

# South Platte River Happy Meadows – Reach 22 River Restoration Plan March 2010

The following document describes the treatments to be implemented on the South Platte River in the area known as Happy Meadows. The segment of the river, 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 project reach is approximately 2.5 miles NW of the town of Lake George, CO, and is two miles in length. 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 both the upstream and downstream of the reach. The downstream property owners, a home owners' association known as Sportsman's Paradise, are partners and stakeholders in the Happy Meadows project, and will be conducting river restoration on their private lands in conjunction with this project.

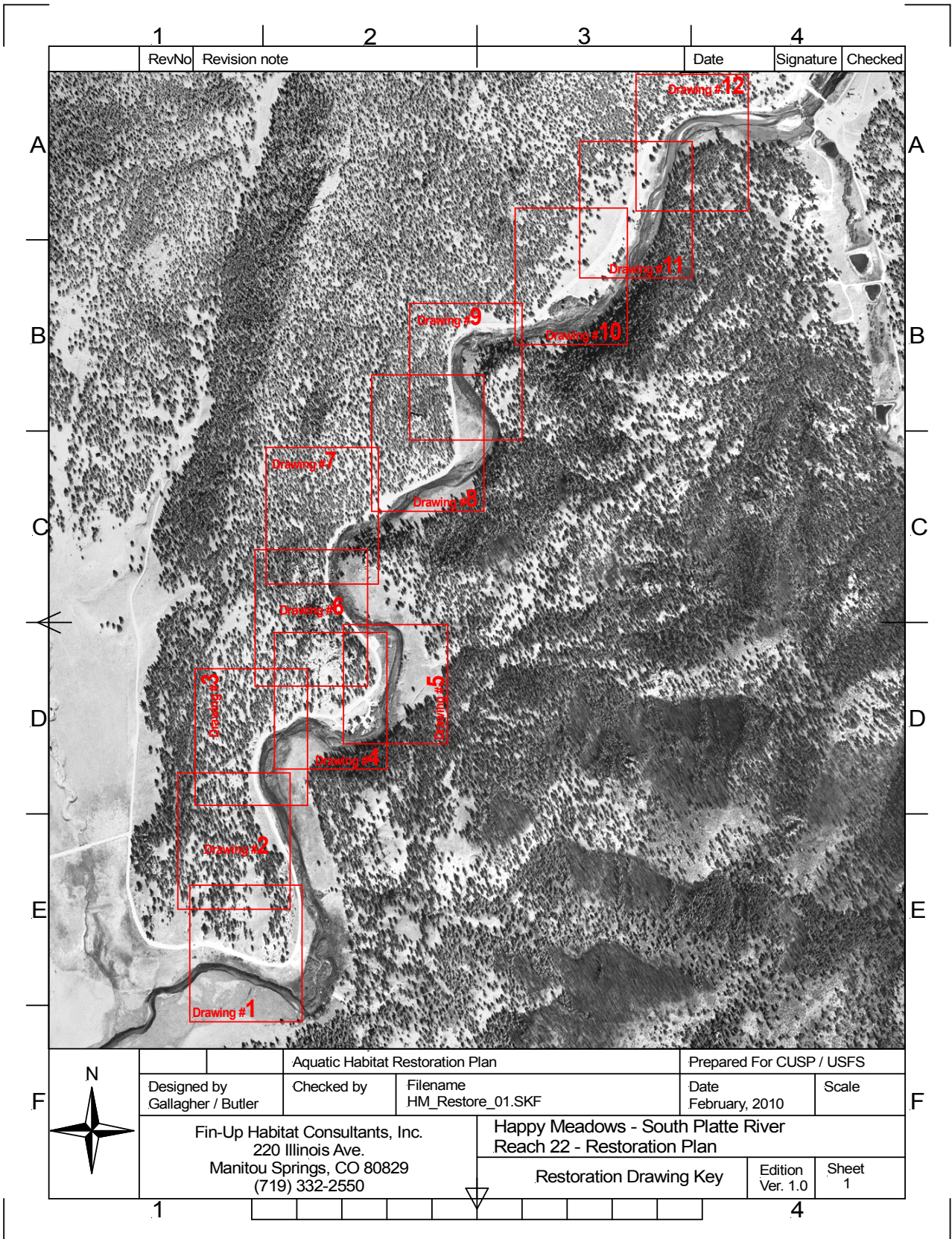
## Purpose & Need:















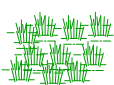
The South Platte River throughout the Happy Meadows reach is limited by excess sediment from sources upstream, and from inputs from the adjacent county road (CR 112). This segment of the river was designated by the State of Colorado as impaired by sediment under Section 303(d) of the Federal Clean Water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

Aquatic monitoring has been conducted by the US Forest Service throughout the project reach, including basin-wide aquatic habitat inventories (1993 & 2002), and extensive channel morphology surveys in 2006 and 2008. This information, and additional channel morphology data collected in 2009, has been utilized to develop the current habitat enhancement proposal. Additionally, a HEC RAS sediment transport model is being developed for the project reach to verify the sediment transport goals of the design. This model is expected to be complete before construction begins in 2010.

The project will address the sedimentation issues presented by the gullies on the burned side of the river by stabilizing these features and cutting off the sediment supply. The low-head diversion structure at Sportsman's Paradise will be re-configured, allowing for restoration of the channel upstream on Forest lands. In-channel work will focus on reducing the width/depth ratio of the channel to improve sediment transport. This work will also include features and techniques that will improve habitat complexity and quality for resident rainbow and brown trout.

The map on the following page delineates the project reach. The reach has been divided into 12 drawings, beginning at the upstream boundary and progressing downstream. Additionally, a key to the treatment types can be found on the page following the reach map. The proposed treatments in each drawing are described in detail in the text adjacent to each drawing.



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RevNo	Revision note			Date	Signature	Checked	
<h2 style="text-align: center;">Happy Meadows Site Plan Symbol Key</h2>							
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Aquatic Habitat Restoration Plan				Prepared For CUSP / USFS			
Designed by Gallagher / Butler	Checked by	Filename HM_Restore_14.SKF		Date February, 2010	Scale		
Fin-Up Habitat Consultants, Inc. 220 Illinois Ave. Manitou Springs, CO 80829 (719) 332-2550				Happy Meadows - South Platte River Reach 22 - Restoration Plan - Gully Treatment			
<b>Site Plan Symbol Key</b>				Edition Ver. 1.0	Sheet 1		
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#### Drawing #1:

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.# 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 be 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.

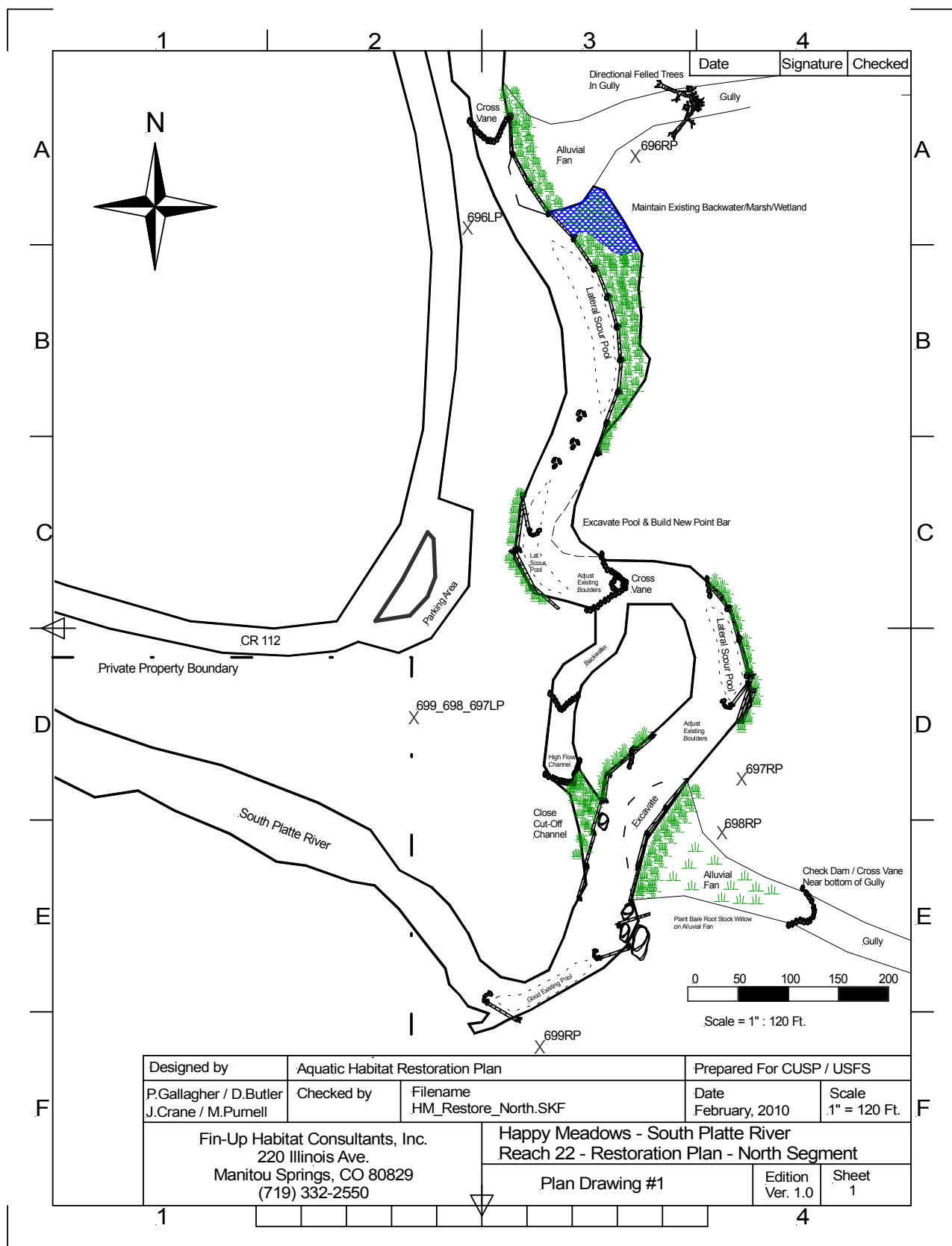
The lateral scour pool along the right bank of the river (Dwg.#1 Grid D4) will be enhanced by installing a log/boulder J-Hook vane upstream of the initial scour point of this habitat. Immediately upstream of the J-Hook, a bank cover feature can be constructed using 2 -3 large trees. The unstable stream 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.#1 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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P.Gallagher / D.Butler J.Crane / M.Pumell		Checked by	Filename HM_Restore_North.SKF	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 #1		Edition Ver. 1.0
					Sheet 1

## Drawing #2:

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. #2 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 be 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.

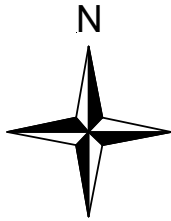
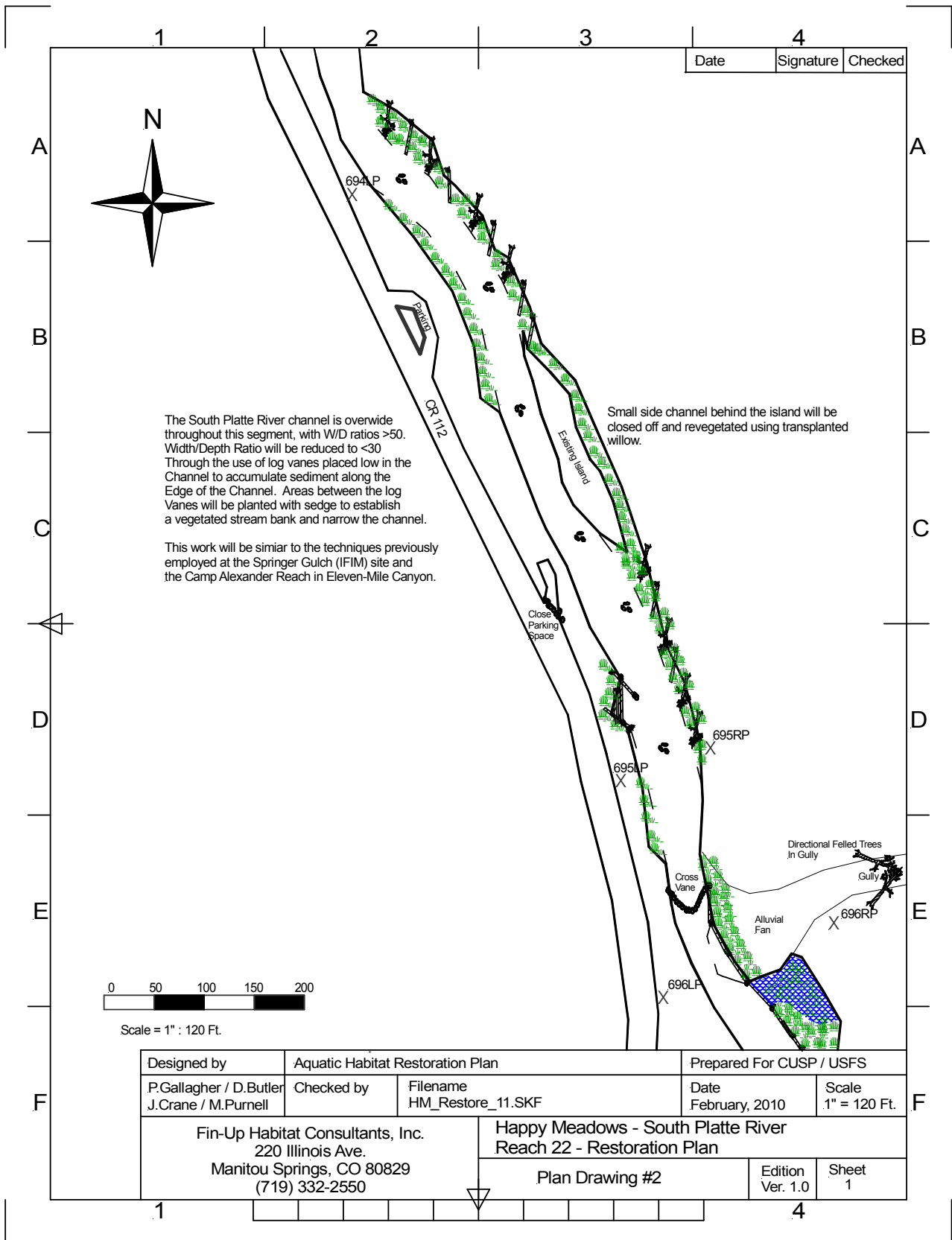
A boulder or double log cross vane may be installed in the channel immediately downstream of the gully to provide vertical stability in the river bed, and to create scour to form a pool immediately below. A river bank cover structure can be installed downstream of this point (Dwg.#2 Grid D3) on the left bank, using 5 to 6 large trees.

The parking area at Grid C3 will be 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.



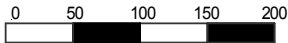
Large Wood installed low in the channel to reduce Width/Depth Ratios - South Platte River, Eleven-mile Canyon, IFIM Middle Station. 2004 "*Trees for Trout*" Demonstration Project



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 similar 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.



Scale = 1" : 120 Ft.

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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 #2	
			Edition Ver. 1.0	Sheet 1



### Drawing #3:

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.#3 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  $\frac{1}{2}$  bank-full stage elevation or less to improve scour and depth behind these features.

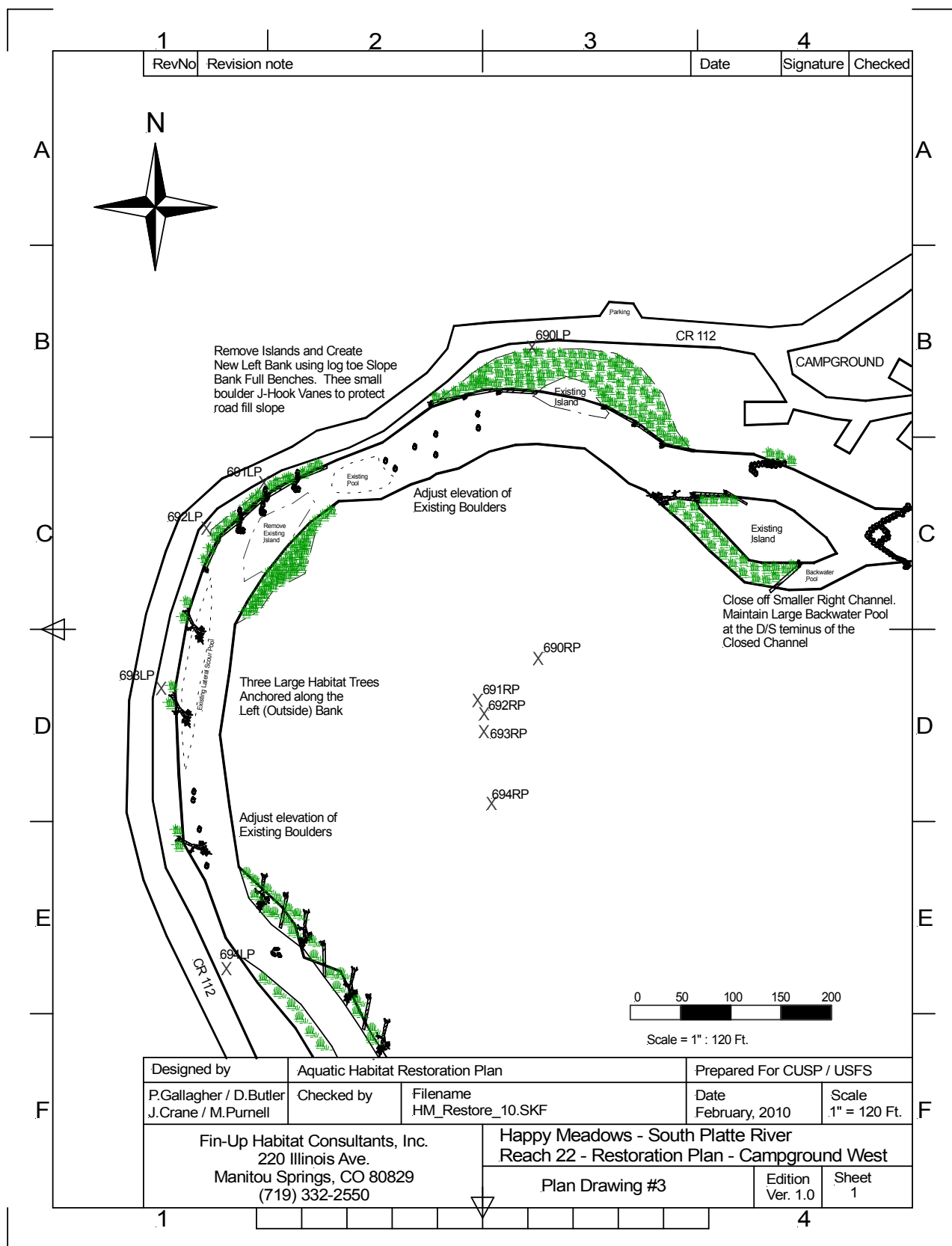


The large mid-channel island at Grid C2 will be removed. Vegetation from the island will be used to form a new point bar along the inside (right) bank of the meander bend adjacent to the island. Log toe-slope bank-full benching will be constructed along the outside (left) bank of the meander bend to 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.#3 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  $\frac{1}{2}$  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.





#### Drawing #4:

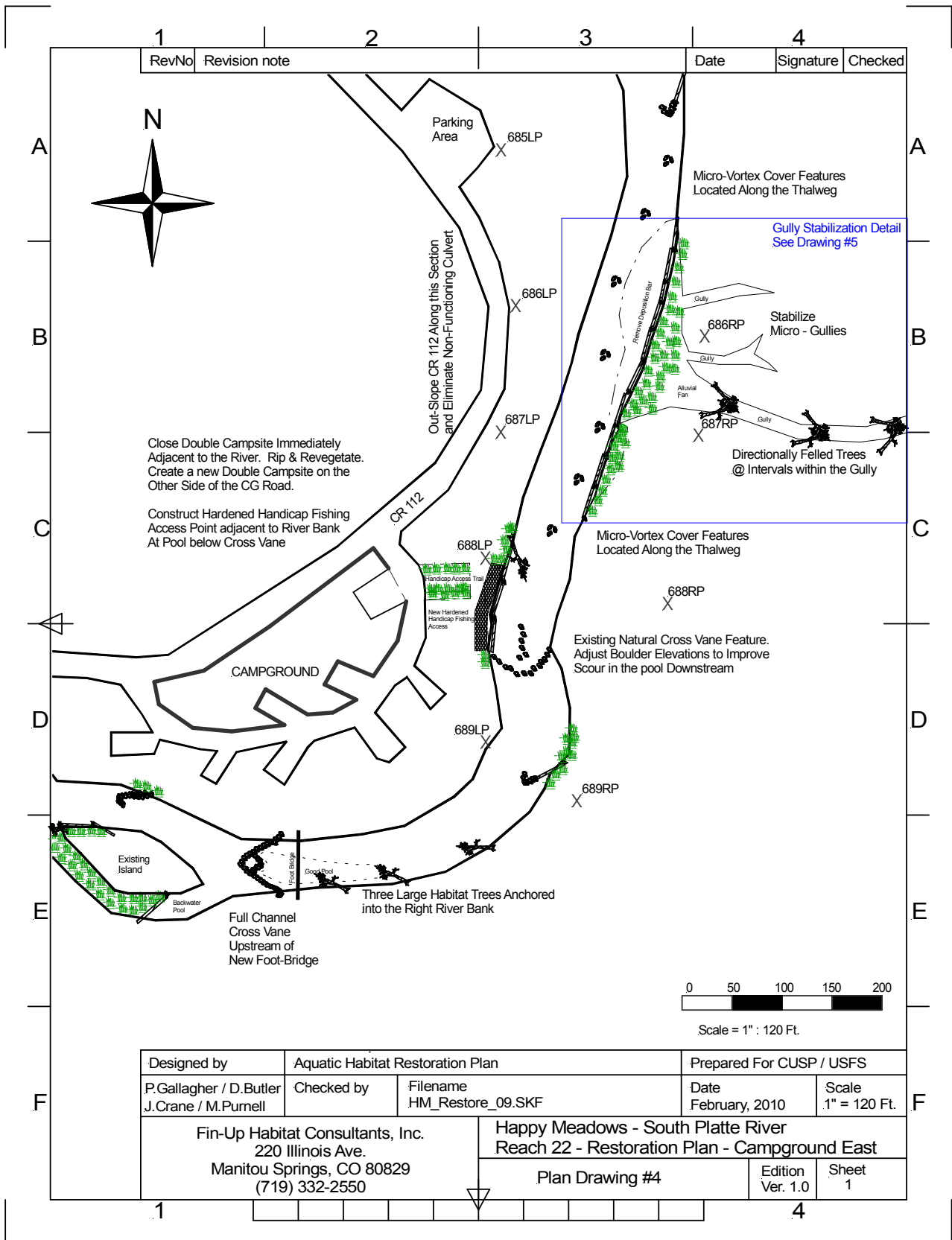
This drawing shows the segment of the river from 7,060ft to 8,000 ft along the longitudinal axis of the project reach. The river throughout this segment is characterized by a meander bend to the north (left). Happy Meadows Campground is located on the left river bank at the upstream part of this segment. 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.#4 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.#4 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.





## Drawing #5

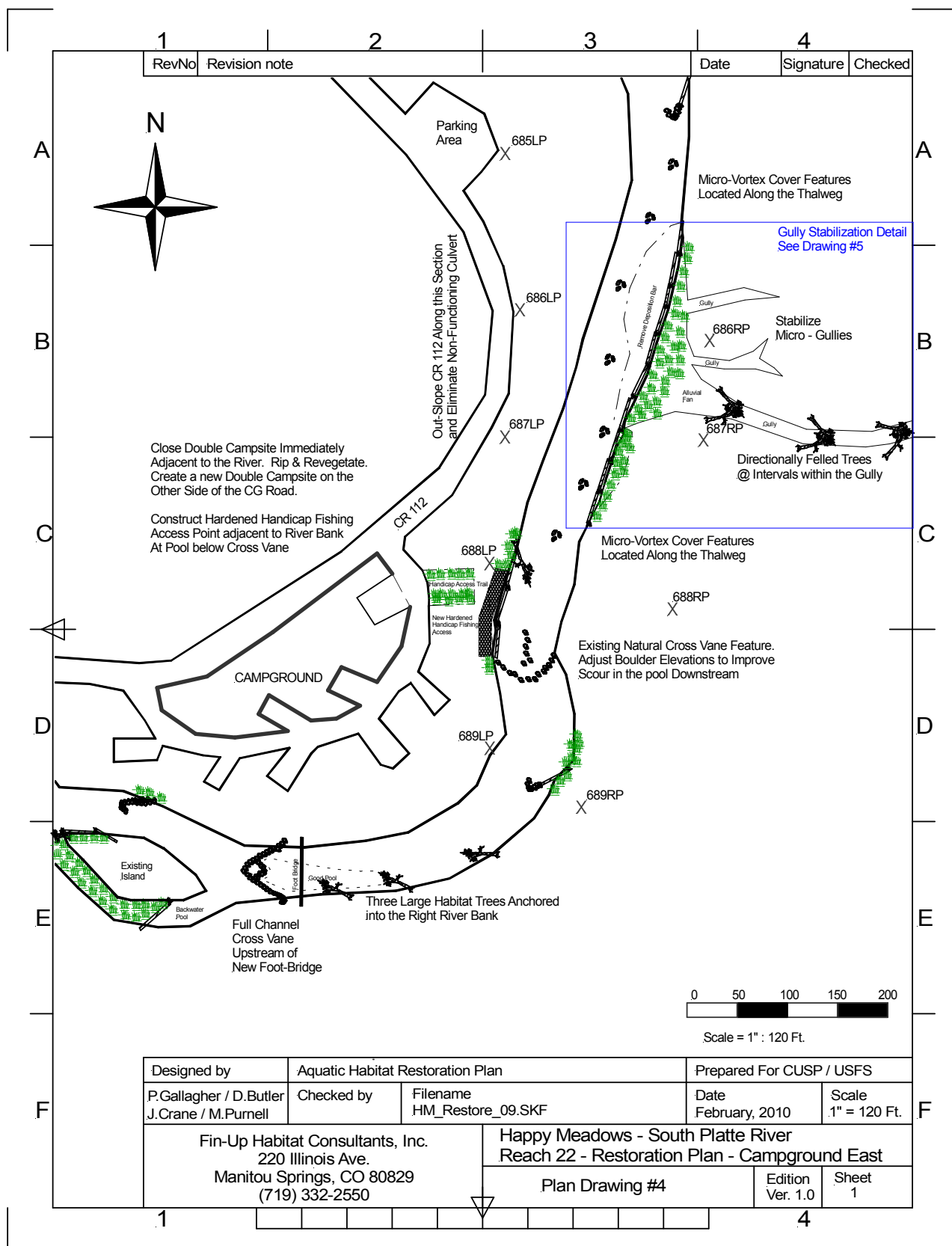
The segment downstream of the campground is affected by sediment inputs from the largest of the erosion gullies from the Hayman burn, which enters the river between cross-sections #687 and #686. Work will include require re-connecting the ephemeral drainages to the historic alluvial fans near the upper 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.





#### Drawing #6:

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.

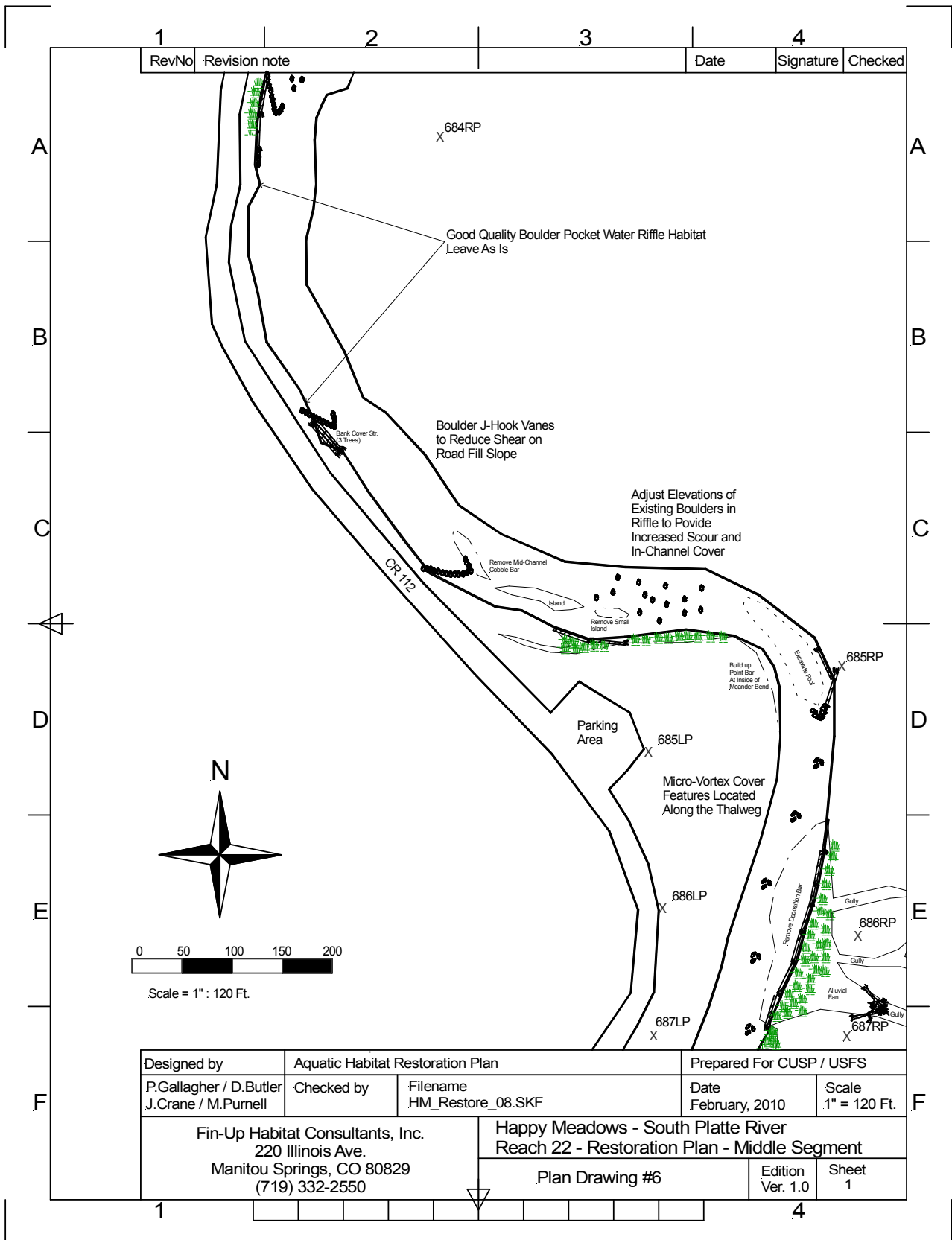
The existing lateral scour pool on the meander bend immediately downstream of the large gully (Dwg.#6 Grid D4) have been severely impacted by sediment from the gully, and currently exhibits characteristics more akin to a glide habitat. The work in the gully, described on the previous page, should effectively 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. #6 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#6 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.





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P.Gallagher / D.Butler J.Crane / M.Purnell		Checked by	Filename HM_Restore_08.SKF	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 - Middle Segment		
Plan Drawing #6				Edition Ver. 1.0	Sheet 1

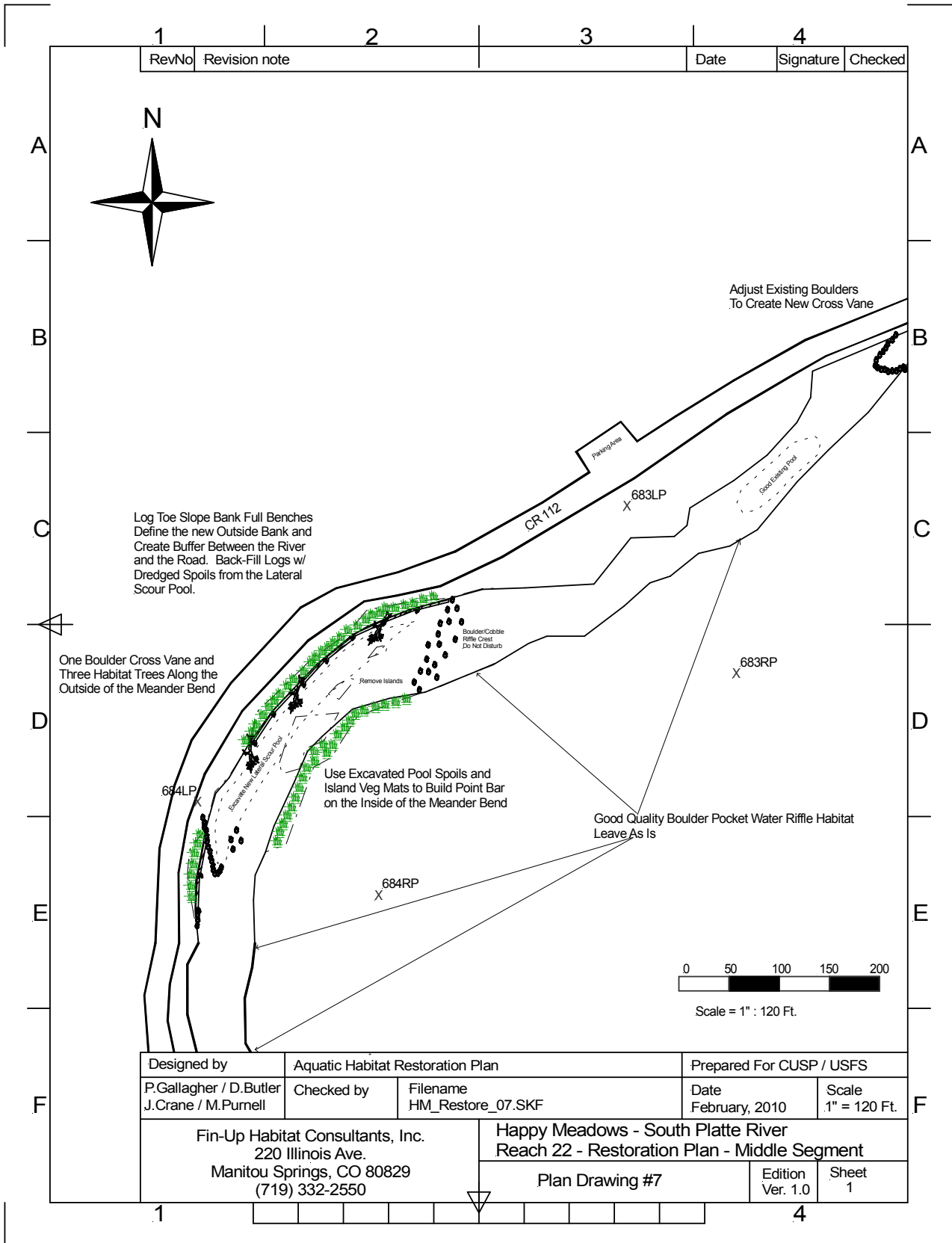
#### Drawing #7:

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.





#### Drawing #8:

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. #8 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.

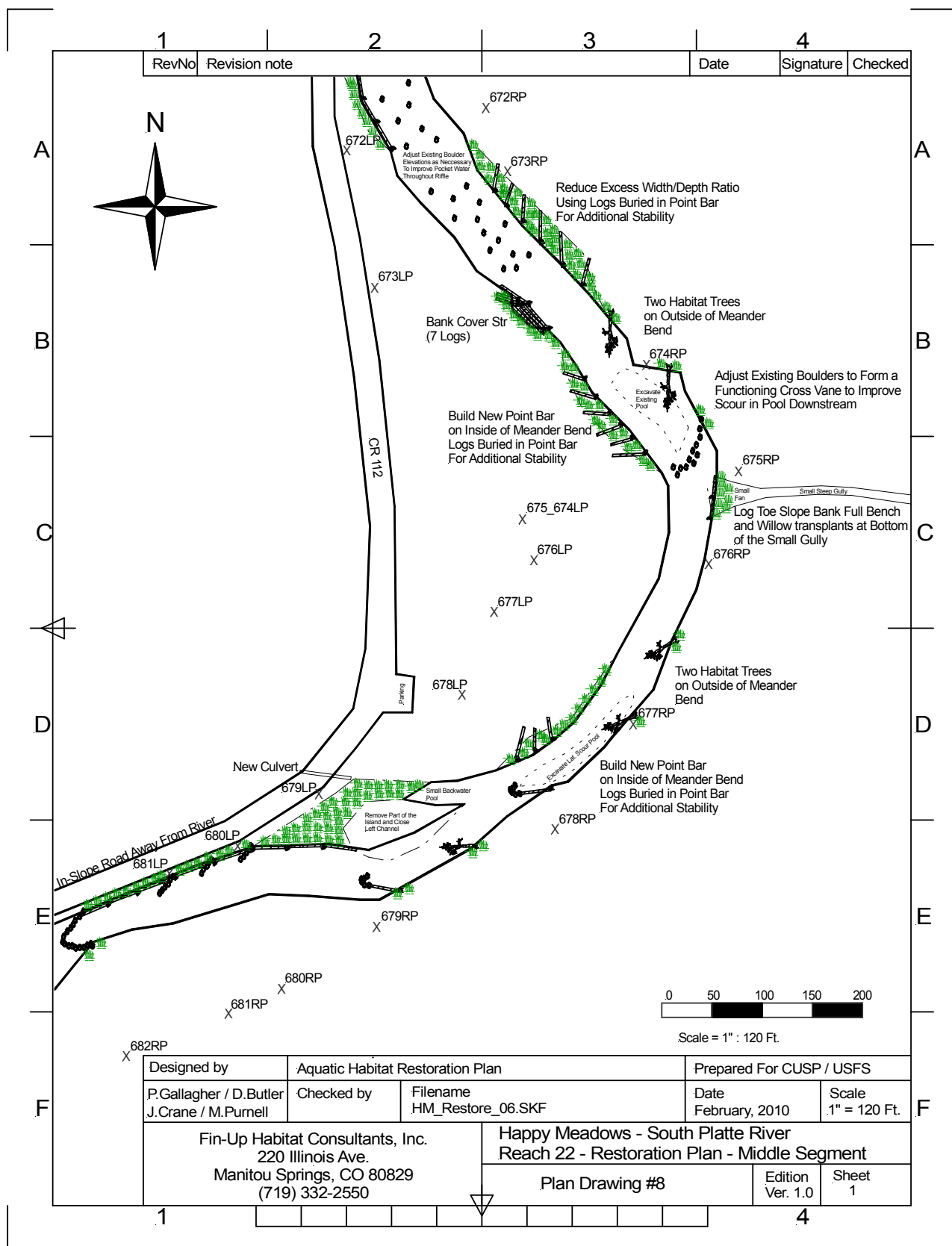
A large log / boulder J-Hook vane will be installed on the right bank near the top of the right channel to protect the river bank along this segment, and to provide pocket water cover within the riffle. An additional habitat tree may be placed approximately 75 ft downstream to provide additional habitat 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 #8 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	Revision note	Date	Signature	Checked
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Designed by		Aquatic Habitat Restoration Plan		Prepared For CUSP / USFS	
P.Gallagher / D.Butler		Checked by		Date	Scale
J.Crane / M.Purnell		Filename		February, 2010	.1" = 120 Ft.
J.Mantou Springs, CO 80829		HM_Restore_06.SKF		Happy Meadows - South Platte River	
(719) 332-2550		Plan Drawing #8		Reach 22 - Restoration Plan - Middle Segment	
				Edition	Sheet
				Ver. 1.0	1

#### Drawing #9:

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.

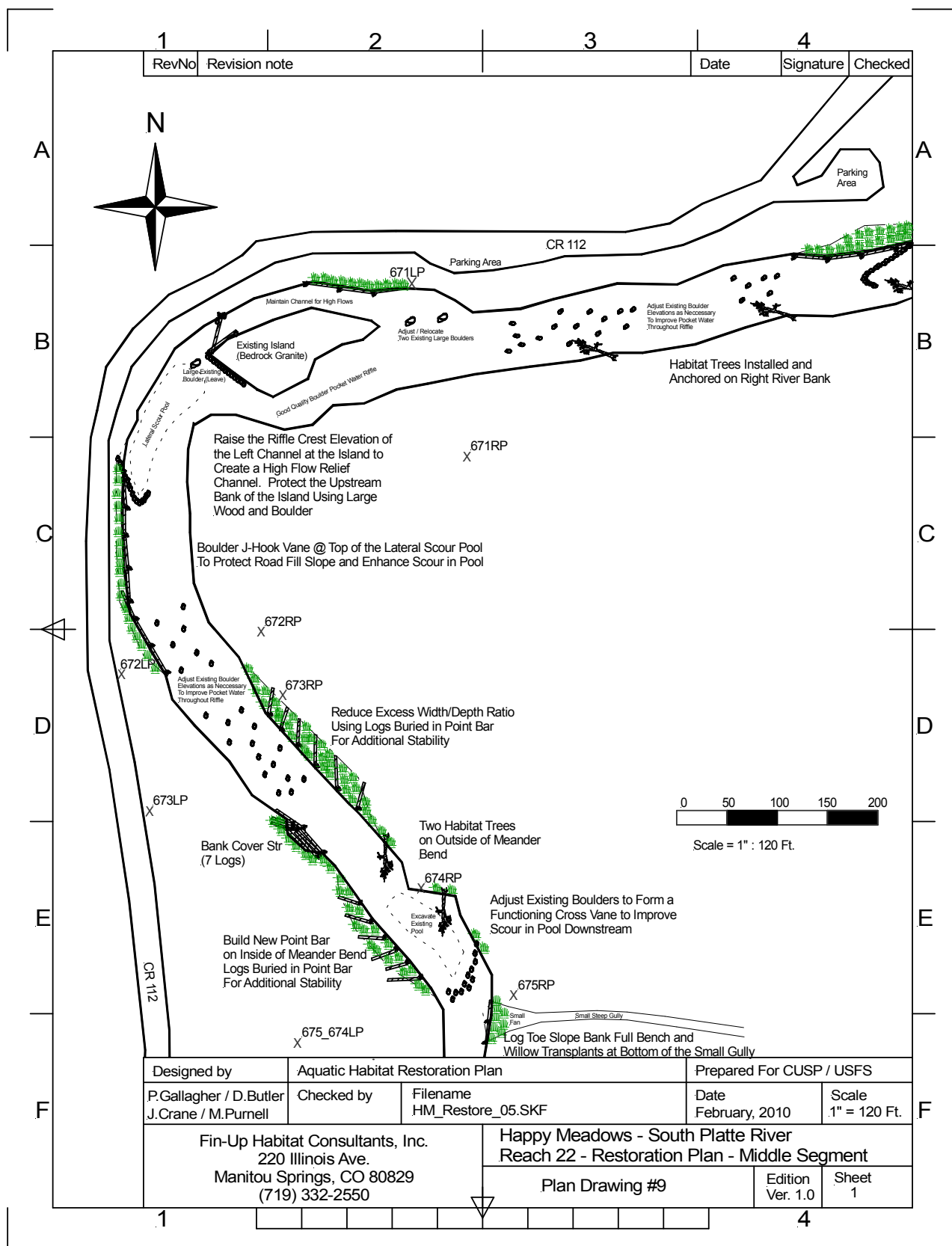


The low gradient boulder riffle is very wide and relatively shallow, exhibiting W/D ratios <50. This segment will be treated using river narrowing techniques developed and demonstrated in Eleven-mile Canyon and utilized upstream. Large wood will be placed low in the channel along the river banks to capture 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.#9 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.





#### Drawing #10:

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 #10 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.

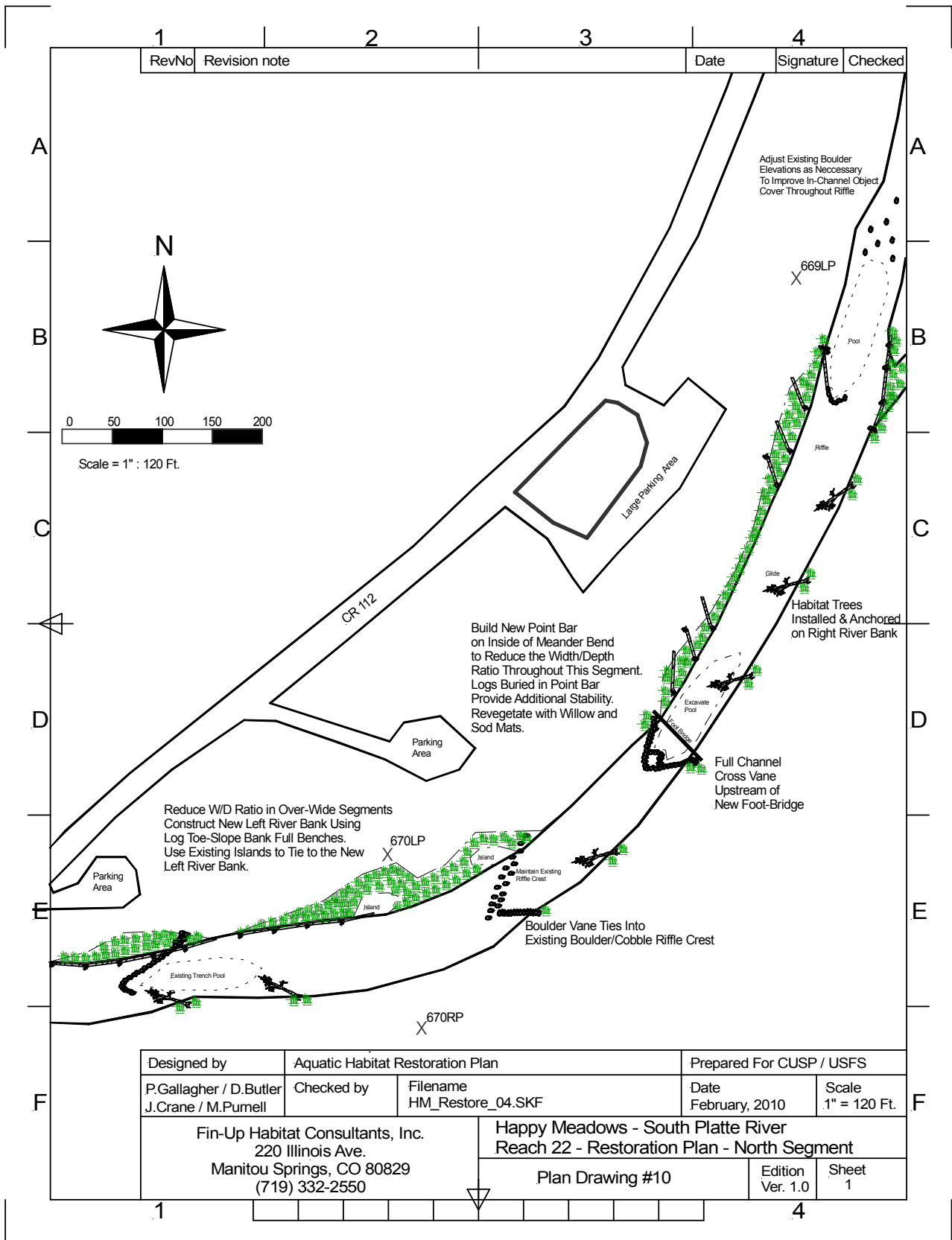
The boulder pocket-water riffle beginning at the upstream boundary of this segment is somewhat over-wide, with considerable sediment deposition occurring behind many of the in channel boulders. This segment, as well as another boulder pocket-water riffle downstream, will be narrowed using log toe-slope 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#10 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.



Designed by	Aquatic Habitat Restoration Plan		Prepared For CUSP / USFS	
P.Gallagher / D.Butler J.Crane / M.Pumell	Checked by	Filename HM_Restore_04.SKF	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 #10	
			Edition Ver. 1.0	Sheet 1

#### Drawing #11:

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.

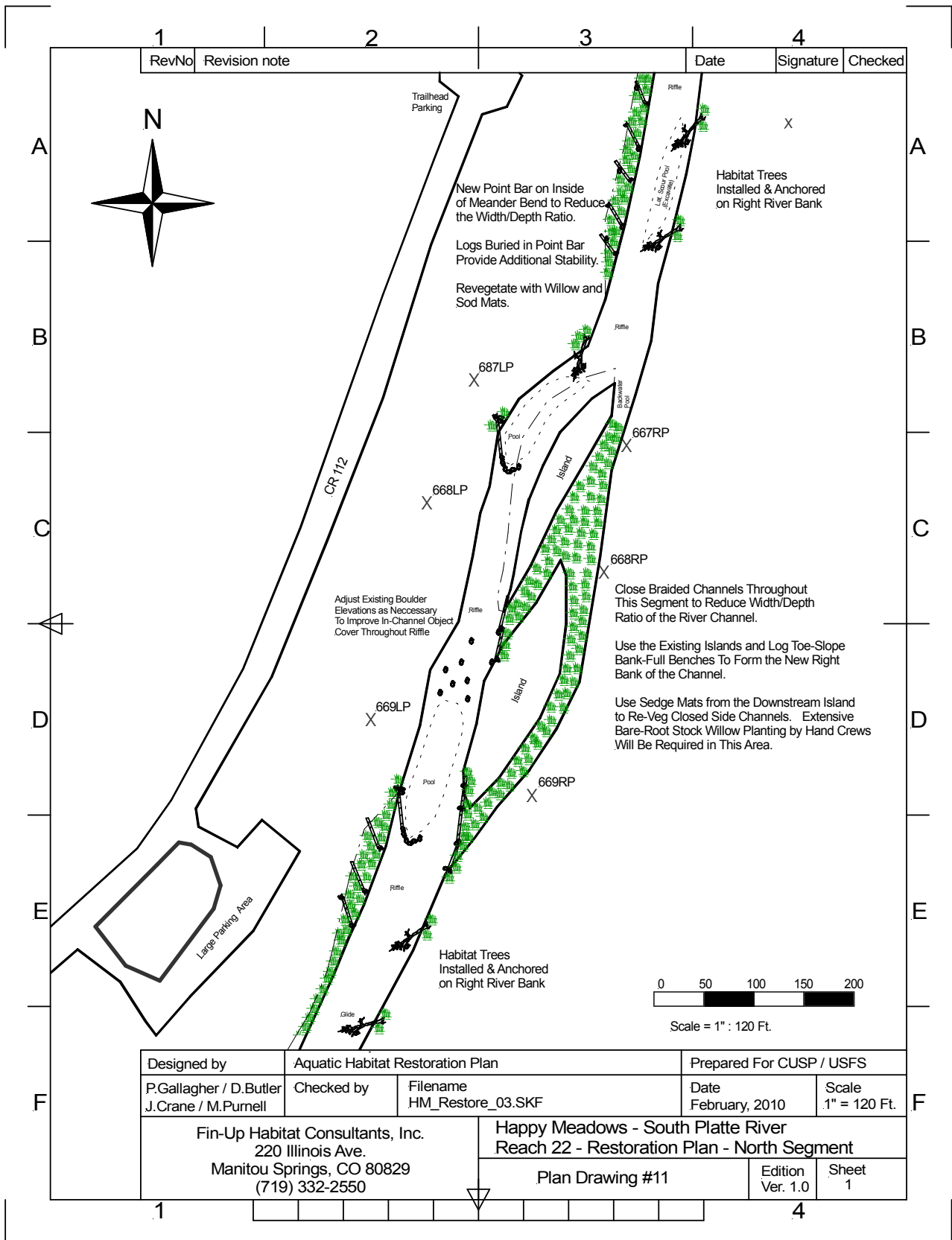


A pool / riffle sequence will be constructed along the left side of the channel from cross-section #669 downstream to cross-section #666. The right side channels will be closed off throughout the segment, utilizing large wood, boulder and vegetation harvested from the islands. Volunteers will be utilized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





#### Drawing #12:

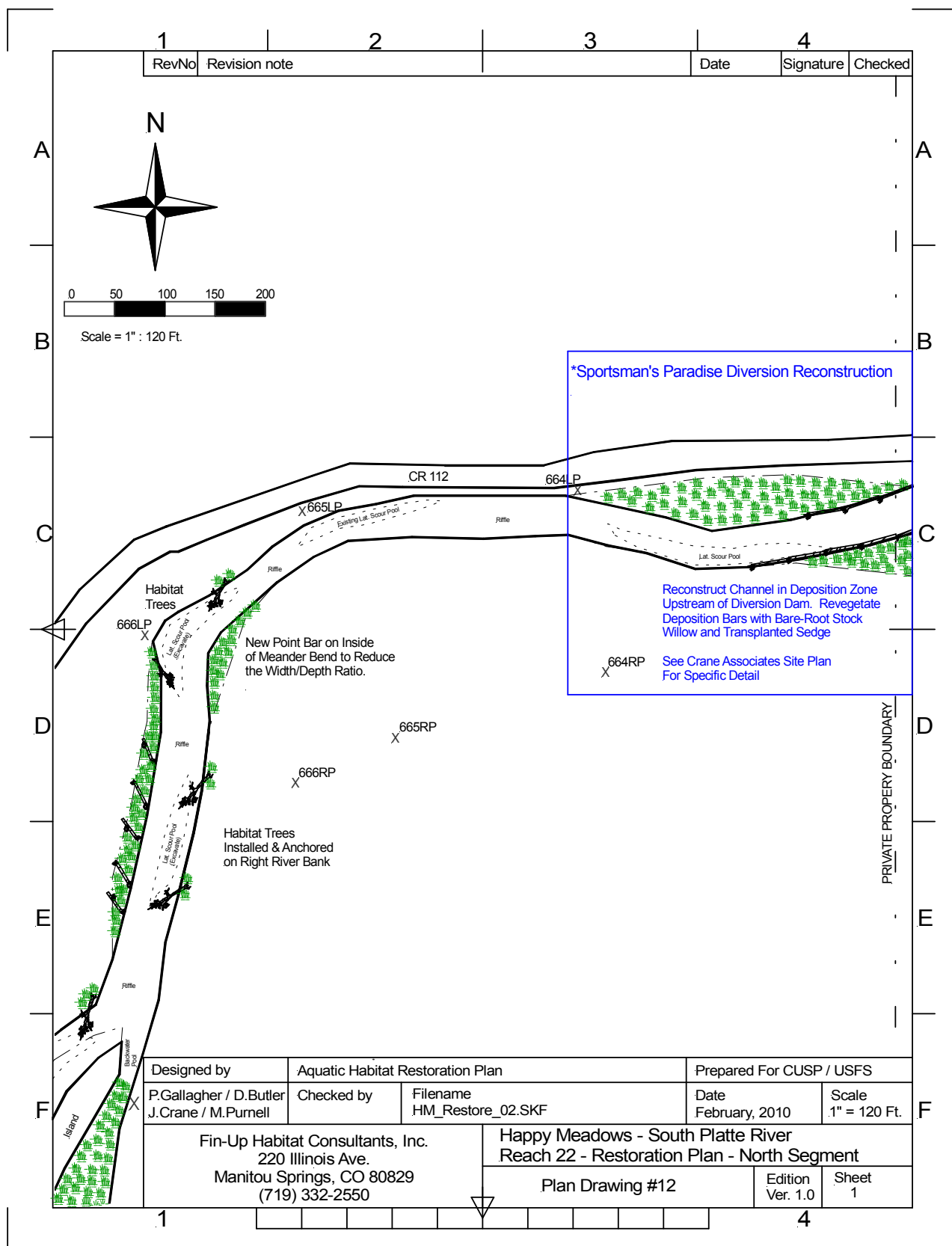
This drawing shows the segment of the river from 0ft to 1,300 ft along the longitudinal axis of the project reach. The river in this segment exhibits the most severe effects of sediment deposition due to the low head diversion structure downstream at the Sportsman's Paradise property boundary. The channel 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 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.



#### Project Materials Harvest Sites:

275 to 300 large trees will need to be harvested from the surrounding National Forest 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, and from recent blow-down sites in the vicinity of Lake George and the Manitou Experimental Forest.

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. 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. 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 10,000 bare root stock plants may eventually be planted to fully revegetate the restored river banks in the reach.

#### Project Development & Design Team:

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

Molly Purnell – Forest Hydrology Technician  
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Jeff Crane – Restoration Plan Review and HEC RAS Model Development  
Crane Associates, Hotchkiss, CO

#### Additional Project Development, Design Planning, and Assistance:

Steve Culver – Fisheries Biologist  
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