152.97	0.28
Happy Meadows	683	100 yr	1610.00	7835.71	7844.61		7844.83	0.000958	4.15	503.60	162.46	0.28
Happy Meadows	683	500-yr	2335.00	7835.71	7845.37		7845.67	0.001183	4.95	632.47	175.09	0.32
Happy Meadows	682	min	32.00	7837.51	7838.27	7838.27	7838.47	0.029377	3.62	8.83	22.06	1.01
Happy Meadows	682	1-yr	160.00	7837.51	7839.01	7839.01	7839.51	0.022339	5.69	28.12	28.96	1.02
Happy Meadows	682	2-yr	426.00	7837.51	7839.95	7839.95	7840.76	0.018618	7.22	59.01	36.85	1.01
Happy Meadows	682	5 yr	660.00	7837.51	7840.51	7840.51	7841.57	0.017356	8.26	79.94	38.12	1.00
Happy Meadows	682	10-yr	846.00	7837.51	7840.90	7840.90	7842.13	0.016801	8.93	94.75	38.88	1.01
Happy Meadows	682	50-yr	1351.00	7837.51	7841.80	7841.80	7843.46	0.014965	10.37	131.70	44.85	1.00
Happy Meadows	682	100 yr	1610.00	7837.51	7842.53	7842.53	7844.01	0.010392	9.88	179.58	97.83	0.86
Happy Meadows	682	500-yr	2335.00	7837.51	7843.70	7843.70	7844.86	0.006740	9.41	334.14	153.96	0.72
Happy Meadows	681	min	32.00	7835.81	7837.43		7837.44	0.000272	0.67	47.45	43.92	0.11
Happy Meadows	681	1-yr	160.00	7835.81	7838.38		7838.43	0.000909	1.75	91.62	49.80	0.23
Happy Meadows	681	2-yr	426.00	7835.81	7839.28		7839.43	0.001754	3.11	137.19	51.25	0.33
Happy Meadows	681	5 yr	660.00	7835.81	7839.86		7840.10	0.002188	3.95	168.47	56.53	0.38
Happy Meadows	681	10-yr	846.00	7835.81	7840.25		7840.57	0.002449	4.51	192.10	66.76	0.41
Happy Meadows	681	50-yr	1351.00	7835.81	7841.19		7841.63	0.002639	5.44	283.62	113.27	0.45
Happy Meadows	681	100 yr	1610.00	7835.81	7841.59		7842.06	0.002649	5.76	331.22	126.66	0.45
Happy Meadows	681	500-yr	2335.00	7835.81	7842.59		7843.12	0.002481	6.30	482.09	173.10	0.45
Happy Meadows	680	min	32.00	7835.99	7837.39		7837.41	0.001668	1.15	27.75	44.91	0.26
Happy Meadows	680	1-yr	160.00	7835.99	7838.28		7838.35	0.002022	2.10	76.12	57.68	0.32
Happy Meadows	680	2-yr	426.00	7835.99	7839.13		7839.31	0.002814	3.35	127.96	63.38	0.41
Happy Meadows	680	5 yr	660.00	7835.99	7839.71		7839.96	0.002994	4.05	165.08	66.93	0.44
Happy Meadows	680	10-yr	846.00	7835.99	7840.11		7840.42	0.003061	4.49	192.77	73.85	0.45
Happy Meadows	680	50-yr	1351.00	7835.99	7841.04		7841.47	0.003028	5.34	276.53	104.67	0.47
Happy Meadows	680	100 yr	1610.00	7835.99	7841.44		7841.91	0.003008	5.67	320.90	120.51	0.48
Happy Meadows	680	500-yr	2335.00	7835.99	7842.46		7842.98	0.002682	6.15	464.26	156.69	0.47
Happy Meadows	679	min	32.00	7836.01	7836.77	7836.72	7836.95	0.020682	3.34	9.59	20.86	0.87
Happy Meadows	679	1-yr	160.00	7836.01	7837.96		7838.02	0.004775	2.11	75.90	109.68	0.45
Happy Meadows	679	2-yr	426.00	7836.01	7838.97		7839.04	0.001647	2.20	193.84	119.09	0.30
Happy Meadows	679	5 yr	660.00	7836.01	7839.61		7839.71	0.001305	2.44	271.57	121.91	0.28
Happy Meadows	679	10-yr	846.00	7836.01	7840.05		7840.16	0.001193	2.62	325.04	123.33	0.28
Happy Meadows	679	50-yr	1351.00	7836.01	7841.06		7841.20	0.001056	3.04	451.06	128.23	0.28
Happy Meadows	679	100 yr	1610.00	7836.01	7841.47		7841.63	0.001053	3.26	505.59	136.09	0.28
Happy Meadows	679	500-yr	2335.00	7836.01	7842.50		7842.71	0.001027	3.73	655.92	155.75	0.29
Happy Meadows	678	min	32.00	7834.59	7836.58		7836.59	0.000521	0.81	39.41	45.07	0.15
Happy Meadows	678	1-yr	160.00	7834.59	7837.58		7837.63	0.001081	1.74	91.83	57.62	0.24
Happy Meadows	678	2-yr	426.00	7834.59	7838.61		7838.73	0.001491	2.77	157.16	79.83	0.31
Happy Meadows	678	5 yr	660.00	7834.59	7839.25		7839.42	0.001573	3.31	217.95	104.35	0.33
Happy Meadows	678	10-yr	846.00	7834.59	7839.69		7839.88	0.001557	3.59	264.91	109.33	0.33
Happy Meadows	678	50-yr	1351.00	7834.59	7840.69		7840.94	0.001535	4.20	385.04	137.72	0.34
Happy Meadows	678	100 yr	1610.00	7834.59	7841.11		7841.37	0.001508	4.41	443.77	143.81	0.35
Happy Meadows	678	500-yr	2335.00	7834.59	7842.16		7842.46	0.001435	4.87	607.69	169.36	0.35
Happy Meadows	677	min	32.00	7834.59	7836.51		7836.52	0.000607	0.80	40.17	53.06	0.16
Happy Meadows	677	1-yr	160.00	7834.59	7837.46		7837.50	0.001034	1.69	94.76	60.03	0.24
Happy Meadows	677	2-yr	426.00	7834.59	7838.44		7838.55	0.001462	2.74	156.85	64.87	0.30
Happy Meadows	677	5 yr	660.00	7834.59	7839.04		7839.22	0.001694	3.41	198.89	72.28	0.34
Happy Meadows	677	10-yr	846.00	7834.59	7839.45		7839.68	0.001825	3.84	229.17	76.92	0.36
Happy Meadows	677	50-yr	1351.00	7834.59	7840.38		7840.72	0.002053	4.76	321.57	145.35	0.40
Happy Meadows	677	100 yr	1610.00	7834.59	7840.81		7841.16	0.001975	4.96	387.71	159.11	0.39
Happy Meadows	677	500-yr	2335.00	7834.59	7841.92		7842.28	0.001661	5.21	577.31	185.60	0.37

HEC-RAS Plan: Plan 01 River: South Platte Reach: Happy Meadows (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Happy Meadows	676	min	32.00	7835.19	7835.94	7835.94	7836.22	0.029590	4.23	7.57	15.04	1.05
Happy Meadows	676	1-yr	160.00	7835.19	7836.79		7837.09	0.016850	4.36	36.71	45.80	0.86
Happy Meadows	676	2-yr	426.00	7835.19	7837.61		7838.05	0.012054	5.33	79.93	57.24	0.79
Happy Meadows	676	5 yr	660.00	7835.19	7838.08		7838.67	0.011257	6.12	107.86	60.28	0.80
Happy Meadows	676	10-yr	846.00	7835.19	7838.39		7839.09	0.011076	6.69	126.82	62.17	0.81
Happy Meadows	676	50-yr	1351.00	7835.19	7839.08		7840.07	0.011050	8.01	170.44	65.29	0.85
Happy Meadows	676	100 yr	1610.00	7835.19	7839.37	7839.11	7840.51	0.011179	8.61	189.59	66.48	0.87
Happy Meadows	676	500-yr	2335.00	7835.19	7839.93	7839.91	7841.62	0.013246	10.49	227.38	68.53	0.97
Happy Meadows	675	min	32.00	7834.60	7835.79		7835.80	0.000932	0.95	33.59	46.91	0.20
Happy Meadows	675	1-yr	160.00	7834.60	7836.48		7836.57	0.002603	2.29	70.00	56.66	0.36
Happy Meadows	675	2-yr	426.00	7834.60	7837.19		7837.41	0.004270	3.82	111.52	60.14	0.49
Happy Meadows	675	5 yr	660.00	7834.60	7837.60		7837.96	0.005324	4.83	136.63	61.82	0.57
Happy Meadows	675	10-yr	846.00	7834.60	7837.87		7838.35	0.005989	5.53	153.59	64.11	0.61
Happy Meadows	675	50-yr	1351.00	7834.60	7838.46		7839.24	0.007524	7.12	194.27	76.18	0.71
Happy Meadows	675	100 yr	1610.00	7834.60	7838.70	7838.16	7839.64	0.008176	7.81	214.37	91.21	0.75
Happy Meadows	675	500-yr	2335.00	7834.60	7839.36	7839.33	7840.57	0.008658	9.06	296.38	149.44	0.80
Happy Meadows	674	min	32.00	7834.79	7835.62		7835.65	0.005112	1.32	24.19	74.12	0.41
Happy Meadows	674	1-yr	160.00	7834.79	7836.22		7836.30	0.003956	2.18	73.39	87.43	0.42
Happy Meadows	674	2-yr	426.00	7834.79	7836.88		7837.04	0.004192	3.22	132.46	91.70	0.47
Happy Meadows	674	5 yr	660.00	7834.79	7837.29		7837.52	0.004494	3.89	169.58	92.57	0.51
Happy Meadows	674	10-yr	846.00	7834.79	7837.56		7837.85	0.004663	4.33	195.29	93.18	0.53
Happy Meadows	674	50-yr	1351.00	7834.79	7838.19		7838.63	0.004957	5.31	254.75	95.08	0.57
Happy Meadows	674	100 yr	1610.00	7834.79	7838.48		7838.99	0.005060	5.73	281.77	96.09	0.58
Happy Meadows	674	500-yr	2335.00	7834.79	7839.17		7839.87	0.005272	6.72	356.96	126.03	0.62
Happy Meadows	673	min	32.00	7833.02	7833.79		7833.84	0.008770	1.84	17.35	48.39	0.54
Happy Meadows	673	1-yr	160.00	7833.02	7834.31		7834.48	0.013188	3.29	48.62	77.20	0.73
Happy Meadows	673	2-yr	426.00	7833.02	7834.85		7835.17	0.012618	4.60	92.63	85.79	0.78
Happy Meadows	673	5 yr	660.00	7833.02	7835.24		7835.66	0.010983	5.19	127.07	88.22	0.76
Happy Meadows	673	10-yr	846.00	7833.02	7835.51		7836.00	0.010323	5.60	151.25	90.29	0.76
Happy Meadows	673	50-yr	1351.00	7833.02	7836.12		7836.79	0.009419	6.55	208.45	101.90	0.76
Happy Meadows	673	100 yr	1610.00	7833.02	7836.39		7837.13	0.009167	6.96	236.34	105.94	0.77
Happy Meadows	673	500-yr	2335.00	7833.02	7837.05		7838.00	0.008733	7.91	309.27	123.23	0.78
Happy Meadows	672	min	32.00	7832.10	7833.00	7832.86	7833.05	0.010459	1.89	16.95	52.11	0.58
Happy Meadows	672	1-yr	160.00	7832.10	7833.60	7833.32	7833.71	0.006754	2.62	61.02	82.40	0.54
Happy Meadows	672	2-yr	426.00	7832.10	7834.35		7834.54	0.004701	3.44	124.03	86.88	0.50
Happy Meadows	672	5 yr	660.00	7832.10	7834.78		7835.04	0.004767	4.11	162.65	93.89	0.53
Happy Meadows	672	10-yr	846.00	7832.10	7835.07		7835.39	0.004815	4.54	190.42	97.39	0.54
Happy Meadows	672	50-yr	1351.00	7832.10	7835.71		7836.17	0.005076	5.53	254.98	107.58	0.58
Happy Meadows	672	100 yr	1610.00	7832.10	7835.99		7836.52	0.005173	5.94	285.30	110.57	0.59
Happy Meadows	672	500-yr	2335.00	7832.10	7836.68		7837.38	0.005261	6.86	367.87	126.32	0.62
Happy Meadows	671.5	min	32.00	7828.69	7829.68		7829.78	0.009543	2.48	12.90	24.39	0.60
Happy Meadows	671.5	1-yr	160.00	7828.69	7830.43	7830.25	7830.71	0.012910	4.26	37.54	39.22	0.77
Happy Meadows	671.5	2-yr	426.00	7828.69	7831.16	7831.16	7831.68	0.020819	5.76	73.99	70.52	0.99
Happy Meadows	671.5	5 yr	660.00	7828.69	7831.55	7831.55	7832.19	0.020104	6.44	102.52	81.08	1.01
Happy Meadows	671.5	10-yr	846.00	7828.69	7831.78	7831.78	7832.52	0.019637	6.91	122.67	86.54	1.01
Happy Meadows	671.5	50-yr	1351.00	7828.69	7832.32	7832.32	7833.32	0.017444	8.04	169.17	87.92	1.01
Happy Meadows	671.5	100 yr	1610.00	7828.69	7832.57	7832.57	7833.68	0.016589	8.49	191.28	88.59	1.00
Happy Meadows	671.5	500-yr	2335.00	7828.69	7833.21	7833.21	7834.60	0.014840	9.51	249.94	95.10	0.99
Happy Meadows	671.3	min	32.00	7826.74	7827.80	7827.80	7827.96	0.031678	3.18	10.07	35.13	1.05
Happy Meadows	671.3	1-yr	160.00	7826.74	7828.32	7828.32	7828.62	0.028184	4.35	36.74	66.92	1.04
Happy Meadows	671.3	2-yr	426.00	7826.74	7828.89	7828.87	7829.33	0.019359	5.30	80.51	90.82	0.99
Happy Meadows	671.3	5 yr	660.00	7826.74	7829.24	7829.18	7829.77	0.016692	5.87	113.02	95.72	0.94
Happy Meadows	671.3	10-yr	846.00	7826.74	7829.48	7829.39	7830.08	0.015366	6.24	136.64	98.11	0.92
Happy Meadows	671.3	50-yr	1351.00	7826.74	7830.09	7829.90	7830.83	0.012624	6.93	198.00	104.64	0.87
Happy Meadows	671.3	100 yr	1610.00	7826.74	7830.33	7830.14	7831.15	0.012502	7.32	223.99	110.57	0.88
Happy Meadows	671.3	500-yr	2335.00	7826.74	7830.83	7830.81	7831.91	0.013665	8.39	284.74	131.71	0.98
Happy Meadows	671	min	32.00	7824.85	7826.19	7825.83	7826.27	0.004937	2.26	14.14	18.28	0.45
Happy Meadows	671	1-yr	160.00	7824.85	7827.27	7826.80	7827.36	0.005652	2.43	65.94	86.99	0.49
Happy Meadows	671	2-yr	426.00	7824.85	7827.78	7827.45	7827.98	0.007817	3.61	118.04	109.58	0.61
Happy Meadows	671	5 yr	660.00	7824.85	7828.02	7827.73	7828.35	0.009730	4.57	144.46	110.89	0.71
Happy Meadows	671	10-yr	846.00	7824.85	7828.16	7827.93	7828.60	0.011421	5.28	160.28	111.67	0.78
Happy Meadows	671	50-yr	1351.00	7824.85	7828.41	7828.39	7829.21	0.017444	7.21	187.54	113.07	0.98
Happy Meadows	671	100 yr	1610.00	7824.85	7828.58	7828.58	7829.52	0.018026	7.79	206.84	114.05	1.02
Happy Meadows	671	500-yr	2335.00	7824.85	7829.12	7829.12	7830.29	0.016000	8.69	269.45	116.12	1.00
Happy Meadows	670	min	32.00	7817.82	7818.49	7818.49	7818.61	0.032318	2.70	11.85	49.57	0.97
Happy Meadows	670	1-yr	160.00	7817.82	7818.92	7818.92	7819.16	0.029401	3.91	40.90	91.29	1.03
Happy Meadows	670	2-yr	426.00	7817.82	7819.43	7819.33	7819.74	0.016526	4.53	94.12	109.50	0.86

HEC-RAS Plan: Plan 01 River: South Platte Reach: Happy Meadows (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Happy Meadows	670	5 yr	660.00	7817.82	7819.80	7819.60	7820.17	0.012280	4.88	135.16	112.04	0.78
Happy Meadows	670	10-yr	846.00	7817.82	7820.08		7820.48	0.010272	5.07	166.99	114.24	0.74
Happy Meadows	670	50-yr	1351.00	7817.82	7820.81		7821.26	0.006960	5.36	252.09	118.04	0.65
Happy Meadows	670	100 yr	1610.00	7817.82	7821.12		7821.60	0.006339	5.59	288.33	119.48	0.63
Happy Meadows	670	500-yr	2335.00	7817.82	7821.89		7822.48	0.005290	6.14	383.41	126.34	0.60
Happy Meadows	669.6	min	32.00	7814.51	7815.64		7815.67	0.002713	1.35	23.78	44.02	0.32
Happy Meadows	669.6	1-yr	160.00	7814.51	7816.36		7816.47	0.004232	2.64	60.65	57.08	0.45
Happy Meadows	669.6	2-yr	426.00	7814.51	7817.12		7817.38	0.004939	4.08	104.94	58.53	0.53
Happy Meadows	669.6	5 yr	660.00	7814.51	7817.64		7818.01	0.005120	4.91	136.00	61.30	0.57
Happy Meadows	669.6	10-yr	846.00	7814.51	7818.00		7818.46	0.005184	5.44	158.37	62.70	0.58
Happy Meadows	669.6	50-yr	1351.00	7814.51	7818.81		7819.48	0.005468	6.65	213.75	89.36	0.63
Happy Meadows	669.6	100 yr	1610.00	7814.51	7819.17		7819.92	0.005410	7.06	248.02	98.23	0.63
Happy Meadows	669.6	500-yr	2335.00	7814.51	7820.02		7820.94	0.005301	7.98	338.82	120.65	0.65
Happy Meadows	669	min	32.00	7813.48	7814.42		7814.44	0.001908	0.97	33.06	77.18	0.26
Happy Meadows	669	1-yr	160.00	7813.48	7815.20		7815.24	0.001361	1.45	110.29	108.62	0.25
Happy Meadows	669	2-yr	426.00	7813.48	7816.32		7816.37	0.000880	1.77	241.02	127.51	0.23
Happy Meadows	669	5 yr	660.00	7813.48	7816.94		7817.01	0.000820	2.06	321.10	129.89	0.23
Happy Meadows	669	10-yr	846.00	7813.48	7817.35		7817.43	0.000812	2.27	375.18	133.04	0.23
Happy Meadows	669	50-yr	1351.00	7813.48	7818.25		7818.37	0.000845	2.76	497.45	140.97	0.25
Happy Meadows	669	100 yr	1610.00	7813.48	7818.63		7818.76	0.000871	2.99	552.48	148.45	0.26
Happy Meadows	669	500-yr	2335.00	7813.48	7819.51		7819.70	0.000944	3.53	688.59	157.95	0.28
Happy Meadows	668	min	32.00	7812.81	7813.67		7813.70	0.005839	1.52	21.04	57.40	0.44
Happy Meadows	668	1-yr	160.00	7812.81	7814.95		7814.98	0.000898	1.30	123.03	103.52	0.21
Happy Meadows	668	2-yr	426.00	7812.81	7816.14		7816.18	0.000731	1.60	266.15	140.67	0.20
Happy Meadows	668	5 yr	660.00	7812.81	7816.78		7816.83	0.000666	1.85	356.88	142.36	0.20
Happy Meadows	668	10-yr	846.00	7812.81	7817.19		7817.26	0.000659	2.04	416.32	144.01	0.21
Happy Meadows	668	50-yr	1351.00	7812.81	7818.08		7818.18	0.000695	2.50	546.65	148.96	0.22
Happy Meadows	668	100 yr	1610.00	7812.81	7818.46		7818.57	0.000721	2.71	602.90	151.02	0.23
Happy Meadows	668	500-yr	2335.00	7812.81	7819.33		7819.49	0.000803	3.24	736.62	156.22	0.25
Happy Meadows	667	min	32.00	7811.98	7813.54		7813.55	0.000436	0.71	45.32	55.53	0.14
Happy Meadows	667	1-yr	160.00	7811.98	7814.87		7814.89	0.000485	1.15	139.69	88.82	0.16
Happy Meadows	667	2-yr	426.00	7811.98	7816.05		7816.09	0.000555	1.66	258.12	108.27	0.19
Happy Meadows	667	5 yr	660.00	7811.98	7816.68		7816.74	0.000621	2.04	328.27	114.47	0.20
Happy Meadows	667	10-yr	846.00	7811.98	7817.08		7817.17	0.000672	2.30	375.69	119.29	0.22
Happy Meadows	667	50-yr	1351.00	7811.98	7817.95		7818.07	0.000803	2.91	482.63	129.07	0.25
Happy Meadows	667	100 yr	1610.00	7811.98	7818.31		7818.46	0.000865	3.19	529.93	133.46	0.26
Happy Meadows	667	500-yr	2335.00	7811.98	7819.14		7819.36	0.001024	3.86	645.05	142.89	0.29
Happy Meadows	666	min	32.00	7811.75	7813.39		7813.39	0.000398	0.63	50.51	68.73	0.13
Happy Meadows	666	1-yr	160.00	7811.75	7814.73		7814.75	0.000313	1.08	148.16	74.72	0.14
Happy Meadows	666	2-yr	426.00	7811.75	7815.84		7815.90	0.000496	1.82	240.59	98.24	0.18
Happy Meadows	666	5 yr	660.00	7811.75	7816.42		7816.51	0.000643	2.32	301.30	110.08	0.21
Happy Meadows	666	10-yr	846.00	7811.75	7816.79		7816.90	0.000744	2.67	343.74	119.97	0.23
Happy Meadows	666	50-yr	1351.00	7811.75	7817.57		7817.74	0.000990	3.46	448.91	157.78	0.28
Happy Meadows	666	100 yr	1610.00	7811.75	7817.90		7818.10	0.001070	3.76	502.95	167.27	0.29
Happy Meadows	666	500-yr	2335.00	7811.75	7818.67		7818.94	0.001244	4.45	638.40	183.01	0.32
Happy Meadows	665	min	32.00	7810.92	7813.32		7813.33	0.000226	0.73	43.73	30.91	0.11
Happy Meadows	665	1-yr	160.00	7810.92	7814.62		7814.65	0.000622	1.48	108.68	63.30	0.19
Happy Meadows	665	2-yr	426.00	7810.92	7815.67		7815.75	0.000924	2.33	205.53	116.45	0.24
Happy Meadows	665	5 yr	660.00	7810.92	7816.22		7816.33	0.001085	2.84	271.71	127.12	0.27
Happy Meadows	665	10-yr	846.00	7810.92	7816.57		7816.71	0.001201	3.19	317.62	144.25	0.29
Happy Meadows	665	50-yr	1351.00	7810.92	7817.31		7817.50	0.001397	3.88	448.90	185.14	0.32
Happy Meadows	665	100 yr	1610.00	7810.92	7817.63		7817.84	0.001457	4.15	512.12	202.39	0.33
Happy Meadows	665	500-yr	2335.00	7810.92	7818.41		7818.66	0.001496	4.65	676.45	220.88	0.35
Happy Meadows	664	min	32.00	7811.56	7813.20		7813.22	0.000919	1.09	29.35	33.05	0.20
Happy Meadows	664	1-yr	160.00	7811.56	7814.29		7814.36	0.002196	2.17	73.84	56.94	0.34
Happy Meadows	664	2-yr	426.00	7811.56	7815.24		7815.35	0.002655	2.70	157.59	100.84	0.38
Happy Meadows	664	5 yr	660.00	7811.56	7815.75		7815.90	0.002527	3.16	209.40	105.02	0.39
Happy Meadows	664	10-yr	846.00	7811.56	7816.04		7816.24	0.002637	3.53	241.31	108.66	0.41
Happy Meadows	664	50-yr	1351.00	7811.56	7816.63		7816.94	0.003149	4.48	307.06	116.23	0.46
Happy Meadows	664	100 yr	1610.00	7811.56	7816.89		7817.26	0.003375	4.90	337.09	122.20	0.48
Happy Meadows	664	500-yr	2335.00	7811.56	7817.48		7818.01	0.003912	5.91	414.43	137.75	0.54
Happy Meadows	663	min	32.00	7811.76	7813.06		7813.07	0.002243	1.13	28.42	59.81	0.29
Happy Meadows	663	1-yr	160.00	7811.76	7814.20		7814.23	0.000701	1.24	128.80	98.20	0.19
Happy Meadows	663	2-yr	426.00	7811.76	7815.14		7815.19	0.000825	1.92	225.87	111.30	0.23
Happy Meadows	663	5 yr	660.00	7811.76	7815.63		7815.72	0.000991	2.41	283.08	116.74	0.26
Happy Meadows	663	10-yr	846.00	7811.76	7815.92		7816.04	0.001151	2.77	316.78	118.41	0.28
Happy Meadows	663	50-yr	1351.00	7811.76	7816.47		7816.68	0.001632	3.69	383.24	121.64	0.34

HEC-RAS Plan: Plan 01 River: South Platte Reach: Happy Meadows (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Happy Meadows	663	100 yr	1610.00	7811.76	7816.71		7816.96	0.001865	4.11	411.86	125.95	0.37
Happy Meadows	663	500-yr	2335.00	7811.76	7817.25		7817.65	0.002446	5.15	486.78	147.78	0.43
Happy Meadows	662	min	32.00	7811.19	7812.91		7812.93	0.001025	1.06	30.22	38.53	0.21
Happy Meadows	662	1-yr	160.00	7811.19	7814.14		7814.16	0.000640	1.21	132.57	98.44	0.18
Happy Meadows	662	2-yr	426.00	7811.19	7815.06		7815.11	0.000795	1.89	233.40	133.88	0.22
Happy Meadows	662	5 yr	660.00	7811.19	7815.54		7815.62	0.000942	2.34	305.97	164.55	0.25
Happy Meadows	662	10-yr	846.00	7811.19	7815.82		7815.92	0.001071	2.66	353.29	174.38	0.27
Happy Meadows	662	50-yr	1351.00	7811.19	7816.35		7816.52	0.001443	3.44	447.13	180.54	0.32
Happy Meadows	662	100 yr	1610.00	7811.19	7816.57		7816.77	0.001604	3.78	488.06	183.16	0.34
Happy Meadows	662	500-yr	2335.00	7811.19	7817.11		7817.40	0.001990	4.60	587.94	189.40	0.39
Happy Meadows	661	min	32.00	7811.19	7812.82		7812.83	0.000875	0.83	38.72	63.57	0.19
Happy Meadows	661	1-yr	160.00	7811.19	7814.08		7814.10	0.000527	1.01	158.20	133.45	0.16
Happy Meadows	661	2-yr	426.00	7811.19	7815.01		7815.03	0.000591	1.35	319.99	195.81	0.18
Happy Meadows	661	5 yr	660.00	7811.19	7815.50		7815.54	0.000600	1.61	417.54	201.37	0.19
Happy Meadows	661	10-yr	846.00	7811.19	7815.77		7815.82	0.000660	1.83	473.32	204.33	0.20
Happy Meadows	661	50-yr	1351.00	7811.19	7816.29		7816.38	0.000873	2.39	580.64	207.65	0.24
Happy Meadows	661	100 yr	1610.00	7811.19	7816.52		7816.62	0.000970	2.64	626.93	209.06	0.26
Happy Meadows	661	500-yr	2335.00	7811.19	7817.05		7817.21	0.001207	3.26	738.69	212.44	0.30
Happy Meadows	660	min	32.00	7810.86	7812.75		7812.76	0.000533	0.74	43.04	57.19	0.15
Happy Meadows	660	1-yr	160.00	7810.86	7814.02		7814.04	0.000666	1.11	144.74	125.57	0.18
Happy Meadows	660	2-yr	426.00	7810.86	7814.94		7814.97	0.000763	1.35	315.94	225.79	0.20
Happy Meadows	660	5 yr	660.00	7810.86	7815.44		7815.47	0.000677	1.54	430.05	232.31	0.20
Happy Meadows	660	10-yr	846.00	7810.86	7815.71		7815.75	0.000705	1.72	493.40	233.51	0.21
Happy Meadows	660	50-yr	1351.00	7810.86	7816.21		7816.29	0.000884	2.21	611.85	235.73	0.24
Happy Meadows	660	100 yr	1610.00	7810.86	7816.43		7816.52	0.000965	2.44	662.71	236.67	0.25
Happy Meadows	660	500-yr	2335.00	7810.86	7816.94		7817.08	0.001165	2.99	785.10	238.93	0.29
Happy Meadows	137	min	32.00	7811.10	7812.70		7812.72	0.000883	1.06	30.16	34.35	0.20
Happy Meadows	137	1-yr	160.00	7811.10	7813.93		7813.96	0.002351	1.34	120.81	218.53	0.31
Happy Meadows	137	2-yr	426.00	7811.10	7814.90		7814.92	0.000595	1.28	344.49	235.84	0.18
Happy Meadows	137	5 yr	660.00	7811.10	7815.40		7815.43	0.000545	1.47	463.44	238.55	0.18
Happy Meadows	137	10-yr	846.00	7811.10	7815.67		7815.71	0.000585	1.66	528.05	240.01	0.19
Happy Meadows	137	50-yr	1351.00	7811.10	7816.16		7816.23	0.000771	2.16	647.49	244.27	0.23
Happy Meadows	137	100 yr	1610.00	7811.10	7816.37		7816.46	0.000856	2.39	698.99	246.30	0.24
Happy Meadows	137	500-yr	2335.00	7811.10	7816.87		7817.00	0.001063	2.95	824.09	251.17	0.28
Happy Meadows	136	min	32.00	7810.86	7812.65		7812.66	0.000411	0.87	36.75	30.96	0.14
Happy Meadows	136	1-yr	160.00	7810.86	7813.76		7813.80	0.001414	1.55	103.52	94.42	0.26
Happy Meadows	136	2-yr	426.00	7810.86	7814.82		7814.86	0.000862	1.41	305.76	230.59	0.21
Happy Meadows	136	5 yr	660.00	7810.86	7815.33		7815.37	0.000713	1.58	425.65	240.65	0.20
Happy Meadows	136	10-yr	846.00	7810.86	7815.60		7815.65	0.000747	1.77	490.35	246.48	0.21
Happy Meadows	136	50-yr	1351.00	7810.86	7816.07		7816.15	0.000966	2.29	608.93	256.82	0.25
Happy Meadows	136	100 yr	1610.00	7810.86	7816.27		7816.37	0.001065	2.53	660.65	261.20	0.27
Happy Meadows	136	500-yr	2335.00	7810.86	7816.75		7816.89	0.001300	3.10	788.29	271.72	0.30
Happy Meadows	135	min	32.00	7811.38	7812.34	7812.34	7812.55	0.029952	3.69	8.67	21.23	1.02
Happy Meadows	135	1-yr	160.00	7811.38	7813.05	7813.05	7813.50	0.023310	5.38	29.72	34.15	1.02
Happy Meadows	135	2-yr	426.00	7811.38	7813.96	7813.96	7814.63	0.020260	6.53	65.21	50.41	1.01
Happy Meadows	135	5 yr	660.00	7811.38	7814.54	7814.54	7815.17	0.020540	6.37	103.81	86.99	1.01
Happy Meadows	135	10-yr	846.00	7811.38	7814.99	7814.99	7815.46	0.020244	5.53	154.56	161.25	0.98
Happy Meadows	135	50-yr	1351.00	7811.38	7815.35	7815.35	7815.92	0.020815	6.07	226.11	209.94	1.01
Happy Meadows	135	100 yr	1610.00	7811.38	7815.51	7815.51	7816.12	0.019837	6.31	259.94	220.47	1.00
Happy Meadows	135	500-yr	2335.00	7811.38	7815.87	7815.87	7816.61	0.018339	6.96	343.48	244.21	1.00
Happy Meadows	134	min	32.00	7809.40	7809.73		7809.81	0.020569	2.33	13.75	51.39	0.79
Happy Meadows	134	1-yr	160.00	7809.40	7810.12	7810.12	7810.39	0.026883	4.18	38.31	72.84	1.01
Happy Meadows	134	2-yr	426.00	7809.40	7810.62	7810.62	7811.05	0.022886	5.28	80.64	95.47	1.01
Happy Meadows	134	5 yr	660.00	7809.40	7811.04	7810.92	7811.49	0.014891	5.36	123.17	103.37	0.87
Happy Meadows	134	10-yr	846.00	7809.40	7811.48		7811.86	0.009321	4.99	169.51	111.34	0.71
Happy Meadows	134	50-yr	1351.00	7809.40	7812.55		7812.87	0.004351	4.51	299.47	129.08	0.52
Happy Meadows	134	100 yr	1610.00	7809.40	7813.14		7813.42	0.003112	4.26	377.80	137.84	0.45
Happy Meadows	134	500-yr	2335.00	7809.40	7814.70		7814.93	0.001625	3.82	612.41	166.48	0.35
Happy Meadows	133	min	32.00	7807.85	7808.75	7808.73	7808.85	0.025928	2.50	12.79	50.83	0.88
Happy Meadows	133	1-yr	160.00	7807.85	7809.37		7809.53	0.010766	3.21	49.82	70.32	0.67
Happy Meadows	133	2-yr	426.00	7807.85	7810.35		7810.51	0.004637	3.16	134.90	104.81	0.49
Happy Meadows	133	5 yr	660.00	7807.85	7810.99		7811.15	0.003271	3.18	209.12	127.04	0.43
Happy Meadows	133	10-yr	846.00	7807.85	7811.45		7811.60	0.002597	3.16	270.97	141.77	0.39
Happy Meadows	133	50-yr	1351.00	7807.85	7812.57		7812.72	0.001463	3.19	440.33	161.81	0.32
Happy Meadows	133	100 yr	1610.00	7807.85	7813.16		7813.31	0.001143	3.16	540.56	181.67	0.29
Happy Meadows	133	500-yr	2335.00	7807.85	7814.73		7814.86	0.000655	3.03	875.51	239.63	0.23

HEC-RAS Plan: Plan 01 River: South Platte Reach: Happy Meadows (Continued)

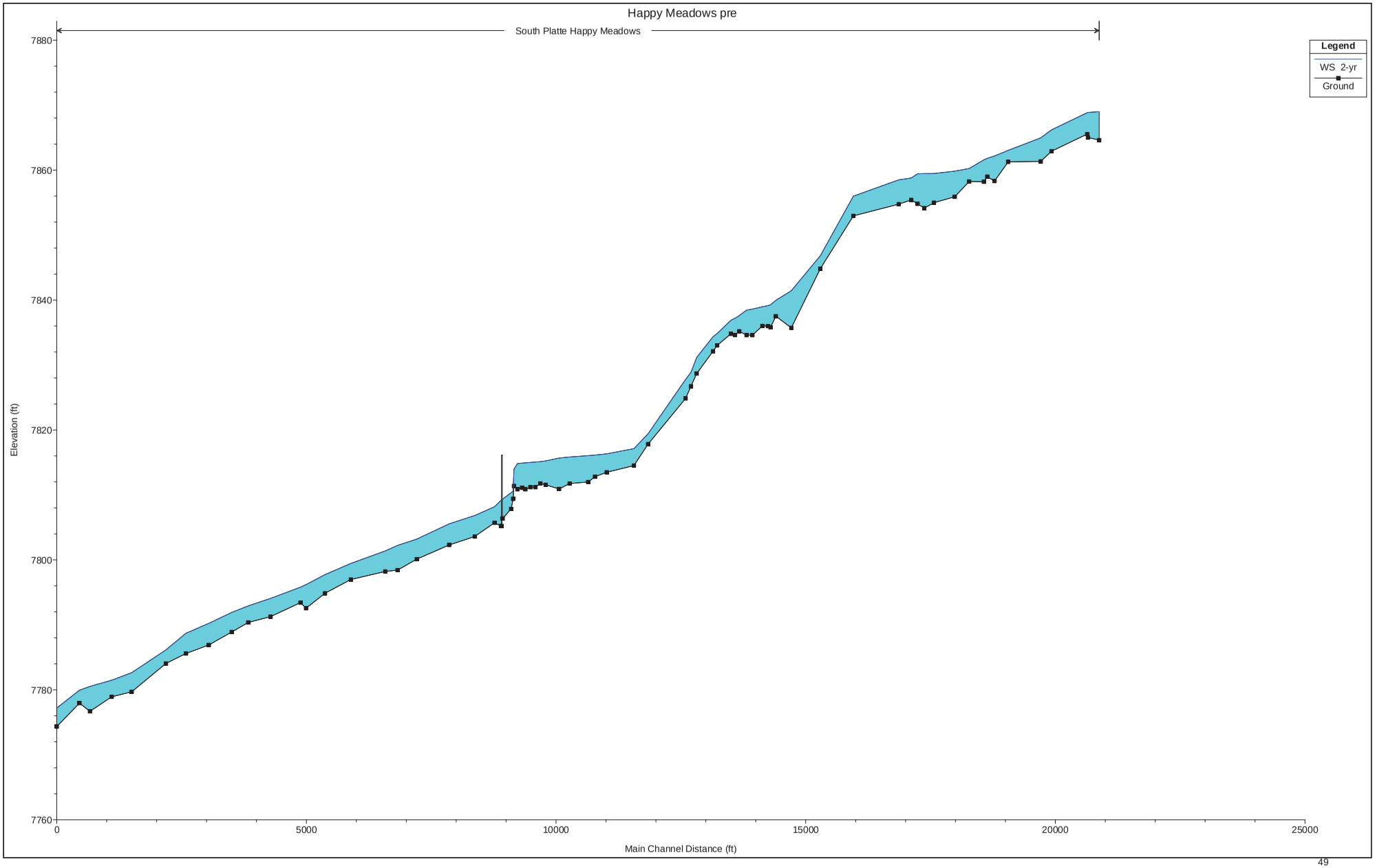
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Happy Meadows	132	min	28.00	7806.37	7807.28	7806.98	7807.33	0.004151	1.79	15.63	25.87	0.41
Happy Meadows	132	1-yr	156.00	7806.37	7808.48	7807.72	7808.60	0.003272	2.84	55.36	40.30	0.42
Happy Meadows	132	2-yr	422.00	7806.37	7809.37	7808.62	7809.70	0.004691	4.67	93.39	46.22	0.54
Happy Meadows	132	5 yr	654.00	7806.37	7809.95	7809.16	7810.44	0.005144	5.68	122.06	51.75	0.59
Happy Meadows	132	10-yr	842.00	7806.37	7810.39	7809.56	7810.96	0.005157	6.24	145.28	54.75	0.60
Happy Meadows	132	50-yr	1347.00	7806.37	7811.58	7810.46	7812.27	0.004291	6.98	213.50	58.35	0.58
Happy Meadows	132	100 yr	1606.00	7806.37	7812.21	7810.85	7812.93	0.003766	7.13	250.62	58.78	0.55
Happy Meadows	132	500-yr	2331.00	7806.37	7813.76	7811.77	7814.58	0.003110	7.72	350.14	70.22	0.52
Happy Meadows	131.6		Bridge									
Happy Meadows	131	min	28.00	7805.22	7807.21		7807.24	0.001335	1.27	22.05	22.70	0.23
Happy Meadows	131	1-yr	156.00	7805.22	7808.39		7808.50	0.002663	2.57	60.62	38.05	0.36
Happy Meadows	131	2-yr	422.00	7805.22	7809.15		7809.49	0.005251	4.69	91.34	42.05	0.54
Happy Meadows	131	5 yr	654.00	7805.22	7809.59		7810.16	0.007025	6.08	110.33	44.58	0.64
Happy Meadows	131	10-yr	842.00	7805.22	7809.87		7810.64	0.008391	7.07	122.95	46.10	0.71
Happy Meadows	131	50-yr	1347.00	7805.22	7810.41	7810.21	7811.77	0.012240	9.51	148.36	48.71	0.88
Happy Meadows	131	100 yr	1606.00	7805.22	7810.62	7810.62	7812.33	0.014261	10.65	158.68	49.79	0.96
Happy Meadows	131	500-yr	2331.00	7805.22	7811.75	7811.75	7813.71	0.011885	11.57	224.06	66.95	0.92
Happy Meadows	130	min	28.00	7805.71	7806.66		7806.81	0.014728	3.17	8.84	16.06	0.75
Happy Meadows	130	1-yr	156.00	7805.71	7807.39	7807.39	7807.69	0.024576	4.37	35.68	58.92	0.99
Happy Meadows	130	2-yr	422.00	7805.71	7808.18		7808.52	0.011421	4.68	90.08	74.93	0.75
Happy Meadows	130	5 yr	654.00	7805.71	7808.70		7809.10	0.008636	5.04	129.70	77.93	0.69
Happy Meadows	130	10-yr	842.00	7805.71	7809.08		7809.51	0.007421	5.29	159.32	80.43	0.66
Happy Meadows	130	50-yr	1347.00	7805.71	7809.88		7810.44	0.006156	6.02	227.71	94.85	0.63
Happy Meadows	130	100 yr	1606.00	7805.71	7810.21		7810.83	0.005906	6.36	261.28	104.35	0.63
Happy Meadows	130	500-yr	2331.00	7805.71	7810.96		7811.72	0.005615	7.15	363.72	150.85	0.64
Happy Meadows	129	min	28.00	7803.60	7804.50		7804.53	0.003000	1.38	20.31	39.26	0.34
Happy Meadows	129	1-yr	156.00	7803.60	7805.61		7805.68	0.002032	2.12	73.72	55.74	0.32
Happy Meadows	129	2-yr	422.00	7803.60	7806.83		7806.95	0.001888	2.77	152.12	71.78	0.34
Happy Meadows	129	5 yr	654.00	7803.60	7807.48		7807.65	0.001879	3.27	200.19	75.70	0.35
Happy Meadows	129	10-yr	842.00	7803.60	7807.92		7808.13	0.001885	3.62	236.10	97.79	0.36
Happy Meadows	129	50-yr	1347.00	7803.60	7808.92		7809.17	0.001739	4.17	364.25	154.31	0.36
Happy Meadows	129	100 yr	1606.00	7803.60	7809.33		7809.60	0.001681	4.37	433.53	182.75	0.36
Happy Meadows	129	500-yr	2331.00	7803.60	7810.14		7810.47	0.001707	4.91	593.18	200.97	0.37
Happy Meadows	128	min	28.00	7802.29	7803.47		7803.49	0.001466	1.15	24.41	36.17	0.25
Happy Meadows	128	1-yr	156.00	7802.29	7804.48		7804.56	0.002370	2.35	66.42	47.98	0.35
Happy Meadows	128	2-yr	422.00	7802.29	7805.55		7805.74	0.003005	3.50	120.57	56.52	0.42
Happy Meadows	128	5 yr	654.00	7802.29	7806.19		7806.45	0.002970	4.09	165.32	75.30	0.44
Happy Meadows	128	10-yr	842.00	7802.29	7806.64		7806.94	0.002866	4.45	199.88	79.95	0.44
Happy Meadows	128	50-yr	1347.00	7802.29	7807.65		7808.05	0.002740	5.23	293.28	122.27	0.45
Happy Meadows	128	100 yr	1606.00	7802.29	7808.08		7808.51	0.002668	5.51	354.57	169.58	0.45
Happy Meadows	128	500-yr	2331.00	7802.29	7808.96		7809.41	0.002451	5.93	519.13	199.50	0.45
Happy Meadows	127	min	28.00	7800.11	7800.74	7800.74	7800.92	0.030088	3.36	8.32	23.75	1.00
Happy Meadows	127	1-yr	156.00	7800.11	7801.85		7802.05	0.007328	3.56	43.81	39.64	0.60
Happy Meadows	127	2-yr	422.00	7800.11	7803.20		7803.46	0.004166	4.05	104.25	50.60	0.50
Happy Meadows	127	5 yr	654.00	7800.11	7803.92		7804.25	0.003873	4.63	141.29	52.69	0.50
Happy Meadows	127	10-yr	842.00	7800.11	7804.41		7804.80	0.003786	5.03	167.57	55.32	0.50
Happy Meadows	127	50-yr	1347.00	7800.11	7805.46		7806.01	0.003620	5.97	231.73	74.24	0.52
Happy Meadows	127	100 yr	1606.00	7800.11	7805.92		7806.52	0.003485	6.29	279.11	117.80	0.52
Happy Meadows	127	500-yr	2331.00	7800.11	7807.13		7807.72	0.002715	6.49	444.51	154.65	0.47
Happy Meadows	126	min	28.00	7798.43	7799.69		7799.71	0.000763	0.99	28.39	32.31	0.19
Happy Meadows	126	1-yr	156.00	7798.43	7801.10		7801.16	0.001048	1.95	79.80	40.88	0.25
Happy Meadows	126	2-yr	422.00	7798.43	7802.23		7802.39	0.001882	3.21	132.28	51.68	0.35
Happy Meadows	126	5 yr	654.00	7798.43	7802.87		7803.12	0.002217	3.99	165.78	52.74	0.39
Happy Meadows	126	10-yr	842.00	7798.43	7803.30		7803.62	0.002456	4.53	188.51	53.75	0.42
Happy Meadows	126	50-yr	1347.00	7798.43	7804.25		7804.75	0.002886	5.72	241.65	58.19	0.47
Happy Meadows	126	100 yr	1606.00	7798.43	7804.67		7805.26	0.003052	6.23	267.08	62.52	0.49
Happy Meadows	126	500-yr	2331.00	7798.43	7805.73		7806.54	0.003310	7.36	341.28	89.70	0.52
Happy Meadows	125	min	28.00	7798.22	7799.33		7799.38	0.002936	1.70	16.46	22.70	0.35
Happy Meadows	125	1-yr	156.00	7798.22	7800.59		7800.71	0.003921	2.69	58.00	50.01	0.44
Happy Meadows	125	2-yr	422.00	7798.22	7801.39		7801.65	0.005318	4.13	102.08	57.75	0.55
Happy Meadows	125	5 yr	654.00	7798.22	7801.85		7802.25	0.006109	5.05	129.44	59.97	0.61
Happy Meadows	125	10-yr	842.00	7798.22	7802.12		7802.64	0.007092	5.79	145.42	61.31	0.66
Happy Meadows	125	50-yr	1347.00	7798.22	7802.67		7803.54	0.009332	7.47	180.33	64.01	0.78
Happy Meadows	125	100 yr	1606.00	7798.22	7802.91		7803.96	0.010315	8.23	195.45	65.82	0.83
Happy Meadows	125	500-yr	2331.00	7798.22	7803.43	7803.32	7805.03	0.012771	10.17	231.08	70.09	0.95
Happy Meadows	124	min	28.00	7796.98	7797.97		7797.98	0.001450	0.86	32.52	73.72	0.23

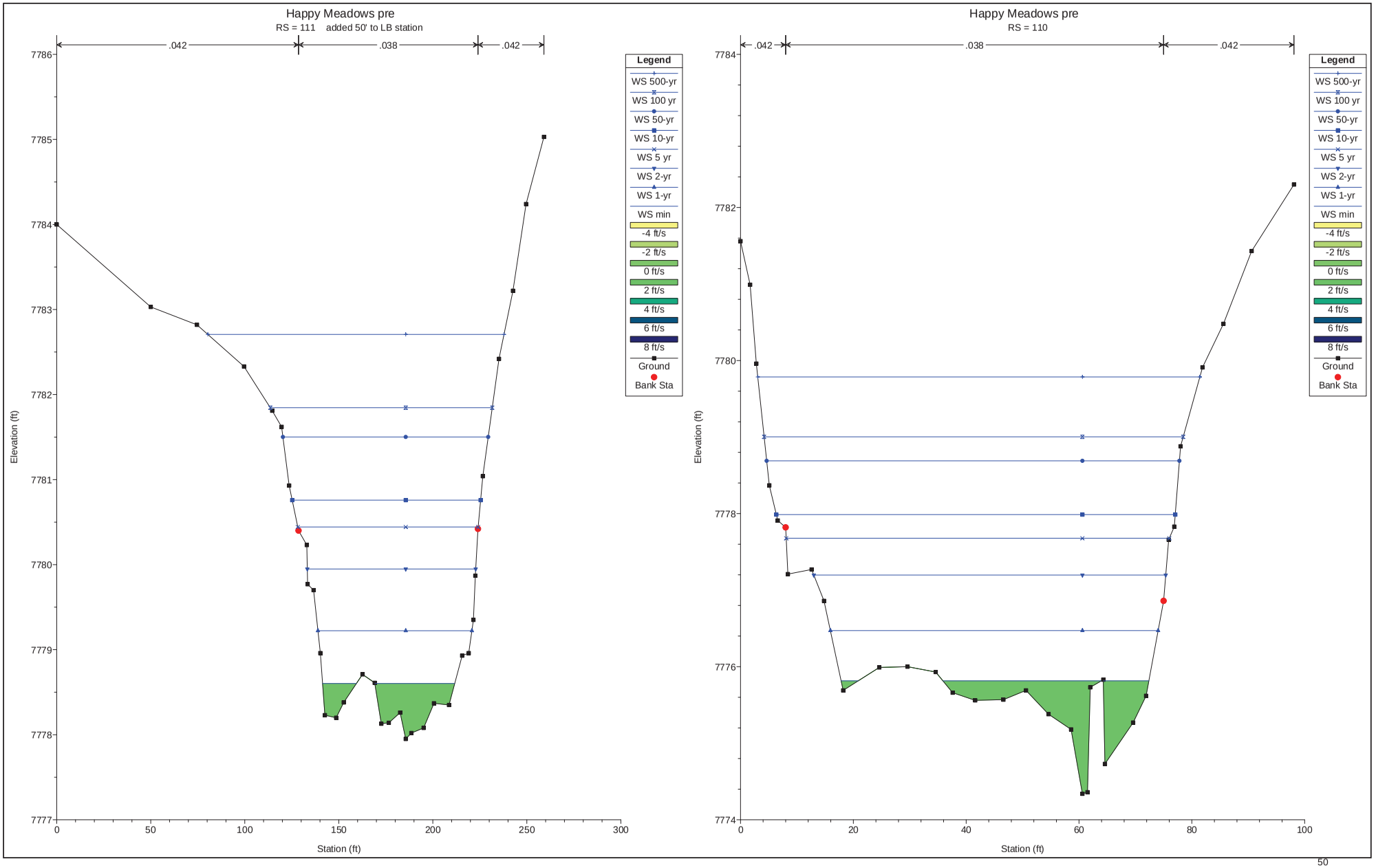
HEC-RAS Plan: Plan 01 River: South Platte Reach: Happy Meadows (Continued)

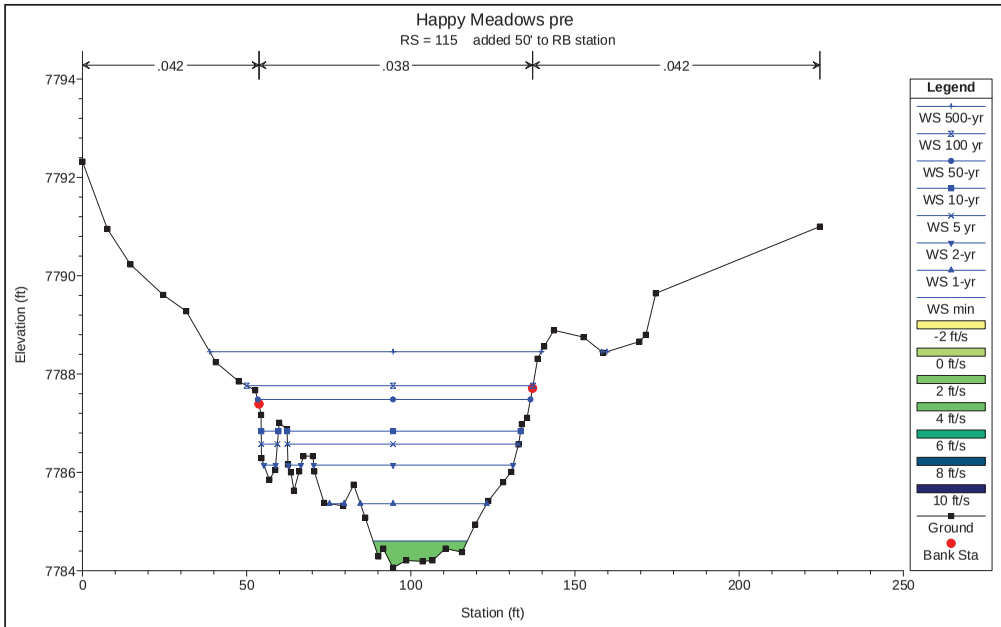
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Happy Meadows	124	1-yr	156.00	7796.98	7798.67		7798.71	0.002177	1.62	96.08	112.62	0.31
Happy Meadows	124	2-yr	422.00	7796.98	7799.46		7799.53	0.001928	2.15	196.05	136.22	0.32
Happy Meadows	124	5 yr	654.00	7796.98	7799.98		7800.07	0.001805	2.39	274.08	156.19	0.32
Happy Meadows	124	10-yr	842.00	7796.98	7800.33		7800.43	0.001671	2.58	328.12	159.60	0.31
Happy Meadows	124	50-yr	1347.00	7796.98	7801.14		7801.28	0.001443	2.95	461.79	167.83	0.31
Happy Meadows	124	100 yr	1606.00	7796.98	7801.52		7801.67	0.001366	3.10	525.72	171.38	0.30
Happy Meadows	124	500-yr	2331.00	7796.98	7802.47		7802.65	0.001218	3.44	708.00	218.49	0.30
Happy Meadows	123	min	28.00	7794.86	7795.75	7795.75	7795.94	0.028898	3.56	7.87	19.97	1.00
Happy Meadows	123	1-yr	156.00	7794.86	7796.77		7796.91	0.006307	2.98	52.28	55.12	0.54
Happy Meadows	123	2-yr	422.00	7794.86	7797.74		7797.97	0.005176	3.88	108.69	66.16	0.53
Happy Meadows	123	5 yr	654.00	7794.86	7798.31		7798.61	0.004792	4.43	147.61	69.34	0.54
Happy Meadows	123	10-yr	842.00	7794.86	7798.69		7799.05	0.004616	4.83	175.01	75.10	0.54
Happy Meadows	123	50-yr	1347.00	7794.86	7799.54		7800.04	0.004312	5.68	243.98	84.75	0.55
Happy Meadows	123	100 yr	1606.00	7794.86	7799.92		7800.48	0.004209	6.03	276.86	88.05	0.55
Happy Meadows	123	500-yr	2331.00	7794.86	7800.82		7801.53	0.004137	6.91	358.71	95.06	0.57
Happy Meadows	122	min	28.00	7792.56	7794.57		7794.58	0.001159	0.98	28.53	43.02	0.21
Happy Meadows	122	1-yr	156.00	7792.56	7795.39		7795.46	0.002521	2.09	74.48	61.55	0.34
Happy Meadows	122	2-yr	422.00	7792.56	7796.20		7796.38	0.003412	3.34	126.47	63.98	0.42
Happy Meadows	122	5 yr	654.00	7792.56	7796.73		7796.99	0.003798	4.08	160.45	65.87	0.46
Happy Meadows	122	10-yr	842.00	7792.56	7797.09		7797.42	0.003978	4.57	184.80	67.97	0.48
Happy Meadows	122	50-yr	1347.00	7792.56	7797.90		7798.40	0.004353	5.66	243.09	78.08	0.52
Happy Meadows	122	100 yr	1606.00	7792.56	7798.26		7798.83	0.004498	6.11	272.48	88.56	0.54
Happy Meadows	122	500-yr	2331.00	7792.56	7799.08		7799.84	0.004786	7.15	354.04	108.97	0.57
Happy Meadows	121	min	28.00	7793.42	7794.26		7794.31	0.007937	1.79	15.62	42.09	0.52
Happy Meadows	121	1-yr	156.00	7793.42	7795.00		7795.09	0.004477	2.34	66.75	78.07	0.45
Happy Meadows	121	2-yr	422.00	7793.42	7795.81		7795.97	0.003830	3.23	130.74	83.14	0.45
Happy Meadows	121	5 yr	654.00	7793.42	7796.36		7796.57	0.003527	3.70	176.76	85.92	0.45
Happy Meadows	121	10-yr	842.00	7793.42	7796.74		7796.99	0.003314	4.00	210.55	88.24	0.45
Happy Meadows	121	50-yr	1347.00	7793.42	7797.61		7797.95	0.003016	4.68	293.98	105.84	0.45
Happy Meadows	121	100 yr	1606.00	7793.42	7797.99		7798.37	0.002931	4.97	337.13	120.11	0.46
Happy Meadows	121	500-yr	2331.00	7793.42	7798.90		7799.36	0.002762	5.58	454.02	136.26	0.46
Happy Meadows	120	min	28.00	7791.27	7792.33		7792.35	0.001747	1.04	27.04	53.18	0.26
Happy Meadows	120	1-yr	156.00	7791.27	7793.12		7793.18	0.002352	2.02	77.18	68.34	0.34
Happy Meadows	120	2-yr	422.00	7791.27	7794.07		7794.21	0.002294	2.95	143.38	71.32	0.36
Happy Meadows	120	5 yr	654.00	7791.27	7794.67		7794.86	0.002331	3.52	187.19	75.14	0.38
Happy Meadows	120	10-yr	842.00	7791.27	7795.06		7795.30	0.002430	3.94	217.71	81.95	0.40
Happy Meadows	120	50-yr	1347.00	7791.27	7795.90		7796.26	0.002651	4.85	292.80	98.04	0.43
Happy Meadows	120	100 yr	1606.00	7791.27	7796.24		7796.65	0.002792	5.26	327.08	105.41	0.45
Happy Meadows	120	500-yr	2331.00	7791.27	7796.99		7797.57	0.003190	6.27	412.79	121.84	0.50
Happy Meadows	119	min	28.00	7790.37	7791.03		7791.07	0.005581	1.50	18.66	50.56	0.44
Happy Meadows	119	1-yr	156.00	7790.37	7791.85		7791.94	0.003353	2.42	64.38	57.47	0.40
Happy Meadows	119	2-yr	422.00	7790.37	7792.93		7793.09	0.002758	3.19	132.51	68.92	0.40
Happy Meadows	119	5 yr	654.00	7790.37	7793.58		7793.79	0.002499	3.67	186.95	119.26	0.40
Happy Meadows	119	10-yr	842.00	7790.37	7794.04		7794.26	0.002224	3.86	244.16	129.02	0.39
Happy Meadows	119	50-yr	1347.00	7790.37	7795.06		7795.28	0.001703	4.08	416.49	210.69	0.36
Happy Meadows	119	100 yr	1606.00	7790.37	7795.46		7795.68	0.001560	4.16	504.90	226.33	0.35
Happy Meadows	119	500-yr	2331.00	7790.37	7796.31		7796.55	0.001436	4.48	711.40	258.14	0.34
Happy Meadows	118	min	28.00	7788.90	7789.77		7789.81	0.002744	1.44	19.47	32.99	0.33
Happy Meadows	118	1-yr	156.00	7788.90	7790.88		7790.97	0.002583	2.42	64.50	47.75	0.37
Happy Meadows	118	2-yr	422.00	7788.90	7791.91		7792.12	0.003040	3.62	116.61	53.03	0.43
Happy Meadows	118	5 yr	654.00	7788.90	7792.57		7792.86	0.003101	4.33	152.56	58.20	0.45
Happy Meadows	118	10-yr	842.00	7788.90	7793.02		7793.38	0.003109	4.78	180.57	64.52	0.46
Happy Meadows	118	50-yr	1347.00	7788.90	7794.06		7794.52	0.002992	5.61	270.65	117.57	0.47
Happy Meadows	118	100 yr	1606.00	7788.90	7794.51		7794.98	0.002784	5.78	348.50	210.85	0.46
Happy Meadows	118	500-yr	2331.00	7788.90	7795.61		7795.99	0.001950	5.55	602.27	246.26	0.40
Happy Meadows	117	min	28.00	7786.91	7788.14	7787.76	7788.20	0.004702	2.00	14.02	21.65	0.44
Happy Meadows	117	1-yr	156.00	7786.91	7789.26	7788.71	7789.38	0.004856	2.84	54.95	51.31	0.48
Happy Meadows	117	2-yr	422.00	7786.91	7790.24	7789.46	7790.49	0.004225	3.98	106.13	52.86	0.49
Happy Meadows	117	5 yr	654.00	7786.91	7790.87	7789.93	7791.21	0.004224	4.68	139.66	53.78	0.51
Happy Meadows	117	10-yr	842.00	7786.91	7791.30	7790.23	7791.72	0.004266	5.16	163.12	54.94	0.53
Happy Meadows	117	50-yr	1347.00	7786.91	7792.26	7790.95	7792.86	0.004423	6.24	216.93	58.09	0.56
Happy Meadows	117	100 yr	1606.00	7786.91	7792.66	7791.34	7793.36	0.004495	6.73	240.98	59.61	0.57
Happy Meadows	117	500-yr	2331.00	7786.91	7793.64	7792.19	7794.61	0.004725	7.91	301.30	63.53	0.61
Happy Meadows	116	min	28.00	7785.59	7786.81	7786.33	7786.84	0.002023	1.21	23.16	39.07	0.28
Happy Meadows	116	1-yr	156.00	7785.59	7787.75		7787.82	0.002469	2.21	70.44	56.05	0.35
Happy Meadows	116	2-yr	422.00	7785.59	7788.71		7788.89	0.002857	3.36	125.72	59.88	0.41
Happy Meadows	116	5 yr	654.00	7785.59	7789.26		7789.52	0.003164	4.12	160.13	65.53	0.44

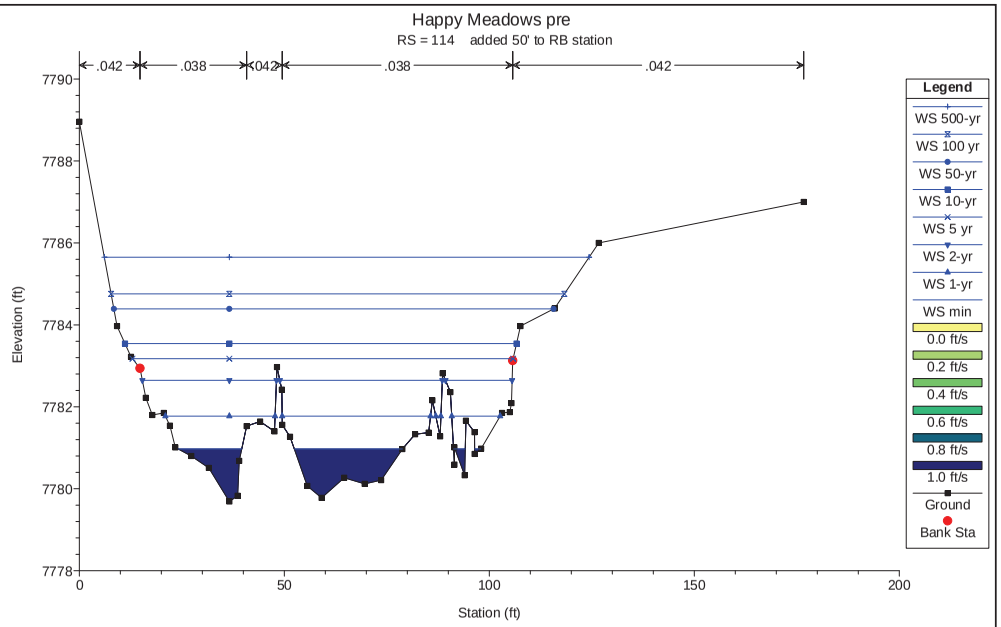
HEC-RAS Plan: Plan 01 River: South Platte Reach: Happy Meadows (Continued)

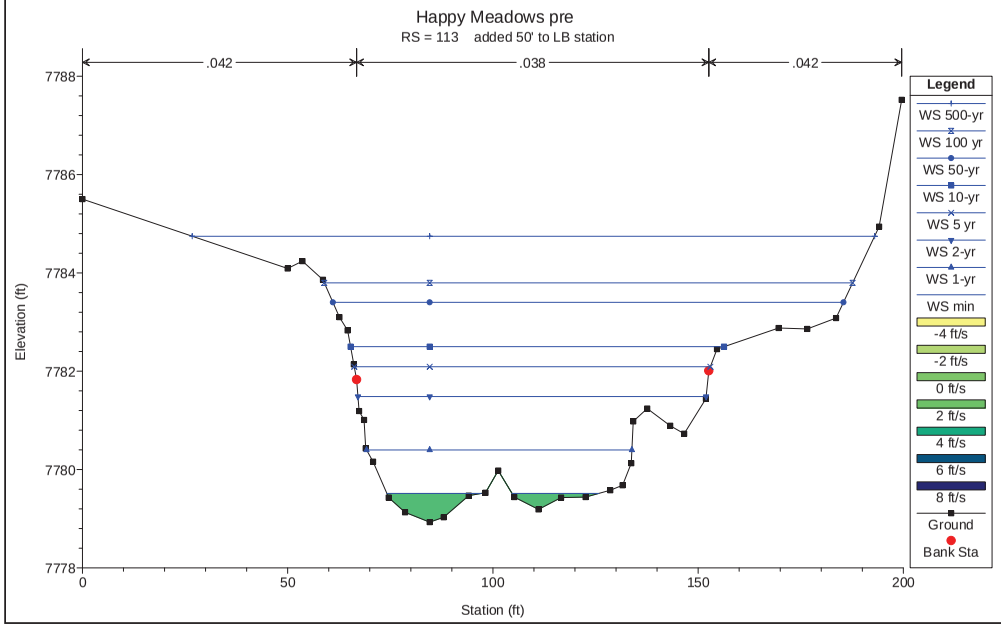
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Happy Meadows	116	10-yr	842.00	7785.59	7789.63		7789.97	0.003359	4.63	185.02	67.65	0.47
Happy Meadows	116	50-yr	1347.00	7785.59	7790.45		7790.95	0.003796	5.77	241.81	72.21	0.52
Happy Meadows	116	100 yr	1606.00	7785.59	7790.79		7791.39	0.004005	6.27	267.07	74.56	0.54
Happy Meadows	116	500-yr	2331.00	7785.59	7791.60	7790.26	7792.44	0.004545	7.51	329.96	81.62	0.59
Happy Meadows	115	min	28.00	7784.06	7784.60	7784.60	7784.76	0.030547	3.13	8.93	28.67	0.99
Happy Meadows	115	1-yr	156.00	7784.06	7785.36	7785.25	7785.68	0.018096	4.53	34.47	42.97	0.89
Happy Meadows	115	2-yr	422.00	7784.06	7786.15	7786.03	7786.59	0.015758	5.37	78.62	68.10	0.88
Happy Meadows	115	5 yr	654.00	7784.06	7786.58	7786.43	7787.13	0.014429	5.96	109.73	75.28	0.87
Happy Meadows	115	10-yr	842.00	7784.06	7786.84	7786.68	7787.49	0.014138	6.50	129.58	76.38	0.88
Happy Meadows	115	50-yr	1347.00	7784.06	7787.48	7787.29	7788.34	0.013126	7.42	181.60	83.06	0.88
Happy Meadows	115	100 yr	1606.00	7784.06	7787.76	7787.56	7788.72	0.012618	7.84	205.22	87.24	0.88
Happy Meadows	115	500-yr	2331.00	7784.06	7788.45	7788.24	7789.65	0.011467	8.81	270.69	102.56	0.88
Happy Meadows	114	min	28.00	7779.69	7780.97	7780.39	7780.99	0.001184	0.96	29.10	46.07	0.21
Happy Meadows	114	1-yr	156.00	7779.69	7781.77		7781.84	0.002623	2.02	77.40	76.02	0.35
Happy Meadows	114	2-yr	422.00	7779.69	7782.65		7782.77	0.002730	2.78	151.54	88.59	0.38
Happy Meadows	114	5 yr	654.00	7779.69	7783.17		7783.34	0.002772	3.28	199.29	92.84	0.39
Happy Meadows	114	10-yr	842.00	7779.69	7783.54		7783.75	0.002739	3.61	234.22	95.51	0.40
Happy Meadows	114	50-yr	1347.00	7779.69	7784.39		7784.68	0.002689	4.31	318.58	107.26	0.41
Happy Meadows	114	100 yr	1606.00	7779.69	7784.76		7785.08	0.002687	4.61	358.54	110.55	0.42
Happy Meadows	114	500-yr	2331.00	7779.69	7785.65		7786.08	0.002688	5.30	460.87	118.24	0.43
Happy Meadows	113	min	28.00	7778.93	7779.52	7779.52	7779.63	0.033853	2.72	10.29	44.14	0.99
Happy Meadows	113	1-yr	156.00	7778.93	7780.40		7780.50	0.004379	2.51	62.15	64.64	0.45
Happy Meadows	113	2-yr	422.00	7778.93	7781.48		7781.62	0.002982	2.98	141.75	84.83	0.41
Happy Meadows	113	5 yr	654.00	7778.93	7782.09		7782.27	0.002585	3.38	193.69	86.76	0.40
Happy Meadows	113	10-yr	842.00	7778.93	7782.50		7782.71	0.002458	3.68	229.70	91.00	0.40
Happy Meadows	113	50-yr	1347.00	7778.93	7783.40		7783.68	0.002281	4.31	329.96	124.41	0.40
Happy Meadows	113	100 yr	1606.00	7778.93	7783.80		7784.11	0.002201	4.54	380.01	128.72	0.40
Happy Meadows	113	500-yr	2331.00	7778.93	7784.75		7785.12	0.002066	5.07	518.10	166.25	0.40
Happy Meadows	112	min	28.00	7776.69	7778.78	7777.47	7778.79	0.000281	0.62	45.35	49.28	0.11
Happy Meadows	112	1-yr	156.00	7776.69	7779.65	7778.37	7779.69	0.000975	1.64	95.36	60.75	0.23
Happy Meadows	112	2-yr	422.00	7776.69	7780.53	7779.22	7780.65	0.001709	2.80	150.67	64.87	0.32
Happy Meadows	112	5 yr	654.00	7776.69	7781.07	7779.62	7781.26	0.002088	3.51	186.71	69.58	0.37
Happy Meadows	112	10-yr	842.00	7776.69	7781.41	7779.89	7781.66	0.002371	4.03	211.06	78.37	0.40
Happy Meadows	112	50-yr	1347.00	7776.69	7782.16	7780.58	7782.56	0.002875	5.13	273.52	88.04	0.46
Happy Meadows	112	100 yr	1606.00	7776.69	7782.50	7780.92	7782.97	0.003048	5.58	303.91	93.12	0.48
Happy Meadows	112	500-yr	2331.00	7776.69	7783.30	7781.73	7783.95	0.003400	6.62	384.57	106.82	0.52
Happy Meadows	111	min	28.00	7777.95	7778.60	7778.42	7778.63	0.004784	1.33	20.99	60.46	0.40
Happy Meadows	111	1-yr	156.00	7777.95	7779.22		7779.31	0.004483	2.30	67.74	81.87	0.45
Happy Meadows	111	2-yr	422.00	7777.95	7779.95		7780.11	0.004242	3.25	129.86	89.56	0.48
Happy Meadows	111	5 yr	654.00	7777.95	7780.44		7780.66	0.004105	3.74	175.08	95.90	0.49
Happy Meadows	111	10-yr	842.00	7777.95	7780.76		7781.02	0.004005	4.10	206.01	100.20	0.49
Happy Meadows	111	50-yr	1347.00	7777.95	7781.50		7781.86	0.003751	4.84	283.86	109.19	0.50
Happy Meadows	111	100 yr	1606.00	7777.95	7781.85		7782.25	0.003634	5.13	322.62	118.03	0.50
Happy Meadows	111	500-yr	2331.00	7777.95	7782.71		7783.20	0.003328	5.75	439.07	157.50	0.50
Happy Meadows	110	min	28.00	7774.34	7775.82	7775.60	7775.87	0.008014	1.82	15.42	39.18	0.51
Happy Meadows	110	1-yr	156.00	7774.34	7776.47	7776.20	7776.62	0.008009	3.10	50.36	58.10	0.59
Happy Meadows	110	2-yr	422.00	7774.34	7777.20	7776.78	7777.51	0.007992	4.49	94.03	62.39	0.64
Happy Meadows	110	5 yr	654.00	7774.34	7777.68	7777.21	7778.10	0.008014	5.19	126.26	67.92	0.67
Happy Meadows	110	10-yr	842.00	7774.34	7777.99	7777.49	7778.50	0.008004	5.73	147.67	70.72	0.68
Happy Meadows	110	50-yr	1347.00	7774.34	7778.69	7778.12	7779.42	0.007999	6.90	198.26	73.16	0.72
Happy Meadows	110	100 yr	1606.00	7774.34	7779.00	7778.43	7779.84	0.008011	7.40	221.38	74.28	0.73
Happy Meadows	110	500-yr	2331.00	7774.34	7779.79	7779.14	7780.90	0.008002	8.55	281.08	78.38	0.75

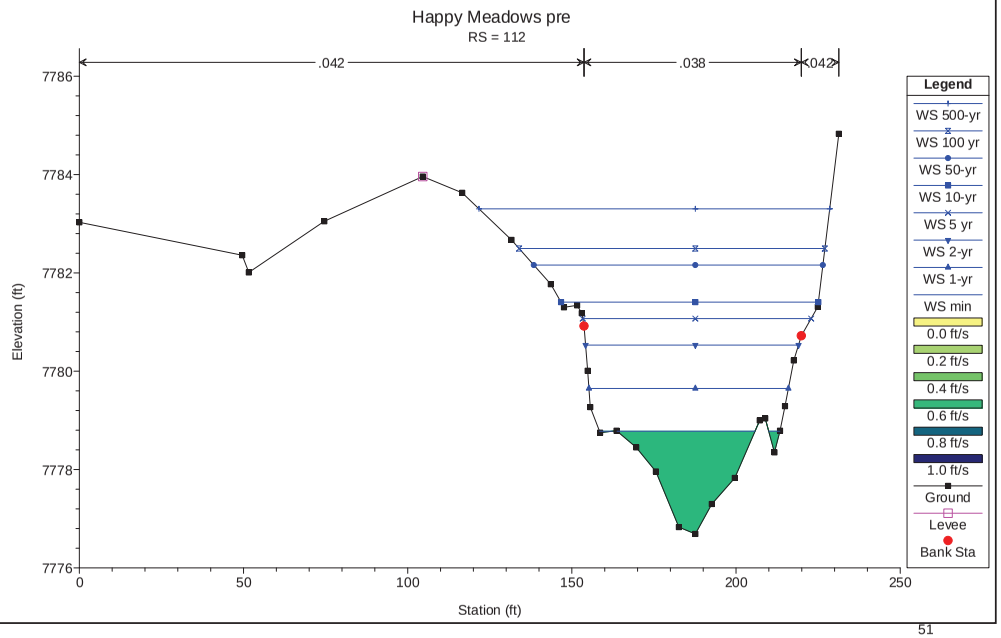

Happy Meadows pre
South Platte Happy Meadows
Legend
WS 2-yr
Ground
Elevation (ft)
7880
7860
7840
7820
7800
7780
7760
0
5000
10000
15000
20000
25000
Main Channel Distance (ft)

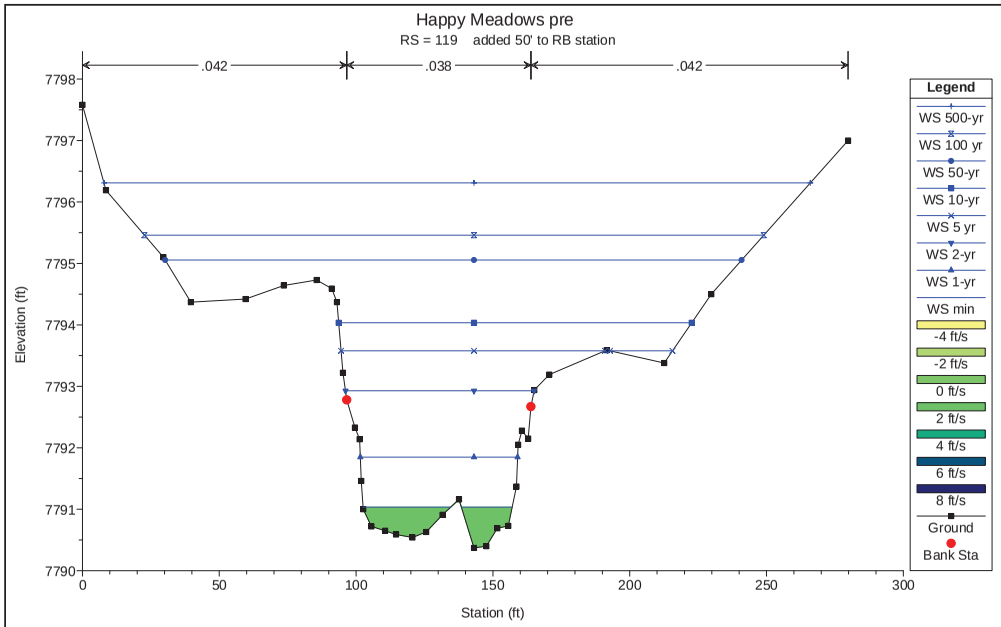

Happy Meadows pre
RS = 111 added 50' to LB station
.042
.038
.042
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)
7786
7785
7784
7783
7782
7781
7780
7779
7778
7777
0
50
100
150
200
250
300
Happy Meadows pre
RS = 110
.042
.038
.042
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)
7784
7782
7780
7778
7776
7774
0
20
40
60
80
100

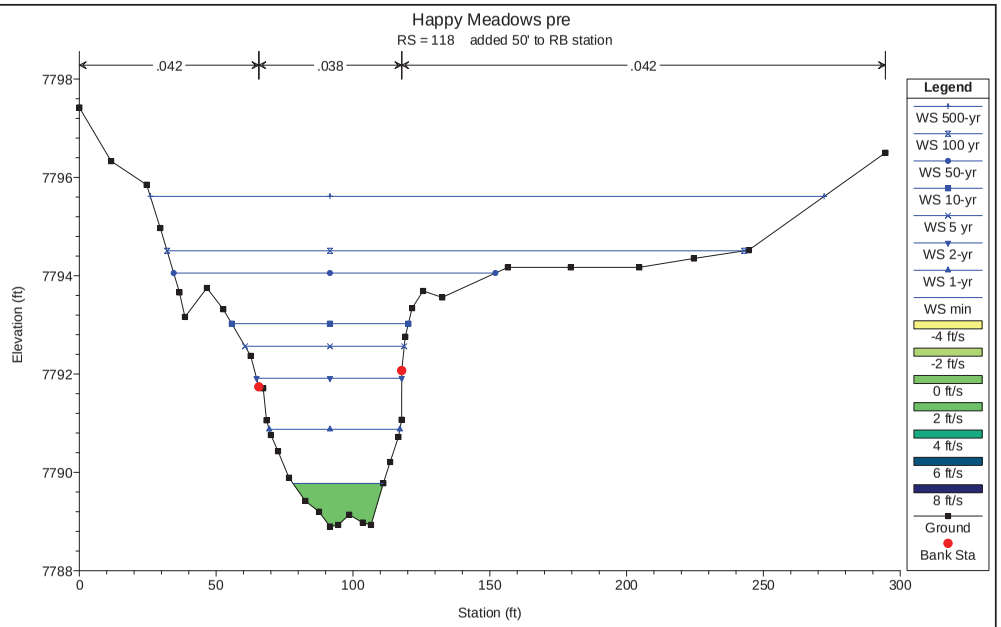

Happy Meadows pre
RS = 115 added 50' to RB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

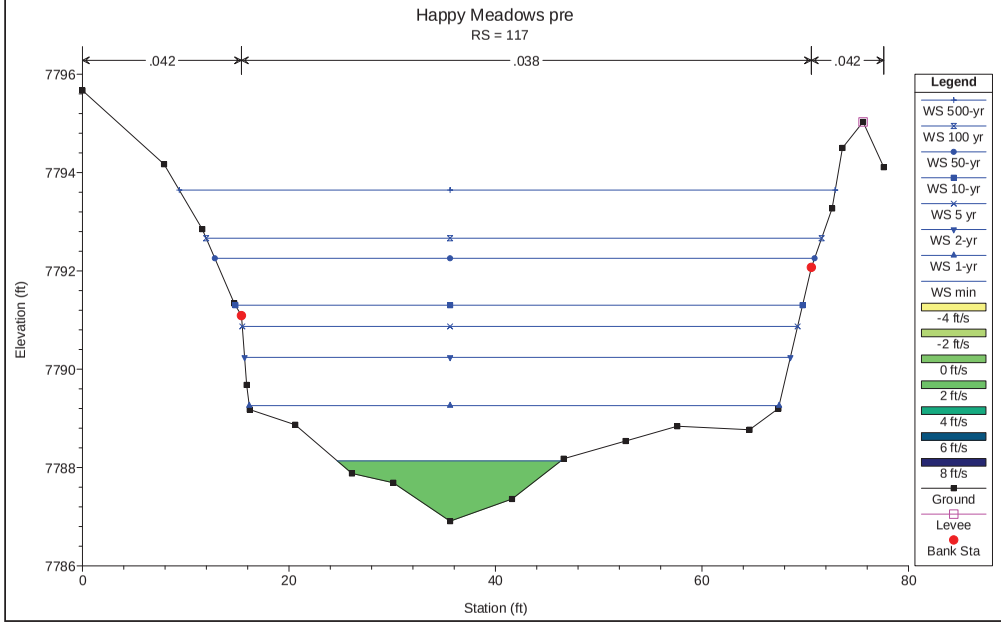

Happy Meadows pre
RS = 114 added 50' to RB station
.042
.038
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

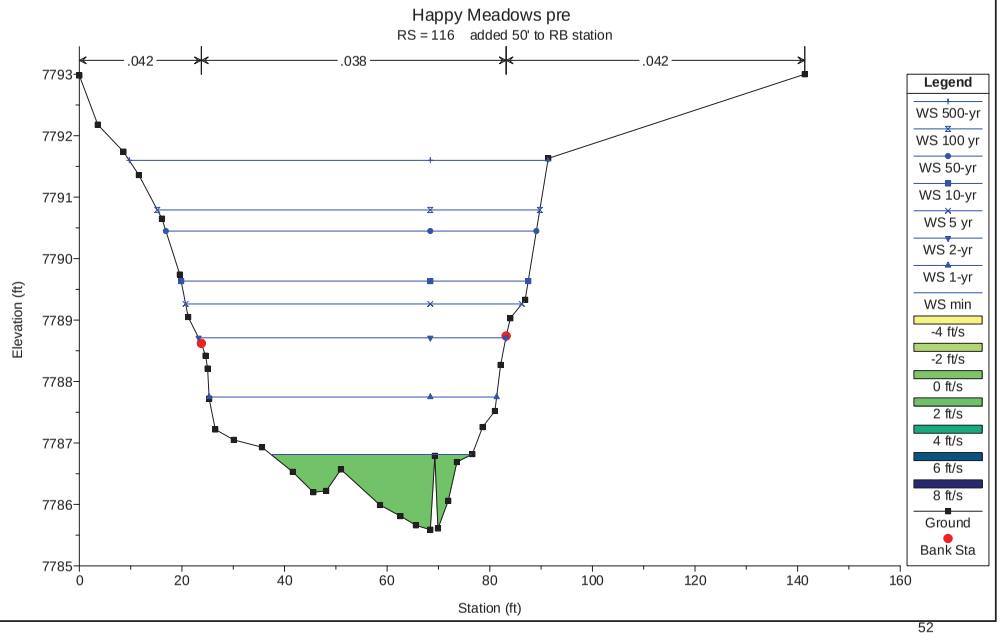

Happy Meadows pre
RS = 113 added 50' to LB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

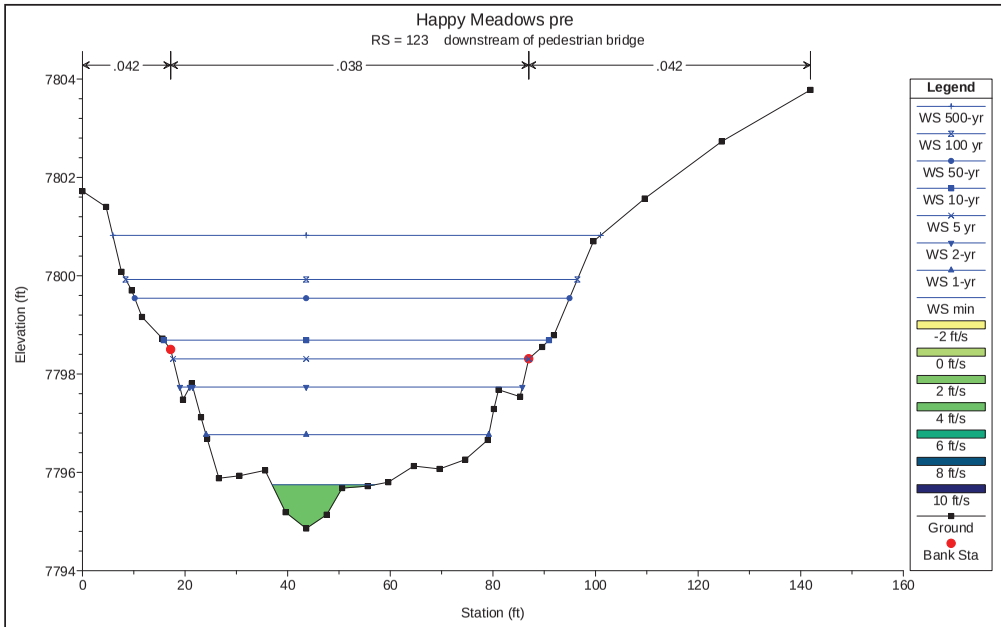

Happy Meadows pre
RS = 112
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Levee
Bank Sta

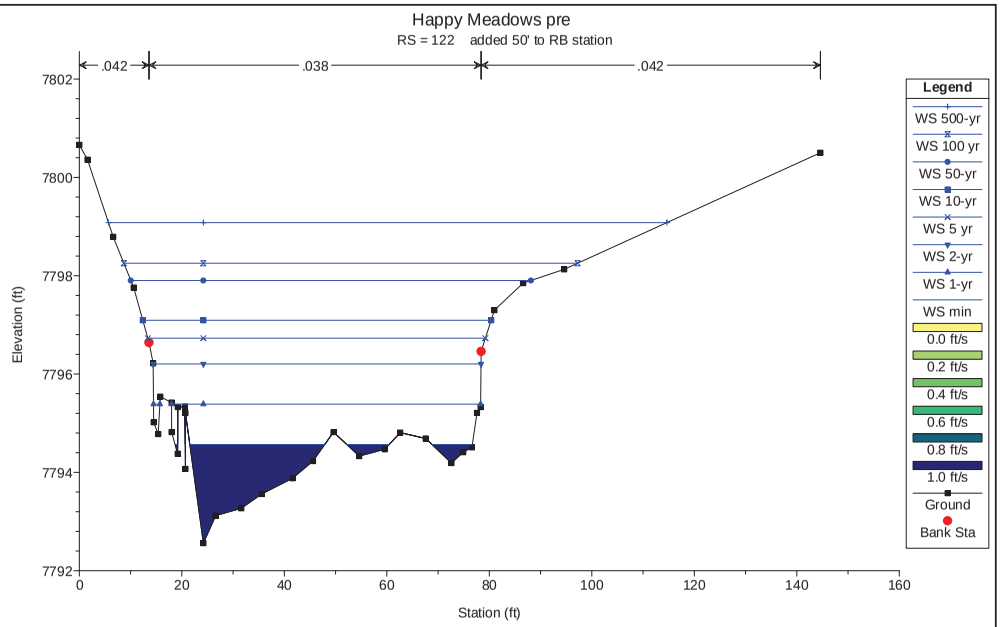

Happy Meadows pre
RS = 119 added 50' to RB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

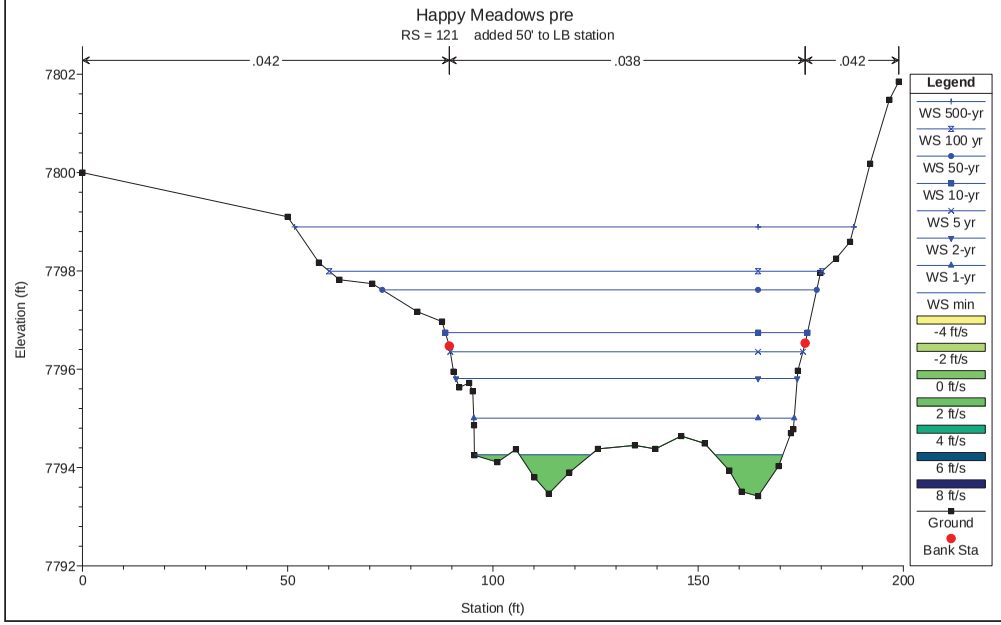

Happy Meadows pre
RS = 118 added 50' to RB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

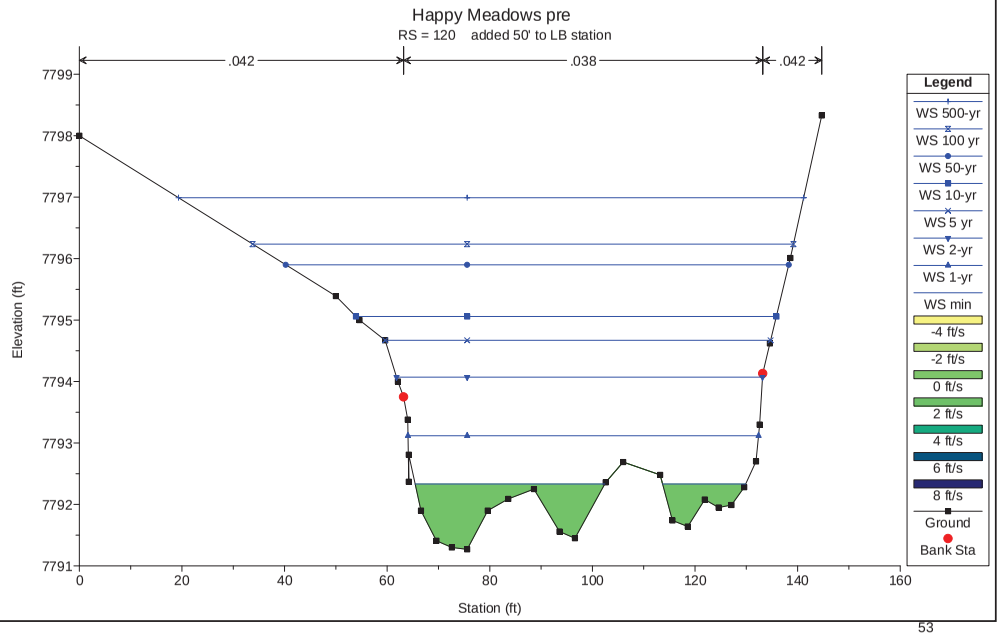

Happy Meadows pre
RS = 117
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Levee
Bank Sta

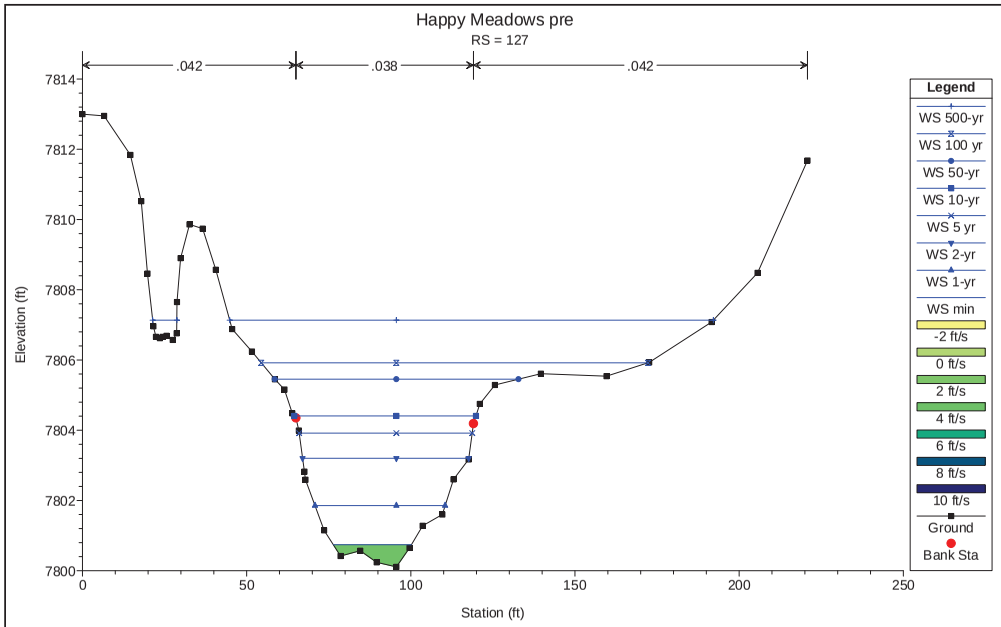

Happy Meadows pre
RS = 116 added 50' to RB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

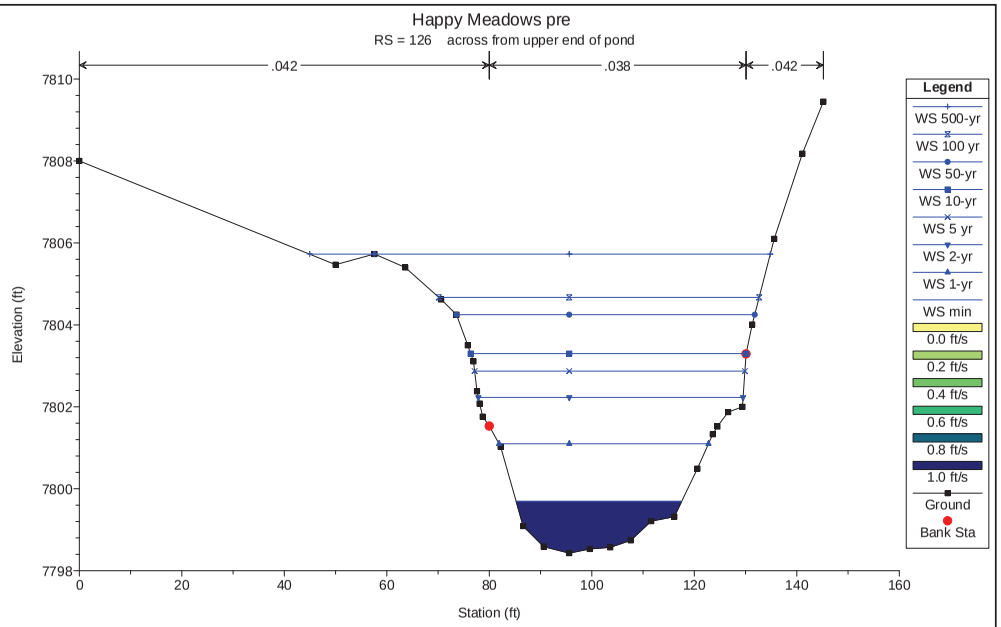

Happy Meadows pre
RS = 123 downstream of pedestrian bridge
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

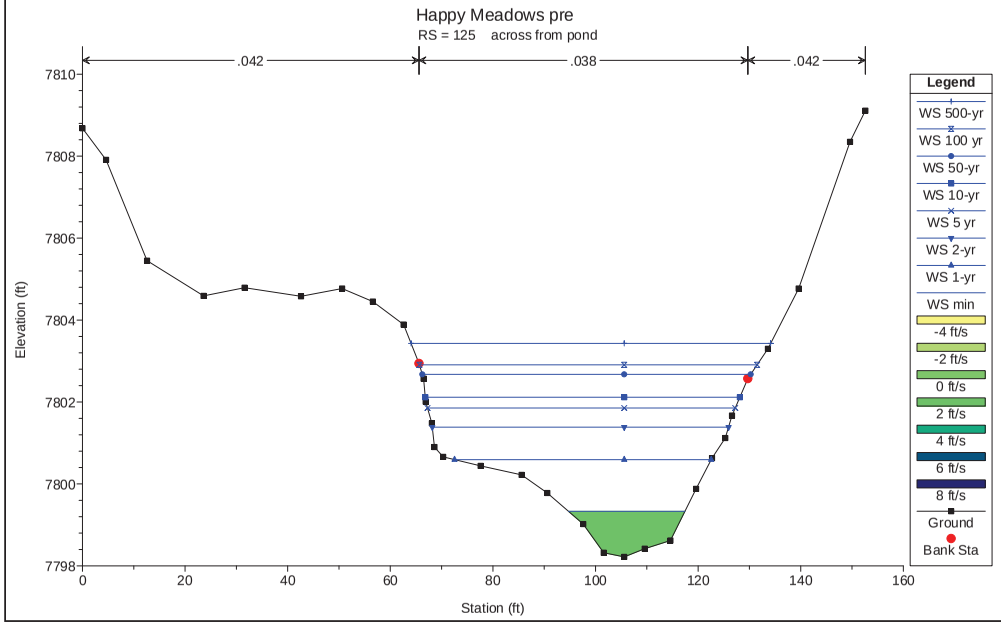

Happy Meadows pre
RS = 122 added 50' to RB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

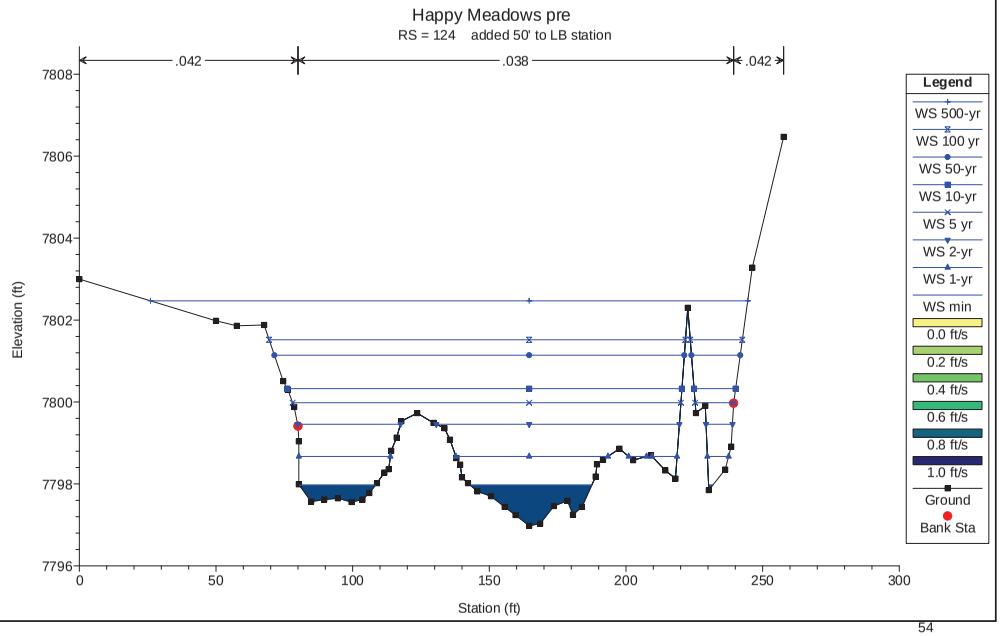

Happy Meadows pre
RS = 121 added 50' to LB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

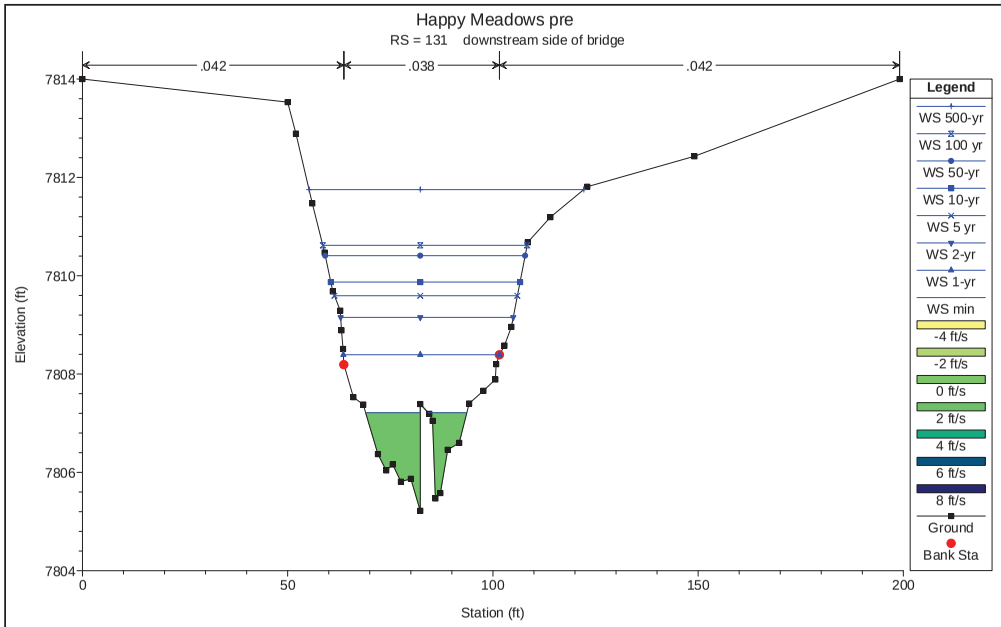

Happy Meadows pre
RS = 120 added 50' to LB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

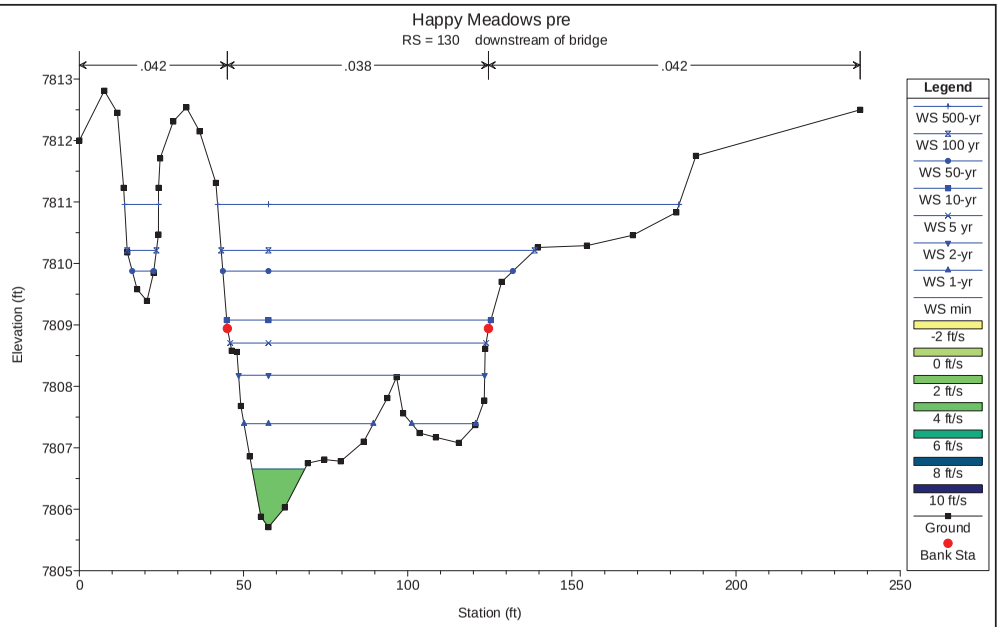

Happy Meadows pre
RS = 127
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

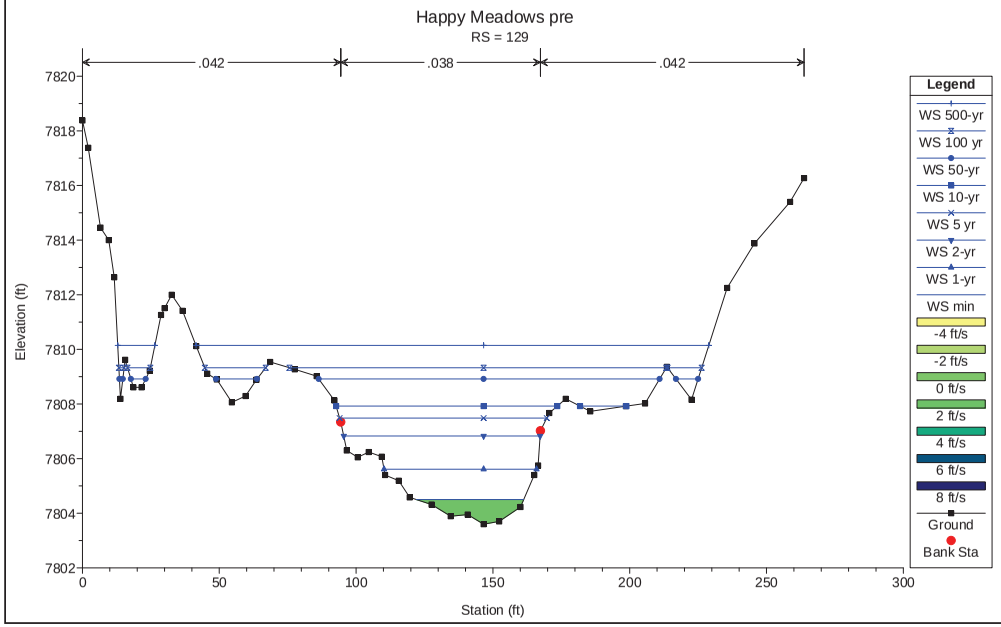

Happy Meadows pre
RS = 126 across from upper end of pond
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

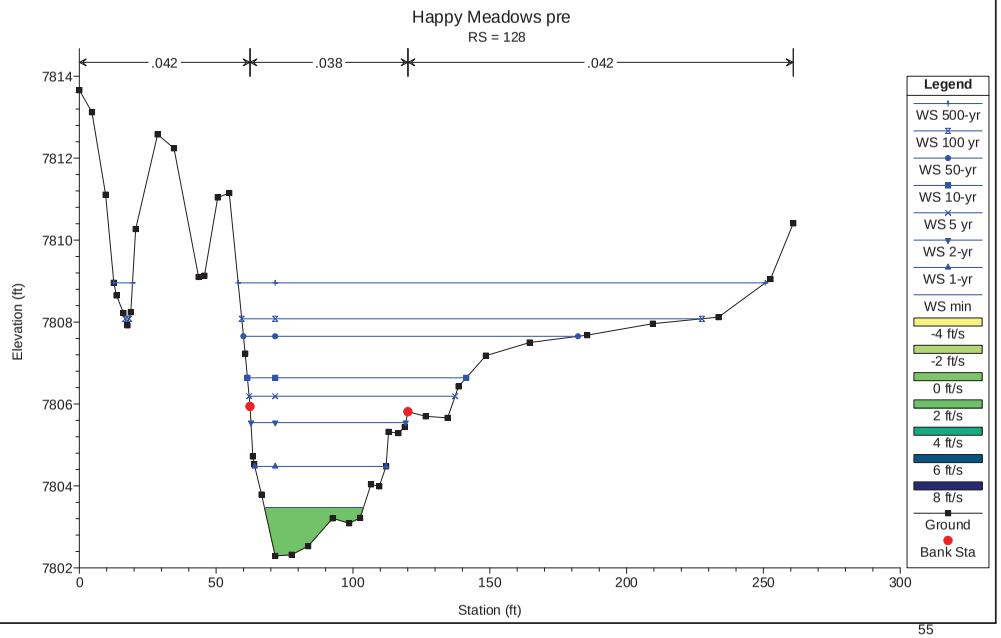

Happy Meadows pre
RS = 125 across from pond
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

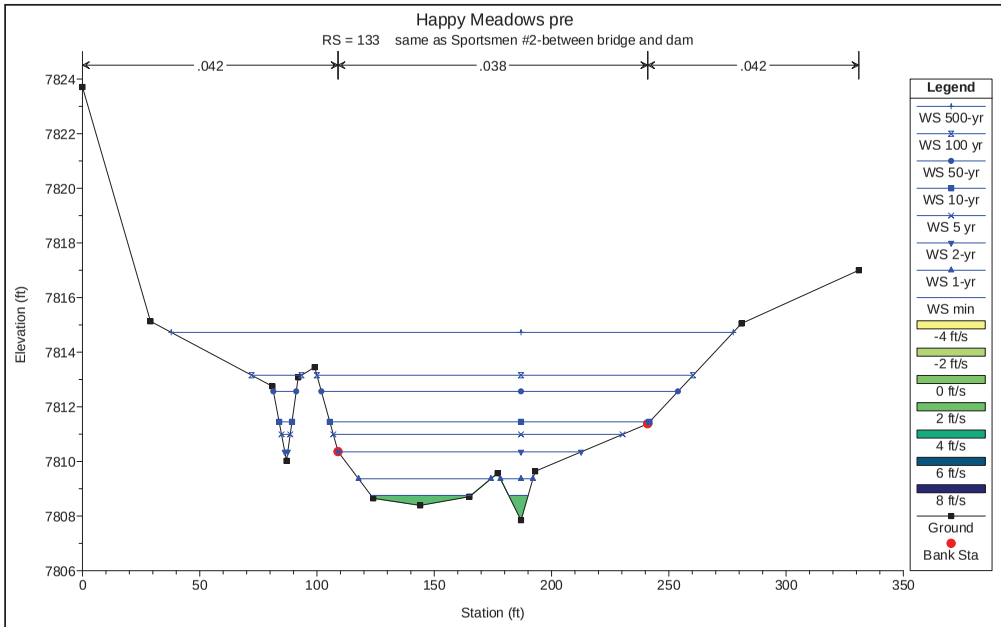

Happy Meadows pre
RS = 124 added 50' to LB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

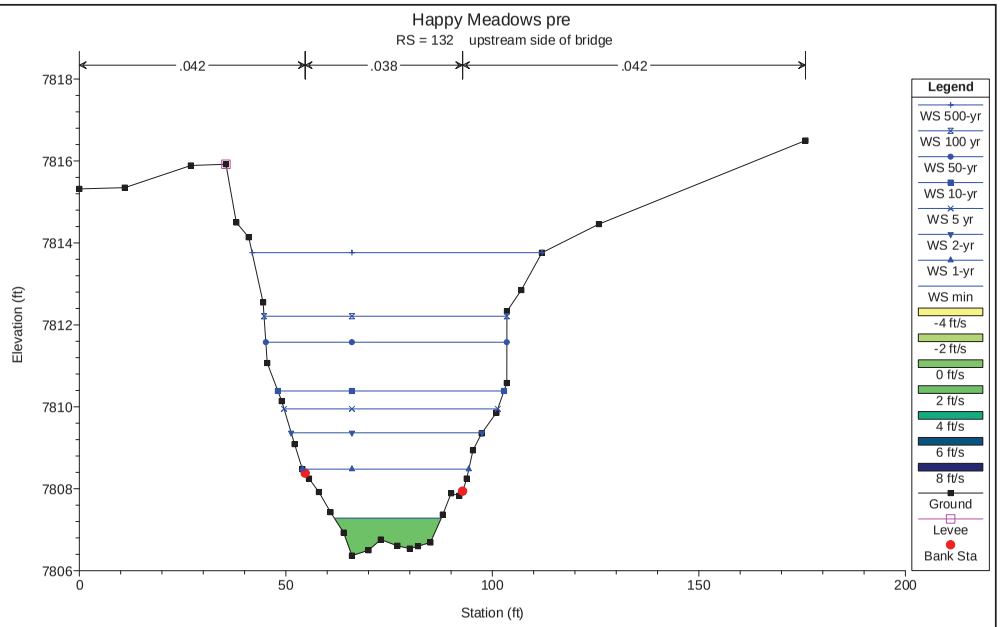

Happy Meadows pre
RS = 131 downstream side of bridge
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

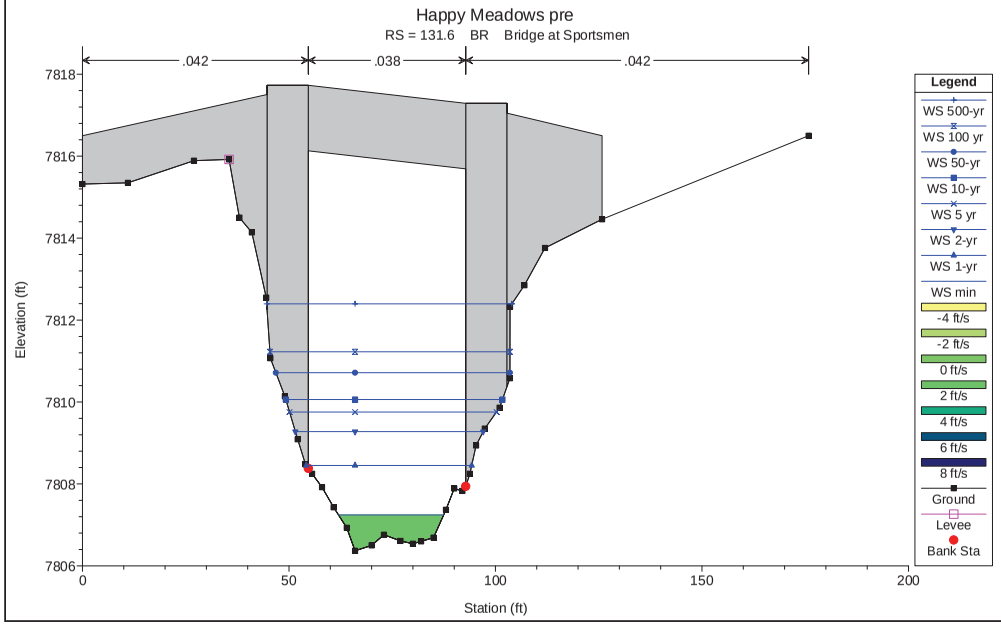

Happy Meadows pre
RS = 130 downstream of bridge
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

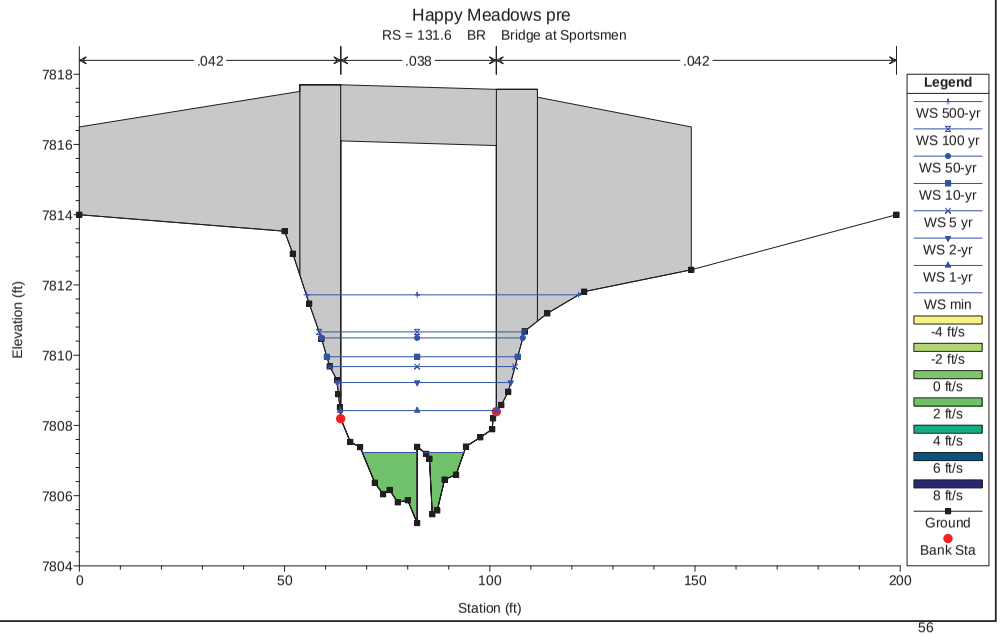

Happy Meadows pre
RS = 129
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

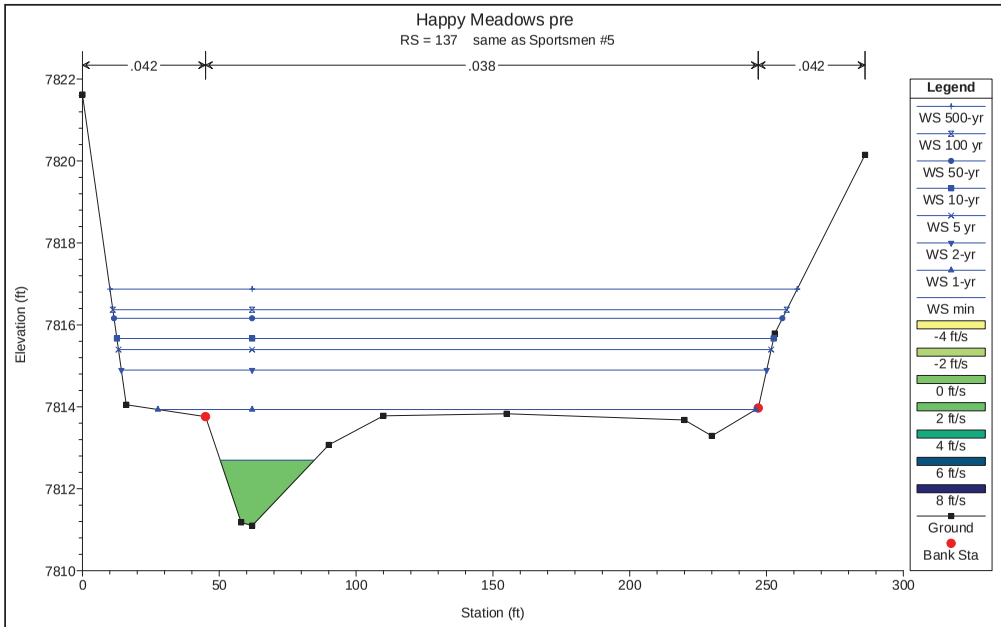

Happy Meadows pre
RS = 128
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

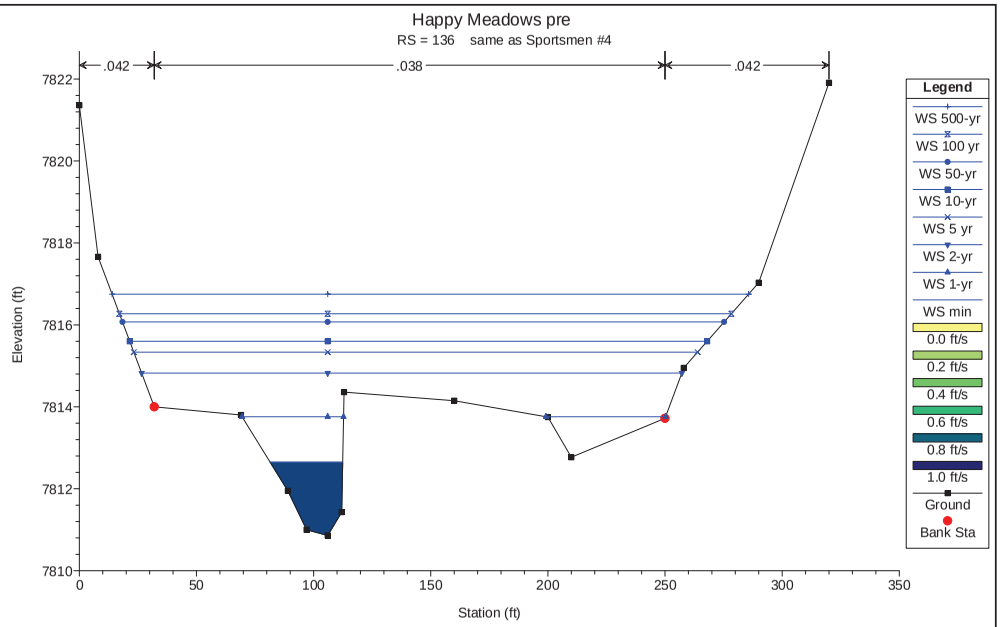

Happy Meadows pre
RS = 133 same as Sportsmen #2-between bridge and dam
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

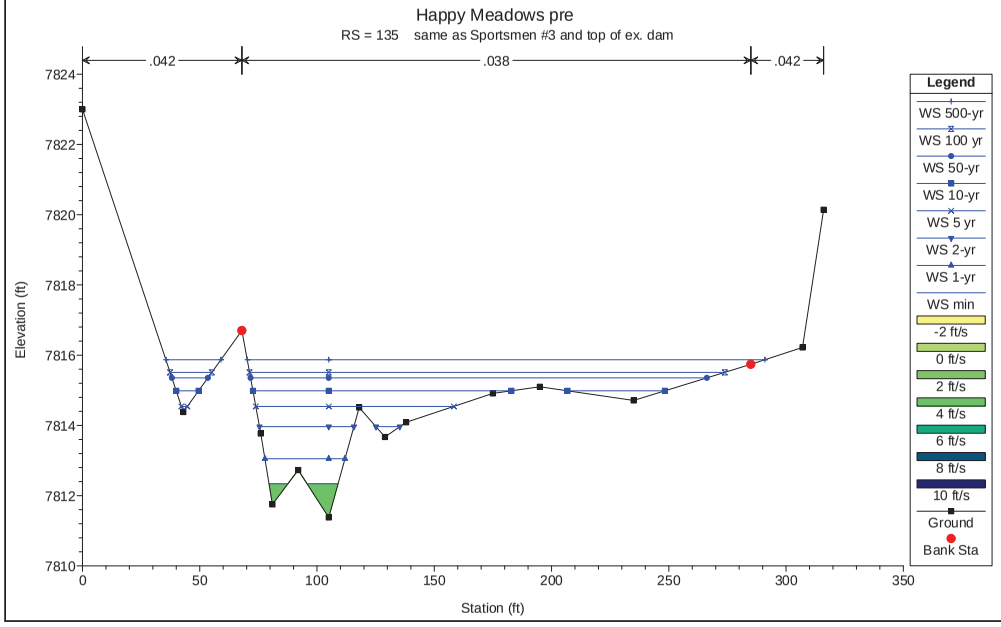

Happy Meadows pre
RS = 132 upstream side of bridge
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Levee
Bank Sta

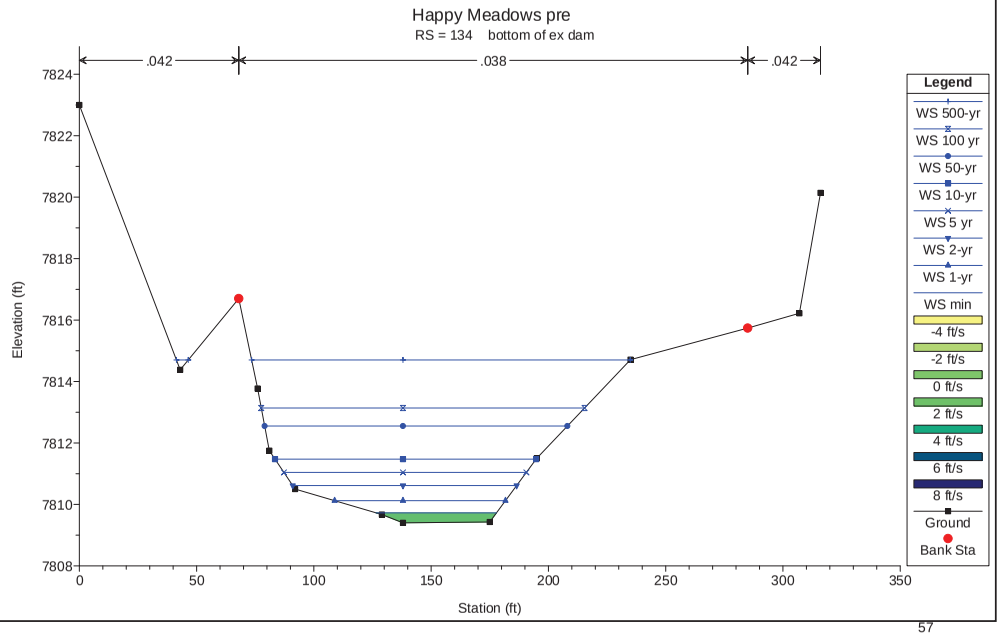

Happy Meadows pre
RS = 131.6 BR Bridge at Sportsmen
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Levee
Bank Sta

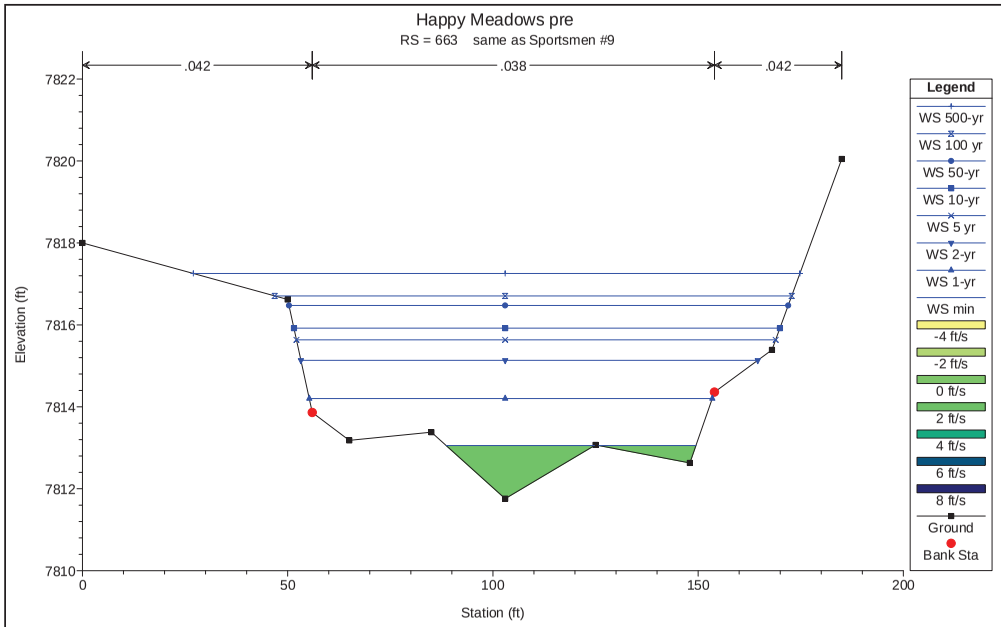

Happy Meadows pre
RS = 131.6 BR Bridge at Sportsmen
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

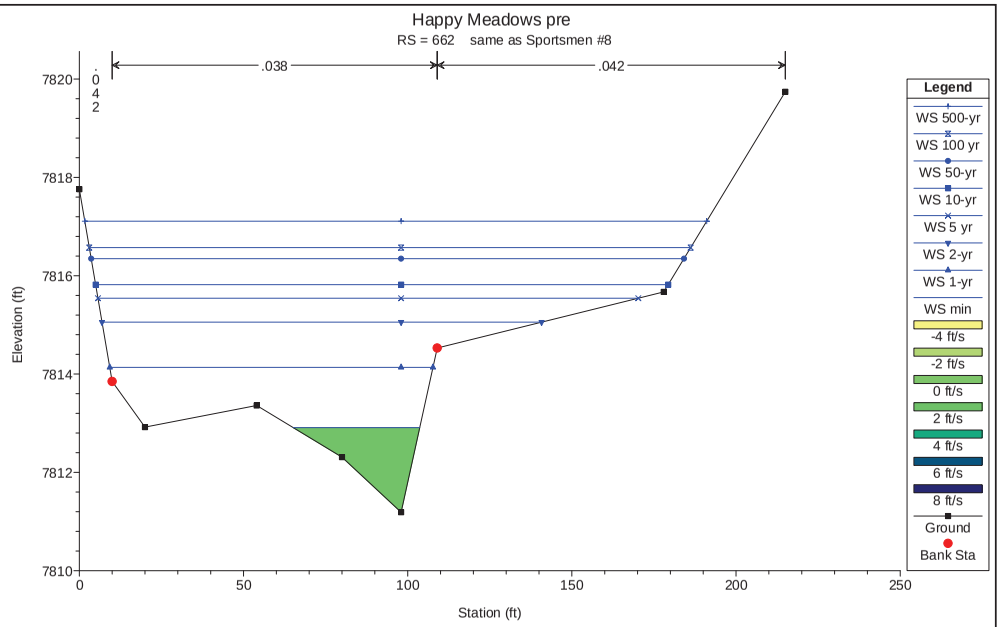

Happy Meadows pre
RS = 137 same as Sportsmen #5
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

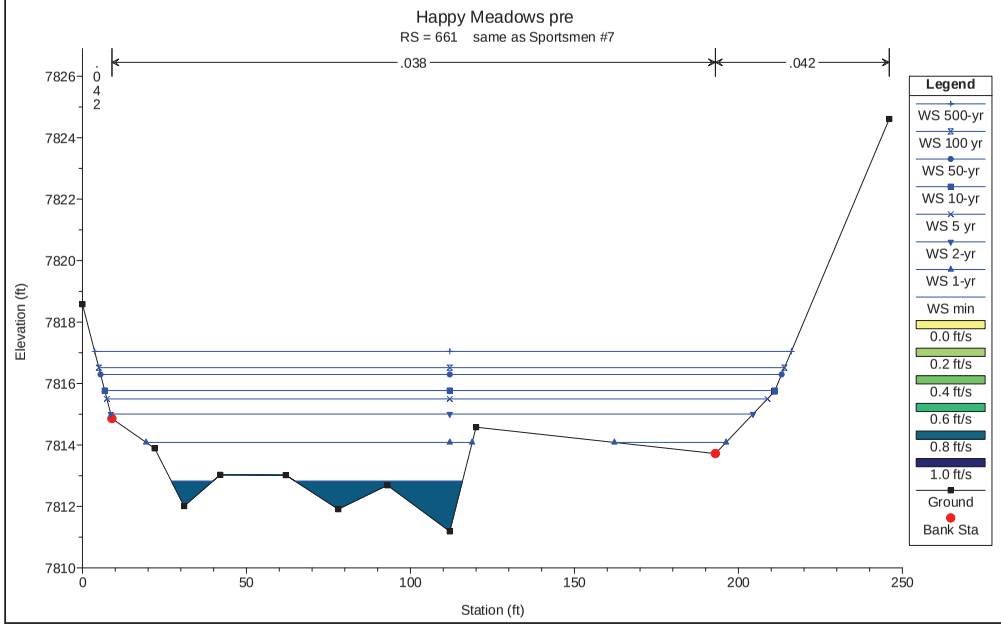

Happy Meadows pre
RS = 136 same as Sportsmen #4
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

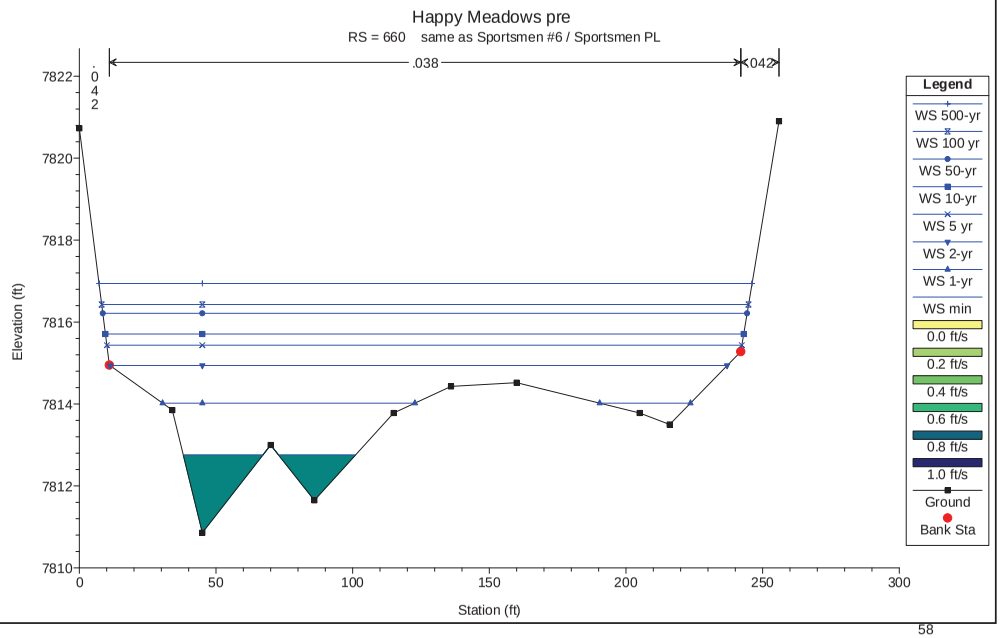

Happy Meadows pre
RS = 135 same as Sportsmen #3 and top of ex. dam
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

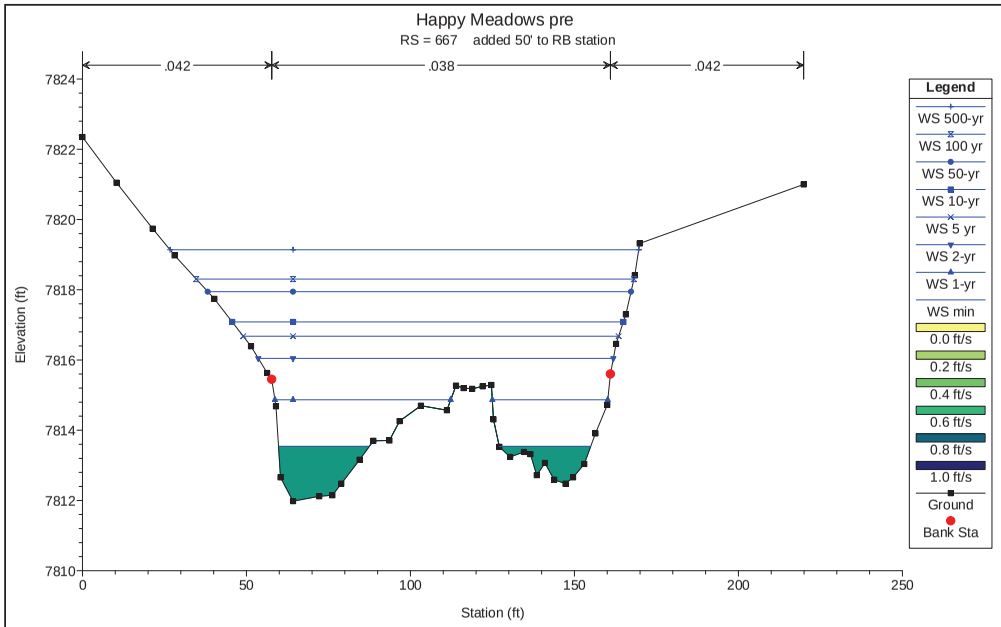

Happy Meadows pre
RS = 134 bottom of ex dam
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

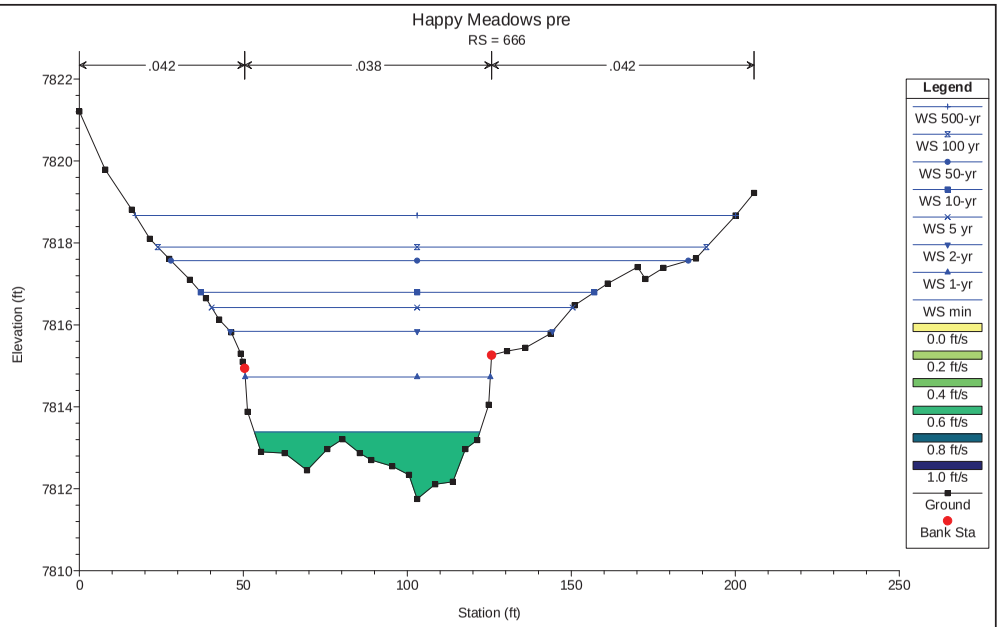

Happy Meadows pre
RS = 663 same as Sportsmen #9
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

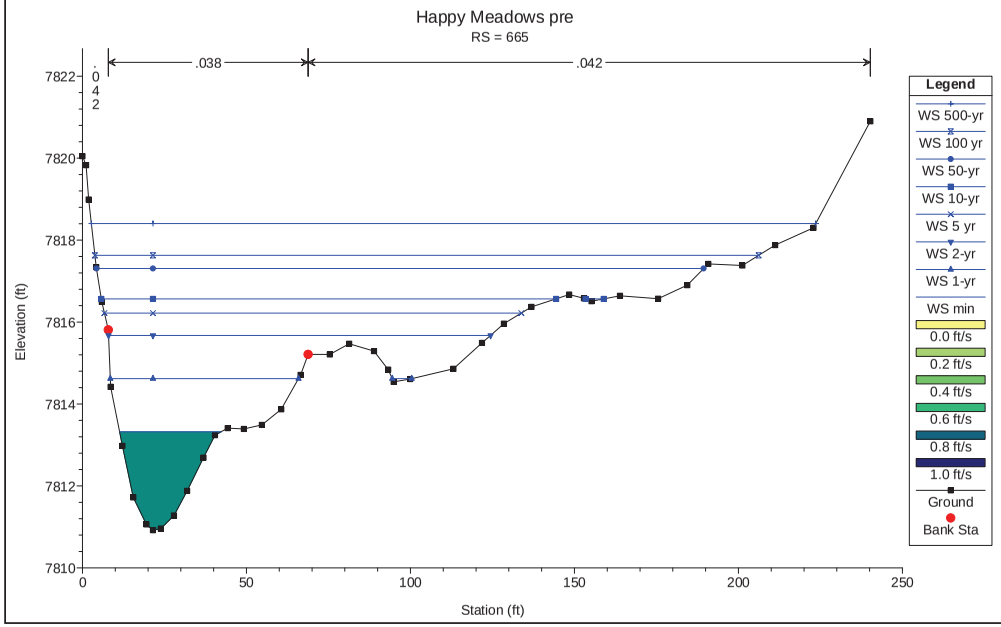

Happy Meadows pre
RS = 662 same as Sportsmen #8
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

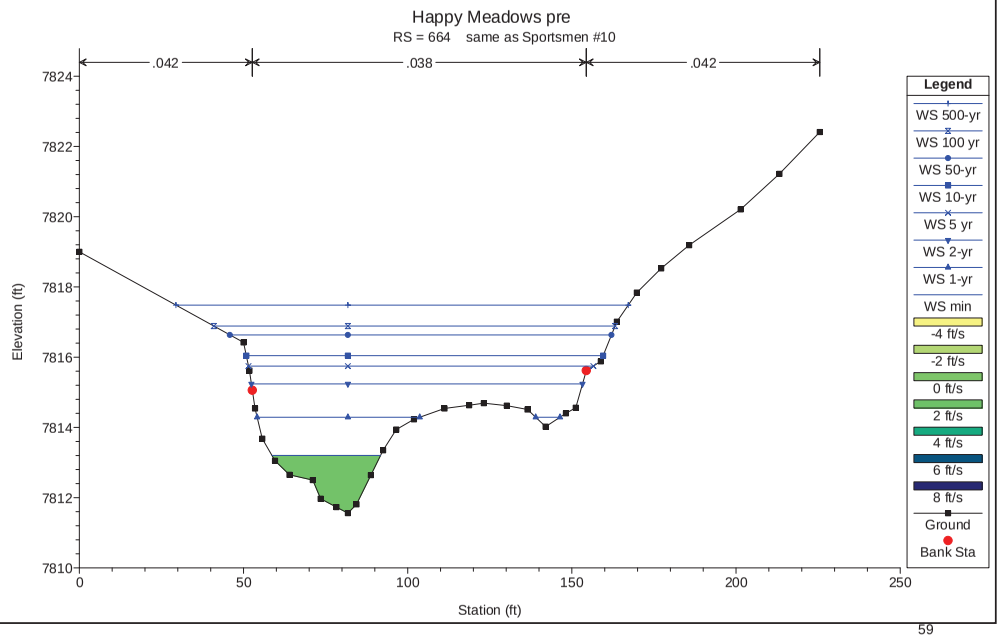

Happy Meadows pre
RS = 661 same as Sportsmen #7
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

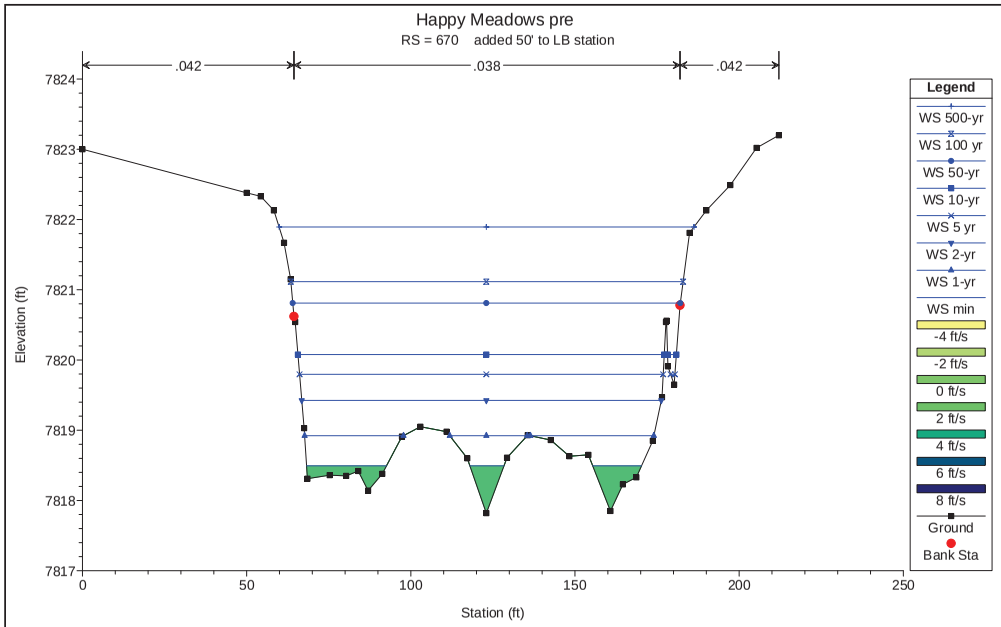

Happy Meadows pre
RS = 660 same as Sportsmen #6 / Sportsmen PL
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

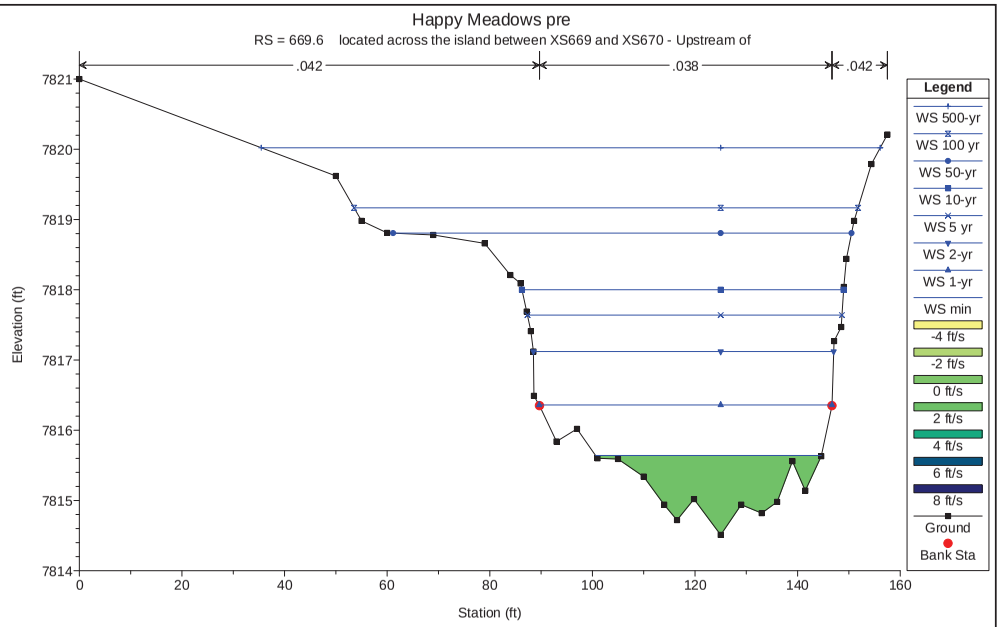

Happy Meadows pre
RS = 667 added 50' to RB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

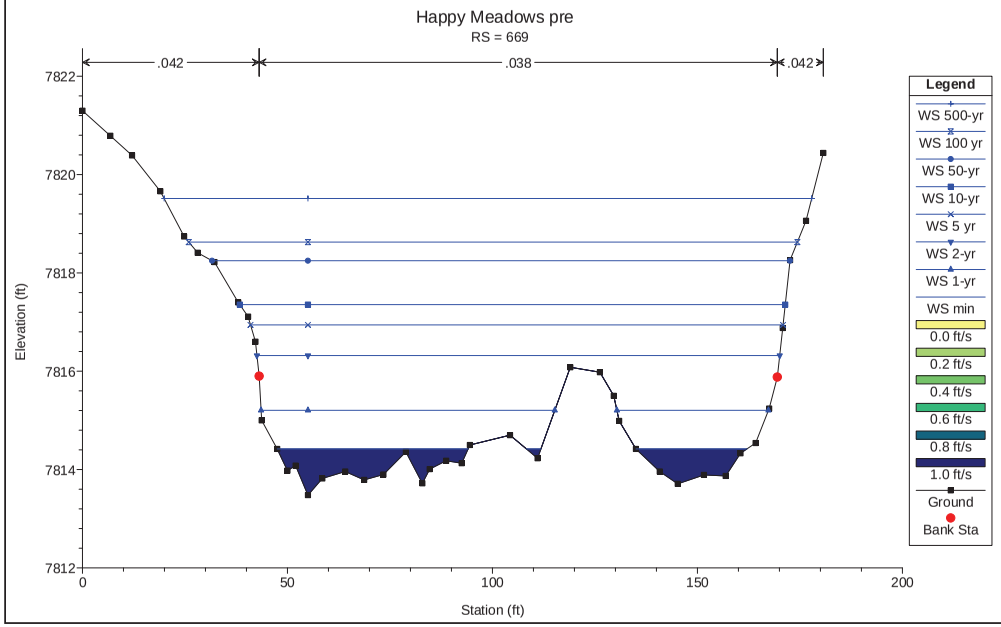

Happy Meadows pre
RS = 666
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

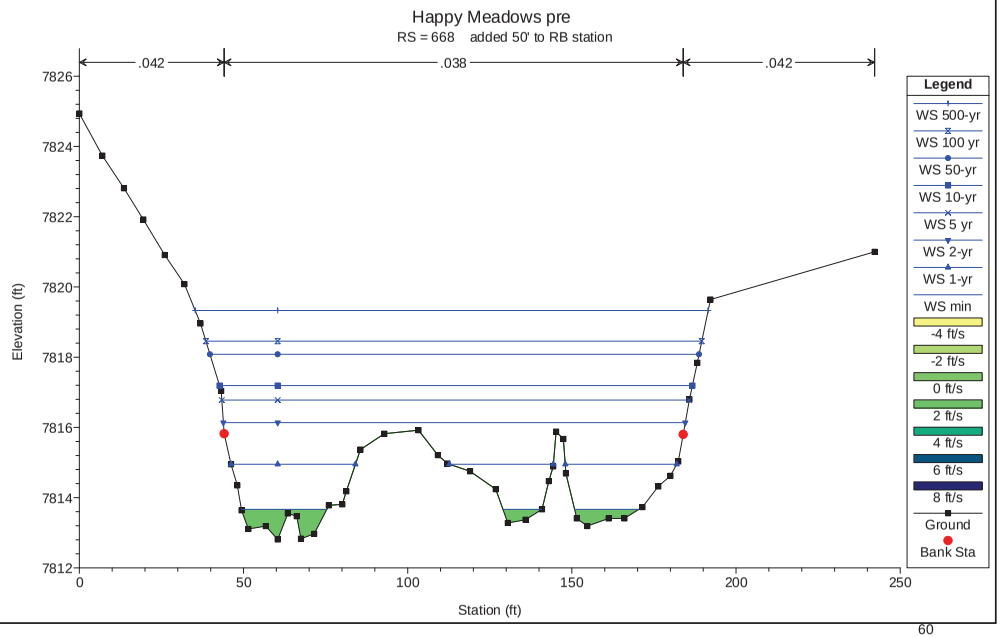

Happy Meadows pre
RS = 665
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

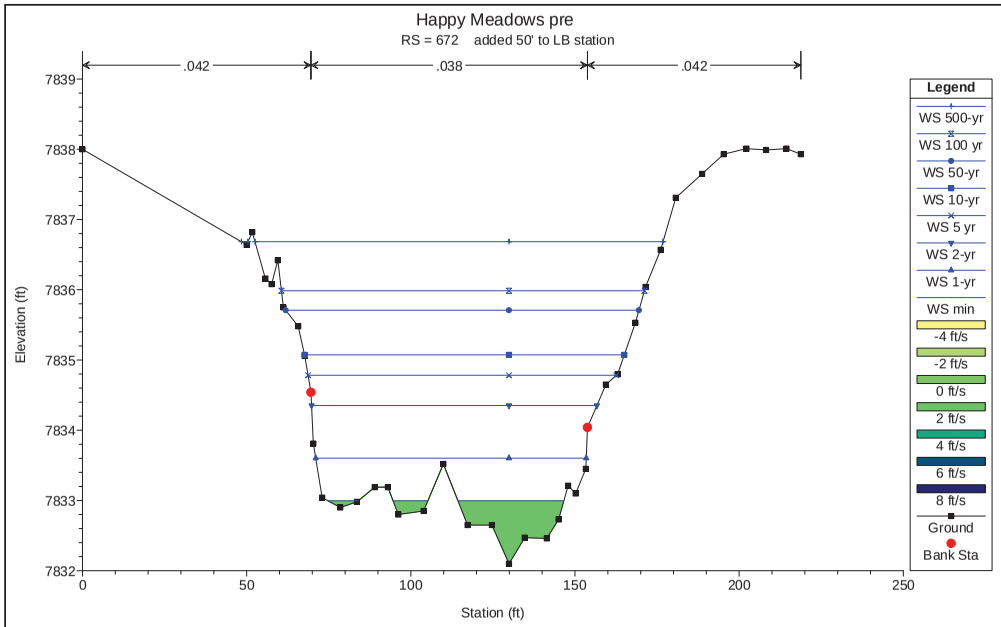

Happy Meadows pre
RS = 664 same as Sportsmen #10
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

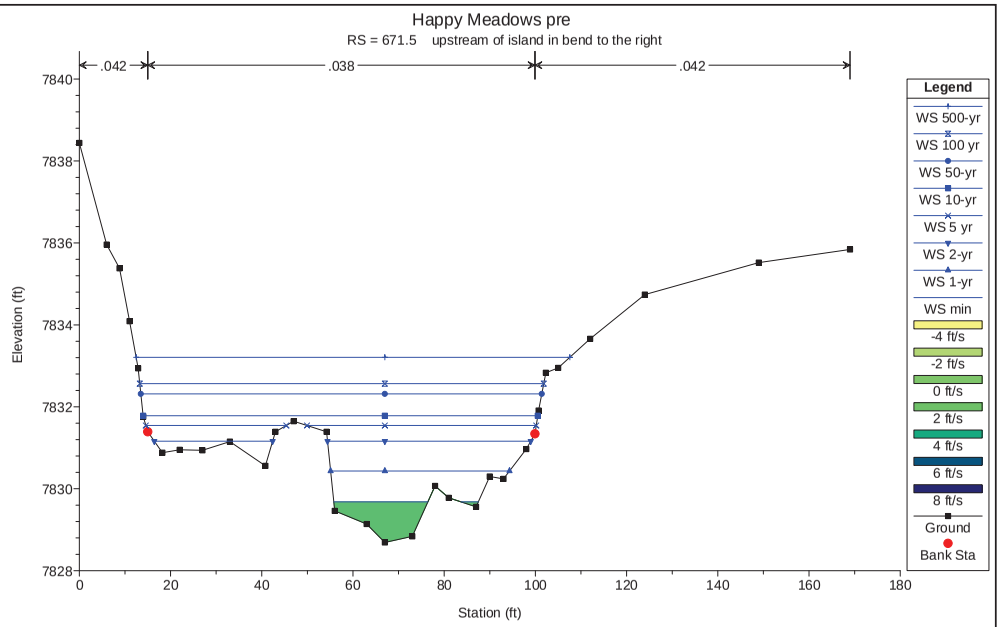

Happy Meadows pre
RS = 670 added 50' to LB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

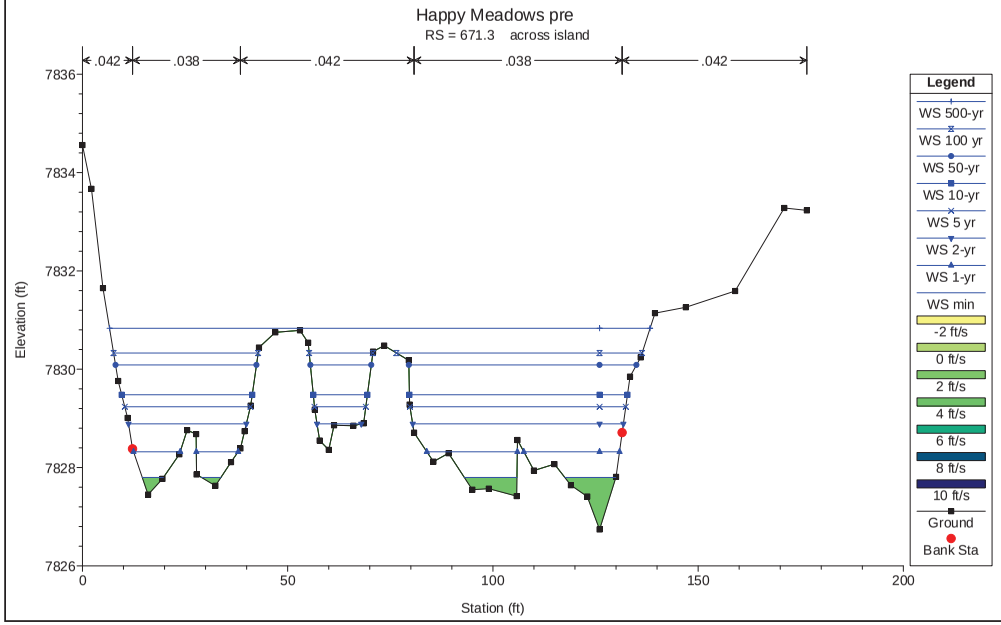

Happy Meadows pre
RS = 669.6 located across the island between XS669 and XS670 - Upstream of
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

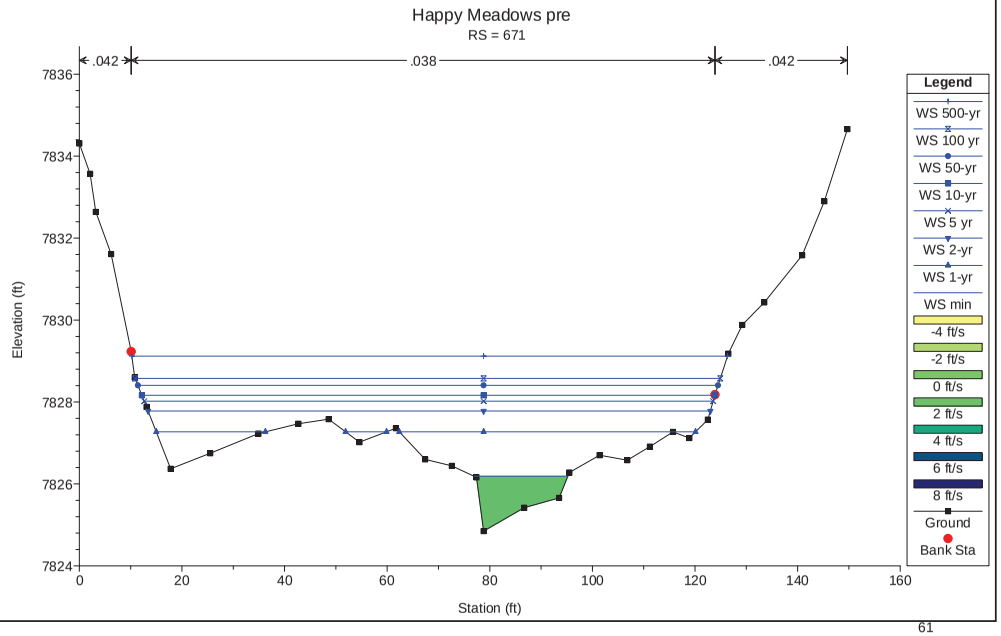

Happy Meadows pre
RS = 669
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

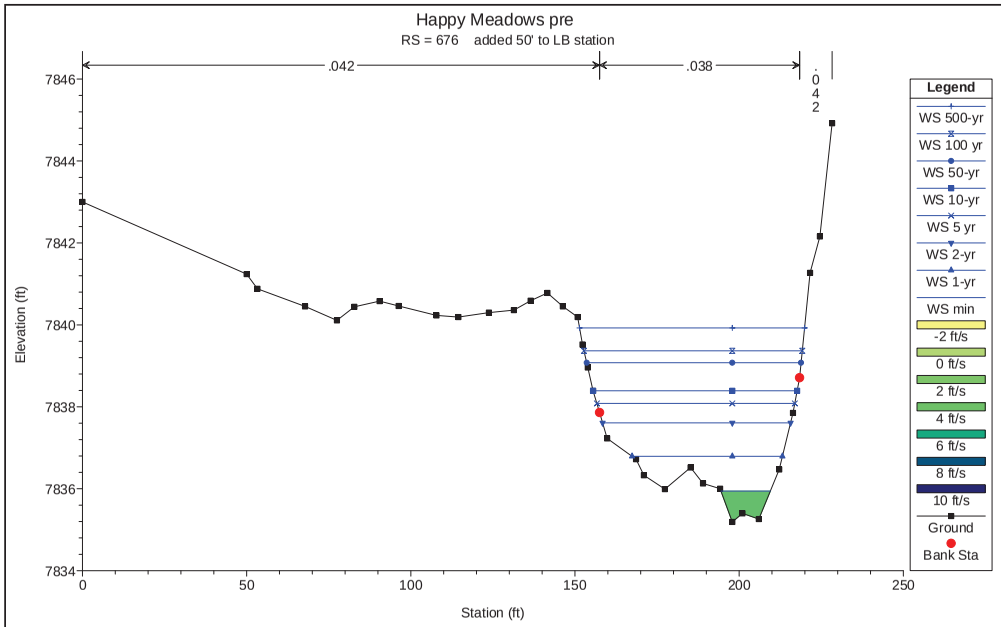

Happy Meadows pre
RS = 668 added 50' to RB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

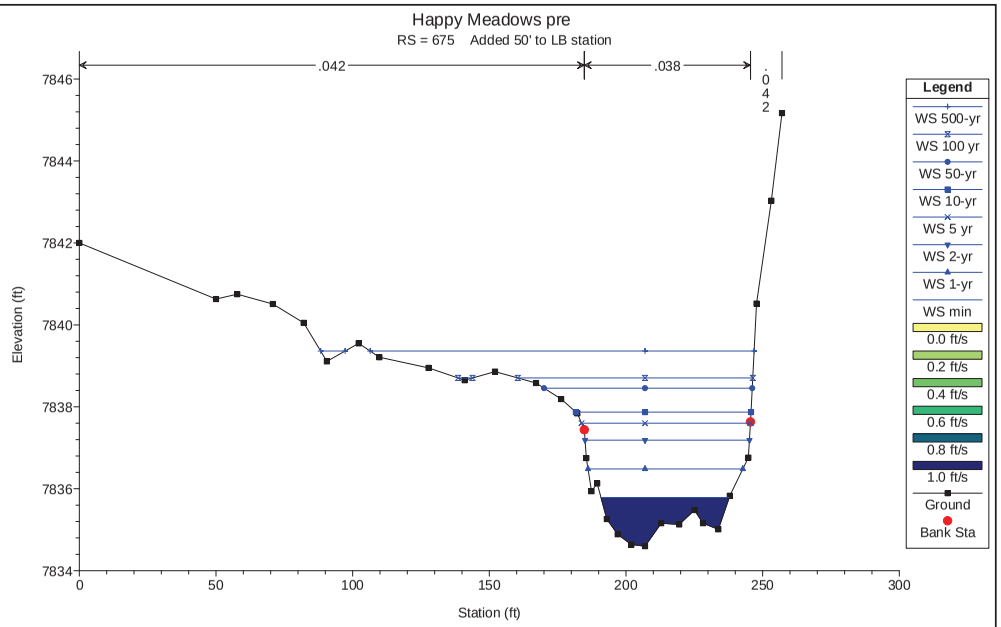

Happy Meadows pre
RS = 672 added 50' to LB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

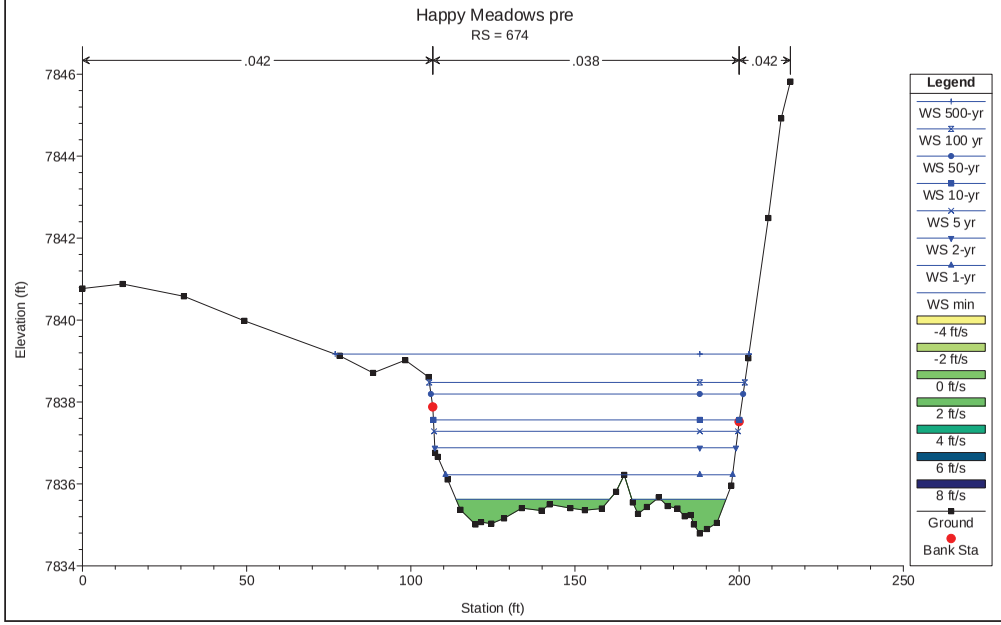

Happy Meadows pre
RS = 671.5 upstream of island in bend to the right
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

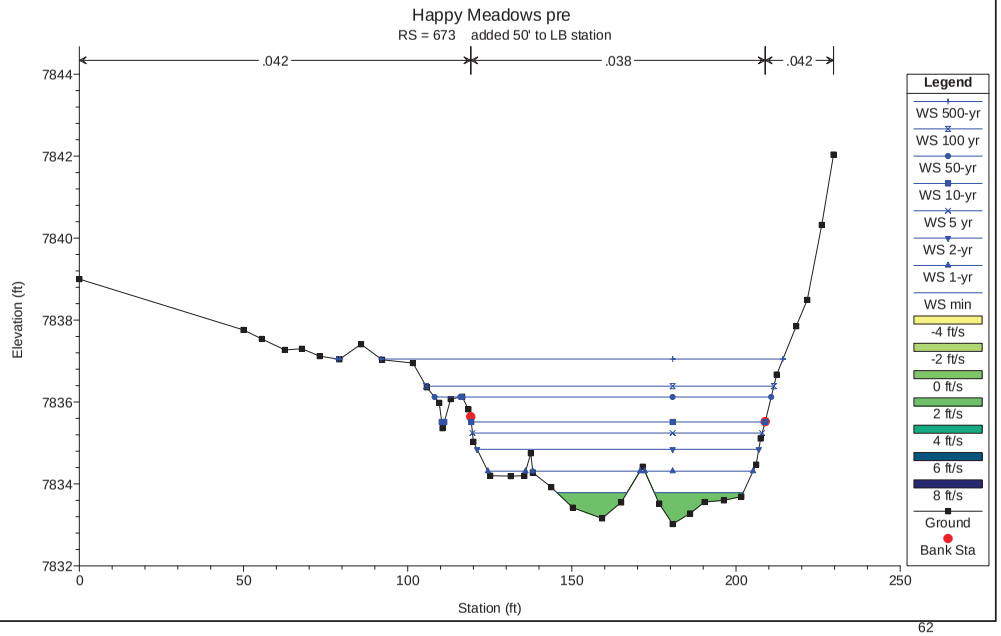

Happy Meadows pre
RS = 671.3 across island
.042
.038
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

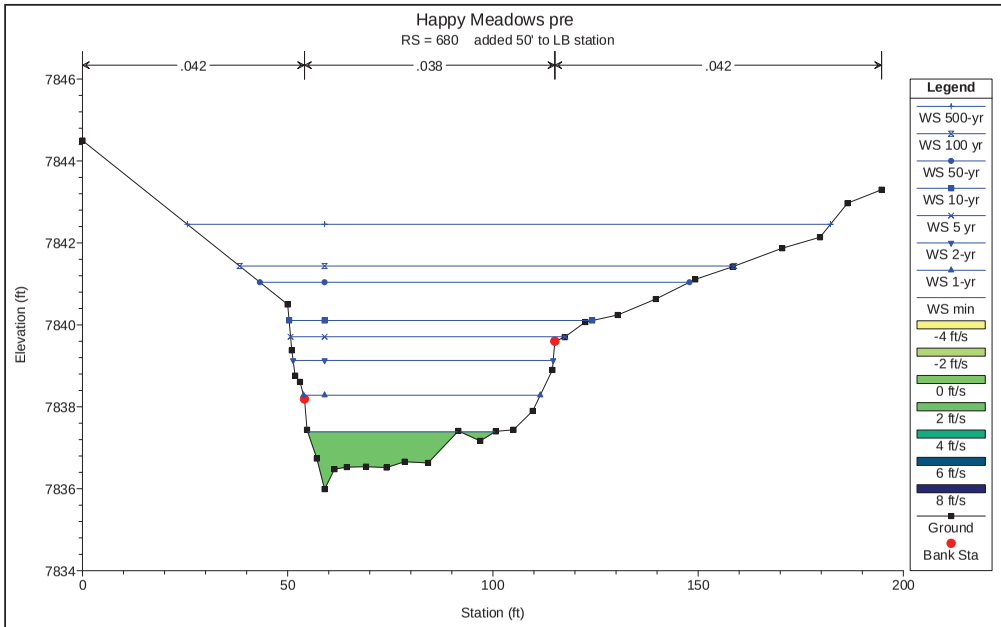

Happy Meadows pre
RS = 671
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

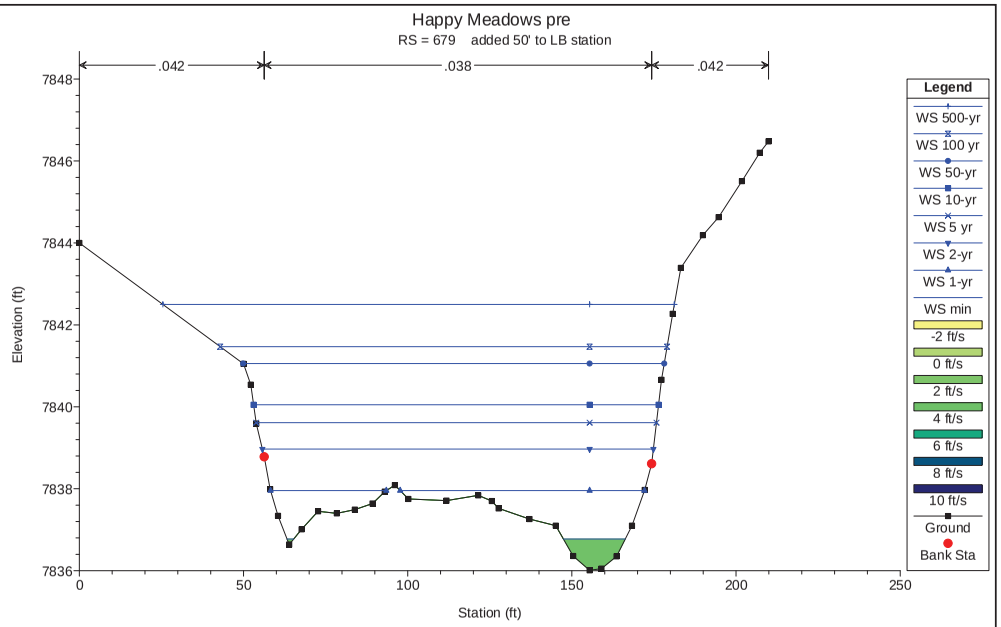

Happy Meadows pre
RS = 676 added 50' to LB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

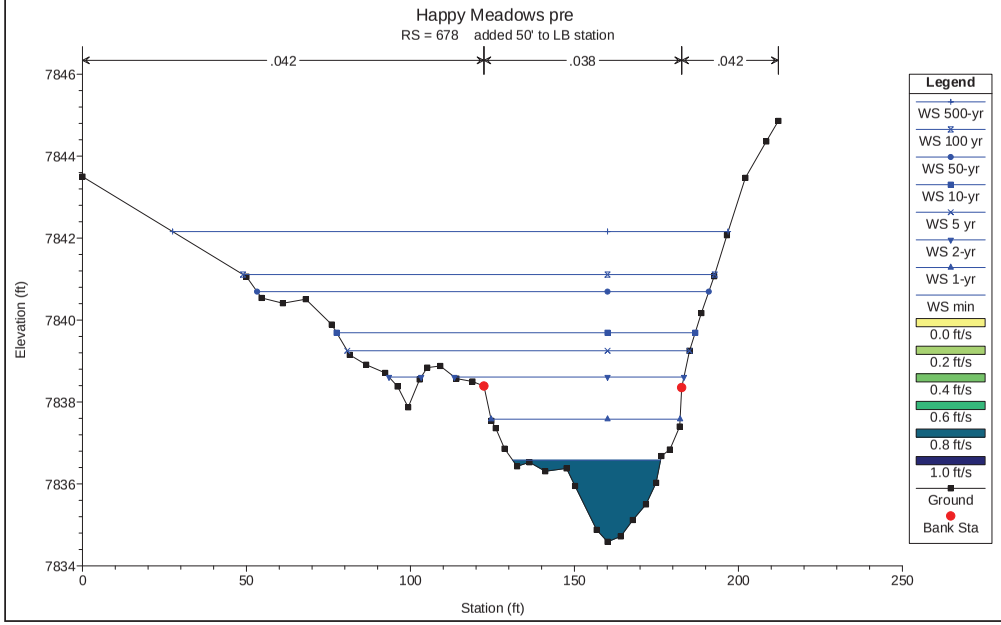

Happy Meadows pre
RS = 675 Added 50' to LB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

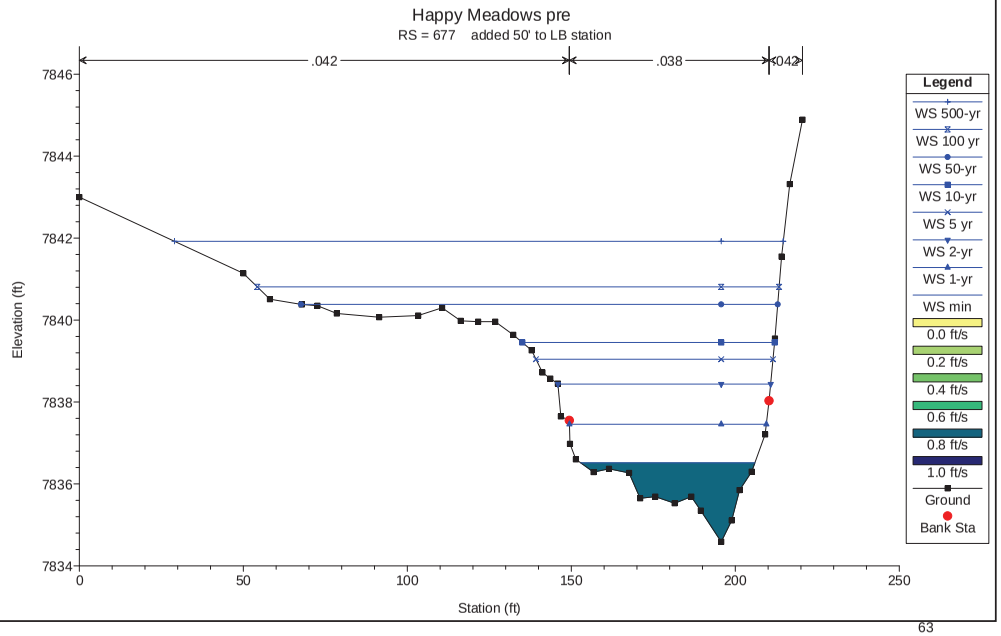

Happy Meadows pre
RS = 674
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

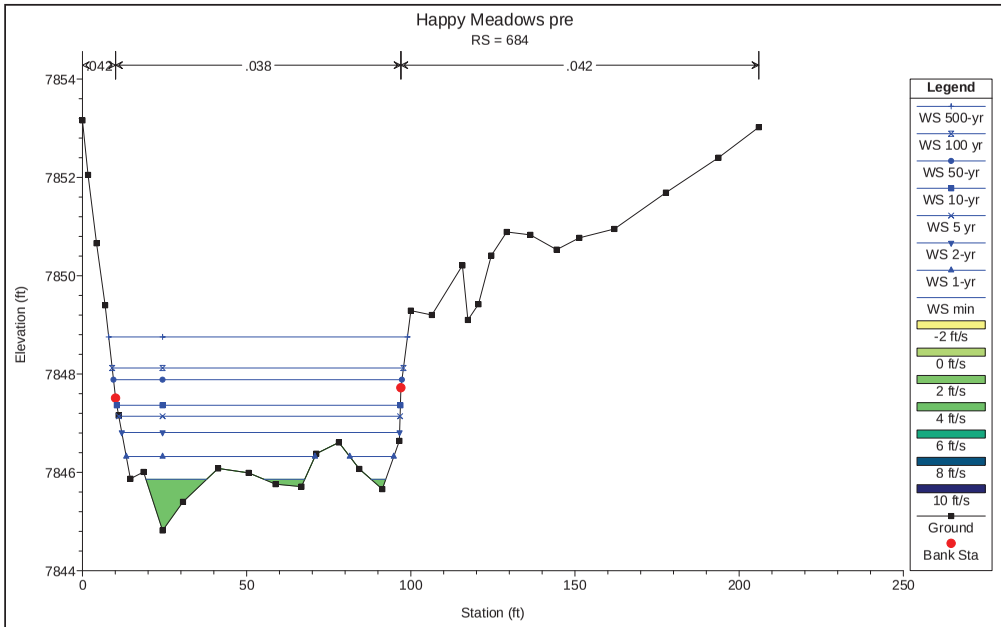

Happy Meadows pre
RS = 673 added 50' to LB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

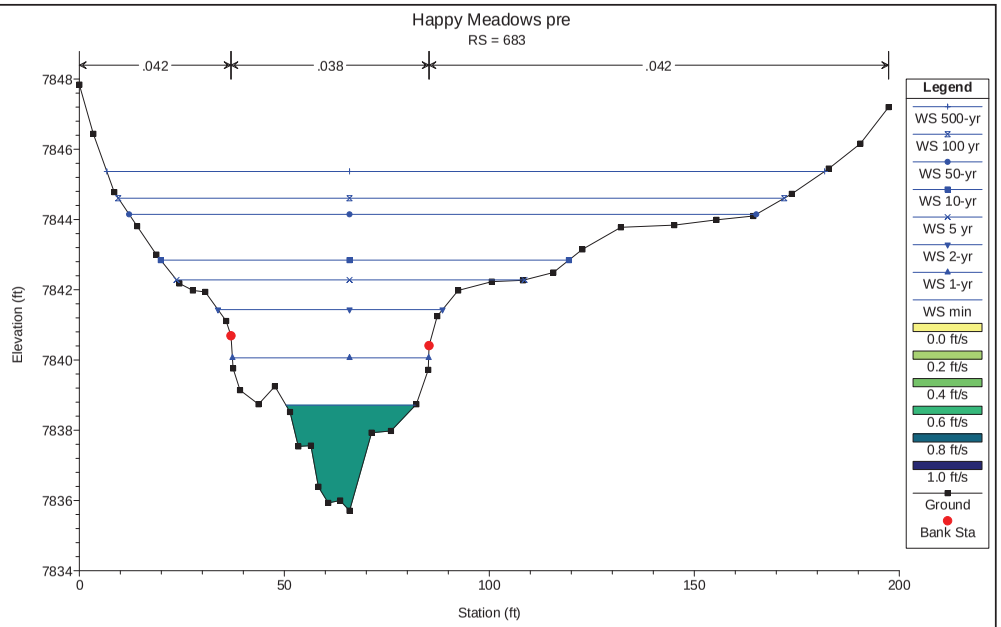

Happy Meadows pre
RS = 680 added 50' to LB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

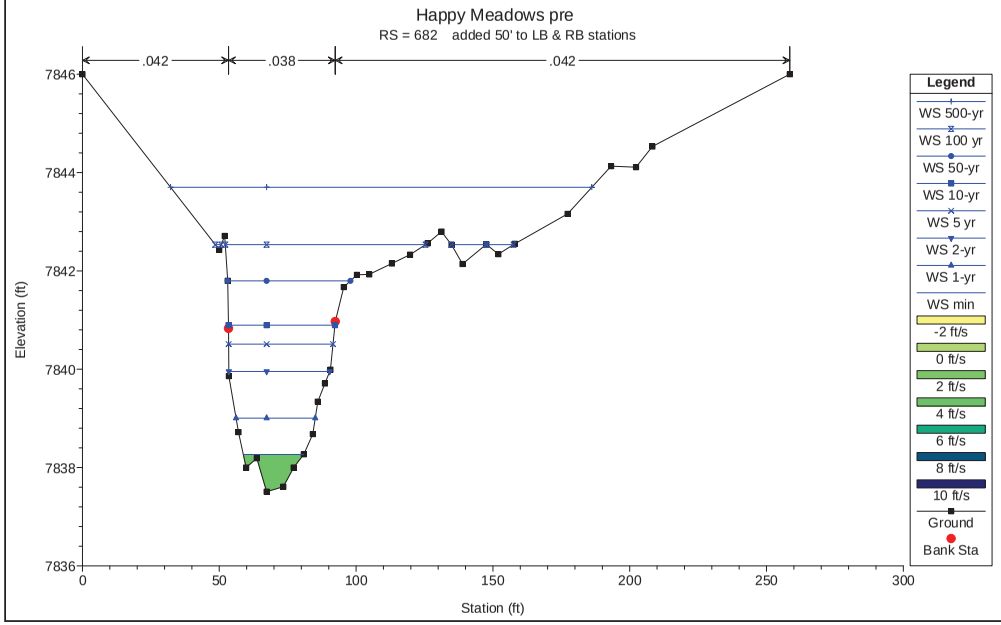

Happy Meadows pre
RS = 679 added 50' to LB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

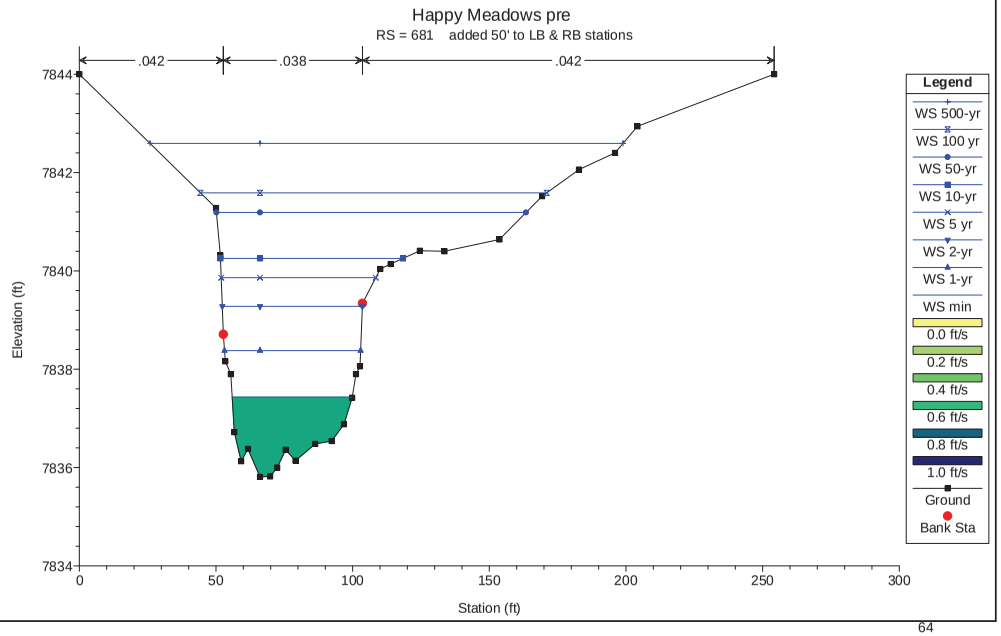

Happy Meadows pre
RS = 678 added 50' to LB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

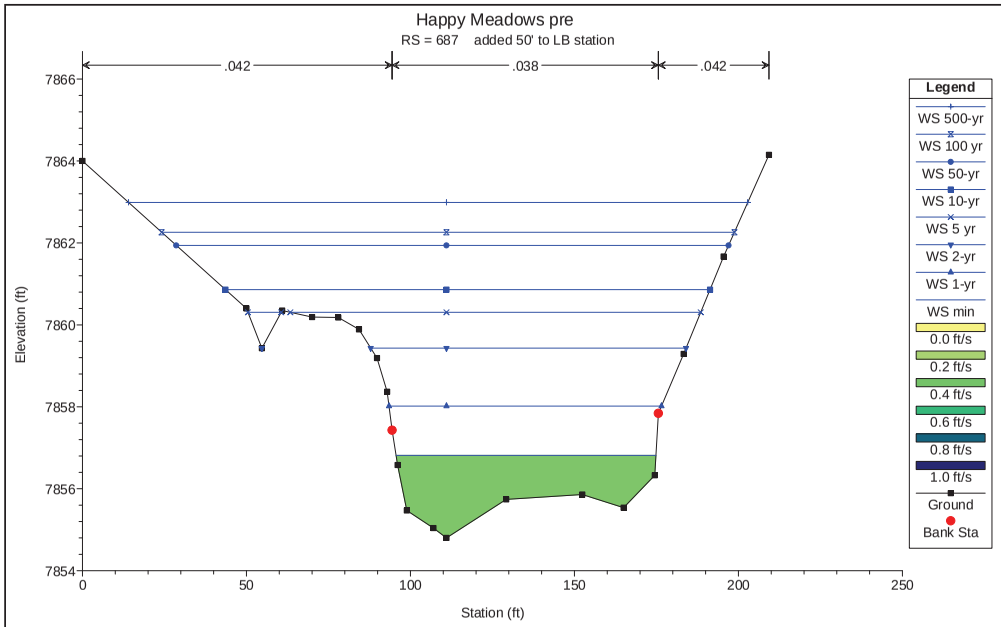

Happy Meadows pre
RS = 677 added 50' to LB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

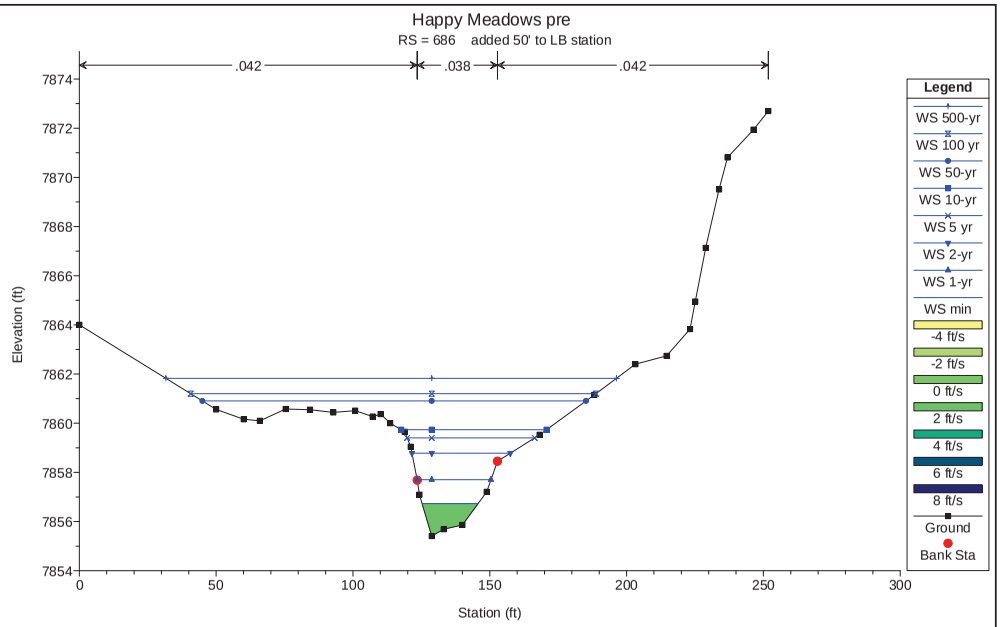

Happy Meadows pre
RS = 684
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

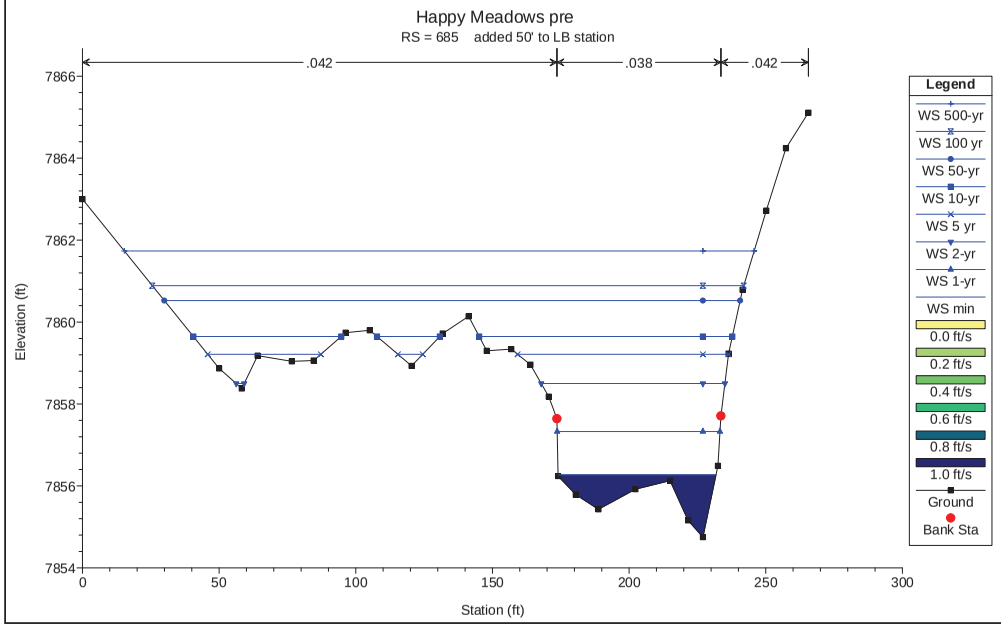

Happy Meadows pre
RS = 683
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

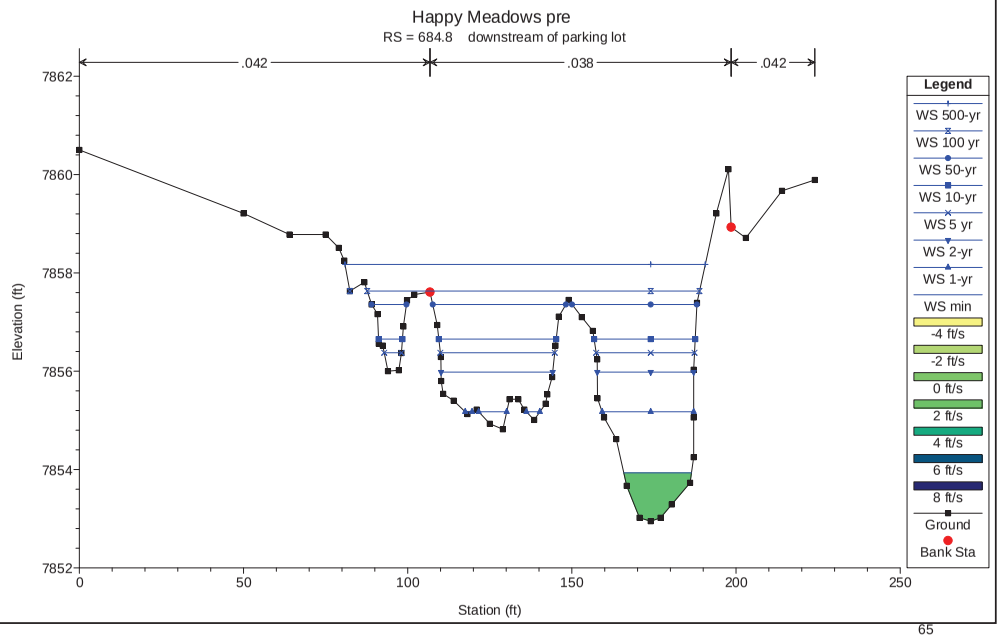

Happy Meadows pre
RS = 682 added 50' to LB & RB stations
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

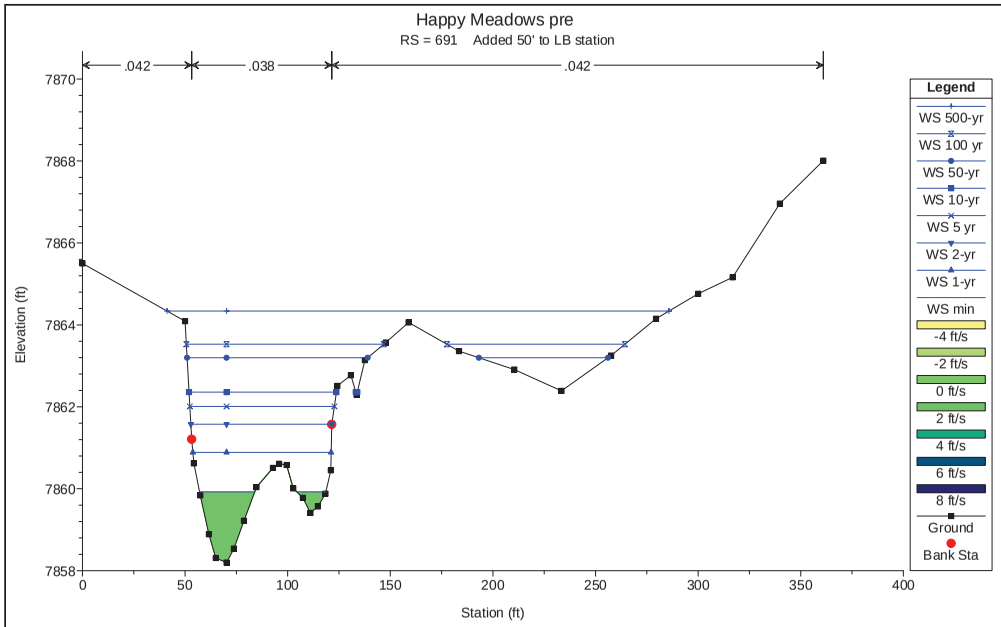

Happy Meadows pre
RS = 681 added 50' to LB & RB stations
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

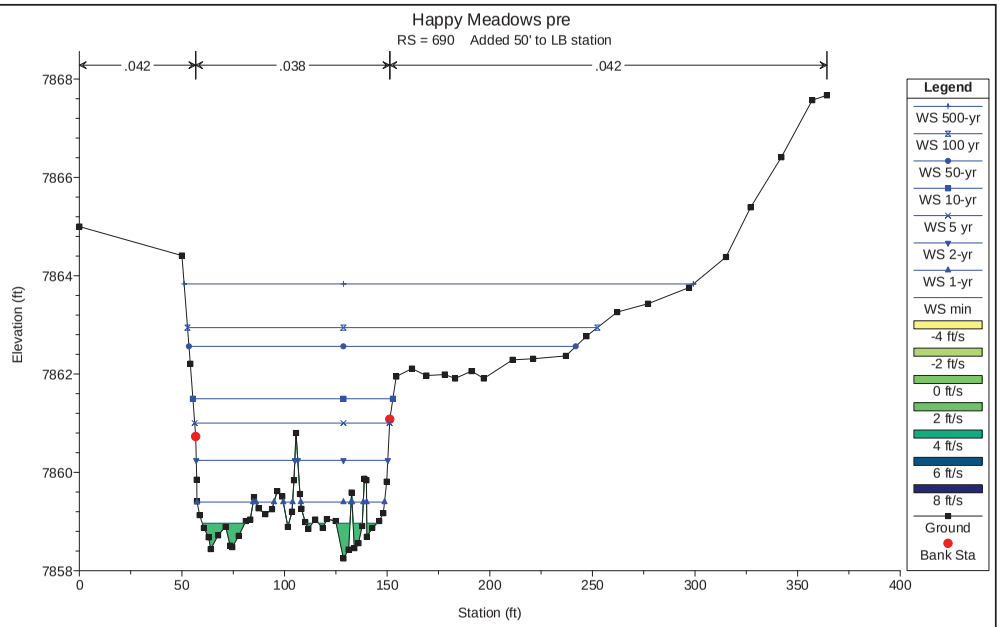

Happy Meadows pre
RS = 687 added 50' to LB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

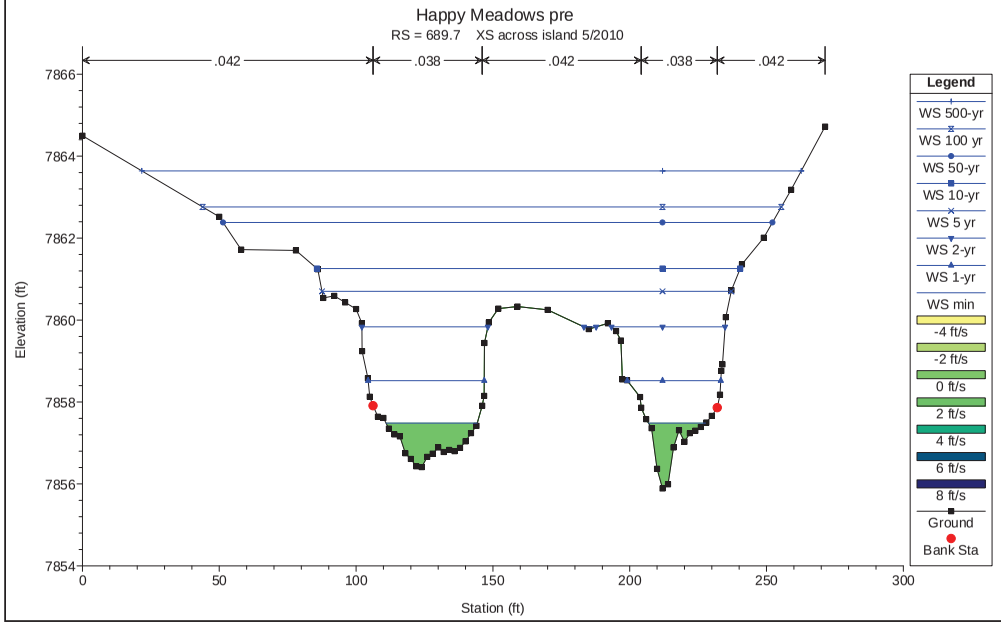

Happy Meadows pre
RS = 686 added 50' to LB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

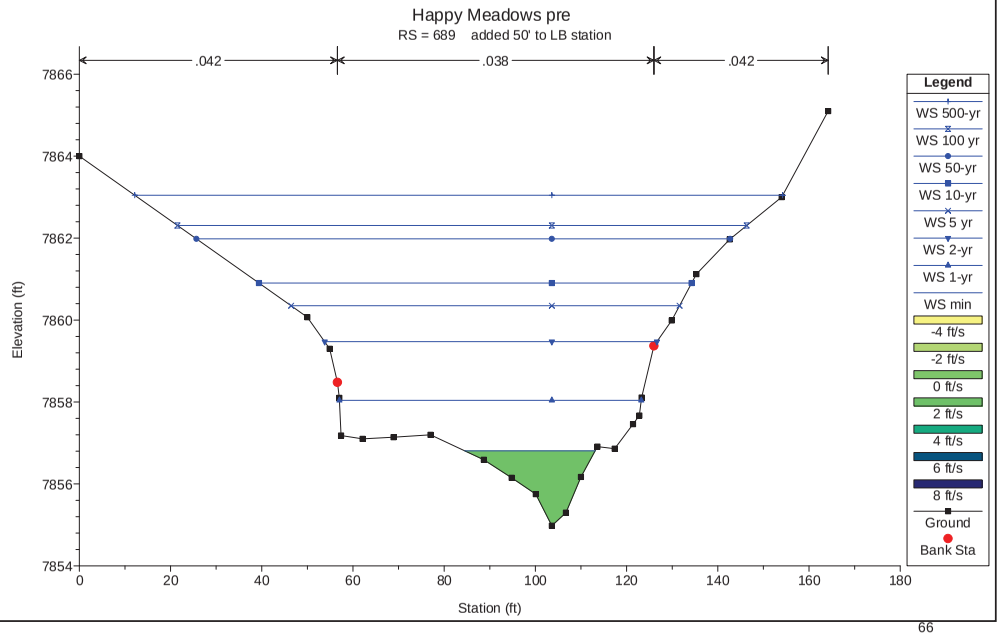

Happy Meadows pre
RS = 685 added 50' to LB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

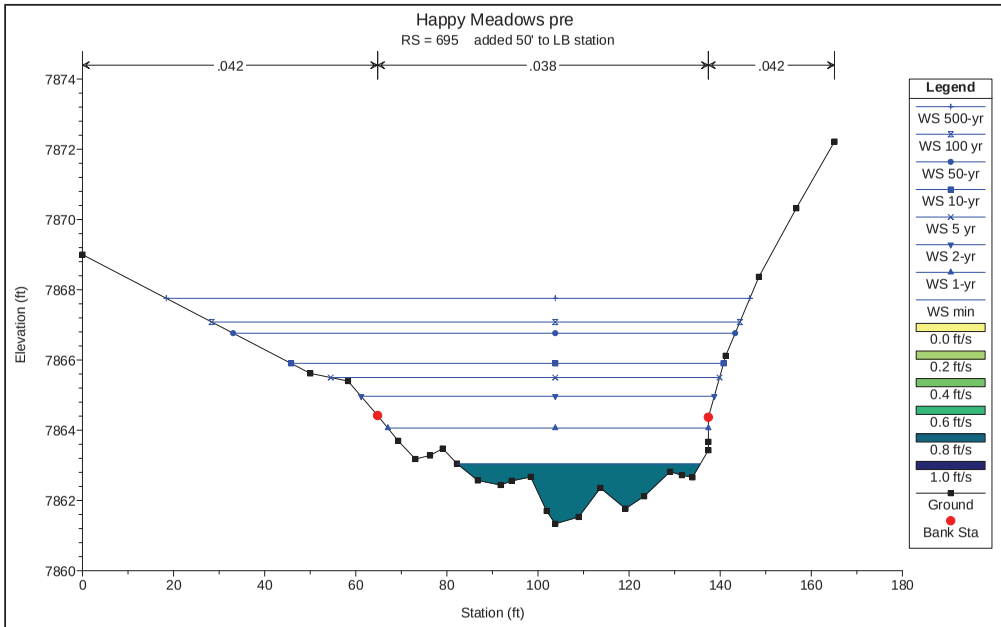

Happy Meadows pre
RS = 684.8 downstream of parking lot
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

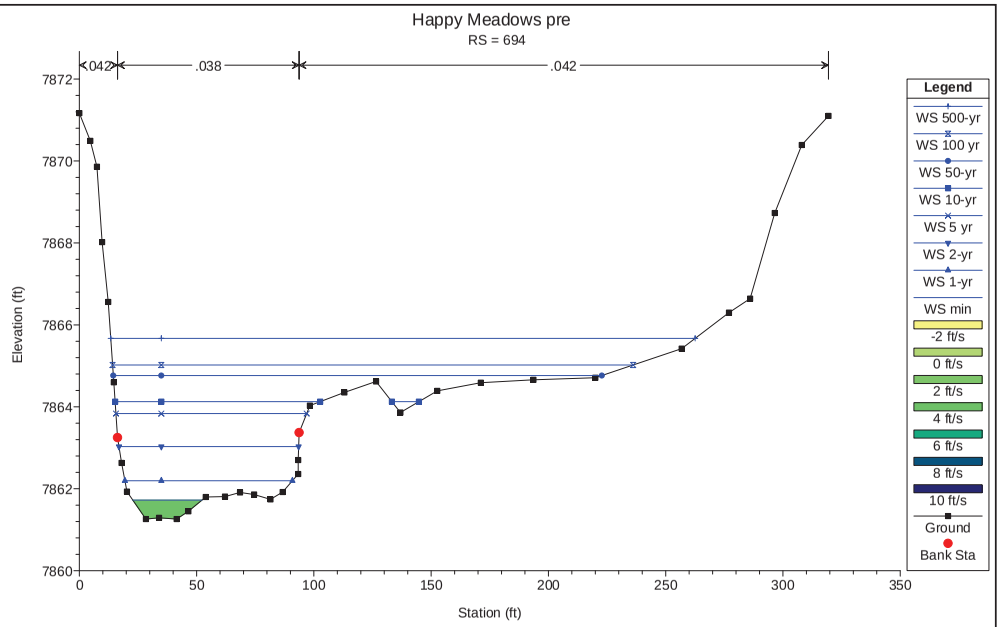

Happy Meadows pre
RS = 691 Added 50' to LB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

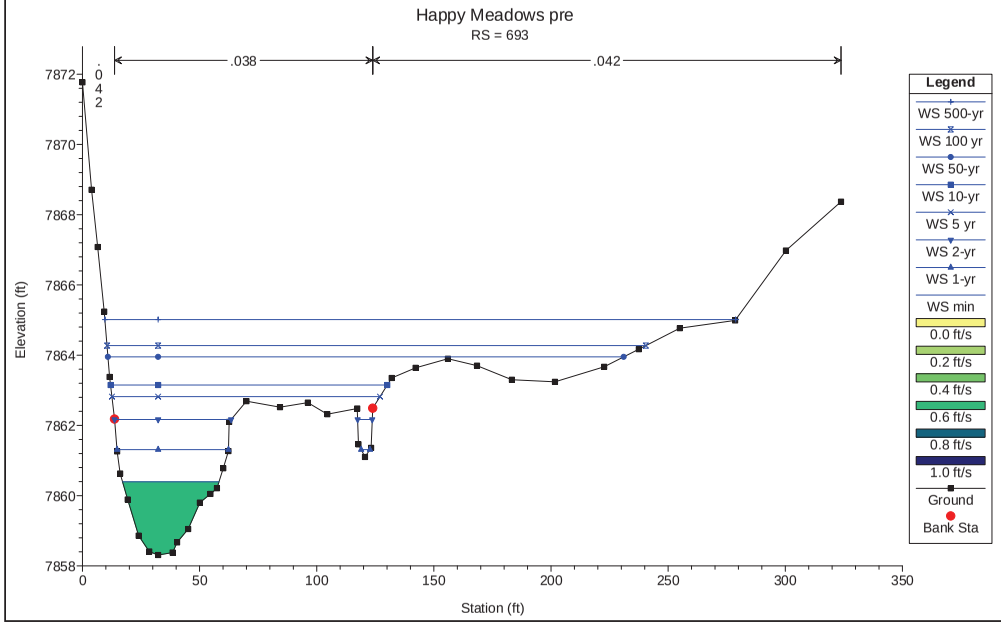

Happy Meadows pre
RS = 690 Added 50' to LB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

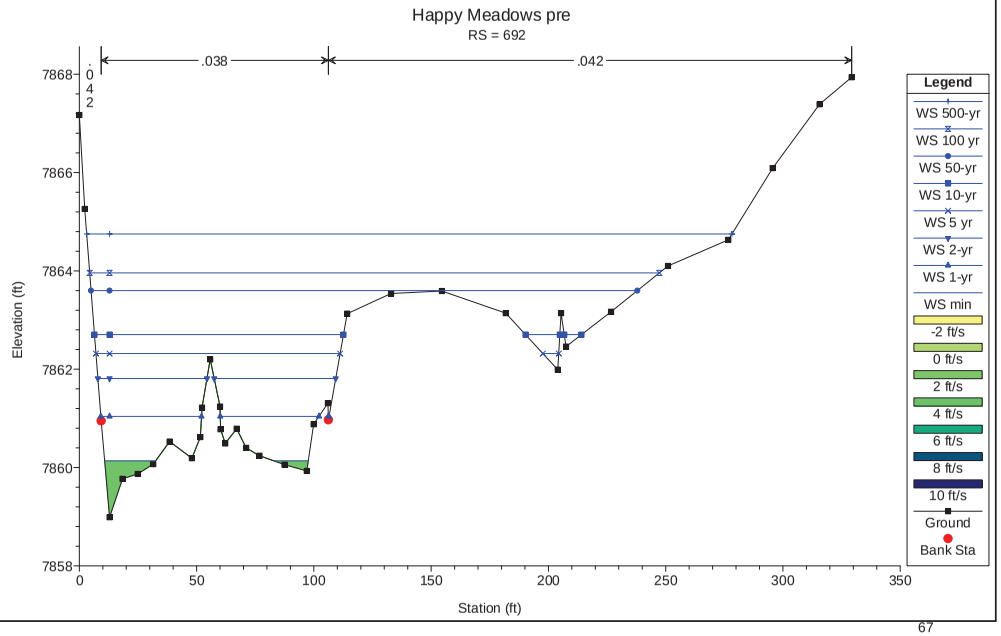

Happy Meadows pre
RS = 689.7 XS across island 5/2010
.042
.038
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

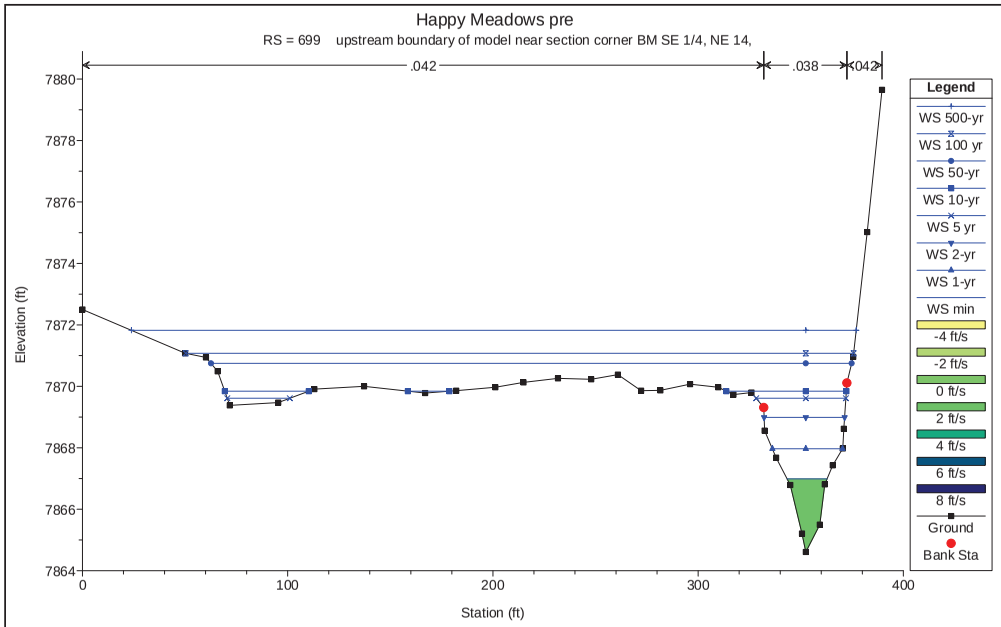

Happy Meadows pre
RS = 689 added 50' to LB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

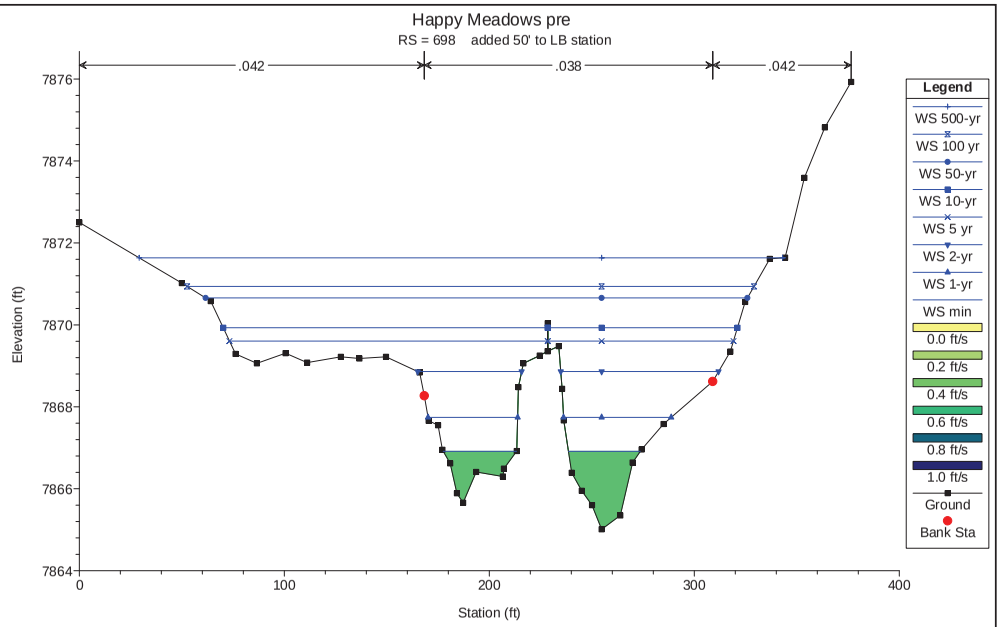

Happy Meadows pre
RS = 695 added 50' to LB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

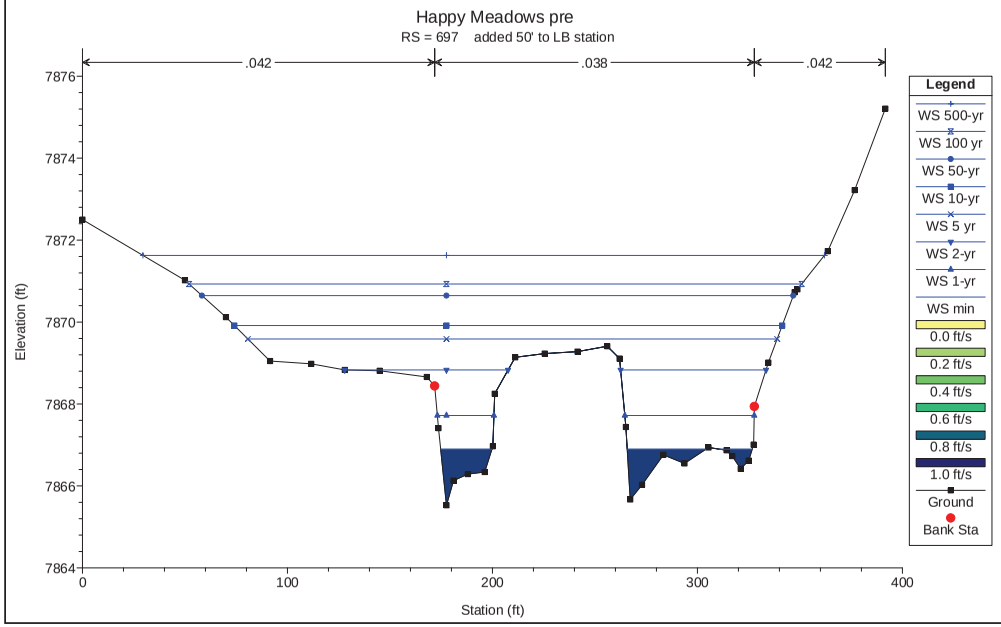

Happy Meadows pre
RS = 694
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

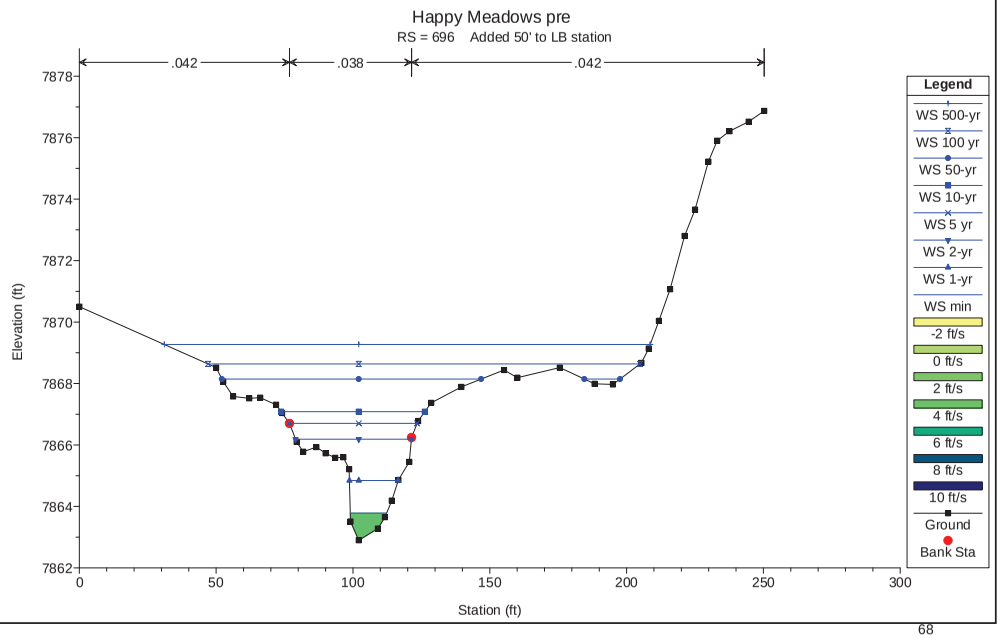

Happy Meadows pre
RS = 693
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta


Happy Meadows pre
RS = 692
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Happy Meadows pre
RS = 699 upstream boundary of model near section corner BM SE 1/4, NE 14,
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta


Happy Meadows pre
RS = 698 added 50' to LB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta


Happy Meadows pre
RS = 697 added 50' to LB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta


Happy Meadows pre
RS = 696 Added 50' to LB station
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

PROPOSED CONDITIONS
OUTPUT REPORT
PROFILE
CROSS SECTIONS

HEC-RAS Plan: Plan 01 River: South Platte Reach: Happy Meadows

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Happy Meadows	699	min	32.00	7864.61	7867.15		7867.17	0.000613	1.13	28.33	21.74	0.17
Happy Meadows	699	1-yr	160.00	7864.61	7868.32		7868.42	0.002076	2.52	63.59	36.83	0.34
Happy Meadows	699	2-yr	426.00	7864.61	7869.56		7869.78	0.002536	3.79	115.89	71.25	0.40
Happy Meadows	699	5 yr	660.00	7864.61	7869.97		7870.33	0.003658	4.94	159.80	201.07	0.49
Happy Meadows	699	10-yr	846.00	7864.61	7870.26		7870.64	0.003736	5.27	232.40	292.90	0.50
Happy Meadows	699	50-yr	1351.00	7864.61	7871.00		7871.24	0.002448	4.86	461.27	319.77	0.42
Happy Meadows	699	100 yr	1610.00	7864.61	7871.28		7871.51	0.002222	4.83	554.70	333.33	0.40
Happy Meadows	699	500-yr	2335.00	7864.61	7871.98		7872.18	0.001808	4.80	796.61	359.10	0.37
Happy Meadows	698	min	32.00	7865.01	7867.07		7867.08	0.000270	0.71	44.89	38.11	0.12
Happy Meadows	698	1-yr	160.00	7865.01	7868.01		7868.05	0.001202	1.78	89.70	58.85	0.25
Happy Meadows	698	2-yr	426.00	7865.01	7869.36		7869.41	0.000938	1.74	262.49	236.50	0.23
Happy Meadows	698	5 yr	660.00	7865.01	7869.81		7869.87	0.000946	1.99	373.19	249.04	0.24
Happy Meadows	698	10-yr	846.00	7865.01	7870.12		7870.18	0.000916	2.14	450.15	253.73	0.24
Happy Meadows	698	50-yr	1351.00	7865.01	7870.80		7870.89	0.000892	2.49	628.29	270.61	0.25
Happy Meadows	698	100 yr	1610.00	7865.01	7871.07		7871.17	0.000924	2.68	702.95	282.44	0.26
Happy Meadows	698	500-yr	2335.00	7865.01	7871.75		7871.88	0.000969	3.09	905.77	319.53	0.27
Happy Meadows	697	min	32.00	7865.00	7867.06	7866.45	7867.07	0.001611	1.00	32.04	61.99	0.24
Happy Meadows	697	1-yr	160.00	7865.00	7867.99	7867.11	7868.04	0.001337	1.77	90.48	64.01	0.26
Happy Meadows	697	2-yr	426.00	7865.00	7869.34		7869.39	0.001321	1.81	261.08	242.16	0.26
Happy Meadows	697	5 yr	660.00	7865.00	7869.80		7869.85	0.001147	1.96	378.14	263.92	0.26
Happy Meadows	697	10-yr	846.00	7865.00	7870.10		7870.16	0.001044	2.07	460.63	272.39	0.25
Happy Meadows	697	50-yr	1351.00	7865.00	7870.79		7870.87	0.000930	2.36	655.19	293.55	0.25
Happy Meadows	697	100 yr	1610.00	7865.00	7871.06		7871.15	0.000939	2.52	736.02	304.39	0.25
Happy Meadows	697	500-yr	2335.00	7865.00	7871.74		7871.85	0.000943	2.88	954.72	338.13	0.26
Happy Meadows	696	min	32.00	7862.90	7863.78	7863.78	7864.07	0.026666	4.28	7.47	13.30	1.01
Happy Meadows	696	1-yr	160.00	7862.90	7864.84	7864.84	7865.53	0.021084	6.64	24.11	17.83	1.01
Happy Meadows	696	2-yr	426.00	7862.90	7866.20	7866.20	7866.94	0.019825	6.88	61.93	42.39	1.00
Happy Meadows	696	5 yr	660.00	7862.90	7866.71	7866.71	7867.66	0.018393	7.85	84.45	46.72	1.01
Happy Meadows	696	10-yr	846.00	7862.90	7867.08	7867.08	7868.16	0.016303	8.35	103.11	52.52	0.98
Happy Meadows	696	50-yr	1351.00	7862.90	7868.15	7868.15	7869.21	0.010162	8.52	182.37	107.76	0.82
Happy Meadows	696	100 yr	1610.00	7862.90	7868.64	7868.64	7869.58	0.007955	8.26	249.46	157.85	0.75
Happy Meadows	696	500-yr	2335.00	7862.90	7869.27	7869.27	7870.28	0.007710	9.01	355.90	177.59	0.75
Happy Meadows	695	min	32.00	7861.34	7863.04	7862.19	7863.05	0.000561	0.78	41.23	53.37	0.16
Happy Meadows	695	1-yr	160.00	7861.34	7864.06		7864.10	0.000854	1.49	107.03	70.37	0.21
Happy Meadows	695	2-yr	426.00	7861.34	7864.97		7865.06	0.001299	2.47	173.47	77.51	0.28
Happy Meadows	695	5 yr	660.00	7861.34	7865.50		7865.65	0.001573	3.11	216.08	85.19	0.32
Happy Meadows	695	10-yr	846.00	7861.34	7865.90		7866.09	0.001639	3.47	253.20	94.94	0.34
Happy Meadows	695	50-yr	1351.00	7861.34	7866.76		7867.04	0.001827	4.27	341.22	110.20	0.37
Happy Meadows	695	100 yr	1610.00	7861.34	7867.08		7867.40	0.001976	4.67	377.33	115.96	0.39
Happy Meadows	695	500-yr	2335.00	7861.34	7867.76		7868.23	0.002454	5.71	459.68	128.13	0.44
Happy Meadows	694	min	32.00	7861.26	7861.72	7861.72	7861.89	0.032164	3.33	9.60	29.25	1.03
Happy Meadows	694	1-yr	160.00	7861.26	7862.20	7862.20	7862.47	0.025943	4.16	38.46	71.55	1.00
Happy Meadows	694	2-yr	426.00	7861.26	7863.04		7863.32	0.008031	4.20	101.48	76.64	0.64
Happy Meadows	694	5 yr	660.00	7861.26	7863.83		7864.09	0.004065	4.05	163.53	81.32	0.49
Happy Meadows	694	10-yr	846.00	7861.26	7864.13		7864.45	0.004307	4.55	189.28	98.88	0.52
Happy Meadows	694	50-yr	1351.00	7861.26	7864.76		7865.22	0.004652	5.54	278.84	208.28	0.56
Happy Meadows	694	100 yr	1610.00	7861.26	7865.02		7865.51	0.004611	5.82	334.20	221.94	0.57
Happy Meadows	694	500-yr	2335.00	7861.26	7865.67		7866.17	0.004180	6.24	487.15	249.02	0.56
Happy Meadows	693	min	32.00	7858.31	7860.32		7860.33	0.000214	0.65	49.28	40.50	0.10
Happy Meadows	693	1-yr	160.00	7858.31	7861.39		7861.43	0.000779	1.64	97.85	52.60	0.21
Happy Meadows	693	2-yr	426.00	7858.31	7862.24		7862.38	0.001769	2.96	143.80	57.06	0.33
Happy Meadows	693	5 yr	660.00	7858.31	7862.84		7863.02	0.003565	3.37	196.75	114.70	0.45
Happy Meadows	693	10-yr	846.00	7858.31	7863.16		7863.37	0.003364	3.65	233.84	118.25	0.44
Happy Meadows	693	50-yr	1351.00	7858.31	7863.95		7864.20	0.002754	4.08	367.57	219.98	0.42
Happy Meadows	693	100 yr	1610.00	7858.31	7864.27		7864.52	0.002550	4.21	439.28	229.77	0.42
Happy Meadows	693	500-yr	2335.00	7858.31	7864.99		7865.28	0.002318	4.61	616.16	269.01	0.41
Happy Meadows	692	min	32.00	7858.25	7859.94	7859.94	7860.20	0.031268	4.09	7.83	16.46	1.04
Happy Meadows	692	1-yr	160.00	7858.25	7861.11		7861.19	0.005249	2.30	69.65	94.77	0.47
Happy Meadows	692	2-yr	426.00	7858.25	7861.90		7862.03	0.003252	2.90	148.20	101.90	0.42
Happy Meadows	692	5 yr	660.00	7858.25	7862.34		7862.52	0.003293	3.46	194.55	111.41	0.44
Happy Meadows	692	10-yr	846.00	7858.25	7862.70		7862.91	0.003029	3.71	236.68	127.71	0.43
Happy Meadows	692	50-yr	1351.00	7858.25	7863.58		7863.82	0.002413	4.11	378.33	224.73	0.41
Happy Meadows	692	100 yr	1610.00	7858.25	7863.93		7864.18	0.002167	4.19	463.41	242.20	0.39
Happy Meadows	692	500-yr	2335.00	7858.25	7864.71		7864.97	0.001890	4.46	664.53	274.58	0.38
Happy Meadows	691	min	32.00	7858.20	7859.71		7859.74	0.001484	1.42	22.51	24.32	0.26
Happy Meadows	691	1-yr	160.00	7858.20	7860.93		7860.99	0.001912	1.94	82.48	67.48	0.31
Happy Meadows	691	2-yr	426.00	7858.20	7861.66	7860.78	7861.82	0.002859	3.21	132.66	69.07	0.41

HEC-RAS Plan: Plan 01 River: South Platte Reach: Happy Meadows (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Happy Meadows	691	5 yr	660.00	7858.20	7861.98	7861.13	7862.26	0.004131	4.27	154.85	70.34	0.50
Happy Meadows	691	10-yr	846.00	7858.20	7862.28		7862.64	0.004458	4.83	176.26	71.54	0.53
Happy Meadows	691	50-yr	1351.00	7858.20	7863.09		7863.58	0.004318	5.71	259.06	139.83	0.55
Happy Meadows	691	100 yr	1610.00	7858.20	7863.42		7863.95	0.004261	6.03	309.96	173.47	0.55
Happy Meadows	691	500-yr	2335.00	7858.20	7864.22		7864.77	0.003727	6.42	475.15	236.18	0.53
Happy Meadows	690	min	32.00	7858.25	7858.78		7858.85	0.008782	2.08	15.42	36.08	0.56
Happy Meadows	690	1-yr	160.00	7858.25	7859.27	7859.27	7859.58	0.024784	4.42	36.21	59.38	1.00
Happy Meadows	690	2-yr	426.00	7858.25	7859.94		7860.25	0.012653	4.46	95.50	92.80	0.77
Happy Meadows	690	5 yr	660.00	7858.25	7860.76		7860.99	0.004380	3.83	172.31	94.28	0.50
Happy Meadows	690	10-yr	846.00	7858.25	7861.30		7861.52	0.003071	3.79	223.24	96.37	0.44
Happy Meadows	690	50-yr	1351.00	7858.25	7862.40		7862.65	0.002109	4.06	355.65	184.07	0.38
Happy Meadows	690	100 yr	1610.00	7858.25	7862.78		7863.05	0.001980	4.22	428.08	194.42	0.38
Happy Meadows	690	500-yr	2335.00	7858.25	7863.67		7863.97	0.001770	4.59	618.56	240.51	0.37
Happy Meadows	689.7	min	32.00	7856.41	7857.68		7857.69	0.002231	0.96	33.17	87.72	0.28
Happy Meadows	689.7	1-yr	160.00	7856.41	7858.50		7858.52	0.000871	1.20	134.30	128.85	0.21
Happy Meadows	689.7	2-yr	426.00	7856.41	7859.78		7859.81	0.000429	1.43	302.54	132.68	0.16
Happy Meadows	689.7	5 yr	660.00	7856.41	7860.64		7860.68	0.000362	1.61	420.47	149.21	0.16
Happy Meadows	689.7	10-yr	846.00	7856.41	7861.20		7861.25	0.000340	1.74	505.07	153.92	0.16
Happy Meadows	689.7	50-yr	1351.00	7856.41	7862.33		7862.39	0.000344	2.09	706.74	199.82	0.17
Happy Meadows	689.7	100 yr	1610.00	7856.41	7862.71		7862.78	0.000370	2.27	783.64	209.65	0.17
Happy Meadows	689.7	500-yr	2335.00	7856.41	7863.58		7863.69	0.000434	2.73	979.98	239.02	0.19
Happy Meadows	689	min	32.00	7854.98	7856.81		7856.84	0.001877	1.43	22.38	28.54	0.28
Happy Meadows	689	1-yr	160.00	7854.98	7858.04		7858.08	0.001301	1.74	92.04	66.19	0.26
Happy Meadows	689	2-yr	426.00	7854.98	7859.48		7859.56	0.000873	2.23	191.77	72.99	0.24
Happy Meadows	689	5 yr	660.00	7854.98	7860.35		7860.46	0.000825	2.61	260.02	85.22	0.24
Happy Meadows	689	10-yr	846.00	7854.98	7860.90		7861.03	0.000826	2.87	309.57	94.85	0.25
Happy Meadows	689	50-yr	1351.00	7854.98	7861.98		7862.16	0.000913	3.51	423.41	117.02	0.27
Happy Meadows	689	100 yr	1610.00	7854.98	7862.31		7862.53	0.001034	3.89	462.72	124.76	0.29
Happy Meadows	689	500-yr	2335.00	7854.98	7863.04		7863.37	0.001343	4.82	561.10	142.02	0.34
Happy Meadows	688	min	32.00	7854.14	7856.82		7856.82	0.000013	0.21	151.83	81.19	0.03
Happy Meadows	688	1-yr	160.00	7854.14	7858.03		7858.04	0.000061	0.63	254.96	90.49	0.06
Happy Meadows	688	2-yr	426.00	7854.14	7859.48		7859.50	0.000114	1.12	406.80	143.52	0.09
Happy Meadows	688	5 yr	660.00	7854.14	7860.35		7860.38	0.000136	1.38	545.05	169.51	0.11
Happy Meadows	688	10-yr	846.00	7854.14	7860.91		7860.94	0.000149	1.54	642.88	180.81	0.11
Happy Meadows	688	50-yr	1351.00	7854.14	7862.00		7862.05	0.000186	1.93	851.67	200.15	0.13
Happy Meadows	688	100 yr	1610.00	7854.14	7862.34		7862.40	0.000217	2.14	919.43	205.64	0.14
Happy Meadows	688	500-yr	2335.00	7854.14	7863.10		7863.19	0.000300	2.70	1083.56	223.28	0.17
Happy Meadows	687	min	32.00	7854.80	7856.82		7856.82	0.000056	0.33	96.64	79.22	0.05
Happy Meadows	687	1-yr	160.00	7854.80	7858.01		7858.03	0.000144	0.83	193.61	83.06	0.09
Happy Meadows	687	2-yr	426.00	7854.80	7859.45		7859.48	0.000207	1.36	321.13	96.53	0.12
Happy Meadows	687	5 yr	660.00	7854.80	7860.31		7860.35	0.000245	1.69	416.07	135.58	0.14
Happy Meadows	687	10-yr	846.00	7854.80	7860.86		7860.92	0.000264	1.89	494.63	147.77	0.15
Happy Meadows	687	50-yr	1351.00	7854.80	7861.94		7862.02	0.000320	2.36	665.01	168.39	0.17
Happy Meadows	687	100 yr	1610.00	7854.80	7862.26		7862.36	0.000372	2.63	720.12	174.64	0.18
Happy Meadows	687	500-yr	2335.00	7854.80	7862.99		7863.14	0.000510	3.31	852.24	188.78	0.21
Happy Meadows	686	min	32.00	7855.41	7856.73		7856.79	0.003331	1.94	16.53	20.48	0.38
Happy Meadows	686	1-yr	160.00	7855.41	7857.70		7857.95	0.006379	4.00	40.01	26.96	0.58
Happy Meadows	686	2-yr	426.00	7855.41	7858.81		7859.35	0.007132	5.89	73.84	36.46	0.66
Happy Meadows	686	5 yr	660.00	7855.41	7859.42		7860.19	0.007816	7.15	99.05	46.89	0.72
Happy Meadows	686	10-yr	846.00	7855.41	7859.74	7859.45	7860.73	0.008853	8.14	115.09	53.29	0.78
Happy Meadows	686	50-yr	1351.00	7855.41	7860.91	7860.91	7861.83	0.006328	8.38	223.21	140.18	0.69
Happy Meadows	686	100 yr	1610.00	7855.41	7861.20	7861.20	7862.15	0.006347	8.75	265.72	148.10	0.70
Happy Meadows	686	500-yr	2335.00	7855.41	7861.82	7861.82	7862.89	0.006703	9.75	363.22	164.64	0.74
Happy Meadows	685	min	32.00	7854.75	7856.27		7856.28	0.001300	0.97	33.07	57.81	0.23
Happy Meadows	685	1-yr	160.00	7854.75	7857.30		7857.35	0.001073	1.71	93.84	59.53	0.24
Happy Meadows	685	2-yr	426.00	7854.75	7858.56		7858.66	0.001070	2.50	173.14	72.29	0.26
Happy Meadows	685	5 yr	660.00	7854.75	7859.24		7859.38	0.001202	3.06	235.04	129.81	0.29
Happy Meadows	685	10-yr	846.00	7854.75	7859.66		7859.82	0.001249	3.36	298.67	170.25	0.30
Happy Meadows	685	50-yr	1351.00	7854.75	7860.50		7860.69	0.001256	3.84	466.10	210.29	0.31
Happy Meadows	685	100 yr	1610.00	7854.75	7860.86		7861.06	0.001233	3.99	542.56	215.90	0.31
Happy Meadows	685	500-yr	2335.00	7854.75	7861.71		7861.93	0.001193	4.35	733.11	230.09	0.31
Happy Meadows	684.8	min	32.00	7852.95	7853.94		7854.02	0.006357	2.35	13.62	20.64	0.51
Happy Meadows	684.8	1-yr	160.00	7852.95	7854.99	7854.51	7855.26	0.007616	4.21	38.02	26.68	0.62
Happy Meadows	684.8	2-yr	426.00	7852.95	7856.17	7855.87	7856.46	0.009240	4.33	98.94	81.27	0.68
Happy Meadows	684.8	5 yr	660.00	7852.95	7856.52	7856.20	7856.94	0.010014	5.24	127.40	83.61	0.73
Happy Meadows	684.8	10-yr	846.00	7852.95	7856.76	7856.46	7857.28	0.010413	5.83	147.65	85.78	0.76
Happy Meadows	684.8	50-yr	1351.00	7852.95	7857.30	7857.02	7858.07	0.011232	7.08	195.46	90.22	0.82

HEC-RAS Plan: Plan 01 River: South Platte Reach: Happy Meadows (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Happy Meadows	684.8	100 yr	1610.00	7852.95	7857.55	7857.27	7858.43	0.011563	7.60	218.40	95.39	0.84
Happy Meadows	684.8	500-yr	2335.00	7852.95	7858.10	7858.02	7859.29	0.012609	8.91	276.09	109.27	0.90
Happy Meadows	684	min	32.00	7844.82	7845.86	7845.86	7846.01	0.031548	3.10	10.31	34.34	1.00
Happy Meadows	684	1-yr	160.00	7844.82	7846.33	7846.33	7846.60	0.027496	4.19	38.17	73.15	1.02
Happy Meadows	684	2-yr	426.00	7844.82	7846.81	7846.81	7847.28	0.022968	5.54	76.89	84.59	1.02
Happy Meadows	684	5 yr	660.00	7844.82	7847.13	7847.13	7847.75	0.020350	6.33	104.32	85.64	1.01
Happy Meadows	684	10-yr	846.00	7844.82	7847.35	7847.35	7848.08	0.019302	6.85	123.51	86.33	1.01
Happy Meadows	684	50-yr	1351.00	7844.82	7847.88	7847.88	7848.87	0.017502	7.99	169.20	87.82	1.01
Happy Meadows	684	100 yr	1610.00	7844.82	7848.12	7848.12	7849.23	0.016861	8.47	190.36	88.69	1.01
Happy Meadows	684	500-yr	2335.00	7844.82	7848.75	7848.75	7850.15	0.015064	9.50	247.51	90.98	1.00
Happy Meadows	683	min	32.00	7835.71	7838.71		7838.72	0.000219	0.71	44.82	31.55	0.11
Happy Meadows	683	1-yr	160.00	7835.71	7840.06		7840.10	0.000593	1.55	103.31	47.86	0.19
Happy Meadows	683	2-yr	426.00	7835.71	7841.44		7841.53	0.000824	2.50	171.95	54.79	0.24
Happy Meadows	683	5 yr	660.00	7835.71	7842.28		7842.43	0.000940	3.09	225.77	84.91	0.26
Happy Meadows	683	10-yr	846.00	7835.71	7842.85		7843.02	0.000965	3.39	278.68	99.59	0.27
Happy Meadows	683	50-yr	1351.00	7835.71	7844.14		7844.36	0.000951	3.94	430.39	152.84	0.28
Happy Meadows	683	100 yr	1610.00	7835.71	7844.61		7844.83	0.000958	4.15	503.60	162.46	0.28
Happy Meadows	683	500-yr	2335.00	7835.71	7845.37		7845.67	0.001183	4.95	632.47	175.09	0.32
Happy Meadows	682	min	32.00	7837.51	7838.27	7838.27	7838.47	0.029377	3.62	8.83	22.06	1.01
Happy Meadows	682	1-yr	160.00	7837.51	7839.01	7839.01	7839.51	0.021898	5.65	28.31	29.00	1.01
Happy Meadows	682	2-yr	426.00	7837.51	7839.95	7839.95	7840.76	0.018798	7.24	58.81	36.81	1.01
Happy Meadows	682	5 yr	660.00	7837.51	7840.51	7840.51	7841.57	0.017495	8.28	79.74	38.11	1.01
Happy Meadows	682	10-yr	846.00	7837.51	7840.90	7840.90	7842.13	0.016801	8.93	94.75	38.88	1.01
Happy Meadows	682	50-yr	1351.00	7837.51	7841.83	7841.83	7843.46	0.014521	10.28	133.05	45.45	0.99
Happy Meadows	682	100 yr	1610.00	7837.51	7842.53	7842.53	7844.01	0.010392	9.88	179.58	97.83	0.86
Happy Meadows	682	500-yr	2335.00	7837.51	7843.70	7843.70	7844.86	0.006740	9.41	334.14	153.96	0.72
Happy Meadows	681	min	32.00	7835.81	7837.43		7837.44	0.000272	0.67	47.48	43.93	0.11
Happy Meadows	681	1-yr	160.00	7835.81	7838.46		7838.50	0.000793	1.67	95.62	49.96	0.21
Happy Meadows	681	2-yr	426.00	7835.81	7839.38		7839.52	0.001555	2.99	142.39	51.72	0.32
Happy Meadows	681	5 yr	660.00	7835.81	7839.94		7840.17	0.002019	3.86	172.97	57.32	0.37
Happy Meadows	681	10-yr	846.00	7835.81	7840.33		7840.63	0.002290	4.41	196.99	69.66	0.40
Happy Meadows	681	50-yr	1351.00	7835.81	7841.24		7841.66	0.002515	5.35	289.73	114.31	0.44
Happy Meadows	681	100 yr	1610.00	7835.81	7841.64		7842.10	0.002546	5.69	337.26	128.71	0.45
Happy Meadows	681	500-yr	2335.00	7835.81	7842.63		7843.14	0.002406	6.23	488.79	174.39	0.45
Happy Meadows	680	min	32.00	7835.99	7837.39		7837.41	0.001665	1.15	27.78	44.94	0.26
Happy Meadows	680	1-yr	160.00	7835.99	7838.38		7838.44	0.001613	1.96	81.76	58.40	0.29
Happy Meadows	680	2-yr	426.00	7835.99	7839.26		7839.41	0.002313	3.16	136.05	63.65	0.37
Happy Meadows	680	5 yr	660.00	7835.99	7839.81		7840.05	0.002637	3.89	171.91	68.38	0.41
Happy Meadows	680	10-yr	846.00	7835.99	7840.19		7840.49	0.002779	4.36	199.40	77.98	0.43
Happy Meadows	680	50-yr	1351.00	7835.99	7841.10		7841.51	0.002857	5.24	283.13	106.70	0.46
Happy Meadows	680	100 yr	1610.00	7835.99	7841.49		7841.95	0.002864	5.58	327.67	122.71	0.47
Happy Meadows	680	500-yr	2335.00	7835.99	7842.50		7843.01	0.002588	6.08	471.16	157.59	0.46
Happy Meadows	679	min	32.00	7836.01	7836.76	7836.71	7836.95	0.020052	3.46	9.26	18.69	0.87
Happy Meadows	679	1-yr	160.00	7836.01	7837.99		7838.10	0.007679	2.73	58.60	82.15	0.57
Happy Meadows	679	2-yr	426.00	7836.01	7839.02		7839.12	0.002709	2.56	166.81	119.32	0.38
Happy Meadows	679	5 yr	660.00	7836.01	7839.65		7839.77	0.001897	2.73	242.66	122.03	0.34
Happy Meadows	679	10-yr	846.00	7836.01	7840.08		7840.21	0.001647	2.89	295.03	123.42	0.32
Happy Meadows	679	50-yr	1351.00	7836.01	7841.07		7841.23	0.001350	3.28	419.05	128.41	0.31
Happy Meadows	679	100 yr	1610.00	7836.01	7841.47		7841.66	0.001317	3.49	472.99	136.18	0.31
Happy Meadows	679	500-yr	2335.00	7836.01	7842.50		7842.73	0.001226	3.94	622.73	155.76	0.31
Happy Meadows	678	min	32.00	7834.59	7836.58		7836.59	0.000525	0.81	39.30	45.04	0.15
Happy Meadows	678	1-yr	160.00	7834.59	7837.58		7837.63	0.001082	1.74	91.80	57.62	0.24
Happy Meadows	678	2-yr	426.00	7834.59	7838.61		7838.73	0.001484	2.77	157.43	79.96	0.31
Happy Meadows	678	5 yr	660.00	7834.59	7839.26		7839.42	0.001564	3.30	218.46	104.40	0.33
Happy Meadows	678	10-yr	846.00	7834.59	7839.69		7839.88	0.001549	3.58	265.39	109.38	0.33
Happy Meadows	678	50-yr	1351.00	7834.59	7840.69		7840.94	0.001535	4.20	385.04	137.72	0.34
Happy Meadows	678	100 yr	1610.00	7834.59	7841.11		7841.37	0.001510	4.41	443.63	143.79	0.35
Happy Meadows	678	500-yr	2335.00	7834.59	7842.16		7842.46	0.001431	4.87	608.35	169.45	0.35
Happy Meadows	677	min	32.00	7834.59	7836.51		7836.52	0.000614	0.80	40.01	52.99	0.16
Happy Meadows	677	1-yr	160.00	7834.59	7837.46		7837.50	0.001035	1.69	94.73	60.03	0.24
Happy Meadows	677	2-yr	426.00	7834.59	7838.44		7838.56	0.001454	2.74	157.14	64.88	0.30
Happy Meadows	677	5 yr	660.00	7834.59	7839.05		7839.23	0.001683	3.40	199.32	72.32	0.34
Happy Meadows	677	10-yr	846.00	7834.59	7839.46		7839.68	0.001814	3.83	229.62	77.01	0.36
Happy Meadows	677	50-yr	1351.00	7834.59	7840.38		7840.72	0.002052	4.75	321.64	145.39	0.40
Happy Meadows	677	100 yr	1610.00	7834.59	7840.81		7841.16	0.001977	4.96	387.56	159.10	0.39
Happy Meadows	677	500-yr	2335.00	7834.59	7841.93		7842.28	0.001654	5.20	578.22	185.74	0.37

HEC-RAS Plan: Plan 01 River: South Platte Reach: Happy Meadows (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Happy Meadows	676	min	32.00	7835.19	7835.94	7835.94	7836.22	0.029590	4.23	7.57	15.04	1.05
Happy Meadows	676	1-yr	160.00	7835.19	7836.85		7837.11	0.013675	4.05	39.50	47.02	0.78
Happy Meadows	676	2-yr	426.00	7835.19	7837.68		7838.08	0.010364	5.08	83.91	57.71	0.74
Happy Meadows	676	5 yr	660.00	7835.19	7838.16		7838.70	0.009835	5.87	112.53	60.75	0.75
Happy Meadows	676	10-yr	846.00	7835.19	7838.47		7839.12	0.009839	6.45	131.69	62.57	0.77
Happy Meadows	676	50-yr	1351.00	7835.19	7839.15		7840.09	0.010148	7.81	175.04	65.58	0.82
Happy Meadows	676	100 yr	1610.00	7835.19	7839.42	7839.11	7840.52	0.010530	8.46	193.19	66.71	0.85
Happy Meadows	676	500-yr	2335.00	7835.19	7839.91	7839.91	7841.62	0.013519	10.56	225.91	68.46	0.98
Happy Meadows	675	min	32.00	7834.60	7835.96		7835.97	0.000476	0.76	41.83	49.03	0.15
Happy Meadows	675	1-yr	160.00	7834.60	7836.67		7836.74	0.001676	1.98	80.94	58.50	0.30
Happy Meadows	675	2-yr	426.00	7834.60	7837.40		7837.58	0.003035	3.44	124.01	60.54	0.42
Happy Meadows	675	5 yr	660.00	7834.60	7837.83		7838.13	0.003846	4.38	151.04	63.50	0.49
Happy Meadows	675	10-yr	846.00	7834.60	7838.11		7838.50	0.004438	5.05	169.10	68.24	0.54
Happy Meadows	675	50-yr	1351.00	7834.60	7838.71		7839.37	0.005711	6.54	215.09	92.40	0.63
Happy Meadows	675	100 yr	1610.00	7834.60	7838.98		7839.75	0.006154	7.14	244.35	120.79	0.66
Happy Meadows	675	500-yr	2335.00	7834.60	7839.67		7840.62	0.006293	8.12	345.40	161.65	0.69
Happy Meadows	674	min	32.00	7834.79	7835.84		7835.87	0.005501	1.46	21.94	61.38	0.43
Happy Meadows	674	1-yr	160.00	7834.79	7836.44		7836.52	0.004596	2.27	70.57	88.91	0.45
Happy Meadows	674	2-yr	426.00	7834.79	7837.11		7837.28	0.004237	3.22	132.28	92.20	0.47
Happy Meadows	674	5 yr	660.00	7834.79	7837.54		7837.77	0.004325	3.84	171.87	93.13	0.50
Happy Meadows	674	10-yr	846.00	7834.79	7837.81		7838.10	0.004544	4.30	196.87	93.78	0.52
Happy Meadows	674	50-yr	1351.00	7834.79	7838.43		7838.86	0.004912	5.30	255.57	95.92	0.57
Happy Meadows	674	100 yr	1610.00	7834.79	7838.70		7839.21	0.005058	5.74	282.14	98.34	0.58
Happy Meadows	674	500-yr	2335.00	7834.79	7839.37		7840.06	0.005351	6.74	360.86	133.06	0.62
Happy Meadows	673	min	32.00	7833.16	7833.81		7833.87	0.010202	1.81	17.71	57.23	0.57
Happy Meadows	673	1-yr	160.00	7833.16	7834.25		7834.45	0.014113	3.57	44.79	66.34	0.77
Happy Meadows	673	2-yr	426.00	7833.16	7834.76	7834.66	7835.21	0.016114	5.39	79.09	69.62	0.89
Happy Meadows	673	5 yr	660.00	7833.16	7835.19	7835.08	7835.71	0.015389	5.76	114.54	87.98	0.89
Happy Meadows	673	10-yr	846.00	7833.16	7835.45	7835.31	7836.04	0.013944	6.14	137.79	89.69	0.87
Happy Meadows	673	50-yr	1351.00	7833.16	7836.04	7835.83	7836.82	0.012067	7.07	192.73	97.38	0.85
Happy Meadows	673	100 yr	1610.00	7833.16	7836.31	7836.07	7837.17	0.011501	7.46	219.83	104.97	0.85
Happy Meadows	673	500-yr	2335.00	7833.16	7836.96	7836.74	7838.02	0.010488	8.37	290.54	113.22	0.85
Happy Meadows	672	min	32.00	7832.10	7832.96	7832.84	7833.01	0.010688	1.82	17.54	57.74	0.58
Happy Meadows	672	1-yr	160.00	7832.10	7833.54		7833.64	0.006877	2.64	60.56	82.11	0.54
Happy Meadows	672	2-yr	426.00	7832.10	7834.29		7834.47	0.004758	3.46	123.33	86.21	0.50
Happy Meadows	672	5 yr	660.00	7832.10	7834.71		7834.98	0.004875	4.14	160.98	91.88	0.53
Happy Meadows	672	10-yr	846.00	7832.10	7835.00		7835.32	0.004936	4.58	188.27	96.55	0.55
Happy Meadows	672	50-yr	1351.00	7832.10	7835.63		7836.10	0.005214	5.58	251.68	105.80	0.59
Happy Meadows	672	100 yr	1610.00	7832.10	7835.92		7836.46	0.005213	5.96	283.49	110.03	0.60
Happy Meadows	672	500-yr	2335.00	7832.10	7836.61		7837.32	0.005362	6.91	363.90	123.39	0.63
Happy Meadows	671.5	min	32.00	7828.69	7829.69		7829.78	0.009148	2.43	13.17	24.91	0.59
Happy Meadows	671.5	1-yr	160.00	7828.69	7830.45		7830.72	0.011981	4.14	38.64	40.02	0.74
Happy Meadows	671.5	2-yr	426.00	7828.69	7831.15	7831.11	7831.64	0.019723	5.65	75.46	71.71	0.97
Happy Meadows	671.5	5 yr	660.00	7828.69	7831.52	7831.50	7832.13	0.019222	6.24	105.79	85.50	0.99
Happy Meadows	671.5	10-yr	846.00	7828.69	7831.73	7831.73	7832.46	0.018797	6.85	123.80	86.36	1.00
Happy Meadows	671.5	50-yr	1351.00	7828.69	7832.27	7832.27	7833.25	0.016757	7.97	170.53	87.79	0.99
Happy Meadows	671.5	100 yr	1610.00	7828.69	7832.50	7832.50	7833.62	0.016335	8.48	191.35	88.42	1.00
Happy Meadows	671.5	500-yr	2335.00	7828.69	7833.15	7833.15	7834.54	0.014592	9.50	249.89	94.40	0.99
Happy Meadows	671.3	min	32.00	7826.74	7827.82	7827.82	7828.00	0.032148	3.49	9.18	25.59	1.03
Happy Meadows	671.3	1-yr	160.00	7826.74	7828.46	7828.46	7828.82	0.024747	4.76	33.61	49.17	1.01
Happy Meadows	671.3	2-yr	426.00	7826.74	7829.14	7829.14	7829.58	0.016337	5.31	80.36	94.52	1.01
Happy Meadows	671.3	5 yr	660.00	7826.74	7829.43	7829.43	7830.01	0.017690	6.13	108.17	97.65	1.02
Happy Meadows	671.3	10-yr	846.00	7826.74	7829.65	7829.65	7830.32	0.017213	6.54	130.19	99.74	1.00
Happy Meadows	671.3	50-yr	1351.00	7826.74	7830.18	7830.13	7831.03	0.016171	7.46	183.65	105.81	0.97
Happy Meadows	671.3	100 yr	1610.00	7826.74	7830.45	7830.42	7831.35	0.015374	7.66	213.76	116.11	0.97
Happy Meadows	671.3	500-yr	2335.00	7826.74	7831.12	7830.97	7832.09	0.012999	8.00	298.69	133.37	0.92
Happy Meadows	671	min	32.00	7824.85	7826.21	7825.83	7826.28	0.004681	2.21	14.48	18.66	0.44
Happy Meadows	671	1-yr	160.00	7824.85	7827.33	7826.81	7827.44	0.005465	2.64	60.57	68.57	0.50
Happy Meadows	671	2-yr	426.00	7824.85	7828.07	7827.52	7828.25	0.006228	3.35	127.01	111.16	0.55
Happy Meadows	671	5 yr	660.00	7824.85	7828.39	7827.95	7828.65	0.006633	4.05	162.91	112.98	0.59
Happy Meadows	671	10-yr	846.00	7824.85	7828.53	7828.12	7828.88	0.008048	4.73	178.80	113.79	0.66
Happy Meadows	671	50-yr	1351.00	7824.85	7828.81	7828.57	7829.45	0.012104	6.44	210.14	114.95	0.83
Happy Meadows	671	100 yr	1610.00	7824.85	7828.93	7828.80	7829.73	0.013832	7.19	224.60	115.42	0.90
Happy Meadows	671	500-yr	2335.00	7824.85	7829.31	7829.31	7830.49	0.016346	8.75	268.04	117.00	1.01
Happy Meadows	670	min	32.00	7817.85	7818.78	7818.78	7818.92	0.031947	3.07	10.42	35.65	1.00
Happy Meadows	670	1-yr	160.00	7817.85	7819.21	7819.21	7819.42	0.029508	3.67	43.65	108.12	1.02
Happy Meadows	670	2-yr	426.00	7817.85	7819.58	7819.58	7819.97	0.024383	5.04	84.47	112.21	1.02

HEC-RAS Plan: Plan 01 River: South Platte Reach: Happy Meadows (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Happy Meadows	670	5 yr	660.00	7817.85	7819.84	7819.84	7820.36	0.021771	5.76	114.59	114.46	1.01
Happy Meadows	670	10-yr	846.00	7817.85	7820.13	7820.04	7820.64	0.015805	5.76	146.98	115.41	0.90
Happy Meadows	670	50-yr	1351.00	7817.85	7820.82		7821.37	0.009585	5.92	228.11	118.09	0.75
Happy Meadows	670	100 yr	1610.00	7817.85	7821.12		7821.70	0.008408	6.11	263.90	119.51	0.72
Happy Meadows	670	500-yr	2335.00	7817.85	7821.90		7822.56	0.006534	6.57	358.65	126.42	0.67
Happy Meadows	669.6	min	32.00	7814.51	7815.69		7815.71	0.002078	1.24	25.90	44.62	0.29
Happy Meadows	669.6	1-yr	160.00	7814.51	7816.53		7816.61	0.002605	2.28	70.26	58.18	0.36
Happy Meadows	669.6	2-yr	426.00	7814.51	7817.34		7817.55	0.003368	3.64	117.96	59.48	0.45
Happy Meadows	669.6	5 yr	660.00	7814.51	7817.88		7818.19	0.003673	4.44	150.96	62.24	0.49
Happy Meadows	669.6	10-yr	846.00	7814.51	7818.25		7818.63	0.003861	4.98	174.15	65.67	0.51
Happy Meadows	669.6	50-yr	1351.00	7814.51	7819.07		7819.63	0.004198	6.11	238.43	97.06	0.55
Happy Meadows	669.6	100 yr	1610.00	7814.51	7819.43		7820.06	0.004206	6.50	274.24	101.39	0.56
Happy Meadows	669.6	500-yr	2335.00	7814.51	7820.29		7821.07	0.004260	7.42	372.71	131.76	0.59
Happy Meadows	669	min	32.00	7813.48	7814.46		7814.48	0.002461	1.27	25.12	46.99	0.31
Happy Meadows	669	1-yr	160.00	7813.48	7815.56		7815.59	0.001365	1.45	110.03	108.42	0.25
Happy Meadows	669	2-yr	426.00	7813.48	7816.61		7816.65	0.000888	1.78	240.13	128.26	0.23
Happy Meadows	669	5 yr	660.00	7813.48	7817.19		7817.26	0.000866	2.10	316.06	131.48	0.24
Happy Meadows	669	10-yr	846.00	7813.48	7817.59		7817.67	0.000866	2.32	368.73	135.04	0.24
Happy Meadows	669	50-yr	1351.00	7813.48	7818.46		7818.59	0.000896	2.82	490.99	146.03	0.26
Happy Meadows	669	100 yr	1610.00	7813.48	7818.84		7818.98	0.000916	3.03	547.00	151.26	0.26
Happy Meadows	669	500-yr	2335.00	7813.48	7819.73		7819.92	0.000976	3.57	685.44	160.19	0.28
Happy Meadows	668	min	32.00	7812.81	7813.73		7813.78	0.003605	1.80	17.83	26.48	0.39
Happy Meadows	668	1-yr	160.00	7812.81	7815.15		7815.20	0.002035	1.86	85.90	78.61	0.31
Happy Meadows	668	2-yr	426.00	7812.81	7816.36		7816.41	0.001222	1.88	226.94	141.25	0.26
Happy Meadows	668	5 yr	660.00	7812.81	7816.97		7817.04	0.000998	2.11	314.56	142.95	0.25
Happy Meadows	668	10-yr	846.00	7812.81	7817.38		7817.46	0.000941	2.28	372.60	145.03	0.25
Happy Meadows	668	50-yr	1351.00	7812.81	7818.26		7818.37	0.000911	2.72	502.59	149.92	0.26
Happy Meadows	668	100 yr	1610.00	7812.81	7818.63		7818.76	0.000919	2.93	559.05	151.98	0.26
Happy Meadows	668	500-yr	2335.00	7812.81	7819.51		7819.69	0.000970	3.44	694.60	157.40	0.28
Happy Meadows	667	min	32.00	7811.98	7813.59		7813.61	0.000577	1.01	31.83	28.12	0.17
Happy Meadows	667	1-yr	160.00	7811.98	7814.93		7814.99	0.001272	1.87	85.72	53.98	0.26
Happy Meadows	667	2-yr	426.00	7811.98	7816.15		7816.22	0.001514	2.25	190.67	109.09	0.29
Happy Meadows	667	5 yr	660.00	7811.98	7816.78		7816.88	0.001322	2.57	262.00	115.69	0.29
Happy Meadows	667	10-yr	846.00	7811.98	7817.18		7817.30	0.001296	2.81	309.39	120.45	0.29
Happy Meadows	667	50-yr	1351.00	7811.98	7818.04		7818.22	0.001327	3.39	417.35	130.27	0.31
Happy Meadows	667	100 yr	1610.00	7811.98	7818.41		7818.61	0.001362	3.65	465.22	134.68	0.32
Happy Meadows	667	500-yr	2335.00	7811.98	7819.25		7819.52	0.001473	4.30	582.40	144.02	0.34
Happy Meadows	666	min	32.00	7811.75	7813.45		7813.45	0.000305	0.58	54.89	69.25	0.12
Happy Meadows	666	1-yr	160.00	7811.75	7814.76		7814.78	0.000297	1.06	150.50	74.77	0.13
Happy Meadows	666	2-yr	426.00	7811.75	7815.87		7815.92	0.000481	1.80	243.34	98.87	0.18
Happy Meadows	666	5 yr	660.00	7811.75	7816.47		7816.55	0.000613	2.29	306.75	110.98	0.21
Happy Meadows	666	10-yr	846.00	7811.75	7816.85		7816.95	0.000710	2.63	350.05	121.53	0.23
Happy Meadows	666	50-yr	1351.00	7811.75	7817.64		7817.81	0.000933	3.39	460.37	161.16	0.27
Happy Meadows	666	100 yr	1610.00	7811.75	7817.98		7818.17	0.001001	3.67	516.91	169.23	0.28
Happy Meadows	666	500-yr	2335.00	7811.75	7818.78		7819.03	0.001150	4.33	658.43	184.97	0.31
Happy Meadows	665	min	32.00	7810.92	7813.39		7813.40	0.000213	0.70	46.01	33.62	0.10
Happy Meadows	665	1-yr	160.00	7810.92	7814.66		7814.69	0.000587	1.45	111.08	65.75	0.18
Happy Meadows	665	2-yr	426.00	7810.92	7815.71		7815.79	0.000880	2.29	209.63	116.97	0.24
Happy Meadows	665	5 yr	660.00	7810.92	7816.28		7816.39	0.001005	2.77	279.83	128.61	0.26
Happy Meadows	665	10-yr	846.00	7810.92	7816.63		7816.77	0.001116	3.11	328.15	166.95	0.28
Happy Meadows	665	50-yr	1351.00	7810.92	7817.41		7817.58	0.001258	3.74	467.51	193.90	0.31
Happy Meadows	665	100 yr	1610.00	7810.92	7817.74		7817.94	0.001300	3.98	535.48	204.85	0.32
Happy Meadows	665	500-yr	2335.00	7810.92	7818.55		7818.78	0.001319	4.44	707.91	222.03	0.33
Happy Meadows	664	min	32.00	7811.56	7813.28		7813.30	0.000706	1.00	32.14	34.00	0.18
Happy Meadows	664	1-yr	160.00	7811.56	7814.35		7814.42	0.002036	2.07	77.46	60.64	0.32
Happy Meadows	664	2-yr	426.00	7811.56	7815.32		7815.42	0.002247	2.57	165.87	101.22	0.35
Happy Meadows	664	5 yr	660.00	7811.56	7815.87		7816.01	0.002067	2.97	222.89	107.45	0.35
Happy Meadows	664	10-yr	846.00	7811.56	7816.18		7816.35	0.002182	3.33	256.12	109.56	0.37
Happy Meadows	664	50-yr	1351.00	7811.56	7816.84		7817.11	0.002494	4.17	331.69	121.15	0.41
Happy Meadows	664	100 yr	1610.00	7811.56	7817.13		7817.44	0.002617	4.53	367.59	128.34	0.43
Happy Meadows	664	500-yr	2335.00	7811.56	7817.81		7818.25	0.002920	5.39	460.50	146.42	0.47
Happy Meadows	663	min	32.00	7811.76	7813.18		7813.20	0.001383	1.14	28.01	40.11	0.24
Happy Meadows	663	1-yr	160.00	7811.76	7814.15		7814.20	0.001969	1.89	84.85	76.47	0.31
Happy Meadows	663	2-yr	426.00	7811.76	7815.12		7815.22	0.001710	2.59	171.21	100.42	0.32
Happy Meadows	663	5 yr	660.00	7811.76	7815.67		7815.81	0.001738	3.07	229.97	110.28	0.34
Happy Meadows	663	10-yr	846.00	7811.76	7815.95		7816.13	0.001959	3.49	261.72	113.91	0.36
Happy Meadows	663	50-yr	1351.00	7811.76	7816.56		7816.84	0.002480	4.46	332.92	121.67	0.42

HEC-RAS Plan: Plan 01 River: South Platte Reach: Happy Meadows (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Happy Meadows	663	100 yr	1610.00	7811.76	7816.81		7817.16	0.002745	4.92	364.66	130.06	0.45
Happy Meadows	663	500-yr	2335.00	7811.76	7817.40		7817.91	0.003354	6.00	448.61	153.67	0.51
Happy Meadows	662	min	32.00	7811.19	7813.10		7813.11	0.000586	0.90	35.38	37.52	0.16
Happy Meadows	662	1-yr	160.00	7811.19	7813.93		7814.00	0.002024	2.18	73.60	54.08	0.33
Happy Meadows	662	2-yr	426.00	7811.19	7814.82		7815.00	0.002679	3.42	131.09	85.95	0.40
Happy Meadows	662	5 yr	660.00	7811.19	7815.33		7815.58	0.002925	4.10	184.74	123.95	0.44
Happy Meadows	662	10-yr	846.00	7811.19	7815.54		7815.86	0.003573	4.76	211.66	139.15	0.49
Happy Meadows	662	50-yr	1351.00	7811.19	7816.00		7816.49	0.004751	6.05	281.33	156.67	0.58
Happy Meadows	662	100 yr	1610.00	7811.19	7816.23		7816.77	0.004994	6.48	317.97	161.94	0.60
Happy Meadows	662	500-yr	2335.00	7811.19	7816.83		7817.48	0.005201	7.32	418.59	175.59	0.63
Happy Meadows	661	min	32.00	7811.19	7813.05		7813.06	0.000341	0.68	46.83	50.48	0.13
Happy Meadows	661	1-yr	160.00	7811.19	7813.77		7813.82	0.001533	1.75	91.68	74.75	0.28
Happy Meadows	661	2-yr	426.00	7811.19	7814.62		7814.72	0.002445	2.54	167.40	110.10	0.36
Happy Meadows	661	5 yr	660.00	7811.19	7815.12		7815.23	0.003228	2.69	245.91	187.49	0.41
Happy Meadows	661	10-yr	846.00	7811.19	7815.32		7815.46	0.003287	2.98	284.92	192.97	0.42
Happy Meadows	661	50-yr	1351.00	7811.19	7815.81		7816.01	0.003320	3.60	381.68	204.56	0.45
Happy Meadows	661	100 yr	1610.00	7811.19	7816.07		7816.29	0.003118	3.78	435.03	206.22	0.44
Happy Meadows	661	500-yr	2335.00	7811.19	7816.73		7817.00	0.002741	4.19	572.45	210.41	0.43
Happy Meadows	660	min	32.00	7811.20	7813.02		7813.03	0.000320	0.65	49.12	53.74	0.12
Happy Meadows	660	1-yr	160.00	7811.20	7813.59		7813.64	0.001987	1.93	82.78	69.63	0.31
Happy Meadows	660	2-yr	426.00	7811.20	7814.27		7814.40	0.004429	2.83	150.42	130.84	0.47
Happy Meadows	660	5 yr	660.00	7811.20	7814.68		7814.82	0.005281	3.00	220.36	201.76	0.51
Happy Meadows	660	10-yr	846.00	7811.20	7814.92		7815.08	0.004527	3.13	269.88	205.49	0.48
Happy Meadows	660	50-yr	1351.00	7811.20	7815.46		7815.65	0.003766	3.54	381.95	211.54	0.46
Happy Meadows	660	100 yr	1610.00	7811.20	7815.77		7815.97	0.003180	3.60	446.97	212.53	0.44
Happy Meadows	660	500-yr	2335.00	7811.20	7816.49		7816.72	0.002517	3.89	601.40	214.85	0.41
Happy Meadows	137.9	min	32.00	7812.70	7812.90	7812.90	7813.01	0.042510	2.68	11.96	62.47	1.08
Happy Meadows	137.9	1-yr	160.00	7812.70	7813.29	7813.29	7813.57	0.026489	4.28	37.36	67.43	1.01
Happy Meadows	137.9	2-yr	426.00	7812.70	7813.97	7813.85	7814.30	0.016524	4.59	92.72	105.49	0.86
Happy Meadows	137.9	5 yr	660.00	7812.70	7814.42		7814.73	0.012330	4.41	149.70	145.48	0.77
Happy Meadows	137.9	10-yr	846.00	7812.70	7814.76		7815.00	0.009408	3.93	215.02	202.51	0.67
Happy Meadows	137.9	50-yr	1351.00	7812.70	7815.35		7815.60	0.005660	4.01	337.04	210.83	0.56
Happy Meadows	137.9	100 yr	1610.00	7812.70	7815.68		7815.93	0.004308	3.96	406.93	211.99	0.50
Happy Meadows	137.9	500-yr	2335.00	7812.70	7816.43		7816.69	0.003064	4.14	565.54	214.58	0.45
Happy Meadows	137.8	min	32.00	7810.70	7812.08		7812.08	0.000059	0.35	92.06	71.95	0.05
Happy Meadows	137.8	1-yr	160.00	7810.70	7813.13		7813.14	0.000217	0.96	170.55	78.70	0.11
Happy Meadows	137.8	2-yr	426.00	7810.70	7814.15		7814.19	0.000664	1.62	267.58	128.39	0.20
Happy Meadows	137.8	5 yr	660.00	7810.70	7814.56		7814.62	0.001452	2.02	330.42	204.12	0.28
Happy Meadows	137.8	10-yr	846.00	7810.70	7814.85		7814.92	0.001402	2.19	390.89	208.68	0.28
Happy Meadows	137.8	50-yr	1351.00	7810.70	7815.42		7815.53	0.001507	2.67	513.57	218.97	0.31
Happy Meadows	137.8	100 yr	1610.00	7810.70	7815.75		7815.87	0.001395	2.80	584.71	221.20	0.30
Happy Meadows	137.8	500-yr	2335.00	7810.70	7816.49		7816.64	0.001298	3.17	750.12	226.30	0.30
Happy Meadows	137	min	32.00	7811.25	7811.83	7811.83	7812.05	0.030324	3.45	8.59	18.98	1.01
Happy Meadows	137	1-yr	160.00	7811.25	7812.62	7812.62	7813.06	0.027195	5.39	29.96	35.24	1.08
Happy Meadows	137	2-yr	426.00	7811.25	7813.55	7813.54	7814.05	0.023280	5.73	74.85	73.64	1.04
Happy Meadows	137	5 yr	660.00	7811.25	7814.34		7814.48	0.006566	3.12	218.97	232.82	0.56
Happy Meadows	137	10-yr	846.00	7811.25	7814.69		7814.82	0.003803	2.91	300.93	234.72	0.45
Happy Meadows	137	50-yr	1351.00	7811.25	7815.28		7815.43	0.002766	3.18	441.36	237.93	0.40
Happy Meadows	137	100 yr	1610.00	7811.25	7815.63		7815.78	0.002241	3.19	524.06	239.81	0.37
Happy Meadows	137	500-yr	2335.00	7811.25	7816.39		7816.57	0.001766	3.44	709.18	246.50	0.35
Happy Meadows	136	min	32.00	7808.70	7810.16		7810.21	0.001985	1.76	18.14	17.23	0.30
Happy Meadows	136	1-yr	160.00	7808.70	7811.30	7810.57	7811.51	0.005306	3.65	43.85	27.59	0.51
Happy Meadows	136	2-yr	426.00	7808.70	7812.46	7811.71	7812.87	0.007810	5.15	82.76	40.17	0.63
Happy Meadows	136	5 yr	660.00	7808.70	7813.39	7812.41	7813.76	0.009186	4.87	135.64	84.13	0.68
Happy Meadows	136	10-yr	846.00	7808.70	7814.04	7813.08	7814.29	0.008785	4.07	208.35	171.66	0.65
Happy Meadows	136	50-yr	1351.00	7808.70	7814.99	7814.05	7815.16	0.003264	3.30	414.85	233.06	0.43
Happy Meadows	136	100 yr	1610.00	7808.70	7815.42	7814.28	7815.57	0.002302	3.18	516.66	242.45	0.37
Happy Meadows	136	500-yr	2335.00	7808.70	7816.24		7816.41	0.001697	3.34	722.68	260.43	0.33
Happy Meadows	135	min	32.00	7809.30	7809.67	7809.67	7809.84	0.029597	3.36	9.51	26.75	0.99
Happy Meadows	135	1-yr	160.00	7809.30	7810.37	7810.37	7810.81	0.022236	5.36	29.84	33.11	1.00
Happy Meadows	135	2-yr	426.00	7809.30	7811.20	7811.20	7812.01	0.020014	7.20	59.17	37.23	1.01
Happy Meadows	135	5 yr	660.00	7809.30	7811.77	7811.77	7812.80	0.019143	8.14	81.09	40.03	1.01
Happy Meadows	135	10-yr	846.00	7809.30	7812.16	7812.16	7813.34	0.018627	8.69	97.31	41.98	1.01
Happy Meadows	135	50-yr	1351.00	7809.30	7813.08	7813.08	7814.57	0.017812	9.81	137.65	46.48	1.01
Happy Meadows	135	100 yr	1610.00	7809.30	7813.68	7813.68	7815.10	0.017695	9.54	168.69	59.81	1.00
Happy Meadows	135	500-yr	2335.00	7809.30	7815.23	7815.23	7816.06	0.018605	7.34	321.70	200.64	1.00

HEC-RAS Plan: Plan 01 River: South Platte Reach: Happy Meadows (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Happy Meadows	134	min	32.00	7807.80	7808.54		7808.55	0.000310	0.55	58.19	81.39	0.11
Happy Meadows	134	1-yr	160.00	7807.80	7809.29		7809.31	0.000752	1.32	120.87	87.76	0.20
Happy Meadows	134	2-yr	426.00	7807.80	7810.30		7810.36	0.000930	1.98	215.09	99.54	0.24
Happy Meadows	134	5 yr	660.00	7807.80	7810.96		7811.05	0.000981	2.33	282.99	105.41	0.25
Happy Meadows	134	10-yr	846.00	7807.80	7811.44		7811.54	0.000991	2.54	333.59	109.59	0.26
Happy Meadows	134	50-yr	1351.00	7807.80	7812.57		7812.70	0.001019	2.89	467.25	127.14	0.27
Happy Meadows	134	100 yr	1610.00	7807.80	7813.14		7813.28	0.000968	2.96	543.08	136.31	0.26
Happy Meadows	134	500-yr	2335.00	7807.80	7814.72		7814.86	0.000779	2.98	783.23	170.40	0.24
Happy Meadows	133	min	32.00	7807.85	7808.44		7808.50	0.012758	1.97	16.27	54.72	0.64
Happy Meadows	133	1-yr	160.00	7807.85	7809.16		7809.24	0.004401	2.29	69.94	84.37	0.44
Happy Meadows	133	2-yr	426.00	7807.85	7810.20		7810.30	0.002288	2.50	170.18	110.34	0.35
Happy Meadows	133	5 yr	660.00	7807.85	7810.88		7810.99	0.001774	2.64	251.70	128.18	0.33
Happy Meadows	133	10-yr	846.00	7807.85	7811.37		7811.48	0.001515	2.70	316.84	140.26	0.31
Happy Meadows	133	50-yr	1351.00	7807.85	7812.53		7812.65	0.000991	2.85	491.50	161.15	0.27
Happy Meadows	133	100 yr	1610.00	7807.85	7813.11		7813.24	0.000828	2.88	589.88	179.29	0.25
Happy Meadows	133	500-yr	2335.00	7807.85	7814.71		7814.83	0.000520	2.84	929.06	239.14	0.21
Happy Meadows	132	min	28.00	7806.37	7807.28	7806.98	7807.33	0.004151	1.79	15.63	25.87	0.41
Happy Meadows	132	1-yr	156.00	7806.37	7808.51	7807.72	7808.63	0.003065	2.78	56.51	40.45	0.40
Happy Meadows	132	2-yr	422.00	7806.37	7809.49	7808.62	7809.79	0.003928	4.42	99.14	47.45	0.50
Happy Meadows	132	5 yr	654.00	7806.37	7810.07	7809.16	7810.51	0.004473	5.44	128.09	52.49	0.55
Happy Meadows	132	10-yr	842.00	7806.37	7810.49	7809.56	7811.03	0.004611	6.03	151.07	55.51	0.57
Happy Meadows	132	50-yr	1347.00	7806.37	7811.61	7810.46	7812.29	0.004173	6.91	215.49	58.37	0.57
Happy Meadows	132	100 yr	1606.00	7806.37	7812.19	7810.85	7812.92	0.003810	7.16	249.67	58.77	0.56
Happy Meadows	132	500-yr	2331.00	7806.37	7813.76	7811.77	7814.58	0.003110	7.72	350.14	70.22	0.52
Happy Meadows	131.6		Bridge									
Happy Meadows	131	min	28.00	7805.22	7807.21		7807.24	0.001335	1.27	22.05	22.70	0.23
Happy Meadows	131	1-yr	156.00	7805.22	7808.43		7808.52	0.002482	2.52	61.92	38.28	0.35
Happy Meadows	131	2-yr	422.00	7805.22	7809.32		7809.62	0.004148	4.36	98.49	42.69	0.48
Happy Meadows	131	5 yr	654.00	7805.22	7809.78		7810.27	0.005646	5.68	118.58	45.64	0.58
Happy Meadows	131	10-yr	842.00	7805.22	7810.06		7810.73	0.006824	6.64	131.70	47.02	0.65
Happy Meadows	131	50-yr	1347.00	7805.22	7810.64	7810.21	7811.82	0.009870	8.89	159.56	49.89	0.80
Happy Meadows	131	100 yr	1606.00	7805.22	7810.84	7810.62	7812.35	0.011775	10.05	169.75	52.26	0.88
Happy Meadows	131	500-yr	2331.00	7805.22	7811.75	7811.75	7813.71	0.011885	11.57	224.06	66.95	0.92
Happy Meadows	130	min	28.00	7805.71	7806.66		7806.81	0.014728	3.17	8.84	16.06	0.75
Happy Meadows	130	1-yr	156.00	7805.71	7807.37	7807.37	7807.75	0.024595	4.94	31.58	43.41	1.02
Happy Meadows	130	2-yr	422.00	7805.71	7808.23	7808.08	7808.67	0.015035	5.36	78.68	65.98	0.87
Happy Meadows	130	5 yr	654.00	7805.71	7808.78		7809.25	0.011486	5.50	118.92	78.41	0.79
Happy Meadows	130	10-yr	842.00	7805.71	7809.14		7809.64	0.009459	5.71	147.65	80.83	0.74
Happy Meadows	130	50-yr	1347.00	7805.71	7809.90		7810.54	0.007544	6.42	214.06	95.69	0.70
Happy Meadows	130	100 yr	1606.00	7805.71	7810.23		7810.93	0.007120	6.75	247.05	104.86	0.69
Happy Meadows	130	500-yr	2331.00	7805.71	7810.97		7811.80	0.006517	7.49	348.91	150.95	0.69
Happy Meadows	129	min	28.00	7803.60	7804.50		7804.53	0.003000	1.38	20.31	39.26	0.34
Happy Meadows	129	1-yr	156.00	7803.60	7805.62		7805.68	0.002027	2.11	73.78	55.74	0.32
Happy Meadows	129	2-yr	422.00	7803.60	7806.83		7806.95	0.001888	2.77	152.12	71.78	0.34
Happy Meadows	129	5 yr	654.00	7803.60	7807.48		7807.65	0.001879	3.27	200.19	75.70	0.35
Happy Meadows	129	10-yr	842.00	7803.60	7807.92		7808.13	0.001885	3.62	236.10	97.79	0.36
Happy Meadows	129	50-yr	1347.00	7803.60	7808.92		7809.17	0.001739	4.17	364.25	154.31	0.36
Happy Meadows	129	100 yr	1606.00	7803.60	7809.33		7809.60	0.001681	4.37	433.53	182.75	0.36
Happy Meadows	129	500-yr	2331.00	7803.60	7810.14		7810.47	0.001707	4.91	593.18	200.97	0.37
Happy Meadows	128	min	28.00	7802.29	7803.47		7803.49	0.001463	1.15	24.43	36.18	0.25
Happy Meadows	128	1-yr	156.00	7802.29	7804.47		7804.56	0.002385	2.35	66.28	47.95	0.35
Happy Meadows	128	2-yr	422.00	7802.29	7805.54		7805.73	0.003017	3.50	120.40	56.50	0.42
Happy Meadows	128	5 yr	654.00	7802.29	7806.19		7806.45	0.002976	4.10	165.21	75.29	0.44
Happy Meadows	128	10-yr	842.00	7802.29	7806.64		7806.94	0.002871	4.45	199.76	79.93	0.44
Happy Meadows	128	50-yr	1347.00	7802.29	7807.65		7808.05	0.002740	5.23	293.28	122.27	0.45
Happy Meadows	128	100 yr	1606.00	7802.29	7808.08		7808.51	0.002668	5.51	354.57	169.58	0.45
Happy Meadows	128	500-yr	2331.00	7802.29	7808.96		7809.41	0.002452	5.93	519.03	199.49	0.45
Happy Meadows	127	min	28.00	7800.11	7800.74	7800.74	7800.92	0.030478	3.38	8.29	23.73	1.01
Happy Meadows	127	1-yr	156.00	7800.11	7801.86		7802.06	0.007163	3.53	44.14	39.70	0.59
Happy Meadows	127	2-yr	422.00	7800.11	7803.21		7803.46	0.004105	4.03	104.74	50.63	0.49
Happy Meadows	127	5 yr	654.00	7800.11	7803.93		7804.26	0.003830	4.61	141.81	52.72	0.50
Happy Meadows	127	10-yr	842.00	7800.11	7804.41		7804.81	0.003756	5.02	167.97	55.40	0.50
Happy Meadows	127	50-yr	1347.00	7800.11	7805.45		7806.00	0.003622	5.97	231.69	74.22	0.52
Happy Meadows	127	100 yr	1606.00	7800.11	7805.91		7806.51	0.003513	6.31	278.02	117.41	0.52
Happy Meadows	127	500-yr	2331.00	7800.11	7807.11		7807.70	0.002768	6.53	440.74	154.30	0.48
Happy Meadows	126	min	28.00	7798.43	7799.73		7799.74	0.000681	0.95	29.45	32.50	0.18

HEC-RAS Plan: Plan 01 River: South Platte Reach: Happy Meadows (Continued)

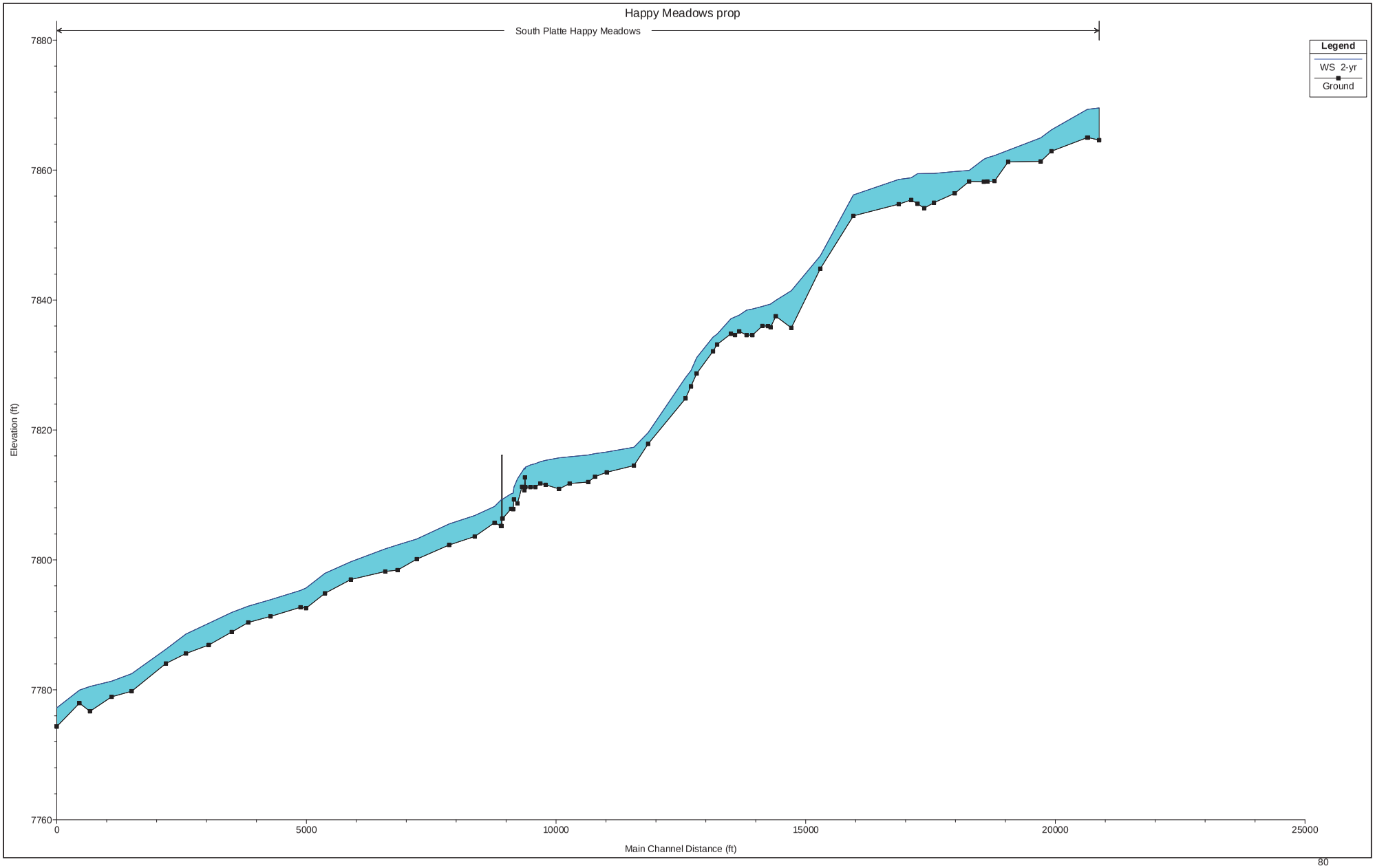
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Happy Meadows	126	1-yr	156.00	7798.43	7801.19		7801.25	0.000921	1.87	83.57	41.61	0.23
Happy Meadows	126	2-yr	422.00	7798.43	7802.31		7802.46	0.001714	3.12	136.25	51.85	0.33
Happy Meadows	126	5 yr	654.00	7798.43	7802.92		7803.16	0.002113	3.93	168.33	52.82	0.38
Happy Meadows	126	10-yr	842.00	7798.43	7803.33		7803.64	0.002383	4.48	190.30	53.90	0.41
Happy Meadows	126	50-yr	1347.00	7798.43	7804.24		7804.74	0.002904	5.73	241.17	58.15	0.47
Happy Meadows	126	100 yr	1606.00	7798.43	7804.64		7805.24	0.003116	6.27	265.16	62.18	0.49
Happy Meadows	126	500-yr	2331.00	7798.43	7805.64		7806.49	0.003478	7.48	334.03	83.92	0.54
Happy Meadows	125	min	28.00	7798.22	7799.44		7799.47	0.001996	1.48	18.93	24.09	0.29
Happy Meadows	125	1-yr	156.00	7798.22	7800.82		7800.90	0.002330	2.22	70.22	54.59	0.35
Happy Meadows	125	2-yr	422.00	7798.22	7801.71		7801.90	0.003154	3.50	120.63	59.13	0.43
Happy Meadows	125	5 yr	654.00	7798.22	7802.12		7802.43	0.004251	4.49	145.72	61.33	0.51
Happy Meadows	125	10-yr	842.00	7798.22	7802.39		7802.81	0.005035	5.18	162.52	62.46	0.57
Happy Meadows	125	50-yr	1347.00	7798.22	7802.95		7803.67	0.006947	6.81	198.19	66.15	0.68
Happy Meadows	125	100 yr	1606.00	7798.22	7803.17		7804.06	0.007804	7.56	213.26	68.06	0.73
Happy Meadows	125	500-yr	2331.00	7798.22	7803.70	7803.32	7805.08	0.010017	9.45	249.92	72.01	0.85
Happy Meadows	124	min	28.00	7796.98	7797.84		7797.87	0.002729	1.31	21.33	41.35	0.32
Happy Meadows	124	1-yr	156.00	7796.98	7798.81		7798.88	0.003823	2.14	72.79	86.95	0.41
Happy Meadows	124	2-yr	422.00	7796.98	7799.72		7799.80	0.002860	2.30	183.96	160.09	0.38
Happy Meadows	124	5 yr	654.00	7796.98	7800.16		7800.26	0.002312	2.56	255.91	162.73	0.36
Happy Meadows	124	10-yr	842.00	7796.98	7800.48		7800.60	0.002072	2.74	308.79	165.64	0.35
Happy Meadows	124	50-yr	1347.00	7796.98	7801.26		7801.41	0.001697	3.11	439.02	171.26	0.33
Happy Meadows	124	100 yr	1606.00	7796.98	7801.62		7801.78	0.001571	3.25	501.79	173.86	0.33
Happy Meadows	124	500-yr	2331.00	7796.98	7802.54		7802.74	0.001346	3.59	683.08	222.21	0.32
Happy Meadows	123	min	28.00	7794.86	7796.13		7796.17	0.004036	1.42	19.72	45.42	0.38
Happy Meadows	123	1-yr	156.00	7794.86	7797.00		7797.09	0.003125	2.40	65.08	56.20	0.39
Happy Meadows	123	2-yr	422.00	7794.86	7797.95		7798.13	0.003548	3.43	122.92	67.70	0.45
Happy Meadows	123	5 yr	654.00	7794.86	7798.46		7798.72	0.003858	4.14	157.97	71.27	0.49
Happy Meadows	123	10-yr	842.00	7794.86	7798.81		7799.14	0.003944	4.61	184.08	77.17	0.50
Happy Meadows	123	50-yr	1347.00	7794.86	7799.62		7800.09	0.004001	5.55	250.16	85.32	0.53
Happy Meadows	123	100 yr	1606.00	7794.86	7799.98		7800.52	0.003979	5.93	282.16	88.61	0.54
Happy Meadows	123	500-yr	2331.00	7794.86	7800.88		7801.58	0.003942	6.80	364.82	95.94	0.55
Happy Meadows	122	min	28.00	7792.56	7793.97	7793.73	7794.06	0.008107	2.39	11.70	20.31	0.56
Happy Meadows	122	1-yr	156.00	7792.56	7794.90		7795.10	0.010441	3.58	43.61	50.57	0.68
Happy Meadows	122	2-yr	422.00	7792.56	7795.68		7796.03	0.009645	4.76	88.64	62.82	0.71
Happy Meadows	122	5 yr	654.00	7792.56	7796.22		7796.66	0.008108	5.33	122.78	63.97	0.68
Happy Meadows	122	10-yr	842.00	7792.56	7796.59		7797.10	0.007595	5.74	146.65	65.10	0.67
Happy Meadows	122	50-yr	1347.00	7792.56	7797.41		7798.11	0.006920	6.73	201.93	70.55	0.68
Happy Meadows	122	100 yr	1606.00	7792.56	7797.76		7798.56	0.006804	7.17	227.71	75.10	0.68
Happy Meadows	122	500-yr	2331.00	7792.56	7798.59		7799.62	0.006749	8.25	298.92	96.90	0.70
Happy Meadows	121	min	28.00	7792.70	7793.48		7793.51	0.003153	1.40	19.98	39.11	0.35
Happy Meadows	121	1-yr	156.00	7792.70	7794.42		7794.49	0.003065	2.17	71.96	71.55	0.38
Happy Meadows	121	2-yr	422.00	7792.70	7795.30		7795.44	0.002831	3.02	139.55	78.47	0.40
Happy Meadows	121	5 yr	654.00	7792.70	7795.91		7796.10	0.002706	3.46	189.13	83.69	0.41
Happy Meadows	121	10-yr	842.00	7792.70	7796.33		7796.55	0.002621	3.75	224.58	85.80	0.41
Happy Meadows	121	50-yr	1347.00	7792.70	7797.26		7797.56	0.002448	4.41	307.80	98.11	0.41
Happy Meadows	121	100 yr	1606.00	7792.70	7797.66		7798.00	0.002413	4.70	348.58	106.82	0.42
Happy Meadows	121	500-yr	2331.00	7792.70	7798.59		7799.03	0.002371	5.38	463.02	132.85	0.43
Happy Meadows	120	min	28.00	7791.30	7792.10		7792.12	0.001792	1.00	27.88	58.92	0.26
Happy Meadows	120	1-yr	156.00	7791.30	7792.87		7792.93	0.002230	2.01	77.56	67.91	0.33
Happy Meadows	120	2-yr	422.00	7791.30	7793.88		7794.01	0.002028	2.86	147.39	70.39	0.35
Happy Meadows	120	5 yr	654.00	7791.30	7794.51		7794.69	0.002046	3.41	192.66	74.07	0.36
Happy Meadows	120	10-yr	842.00	7791.30	7794.92		7795.14	0.002116	3.81	223.98	79.61	0.38
Happy Meadows	120	50-yr	1347.00	7791.30	7795.80		7796.14	0.002300	4.69	300.92	95.88	0.41
Happy Meadows	120	100 yr	1606.00	7791.30	7796.15		7796.54	0.002426	5.09	335.89	103.57	0.43
Happy Meadows	120	500-yr	2331.00	7791.30	7796.93		7797.48	0.002803	6.10	422.62	120.44	0.47
Happy Meadows	119	min	28.00	7790.37	7790.91		7790.94	0.004205	1.35	20.67	52.87	0.38
Happy Meadows	119	1-yr	156.00	7790.37	7791.77		7791.85	0.002660	2.26	68.88	57.33	0.36
Happy Meadows	119	2-yr	422.00	7790.37	7792.88		7793.02	0.002394	3.06	138.14	68.55	0.38
Happy Meadows	119	5 yr	654.00	7790.37	7793.54		7793.74	0.002214	3.55	192.03	113.62	0.38
Happy Meadows	119	10-yr	842.00	7790.37	7794.01		7794.22	0.002010	3.75	249.59	128.55	0.37
Happy Meadows	119	50-yr	1347.00	7790.37	7795.04		7795.26	0.001586	4.02	421.74	210.10	0.35
Happy Meadows	119	100 yr	1606.00	7790.37	7795.44		7795.66	0.001466	4.11	510.32	225.72	0.34
Happy Meadows	119	500-yr	2331.00	7790.37	7796.30		7796.53	0.001369	4.45	717.45	257.85	0.34
Happy Meadows	118	min	28.00	7788.90	7789.80		7789.83	0.002703	1.43	19.65	33.39	0.33
Happy Meadows	118	1-yr	156.00	7788.90	7790.88		7790.97	0.002634	2.43	64.12	47.78	0.37
Happy Meadows	118	2-yr	422.00	7788.90	7791.92		7792.12	0.003066	3.63	116.28	53.05	0.43
Happy Meadows	118	5 yr	654.00	7788.90	7792.57		7792.86	0.003117	4.34	152.31	58.26	0.45

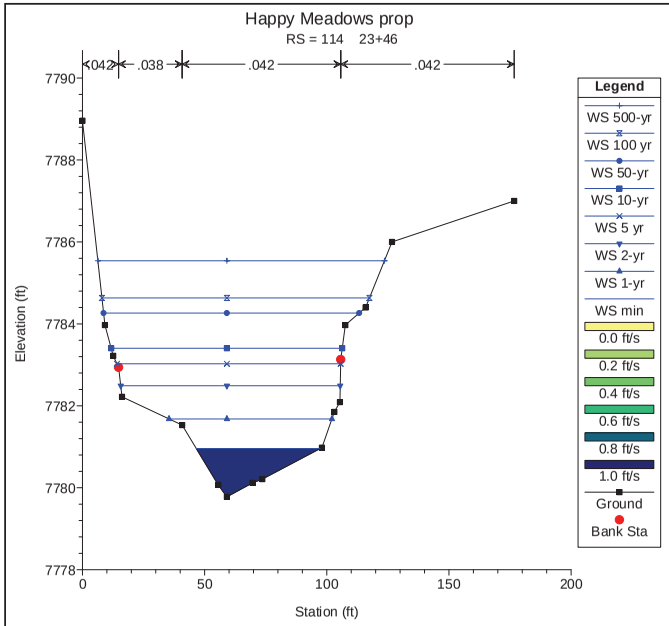
HEC-RAS Plan: Plan 01 River: South Platte Reach: Happy Meadows (Continued)

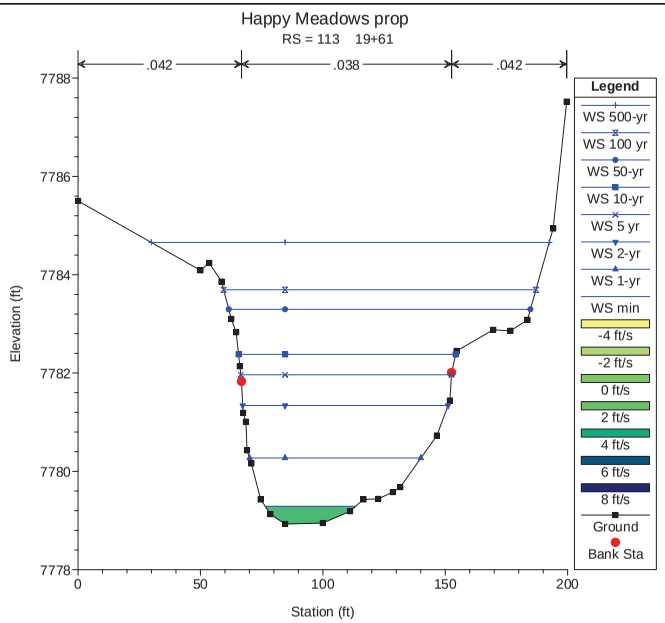
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Happy Meadows	118	10-yr	842.00	7788.90	7793.03		7793.38	0.003123	4.79	180.32	64.58	0.46
Happy Meadows	118	50-yr	1347.00	7788.90	7794.06		7794.53	0.003003	5.62	270.46	117.70	0.47
Happy Meadows	118	100 yr	1606.00	7788.90	7794.51		7794.98	0.002797	5.79	348.16	210.97	0.47
Happy Meadows	118	500-yr	2331.00	7788.90	7795.61		7795.98	0.001962	5.56	601.01	246.17	0.40
Happy Meadows	117	min	28.00	7786.91	7788.12	7787.76	7788.19	0.004987	2.04	13.74	21.50	0.45
Happy Meadows	117	1-yr	156.00	7786.91	7789.27	7788.71	7789.39	0.004721	2.81	55.43	51.33	0.48
Happy Meadows	117	2-yr	422.00	7786.91	7790.25	7789.46	7790.49	0.004199	3.97	106.33	52.87	0.49
Happy Meadows	117	5 yr	654.00	7786.91	7790.87	7789.93	7791.21	0.004252	4.69	139.37	53.78	0.51
Happy Meadows	117	10-yr	842.00	7786.91	7791.29	7790.23	7791.71	0.004318	5.18	162.51	54.90	0.53
Happy Meadows	117	50-yr	1347.00	7786.91	7792.24	7790.95	7792.85	0.004502	6.28	215.74	58.01	0.56
Happy Meadows	117	100 yr	1606.00	7786.91	7792.64	7791.34	7793.35	0.004579	6.76	239.59	59.52	0.58
Happy Meadows	117	500-yr	2331.00	7786.91	7793.62	7792.19	7794.59	0.004806	7.95	299.63	63.43	0.61
Happy Meadows	116	min	28.00	7785.59	7786.78	7786.30	7786.80	0.001980	1.23	22.68	37.71	0.28
Happy Meadows	116	1-yr	156.00	7785.59	7787.68		7787.77	0.002720	2.31	67.67	55.85	0.37
Happy Meadows	116	2-yr	422.00	7785.59	7788.59		7788.79	0.003256	3.53	119.47	58.93	0.44
Happy Meadows	116	5 yr	654.00	7785.59	7789.16		7789.44	0.003444	4.26	154.33	64.30	0.47
Happy Meadows	116	10-yr	842.00	7785.59	7789.54		7789.89	0.003597	4.77	179.19	67.22	0.49
Happy Meadows	116	50-yr	1347.00	7785.59	7790.36		7790.89	0.003957	5.89	236.17	71.68	0.53
Happy Meadows	116	100 yr	1606.00	7785.59	7790.70		7791.32	0.004153	6.40	261.19	73.80	0.56
Happy Meadows	116	500-yr	2331.00	7785.59	7791.50		7792.38	0.004686	7.65	323.12	80.68	0.61
Happy Meadows	115	min	28.00	7784.06	7784.58	7784.58	7784.74	0.032966	3.22	8.69	28.34	1.03
Happy Meadows	115	1-yr	156.00	7784.06	7785.46		7785.69	0.013237	3.84	40.60	51.27	0.76
Happy Meadows	115	2-yr	422.00	7784.06	7786.25		7786.61	0.010576	4.80	87.96	67.24	0.74
Happy Meadows	115	5 yr	654.00	7784.06	7786.66		7787.15	0.010930	5.58	117.23	73.20	0.78
Happy Meadows	115	10-yr	842.00	7784.06	7786.95		7787.52	0.011135	6.08	138.42	76.92	0.80
Happy Meadows	115	50-yr	1347.00	7784.06	7787.57		7788.36	0.011182	7.13	189.00	83.67	0.83
Happy Meadows	115	100 yr	1606.00	7784.06	7787.84	7787.54	7788.74	0.010966	7.59	212.36	89.58	0.84
Happy Meadows	115	500-yr	2331.00	7784.06	7788.51	7788.24	7789.66	0.010375	8.63	277.22	107.52	0.85
Happy Meadows	114	min	28.00	7779.78	7780.96	7780.41	7780.97	0.001383	0.93	30.11	50.61	0.21
Happy Meadows	114	1-yr	156.00	7779.78	7781.68		7781.75	0.003129	2.18	71.72	66.66	0.37
Happy Meadows	114	2-yr	422.00	7779.78	7782.49		7782.64	0.003569	3.05	138.17	89.84	0.43
Happy Meadows	114	5 yr	654.00	7779.78	7783.03		7783.22	0.003409	3.50	186.63	91.55	0.43
Happy Meadows	114	10-yr	842.00	7779.78	7783.40		7783.63	0.003291	3.81	221.79	94.55	0.43
Happy Meadows	114	50-yr	1347.00	7779.78	7784.26		7784.57	0.003096	4.47	306.22	104.61	0.43
Happy Meadows	114	100 yr	1606.00	7779.78	7784.63		7784.98	0.003060	4.76	346.04	109.50	0.44
Happy Meadows	114	500-yr	2331.00	7779.78	7785.54		7785.99	0.002982	5.43	448.86	117.29	0.45
Happy Meadows	113	min	28.00	7778.93	7779.29	7779.29	7779.42	0.033054	2.90	9.64	36.89	1.00
Happy Meadows	113	1-yr	156.00	7778.93	7780.27		7780.36	0.003881	2.35	66.40	69.99	0.43
Happy Meadows	113	2-yr	422.00	7778.93	7781.34		7781.46	0.002428	2.82	149.61	83.89	0.37
Happy Meadows	113	5 yr	654.00	7778.93	7781.97		7782.13	0.002186	3.22	202.97	86.05	0.37
Happy Meadows	113	10-yr	842.00	7778.93	7782.38		7782.57	0.002114	3.53	239.21	88.71	0.37
Happy Meadows	113	50-yr	1347.00	7778.93	7783.30		7783.56	0.002035	4.18	336.89	123.24	0.38
Happy Meadows	113	100 yr	1606.00	7778.93	7783.69		7783.99	0.001989	4.43	386.92	127.60	0.39
Happy Meadows	113	500-yr	2331.00	7778.93	7784.66		7785.02	0.001902	4.98	523.45	162.56	0.39
Happy Meadows	112	min	28.00	7776.69	7778.73	7777.47	7778.73	0.000230	0.59	47.79	48.47	0.10
Happy Meadows	112	1-yr	156.00	7776.69	7779.63	7778.37	7779.67	0.000825	1.56	100.09	60.69	0.21
Happy Meadows	112	2-yr	422.00	7776.69	7780.52	7779.10	7780.63	0.001529	2.71	155.56	64.79	0.31
Happy Meadows	112	5 yr	654.00	7776.69	7781.06	7779.52	7781.24	0.001909	3.42	191.57	69.44	0.35
Happy Meadows	112	10-yr	842.00	7776.69	7781.40	7779.82	7781.64	0.002176	3.93	216.23	78.29	0.39
Happy Meadows	112	50-yr	1347.00	7776.69	7782.15	7780.52	7782.54	0.002683	5.03	278.67	87.94	0.44
Happy Meadows	112	100 yr	1606.00	7776.69	7782.49	7780.79	7782.95	0.002857	5.48	309.15	93.04	0.46
Happy Meadows	112	500-yr	2331.00	7776.69	7783.30	7781.64	7783.93	0.003217	6.52	390.05	106.78	0.51
Happy Meadows	111	min	28.00	7777.95	7778.57		7778.60	0.004961	1.39	20.17	56.36	0.41
Happy Meadows	111	1-yr	156.00	7777.95	7779.24		7779.32	0.004619	2.33	66.91	81.35	0.45
Happy Meadows	111	2-yr	422.00	7777.95	7779.96		7780.13	0.004230	3.25	129.88	89.61	0.48
Happy Meadows	111	5 yr	654.00	7777.95	7780.45		7780.67	0.004154	3.75	174.30	95.97	0.49
Happy Meadows	111	10-yr	842.00	7777.95	7780.76		7781.03	0.004049	4.12	205.16	100.26	0.50
Happy Meadows	111	50-yr	1347.00	7777.95	7781.50		7781.87	0.003789	4.86	282.78	109.21	0.50
Happy Meadows	111	100 yr	1606.00	7777.95	7781.85		7782.25	0.003672	5.15	321.39	118.05	0.51
Happy Meadows	111	500-yr	2331.00	7777.95	7782.71		7783.21	0.003359	5.77	437.48	157.38	0.50
Happy Meadows	110	min	28.00	7774.34	7775.71	7775.40	7775.76	0.007998	1.93	14.49	35.02	0.53
Happy Meadows	110	1-yr	156.00	7774.34	7776.45	7776.15	7776.61	0.008009	3.22	48.47	54.49	0.60
Happy Meadows	110	2-yr	422.00	7774.34	7777.23	7776.80	7777.53	0.008012	4.42	95.49	67.02	0.65
Happy Meadows	110	5 yr	654.00	7774.34	7777.66	7777.22	7778.09	0.008008	5.25	124.81	67.79	0.68
Happy Meadows	110	10-yr	842.00	7774.34	7777.97	7777.50	7778.49	0.008004	5.80	145.93	70.62	0.69
Happy Meadows	110	50-yr	1347.00	7774.34	7778.66	7778.13	7779.41	0.008002	6.98	195.90	73.09	0.73
Happy Meadows	110	100 yr	1606.00	7774.34	7778.97	7778.43	7779.83	0.008010	7.48	218.76	74.11	0.74

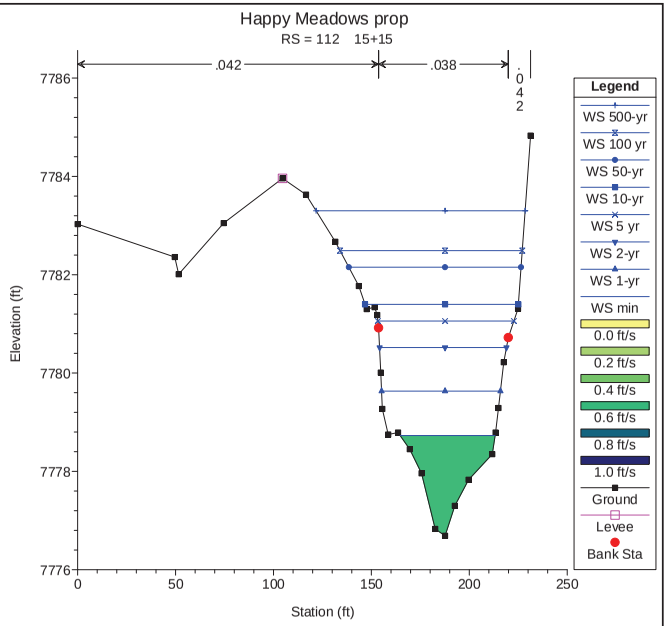
HEC-RAS Plan: Plan 01 River: South Platte Reach: Happy Meadows (Continued)

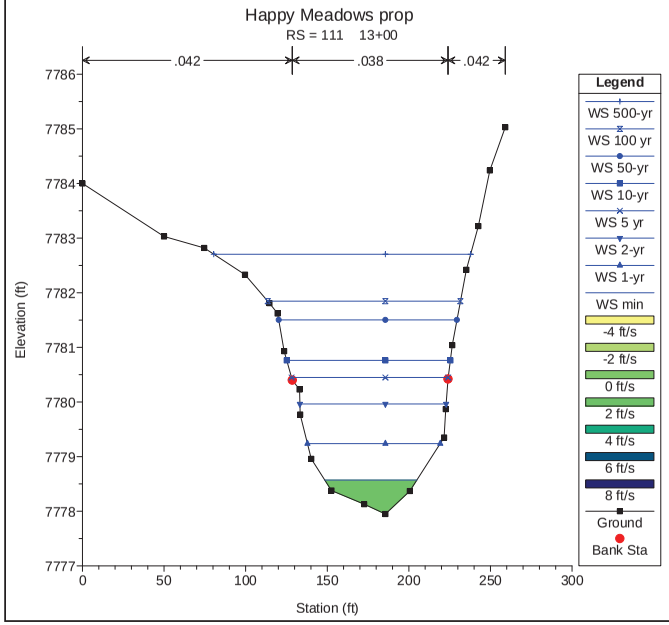
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Happy Meadows	110	500-yr	2331.00	7774.34	7779.75	7779.16	7780.89	0.008002	8.65	277.72	78.16	0.77

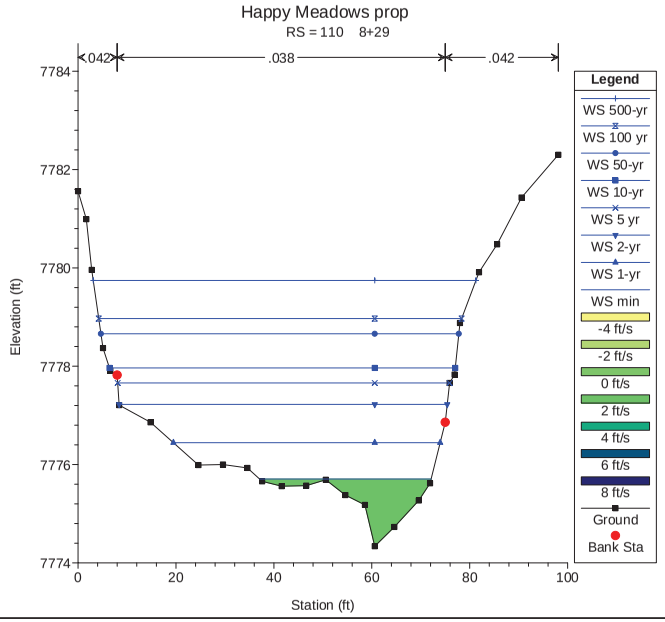

Happy Meadows prop
South Platte Happy Meadows
Legend
WS 2-yr
Ground
Elevation (ft)
7880
7860
7840
7820
7800
7780
7760
0
5000
10000
15000
20000
25000
Main Channel Distance (ft)

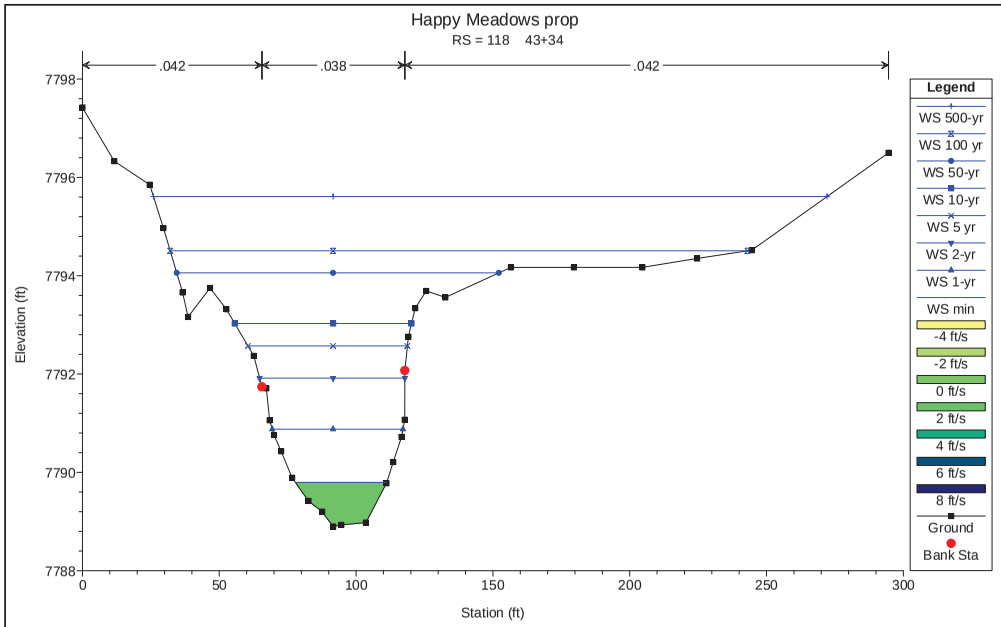

Happy Meadows prop
RS = 114 23+46
.042
.038
.042
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

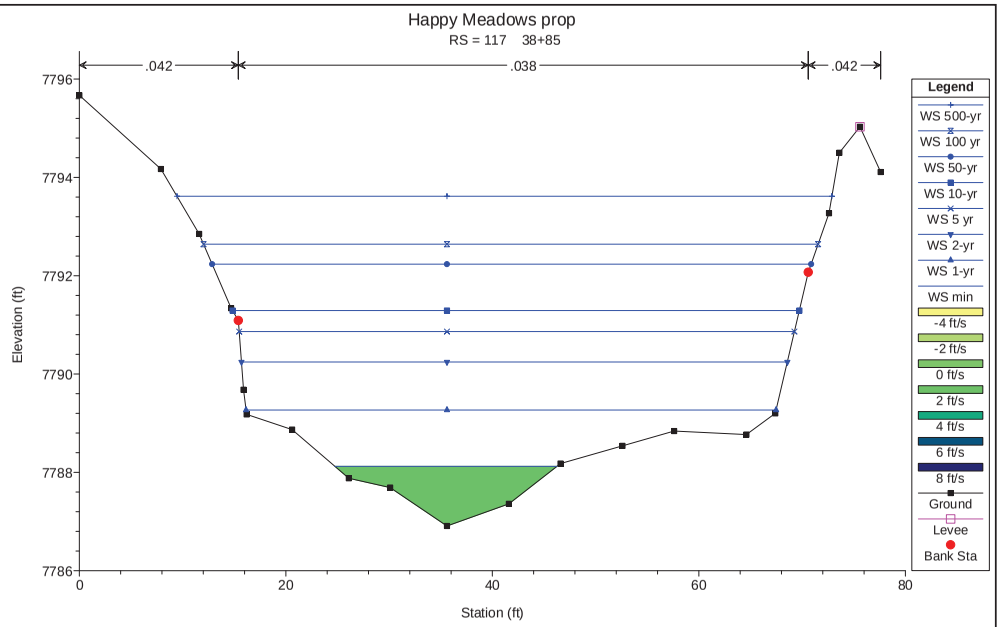

Happy Meadows prop
RS = 113 19+61
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

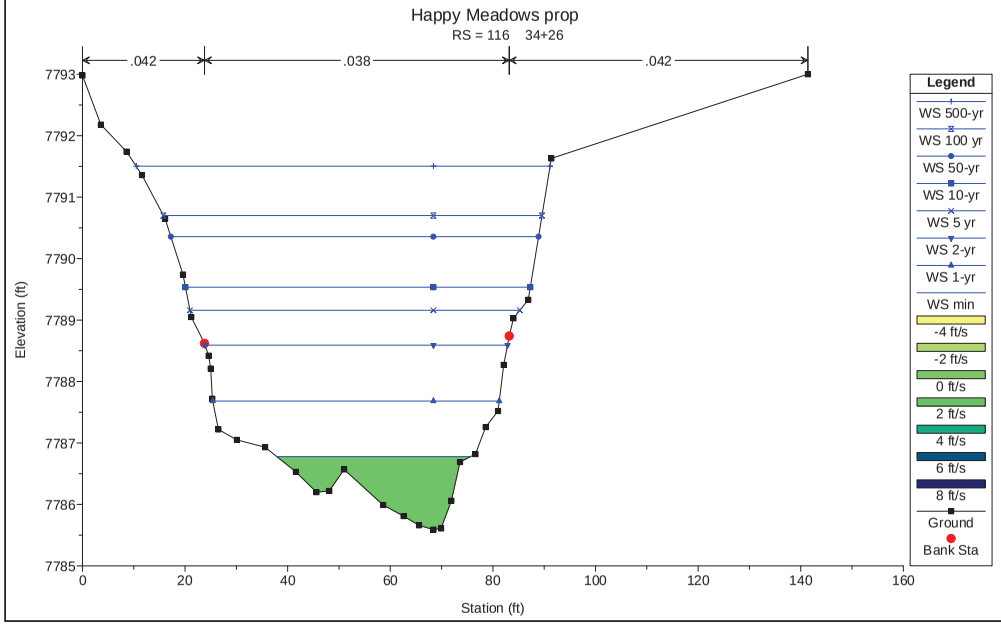

Happy Meadows prop
RS = 112 15+15
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Levee
Bank Sta

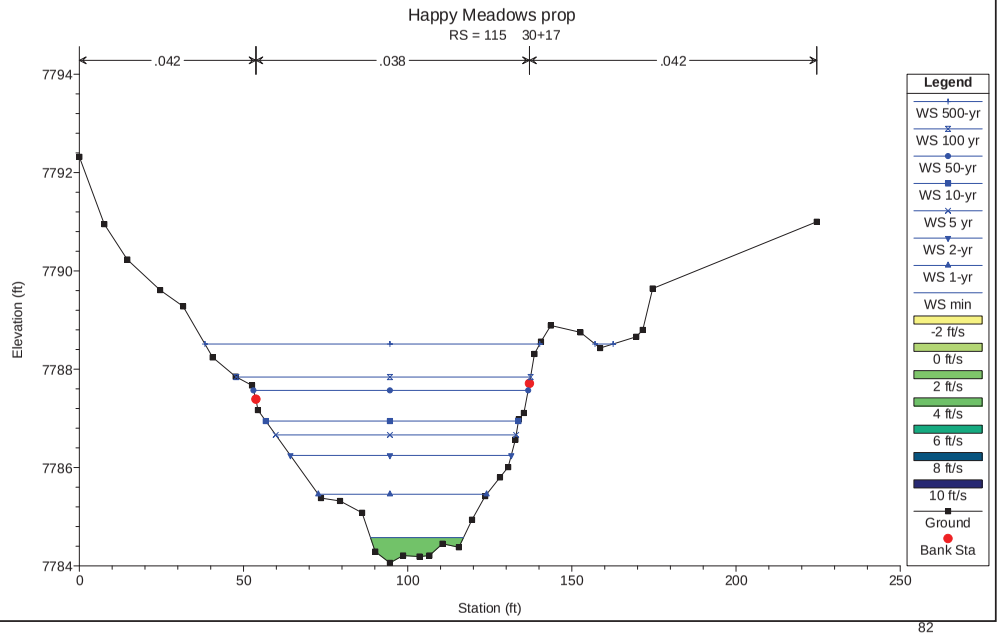

Happy Meadows prop
RS = 111 13+00
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

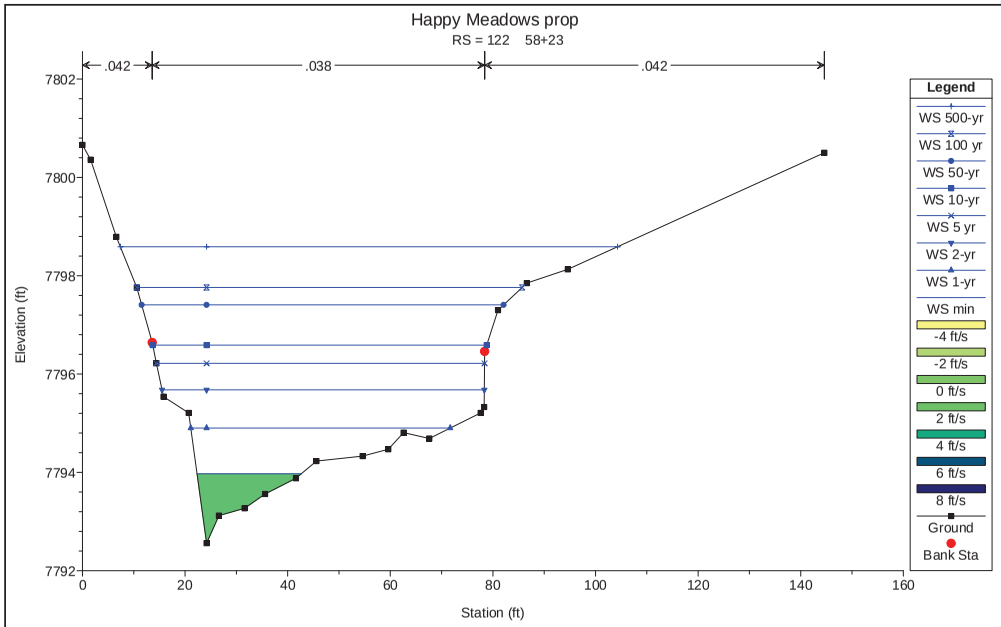

Happy Meadows prop
RS = 110 8+29
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

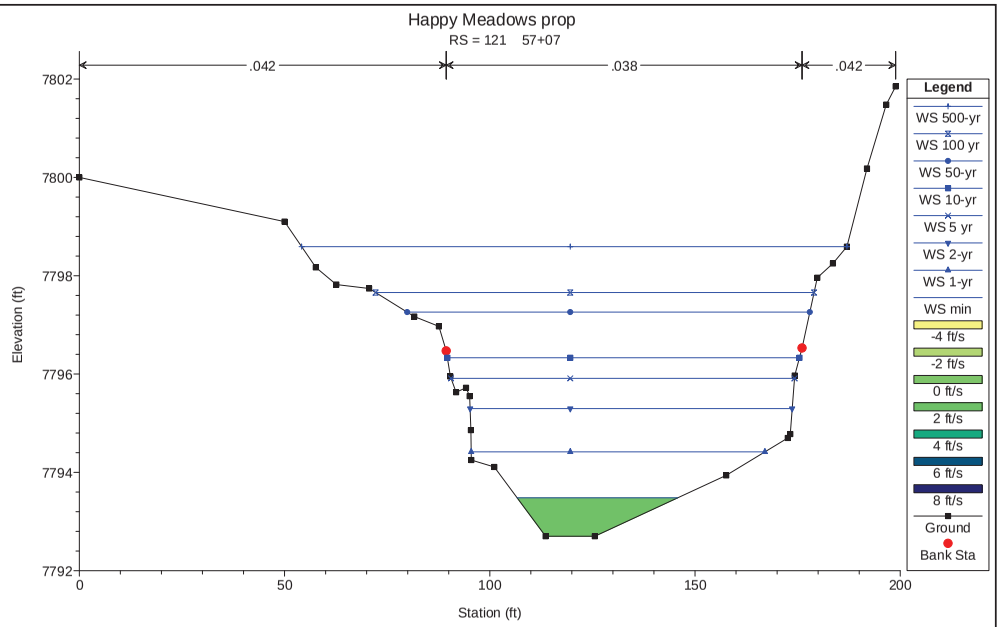

Happy Meadows prop
RS = 118 43+34
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

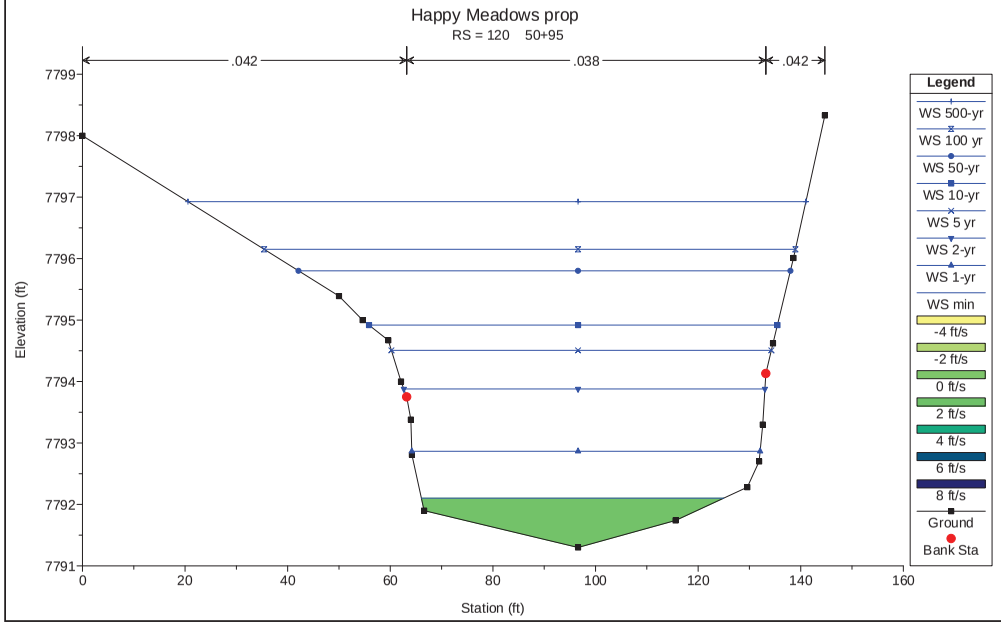

Happy Meadows prop
RS = 117 38+85
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Levee
Bank Sta

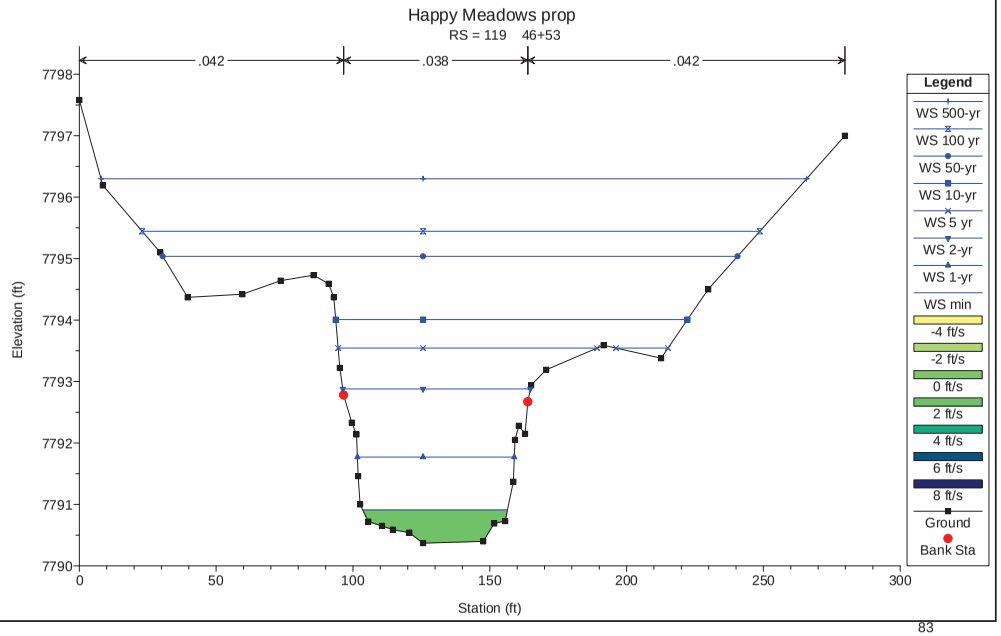

Happy Meadows prop
RS = 116 34+26
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

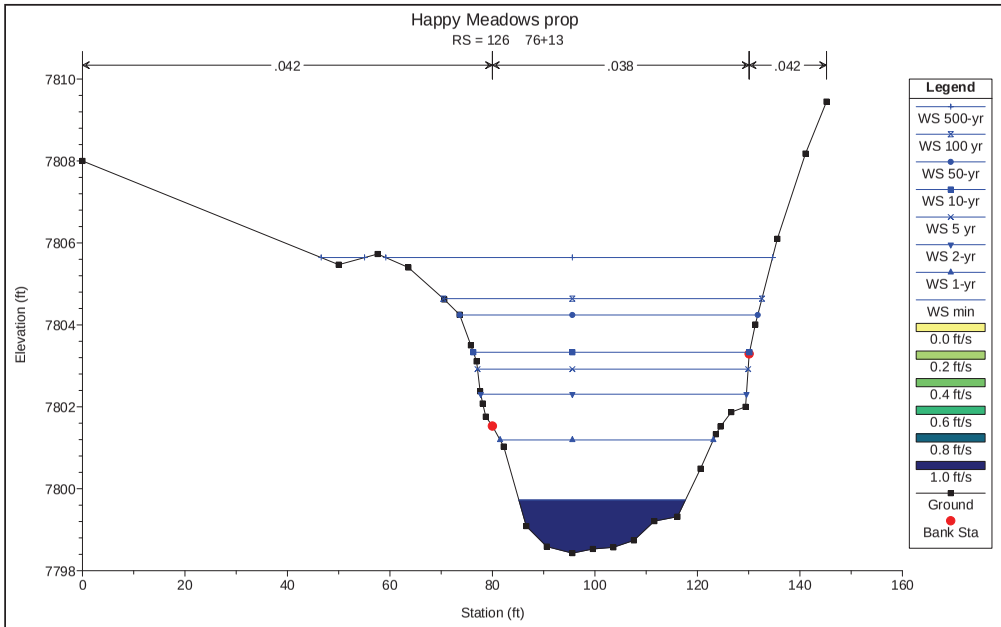

Happy Meadows prop
RS = 115 30+17
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

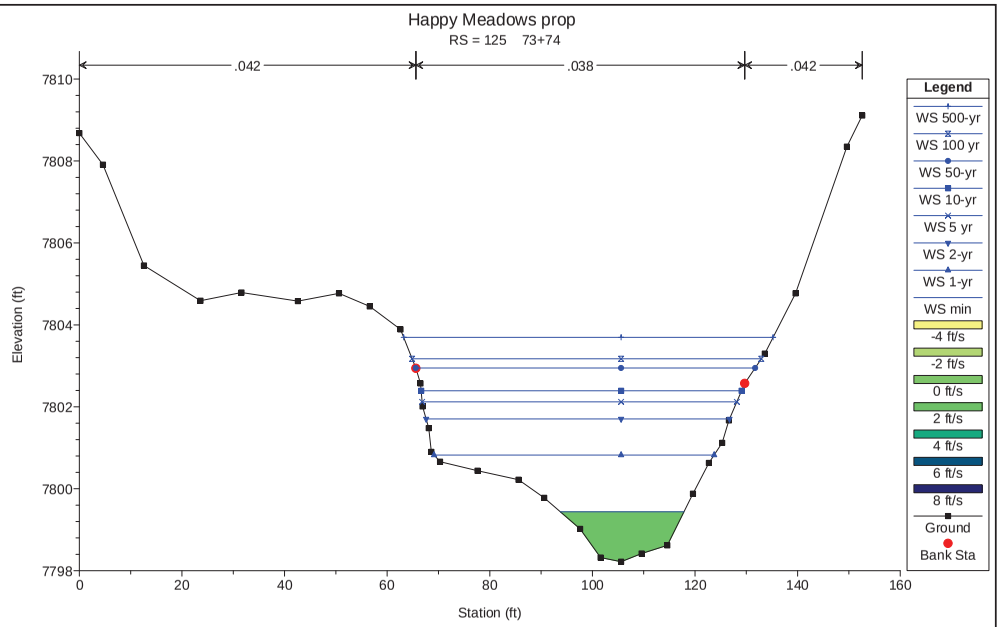

Happy Meadows prop
RS = 122 58+23
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

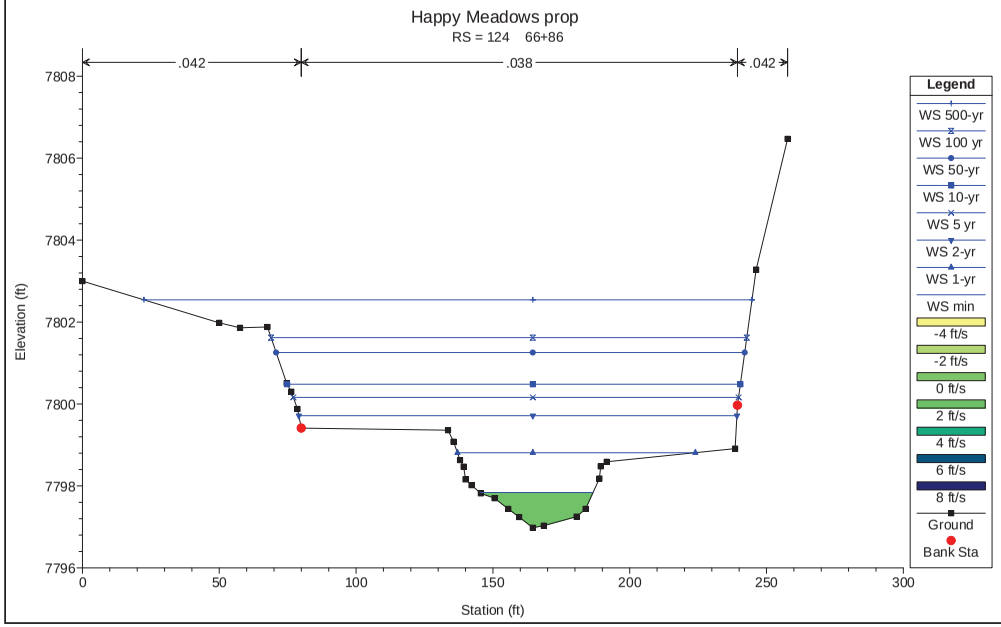

Happy Meadows prop
RS = 121 57+07
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

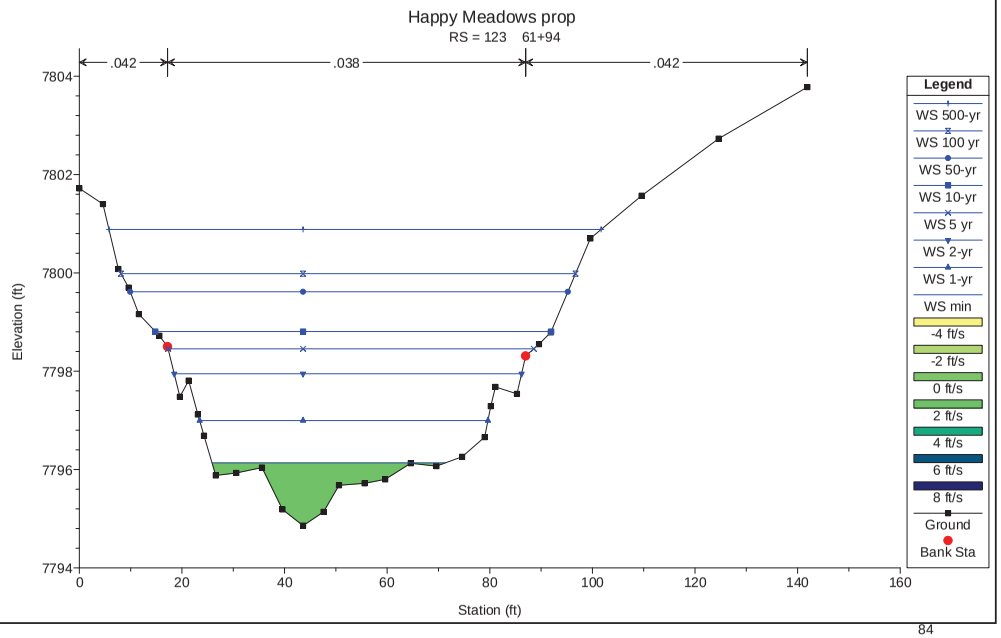

Happy Meadows prop
RS = 120 50+95
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

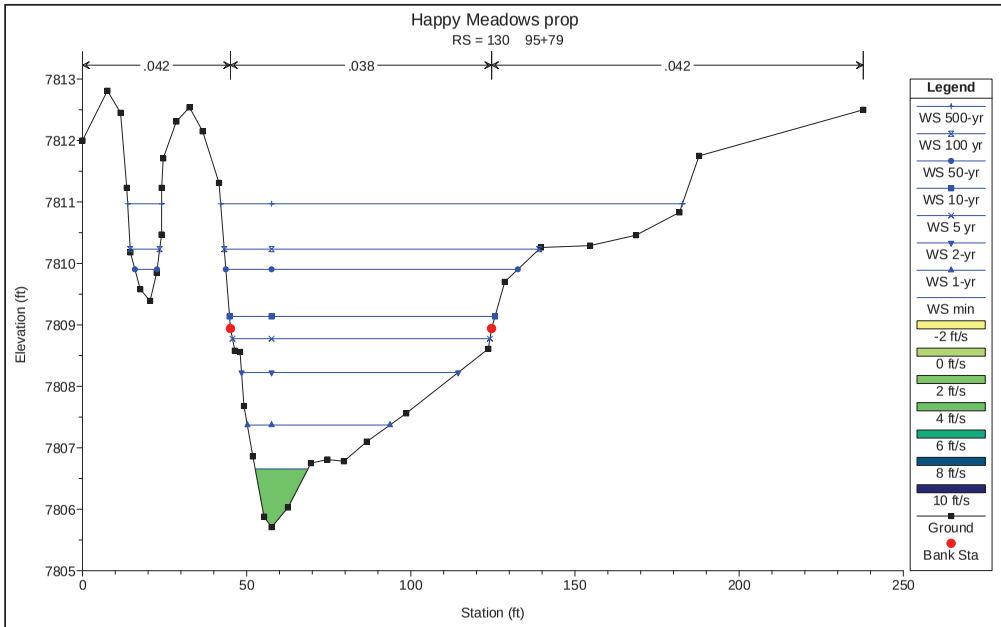

Happy Meadows prop
RS = 119 46+53
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

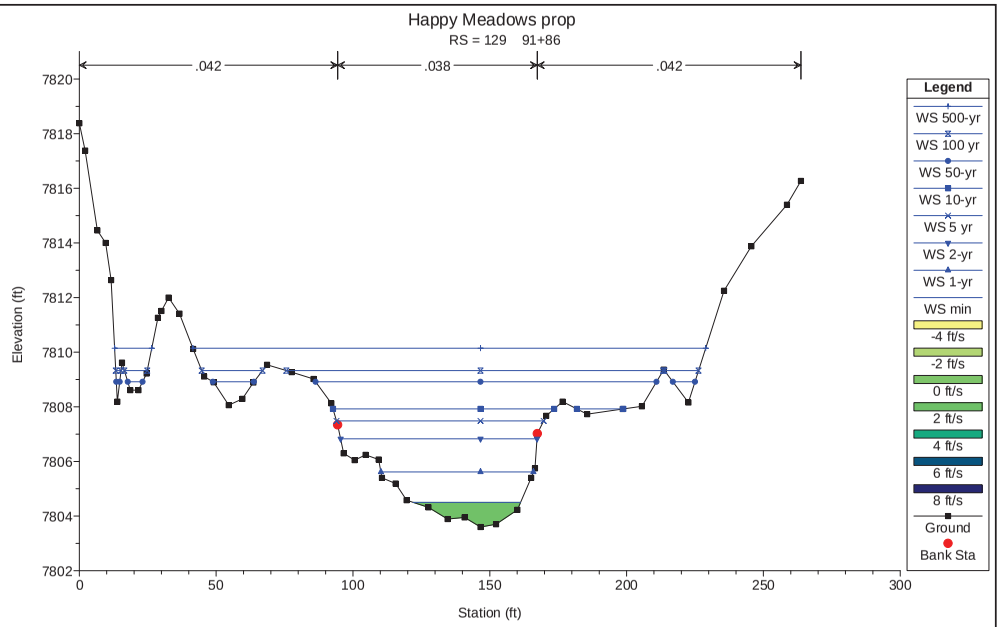

Happy Meadows prop
RS = 126 76+13
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

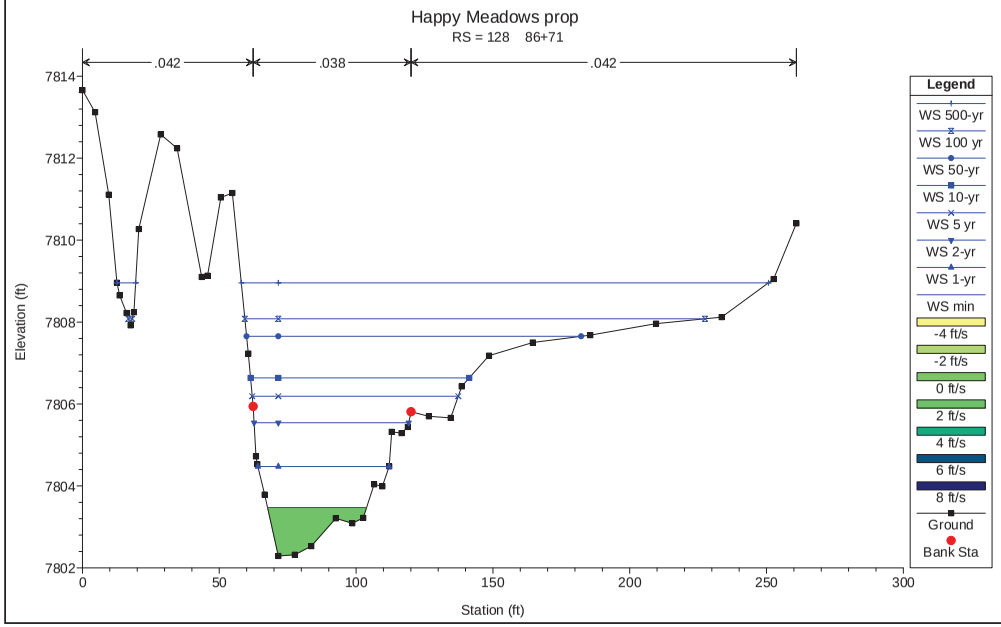

Happy Meadows prop
RS = 125 73+74
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

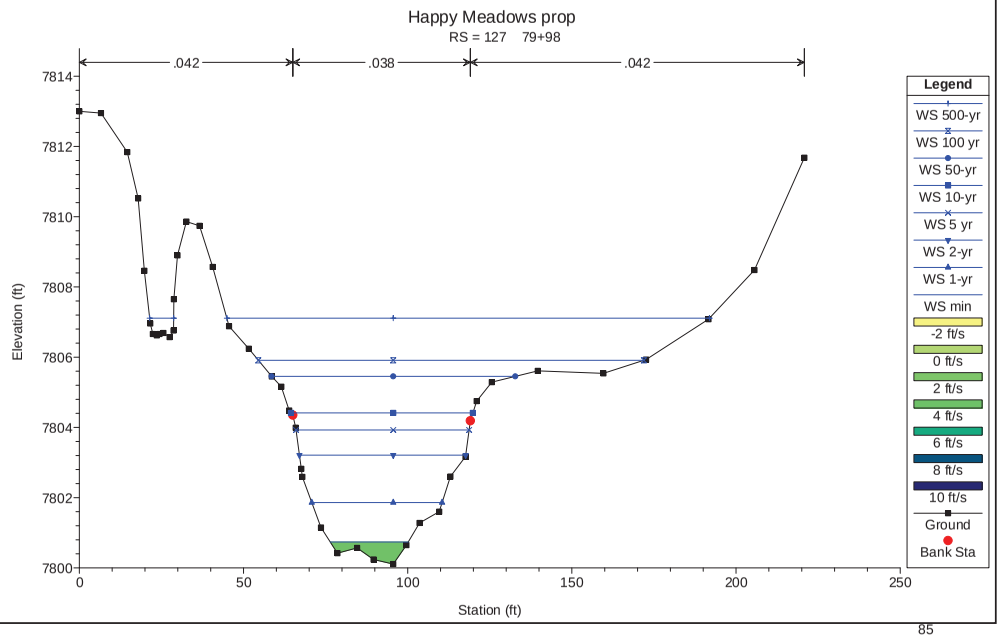

Happy Meadows prop
RS = 124 66+86
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

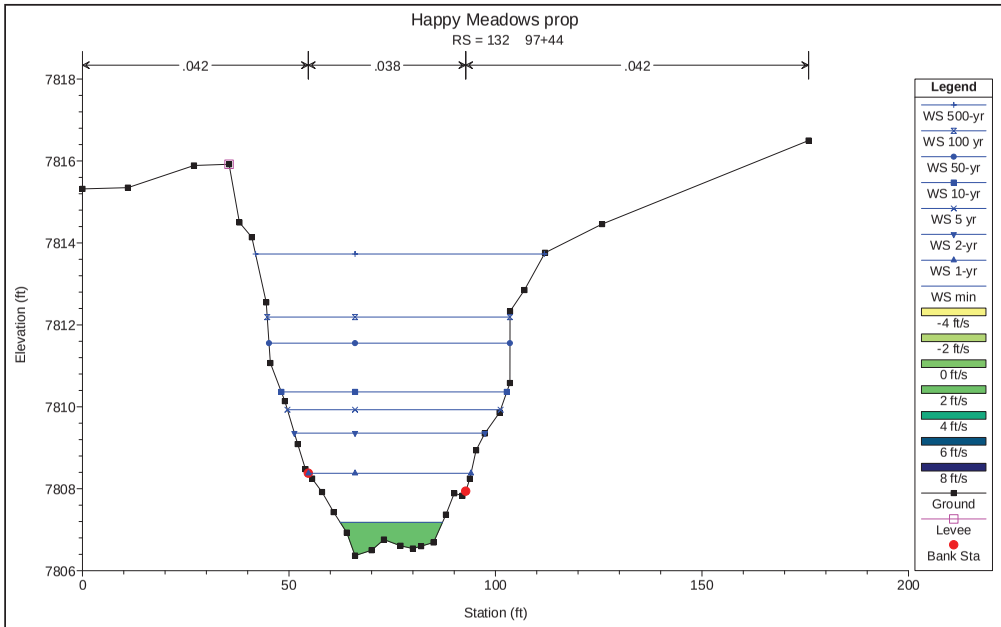

Happy Meadows prop
RS = 123 61+94
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

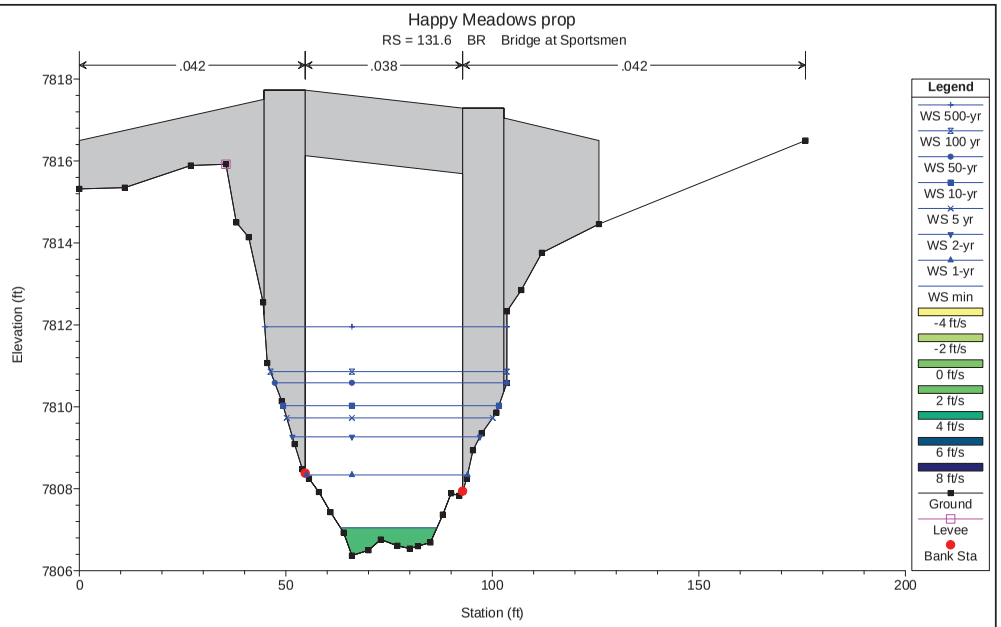

Happy Meadows prop
RS = 130 95+79
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

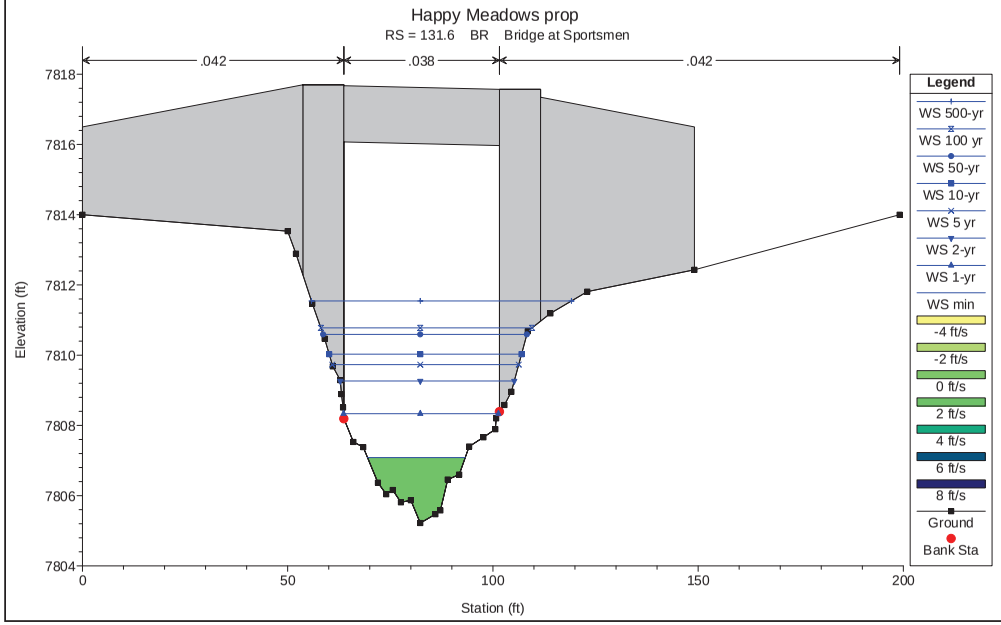

Happy Meadows prop
RS = 129 91+86
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

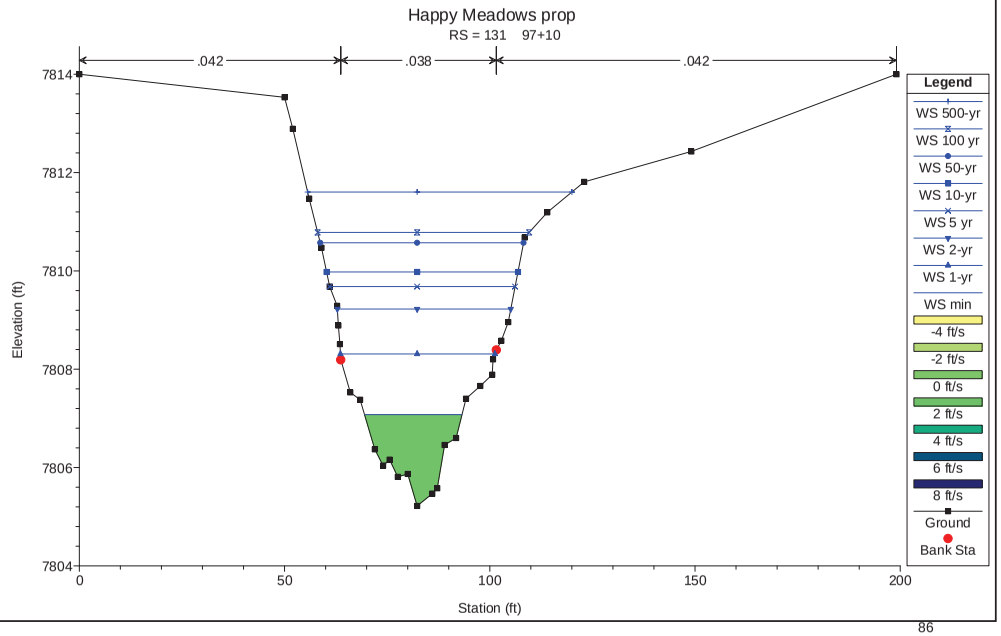

Happy Meadows prop
RS = 128 86+71
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

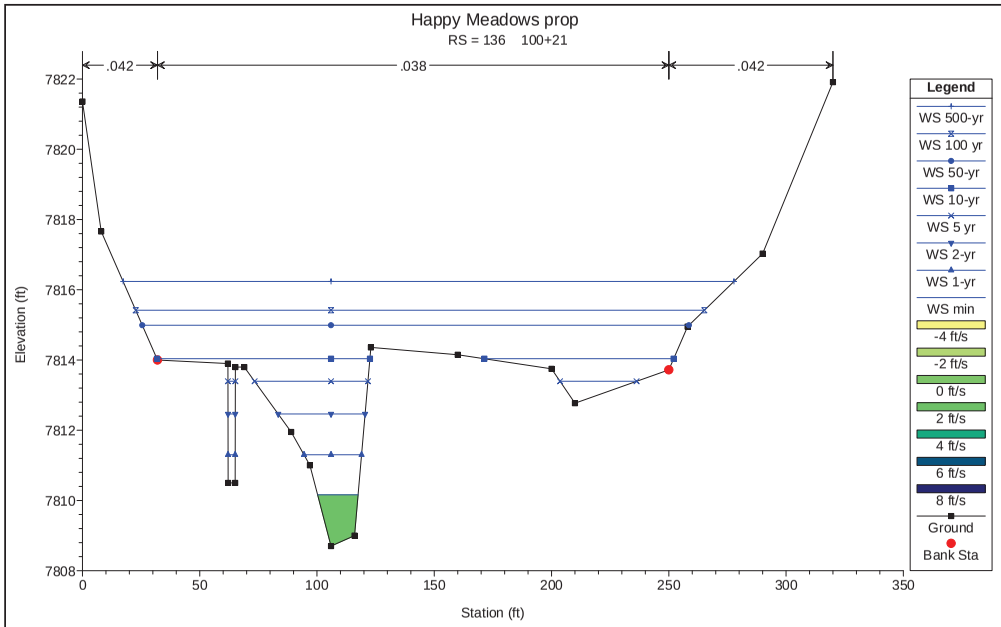

Happy Meadows prop
RS = 127 79+98
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

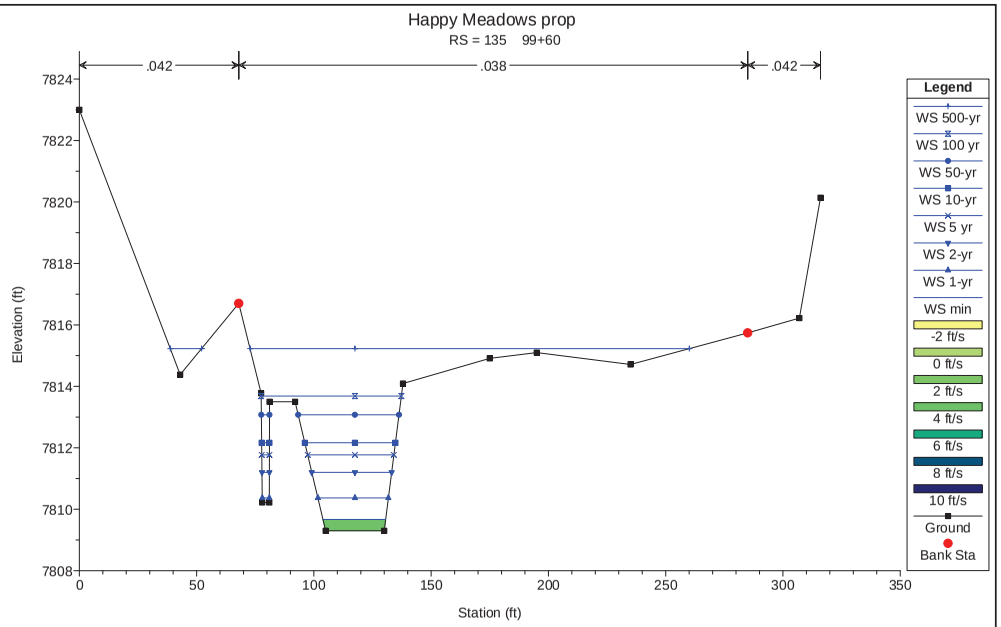

Happy Meadows prop
RS = 132 97+44
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Levee
Bank Sta

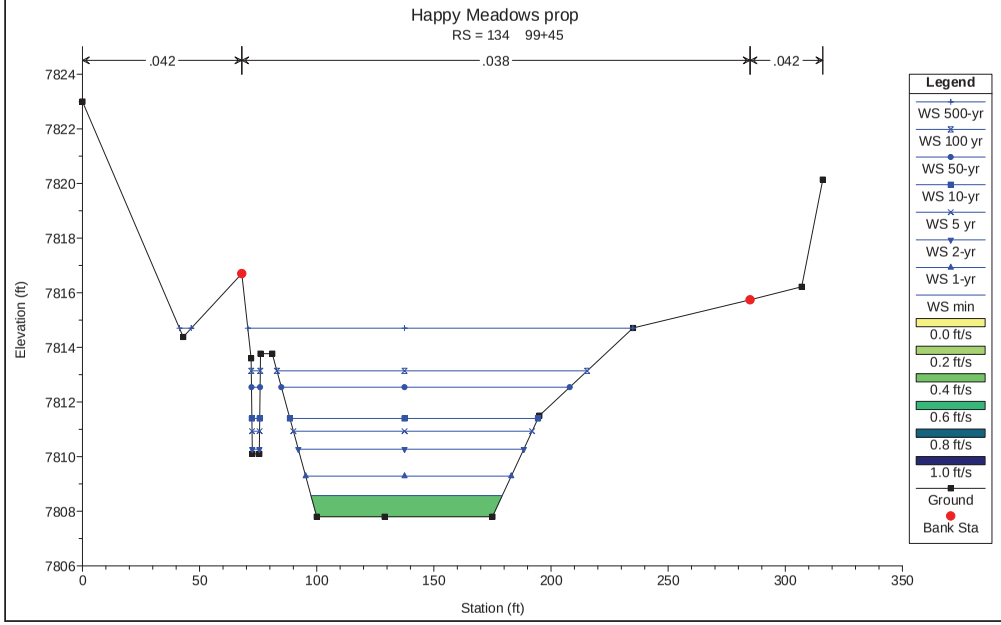

Happy Meadows prop
RS = 131.6 BR Bridge at Sportsmen
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Levee
Bank Sta

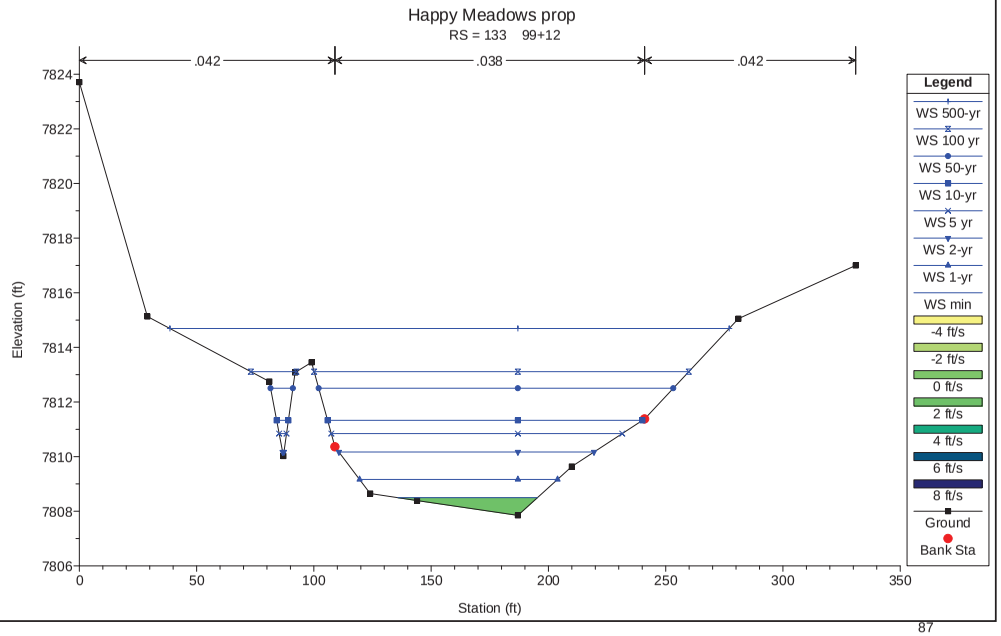

Happy Meadows prop
RS = 131.6 BR Bridge at Sportsmen
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

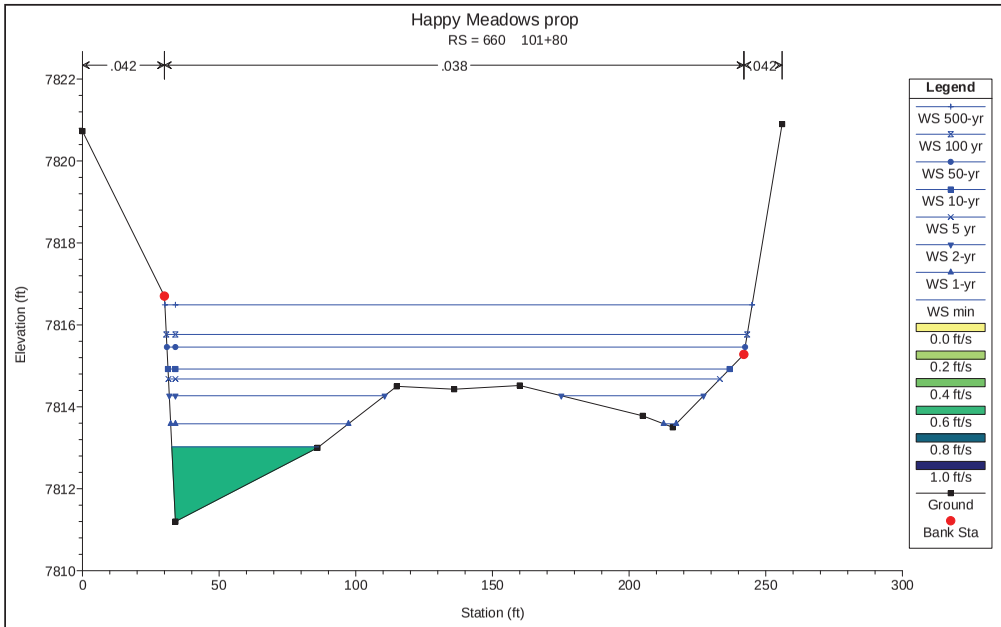

Happy Meadows prop
RS = 131 97+10
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

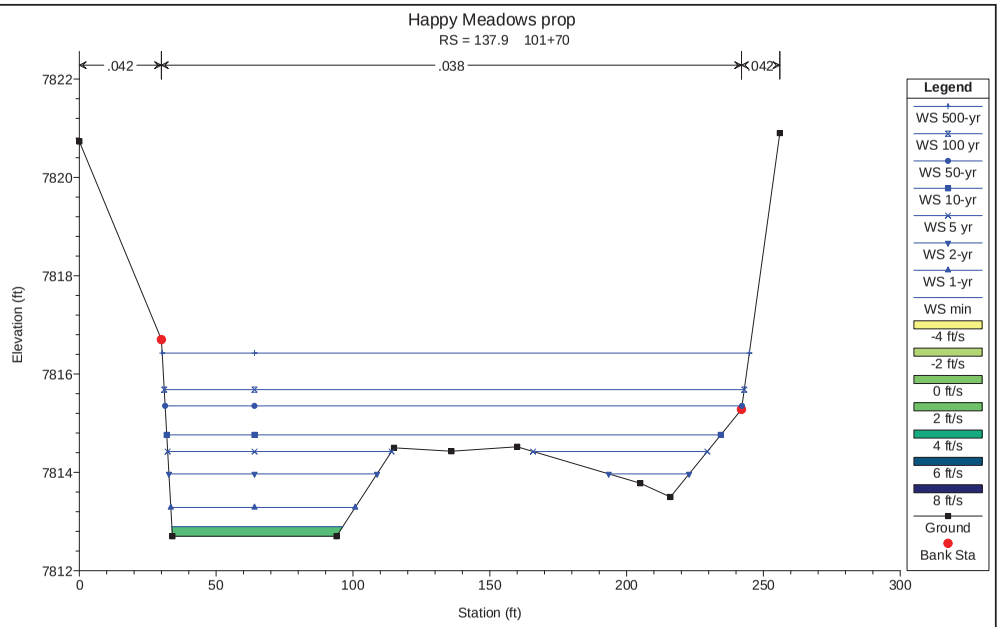

Happy Meadows prop
RS = 136 100+21
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

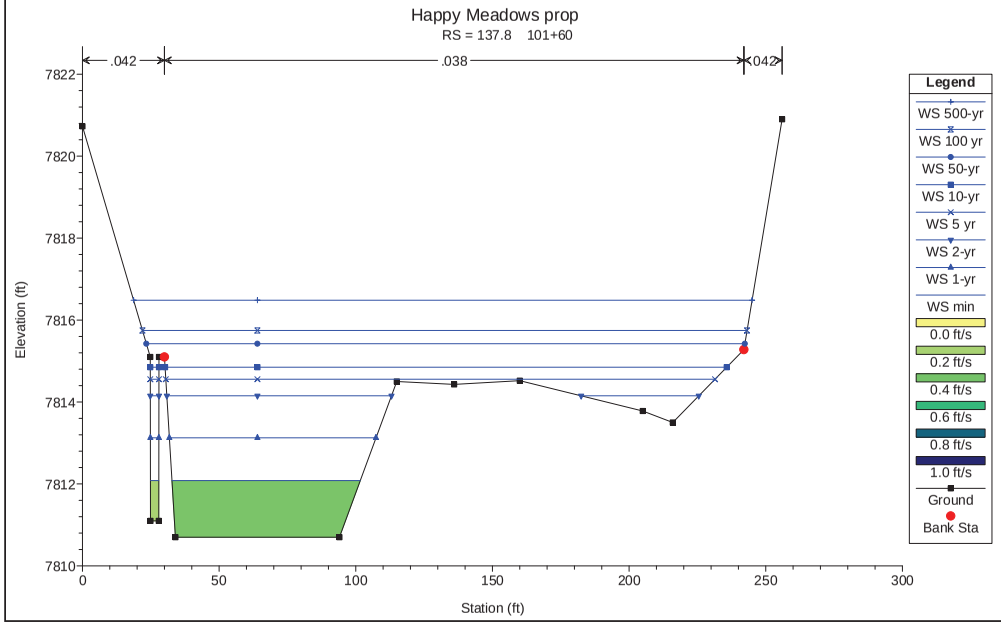

Happy Meadows prop
RS = 135 99+60
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

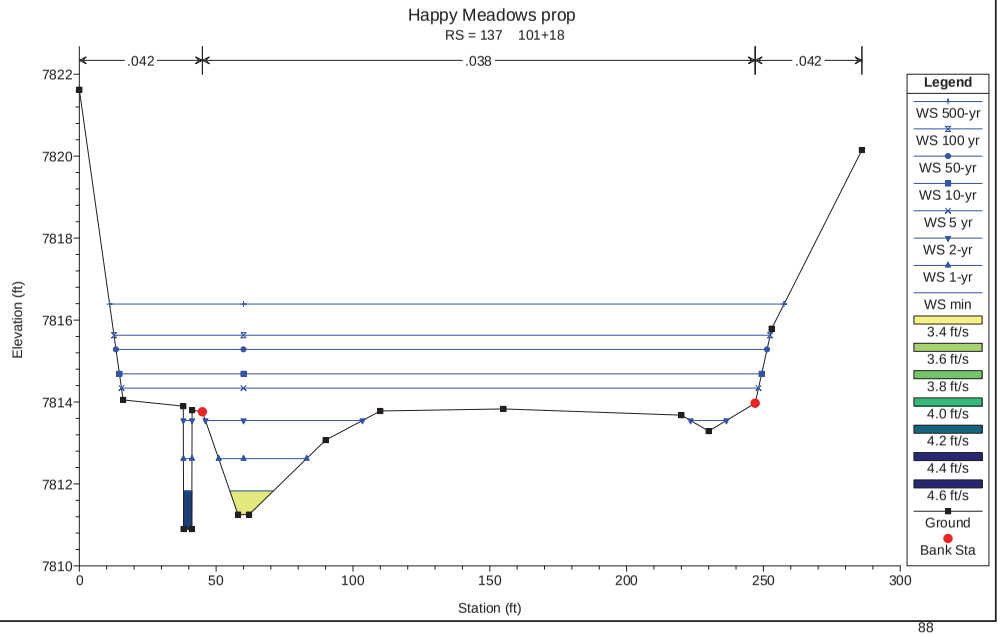

Happy Meadows prop
RS = 134 99+45
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

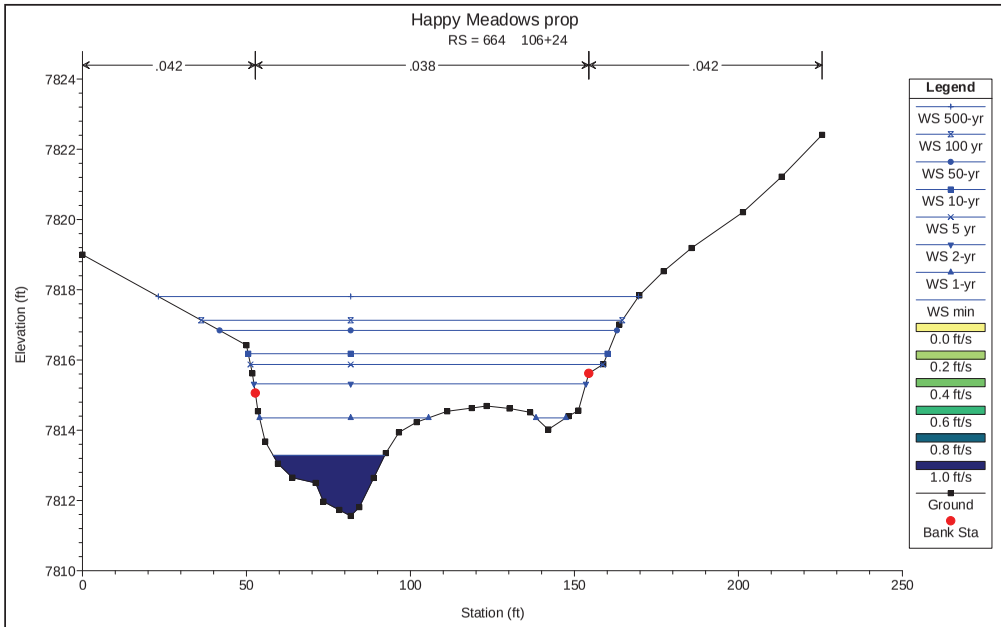

Happy Meadows prop
RS = 133 99+12
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

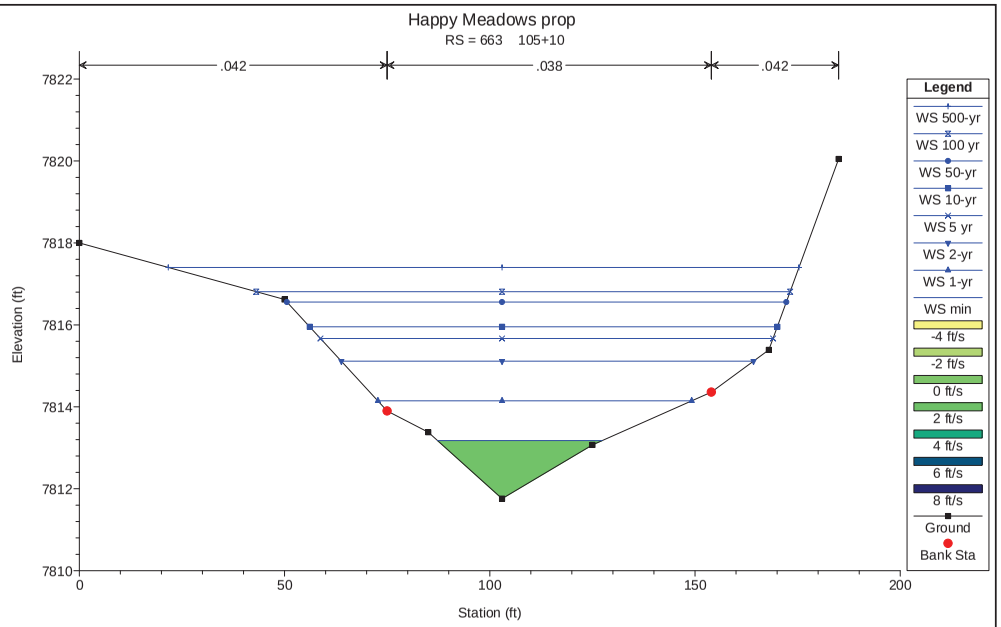

Happy Meadows prop
RS = 660 101+80
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

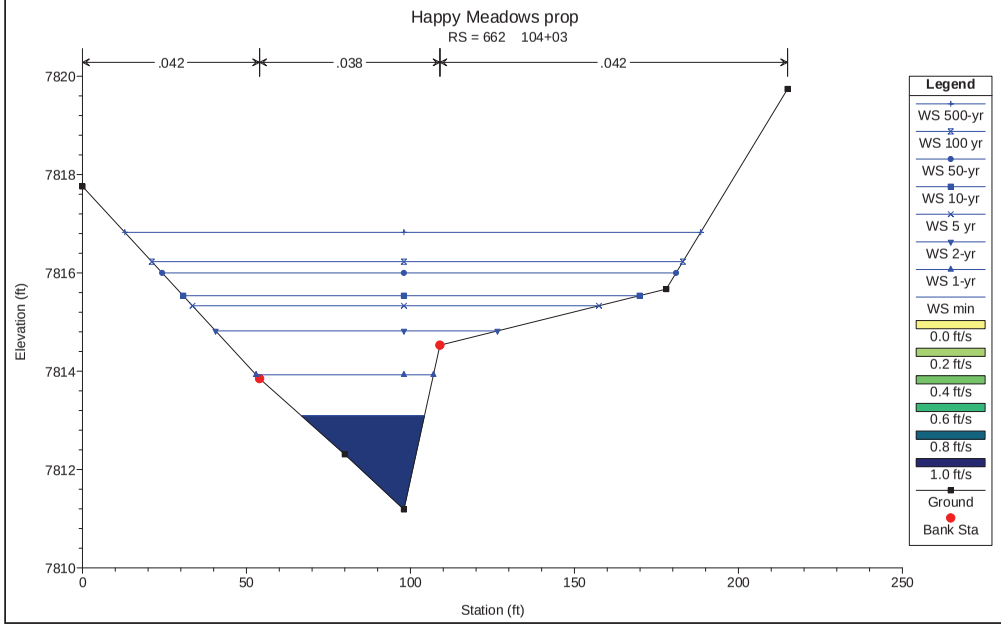

Happy Meadows prop
RS = 137.9 101+70
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

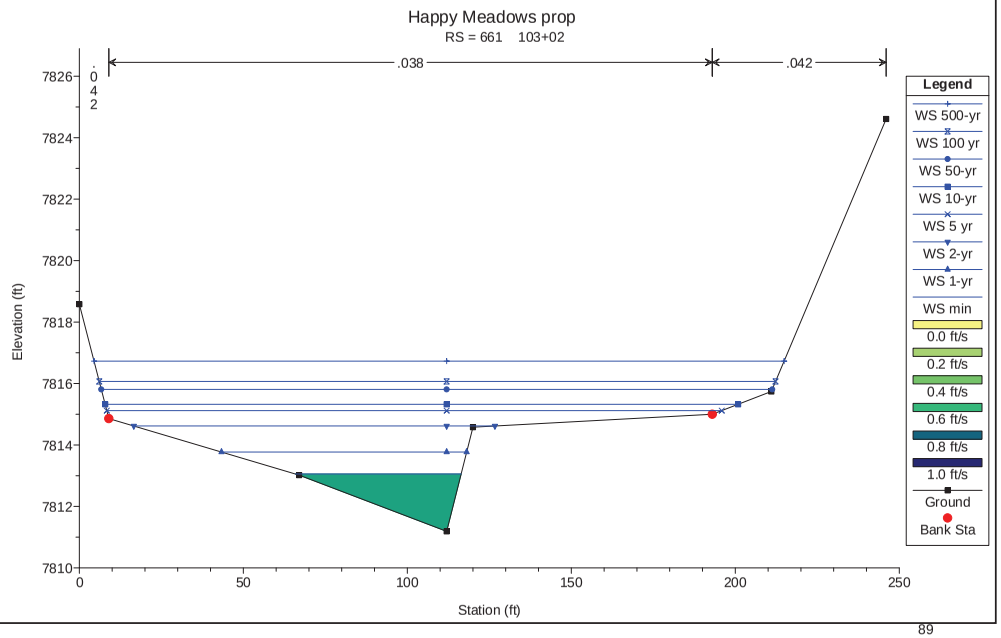

Happy Meadows prop
RS = 137.8 101+60
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

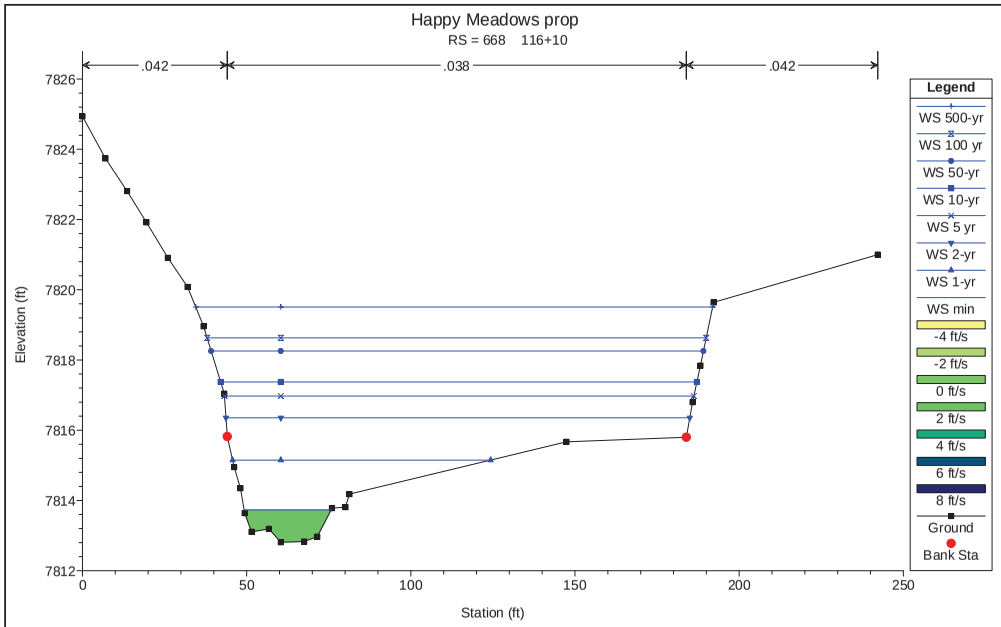

Happy Meadows prop
RS = 137 101+18
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
3.4 ft/s
3.6 ft/s
3.8 ft/s
4.0 ft/s
4.2 ft/s
4.4 ft/s
4.6 ft/s
Ground
Bank Sta

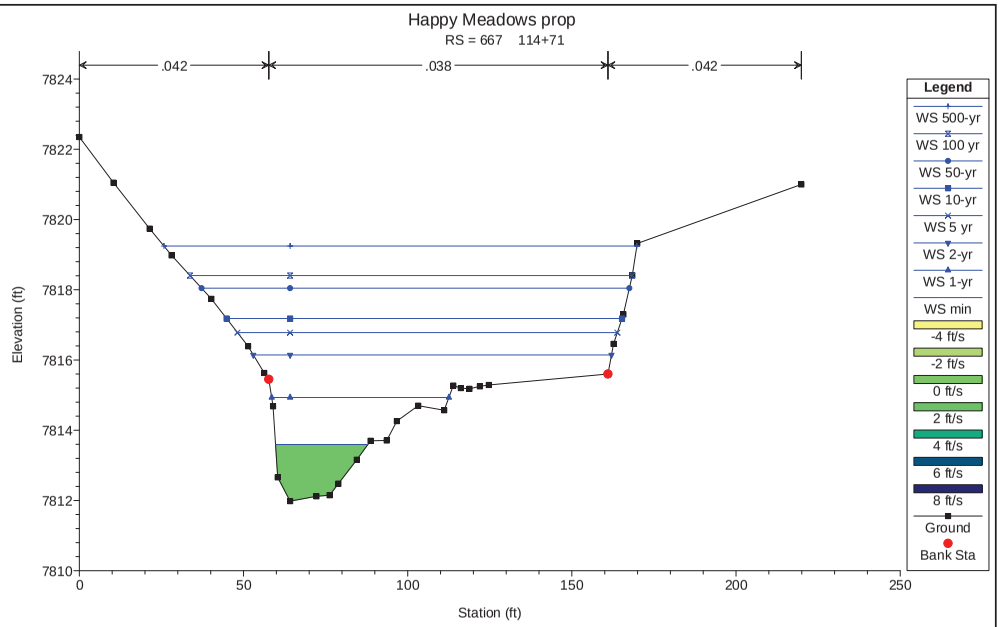

Happy Meadows prop
RS = 664 106+24
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

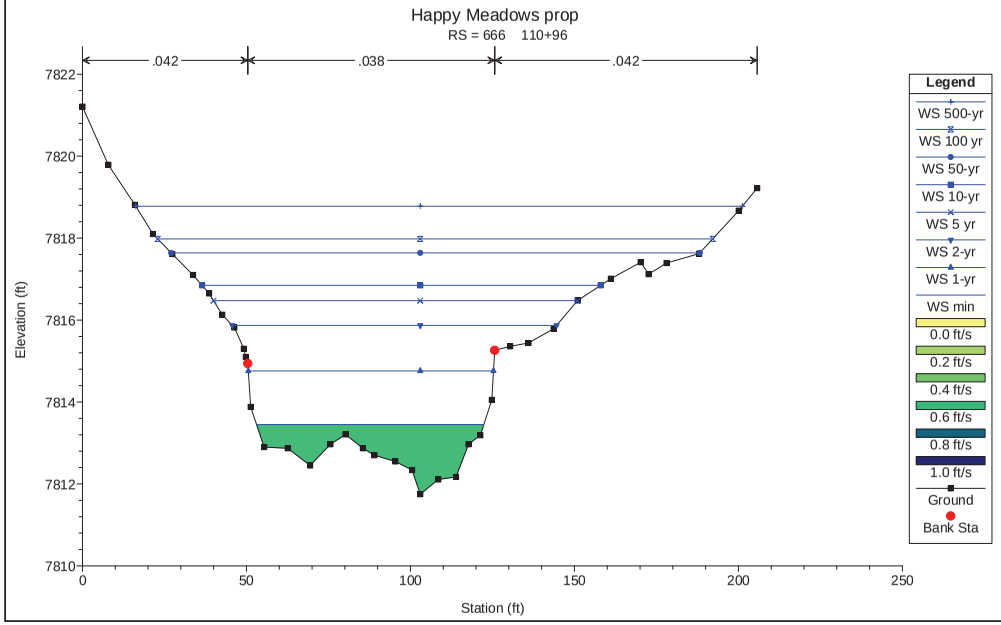

Happy Meadows prop
RS = 663 105+10
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

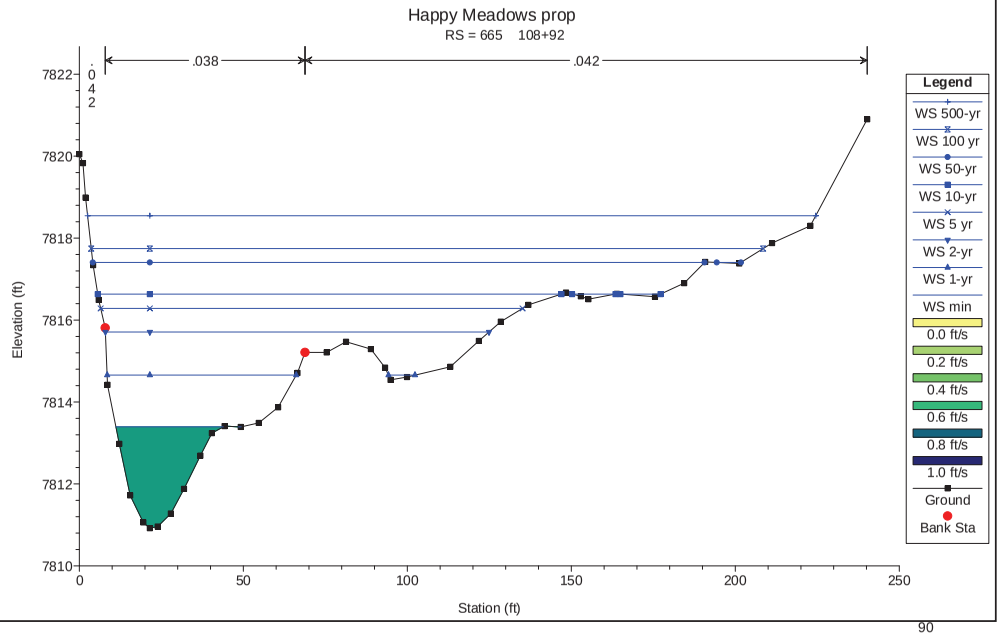

Happy Meadows prop
RS = 662 104+03
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

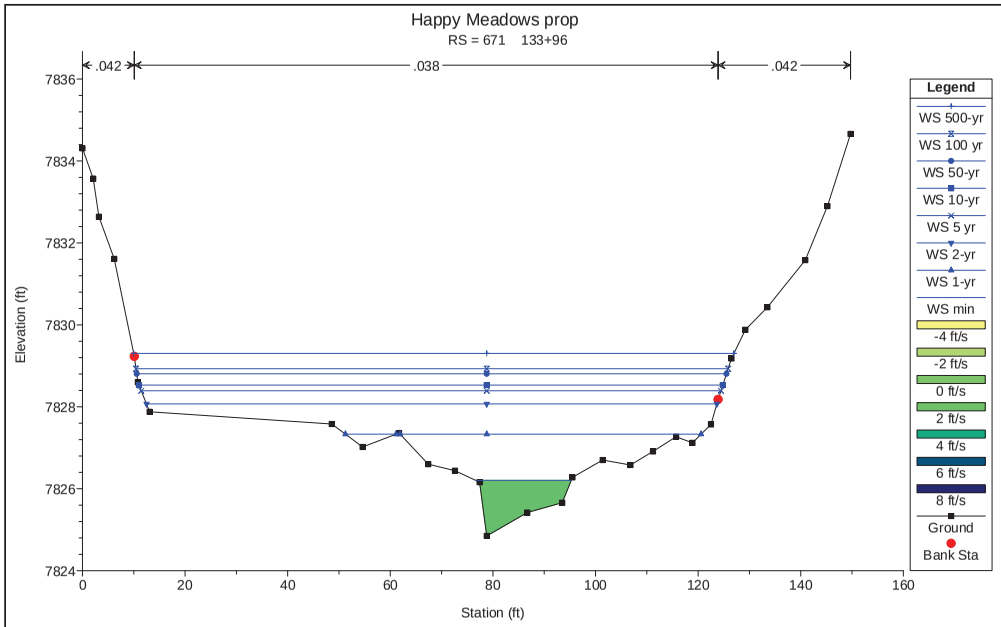

Happy Meadows prop
RS = 661 103+02
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

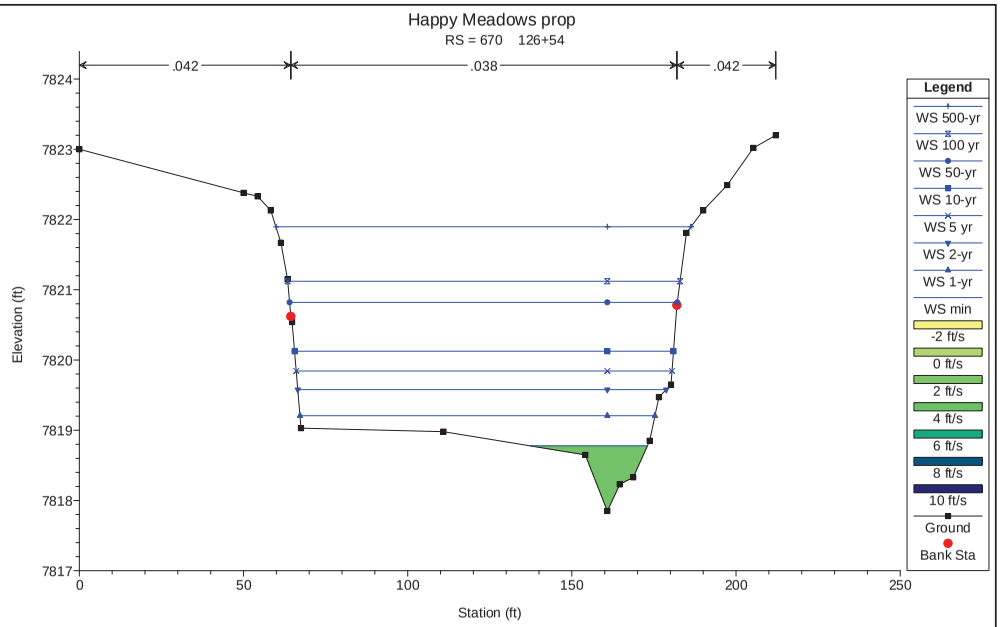

Happy Meadows prop
RS = 668 116+10
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

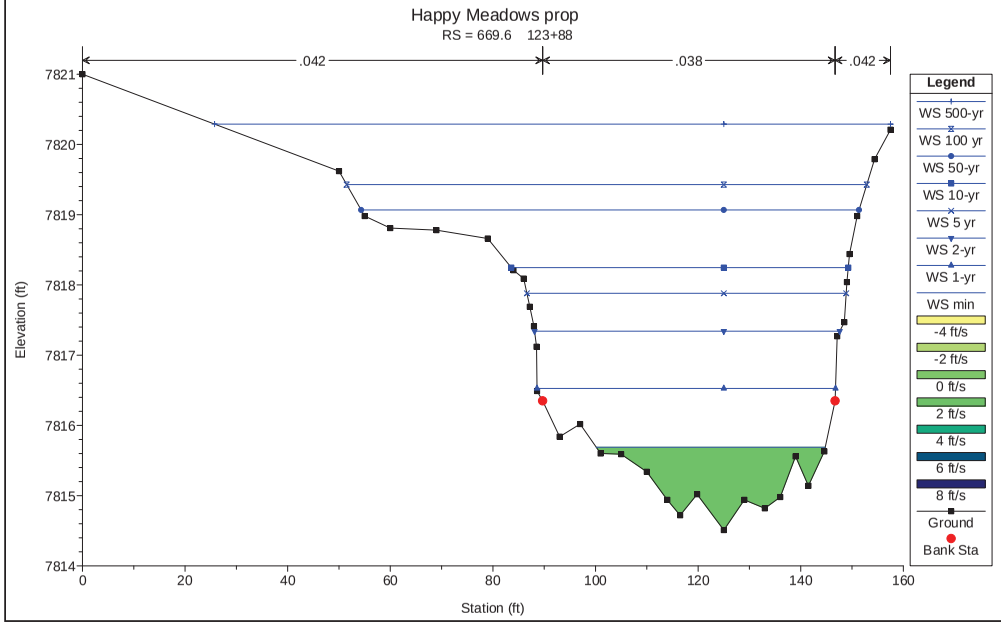

Happy Meadows prop
RS = 667 114+71
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

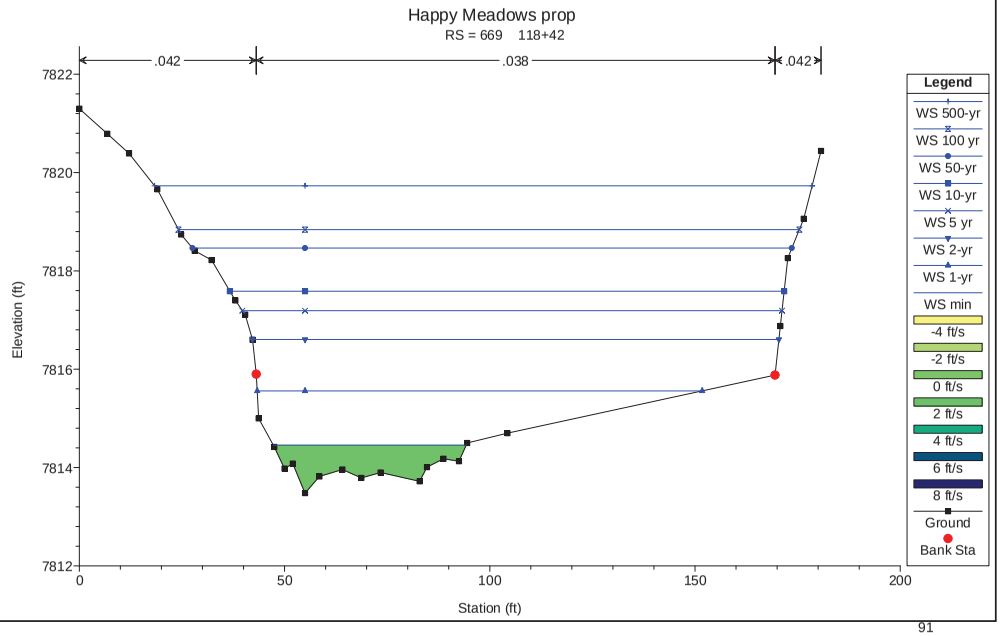

Happy Meadows prop
RS = 666 110+96
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

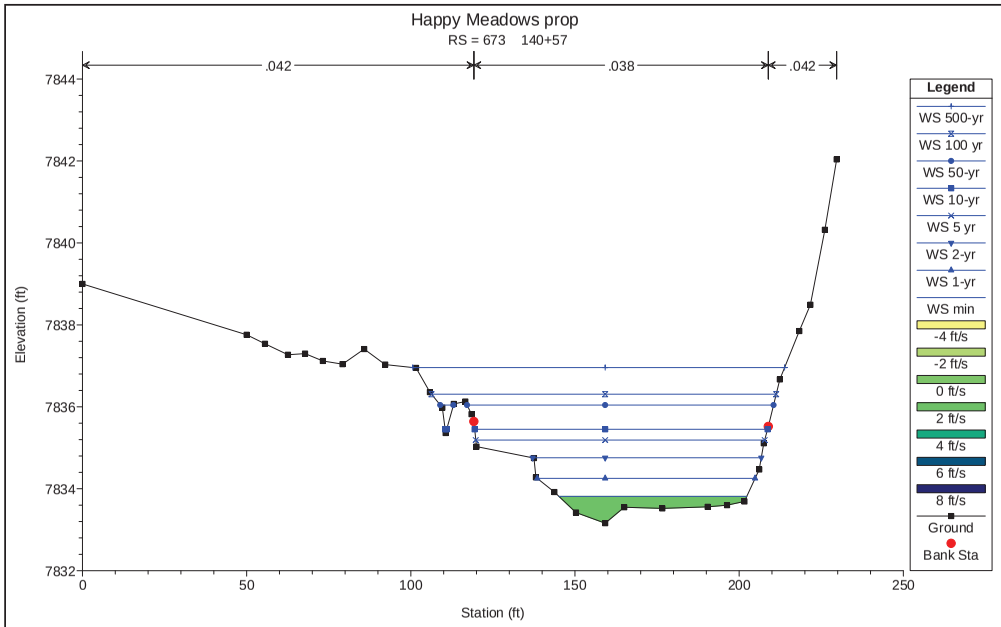

Happy Meadows prop
RS = 665 108+92
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

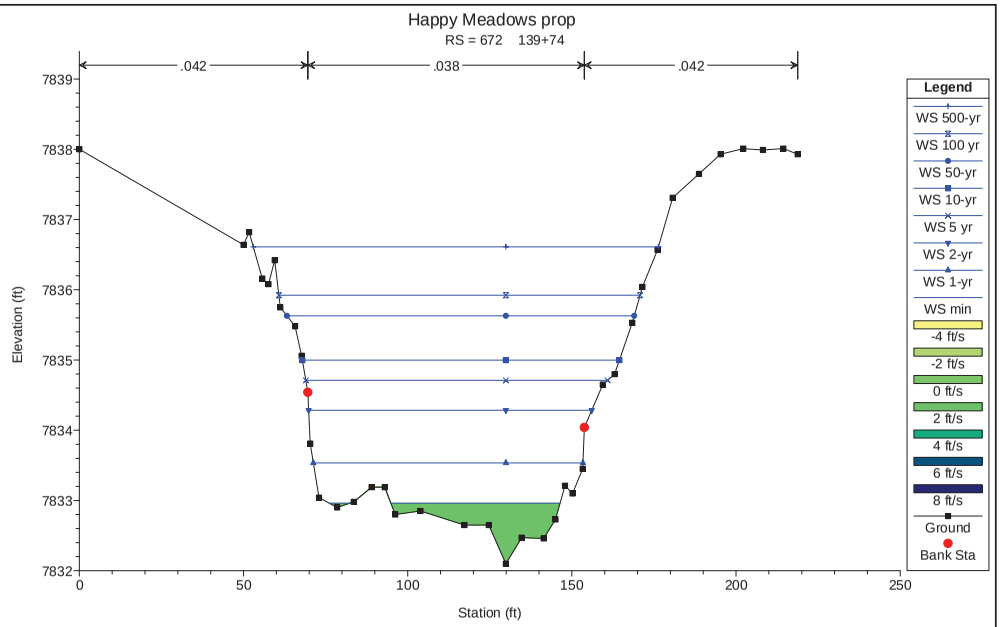

Happy Meadows prop
RS = 671 133+96
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

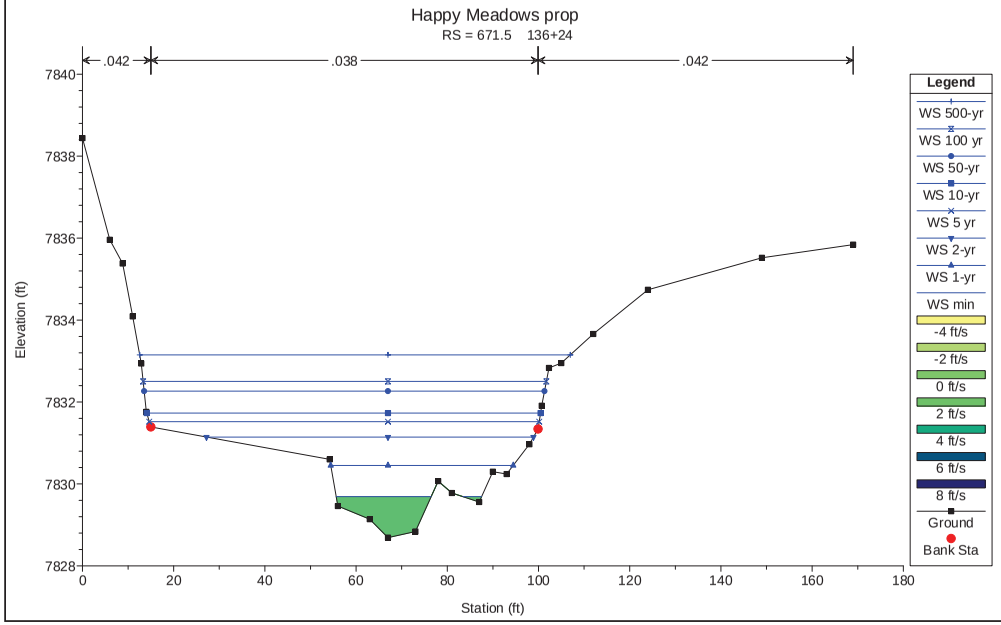

Happy Meadows prop
RS = 670 126+54
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

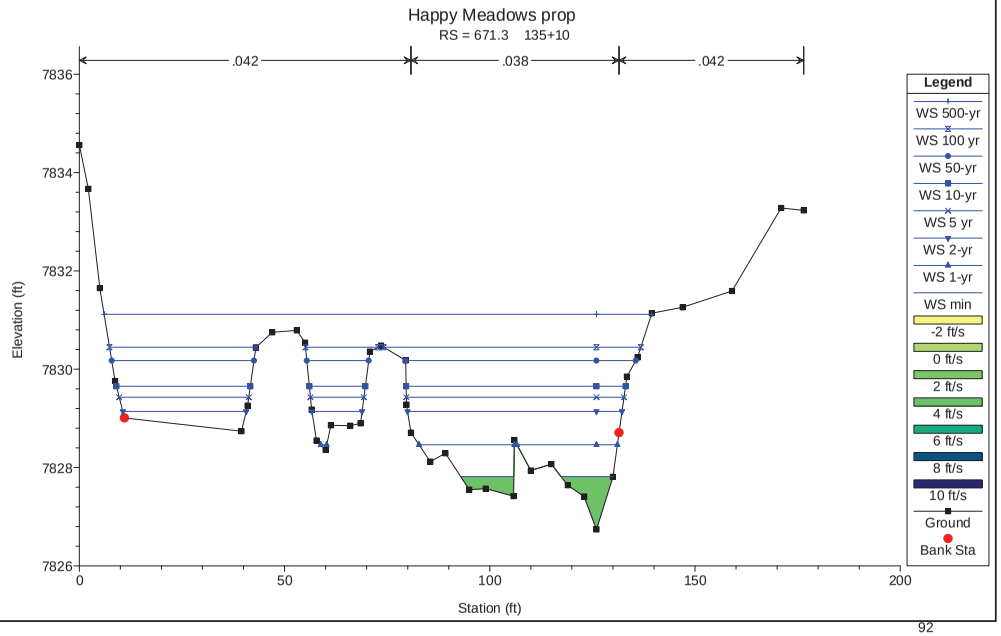

Happy Meadows prop
RS = 669.6 123+88
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

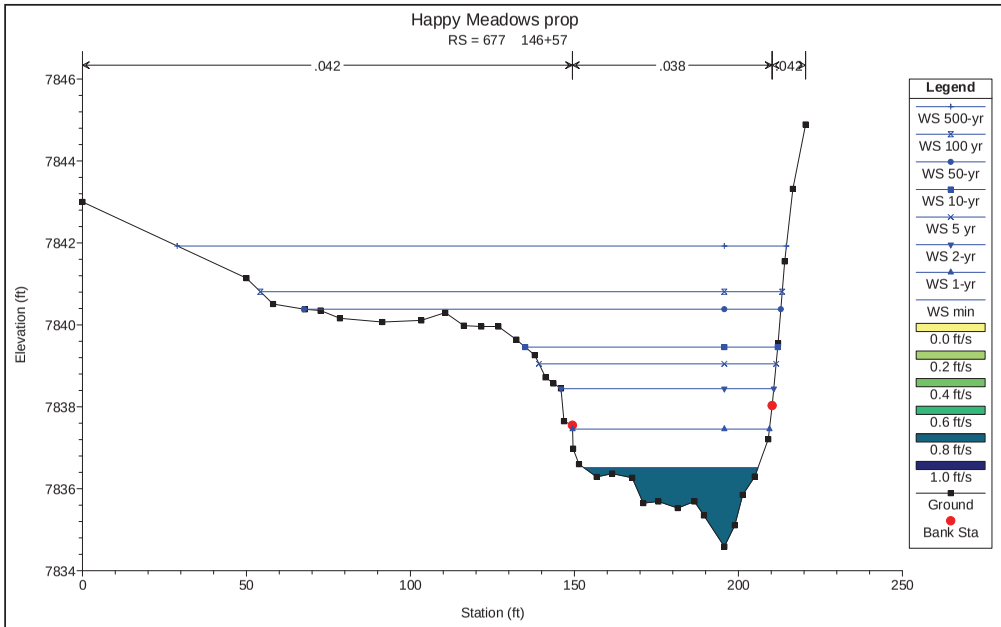

Happy Meadows prop
RS = 669 118+42
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

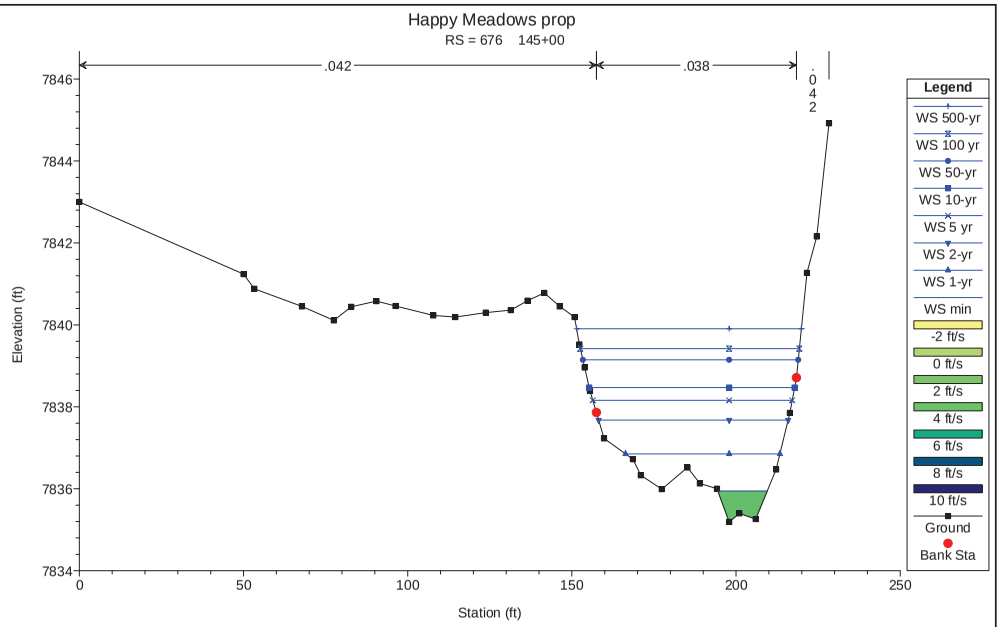

Happy Meadows prop
RS = 673 140+57
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

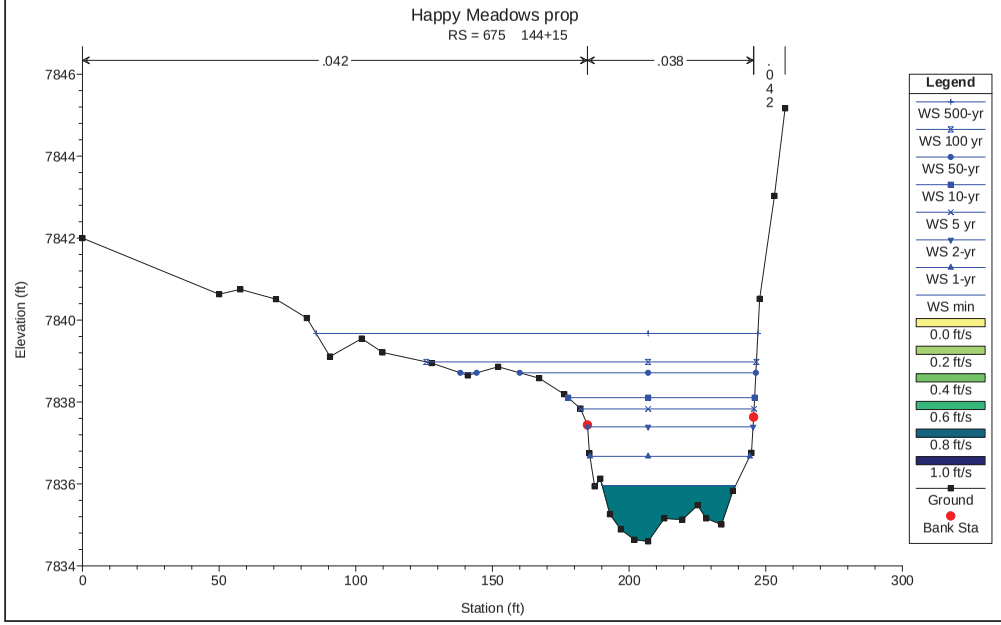

Happy Meadows prop
RS = 672 139+74
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

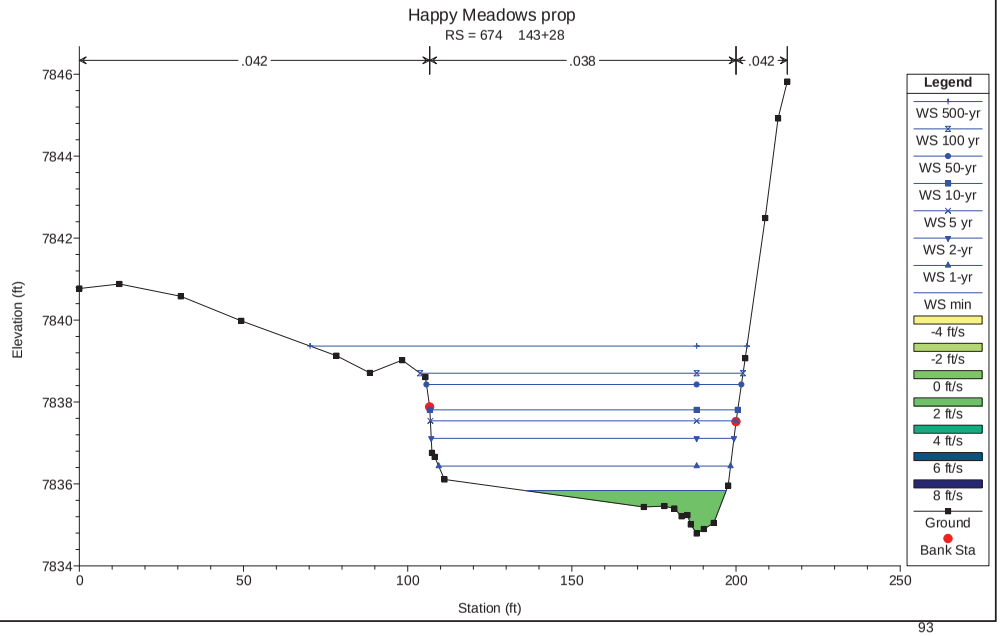

Happy Meadows prop
RS = 671.5 136+24
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

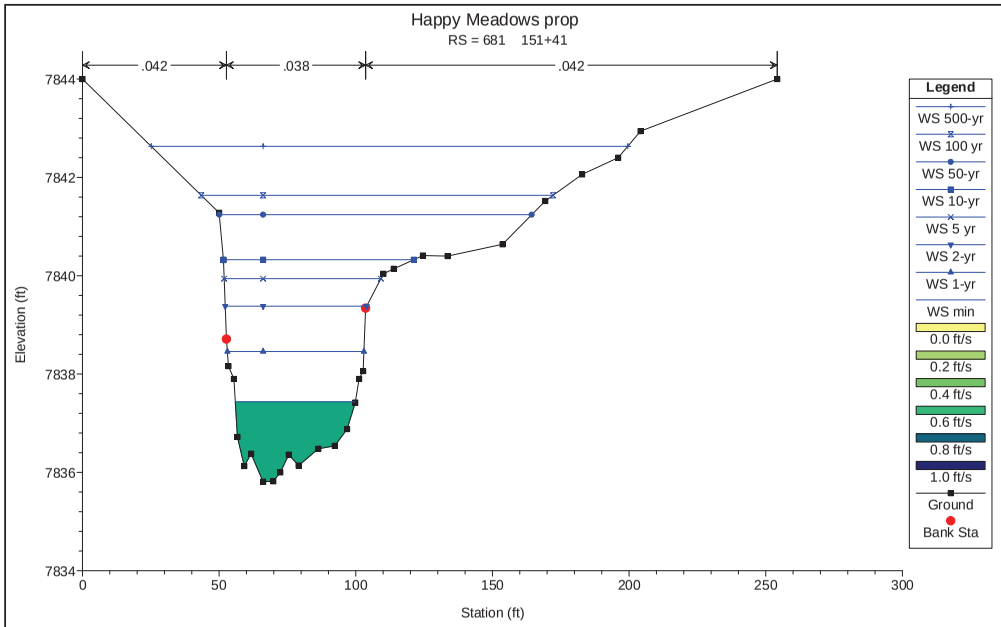

Happy Meadows prop
RS = 671.3 135+10
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

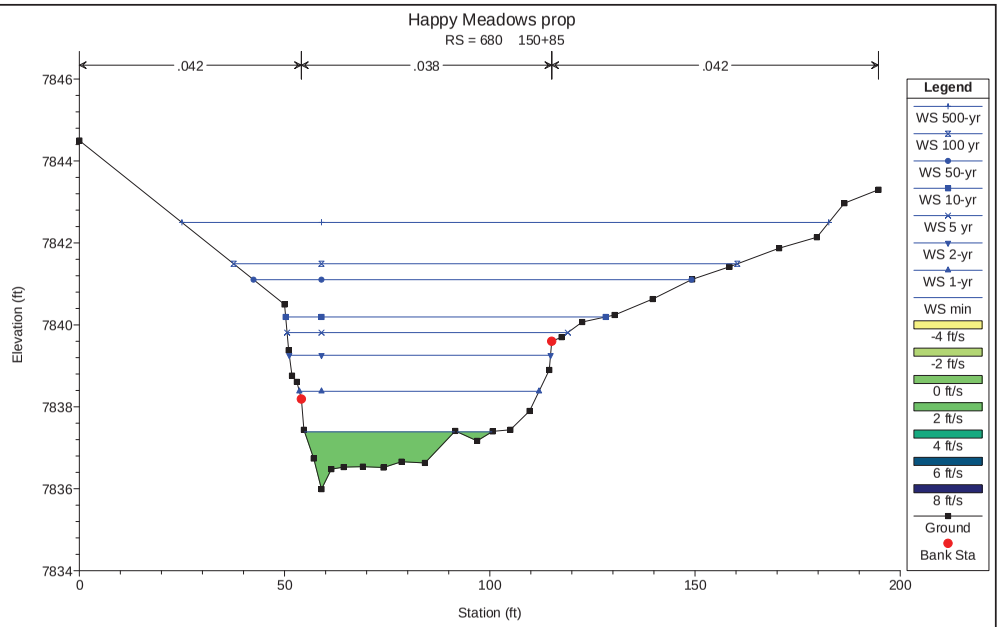

Happy Meadows prop
RS = 677 146+57
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

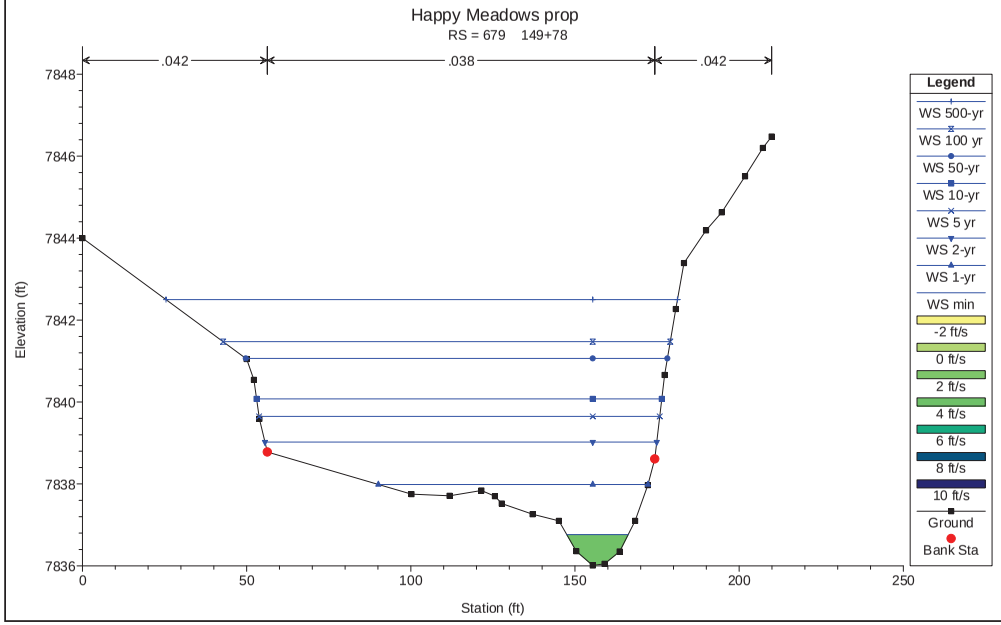

Happy Meadows prop
RS = 676 145+00
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

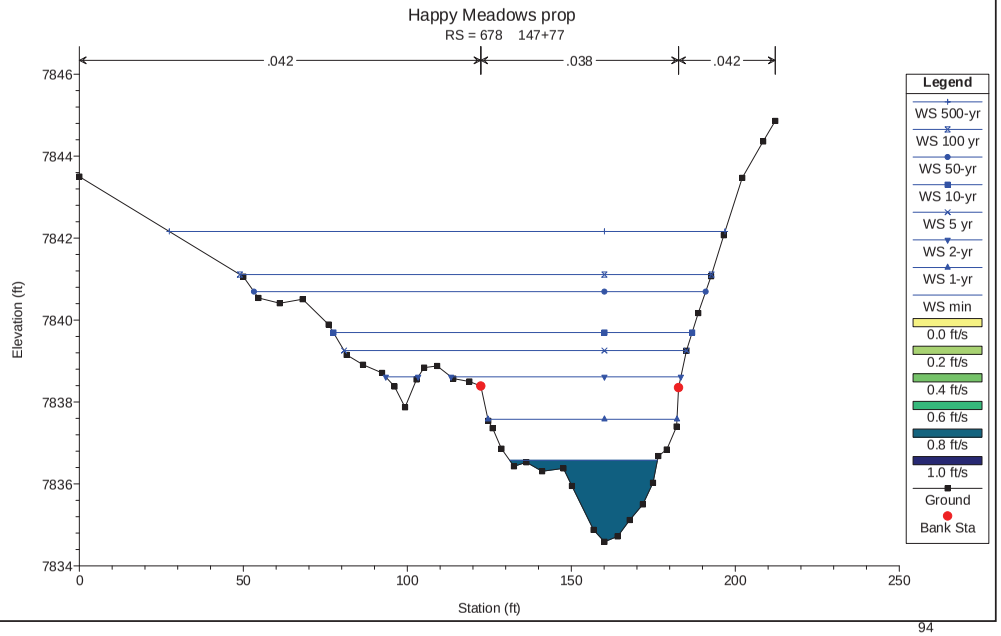

Happy Meadows prop
RS = 675 144+15
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

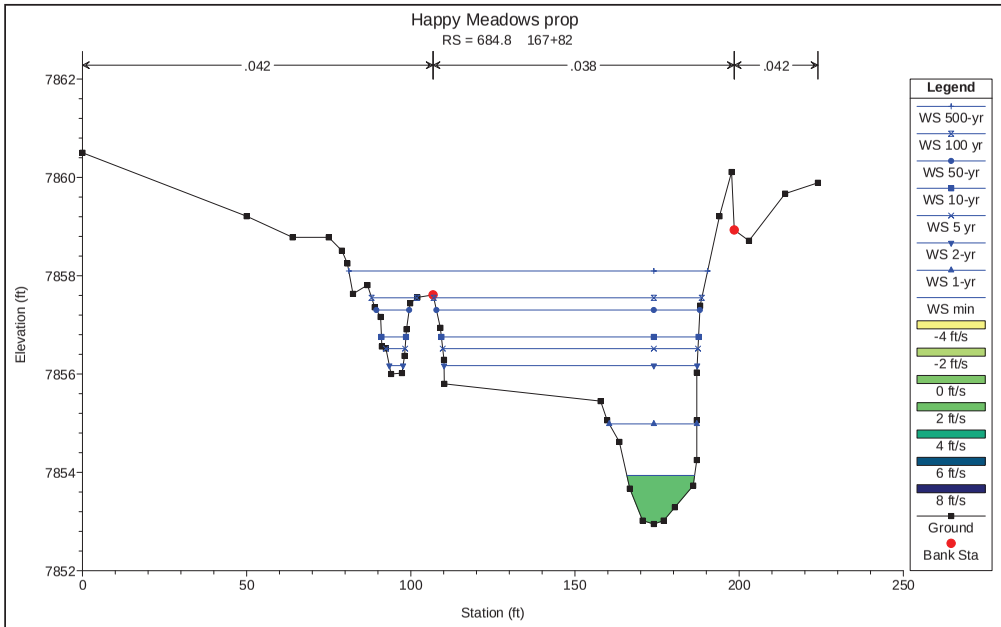

Happy Meadows prop
RS = 674 143+28
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

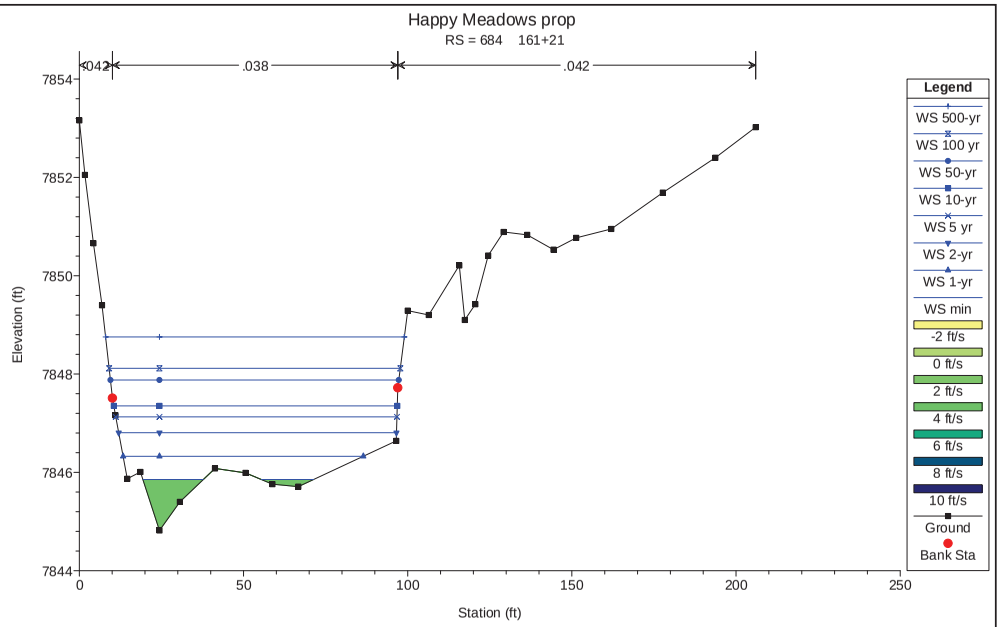

Happy Meadows prop
RS = 681 151+41
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

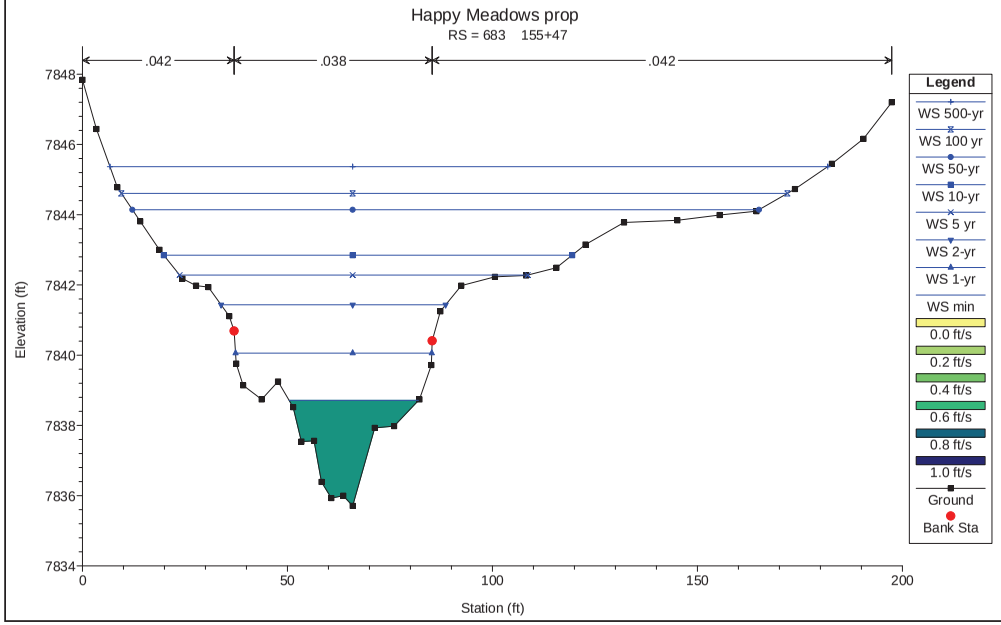

Happy Meadows prop
RS = 680 150+85
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

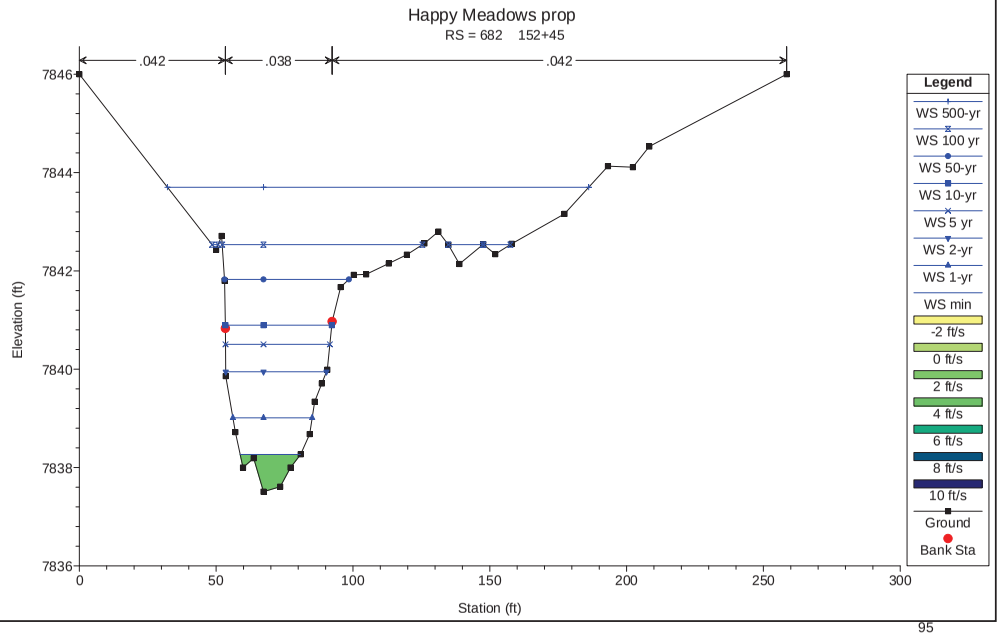

Happy Meadows prop
RS = 679 149+78
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

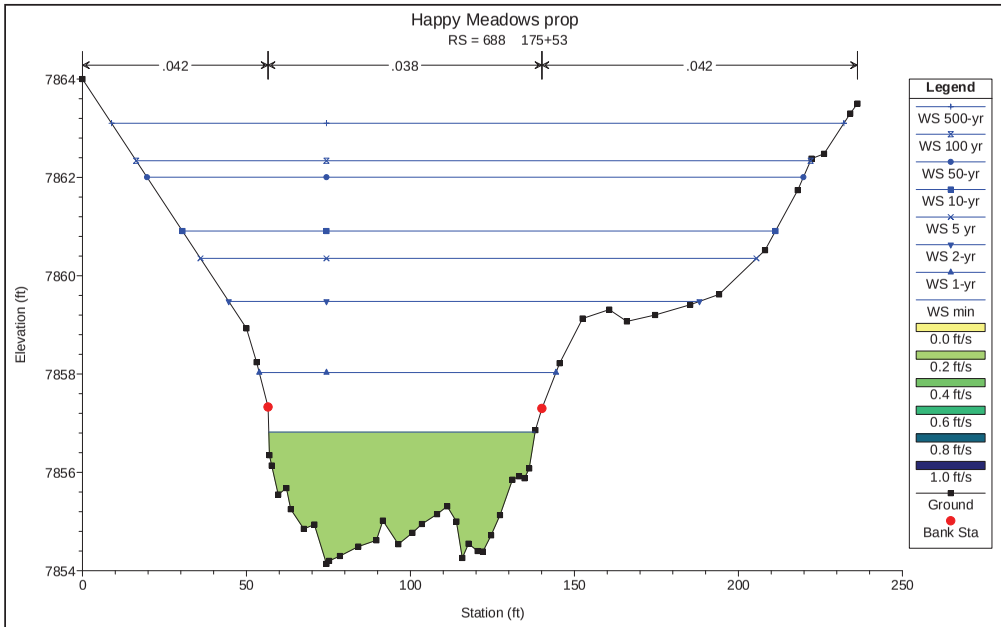

Happy Meadows prop
RS = 678 147+77
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

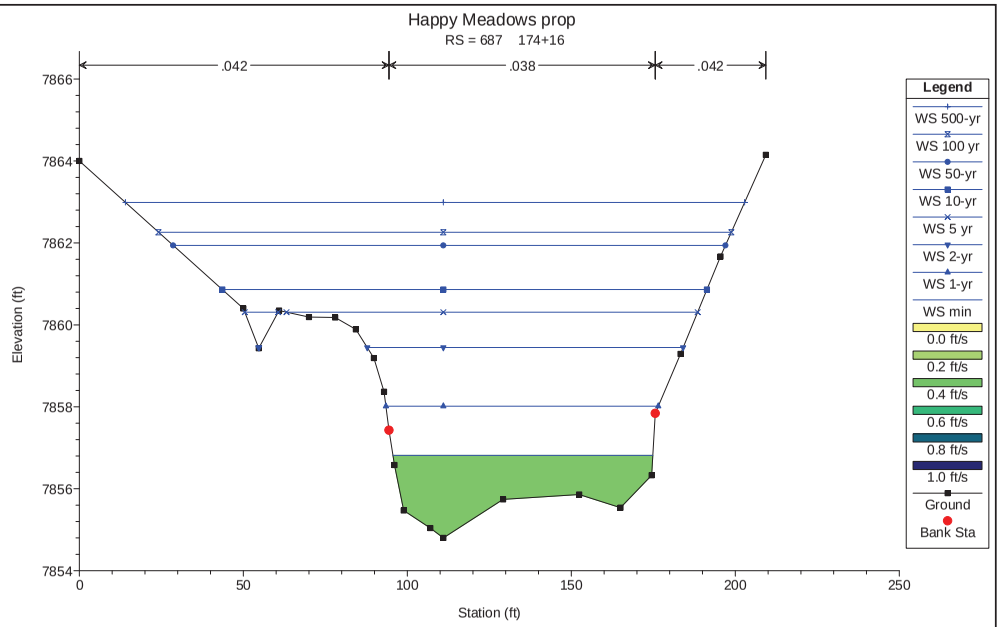

Happy Meadows prop
RS = 684.8 167+82
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

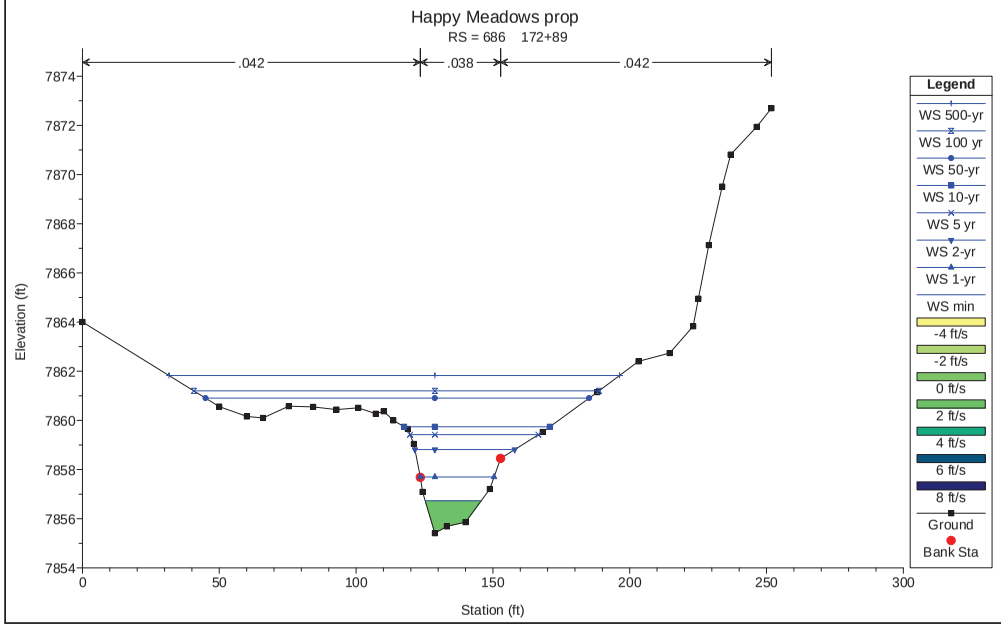

Happy Meadows prop
RS = 684 161+21
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

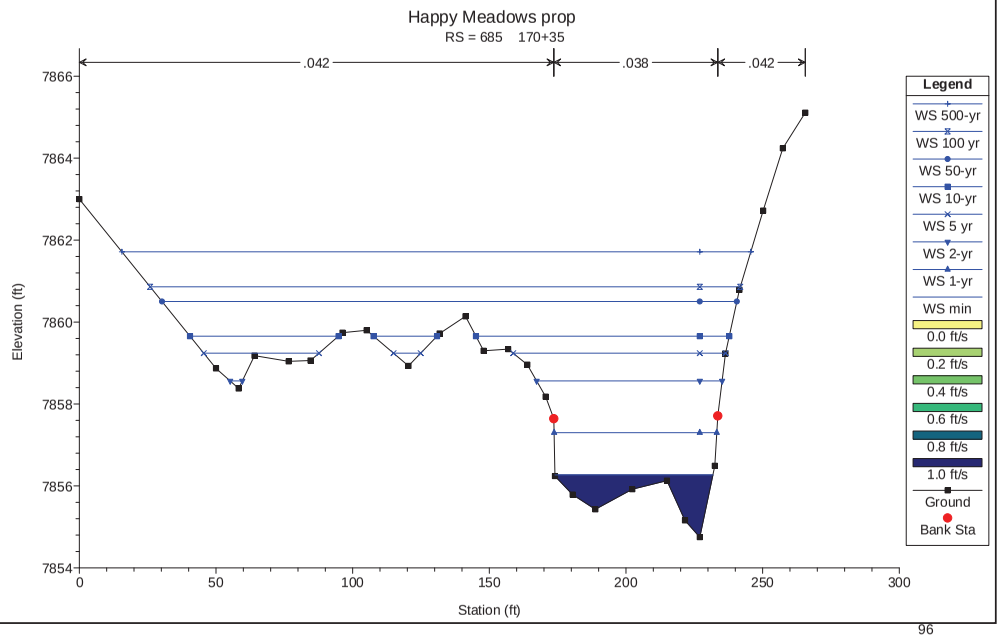

Happy Meadows prop
RS = 683 155+47
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

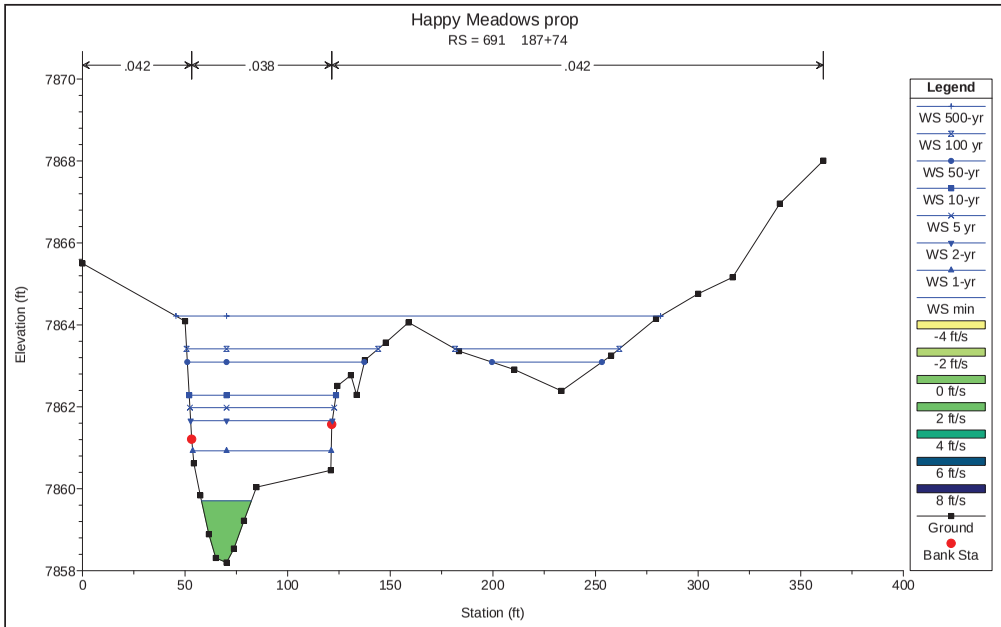

Happy Meadows prop
RS = 682 152+45
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

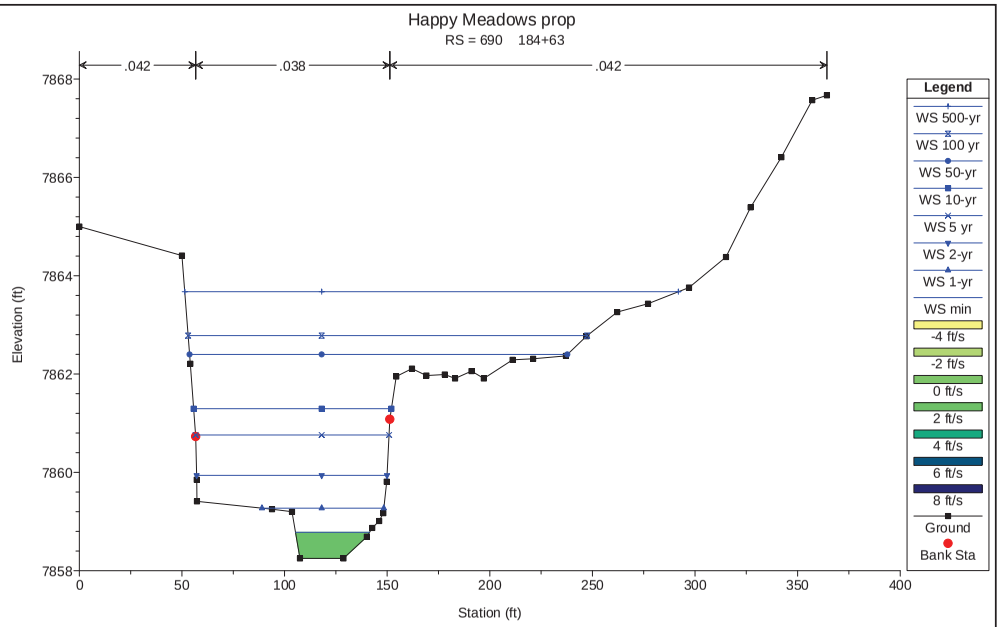

Happy Meadows prop
RS = 688 175+53
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

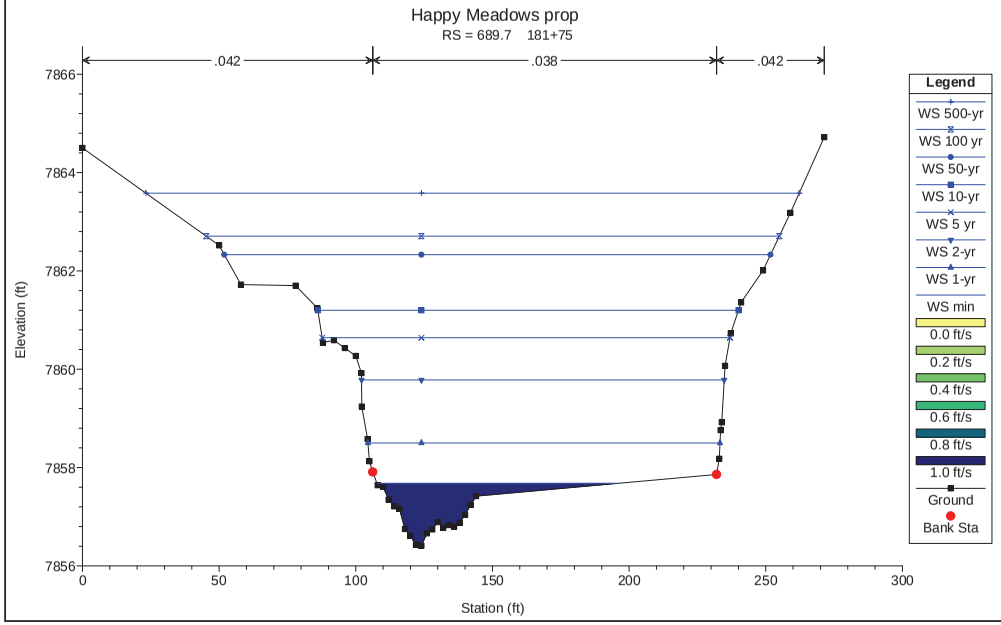

Happy Meadows prop
RS = 687 174+16
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

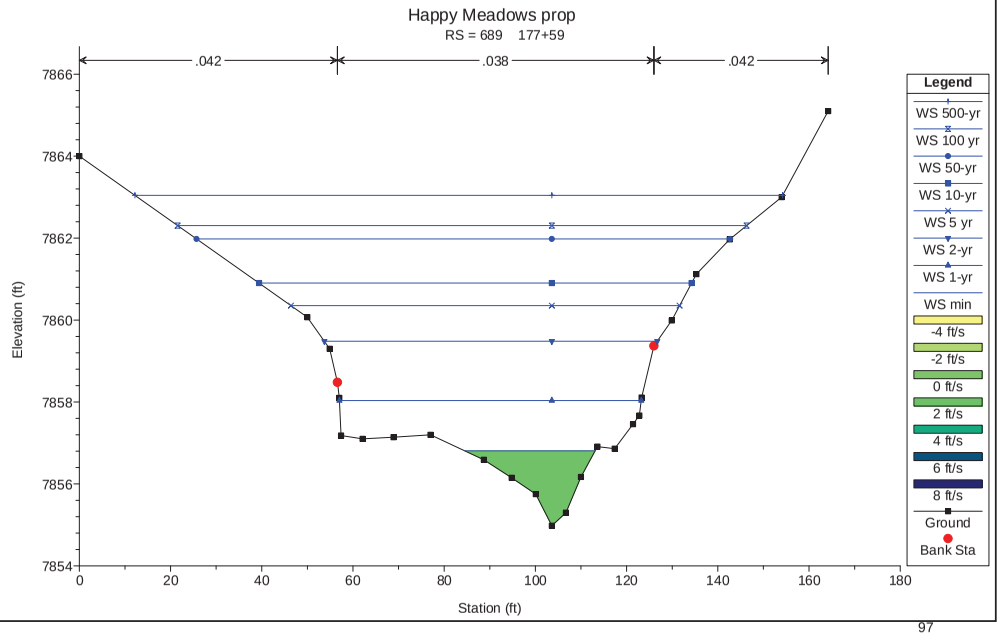

Happy Meadows prop
RS = 686 172+89
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

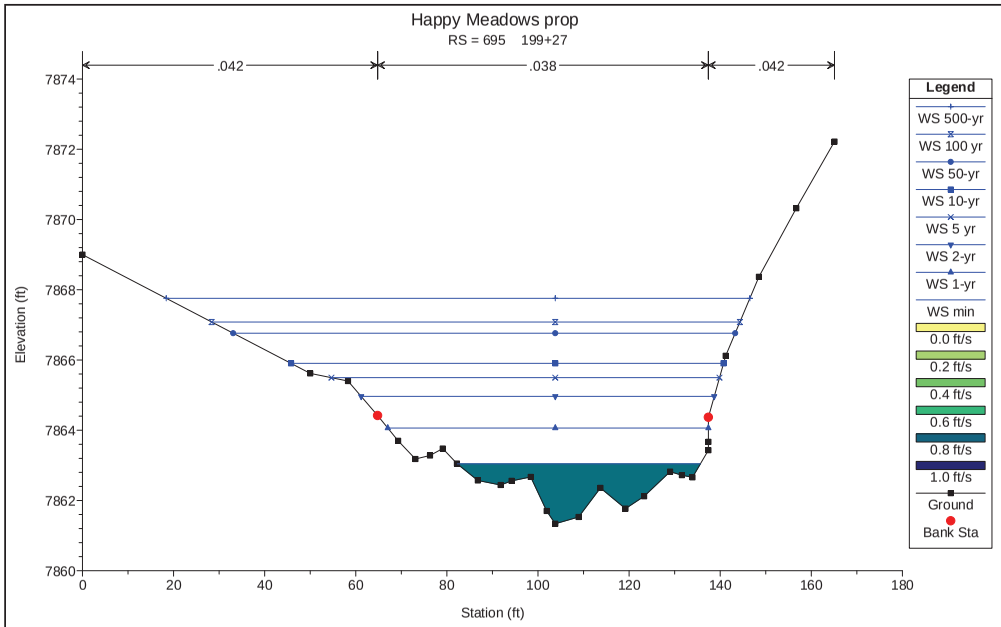

Happy Meadows prop
RS = 685 170+35
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

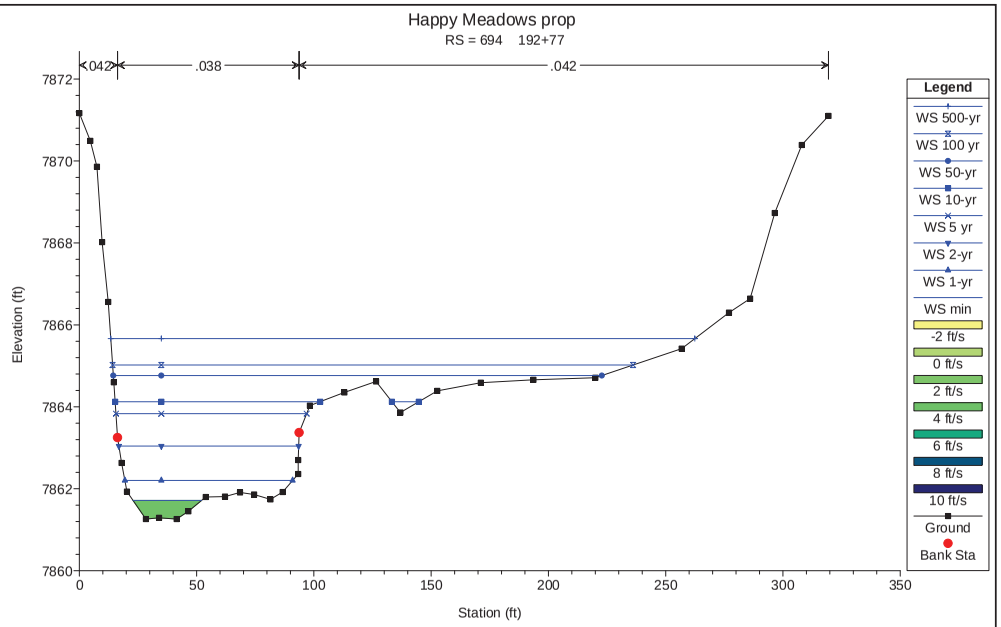

Happy Meadows prop
RS = 691 187+74
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

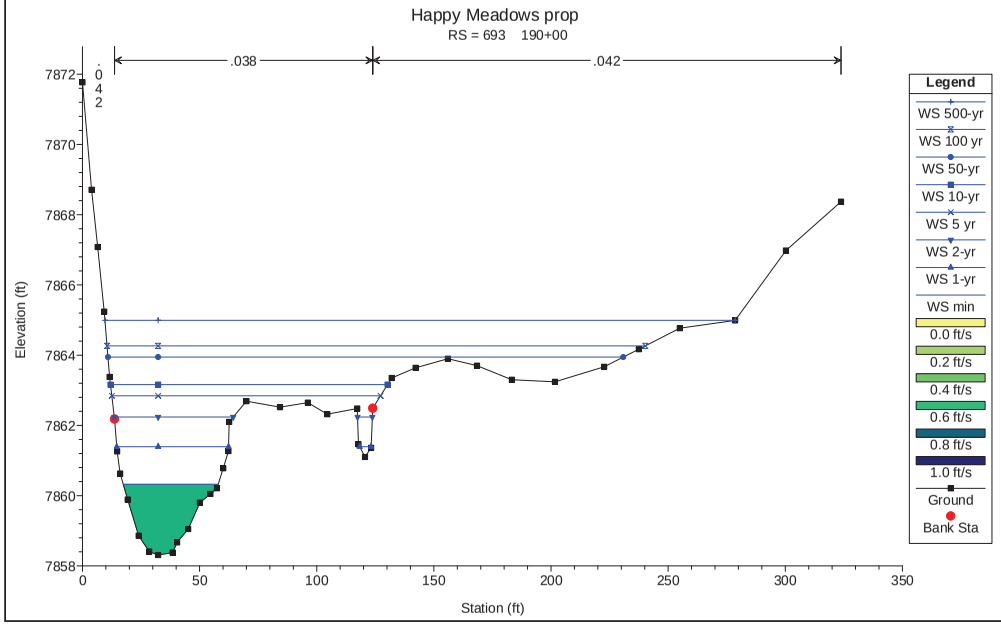

Happy Meadows prop
RS = 690 184+63
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

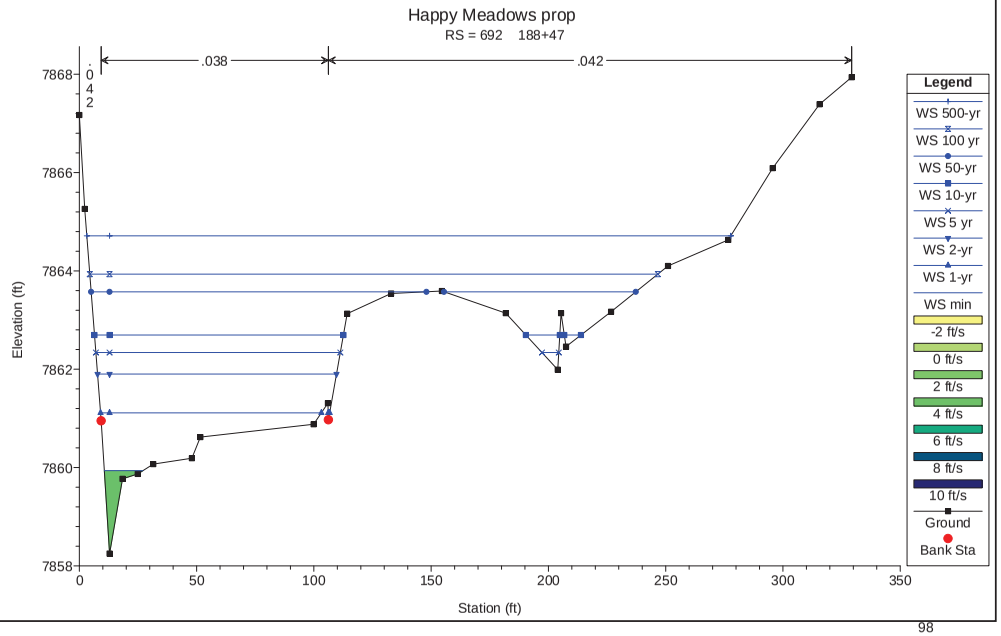

Happy Meadows prop
RS = 689.7 181+75
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

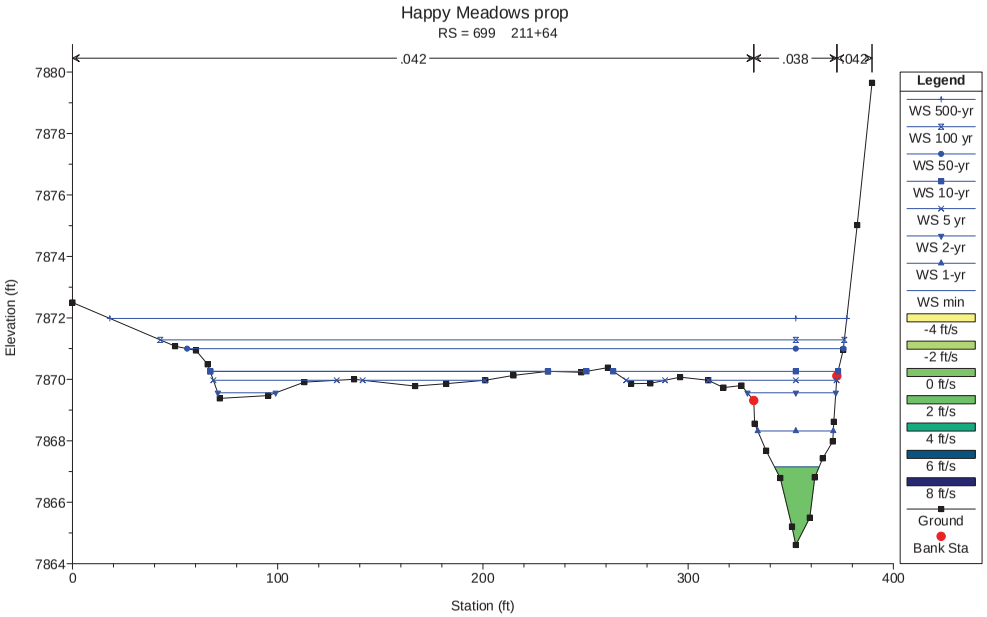

Happy Meadows prop
RS = 689 177+59
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

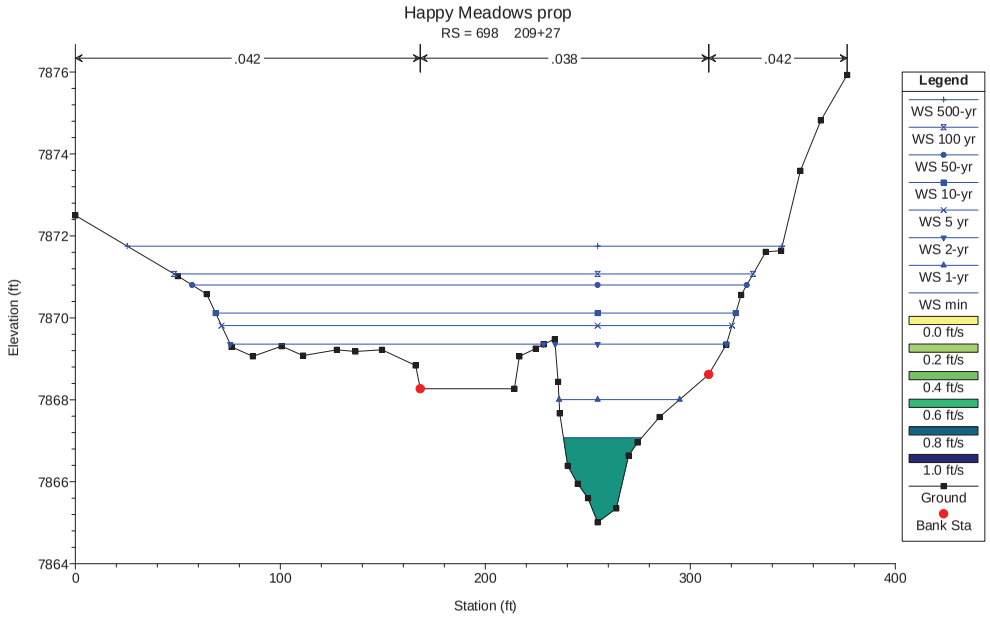

Happy Meadows prop
RS = 695 199+27
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta

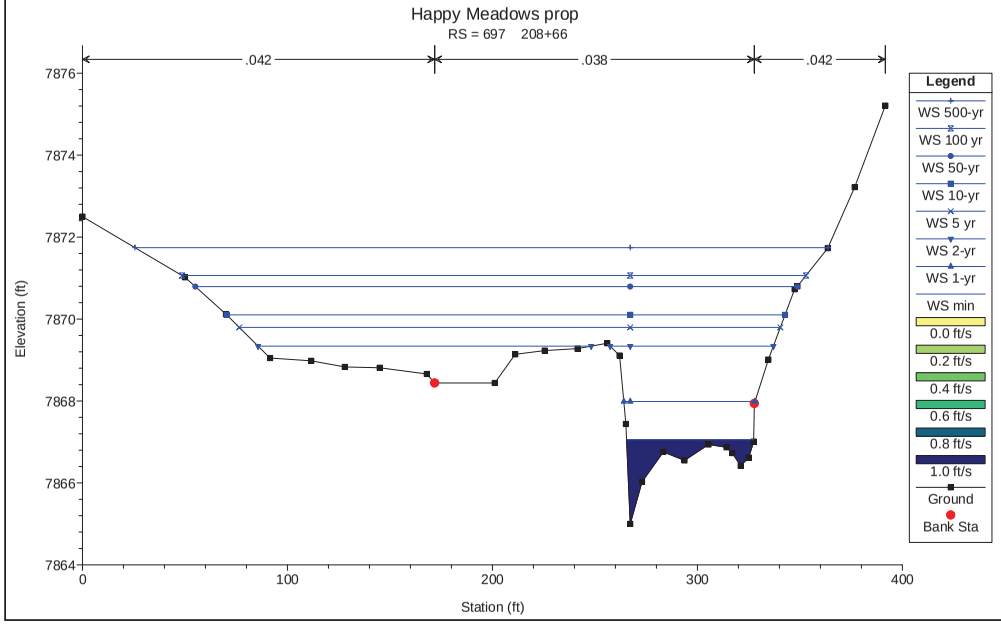

Happy Meadows prop
RS = 694 192+77
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

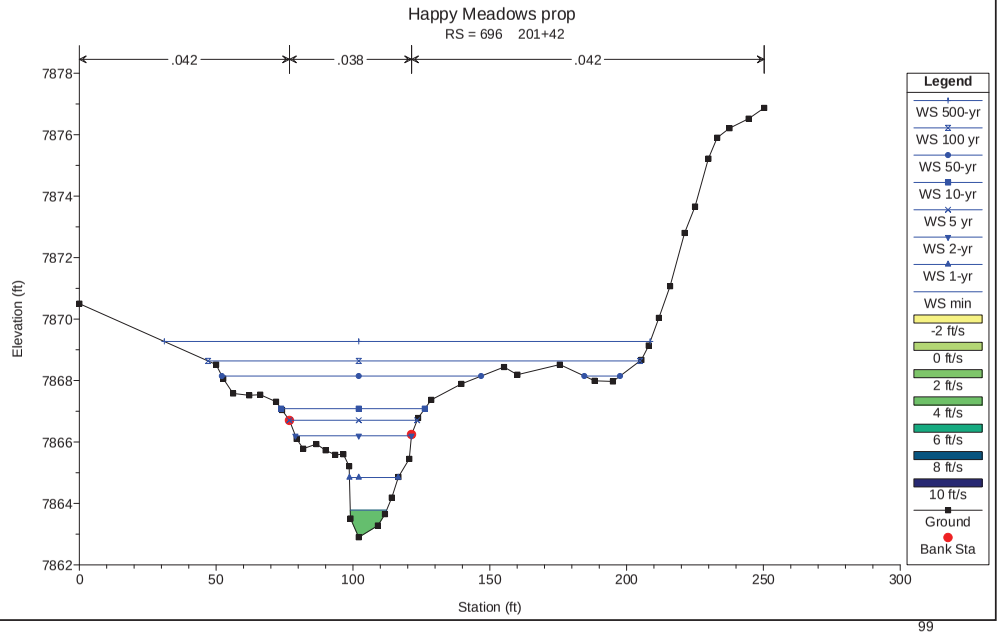

Happy Meadows prop
RS = 693 190+00
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta


Happy Meadows prop
RS = 692 188+47
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Happy Meadows prop
RS = 699 211+64
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta


Happy Meadows prop
RS = 698 209+27
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta


Happy Meadows prop
RS = 697 208+66
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta


Happy Meadows prop
RS = 696 201+42
.042
.038
.042
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100 yr
WS 50-yr
WS 10-yr
WS 5 yr
WS 2-yr
WS 1-yr
WS min
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta