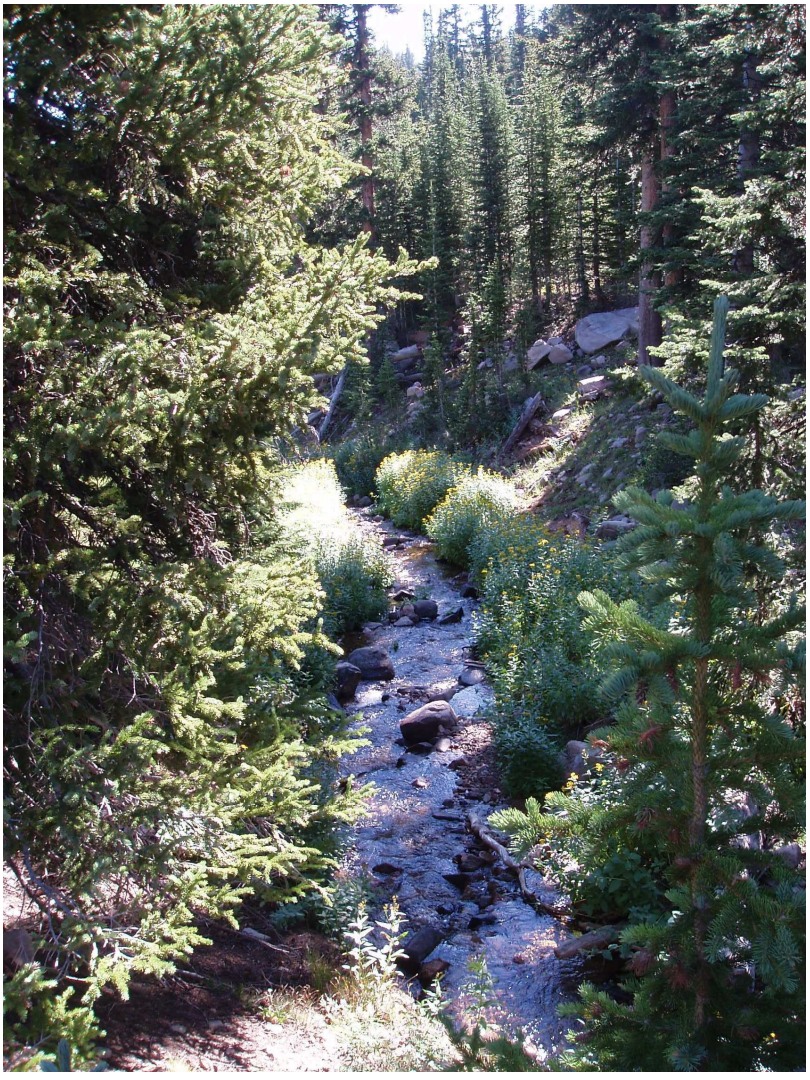
Halleck Creek
Aquatic Habitat Enhancement Project
Elk Mountain Ranch
Carbon County, WY
Prepared by



FIN-UP Habitat Consultants, Inc.

J. Peter Gallagher
220 Illinois Ave
Manitou Springs, CO 80829
(719) 685-9768 (Office)
(719) 332-2550 (Cell)

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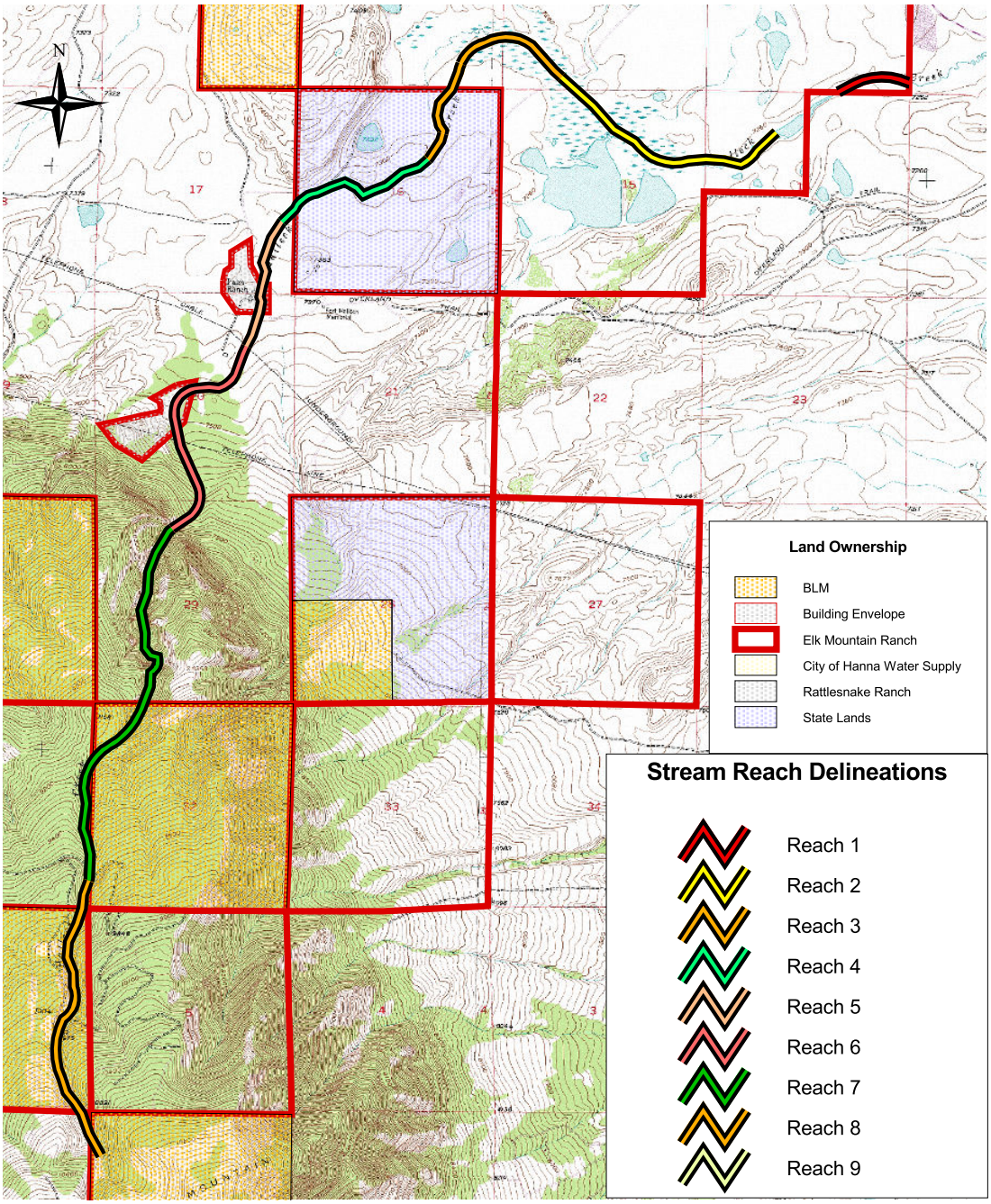
Elk Mountain lies on the watershed divide between the Medicine Bow River and Pass Creek watersheds, two major tributaries of the North Platte River in south central Wyoming. Within the Elk Mountain Ranch there are four perennial streams and over 25 ponds and lakes. The headwaters of two major streams, Rattlesnake and Halleck Creeks, are found on the ranch. Two other lesser headwater streams, Brush Creek and Johnson Creek, also originate on the ranch.

A rapid, landscape scale assessment of aquatic habitat conditions was conducted by Land Stewardship Associates, LLC and FIN-UP Habitat Consultants, Inc. in August and September, 2006. The results of this assessment are contained in the documents *Elk Mountain Ranch - NATURAL RESOURCE MASTER PLAN - PARTS 1& 2* (LSA, LLC, 2006). The 2006 aquatic assessment identified limiting factors and potential restoration projects for fisheries on the streams within the Elk Mountain Ranch, including Halleck Creek. During the course of this assessment, Halleck Creek Reach 6 was identified as presenting an opportunity for aquatic habitat manipulation and enhancement to enhance the resident brook trout fishery in the headwaters.

In July, 2007, FIN-UP, Inc. returned to the Elk Mountain Ranch to collect additional data to develop a detailed habitat enhancement plan for Reach 6 on Halleck Creek, with the primary goal of increasing pool depth and complexity, providing enhanced "pocket water" cover habitats in the riffles, and addressing the road/stream interactions in the project reach. This document will describe a recommended treatment plan for addressing the habitat and bank stability issues in the study reach.

Project Reach Descriptions and Existing Conditions:
The main stem of Halleck Creek begins near the saddle between the main summit and the west summit of Elk Mountain and flows to the north, down through a steep gorge for several hundred feet. Emerging from this gorge, the stream flows across a broad alluvial fan and onto the pastures adjacent to the Elk Mountain Ranch headquarters. Two other perennial headwater tributaries, Halleck #2 and Halleck #4, drain sub-basins of the north flank of Elk Mountain west and east of the main stem, coming together with the main stem to form a single channel approximately 1/2 mile downstream of the Ranch headquarters. A forth perennial tributary, Halleck #1, drains a large portion of the northwest flank of Elk Mountain, but becomes intermittent before reaching the main stem of the creek. Below the confluence of the three headwater tributaries, the stream passes through open pasture land into a large wetland meadow on the northeast corner of the ranch. The stream was dry in the lower portion of this wetland meadow during the 2006 assessment. At the downstream boundary of the ranch, Halleck Creek flows into a man-made impoundment, Elk Mountain Reservoir, and then eventually joins Mill Creek, a major tributary of the Medicine Bow River.



Map 1: Reach delineations on Halleck Creek - Elk Mountain Ranch.

Halleck Creek was delineated into eight distinct reaches, based on valley type, channel morphology, perennial vs. intermittent flows, and administrative or physical boundaries. Reaches were numbered consecutively, from 1 to 8, beginning at Elk Mountain Reservoir at the ranch boundary, and continuing upstream to the headwaters. The reach delineations depicted in Map 1.

A significant portion of Halleck Creek downstream of the headwater gorge is influenced by irrigation practices and water diversion. This seasonal dewatering and augmentation may result in negative effects due to variation of the natural hydrograph of the stream and fragmentation of aquatic habitat.

Additionally, historic and current agricultural practices may be limiting the potential of the stream to sustain a viable aquatic ecosystem. Historic data indicates that a self-sustaining brook trout fishery was once present on this stream, but current observations would indicate that this may no longer be the case. Aquatic habitat conditions throughout this watershed range from good in the upper wet reaches of the stream to extremely poor in a few of the lower reaches.

Reach 6:

Halleck Creek Reach 6 extends from the Ranch Headquarters (Palm Ranch) upstream to a waterfall barrier at the obvious rock outcrop in the steep canyon above the ranch headquarters. Halleck Creek throughout Reach 6 flows through an alluvial fan at the base of the steep headwater canyon on the northern flank of Elk Mountain. There is evidence of considerable historic lateral migration of the channel across the alluvial plain in this reach, and old abandoned channels may be observed throughout the area. Near the center of the reach, there are a series of diversion points which feed irrigation ditches leading to the pastures below. These diversions present significant barriers to fish passage, and may dramatically alter the natural flow regime in the segment downstream, likely limiting the reach in terms of quality aquatic habitat and depth (Photo 1). Upstream of these diversions, extensive historic logging operations have disturbed the stream channel in many locations, altering channel morphology and mobilizing stream substrates. An old logging road parallels the stream channel on the east bank from a point a few hundred feet upstream of the uppermost diversion point to the rocky waterfall at the upstream boundary of the reach. Large stumps (3-4' DBH) between this road and the stream lend evidence to extensive logging occurring down to the waters edge, and may partially explain the frequent lateral migration of the channel and generally poor pool habitat conditions observed in the reach. The waterfall at the top of the reach is an impenetrable barrier to fish migration upstream, and may account for no fish being observed in any of the reaches upstream on Elk Mountain.

Photo 1: Low flows on Reach 6 below ditch.

Although there is substantial evidence of historic disturbance in the reach, the current trend of riparian function and channel integrity appears to be recovering. Riparian conditions were found to be in properly functioning

condition during the 2006 assessment. Riparian areas consisted primarily of aspen and alder, with robust willow under-story. Riparian plant regeneration was evident, and disturbed banks appeared to be naturally re-vegetating.

An electro-fishing sample was collected by the Wyoming Fish and Game Dept. (WFGD) near the ranch headquarters in August 1984, and found Brook trout present in the stream at densities of 466 individuals/acre with an estimated biomass of 75 lbs/acre. Density and biomass estimates indicate that the population was marginally viable, but not robust. The 1984 sample data does not indicate any other fish species being present. The average length of brook trout sampled in the reach in 1985 was 5.7 inches. No fish were observed during the 2006 assessment, but were observed in the reach in 2007.

Aquatic Habitat Inventory:
A detailed aquatic habitat analysis was conducted within Reach 6 along a representative 1,000 foot long segment beginning at Treatment Site Access_1, and continuing upstream through Sites Access_2 and Access_3 in July 2007, using a US Forest Service developed protocol, the Basin-Wide Stream Habitat Inventory (BWSHI)(D. Winters & P. Gallagher, 1997) to quantify aquatic habitat in the reach. A summary of the BWSHI assessment is presented here. Detailed habitat metrics for the study segment can be found in the appendix.

The channel type in the representative segment is classified as Rosgen B3a, exhibiting a relatively steep gradient and slightly entrenched channel. The riparian buffer along the entire length of the reach is limited to the green line immediately adjacent to the creek. Dominant riparian vegetation is alder / willow, with aspen and some mixed conifers, and the reach riparian component was considered to be properly functioning. Stream flow was measured at 2 cfs. Water temperature in the reach was measured at 53˚ f., and pH was measured at 8.43.

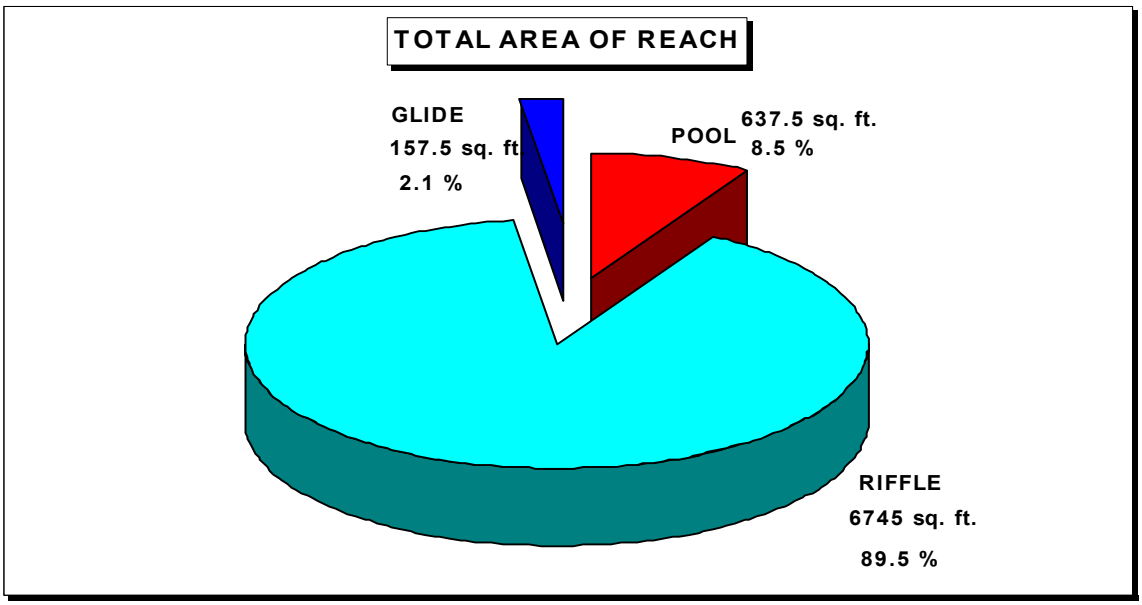


Chart 1: Distribution of Pool, Riffle, & Glide Habitats in Reach 6 on Halleck Creek.

A total of thirty-seven separate meso-habitats were identified in the study segment. These were composed of eleven pools, twenty-four riffles, and two glide habitats (Chart 1). The average width of the stream was 7.9 feet and the average depth was 0.4 feet. Channel substrate was predominately gravel and cobble, with considerable accumulations of boulders. Sand and silt was limited in all habitat types, and in- filling of depositional areas such as the bottom of pools was relatively insignificant. There are considerable accumulations of large wood in the representative segment, with 87 individual pieces counted during the survey. Large wood provided important velocity shelter and cover, and was a significant contributor to habitat creation and scour. Stream banks were generally vegetated and stable throughout the reach, and the bank rock particle size (BRC) consisted mostly of larger cobble providing good armoring of the banks. Only forty-two feet of active eroding banks were measured in the study segment, and were primarily associated with old skid trails crossing the channel.

Pools were principally formed by water plunging over boulders, logs and woody debris obstructions in the channel. Pool habitats comprised approximately 8.5% of the total wetted area of the study segment. The average depth of all of the pools measured was 0.7 ft., with maximum pool depths ranging from 1.0 to 1.4 feet. Residual pool depth (RPD) was found to range from 0.5 to 1.1 feet, with an average of 0.6 feet throughout the reach. RPD and maximum pool depth was found to be generally poor in the reach, and may limit over-wintering capacity for brook trout at this elevation.

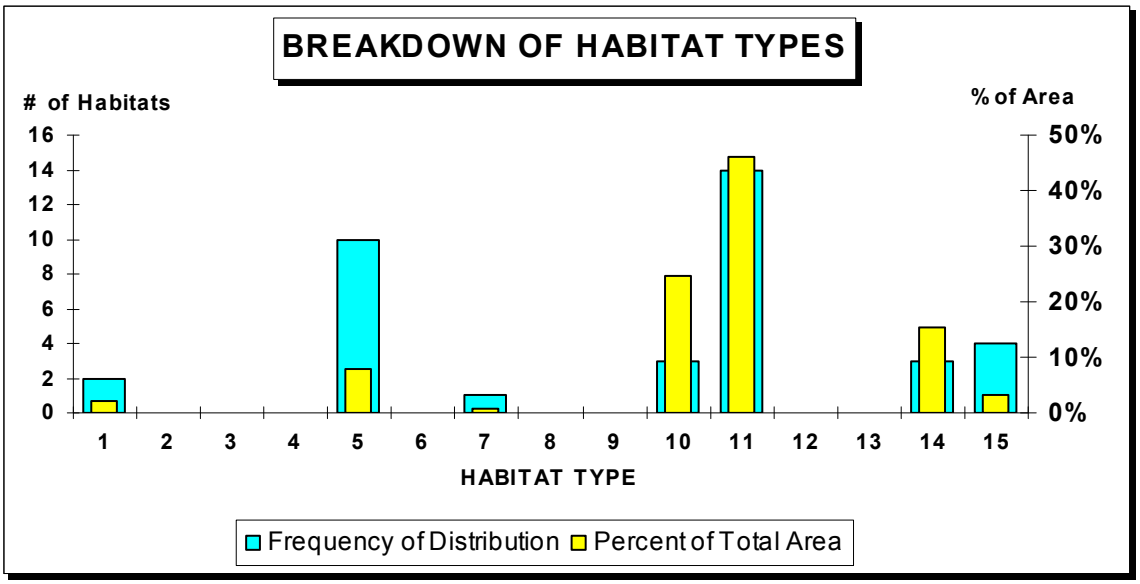


Chart 2: Percentage distribution of Pool, Riffle, & Glide Habitat forms in Reach 6.

High-gradient, pocket water dominated cobble and boulder riffles were the most abundant habitat type, in terms of both numbers and area, in the study segment, comprising more than 89% of the wetted area (Chart 2). These riffles typically dominate A and B channel types, and depending on depth and substrate structure, may provide important holding and feeding habitats for trout, as well as critical habitat for benthic macro-invertebrates and other aquatic organisms. Pocket water cover for trout was observed in several of the

riffles, but totaled only 24 ft^2, comprising less than 1% of the wetted perimeter of these habitats. Overhead cover was present, to a limited degree, totaling 21 ft^2 in the riffle habitats. Riffles in the study segment did appear to provide adequate spawning habitat for brook trout.

Two glides was observed in the reach. Glides are not typically encountered in A and steeper B channels, unless they are due to some form of disturbance. These glides were associated with old skid trail crossings along the creek. Glide habitats tended to be over-wide (~9 ft) and shallow to the point creating barriers to migration at lower flows. These habitats accounted for approximately 2% of the total wetted area of the reach.

The quantity of suitable cover in the Halleck Creek study segment was very limited (Chart 3), accounting for slightly more than 1% of the total wetted area of the channel. Cover was principally composed of vegetation overhanging the stream providing overhead protection but no velocity shelter. In-channel pocket water cover was the next most dominant type, and was equally distributed between riffle and pool habitats. Combination cover was very limited in the reach, and was typically associated with large wood in the channel. Pool cover, an important metric for determining over-wintering capacity, was not present in the study segment, and is likely a serious limiting factor to the fishery at this time.

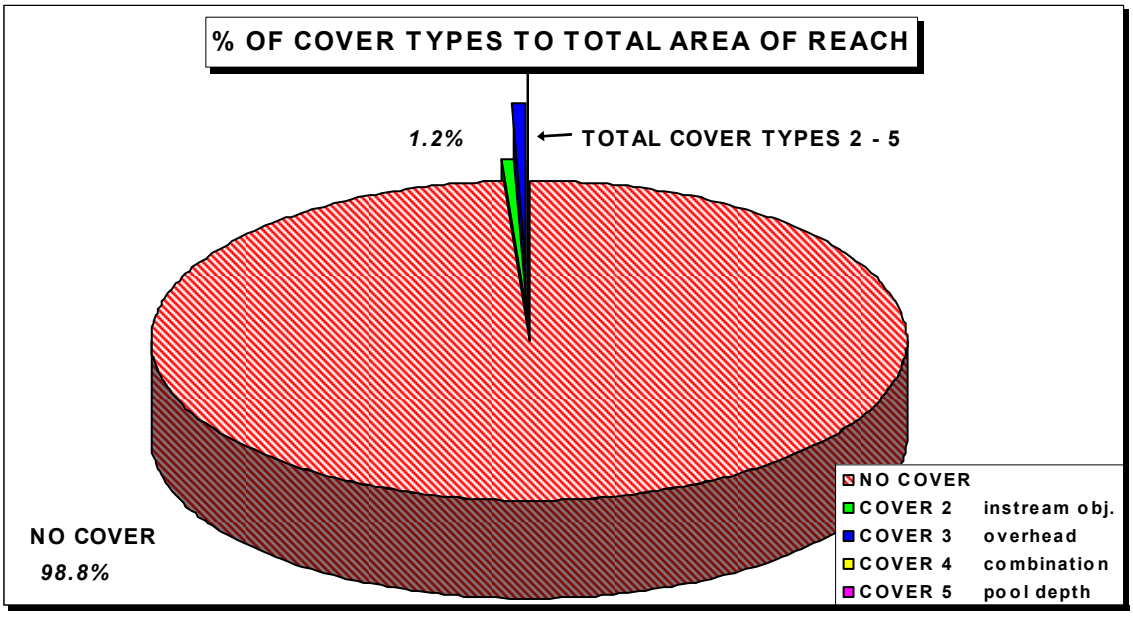


Chart 3: Percentage of Cover Types within Reach 6 on Halleck Creek.

The habitat data collected in this segment suggests that Reach 6 may be enhanced to improve the existing brook trout fishery. Pool residual depth and cover appear to be limiting factors in the reach. It may be desirable to enhance pool and pocket water habitats in the reach by removing armor (boulder and cobble) from the bottom of existing pools to enhance scour, improve RPD, and deepen these habitats. This work can be done by back-hoe, small excavator, or by hand.

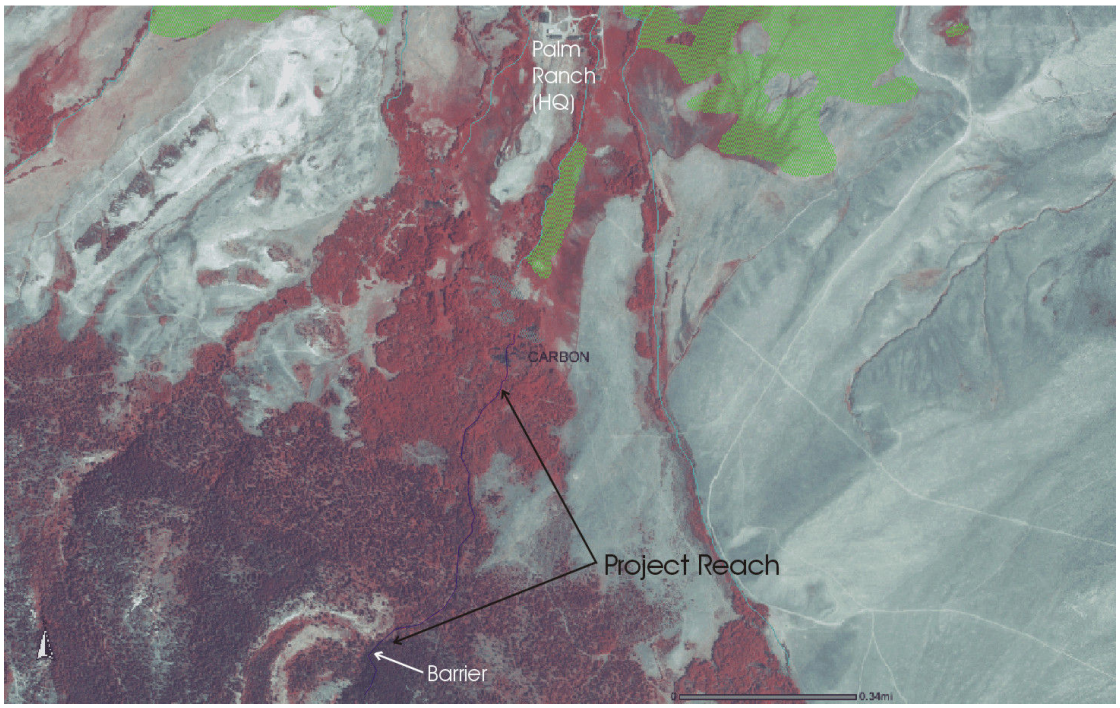


Photo 2: IR Photo showing NWI polygon and line features within Reach 6on Halleck Creek. NWI line features are shown as light blue. The stream within the project area is shown in dark blue for clarity

National Wetlands Inventory data and IR color photographs (2000) from the WyGISC Data Server (http://partners.wygisc.uwyo.edu) were used to identify important wetland and riparian features within Reach 6 on Halleck Creek. A composite photograph showing the NWI line and polygon features super-imposed over the color IR photo is shown above, and at a larger scale in the appendix. The IR photo, as well as ground verification in the field, indicates that the riparian/water influence zone surrounding the stream is limited to a narrow green-line immediately adjacent to the stream throughout the project area. No NWI green-line or wetland polygon features are found within the project reach. Downstream of the project area, in the lower half of Reach 6, there is an extensive area of beaver ponds and associated wetlands. The NWI data indicates that these consist of extensive areas of palustrine scrub/shrub (PSSCb), emergent (PEMC), and aquatic bed (PABGb) wetland/riparian features. Stream channel work will avoid impacting any critical riparian or other wetland resources along the project reach.

Stream Channel Morphology:

For the purposes of the stream channel morphology study, a representative sub-reach consisting of two existing pools and six riffles along a 158 ft segment of the creek was identified, and is located entirely within the Access_2 treatment site. The representative sub-reach begins at Riffle 11 described in the BWSHI survey in the previous segment, and continues upstream to Riffle 16. Two cross-sections were established and numbered consecutively beginning at the top of the representative sub-reach and continuing downstream. The cross-sections also correspond to either existing or new pool development sites identified in the habitat enhancement plan. The channel type within the representative sub-reach was classified as B3a (Rosgen, Catena 1994), considering slope, sinuosity, entrenchment, width/depth ratio, and substrate composition. All directional references to stream banks and cross-sectional head pins for the channel morphology study are from a hydrologist's perspective, with left and right banks determined looking downstream along the channel.

The stream channel was slightly entrenched throughout this segment. Stream substrate typically was composed of gravel and smaller cobbles, and did not appear to be significantly embedded. Stream banks were vegetated and stable, and the banks were mostly composed of particles 3" - 6" in diameter, providing some armoring from high flows. The width of the stream throughout the longitudinal profile was typically 6 -7 feet, and considerable large wood was present in the channel, creating scour habitat and cover, as well as channel roughness and complexity. Pool habitats, however, were relatively infrequent and of poor quality throughout the reach. Maximum pool depth was not more than 1.0 foot, and residual pool depths did not exceed 0.5 foot. Over-wintering habitat was exceptionally limited along the longitudinal profile.

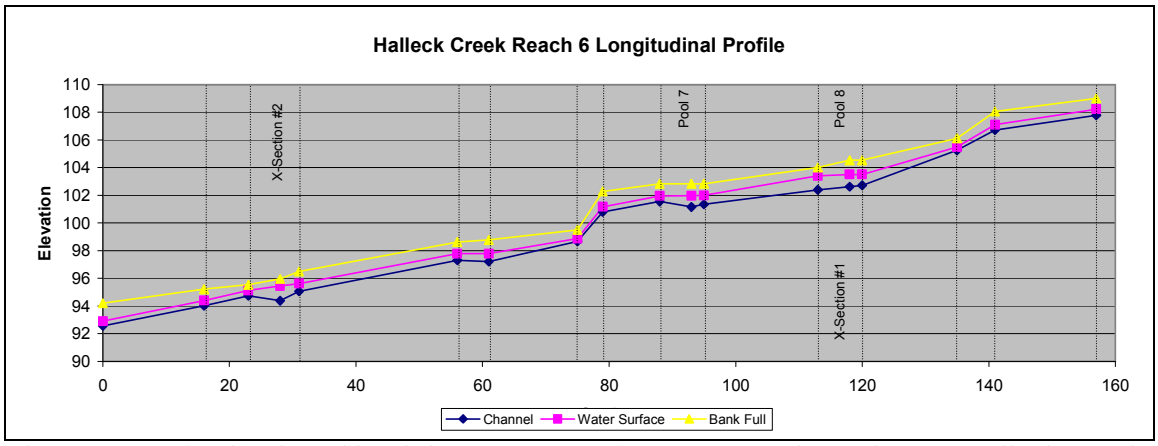


Chart 4: Longitudinal Profile of the representative segment of Reach 6 on Halleck Creek.

A longitudinal profile (Chart 4) of the stream channel and the two cross-sections were established in July 2007. Stream flow was measured at cross-section #1, using a Marsh-McBirney FlowMate 2000 flow meter, and was calculated to be 2 cfs. The longitudinal profile is typical of the steeper Ba channel type, characterized by high gradient and infrequent pool habitat. The

average slope of the channel and the water surface throughout the profile was 9.7%, and the slope of the bank full elevation was 9.4%. Riffle slopes ranged from 8% to 13%, with two transitional areas exhibiting slopes of 4% to 6%. These transitional segments in the riffles are identified for conversion to pool habitat in the habitat enhancement plan. Stream channel sinuosity was low (<1.5) in the representative sub-reach, as would be expected for a Ba type channel.

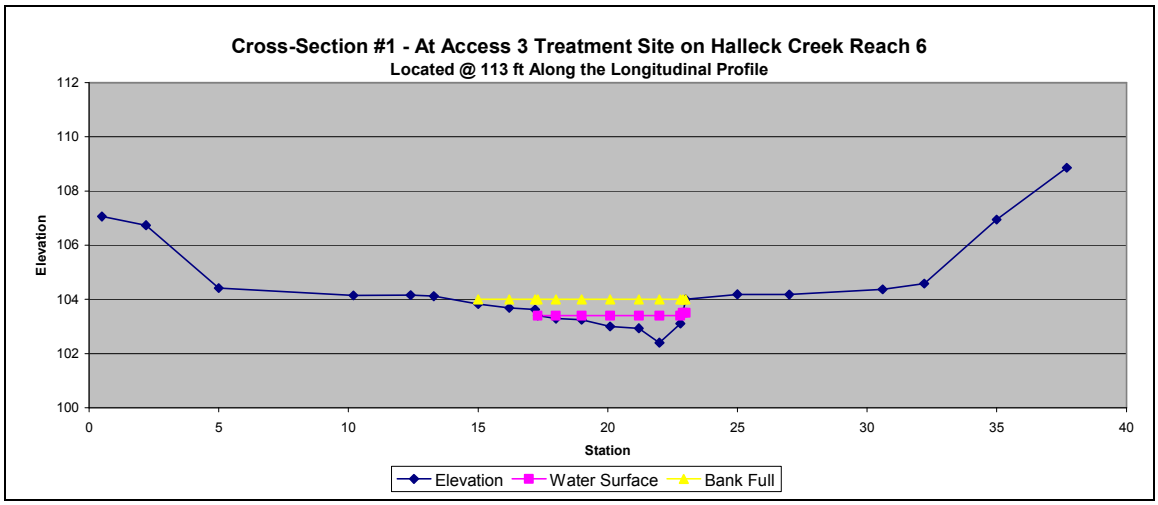


Chart 5: Cross Section #1 on Halleck Creek.

Cross-sections #1 and #2 show the moderately entrenched characteristics of the stream channel within the reach. Entrenchment ratios of 3.2 and 2.3 were observed at each cross-section. Width/depth ratios were calculated to be 12 and 14. Entrenchment ratios and W/D ratios were slightly higher than expected for a Ba channel type, but were likely due to the locating of the cross-sections at brief low gradient transitional areas within the representative sub-reach. The cross-sections bisect the creek at Pool 8 and a new pool described later in this document.

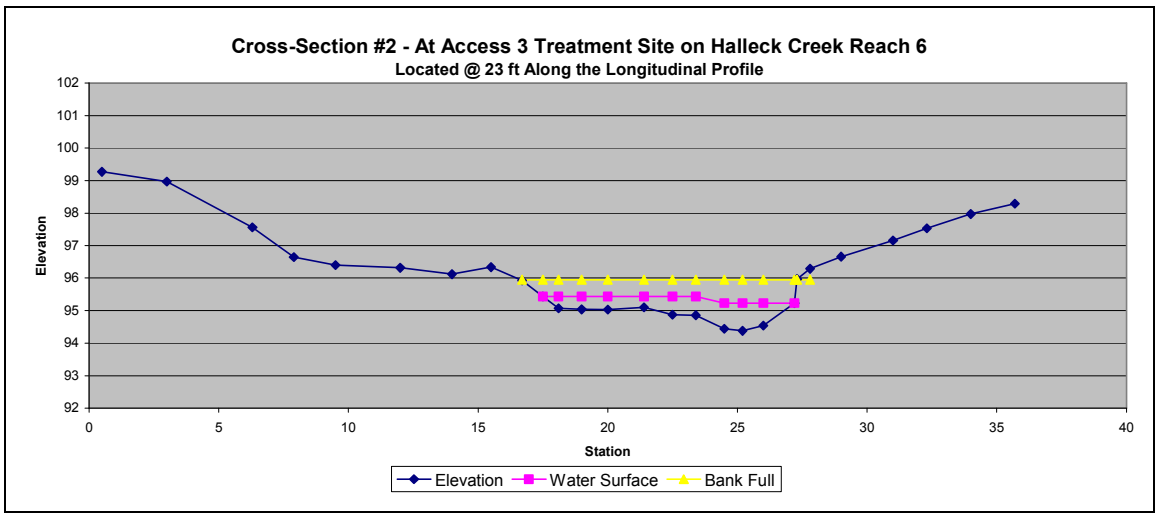
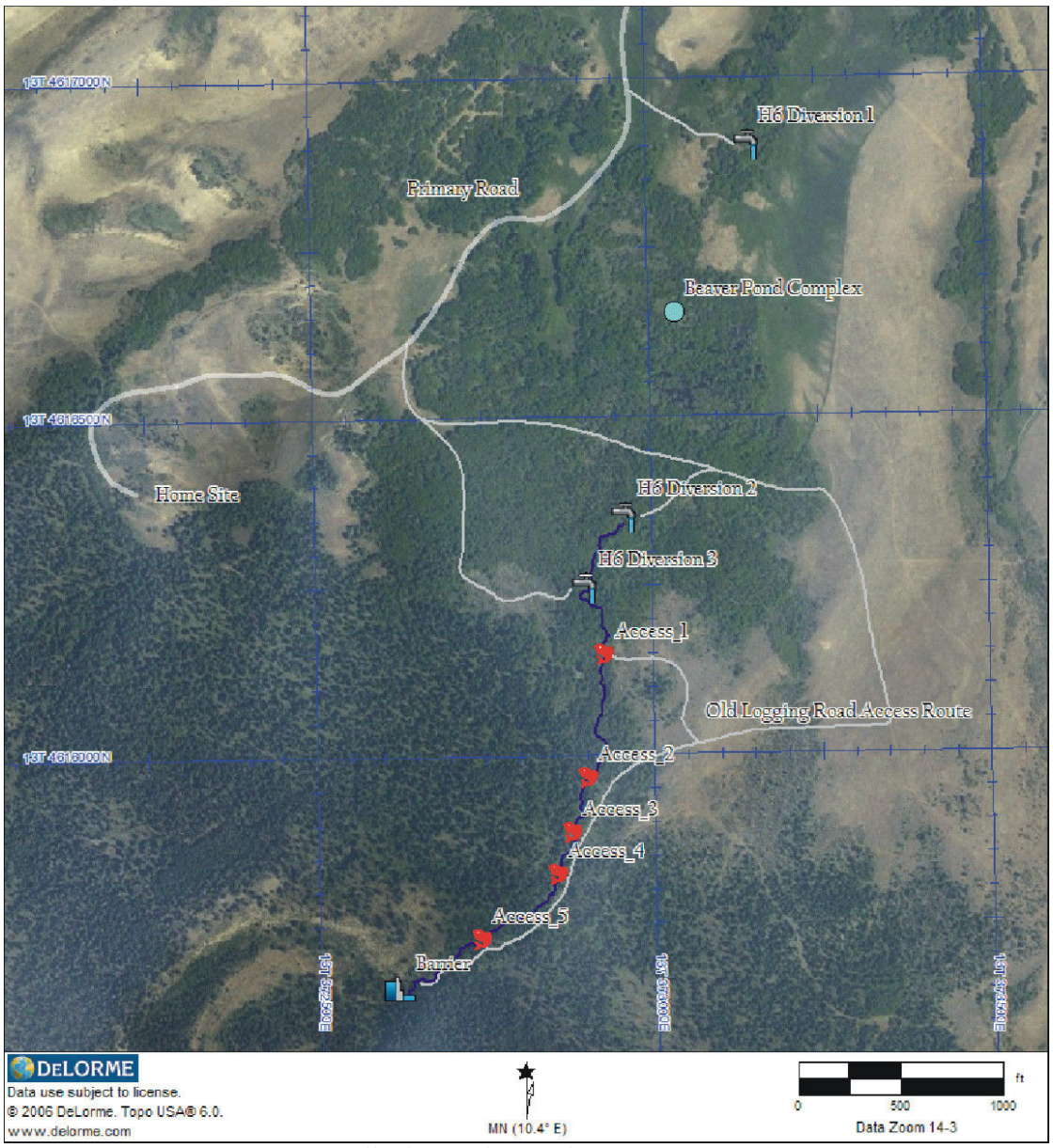


Chart 6: Cross-Section #2 on Halleck Creek.

A modified Z-Walk pebble count (Bevenger, USDA 1996) was collected within the representative sub-reach to characterize the channel substrate and stream bank particle size. The results of this survey are shown in the table below. Fine particles of sand comprise only 7% of the substrate composition, with the median particle size comprised of very coarse gravel. The D84 particle size in the reach is estimated to be comprised of large cobble measuring approximately 128mm along the medial axis. Stream substrate appears to be well armored throughout the study reach, effectively limiting pool scour and depth. Stream banks were found to be well armored throughout the sub-reach, with bank rock content composed primarily of large and small cobble.

Z-Walk		Class		Total	% of	Cumulative
Metric - mm	Inches	Name		Number	Total	%
less .066		Silt/Clay			0.0%	0.0%
.062-.125		Very Fine	SAND		0.0%	0.0%
.125-.25		Fine	SAND		0.0%	0.0%
.25-.50		Medium	SAND	5	4.0%	4.0%
.50-1.0		Coarse	SAND	2	1.6%	5.6%
1.0-2.0		Very Coarse	SAND	2	1.6%	7.2%
2.0-4.0		Very Fine	GRAVEL	1	0.8%	8.0%
4.0-8.0		Fine	GRAVEL	6	4.8%	12.8%
8.0-16	.08-.6	Medium	GRAVEL	6	4.8%	17.6%
16-32	.6-1.3	Coarse	GRAVEL	18	14.4%	32.0%
32-64	1.3-2.5	Very Coarse	GRAVEL	31	24.8%	56.8%
64-128	2.5-5.0	Small	COBBLE	36	28.8%	85.6%
128-256	5-10	Large	COBBLE	9	7.2%	92.8%
256-512	10-20	Small	BOULDERS	6	4.8%	97.6%
512-1024	20-40	Medium	BOULDERS	3	2.4%	100.0%
1024-2048	40-80	Large	BOULDERS		0.0%	100.0%
2048-4096	80-160	Very Large	BOULDERS		0.0%	100.0%



Map 2: Halleck Creek Reach 6 Treatment Sites.

Halleck Creek Reach 6 Aquatic Habitat Enhancement Plan

The aquatic assessment indicates that poor pool development, insufficient residual pool depth, and lack of cover are significant limits to the viability of a trout fishery in the headwaters of Halleck Creek. Overwintering habitat is rare within the reach, due to large cobble and small boulder substrates effectively armoring the stream bed and preventing scour and formation of deeper pool habitats. Downstream of the irrigation diversions, water depletion further limits available habitat in summer months. Upstream of the diversions, the stream does present an opportunity for aquatic habitat enhancement to

improve the existing brook trout fishery. The old logging road on the east side of the stream in the upper half of the reach will allow for a small excavator to access the stream to improve existing pool habitats and create new ones. A detailed habitat enhancement plan for the reach has been developed with the goal of increasing pool depth and complexity, as well as providing enhanced "pocket water" cover habitats in the riffles.

The following chapter will describe the specific treatments recommended to address the limiting factors identified in the aquatic habitat assessment and inventory. Each treatment site will be described in detail. Recommended treatments include improving scour in the pools by removing large cobble and boulder armoring the bottom of the channel. These excavated materials may be used to construct boulder cross vanes to focus flow and scour in the pools, and for the installation of boulder micro-vortex pocket water structures in some of the riffles. At the same time, the diversion structures will be reconstructed as boulder cross vanes in order to eliminate aquatic organism migration barriers, reducing yearly maintenance needs and cost, and providing additional habitat for fish. Technical drawings of the specific treatment types may be found in the appendix of this document.

For the purposes of the stream aquatic habitat enhancement plan, treatment sites were identified and numbered consecutively beginning at the downstream boundary of the reach and continuing upstream. All directional references to stream banks and other features are from a fisheries biologist's perspective, with left and right banks determined looking upstream along the channel.

Reach 6:
The Project area along Reach 6 on Halleck Creek extends from the point where the Halleck Creek crosses the east/west ATV access route, near the NE 1/4 of the SW 1/4 of R.81 W., T.20 N., Sec. 20., upstream to a bedrock falls creating a barrier to fish passage. Several ATV access trails access diversion structures in the lower segment of the project area, and an old logging road / skid trail parallels the creek along the east side of the upper half of the project area, terminating a short distance below the barrier. This old road provides good access to the creek for equipment at five locations. Access routes have been mapped, using a GPS, for the project and are shown in Map 2 on the preceding page and included in the Appendix.

Most of the enhancement activity will focus on enhancing pool depth and scour within existing pool habitats within the five sites. This work will entail removing large cobble and small boulder from the pool habitats with a small (<10,000lb) excavator with a hydraulic thumb. Substrates removed from the stream channel will be relocated well away from the stream and surrounding riparian / water influence zones. Some of the larger boulders removed from the pools will be utilized to re-configure the pool crest in order to provide for more efficient scour through the habitat.

Additionally, several new pool habitats will be developed at suitable sites within the stream channel at each treatment site. Large wood will be incorporated into the channel to provide additional cover and scour. Several potential barriers to

fish passage will be adjusted to improve migration through the reach. However, the large bedrock barrier at the upstream boundary of the project area will not be addressed under this project. All of the treatment sites are accessible only because they are situated along old skid trails that were never properly closed and rehabilitated. Stream banks along these old trails will be stabilized and revegetated. Over-wide stream channels at these crossings will be narrowed using log-toe slope bank treatments to redefine the stream channel. One of these crossings will remain open to allow ranch workers access to the forest on the west side of the stream. This crossing will be hardened to minimize impacts to improved habitats downstream.

Treatment Site Access_1:

Treatment Site Access_1 is located approximately 420 feet upstream of the 3rd Diversion on Halleck Creek. There is a faint remnant of a skid trail accessing the creek through the aspen forest on the east side, and this path appears to be regularly used by elk and cattle. The stream channel at the site is somewhat over-wide, due to tramping of the stream banks. A cross-section of the stream at the crossing shows a bank full width of >22 ft, a width/depth ratio in excess of 16 (Chart 7). A boulder cross vane will be installed immediately upstream of the crossing, and the cobble armoring the channel will be excavated to create a large plunge pool, with a maximum depth of 2 ft and a residual pool depth of 1.3 - 1.6 ft. Some of the excavated cobble may be used to reinforce the riffle crest and tail of the pool, creating crossing and watering site for elk and cattle utilizing the path. Two large logs will be used to redefine and protect the stream banks on either side of the new pool. Native willow and alder will be planted behind these logs to establish robust streamside vegetation. Large wood will be placed along the path above the ordinary high water mark of the stream in order to direct elk and cattle towards the hardened pool tail and riffle crest to protect the newly vegetated stream banks along the constructed pool. The structures in Access_1 will require 12 - 15 boulders and 6 trees to complete. Estimated fill below the ordinary high water mark of the stream is 6 to 7 yd^3 for the cross vane structure, and 0.2 yd^3/linear ft of log toe slope stabilization (4 yd^3 total).

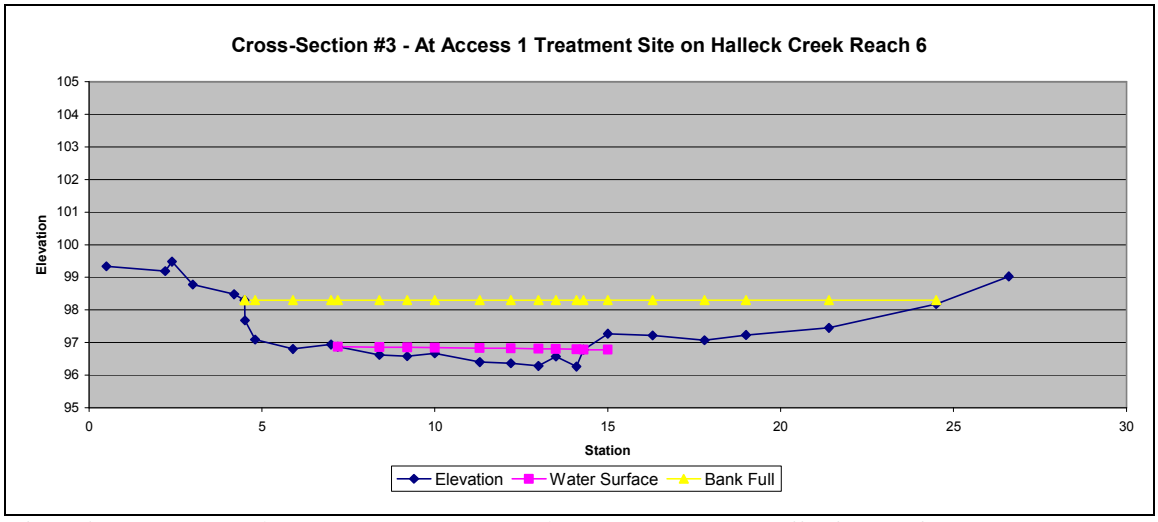


Chart 7: Cross-Section #3 at Treatment Site Access_1 on Halleck Creek.

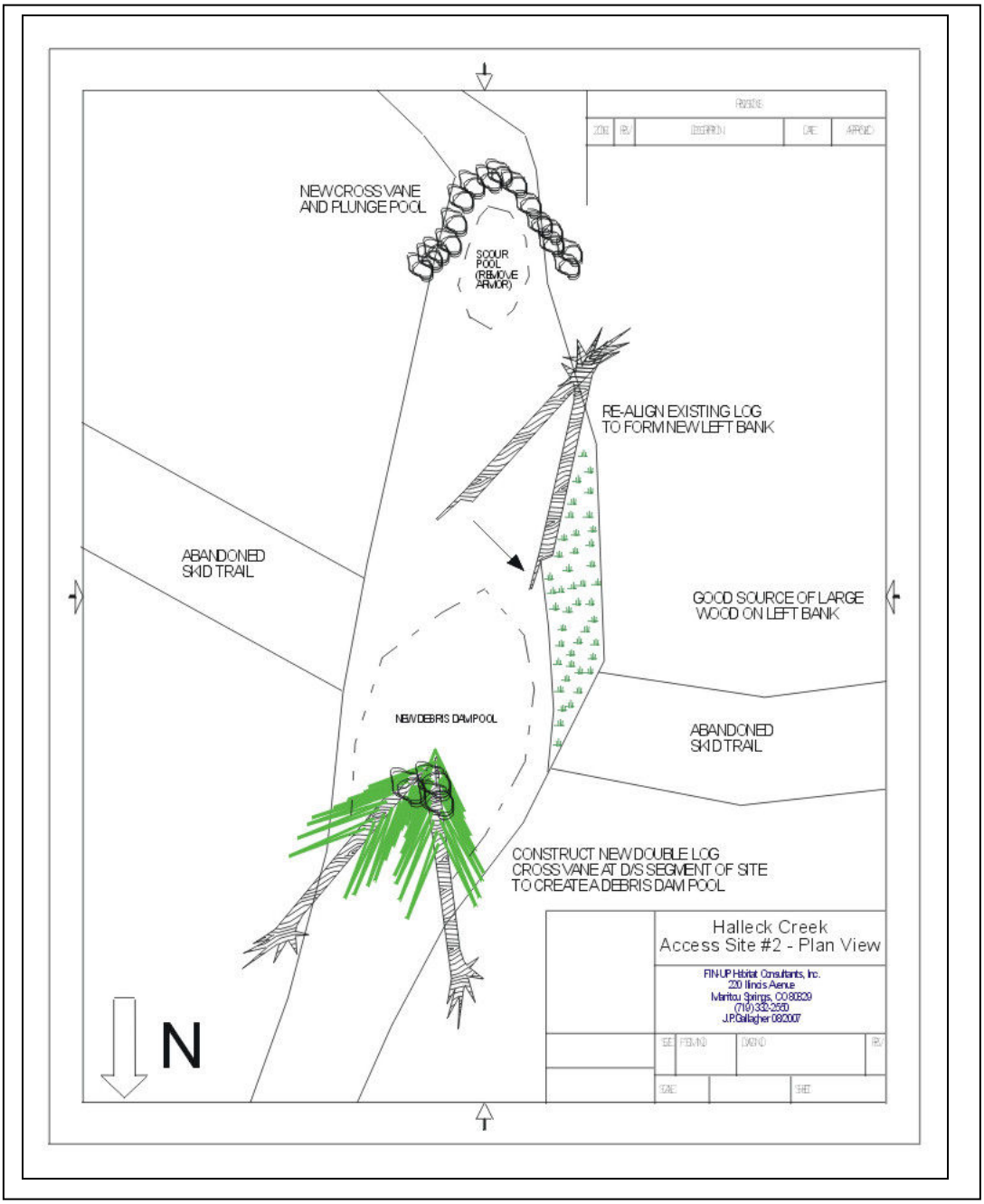


Photo 3: Treatment Site ACCESS_2 on Halleck Creek - looking upstream.

Treatment Site Access_2:
Treatment Site Access_2 is located approximately 700 feet upstream of Access_1 on Halleck Creek. Access to the treatment site is along an abandoned skid trail on the east side of the stream. The treatment site is approximately 75 ft in length, and exhibits an over wide bank full width and poor width/depth ratio throughout. Sediment is actively being contributed to the site from the left bank skid trail crossing. A plan view drawing of the proposed treatments at Access_2 is shown in the diagram on the left.

A boulder cross vane will be installed at the upstream boundary of the treatment site to create a new large plunge pool. Cobble armoring the channel at this new pool site will be excavated to maximum depth of 2 ft and a residual pool depth of 1.3 - 1.6 ft. It is estimated that the cross vane will require from 8 to 12 boulders to complete.

An existing piece of large wood in the stream channel will be re-positioned in order to create a new bank-full bench on the west side of the stream channel. Additional wood may be added to redefine a new narrower channel through the old skid trail crossing. Areas behind these large wood bank features will be revegetated using sedge mats, willows and alder harvested from nearby areas. Wood and willows for this segment of the work will be harvested from an area along the skid trail to the west of the treatment site.

Two medium sized trees (DBH = 14" - 16") will be directionally felled into the stream channel at the constriction downstream of the skid trail crossing to create a new woody debris dam pool. These trees will be dropped into the channel with their root-wads intact, to ensure that these features do not move during peak spring run-off flows. Disturbed areas around the base of the trees will be contoured and revegetated to prevent bank erosion at these points. Gradual accumulation of woody debris in this debris jam should create a new dam pool approximately 2 -2.5 feet deep and approximately 20 feet long.

Upon completion of the channel and bank stabilization work, the skid trail approaches on either side of the stream will be obliterated and re-seeded. The steeper east side approach will require one or two water-bars be installed to ensure that the skid trail and adjacent logging road are effectively disconnected from the stream.

The in-channel and bank stabilization work in Access_2 will require 16 - 20 boulders and up to 5 trees to complete. Estimated fill below the ordinary high water mark of the stream is 4 to 6 yd^3 each for the cross vane structure and woody debris dam pool, and 0.2 yd^3/linear ft for the log toe slope stabilization (4 yd^3 total).

Treatment Site Access_3:
Treatment Site Access_3 is located approximately 320 feet upstream of Access_2. Access to the treatment site is along a skid trail on the east side of the stream. This access route has been identified by the ranch as necessary to access the lands on the west side of the creek, and therefore will not be oblit-erated under this project. The treatment site is approximately 175 ft in length,

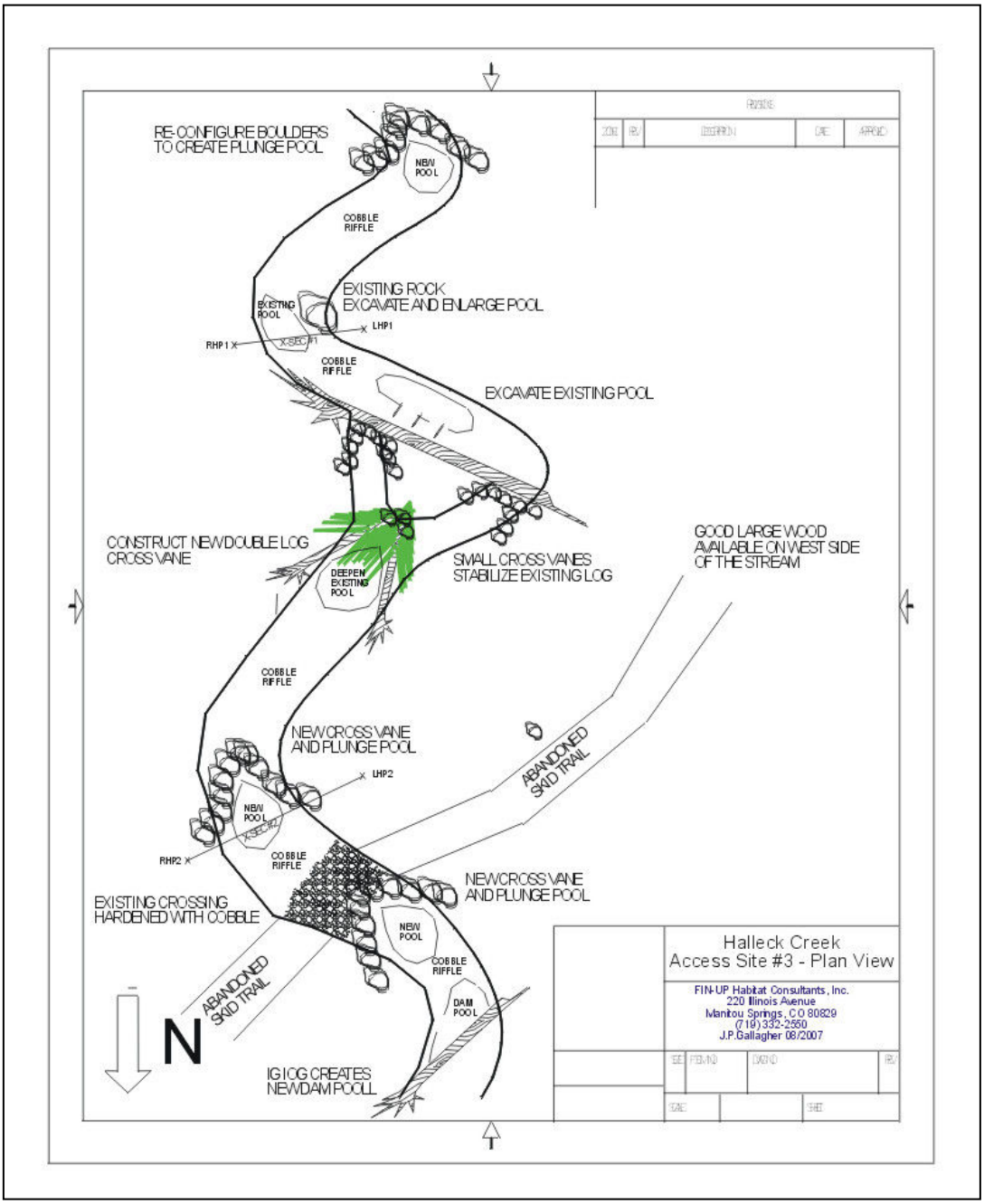


Photo 4: Treatment Site ACCESS_3 on Halleck Creek - from the left stream bank.

with good access for a small excavator throughout the segment. A plan view drawing of the proposed treatments at Access_3 is shown in the diagram on the left. Treatments will be described beginning at the downstream boundary of the segment.

A large log vane will be installed near the bottom of the site to create a new dam pool. Some small cobble will be removed from upstream of this feature to create additional depth in the pool. The new maximum depth of the pool will be 2.0 ft. Cobble removed from this habitat will be used to harden the skid trail crossing described below.

A boulder cross-vane will be installed immediately downstream of the skid trail crossing in order to maintain the channel grade at the crossing. A new plunge pool will be excavated immediately downstream of the structure. The maximum depth of the pool will be 1.5 -1,7 ft, and the RPD will be 1.0 to 1.2 ft. Suitable materials from this excavation will be used to harden the crossing and approach slopes. Any excess materials will be completely removed from the site. Channel width at the crossing will be less than 12 ft in order to maintain adequate depth along the crossing during low flow to allow for fish passage. Another boulder cross-vane and new plunge will be installed at Cross-section #2, approximately 15 ft upstream of the skid trail crossing. The new pool will be 1.7 - 2.0 ft deep with a RPD of 1.3 -1.5. Excavated cobble will be removed from the site.

A double log cross-vane and new plunge pool will be installed downstream of the split channel in the middle of the site. The logs will be placed so that each vane ties into the mid-channel island immediately upstream. The new pool will be excavated to 1.7 - 2.0 ft deep with a RPD of 1.3 -1.5. Small boulder clusters will be installed at the head of each of the split channels in order to stabilize the log-jam pool upstream, and to provide pocket water features within this high gradient riffle habitat. The boulders will be placed in a manner that will form step pools to allow for fish passage at low flows. The existing pool upstream of the log-jam will be deepened to 1.5 ft by excavating cobble from along the right bank. This will also create some under-cut combination cover along the well vegetated stream bank.

The existing pool at Cross-section #1 will be enlarged and enhanced by removing cobble armoring the bottom of the pool to obtain a maximum depth of 1.5 - 1.7ft. At the upstream boundary of the site, a new pool will be constructed by re-aligning existing boulders in the stream channel into a boulder cross-vane structure. The new pool will be 1.7 - 2.0 ft deep with a RPD of 1.3 -1.5 ft.

The in-channel and bank stabilization work in Access_3 will require 35 - 40 boulders and up to 3 trees to complete. Estimated fill below the ordinary high water mark of the stream is 4 to 6 yd^3 each for the cross vane structure and the double log cross-vane pool, and 2 yd^3 for hardening the low water crossing at the existing skid trail.

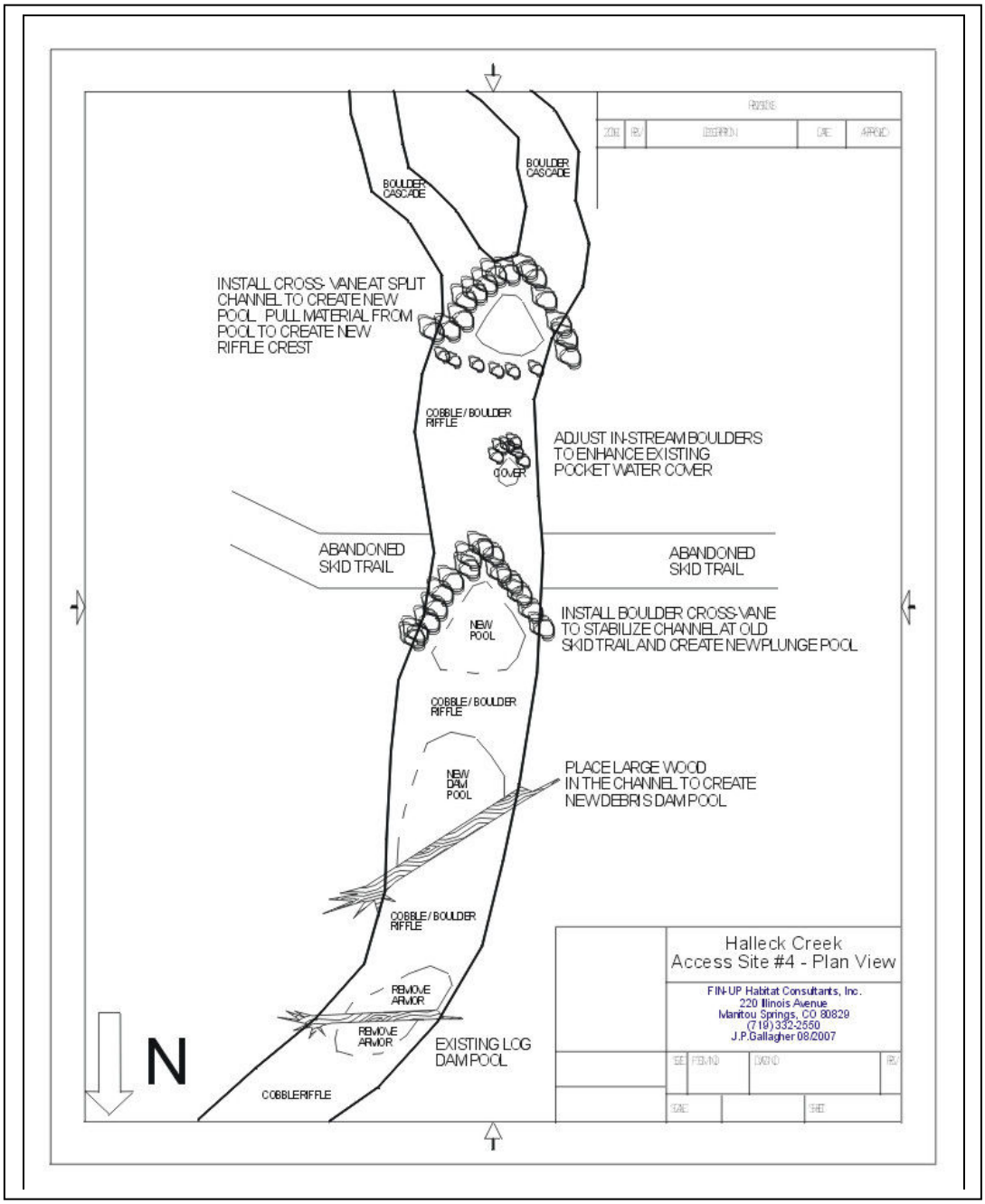


Photo 5: Treatment Site ACCESS_4 on Halleck Creek - from the left stream bank.

Treatment Site Access_4:

Treatment Site Access_4 is located approximately 40 feet upstream of Access_4. Access to the treatment site is along a skid trail on the east side of the stream. The treatment site is approximately 125 ft in length, with good access for a small excavator throughout the segment. A plan view drawing of the proposed treatments at Access_4 is shown in the diagram on the left. Treatments will be described beginning at the downstream boundary of the segment.

The two existing pools at the downstream boundary of the site (BWSHI pools 9 & 10) will be enhanced by excavating cobble armor from the bottom of each pool to create a new maximum depth of 1.7 - 2.0 ft deep with a RPD of 1.3 -1.5 ft. The large log associated with these habitats will not be disturbed. A new log vane will be installed in the riffle upstream of these pools to form a new log-jam debris dam pool. Some minor excavation of the channel upstream of this log will be necessary to create a pool.

A boulder cross-vane will be installed immediately downstream of the skid trail crossing in order to maintain the channel grade at the crossing. A new plunge pool will be excavated immediately downstream of the structure. The maximum depth of the pool will be 1.5 -1,7 ft, and the RPD will be 1.0 to 1.2 ft. Excavated material will be completely removed from the site. The skid trail approach slopes will be ripped and revegetated, and the stream banks at the crossing will be planted with willow and alder. If necessary, log toe-slope bank stabilization structures may be used at the crossing to provide adequate foundation for re-establishing vegetation.

Pocket water cover will be created in the riffle upstream of the skid trail crossing by manipulating existing boulders into small micro-vortex boulder clusters. Up to three of these cover features may be installed in the site.

A new full-channel boulder cross-vane and plunge pool will be constructed at the upstream boundary of Access_4. This structure will be located immediately downstream of a multiple-thread boulder cascade, at a brief, low gradient transition in the stream channel. Cobble armoring the channel below the cross-vane will be excavated and removed from the site. Additionally, small boulders in the habitat will be re-positioned to create a new, slightly higher riffle crest to further deepen and enhance the new pool. The new pool will have a targeted maximum depth of 1.7 - 2.0 ft deep with a RPD of 1.3 -1.5 ft.

The in-channel and bank stabilization work in Access_4 will require 20 - 25 boulders and up to 3 trees to complete. Estimated fill below the ordinary high water mark of the stream is 4 to 6 yd^3 each for the cross vane structures and the log-vane pool, and 0.2 yd^3/linear ft for the log toe slope stabilization (4 yd^3 total).

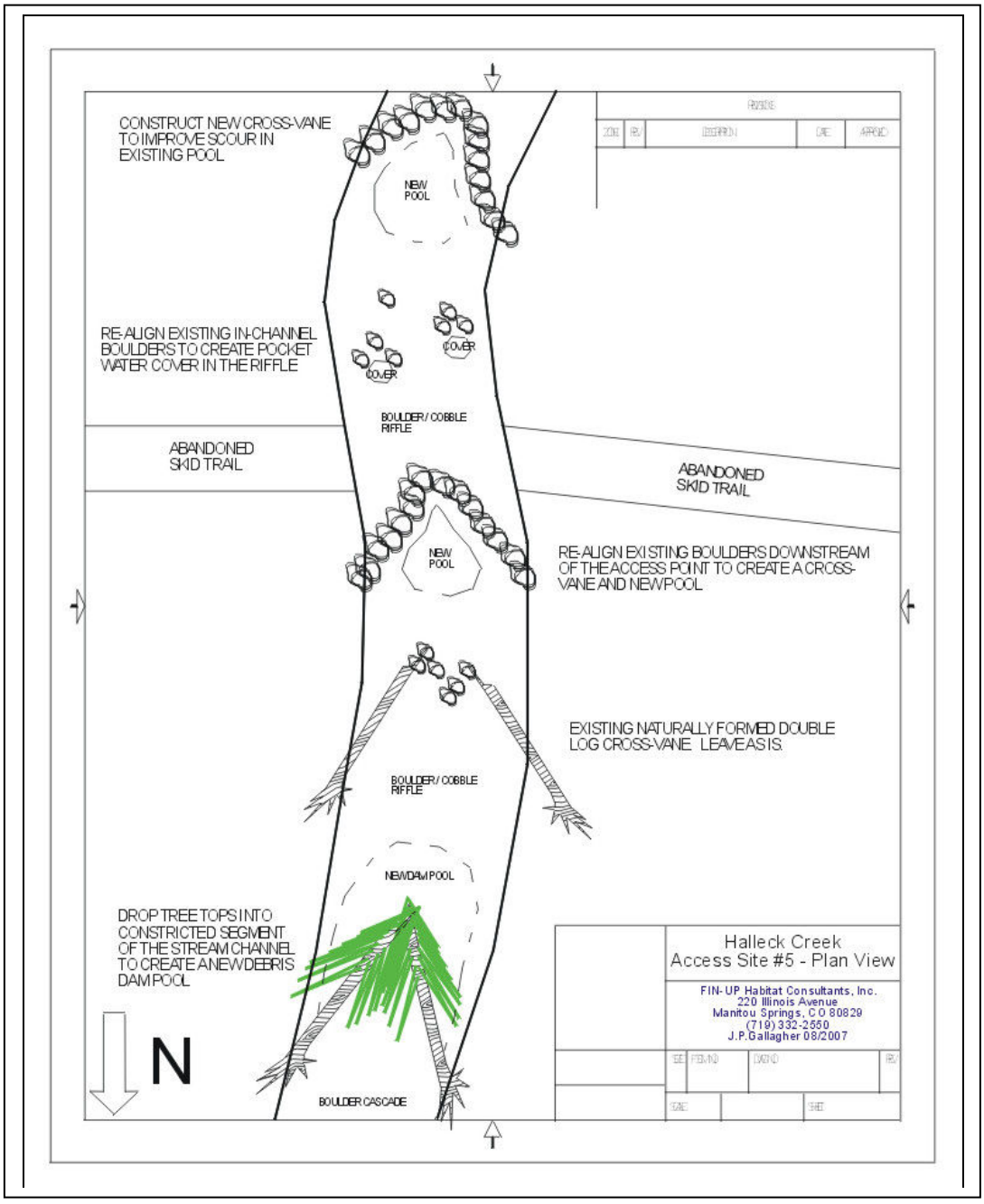


Photo 6: Treatment Site ACCESS_5 on Halleck Creek - from the right stream bank.

Treatment Site Access_5:

Treatment Site Access_5 is located approximately 570 feet upstream of Access_5. Access to the treatment site is along a skid trail on the east side of the stream. The treatment site is approximately 80 ft in length, exhibiting generally sparse riffle habitat with little or no cover. A plan view drawing of the proposed treatments at Access_5 is shown in the diagram on the left. Treatments will be described beginning at the downstream boundary of the segment.

Two medium sized trees (DBH = 14" - 16") will be directionally felled into the stream channel at the constriction at the downstream boundary of Access_5 to create a new woody debris dam pool. These trees will be pushed down into the channel with their root-wads intact, to ensure that these features do not move during peak spring run-off flows. Disturbed areas around the base of the trees will be contoured and revegetated to prevent bank erosion at these points. Gradual accumulation of woody debris in this debris jam should create a new dam pool approximately 2 -2.5 feet deep and approximately 20 feet long.

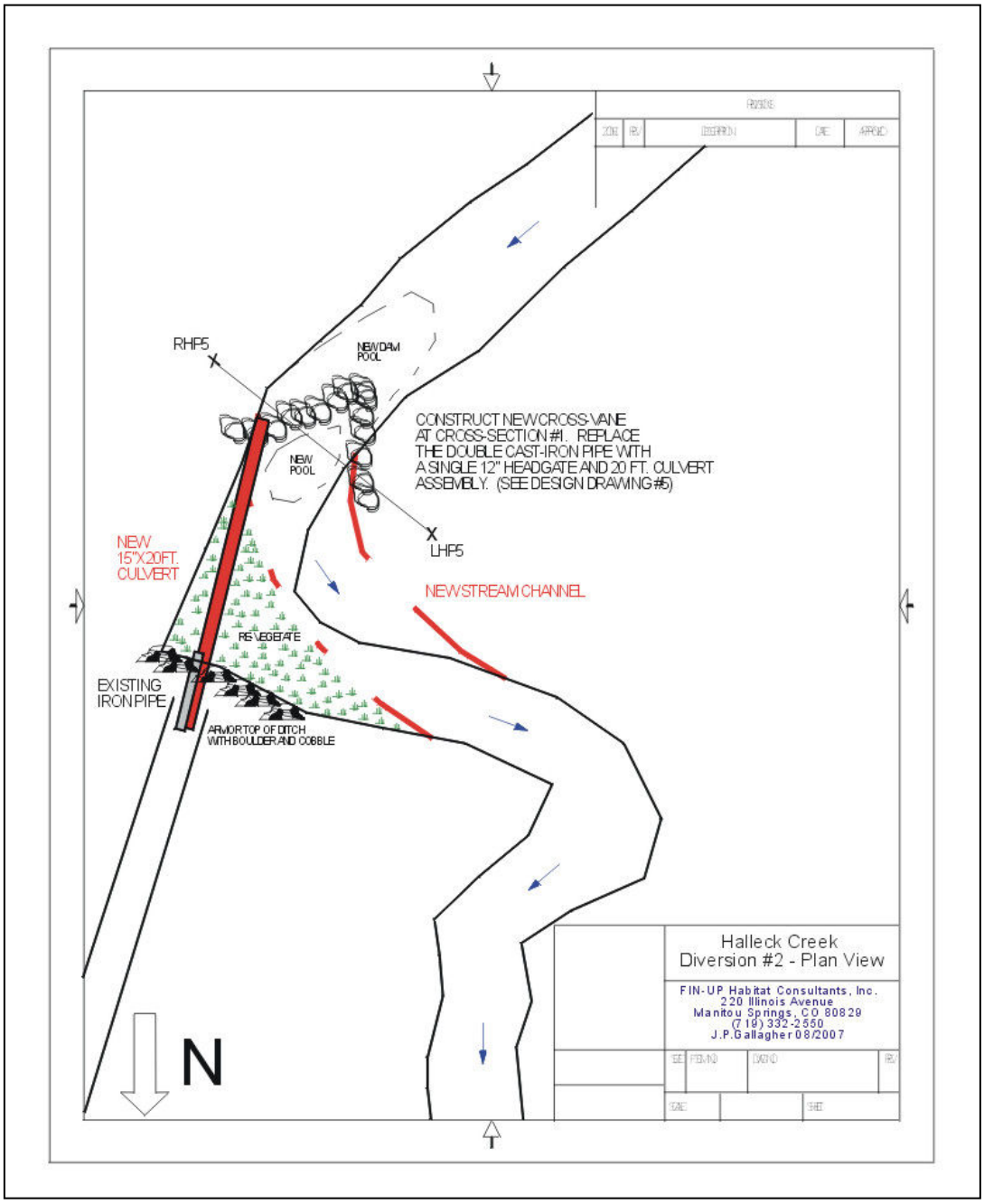
An existing naturally formed double log cross-vane is found in the site upstream of the proposed new woody-debris dam pool. This area contains some pocket water depth in and around the logs, and will be not be altered or disturbed under this project.

A boulder cross-vane will be installed immediately downstream of the skid trail crossing by re-aligning existing boulders in the stream channel to form the cross-vane. A new plunge pool will be excavated immediately downstream of this structure. The maximum depth of the pool will be 1.5 -1,7 ft, and the RPD will be 1.0 to 1.2 ft. Excavated material will be completely removed from the site. The skid trail approach slopes will be ripped and revegetated, and the stream banks at the crossing will be planted with willow and alder. If necessary, log toe-slope bank stabilization structures may be used at the crossing to provide adequate foundation for re-establishing vegetation.

Pocket water cover will be created in the riffle upstream of the skid trail crossing by manipulating existing boulders into small micro-vortex boulder clusters. Up to three of these cover features may be installed in the site.

A new full-channel boulder cross-vane and plunge pool will be constructed at the upstream boundary of Access_5, at a brief, low gradient transition in the stream channel. Cobble armoring the channel below the cross-vane will be excavated and removed from the site. The new pool will have a targeted maximum depth of 1.7 - 2.0 ft deep with a RPD of 1.3 -1.5 ft.

The in-channel and bank stabilization work in Access_5 will require 20 - 25 boulders and up to 3 trees to complete. Estimated fill below the ordinary high water mark of the stream is 4 to 6 yd^3 each for the two cross vane structures and the woody debris dam pool, and 0.2 yd^3/linear ft for the log toe slope stabilization (4 yd^3 total).



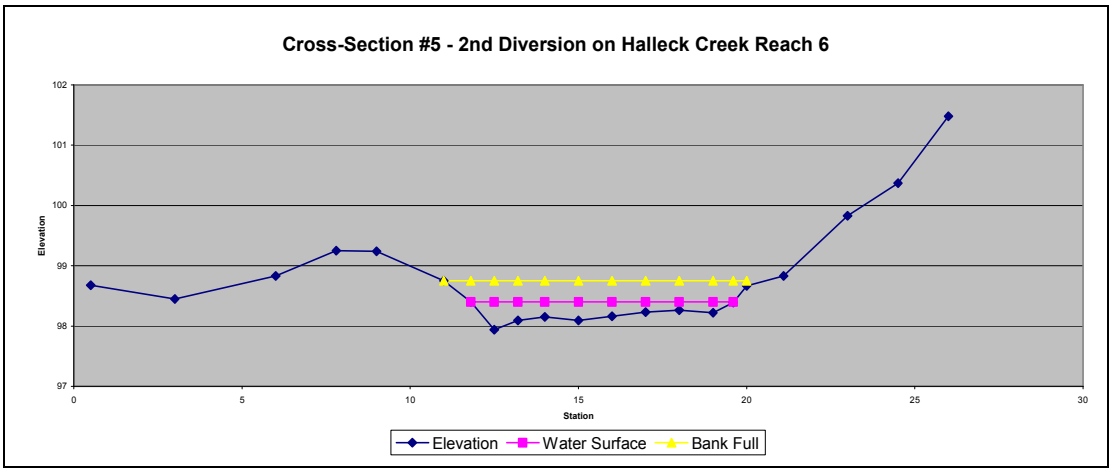


Chart 8: Cross-Section #5 at the 2nd Diversion on Reach 6 of Halleck Creek.

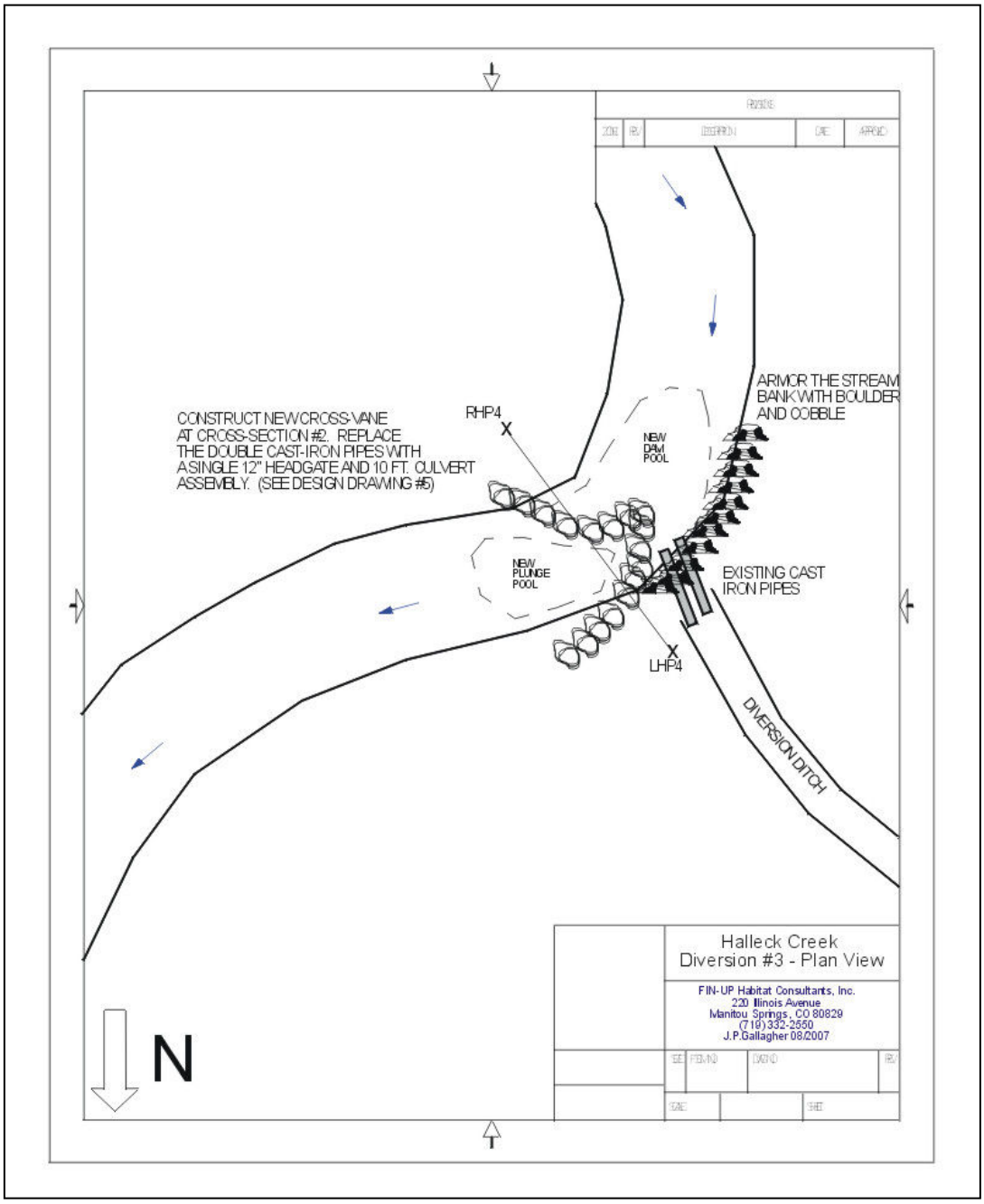
Treatment Site H6 Diversion 2:

Treatment Site H6 Diversion 2 is located near the downstream boundary of Halleck Creek Reach 6, and is approached from an ATV access route that parallels the irrigation ditch feeding the pasture lands between the main stem of Halleck Creek and Halleck#4 Creek to the east. H6 Diversion 2 is approximately 450 ft upstream of the east/west ATV access route that defines the downstream boundary of the project area. The existing diversion structure at H6 Diversion 2 consists of a 12" cast iron pipe embedded into an earthen berm consisting mostly of small cobble and gravel. The diversion is at a sharp, 90 degree bend that appears to have been constructed when the diversion was installed. Downstream of this point, there is a brief higher gradient riffle leading to the undisturbed stream channel below. The "head-gate" control on this diversion consists of a steel cap that seals the end of the pipe extending into the stream. In order for the diversion to function, a "come-a-long" block and tackle must be fastened to trees upstream of the pipe, and the cap forced open and held in place (Photo 7).

In addition to being difficult to operate, the diversion at H6 Diversion 2 is at risk of catastrophic failure from high flows breaching the earthen berm creating the artificially tight meander bend. If the existing structure were to be over-topped and fail, there is a high probability that the stream could re-align into the diversion ditch, creating significant problems downstream along the ATV access trail and in the pasture lands below. Additionally, the current structure, as configured, presents a significant barrier to fish and other aquatic organisms moving through the reach.

To reduce the risk of failure and improve the functionality of the diversion, a new 12" culvert and screw-type head-gate will be installed approximately 15 feet upstream of the present diversion point. This culvert and head-gate will be incorporated into a boulder cross vane that will provide sufficient stage at low flow to provide full capacity to the pipe leading to the diversion ditch. Downstream of the new cross-vane diversion structure, the stream channel will be re-aligned to reduce the radius of curvature of the meander bend and create a more consistent channel bed and water surface slope through the pocket water riffle below. Approximately 15 feet of stream channel will need to be re-aligned toward the right bank. Willow and alder vegetation removed along the right bank will be used to create a new bank-full riparian bench on the left bank at the old diversion point. Additionally, the existing earthen berm will be raised and re-enforced to ensure that the stream does not over-top this structure.

Photo 7: Diversion 2 looking downstream



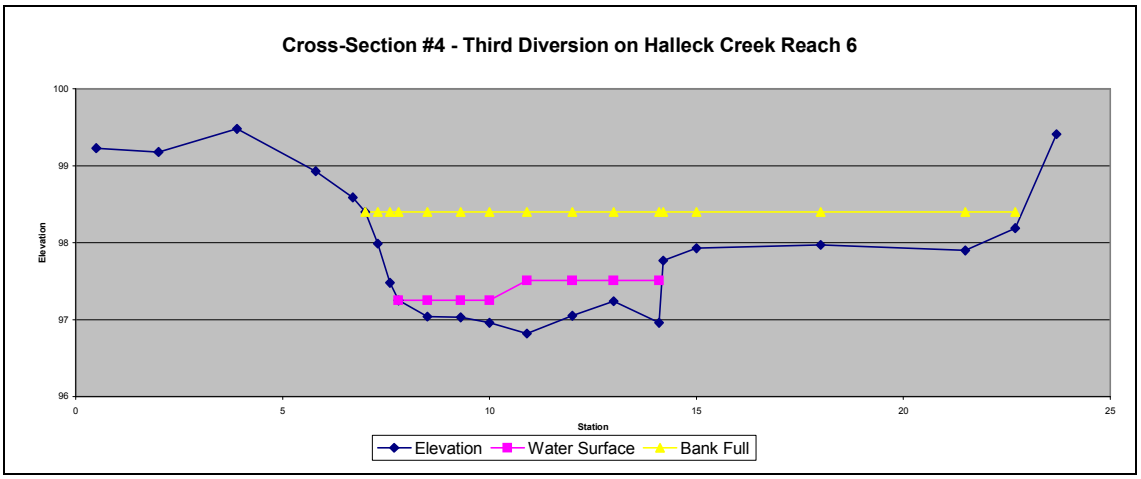


Chart 8: Cross-Section #4 at the 3nd Diversion on Reach 6 of Halleck Creek.

In addition to addressing the potential barrier by reducing the channel bed and water surface slope of the riffle immediately downstream of the diversion, additional cover and pool habitat will be gained by selectively removing cobble armoring the channel bed immediately upstream and downstream of the new boulder cross-vane to create a new dam pool and plunge pool above and below the structure.

Treatment Site H6 Diversion 3:

Treatment Site H6 Diversion 3 is located approximately 450 ft upstream of H6 Diversion 2, and is approached from an ATV access route leading from the intersection of the Main Ranch road and the east / west ATV route defining the downstream boundary of the project area. The existing diversion structure at H6 Diversion 3 consists of two 12" cast iron pipes at differing elevations, embedded into an earthen berm consisting mostly of small cobble and gravel. The diversion is at a natural meander bend that does not appear to have been significantly altered when the diversion was installed. The "head-gate" control on this diversion is similar to H6 Diversion 2, and consists of a steel caps that seal the ends of the pipes extending into the stream. It does not appear necessary to use a block and tackle to keep this diversion open, however, the stream channel does appear be down-cutting to the point where water may not enter either pipe at low flows.

The diversion at H6 Diversion 3 appears to have a slight risk of catastrophic failure from high flows breaching the earthen berm, possibly resulting in an undesirable stream re-alignment into the diversion ditch. The existing irrigation ditch elevation is considerably lower than the stream channel bed elevation, and failure of the structure would likely create a head-cut that would progress upstream.

To reduce the risk of failure and improve the functionality of the diversion all flows, a new 12" culvert and screw-type head-gate will be installed at the same location as the present diversion point. This culvert and head-gate will be incorporated into a boulder cross vane that will provide sufficient stage at low flow to provide full capacity to the pipe leading to the diversion ditch. The right stream bank forming the outside of the meander bend upstream of the diversion point will be reinforced using boulder and large wood to ensure that the stream cannot re-align into the diversion ditch The existing earthen berm will be raised and re-enforced at the same time so that the stream does not over-top this structure.

Photo 9: Diversion #3 looking downstream

Fish passage through the diversion will be assured by selectively removing cobble armoring the channel bed immediately upstream and downstream of the new boulder cross-vane to create new dam pool and plunge pool habitats both above and below the diversion point.

Photo 10: Example of a Cross-Vane Diversion Structure w/Screw Type Headgate

Summary:
The table below lists the sites along Halleck Creek Reach 6 that will be treated under this project. The table includes each site name as shown on the GPS location map, the treatment type, and an estimate of cut (armor removal) and fill (installation of new structures). The project is predominately concerned with increasing pool volume, depth and cover, as well as increasing over-wintering capacity for salmonids throughout the reach.

HALLECK CREEK REACH 6		Estimated	Estimated
Site	Treatment Type	Cut (Yd3)	Fill (Yd3)
Treatment Site ACCESS_1			
	Cross-Vane - Remove Cobble Armor	0.2	7
	Log Toe Slope Structures - Bank Revegetation.		4
Treatment Site ACCESS_2			
	Tree-Top Cross-Felling to Create Debris Dam	0.2	6
	Log Toe Slope Structures - Bank Revegetation.		4
	Cross-Vane - Remove Cobble Armor	0.2	7

HALLECK CREEK REACH 6 (Continued from previous page)		Estimated	Estimated
Site	Treatment Type	Cut (Yd3)	Fill (Yd3)
Treatment Site ACCESS_3			
	Log Vane to Create New Debris Jam Pool	0.2	3
	Cross-Vane - Remove Cobble Armor	0.2	7
	Harden Skid Trail Low Water Stream Crossing		2
	Cross-Vane - Remove Cobble Armor	0.2	7
	Double Log Cross-Vane - Remove Cobble Armor	0.2	4
	Boulder Cluster / Cross-vane cascade		3
	Boulder Cluster / Cross-vane cascade		3
	Excavate Existing Pool	0.2	
	Excavate Existing Pool	0.2	
	Cross-Vane - Remove Cobble Armor	0.2	7
Treatment Site ACCESS_4			
	Excavate Existing Pool	0.2	
	Excavate Existing Pool	0.2	
	Log Vane to Create New Debris Jam Pool	0.2	3
	Cross-Vane - Remove Cobble Armor	0.2	7
	Log Toe Slope Structures - Bank Revegetation.		4
	Boulder Cluster / Micro-Vortex		2
	Boulder Cluster / Micro-Vortex		2
	Boulder Cluster / Micro-Vortex	0.2	2
	Cross-Vane - Remove Cobble Armor	0.4	7
Treatment Site ACCESS_5			
	Tree-Top Cross-Felling to Create Debris Dam	0.2	6
	Cross-Vane - Remove Cobble Armor	0.2	7
	Log Toe Slope Structures - Bank Revegetation.		4
	Boulder Cluster / Micro-Vortex		2
	Boulder Cluster / Micro-Vortex		2
	Boulder Cluster / Micro-Vortex	0.2	2
	Cross-Vane - Remove Cobble Armor	0.3	7
Treatment Site H6 Diversion 2			
	Cross-Vane - Culvert/Head-Gate Assembly	0.4	7
	Log Toe Slope Structures - Bank Revegetation.		6
Treatment Site H6 Diversion 3			
	Cross-Vane - Culvert/Head-Gate Assembly	0.4	7
	Log Toe Slope Structures - Bank Revegetation.		6

Seventeen new pool habitats will be created in the reach to provide additional over wintering habitat, depth and cover. Seven existing pools will be enhanced, and new pocket water cover micro habitats will be created in several of the longer high-gradient riffles It is estimated that the work will increase in-channel, combination and pool cover in the reach by approximately 200 square feet, increasing overall cover for trout in the reach more than 300%. Several potential barriers to fish passage will be treated within the reach, allowing movement of salmonids and other important aquatic organisms throughout the project area

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APPENDIX

Location Maps

NWI/Color IR Photo of Project Site

Stream Channel Structure and Treatment Drawings

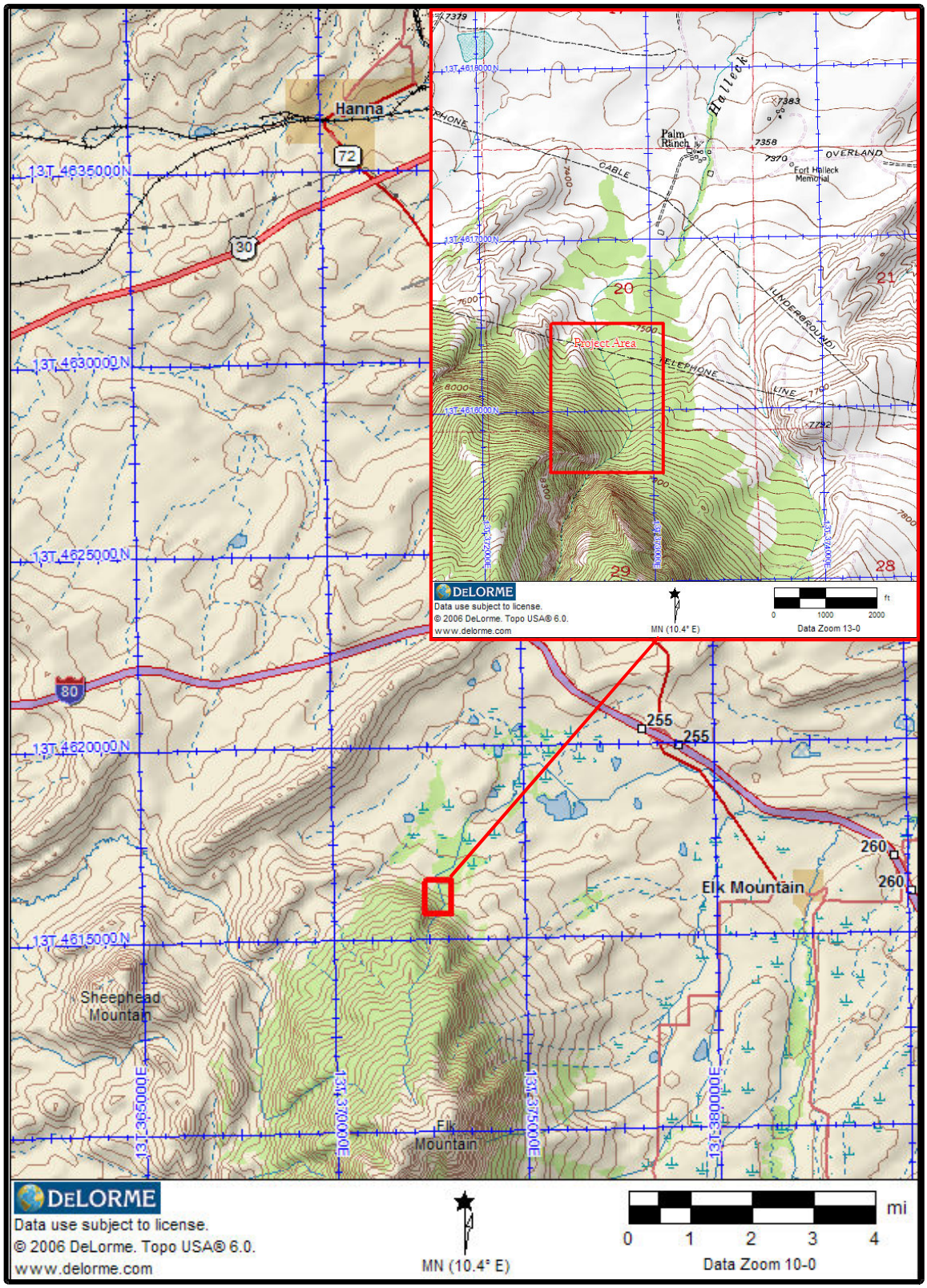
Photographic Representations of Treatment Types

Longitudinal Profile & Cross Section Plots

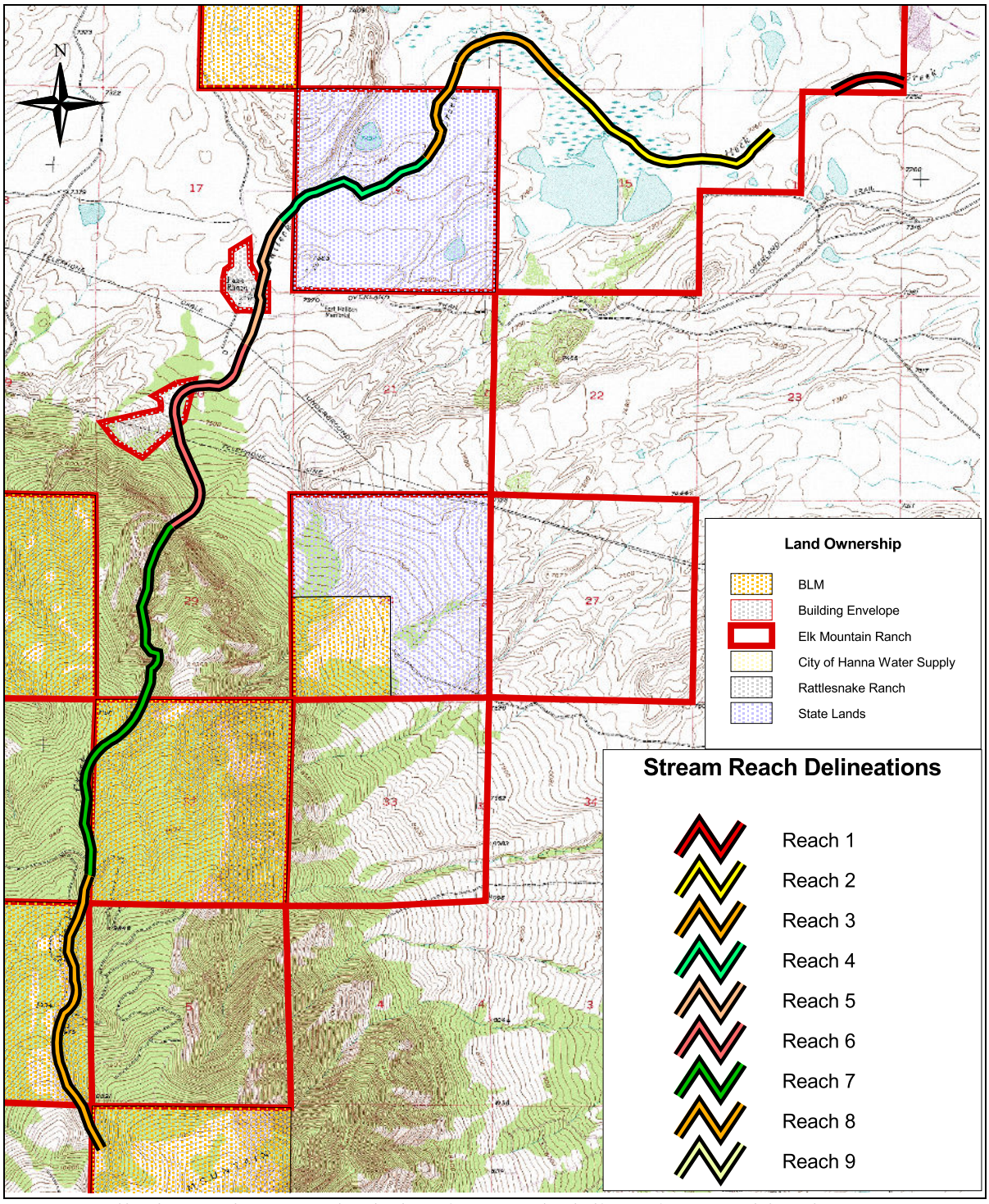
Basin-wide Stream Survey (BWSHI) Data

References

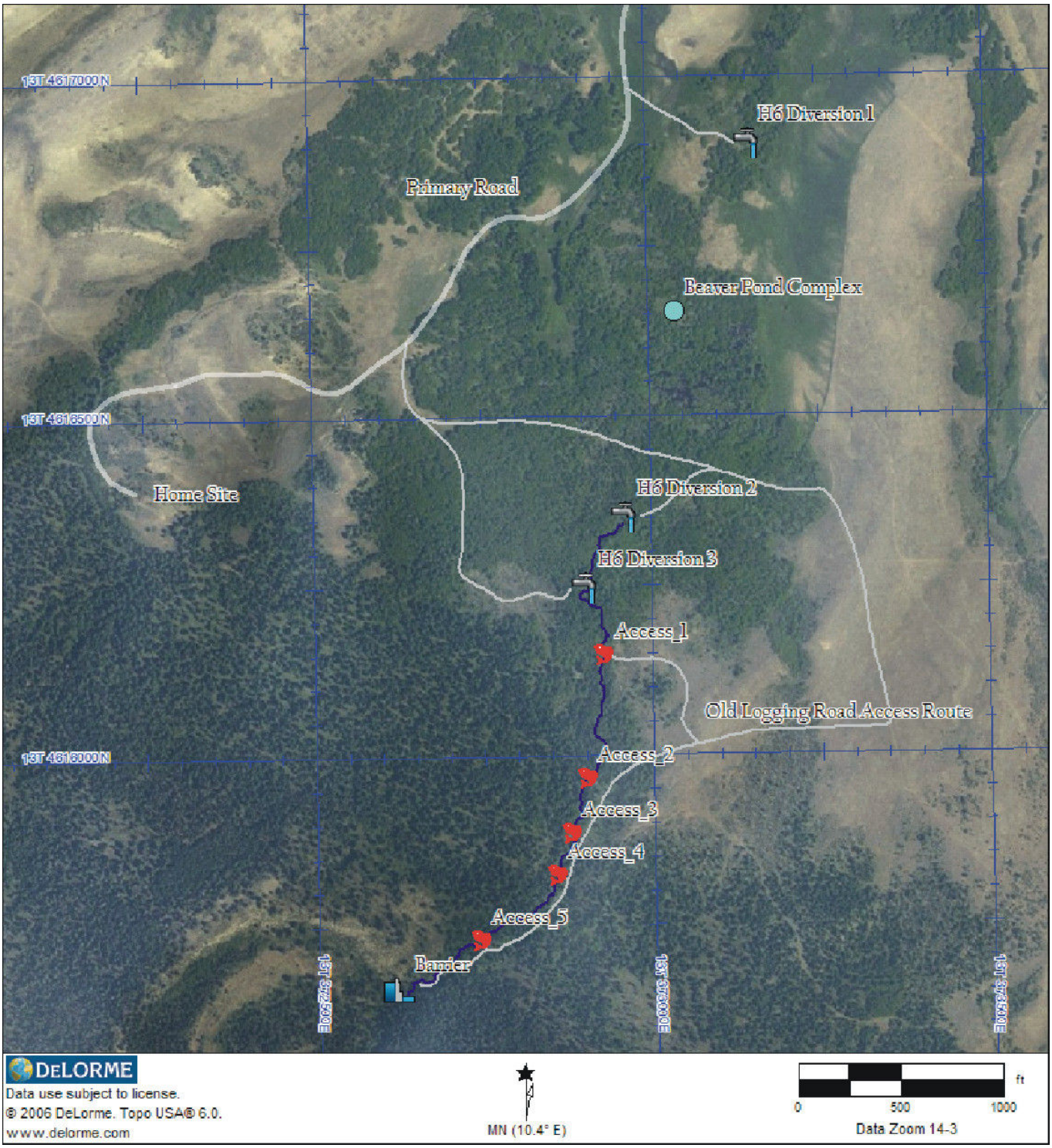
Location Maps



Vicinity Map Showing the Location of the Halleck Creek Reach 6 Project

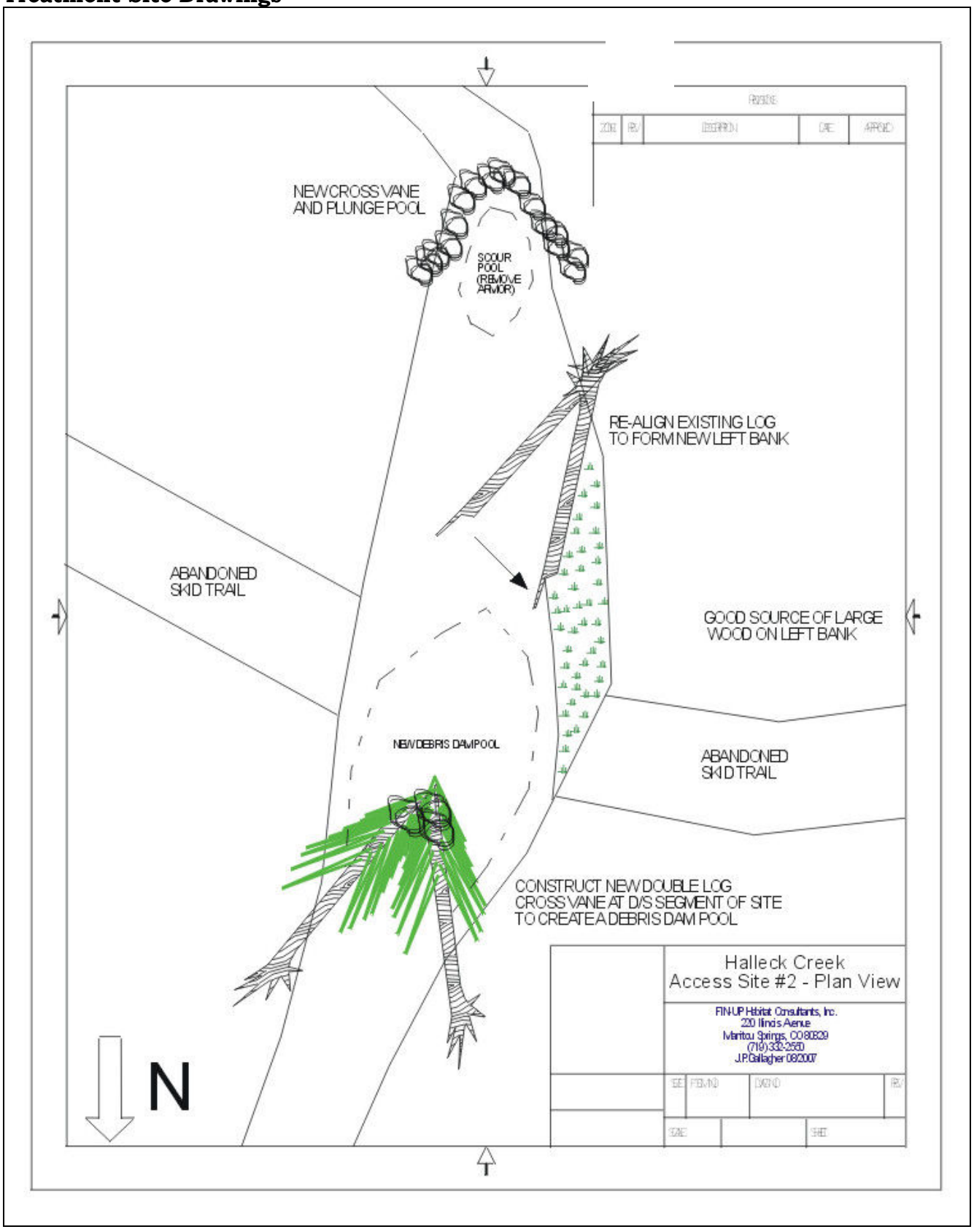


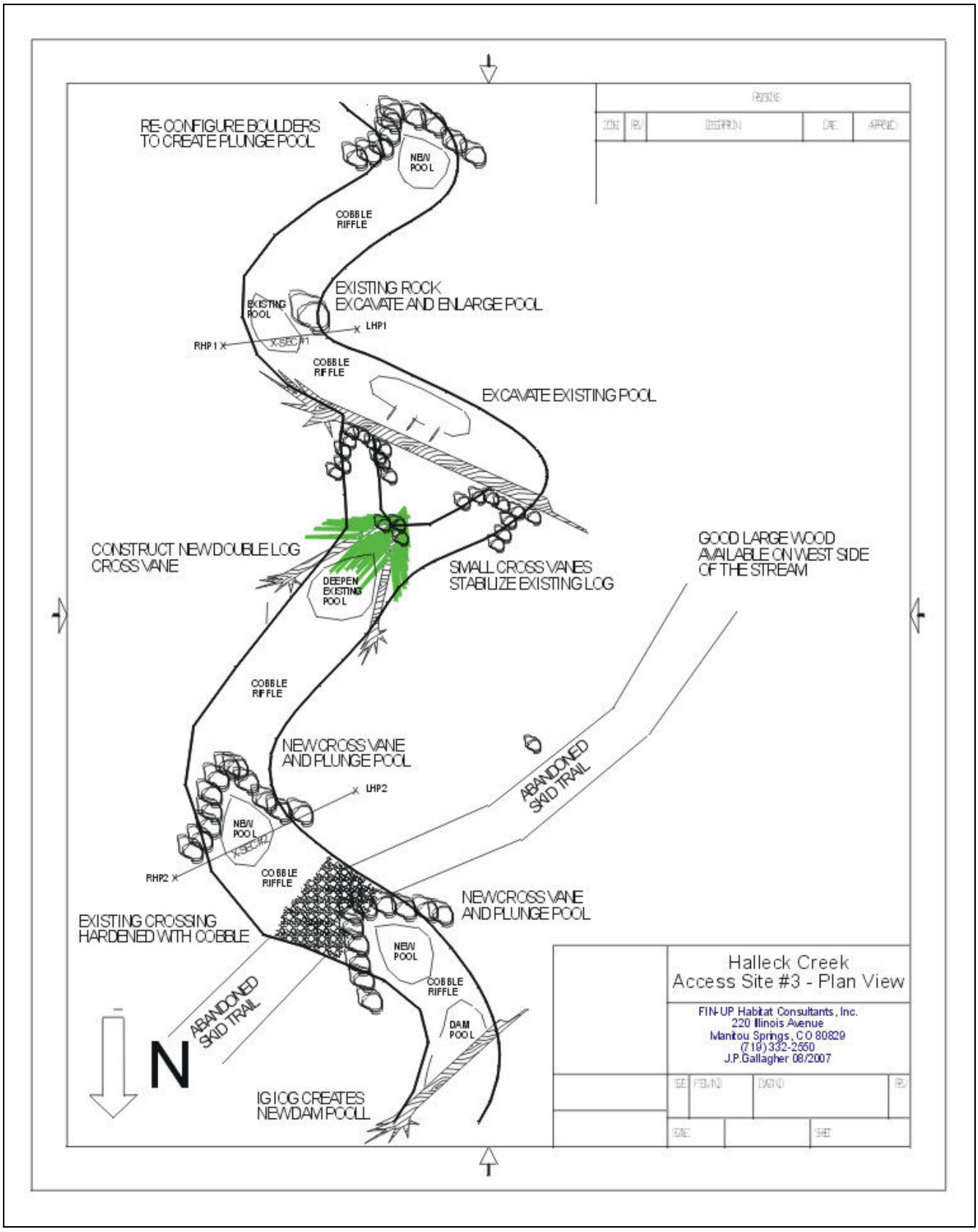
Upper Halleck Creek Watershed showing reach delineations and land Ownership



Location of Treatment Sites along Reach 6 on Halleck Creek

Treatment Site Drawings




RE-CONFIGURE BOULDERS
TO CREATE PLUNGE POOL
NEW POOL
COBBLE RIFFLE
EXISTING ROCK
EXCAVATE AND ENLARGE POOL
EXISTING POOL
LHP1
RHP1
X-SECT1
COBBLE RIFFLE
EXCAVATE EXISTING POOL
CONSTRUCT NEW DOUBLE LOG
CROSS VANE
DEEPEN EXISTING POOL
SMALL CROSS VANES
STABILIZE EXISTING LOG
GOOD LARGE WOOD
AVAILABLE ON WEST SIDE
OF THE STREAM
COBBLE RIFFLE
NEW CROSS VANE
AND PLUNGE POOL
LHP2
ABANDONED
SKID TRAIL
NEW POOL
X-SECT2
RHP2
COBBLE RIFFLE
NEW CROSS VANE
AND PLUNGE POOL
EXISTING CROSSING
HARDENED WITH COBBLE
NEW POOL
COBBLE RIFFLE
DAM POOL
ABANDONED
SKID TRAIL
N
IG LOG CREATES
NEW DAM POOL
Halleck Creek
Access Site #3 - Plan View
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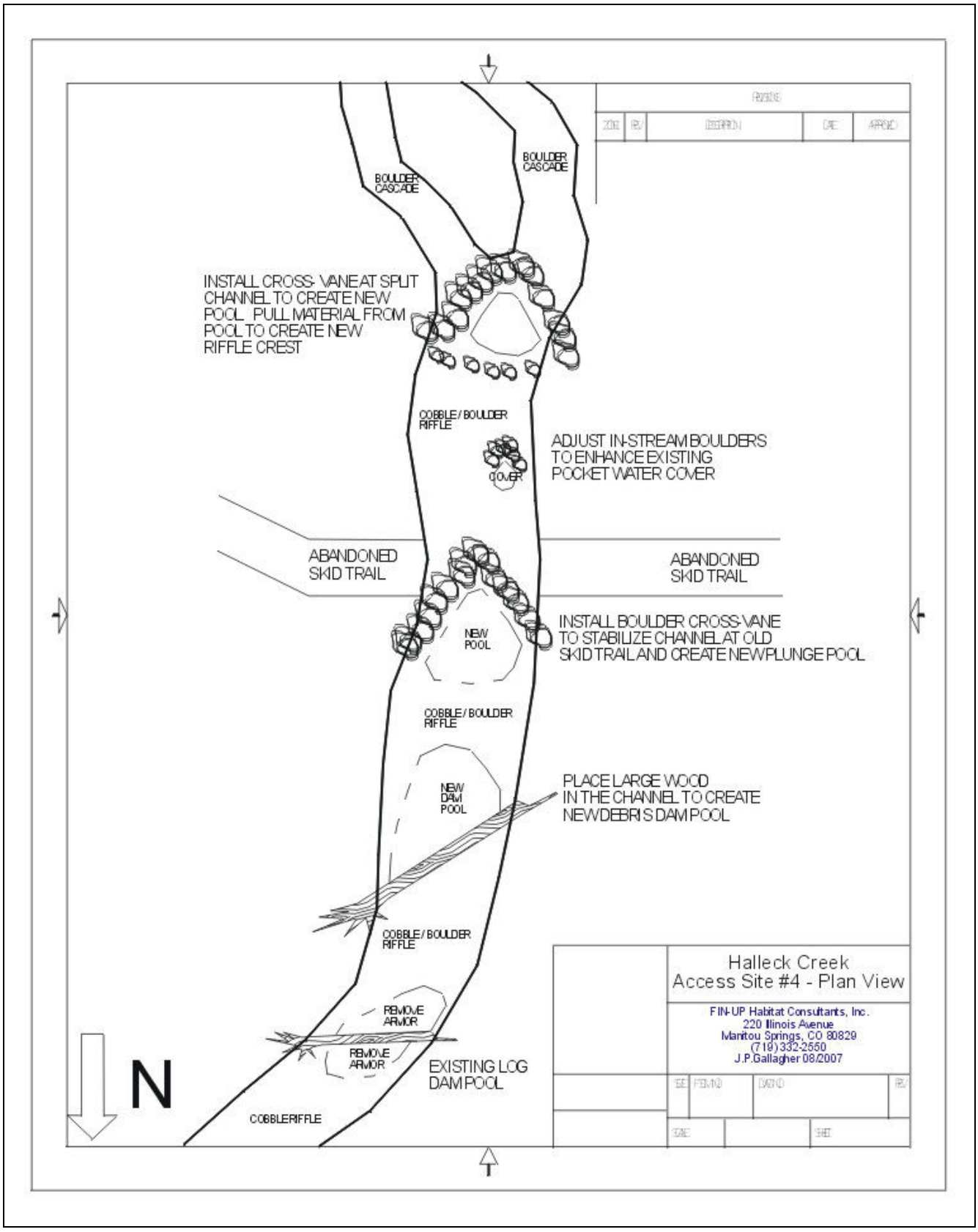
BOULDER CASCADE
BOULDER CASCADE
INSTALL CROSS- VANE AT SPLIT CHANNEL TO CREATE NEW POOL. PULL MATERIAL FROM POOL TO CREATE NEW RIFFLE CREST
COBBLE / BOULDER RIFFLE
ADJUST IN-STREAM BOULDERS TO ENHANCE EXISTING POCKET WATER COVER
COVER
ABANDONED SKID TRAIL
ABANDONED SKID TRAIL
NEW POOL
INSTALL BOULDER CROSS-VANE TO STABILIZE CHANNEL AT OLD SKID TRAIL AND CREATE NEW PLUNGE POOL
COBBLE / BOULDER RIFFLE
NEW DAM POOL
PLACE LARGE WOOD IN THE CHANNEL TO CREATE NEW DEBRIS DAM POOL
COBBLE / BOULDER RIFFLE
REMOVE ARMOR
REMOVE ARMOR
EXISTING LOG DAM POOL
COBBLE RIFFLE
N
Halleck Creek
Access Site #4 - Plan View
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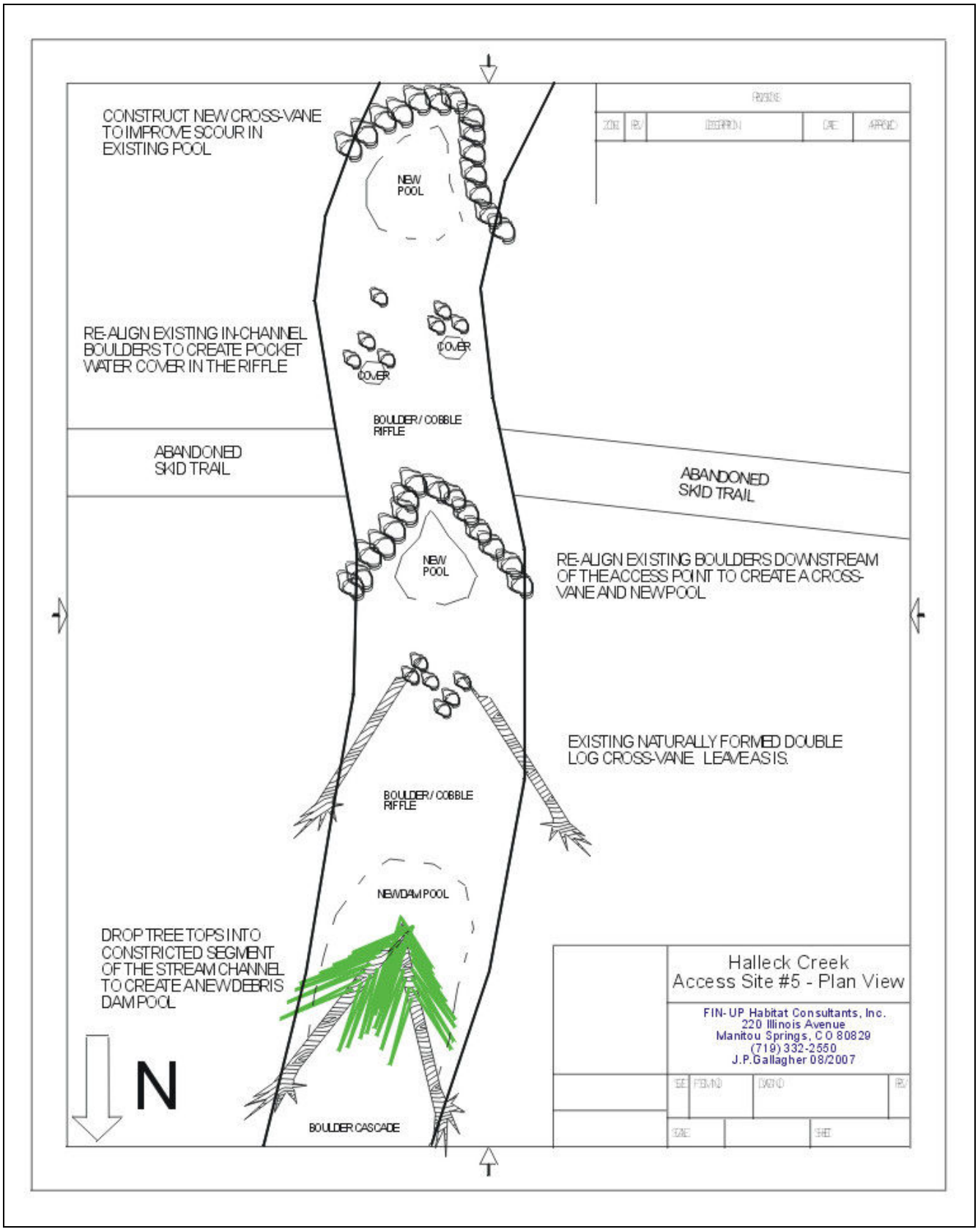
CONSTRUCT NEW CROSS-VANE TO IMPROVE SCOUR IN EXISTING POOL
NEW POOL
RE-ALIGN EXISTING IN-CHANNEL BOULDERS TO CREATE POCKET WATER COVER IN THE RIFFLE
COVER
COVER
BOULDER / COBBLE RIFFLE
ABANDONED SKID TRAIL
ABANDONED SKID TRAIL
NEW POOL
RE-ALIGN EXISTING BOULDERS DOWNSTREAM OF THE ACCESS POINT TO CREATE A CROSS-VANE AND NEW POOL
EXISTING NATURALLY FORMED DOUBLE LOG CROSS-VANE LEAVE AS IS.
BOULDER / COBBLE RIFFLE
NEW DAM POOL
DROP TREE TOPS INTO CONSTRICTED SEGMENT OF THE STREAM CHANNEL TO CREATE A NEW DEBRIS DAM POOL
N
BOULDER CASCADE
Halleck Creek
Access Site #5 - Plan View
FIN-UP Habitat Consultants, Inc.
220 Illinois Avenue
Manitou Springs, CO 80829
(719) 332-2550
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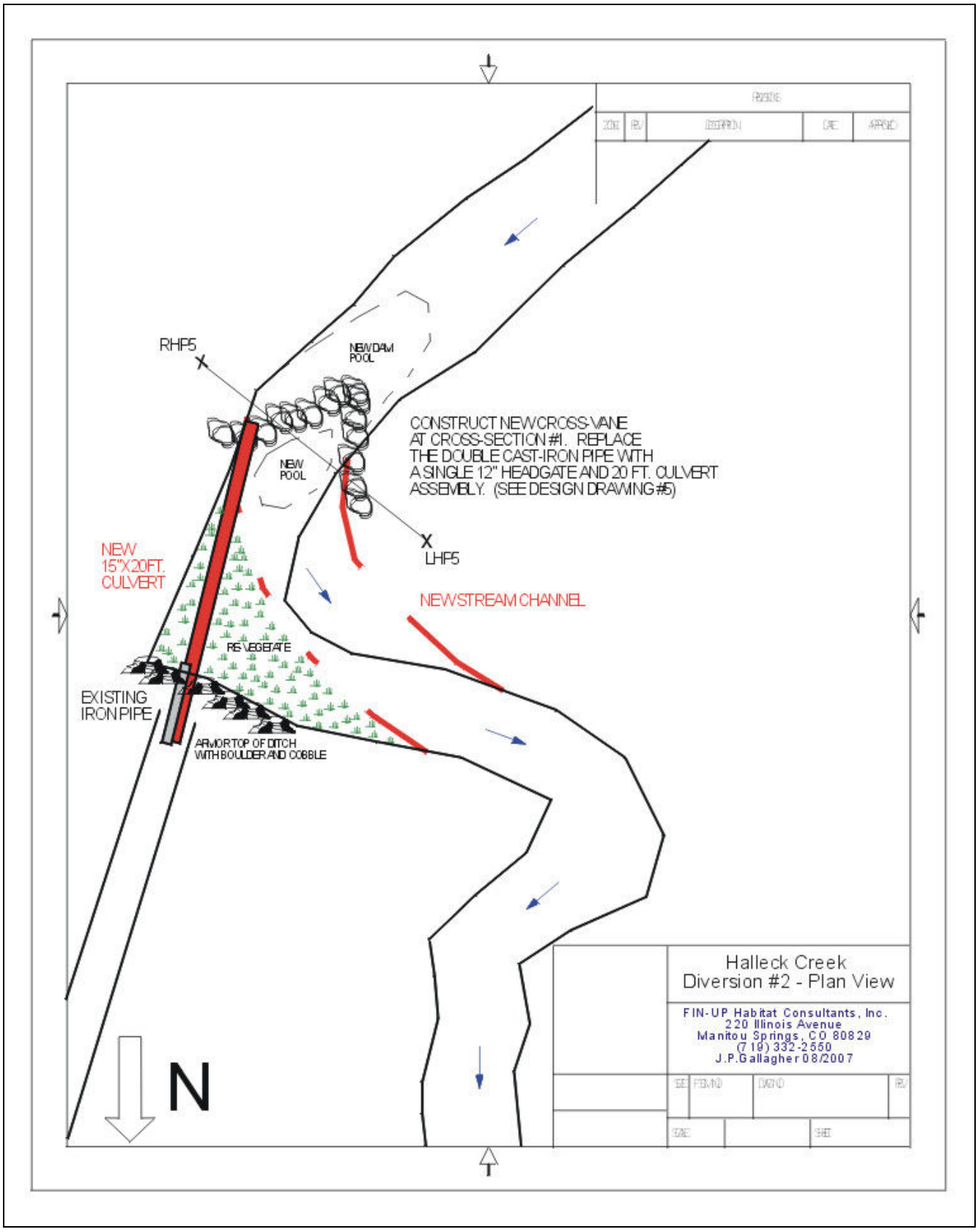
RHP5
NEW DAM POOL
NEW POOL
CONSTRUCT NEW CROSS-VANE AT CROSS-SECTION #1. REPLACE THE DOUBLE CAST-IRON PIPE WITH A SINGLE 12" HEADGATE AND 20 FT. CULVERT ASSEMBLY. (SEE DESIGN DRAWING #5)
LHP5
NEW 15"X20FT. CULVERT
NEW STREAM CHANNEL
RE-VEGETATE
EXISTING IRON PIPE
ARMOR TOP OF DITCH WITH BOULDER AND COBBLE
N
Halleck Creek
Diversion #2 - Plan View
FIN-UP Habitat Consultants, Inc.
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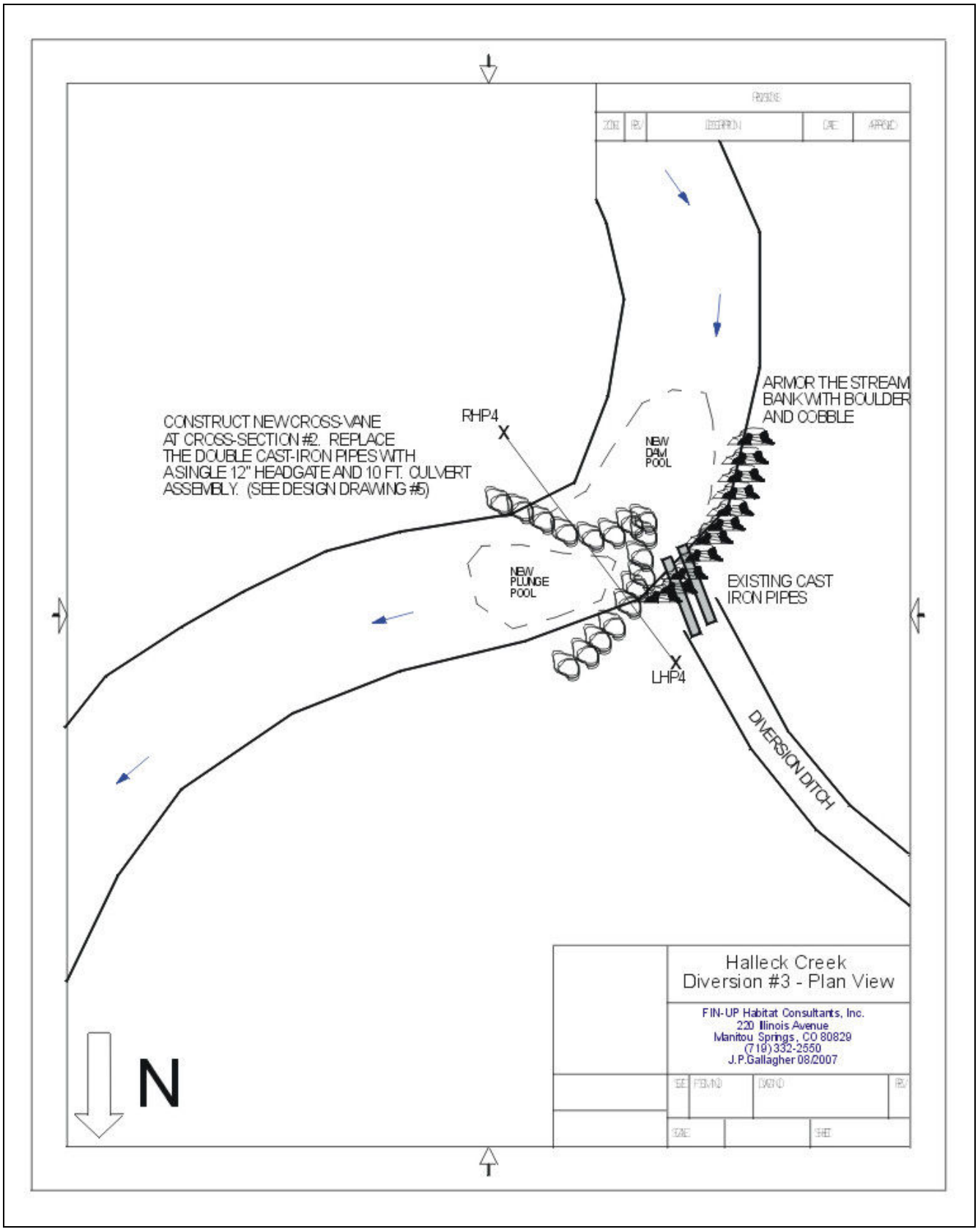
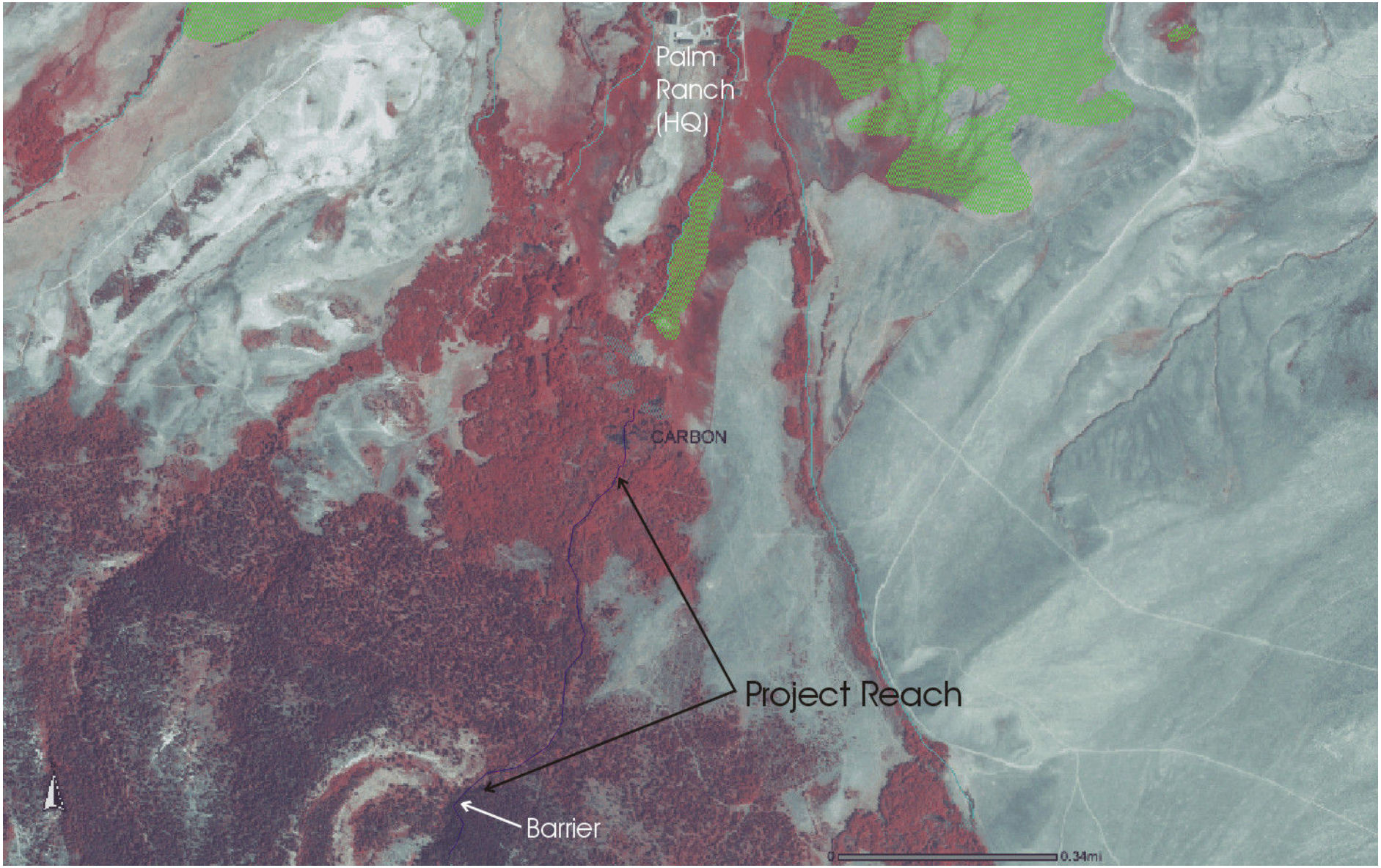
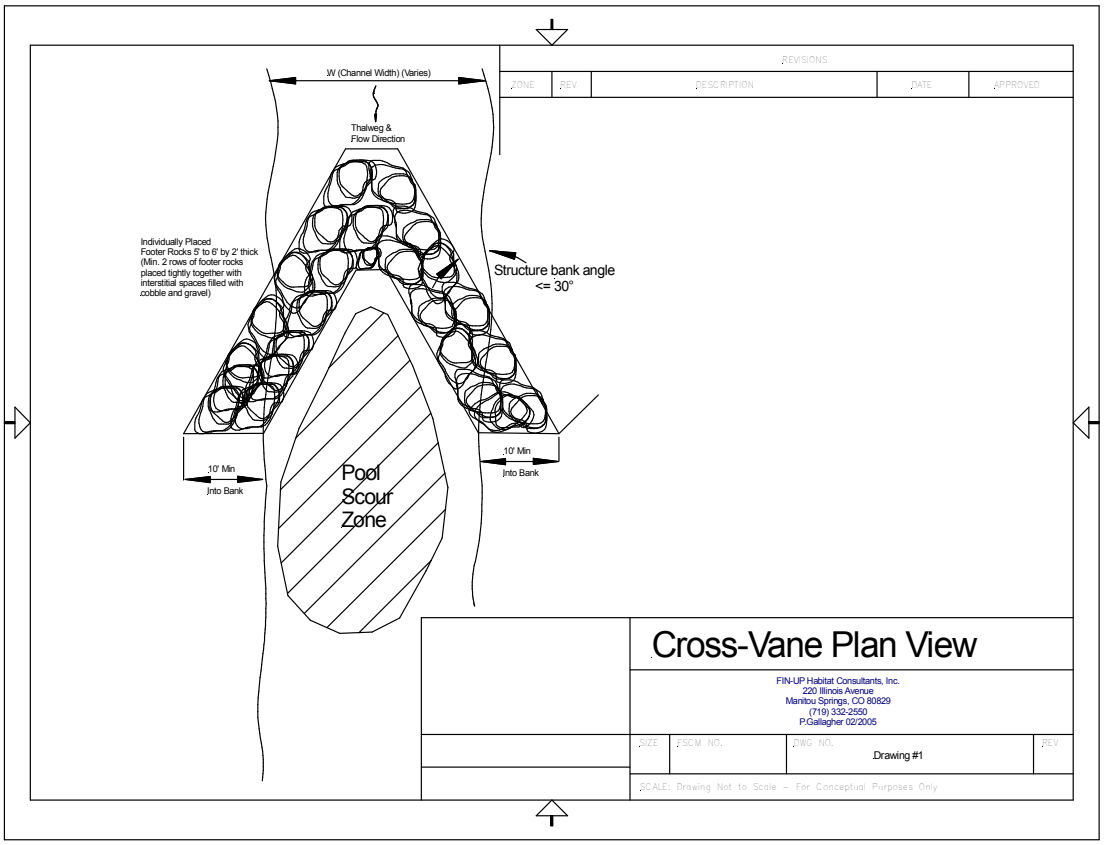
J.P.Gallagher 08/2007

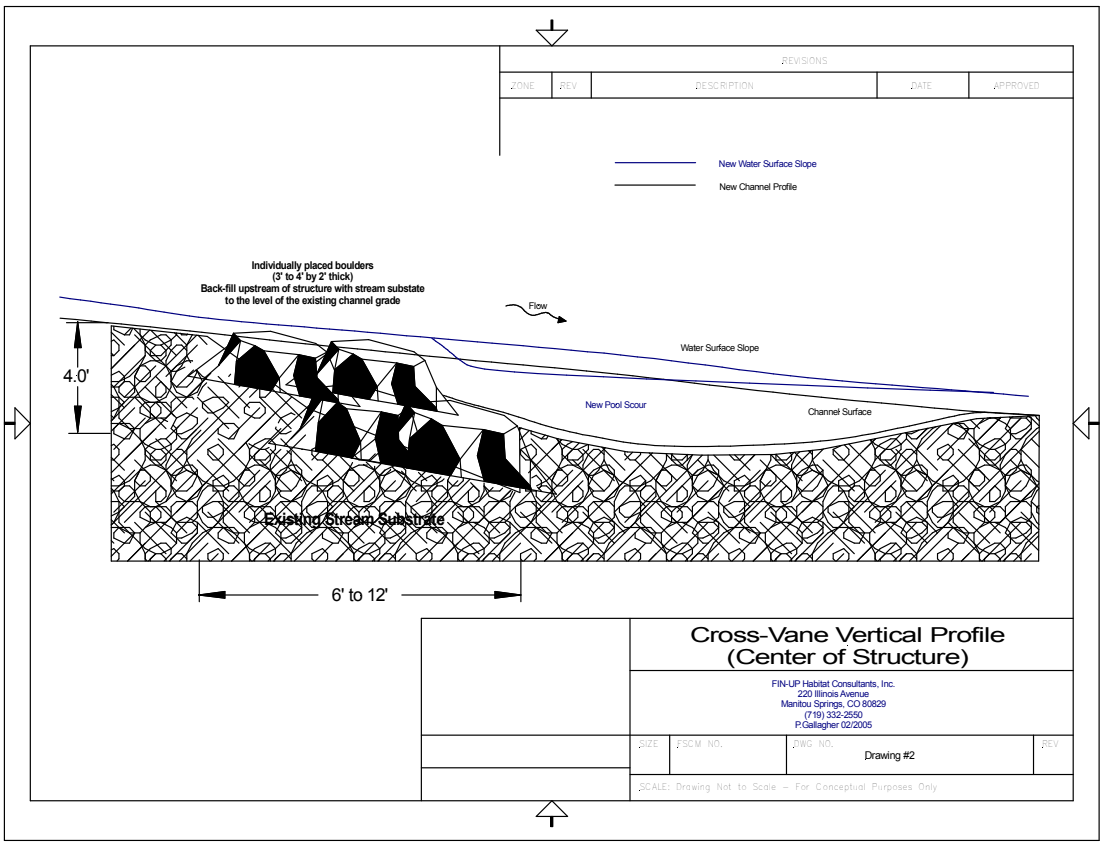

CONSTRUCT NEW CROSS-VANE AT CROSS-SECTION #2. REPLACE THE DOUBLE CAST-IRON PIPES WITH A SINGLE 12" HEADGATE AND 10 FT. CULVERT ASSEMBLY. (SEE DESIGN DRAWING #5)
RHP4
LHP4
NEW DAM POOL
NEW PLUNGE POOL
ARMOR THE STREAM BANK WITH BOULDER AND COBBLE
EXISTING CAST IRON PIPES
DIVERSION DITCH
N
Halleck Creek
Diversion #3 - Plan View
FIN-UP Habitat Consultants, Inc.
220 Illinois Avenue
Manitou Springs, CO 80829
(719) 332-2550
J.P.Gallagher 08/2007

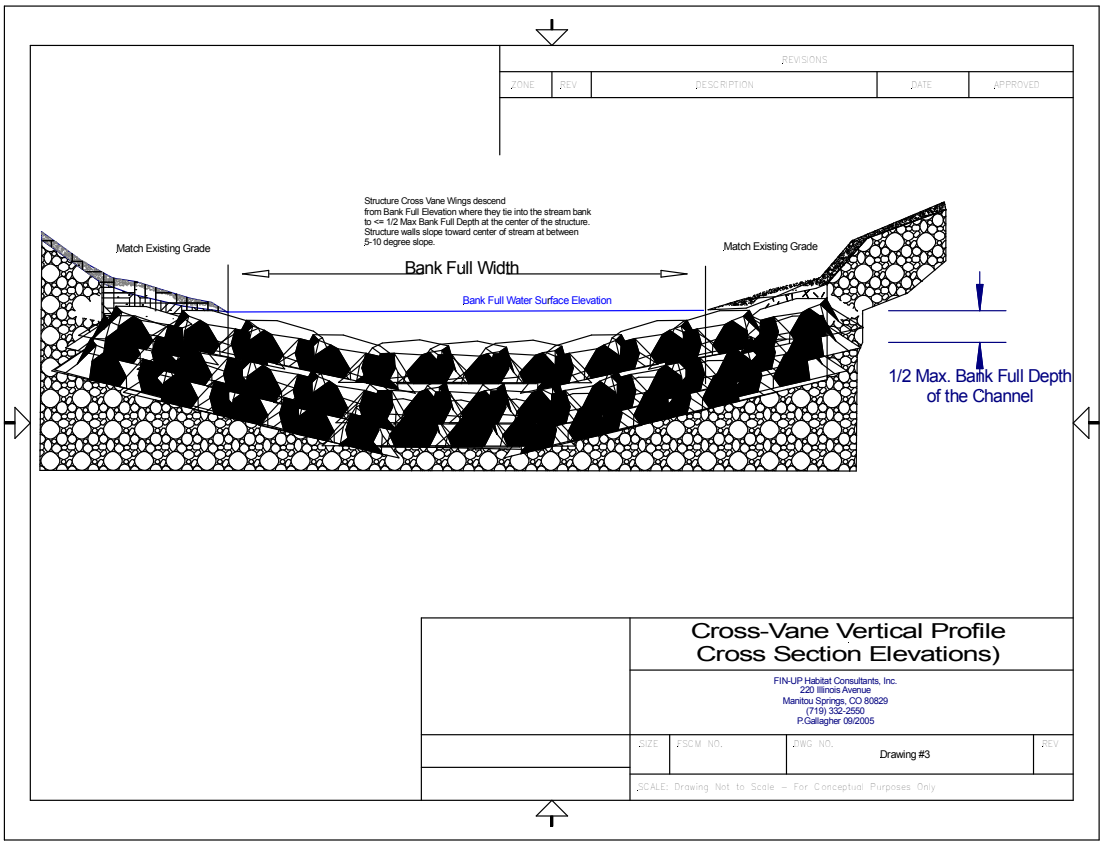


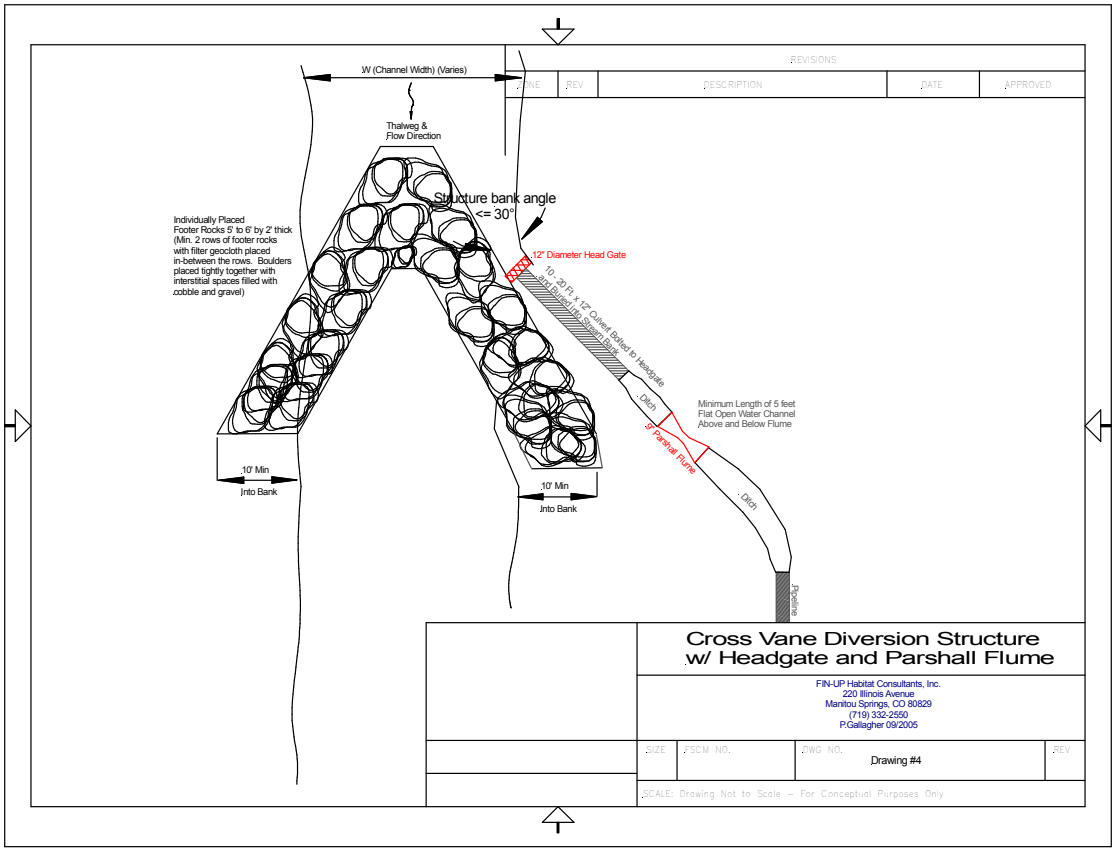
NWI/Color IR Photo of Project Site at Reach 6 on Halleck Creek.

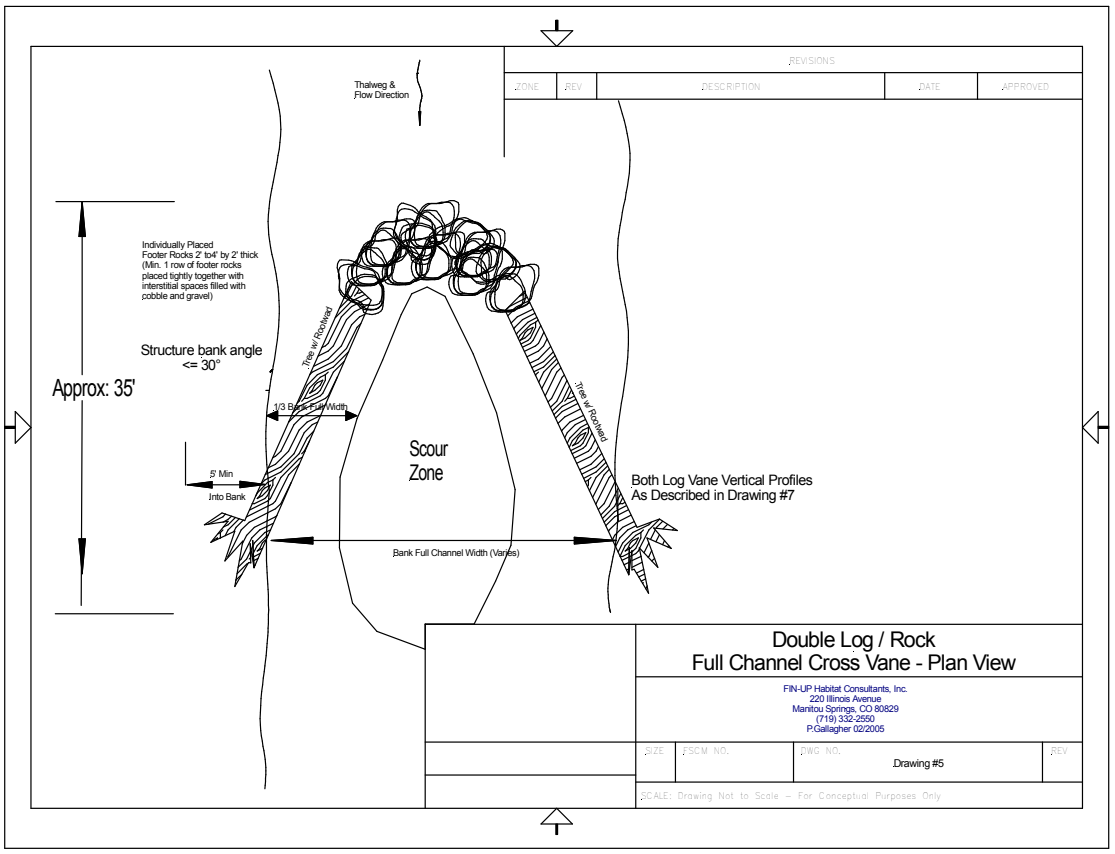
Stream Channel Structure and Treatment Drawings

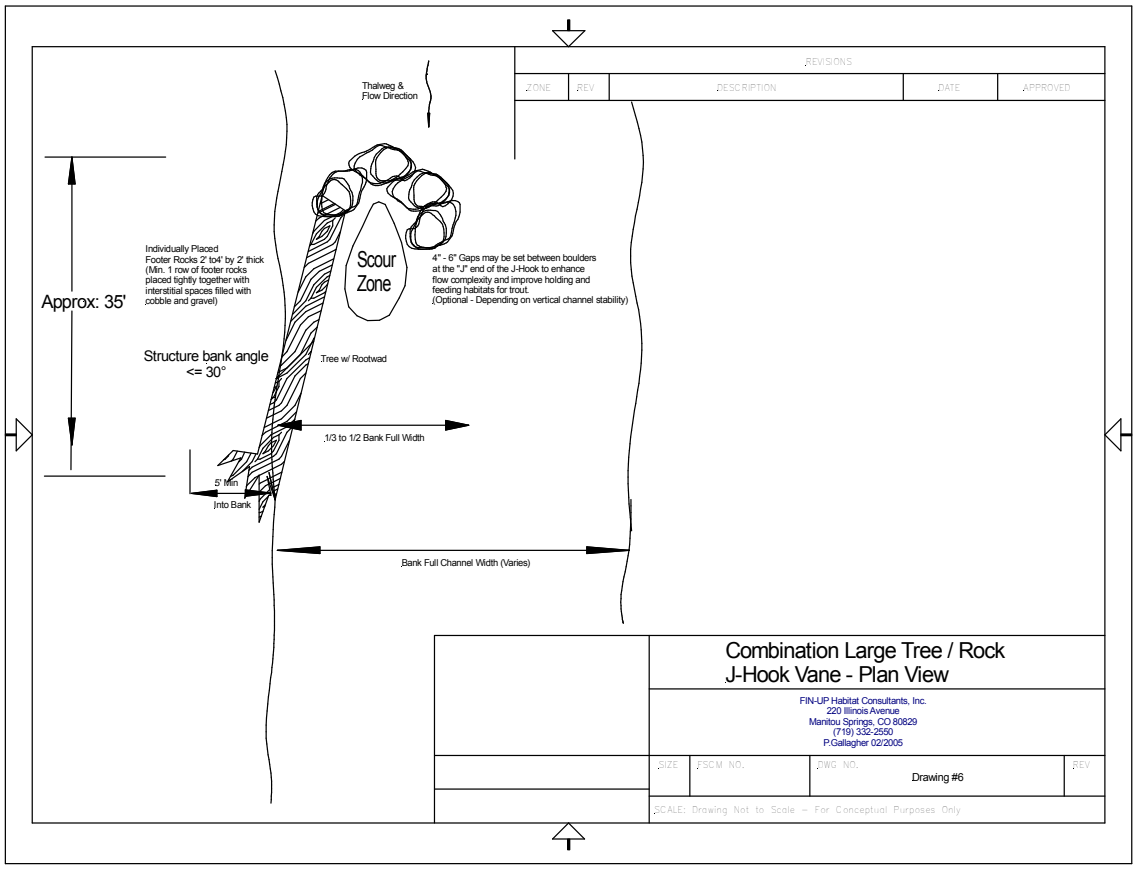


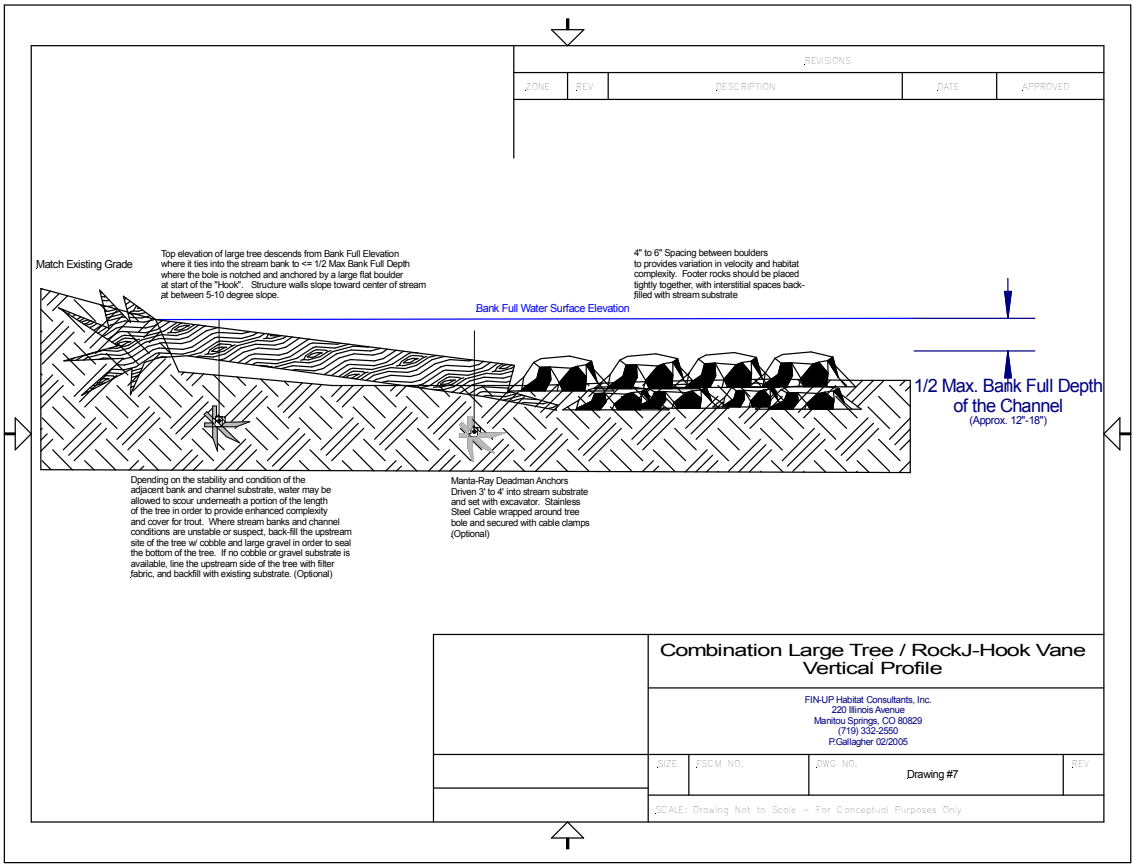


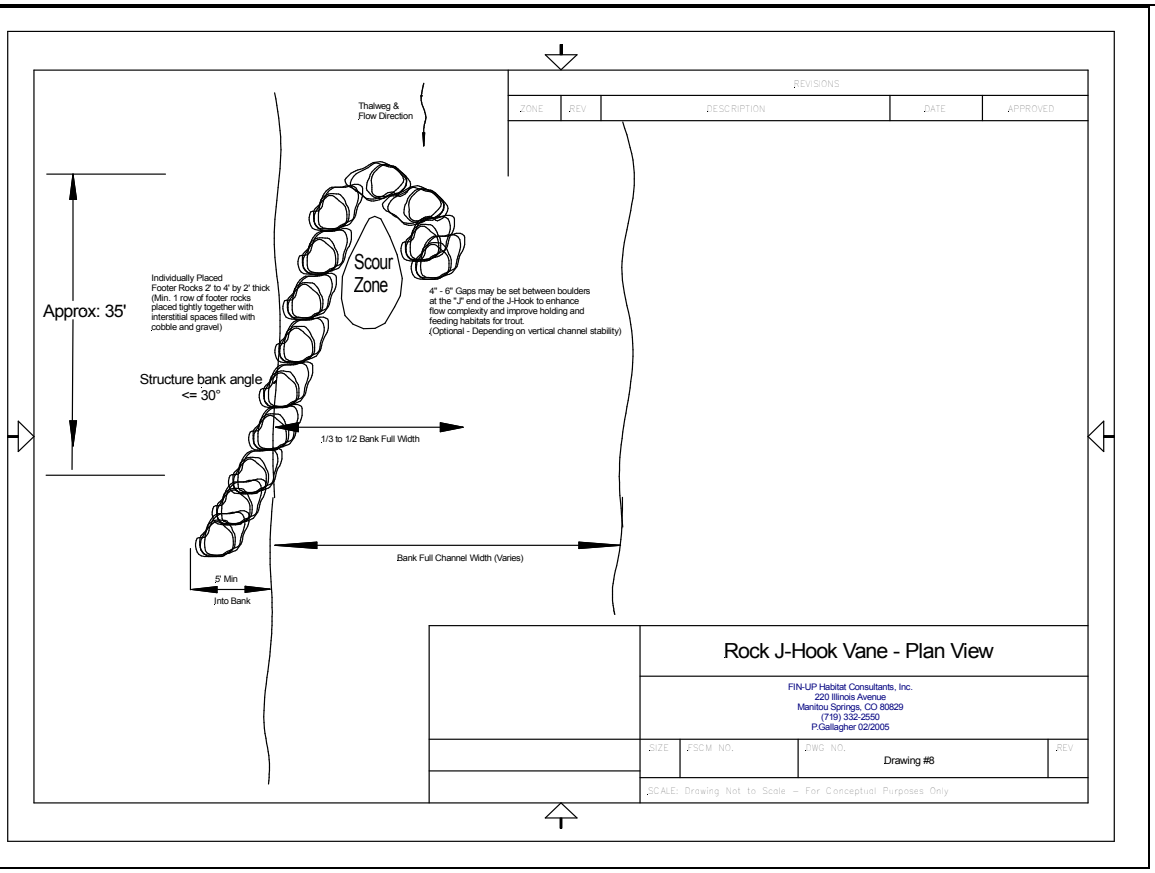

REVISIONS
ZONE
REV
DESCRIPTION
DATE
APPROVED
Structure Cross Vane Wings descend from Bank Full Elevation where they tie into the stream bank to <= 1/2 Max Bank Full Depth at the center of the structure. Structure walls slope toward center of stream at between 5-10 degree slope.
Match Existing Grade
Bank Full Width
Bank Full Water Surface Elevation
Match Existing Grade
1/2 Max. Bank Full Depth of the Channel
Cross-Vane Vertical Profile
Cross Section Elevations)
FIN-UP Habitat Consultants, Inc.
220 Illinois Avenue
Manitou Springs, CO 80829
(719) 332-2550
P.Gallagher 09/2005
SIZE
FSCM NO.
DWG NO.
Drawing #3
REV
SCALE: Drawing Not to Scale – For Conceptual Purposes Only

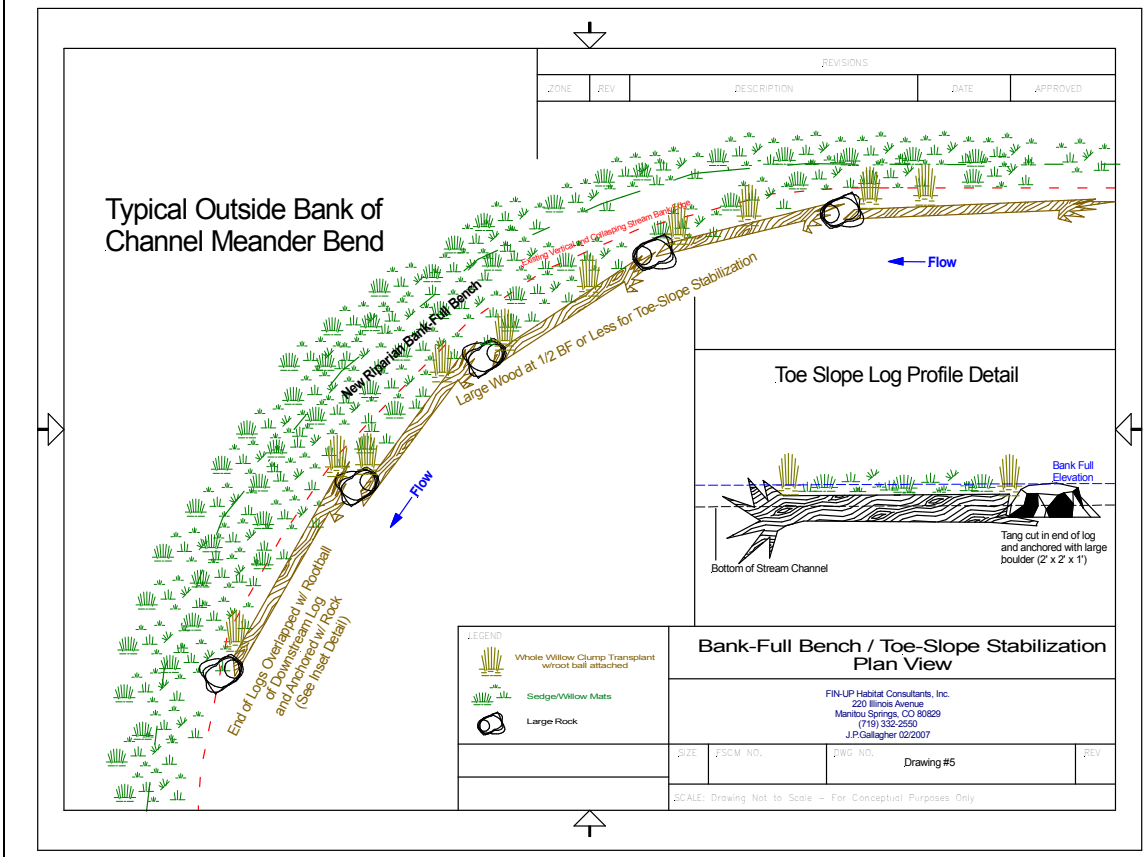

REVISIONS
ZONE
REV
DESCRIPTION
DATE
APPROVED
W (Channel Width) (Varies)
Thalweg & Flow Direction
Structure bank angle <= 30°
Individually Placed Footer Rocks 5' to 6' by 2' thick (Min. 2 rows of footer rocks with filter geocloth placed in-between the rows. Boulders placed tightly together with interstitial spaces filled with cobble and gravel)
12" Diameter Head Gate
10 - 20 Ft. x 12" Culvert Rolled to Headgate and Extended to Stream Bank
Ditch
9' Parshall Flume
Minimum Length of 5 feet Flat Open Water Channel Above and Below Flume
Ditch
Header
10' Min Into Bank
10' Min Into Bank
Cross Vane Diversion Structure
w/ Headgate and Parshall Flume
FIN-UP Habitat Consultants, Inc.
220 Illinois Avenue
Manitou Springs, CO 80829
(719) 332-2550
P.Gallagher 09/2005
SIZE
FSCM NO.
DWG NO.
Drawing #4
REV
SCALE: Drawing Not to Scale – For Conceptual Purposes Only

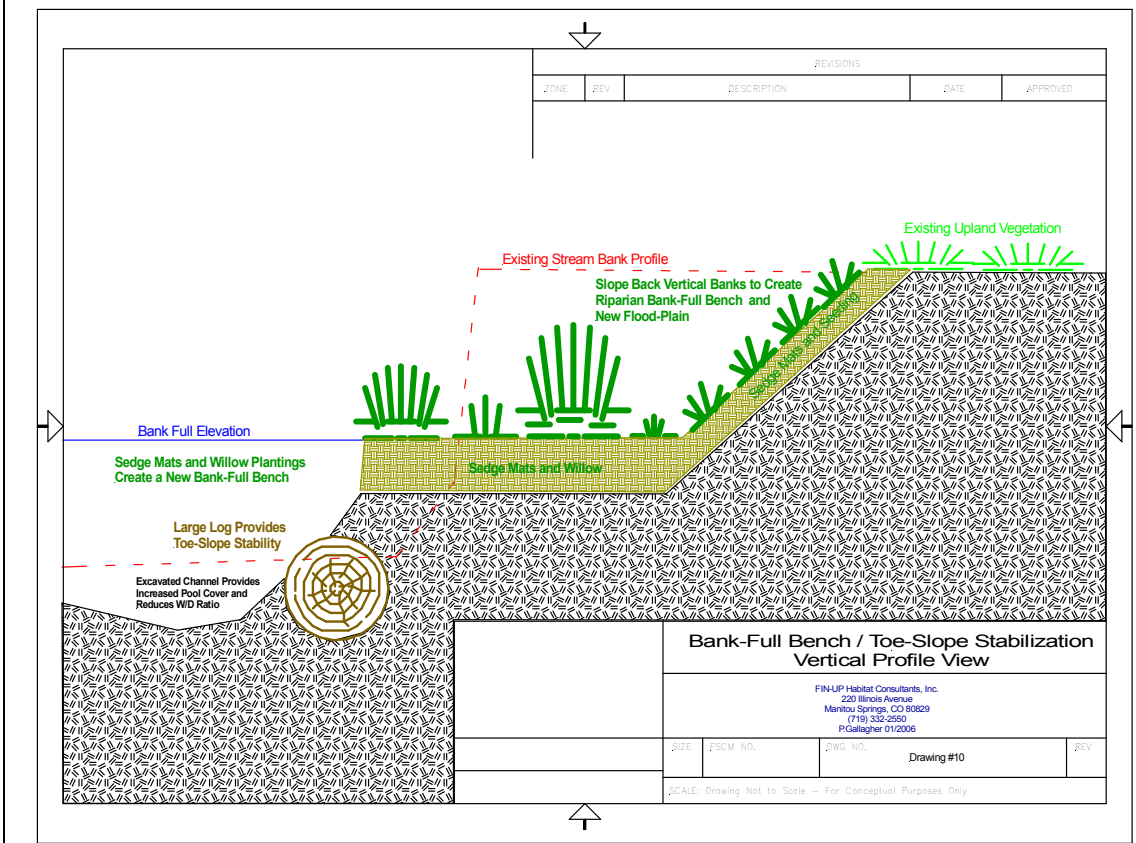

REVISIONS
ZONE
REV
DESCRIPTION
DATE
APPROVED
Thalweg & Flow Direction
Individually Placed Footer Rocks 2' to4' by 2' thick (Min. 1 row of footer rocks placed tightly together with interstitial spaces filled with cobble and gravel)
Structure bank angle <= 30°
Approx: 35'
Tree w/ Rootwad
Tree w/ Rootwad
1/3 Bank Full Width
Scour Zone
5' Min Into Bank
Both Log Vane Vertical Profiles As Described in Drawing #7
Bank Full Channel Width (Varies)
Double Log / Rock
Full Channel Cross Vane - Plan View
FIN-UP Habitat Consultants, Inc.
220 Illinois Avenue
Manitou Springs, CO 80829
(719) 332-2550
P.Gallagher 02/2005
SIZE
FSCM NO.
DWG NO.
Drawing #5
REV
SCALE: Drawing Not to Scale – For Conceptual Purposes Only


REVISIONS
ZONE
REV
DESCRIPTION
DATE
APPROVED
Thalweg & Flow Direction
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)
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)
Approx: 35'
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
FIN-UP Habitat Consultants, Inc.
220 Illinois Avenue
Manitou Springs, CO 80829
(719) 332-2550
P.Gallagher 02/2005
SIZE
FSCM NO.
DWG NO.
Drawing #6
REV
SCALE: Drawing Not to Scale – For Conceptual Purposes Only

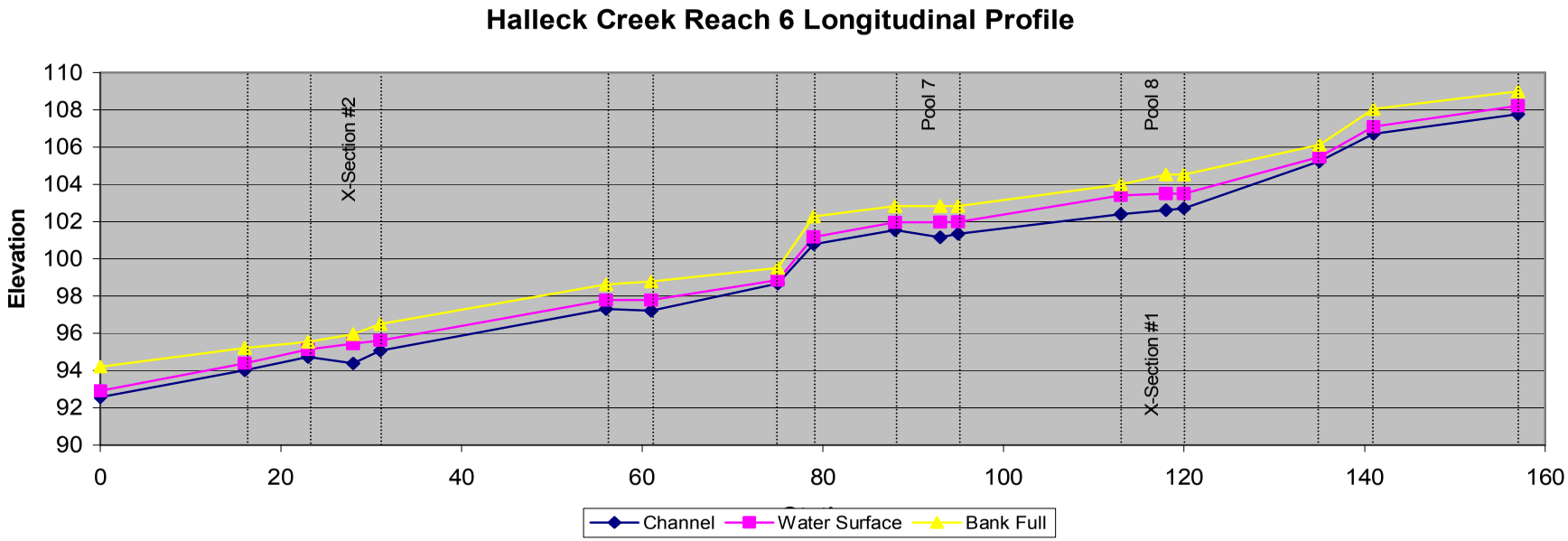

REVISIONS
ZONE
REV
DESCRIPTION
DATE
APPROVED
Match Existing Grade
Top elevation of large tree descends from Bank Full Elevation where it ties into the stream bank to <= 1/2 Max Bank Full Depth where the bole is notched and anchored by a large flat boulder at start of the "Hook". Structure walls slope 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")
Dpending 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
FIN-UP Habitat Consultants, Inc.
220 Illinois Avenue
Manitou Springs, CO 80829
(719) 332-2550
P.Gallagher 02/2005
SIZE
FSCM NO.
DWG NO.
Drawing #7
REV
SCALE: Drawing Not to Scale -- For Conceptual Purposes Only

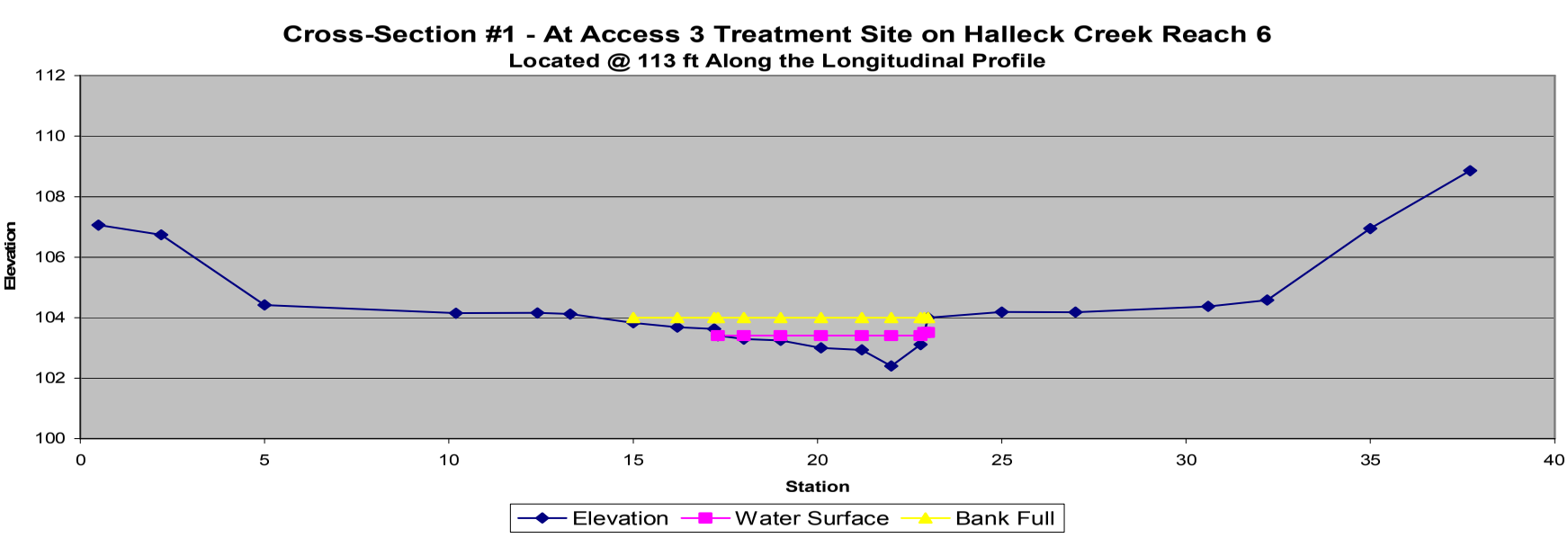

REVISIONS
ZONE
REV
DESCRIPTION
DATE
APPROVED
Thalweg & Flow Direction
Approx: 35'
Individually Placed Footer Rocks 2' to 4' by 2' thick (Min. 1 row of footer rocks placed tightly together with interstitial spaces filled with cobble and gravel)
Scour Zone
4" - 6" Gaps may be set between boulders at the "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
FIN-UP Habitat Consultants, Inc.
220 Illinois Avenue
Manitou Springs, CO 80829
(719) 332-2550
P.Gallagher 02/2005
SIZE
FSCM NO.
DWG NO.
Drawing #8
REV
SCALE: Drawing Not to Scale -- For Conceptual Purposes Only

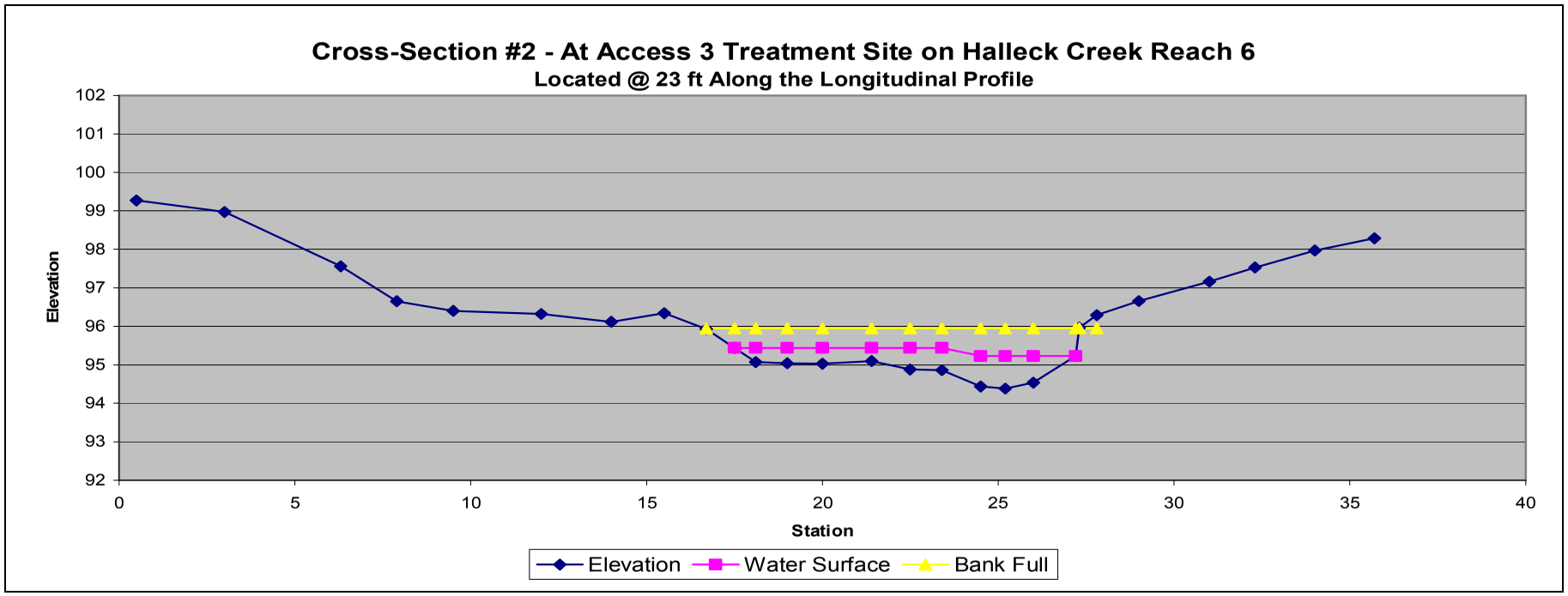

REVISIONS
ZONE REV DESCRIPTION DATE APPROVED
Typical Outside Bank of Channel Meander Bend
Existing Vertical and Undercutting Stream Bank Profile
New Riparian Bank-Full Bench
Large Wood at 1/2 BF or Less for Toe-Slope Stabilization
Flow
Flow
End of Logs Overlapped w/ Rootball of Downstream Log and Anchored w/ Rock (See Inset Detail)
Toe Slope Log Profile Detail
Bank Full Elevation
Tang cut in end of log and anchored with large boulder (2' x 2' x 1')
Bottom of Stream Channel
LEGEND
Whole Willow Clump Transplant w/root ball attached
Sedge/Willow Mats
Large Rock
Bank-Full Bench / Toe-Slope Stabilization Plan View
FIN-UP Habitat Consultants, Inc.
220 Illinois Avenue
Manitou Springs, CO 80829
(719) 332-2550
J.P.Gallagher 02/2007
SIZE FSCM NO. DWG NO. Drawing #5 REV
SCALE: Drawing Not to Scale – For Conceptual Purposes Only

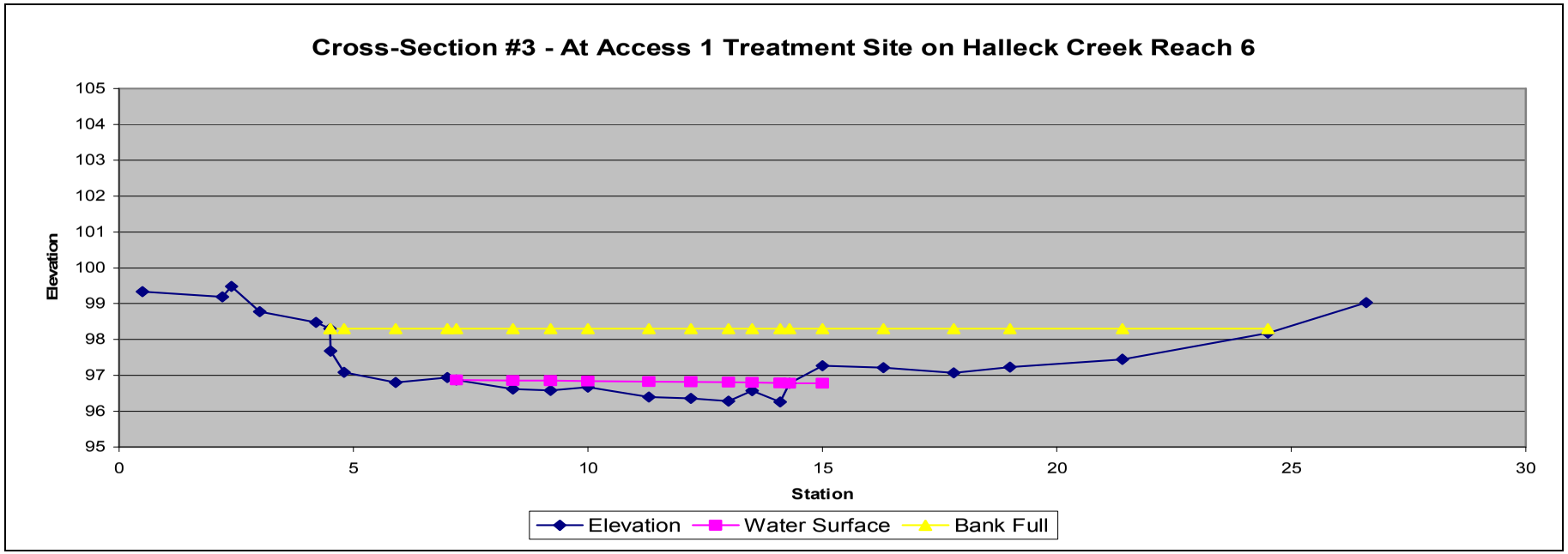

REVISIONS
ZONE REV DESCRIPTION DATE APPROVED
Existing Upland Vegetation
Existing Stream Bank Profile
Slope Back Vertical Banks to Create Riparian Bank-Full Bench and New Flood-Plain
Bank Full Elevation
Sedge Mats and Willow Plantings Create a New Bank-Full Bench
Sedge Mats and Willow
Large Log Provides Toe-Slope Stability
Excavated Channel Provides Increased Pool Cover and Reduces W/D Ratio
Bank-Full Bench / Toe-Slope Stabilization Vertical Profile View
FIN-UP Habitat Consultants, Inc.
220 Illinois Avenue
Manitou Springs, CO 80829
(719) 332-2550
P.Gallagher 01/2006
SIZE FSCM NO. DWG NO. Drawing #10 REV
SCALE: Drawing Not to Scale – For Conceptual Purposes Only

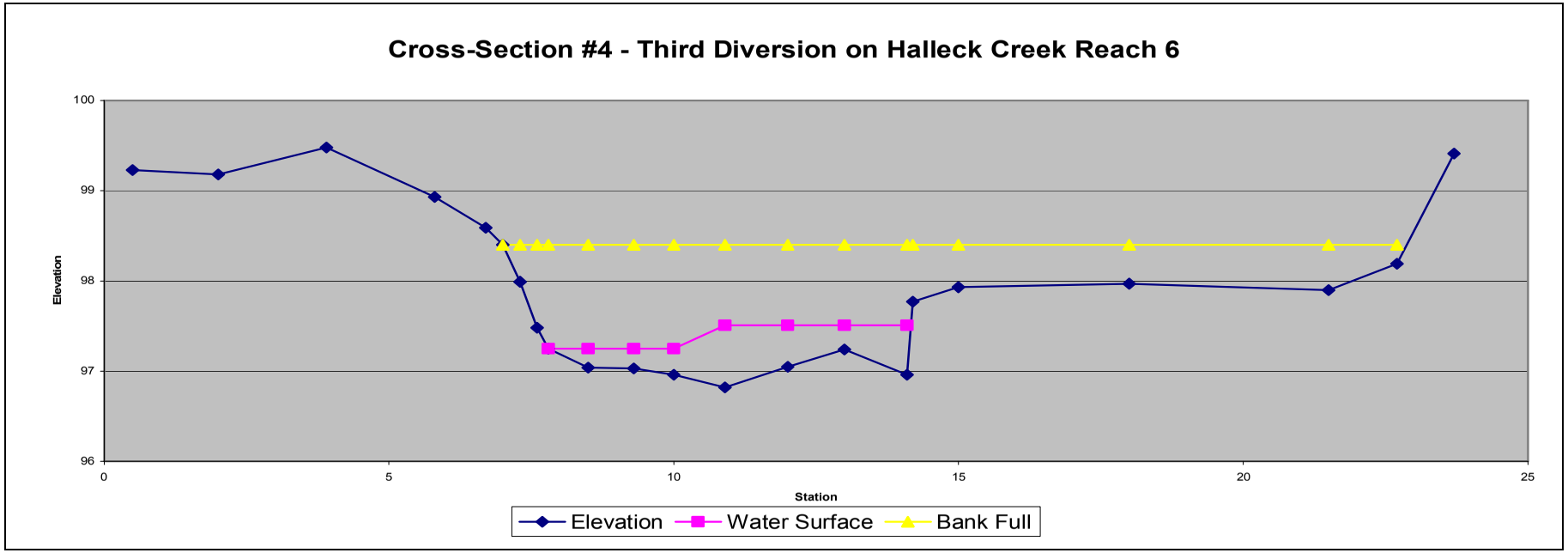
Longitudinal Profile and Cross-Sections

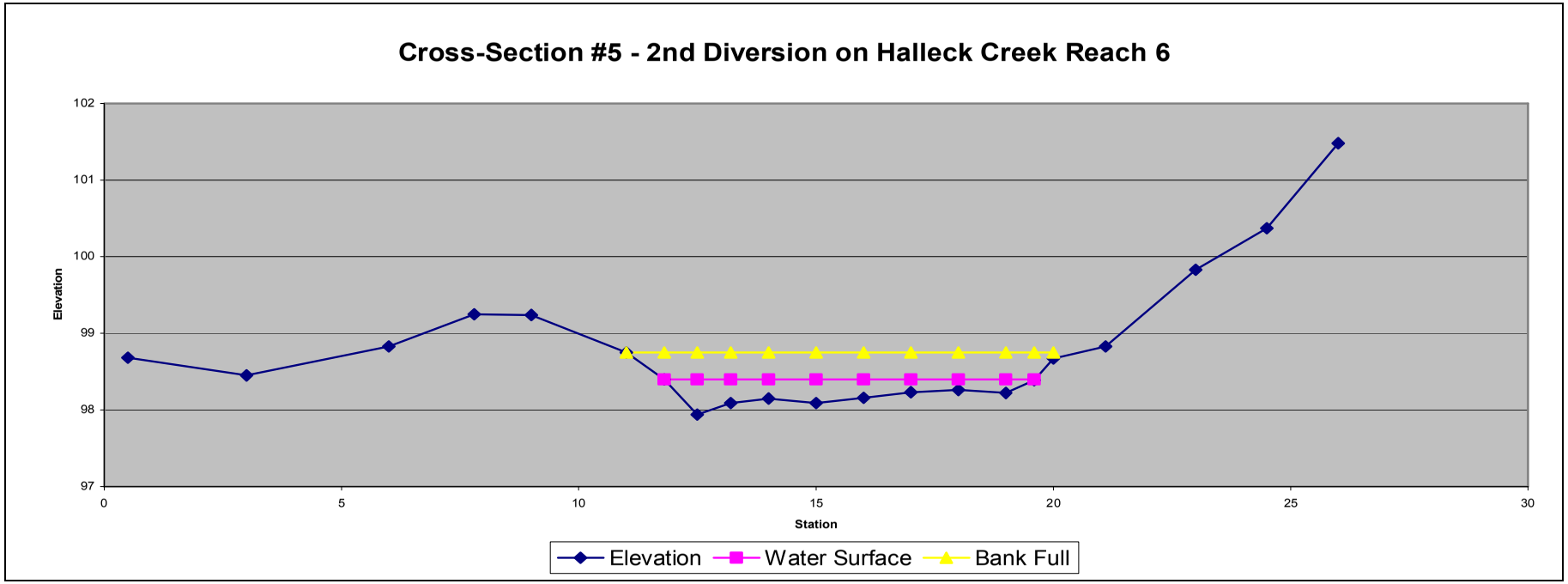





Cross-Section #2 - At Access 3 Treatment Site on Halleck Creek Reach 6
Located @ 23 ft Along the Longitudinal Profile
Elevation
102
101
100
99
98
97
96
95
94
93
92
0
5
10
15
20
25
30
35
40
Station
Elevation
Water Surface
Bank Full


Cross-Section #3 - At Access 1 Treatment Site on Halleck Creek Reach 6
Elevation
105
104
103
102
101
100
99
98
97
96
95
0
5
10
15
20
25
30
Station
Elevation
Water Surface
Bank Full


Cross-Section #4 - Third Diversion on Halleck Creek Reach 6
Elevation
100
99
98
97
96
0
5
10
15
20
25
Station
Elevation
Water Surface
Bank Full


Cross-Section #5 - 2nd Diversion on Halleck Creek Reach 6
Elevation
102
101
100
99
98
97
0
5
10
15
20
25
30
Station
Elevation
Water Surface
Bank Full

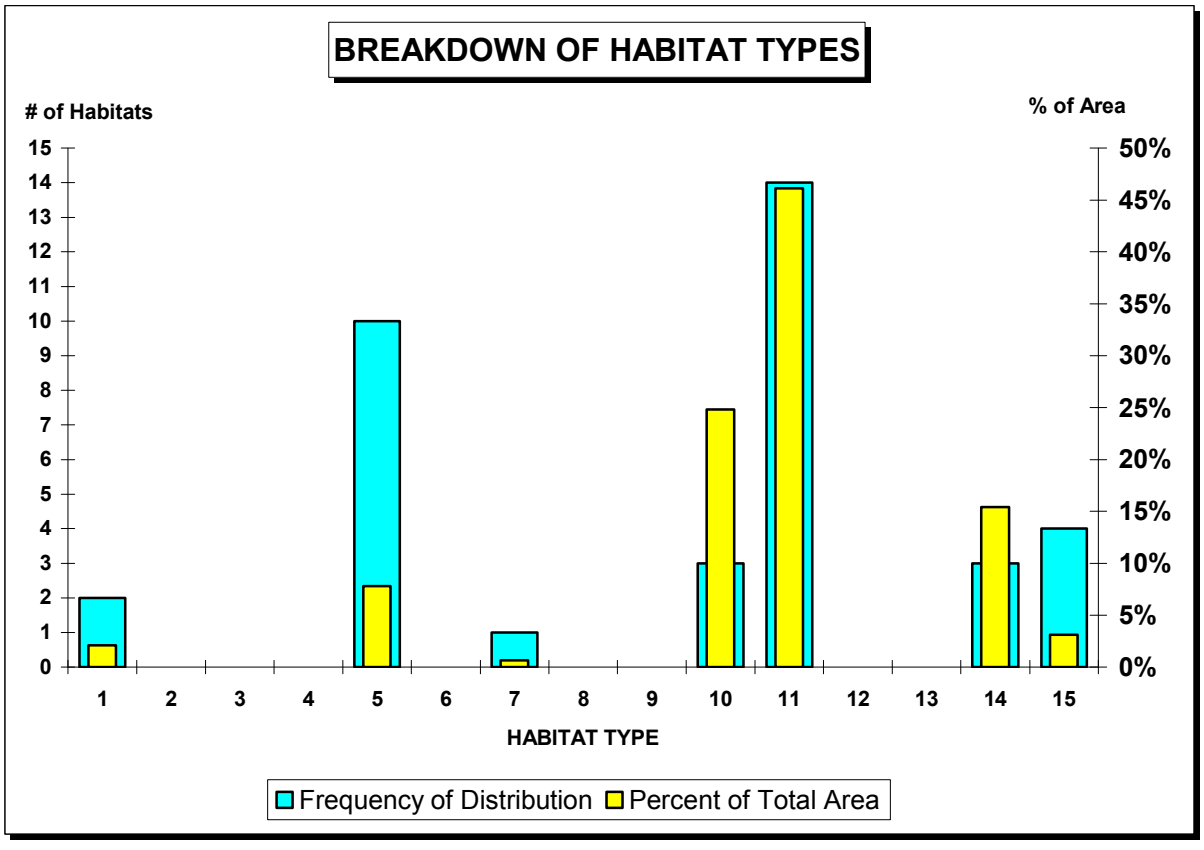
BASINWIDE STREAM HABITAT SURVEY DATA AND RESULTS (BWSHI)

HALLECK CREEK - REACH 6

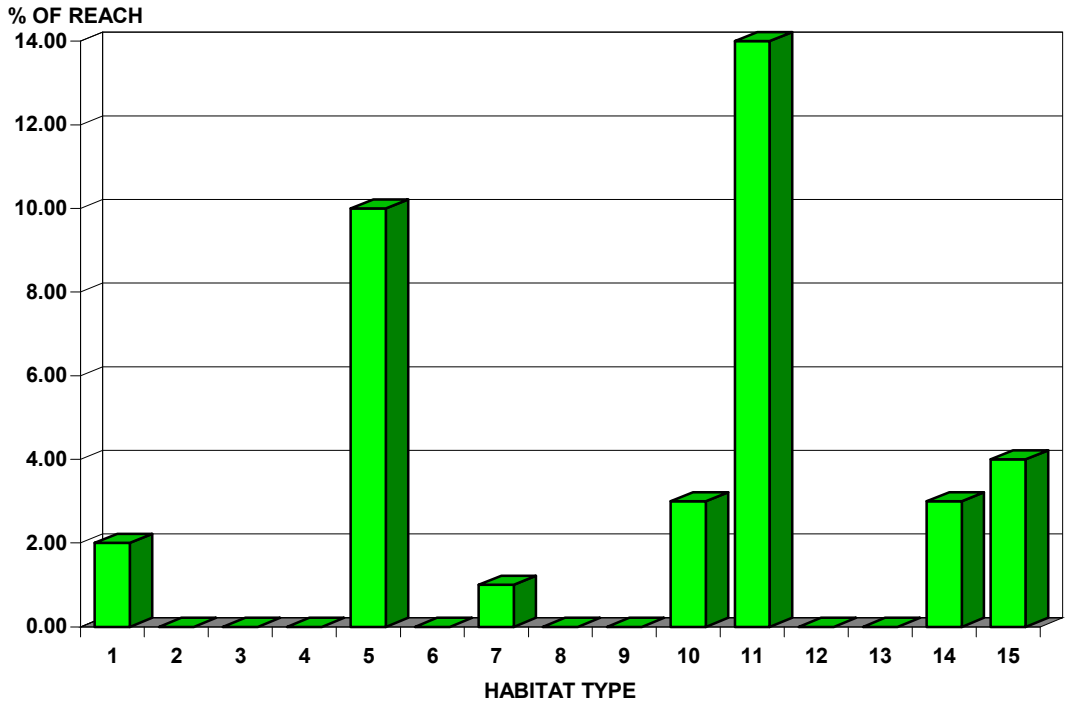
JULY 18, 2007

	POOL	RIFFLE	GLIDE	REACH TOTAL		POOL	RIFFLE	GLIDE	REACH TOTAL
TOTAL LENGTH OF HABITAT (	85.00	897.00	18.00	1000.00	TOTAL AREA OF HABITAT (sc	637.50	6745.00	157.50	7540.00
AVERAGE WIDTH OF HABITAT	7.45	7.39	8.75	7.86	% OF TOTAL NUM. OF HABIT/	29.73	64.86	5.41	100.00
AVERAGE RESIDUAL DEPTH (	0.64	0.00	0.00	0.64	HABITAT TYPE	8.45	89.46	2.09	100.00
					AS A % OF TOTAL AREA				
AVERAGE DEPTH (ft.)	0.69	0.00	0.00	0.69					
					% OF TOTAL COVERS 2 - 5	7.22	0.67	0.00	1.21
TOTAL COVER TYPE 2 (sq. ft.)	20.00	19.00	0.00	39.00	TO TOTAL HABITAT				
AVE. TYPE 2 COVER PER UNI	1.82	0.79	0.00	0.52					
					% OF CVR 2 TO TOTAL AREA	3.14	0.28	0.00	0.52
TOTAL COVER TYPE 3 (sq. ft.)	23.00	21.00	0.00	44.00	% OF CVR 3 TO TOTAL AREA	3.61	0.31	0.00	0.58
AVE. TYPE 3 COVER PER UNI	2.09	0.88	0.00	0.58					
TOTAL COVER TYPE 4 (sq. ft.)	3.00	5.00	0.00	8.00	% OF CVR 4 TO TOTAL AREA	0.47	0.07	0.00	0.11
AVE. TYPE 4 COVER PER UNI	0.27	0.21	0.00	0.11					
TOTAL COVER TYPE 5 (sq. ft.	0.00	0.00	0.00	0.00	% OF CVR 5 TO TOTAL AREA	0.00	0.00	0.00	0.00
AVE. TYPE 5 COVER PER UNI	0.00	0.00	0.00	0.00					
					% BANK ROCK CONTENT				
% BANK STABILITY TYPE 1					TYPE 2				
LEFT BANK	100.00	100.00	50.00	97.30	LEFT BANK	0.00	4.17	0.00	2.70
RIGHT BANK	100.00	100.00	100.00	100.00	RIGHT BANK	9.09	4.17	0.00	5.41
% BANK STABILITY TYPE 2					TYPE 3				
LEFT BANK	0.00	0.00	50.00	2.70	LEFT BANK	18.18	8.33	0.00	10.81
RIGHT BANK	0.00	0.00	0.00	0.00	RIGHT BANK	9.09	8.33	0.00	8.11
% BANK STABILITY TYPE 3					TYPE 4				
LEFT BANK	0.00	0.00	0.00	0.00	LEFT BANK	36.36	54.17	0.00	45.95
RIGHT BANK	0.00	0.00	0.00	0.00	RIGHT BANK	18.18	54.17	0.00	40.54
% BANK STABILITY TYPE 4					TYPE 5				
LEFT BANK	0.00	0.00	0.00	0.00	LEFT BANK	18.18	29.17	0.00	24.32
RIGHT BANK	0.00	0.00	0.00	0.00	RIGHT BANK	36.36	25.00	0.00	27.03
					TYPE 6				
					LEFT BANK	9.09	0.00	50.00	5.41
					RIGHT BANK	18.18	8.33	50.00	13.51
TOTAL OF ERODING BANKS (	0.00	37.00	5.00	42.00					
					TYPE 7				
					LEFT BANK	18.18	4.17	50.00	10.81
					RIGHT BANK	9.09	0.00	50.00	5.41
TOTAL LRG. ORGANIC DEBRIS	9.00	78.00	0.00	87	TYPE 8				
					LEFT BANK	0.00	0.00	0.00	0.00
					RIGHT BANK	0.00	0.00	0.00	0.00
AVERAGE OF SUBSTRATA TYPE FOR HABITAT ON THIS REACH									
PLANT DEBRIS	0.00	0.00	0.00	0.00	SAND\SILT	0.00	0.00	0.00	0.00
GRAVEL	0.00	0.00	0.00	0.00	RUBBLE	0.00	0.00	0.00	0.00
BOULDER	0.00	0.00	0.00	0.00	BEDROCK	0.00	0.00	0.00	0.00

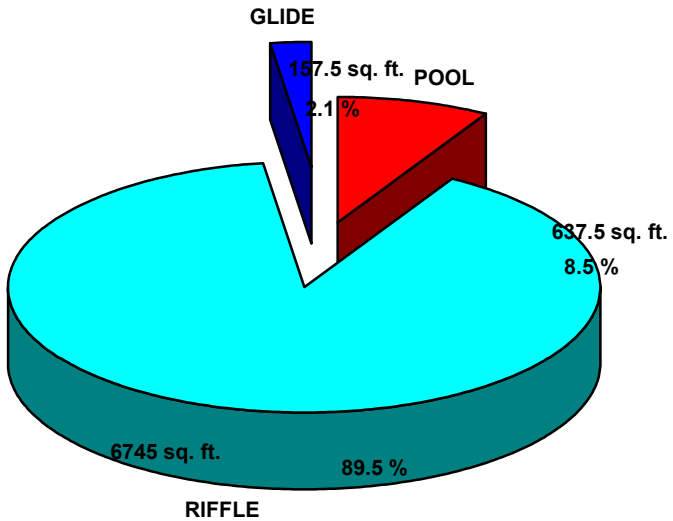
HABITAT TYPE ANALYSIS									
				TOTAL					TOTAL
NUMBER OF TYPE 2 HABITAT	0.00	0.00	0.00	0.00	NUMBER OF TYPE 9 HABITAT	0.00	0.00	0	0.00
% OF HABITAT	0.00	0.00	0.00	0.00	% OF HABITAT	0.00	0.00	0	0.00
NUMBER OF TYPE 3 HABITAT	0.00	0.00	0.00	0.00	NUMBER OF TYPE 10 HABITAT	0.00	3.00	0	3.00
% OF HABITAT	0.00	0.00	0.00	0.00	% OF HABITAT	0.00	27.73	0	8.11
NUMBER OF TYPE 4 HABITAT	0.00	0.00	0.00	0.00	NUMBER OF TYPE 11 HABITAT	0.00	14.00	0	14.00
% OF HABITAT	0.00	0.00	0.00	0.00	% OF HABITAT	0.00	51.55	0	37.84
NUMBER OF TYPE 5 HABITAT	10.00	0.00	0.00	10.00	NUMBER OF TYPE 12 HABITAT	0.00	0.00	0	0.00
% OF HABITAT	92.47	0.00	0.00	27.03	% OF HABITAT	0.00	0.00	0	0.00
NUMBER OF TYPE 6 HABITAT	0.00	0.00	0.00	0.00	NUMBER OF TYPE 13 HABITAT	0.00	0.00	0	0.00
% OF HABITAT	0.00	0.00	0.00	0.00	% OF HABITAT	0.00	0.00	0	0.00
NUMBER OF TYPE 7 HABITAT	1.00	0.00	0.00	1.00	NUMBER OF TYPE 14 HABITAT	0.00	3.00	0	3.00
% OF HABITAT	7.53	0.00	0.00	2.70	% OF HABITAT	0.00	17.23	0	8.11
NUMBER OF TYPE 8 HABITAT	0.00	0.00	0.00	0.00	NUMBER OF TYPE 15 HABITAT	0.00	4.00	0	4.00
% OF HABITAT	0.00	0.00	0.00	0.00	% OF HABITAT	0.00	3.48	0	10.81
TOTAL NUMBER OF HABITAT	11.00	24.00	2.00	37.00	NUMBER OF GLIDES	0.00	0.00	2	2.00
TOTAL % OF HABITAT	100.00	100.00	100.00	100.00		0.00	0.00	100.00	5.41



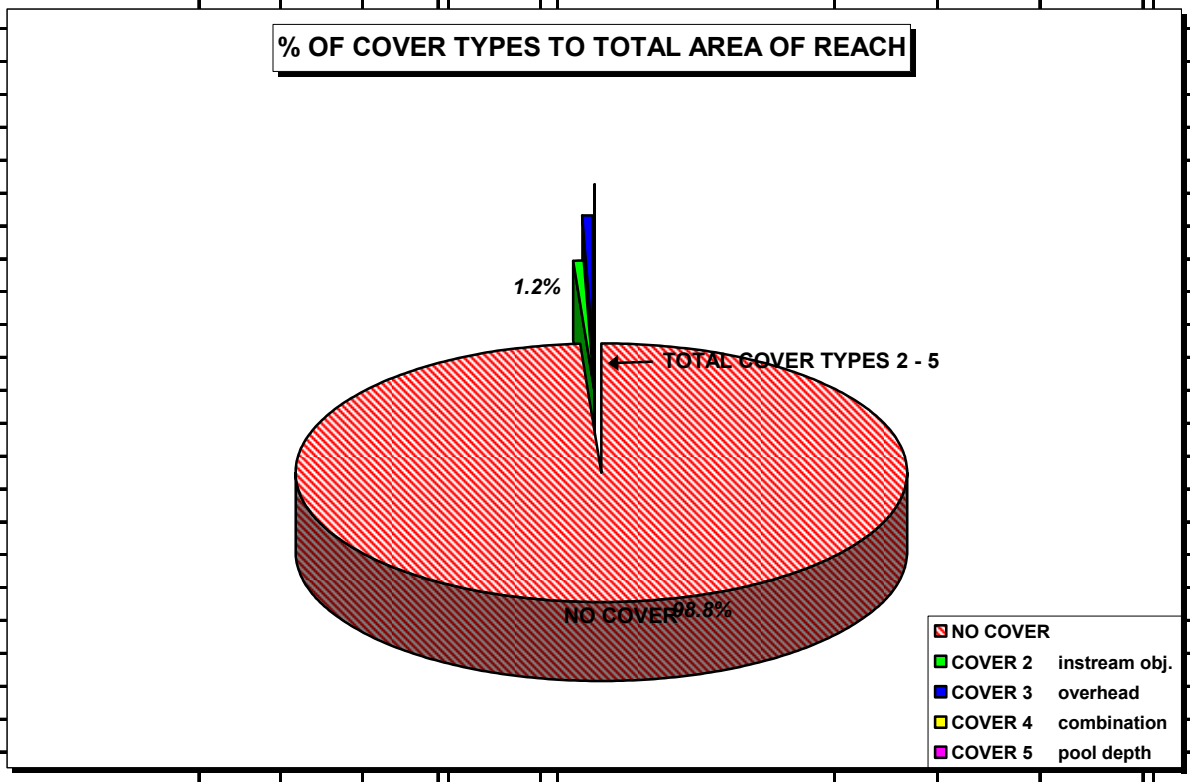
BREAKDOWN OF HABITAT TYPES

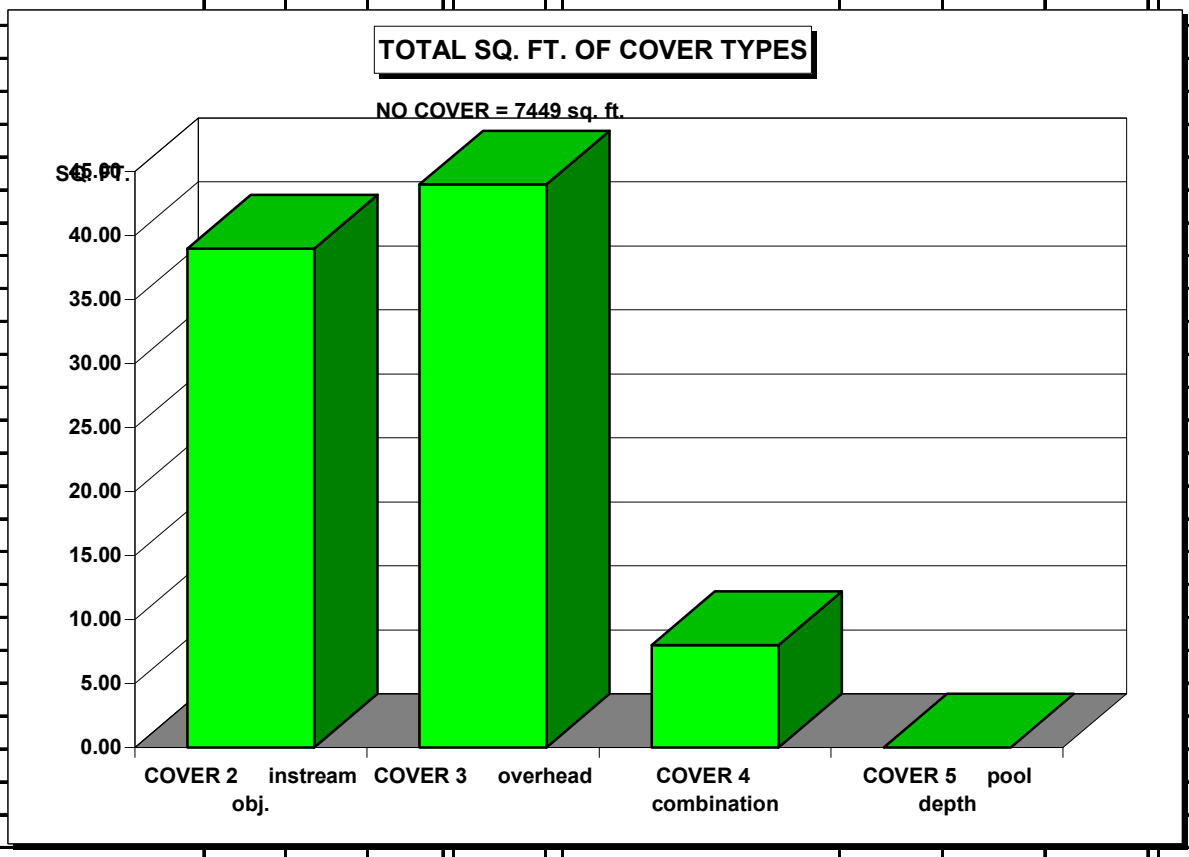


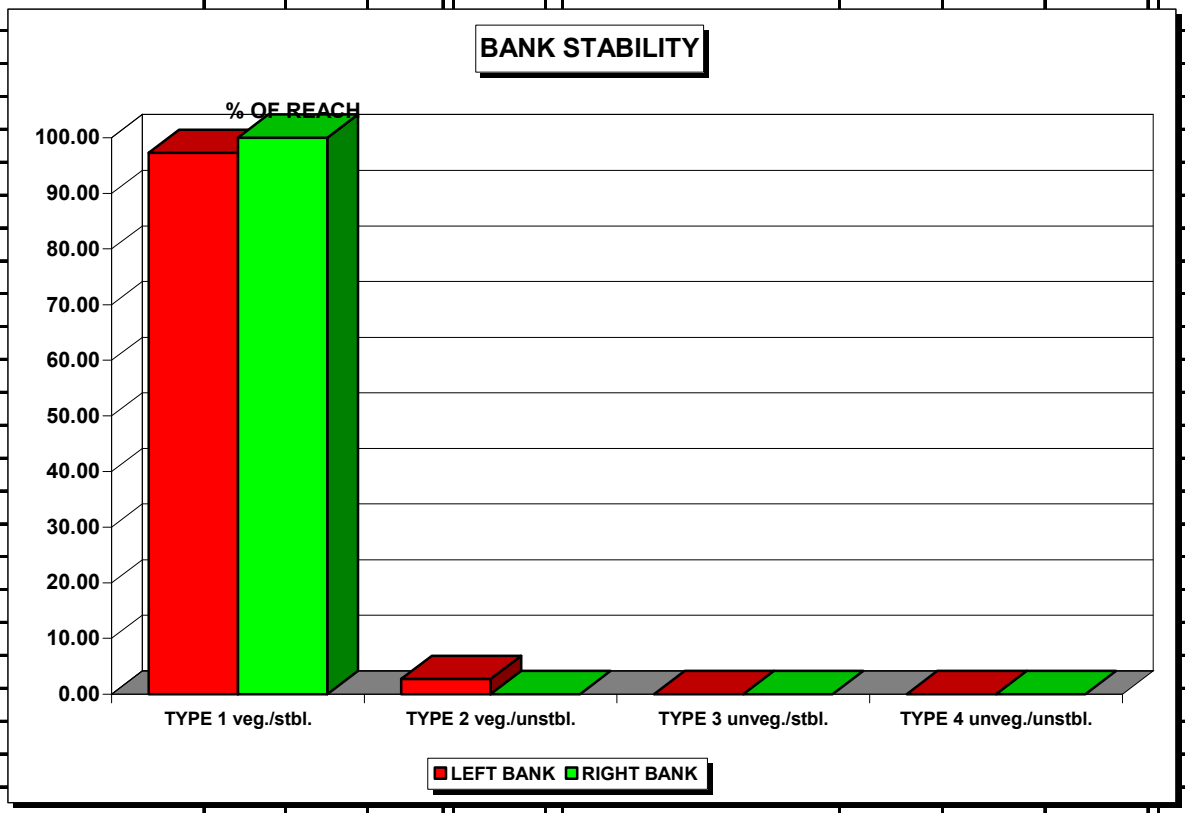
TOTAL AREA OF REACH

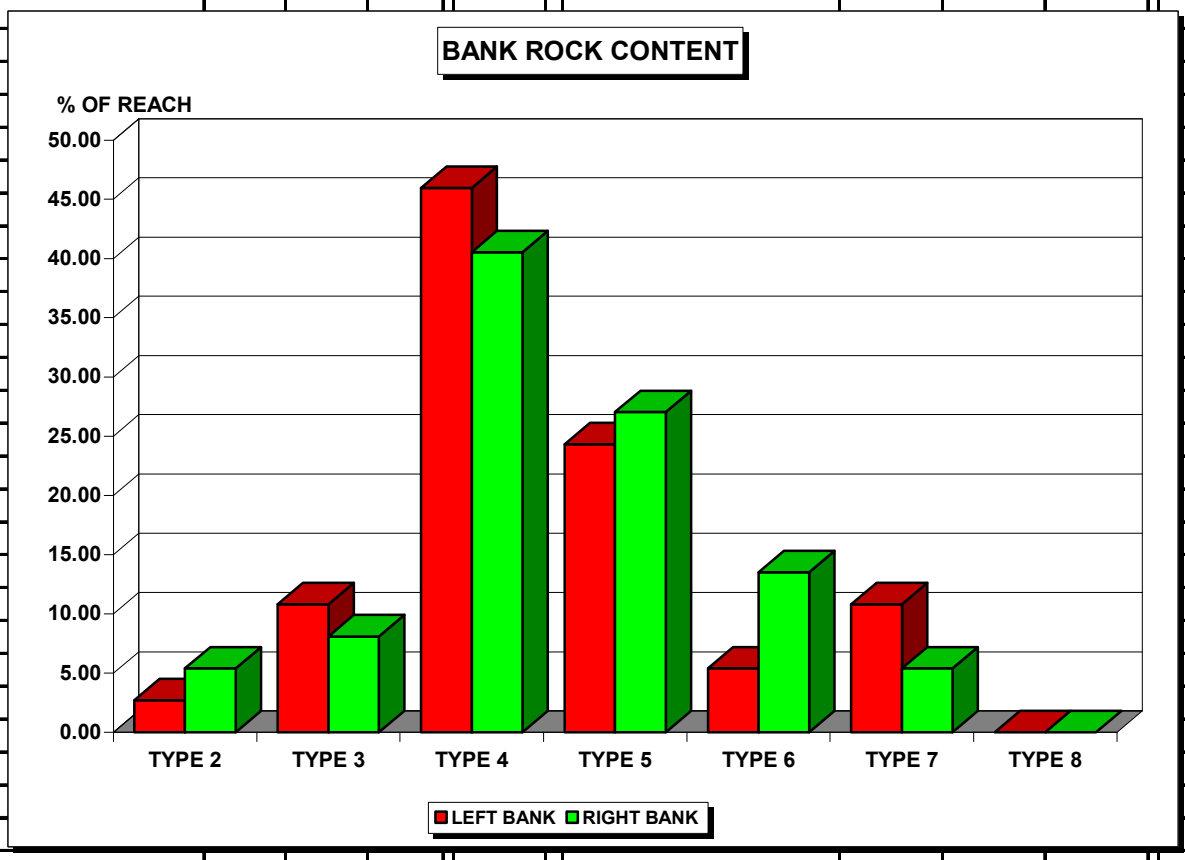


total area of this reach = 7,540.00 sq. ft.


% OF COVER TYPES TO TOTAL AREA OF REACH
1.2%
TOTAL COVER TYPES 2 - 5
NO COVER
98.8%
NO COVER
COVER 2 instream obj.
COVER 3 overhead
COVER 4 combination
COVER 5 pool depth


TOTAL SQ. FT. OF COVER TYPES
NO COVER = 7449 sq. ft.
SQ. FT.
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
COVER 2 instream obj.
COVER 3 overhead
COVER 4 combination
COVER 5 pool depth


BANK STABILITY
% OF REACH
100.00
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
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
TYPE 2
TYPE 3
TYPE 4
TYPE 5
TYPE 6
TYPE 7
TYPE 8
LEFT BANK
RIGHT BANK

HALLECK CREEK REACH 6 page 1	POOLS						RIFFLES								GLIDES
	TYPE 2	TYPE 3	TYPE4	TYPE5	TYPE 6	TYPE 7	TYPE 8	TYPE 9	TYPE 10	TYPE 11	TYPE 12	TYPE 13	TYPE 14	TYPE 15	TYPE 1
TOTAL LENGTH OF HABITAT TYPES	0.00	0.00	0.00	77.00	0.00	8.00	0.00	0.00	248.00	448.00	0.00	0.00	169.00	32.00	18.00
AVERAGE WIDTH OF HABITAT (ft.)	0.00	0.00	0.00	7.60	0.00	6.00	0.00	0.00	7.17	7.75	0.00	0.00	6.83	6.70	8.75
AVERAGE DEPTH (ft.)	0.00	0.00	0.00	0.68	0.00	0.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RESIDUAL DEPTH (ft.)	0.00	0.00	0.00	0.64	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL AREA OF HABITAT (sq. ft.)	0.00	0.00	0.00	589.50	0.00	48.00	0.00	0.00	1870.50	3477.00	0.00	0.00	1162.50	235.00	157.50
% OF TTL # OF HABITATS	0.00	0.00	0.00	0.27	0.00	0.03	0.00	0.00	0.08	0.38	0.00	0.00	0.08	0.11	0.05
HAB. TYPE AS A PERCENTAGE OF TOTAL AREA OF REACH	0.00	0.00	0.00	0.08	0.00	0.01	0.00	0.00	0.25	0.46	0.00	0.00	0.15	0.03	0.02
COVER															
TOTAL COVER TYPE 2 (sq.ft.)	0.00	0.00	0.00	18.00	0.00	2.00	0.00	0.00	7.00	5.00	0.00	0.00	2.00	5.00	0.00
AVE. COVER 2 per UNIT	0.00	0.00	0.00	2.25	0.00	2.00	0.00	0.00	3.50	2.50	0.00	0.00	2.00	1.67	0.00
% OF COVER 2 TO TTL AREA	0.00	0.00	0.00	3.05	0.00	4.17	0.00	0.00	0.37	0.14	0.00	0.00	0.17	2.13	0.00
TOTAL COVER TYPE 3 (sq.ft.)	0.00	0.00	0.00	22.00	0.00	1.00	0.00	0.00	12.00	6.00	0.00	0.00	2.00	1.00	0.00
AVE. COVER 3 per UNIT	0.00	0.00	0.00	2.44	0.00	1.00	0.00	0.00	6.00	3.00	0.00	0.00	2.00	1.00	0.00
% OF COVER 3 TO TTL AREA	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	0.00	0.00
TOTAL COVER TYPE 4 (sq.ft.)	0.00	0.00	0.00	2.00	0.00	1.00	0.00	0.00	2.00	1.00	0.00	0.00	0.00	2.00	0.00
AVE. COVER 4 per UNIT	0.00	0.00	0.00	1.00	0.00	1.00	0.00	0.00	2.00	1.00	0.00	0.00	0.00	1.00	0.00
% OF COVER 4 TO TTL AREA	0.00	0.00	0.00	0.34	0.00	2.08	0.00	0.00	0.11	0.03	0.00	0.00	0.00	0.85	0.00
TOTAL COVER TYPE 5 (sq.ft.)	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	0.00	0.00
AVE. COVER 5 per UNIT	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	0.00	0.00
% OF COVER 5 TO TTL AREA	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	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	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	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	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	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	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	0.00	0.00

HALLECK CREEK REACH 6 page 2	POOLS						RIFFLES								GLIDES
	TYPE 2	TYPE 3	TYPE4	TYPE5	TYPE 6	TYPE 7	TYPE 8	TYPE 9	TYPE 10	TYPE 11	TYPE 12	TYPE 13	TYPE 14	TYPE 15	TYPE 1
BANK STABILITY															
% OF BANK STABILITY TYPE 1															
LEFT BANK	0.00	0.00	0.00	100.00	0.00	100.00	0.00	0.00	100.00	100.00	0.00	0.00	100.00	100.00	50.00
RIGHT BANK	0.00	0.00	0.00	100.00	0.00	100.00	0.00	0.00	100.00	100.00	0.00	0.00	100.00	100.00	100.00
% OF BANK STABILITY TYPE 2															
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	0.00	50.00
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	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	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	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	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	0.00	0.00
BANK ROCK CONTENT															
TYPE 2															
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	25.00	0.00
RIGHT BANK	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00	0.00
TYPE 3															
LEFT BANK	0.00	0.00	0.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.33	25.00	0.00
RIGHT BANK	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66.67	0.00	0.00
TYPE 4															
LEFT BANK	0.00	0.00	0.00	40.00	0.00	0.00	0.00	0.00	100.00	42.86	0.00	0.00	66.67	50.00	0.00
RIGHT BANK	0.00	0.00	0.00	20.00	0.00	0.00	0.00	0.00	100.00	42.86	0.00	0.00	33.33	75.00	0.00
TYPE5															
LEFT BANK	0.00	0.00	0.00	20.00	0.00	0.00	0.00	0.00	0.00	50.00	0.00	0.00	0.00	0.00	0.00
RIGHT BANK	0.00	0.00	0.00	40.00	0.00	0.00	0.00	0.00	0.00	42.86	0.00	0.00	0.00	0.00	0.00
TYPE 6															
LEFT BANK	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00
RIGHT BANK	0.00	0.00	0.00	20.00	0.00	0.00	0.00	0.00	0.00	14.29	0.00	0.00	0.00	0.00	50.00
TYPE7															
LEFT BANK	0.00	0.00	0.00	10.00	0.00	100.00	0.00	0.00	0.00	7.14	0.00	0.00	0.00	0.00	50.00
RIGHT BANK	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00
TYPE 8															
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	0.00	0.00
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	0.00	0.00
OTHER															
TOTAL OF ERODING BANKS (ft.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.00	17.00	0.00	0.00	0.00	0.00	5.00
TOTAL LRG. ORG. DEBRIS	0.00	0.00	0.00	9.00	0.00	0.00	0.00	0.00	24.00	38.00	0.00	0.00	7.00	9.00	0.00

Z-Walk		Class		Dot & Dash Count	Total	% of	Cumulative
Metric - mm	Inches	Name		: . = 3, ⊟ : = 9	Number	Total	%
less .066		Silt/Clay				0.0%	0.0%
.062-.125		Very Fine	SAND			0.0%	0.0%
.125-.25		Fine	SAND			0.0%	0.0%
.25-.50		Medium	SAND		5	4.0%	4.0%
.50-1.0		Coarse	SAND		2	1.6%	5.6%
1.0-2.0		Very Coarse	SAND		2	1.6%	7.2%
2.0-4.0		Very Fine	GRAVEL		1	0.8%	8.0%
4.0-8.0		Fine	GRAVEL		6	4.8%	12.8%
8.0-16	.08-.6	Medium	GRAVEL		6	4.8%	17.6%
16-32	.6-1.3	Coarse	GRAVEL		18	14.4%	32.0%
32-64	1.3-2.5	Very Coarse	GRAVEL		31	24.8%	56.8%
64-128	2.5-5.0	Small	COBBLE		36	28.8%	85.6%
128-256	5-10	Large	COBBLE		9	7.2%	92.8%
256-512	10-20	Small	BOULDERS		6	4.8%	97.6%
512-1024	20-40	Medium	BOULDERS		3	2.4%	100.0%
1024-2048	40-80	Large	BOULDERS			0.0%	100.0%
2048-4096	80-160	Very Large	BOULDERS			0.0%	100.0%

Left/Right	Station	Willow Size
		125
	0 + 0 ft	
	0 + 50 ft	
	0 + 100 ft	
	0 + 150 ft	
	0 + 200 ft	
	0 + 250 ft	
	0 + 300 ft	
	0 + 350 ft	
	0 + 400 ft	
	0 + 450 ft	
	0 + 500 ft	
	0 + 550 ft	
	0 + 600 ft	
	0 + 650 ft	
	0 + 700 ft	
	0 + 750 ft	
	0 + 800 ft	
	0 + 850 ft	
	0 + 900 ft	
	0 + 950 ft	
	0 + 1,000 ft	

Bankside Willow Growth & Regeneration

(Largest Willow within a 1 square meter area along side stream is measured every 50 feet, switching between right and left banks. If no willow within 1 square meter of bank at station interval, mearsurement is entered as Zero)

Other Comments:

Discharge

Stream Name: HALLECK CREEK Reach #: 6

Date: JULY 16, 2007 Personnel: GALLAGHER

Discription: Calibration: 1.07

UPSTREAM OF LAST DIVERSION STRUCTURE

MARSH-McBIRNEY FLOW MATE 2000

Station	Width	Depth	Area	Velocity	Q	Sum(Q)
0.7	0.1	0	0	0	0	0
0.9	0.3	0.2	0.06	1.04	0.0624	0.0624
1.3	0.35	0.2	0.07	1.59	0.1113	0.1737
1.6	0.4	0.2	0.08	2.41	0.1928	0.3665
2.1	0.45	0.2	0.09	0	0	0.3665
2.5	0.35	0.4	0.14	0	0	0.3665
2.8	0.25	0.4	0.1	1.63	0.163	0.5295
3	0.25	0.4	0.1	1.99	0.199	0.7285
3.3	0.35	0.1	0.035	0.04	0.0014	0.7299
3.7	0.35	0.3	0.105	0	0	0.7299
4	0.3	0.3	0.09	0.85	0.0765	0.8064
4.3	0.3	0.2	0.06	1.61	0.0966	0.903
4.6	0.35	0.35	0.1225	0.12	0.0147	0.9177
5	0.4	0.3	0.12	1.53	0.1836	1.1013
5.4	0.35	0.35	0.1225	2.11	0.258475	1.359775
5.7	0.3	0.4	0.12	1.9	0.228	1.587775
6	0.35	0.3	0.105	0.42	0.0441	1.631875
6.4	0.4	0.3	0.12	0.99	0.1188	1.750675
6.8	0.4	0.2	0.08	1.53	0.1224	1.873075
7.2	0.3	0.3	0.09	1.7	0.153	2.026075
7.4	0.2	0.4	0.08	0.24	0.0192	2.045275
7.6	0.1	0	0	0	0	2.045275
			DISCHARGE =		2.05	CFS

STREAMNAME	HALLECK CREEK										CHANNEL TYPE	A3						
REACH NO.	6										MIN. TEMP.							
DATE	JULY 18, 2007										MAX. TEMP							
PERSONNEL	P. GALLAGHER										DISTRICT	ELK MOUNTAIN RANCH						
DESCRIPTION	1,000 FT REPRESENTATIVE REACH BEGINNING AT ACCESS 1 AND CONTINUING																	
	TO ACCESS 2/3 - SEE GPS MAPPING																	
	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	11	O	49.00	10.00								1	1	4	4	10.00	5	
P1	5	B/W	9.00	8.50	0.40	0.61	1.10		3			1	1	4	5		1	
R2	11	O	17.00	7.50								1	1	5	6		2	
P2	5	L	7.00	6.00	0.50	0.63	1.00	1	3			1	1	6	5		2	
R2	11	P	18.00	8.50								1	1	4	4		2	
P3	5	W/B	7.00	9.50	1.10	0.82	1.40	5	2	1		1	1	4	6		3	
R4	11	O	22.00	6.50								1	1	4	5			
R5	15	F/W	9.00	7.00								1	1	3	4		3	
R6	11	O	17.00	11.00					2			1	1	4	6	2.00	2	
P4	5	R	10.00	10.00	0.60	0.57	1.00	2	2			1	1	3	2			
R7	15	P/B	10.00	8.00				2		1		1	1	2	2			
R8	11	P	12.00	8.00								1	1	4	4		3	
G1	1		9.00	10.00								1	1	7	7			
P5	5	B/W	9.00	6.00	0.60	0.67	1.00		2			1	1	7	4		2	
R9	10	P	88.00	7.00				5	4	2		1	1	4	4	10.00	6	
G2	1		9.00	7.50								2	1	6	6	5.00		
P6	5	B/W	7.00	6.50	0.70	0.62	1.10	1				1	1	4	4			
R10	11	P	35.00	7.00								1	1	4	4		8	
R11	11	O	78.00	8.50				1		1		1	1	5	5		11	START OF ACCESS 2 AND LONGITUDINAL PROFILE
R12	15	F/L	8.00	11.00				1				1	1	4	4		3	
R13	11	O	11.00	7.00								1	1	5	5			
P7	5	B/L	7.00	7.00	0.50	0.68	1.00	1	4			1	1	5	5			
R14	11	O	16.00	6.50								1	1	5	4		2	
P8	5	B	8.00	7.00	0.50	0.65	1.00	1	2			1	1	4	6			POOL AT X-SECTION #5
R15	10	P	17.00	6.50								1	1	4	4			
R16	15	W/F	5.00	0.80				2	1	1		1	1	4	4		3	
R17	11	O	39.00	7.50					4			1	1	7	4			
P9	5	L	6.00	8.50	0.90	0.80	1.40	5	3	1		1	1	5	5		1	START OF ACCESS 3
P10	7	L	8.00	6.00	0.60	0.88	1.20	2	1	1		1	1	7	7			
R18	11	O	47.00	7.00								1	1	5	5	5.00	1	
R19	10	P	143.00	8.00				2	8			1	1	4	4	10.00	18	
P11	5	B	7.00	7.00	0.60	0.72	1.10	2	1			1	1	3	3			
R20	14	P	103.00	7.00					2			1	1	3	3		7	
R21	11	O	55.00	6.00								1	1	5	5			
R22	14	P	25.00	7.00				2				1	1	4	4			
R23	11	O	32.00	7.50				4				1	1	5	5		2	
R24	14	P	41.00	6.50								1	1	4	3			END OF REACH

STREAMNAME	HALLECK CREEK										CHANNEL TYPE	A3						
REACH NO.	6										MIN. TEMP.							
DATE	JULY 18, 2007										MAX. TEMP							
PERSONNEL	P. GALLAGHER										DISTRICT	ELK MOUNTAIN RANCH						
DESCRIPTION	1,000 FT REPRESENTATIVE REACH BEGINNING AT ACCESS 1 AND CONTINUING																	
	TO ACCESS 2/3 - SEE GPS MAPPING																	
POOLS																		
	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
P1	5	B/W	9.00	8.50	0.40	0.61	1.10		3			1	1	4	5		1	
P2	5	L	7.00	6.00	0.50	0.63	1.00	1	3			1	1	6	5		2	
P3	5	W/B	7.00	9.50	1.10	0.82	1.40	5	2	1		1	1	4	6		3	
P4	5	R	10.00	10.00	0.60	0.57	1.00	2	2			1	1	3	2			
P5	5	B/W	9.00	6.00	0.60	0.67	1.00		2			1	1	7	4		2	
P6	5	B/W	7.00	6.50	0.70	0.62	1.10	1				1	1	4	4			
P7	5	B/L	7.00	7.00	0.50	0.68	1.00	1	4			1	1	5	5			
P8	5	B	8.00	7.00	0.50	0.65	1.00	1	2			1	1	4	6			POOL AT X-SECTION #5
P9	5	L	6.00	8.50	0.90	0.80	1.40	5	3	1		1	1	5	5		1	START OF ACCESS 3
P11	5	B	7.00	7.00	0.60	0.72	1.10	2	1			1	1	3	3			
P10	7	L	8.00	6.00	0.60	0.88	1.20	2	1	1		1	1	7	7			

STREAMNAME	HALLECK CREEK										CHANNEL TYPE	A3						
REACH NO.	6										MIN. TEMP.							
DATE	JULY 18, 2007										MAX. TEMP							
PERSONNEL	P. GALLAGHER										DISTRICT	ELK MOUNTAIN RANCH						
DESCRIPTION	1,000 FT REPRESENTATIVE REACH BEGINNING AT ACCESS 1 AND CONTINUING																	
	TO ACCESS 2/3 - SEE GPS MAPPING																	
RIFFLES																		
	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
R9	10	P	88.00	7.00				5	4	2		1	1	4	4	10.00	6	
R15	10	P	17.00	6.50								1	1	4	4			
R19	10	P	143.00	8.00				2	8			1	1	4	4	10.00	18	
R1	11	O	49.00	10.00								1	1	4	4	10.00	5	
R2	11	O	17.00	7.50								1	1	5	6		2	
R2	11	P	18.00	8.50								1	1	4	4		2	
R4	11	O	22.00	6.50								1	1	4	5			
R6	11	O	17.00	11.00					2			1	1	4	6	2.00	2	
R8	11	P	12.00	8.00								1	1	4	4		3	
R10	11	P	35.00	7.00								1	1	4	4		8	
R11	11	O	78.00	8.50				1		1		1	1	5	5		11	START OF ACCESS 2 AND LONGITUDINAL PROFILE
R13	11	O	11.00	7.00								1	1	5	5			
R14	11	O	16.00	6.50								1	1	5	4		2	
R17	11	O	39.00	7.50					4			1	1	7	4			
R18	11	O	47.00	7.00								1	1	5	5	5.00	1	
R21	11	O	55.00	6.00								1	1	5	5			
R23	11	O	32.00	7.50				4				1	1	5	5		2	
R20	14	P	103.00	7.00					2			1	1	3	3		7	
R22	14	P	25.00	7.00				2				1	1	4	4			
R24	14	P	41.00	6.50								1	1	4	3			END OF REACH
R5	15	F/W	9.00	7.00								1	1	3	4		3	
R7	15	P/B	10.00	8.00				2		1		1	1	2	2			
R12	15	F/L	8.00	11.00				1				1	1	4	4		3	
R16	15	W/F	5.00	0.80				2	1	1		1	1	4	4		3	

STREAMNAME	HALLECK CREEK	CHANNEL TYPE	A3
REACH NO.	6	MIN. TEMP.	
DATE	JULY 18, 2007	MAX. TEMP	
PERSONNEL	P. GALLAGHER	DISTRICT	ELK MOUNTAIN RANCH
DESCRIPTION	1,000 FT REPRESENTATIVE REACH BEGINNING AT ACCESS 1 AND CONTINUING		
	TO ACCESS 2/3 - SEE GPS MAPPING		

GLIDES

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		9.00	10.00								1	1	7	7			
G2	1		9.00	7.50								2	1	6	6	5.00		

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