FINAL

Assessment of Aquatic Ecosystem Restoration Projects

1999 – 2014

North Fork Gunnison River
Delta County, CO

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1.0 BACKGROUND AND PURPOSE

Over the last century, the North Fork of the Gunnison River (North Fork) has been impacted by anthropogenic activities such as gravel mining, surface water irrigation diversions, and river channelization. These activities have disrupted the natural functioning of the ecosystem and have resulted in accelerated bank erosion, loss of prime agricultural lands, and degraded aquatic and terrestrial habitat in and along the North Fork.

Recently, efforts have been made to improve and restore a natural and stable riverine ecosystem throughout the North Fork Gunnison River basin. In particular, numerous river restoration projects have been completed over the last 15 years with goals such as floodplain rehabilitation, channel and bank stabilization, diversion structure improvement, and aquatic habitat enhancement. These projects are located along a 16-mile stretch of the North Fork extending from approximately 4 miles upstream of the Town of Paonia to 3 miles downstream of the Town of Hotchkiss where the river emerges from a canyon environment and transitions into a broad valley accentuated by multiple terraces and mesas.

The purpose of this report is to evaluate the effectiveness and success of 19 river restoration projects completed to date on the North Fork of the Gunnison River. To that end, the report compares pre-project habitat quality assessments to current assessments of corresponding river reaches. Ultimately, the report will make recommendations for future restoration projects on the North Fork, and will help to define the meaning of successful restoration for the North Fork Gunnison River watershed.

2.0 METHODS

In order to gauge the success of restoration projects on the North Fork, habitat quality assessments of pre-project site conditions are compared to assessments of the same locations following project completion. Identical criteria are used in both pre-project and post-project assessments in order to better evaluate effectiveness of each restoration project relative to project goals. This section identifies and describes the habitat quality assessment protocol used for all projects, explains how pre-project and post-project assessments were conducted in the field, and details the methodology for comparison between pre-project and post-project assessments.

2.1 SITE HABITAT QUALITY EVALUATION

Aquatic and riparian habitat quality was assessed at each site using a modification of the U.S. Environmental Protection Agency (EPA) Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers, Second Edition (Barbour et al. 1999). The EPA protocols consist of a number of procedures for measuring various aspects of riverine biota and habitat structural and functional characteristics. For this project, a modified procedure for Habitat Assessment and Physiochemical Parameters was selected. This assessment protocol is designed and approved by EPA for use nationwide, and provides procedures for measuring habitat characteristics relevant to a broad range of stream-dependent life forms. The procedures can be modified to reflect the habitat variables of interest, and indices can be calculated to compare measured pre-project habitat value to post-project habitat value.

The EPA Protocol lists 13 habitat criteria for evaluation of both low and high-gradient streams, and provides definitions for guidance on scoring each criterion in the field on a scale from 0 to 20. A multidisciplinary project team consisting of wildlife biologists, aquatic biologists, wetland scientists, and hydrologists evaluated and modified the EPA Protocol. Six criteria were eliminated from the original EPA protocol because those criteria were not applicable or did not vary substantially within the project area. The following 4 additional criteria were included to better reflect habitats and habitat improvement opportunities in the project area: aquatic habitat barriers and population sinks, riparian vegetation structural diversity, percent native woody vegetation, and palustrine wetland area and function. Appendix A contains a copy of the worksheets used to conduct habitat assessments in the field, including the criteria and scoring definitions used. The final 11 parameters used in the habitat quality assessments and short summaries of their defining characteristics are listed here.

1. Aquatic habitat barriers and sinks – the extent to which physical barriers and diversion structures exist within the channel and whether these structures restrict or inhibit the movement of aquatic organisms;

2. Aquatic structure as cover – the percentage of stable in-stream habitat for aquatic biota, including snags, submerged logs, undercut banks, and large in-stream rocks;

3. Velocity/depth regimes – the number of velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow);

4. Flow continuity – the extent to which the channel may be dewatered or riffle substrates exposed under low-flow conditions;

5. Channel alteration – the level of channelization and disruption within the stream reach, in such forms as bridge abutments, embankments, shoring structures, gabions, or evidence of past dredging;

6. Channel sinuosity – the ratio of channel length to valley length;

7. Bank stability – the extent of and potential for erosion or bank sloughing (each bank evaluated separately);

8. Riparian vegetation cover – the percentage of riparian area that is composed of unconsolidated shore or gravel bars and the extent to which disruption by grazing or cutting may affect riparian vegetation structure;

9. Riparian vegetation structural diversity – the extent to which the 4 riparian structural classes (mature trees, young trees/seedlings, shrubs, and herbaceous vegetation) are represented (each bank evaluated separately);

10. Percent native woody vegetation – the percentage of native vegetation compared to exotic species (each bank evaluated separately);

11. Palustrine wetland area and function – the percentage of riparian area containing backwaters, sloughs, or beaver ponds that support emergent wetland vegetation and the size of area wetlands.

Some of the EPA definitions for scoring the criteria were modified based on knowledge of the existing conditions and habitat capabilities of the North Fork within the project area. Scoring definitions were constructed so that the highest and lowest possible scores reflect the presumed range of conditions that could reasonably exist in the project area.

2.2 PRE-PROJECT HABITAT QUALITY ASSESSMENTS

The North Fork River Improvement Association (NFRIA) began river assessments on the North Fork in 1996 (Preliminary Assessment of the Morphological Characteristics of the North Fork of the Gunnison River, Crane 1997) and implemented several channel and floodplain rehabilitation projects prior to acceptance in 1999 into the Aquatic Ecosystem Restoration Program administered by the US Army Corps of Engineers (USACE) under Section 206 of the Water Resources Development Act (WRDA). The Section 206 project commenced in 2002, and yielded several versions of a Detailed Project Report (DPR) describing a number of restoration projects along the North Fork between 2002 and 2007. The program never funded any actual restoration activities, but did generate assessments, preliminary plans, and cost estimates for 9 individual projects. During and following the course of the Section 206 assessments, NFRIA obtained funding and constructed 6 of the 9 projects identified in the DPR. Three were never completed due to either a lack of approval by the landowners (Stewart Ditch and Farmers Ditch) or a low priority for implementation (Waters/Carpenter site).

Habitat quality assessments for projects included in the USACE Section 206 North Fork Gunnison River Aquatic Ecosystem Restoration plan were conducted in 2002 and are included in the DPR for this plan (USACE 2007). This plan also serves as the basis for the evaluation methods used for both pre-project and post-project assessments (refer to Appendix D of the DPR for more information).

This section describes the assessment method details for both projects included in the DPR ("DPR projects") and not included in the DPR ("non-DPR projects"). A list of projects evaluated in this report, along with information about project timing, status, and inclusion in the DPR, is presented in Table 1. Project locations are shown in Figure 1. The pre-project habitat quality assessments for non-DPR projects were conducted retroactively in 2014. At locations where a project was proposed but not completed, only one (pre-project) assessment was conducted[1].

2.2.1 DPR Projects

For DPR projects, a team consisting of a biologist, wetland scientist, and hydrologist scored the habitat criteria at each reach or sub-reach in March 2002. The field team walked the entire reach at each location, taking notes and photographs as necessary, and then assigned a score for each habitat criterion. Most criteria were scored based on field observations; however, two criteria were scored or corrected following analysis of maps and ortho-rectified aerial photographs created for the project in November 2002: channel sinuosity and riparian vegetation cover.

Channel sinuosity was calculated by a Geographic Information System (GIS) procedure that measured the total length of the low flow channel center visible in aerial photographs (stream length), and the straight-line distance from the low-flow channel center at the top and bottom of the reach (valley length). Sinuosity was calculated as stream length divided by valley length, and scored using the definitions in Appendix A. This provided a more precise measure of sinuosity than was possible by field estimation.

Riparian vegetation cover was difficult to estimate in the field because of extreme variability within sites and the timing of fieldwork in March before the growing season. As a result, riparian vegetation cover was calculated as an index based on the extent of cobble/gravel bar (Habitat type R3US, Riverine Unconsolidated Shore) in the site boundary. For each reach or sub-reach, the area of R3US mapped during fall 2002 was calculated in a GIS procedure and divided by the total acreage of terrestrial riparian area (site area minus upland area minus river channel area). The resulting percentage was then scored using the definitions in Appendix A.

2.2.2 Non-DPR Projects

Non-DPR projects did not undergo a habitat quality assessment prior to project work. Pre-project assessments at these locations were conducted retroactively along with post-project assessments in the following manner. All of the project sites were visited in September 2014 by a two-person team consisting of a watershed scientist and a hydrologist. Prior to conducting the post-project assessment, the criteria were evaluated from a pre-project perspective by the hydrologist who was present during the DPR pre-

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[1] The only exception is the Waters-Carpenter site, where certain site habitat quality criteria results included in the pre-project assessment conducted in 2002 differed considerably from those assigned in the 2014 pre-project assessment for site-specific reasons (refer to Section 3.4).

project assessments between 1996 and 2007. This individual based his assessment on recollection of the site prior to any project work, and augmented his recall via consultation of historical aerial photographs, on-the-ground project photographs, field notes, and narrative descriptions of the area prior to restoration work. Because this is not a quantitative study but rather a comparative evaluation of pre-project to post-project conditions at each project site, this rough historical estimation is acceptable.

2.3 POST-PROJECT HABITAT QUALITY ASSESSMENTS

All of the project sites (both DPR projects and non-DPR projects) were visited in September 2014 by a two-person team consisting of a watershed scientist and a hydrologist. The field team conducted an ocular assessment at each location, taking notes and photographs as necessary, and then assigned a score based on field observations for each habitat criterion.

2.4 COMPARISON OF PRE-PROJECT AND POST-PROJECT ASSESSMENTS

For each project, a qualitative comparison of pre-project to post-project habitat quality was conducted in order to evaluate the effectiveness or success of the restoration project relative to project goals. The comparison is not meant to be quantitative; rather, it is a relative comparison designed to gauge changes and improvements at the site over time related to restoration. Comparisons are also used to develop recommendations for future restoration work at project locations.

Limitations of the pre-project/post-project habitat quality comparisons were: (1) the pre-project assessments performed for DPR projects were conducted by a different team than the team performing post-project assessments at those locations; and (2) the pre-project assessments performed for DPR projects were conducted in early spring (March), whereas post-project assessments for those projects were conducted in the fall (September). However, despite these limitations, meaningful conclusions can still be made regarding relative habitat quality changes over time.

3.0 PROJECT ASSESSMENTS AND RECOMMENDATIONS

This section provides a description of the site location and project goals for each of the 19 projects assessed in this report. Project descriptions are not intended to be exhaustive, but rather to provide a summary of the site-specific information needed to understand the habitat quality assessments at each location. In cases where more detail is available, the reader is referred to project reports and other documents.

Following the site and project descriptions, each section discusses the pre-project and post-project habitat quality assessments, and provides a comparison of pre-project and post-project environmental conditions in order to gauge the successes, limitations, challenges, and/or improvements to habitat quality as a result of the restoration project. Photographs are provided in Appendix B to supplement habitat quality assessments where available. Finally, recommendations for future projects are provided.

3.1 TOM KAY PROPERTY (DPR SITE 1)

Located approximately 1.8 miles southwest of the Town of Hotchkiss, the Tom Kay property is the furthest downstream of all project sites reviewed in this report (Figure 1). The river upstream and alongside the site is generally confined by a large shale bluff to the west and agricultural fields to the east (USACE 2007). Prior to any work at the site, the land was farmed and grazed along the east side right up to the river's edge. Unprotected banks along the east side of the river were sheer and vertical, causing the river to steadily meander east and erode the east banks faster than point bars could form. The unprotected banks, up to 16 feet high in some areas, were continually sloughing off into the river. Furthermore, this rapid rate of bank erosion was contributing to an aggrading condition occurring downstream of the property.

NFRIA, a local non-profit organization founded in 1996 to restore the health of the river, had been monitoring a permanent geomorphic cross-section on this property since 1997, and documented horizontal bank erosion of several feet per year on the east side of the river. NFRIA determined that this erosion was occurring on the upper section of the banks and was likely the result of uncontrolled releases of irrigation water across the steep clay slopes adjacent to the river.

3.1.1 Project Description

The major concerns at this site prior to restoration were the steep, unstable banks, the rapid rate of bank erosion, and the loss of property contributing to aggradation downstream. Thus, the primary goals of restoration on the Tom Kay property were erosion mitigation and bank stabilization along approximately 1,800 linear feet of the river's east bank.

Project work on the Tom Kay property began in 2006 and was designed and permitted by Crane Associates and implemented by the owner. Agricultural fields were pushed back slightly from the river's edge and a small riparian buffer was created between the fields and the river. The upper bank was planted with native grasses, riparian shrubs, and cottonwood trees. Banks were regraded to a gentler and lower-angle slope, reducing further erosion and sedimentation into the river. Toe rocks and rock vanes were installed to protect the toe of the slope. A riprapped open channel diverted irrigation wastewater back to the river.

3.1.2 Pre-Project Assessment

An aerial photograph of the project site taken in 1997 and prior to any restoration work is provided in Appendix B (Photo 1). Steep vertical banks on the east side of the river are illustrated in the top portion of the photograph, and massive amounts of stream meandering and bank erosion are evident.

Pre-project habitat assessment scores are presented in Table 2. The lowest scores were achieved for criteria related to bank stability (parameter 7) and vegetation cover, structure, and composition (parameters 8-11). The lowest possible score of 1/10 for left (east) bank stability was the main reason for restoration in this area. As stated previously, the east bank was devoid of riparian vegetation due to farming and grazing up to the river's edge, earning a left bank score of 1/10 for riparian vegetation structural diversity (parameter 9). The suboptimal rating of 11/20 for riparian vegetation cover was a combination of existing stable vegetation on the right (west) bank and a lack of vegetation on the left (east) bank. Modest scores were earned for percent native woody vegetation mainly due to the presence of Russian olive trees on both banks (parameter 10). Lack of space and wetland vegetation species resulted in a poor rating of 4/20 for palustrine wetland area and function (parameter 11).

3.1.3 Post-Project Assessment

A landscape photograph of the project site taken in 2014, approximately 8 years after restoration activities, is provided in Appendix B (Photo 2). The restoration site begins just downstream of the location where the flows are split in the middle of the photograph, and continues downstream along the east (far) banks to the cottonwood gallery on the right side of the photograph. Note that the bank on the far side of the river has been planted with native riparian vegetation and the slope has been regraded so that it is no longer sheer and easily erodible. Large cottonwood galleries to the left and right of the previously vertical bank also provide stabilization. Although the fields are still close to the river to maximize profitable farmland, they are not directly adjacent to the bank like they were previously.

Post-project habitat assessment scores are presented alongside the pre-project scores in Table 2. In response to the primary restoration project objective of bank stabilization, the left (east) bank achieved a suboptimal score of 7/10 (parameter 7), and the right bank had an optimal rating of 9/10. The project also involved planting vegetation to further stabilize the banks, and vegetation-related parameters (parameters 8-11) were relatively high as a result as well. Plantings on the east side of the river contributed to a left bank score of 6/10 for riparian vegetation structural diversity (parameter 9) and an overall rating of 15/20 for riparian vegetation cover (parameter 8). Relatively high scores of 8/10 (left bank) and 7/10 (right bank) were achieved for percent native woody vegetation (parameter 10). A suboptimal rating of 11/20 was recorded for wetland area and function (parameter 11).

3.1.4 Assessment Comparison

At this location, slight improvements were noted between pre-project and post-project habitat assessment ratings for the in-stream parameters measured (parameters 1-6). However, the most significant changes are evident in the bank stability and vegetation-related metrics (parameters 7-11).

Bank stability (parameter 7) ratings increased from 1/10 (poor) to 7/10 (suboptimal) on the left (east) bank where most restoration activities occurred (Table 2). The right bank achieved an optimal rating of 9/10 in both the pre-project and post-project assessments.

As a result of riparian plantings and subsequent natural recruitment, riparian vegetation cover (parameter 8) increased from the lowest to the highest end of the suboptimal range, from 11/20 pre-project to 15/20 post-project. Riparian vegetation structural diversity scores also increased from 1/10 to 6/10 and 8/10 to 9/10 on the left (east) and right (west) banks, respectively. Scores for percent native woody vegetation (parameter 10) similarly increased. Many saplings and young shrubs were observed when the site was visited in 2014, indicating a decent likelihood of further spread of native riparian vegetation, with natural recruitment supplementing the vegetation planted as part of the project. The emergence of a number of small wetland areas has improved the palustrine wetland area and function (parameter 11) score for this location from poor (4/20) to suboptimal (11/20).

3.1.5 Conclusions and Recommendations

Based on project goals to reduce erosion and sedimentation at this location by stabilizing the east bank of the river and creating a riparian buffer between the river and the agricultural fields, the project can be considered a success. Improvements in bank stability and vegetation community and cover habitat assessment ratings support this conclusion. As of 2014, the site continues to improve as natural recruitment of native riparian vegetation supplements native grass and shrub growth from 2008 plantings. Recommendations for further work at this site are minimal; a small revetment at the upstream end of the project where the agricultural fields meet the riparian forest could further improve bank stability there, and additional plantings could assist in accomplishing stated project goals by accelerating native vegetation growth. However, additional restoration activities at this location are not a high priority.

3.2 CHIPETA DAM REMOVAL

The Chipeta Dam was located approximately 1.8 miles southwest of the Town of Hotchkiss, just upstream of the Tom Kay property and downstream of the Town’s wastewater treatment plant (Figure 1). This concrete structure was 4 feet high and spanned 175 feet across the width of the North Fork of the Gunnison River. Erected in the 1950s, the Chipeta Dam was built to divert water to the Chipeta Unit of the US Fish and Wildlife Service’s (USFWS) Hotchkiss National Fish Hatchery. The hatchery was decommissioned after a massive landslide in 1981 rendered the dam defunct.

3.2.1 Project Description

In 2002, the USFWS attempted to remove the Chipeta diversion because it was no longer necessary, but failed due to funding limitations and bureaucratic restrictions.

Following this attempt, NFRIA petitioned the USFWS to fund the dam's removal because of its hazards to recreational boaters and blockage of native fish passage. NFRIA removed the dam in 2006.

The structure was removed in the winter of 2006 (refer to Appendix B, Photos 3-5), but a small part of the dam on the south side of the river was kept intact as a keyway to protect the bank by creating an eddy to slow the flow and dissipate some of the river's energy. Other measures taken to dissipate energy at the old dam site were riparian habitat rehabilitation and riffle creation. Willows were planted in a row on the point bar on the south side of the river and in the floodplain just downstream of the old dam site to catch flood flows and woody debris, and to slow the water as it enters the Tom Kay property area. A riffle was also created downstream of the old dam site to dissipate energy and slow flow. Bedrock and stable banks already existed on the north side of the river, so that bank was left alone.

3.2.2 Pre-Project Assessment

Pre-project habitat assessment scores are presented in Table 3. The lowest habitat quality scores prior to dam removal were related to natural channel alteration, fish passage barriers, and flow regimes. Non-native vegetation and lack of wetlands also yielded low scores for associated parameters.

Poor condition ratings were documented for aquatic habitat barriers (1/20, parameter 1), channel alteration (2/20, parameter 5), and channel sinuosity (1/20, parameter 6) prior to dam removal. Clearly the dam provided a major blockage for fish passage, and the channel was heavily altered and channelized while the dam was in operation. Marginal ratings were earned for in-stream categories such as aquatic structure as cover (9/20, parameter 2) and velocity/depth regimes (9/20, parameter 3). The velocity/depth regime score was likely also related to the dam's presence, as dams are known and designed to alter and regulate flows. However, flow continuity (parameter 4) was maintained while the dam was present, so an optimal rating of 18/20 was achieved for that metric.

Bank stability and vegetation structure and cover scores (parameters 7-9) ranged from suboptimal to optimal prior to dam removal. Low ratings for percent native woody vegetation (parameter 10) and wetland area and function (parameter 11) may or may not have been associated with the presence of the dam.

3.2.3 Post-Project Assessment

A photograph of the project site taken in 2014, approximately 8 years after dam removal, is provided in Appendix B (Photo 6). Planted willows are evident and have taken root on the far side of the photograph (south bank of the river) just downstream of the old dam location.

Post-project habitat assessment scores are presented alongside the pre-project scores in Table 3. Dam removal immediately resulted in an aquatic habitat barrier (parameter 1) score of 20/20, as the major barrier to fish movement was eliminated. Dam removal also increased the number of velocity/depth regimes (parameter 3), achieving a suboptimal rating of 14/20 for that parameter. Willow plantings that were part of the Chipeta Dam removal project played a role in the percent native woody vegetation (parameter 10) score of 7/10 for the left (east) bank, as well as the wetland area and function (parameter 11) rating of 10/20.

3.2.4 Assessment Comparison

Minor or no changes were documented in 6 of the 11 habitat quality parameters (parameters 2, 4, 6, 7, 8, and 9). However, the dam removal project yielded some major changes in the remaining 5 metrics (Table 3). The most obvious change was the rating for aquatic habitat barriers (parameter 1), which increased from 1/20 to 20/20 with the removal of the dam, allowing fish and other aquatic organisms to pass through the area unrestricted. The score for channel alteration (parameter 5) also increased from poor (2/20) to suboptimal (12/20) as a result of dam removal. Elimination of the dam allowed for an additional velocity/depth regime to be active in the system, increasing the rating for parameter 3 from 9/20 to 14/20.

In addition to the physical removal of the dam, this project also included the planting of riparian vegetation such as willows, primarily on the south bank of the North Fork. These activities promoted an increase in ratings for left bank native woody vegetation (3/10 to 7/10, parameter 10) and wetland area and function (1/20 to 10/20, parameter 11). The north reach of river near the Chipeta Dam was devoid of wetlands until the dam was removed, and wetlands are now forming as a result of more natural flow regimes in the area, supplemented by plantings of native riparian vegetation for the project.

3.2.5 Conclusions and Recommendations

The Chipeta Dam removal project goals were to improve fish passage and increase recreational boater safety by removing the dam as an obstruction across the width of the channel. These goals were achieved successfully by eliminating the dam and allowing clear passage through this river reach by recreationalists and aquatic biota alike, while generating no adverse effects to adjacent property or agricultural activities. By planting willows, building a riffle, and using a remnant of the old dam to create an eddy for energy dissipation, the project achieved some added benefits, including protection of the Tom Kay property just downstream of the dam site and incorporating wetlands into an area previously lacking wetland vegetation. In general, the project goals were met and the old dam site has been replaced with a relatively stable riverine system. No further restoration activities are recommended at this location.

3.3 HOTCHKISS DEMONSTRATION PROJECT/SMITH-MCKNIGHT DITCH

The Hotchkiss Demonstration Project site spans a 1.5-mile stretch of the North Fork of the Gunnison River between two bridges south of the Town of Hotchkiss, from the Cedar Drive bridge on the western end of town (downstream) to the Highway 92 bridge on the east (upstream) side of town (Figure 1). This was the first project developed by NFRIA in 1998, and was selected by the organization’s Board due to its visibility by the public and high level of anthropogenic disturbance generated throughout multiple decades. Disturbances included bulldozing the channel for the Smith-McKnight irrigation diversion, straightening the channel for flood control, and riprapping the banks for erosion control.

Surrounded by private land, the river was historically bulldozed annually in an effort to protect structures and farmland. Appendix B (Photo 7) shows bulldozing of the North Fork at the downstream end of the Hotchkiss demonstration project site in 1980 (Photo 8 shows the same location more than 30 years later after restoration activities). Landowners attempted to protect their property by channelizing the river and armoring the banks with concrete, cabled tires, junked cars, and large wood (Crane 1997). Much of the channel in the 1.5-mile reach that became the Hotchkiss Demonstration Project was a wide and shallow braided stream system, with levees and areas of high ground built up on either side in an attempt to channelize the river. Little to no riparian zone existed along the river corridor.

At the upstream end of the 1.5-mile stretch, the Smith-McKnight Ditch Company would annually construct a “push-up” gravel dam by piling in-stream substrate, concrete, car bodies, and other available material against the Highway 92 bridge abutment in order to divert water for irrigation.

3.3.1 Project Description

Constructed in 1999, the Hotchkiss Demonstration Project was the first large-scale restoration project on the North Fork of the Gunnison River. It was a 1.5-mile stream restoration project whose main goal was to demonstrate the effectiveness of natural channel design by reconstructing a single-thread meandering channel, rehabilitating a functional floodplain with grading and revegetation techniques, stabilizing river banks to protect property, and enhancing aquatic and terrestrial habitat in a location that was visible to the entire community. Sustainably rebuilding the Smith-McKnight irrigation diversion at the upstream end of the site was another project goal.

As a result of the Hotchkiss Demonstration Project, the braided stream system was consolidated into a new, morphologically balanced single thread channel. Removing old dikes and subsequently increasing the river’s capacity to spread floodwaters in a hydrologically stable manner restored the river’s historic floodplain. A substantial amount of native vegetation was planted for the project, in large part by volunteers and students, rehabilitating the riparian zone and dissipating energy during high flows. Growth of the planted willows, cottonwoods, rushes, and sedges over time has been substantial, and the project site now boasts a healthy riparian corridor and acres of wetlands.

As part of the restoration project, additional meander bends were created along the 1.5-mile reach to increase the sinuosity of the channel, and the natural riffle-pool sequencing design created numerous deep-water pools for fish habitat. Random boulder clusters were placed in the channel to provide further aquatic habitat and augment channel complexity.

The project attempted to foster resiliency and sustainability in the river channel and discourage landowners from modifying it themselves. Since the project was implemented in 1999, the river has adjusted naturally, creating meanders, deepening pools, capitalizing on wetlands, depositing silt on the floodplain, and becoming a stable and functioning system. As a result, both aquatic and terrestrial habitats are thriving, and local biota such as fish, amphibians, and waterfowl have become more diverse and abundant. The community takes pride in its river, and many locals participate in NFRIA’s “annual river awareness float.”

The Smith-McKnight diversion was redeveloped as part of the project as well. The new and properly functioning diversion intake illustrates a simple technology in which a low-head weir structure can divert irrigation water, eliminating the need for bulldozers in the stream to construct annual “push-up” gravel dams. The diversion structure has a sufficiently low profile to allow the upstream migration of fish and safe passage of recreational boats while creating just enough backwater to divert a full decree of irrigation water. Also, the new concrete head gate can meter water at the point of diversion, thereby increasing in-stream flows between the head gate and the return structure a quarter-mile downstream.

3.3.2 Pre-Project Assessment

Results of the pre-project site habitat quality assessment are presented in Table 4. Nine of the 11 habitat quality parameters received a poor or marginal rating. Regarding physical parameters, the old temporary “push-up” dams at the Smith McKnight diversion location resulted in an aquatic habitat barrier rating of 1/20 (parameter 1). The length of the reach did allow for the presence of all four velocity/depth regimes, resulting in a score of 16/20 for parameter 3. Ratings were low for all of the other physical parameters. Metrics related to vegetation cover, diversity, and presence of wetlands received marginal scores, but a slightly higher score was earned for percent native vegetation (6/10 for each bank, parameter 10).

3.3.3 Post-Project Assessment

Two photographs of the project site taken in 2014, fifteen years after project completion, are provided in Appendix B (Photos 9 and 10). Photo 9, taken at the downstream end of the project reach, shows a meander bend in the channel with a chain of riffle-pool features surrounded by various species and seral stages of riparian vegetation. Photo 10 depicts a large deep pool under the bridge at the upstream end of the reach, with boulder clusters scattered through the channel flanked by vegetation growing throughout a healthy riparian corridor.

Post-project site habitat quality assessment ratings are presented in Table 4 alongside the pre-project ratings. With the exception of channel sinuosity (14/20, parameter 6), all of the physical habitat quality parameters achieved an optimal score. Similarly, all of the riparian and vegetation-related habitat quality criteria with the exception of percent native woody vegetation (15/20, parameter 10) received an optimal score as well. The Hotchkiss Demonstration Project resulted in a morphologically stable river system with an abundance of wetlands and a healthy riparian community. The constructive physical and riparian changes support a prosperous community of aquatic and terrestrial biota.

3.3.4 Assessment Comparison

Major positive changes to the river system resulted from the Hotchkiss Demonstration Project, illustrated by increases in all 11 habitat quality parameters measured (refer to Appendix B Photos 11 and 12 for a before-after photo pair of a portion of the Hotchkiss Demonstration Project site). The reconstruction of the Smith-McKnight diversion raised the aquatic habitat barrier rating from 1/20 to 17/20 (parameter 1) (refer to Appendix B Photos 13 and 14 for images of the Smith-McKnight diversion immediately following construction and in 2014). Boulder clusters, in-stream wood, and a diversity of habitat features placed during the project increased the aquatic structure as cover score from 3/20 to 18/20 (parameter 2). Results for flow continuity improved as well, as the channel was no longer being temporarily dewatered by the “push-up” dams and bulldozing (3/20 to 18/20, parameter 4). Because constructed dikes and levees are no longer channelizing the stream, the results for the channel alteration parameter increased from 6/20 to 16/20 (parameter 5). Meander bends in the channel created at the time of the project and also naturally by the river in the years following project implementation raised the channel sinuosity score from 3/20 to 14/20 (parameter 6). Bank stability scores increased from 3/10 to 9/10 on both banks (parameter 7), in large part due to the regrading activities conducted at the time of the project, and to the healthy riparian zone fostered by revegetation efforts.

Ratings for riparian vegetation cover (parameter 8), diversity (parameter 9), and wetland area and function (parameter 11) increased from marginal to optimal as a result of the revegetation activities. Wetlands increased tremendously in size and diversity, and continue to do so over time. Scores for percent native woody vegetation (parameter 10) increased slightly, but Russian olives and some tamarisks have flourished alongside the native vegetation.

3.3.5 Conclusions and Recommendations

The Hotchkiss Demonstration Project had a diverse set of goals and objectives, including reconfiguration of natural river channel morphology to encourage natural processes to maintain channel stability and reduce excessive bank erosion; design and reconstruction of a permanent low-head irrigation diversion to deliver a full decree of water while allowing fish migration and safe passage for recreational boats; enhancement and rehabilitation of riparian, wetland, and natural floodplain areas; improvement of native fish and wildlife habitat; and creation of a visible project that could educate the community about local watershed restoration opportunities and techniques.

Based on these project goals, the project is a clear success. Improvements in all of the site habitat assessment ratings support this conclusion. The project work has created a situation where the river's natural processes are working to maintain a stable and healthy system without constant human intervention. Riparian vegetation and wetland areas continue to grow and flourish, and an abundance and diversity of aquatic and terrestrial biota inhabit the area as a result. Most importantly, the project has effectively educated the local community to support and enjoy a properly functioning river system.

In order to maintain and continue to improve on such a large restoration project, several recommendations for future work at this site are suggested:

(1) Geomorphic monitoring has not been conducted along the project reach in several years, but the site could benefit from another round of monitoring in the near future in order to assess the state of the channel and compare the current geomorphology to historical conditions;

(2) In several areas along the riparian zone, relatively large communities of exotic Russian olive trees are established and are competing with native vegetation. Consequently, certain areas within the site boundaries would benefit from a Russian olive removal project;

(3) Design and construction of a boat ramp on the County fairgrounds property just downstream of the upstream bridge has been discussed, and would benefit the community by encouraging local recreation and tourism; and

(4) Small improvements could be made to the Smith McKnight diversion structure, perhaps chasing grade a little further upstream, so that the ditch company does not have to periodically redo small portions of the structure.

These additional projects would enhance an already successful project and an already stable and productive 1.5-mile section of the North Fork of the Gunnison River. Community involvement through local volunteers could strengthen the connection between the local community and their river, and would work well with a potential project like Russian olive tree removal.

3.4 WATERS-CARPENTER SITE (DPR SITE 2)

The section of the North Fork located on the Waters and Carpenter properties is east of the Town of Hotchkiss and adjacent to the downstream permit boundary for the Tri-County Gravel pit (Figure 1). This stretch of river has a history of channelization and bank erosion, possibly resulting from in-stream gravel mining upstream of the reach since 1977 (Crane 1997). Sometime in the past, a dike was constructed on the north side of the river, disjointing the river from its floodplain and causing high flows to dramatically cut into the opposite (south) bank. The result is a vertical south bank, about 15 feet high in some locations, and a terrace instead of a floodplain on that side of the river.

Geomorphic cross-sections have been surveyed periodically in this reach since 1997, with little change in the seemingly unstable bank, even following high-flow events. Erosion pins installed in 1997 exhibit little change as well (USACE 2007).

3.4.1 Project Description

As part of the USACE Section 206 Aquatic Ecosystem Restoration plan, a project was proposed at this location to slightly realign the channel to reduce shear stress and bank erosion on the south bank. Other project objectives were creation of a riparian buffer and control of irrigation wastewater return to the river. This project was never implemented primarily due to the minimal changes in measured erosion rates. However, habitat quality has changed somewhat between 2002 and 2014 when the assessments were done, perhaps as a result of restoration efforts in upstream reaches, so the two assessments are still compared here.

3.4.2 2002 Pre-Project Assessment

Pre-project assessment scores assigned in 2002 are presented in Table 5. Poor to marginal condition ratings were documented for aquatic structure as cover (4/20, parameter 2), bank stability (1/10 and 2/10 for left/south and right/north banks, respectively, parameter 7), riparian vegetation structural diversity (1/10 and 5/10 for left/south and right/north banks, respectively, parameter 9), and wetland area and function (2/10, parameter 11).

Suboptimal to optimal ratings were recorded for aquatic barriers (19/20, parameter 1), velocity/depth regimes (11/20, parameter 3), flow continuity (18/20, parameter 4), channel alteration (11/20, parameter 5), channel sinuosity (17/20, parameter 6), riparian vegetation cover (16/20, parameter 8), and percent native woody vegetation (6/10 and 8/10 for left/south and right/north banks, respectively, parameter 10).

3.4.3 2014 Pre-Project Assessment

Photo 15 presented in Appendix B shows evidence that the steep bank on the south side of the channel has remained so for more than a decade and actually appears quite stable, with new riparian vegetation growing at the toe of the vertical slope.

Pre-project assessment scores reassigned in 2014 are presented in Table 5 alongside the 2002 pre-project scores. Poor to marginal condition ratings were documented for aquatic structure as cover (5/20, parameter 2), channel sinuosity (7/20, parameter 6), riparian vegetation structural diversity (3/10 for left/south bank, parameter 9), and wetland area and function (2/10, parameter 11). Suboptimal to optimal ratings were documented for the remaining parameters, including bank stability (6/10 for both the left/south and right/north banks, parameter 7).

3.4.4 Assessment Comparison

The main differences between the 2002 and 2014 habitat quality assessments are in parameters 6 (channel sinuosity), 7 (bank stability), and 9 (riparian vegetation structural diversity). The channel sinuosity score decreased from 17/20 to 7/20, possibly because the 2002 assessment was taking into account a slightly longer reach, with better accounting for meander bends. The reach that was rated in 2014 was relatively short, encompassing only the area where the vertical banks on the south side of the river are present, resulting in a low sinuosity score.

The bank stability metric scores improved from poor to suboptimal based on the fact that over nearly 2 decades, the steep vertical south bank has not eroded further, exemplifying a stable system. The new vegetation growth at the base of the slope accounts for the increase in riparian vegetation structural diversity scores.

3.4.5 Conclusions and Recommendations

Despite the project recommendations in the Crane (1997) and USACE (2007) reports, it appears that a restoration project does not need to be performed at this location; the bank, while vertical, is quite stable and has not eroded significantly for almost two decades over a range of flow conditions. No recommendations for future projects at this location are suggested at this time.

3.5 TRI-COUNTY GRAVEL PIT (DPR SITE 3)

Tri-County Gravel is a gravel mining company that has owned and operated in-stream mining operations on the North Fork of the Gunnison River northeast of the Town of Hotchkiss since 1977 (Figure 1). Downcutting, channelization, and headcutting are prevalent at this site. Between low-flow and high-flow conditions in 1997-1998, six feet of channel scour were measured upstream of the active in-stream mine, resulting in the channel downcutting to solid shale bedrock. The channel has been excavated along the vertical Mancos shale bluffs on the north side of the river, cutting off meanders and increasing slope, shear stress, and erosion (USACE 2007). Negotiations with NFRIA resulted in the abandonment of in-stream gravel mining for an off-channel mining operation and the development of a conservation easement along the 1.5-mile long riparian corridor.

3.5.1 Project Description

The project objectives at this site were to eliminate in-stream gravel mining and restore a meandering channel though the highly disturbed mined areas of the site. The project included a conservation easement to prohibit in-stream gravel mining in perpetuity, as well as major channel reconstruction, regrading, floodplain rehabilitation, revegetation efforts, and development of a mine reclamation plan.

3.5.2 Pre-Project Assessment

Prior to project work at the Tri-County Gravel Pit, habitat quality scores were generally marginal. Table 6 presents pre-project assessment ratings for all 11 parameters. The lowest habitat quality scores were related to channel alteration (4/20, parameter 5) and sinuosity (4/20, parameter 6), resulting from in-stream mining operations. Relatively low scores were also recorded for aquatic structure as cover (10/20, parameter 2) and bank stability (4/10 and 3/10 for left and right banks, respectively, parameter 7). Velocity/depth regime (14/20, parameter 3) and flow continuity (14/20, parameter 4) criteria had suboptimal ratings. Metrics related to vegetation cover, diversity, community, and wetlands scored from 4 to 8 (in the marginal to suboptimal range).

3.5.3 Post-Project Assessment

A current (2014) depiction of the Tri-County Gravel Pit restoration site is presented in Appendix B (Photos 16-18). Post-project assessment scores are presented alongside pre-project scores in Table 6. With the exception of the channel sinuosity metric (4/20, parameter 6), all of the physical habitat quality criteria scored a suboptimal or optimal rating following restoration. Similarly, as a result of the revegetation and floodplain rehabilitation efforts, all of the vegetation-related habitat quality criteria had scores that were ranked suboptimal to optimal as well. Notably, wetland area and function received a high score as extensive wetlands have emerged throughout the project site (18/20, parameter 11, also evident in Photos 17 and 18, Appendix B).

3.5.4 Assessment Comparison

Aside from channel sinuosity, which achieved the same rating in both the pre-project and post-project habitat quality assessments, all habitat quality metrics improved following project completion. The project created a more stable system with the ability to support aquatic biota. Both riparian vegetation cover and diversity and wetland area size and function improved dramatically as a result of the project as well.

3.5.5 Conclusions and Recommendations

The primary goal of eliminating in-stream gravel mining in this reach was achieved by advocating for and supporting the development of a conservation easement throughout the riparian corridor and assisting the company in developing a new mine reclamation plan. NFRIA raised funds for channel and floodplain restoration that resulted in the adjacent Upper Curry restoration project in the spring of 2005 (see Section 3.6) and the reconstruction of the Vandiford Ditch in 2007. The simple elimination of mining allowed the river to recover on its own in several locations and natural sedimentation in what was once an in-channel mining pit is now high quality wetlands in many areas.

In 2005, a heavy spring runoff broke through the dike separating the river from the new off-stream mining operation and created a major channel avulsion along the south bank (see Appendix B, Photo 19). NFRIA worked with the Curry family to fund, design, and implement a restoration effort and develop a new mining reclamation plan. The river was subsequently returned to its pre-flood alignment and a new bank stabilization plan was implemented (see Appendix B, Photo 20). In 2007, United Companies leased the site from the Curry family and supplemented previous floodplain rehabilitation efforts by constructing large rock revetment structures at the toe of the slope and revegetating the south riverbank between the river and the new mining operation outside the channel.

In 2011, NFRIA and the Delta Conservation District organized a project to eradicate non-native tamarisk and Russian olive trees throughout the south side of the riparian corridor. Since then, new plant growth has emerged and a new removal effort should be organized.

The Tri-County Gravel Pit site has made a remarkable recovery since 2000 (Appendix B, Photo 21), but proposed channel and floodplain restoration in the downstream reach of the site below the railroad bridge was never implemented due to funding constraints. The floodplain will most likely continue to recover on its own, but additional restoration efforts could significantly accelerate recovery. The site could be enhanced by reducing the width-to-depth ratio of the channel, constructing a riffle-pool sequencing, eliminating non-native vegetation, adding large woody debris, and stabilizing stream banks.

Further eradication of non-native vegetation can be implemented through the entire riparian corridor. Beginning near the Paonia River Park, tamarisk and Russian olive trees become more prevalent as one travels down-valley. A coordinated effort to identify willing landowners and high priority sites with organizations such as the Conservation Corps and the Delta Soil District could prove effective.

3.6 UPPER CURRY RESTORATION SITE

The Upper Curry restoration site is located along the upper half of the conservation easement owned by Thomas Curry at the upper end of the Curry Ranch on the North Fork of the Gunnison River approximately one mile northeast of the Town of Hotchkiss (Figure 1).

Aquatic and terrestrial habitat on the site had been damaged by past grazing practices and decades of bulldozing to straighten the channel in an effort to protect adjacent agricultural land from excessive bank erosion during spring runoff. There was little fish-holding capacity in the stream, and the riparian area was in poor functioning condition. The channel was degrading, contributing sediment and affecting downstream stability, and dewatering the adjacent riparian zone. Wildlife value had been degraded and Russian olive trees and tamarisks are increasing on the site.

3.6.1 Project Description

The 2005 Upper Curry restoration project treated an estimated 1,600 linear feet of channel and adjacent riparian area with a new channel alignment that increased sinuosity, reduced grade, widened the riparian zone, and re-established a natural riffle-pool sequence for preferred fish habitat. Large boulders were introduced into the system to stabilize the outside bends of the new channel with typical J-hook structures to reduce shear stress on the banks and create slow pools for additional fish holding and spawning habitat. Habitat values in the riparian area were improved with cottonwood and willow plantings along with deferred grazing. Fencing was installed and new riparian vegetation was irrigated with off-site water. Portions of the abandoned channel were developed into wetland and nesting areas for waterfowl, and adjacent uplands were seeded to improve upland bird habitat.

The length of the entire project was lined with native willow cuttings in bundles and brush mattresses for the quick establishment of riparian vegetation. Live willow silt fences and log debris were used to dissipate fluvial energy during overbank flooding above the 2-year return flow and allowed for the natural sediment deposition on the floodplain and the recruitment of native vegetative species. The project was tied into a natural single-thread meandering channel along the Mancos shale bluffs near Highway 133.

3.6.2 Pre-Project Assessment

Pre-project habitat quality scores are presented in Table 7. Optimal ratings were achieved for aquatic habitat barriers (18/20, parameter 1), velocity/depth regimes (16/20, parameter 3), and palustrine wetland area and function (16/20, parameter 11). Flow continuity (parameter 4) received a suboptimal score of 11/20. Marginal ratings were earned for aquatic structure as cover (8/20, parameter 2), bank stability (8/20, parameter 7), riparian vegetation structural diversity (8/20, parameter 9), and percent native woody vegetation (8/20, parameter 10). Finally, rankings for channel alteration (5/20, parameter 5), channel sinuosity (5/20, parameter 6), and riparian vegetation cover (3/20, parameter 8) fell into the poor condition category.

3.6.3 Post-Project Assessment

All of the post-project habitat quality assessment criteria achieved suboptimal or optimal condition category ratings (Table 7) at the Upper Curry restoration site (Appendix B, Photo 22). Structural and hydrologic improvements such as increasing sinuosity, reducing grade, creating riffle-pool sequencing within the channel, and installing large boulders and J-hook structures contributed to high scores for aquatic structure as cover (13/20, parameter 2), velocity/depth regimes (17/20, parameter 3), flow continuity (16/20, parameter 4), channel alteration (14/20, parameter 5), channel sinuosity (16/20, parameter 6), and bank stability (18/20, parameter 7). Ratings for vegetation-related parameters (parameters 8-11) also fared extremely well as a result of cottonwood and willow plantings, restricted grazing, and development of abandoned channels into wetland areas. In particular, riparian vegetation cover (parameter 8), riparian vegetation structural diversity (parameter 9), and wetland area and function (parameter 11) criteria all achieved optimal scores of 18/20.

3.6.4 Assessment Comparison

In general, habitat quality scores increased approximately 40 percent as a result of the Upper Curry restoration project. As described above, structural and hydrologic improvements led to increases habitat quality ratings for aquatic structure as cover (8/20 to 13/20, parameter 2), flow continuity (11/20 to 16/20, parameter 4), channel alteration (5/20 to 14/20, parameter 5), channel sinuosity (5/20 to 16/20, parameter 6), and bank stability (8/20 to 18/20, parameter 7). Notable improvements were also evident in ratings for vegetation-related parameters (parameters 8-11) as a result of riparian zone widening, native vegetation plantings, grazing restrictions, and wetland development. Scores improved considerably for riparian vegetation cover (3/20 to 18/20, parameter 8), riparian vegetation structural diversity (8/20 to 18/20, parameter 9), percent native woody vegetation (8/20 to 14/20, parameter 10), and wetland area and function (16/20 to 18/20, parameter 11).

3.6.5 Conclusions and Recommendations

The channel and floodplain enhancements implemented at this site have withstood the test of time and high water. Cattle continue to be fenced out of the riparian zone and most of the willow cuttings took hold and are continuing to spread across the stream banks. The channel is stable and the constructed J-hooks have adjusted over time and have transformed into in-channel aquatic habitat while maintaining a stable bank. However, non-native riparian species are beginning to re-emerge and the site would benefit from a second eradication treatment.

3.7 MIDWAY ENHANCEMENT PROJECT: ROSS PROPERTY (DPR SITE 4)

The Midway Enhancement Project site encompasses a 4.5-mile stretch of the North Fork of the Gunnison River “midway” between the Towns of Paonia and Hotchkiss, in a broad valley where the river dissects a series of terraces and mesas (Figure 1). The large Ross property is one of dozens of properties contained within Midway Project boundaries, and the moniker “Ross property” is used for simplicity to collectively denote all of the land in the particular area described below.

The Ross property site (DPR Site 4) is located at the downstream end of the Midway Enhancement Project site and is approximately 1.7 miles long. In years past, landowners tried to straighten and channelize the river in this area using bulldozers and slow its flow using hay bales, car bodies, and any other available materials to protect their property and create more land for cattle grazing and hay production.

3.7.1 Project Description

The initial phase of the Midway Enhancement Project, constructed mainly in 2001 and completed in the spring of 2002, consolidated several braided channels into one single-thread meandering system. The project was designed to return natural function to the ecosystem by utilizing the full potential of the floodplain to reduce erosion, improve water quality, enhance fish and wildlife habitat, and recharge groundwater storage (USACE 2007). Agricultural and residential property on the edges of the floodplain was protected by stabilizing the banks with large boulders placed at the toe of the stream bank and a variety of natural vegetative treatments. In high velocity areas, upstream-pointing jetties, known as rock vanes, were installed to slow the water down while providing additional fish habitat in the channel (see Appendix B, Photo 23). This type of treatment holds the outside banks of the channel in place and prevents natural movement of the river, but cost-effectively protects private property, economic investments, and serves the social and political agendas of the community while providing additional habitat, an aesthetically pleasing natural stream bank, and improved recreational potential.

Since the initial phase of the Midway project, the reconstructed channels have increased the sinuosity of the river by 50 percent in some places, and intermittent rock structures along the outside bends of the meanders have generated long-term bank stability. However, the project did not provide for bank stabilization or revegetation of all floodplain areas vulnerable to erosion. Some areas, particularly within the downstream reaches of the Ross property boundaries, were left vulnerable to potential avulsion and increased erosion (see Appendix B, Photo 24).

A second phase of the Midway project on the Ross property, completed in 2008, added additional stabilizing rock structures to a few high-impact areas, and enhanced the riparian zone and floodplain with native vegetation, including natural recruitment (see Appendix B, Photo 25).

3.7.2 Pre-Project Assessment

The habitat quality assessment conducted in 2002 and included in the DPR was completed after the first phase of the Midway Enhancement Project. Therefore, as with the non-DPR project sites, retroactive pre-project habitat quality ratings were assigned in 2014 along with the post-project ratings. In this way, a true comparison can be made between pre-project and post-project conditions at this multi-phase project site. Ratings are presented in Table 8.

Prior to any restoration activities, several habitat quality parameters were still assigned an optimal condition category, including aquatic habitat barriers (18/20, parameter 1), velocity/depth regimes (16/20, parameter 3), and wetland area and function (18/20, parameter 11). Riparian vegetation structural diversity scores for both banks were suboptimal (6/10 for each bank, parameter 9). The remaining habitat quality metrics were all assigned ratings in the marginal condition category.

3.7.3 Post-Project Assessment

Both phases of the Midway project completed on the Ross property improved the in-stream channel and riparian area, primarily by creating additional meander bends, constructing structures such as rock vanes to slow flow and armor the banks, and planting native vegetation to stabilize the banks and reconnect the floodplain. The positive impact of these restoration efforts is reflected in the post-project habitat quality ratings.

Site habitat quality assessment results are presented in Table 8. A score in the optimal condition category was achieved for the following habitat quality criteria: aquatic habitat barriers (20/20, parameter 1), aquatic structure as cover (18/20, parameter 2), velocity/depth regimes (18/20, parameter 3), flow continuity (18/20, parameter 4), channel alteration (19/20, parameter 5), channel sinuosity (18/20, parameter 6), and palustrine wetland area and function (18/20, parameter 11). Suboptimal ranks were assigned for bank stability (8/10 for each bank, parameter 7), riparian vegetation cover (15/20, parameter 8), and riparian vegetation structural diversity (8/10 for each bank, parameter 9). Due to the presence of communities of Russian olive trees in some locations, a marginal score of 5/10 was recorded for the percent native woody vegetation on each bank (parameter 10).

3.7.4 Assessment Comparison

Much of the work accomplished as part of the Midway project on the Ross property involved the creation of a stable single-thread channel with additional meanders and opportunities for dissipating high flows, as well as fostering the growth of an established riparian community. These efforts are reflected in increases in physical habitat quality scores between the pre-project and post-project assessments. In particular, flow continuity (parameter 4), channel alteration (parameter 5), and channel sinuosity (parameter 6) scores all improved from marginal to optimal. An additional benefit of the restoration activities was to create more in-stream habitat for fish and other aquatic organisms, and as a result, the aquatic structure as cover (parameter 2) score also improved from marginal to optimal. Another goal of the project was bank stability, and the ratings for that metric increased from 5/10 to 8/10 (parameter 7) on both banks.

Increased habitat quality ratings were also noted in the vegetation-related criteria. The riparian vegetation cover score increased from 9/20 to 15/20 (parameter 8) as a result of revegetation efforts. Riparian vegetation structural diversity scores increased as well (6/10 to 8/10 for each bank, parameter 9). However, there was no change in the marginal percent native woody vegetation ratings (parameter 10).

3.7.5 Conclusions and Recommendations

Improvements in site habitat quality criteria scores as a result of specific restoration activities are evidence that the Midway project has had a positive effect on the North Fork through the Ross property. The channel is sinuous, stable, and armored through the majority of the site. While revegetation efforts have improved riparian cover and diversity, this site could benefit from a Russian olive tree removal project in specific areas and additional large woody debris revetments at the lower end of the property to prevent a potential channel avulsion and increase habitat complexity.

3.8 MIDWAY ENHANCEMENT PROJECT: CAMPBELL RANCH (DPR SITE 5)

As described in Section 3.7, the 4.5-mile Midway Enhancement Project site is located in a broad valley midway between the Towns of Paonia and Hotchkiss (Figure 1). The Campbell Ranch site (DPR Site 5) is located at the upstream end of this stretch and is approximately 1 mile long. Similar to the Ross property designation, the Campbell Ranch property is one of dozens of properties contained within Midway Project boundaries, and the moniker “Campbell Ranch” is used for simplicity to collectively denote all of the land in the 1-mile long stretch described above.

3.8.1 Project Description

Refer to Section 3.7.1 for a description of the Midway Enhancement Project. As with activities on the Ross property, additional projects occurred on the Campbell reach as well in the years following the 2002 Midway project. In general, projects throughout this reach during and following the 2002 Midway project included channel realignments, floodplain revegetation, bank stabilization, irrigation diversion reconstruction and habitat enhancements (refer to Appendix B, Photos 26 and 27).

3.8.2 Pre-Project Assessment

As with the Ross property, the habitat quality assessment conducted in 2002 and included in the DPR was completed after the first phase of the Midway Enhancement Project. Therefore, retroactive pre-project habitat quality ratings were assigned in 2014 along with the post-project ratings so that a true comparison can be made between pre-project and post-project conditions at this multi-phase project site. Ratings are presented in Table 9.

Ratings of 4/20 in the poor condition category were documented for flow continuity (parameter 4), channel alteration (parameter 5), bank stability (parameter 7), and riparian vegetation cover (parameter 8). The velocity/depth regimes parameter received an optimal score (16/20, parameter 3). All remaining criteria earned ratings in the marginal condition category.

3.8.3 Post-Project Assessment

Post-project habitat quality assessment results are presented alongside pre-project results in Table 9. As a result of restoration activities such as efforts to consolidate the braided system into a single-thread meandering channel; installation of rock vanes, root wads, and other features to control high flows and strengthen banks; and substantial revegetation work both in the riparian corridor and on the floodplain, all of the habitat quality criteria achieved scores in the suboptimal or optimal condition category.

3.8.4 Assessment Comparison

All 11 of the habitat quality scores increased between the pre-project and post-project assessments. The most substantial improvements were related to channel realignments and bank stabilization, as indicated by significant increases in scores for the following physical parameters: aquatic habitat barriers (8/20 to 20/20, parameter 1), aquatic structure as cover (6/20 to 16/20, parameter 2), flow continuity (4/20 to 12/20, parameter 4), channel alteration (4/20 to 16/20), and bank stability (2/10 to 9/10 for each bank, parameter 7).

Marked improvements also resulted from revegetation and floodplain rehabilitation measures. In particular, the score for riparian vegetation cover (parameter 8) increased from 4/20 to 15/20, and the scores for riparian vegetation structural diversity (parameter 9) increased from 4/10 to 8/10 on both banks. Revegetation efforts that included a focus on natural recruitment also fostered the formation of wetlands, reflected in increased scores for percent native woody vegetation (5/10 to 9/10 for each bank, parameter 10) and palustrine wetland area and function (6/20 to 11/20, parameter 11).

3.8.5 Conclusions and Recommendations

Prior to the Midway project, the Campbell Ranch reach contained some of the most unstable sections of the North Fork due to constant and regular anthropogenic activities such as bulldozing the channel in the “uncontainable” wide, flat valley in which it sits. The Midway project made great strides in restoring a section of river that was extremely unstable at the outset, as evidenced by the significant improvements in habitat quality assessment scores from 2002 to 2014. However, a few of the sweeping meander bends constructed during the Midway project can still be somewhat prone to avulsion while mature vegetation continues to take hold.

Throughout most of the Midway reach, large cottonwood trees have regularly lodged in the channel during spring runoff and have altered the flow and alignment of the river in a manner detrimental to property owners and ditch companies. The establishment of a small annual fund that can hire equipment prior to runoff could help maintain alignment continuity and utilize large woody debris to the benefit of the riverine ecosystem. The eradication of non-native vegetation is still needed in many reaches as well.

3.9 MIDWAY ENHANCEMENT PROJECT: 2010 BANK STABILIZATION

The 2010 bank stabilization effort was an EPA Clean Water Act Section 319 project located on a short stretch of the North Fork on the Campbell Ranch (Figure 1). Between 2008 and 2010, nearly 10,000 tons of sediment washed away from approximately 390 linear feet of stream bank, as measured from permanent cross sections established in 2001 prior to implementation of the Midway Project. Furthermore, an avulsion located downstream and adjacent to the bank erosion site scoured approximately an additional 825 tons of sediment and destroyed approximately half an acre of riverine wetlands.

3.9.1 Project Description

This project was conducted in an area where new channels were forming and a portion of the channel was avulsing in the years following Phase I restoration efforts. Phase II utilized adaptive management strategies to stabilize the banks and divert water away from the avulsion back into the main channel. In particular, an abundance of large wood was used both within the channel and on the floodplain to help guide the river and stabilize its banks. A log retaining wall structure was installed along the bank erosion reach by securing horizontal logs onto vertical posts with rebar and dovetail joints. The backside of the structure was planted with willow cuttings and cottonwood poles prior to backfilling. Horizontal logs were incorporated into the reach along the avulsion, with posts installed at varying angles to act as a trap to catch woody debris. Felled cottonwood trees in the floodplain were the main resource used for the restoration activities, making the project quite cost-effective. A trench behind the structure was used to plant a live willow silt fence designed to slow down rising waters and settle out sediment and the natural waterborne seed base. Photographs of the avulsion channel blocked by woody debris are provided in Appendix B (Photos 28 and 29).

3.9.2 Pre-Project Assessment

Pre-project habitat quality assessment results are presented in Table 10. The lowest habitat quality scores prior to the 2010 bank stabilization effort were related to bank stability and riparian vegetation cover. In fact, the bank stability rating was 2/10 for both banks (parameter 7) and the riparian vegetation cover criterion received a score of 3/20 (parameter 8). Marginal ratings were assigned for flow continuity (7/20, parameter 4), channel sinuosity (6/20, parameter 6), and wetland area and function (8/20, parameter 11). Suboptimal or optimal ratings were earned for the remaining criteria, likely due in large part to earlier phases of the Midway project through this reach.

3.9.3 Post-Project Assessment

Table 10 presents the post-project habitat quality assessment results alongside the pre-project results. As a result of the focus on bank stabilization and revegetation, all of the habitat quality parameters scored within the optimal to suboptimal condition category range. Suboptimal scores were assigned for flow continuity (11/20, parameter 4) and channel alteration (14/20, parameter 5), but the rest of the metrics achieved optimal ratings.

3.9.4 Assessment Comparison

Many of the habitat quality parameters improved between pre-project and post-project conditions. The most profound changes were evident in criteria related to bank stability, vegetation cover, wetlands, aquatic habitat structure, and sinuosity. Dramatic increases in bank stability (from 2/10 to 9/10 on both banks, parameter 7) and riparian vegetation cover (3/20 to 18/20, parameter 8) were a direct result of the specific goals of the restoration project. The project also restored some wetlands that had been lost, increasing the wetland area and function score from 8/20 to 16/20 (parameter 11). An added benefit of using large wood for this restoration project was the enhancement of aquatic habitat as cover, raising the score for that metric from 13/20 to 18/20 (parameter 2). Finally, the project worked to recreate some of the meander bends that had avulsed, increasing the channel sinuosity rating from 6/20 to 16/20 (parameter 6).

3.9.5 Conclusions and Recommendations

This project accomplished its goals by effectively stabilizing the riverbanks and blocking the side channels created by avulsions. Installing large wood proved to work well in this situation and was very cost-effective. The revegetation component of this restoration effort was critical. After wood was placed in one location and followed up by revegetation, the project was extended downstream to an area where more large wood was placed, but willows were not planted. The difference between these two areas in terms of the riparian zone and the amount of additional woody debris that has since been trapped is remarkable, and shows the importance of revegetation. Additional revegetation is recommended for this area at locations where wood was placed without that vegetation component.

3.10 SHORT DITCH

The Short Ditch is located in the upstream portion of the Campbell Ranch on the left (south) side of the North Fork (Figure 1). This area has historically been bulldozed from the downstream end to create a gravel “push-up” dam and divert water for agricultural uses. A photograph of the Short Ditch diversion prior to construction is provided in Appendix B (Photo 30). Because this diversion is one of the furthest downstream on the North Fork, most of the water remaining in the river has historically been diverted at this location, leaving little water to flow downstream. The Short Ditch was built as a permanent diversion structure in 2002.

3.10.1 Project Description

The 2002 Short Ditch project included the design and reconstruction of a sustainable irrigation diversion to eliminate the construction of annual push-up dams and limit flows to the decreed amount, leaving more flow in the river for other users and improving aquatic habitat. However, the ditch frequently does not receive a full decree of water and needs to take all of the flow in the river. Because of this, the ditch company continues to bulldoze the channel, albeit unnecessarily. Channel downcutting still occurs, and the destabilization of the channel bed has created an erosion problem for the Campbell Ranch downstream. A current photograph of the Short Ditch diversion is provided in Appendix B (Photo 31).

3.10.2 Pre-Project Assessment

Prior to the construction of the Short Ditch, gravel "push-up" dams were created annually in order to divert water as needed, resulting in poor to marginal pre-project habitat quality scores for physical parameters (parameters 1-7, Table 11). The one exception is channel sinuosity, which earned a suboptimal rating of 12/20 (parameter 6). Because these disruptive activities occurred at least annually, vegetation could not become established. As a result, scores for riparian vegetation cover (3/20, parameter 8), riparian vegetation structural diversity (6/10 for each bank, parameter 9), percent native woody vegetation (3/10 and 4/10 for the left and right banks, respectively, parameter 10), and wetland area and function (2/20, parameter 11) were relatively low.

3.10.3 Post-Project Assessment

Table 11 presents the post-project habitat quality assessment results alongside the pre-project results. Similar to pre-project habitat quality assessment scores, poor to marginal results were achieved for physical parameters (parameters 1-7) with the exception of channel sinuosity, which earned a suboptimal rating of 12/20 (parameter 6). Riparian vegetation cover (5/20, parameter 8) and wetland area and function (2/20, parameter 11) results fell in the poor condition category, while marginal results were achieved for percent native woody vegetation (5/10 for each bank, parameter 10). Riparian vegetation structural diversity (7/10 for each bank, parameter 9) was assigned a suboptimal ranking.

3.10.4 Assessment Comparison

Scores for 6 of the 11 habitat quality parameters remained unchanged between pre-project and post-project assessments (Table 11). However, some slight but notable increases in habitat quality scores were related to bank stability and riparian vegetation growth. Construction of a permanent ditch structure added bank stability, and was designed to allow for natural regeneration of riparian vegetation. As a result, bank stability scores increased from 2/10 to 4/10 for each bank (parameter 7), riparian vegetation cover ratings improved from 3/20 to 5/20 (parameter 8), and scores for riparian vegetation structural diversity (parameter 9) and percent native woody vegetation (parameter 10) showed slight increases as well. Despite the presence of a permanent diversion structure, landowners still recruit heavy equipment and bulldoze at this location annually, inhibiting further habitat quality improvements.

3.10.5 Conclusions and Recommendations

Very minor improvements were observed in habitat quality as a result of this project, largely due to the fact that instead of leaving the diversion structure alone, the river adjacent to structure is still being consistently bulldozed, rendering the restoration project somewhat ineffective. Potential retrofits or improvements could be made to the structure and to the river just downstream of the structure to prevent further bulldozing. In particular, grade control structures could be installed downstream of the diversion under the head gate, and/or the channel could be narrowed to allow flows to pass through the area more efficiently. Grouting the existing diversion structure could help eliminate bulldozing. There is an opportunity for the West Slope Conservation Center (WSCC) to develop a project at this location to further stabilize the channel and improve diversion efficiency. The ditch company has been reluctant in the past to accept advice and assistance but after years of failed attempts there could be an opportunity to fundraise for improvements.

3.11 SHEPPARD-WILMOT DITCH

The Sheppard-Wilmot Ditch is located at the upstream end of the Campbell Ranch on the right (north) side of the North Fork (Figure 1). Prior to the project, the channel was bulldozed to create a diversion dam but bypassed the Short Ditch as a result. This ditch was built as a permanent diversion structure in 2000.

3.11.1 Project Description

The goal of the Sheppard-Wilmot Ditch diversion project was to design and reconstruct a permanent irrigation diversion to limit flows to the decreed amount, leaving more flow in the river for other users and improving aquatic habitat.

3.11.2 Pre-Project Assessment

Prior to the construction of a permanent diversion structure at the Sheppard-Wilmot Ditch, most of the habitat quality criteria were rated in the suboptimal or optimal condition category (Table 12). However, the stability of the right (north) bank was compromised as temporary irrigation diversions were constructed and reconstructed over time. As a result, the bank stability score for the right bank was assigned a marginal score of 3/10 (parameter 7). Wetlands were absent from the area, yielding a poor score of 1/20 for wetland area and function (parameter 11).

3.11.3 Post-Project Assessment

Post-project habitat quality assessment results are presented alongside pre-project results in Table 12. Although the Sheppard-Wilmot diversion structure has undergone reconstruction twice since it was built in 2000, the overall structure has held up well (refer to Appendix B, Photo 32 for a current photograph of the diversion structure). Suboptimal to optimal scores were achieved for all habitat quality parameters except for wetland area and function (3/20, parameter 11).

3.11.4 Assessment Comparison

Improvements in habitat quality scores between pre-project and post-project assessments of the Sheppard-Wilmot Ditch diversion project were evident but slight for most criteria. However, the permanent diversion structure has greatly improved bank stability on the right (north) bank where the structure is located. Bank stability scores increased from 3/10 to 8/10 (parameter 7) as a direct result of the project. A stable bank also led to improvements in riparian vegetation cover, with scores for this parameter increasing from 11/20 to 18/20 (parameter 8) following construction of the Sheppard-Wilmot Ditch.

3.11.5 Conclusions and Recommendations

Although the diversion ditch has held up relatively well over time, landowners fortify the diversion structure with carpet, hay bales, and other materials in an attempt to increase flows to the ditch during low flow periods. A recommendation for a future project is to extend the Sheppard-Wilmot Ditch diversion structure further into the main channel to make it more sustainable over the long term, so that landowners do not need to improvise by adding outside materials to extend the diversion. A slide gate valve at the headwall could improve manageability of maintenance operations. The J-hook flow structure downstream of the diversion could also be rebuilt as part of this potential project.

3.12 MONITOR DITCH (DPR SITE 6)

The site of the Monitor Ditch diversion (DPR Site 6) is approximately one mile downstream of the Town of Paonia on the right (west) bank of the North Fork of the Gunnison River (Figure 1). The diversion is located on property owned by George Hall and Devon Van Dusen. Historically, this was the site of a temporary gravel “push-up” dam that was constructed annually using heavy machinery. Photo 33 (Appendix B) shows an aerial pre-construction photograph of the site, where the majority of the river’s flow was diverted into a narrow ditch, while the main channel was blocked off by plowed gravel. Photo 34 (Appendix B) shows a historical photograph of an old rusted car body used for bank stabilization on the right bank of the North Fork just upstream of the diversion (Photo 35 shows a current photo of riparian vegetation occupying the same location).

3.12.1 Project Description

The Monitor Ditch diversion was constructed in early 2004 in order to eliminate the practice of annual construction of temporary gravel “push-up” dams at this location. The objective of the project was to construct a permanent irrigation structure to replace periodic bulldozing at the site, thereby enhancing aquatic and riparian habitat while still delivering a full decree of water. Of all the diversion ditches on the North Fork, the Monitor Ditch is the only one constructed using grout between the large rocks; the rocks are grouted about halfway across the channel.

3.12.2 Pre-Project Assessment

Pre-project habitat quality scores are presented in Table 13. Due to annual temporary push-up dam construction, this site earned low scores for flow continuity (6/20, parameter 4), channel alteration (3/20, parameter 5), left bank stability (2/10, parameter 7), and left bank riparian vegetation structural diversity (5/10, parameter 9). Habitat quality ratings for channel sinuosity (2/20, parameter 6) and wetland area and function (1/20, parameter 11) were in the poor condition category as well. Remaining habitat quality criteria ranked in the suboptimal to optimal range.

3.12.3 Post-Project Assessment

Post-project habitat quality scores are provided alongside pre-project scores in Table 13. Following the construction of a permanent irrigation diversion structure, the site achieved optimal ratings for 7 of the 11 habitat quality metrics: aquatic habitat barriers (16/20, parameter 1), aquatic structure as cover (16/20, parameter 2), velocity/depth regimes (16/20, parameter 3), bank stability (18/20, parameter 7), riparian vegetation cover (18/20, parameter 8), riparian vegetation structural diversity (18/20, parameter 9), and percent native woody vegetation (18/20, parameter 10). Photo 36 (Appendix B) shows a 2014 photograph of the grouted rocks emanating from the diversion point, as well as a healthy riparian vegetation community on the left bank of the river opposite the diversion structure.

Suboptimal scores were earned for flow continuity (13/20, parameter 4) and channel alteration (13/20, parameter 5). Ratings in the poor condition category were assigned for channel sinuosity (2/20, parameter 6) and wetland area and function (4/20, parameter 11).

3.12.4 Assessment Comparison

The constructed diversion structure does not act as a barrier limiting the passage of fish, and the large rocks used in the structure add some habitat diversity and cover to the reach. As a result, habitat quality ratings for aquatic habitat barriers (parameter 1) and aquatic structure as cover (parameter 2) rose slightly between pre-project and post-project assessments. However, the most significant in-stream habitat quality improvements were evident in the scores for flow continuity (6/20 to 13/20, parameter 4) and channel alteration (3/20 to 13/20, parameter 5). Major improvements were also achieved in left bank scores for bank stability (2/10 to 9/10, parameter 7) and riparian vegetation structural diversity (5/10 to 9/10, parameter 9).

3.12.5 Conclusions and Recommendations

In general, the Monitor Ditch project is a successful demonstration of how a permanent and sustainable irrigation diversion structure can be constructed to deliver a full decree of water while still promoting a healthy aquatic and riparian community. However, in 2014 some carpet was observed in the river, indicating that landowners are still actively fortifying the diversion structure at times. It is recommended that the Monitor Ditch diversion structure be grouted all the way across the channel. A slide gate valve could also improve maintenance operations in the ditch.

3.13 FARNSWORTH GRAVEL PIT

The Farnsworth gravel pit, owned by Farnsworth Construction and Gravel and located approximately one half mile west of the Town of Paonia (Figure 1), is one of three in-stream gravel mines that has been operating on the North Fork in the past several decades. The other two operations have since been reclaimed[2], but Farnsworth in still engaged in mining activities on both sides of the river, with the potential to resume in-stream mining at any time. For the purposes of in-stream mining, the channel has been

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[2] Tri-County Gravel and United Company owned the other two in-stream gravel mining operations. The Tri-County Gravel operation was reclaimed (refer to Sections 3.5 and 3.6 of this report) in 2003, and the United Company owned the site that became the Paonia River Park in 2012 (refer to Section 3.15 of this report).

bulldozed and widened, and resembles a lentic environment instead of a lotic, flowing river (see Appendix B, Photo 37). As of 2014, the company appears to be mining on the left (south) side of the river, processing on the right (north) side of the river, and using a low-flow crossing to transport material from one side to the other. None of the area has been reclaimed and remains extremely shallow and wide (see Appendix B, Photo 38). The extremely high width-to-depth ratio has limited aquatic habitat in the area.

In addition to in-stream gravel mining operations, this section of the North Fork has also experienced channel straightening and diking in an attempt to protect private property. Evidence of gabion structures, levees, and other built embankments are obvious throughout this section of the North Fork. As a result of channelization, water velocities are quite high through this area, downcutting and incising the channel.

3.13.1 Pre-Project Assessment

Because restoration activities have not occurred at this location, only pre-project habitat quality assessment scores are presented (Table 14). Optimal and suboptimal ratings were assigned for most vegetation-related criteria, including riparian vegetation cover (13/20, parameter 8), riparian vegetation structural diversity (6/10 for each bank, parameter 9), and percent native woody vegetation (9/10 for each bank, parameter 10). Bank stability (7/10 for each bank, parameter 7) and aquatic habitat barrier (18/20, parameter 1) scores were also high.

The remaining habitat quality criteria achieved ratings in the poor condition category. Historical channel-straightening activities have resulted in poor scores for channel alteration (3/20, parameter 5) and channel sinuosity (2/20, parameter 6). Bulldozing and in-stream mining have increased the width-to-depth ratio in this entire reach, altering flow regimes and compromising flow continuity in areas. Subsequently, velocity-depth regimes (4/20, parameter 3) and flow continuity (4/20, parameter 4) earned low scores. This section of the North Fork does not contain much structure such as snags, boulders, large wood, or undercut banks that aquatic biota could use as cover, resulting in a poor score for aquatic structure as cover (3/20, parameter 2) as well. Wetlands areas are minimal, yielding a wetland area and function score of 3/20 (parameter 11).

3.13.2 Conclusions and Recommendations

Significant opportunities for river restoration exist at this location. Restoration activities in this area could be focused on improving the channel sinuosity and reducing width-to-depth ratios by creating meander bends, a low-flow channel, and more habitat complexity throughout the reach. However, Farnsworth Construction and Gravel would have to support this effort. Although some negotiations have taken place in the past to transfer the mining permit and engage in restoration activities, no such actions have been completed to date. Perhaps the company could be approached in the near term to re-assess the situation and ascertain whether restoration activities may be a possibility in the future.

3.14 PAONIA SEWER CROSSING

The Paonia Sewer Crossing site is located on the west (downstream) side of the Grand Avenue bridge in the southwest corner of the Town of Paonia (Figure 1). In 2008, the town engineer buried a sewer line under 2 feet of cover at the bottom of the riverbed.

However, the river exposed the pipe the following year, creating a need for protection of the sewer line.

3.14.1 Project Description

A W-weir structure was designed and constructed to protect the Paonia sewer line that had been buried underneath the North Fork but became exposed in 2009 (the year following installation). The purpose of the W-weir was to prevent channel bed scour and maintain 2 feet of fill over the top of the buried pipeline, acting as a grade control structure and eliminating the downcut that had been created. A photograph of the W-weir (looking downstream) is provided in Appendix B (Photo 39).

3.14.2 Pre-Project Assessment

Pre-project habitat quality scores for the Paonia sewer crossing project site are presented in Table 15. The lowest habitat quality scores at this location were documented for wetland area and function (1/20, parameter 11), channel sinuosity (3/20, parameter 6), and flow continuity (8/20, parameter 4). The remainder of the habitat quality criteria achieved ratings in the suboptimal or optimal condition categories.

3.14.3 Post-Project Assessment

Post-project habitat quality scores for the sewer crossing site are presented alongside pre-project scores in Table 15. Similar to the pre-project ratings, suboptimal or optimal ratings were achieved for the majority of habitat quality criteria, with the following exceptions: channel sinuosity (3/20, parameter 6), wetland area and function (5/20, parameter 11), and flow continuity (8/20, parameter 4).

3.14.4 Assessment Comparison

The Paonia sewer crossing project accomplished its stated goals of protecting the town sewer line and keeping it buried under the river’s bed load. However, in terms of habitat quality, most of the measured parameters remained unchanged. Three notable exceptions include increases in aquatic structure as cover (12/20 to 18/20, parameter 2), wetland area and function (1/20 to 5/20, parameter 11), and velocity/depth regimes (14/20 to 18/20, parameter 3) scores. A known added benefit of the W-weir was the enhancement of fish habitat by creating usable holding, spawning, and feeding areas. Furthermore, the structure is designed to increase depth and decrease flow velocities in the near-bank regions, encouraging the formation of wetlands.

3.14.5 Conclusions and Recommendations

The Paonia sewer crossing project succeeded in protecting the town’s buried sewer pipe while making some slight enhancements to aquatic habitat quality. No additional restoration or maintenance activities are recommended at this time.

3.15 PAONIA RIVER PARK (DPR SITE 7)

The Paonia River Park site (DPR Site 7) is directly north of the Town of Paonia (Figure 1). Throughout much of the 1970s, 1980s, and 1990s, this 19-acre site was an active in-stream gravel mine owned by United Companies. In-stream mining contributed substantially to the destabilization of the channel and created extensive downcutting of the riverbed both up and downstream of the actual mining boundaries. This excessive scouring threatened the integrity of two bridge structures and resulted in the abandonment and relocation of several irrigation diversions, lowering of the local groundwater table, accelerated bank erosion, and a series of braided channels with no primary watercourse. In 1997, NFRIA negotiated with the gravel mining company to curtail in-stream mining activities and mine exclusively on the floodplain. The existing floodplain was reclaimed in 2004, and United Companies donated 19 acres in and along both banks of the river for a community river park.

3.15.1 Project Description

The Paonia River Park project aimed to turn the remnants of an in-stream gravel mine into a public park by reconstructing a floodplain from several braided channels and consolidating river flows into a single meandering channel, thereby enhancing both aquatic and terrestrial habitat. Appendix B (Photo 40) shows an aerial photograph of the Paonia River Park site prior to restoration activities. The 2012 project was designed to balance the bedload transport capabilities of the channel and enhance the morphological integrity of the ecosystem. Project design, implementation, and monitoring details, as well as an array of photographs, are provided in the Paonia River Park Final Report (WSCC 2013), and a short summary is presented here.

This project was implemented by reconstructing one of the braided channels into the primary channel and securing logs and woody debris in the secondary channels. The secured debris slows the velocity of water overtopping the bankfull elevation of the floodplain and allows the river to deposit sediment and its natural seed base onto the floodplain. This floodplain rehabilitation project utilizes the natural riverine processes to sustainably revegetate the floodplain. Refer to Appendix B (Photo 41) for a pair of Paonia River Park pre- and post-construction photo points.

Rock structures and root wad revetments (bank stabilization structures) were installed along the outside bends of the primary channel to stabilize the riverbank. Similar structures were also employed at the head of the secondary channels but not constructed any higher than bankfull elevation, encouraging overtopping of the floodplain during high runoff events. Numerous willow cuttings and cottonwood tree transplants supplemented the revetment structures and added native riparian vegetation to the exposed banks, and live willow silt fences trapped large woody debris and further enhanced the riparian zone.

Finally, a portion of the river park area doubles as a natural classroom, with a rock podium constructed for lectures and six piezometers installed throughout the site for groundwater level measurements.

3.15.2 Pre-Project Assessment

A pre-project habitat quality assessment was conducted prior to any restoration activities (Table 16). Poor condition ratings were documented for aquatic habitat barriers (4/10, parameter 1), flow continuity (3/10, parameter 4), and channel sinuosity (3/10, parameter 6) prior to restoration. Marginal ratings were assigned for channel alteration (6/20, parameter 5), bank stability (3/10 for each bank, parameter 7), riparian vegetation cover (7/20, parameter 8), left bank riparian vegetation structural diversity (5/10, parameter 9), and wetland area and function (8/20, parameter 11). Right bank riparian vegetation structural diversity (8/10, parameter 9), aquatic structure as cover (15/20, parameter 2), and velocity/depth regimes (12/20, parameter 3) earned scores in the suboptimal condition category. The only metric achieving an optimal ranking was the percent native woody vegetation (10/10 for each bank, parameter 10).

3.15.3 Post-Project Assessment

A post-project habitat quality assessment was conducted in 2014. The results of this assessment are provided in Table 16. Restoration activities yielded a stable fluvial system with remarkable native vegetation growth. With two exceptions, all of the habitat quality parameters achieved scores in the optimal condition category. A suboptimal rating was recorded for channel sinuosity (15/20, parameter 6), and a marginal score was earned for flow continuity (8/20, parameter 4).

3.15.4 Assessment Comparison

The Paonia River Park project created major improvements to the river system, as evidenced by increased scores for all of the site habitat quality parameters measured. Narrowing of the channel and restoration of the riverine ecosystem from gravel mining impacts yielded increases in scores for aquatic habitat barriers (4/20 to 18/20, parameter 1), flow continuity (3/20 to 8/20, parameter 4), and channel alteration (6/20 to 18/20, parameter 5). Addition of meander bends in the channel raised the channel sinuosity score from 3/20 to 14/20 (parameter 6). Rock structures and root wad revetments fortified the banks and enhanced aquatic habitat, resulting in bank stability score improvements from 3/10 to 9/10 for both banks (parameter 7), as well as an aquatic structure as cover score increase from 15/20 to 18/20 (parameter 2). Six new pools were constructed to hold fish during low flows.

The extensive revegetation efforts fostered a healthy riparian ecosystem filled with a diverse plant community and abundant wetlands. In particular, scores for riparian vegetation cover (parameter 8), diversity (parameter 9), and wetland area and function (parameter 11) increased from marginal or suboptimal to optimal as a result of the revegetation activities. Approximately 1.5 acres of new wetlands were developed.

3.15.5 Conclusions and Recommendations

The primary project objectives of transforming an in-stream gravel mine to a functioning stream corridor and the site of a community river park were attained, and many local community members and even tourists continue to enjoy the Paonia River Park, one of the few public access points along the North Fork corridor (Appendix B, Photo 42). Because this is such a large project site that was only recently completed, the Paonia River Park would benefit from some adaptive management strategies, including point bar and bank stabilization, creation of additional fish habitat, construction of flow inhibitors to prevent future channel braiding, and flow consolidation at the end of the project just above the confluence with Minnesota Creek. Specific locations for these and other potential adaptive management strategies are provided in the final section of the Paonia River Park Final Report (WSCC 2013).

3.16 PAONIA DITCH

The Paonia Ditch diversion is located on the east side North Fork of the Gunnison River, adjacent to the Town of Paonia and immediately upstream of the Paonia River Park (Figure 1). Prior to the project, the diversion used a rock, gravel, and debris structure created by bulldozing the river bed to divert water into the ditch. The Paonia Ditch had no control structure at the diversion point; it used a metal culvert as the intake structure. When the irrigation season ended, poles were placed across the mouth of the culvert to stop flow into the ditch.

The Paonia Ditch is the senior ditch on the North Fork, with a 13.1 cfs water right dating back to 1901. During low-water conditions in late summer, the Paonia Ditch typically dries up the river and diverts all of the flow into the ditch. The total decree for the Paonia Ditch is 34.54 cfs. The Paonia Ditch also carries water for the Wade and Hightower Ditches. The Paonia Ditch water serves 700 acres of agricultural lands, with the bulk of the supplied water irrigating fruit orchards, hay meadows, and vineyards. The Town of Paonia holds 3.9 percent of the Paonia Ditch shares, and uses its water to irrigate lawns and gardens within the town. Delta County owns several shares, using the water to irrigate the ball fields at Volunteer Park, a County-owned recreation area near Paonia.

The Paonia Ditch diversion is situated immediately upstream of a previous in-stream gravel mine. As a result of gravel mining, extensive downcutting and headcutting has occurred immediately below the current diversion point. This erosion of the river bed resulted in the need to move the diversion point of the Paonia Ditch upstream several times in past few decades. The magnitude of the downcutting is evidenced by the fact that between 1992 and 1997 the river downcut 5 feet at the highway bridge located less than one-mile downstream of the diversion. Headcutting upstream from the gravel pit has also been measured. At the point of diversion for the Paonia Ditch, approximately 3,000 feet upstream from the bridge, 30 inches of bank erosion and 24 inches of channel degradation was recorded in one year in 1997.

3.16.1 Project Description

Further degradation of the riparian corridor, including the stream channel, slowed as a result of cessation of in-stream mining. However, in 2007 the Ditch company recognized that imminent failure of the Paonia Ditch diversion, which was acting as a grade control, would have allowed the headcut to progress further upstream, and annual repairs to the diversion and the associated disturbance to the channel bed would continue in the future. Therefore, the ditch company solicited assistance from NFRIA to fund, design and construct a new diversion structure and head gate in 2007. NFRIA raised $111,000 from the Gunnison Basin Roundtable to build the Paonia Ditch and the Feldman Ditch just upstream on the opposite bank.

The Paonia Ditch diversion project was designed to create an efficient, low-maintenance, and permanent concrete head gate with a low-head rock weir at the diversion point to deliver a full decree into the existing ditch supply systems while conserving water, improving use efficiencies, reducing the need for bulldozers in the channel, and decreasing suspended sediment. In addition, it was to provide for fish migration and allow boaters to travel across the diversion, both of which were previously prevented by the old diversion structure. These objectives were consistent with watershed management goals and needs assessments of the North Fork Water

Conservancy District, the North Fork Gunnison Action Strategy (2000), and the Statewide Water Supply Initiative Findings and Key Recommendations.

The three main goals included:

(1) enhancement of watershed health through restoration of an efficient water-conserving diversion structure;

(2) improvement fish and wildlife habitat by reducing the need for bulldozers; and

(3) creation of safer recreation through construction of a low-head rock diversion wall.

As with every structure that is constructed in an active river channel, some amount of repair and revision is typically required to meet the design objectives. NFRIA anticipated the need to raise additional funds for rock replacement, diversion sealing, and/or a trash rack to improve long-term sustainability of the structure.

During high-flow spring runoff conditions following construction in 2008, the west end of the diversion structure on the opposite side of the head gate failed and washed out. NFRIA raised an additional $12,000 to repair the structure where it had been compromised. However, the ditch company insisted on using the money to build a concrete and rock dam across the river with no low flow channel and no fish or recreational capabilities, negating the original goals of the project. The current diversion structure is pictured in Appendix B (Photo 43).

3.16.2 Pre-Project Assessment

Pre-project habitat assessment scores are presented in Table 17. The lowest habitat quality scores prior to diversion construction were related to natural channel alteration, aquatic habitat availability, flow continuity during base flow, and area wetlands.

Poor condition ratings were assigned for aquatic habitat barriers (1/20, parameter 1), aquatic structure as cover (4/20, parameter 2), flow continuity (1/20, parameter 4), channel alteration (2/20, parameter 5), and wetland area and function (1/20, parameter 11) prior to reconstruction of the diversion structure. Marginal ratings were earned for velocity/depth regimes (8/20, parameter 3), channel sinuosity (6/20, parameter 6), left bank stability (5/10, parameter 7), and right bank vegetation structural diversity (5/10, parameter 9). Scores in the suboptimal category were documented for right bank stability (8/10, parameter 7), riparian vegetation cover (12/20, parameter 8), left bank vegetation structural diversity (8/10, parameter 9), and right bank percent native vegetation (8/10, parameter 10). An optimal score was earned for left bank percent native vegetation (9/10, parameter 10).

3.16.3 Post-Project Assessment

Post-project habitat assessment scores are presented alongside pre-project scores in Table 17. Similar to pre-project conditions, the lowest habitat quality scores after diversion construction were related to natural channel alteration, aquatic habitat availability, flow continuity during base flow, and area wetlands. The new concrete structure diverts all of the water from the river during base flow, with no water passing in the main channel except for groundwater. Thus, scores for aquatic habitat barriers (1/20, parameter 1), flow continuity (1/20, parameter 4), channel alteration (3/20, parameter 5), and wetland area and function (5/20, parameter 11) fell in the poor condition category. Marginal ratings were documented for aquatic structure as cover (8/20, parameter 2), velocity/depth regimes (8/20, parameter 3), and channel sinuosity (6/20, parameter 6). The remaining criteria received suboptimal or optimal scores.

3.16.4 Assessment Comparison

Pre-project and post-project habitat assessment scores were relatively similar, with a 20 percent overall change in ratings before and after project implementation (Table 17).

3.16.5 Conclusions and Recommendations

While the concrete ditch structure accomplished the needs of the Paonia Ditch Company to divert water for irrigation, it was not constructed in a way that improves aquatic habitat quality. Recommendations include negotiating with the Paonia Ditch Company to rehabilitate the existing structure to provide for a multi-objective diversion that meets the original goals of the project for which State funds were used. In times of low flow, the channel often gets dewatered downstream of the diversion structure, compromising the health and viability of aquatic biota populations.

Instream flows on the North Fork are becoming an increasingly important issue with respect to aquatic health of the river. The Paonia Ditch is the senior water right on the river. Ii would take substantial engineering and legal work to achieve in-stream flows for this and other reaches of the North Fork of the Gunnison River but developing this project now is recommended. It will take a lot of time and work to accomplish the goal of instream flows on this reach of the North Fork.

3.17 FELDMAN DITCH

The Feldman Ditch is situated on the west side of the river several hundred feet upstream of the Paonia Ditch (Figure 1). Prior to the project, the diversion used a rock, gravel and debris structure created by bulldozing the river bed to divert water into the ditch, with no control structure at the diversion point. The Feldman Ditch allowed an unmeasured amount of water to be diverted into the ditch, and water in excess of their decree was returned to the river downstream of the diversion point. At the end of the irrigation season, the ditch was closed off by blocking the mouth of the ditch with soil.

The 3.8 cfs Feldman ditch decree provides water for 76 acres of orchards and hay fields. Some gardens and yards are also irrigated from the Feldman ditch. The Feldman Ditch has a 1914 decree for 1.9 cfs and an additional 1976 decree for 1.9 cfs. The 1914 decree is a relatively junior water right, and as a result the water commissioner shuts down the diversion early in the season.

3.17.1 Project Description

The Feldman Ditch was constructed in 2007 at the same time as the Paonia Ditch. The goals of the project were also the same as those for the Paonia Ditch (refer to Section 3.16.1), including reconstruction of an efficient diversion structure, enhancement of aquatic and terrestrial habitat, and promotion of safer recreation. The current diversion structure is pictured in Appendix B (Photo 44).

3.17.2 Pre-Project Assessment

Pre-project habitat assessment scores are presented in Table 18. The lowest habitat quality scores prior to diversion construction were for wetland area and function (5/20, parameter 11), channel sinuosity (6/20, parameter 6), aquatic structure as cover (9/20, parameter 2), and aquatic habitat barriers (10/20, parameter 1). The remaining criteria achieved habitat quality ratings in the suboptimal to optimal condition categories.

3.17.3 Post-Project Assessment

Post-project habitat assessment scores did not differ much from pre-project scores (Table 18). Similar to pre-project rankings, the lowest scores were documented for wetland area and function (6/20, parameter 11) and channel sinuosity (6/20, parameter 6). All of the other criteria were rated in the suboptimal or optimal categories.

3.17.4 Assessment Comparison

Pre-project and post-project habitat assessment scores were essentially the same, with just a 4 percent overall change in ratings before and after project implementation (Table 18). Slight improvements are observed in scores for aquatic structure as cover (9/20 to 11/20, parameter 2), channel alteration (12/20 to 14/20, parameter 5), aquatic habitat barriers (10/20 to 11/20, parameter 1), and wetland area and function (5/20 to 6/20, parameter 11).

3.17.5 Conclusions and Recommendations

The Feldman Ditch is operating well and successfully allowing for fish passage through the structure. Specific recommendations for future projects are not needed at this time.

3.18 FARMERS DITCH (DPR SITE 8)

The Farmers Ditch (DPR Site 8) is located approximately 2 miles northeast of the Town of Paonia at a point where the North Fork parallels Highway 133 (Figure 1). The existing permanent diversion for the Farmers Ditch is essentially a 5-foot high check dam constructed of timber, rock, and concrete (Appendix B, Photo 45). The river upstream of the check dam occupies a stable meandering channel, and below the dam the river enters an entrenched straight channel narrowly confined by irrigated land on the left (south) and the Highway 133 embankment on the right (north) (USACE 2007). The structure diverts all of the water in the North Fork into the ditch, posing a barrier for fish movement during low-flow conditions and creating a safety hazard for recreational boating during higher flows. A restoration project at this location has been proposed by NFRIA but not conducted due to lack of landowner approval.

3.18.1 Pre-Project Assessment

Because restoration activities have not occurred at this location, only the pre-project habitat quality assessment scores assigned in 2014 are presented (Table 19). Poor to marginal condition ratings were documented for aquatic habitat barriers (3/20, parameter 1), velocity/depth regimes (10/20, parameter 3), flow continuity (2/20, parameter 4), channel alteration (5/20, parameter 5), channel sinuosity (2/20, parameter 6), and wetland area and function (2/10, parameter 11).

Suboptimal to optimal ratings were recorded for aquatic structure as cover (12/20, parameter 2), bank stability (9/10 for both banks, parameter 7), riparian vegetation cover (18/20, parameter 8), riparian vegetation structural diversity (8/10 for both banks, parameter 9), and percent native woody vegetation (10/10 for both banks, parameter 10).

3.18.2 Conclusions and Recommendations

As part of the USACE Section 206 Aquatic Ecosystem Restoration plan, a project was proposed at this location to improve channel morphology at the existing diversion structure to consolidate flows to one side using a single-wing deflector above the diversion and allow fish passage via a series of nine rock drop/pool structures. The existing head gate would be retrofitted to improve diversion efficiencies (USACE 2007). This project has not been completed to date, but approaching the North Fork Farmers Ditch Association in Paonia to revisit funding and implementation of this project is recommended.

3.19 STEWART DITCH (DPR SITE 9)

The Stewart Ditch (DPR Site 9) is located almost 3 miles northeast of the Town of Paonia, and is the furthest upstream location of all project sites evaluated in this report (Figure 1). The diversion is a temporary push-up dam, typically requiring excavation work in the river channel several times per year during the irrigation season. The river is bulldozed into a side channel along the south side of the floodplain approximately 1,200 feet upstream of the diversion point, with very high water losses between the point of the diversion and the makeshift head gate (USACE 2007). This method results in over-diverting flows and often dewatering the downstream reach, particularly during base flow and drought conditions.

A restoration project has been proposed but not conducted at this location. NFRIA raised $60,000 towards a reconstruction of the Stewart Ditch in 2006, but at the last minute the ditch company Board deemed the project unnecessary and decided against reconstruction.

3.19.1 Pre-Project Assessment

Appendix B includes three photos that depict the condition of the North Fork at the location of the Stewart Ditch. Photo 46 shows the makeshift head gate for the diversion structure in the back of the photo, with the actual main stem of the North Fork in the foreground containing water from groundwater and precipitation only. The left side of Photo 47 shows the water going through the ditch, divided from the essentially dry main stem of the North Fork on the right. Photo 48 depicts the North Fork’s dry riverbed upstream of the diversion.

Because restoration activities have not occurred at this location, only the pre-project habitat quality assessment scores assigned in 2014 are presented (Table 19). Poor to marginal condition ratings were assigned for aquatic habitat barriers (3/20, parameter 1), aquatic structure as cover (8/20, parameter 2), velocity/depth regimes (10/20, parameter

3), flow continuity (3/20, parameter 4), channel alteration (7/20, parameter 5), channel sinuosity (5/20, parameter 6), bank stability (5/10 and 4/10 for the left/south and right/north banks, respectively, parameter 7), and wetland area and function (3/10, parameter 11).

Suboptimal to optimal ratings are documented for riparian vegetation cover (14/20, parameter 8), riparian vegetation structural diversity (9/10 for both banks, parameter 9), and percent native woody vegetation (10/10 and 9/10 for the left/south and right/north banks, respectively, parameter 10).

3.19.2 Conclusions and Recommendations

A project was proposed at this location as part of the USACE Section 206 Aquatic Ecosystem Restoration plan, and NFRIA raised money to fund the restoration. The proposed project would retrofit the Stewart Ditch with a low-head rock weir and replace the ditch next to the North Fork with a specialized ditching or piping system. Rebuilding of the irrigation diversion in this manner would eliminate the need for annual in-stream excavation activities, enhance aquatic and riparian habitat, and improve diversion efficiencies to reduce dewatering of the river. Approaching the Stewart Ditch board and/or the local landowners again is recommended, as a restoration project at this site would greatly improve the morphology and habitat of North Fork river corridor in this area. The Lazy H Ranch, where the diversion is located, just finished an unrelated and separate stream restoration project upstream of the Stewart Ditch. The owner of the ranch may be willing to approach the ditch company.

4.0 SUMMARY AND RECOMMENDATIONS FOR FUTURE PROJECTS

Since the late 1990s, efforts to improve and restore a natural and stable riverine ecosystem along the 16-mile stretch of the North Fork of the Gunnison River and throughout the North Fork basin have accomplished many of their specified goals, including floodplain and riparian zone rehabilitation, channel and bank stabilization, diversion structure improvement, and fishery and aquatic habitat enhancement. Where possible and practical, restoration activities have allowed natural fluvial processes to resume, restoring a stable and healthy system without the need for constant human intervention. However, project success could be improved further and the river could recover more quickly if some additional maintenance activities were undertaken, such as eradication of non-native riparian vegetation, additional retrofitting of some of the diversion structures, and localized bank stabilization efforts.

The remainder of this section provides a list of recommendations for additional restoration activities. Factors such as potential project costs, likelihood of implementation, and degree of habitat quality improvement should be considered when prioritizing projects. Most of the recommendations have been presented by project in Section 3 of this report.

<u>Revegetation and non-native species removal activities:</u>

(1) Eradication of non-native riparian vegetation species (e.g., Russian olive trees and tamarisks) primarily along the downstream reaches and particularly at the Hotchkiss Demonstration Project site, the Tri-County Gravel Pit site, the Upper Curry restoration site, and the Midway Project Ross property and Campbell Ranch sites. Many of these exotic vegetation removal projects could be conducted with community volunteer support as they have been in the past. A coordinated effort to identify willing landowners and high priority sites with organizations such as the Conservation Corps and the Delta Soil District could prove effective.

(2) Additional riparian vegetation plantings at the Midway 2010 bank stabilization project site (higher priority) and on the Tom Kay property (lower priority).

<u>Bank stabilization, channel realignment, and aquatic habitat enhancement activities:</u>

(1) Adaptive management strategies at the Paonia River Park as described in Paonia River Park Final Report (WSCC 2013), including point bar and bank stabilization, creation of additional fish habitat, construction of flow inhibitors to prevent future channel braiding, and flow consolidation at the end of the project just above the confluence with Minnesota Creek.

(2) Additional improvements to the Tri-County Gravel Pit site, including reduction of channel width-to-depth ratios, construction of riffle-pool sequencing within the channel, elimination of non-native vegetation, addition of large woody debris, and bank stabilization activities.

(3) Installation of additional large woody debris revetments at potential avulsion sites primarily at side channels on the Ross and Carsten properties (higher priority) and the Tom Kay property site (lower priority) to improve bank stability and enhance habitat complexity.

(4) Revisiting negotiations with Farnsworth Construction and Gravel to improve channel sinuosity and reduce width-to-depth ratios by creating meander bends, a low-flow channel, and more habitat complexity throughout the reach.

(5) Bank stabilization efforts on certain tributaries to the North Fork such as Cottonwood Creek. Cottonwood Creek drains the ‘dobe’ area between Crawford and Hotchkiss and has been identified as hot spot for selenium. Bank stabilization in priority areas on Cottonwood Creek would reduce sediment and potentially reduce both salinity and selenium. Leroux Creek and Alum Gulch have also been identified as high in selenium. An assessment of those three creeks is recommended to potentially lead to additional projects to improve water quality and aquatic enhancements.

<u>Diversion structure improvement activities:</u>

(1) Small improvements to the Smith McKnight diversion structure, such as chasing grade a bit further upstream.

(2) Improvements to the Short Ditch diversion in the form of grade control structures installed downstream of the diversion under the head gate, narrowing of the channel to allow flows to pass through the area more efficiently, and/or grouting of the existing diversion structure to eliminate continued bulldozing.

(3) Retrofits to the Sheppard-Wilmot Ditch diversion structure, including extension of the structure further into the main channel to make it more sustainable over the long term, installation of a slide gate valve at the headwall to improve manageability of maintenance operations, and rebuilding of the J-hook flow structure downstream of the diversion.

(4) Grouting the Monitor Ditch diversion structure all the way across the channel and potentially installing a slide gate valve to improve maintenance operations in the ditch.

(5) Initiating negotiations with the Paonia Ditch Company to rehabilitate the existing structure to provide for a multi-objective diversion that meets the original goals of the project for which State funds were used.

(6) Approaching the North Fork Farmers Ditch Association to revisit funding and implementation of the Farmers Ditch DPR project.

(7) Approaching the Stewart Ditch board and the Lazy H Ranch landowner to revisit implementation of the Stewart Ditch DPR project.

Monitoring and/or maintenance activities:

(1) Geomorphic monitoring at the Hotchkiss Demonstration Project site to assess the state of the channel and compare the current geomorphology to historical conditions.

(2) Conducting an assessment of tributaries feeding the North Fork to assess potential restoration opportunities related to bank stabilization, riparian zone enhancement, and habitat quality improvements.

(3) Establishment of a small annual maintenance fund with the ability to hire professionally managed equipment prior to runoff to help maintain alignment continuity and utilize large woody debris to the benefit of the riverine ecosystem. This would be especially beneficial through most of the Midway Project reach in response to regular lodging of large cottonwood trees in the channel during spring runoff. Such trees alter the flow and alignment of the river in a manner detrimental to property owners and ditch companies.

Miscellaneous site-specific activities:

(1) Design and construction of a boat ramp on the County fairgrounds property just downstream of the Hotchkiss Demonstration Project upstream bridge to encourage local recreation and tourism.

(2) Initiation of engineering and legal work to achieve in-stream flow designations for the Paonia Ditch and other reaches of the North Fork of the Gunnison River. The Colorado Water Trust has made instream flows on the North Fork a long-term priority. Partnering with the Trust could provide the engineering and legal expertise needed to begin the search for a solution.

Additional restoration activities on the North Fork of the Gunnison River depend largely on funding and stakeholder buy-in (including private landowners, ditch companies, and the general public). These elements play a significant role in dictating the likelihood of project initiation and implementation. All of the restoration projects recommended above would benefit the North Fork basin and potentially add to the growing list of successful river restoration projects along the North Fork corridor.

5.0 REFERENCES

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TABLES

Table 1. List of North Fork Gunnison River Restoration Projects

Site No.	Project	Year Completed	DPR Site No.
1	Tom Kay Property	2006	DPR Site 1
2	Chipeta Dam Removal	2006	
3	Hotchkiss Demonstration Project/Smith McKnight Ditch	1999	
4	Waters-Carpenter Site	not completed	DPR Site 2
5	Tri-County Gravel Pit	2002	DPR Site 3
6	Upper Curry Restoration Site	2005	
7	Midway Enhancement Project: Ross Property	2002	DPR Site 4
8	Midway Enhancement Project: Campbell Ranch	2002	DPR Site 5
9	Midway Enhancement Project: 2010 Bank Stabilization	2010	
10	Short Ditch	2002	
11	Sheppard-Wilmot Ditch	2000	
12	Monitor Ditch	2004	DPR Site 6
13	Farnsworth Gravel Pit	not completed	
14	Paonia Sewer Crossing	2009	
15	Paonia River Park	2012	DPR Site 7
16	Paonia Ditch	2007	
17	Feldman Ditch	2007	
18	Farmers Ditch	not completed	DPR Site 8
19	Stewart Ditch	not completed	DPR Site 9

Note: The DPR Site No. field for non-DPR project sites has been left blank.

Table 2. Tom Kay Property Pre-Project and Post-Project Habitat Quality Assessment Scores

Habitat Quality Parameter	Pre-Project Score	Pre-Project Condition Category	Post-Project Score	Post-Project Condition Category	Percent Change
1 Aquatic Habitat Barriers	20	Optimal	20	Optimal	0
2 Aquatic Structure as Cover	5	Poor	9	Marginal	44
3 Velocity/Depth Regimes	16	Optimal	17	Optimal	6
4 Flow Continuity	15	Suboptimal	15	Suboptimal	0
5 Channel Alteration	16	Optimal	18	Optimal	11
6 Channel Sinuosity	7	Marginal	8	Marginal	13
7 Bank Stability (Left)	1	Poor	7	Suboptimal	86
7 Bank Stability (Right)	9	Optimal	9	Optimal	0
8 Riparian Vegetation Cover	11	Suboptimal	15	Suboptimal	27
9 Riparian Vegetation Structural Diversity (Left)	1	Poor	6	Suboptimal	83
9 Riparian Vegetation Structural Diversity (Right)	8	Suboptimal	9	Optimal	11
10 Percent Native Woody Vegetation (Left)	5	Poor	8	Suboptimal	38
10 Percent Native Woody Vegetation (Right)	4	Poor	7	Suboptimal	43
11 Palustrine Wetland Area and Function	4	Poor	11	Suboptimal	64
Total Score	122		159		23

Table 3. Chipeta Dam Removal Pre-Project and Post-Project Habitat Quality Assessment Scores

Habitat Quality Parameter	Pre-Project Score	Pre-Project Condition Category	Post-Project Score	Post-Project Condition Category	Percent Change
1 Aquatic Habitat Barriers	1	Poor	20	Optimal	95
2 Aquatic Structure as Cover	9	Marginal	10	Marginal	10
3 Velocity/Depth Regimes	9	Marginal	14	Suboptimal	36
4 Flow Continuity	18	Optimal	18	Optimal	0
5 Channel Alteration	2	Poor	12	Suboptimal	83
6 Channel Sinuosity	1	Poor	1	Poor	0
7 Bank Stability (Left)	6	Suboptimal	8	Suboptimal	25
7 Bank Stability (Right)	7	Suboptimal	7	Suboptimal	0
8 Riparian Vegetation Cover	18	Optimal	18	Optimal	0
9 Riparian Vegetation Structural Diversity (Left)	9	Optimal	9	Optimal	0
9 Riparian Vegetation Structural Diversity (Right)	9	Optimal	9	Optimal	0
10 Percent Native Woody Vegetation (Left)	3	Marginal	7	Suboptimal	57
10 Percent Native Woody Vegetation (Right)	2	Poor	2	Poor	0
11 Palustrine Wetland Area and Function	1	Poor	10	Marginal	90
Total Score	95		145		34

Table 4. Hotchkiss Demonstration Project and Smith-McKnight Ditch Pre-Project and Post-Project Habitat Quality Assessment Scores

Habitat Quality Parameter	Pre-Project Score	Pre-Project Condition Category	Post-Project Score	Post-Project Condition Category	Percent Change
1 Aquatic Habitat Barriers	1	Poor	17	Optimal	94
2 Aquatic Structure as Cover	3	Poor	18	Optimal	83
3 Velocity/Depth Regimes	16	Optimal	18	Optimal	11
4 Flow Continuity	3	Poor	18	Optimal	83
5 Channel Alteration	6	Marginal	16	Optimal	63
6 Channel Sinuosity	3	Poor	14	Suboptimal	79
7 Bank Stability (Left)	3	Poor	9	Optimal	67
7 Bank Stability (Right)	3	Marginal	9	Optimal	67
8 Riparian Vegetation Cover	6	Marginal	18	Optimal	67
9 Riparian Vegetation Structural Diversity (Left)	5	Marginal	9	Optimal	44
9 Riparian Vegetation Structural Diversity (Right)	5	Marginal	9	Optimal	44
10 Percent Native Woody Vegetation (Left)	6	Suboptimal	8	Suboptimal	25
10 Percent Native Woody Vegetation (Right)	6	Suboptimal	7	Suboptimal	14
11 Palustrine Wetland Area and Function	6	Marginal	17	Optimal	65
Total Score	72		187		61

Table 5. Waters-Carpenter Site 2001 and 2014 Pre-Project Habitat Quality Assessment Scores

Habitat Quality Parameter	Pre-Project Score	2001 Pre-Project Condition Category	Post-Project Score	2014 Pre-Project Condition Category	Percent Change
1 Aquatic Habitat Barriers	19	Optimal	19	Optimal	0
2 Aquatic Structure as Cover	4	Poor	5	Poor	20
3 Velocity/Depth Regimes	11	Suboptimal	12	Suboptimal	8
4 Flow Continuity	18	Optimal	18	Optimal	0
5 Channel Alteration	11	Suboptimal	16	Optimal	31
6 Channel Sinuosity	17	Optimal	7	Marginal	-143
7 Bank Stability (Left)	1	Poor	6	Suboptimal	83
7 Bank Stability (Right)	2	Poor	6	Suboptimal	67
8 Riparian Vegetation Cover	16	Optimal	17	Optimal	6
9 Riparian Vegetation Structural Diversity (Left)	1	Poor	3	Marginal	67
9 Riparian Vegetation Structural Diversity (Right)	5	Marginal	6	Suboptimal	17
10 Percent Native Woody Vegetation (Left)	6	Suboptimal	7	Suboptimal	14
10 Percent Native Woody Vegetation (Right)	8	Suboptimal	8	Suboptimal	0
11 Palustrine Wetland Area and Function	2	Poor	2	Poor	0
Total Score	121		132		8

Table 6. Tri-County Gravel Pit Pre-Project and Post-Project Habitat Quality Assessment Scores

Habitat Quality Parameter	Pre-Project Score	Pre-Project Condition Category	Post-Project Score	Post-Project Condition Category	Percent Change
1 Aquatic Habitat Barriers	16	Optimal	19	Optimal	16
2 Aquatic Structure as Cover	10	Marginal	16	Optimal	38
3 Velocity/Depth Regimes	14	Suboptimal	16	Optimal	13
4 Flow Continuity	14	Suboptimal	15	Suboptimal	7
5 Channel Alteration	4	Poor	15	Suboptimal	73
6 Channel Sinuosity	4	Poor	4	Poor	0
7 Bank Stability (Left)	4	Marginal	8	Suboptimal	50
7 Bank Stability (Right)	3	Marginal	8	Suboptimal	63
8 Riparian Vegetation Cover	8	Marginal	16	Optimal	50
9 Riparian Vegetation Structural Diversity (Left)	5	Marginal	9	Optimal	44
9 Riparian Vegetation Structural Diversity (Right)	8	Suboptimal	9	Optimal	11
10 Percent Native Woody Vegetation (Left)	4	Marginal	8	Suboptimal	50
10 Percent Native Woody Vegetation (Right)	5	Marginal	7	Suboptimal	29
11 Palustrine Wetland Area and Function	8	Marginal	18	Optimal	56
Total Score	107		168		36

Table 7. Upper Curry Restoration Site Pre-Project and Post-Project Habitat Quality Assessment Scores

Habitat Quality Parameter	Pre-Project Score	Pre-Project Condition Category	Post-Project Score	Post-Project Condition Category	Percent Change
1 Aquatic Habitat Barriers	18	Optimal	18	Optimal	0
2 Aquatic Structure as Cover	8	Marginal	13	Suboptimal	38
3 Velocity/Depth Regimes	16	Optimal	17	Optimal	6
4 Flow Continuity	11	Suboptimal	16	Optimal	31
5 Channel Alteration	5	Poor	14	Suboptimal	64
6 Channel Sinuosity	5	Poor	16	Optimal	69
7 Bank Stability (Left)	4	Marginal	9	Optimal	56
7 Bank Stability (Right)	4	Marginal	9	Optimal	56
8 Riparian Vegetation Cover	3	Poor	18	Optimal	83
9 Riparian Vegetation Structural Diversity (Left)	4	Marginal	9	Optimal	56
9 Riparian Vegetation Structural Diversity (Right)	4	Marginal	9	Optimal	56
10 Percent Native Woody Vegetation (Left)	4	Marginal	7	Suboptimal	43
10 Percent Native Woody Vegetation (Right)	4	Marginal	7	Suboptimal	43
11 Palustrine Wetland Area and Function	16	Optimal	18	Optimal	11
Total Score	106		180		41

Table 8. Midway Project Ross Property Pre-Project and Post-Project Habitat Quality Assessment Scores

Habitat Quality Parameter	Pre-Project Score	Pre-Project Condition Category	Post-Project Score	Post-Project Condition Category	Percent Change
1 Aquatic Habitat Barriers	18	Optimal	20	Optimal	10
2 Aquatic Structure as Cover	10	Marginal	18	Optimal	44
3 Velocity/Depth Regimes	16	Optimal	18	Optimal	11
4 Flow Continuity	8	Marginal	18	Optimal	56
5 Channel Alteration	8	Marginal	19	Optimal	58
6 Channel Sinuosity	8	Marginal	18	Optimal	56
7 Bank Stability (Left)	5	Marginal	8	Suboptimal	38
7 Bank Stability (Right)	5	Marginal	8	Suboptimal	38
8 Riparian Vegetation Cover	9	Marginal	15	Suboptimal	40
9 Riparian Vegetation Structural Diversity (Left)	6	Suboptimal	8	Suboptimal	25
9 Riparian Vegetation Structural Diversity (Right)	6	Suboptimal	8	Suboptimal	25
10 Percent Native Woody Vegetation (Left)	5	Marginal	5	Marginal	0
10 Percent Native Woody Vegetation (Right)	5	Marginal	5	Marginal	0
11 Palustrine Wetland Area and Function	18	Optimal	18	Optimal	0
Total Score	127		186		32

Table 9. Midway Project Campbell Ranch Pre-Project and Post-Project Habitat Quality Assessment Scores

Habitat Quality Parameter	Pre-Project Score	Pre-Project Condition Category	Post-Project Score	Post-Project Condition Category	Percent Change
1 Aquatic Habitat Barriers	8	Marginal	20	Optimal	60
2 Aquatic Structure as Cover	6	Marginal	16	Optimal	63
3 Velocity/Depth Regimes	16	Optimal	18	Optimal	11
4 Flow Continuity	4	Poor	12	Suboptimal	67
5 Channel Alteration	4	Poor	16	Optimal	75
6 Channel Sinuosity	10	Marginal	12	Suboptimal	17
7 Bank Stability (Left)	2	Poor	9	Optimal	78
7 Bank Stability (Right)	2	Poor	9	Optimal	78
8 Riparian Vegetation Cover	4	Poor	15	Suboptimal	73
9 Riparian Vegetation Structural Diversity (Left)	4	Marginal	8	Suboptimal	50
9 Riparian Vegetation Structural Diversity (Right)	4	Marginal	8	Suboptimal	50
10 Percent Native Woody Vegetation (Left)	5	Marginal	9	Optimal	44
10 Percent Native Woody Vegetation (Right)	5	Marginal	9	Optimal	44
11 Palustrine Wetland Area and Function	6	Marginal	11	Suboptimal	45
Total Score	80		172		53

Table 10. Midaway 2010 Stabilization Pre-Project and Post-Project Habitat Quality Assessment Scores

Habitat Quality Parameter	Pre-Project Score	Pre-Project Condition Category	Post-Project Score	Post-Project Condition Category	Percent Change
1 Aquatic Habitat Barriers	18	Optimal	18	Optimal	0
2 Aquatic Structure as Cover	13	Suboptimal	18	Optimal	28
3 Velocity/Depth Regimes	18	Optimal	18	Optimal	0
4 Flow Continuity	7	Marginal	11	Suboptimal	36
5 Channel Alteration	12	Suboptimal	14	Suboptimal	14
6 Channel Sinuosity	6	Marginal	16	Optimal	63
7 Bank Stability (Left)	2	Poor	9	Optimal	78
7 Bank Stability (Right)	2	Poor	9	Optimal	78
8 Riparian Vegetation Cover	3	Poor	18	Optimal	83
9 Riparian Vegetation Structural Diversity (Left)	8	Suboptimal	9	Optimal	11
9 Riparian Vegetation Structural Diversity (Right)	8	Suboptimal	9	Optimal	11
10 Percent Native Woody Vegetation (Left)	9	Optimal	9	Optimal	0
10 Percent Native Woody Vegetation (Right)	9	Optimal	9	Optimal	0
11 Palustrine Wetland Area and Function	8	Marginal	16	Optimal	50
Total Score	123		183		33

Table 11. Short Ditch Pre-Project and Post-Project Habitat Quality Assessment Scores

Habitat Quality Parameter	Pre-Project Score	Pre-Project Condition Category	Post-Project Score	Post-Project Condition Category	Percent Change
1 Aquatic Habitat Barriers	8	Marginal	8	Marginal	0
2 Aquatic Structure as Cover	2	Poor	2	Poor	0
3 Velocity/Depth Regimes	8	Marginal	8	Marginal	0
4 Flow Continuity	2	Poor	2	Poor	0
5 Channel Alteration	4	Poor	6	Marginal	33
6 Channel Sinuosity	12	Suboptimal	12	Suboptimal	0
7 Bank Stability (Left)	2	Poor	4	Marginal	50
7 Bank Stability (Right)	2	Poor	4	Marginal	50
8 Riparian Vegetation Cover	3	Poor	5	Poor	40
9 Riparian Vegetation Structural Diversity (Left)	6	Suboptimal	7	Suboptimal	14
9 Riparian Vegetation Structural Diversity (Right)	6	Suboptimal	7	Suboptimal	14
10 Percent Native Woody Vegetation (Left)	3	Marginal	5	Marginal	40
10 Percent Native Woody Vegetation (Right)	4	Marginal	5	Marginal	20
11 Palustrine Wetland Area and Function	2	Poor	2	Poor	0
Total Score	64		77		17

Table 12. Sheppard-Wilmot Ditch Pre-Project and Post-Project Habitat Quality Assessment Scores

Habitat Quality Parameter	Pre-Project Score	Pre-Project Condition Category	Post-Project Score	Post-Project Condition Category	Percent Change
1 Aquatic Habitat Barriers	12	Suboptimal	14	Suboptimal	14
2 Aquatic Structure as Cover	13	Suboptimal	13	Suboptimal	0
3 Velocity/Depth Regimes	13	Suboptimal	13	Suboptimal	0
4 Flow Continuity	18	Optimal	18	Optimal	0
5 Channel Alteration	12	Suboptimal	14	Suboptimal	14
6 Channel Sinuosity	15	Suboptimal	16	Optimal	6
7 Bank Stability (Left)	7	Suboptimal	7	Suboptimal	0
7 Bank Stability (Right)	3	Marginal	8	Suboptimal	63
8 Riparian Vegetation Cover	11	Suboptimal	18	Optimal	39
9 Riparian Vegetation Structural Diversity (Left)	7	Suboptimal	7	Suboptimal	0
9 Riparian Vegetation Structural Diversity (Right)	9	Optimal	10	Optimal	10
10 Percent Native Woody Vegetation (Left)	6	Suboptimal	7	Suboptimal	14
10 Percent Native Woody Vegetation (Right)	6	Suboptimal	7	Suboptimal	14
11 Palustrine Wetland Area and Function	1	Poor	3	Poor	67
Total Score	133		155		14

Table 13. Monitor Ditch Pre-Project and Post-Project Habitat Quality Assessment Scores

Habitat Quality Parameter	Pre-Project Score	Pre-Project Condition Category	Post-Project Score	Post-Project Condition Category	Percent Change
1 Aquatic Habitat Barriers	15	Suboptimal	16	Optimal	6
2 Aquatic Structure as Cover	15	Suboptimal	16	Optimal	6
3 Velocity/Depth Regimes	13	Suboptimal	16	Optimal	19
4 Flow Continuity	6	Marginal	13	Suboptimal	54
5 Channel Alteration	3	Poor	13	Suboptimal	77
6 Channel Sinuosity	2	Poor	2	Poor	0
7 Bank Stability (Left)	2	Poor	9	Optimal	78
7 Bank Stability (Right)	9	Optimal	9	Optimal	0
8 Riparian Vegetation Cover	16	Optimal	18	Optimal	11
9 Riparian Vegetation Structural Diversity (Left)	5	Marginal	9	Optimal	44
9 Riparian Vegetation Structural Diversity (Right)	7	Suboptimal	9	Optimal	22
10 Percent Native Woody Vegetation (Left)	8	Suboptimal	9	Optimal	11
10 Percent Native Woody Vegetation (Right)	9	Optimal	9	Optimal	0
11 Palustrine Wetland Area and Function	1	Poor	4	Poor	75
Total Score	111		152		27

Table 14. Farnsworth Gravel Pit Pre-Project Habitat Quality Assessment Scores

Habitat Quality Parameter	Pre-Project Score	Pre-Project Condition Category
1 Aquatic Habitat Barriers	18	Optimal
2 Aquatic Structure as Cover	3	Poor
3 Velocity/Depth Regimes	4	Poor
4 Flow Continuity	4	Poor
5 Channel Alteration	3	Poor
6 Channel Sinuosity	2	Poor
7 Bank Stability (Left)	7	Suboptimal
7 Bank Stability (Right)	7	Suboptimal
8 Riparian Vegetation Cover	13	Suboptimal
9 Riparian Vegetation Structural Diversity (Left)	6	Suboptimal
9 Riparian Vegetation Structural Diversity (Right)	6	Suboptimal
10 Percent Native Woody Vegetation (Left)	9	Optimal
10 Percent Native Woody Vegetation (Right)	9	Optimal
11 Palustrine Wetland Area and Function	3	Poor
Total Score	94	

Table 15. Paonia Sewer Crossing Pre-Project and Post-Project Habitat Quality Assessment Scores

Habitat Quality Parameter	Pre-Project Score	Pre-Project Condition Category	Post-Project Score	Post-Project Condition Category	Percent Change
1 Aquatic Habitat Barriers	18	Optimal	16	Optimal	-13
2 Aquatic Structure as Cover	12	Suboptimal	18	Optimal	33
3 Velocity/Depth Regimes	14	Suboptimal	18	Optimal	22
4 Flow Continuity	8	Marginal	8	Marginal	0
5 Channel Alteration	13	Suboptimal	13	Suboptimal	0
6 Channel Sinuosity	3	Poor	3	Poor	0
7 Bank Stability (Left)	8	Suboptimal	9	Optimal	11
7 Bank Stability (Right)	8	Suboptimal	9	Optimal	11
8 Riparian Vegetation Cover	14	Suboptimal	14	Suboptimal	0
9 Riparian Vegetation Structural Diversity (Left)	6	Suboptimal	6	Suboptimal	0
9 Riparian Vegetation Structural Diversity (Right)	9	Optimal	9	Optimal	0
10 Percent Native Woody Vegetation (Left)	9	Optimal	9	Optimal	0
10 Percent Native Woody Vegetation (Right)	9	Optimal	9	Optimal	0
11 Palustrine Wetland Area and Function	1	Poor	5	Poor	80
Total Score	132		146		10

Table 16. Paonia River Park Pre-Project and Post-Project Habitat Quality Assessment Scores

Habitat Quality Parameter	Pre-Project Score	Pre-Project Condition Category	Post-Project Score	Post-Project Condition Category	Percent Change
1 Aquatic Habitat Barriers	4	Poor	18	Optimal	78
2 Aquatic Structure as Cover	15	Suboptimal	18	Optimal	17
3 Velocity/Depth Regimes	12	Suboptimal	18	Optimal	33
4 Flow Continuity	3	Poor	8	Marginal	63
5 Channel Alteration	6	Marginal	18	Optimal	67
6 Channel Sinuosity	3	Poor	15	Suboptimal	80
7 Bank Stability (Left)	3	Marginal	9	Optimal	67
7 Bank Stability (Right)	3	Marginal	9	Optimal	67
8 Riparian Vegetation Cover	7	Marginal	17	Optimal	59
9 Riparian Vegetation Structural Diversity (Left)	5	Marginal	10	Optimal	50
9 Riparian Vegetation Structural Diversity (Right)	8	Suboptimal	10	Optimal	20
10 Percent Native Woody Vegetation (Left)	10	Optimal	10	Optimal	0
10 Percent Native Woody Vegetation (Right)	10	Optimal	10	Optimal	0
11 Palustrine Wetland Area and Function	8	Marginal	19	Optimal	58
Total Score	97		189		49

Table 17. Paonia Ditch Pre-Project and Post-Project Habitat Quality Assessment Scores

Habitat Quality Parameter	Pre-Project Score	Pre-Project Condition Category	Post-Project Score	Post-Project Condition Category	Percent Change
1 Aquatic Habitat Barriers	1	Poor	1	Poor	0
2 Aquatic Structure as Cover	4	Poor	8	Marginal	50
3 Velocity/Depth Regimes	8	Marginal	8	Marginal	0
4 Flow Continuity	1	Poor	1	Poor	0
5 Channel Alteration	2	Poor	3	Poor	33
6 Channel Sinuosity	6	Marginal	6	Marginal	0
7 Bank Stability (Left)	5	Marginal	9	Optimal	44
7 Bank Stability (Right)	8	Suboptimal	7	Suboptimal	-14
8 Riparian Vegetation Cover	12	Suboptimal	15	Suboptimal	20
9 Riparian Vegetation Structural Diversity (Left)	8	Suboptimal	9	Optimal	11
9 Riparian Vegetation Structural Diversity (Right)	5	Marginal	9	Optimal	44
10 Percent Native Woody Vegetation (Left)	9	Optimal	9	Optimal	0
10 Percent Native Woody Vegetation (Right)	8	Suboptimal	8	Suboptimal	0
11 Palustrine Wetland Area and Function	1	Poor	5	Poor	80
Total Score	78		98		20

Table 18. Feldman Ditch Pre-Project and Post-Project Habitat Quality Assessment Scores

Habitat Quality Parameter	Pre-Project Score	Pre-Project Condition Category	Post-Project Score	Post-Project Condition Category	Percent Change
1 Aquatic Habitat Barriers	10	Marginal	11	Suboptimal	9
2 Aquatic Structure as Cover	9	Marginal	11	Suboptimal	18
3 Velocity/Depth Regimes	16	Optimal	16	Optimal	0
4 Flow Continuity	13	Suboptimal	13	Suboptimal	0
5 Channel Alteration	12	Suboptimal	14	Suboptimal	14
6 Channel Sinuosity	6	Marginal	6	Marginal	0
7 Bank Stability (Left)	6	Suboptimal	6	Suboptimal	0
7 Bank Stability (Right)	9	Optimal	9	Optimal	0
8 Riparian Vegetation Cover	13	Suboptimal	13	Suboptimal	0
9 Riparian Vegetation Structural Diversity (Left)	7	Suboptimal	7	Suboptimal	0
9 Riparian Vegetation Structural Diversity (Right)	9	Optimal	9	Optimal	0
10 Percent Native Woody Vegetation (Left)	9	Optimal	9	Optimal	0
10 Percent Native Woody Vegetation (Right)	9	Optimal	9	Optimal	0
11 Palustrine Wetland Area and Function	5	Poor	6	Marginal	17
Total Score	133		139		4

Table 19. Farmers Ditch and Stewart Ditch Pre-Project Habitat Quality Assessment Scores

Habitat Quality Parameter	Farmers Ditch Pre-Project Score	Farmers Ditch Pre-Project Condition Category	Stewart Ditch Pre-Project Score	Stewart Ditch Pre-Project Condition Category
1 Aquatic Habitat Barriers	3	Poor	3	Poor
2 Aquatic Structure as Cover	12	Suboptimal	8	Marginal
3 Velocity/Depth Regimes	10	Marginal	10	Marginal
4 Flow Continuity	2	Poor	3	Poor
5 Channel Alteration	5	Poor	7	Marginal
6 Channel Sinuosity	2	Poor	5	Poor
7 Bank Stability (Left)	9	Optimal	5	Marginal
7 Bank Stability (Right)	9	Optimal	4	Marginal
8 Riparian Vegetation Cover	18	Optimal	14	Suboptimal
9 Riparian Vegetation Structural Diversity (Left)	8	Suboptimal	9	Optimal
9 Riparian Vegetation Structural Diversity (Right)	8	Suboptimal	9	Optimal
10 Percent Native Woody Vegetation (Left)	10	Optimal	10	Optimal
10 Percent Native Woody Vegetation (Right)	10	Optimal	9	Optimal
11 Palustrine Wetland Area and Function	2	Poor	3	Poor
Total Score	108		99	

FIGURE

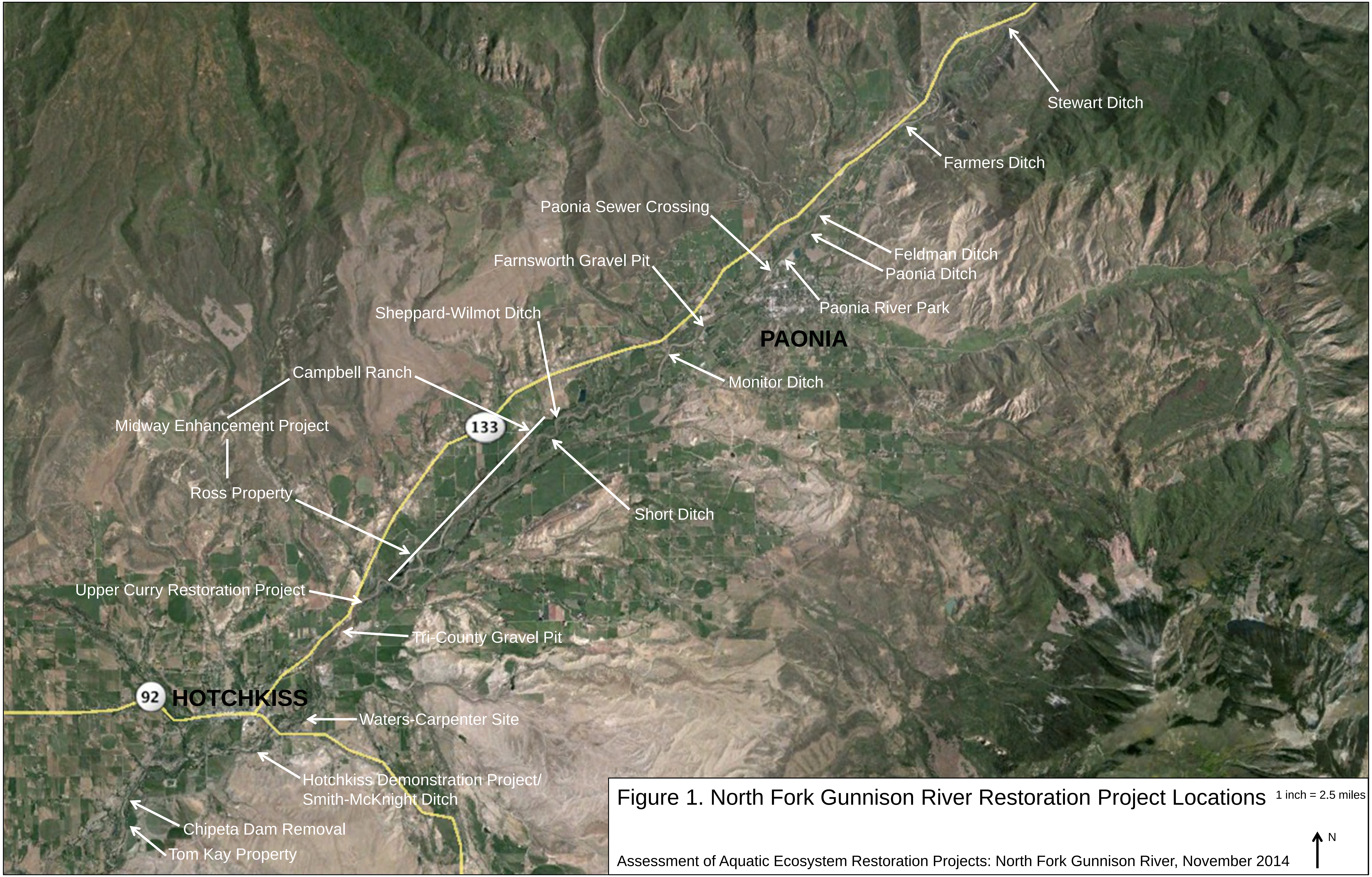

Figure 1. North Fork Gunnison River Restoration Project Locations

Assessment of Aquatic Ecosystem Restoration Projects: North Fork Gunnison River, November 2014

APPENDIX A

SITE HABITAT QUALITY ASSESSMENT FIELD WORKSHEET

NORTH FORK GUNNISON RIVER

SITE HABITAT QUALITY EVALUATION FORM

Site #: ___________________________
Date: ___________________________
Time: ___________________________
Observer: ___________________________

Weather Conditions:
River Flow Notes (e.g., volume, turbidity, recent precip, human-caused flow alterations):
____
____

PARAMETER	CONDITION CATEGORY			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Aquatic Habitat Barriers and Sinks	Physical barriers do not exist, or minimally inhibit movement of aquatic animals. Diversion structures are absent or mostly prevent aquatic animal movement into ditches.	Physical barriers exist but prevention of aquatic animal movement is limited to brief seasons or to only large fish. Diversion structures partially prevent movement of aquatic animals into ditches.	Physical barriers exist that inhibit movement of aquatic animals during substantial time periods, or inhibit movement of a range of fish size classes.	Substantial physical barriers exist that mostly or entirely prevent movement of aquatic animals. Diversion structures allow and encourage movement of aquatic animals into ditches.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

PARAMETER	CONDITION CATEGORY			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
2. Aquatic Structure as Cover	Greater than 50% of substrate provides fish cover, mix of snags, submerged logs, undercut banks, in-stream rocks larger than cobbles; structures are stable (remain at least 5 yrs).	25-50% mix of stable habitat; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-25% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed, removed, or absent.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

PARAMETER	CONDITION CATEGORY			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
3. Velocity/Depth Regimes	All 4 velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). [Slow is <0.3 m/s, deep is >0.5 m).]	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by one velocity/depth regime (usually slow-deep).
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

PARAMETER	CONDITION CATEGORY			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
4. Flow Continuity	Channel is not dewatered during any season and water covers riffle substrate throughout the year.	Channel is dewatered or shallowed for less than 100 feet of reach; riffle substrates are partially exposed dring some portion of the year.	Channel is dewatered for 100 to 500 feet of reach; water tends to form pools and riffle substrates are mostly exposed for some part of the year.	Channel is dewatered for greater than 500 feet of reach; very little to no water in channel, not even as standing pools.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

Site #: ______________________

PARAMETER	CONDITION CATEGORY			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
5. Channel Alteration	Channelization absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization (i.e., dredging, greater than past 20 years) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of stream reach channelized and disrupted. In-stream habitat greatly altered or removed entirely.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

PARAMETER	CONDITION CATEGORY			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
6. Channel Sinuosity	Channel/valley ratio 1.4 to 1.6 or more, high sinuosity, natural pattern.	Channel/valley ratio 1.4 to 1.26, moderate sinuosity, fairly natural pattern.	Channel/valley ratio 1.25 to 1.11, slight sinuosity, moderately altered pattern.	Channel/valley ratio 1 to 1.1, channel straight; waterway has been straightened for a long distance.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

PARAMETER	CONDITION CATEGORY			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
7. Bank Stability (score each bank, left bank is on left facing downstream)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. Less than 5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5 to 30% of bank in reach has areas of erosion.	Moderately unstable; 30 to 60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60 to 100% of bank has erosional scars.
SCORE (LEFT BANK):	10 9	8 7 6	5 4 3	2 1 0
SCORE (RIGHT BANK):	10 9	8 7 6	5 4 3	2 1 0

PARAMETER	CONDITION CATEGORY			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
8. Riparian Vegetation Cover; Percentage Riverine Unconsolidated Shore (R3US) and Disturbance	Less than 20% of reach (excluding upland areas) is comprised of Unconsolidated Shore or gravel bars; disruption by grazing, cutting, or human activities minimal or absent; almost all plants allowed to grow naturally.	20 to 35% of reach (excluding upland areas) is comprised of Unconsolidated Shore or gravel bars; disruption by grazing or cutting may be evident but not seriously affecting riparian vegetation structure.	36 to 50% of reach (excluding upland areas) is comprised of Unconsolidated Shore or gravel bars; disruption by grazing or cutting may be evident and seriously affecting riparian vegetation structure.	More than 50% of reach (excluding upland areas) is comprised of Unconsolidated Shore or gravel bars; disruption by grazing or cutting may be present and severely affecting riparian vegetation structure.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

Site #: ______________________

PARAMETER	CONDITION CATEGORY			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
9. Riparian Vegetation Structural Diversity (score each bank)	Riparian vegetation from stream bank to project area boundary has even mix of mature trees (>10m tall), young trees (seedlings to 10m tall), shrubs, and herbaceous vegetation or wetland emergents.	Riparian vegetation from stream bank to project area boundary is mostly lacking one of the 4 structural classes (rank higher if the other 3 classes are well represented, lower if one or more is partially lacking).	Riparian vegetation from stream bank to project area boundary is mostly lacking 2 of the 4 structural classes (rank higher if the other 2 classes are well represented, lower if one is partially lacking).	Riparian vegetation from stream bank to project area boundary is mostly or entirely composed of one of the 4 structural classes.
SCORE (LEFT BANK):	10 9	8 7 6	5 4 3	2 1 0
SCORE (RIGHT BANK):	10 9	8 7 6	5 4 3	2 1 0

PARAMETER	CONDITION CATEGORY			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
10. Percent Native Woody Vegetation (score each bank)	Riparian woody vegetation (trees and shrubs) from streambank to project area boundary is >90% native species; exotic species are absent or scattered, rarely or never dominant.	Riparian woody vegetation from streambank to project area boundary is 60 to 90% native species; exotic species are scattered, infrequently dominant.	Riparian woody vegetation from streambank to project area boundary is 30 to 60% native species; exotic species are distributed thoughout and sometimes dominant.	Riparian woody vegetation from streambank to project area boundary is <30% native species; exotic species are widely distributed thoughout and frequently or entirely dominant.
SCORE (LEFT BANK):	10 9	8 7 6	5 4 3	2 1 0
SCORE (RIGHT BANK):	10 9	8 7 6	5 4 3	2 1 0

PARAMETER	CONDITION CATEGORY			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
11. Palustrine Wetland Area and Function	10% or more of riparian area contains backwaters, sloughs, or beaver ponds; most of these support dense, tall (>1m) emergent wetland vegetation; 1 or more wetlands are at least 3 acres in size.	5 to 10% of riparian area contains backwaters, sloughs, or beaver ponds; some but not most support dense, tall emergent wetland vegetation; 1 or more wetlands are at least 2 acres in size.	<5% of riparian area contains backwaters, sloughs, or beaver ponds; some support dense, tall emergent wetland vegetation; 1 or more wetlands are at least 1 acre in size.	<5% of riparian area contains backwaters, sloughs, or beaver ponds; few support dense, tall emergent wetland vegetation; wetlands are <1 acre in size.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

APPENDIX B

PHOTO LOG

Photo 1. Aerial Photograph of Tom Kay property, 1997

Photo 2. Landscape Photograph of Tom Kay property, 2014

Photo 3. Chipeta Dam Prior to Removal, 2006

Photo 4. Chipeta Dam Removal, 2006

Photo 5. Aerial View of Chipeta Dam Site Following Removal, 2006

Photo 6. Chipeta Dam Site, 2014

Photo 7. Hotchkiss Demonstration Site, Cedar Drive Bridge Looking Downstream, 1980

Photo 8. Hotchkiss Demonstration Site, Cedar Drive Bridge Looking Downstream, 2014

Photo 9. Hotchkiss Demonstration Site, Cedar Drive Bridge Looking Upstream, 2014

Photo 10. Hotchkiss Demonstration Site, Highway 92 Bridge Looking Downstream, 2014

Photo 11. Hotchkiss Demonstration Site, 1999

Photo 12. Hotchkiss Demonstration Site, 2014

Photo 13. Smith-McKnight Ditch Immediately Following Construction, 2000

Photo 14. Smith-McKnight Ditch, 2014

Photo 15. Waters-Carpenter Site, 2014

Photo 16. Tri-County Gravel Pit, 2014

Photo 17. Tri-County Gravel Pit, 2014

Photo 18. Tri-County Gravel Pit, 2014

Photo 19. Tri-County Gravel Pit Blowout, 2005

Photo 20. Tri-County Gravel Pit Blowout Location, 2014

Photo 21. Tri-County Gravel Pit Site, The Ledges, 2014

Photo 22. Upper Curry Restoration Site, 2014

Photo 23. Midway Project: Ross Property Rock Vane, 2014

Photo 24. Midway Project: Ross Property Historical Avulsion Site, 2014

Photo 25. Midway Project: Ross Property, Upstream End, 2014

Photo 26. Midway Project: Campbell Ranch, 2014

Photo 27. Midway Project: Campbell Ranch, 2014

Photo 28. 2010 Midway Bank Stabilization Project, 2012

Photo 29. 2010 Midway Bank Stabilization Project, 2014

Photo 30. Short Ditch Prior to Construction

Photo 31. Short Ditch, 2014

Photo 32. Sheppard-Wilmot Ditch, 2014

Photo 33. Aerial Photograph of the Monitor Diversion Site Prior to Ditch Construction

Photo 34. Bank on Monitor Ditch Site Prior to Construction

Photo 35. Bank on Monitor Ditch Site, 2014

Photo 36. Monitor Ditch Diversion and Left Bank Vegetation, 2014

Photo 37. Farnsworth In-Stream Gravel Pit, 2014

Photo 38. Wide Shallow Channel at Farnsworth Construction and Gravel, 2014

Photo 39. Paonia Sewer Crossing “W” Weir, 2014

Photo 40. Paonia River Park Site Prior to Construction

Photo 41. Paonia River Park Pre- and Post-Construction Photo Points

Photo 42. Paonia River Park Post-Construction


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Photo 43. Paonia Ditch, 2014

Photo 44. Feldman Ditch, 2014

Photo 45. Farmer’s Ditch, 2014

Photo 46. Stewart Ditch Diversion Headgate, 2014

Photo 47. Stewart Ditch Diversion, 2014

Photo 48. North Fork Main Channel Upstream of Stewart Ditch Diversion, 2014