Final
State Wetlands/Riparian Areas Plan


1999 Streamside Tailings Consent Decree
Habitat Creation and Enhancement Obligations
Upper Clark Fork River Basin
Wetlands and Riparian Areas

APRIL 2019

Montana Department of Justice
Natural Resource Damage Program

Contents

1. INTRODUCTION

Paragraph 22 of the 1999 Streamside Tailings Consent Decree (SST CD) requires the State to develop, in consultation with U.S. Fish and Wildlife Service (USFWS), the State Wetlands/Riparian Areas Plan. Paragraph 22 requires the State to create in the Upper Clark Fork River Basin (UCFRB) up to 400 acres of any combination of the following: newly constructed wetlands or restoration of destroyed wetlands, enhancement of existing wetlands, or enhancement of riparian areas on or along the Clark Fork River or its tributaries. In fulfilling the requirements of Paragraph 22, the State is not required to incur more than $3.2 million in wetlands/riparian areas restoration costs, as that term is defined in the SST CD.

In accordance with the SST CD, upon concurrence of this State Wetlands/Riparian Areas Plan by the USFWS Regional Director, and after reasonable opportunity for review and comment by the public, including the Tribes and ARCO, the State, through the Natural Resource Damage Program (NRDP), will implement the State Wetlands/Riparian Areas Plan, in accordance with the schedules and requirements of the plan.

To meet the requirements of the SST CD, as well as to protect and enhance fish and wildlife resources within the UCFRB, NRDP proposes to perform the following wetlands/riparian areas actions:

Wetlands/riparian areas restoration, creation, protection, and enhancement projects will be implemented on State-owned land within the Milltown area. The predominant tasks include maintaining and protecting wetland/riparian area vegetation through invasive species control, additional plantings, streambank maintenance, and soil treatment. Control of these invasive species will continue to promote the development of high-quality wetlands/riparian areas. The majority of the wetlands/riparian areas funding would be expended here. Under Paragraph 22 of the SST CD, the State will not receive credit for any acres created, restored, or enhanced as mitigation for the net loss of functional wetlands resulting from the implementation of response actions at any of the Clark Fork NPL Sites.

Riparian habitat protection and enhancement projects will be implemented within the Spotted Dog Wildlife Management Area on Spotted Dog Creek and Trout Creek. These include riparian fencing, weed control, beaver mimicry, streambank and channel restoration to enhance floodplain connectivity.

All work is expected to occur within the next ten years, and on State property, thereby adding to the State's ability to protect and maintain restoration efforts in future years. Those State properties (the Milltown area, and Spotted Dog Creek and Trout Creek in the Spotted Dog Wildlife Management Area), are owned by the State of Montana, and managed by Montana Department of Fish, Wildlife and Parks (FWP). The Milltown area is included within the Milltown State Park. Under Montana law, ARM 12.8.102, the management of state parks "will be directed toward retention of state parks in as near a natural condition as possible, without impairment of ecological features and values."

Spotted Dog Creek and Trout Creek are within a wildlife management area. There are weed free feed requirements in wildlife management areas, and activities such as removal of natural resources are prohibited. Though State expenditures are not required beyond the $3.2 million, the State expects in both instances that the properties will be protected in perpetuity by way of these State ownerships. In accordance with the SST CD, the State will allow the USFWS access to these sites for the purpose of monitoring State implementation of the State Wetlands/Riparian Areas Plan.

1.1 Site Descriptions

Milltown

The State-owned Milltown property is located near Milltown, Montana approximately four miles east of Missoula, Montana (Figure 1). The State of Montana owns approximately 450 acres at this site upstream of the former Milltown Dam. This site underwent an integrated remediation/restoration action in accordance with the 2005 Milltown Reservoir Sediments OU Consent Decree. Remediation and restoration actions included removal of Milltown Dam along with some of the contaminated sediments that had accumulated behind the dam, and construction of a new Clark Fork River channel and floodplain through the site. The Milltown property is currently managed by FWP. The property was recently transferred to FWP for the development and operation of the Milltown State Park. The NRDP will maintain certain restoration monitoring and maintenance responsibilities associated with the restoration actions that took place at the site. The Milltown Reservoir Sediments CD states, the 2005 Milltown Reservoir the "net loss" of functional wetlands that is calculated in the manner set forth in Section 4.0 of Attachment 4 to the SOW shall be accounted for basinwide, taking into consideration wetlands Atlantic Richfield has or will create, restore or enhance through performance of response actions in the UCFR Basin.

The NRDP led restoration actions at the site through implementation of the Milltown Conceptual Restoration Plan for the Clark Fork and Blackfoot Rivers near the Milltown Dam (NRDP, 2005). The main goal of the Milltown Conceptual Restoration Plan was to develop a site that was naturally functioning and self-maintaining. To meet this goal, the floodplain was designed to be hydrologically connected to the river to promote natural processes needed for riparian and wetland development. These processes include deposition of sediment and seeds during high water events, recharge of nutrients and food web support, and creation of diverse temporal and spatial habitats in the floodplain. The Milltown Conceptual Restoration Plan included the construction of a new Clark Fork River channel, with a bankfull floodplain that includes wetlands and swales, off-channel wetlands and swales, and floodplain terraces. The entire site was revegetated with plant species appropriate for the various floodplain elevations associated with the surface water elevation of the river. NRDP developed the *State Restoration Monitoring and Maintenance Plan for the Milltown site) (Draft)* (Milltown M&M Plan) *(*NRDP 2008*)* to measure the success of the Milltown restoration and to guide maintenance actions to ensure the goals of the restoration plan are met.

Spotted Dog Wildlife Management Area

Spotted Dog Creek and Trout Creek are located within the Spotted Dog Wildlife Management Area (WMA) that is east of Garrison, Montana and north of Deer Lodge, Montana between Highway 12 and Interstate 90. The Spotted Dog WMA is over 27,000 acres in size and contains extensive native grasslands and rolling foothills defined with springs, gulches and creeks. Riparian areas within the WMA include 4 ½ miles of Spotted Dog Creek and 4 miles of Trout Creek. A recent riparian assessment of the 4 ½ miles of Spotted Dog Creek noted areas of high quality riparian habitat that should be protected as well as areas that needed to be enhanced and restored. Some areas of Spotted Dog Creek within the WMA are entrenched and disconnected from the floodplain. This is a result of reduced beaver activity and historic grazing of the riparian area. Trout Creek also has high quality riparian areas that should be protected as well as areas that needed to be enhanced and restored. Similar to Spotted Dog Creek some areas of Trout Creek are also entrenched and disconnected from the floodplain. Riparian and wetland restoration actions on Spotted Dog Creek and Trout Creek within the WMA would be coordinated with similar riparian and wetland restoration work being implemented by NRDP on adjacent reaches of Spotted Dog Creek and the Little Blackfoot River outside the WMA as well as management actions being implemented in the WMA by FWP.

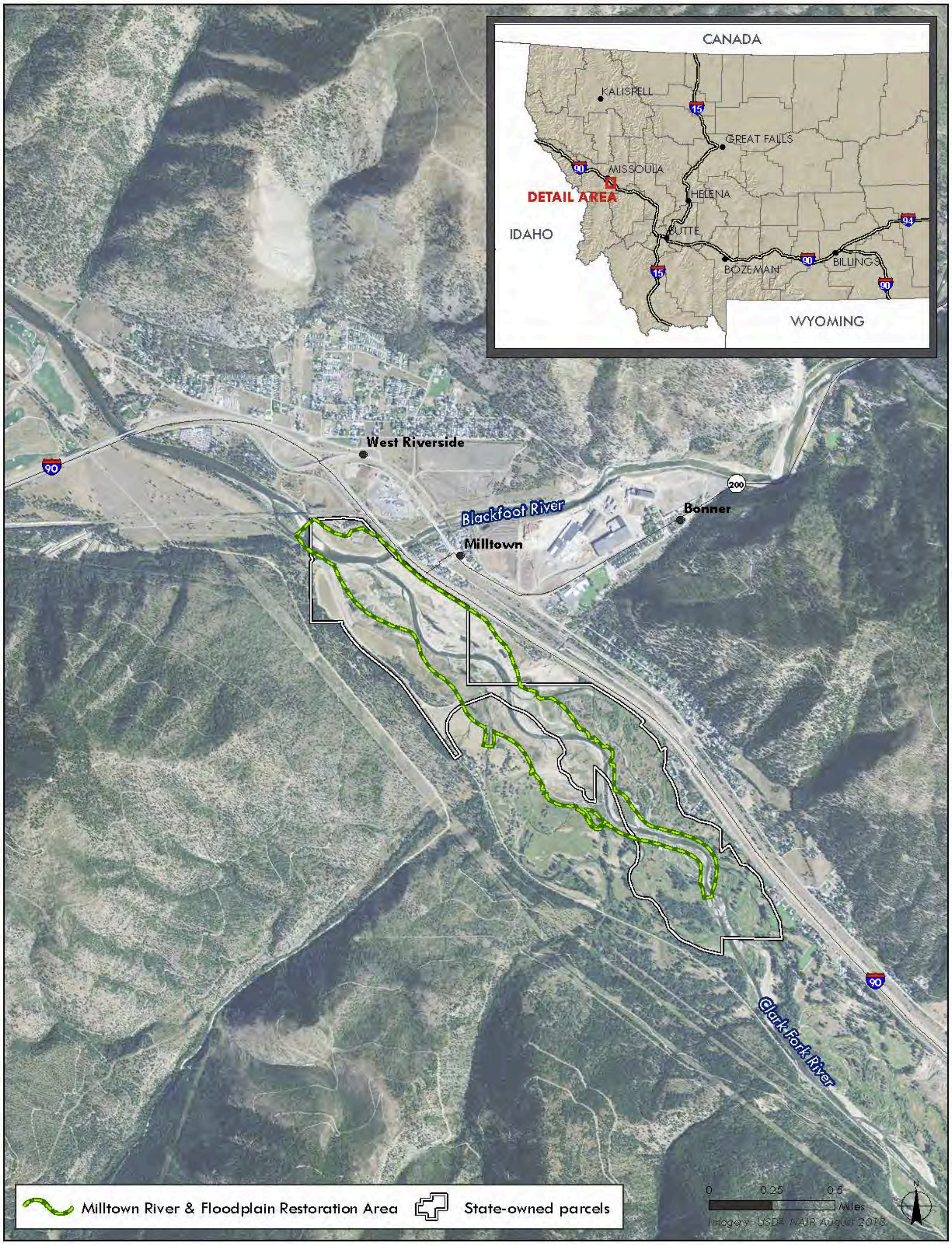


Figure 1. Vicinity map of Milltown Dam site.

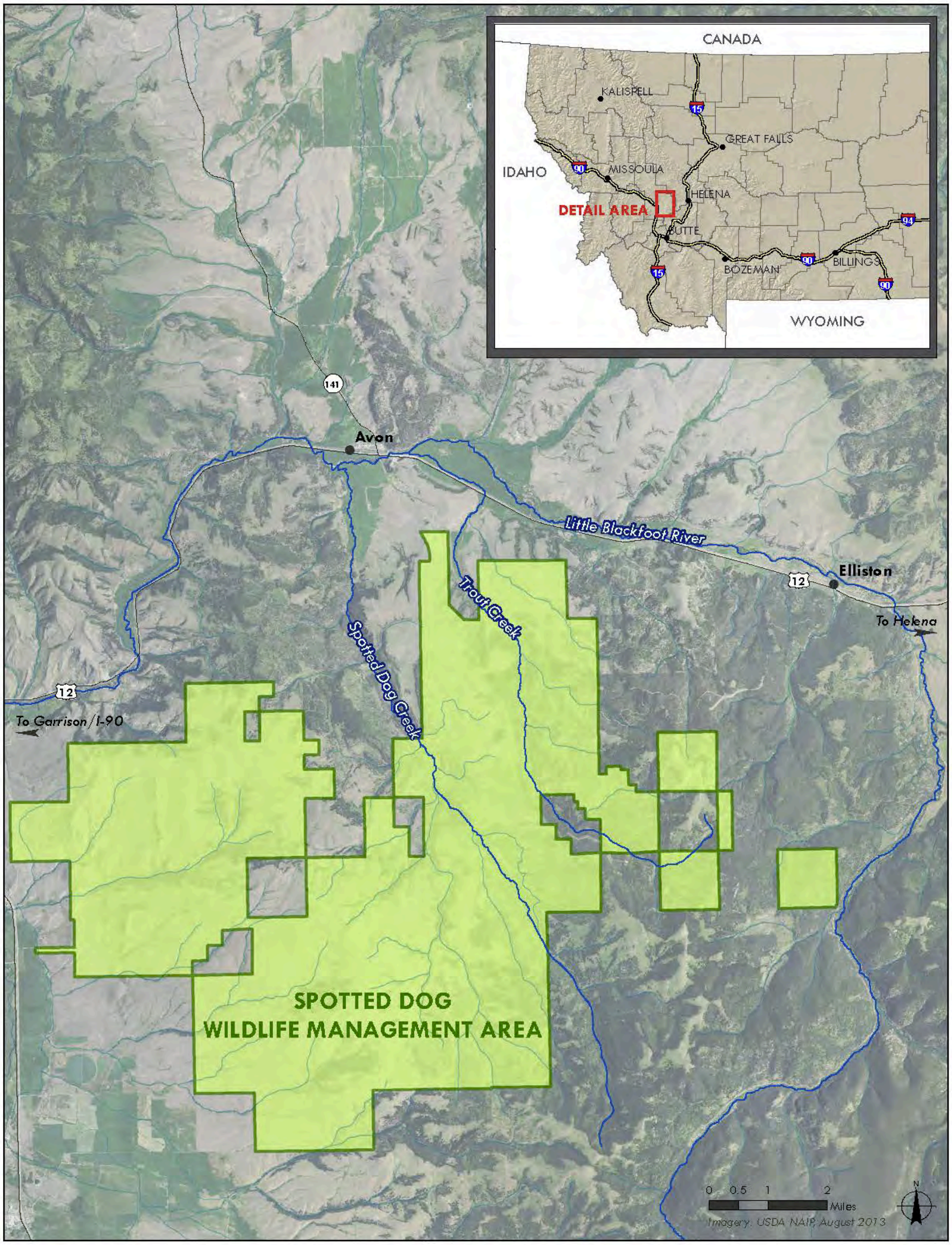


Figure 2. Vicinity map of Spotted Dog Wildlife Management Area.

1.2 Wetlands/Riparian Areas Actions

The Milltown Floodplain and Restoration Area and Spotted Dog WMA are proposed due to existing wetland/riparian values as well as the potential wetland/riparian values of each site. At the Milltown site, wetland and riparian areas are developing throughout the recently constructed floodplain and adjacent protected areas following completion of restoration and remedial actions. To protect and enhance these developing areas, control of noxious weeds and other invasive species, and enhancement of vegetation will be implemented to help ensure success of these areas. At the Spotted Dog Creek and Trout Creek sites located within the Spotted Dog WMA, restoration actions such as wetland and riparian fencing, supplemental planting, invasive weed control, beaver mimicry, and channel and stream restoration for floodplain connectivity will be implemented to protect, enhance and create wetland and riparian areas in coordination with FWP management of this newly created WMA.

This State Wetlands/Riparian Areas Plan proposes to implement wetlands/riparian areas actions primarily through wetlands/riparian areas monitoring and management on these two State-owned properties. The main components of the State Wetlands/Riparian Areas Plan are:

- For the Milltown site, the *State Restoration Monitoring and Maintenance Plan (for the Milltown site) (Draft)* (Milltown M&M Plan) (NRDP 2008) (Attachment A).

- For the Spotted Dog Creek site, the *Spotted Dog Reach SD-01b and SD-01c Restoration Concept* (Spotted Dog Conceptual Restoration Plan) (NRDP 2014a) (Attachment B), which sets forth the restoration actions to occur at the site, and the *Upper Clark Fork River Basin Aquatic Resources Restoration Plan Monitoring and Maintenance Plan* (UCFRB M&M Plan) (NRDP 2014c) (Attachment C), which sets forth the restoration monitoring and maintenance framework for the site. For the Trout Creek site a conceptual restoration plan will be developed and the *Upper Clark Fork River Basin Aquatic Resources Restoration Plan Monitoring and Maintenance Plan* (UCFRB M&M Plan) (NRDP 2014c) (Attachment C), which sets forth the restoration monitoring and maintenance framework for the site.

Key restoration strategies for both sites include: vegetation management such as the control of noxious weeds and invasive species and protection of planted and establishing vegetation; reduction of soil erosion; restoration and enhancement activities that improve ecological diversity and function, and expand riparian and wetland areas; limiting livestock grazing in riparian and wetland areas; and creating and/or maintaining public access and recreational opportunities. These strategies are described in Sections 2 and 3 below. Two restoration plans serve as foundations for the identified wetlands/riparian areas restoration. For Milltown, the actions result from the *Conceptual Restoration Plan for the Clark Fork and Blackfoot Rivers near the Milltown Dam* (Milltown Conceptual Restoration Plan) (NRDP 2005). For Spotted Dog Creek and Trout Creek, the actions result from the *Final Upper Clark Fork River Basin Aquatic and Terrestrial Resources Restoration Plans* (UCFRB Restoration Plans) (NRDP 2012).

The overall goal of this State Wetlands/Riparian Areas Plan is to implement management strategies and restoration actions that will create highly productive, diverse riparian and wetland communities that will provide high quality native fish and wildlife habitat while supporting recreational opportunities for the public. Certain UCFRB wetlands/riparian areas restoration have already been performed at the Milltown restoration project, a description of these actions is included as Attachment D.

2. RESTORATION MONITORING

2.1 Baseline Data

The post-restoration construction conditions of the Milltown restoration project were established through construction compliance surveys and a comprehensive Lidar survey. Additional surveying and monitoring per the Milltown M&M Plan as well as documentation of the effects of the 2011 high flow event have thoroughly documented the post-restoration conditions at the Milltown site. In 2015 and 2016 wetland and riparian areas surveys were conducted to estimate the Functionally Equivalent Wetland Area (FEWA) (ARCO, 1992) acreages presently located on the Milltown site. Under Paragraph 22 of the SST CD, the State will not receive credit for any acres created, restored, or enhanced as mitigation for the net loss of functional wetlands resulting from the implementation of response actions at any of the Clark Fork NPL Sites.

The baseline conditions of Spotted Dog Creek were evaluated and documented through riparian assessments using the NRCS Riparian Assessment Method (NRCS 2012 and 2004) and wetland delineations completed by Geum Environmental Consulting, Inc. for NRDP in spring 2014 and 2015. In total 24.8 acres of wetlands were mapped within the proposed project area and all 4 ½ miles of the riparian area was assessed (riparian assessment scores varied considerably along the 4 ½ miles within the proposed project area). Additional baseline condition information is provided in the Spotted Dog Conceptual Restoration Plan. For Trout Creek a baseline riparian assessment will be completed using the NRCS Riparian Assessment Method (NRCS 2012 and 2004) to document the existing condition. Upon the completion of the riparian assessment a Trout Creek Conceptual Restoration Plan will be developed, and the wetland/riparian acres calculated.

2.2 Ongoing Monitoring Efforts

To monitor the status of the wetland and riparian areas at the Milltown site the Milltown M&M Plan describes specific methods for monitoring vegetation and physical habitat (channel and floodplain). Per the Milltown M&M Plan, years 10 (2021) and 15 (2026) post-restoration completion monitoring of the wetlands and riparian areas will occur. For consistency the FEWA assessment will be used to assess the Milltown site. If another assessment process is determined to be a better measure of these areas at the time of the future surveys the NRDP will provide an update to this plan proposing a different method.

The UCFRB M&M Plan will be used for Spotted Dog Creek and Trout Creek, with a site-specific monitoring plan for each site to be developed after initial restoration actions have been implemented. Following restoration action implementation, post-restoration construction conditions will be documented through survey to determine riparian condition uplift. The riparian condition of Spotted Dog Creek and Trout Creek will be assessed and scored using the NRCS Riparian Assessment Method (NRCS 2012 and 2004). The NRCS Riparian Assessment Method provides a raw total score for existing riparian area condition and raw score for the realistic potential for a given site. When the raw score for existing condition is divided by the sites raw score for its potential condition and multiplied by 100 a percentage is given. A riparian score percentage of 80=100% is considered sustainable, a score of 50-80% at-risk, and less than 50% unsustainable. The monitoring periods will be established in the site-specific monitoring plans, but are anticipated to be years 2, 5 and 7 post-implementation of the restoration action. If another assessment process is determined to be a better measure of these areas at the time of the future surveys the NRDP will provide an update to this plan proposing a different method. A NRCS riparian score of 80% or above is a riparian area that is considered sustainable under existing conditions and would be comparable habitat to a restored wetland.

2.3 Vegetation and Physical Habitat

The NRDP has completed the 2009 (year 1) and 2011 (year 3) monitoring activities at the Milltown site as described in the Milltown M&M Plan. This plan includes monitoring channel morphology and floodplain vegetation development. Because of the multi-year construction schedule, additional monitoring was completed in 2010, 2012, and 2013 in order to monitor year 1 and year 3 post-construction in all areas of the site. These monitoring results are described in the monitoring and maintenance reports prepared for years 1 and 3 (NRDP 2011, NRDP 2012b, NRDP 2013, and NRDP 2014d). Monitoring of riparian conditions will continue per the Milltown M&M Plan to track the progress of the site, provide guidance for management and maintenance actions, and demonstrate to the Trustees whether or not the site is trending toward the intended goals. In addition, surveys are completed annually or bi-annually to document the presence and location of noxious weeds and other invasive species. The monitoring process includes the use of contractors, including University of Montana staff, to help collect data and monitor the progress of the site.

The UCFRB M&M Plan sets forth the framework for monitoring the riparian conditions of Spotted Dog Creek and Trout Creek to track the progress of the sites, provide guidance for management and maintenance actions, and demonstrate to the Trustees whether or not the sites are trending toward the intended goals. In addition, surveys will be completed annually or bi-annually to document the presence and location of noxious weeds and other invasive species. The monitoring process includes the use of contractors, including University of Montana staff, to help collect data and monitor the progress of the site.

2.4 Fish and Wildlife Populations

NRDP funded baseline bird surveys at the Milltown and Spotted Dog WMA sites in 2013 as part of implementing the UCFRB Restoration Plans. To measure wetland and riparian area development at each site, NRDP proposes to continue these bird surveys. Monitoring of fish and wildlife populations at the Milltown site and Spotted Dog WMA remains the responsibility of FWP. The FWP monitors the fish populations within the Clark Fork River and Spotted Dog Creek. These fish population surveys are integrated with the UCFRB M&M Plan.

2.5 Public Use

Access monitoring will be determined through FWP management plans for the Milltown State Park and Spotted Dog WMA. Access monitoring may consist of monitoring designated trailheads or access points and monitoring the existing perimeter fence, and any future fences.

3. MANAGEMENT ACTIONS

For both sites, restoration management activities for wetland, floodplain, and riparian areas are set forth in the respective monitoring and maintenance plans and will be implemented to address deficiencies found during restoration monitoring. Restoration management activities for Spotted Dog Creek also include the primary restoration actions set forth in the Spotted Dog Conceptual Restoration Plan. Management actions at both the Milltown site, the Spotted Dog Creek site, and the Trout Creek site will rely upon full evaluation of the implemented wetland, floodplain, and riparian area restoration actions. The Milltown M&M Plan includes an adaptive management framework which provides a methodology for evaluating proposed actions through use of a decision matrix to determine if the action will support achieving goals and objectives for a site. This process has proven effective at the Milltown site and ensures that all management actions be evaluated prior to implementation to ensure the actions are necessary and are needed to keep the site trending towards meeting project goals. A similar adaptive management framework will be followed for the Spotted Dog Creek and Trout Creek sites, consistent with the UCFRB M&M Plan.

3.1 Vegetation

The following vegetation management activities will be implemented at the Milltown, Spotted Dog Creek, and Trout Creek sites: control of noxious weeds and other invasive species, and supplemental revegetation as needed. Noxious weeds are managed annually at the Milltown site based on information collected during monitoring and site evaluation activities. Weed control activities are described in annual progress reports. Control of state-listed noxious weeds will continue at the Milltown site. Other invasive species that may be selected for control at the site include reed canarygrass (*Phalaris arundinacea*), Siberian elm (*Ulmus pumila*) and redtop (*Agrostis stolonifera*). Control of these species will be determined using the Milltown M&M Plan adaptive management process. Management of noxious weeds and other species will also occur at the Spotted Dog and Trout Creek sites, in accordance with the FWP management plan developed for the WMA in addition to the UCFRB M&M Plan.

Wildlife may influence developing riparian and wetland areas at both the Milltown, Spotted Dog Creek, and Trout Creek sites. Wildlife management actions such as plant cages and fenced exclosures may be needed to protect developing vegetation from browse, herbivory and damage, particularly from ungulates and beaver.

Additional vegetation management activities may occur at the Milltown site including supplemental seeding, supplemental planting, surface re-grading and addition of soil amendments.

3.2 Erosion Control

Erosion risk is associated with streambanks and floodplain surfaces. The risk of unacceptably high streambank and floodplain erosion is expected to decrease at the Milltown site as floodplain and streambank vegetation continue to mature. Natural erosion and deposition events as well as beaver activity are expected to influence the site over time and are desirable for natural channel and floodplain function. NRDP will address accelerated erosion through the Milltown M&M Plan adaptive management process to determine if management actions are required.

Accelerated erosion is also occurring along some reaches of Spotted Dog Creek and Trout Creek within the Spotted Dog WMA. Erosion will be addressed through implementation of restoration actions described in Section 1.2.

3.3 Grazing

Grazing will be prohibited at the Milltown site. Grazing occurs on private lands adjacent to the Milltown site and periodic fence maintenance may be required.

Grazing is prohibited for a minimum of 5 years after acquisition of the Spotted Dog WMA, this decision will be reviewed in 2020. Grazing is still prohibited at this time, but NRDP proposes to use fencing or other management practices to protect the riparian areas restored along Spotted Dog Creek and Trout Creek should grazing become permissible in the larger WMA.

3.4 Public Use

FWP will manage public use at both the Milltown property and Spotted Dog WMA. The Milltown site will be managed by the FWP State Parks Division as the Milltown State Park. A FWP management plan is currently being developed for the Milltown State Park, and will identify specific public access points. The river through the site is currently open to boats. Anticipated users include hunters, hikers, fisherman, birders, and general outdoor enthusiasts.

The Spotted Dog WMA is managed as a Wildlife Management Area with wildlife and wildlife conservation as its foremost concern. An FWP management plan for the newly acquired WMA is under development and will address public access points. The management area will remain as walk-in access only for public access. Anticipated users include hunters, hikers, fisherman, and general outdoor enthusiast.

Management of both areas may allow for temporary closure of trails or specific sites to protect sensitive natural resources (e.g., nesting bald eagles, developing wetland vegetation, streambanks) or for public safety (e.g. heavy equipment working at the site).

3.5 Costs

The State has already expended approximately $472,000 of the $3,200,000 funding pursuing wetlands/riparian areas restoration in other UCFRB areas. Though the State expended time and effort in the planning and development of actions in Willow Creek, Warms Springs Creek, and Dutchman wetland areas, the State's efforts to restore wetlands/ riparian areas in these areas were unsuccessful due to complicated remediation/restoration integration and liability issues and that could not be resolved to ensure successful implementation by the State. Though the planning and development did not lead to implementation, the costs incurred meet the SST CD Wetlands/Riparian Area Restoration Costs definition of funds reasonably expended to acquire, restore, protect, or enhance areas, including indirect, planning, and administrative costs.

Estimated costs associated to implement the monitoring and management actions at the Milltown site and the Spotted Dog Creek/Lost Creek Restoration, including administrative and indirect costs, are $1,714,000 and $1,000,000, respectively. For the Milltown site, only costs associated with restoration of wetlands/ riparian areas used for meeting the SST CD requirements will be included in the cost documentation. Funding used to restore wetlands as mitigation for the net loss of functional wetlands resulting from implementation of response actions at any of the Clark Fork NPL Sites will not be counted towards the $3,200,000 total.

4. REPORTING

NRDP will prepare annual reports detailing the previous year's activities by June of the following year. The reports will include locations, monitoring dates, site inspections, management efforts undertaken, and summary of changes in wetland condition and acreages as well as specific monitoring data. The annual report will provide an assessment of the success of actions taken (as defined by the respective Monitoring and Maintenance plans for both sites) as well as recommendations for additional work to achieve project goals for the upcoming year. NRDP will distribute annual reports to USFWS and FWP, along with an annual summary of expenditures. The annual reports and summary of expenditures will be provided at a minimum until the Wetlands/Riparian Areas Restoration Costs total $3.2 million, though annual reports may continue to be distributed after that time.

All Milltown scoring will use FEWA scoring as mentioned above in Section 2.2. The State will receive credit for all acreage that meets or exceeds the definition of a Restored Wetland, these wetlands have a score of 2.3 on the FEWA scale. All riparian areas will be scored using the NRCS method as mentioned above in Section 2.2. The State will receive credit for all acreage with a NRCS riparian score of 80% or above. A NRCS riparian score of 80% or above is a riparian area that is considered sustainable under existing conditions and would be comparable habitat to a restored wetland. However, regardless of scoring and credits, as noted in Section 1, the State is not required to incur more than $3.2 million in wetlands/riparian areas restoration costs, subject to the SST CD requirement that the State will not receive credit for any acres, created, restored, or enhanced as mitigation for the net loss of functional wetlands resulting from the implementation of the response actions at any of the Clark Fork NPL Sites.

5. REFERENCES

ARCO. 1992. Evaluation Form for Determining Wetland Functional Value and Effective Wetland Area in Upper Clark Fork River Superfund Sites. Report submitted to USEPA. Helena, MT

Natural Resource Damage Program (NRDP), 2014a. Spotted Dog Conceptual Restoration Recommendation. Memo prepared by Geum Environmental Consulting, Inc. and River Design Group, Inc. December, 2014.

Natural Resource Damage Program (NRDP), 2014b. Draft 2012 Upper Clark Fork River Basic Aquatic Resources Restoration Plan Monitoring and Maintenance Plan. Prepared by Geum Environmental Consulting, Inc. July, 2014.

Natural Resource Damage Program (NRDP), 2014c. Little Blackfoot Riparian Assessment. Prepared by Geum Environmental Consulting, Inc. and River Design Group, Inc. July, 2014.

Natural Resource Damage Program (NRDP), 2014d. Milltown 2013 Vegetation Monitoring Report. Prepared by University of Montana and Geum Environmental Consulting, Inc. May, 2014.

Natural Resource Damage Program (NRDP), 2013. Milltown 2012 Vegetation Monitoring Report. Prepared by University of Montana and Geum Environmental Consulting, Inc. April, 2013.

Natural Resource Damage Program (NRDP), 2012a. Final Upper Clark Fork River Basin Aquatic and Terrestrial Resource Restoration Plans. December, 2012.

Natural Resource Damage Program (NRDP), 2012b. Milltown 2011 Vegetation Monitoring Report. Prepared by Geum Environmental Consulting, Inc. July, 2012.

Natural Resource Damage Program (NDRP), 2011. Milltown 2010 Vegetation Monitoring Report. Prepared by University of Montana and Geum Environmental Consulting, Inc. May, 2011.

Natural Resource Damage Program (NRDP), 2008. State Restoration Monitoring and Maintenance Plan (Draft) (for Restoration Plan for the Clark Fork River and Blackfoot River near Milltown Dam). Prepared by Geum Environmental Consulting, Inc., River Design Group, Inc., and WestWater Consultants, Inc. March 24, 2008.

Natural Resource Damage Program (NRDP), 2005. Restoration Plan for the Clark Fork and Blackfoot Rivers near the Milltown Dam. Prepared by WestWater Consultants, Inc. (Corvallis, MT), River Design Group, Inc. (Whitefish, MT), and Geum Environmental Consulting, Inc. (Hamilton, MT). March, 2005.

USDA Natural Resources Conservation Service (NRCS). 2004. Riparian Assessment Using the NRCS Riparian Assessment Method. United States Department of Agriculture, Natural Resources Conservation Service. USDA Natural Resources Conservation Service (NRCS). 2012.

Riparian Assessment Using the NRCS Riparian Assessment Method. United States Department of Agriculture, Natural Resources Conservation Service. Environmental Technical Note No MT-2 (Rev. 1).

Appendix A State Restoration Monitoring and Maintenance Plan (for the Milltown site) (Draft) (NRDP 2008)

State Restoration Monitoring and Maintenance Plan (Draft)

Restoration Plan for the Clark Fork River and Blackfoot River near Milltown Dam

March 24, 2008

Prepared For:

State of Montana
Natural Resource Damage Program and
Montana Fish, Wildlife & Parks
In consultation with the U.S. Fish and Wildlife Service and
Confederated Salish and Kootenai Tribes

Prepared By:

Geum Environmental Consulting, Inc.
307 State Street
Hamilton, Montana 59840

River Design Group, Inc.
5098 Highway 93 South
Whitefish, Montana 59937

WestWater Consultants, Inc.
1112 Catherine Lane
Corvallis, Montana 59828

TABLE OF CONTENTS

Section 1 Introduction

This document describes the monitoring and maintenance plan for the restoration of the Clark Fork River (CFR) and Blackfoot River (BFR) near Milltown Dam. The purpose of this plan is to describe the monitoring program that will be conducted to (1) ensure compliance with the requirements applicable to the State set forth in the Milltown Site Consent Decree Remedial Design/Remedial Action Statement of Work (SOW, EPA 2004a) specifically, Attachments 1 and 2; and (2) evaluate restoration project effectiveness, determine project maintenance needs, and support a decision making framework to evaluate site response.

Monitoring is described for surface water quality, air quality, biology, river channel morphology, and floodplain vegetation.

Section 2 describes the monitoring requirements in Attachment 2 of the SOW that are applicable to the State. Section 2 also describes the monitoring of the State's compliance with the Restoration Performance Standards (RPS) which are set forth in Attachment 1 of the SOW.

Restoration Performance Criteria are described in Section 3. Restoration Performance Criteria are intended to evaluate the effectiveness of restoration actions based on the *Design Summary and Implementation Plan* (State of Montana 2008).

Monitoring goals related to the restoration of the CFR and BFR near Milltown Dam include:

- Perform required monitoring as set forth in Attachment 2 of the SOW.
- Monitor compliance with Restoration Performance Standards.
- Evaluate effectiveness and success of restoration actions.
- Determine project maintenance needs.
- Support a decision making framework where monitoring data are interpreted by a team of experts to guide project modifications and changes to the monitoring program.

This document is organized as follows:

- **Section 2** describes required SOW monitoring and the Restoration Performance Standards monitoring.
- **Section 3** describes how broader restoration-oriented goals and objectives relate to Restoration Performance Criteria that will be used to evaluate effectiveness of restoration actions.
- **Section 4** describes the integrated monitoring program and includes descriptions of baseline, construction, and effectiveness monitoring.

- **Section 5** describes a framework for making decisions about future project actions, including routine maintenance, based on data collected as part of the monitoring program.
- **Section 6** describes how monitoring data will be stored and analyzed.
- **Section 7** describes the quality assurance aspect of the monitoring and maintenance plan.
- **Appendix A** provides definitions and protocols for proposed monitoring metrics.
- **Appendix B** provides summary data from reference reaches that are the basis for some performance criteria.

The monitoring and maintenance plan includes a large number of monitoring metrics. After monitoring begins, metrics will be evaluated by the State and may be modified over time.

Section 2 Monitoring Responsibilities

2.1 Introduction

Attachment 2 of the SOW sets forth the monitoring responsibilities applicable to the State. The monitoring is required in the remedial action project area during Restoration.

For terrestrial biota monitoring, the State must monitor post-construction revegetation including woody vegetation survival and vegetation canopy cover in the floodplain to satisfy certain of the monitoring requirements set forth in the Milltown ROD, pp. 2-123, and 2-124.

For streambank, floodplain, and upland structural monitoring, the State must monitor general floodplain and streambank stability, and channel complexity in accordance with DCRP to satisfy certain of the monitoring requirements set forth in the Milltown ROD, pp. 2-123, 2-124, and monitor for erosion control in the floodplain to satisfy certain of the monitoring requirements set forth in the Milltown ROD, p. 2-124.

The State's monitoring for SOW Attachment 2 is set forth below in Table 2-1. These criteria are discussed further in Sections 3 and 4.

Table 2-1. State's Restoration Monitoring Responsibilities

Metric	Short-term	Long-term
Channel Morphology		
Channel Cross Section Area Mean depth Width:depth ratio Sinuosity Meander length Meander radius Water surface slope	Design dimensions +/- 20% (See Table B-1 in Appendix B for design dimensions)	Mean reference reach dimensions +/- coefficient of variance (See Table B-1 in Appendix B for design dimensions)
Floodplain		
Floodplain erosion (% floodplain area rills and gullies)	Less than 10% of floodplain area with rills and gullies	N/A
Percent cover herbaceous vegetation	Greater than 90% cover of herbaceous vegetation in seeded area	Greater than 90% cover of herbaceous vegetation in seeded area
Proportional abundance floodplain cover types	Floodplain vegetation cover type proportions are appropriate given time since construction (see Table B-2 in Appendix B).	Floodplain vegetation cover type proportions are appropriate given time since construction (see Table B-2 in Appendix B).

2.2 Restoration Performance Standards

This section describes the compliance monitoring requirements for the Restoration Plan (RP). The purpose of compliance monitoring is to monitor the compliance of the RPS. Attachment 1 of the SOW sets forth the performance standards applicable to the State. The RPS include:

- Surface water quality
- Air quality
- Floodplain management
- Protection of biological resources
- Protection of Native American cultural resources

Although the State will demonstrate its compliance with State Restoration Performance Standards in its Restoration Performance Standard Analysis document, the State has included the monitoring required to evaluate RPS compliance in this monitoring and maintenance plan. Some of the RPS described in Attachment 1 of the SOW were met during the design phase (such as the RPS for floodplain management). Others will require monitoring during construction. The monitoring activities that will be necessary during construction are described in the section below. Table 2-2 provides the RPS with related monitoring components.

Table 2-2. Monitoring for Restoration Performance Standards (RPS)

RPS and SOW Attachment 1 Section Reference	Additional Documents Describing Monitoring Related to Standard	Metrics or Measurements to Monitor Requirements
Temporary Surface Water Quality Standards (Section 1.2.2)	Remedial Action Monitoring Plan (Envirocon 2006)	Turbidity and Dissolved Metals
Air Quality Standards (Sections 1.3 and 3.2.1)	State's health and safety plan	Air quality monitoring (Personal and ambient air) – note: monitoring may not be required based on RA monitoring results.
Endangered Species Act (Section 2.2)	Biological Opinion (UWFWS 2004)	Monitoring as described in the Biological Opinion
Vegetation (Section 3.1)	None	Revegetation Standards set forth in Paragraph 2.2.4
Storm Water Runoff and Causing of Pollution (Sections 3.2.2 and 3.2.3)	State Restoration Plan (2007) and construction documents (pending)	BMP effectiveness monitoring during RP construction
Montana Noxious Weed Control (Section 3.2.4)	State Weed Management Plan (State 2007)	Weed mapping
Mine Reclamation Requirements (Section 3.5.1)	None	Revegetation Standards set forth in Paragraph 2.2.4 and metrics identified as RPS metrics in the 'Additional Metrics' in this plan

2.2.1 Surface Water Quality Monitoring

The RPS for surface water quality is described in Section 1.2.2 of SOW Attachment 1. During construction, surface water quality monitoring will be required. Surface water quality monitoring is intended to measure the impacts that construction activities have on surface water quality. For construction activities, monitoring is required for cadmium, copper, zinc, lead, arsenic, and iron, all dissolved, and for total suspended solids (TSS). During RA, this monitoring will be performed by the Settling Defendants at USGS sampling station downstream of the Milltown Dam location (Station 12340500). However, upon completion of RA, the State may need to measure lead and zinc as dissolved, and TSS, since at that point in time, the Settling Defendants begin to measure total recoverable only for those two metals and are no longer required to measure TSS. The monitoring at the USGS location would cease for the State upon completion of RP construction.

During RP construction, the State will also measure turbidity at Duck Bridge, although this monitoring is not for RPS compliance. The Duck Bridge monitoring ceases upon completion of RP construction.

2.2.2 Air Quality Monitoring

The RPS for air quality during RP construction is described in Sections 1.3 and 3.2.1 of SOW Attachment 1. RP air monitoring may not be required, based on RA construction activities monitoring levels. Possible RP air monitoring, if required, could include some or all of the following: personal air monitoring (arsenic, cadmium and lead), opacity readings, and ambient air monitoring for settled particulate matter, PM-10, and lead.

2.2.3 ESA Compliance

A Biological Opinion (BO) and incidental take statement were issued for the project. Monitoring will be conducted by the United States Fish and Wildlife Service (USFWS 2004). The BO covered bull trout and bald eagle. Monitoring by the State is not required.

2.2.4 Vegetation Monitoring

The RPS for vegetation is described in Sections 3.1 and 3.5.1 of SOW Attachment 1. Vegetation Monitoring in the blue and gold areas shown on Figure 1-1 of SOW Attachment 1 will be performed, until the vegetation is sufficiently established, as set forth in Table 2-1 (percent cover herbaceous vegetation and proportional abundance floodplain cover types).

2.2.5 Noxious Weeds

Noxious weed monitoring will occur in the blue and gold areas shown on Figure 1-1 of SOW Attachment 1, until the vegetation is sufficiently established, as set forth in the State Weed Management Plan (2007).

2.2.6 BMP Effectiveness Monitoring

Certain RPS elements require implementation of effectiveness monitoring of various BMPs. BMPs are described in the construction documents. Monitoring to evaluate the effectiveness of BMPs will be done throughout construction.

Section 3 Restoration Performance Criteria

3.1 Introduction

This section describes Restoration Performance Criteria that will be used to evaluate effectiveness of restoration actions and guide long-term management of the restoration project. The following definitions explain how various terms used throughout this section are related to one another:

> ***Goals*** are broad statements that reflect desired outcomes.
>
> ***Objectives*** are specific statements that re-state goals in ways that can be measured.
>
> ***Monitoring metrics*** are used to quantify the objectives. Performance criteria are presented in terms of metrics. Monitoring metrics have target ranges or values that are intended to be used to evaluate effectiveness of the restoration project. Metrics help determine whether the project is trending towards or away from project objectives and provide a way to evaluate maintenance needs.
>
> ***Performance criteria*** are target ranges or values of metrics used to evaluate the restoration project in terms of ecological functions and processes expressed as goals and objectives in the RP.

Table 3-1 summarizes restoration project goals, the ecosystem function or process necessary to achieve each goal, related objectives, and related monitoring metrics. Methods for each monitoring metric are described in Appendix A. Table 3-2 defines short-term and long-term time frames in terms of ecological function. Restoration Performance Criteria were developed for the project in terms of these time frames. Performance criteria are shown in Table 3-3 and described in more detail in Sections 3.2 and 3.3.

Table 3-1. Project Goals, Objectives and Related Monitoring Metrics

Goal	Ecosystem Function or Process	Objectives	Monitoring Metrics
1) Maintain water quality	*Channel stability* Lateral channel migration Vertical channel migration	1-1) Sediment contribution will be similar to or less than the reference condition.	- Turbidity - Metals[1]
2) Channel is appropriate for valley setting, transports sediment, and is connected to the floodplain	*River morphology* Channel morphology	2-1) Channel is stable. • Dimensions, profile and plan form will be similar to the reference condition for the particular stream type. o Short term (0-15 years): Channel migration will not compromise channel or floodplain stability. Structures are functioning o Long term (15-25+ years): Channel migration will be similar to the reference condition • For CFR, construct C stream type that transitions to B stream type at the confluence. • For BFR, construct B stream type. • For CFR downstream of confluence, construct B stream type.	-Channel dimensions • Cross section area • Width • Mean depth • Width/depth ratio • Bank erosion rate -Channel planform • Sinuosity • Channel migration • Belt width • Meander length • Radius -Channel profile • Water surface slope -Structure performance
	Sediment transport	2-2) Maintain sediment transport continuity through the restoration project area (input = output).	-Particle size distribution -Scour and fill depth (periodic)
	Floodplain morphology	2-3) The floodplain shall be active at flows greater than bankfull discharge (Q=1.5 yr to 2 yr event).	-Bank height ratio -Hydrologic connectivity
3) Provide habitat for fish and wildlife	*Diverse habitats for the proliferation of native fishes* Migration Spawning *Diverse cover types for the proliferation of wildlife*	3-1) Habitats and biological communities are similar to reference conditions.	-Monitoring will be completed by Montana Fish, Wildlife and Parks according to their protocols

Table 3-1. Project Goals, Objectives and Related Monitoring Metrics

Goal	Ecosystem Function or Process	Objectives	Monitoring Metrics
4) Provide functional wetlands and riparian plant communities. This applies primarily to sections where the floodplain is reconstructed (i.e, the BFR section and the CFR section upstream of the confluence).	*Revegetation* Riparian Succession Wetland Functionality	4-1) Wetlands are part of the floodplain mosaic as appropriate given the geomorphic setting, groundwater level, and hydroperiod. Functional scores and areas are within the designed/negotiated range.	-Wetland delineation using 1987 COE Manual -FEWA score -FEWA acres -Prevalence index -Groundwater depth
		4-2) Floodplain is stable. Cover types are distributed as in Table 3 and there are well-developed connections between patches. Ecological types (habitat types and community types) match design ranges, and canopy cover within the different layers (tree, shrub and herbaceous) match design ranges, thus ensuring erosion rates do not exceed expected rates within an alluvial floodplain. Wetlands are part of the floodplain mosaic as appropriate given the geomorphic setting, groundwater level and hydroperiod. Functional scores and areas are within the designed/negotiated range.	-Proportional abundance of floodplain vegetation cover types -Floodplain hydrologic connectivity -Erosion (rills and gullies) -Canopy cover of herbaceous vegetation -FEWA score
		4-3) Native plant communities and streambank vegetation are represented according to target cover type distribution ranges, and weeds are not compromising designed floodplain function.	-Proportional abundance of floodplain vegetation cover types -Canopy cover of different vegetation layers (trees, shrubs, herbaceous) -Canopy cover invasive species -Hydroperiod -Bioengineering • Toe scour • Canopy cover • Survival -Weed mapping -Additional metrics • Woody browse levels

Table 3-1. Project Goals, Objectives and Related Monitoring Metrics

Goal	Ecosystem Function or Process	Objectives	Monitoring Metrics
			• Woody vegetation survival by species • Species richness • Plant reproduction (Natural recruitment) • Species diversity
5) Provide visual and aesthetic values consistent with restoring the natural condition	*Biodiversity*	5-1) Short-term: Post construction—many raw, exposed soil surfaces, immature vegetation, visible signs of construction activity (0 to 5 years) and floodplain functioning but not yet mature (5 to 15 years) Long-term: Provide an environment similar to those of the reference reaches (15-25+ years)	See metrics for Goals 1-4
6) Provide safe recreational opportunities compatible with above Goals and Objectives	*Recreation* Safety Access	6-1) Provide recreational opportunities available in similar, natural river environments in the long-term. 6-2) Incorporate safety considerations in the restoration design (e.g. structure type and placement) while meeting construction risk and natural river restoration objectives.	None

[1] The State will conduct certain surface water sampling for metal concentrations if necessary upon Substantial Completion of the Remedial Action.

3.2 Performance Criteria Development

Performance criteria were chosen for their ability to signal whether desired ecological processes and functions are being achieved by restoration actions. For example, while positive fish population response is a desirable restoration outcome, fish populations at any one time may not reflect effectiveness of restoration because (1) fish are mobile and (2) factors outside of the restoration area may influence how fish use the river reach within the restoration area. On the other hand, channel dimensions (e.g. width to depth ratio) can be linked directly to design parameters. Similarly, observing changes in plant species cover and composition over time makes it possible to evaluate the project in light of the desired future condition outlined in the RP. Therefore, performance criteria include channel, floodplain and vegetation components, but do not include fish and wildlife components. Fish and wildlife are included as part of the integrated monitoring program (Section 4.0) because these components will likely be monitored by Montana Fish, Wildlife and Parks (FWP).

During the final design process, a range of values was established for performance criteria, and these ranges are listed in Table 3-3. In order to develop these ranges, several reference reaches on the CFR and BFR (Figure 3-1) were selected as study areas for measuring channel and floodplain parameters (Geomorphic Data Summary Report, State of Montana 2006). This exercise provided an empirical basis for developing monitoring metrics. Reference reaches exhibit channel and floodplain characteristics that represent the desired restoration outcome. Other criteria included relative natural stability, presence of mature, native riparian cover types, presence of diverse aquatic habitat, and proximity to the restoration project area. Data from reference reaches make it possible to relate performance of the restored system to that of a natural system.

For other components of the RP, such as riparian areas and wetlands, reference data are less useful because: (1) a newly constructed site may not have the potential to support reference plant communities for many years, and (2) a complete reference riparian condition may not exist because of land alteration. For these reasons, a regional riparian habitat type classification (Hansen et al. 1995) was used in combination with a hydrogeomorphic classification (Hauer et al. 2002) that links vegetation cover with riverine geomorphic features. Information about existing plant communities collected prior to restoration was used to define the existing condition (State of Montana 2006), and served to describe the starting point for restoration actions in areas that will not be disturbed by grading. The RP describes how these classifications and data were used to define the desired future condition for floodplain, streambanks and wetlands within the restoration area.

Table 3-2 defines short-term and long-term time frames in terms of ecological function. Table 3-3 lists performance criteria in terms of monitoring metrics, by short-term and long-term time frames.

Figure 3-1. Monitoring reaches (CFR 3A, CFR 2, CFR 1, BFR 1) and Reference Reaches (CFR 3B and Bandmann Flats)

3.3 Performance Criteria Timeframes

Because some ecological objectives may take longer to achieve than others, it is necessary to distinguish between short-term and long-term periods for values assigned to metrics that quantify performance. For example, this project's long-term desired outcome is a natural channel that is free to migrate across its floodplain. However, in order to create a stable floodplain that will ultimately allow channel migration to occur at a natural rate, the channel must remain within its designed alignment during the short-term while floodplain vegetation becomes established. Therefore, with respect to channel migration, the short-term performance criteria are set lower than long-term performance criteria in order to allow mature vegetation to become established on the floodplain. These time frames can be defined as:

1) Short-term (0 to 15 years) is the post-construction period when floodplain vegetation is immature.
2) Long-term (after 15 years) is the period when mature vegetation is present and self-sustaining on the floodplain and the channel can migrate and change at natural rates without compromising project objectives.

Table 3-2 describes the general expectations for ecological function during the short-term and long-term periods. These time frames will serve as general guidance for evaluating performance criteria. Restoration performance criteria are presented in Table 3-3.

Table 3-2. Short and Long Term Restoration Expectations

Short Term Expectations (0-15 Years)	Long Term Expectations (15+ Years)
Structures control channel form, which in turn, dictates lateral and vertical channel stability.	Vegetation dictates lateral channel stability. Channel armoring processes dictate vertical stability.
Vegetation provides stability on floodplain surface and along streambanks.	Vegetation communities are established and provide habitat and other riparian/wetland functions.
Structures are stable.	Structures decompose and become buried.
Habitat is enhanced by bank stabilization and grade control structures.	Habitat is created by bed forms and vegetation.
Bank erosion rates are low.	Bank erosion rates are low.
Natural processes are maintained.	Natural processes govern.

Table 3-3. Restoration Performance Criteria

Metric	Short-term (0-15 years)	Long-term (15+) years
Water Quality		
Turbidity	<20% increase in mass balance from Blackfoot and Clark Fork above the dam two or more years after construction	N/A
Channel		
Cross section area Width Mean depth Width:depth ratio Sinuosity Channel migration Belt width Meander length Meander radius Water surface slope Riffle stability index Bank height ratio	Design dimensions +/- 20% (See Table B-1 in Appendix B for design dimensions)	Mean reference reach dimensions +/- coefficient of variance (See Table B-1 in Appendix B for design dimensions)
Floodplain		
Hydrologic connectivity	80% of secondary channels and other connected floodplain ponds are connected to the channel at flows exceeding bankfull and not during base flow (both observation and floodplain modeling will be done using surveyed channel cross sections to verify connectivity)	60-80% of secondary channels and other connected floodplain ponds are connected to the channel at flows exceeding bankfull and not during base flow (both observation and floodplain modeling will be done using surveyed channel cross sections to verify connectivity)
Prevalence index	Trend towards desired condition	Trend towards desired condition
Proportional abundance floodplain cover types	Floodplain vegetation cover type proportions are appropriate given time since construction (see Table B-2 in Appendix B).	Floodplain vegetation cover type proportions are appropriate given time since construction (see Table B-2 in Appendix B).
Invasive species (% cover)	Less than 10%	Less than 10%
Bioengineering		
Toe Scour	Less than 5%	Less than 15%
Percent cover woody plants	Greater than 70%	Greater than 80%
Percent survival woody plants	Greater than 50%	N/A
Additional Metrics		
Woody browse	No more than browse of one year's growth on >50% of plants within a monitoring plot	Browse is not limiting function of riparian shrubs and trees
Woody vegetation survival by species	Greater than 80%	N/A
Species richness	Not trending toward monocultures of invasive species and meets weed criteria	Each cover type is represented by an appropriate range of native species with non-natives <20% and meets weed criteria.
Plant reproduction/ Natural recruitment	Process is occurring as appropriate within each cover type	Process is occurring as appropriate within each cover type

Section 4 Integrated Monitoring Program

This section describes the monitoring program for the RP. The purpose of this section is to describe how monitoring data will be used to collect the necessary information to evaluate the success of the project and progress towards success. All monitoring metrics that will be evaluated for effectiveness monitoring are included in Table 3-1. Monitoring metrics and methods are described in Appendix A. Although they will be evaluated for different purposes, this integrated monitoring plan incorporates both the RPS and performance criteria metrics.

Three types of monitoring are necessary to establish the integrated monitoring program. These include: baseline, construction, and effectiveness monitoring. ***Baseline monitoring*** documents the pre-restoration condition. ***Construction monitoring*** describes monitoring requirements during floodplain, channel, and revegetation implementation and documents the restoration project as completed. ***Effectiveness monitoring*** addresses whether project objectives are being met, determines maintenance needs, and provides inputs into decision pathways.

4.1 Baseline Monitoring

Baseline data were collected to support the final design. These data will be used for a post-project comparison where appropriate. The baseline monitoring data for the project includes data collected within the project reach and from reference reaches that form the basis for many RPS and criteria. For purposes of determining project success and trends towards achieving RPS and performance criteria, the as-built documentation (Section 4.2 Implementation Monitoring) will effectively become the baseline for monitoring change.

Baseline data for the project are described in other documents.

- Geomorphic Data Summary Report (State of Montana 2006b)
- Milltown Revegetation Data Summary Report (State of Montana 2006a)
- Restoration Plan for the Clark Fork and Blackfoot river near Milltown Dam (State of Montana 2005)
- Upper Clark Fork Wetland Mitigation Process, Step 3—Detailed Analysis, Milltown Reservoir Operable Unit, Milltown Reservoir Sediments NPL Site (Walsh Environmental Scientists and Engineers, LLC 2004)

A detailed as-built survey will be completed to document the completed restoration project. During the as-built survey, permanent monitoring stations will be established for the purpose of conducting effectiveness monitoring. The exact location of permanent monitoring stations will be determined as construction proceeds. Similar to construction, as-built documentation will occur in phases following completion of each project reach.

The following information and data may be collected as part of the as-built documentation:

- Detailed aerial (LiDAR), ground, and bathymetric topographic surveys of the channel and floodplain for use as base maps for project monitoring.
- Aerial photographs of the project reach.
- Longitudinal profile and channel cross sections with as-built stationing.
- Resource-grade GPS surveys to create maps documenting revegetation treatment areas and vegetation cover type extents.
- Resource-grade GPS survey to create maps to document structure locations
- Resource-grade GPS surveys to create as-built wetland maps

Data will continue to be collected within reference reaches throughout the duration of the project as a way to further evaluate natural system variability. This information will be used to adjust ranges and values associated with various performance criteria as appropriate.

4.2 Construction Monitoring

Construction monitoring includes the monitoring requirements during floodplain and channel construction, and during revegetation implementation. Bid documents and task orders for each project phase will include requirements to ensure compliance with plans and specifications, and contractors will be required to develop and follow a quality assurance plan that is approved by the State. Compliance monitoring during construction and monitoring that triggers BMPs are described in Section 2. This section describes the as-built surveys that will be completed as part of implementation monitoring. As-built surveys will document post-construction conditions, and these data will be used as the baseline for effectiveness monitoring.

4.3 Effectiveness Monitoring

Effectiveness monitoring is designed to measure progress toward achieving project goals and objectives and RPS, determine maintenance needs and provide input into determining whether the site is trending towards or away from achieving project goals and objectives. This monitoring effort will focus on collecting data necessary to calculate the monitoring metrics established as performance standards and performance criteria for the project. This section describes how the effectiveness monitoring plan will be implemented including: monitoring methods, monitoring locations, level of effort, and monitoring schedule and frequency. How the data are collected for effectiveness monitoring will be used to make decisions regarding project success, and determine corrective actions and maintenance needs is described in Section 5.

4.3.1 Monitoring Methods

The monitoring metrics that are included in this monitoring plan are listed in Table 3-1. Descriptions of each metric and methods for collecting data for each monitoring metric are provided in Appendix A.

4.3.2 Monitoring Locations, Level of Effort, Timing and Frequency

Monitoring locations will be identified during the as-built survey. The sampling density (level of effort) will be determined according to the parameter that is being measured and this is addressed in Appendix A. Table 4-1 provides an estimate of the number of sampling sites, anticipated sampling locations, timing and sampling frequency for each monitoring metric.

Table 4-1. Monitoring Sampling Locations, Effort, Timing and Frequency

Monitoring Metric	Sampling Locations	Total Samples/ Sampling Event	Timing	Scheduled Frequency*
Water Quality				
Turbidity	1-Remedial Action Bridge at bypass channel (BPC)—new station 2-USGS Station # 12340500 above Missoula (upon substantial completion of RA)	Per RAMP (2006) Protocols	During peak runoff and associated with construction monitoring	Twice daily during project implementation
Channel				
Channel dimensions	3 per feature (riffle, run, glide, pool) per reach including reference reaches	Up to 48	After peak runoff	Years 1, 3, 5, 10, 15
Channel planform	Entire restoration area and reference reaches via remote sensing	1	After peak runoff	Years 1, 3, 5, 10, 15
Channel profile	Entire restoration and reference reaches	1	After peak runoff	Years 1, 3, 5, 10, 15
Structure performance	All structures	All	After peak runoff	Years 1, 3, 5, 10, 15
Particle size distribution	All riffles and point bars including reference reach	Up to15	After peak runoff	Years 1, 3, 5, 10, 15
Scour and fill	Calculate from channel dimensions data	5	Periodic	Years 1, 3, 5, 10, 15
Bank height ratio	Calculate from channel dimensions data	15	After peak runoff	Years 1, 3, 5, 10, 15
Hydrologic connectivity	Entire restoration area	1	During peak runoff	Years 1, 3, 5, 10, 15
Floodplain				
Wetland delineation	Entire restoration project area	1	Growing season	Years 1, 5, 10, 15
FEWA assessment	Entire restoration project area	1	Growing season	Year 15
Prevalence index	Calculate from vegetation composition data in emergent wetlands and other cover types that might contribute to wetland totals	40	During peak runoff	Years 15

Table 4-1. Monitoring Sampling Locations, Effort, Timing and Frequency

Monitoring Metric	Sampling Locations	Total Samples/ Sampling Event	Timing	Scheduled Frequency*
Groundwater depth	TBD	TBD	After peak runoff	Years 1, 3, 5, 10, 15
Proportional abundance of floodplain vegetation cover types	Entire restoration area	1	Growing season	Years 1, 5, 10, 15
Erosion (rills and gullies)	Entire restoration area, focusing on high risk areas	Entire project reach	Growing season	Years 1, 3, 5, 10, 15
Percent cover of herbaceous vegetation	5 plots in Restoration Area (2 plots within RA)	5	Growing season	Years 1, 3, 5, 10, 15
Canopy cover of different vegetation layers	5 plots per woody vegetation cover type per reach (2 plots within RA)	40	Growing season	Years 1, 3, 5, 10, 15
Invasive species canopy cover	5 plots per cover type per reach (2 plots within RA)	40	Growing season	Years 1, 3, 5, 10, 15
Hydroperiod	Visual observation corresponding to other monitoring or based on well data	1	Growing season	Years 1, 3, 5, 10, 15
Bioengineering				
Bioengineering	All structures	All	Growing season	Years 1, 3, 5, 10, 15
Additional Metrics				
Woody browse levels	5 plots per woody vegetation cover type per reach	40	Growing season	Years 1, 3, 5, 10, 15
Woody vegetation survival by species	5 plots per woody vegetation cover type per reach	40	Growing season	Years 1, 3, 5, 10, 15
Species richness	5 plots per cover type per reach calculated from species composition data	40	Growing season	Years 1, 3, 5, 10, 15
Plant reproduction (natural recruitment)	5 plots per cover type per reach	40	Growing season	Years 1, 3, 5, 10, 15

*Significant floods and other disturbances may trigger additional monitoring events (e.g. drought, ice jams, unseasonal flow events exceeding bankfull)

Section 5 Framework for Making Decisions Based on Monitoring Data

Implementing large-scale ecosystem restoration requires building in mechanisms to address uncertainty that is inherent within natural systems. To address this uncertainty, this monitoring plan includes a decision-making framework that will allow the project monitoring team to interpret effectiveness monitoring data.

This framework requires that the State establish a interdisciplinary monitoring team familiar with the RP. This team will critically review monitoring data both in the office and in the field so team members can interpret monitoring results in the context of developing ecosystem functions and processes. Through this framework, it will be possible to determine whether project objectives are being met, which corrective measures may be necessary, and whether monitoring methods and/or performance criteria should be modified. This framework will also be used for the RPS, except that the RPS cannot be modified (RPS apply within the remedial action project area).

5.1 Interpreting Monitoring Results for Decision-Making

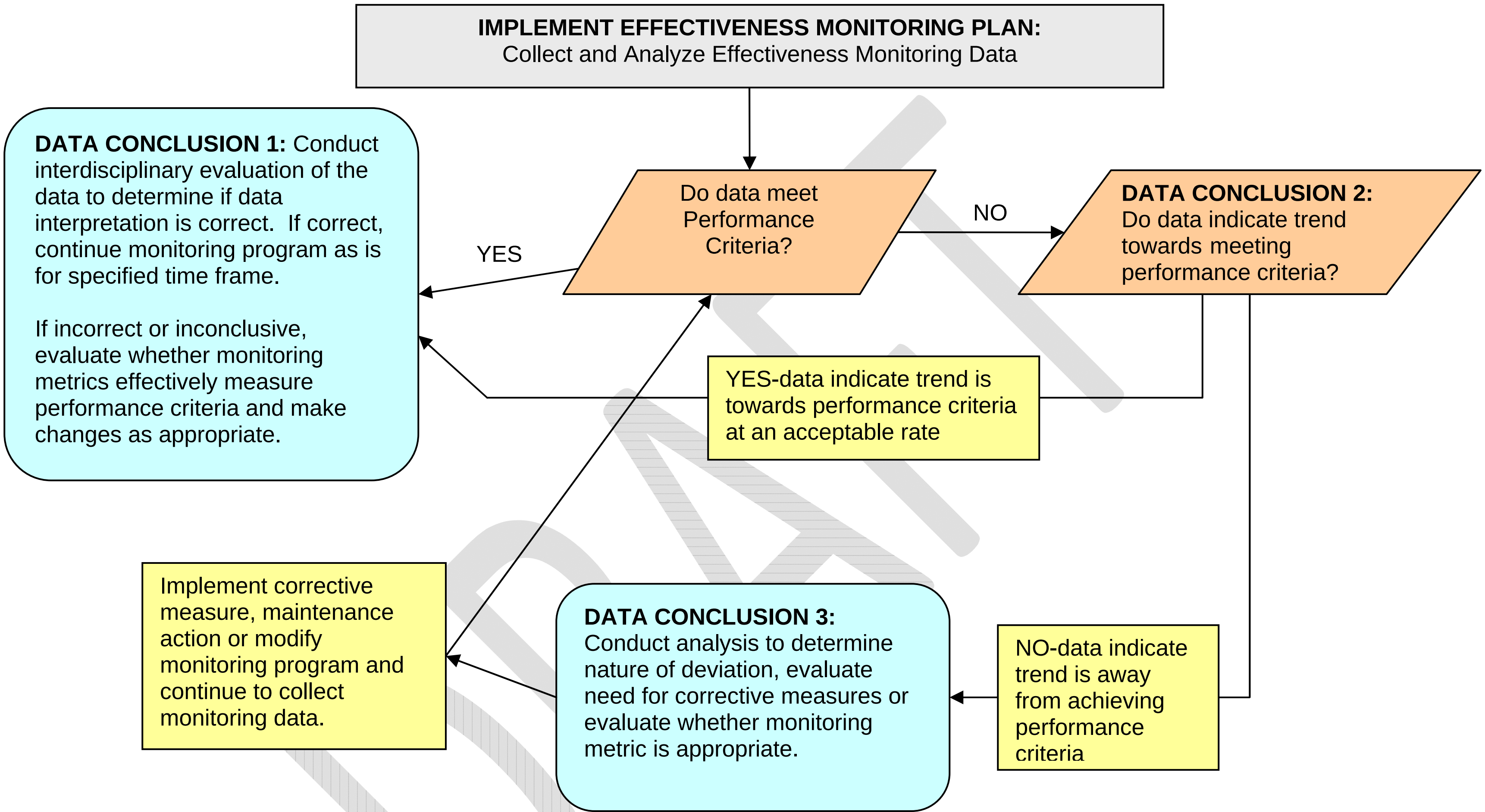
At a coarse scale, data generated during monitoring will point toward one of three conclusions related to whether project objectives are being met: (1) project is meeting objectives, (2) project is trending toward meeting objectives, or (3) project is either not meeting objectives or trending toward not meeting objectives. The latter conclusion may be reached for several reasons:

- Incorrect implementation of restoration action(s) or underlying restoration assumptions are incorrect.
- Site conditions (e.g. anticipated hydrology not occurring, substrate does not support desired plant community).
- Non-project related factors (e.g. prolonged drought, other climatic variability, floods, invasive species and land use impacts).
- Insufficient time has elapsed since implementation (e.g. may affect seed bank response, cover and wetland establishment, plant community succession rates, species specific colonization and reproduction rates).
- Ineffective monitoring program (e.g. inappropriate data collection methods, sampling regime, sampling locations not capturing variability, or data analysis).

Monitoring data will be interpreted by the monitoring team and decisions will be made using professional judgment in the context of this framework. This framework can be applied by goal, objective or metric and can be applied either annually or as monitoring data allow. Once a conclusion has been deduced, the monitoring team should evaluate causes and uncertainties related to data interpretation, including ensuring that the correct conclusion has been reached. Once this is done, the monitoring team should identify the appropriate action related to that conclusion. Table 5-1 describes the three types of conclusions and related decisions and actions. Figure 5-1 outlines the decision making framework that leads to one of the three data interpretations.

Table 5-1. Monitoring Program Decision-Making Framework

Conclusion Categories	Decisions and Actions
Conclusion 1. Project is meeting objectives based on values of performance criteria.	-Evaluate monitoring program (continue, reduce, eliminate some metrics).
Conclusion 2. Project is trending towards objectives based on values of performance criteria.	-Evaluate monitoring program (continue, reduce, modify, eliminate some metrics) -Evaluate whether rates of progress toward objectives are appropriate.
Conclusion 3. Project is not meeting (or trending away from) objectives based on values of performance criteria.	-Evaluate causes of why project is not meeting objectives. -Assess monitoring program to determine if appropriate data are being collected to determine and evaluate causes. -Evaluate whether performance criteria are appropriate. -Develop plan to address problems. -Implement plan and monitor results.



NOTE: Flow chart can be applied to individual monitoring metrics, project goals and objectives or project maintenance needs.

Figure 5-1. Monitoring Program Decision-Making Framework.

5.2 Interpreting Monitoring Results for Routine Maintenance Needs

In addition to monitoring project effectiveness, monitoring will be used to determine maintenance needs for the project. Some maintenance needs will occur annually regardless of monitoring results and others will occur as a direct result of interpreting monitoring data or observations made during monitoring data collection. Anticipated routine and monitoring induced maintenance needs, maintenance methods and frequency for the project are summarized in Table 5-1. The decision framework shown in Figure 5-1 will be used to evaluate monitoring induced project maintenance needs.

5.3 Detecting Data Trends

Interpreting data and determining trends will be an important component of the Milltown monitoring program due to the natural variability and various timeframes associated with restoring ecological systems. Trend analysis requires evaluating data collected at specified intervals over a specified period in order to determine the magnitude and direction of change. The amount of data needed to conduct a trend analysis will depend on various factors, such as the type of data being collected or the expected response time. For some metrics, such as plant community structure, several years of data may be needed to detect trends. Trend analysis has the following applications:

- May provide better interpretation of the effects of natural variability (such as occasional herbivory or unusual weather conditions) on the developing floodplain and channel system.
- Due to the long periods of time that may be required to reach some restoration objectives, detecting data trends will allow early indication of restoration success (e.g. increasing abundance of desired species, hydric soils developing, areal coverage by desired cover types or vegetation structure establishing).

Table 5-2 provides examples and guidance on how data collected during effectiveness monitoring may be used to determine trends and which data interpretation category and associated decisions actions may apply. Ultimately, this interpretation will be done by the interdisciplinary monitoring team and based on actual data collected specific to the site.

Table 5-2. Routine and Monitoring Induced Maintenance Needs

Maintenance Task	Method	Possible Maintenance Action	Maintenance Frequency and Duration
Channel adjustments	Visual inspection Channel morphology data	Localized adjustments may be repaired; large scale adjustments may not be repaired	Once per year and as determined by monitoring data over the first 5-10 years
Channel structures	Visual inspection Photo points as needed	If structure is not performing but channel has not adjusted (i.e. fabric sealer fails on log vane), repair structure	Once per year and as determined by monitoring data over the first 5-10 years
Bioengineering	Visual inspection Monitoring data Photo points as needed	Repairs to fabric; supplemental willow cuttings, planting or seeding, additional toe protection	Once per year and as determined by monitoring data over the first 5-10 years
Floodplain erosion control	Visual inspection Monitoring data	Fill or plug gullies and revegetate if fails to meet criteria	Once per year and as determined by monitoring data over the first 5- 10 years
Irrigation	Visual inspection	Increase	Twice monthly during the first three growing seasons and as determined by monitoring data after that period
Weed control	Various (see weed management plan, State 2007)	Various (see weed management plan, State 2007)	Annually or more frequently as determined by monitoring data and for length of time as
Herbivory	Visual inspection	Straighten, replace, re-stake, re-tie or removal of herbivory protection	Annually for first 5 years and then as monitoring determines

Table 5-2. Monitoring Data Trends, Conclusions and Responses for Selected Metrics

Metric	Example Monitoring Data Results	Decision Pathway/Trend Determination	Maintenance/ Corrective Action	Areas Where Metric Applies
Turbidity	Does not exceed threshold	Continue to monitor (Conclusion 1)	No action	Main channel and side channels
	Exceeds threshold at POC monitoring site	Implement maintenance or corrective action (Conclusion 3)	Identify source of sediment—if source is from within the restoration area, identify additional BMPs or treatments to address source	
Channel Morphology	90 to 100 percent of project within criteria ranges	Continue to monitor (Conclusion 1)	Modify land management, No corrective actions or maintenance required; Evaluate portions of project that are out of range in terms of how those reaches affect trend and determine causes if possible	Main channel and floodplain, including side channels and structures
	70 to 90 percent of project within criteria ranges	Observe larger scale patterns, Evaluate design criteria and performance criteria thresholds (Conclusion 2)	Modify land management Repair localized structures or areas within reach Modify design criteria and retrofit project on reach scale	
	<70 percent within criteria ranges	Re-evaluate design concept and expectations related to function and process (Conclusion 3)	Re-design—options range from no action to reconstructing portions of the channel	
Cover Type Distribution	80-90% of cover types within criteria ranges	Continue to monitor (Conclusion 1)	None required	Floodplain

Table 5-2. Monitoring Data Trends, Conclusions and Responses for Selected Metrics

Metric	Example Monitoring Data Results	Decision Pathway/Trend Determination	Maintenance/ Corrective Action	Areas Where Metric Applies
	60-80% of cover types within criteria ranges	Determine if cover type is trending towards desired distribution or if adjustments in desired distribution should be made based on site conditions (Conclusion 2)	If cover type distribution is trending towards desired ranges no corrective actions needed; if not, modify design criteria and retrofit project on reach scale	
	Less than 60% of cover types within criteria ranges	Re-evaluate design concept and expectations related to function and process (Conclusion 3)	Re-design and implement changes	
Percent Survival Woody Plants	80-100% of planted shrubs and trees survive in years 1-3	Continue to monitor; observe (Conclusion 1)	Recommendations to achieve project objectives. (1) additional planting; (2) species specific recommendations; (3) maintenance needs	All planted areas
	50-80% survival in years 1-3	Implement maintenance action (Conclusion 2)	Determine cause of mortality (hydrology, browse, etc.); Recommend ways to achieve project objectives: (1) Increase supplemental irrigation, (2) improve browse protection; (3) increase weed suppression; (4) add additional microsites.	
	Less than 50% survival in years 1-3	Modify restoration approach (Conclusion 3)	Determine reasons for low survival before planting additional project phases.	

Section 6 Data Storage and Analysis

6.1 Data Storage

Monitoring data will be stored by the State or its contractor in standard database(s). Data tables will be normalized to avoid redundant data structures and to ensure consistent data formats among sampling events. Data will be easily exportable to a format that will allow SQL queries (e.g. stored as delimited rows and tagged with date of sampling, sampling location code, name of person who collected data, method used, and other appropriate attributes). Where appropriate, data will be stored as attribute tables associated with Geographic Information Systems (GIS), either as part of shape (.shp) files or as geodatabases. Prior to the first sampling event, the monitoring team will work together to develop consistent data naming conventions, table structures, and other coordination items that will facilitate data transmission and analysis. Data will be routinely backed up on central data servers with a RAID (Redundant Arrays of Inexpensive Disks) configuration, which is a way of storing the same data in different places, and archived on durable media such as Compact Discs (CDs), Digital Versatile Discs (DVDs), tape backup, or external hard drives. Selected data sets will be made available via File Transfer Protocol (FTP) or other web-based protocols.

6.2 Data Analysis and Reporting

Data will be analyzed according to methods associated with metrics as described in Appendix A. After each monitoring event, a brief monitoring report will be prepared that includes:

- A summary of metrics for which data were collected.
- Methods used to collect data (referencing this plan for methodologies).
- Tabular and graphical summaries of results.
- Narrative discussions to explain results in the context of project objectives and performance criteria.
- A discussion section documenting interdisciplinary team decision processes and any recommended actions.

Section 7 Monitoring Quality Assurance Plan

To ensure the quality of the monitoring program, it is necessary to have quality assurance (QA) and quality control (QC) procedures in place. QA and QC procedures will be applied to the following aspects of the monitoring plan:

- Data collection
- Data storage
- Data analysis and reporting

The interdisciplinary monitoring team will be responsible for quality assurance. Each member of the team will be responsible for ensuring that data collected within their particular discipline meets professional standards and complies with appropriate methodologies and protocols. Where data must be integrated either for analysis or reporting, the team will work together to develop consistent procedures. Specific items that will be addressed by the interdisciplinary monitoring team include:

- Exact location and documentation of monitoring locations
- Training or certification requirements of individuals collecting data
- Documentation and records management for how field data are recorded including development of standardized monitoring forms
- Sample handling and custody requirements
- Analytical methods for analysis of samples
- Instrument and equipment testing, inspection and maintenance requirements
- Instrument calibration and frequency of maintenance
- Data review, validation and verification requirements (i.e. cross checking field data sheets, looking for data gaps, checking calculations, looking for outliers, etc.)
- Data management protocols
- Reporting procedures
- Procedures for reconciliation of data with performance criteria

Section 8 References

Edwards, T.K. and G.D. Glysson. 1999. Field methods for measurement of fluvial sediment. Techniques of Water-Resources Investigations of the U.S. Geological Survey. Book 3, Applications of Hydraulics.

Envirocon. 2006. Final Remedial Action Monitoring Plan for the Milltown Reservoir Sediments Operable Unit.

State of Montana. October 2005. Restoration Plan for the Clark Fork River and Blackfoot River near Milltown Dam. State of Montana Department of Justice Natural Resource Damage Program, Helena, Montana. Prepared by River Design Group, Inc., WestWater Consultants, Inc., and Geum Environmental Consulting, Inc.

State of Montana. 2006a. Milltown Revegetation Data Summary Report. State of Montana Department of Justice Natural Resource Damage Program, Helena, Montana. Prepared by Geum Environmental Consulting, Inc.

State of Montana. 2006b. Growth Media and Soil Investigation at Milltown OU for Restoration Purposes. Prepared for the State of Montana, Department of Justice, Natural Resource Damage Program. Prepared by Reclamation Research Unit, Montana State University, Bozeman, MT.

State of Montana. 2007. Milltown Restoration Weed Management Plan. Prepared for the State of Montana, Department of Justice, Natural Resource Damage Program. Prepared by Geum Environmental Consulting, Inc.

State of Montana. pending. Milltown Restoration Monitoring and Maintenance Plan. Prepared for the State of Montana, Department of Justice, Natural Resource Damage Program. Prepared by River Design Group, Inc., WestWater Consultants, Inc., and Geum Environmental Consulting, Inc.

U.S. v. ARCO. 2006. Milltown Site Consent Decree Statement of Work. Civil Action No. CV89-039-BU-SEH.

U.S. Environmental Protection Agency (EPA). 2004a. Record of Decision for Milltown Reservoir Sediments Operable Unit of the Milltown Reservoir/Clark Fork River Superfund Site. U.S. Environmental Protection Agency, Region 8, Helena, Montana.

U.S. Fish & Wildlife Service (USFWS). 2004. Biological opinion for threatened and endangered species USEPA Superfund Program Revised Proposed Clean-up Plan for the Milltown Reservoir Sediments Operable Unit of the Milltown Reservoir/Clark Fork River Superfund Site. U.S. Fish and Wildlife Service Montana Ecological Services Field Office. December 17, 2004.

Walsh Environmental Scientists and Engineers, LLC. 2004. Upper Clark Fork Wetland Mitigation Process, Step 3—Detailed Analysis, Milltown Reservoir Operable Unit, Milltown Reservoir Sediments NPL Site. Prepared for ARCO.

Appendix A. Monitoring Protocols and Metric Definitions

A.1 Introduction

Appendix A presents monitoring protocols and definitions for selected monitoring metrics. Monitoring protocols are accompanied by references to promote consistent data collection throughout the monitoring period. Section 4 addresses minimum sampling criteria for ensuring that data populations are statistically significant.

The monitoring area encompasses five river reaches on the CFR and BFR with varied channel and valley morphologies. Figure 3-1 displays the locations of the monitoring reaches. Table A-1 summarizes the reaches and associated lengths.

Table A-1. Monitoring reaches, waterbody and reach length.

Reach	Waterbody	Reach Length (ft)
CFR3B ref	CFR reference reach upstream of the confluence	4,000
CFR3B	CFR upstream of the confluence	2,000
CFR3A	CFR upstream of the confluence	5,200
CFR2	CFR upstream of the confluence	4,100
CFR1	CFR downstream of the confluence	1,700
BFR1	BFR upstream of the confluence	800
Bandmann	CFR near Bandmann Flats	800
Total		18,600 (3.5 miles)

A.2 Water Quality

<u>Turbidity</u>

Turbidity (NTU) is being used to measure the effects of construction activity on water quality and to determine the effectiveness of surface erosion control. Turbidity will be monitored and reported according to the methods and procedures described in the Final Remedial Action Monitoring Plan for the Milltown Reservoir Sediments Operable Unit (Envirocon 2006).

A.3 Channel Morphology

This section describes the methods used for data collection, processing and reporting for channel morphology and sediment transport metrics (Table B-2). Channel cross section, profile, planform and substrate measurements provide the means to monitor short-term and long-term channel response to restoration. Examples of physical processes that can be monitored using these measurements include erosion, deposition, sediment transport, floodplain connection and channel stability. In addition, these measurements are useful for evaluating aquatic habitat complexity.

For the purposes of this document, the channel-forming discharge is considered to be morphological bankfull (Charlton et al. 1978; Andrews 1983; Hey and Thorne 1986). Morphological bankfull indicators shall be surveyed throughout all reaches and used as a tool to calibrate bankfull discharge and set the boundaries for data included in the reported metrics.

A.3.1 Definitions

Area - Channel cross-section area measured at bankfull conditions.

Width - Channel width measured at bankfull conditions.

Mean depth - Channel mean depth at bankfull conditions calculated as area divided by width.

Width-depth ratio - A measure of channel shape and stream type classification, calculated by dividing width by mean depth.

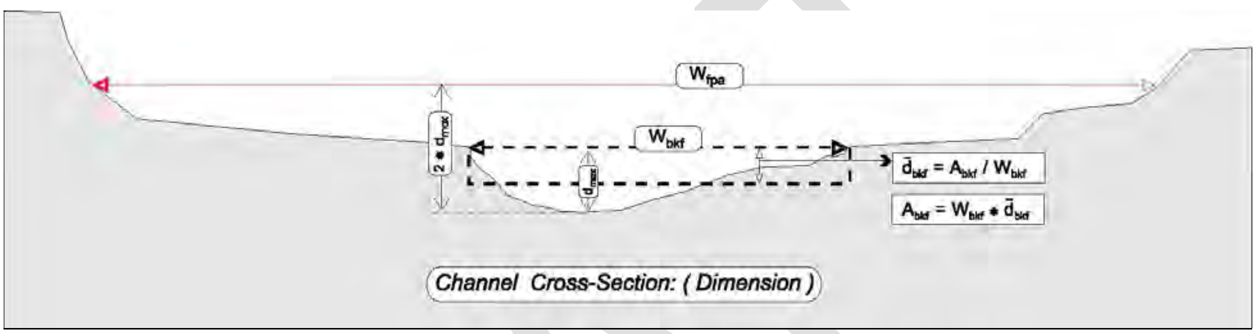


Figure A-1. Illustration of channel cross section metrics.

Sinuosity - A measure of channel pattern expressed as channel length divided by valley length or channel slope divided by valley slope.

Channel migration - Movement of a channel within a floodplain resulting from bank erosion and deposition.

Belt width - A measure of the lateral extents of a channel pattern expressed as the average width occupied by a meandering channel within a floodplain

Meander wavelength - A measure of channel pattern expressed as the distance between successive meander apexes.

Radius - A measure of meander curvature.

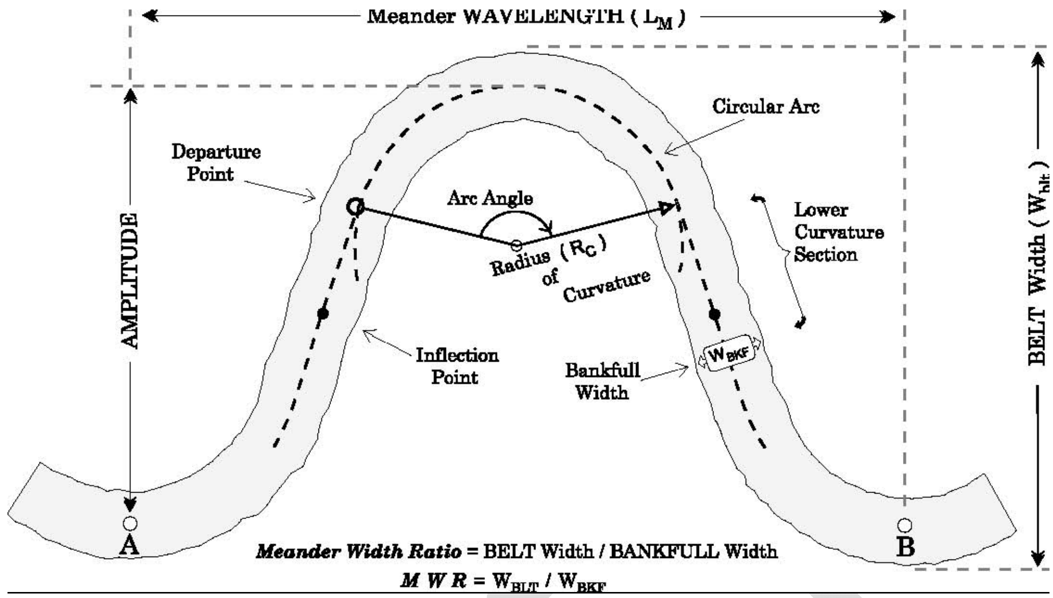


Figure A-2. Illustration of channel planform metrics.

Bankfull slope - Average longitudinal gradient measured along channel bankfull elevations.

D_{16}, D_{25}, D_{50}, D_{75} *and* D_{84} - Size of channel bed material (e.g., 16%, 25%, 50%, etc.) for which the bed composition is smaller than the percentile value.

Scour Chains - A field method for measuring riffle scour depth and substrate mobility.

Bank Erosion Hazard Index (BEHI) rating and Near Bank Stress (NBS) rating - A field based method for evaluating and rating bank stability. BEHI and NBS ratings are developed from several field measurements including bank height ratio, root depth, root density, bank angle, bank material, bank stratification and vegetation coverage. Calibrated BEHI and NBS ratings can be used to estimate erosion rates in feet per year and in-stream sediment loading in tons per year.

Bank height ratio - Ratio of maximum riffle depth at bankfull to lowest channel bank height measured from channel thalweg.

A.3.2 Data Collection Protocols

Aerial photographs shall be used to measure channel planform metrics. A Total Station or survey grade GPS shall be used to survey the longitudinal profile and cross sections. Table A-2 summarizes the protocols including the data collection, reporting metrics and sampling protocols.

Table A-2. Channel morphology data collection, reporting metrics and sampling protocols.

Data Collection and Reporting Metrics	Protocol
Channel cross-section Width Mean depth Maximum depth Area Bankfull elevation Water surface elevation Terrace elevations	Harrelson et al. 1994
Channel longitudinal profile Thalweg elevation Bankfull elevation Terrace elevations Water surface elevation	Harrelson et al. 1994
Channel Planform Belt Width Meander wavelength Meander radius Sinuosity	Langbein and Leopold 1966; Thorne 1997 (Aerial photograph analysis)
Channel substrate characterization	
Riffle particle size distribution (PSD)	Wolman 1954
Composite (all features) PSD	Wolman 1954
Bar sample PSD	Rosgen 2006 p. 5-13; Harrelson et al. 1994
Riffle stability index	Kappeser 1992
Scour chains	Rosgen 2006 p. 6-11; Harrelson et al.1994
Bank erosion Bank erosion hazard index Near bank stress	Rosgen 2006 p. 6-13

<u>Channel Cross-Sections</u>

Representative channel cross-sections shall be surveyed using standard methods (Harrelson et al. 1994). Cross-sections shall span the active bankfull channel, adjacent floodplain, and low terrace features, if possible. Channel units shall be divided into habitat and channel unit types including pool, riffle, run, and glide features (Bisson et al. 1982). Cross-section locations will be established in the as-built survey.

<u>Longitudinal Profiles</u>

Longitudinal profiles shall be established in each surveyed reach and include the entire reach. The profiles shall include consistent measurement of left and right channel bankfull indicators, channel thalweg, low terraces, and water surface elevations at select locations along the profile.

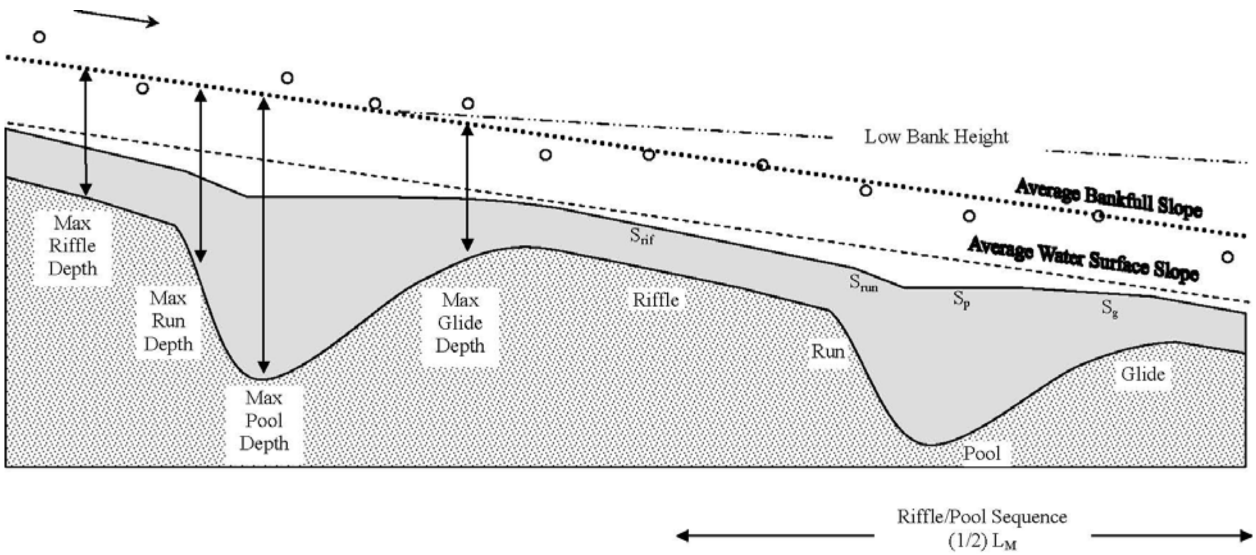


Figure A-3. Illustration of channel profile metrics.

<u>Planform Meander Geometry</u>
Planform meander geometry, including meander radius, meander wavelength, meander belt width, and sinuosity shall be measured using aerial photography complemented by field survey methods (Langbein and Leopold 1966; Thorne 1997).

<u>Substrate characterization</u>
Channel materials shall be sampled to characterize bed material characteristics as well as to complement hydraulic and sediment transport evaluations. Several sampling methods shall be employed to meet these requirements.

The Wolman method (Wolman 1954) shall be used to characterize the particle size distribution of channel materials. The material sampling locations shall be replicated for each survey and will be established in the as-built survey. The intermediate axis of each particle shall be measured (Wolman 1954; Bunte and Abt 2001). Samples from habitat units shall be recorded separately and reported individually and as a composite.

A Riffle Stability Index (RSI) shall be applied to evaluate the particle size percentile of the riffle that is mobile (Kappesser 1992). RSI protocol shall occur in each riffle and point bar. This method involves locating a riffle in a relatively straight section of the reach that displayed uniform depth in the cross-section. Particle size distribution on each riffle shall be determined by the Wolman (1954) method. A point bar or similar depositional feature shall be identified in close proximity to the sampled riffle. The intermediate axes of the 30 largest recently deposited particles shall be measured and the geometric mean calculated and compared with the cumulative particle size distribution of the riffle. The percentile of the cumulative particle size distribution corresponding to the geometric mean of the largest particle sizes on the lateral bar shall be recorded as the RSI value.

Volumetric bar samples shall be sieved using standard sieves and a scale (Rosgen 2006). Sieves are stacked according to sieve opening size with coarser sieves on top and the finest sieve on the bottom. The stacked sieves are placed on a drain bucket. Sediment samples are placed in the top sieve and the sieve column is agitated while water was poured over the sieve column. Sand particles that pass through all of the sieves are retained in the drain bucket. Once the samples are completely sieved, each sieve is weighed. The weight of the sieve and the sample collected in that sieve was recorded. The weight of the sieve was deducted from the sieve and sample weight to calculate the weight of the sample retained. Once the weight for each sieved sample is completed, a total weight is calculated for all samples. A relative weight for each size class is derived by comparing the individual sieve results to the overall total weight of the sample.

<u>Scour Chains</u>
Scour chains are small diameter chains attached to a duckbill anchor and driven vertically into the bed. The chain is left flush with the surface and is resurveyed after a large flow event to determine vertical bed adjustment and entrainment sizes of bed material. Standard protocols shall be used for installation, measurement and reporting of scour chains (Harrelson et al. 1994; Rosgen 2006).

<u>Bank Erosion</u>
Prediction of stream bank erosion rates and sediment loading shall be made using the Bank Assessment for Non-point Source Consequences of Sediment (BANCS) method (Rosgen, 2006). The method utilizes two bank erodibility estimation tools including the Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS). The application involves evaluating bank characteristics and flow distribution along the river reach and mapping various risk ratings commensurate with bank and channel changes. A numerical reach score is then developed to rank streambank erosion potential on a scale ranging from very low to extreme.

Bank pins are smooth steel rods, four feet long, which are driven horizontally and flush to the bank surface at various positions in the streambank. The mount of exposed pin upon resurvey following runoff evens is measured as the amount of lateral erosion at the site (Rosgen 2006).

The BEHI procedure integrates multiple bank integrity parameters which have a direct impact on streambank stability, including the following.

- Ratio of streambank height to bankfull stage
- Ratio of riparian vegetation rooting depth to streambank height
- Degree of rooting density
- Composition of streambank materials
- Streambank angle
- Bank material stratigraphy
- Bank surface protection afforded by woody debris and vegetation

The BEHI index incorporates these seven variables into a numerical reach score that is used to rank streambank erosion potential on a scale ranging from very low to extreme. BEHI sites shall be established during the as-built survey.

A.3.3 Data Processing Protocols

Geomorphic data shall processed and analyzed in RIVERMorph® version 4.1 (RIVERMorph LLC 2005) or approved equal. RIVERMorph®, a geomorphic stream channel assessment and data storage software package, merges all aspects of the surveys by transcribing the total station data from x, y, and z coordinates to station and elevation formats

<u>Processing Profiles</u>
Raw longitudinal profile (LP) data shall be transcribed by Rivermorph and plotted in station/elevation format in the LP module. Data types such as channel thalweg, water surface and bankfull points are automatically selected, and any additional data points such as right or left bank, terrace features or other survey data, are selected manually. The LP module is used to generate channel slope and maximum depth values. After the LP data is plotted and the channel features are labeled, outlier points are edited. Then, trendlines depicting average channel slopes are applied to both water surface and bankfull indicator data points. If available, channel bank or terrace slopes are displayed as well. Using the Rivermorph measuring tool, the average channel slopes are derived by tracing the trendlines through the entire reach from top of riffle feature to top of riffle feature. In the same manner, individual facet slopes are measured using the tool to trace the water surface slopes at individual facets to obtain a range of values for riffle, pool, run and glide features. The bankfull trendline not only illustrates the average energy gradient at high flow, but also serves as the line from which maximum bankfull channel depths are measured. The measuring tool is used to calculate the distance between the channel thalweg and the average bankfull slope line to generate a range of maximum depth values for individual feature types. Additional metrics such as pool to pool spacing, pool length and low bank height are also derived in the LP module.

<u>Processing Cross Sections</u>
Raw cross-section data shall be transcribed by Rivermorph and plotted in station/elevation format into the cross-section module. Surveyed cross-section points and identifying features such as channel bottom, edge of water, bankfull indicators, top of bank, floodplains and terraces are selected and downloaded to the cross-section module. The cross-section module is used to generate channel metrics used for basic hydraulic calculations. Metrics generated in this module shall be summarized and used to obtain a range of values for riffle, pool, run and glide features at the reach scale.

Bankfull elevations shall be plotted across each cross-section and shall serve as the vertical limit for depth-related calculations such as mean depth or cross-sectional area. The bankfull elevation at each cross-section is refined in Rivermorph by comparison with the average bankfull trendline plotted through the LP data. Through comparison with the average trendline, the variation in bankfull elevation is reduced and consistency between cross-sections increased.

The lateral cross-section limits are defined by the channel margins below the bankfull elevation. This is considered to be the active channel. Frequently, low areas on the floodplain occur below the bankfull elevation and are automatically included in the cross-section summary calculations. This can lead to incorrect results, or increased variation when summarizing the cross-section data. To confine the calculations to the active channel and exclude the low-lying floodplain areas, limits shall be applied to the cross-section at or near the bankfull indicator points. The limits serve as lateral boundaries and enclose the active channel. Bankfull channel metrics are calculated within these limits.

The lateral limits do not influence the floodprone width calculations. The floodprone width is defined as the width of the surveyed cross-section at or below an elevation that is determined by two times the maximum riffle depth. If the cross-section extents intercept the floodprone elevation on each side then the entire floodprone area is defined by the surveyed cross-section. However, if the lateral extents of the surveyed cross-section do not intercept the calculated floodprone mark and remain at a lower elevation, then Rivermorph assumes the endpoints of the cross-section are the lateral extents of the floodprone area. In this case, the floodprone width is arbitrarily limited by Rivermorph and is thus reflected in the related calculations. To remedy this situation, the floodprone width over-ride check box is selected and a user-supplied width is entered based on field observations. The observed value is then utilized by Rivermorph for calculations related to floodprone width.

<u>Processing Dimensionless Ratios</u>

After the longitudinal profile and cross-section dimensions are established, the data are imported into the Ratios module. Prior to analysis, individual cross-sections are grouped according to feature type. Dimensionless ratios are computed by normalizing the data to average bankfull riffle dimensions. Rivermorph displays the minimum, mean and maximum values for the metrics and dimensionless ratios in table format that can be exported into excel for further analysis.

<u>Processing Channel Substrate Data</u>

Channel substrate data including pebble counts, RSI data, and bar samples shall also be entered into Rivermorph, processed and reported. Unlike LP and cross section data, no analytical tools are applied to refine the substrate data.

<u>Processing Scour Chain Data</u>

Procedures for processing scour chain data are outlined in Watershed Assessment of River Stability and Sediment Supply (WARSSS) page 6-10 (Rosgen 2006).

<u>Processing Bank Erosion Data</u>

Procedures for processing bank erosion data are outlined in WARSSS page 6-13 (Rosgen 2006).

A.4 Floodplain Hydrologic Connectivity

Floodplain hydrologic connectivity will be evaluated by observing indicators of surface hydrology on the floodplain surface, using methods in the Army Corps of Engineers Wetland Delineation Manual (Environmental Laboratory 1987). Additionally, in order to allow assessment of connectivity during low flow years, channel dimension data will be used to analytically deterimine whether particular floodplain surfaces would be accessed during bankfull events and higher.

A.5 Structure Performance

Structure performance will be evaluated by visually inspecting structures and areas around structures. Data will be recorded on a field form, and will be used by the monitoring team to determine maintenance needs.

A.6 Erosion

Erosion will be evaluated by isual inspection of erosion (rills, gullies) and by assessing how effectively vegetative cover is limiting erosion.

A.7 Revegetation

A.7.1 Wetlands

Wetland Area

Wetland areas will be delineated using the 1987 Army Corps of Engineers Wetland Delineation Manual (Environmental Laboratory 1987). Based on this method, wetlands are defined as those areas having wetland vegetation, soils and hydrology. Standardized data forms and paired data points will be used to delineate wetland areas.

FEWA (Functional Effective Wetland Area)

FEWA is an EPA-approved and USFWS-accepted methodology for determining wetland functional value and effective wetland areas in Upper Clark Fork River Superfund sites (ARCO 1992). FEWA assessments will be used to document progress toward wetland requirements from the consent decree (U.S. vs. ARCO 2005).

Prevalence Index

The prevalence index provides a quantitative way to compare relative wetness among plant communities using broadly accepted wetland indicator status categories, for individual plant species, published as part of the National List of Wetland Plants (Reed 1996). The origin and potential applications for this index are described in National Research Council (1995). Prevalence index (or another related metric) will be a monitoring metric used to estimate trends toward or away from wetland status. Standardized data forms and data processing worksheets will be developed to record prevalence index data and calculate prevalence index.

Groundwater Depth

Groundwater depth will be measured using shallow wells with continuous-recording depth gages. The goal will be to record the location of the free water table surface throughout the growing season. Locations of groundwater monitoring wells and data recording devices will be determined once construction is complete.

A.7.2 Vegetation

Vegetation monitoring is needed to measure the success of planting or decolonization. Transects or quadrates should be permanently marked in the field (e.g., rebar painted orange) and identified on surveyed topographic maps. GPS locations can be useful but are not a substitute for specific permanent markers. Each sampling site should also be photographed at the time of monitoring. Often, permanent photo plots are established and regular photos are taken for a visual record of vegetation development. Aerial photos can also be a useful method of evaluating general canopy development.

<u>Floodplain Cover Types</u>
Floodplain cover types (Table 3) are modified from Hauer and others (2002). These are landscape scale cover types that represent a functioning floodplain when distributed proportionately as in Table 3. Floodplain cover types are described in detail in the RP. Floodplain cover types will be recorded using a combination of aerial photograph interpretation and on-the-ground data collection. Standardized forms will be used to record data within planting polygons to determine which ecological type is developing. Once floodplain cover type data are evaluated, the proportional abundance of established and developing cover types will be compared with desired cover type distributions.

Ecological types are plant communities described in Hansen and others (1995). Within this system, community types represent ecological types dependent upon, or created by, disturbance—for example, floods. Habitat types represent mature (later succession) plant communities that reflect a site's potential given soils, hydrology, climate and landform. Ecological type classification will be used to evaluate site progress at the plant community scale. Ecological cover types will be recorded using a combination of aerial photograph interpretation and on-the-ground data collection. Standardized forms will be developed that will aim to record data within planting polygons to determine what type of ecological type is developing. This information will be used to detect trends toward development of Floodplain Cover Types.

<u>Canopy Cover</u>
Canopy cover is the percentage of ground within a given area covered by a species or life form. Canopy cover is recorded using the following categories expressed as percent of aerial cover: <1; 1-5; 5-15; 15-25; 25-35; 35-45; 45-55; 55-65; 65-75; 75-85; 85-95; and >95 (USDA USFS 1989). Canopy cover is used to determined abundance of individual species (including weeds) and life forms within plant communities. Canopy cover will be recorded in established plots to monitor plant community development. Canopy cover will also be used within the entire restoration project area to monitor weed infestations. Canopy cover of herbaceous vegetation will be used to evaluate erosion control performance standards. Standardized forms will be developed to record canopy cover for these various monitoring purposes.

A.7.3 Bioengineering

Bioengineering monitoring is needed to measure the success of vegetation establishment within bioengineering structures and overall structure stability. There is currently no standard protocol for monitoring these structures; the following protocol is currently being used on the Jocko River on the Flathead Indian Reservation. Structures will be monitored by recording data at five foot intervals to establish vegetation survival and growth and other factors affecting effectiveness of the structures, such as toe scour. Structure effectiveness and maintenance needs will be assessed during annual monitoring events. In addition to these metrics, structure locations will be recorded using resource grade GPS and a photo point will be established for each bioengineering structure. Standardized data forms will be developed for this monitoring and data will be recorded on field data forms or with a Pocket PC using Pendragon software.

<u>Toe Scour</u>

Toe scour evaluates the length of bioengineering structure affected by the mobilization of cobble and other material from under the structure by high flows and scour. Toe scour may cause structural instability, requiring maintenance. The length of the structure exhibiting scour will be recorded during annual monitoring of these structures.

<u>Canopy Cover</u>

Canopy cover is the percentage of the bioengineering structure that is covered by vegetation. Percent cover is recorded in five-foot increments and recorded for combined cover of all species for the vertical face of the structure. A second percent cover measurement is made of the bench formed by the structure. The bench percent cover is recorded separately for native species and weedy species. Percent cover will be recorded using the USDA USFS (1989) canopy cover categories.

<u>Survival</u>

Survival of installed willow cuttings or other plant materials is evaluated by counting the number of live stems, in five foot increments, along the length of the structure. This number is compared with the baseline and is used as a measure of survival. Success of bioengineering structures is based largely on the establishment of willow cuttings and development of deep, binding root mass to stabilize soil.

A.7.4 Additional Metrics

The metrics in this section will be recorded within permanent monitoring plots established in planting areas along the channel and within the floodplain. Permanent monitoring plots will be established across a range of geomorphic features to evaluate these metrics. Permanent plots will be marked with capped re-bar and recorded with GPS. Photo points will also be established for all permanent monitoring plots. Standardized data forms will be developed for this monitoring and data will be recorded on field data forms or with a Pocket PC using Pendragon software.

<u>Woody Vegetation Browse Levels</u>

The level of browse on woody vegetation will be evaluated by recording age class, growth form, and amount of individual plants browsed for monitoring plots established within floodplain planting areas. Methods for evaluating browse will be adapted from Keigley and Frisina (1998).

Woody Vegetation Survival
Woody vegetation survival monitoring will be used to evaluate container plant installation. Woody vegetation survival will be monitored by establishing permanent monitoring plots within floodplain and streambank planting polygons. Corners of each plot should be marked using capped re-bar and flagging, and cardinal directions to each of the corners recorded. A GPS location should be recorded at the center of each plot. A permanent photo monitoring point should be established during the first year of monitoring for each plot. One hundred percent of each survival plot will be sampled. Total percent survival and percent survival by species will be extrapolated based on both the number of plants observed during the survey and the total number planted.

Species Richness
Species richness is the number of species within a community, ecosystem, landscape, or region. Species richness data will be recorded within a sub-set of or selected area within permanent vegetation monitoring plots. Species richness will be used to evaluate trends in plant community succession. All species present within monitoring plots will be recorded.

Plant Reproduction (Natural Recruitment)
Natural recruitment of desired woody species will be recorded both in permanent vegetation monitoring plots and on point bars and in depositional areas where woody species recruitment is expected to occur. The number of woody species seedlings will be recorded within a two by two meter plot at two foot intervals along a 30 foot transect.

Weed Mapping
Weed species abundance will be measured within permanent vegetation monitoring plots using the USDA USFS (1989) canopy cover estimation method. The presence and percent cover of weedy species will be recorded on standardized field data forms. Populations of weedy species within the restoration project area, outside of monitoring plots, will be mapped using a professional grade GPS unit and ARCGIS 9.2. Methods for weed mapping are described in the weed management plan for the site (State of Montana, 2007).

A.8 References

Andrews, E.D. 1983. Entrainment of gravel from naturally sorted riverbed material. Geological Society of America Bulletin 94: 1225-1231.

Bisson, P.A., J.L. Nielsen, R.A. Palmason, and L.E. Grove. 1982. A system of naming habitat types in small streams, with examples of habitat utilization by salmonids during low streamflow. In N.B. Armantrout [ed.] Acquisition and Utilization of Aquatic Habitat Inventory Information: Proceedings of the Symposium. [Portland, OR, October 1981].

Bunte, K., and S.R. Abt. 2001. Sampling surface and subsurface particle-size distributions in wadable gravel- and cobble-bed streams for analyses in sediment transport, hydraulics, and streambed monitoring. USDA Forest Service, Rocky Mountain Research Station, Gen. Tech. Rep. RMRS-GTR-74, Fort Collins, CO, 428 p.

Charlton, F.G., P.M. Brown, and R.W. Benson. 1978. The Hydraulic Geometry of Some Gravel Rivers in Britain. Hydraulics Research Station, Wallingford, Oxfordshire, United Kingdom, Report IT 180.

Edwards, T.K. and Glysson, G.D. 1999. Field methods for measurement of fluvial sediment: Techniques of Water-Resources Investigations of the U.S. Geological Survey, Book 3, Applications of Hydraulics, Chapter C2, 89 p.

Environmental Laboratory. 1987. Corps of Engineers Wetlands Delineation Manual, Technical Report Y-87-1, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Hansen, P.L., Pfister, R.D., Boggs, K., Cook, B.J., Joy, J., and Hinckley, D.K. 1995. Classification and management of Montana's riparian and wetland sites. Montana Riparian and Wetland Association, Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Missoula, Montana, USA.

Harrelson, C.C., Rawlins, C.L., and Potyondy, J.P. 1994. Stream Channel Reference Sites: An Illustrated Guide to Field Technique. Gen Tech Rep RM-245. Fort Collins, CO: U.S. Dept of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.

Hauer, F.R., Cook, B.J., Gilbert, M.C., Clairain, E.Jl, Jr., and Smith, R.D. 2002. A regional guidebook for applying the hydrogeomorphic approach to assessing wetland functions of riverine floodplains in the northern Rocky Mountains, ERDC/EL TR-02-21, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Hey, R.D., and Thorne, C.R. 1986. Stable channels with mobile gravel beds. Journal of Hydraulic Engineering, American Society of Civil Engineers, 112(8): 671-689.

Kappesser, G. 1992. Riffle armor stability index. Unpublished report, Idaho Panhandle National Forest, Coeur d'Alene, Idaho. 7 pages.

Keigley, R.B. and Frisina, M.R. 1998. Browse evaluation by analysis of growth form. Montana Fish, Wildlife, and Parks. Helena, MT. 149 pp.

Lambing, J.H. and Dodge, K.A. 1993. Quality assurance for laboratory analysis of suspended-sediment samples by the U.S. Geological Survey in Montana: USGS Open-File Report 93-131, 34 p.

Langbein, W.B., and Leopold, L.B. 1966. River meanders - theory of minimum variance. Geol. Surv. Prof. Papers, United States Printing Office, Washington, Report No: 422-H, 1-15.

Rosgen, D.R., and Silvey, H.L. 1996. Applied River Morphology, Wildland Hydrology, Pagosa Springs, CO.USLC Catalog No. 96-60962.365.

Rosgen, D. 2006. Watershed Assessment of River Stability and Sediment Supply. Wildland Hydrology.

RIVERMorph LLC. 2005. Stream Restoration Software. Louisville, Kentucky 40223-2177.

State of Montana. 2007. Milltown Restoration Weed Management Plan. Prepared for the State of Montana, Department of Justice, Natural Resource Damage Program. Prepared by Geum Environmental Consulting, Inc.

Thorne, C.R., Hey, R.D., and Newson, M.D. (Editors). 1997. Applied Fluvial Geomorphology for River Engineering and Management. J. Wiley & Sons, Chichester.

USDA Forest Service. 1989. Ecosystem Classification Handbook: ECODATA. USDA Forest Service, Northern Region, Missoula, Montana.

Wolman, M.G. 1954. A method of sampling coarse river-bed gravel. Transactions of American Geophysical Union 35: 951-956.

Appendix B. Data to support performance criteria development

Table B-1. Channel Metrics from Reference Reaches

Metric	Reach	#	Mean	Med	1SD	CV	Min	Max
Channel Area (sq ft)	CFR Above Confluence	55	571	563	115	20%	333	951
	CFR Below Confluence	13	1,359	1,304	243	18%	1,014	1,849
	BFR	10	906	908	153	17%	662	1,079
Width (ft)	CFR Above Confluence	55	168	161	33	19%	120	266
	CFR Below Confluence	13	255	242	32	13%	217	302
	BFR	10	192	189	16	8%	175	217
Mean Depth (ft)	CFR Above Confluence	55	3.4	3.4	0.6	18%	2.1	4.8
	CFR Below Confluence	12	5.2	4.9	0.9	18%	4.4	7.7
	BFR	10	4.7	4.9	0.7	14%	3.7	5.6
Maximum Depth (ft)	CFR Above Confluence	55	5.6	5.4	1.3	22%	3.4	9
	CFR Below Confluence	12	7.7	7.4	1.8	23%	5.7	12
	BFR	10	7.1	7.3	1.4	20%	5	9.8
Bank Height Ratio*	CFR Above Confluence	30	1.1	1.1	0.1	9%	1	1.4
	CFR Below Confluence	11	2.3	2.3	0.5	20%	1.4	2.9
	BFR	3	1.5	1.6	0.3	19%	1.1	1.6
Belt Width (ft)	CFR Above Confluence	52	685	689	218	32%	325	1,175
Meander Length (ft)	CFR Above Confluence	49	2,180	2,250	534	24%	1,250	3,144
Radius (ft)	CFR Above Confluence	50	748	700	287	38%	200	1,450
Meander Migration (ft/yr)	CFR Above Confluence	40	13	6	16	120%	0	67
Riffle Stability Index	CFR Above Confluence	9	D_{84}	D_{85}	9	11%	D_{66}	D_{98}
Largest Particle Entrained (mm) From Scour Chain Data	CFR Above Confluence	6	139	139	19	13%	113	170

Notes:
1. Planform metrics were not analyzed for CFR below the confluence or the BFR since restoration will not significantly alter planform metrics from the existing condition.
2. Except for channel migration, no distinction is made between short-term and long-term channel metrics because channel metrics exist in dynamic equilibrium. Short-term and long-term channel migration values are presented in Table 1.

* Low bank height (measured from thalweg) divided by maximum channel depth

- Number of samples
Med – median
1 SD – the value of one standard deviation
CV – coefficient of variance (SD/avgas)
Min – minimum value
Max – maximum value

Table B-2. Performance Criteria Proportional Abundance of Floodplain Cover Types Existing, Short-term and Long-term

Cover type	Existing (from Reach 3) (% canopy cover)	Short-Term 5-15 yrs (% canopy cover)	Long-Term 15-25 yrs (% canopy cover)
Main channel water surface at base flow	8	5-8	5-8
Off channel water surface at base flow	6	2-5	2-5
Exposed depositional areas at base flow	2	5-15	5-10
Depositional areas with colonizing willows and cottonwoods	1	10-25	5-15
Other shrub wetland (PSS) communities	22	5-15	10-20
Herbaceous wetland (PEM) communities	10	10-20	5-15
Pole cottonwood and aspen 2 to 6 meters in height	1	5-10	10-20
Mature cottonwood	7	10-20	20-40
Conifer (ponderosa pine and Douglas-fir)	5	5-10	10-20
Agricultural field	38	Determined by post-restoration land use plan	Determined by post-restoration land use plan
Developed, including buildings/roads/trails/recreational facilities	0	0-5	0-5

*Cover types and desired proportional distributions are adapted from Hauer et al. (2002). Existing distribution is based on actual cover type distributions within Reach 3. Long term and short term proportional distribution ranges are adapted from Hauer et al. (2002) and adjusted to match expected belt widths within the CFR floodplain.

Appendix B Spotted Dog Reach SD-01b and SD-01c Restoration Concept (NRDP 2014)

Geum Environmental Consulting, Inc.

307 State Street
P.O. Box 1956
Hamilton, MT 59840
Phone: (406) 363-2353, Fax (406) 363-3015
http://www.geumconsulting.com

Date: December 11, 2014

To: Doug Martin, Department of Justice Natural Resource Damage Program

From: Amy Sacry, Geum Environmental Consulting
Matt Daniels, River Design Group

Subject: Spotted Dog Reach SD-01b and SD-01c Restoration Concept

This memo describes the recommended restoration concept for Spotted Dog reaches SD-01b and SD-01c. These reaches of Spotted Dog Creek are described in the Little Blackfoot River Riparian Assessment Report (Geum and River Design Group 2014). This report identified Spotted Dog Reach SD-01c as a candidate for active restoration and further development of a restoration concept for this reach was requested. On September 24, Geum and River Design Group walked Spotted Dog Reaches SD-01a, SD-01b and SD-01c to develop a restoration concept for Reach SD-01c. During this assessment, additional active restoration opportunities in Reach SD-01b were identified that support restoration actions recommended for Reach SD-01c. The following sections describe the restoration concept for each reach, approximate costs for design and implementation, and next steps.

Restoration Concept: Reach SD-01b

Reach SD-01b is 9,782 feet in length and located on land owned by Montana Fish, Wildlife and Parks. This reach is heavily influenced by current and past beaver activity and grazing. Few active beaver dams were observed in this reach in 2014, but where beaver dams are present there is diverse aquatic habitat and riparian vegetation. Where there is little or no beaver activity the channel has incised with high amounts of bank erosion, limited streambank vegetation and uniform aquatic habitat. This channel incision is likely a result of beaver dam failure due to declining beaver activity and grazing that has removed woody vegetation along streambanks. Floodplain connectivity therefore varies throughout the reach, with some areas well connected supporting diverse vegetation and habitat and other areas disconnected and much drier and more impacted by grazing.

Restoration actions were identified in SD-01b to enhance aquatic habitat; restore floodplain connection; and transition between restoration actions in this reach and restoration actions proposed in reach SD-01c. The basis for the restoration concept for SD-01b is that increased beaver activity or mimicked beaver activity in the form of constructed porous woody debris structures will gradually aggrade the incised portions of the reach enough to raise the alluvial water table and reconnect the stream to its former floodplain. These actions should only be considered in conjunction with the actions proposed for Reach SD-01c to eliminate the active upstream propagation of incision occurring there. To sustain an elevated water table, restore floodplain connection and promote natural restoration and sustainability of a diverse willow dominated riparian area will require continued and even increased beaver activity in the reach to help maintain and re-build installed structures and additional beaver dams. The current level of beaver activity is uncertain, but appears to have declined in recent years.

The restoration concept for SD-01b includes the following actions. The approximate locations of restoration actions are shown on Figure 1.

- Install porous woody debris structures mimicking natural beaver dams to raise the water table, create aggradation and restore floodplain connectivity. The approximate locations of structures are shown in Figure 1. These are generally located where beaver dams have existed in the past as evidenced by dam remnants and areas of sediment deposition. The number of structures may need to be increased depending on anticipated future levels of beaver activity.
- Increase natural beaver activity through management actions. Management actions to increase natural beaver activity would need to be determined with project partners and guided by identification of factors currently limiting beaver activity, but may include: reducing or eliminating grazing and herbivory to increase cover of willows, reducing trapping (if this is occurring) or other predation, and protecting and expanding existing woody vegetation.
- Implement weed control in floodplain.
- Fence or repair fencing to exclude cattle from riparian area and install water gaps or water access points as needed.



Photo on the top left shows an area in SD-01b where beaver dams have helped aggrade the channel and provide floodplain connectivity; Photo on the top right shows an area in SD-01b where channel incision has resulted in lost floodplain connectivity; Photo on the bottom shows a beaver dam remnant.

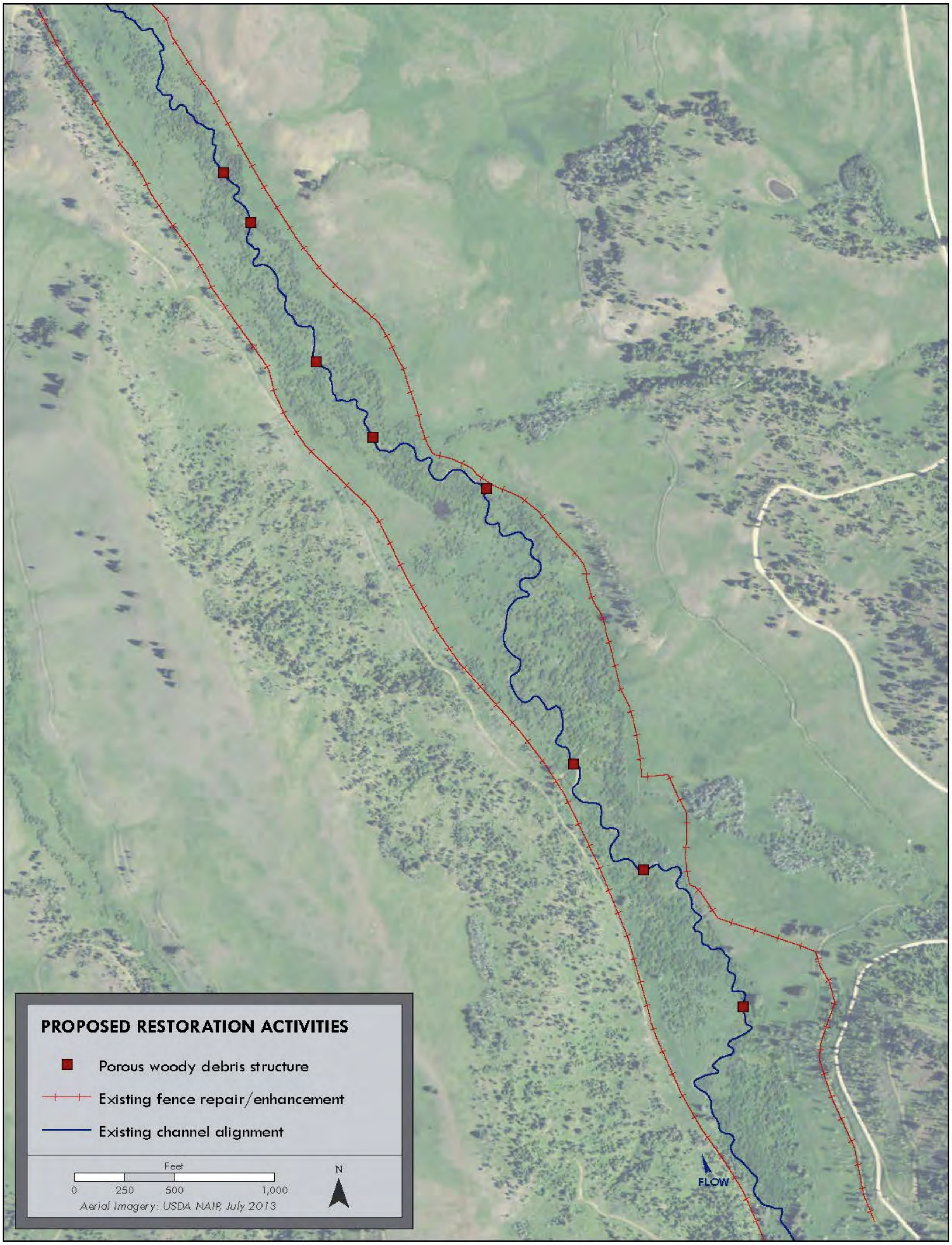


Figure 1. Recommended restoration concept for Spotted Dog Reach SD-01b.

Restoration Concept: Reach SD-01c

Reach SD-01c is a 5,174 foot long reach located on land owned by the Montana Department of Fish, Wildlife and Parks. This reach begins at a long section of unstable channel that is actively propagating instability upstream in the form of a headcut near the downstream end of reach SD-01b. This unstable section is over 200 feet long, is characterized by erosion of both streambanks and is incised below the floodplain by up to 4 feet. It is likely that the incision is the result of discontinued beaver activity in this reach combined with removal of woody vegetation from the floodplain due to cattle grazing. The headcut has been temporarily arrested by two successive beaver dams with approximately two to four foot vertical drops. Eventual failure of these dams will allow the headcut to propagate into Reach SD-01b thus abandoning the existing floodplain and initiating the evolutionary process from wetlands to various transitional alluvial channels as evidenced downstream. Below this unstable section, the channel becomes more sinuous and regains connectivity with the floodplain. Bank erosion is still high in this portion of the reach due to the loss of woody streambank and floodplain vegetation. Approaching the lower end of SD-01c, there is an abandoned bridge crossing the channel that has accumulated sediment and woody debris over time. This has resulted in sediment deposition above the structure and channel braiding. Below this crossing, the channel again becomes incised up to 3 feet below the floodplain and bank erosion increases. A small tributary enters Spotted Dog Creek from the west near the end of the reach, just upstream of an existing road crossing. Approximately 150 feet below this road crossing the channel becomes less incised as it transitions into a narrow valley bottom.

The objective of restoration in this reach is to construct a new channel that is connected with the floodplain. Restoration would improve stability and reduce sediment loading to downstream reaches. The incised channel could recover and aggrade naturally, but would require a very long period of time. For this reason, building a new channel that is hydrologically connected to the floodplain is recommended. Beaver activity may affect the newly constructed channel; however, due to lack of food sources in Reach SD-01c beaver are not likely to occupy or build dams in the new channel for a number of years post restoration. Once beaver do colonize this area, there will may be short-term disturbances such as localized erosion and aggradation, but these will lead to long-term beneficial effects on habitat and the ecosystem.

The ecological potential for this reach is a mosaic of wet meadow and willow dominated shrub communities. Currently the floodplain is dominated by a mix of dry grasses and wetland graminoids, and it is expected that the vegetation will rapidly transition to deep rooted herbaceous wetland species with reconnection of the channel and floodplain and resulting increase of the alluvial groundwater elevation. Restored floodplain connection and reduced grazing pressure will also increase woody riparian vegetation, primarily willows.

The restoration concept for reach SD-01c includes the following actions. The approximate locations of restoration actions are shown in Figure 2.

- Reconnect the channel to the abandoned floodplain surface through construction of a new channel. There may be a number of options for the location of the new channel and this can only be determined through collection of detailed topographic data. Some sections of the existing channel would be maintained that are currently connected with the floodplain, have sustainable channel dimensions and exhibit aquatic habitat diversity. Abandoned segments of the existing channel would be filled or converted into off-channel wetland features.

- Incorporate aquatic habitat features into the newly constructed channel. The recommended channel type for this reach is a sinuous (approx. 1.5 to 2.0) E channel that is well connected to the floodplain. This type of channel often requires fewer channel structures than other channel types, although habitat structures consisting of woody debris would be used to diversify aquatic habitat.
- The amount of floodplain grading that will be required is uncertain. The aim would be to reconnect the channel to as much of the existing ground as possible to minimize the need for floodplain grading. Where floodplain grading is required, floodplain roughness elements will be included such as small undulations in topography and placement of woody debris on and buried into the surface for erosion control and to provide microsites for establishing vegetation.
- Restore woody riparian vegetation through active revegetation. Although natural revegetation of the reach is expected to be high with an elevated water table and grazing eliminated, some planting should be done in select locations along the restored channel to promote rapid establishment of desired woody vegetation.
- Construct and/or repair fence around project reaches. Shrubs are currently being suppressed by cattle grazing. Reducing or eliminating grazing along the channel, combined with reconnection of the channel with the floodplain, should result in rapid establishment of desired woody vegetation.
- Remove bridge, corrals and other unnecessary infrastructure within and along the stream.



Photo on the top left shows the upper end of Spotted Dog SD-01-c where reconstruction of the channel is proposed; Photo on the top right shows the mid to lower end of Spotted Dog SD-01-c where channel conditions can be preserved; Photo on the bottom shows the bridge that should be removed or replaced.

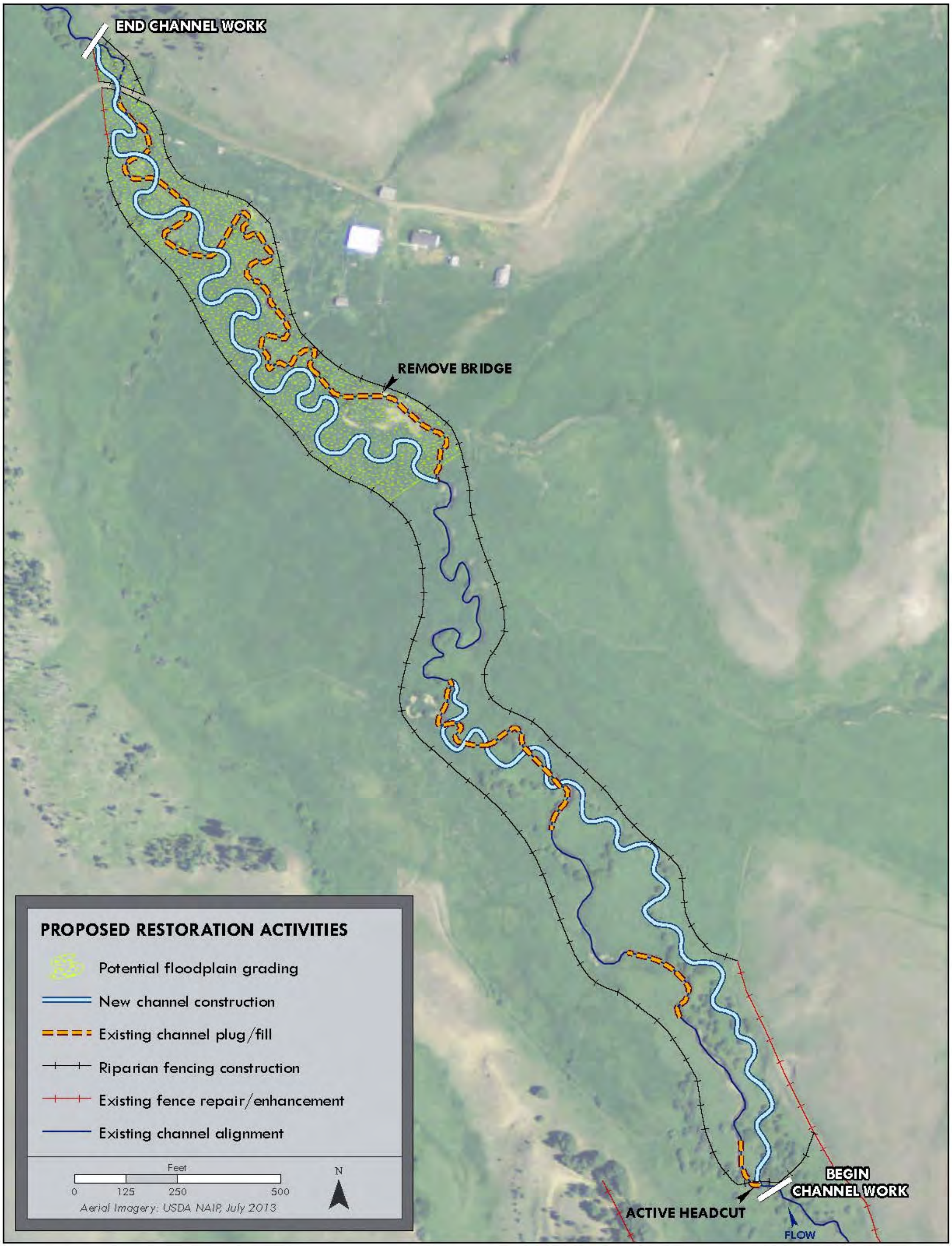


Figure 2. Recommended restoration concept for Spotted Dog Reach SD-01c.

Data Collection and Restoration Design

To develop a restoration design that can be used to solicit bids and construct the project, the following next steps are needed:

- Collect data to support restoration design; recommended data collection needs include:
  - **LiDAR –** Collection of LiDAR data for the project reaches will be the most cost effective way to determine options for the new channel location in Reach SD-01c and woody debris structure locations in Reach SD-01b. This data may also support additional land management decisions in this area.
  - **Channel bathymetry** – Supplement terrestrial LiDAR topography data with channel topography below the water surface.
  - **Bankfull profile** - Identify floodplain tie-in elevations by surveying existing bankfull indicators.
  - **Channel geometry** – Measure cross sections at reference riffle and pool units to support development of dimensions for new channel construction.
  - **Channel substrate** – Collect pebble count data to characterize bed conditions and support sediment transport investigations.
  - **Vegetation Assessment –** Riparian vegetation was already assessed in the reaches, but additional analysis of vegetation should be completed, including evaluating relative elevation of vegetation communities to the existing and proposed channel and identification of high quality vegetation to preserve in the vegetation design.
  - **Wetland delineation** – Identify jurisdictional wetlands in the project area to support project permitting and restoration design.
  - **Verify beaver activity** – Proposed restoration actions in Reach SD-01b depend on continued beaver activity to maintain and enhance constructed woody debris structures. Data needed to determine the potential for continued beaver activity includes accurately determining the presence or absence of beaver through observation of beaver sign and evaluating habitat suitability to support beaver and their dams. There are a number of beaver habitat suitability and capacity models, such as the Beaver Restoration Assessment Tool (BRAT) (Macfarlane and Wheaton 2013) and the Habitat Suitability Index (HIS) (Suzuki and McComb 1998), that provide information on how to determine habitat suitability which can be used as guidance on assessing Reach SD-01b. An assessment of the reach would include evaluating some of the key variables identified in these models such as: availability of hardwood vegetation (food and dam building), consistent and adequate water availability, stream gradient, suitable soil/sediment for dam construction, sufficient valley floor width, grazing, trapping pressure, and proximity to human conflicts.
- Prepare a brief permit support document and construction plan set to support permit acquisition and procuring contractors that includes:
  - Plan view of treatment locations
  - Channel dimensions
  - Detail drawings for channel structures
  - Revegetation plan
  - Location of jurisdictional wetlands and wetland impacts
  - Earthwork volumes and materials quantities
  - Detailed cost estimate

Cost Estimate

The following table provides a preliminary estimate of costs to design and implement the proposed restoration concepts described above. Additional data collection, particularly collection of LiDAR data, will help refine costs associated with new channel construction and floodplain grading.

Table 1. Summary of approximate costs for design and implementation of the proposed restoration concepts for Spotted Dog reaches SD-01b and SD-01c.

Item	Quantity	Units	Unit Cost	Cost
Reach SD-01b Construction				
1-Mobilization and Demobilization[1]	1	Lump Sum	$ 3,000	$ 3,000
2-Water Management	1	Lump Sum	$ 2,000	$ 2,000
3-Acquire and Furnish Trees and Brush	8	Trees	$ 300	$ 2,400
4-Porous woody debris jams	8	Structures	$ 2,000	$ 16,000
5-Weed Control	95	Acres	$ 50	$ 4,750
6-Seeding	0.5	Acres	$ 300	$ 150
7-Fence Repair, Maintenance, Additional Fence, Water Gaps	15,450	Lump Sum	$ 5,000	$ 5,000
			CONSTRUCTION TOTAL	**$ 33,300**
Reach SD-01c Construction	**Stream Length: 4,655 ft**		**Cost/ft: $70**	
1-Mobilization and Demobilization[1]	1	Lump Sum	$ 30,000	$ 30,000
2-Water Management	1	Lump Sum	$ 5,000	$ 5,000
3-Acquire and Furnish Trees and Brush for Banks and Floodplain	203	Trees	$ 300	$ 60,930
4-Acquire and Furnish Gravel for Streambed Material	414	Cubic Yards	$ 40	$ 16,551
5-Materials Salvage (trees, soil, vegetation)	2	Acres	$ 3,000	$ 6,000
6-Floodplain Excavation	10,000	Cubic Yards	$ 6	$ 60,000
7-Streambed Construction	4.655	Linear Feet	$ 5	$ 23,275
8-Bioengineering Streambank Structures	931	Linear Feet	$ 45	$ 41,895
9-Vegetated Wood and Brush Fascine Streambank Structures	931	Linear Feet	$ 15	$ 13,965
10-Woody Debris Jam Streambank Structures	10	Structures	$ 500	$ 5,000
11-Acquire Vegetative Cuttings for Streambank Structures	9,310	Cuttings	$ 1	$ 9,310
12-Floodplain Surface Roughness Treatments	2	Acres	$ 2,500	$ 5,000
13-Revegetation	2	Acres	$ 10,000	$ 20,000
14-Seeding	5	Acres	$ 300	$ 1,500
15-Riparian Fencing Installation	6,600	Linear Feet	$ 4	$ 26,400
16-Weed Control	100	Acres	$ 50	$ 5,000
			CONSTRUCTION TOTAL	**$329,826**
Other Costs				
Design (data collection, analysis, plans and permitting)	15% of Construction Cost			$ 54,469
LiDAR				$ 10,000
Construction oversight (staking and compliance)	10% of Construction Cost			$ 36,313
Monitoring and Maintenance	15% of Construction Cost			$ 54,469
Contingency[2]	15% of Sub-total			$ 77,756
			GRAND TOTAL	**$596,133**

[1] Includes site preparation, development of access and staging, site facilities, site reclamation and other miscellaneous costs.

[2] Included to address uncertainty.

References

Geum Environmental Consulting, Inc. and River Design Group, Inc. 2014. Little Blackfoot River Riparian Assessment. Report prepared for Natural Resource Damage Program, Montana Department of Justice, Helena, MT.

Macfarlane, W.W. and J.M. Wheaton. 2013. Modeling the capacity of riverscapes to support dam-building beaver – case study: Escalante River watershed. Ecogeomorphology and Topographic Analysis Lab, Utah State University, Prepared for Walton Family Foundation, Logan, Utah, 78 pp.

Suzuki, N. and W.W. McComb. 1998. Habitat classification models for beaver (*Castor Canadensis*) in the streams of the Central Oregon Coast Range. Northwest Science 72(2) 102-110.

Appendix C Upper Clark Fork River Basin Aquatic Resources Restoration Plan Monitoring and Maintenance Plan (NRDP 2014)

DRAFT 2012 Upper Clark Fork River Basin Aquatic Resources Restoration Plan
Monitoring and Maintenance Plan

Prepared For:

Natural Resource Damage Program

Montana Department of Justice

Helena, Montana

Prepared By:

Geum Environmental Consulting, Inc.

Hamilton, Montana

2015

[*This page intentionally left blank*]

Table of Contents

[*This page intentionally left blank*]

1 Introduction

1.1 Purpose, Scope, and History

This *2012 Upper Clark Fork River Basin Aquatic Resources Restoration Plan, Monitoring and Maintenance Plan* (Monitoring Plan) is a working document that describes a program to evaluate the effectiveness of the State of Montana, Natural Resource Damage Program's (NRDP) restoration actions for aquatic resources in tributaries of the Upper Clark Fork River Basin (UCFRB). The *Final Upper Clark Fork River Basin Aquatic and Terrestrial Resource Restoration Plans* (2012 Restoration Plan) (NRDP 2012a) document describes the need for this Monitoring Plan. Monitoring and maintenance recommendations in this document are based on tributary restoration actions proposed in the Aquatic Resources portion of the 2012 Restoration Plan. Monitoring and maintenance associated with instream flow and terrestrial restoration projects are being addressed through separate, but coordinating programs. The information from these and other programs will be used to inform and interpret monitoring results for the aquatic resources restoration actions.

This monitoring and maintenance plan is intended to ensure that restoration projects implemented through the NRDP's tributary restoration actions comply with project requirements and describes measures to evaluate how restoration actions are meeting goals established for the project (project performance monitoring), the watershed (watershed monitoring), and the basin (basin monitoring).

This Monitoring Plan provides a framework and for the Monitoring Program and also identifies additional components that will be developed in more detail including a monitoring data management framework, an adaptive management framework and detailed monitoring plans. This document provides a 'toolbox' of monitoring metrics and methods to develop basin, watershed, and project-specific monitoring plans and project-specific maintenance plans. The Next Steps section at the end of this document describes what is needed to develop these portions of the Monitoring Program along with other tasks to further develop this working draft of the monitoring plan and begin implementing the Monitoring Program.

The 2012 Restoration Plan includes a detailed history of the NRDP's litigation against the Atlantic Richfield Company (ARCO) on behalf of the State of Montana and subsequent settlement agreements that led to the establishment of the UCFRB Restoration Fund. The 2012 Restoration Plan also describes the UCFRB Restoration Fund's structure and purpose; and how funds are managed and allocated to restore, rehabilitate, replace, or acquire the equivalent of UCFRB injured natural resources.

Several documents preceded the 2012 Restoration Plan and guided its development as well as the development of this Monitoring and Maintenance Plan, including the following:

- *Final Upper Clark Fork River Basin Interim Restoration Process Plan* (NRDP 2012b)
- *2011 Final Upper Clark Fork River Basin Long Range Priorities and Fund Allocation Guidance Plan* (NRDP 2011)
- *Prioritization of Areas in the Upper Clark Fork River Basin for Fisheries Enhancement* (MFWP and NRDP 2011a)

- *Upper Clark Fork River Basin Terrestrial Wildlife Resource Prioritization* (MFWP and NRDP 2011b)
- *Upper Clark Fork River Basin Terrestrial Resource Assessment Final Report* (MFWP and NRDP 2010a)

The UCFRB is the focus of intensive monitoring for ongoing remediation and restoration efforts as well as other natural resource monitoring. Additionally, the NRDP is developing separate monitoring plans for evaluating instream flows and terrestrial habitats. The NRDP will coordinate with other entities conducting monitoring in the UCFRB and reference information from these other monitoring efforts to inform interpretation and findings of monitoring results from this Monitoring Plan.

1.2 Document Organization

This document is organized as follows:

- Section 2 describes components of the monitoring program including the spatial scales and types of monitoring that will be used to evaluate the NRDP's implementation of the 2012 Restoration Plan.
- Section 3 describes restoration goals and limiting factors discussed in the 2012 Restoration Plan.
- Section 4 describes the monitoring plan framework that links limiting factors and restoration goals with monitoring metrics and performance targets that will be used to evaluate the success of the restoration actions and the restoration program.
- Section 5 describes a framework for developing project specific maintenance plans.
- Section 6 describes the timeframes and anticipated costs for implementing this Monitoring and Maintenance Plan.
- Section 7 describes a data management system for organizing and storing monitoring data.
- Section 8 describes an adaptive management framework for evaluating monitoring data and making decisions for maintenance needs.
- Section 9 describes next steps in continuing to develop the NRDP's monitoring program for aquatic restoration actions in the UCFRB.

2 Monitoring Components

2.1 Monitoring Scale

This monitoring program evaluates the NRDP's restoration program at three spatial scales: basin, watershed, and project. Restoration goals differ at each spatial scale; therefore, monitoring recommendations are also different. The following is a more detailed discussion of the three spatial scales in this Monitoring Plan. Figure 1 shows an overview of the UCFRB and the priority watersheds that are the focus of the 2012 Restoration Plan and this Monitoring Plan.

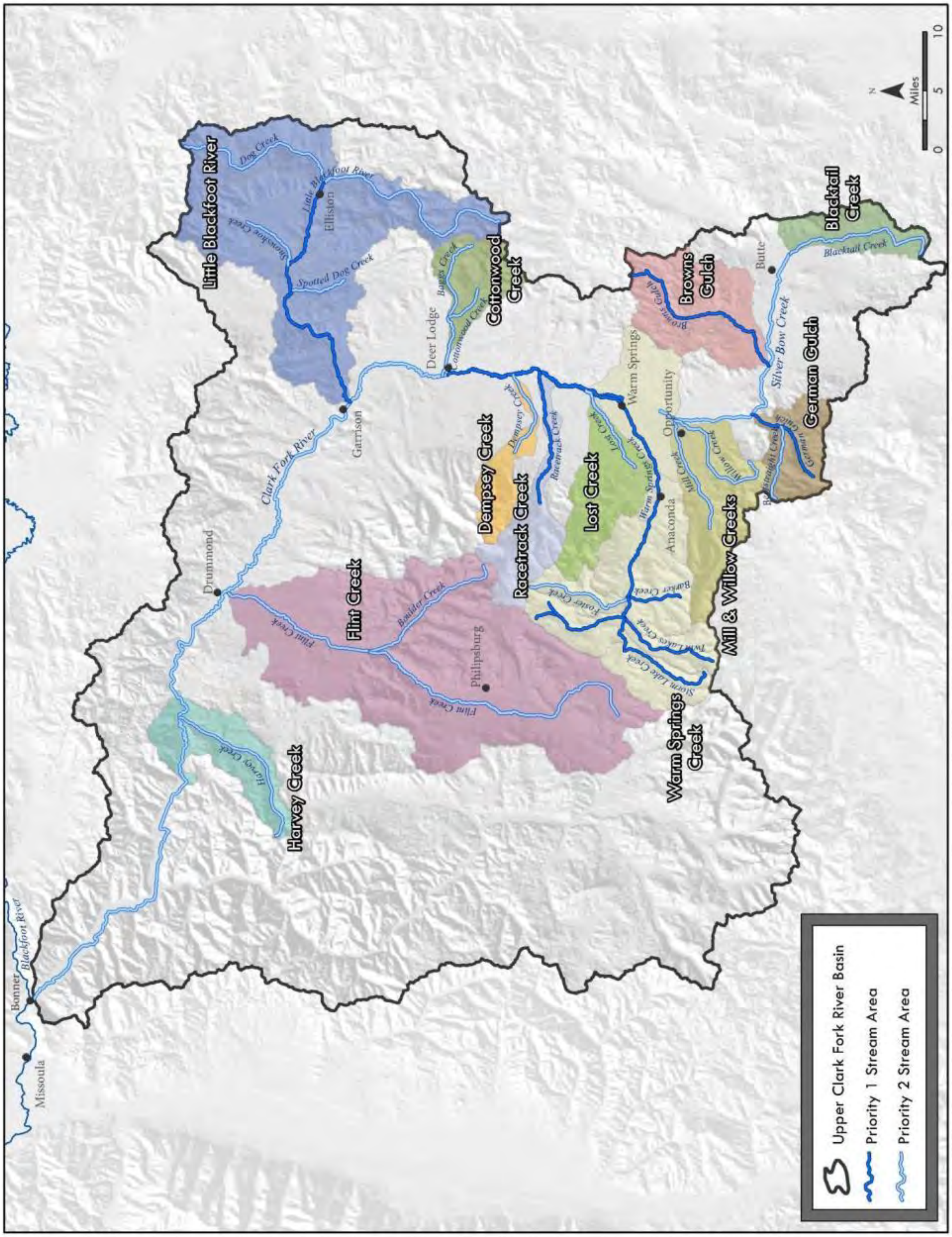


Figure 1. Overview of the Upper Clark Fork River Basin and the 12 Priority 1 and 2 tributary watersheds that are the focus of the 2012 Restoration Plan.

2.1.1 Basin Monitoring

The basin refers to the mainstems of the Clark Fork River and Silver Bow Creek from the headwaters near Butte, Montana downstream to the confluence of the Clark Fork River with the Blackfoot River near Bonner, Montana (Figure 1). Monitoring at this scale "measures the effectiveness of all the restoration projects and how they are contributing to the recovery of the Silver Bow Creek and Clark Fork River mainstem fisheries," (NRDP 2012a). Monitoring at the basin scale includes recommendations for specific monitoring metrics, methods, and performance targets reflecting the specific restoration goals that have been established by the NRDP's restoration program described in Sections 3.1 and 4.1.

2.1.2 Watershed Monitoring

The watershed refers to 12 of the Priority 1 and 2 tributary watersheds within the UCFRB that are the focus of the 2012 Restoration Plan; these include tributaries to both Silver Bow Creek and the Clark Fork River (Figure 1):

- Blacktail Creek
- Browns Gulch
- Cottonwood Creek
- Dempsey Creek
- Flint Creek
- German Gulch
- Harvey Creek
- Little Blackfoot River
- Lost Creek
- Mill-Willow Watershed
- Racetrack Creek
- Warm Springs Creek

Section 3.2 briefly describes each watershed including restoration goals based on proposed restoration actions described in the 2012 Restoration Plan and priorities to guide restoration planning from the 2011 Prioritization Plan (MFWP and NRDP 2011a). In some watersheds, restoration actions are proposed for secondary streams in addition to the main tributary channel. Monitoring at the watershed scale also includes metrics, methods, and performance targets to evaluate the cumulative effects of restoration actions similar to basin monitoring. However, watershed monitoring is more specific relative to the restoration goals and actions that are implemented in the watershed. Details of watershed monitoring are described in Section 4 below.

2.1.3 Project Monitoring

Project monitoring refers to specific restoration projects occurring within a watershed. Restoration projects are currently being identified and developed and may include one or more restoration actions. Because restoration projects are being developed during and after completion of this Monitoring Plan, recommended monitoring protocols are included for the types of restoration actions that are expected to occur, rather than for specific restoration projects. Section 4.3 of this document provides guidance on developing site-specific monitoring plans using a suite of monitoring metrics, methods, and performance targets related to restoration goals and actions. Appendix A includes an example monitoring plan developed using this framework for a restoration project in the Harvey Creek watershed.

2.2 Types of Monitoring

This Monitoring Plan evaluates restoration through four types of monitoring: baseline, compliance, implementation, and effectiveness.

2.2.1 Baseline Monitoring

Baseline monitoring documents the pre-restoration (degraded) condition and is completed prior to implementing restoration actions. Baseline monitoring also informs project selection and design and can serve as the initial comparison point for the effects of the implemented restoration actions for certain types of effectiveness monitoring. Baseline monitoring data may also be used to establish specific, measurable goals and set appropriate performance targets for each project (described in effectiveness monitoring below). Baseline monitoring occurs at the basin, watershed, and project scale. Baseline monitoring may also include the selection of control or reference sites to be used as a comparison to restoration sites for some types of effectiveness monitoring. Control or reference sites may occur within the UCFRB or within nearby drainages and represent areas with similar physical and biological characteristics where restoration actions are not being implemented. Specific control or reference site needs and locations will be determined for each monitoring scale as detailed monitoring plans are developed for effectiveness monitoring described below.

2.2.2 Compliance Monitoring

Compliance monitoring addresses requirements from permits or other regulations during and after the construction process. It ensures that all conditions of project permits are met. Compliance monitoring may include documenting when work occurred if work windows were specified, documenting the use and effectiveness of Best Management Practices (BMPs), and other requirements as needed. Compliance monitoring only occurs at the project scale.

2.2.3 Implementation Monitoring

Implementation monitoring documents conditions during project construction and the as-built condition. It documents treatment locations and extents, materials quantities, and other treatment specific information to show how the as-built condition compares to the designed restoration actions. Implementation monitoring only occurs at the project scale.

2.2.4 Effectiveness Monitoring

Effectiveness monitoring documents whether the goals of the overall UCFRB restoration program and specific restoration projects are being met following the implementation of restoration actions, determines maintenance needs, and provides inputs for adaptive management decision pathways. Effectiveness monitoring occurs at the basin, watershed, and project scale.

Monitoring metrics represent measurable units that will be used to evaluate restoration goals. Performance targets are developed for each metric that further evaluate the restoration goal and provide a target for each metric that measures progress toward achieving the restoration goal. Effects of restoration may take variable amounts of time to manifest in both physical habitat and biological populations; therefore, expectations in terms of restoration goals, monitoring metrics, and performance targets for the monitoring metrics may be different during the course of the monitoring timeframe. There are generally three timeframes for evaluating effectiveness monitoring:

- Short-term – the first five years following implementation;
- Mid-term – five to fifteen years following implementation; and
- Long-term – more than fifteen years following implementation.

During the short-term timeframe, results of restoration actions may not be very apparent as vegetation is establishing and pioneer species colonize the disturbed site. Newly constructed channel and floodplain surfaces rely on built structures for temporary stability as vegetation establishes. Most observable changes will be related to direct restoration actions that were implemented to change the physical environment, such as increased herbaceous vegetation cover where riparian areas are restricted from grazing. Evidence of changes in biological populations will be variable in the short-term. For example, response of migratory fish species to fish passage improvement projects can be significant even in the short-term; while population changes resulting from other types of habitat improvement projects may be more apparent during the mid- to long-term timeframe as generational responses are detectable. During the short-term timeframe it is also important to detect early trends in the effectiveness of restoration actions and to identify maintenance needs and inform planning decisions for future similar projects. Maintenance actions are typically required during this timeframe.

During the mid-term timeframe, results of restoration actions become more apparent such as planted vegetation transitioning to self-sustaining communities that no longer require maintenance actions. Constructed channel and floodplain surfaces begin to develop natural stability from vegetation establishment. Changes in biological populations may be more apparent as generational responses are observed.

During the long-term timeframe, riparian and aquatic habitats are expected to reflect natural conditions and support dynamic channel and floodplain processes. Mature vegetation provides stability that also allows for natural channel adjustments. Changes in the distributions of, proportions of, or use of habitats by biological populations may be more evident as multiple generations respond to the changes in habitat conditions.

Effectiveness monitoring requires the development of specific, measurable goals and detailed monitoring plans that determine sampling designs including selecting appropriate reference or control sites as needed. This Monitoring Plan provides the framework to support further development of detailed monitoring plans that will include specific, measurable goals. General goals and performance targets are described in Section 3.0. These goals and performance targets will be refined as detailed monitoring plans are developed to ensure they are measurable. During the process of developing detailed monitoring plans, appropriate sample designs for the different spatial scales and metrics being evaluated will be considered. Examples of sample designs that may be used include, but are not be limited to: before-after, control-impact (BACI) assessments, end-point assessments, or response ratio assessments. Each type of assessment answers different kinds of questions and may be more or less appropriate for each monitoring scale and the metrics that will be evaluated within each scale.

Before-after, control-impact study designs require control(s) sites with similar conditions to the treatment area. Data are collected in both the treatment and control sites before and after the restoration action is implemented. At the basin scale, control sites with the same degraded conditions as the UCFRB do not likely exist, prohibiting the use of this type of assessment. A BACI study design may be most appropriate for project scale effectiveness monitoring to evaluate the success of expensive or complex restoration actions where knowing if the action is directly causing a desired result (or achieving a specific project goal) would be beneficial to the NRDP and project proponents. This type of information would also be useful for future project planning to determine if specific restoration actions achieve the desired outcome.

End-point study designs require only post-project monitoring data to determine if a desired outcome is occurring. This type of assessment is possible for all three spatial scales of effectiveness monitoring and may be useful when establishing a cause-effect relationship is not necessary or is not possible, and achieving a defined goal indicates success.

Response ratio study designs require data collection at a treatment site and at a suitable reference site that represents the desired aquatic habitat, riparian habitat, or population composition conditions. This type of assessment is possible for all three spatial scales of effectiveness monitoring. Response-ratio assessments may be most useful where variable outcomes may indicate success if the results are comparable to conditions at the reference site.

3 Aquatic Restoration Goals and Limiting Factors

Restoration goals for the UCFRB are described in the 2011 Prioritization Plan and the 2012 Restoration Plan which identify the desired results of the NRDP's restoration program for the basin and the watershed (NRDP 2011 and 2012a). Limiting factors as they are used in this document refer to environmental conditions such as aquatic and riparian habitat that limit the abundance, distribution, or growth of biological populations. Limiting factors can generally be changed through restoration actions versus constraints which cannot be changed. The 2012 Restoration Plan identified limiting factors for priority watersheds described in Section 3.2 which were linked to aquatic restoration goals that directly address these limiting factors. Project restoration goals will be established as restoration projects are developed within the watersheds as a collaborative effort between the NRDP and the project proponents. Project goals will generally correspond with limiting factors identified within the watersheds but more specific goals may also be developed depending on the project and the limiting factors that are present. Monitoring described in Section 4 is tied to the restoration goals for addressing limiting factors.

The following sections describe the specific basin restoration goal along with watershed and project restoration goals and limiting factors.

3.1 Basin Goal

The basin scale restoration goal is as follows: "The primary goal for the Silver Bow Creek and Clark Fork River mainstem fisheries is to restore trout populations and associated angling opportunities to levels similar for other area rivers" (NRDP 2011). Measuring whether or not the goal of restoring trout populations and angling opportunities to the mainstem Clark Fork River and Silver Bow Creek fisheries through tributary restoration is achieved is the focus of basin monitoring. Achievement of specific goals associated with recruitment from tributaries and restoration of tributary populations will be evaluated through watershed monitoring, described below.

Basin scale limiting factors in the Clark Fork River and Silver Bow Creek mainstems are being addressed through separate, but coordinating ongoing reclamation, remediation and restoration efforts that are expected to have a large cumulative benefit to the UCFRB. Monitoring physical changes in the mainstem Clark Fork River and Silver Bow Creek is outside the scope of this Monitoring and Maintenance Plan and will instead be addressed through site specific monitoring plans developed as part of remediation and restoration actions. Basin scale monitoring described in this Monitoring Plan will focus instead on evaluating trout populations and angling opportunities in the mainstem Silver Bow Creek and Clark Fork River to determine if the basin goal of restoring trout populations and angling opportunities to levels similar for other areas is achieved without necessarily determining a cause-effect relationship. Watershed and project monitoring described in the following sections may provide information to support identifying correlations or relationships between the effectiveness of tributary restoration actions and changes to mainstem trout populations.

3.2 Watershed Limiting Factors and Goals

The basin scale restoration goal was expanded to tributary watersheds in the 2011 Prioritization Plan (NRDP 2011). These more specific watershed scale goals, listed below, supported the prioritization process for evaluating the tributary watersheds for restoration potential. Watershed restoration goals include:

- Restore the mainstem fishery by improving recruitment of fish from tributaries;
- Replace lost trout angling in the mainstem by improving trout populations in tributaries; and
- Maintain or improve native trout populations in the UCFRB to preserve rare and diverse gene pools, and improve the diversity and resiliency of the trout fishery.

Additionally, restoration priorities and goals are linked to five main categories of limiting factors identified in the UCFRB tributary watersheds (NRDP 2012a), including:

- Water quantity,
- Riparian habitat,
- Fish passage,
- Fish entrainment, and
- Instream habitat.

Water quantity or flow, particularly in the mainstem Clark Fork River and Silver Bow Creek, will be addressed and monitored through a separate NRDP Instream Flow Program. However, some aspects of addressing limited instream flows through irrigation infrastructure improvements are included in this Plan. These projects generally involve improvements to irrigation diversion structures that currently capture most or all of the tributary water before it reaches the mainstem Clark Fork River channel. Monitoring proposed in this plan evaluates the effects to instream flow related to discharge rate and temperature of water entering the mainstem from the tributaries. The rest of the limiting factors are addressed in this Plan.

Table 1 summarizes the watershed scale limiting factors and restoration goals. The links between limiting factors and corresponding restoration goals are similar throughout the 12 tributary watersheds. However, not all the limiting factors are present in all of the watersheds and the priority to address these limiting factors varies based on the existing conditions within each watershed. The following sections briefly describe each of the 12 priority watersheds, including: a brief discussion of the existing resources within each watershed that influence their restoration potential and restoration goals based on proposed restoration actions described in the 2012 Restoration Plan that may be used to address the identified limiting factors. Additional details of the watersheds can be found in Section 3 of the 2012 Restoration Plan as well as other reports referenced in Section 1.1 of this document.

Table 1. Summary of watershed scale limiting factors and restoration goals from the 2011 Prioritization Plan (NRDP 2011) and 2012 Restoration Plan (NRDP 2012a).

Watershed Scale Limiting Factors	Watershed Scale Restoration Goals
Not Applicable	Restore the mainstem fishery by improving recruitment of fish from tributaries
	Replace lost trout angling in the mainstem by improving trout populations in tributaries
	Maintain or improve native trout populations in the UCFRB to preserve rare and diverse gene pools, and improve the diversity and resiliency of the trout fishery
Riparian Habitat	Improve riparian habitat conditions within targeted watersheds
Fish Passage	Improve fish passage to allow movement within the watershed and movement to and from the mainstems
Fish Entrainment	Reduce fish entrainment numbers
In-stream Habitat	Improve instream habitat conditions
Flow	Increased flow in targeted watersheds and the mainstem Clark Fork River

3.2.1 Blacktail Creek Watershed

Blacktail Creek is a tributary to Silver Bow Creek, located south of Butte, Montana that flows to the north before entering Silver Bow Creek. The Prioritization Plan ranked Blacktail Creek as a Priority 2 watershed with the potential to support the UCFRB restoration goals of improving fish recruitment from the tributaries to the mainstem Silver Bow Creek and replacing lost angling in the mainstem river by improving trout populations in the tributary (NRDP 2011). Blacktail Creek supports a native trout population including westslope cutthroat trout in its headwaters. Genetic sampling indicates this is a 100 percent pure population (Liermann et al. 2009).

Restoration goals for the Blacktail Creek watershed listed below are based on limiting factors and proposed restoration actions described in the 2012 Restoration Plan. These goals may be revised as additional assessments are completed, priorities are re-evaluated, and specific restoration opportunities are identified. Current Blacktail Creek watershed restoration goals are:

- Improve riparian habitat condition through riparian enhancement and protection measures;
- Improve instream habitat through riparian enhancement and protection measures; and
- Improve fish passage through selective irrigation diversion and/or culvert improvements and support movement of westslope cutthroat from the headwaters of Blacktail Creek into Silver Bow Creek (Pat Saffel, personal communication).

3.2.2 Browns Gulch Watershed

Browns Gulch, a tributary of Silver Bow Creek, is located northwest of Butte, Montana and flows south before entering Silver Bow Creek west of Butte. The Prioritization Plan ranked Browns Gulch as a Priority 1 tributary with the potential to support the restoration goals of improving fish recruitment from the tributaries to the mainstem and replacing lost angling in the mainstem river by improving trout populations in the tributary (NRDP 2011). Some Browns Gulch tributaries have genetically pure westslope cutthroat trout populations (unpublished data, as cited in WRC-TU 2012). Also, westslope cutthroat trout tagged in Silver Bow Creek have been observed in Browns Gulch close to the mouth (Naughton et al. 2011).

Restoration goals for the Browns Gulch watershed listed below are based on limiting factors and proposed restoration actions described in the 2012 Restoration Plan. These goals may be revised as additional assessments are completed, priorities are re-evaluated, and specific restoration opportunities are identified. Current Browns Gulch watershed restoration goals are:

- Improve instream flows through flow augmentation projects;
- Improve fish passage in select locations to support recruitment of native trout to the mainstem river;
- Improve instream habitat condition via increased flows and evaluating the need for selective channel stabilization and/or reconstruction work where severe instability is present;
- Improve riparian habitat condition via increased flows and riparian habitat protection and enhancement measures; and
- Reduce fish entrainment by prioritizing and selectively installing fish screens where most needed in the watershed and in coordination with fish passage projects.

3.2.3 Cottonwood Creek Watershed

Cottonwood Creek flows west to join the Clark Fork River north of Deer Lodge, Montana. The watershed includes three main stream reaches that are the focus of the NRDP's 2012 Restoration Plan, including: Baggs Creek, the lower reaches of Cottonwood Creek, and the upper reaches of Cottonwood Creek. Cottonwood Creek supports mixed trout populations (Lindstrom et al. 2008). All three stream reaches in the Cottonwood Creek watershed were ranked as Priority 2 streams with the potential to support restoration goals of improving fish recruitment from the tributaries to the mainstem and replacing lost angling in the mainstem river by improving trout populations in the tributary (NRDP 2011).

Restoration goals for the Cottonwood Creek watershed listed below are based on limiting factors and proposed restoration actions described in the 2012 Restoration Plan. These goals may be revised as additional assessments are completed, priorities are re-evaluated, and specific restoration opportunities are identified. Current Cottonwood Creek watershed restoration goals are:

- Improve fish passage at the mouth of Cottonwood Creek by improving the Kohrs Manning irrigation diversion structure;
- Improve flows and potentially water temperature at the confluence of Cottonwood Creek and the Clark Fork River by improving the Kohrs Manning irrigation diversion;
- Improve fish passage throughout the watershed by prioritizing and selectively improving irrigation diversions;
- Improve riparian habitat condition through riparian habitat protection and enhancement measures;
- Reduce fish entrainment by prioritizing and selectively installing fish screens where most needed in the watershed; and
- Improve instream habitat condition through riparian habitat protection and enhancement measures or through active restoration if needed.

3.2.4 Dempsey Creek Watershed

Dempsey Creek flows east to join the Clark Fork River south of Deer Lodge, Montana. Dempsey Creek supports westslope cutthroat trout, brook trout, and brown trout populations. Brown trout occur primarily in the lower reaches of the stream. Genetic sampling from 1986 showed a pure westslope cutthroat trout population in this stream (Liermann et al. 2009). The Prioritization Plan ranked Dempsey Creek as a Priority 2 stream with the potential to support the restoration goals of improving fish recruitment from the tributaries to the mainstem and replacing lost angling in the mainstem river by improving trout populations in the tributary (NRDP 2011).

Restoration goals for the Dempsey Creek watershed listed below are based on limiting factors and proposed restoration actions described in the 2012 Restoration Plan. These goals may be revised as additional assessments are completed, priorities are re-evaluated, and specific restoration opportunities are identified. Current Dempsey Creek watershed restoration goals are:

- Improve instream flows through flow augmentation projects;
- Improve fish passage by prioritizing and selectively redesigning and implementing irrigation diversion improvements where most needed in the watershed;
- Improve riparian habitat condition through flow augmentation projects and riparian habitat protection and enhancement measures;
- Reduce fish entrainment risks by prioritizing and selectively installing fish screens where most needed in the watershed; and
- Improve instream habitat condition through flow augmentation projects, riparian habitat protection and enhancement measures, and active streambank and channel restoration where needed.

3.2.5 Flint Creek Watershed

Flint Creek flows north from Georgetown Lake to join the Clark Fork River near Drummond, Montana. The Flint Creek watershed includes three stream reaches that are the focus of the NRDP's 2012 Restoration Plan, including: lower Flint Creek, upper Flint Creek, and Boulder Creek. Flint Creek and Boulder Creek support a mixed trout population including some fluvial bull trout (Lindstrom et al. 2008). Both streams are designated by the USFWS as Critical Habitat for bull trout (USFWS 2010) and Flint Creek serves as a bull trout migration corridor. The Prioritization Plan ranks Flint Creek and Boulder Creek as Priority 2 streams with the potential to support the restoration goals of improving fish recruitment from the tributaries to the mainstem and replacing lost angling in the mainstem river by improving trout populations in the tributary. Additionally, Boulder Creek has potential to support the restoration goal of maintaining or improving native trout populations in the UCFRB (NRDP 2011).

Restoration goals for the Flint Creek watershed listed below are based on limiting factors and proposed restoration actions described in the 2012 Restoration Plan. These goals may be revised as additional assessments are completed, priorities are re-evaluated, and specific restoration opportunities are identified. Current Flint Creek watershed restoration goals are:

- Improve instream flows through flow augmentation projects;
- Reduce fish entrainment by selectively installing fish screens on irrigation diversion structures;

- Improve fish passage by selectively improving irrigation diversion structures and culverts; and
- Improve riparian habitat condition through riparian habitat protection and enhancement measures.

3.2.6 German Gulch Watershed

German Gulch flows north to join Silver Bow Creek south of Anaconda, Montana. German Gulch and its tributary, Beefstraight Creek, are the focus of the NRDP's 2012 Restoration Plan. The German Gulch watershed supports populations of westslope cutthroat trout and brook trout (Liermann et al. 2009). German Gulch is ranked as a Priority 1 stream and Beefstraight Creek is a Priority 2 stream in the Prioritization Plan. Both streams have the potential to support the restoration goals of improving fish recruitment from the tributaries to the mainstem and replacing lost angling in the mainstem river by improving trout populations in the tributary. German Gulch also has potential to support the restoration goal of maintaining or improving native trout populations in the UCFRB (NRDP 2011).

Remediation actions are being implemented in lower German Gulch by the Montana Department of Environmental Quality. As this work is completed, further assessments will evaluate and prioritize the types and locations of riparian habitat protection and enhancement action that could be implemented in the watershed.

Currently, the only restoration goal for the German Gulch watershed is to improve riparian habitat condition through riparian habitat protection and enhancement measures based on limiting factors and proposed restoration actions described in the 2012 Restoration Plan. This goal may be revised if assessments completed after remediation actions are complete find different limiting factors or other restoration opportunities are identified in the watershed.

3.2.7 Harvey Creek Watershed

Harvey Creek flows north to join the Clark Fork River east of the Bearmouth exit on Interstate 90. The fish population in the Harvey Creek watershed consists exclusively of native bull trout and genetically pure westslope cutthroat trout that are isolated by a grade control structure upstream from the mouth of the stream. A mixed fishery of native fish and non-native brown and rainbow trout are found in the reach below the grade control structure (barrier) (Liermann et al. 2009). Harvey Creek is ranked as a Priority 2 stream by the Prioritization Plan with the potential to support the restoration goal of maintaining or improving native trout populations in the UCFRB (NRDP 2011).

Restoration goals for the Harvey Creek watershed listed below are based on limiting factors and proposed restoration actions described in the 2012 Restoration Plan. These goals may be revised as additional assessments are completed, priorities are re-evaluated, and specific restoration opportunities are identified. Current Harvey Creek watershed restoration goals are:

- Improve riparian habitat condition through riparian habitat protection and enhancement measures;
- Reduce fish entrainment by selectively installing fish screens on irrigation diversion structures;
- Improve fish passage by selectively improving irrigation diversion structures and culverts;
- Improve flows and potentially water temperature near the confluence of Harvey Creek and the Clark Fork River by installing a new irrigation siphon structure;

- Protect native trout population by maintaining an existing fish passage barrier; and
- Improve instream flows through flow augmentation projects.

3.2.8 Little Blackfoot River Watershed

The Little Blackfoot River flows west to join the Clark Fork River near Garrison, Montana. In addition to the Little Blackfoot River, three tributaries, Dog Creek, Snowshoe Creek, and Spotted Dog Creek, are also included in the focus of the NRDP's 2012 Restoration Plan for this watershed. Brown trout dominate the lower reaches of the Little Blackfoot River, while westslope cutthroat trout and brook trout become increasingly more common in upstream reaches. Spotted Dog Creek and Dog Creek both have mixed trout populations, with brown trout being the dominant species in the lower reaches and westslope cutthroat trout dominating the upper reaches. Snowshoe Creek also has brown trout in the lower reaches and a mixed brown trout and westslope cutthroat trout population in the upper reaches. The dam and outlet to a reservoir near the middle of the Snowshoe Creek reach may act as an upstream fish migration barrier (Lindstrom et al. 2008).

The lower Little Blackfoot River is ranked as a Priority 1 stream in the Prioritization Plan and the three others streams in the watershed and upper Little Blackfoot River are ranked as Priority 2 streams. Lower and upper Little Blackfoot River, Dog Creek, Snowshoe Creek, and lower Spotted Dog Creek all have the potential to support restoration goals of improving fish recruitment from the tributaries to the mainstem and replacing lost angling in the mainstem river by improving trout populations in the tributary. Lower and upper Little Blackfoot River may potentially support the restoration goal of maintaining or improving native trout populations in the UCFRB (NRDP 2011).

Restoration goals for the Little Blackfoot River watershed listed below are based on limiting factors and proposed restoration actions described in the 2012 Restoration Plan. These goals may be revised as additional assessments are completed, priorities are re-evaluated, and specific restoration opportunities are identified. Current Little Blackfoot River watershed restoration goals are:

- Improve riparian habitat condition through riparian habitat protection and enhancement measures;
- Improve instream flows through flow augmentation projects;
- Improve fish passage by selectively improving irrigation diversion structures and culverts;
- Reduce fish entrainment by selectively installing fish screens on irrigation diversion structures; and
- Improve instream habitat condition through flow augmentation projects, riparian habitat protection and enhancement measures, and active streambank and channel restoration where needed.

3.2.9 Lost Creek Watershed

Lost Creek flows east to join the Clark Fork River near Warm Springs, Montana. The trout population consists primarily of brown trout in the lower reaches, a mixed trout population in the middle reaches, and brook trout and westslope cutthroat trout in the upper reaches (Liermann et al. 2009). Lower Lost Creek is ranked as a Priority 2 stream in the Prioritization Plan with the potential to support the restoration goals of improving fish recruitment from the tributaries to the mainstem and replacing lost angling in the mainstem river by improving trout populations in the tributary (NRDP 2011).

Currently, the only restoration goal for the lower Lost Creek watershed is improving instream flow through flow augmentation projects based on the limiting factors and proposed restoration actions described in the 2012 Restoration Plan. This goal may be revised if additional assessments are conducted, priorities are revised, or new restoration opportunities are identified.

3.2.10 Mill-Willow Watershed

The Mill-Willow watershed includes Mill Creek and Willow Creek which both flow to the east and join together in the Mill-Willow Bypass downstream of Opportunity, Montana where they are routed around Warm Springs Ponds. Lower Mill Creek and Willow Creek are the focus of the 2012 Restoration Plan. Westslope cutthroat trout populations are present in both streams with mixed trout populations in all but the upper reaches of Mill Creek. The upper Mill Creek trout population consists entirely of westslope cutthroat above a small waterfall that is likely an upstream fish barrier. The upper Mill Creek westslope cutthroat trout population appears to be genetically pure based on testing conducted in 2009 (Lindstrom, personal communication). Both Mill Creek and Willow Creek are ranked as Priority 2 streams in the Prioritization Plan with the potential to support restoration goals of improving fish recruitment from the tributaries to the mainstem and replacing lost angling in the mainstem river by improving trout populations in the tributary (NRDP 2011).

Restoration goals for the Mill-Willow watershed listed below are based on limiting factors and proposed restoration actions described in the 2012 Restoration Plan. These goals may be revised as additional assessments are completed, priorities are re-evaluated, and specific restoration opportunities are identified. Current Mill-Willow watershed restoration goals are:

- Improve instream flows through flow augmentation projects;
- Improve riparian habitat condition through flow augmentation projects and selective implementation of riparian habitat protection and enhancement measures;
- Reduce fish entrainment by selectively installing fish screens on irrigation diversion structures; and
- Improve instream habitat condition through flow augmentation projects, riparian habitat protection and enhancement measures, and active streambank and channel restoration where needed.

3.2.11 Racetrack Creek Watershed

Racetrack Creek flows east to join the Clark Fork River between Deer Lodge and Warm Springs, Montana. A mixed trout population that includes primarily brown trout in the lower reaches and hybridized westslope cutthroat trout and rainbow trout in the upper-most reaches is documented in the watershed (Lindstrom et al. 2008). A natural falls near river mile 13 appears to be a natural upstream fish passage barrier (WRC and TU 2012). Racetrack Creek is a Priority 1 stream with the potential to support restoration goals of improving fish recruitment from the tributaries to the mainstem and replacing lost angling in the mainstem river by improving trout populations in the tributary (NRDP 2011).

Restoration goals for the Racetrack Creek watershed listed below are based on limiting factors and proposed restoration actions described in the 2012 Restoration Plan. These goals may be revised as additional assessments are completed, priorities are re-evaluated, and specific restoration opportunities are identified. Current Racetrack Creek watershed restoration goals are:

- Improve instream flows through flow augmentation projects;
- Improve fish passage by selectively improving irrigation diversion structures and culverts after instream flows improve;
- Improve riparian habitat condition through flow augmentation projects and selective implementation of riparian habitat protection and enhancement measures;
- Reduce fish entrainment by selectively installing fish screens on irrigation diversion structures; and
- Improve instream habitat condition through flow augmentation projects, riparian habitat protection and enhancement measures, and selective implementation of channel and/or streambank projects if improvements are still needed.

3.2.12 Warm Springs Creek Watershed

Warm Springs Creek flows to the east and joins the Clark Fork River at Warm Springs, Montana. The Warm Springs Creek watershed includes seven streams or stream reaches that are the focus of the NRDP's 2012 Restoration Plan including: lower Warm Springs Creek, upper Warm Springs Creek, Barker Creek, Twin Lakes Creek, Storm Lake Creek, Foster Creek, and West Fork Warm Springs Creek. Warm Springs Creek is designated Critical Habitat for bull trout (USFWS 2010) and contains the upstream-most bull trout population in the basin (WRC and TU 2011). The fishery also includes a mixed trout population (Lindstrom et al. 2008). The lower reaches of the watershed currently contribute to recreational fishing opportunities in the UCFRB (Pat Saffel, personal communication).

The seven stream reaches within the Warm Springs Creek watershed are ranked in the Prioritization Plan as Priority 1 streams, except Foster Creek which is listed as a Priority 2 stream. Lower and upper Warm Springs Creek and Foster Creek both have the potential to support restoration goals of improving fish recruitment from the tributaries to the mainstem and replacing lost angling in the mainstem river by improving trout populations in the tributary. Upper and lower Warm Springs Creek may also have the potential to support the restoration goal of maintaining or improving native trout populations in the UCFRB. Barker Creek, Twin Lakes Creek, Storm Lake Creek, and West Fork Warm Springs Creek have high potential to support the restoration goal of maintaining or improving native trout populations in the UCFRB and are considered high restoration priorities because of the distribution of isolated native bull trout populations (NRDP 2011).

Restoration goals for the Warm Springs Creek watershed listed below are based on limiting factors and proposed restoration actions described in the 2012 Restoration Plan. These goals may be revised as additional assessments are completed, priorities are re-evaluated, and specific restoration opportunities are identified. Current Warm Spring Creek watershed restoration goals are:

- Improve instream flows through flow augmentation projects;
- Improve fish passage by replacing culverts and selectively improving irrigation diversion structures and culverts;
- Protect native trout population by selectively maintaining existing fish passage barrier(s);
- Reduce fish entrainment by selectively installing fish screens on irrigation diversion structures;
- Improve riparian habitat condition through selective implementation of riparian habitat protection and enhancement measures; and
- Improve instream habitat condition through riparian habitat protection and enhancement measures and selective implementation of channel and/or streambank projects if improvements are still needed.

3.3 Project Limiting Factors and Goals

Restoration projects will achieve watershed restoration goals by directly addressing watershed limiting factors by implementing specific restoration actions. A restoration project may include one or more restoration actions to address all or a subset of the limiting factors identified within a particular watershed. Project-specific, measurable restoration goals will be developed during the project development process and will aim to achieve watershed goals. Example project scale restoration goals related to project scale limiting factors and associated restoration actions are described in this section.

3.3.1 Restoration Actions to Address Limiting Factors

Table 2 below summarizes potential restoration actions for the 12 Priority watersheds. Additional restoration actions may be identified as specific projects are developed and more detailed site assessments are conducted and project designs developed. Restoration actions are not described in detail in this Plan. Project-specific restoration designs will include detailed treatment descriptions including treatment locations, dimensions, and quantities.

Table 2 also includes example restoration goals that may be applied to each restoration action. The actual restoration goals of a project will depend on a number of site specific conditions that will be determined through the project design. For example, riparian habitat protection and enhancement actions are proposed for many watersheds; including riparian fencing as a specific restoration action. Existing conditions may vary significantly between project sites where riparian fencing is proposed; ranging from highly degraded sites with poor aquatic habitat, streambanks, and riparian vegetation communities to relatively intact sites that may only be lacking multiple age classes of woody riparian vegetation. At highly degraded sites, the goals of riparian fencing may be to protect the site from land use disturbances and support the natural recovery of riparian vegetation so that streambanks and instream habitat improve over time. For intact sites, the goals of riparian fencing may be to protect existing conditions and encourage natural recruitment and regeneration of woody riparian vegetation to increase age-class diversity.

The actual restoration actions and goals that are selected for restoration projects will dictate the specific monitoring metrics that will be utilized for the different types of monitoring.

Table 2. Restoration actions from the 2012 Restoration Plan (NRDP 2012a) that may be implemented through restoration projects to address limiting factors in UCFRB tributaries with associated restoration goals.

Project Scale Limiting Factor	Project Scale Restoration Actions	Example Project Scale Restoration Goals
Water quantity [1]	• Purchase and/or lease water rights[1] • Others [2]	• Increase flow in the watershed and the mainstem • Improve riparian habitat conditions and floodplain connectivity • Improve fish passage • Improve aquatic habitat conditions • Reduce water temperatures
Riparian habitat	• Riparian fencing • Revegetation • Weed management • Conservation easement [3] • Grazing management strategies • Off-stream water source development	• Improve riparian habitat conditions • Improve streambank conditions and reduce erosion • Improve aquatic habitat conditions • Reduce noxious weed density • Increase vegetation structural diversity • Reduce livestock browse • Support natural woody vegetation recruitment • Provide sustainable water sources for livestock
Fish passage	• Improve irrigation infrastructure • Culvert and bridge improvements	• Improve fish passage to support recruitment to the mainstem • Preserve select passage barriers to protect pure native trout populations that are currently isolated
Fish entrainment	• Install fish screens • Alternative irrigation systems	• Reduce fish entrainment
Instream habitat	• Streambank construction • Channel construction	• Reduce streambank erosion and excessive sediment input • Improve aquatic habitat (i.e. pool spacing/density)
Data gaps/feasibility questions	• Evaluations to identify flow restoration projects • Riparian assessment to identify restoration needs, locations, and treatments • Inventory of irrigation infrastructure and other potential passage barriers	• Identify key locations and types of restoration actions to address limiting factors

[1] Separate instream flow projects are being implemented by the NRDP to address water quantity and will be monitored through the Instream Flow Monitoring Plan.

[2] Restoration actions described for other limiting factors may also benefit water quantity, such as improving irrigation systems.

[3] Conservation easements are currently only available for the Little Blackfoot River watershed, but this may change overtime for other areas.

4 Monitoring Metrics

This section is organized first by the three spatial scales: basin, watershed and project. Within each spatial scale each type of monitoring, baseline, compliance, implementation and effectiveness, is described. As mentioned earlier, compliance and implementation monitoring occur only at the project scale, but baseline and effectiveness monitoring occur at all spatial scales (Table 3). The ***Adaptive Management*** section describes how the information from the three monitoring scales is compiled to interpret monitoring results at the project, watershed, and basin scale.

Table 3. Relationship between spatial scales and type of monitoring.

Monitoring Spatial Scale	Type of Monitoring
Basin	Baseline and effectiveness
Watershed	Baseline and effectiveness
Project	Baseline, compliance, implementation and effectiveness

The main goals of the NRDP's restoration program in the Upper Clark Fork tributaries are related to improving trout populations; however, physical limiting factors contribute to the current status of trout populations in the UCFRB. Project specific restoration actions listed in Table 2 focus on improving physical habitat in the tributaries. These actions are expected to benefit trout populations in the tributaries and the mainstem streams by increasing population numbers and habitat connectivity throughout the basin. Recent studies have noted the importance of UCFRB tributaries for supporting spawning activities and the importance of restoring connectivity and habitat quality in combination with remediation for increasing trout spawning in the UCFRB (Mayfield 2013). Biological monitoring of fish populations and their movement within the basin occurs at the basin and watershed scales. Physical habitat monitoring occurs at the project and watershed scale.

Monitoring metrics and methods proposed below are intended to be repeatable and accurate over time. Basin and watershed monitoring will generally be conducted by resource professionals that may include state government employees, conservation organizations, private consultants or other companies, graduate students, university programs, or others. Project monitoring may also be conducted by resource professional, but may also be conducted by land owners or land managers.

4.1 Basin Monitoring

Basin monitoring evaluates whether the goal of *restoring trout populations and associated angling opportunities for the Silver Bow Creek and Clark Fork River mainstem fisheries to levels similar for other area rivers* is being achieved. The following sections describe basin scale baseline and effectiveness monitoring in more detail.

4.1.1 Basin Baseline Monitoring

Existing basin baseline data includes fish population studies and angler surveys conducted in the UCFRB prior to 2014. Data from these existing surveys documents the pre-restoration status of fish populations and will be used to evaluate changes in fish populations over time through effectiveness monitoring. Additional baseline monitoring data collection may include genetic sampling of bull trout captured during population survey monitoring in coordination with Montana Fish, Wildlife, and Parks (MFWP) and the U.S. Fish Wildlife Service. Baseline monitoring data sets are summarized below.

Fish Populations

Fish population survey data collected to date are available through the Montana Fisheries Information System (MFISH) maintained by the Strategic Planning and Data Services Bureau (SPDS) of the Fish and Wildlife Division of Montana Fish, Wildlife, and Parks.

Data collection sites between Turah and upstream to Warm Springs Ponds will be used to evaluate the Clark Fork River and data collection sites between Warm Springs Ponds and upstream to Butte, Montana will be used to evaluate Silver Bow Creek. Additional details of proposed fish population sampling are included in Appendix C. Specific metrics from the fish population surveys to be used as baseline data for this Monitoring Plan include estimate or count for each species of trout at each data collection site or reach, including both native and introduced trout species

Angler Surveys

Angler surveys are conducted by MFWP. Surveys within the UCFRB prior to 2014 will be used as baseline data to evaluate changes in fishing pressure over time. Specifically angling data reported for Silver Bow Creek (water code 2 065761-19) and the Clark Fork River between Warm Springs Ponds and Turah (section 3 – water code 2 061118-01, section 4 – water code 2 061121-01, and section 5 – water code 2 061140-01) will be used as baseline data. Specific metrics from the angler surveys that will be used as baseline data include: angling pressure, crowd ratings, and satisfaction rating results. These data sets are described in more detail in Appendix C.

Genetic Sampling

Limited genetic sampling data are available for the UCFRB also through MFISH. Much of the existing genetic data documents the genetic purity of native westslope cutthroat trout and bull trout individuals and/or populations. Additional genetic data may be collected for bull trout to more clearly document the baseline condition within the mainstem Clark Fork River and Silver Bow Creek. Genetic sampling would focus on bull trout because of their smaller population numbers relative to westslope cutthroat trout. The genetic health of bull trout populations could potentially be used as an indicator of the health of other trout populations in the UCFRB. This sampling would document the genetic purity and genetic diversity of bull trout as well as identify population genetic characteristics of individuals captured in the mainstem Clark Fork River and Silver Bow Creek to link these individuals to tributary populations with similar genetic structure through watershed scale monitoring described below. Genetic sampling of bull trout would be coordinated with MFWP and the U.S. Fish Wildlife Service.

4.1.2 Basin Effectiveness Monitoring

To evaluate the basin restoration goal, effectiveness monitoring will measure trout population numbers and angling opportunities throughout the UCFRB, but particularly in the mainstem Clark Fork River and Silver Bow Creek. Table 4 below summarizes the basin restoration goal and links it to proposed monitoring metrics and performance targets that will be used to evaluate whether the basin goal is achieved.

A detailed basin effectiveness monitoring plan will be developed that identifies specific analyses, monitoring protocols and methods, and sampling locations. Proposed fish sampling locations on the mainstem Clark Fork River and Silver Bow Creek for basin effectiveness monitoring are described in

Appendix C. These preliminary sites were identified as a collaborative effort between the NRDP and MWFP based on existing sampling location and additional sites that would provide more information to evaluate the basin goal. Actual sampling locations will be revised as needed as the sampling plan is developed.

Changes in fish populations and angling use may take several years to manifest in the mainstem Clark Fork River and Silver Bow Creek as restoration occurs over several years and new generations of fish are able to access more areas within the basin and population dynamics change. The 2012 Restoration Plan (2012a) specifies that basin monitoring will be implemented twice at five-year intervals (2017 and 2022). Changes may not be evident during the first five year monitoring effort as restoration actions are being implemented. However, this first monitoring effort may indicate initial changes and future trends that may become more apparent during monitoring scheduled for 2022. The adaptive management framework will be used to determine whether additional actions are needed as effectiveness monitoring data is collected and evaluated.

Fish population and angler survey metrics may be compared to reference sites to evaluate whether the basin goal is being achieved. Reference sites may help determine if population trends within the UCFRB are unique to the basin related to the combined remediation and restoration efforts. Reference sites will also provide information to determine if the UCFRB fishery is trending toward achieving population dynamics and fishing opportunities similar to other area rivers. The *Aquatics Resources Injury Assessment Report, Upper Clark Fork River Basin* (Lipton et al. 1995) used control reaches representing un-impacted streams within the UCFRB that may serve as appropriate reference sites for basin effectiveness monitoring. These reaches included: Rock Creek and Flint Creek; as well as other streams outside the UCFRB including the Big Hole River, Ruby River, Beaverhead River, and Bison Creek. Other rivers in the area that could be used as references may include: the lower Clark Fork River downstream from Missoula, the Bitterroot River, the Madison River, the Blackfoot River, and the Flathead River. The actual stream or stream reaches to be used as reference sites to evaluate changes in trout populations and angling use will be determined through a collaborative effort with project partners as detailed monitoring plans are developed. Sites will be selected early enough for planning and data collection to occur prior to the first 5-year monitoring interval in 2017. Reference sites should be characterized as having desired aquatic and riparian habitat conditions, fish populations, and angling opportunities.

Table 4. The basin restoration goal linked to proposed monitoring metrics and performance targets for effectiveness monitoring.

Basin Restoration Goal	Monitoring Metrics	Performance Targets (Effectiveness Monitoring)
Restore trout populations and associated angling opportunities for the Silver Bow Creek and Clark Fork River mainstem fisheries to levels similar for other area rivers	Fish population surveys (MFWP): • Short-term: ○ Juvenile abundance • Mid- to Long-term: ○ Number of trout (all species and age classes) ○ Number of native trout	• Short-term (2017): ○ Increased juvenile abundance in mainstems • Mid- to Long-term (2022): ○ Increased trout population numbers in UCFRB ○ Increased native trout numbers in UCFRB ○ Trout numbers in UCFRB approaching densities observed in other area rivers ○ Native trout numbers approaching densities observed in other area rivers
	Angler surveys, annual data (MFWP): • Mid- to Long-term (no short-term): ○ Total angling pressure ○ Regional and state rank ○ Total average satisfaction rating	• Mid- to Long-term (no short-term) (2022): ○ Increased angling opportunities measured by use in UCFRB ○ Improve regional and state rank ○ Increased average satisfaction rating ○ Increased satisfaction rating relative to other area rivers

4.2 Watershed Monitoring

Watershed monitoring includes baseline and effectiveness monitoring. Watershed monitoring evaluates whether the cumulative effects of restoration actions implemented within each of the 12 Priority tributary watersheds are addressing limiting factors and achieving the restoration goals listed in Table 1.

Watershed monitoring includes evaluating biological populations similar to basin monitoring to determine if goals related to improving trout populations in the tributaries and replacing lost mainstem angling opportunities are being achieved. It also includes evaluating the status and change of trout populations and their movement within the watershed, between watersheds and the mainstems, and throughout the basin to determine if the tributary populations are supporting recovery goals in the mainstem Clark Fork River and Silver Bow Creek. Watershed monitoring also includes physical habitat assessment such as watershed-wide or large-scale reach riparian and aquatic habitat assessments as well as fish passage and entrainment condition evaluations to determine if habitat conditions are present to support improvements in fish populations within the tributaries.

4.2.1 Watershed Baseline Monitoring

Similar to basin monitoring, existing data sets will be used for much of the baseline monitoring data set. Table 5 below summarizes sources of existing data including: fish population surveys, angler surveys, fish migration evaluations, riparian habitat assessments, fish passage evaluations, fish entrainment evaluations, instream habitat assessments, instream flow studies, and water temperature monitoring. Large amounts of data have been collected in the 12 Priority tributary watersheds, but some locations lack sufficient baseline data to support project planning and site evaluations and additional baseline data collection may occur in these watersheds to support restoration project planning.

Additional baseline data collection will utilize the same data collection and assessment methods that have been used for other surveys in the UCFRB tributaries including:

- Riparian habitat assessments using the NRCS Riparian Assessment Method (NRCS 2012)
- Fish passage and entrainment assessment using methods described in the *Upper Clark Fork Diversion Inventory* (WRC-TU 2012)
- Instream habitat assessments using the NRCS Riparian Assessment (NRCS 2012) and supplemental attributes from this assessment (NRCS 2004)

The following paragraphs include summary descriptions of these baseline data sets. Details of monitoring methods for these baseline data sets are included in Appendix C.

Tributary Fish Populations

Several reports document the current status of fish populations in the UCFRB tributaries including:

- *An Assessment of Fish Populations and Riparian Habitat in Tributaries of the Upper Clark Fork River Basin* from MFWP (Lindstrom et al. 2008)
- *An Assessment of Fish Populations and Riparian Habitat in Tributaries of the Upper Clark Fork River Basin: Phase II* from MFWP (Liermann et al. 2009)
- *As Assessment of Fish Populations and Riparian Habitat in Tributaries of the Upper Clark Fork River Basin – 2009 Report* from MFWP (Lindstrom 2011)

- *Upper Clark Fork River Basin Stream Fish Sampling 2010-2012* from MFWP (Lindstrom 2013)
- *Limiting factors for trout populations in the Upper Clark Fork River Superfund Site, Montana* (Mayfield 2013)
- *Salmonid response to superfund remediation in Silver Bow Creek, Montana* (Naughton 2013)
- Montana Fisheries Information System (MFISH) fish population data (MFWP 2014)

Data from these reports and resources may also serve as baseline monitoring data to evaluate changes in fish population numbers, composition, and distribution after implementation of restoration actions in the UCFRB and its tributaries. However, these data and reports should be used with some caution when making comparisons with future data during effectiveness monitoring because they provide only a snapshot of pre-project conditions. A proposed fish population sampling plan is described in Appendix C. Population data generated from new sampling will primarily be used for effectiveness monitoring, but these data may also be used as baseline data if they are collected prior to implementing restoration actions.

New baseline genetics data may be collected to establish a baseline map of the status of bull trout populations in the UCFRB (genetic purity and genetic diversity). These data will also document population genetic markers for tributary populations to support evaluating whether tributary trout populations are supporting recovery of mainstem trout populations by using the status of bull trout as an indicator of other trout population trends. Project partners, including MFWP and the U.S. Fish Wildlife Service, will develop a baseline sampling plan for population genetic sampling that will identify watersheds where genetic sampling will be focused. Priority watersheds with documented bull trout populations include: Harvey Creek, Flint Creek, and Warm Springs Creek.

Mainstem Recruitment from Tributaries – Trout and Native Trout

Trout movement studies undertaken in the UCFRB (Mayfield 2013) used radio telemetry and Passive Integrated Transponder (PIT) tag tracking methods. These data provide insight into the current movement patterns of trout, including native westslope cutthroat trout in some portions of the drainage, and how they utilize the mainstem and tributary habitats.

Additional fish population studies or migration monitoring using rotary screw traps may be conducted to determine outmigration rates of trout from tributaries. Much of these data will be used for effectiveness monitoring, but they may also be used as baseline data if they are collected prior to implementing restoration actions.

Additional baseline data for bull trout population genetics, described above, may be used to establish unique genetic markers for tributary populations. Through effectiveness monitoring, these data may be used to evaluate whether genetic markers show that tributary bull trout populations are supporting mainstem trout populations which may also indicate trends for other trout populations.

Tributary Angling Opportunities

Annual angler surveys conducted by MFWP described for basin monitoring include data from some UCFRB tributaries during some years. Where available these data will be used to establish existing angler use in UCFRB tributaries (Table 5).

Riparian Habitat

Riparian habitat assessments using the NRCS Riparian Assessment Method (NRCS 2012 and 2004) have been or will be conducted for the following watersheds: Blacktail Creek, Browns Gulch, Cottonwood Creek, Dempsey Creek, Flint Creek, Little Blackfoot River, Lost Creek, Racetrack Creek, and Willow Creek. These assessments were also conducted within shorter reaches of streams associated with fish population sampling by MFWP (Lindstrom et al. 2008 and Liermann et al. 2009).

Fish Passage and Fish Entrainment

Fish passage and fish entrainment evaluations for irrigation diversion structures and some culverts in some watersheds are described in diversion inventory reports (WRC-TU 2012, Schreck et al. 2010 and 2011, Workman 2009). The MFWP fish population reports (Lindstrom et al. 2008 and Liermann et al. 2009) also describe fish passage issues associated with irrigation diversion structures. In 2013 additional fish passage and entrainment surveys were conducted in the Blacktail Creek, Browns Gulch, Flint Creek, and Little Blackfoot River watersheds that were not evaluated in the 2012 Irrigation Diversion report. These surveys will serve as baseline data for evaluating changes in fish passage and entrainment.

Instream Habitat Monitoring

Instream habitat assessments have been or will be conducted in conjunction with riparian habitat assessments using the NRCS Riparian Assessment Method (NRCS 2012 and 2004) for Blacktail Creek, Browns Gulch, Flint Creek, and Little Blackfoot River watersheds. These assessments were also conducted within shorter reaches of streams associated with MFWP fish population sampling (Lindstrom et al. 2008 and Liermann et al. 2009).

Flow Monitoring

Flow monitoring has been conducted as part of the MFWP fish population assessments as well as other assessments throughout the UCFRB. Flow monitoring will primarily be addressed through the separate Instream Flow Project, but as mentioned previously, selective monitoring of flows associated with irrigation diversion improvements is included in this Monitoring Plan. Existing data from these reports will be used as the baseline for evaluating changes in flow and water temperature at these select locations. The U.S. Geological Survey maintains stream gages on some of the priority tributaries that are the focus of this Monitoring Plan (Table 5) where stream flow and/or water stage are monitored. These data will also be used as baseline data for the watersheds where gages are located.

Water Temperature Monitoring

The MFWP collected water temperature data in some streams associated with fish population sampling reported with NRCS Riparian Assessments (Lindstrom et al. 2008 and Liermann et al. 2009). Water temperature data have also been collected by various organizations including: Watershed Restoration Coalition, the Clark Fork Coalition, Montana Trout Unlimited, and others. Where available, these data will be used to document baseline water temperature conditions.

Table 5. Sources of existing data for watershed baseline monitoring.

Watershed	Fish Populations [2]	Fish Migration	Angling	Riparian Habitat	Fish Passage	Fish Entrainment	Instream Habitat	Flow and Temperature
Blacktail Creek	• Liermann et al. 2009 • Naughton 2013 • Lindstrom 2013	• Naughton 2013		• Liermann et al. 2009 • WRC 2013	• TU 2013	• TU 2013	• Naughton 2013	• Lindstrom 2011 (temperature) • USGS stream gage (flow & stage)
Browns Gulch	• Lindstrom 2011 & 2013 • Naughton 2013	• Naughton 2013	• FWP Angler Surveys	• Lindstrom 2011 • WRC Riparian Assessments 2005 & 2013 • WRC Geomorphic Assessments 2010 & 2011 (WRC 2012)	• WRC-TU 2012 • Schreck et al. 2010 and 2011	• WRC-TU 2012	• USFS PIBO • WRC R1/R4 Fish Habitat Assessments 2011(WRC 2012)	• WRC (flow & temperature) (WRC 2012) • Lindstrom 2011 (temperature)
Cottonwood Creek	• Lindstrom et al. 2008 • Liermann et al. 2009 • Lindstrom 2013	• Mayfield 2013	• FWP Angler Surveys	• Lindstrom et al. 2008 • Liermann et al. 2009 • WRC Geomorphic Assessment 2010 • WRC Riparian Assessment 2010 & 2011 (WRC 2012)	• WRC-TU 2012 • Schreck et al. 2010 and 2011 • Mayfield 2013	• WRC-TU 2012	• WRC R1/R4 Fish Habitat Assessments 2011 (WRC 2012)	• WRC (flow & temperature) (WRC 2012) • Lindstrom 2011 (temperature)
Dempsey Creek [1]	• Liermann et al. 2009			• Liermann et al. 2009 • WRC Geomorphic Assessment 2010 & 2011 • WRC Riparian Assessment 2010 & 2011 (WRC 2012)	• WRC-TU 2012 • Schreck et al. 2010	• WRC-TU 2012	• USFS PIBO • WRC R1/R4 Fish Habitat Assessment 2010 and 2011	• WRC (flow & temperature) (WRC 2012)
Flint Creek	• Lindstrom et al. 2008 • Liermann et al. 2009 • New genetic data (BT)	• Mayfield 2013	• FWP Angler Surveys	• Lindstrom e al. 2008 • Liermann et al. 2009 • WRC pending	• TU 2013 • Mayfield 2013	• TU 2013	• Mayfield 2013	• USGS stream gage (flow & stage)
German Gulch	• Liermann et al. 2009 • Naughton 2013 • Lindstrom 2013	• Naughton 2013	• FWP Angler Surveys	• Liermann et al. 2009	• WRC-TU 2012	• WRC-TU 2012		• Lindstrom 2011 (temperature)
Harvey Creek	• Liermann et al. 2009 • New genetic data (BT)	• Mayfield 2013		• Liermann et al. 2009	• WRC-TU 2012 • Schreck et al. 2010 and 2011 • Mayfield 2013	• WRC-TU 2012	• Mayfield 2013	• Unpublished temperature data (TU)
Little Blackfoot River	• Lindstrom et al. 2008 • Liermann et al. 2009 • Lindstrom 2011 & 2013	• Mayfield 2013	• FWP Angler Surveys	• Lindstrom et al. 2008 • Liermann et al. 2009 • WRC pending	• WRC-TU 2012 and 2013 • Mayfield 2013	• WRC-TU 2012 & 2013	• Mayfield 2013	• Lindstrom 2011 (temperature) • USGS stream gage(flow & stage)

Watershed	Fish Populations [2]	Fish Migration	Angling	Riparian Habitat	Fish Passage	Fish Entrainment	Instream Habitat	Flow and Temperature
Lost Creek [1]	• Liermann et al. 2009	• Mayfield 2013	• FWP Angler Surveys	• Liermann et al. 2009 • WRC Riparian Assessment 2010 & 2011 (WRC 2012)	• WRC-TU 2012 • Schreck et al. 2010 and 2011 • Mayfield 2013	• WRC-TU 2012	• USFS PIBO • Mayfield 2013	• WRC (flow & temperature) • Lindstrom 2011 (temperature) • USGS stream gage (flow & stage)
Mill-Willow [1]	• Liermann et al. 2009		• FWP Angler Surveys	• Liermann et al. 2009 • WRC Riparian Assessment 2010 & 2011 (WRC 2012)	• WRC-TU 2012	• WRC-TU 2012		• USGS stream gage (flow & stage)
Racetrack Creek [1]	• Lindstrom et al. 2008	• Mayfield 2013	• FWP Angler Surveys	• Lindstrom et al. 2008 • WRC Riparian Assessment 2010 & 2011 (WRC 2012)	• WRC-TU 2012 • Schreck et al. 2010 and 2011 • Mayfield 2013	• WRC-TU 2012	• USFS PIBO • Mayfield 2013	• WRC Flow and Temperature (WRC 2012) • Lindstrom 2011 (temperature)
Warm Springs Creek	• Lindstrom et al. 2008 • Liermann et al. 2009 • Lindstrom 2013 • New genetic data (BT)	• Mayfield 2013	• FWP Angler Surveys	• Lindstrom et al. 2008 • Liermann et al. 2009	• WRC-TU 2012 • Schreck et al. 2010 and 2011 • Mayfield 2013	• WRC-TU 2012	• Mayfield 2013	• Lindstrom 2011 (temperature) • USGS stream gage (flow and stage)

[1] Flow limited watersheds where instream flows need to be addressed prior to any other restoration actions from the 2012 Restoration Plan (NRDP 2012a).

[2] BT = bull trout. Additional baseline genetics data may be collected for bull trout depending on whether it is needed to support analyses in the final sampling plans that will be developed for the watersheds.

4.2.2 Watershed Effectiveness Monitoring

Watershed effectiveness monitoring will utilize similar metrics as the data sets described for watershed baseline monitoring, Section 4.2.1. Table 6 summarizes watershed restoration goals linked to limiting factors for the Priority tributary watersheds with potential monitoring metrics to evaluate the effectiveness of the restoration program at the watershed scale.

Rather than collecting data for all effectiveness monitoring metrics in all 12 Priority tributary watersheds; locations and types of monitoring data to be collected depends on the restoration goals for the specific watershed and actual restoration actions that are implemented in the watershed. Detailed watershed monitoring plans will be developed to identify specific metrics to be evaluated, study designs, and data collection methods. Table 7 summarizes habitat metrics that may be evaluated at the project scale within each watershed based on proposed restoration actions; this information will be used to develop detailed watershed scale monitoring plans that identify specific data collection locations and metrics based on the restoration actions that are actually implemented within each watershed. Appendix C describes proposed locations for watershed fish population, migration, and genetics data collection. These preliminary sites were identified as a collaborative effort between the NRDP and MWFP based on existing sampling location and additional sites that would provide more information to evaluate the watershed restoration goals. Actual sampling locations will be revised as specific sampling plans for the watersheds are developed. Project scale monitoring data will also be compiled for the watersheds to evaluate changes in habitat conditions throughout the watershed. These watersheds and selected metrics may change over time if restoration goals and/or actions change within the watersheds.

Similar to basin monitoring, most watershed effectiveness monitoring will be conducted at approximately three to five-year intervals. The actual timing of data collection may vary slightly from this based on the rotating schedule of some existing data collection plans such as MFWP monitoring of fish populations in the tributary watersheds that is described in more detail below.

The paragraphs below summarize the monitoring data to be collected and evaluated for watershed effectiveness monitoring with details included in Appendix A.

Table 6. Watershed limiting factors, restoration goals, monitoring metrics and performance targets for effectiveness monitoring.

Limiting Factor	Watershed Scale Restoration Goal	Monitoring Metric (monitoring method)	Performance Target
Not Applicable	Restore mainstem fishery - improve **recruitment from tributaries** [1]	Number of trout exiting tributary (migration surveys)	• Short-term: ○ Increase juvenile abundance in tributary • Mid- to Long-term: ○ Increase outmigration numbers to the mainstems
		Genetic relationship of mainstem and tributary bull trout populations (genetic sampling; indicating habitat connectivity and trends for other trout populations)	• Mid- to Long-term (no short-term): ○ Increase abundance of trout in mainstem that are related to tributary populations
	Replace lost **trout angling** in mainstem/ improve **tributary trout populations** [1]	Number of trout – all species (Fish population surveys – MFWP); Total angling pressure, Regional/state rank, average satisfaction (Angler surveys, annual data – MFWP)	• Mid- to Long-term (no short-term): ○ Increase population numbers ○ Increase angling use, rank, and/or satisfaction
	Maintain/improve UCFRB <u>native</u> trout populations – preserve rare and diverse gene pools, and improve the diversity and resiliency of the trout fishery [1]	Number of native trout in tributary (Fish population surveys – MFWP)	• Short-term: ○ Increase juvenile abundance in tributary • Mid- to Long-term: ○ Increase population numbers of native trout
		Number of native trout exiting tributary (migration surveys)	• Short-term: ○ Increase native trout juvenile abundance in tributary • Mid- to Long-term: ○ Increase outmigration of native trout to mainstem
		Genetic purity of native trout populations, genetic diversity of native trout populations (genetic sampling)	• Short-, Mid-, and Long-term: ○ Preserve genetically pure native trout populations • Mid- to Long-term: ○ Maintain or increase genetic diversity of native trout populations in tributaries ○ Increase abundance of native trout in mainstems that are related to tributary populations
Riparian Habitat	Improve riparian habitat conditions [2]	Riparian habitat condition score (average score by assessed reaches or cumulative watershed assessment)	• Short-term: ○ Positive trends in project specific revegetation monitoring • Mid- to Long-term: ○ Improve cumulative riparian habitat condition scores (improve rating to 'Sustainable')

Limiting Factor	Watershed Scale Restoration Goal	Monitoring Metric (monitoring method)	Performance Target
Fish Passage	Improve fish passage within watershed and to mainstem [2]	Cumulative number of improved structures that now allow fish passage in the watershed	• Short-term: ○ Redesigned structures are implemented as designed • Mid- to Long-term: ○ Improve fish passage and/or selectively preserve passage barriers to protect isolated native trout populations
Fish Entrainment	Reduce entrainment numbers [2]	Cumulative summary of fish screens installed Fish entrainment numbers	• Short-term: ○ Fish screens are installed as designed • Mid- to Long-term: ○ Reduce fish entrainment numbers
In-stream Habitat	Improve instream habitat conditions [2]	Instream habitat condition score	• Short-term: ○ Positive trends in project specific aquatic habitat and riparian monitoring • Mid- to Long-term: ○ Improve cumulative aquatic habitat condition scores (improve to rating of 'Sustainable')
Flow	Increase flow in targeted watersheds & mainstem Clark Fork River [2]	Instream flows, water temperature	• Short-, Mid-, and Long-term: ○ Improve instream flow discharge rates and reduce water temperatures

[1] Restoration potential from the Prioritization Plan
[2] Proposed restoration actions from the 2012 Restoration Plan

Tributary Fish Populations

MFWP will conduct fish population surveys within the UCFRB tributaries on a rotating schedule over the next several years. These data will be used to evaluate changes in the fishery population composition and numbers. Details of a proposed sampling plan are described in Appendix C. Watersheds or stream reaches within the UCFRB where little or no restoration actions are implemented may be used as control or reference sites as well as other nearby similar streams outside the UCFRB depending on the sample designs that are developed for the detailed watershed monitoring plan.

Genetic data from bull trout may be used to document that existing genetically pure bull trout populations are being preserved and maintained in tributaries where they exist. Genetic data will be collected in coordination with the U.S. Fish Wildlife Service during fish population surveys conducted by MFWP.

Mainstem Recruitment from Tributaries – Trout and Native Trout

Tributary restoration actions are expected to improve trout populations, including native trout, by improving habitat conditions in the tributary watersheds and improving connectivity and passage between tributary streams, Silver Bow Creek, and the Clark Fork River. Monitoring will track the movement of trout from select tributary streams to evaluate changes in recruitment numbers over time. This monitoring will be closely linked with fish passage and entrainment monitoring within the tributary watersheds described below to determine if improved passage and reduced entrainment influences fish population numbers.

Effectiveness monitoring of trout movement will utilize similar methods to those used in previous studies including radio telemetry and Passive Integrated Transponder (PIT) tag methods. Additionally, more comprehensive monitoring of outmigration using rotary screw traps and/or other trapping methods may be undertaken in key locations within the basin to more thoroughly document trout movement to the mainstem. These watersheds will be determined based on several factors including: the existing trout population and its expected ability to support recruitment to the mainstem; actual restoration actions that are implemented in the watershed; and the native trout population status in the watershed. Key watersheds for monitoring outmigration may include: Blacktail Creek, Browns Gulch, Cottonwood Creek, German Gulch, the Little Blackfoot River, Flint Creek, or Warm Springs Creek. Appendix C includes additional details for proposed migration monitoring locations.

Genetic data collected from trout in specific watersheds during fish population sampling may also be used to monitoring fish movement by using unique genetic markers from tributary trout populations to compare with genetic markers found in mainstem trout populations.

Tributary Angling Opportunities

Angling surveys conducted by MFWP will be used as they are available for the Priority watersheds to evaluate trends in angling use within the tributaries.

Riparian Habitat

Riparian habitat protection and enhancement actions are proposed for all the Priority tributary watersheds in the 2012 Restoration Plans except for Lost Creek. Evaluations are proposed for most watersheds to determine the best locations and types of riparian habitat restoration actions to implement. Monitoring for the specific treatments is described in the project monitoring section. At the watershed-scale, riparian habitat monitoring will evaluate the overall results of cumulative restoration actions to determine if they are improving conditions at a reach- or watershed-scale.

The NRCS Riparian Assessment Method (NRCS 2012) will be used to evaluate riparian habitat conditions in locations where restoration actions are actually implemented. Other riparian assessment methods have been used in some watersheds, but the NRCS Riparian Assessment has been the most widely used method throughout the UCFRB and will continue to be used to evaluate conditions in all the watersheds. If riparian habitat restoration actions are not implemented in a watershed, these assessments will not be conducted unless that watershed is selected to be monitored as a control site. These assessments are intended to capture large-scale riparian vegetation community changes in the tributaries that may take several years to be apparent following implementation of restoration actions.

Fish Passage

As fish passage improvement projects are implemented in a watershed, the overall connectivity of the watershed that allows movement of fish into and out of the drainage will be evaluated. To evaluate fish passage at the watershed scale, project scale fish passage effectiveness monitoring data will be compiled for the watershed. These project scale data will document whether redesigned irrigation structures or culverts are effectively providing fish passage and the total number of structures that do provide effective passage will be compared with the overall number of structures in the watershed. Fish passage monitoring ties into evaluating fish populations in the tributary watersheds to evaluate whether improving fish passage influences recruitment to the mainstem and trout population numbers.

Fish Entrainment

Similar to fish passage effectiveness monitoring, fish entrainment monitoring will also include compiling project monitoring data for fish screen installations to document the number of screened diversion structures in a watershed versus the total number of diversions. If radiotelemetery monitoring is used to track fish movement, the number of fish that are relocated in irrigation canals will be reported for a watershed. If the number of fish avoiding entrainment is desired for select locations, traps may be installed on individual fish screens to derive these numbers. Fish entrainment monitoring relates to fish population in the tributary watersheds by evaluating whether reducing entrainment influences population numbers.

Instream Habitat Monitoring

Evaluations to identify key locations for instream habitat improvement projects are proposed for 9 of the 12 Priority tributary watersheds including: Blacktail Creek, Browns Gulch, Cottonwood Creek, Dempsey Creek, Little Blackfoot River, Mill-Willow Creek, Racetrack Creek, and Warm Springs Creek. For many of these watersheds, channel and streambank construction will only be considered after either first addressing instream flow issues or after passive restoration or riparian habitat protection and enhancement actions have been implemented. Instream habitat monitoring will be conducted in association with riparian habitat effectiveness monitoring in these watersheds to evaluate whether riparian habitat restoration measure are influencing the aquatic habitat conditions and to determine the need for additional channel and/or streambank restoration actions. The NRCS Riparian Assessment

Method and supplemental attributes (NRCS 2012 and 2004) will be used to evaluate aquatic habitat conditions.

Flow Monitoring

The separate Instream Flow Project being implemented by the NRDP will provide comprehensive monitoring of flows throughout the UCFRB. However, select monitoring of instream flows will occur as part of this Monitoring Plan where specific restoration actions will address instream flows in terms of improving aquatic habitat. These locations include Cottonwood Creek and Harvey Creek.

At Cottonwood Creek and Harvey Creek, irrigation diversion structures located near the mouth of these two streams capture most of the tributary flow before it enters the mainstem Clark Fork River. Restoration actions are proposed to complete final design and implementation of improvements to the Kohrs-Manning irrigation diversion structure on Cottonwood Creek and the irrigation diversion on Harvey Creek. By implementing these two projects, additional cold, clean water is expected to be delivered to the Clark Fork River. Project scale monitoring, described below, will evaluate the physical changes associated with implementing these irrigation diversion improvement projects.

Water Temperature Monitoring

Water temperature monitoring will primarily occur through the separate instream flow projects being implemented by the NRDP. However, water temperature monitoring at the watershed scale may occur in watersheds where tributary restoration actions to improve riparian or instream habitat are implemented at a relatively large scale in the watershed or in association with irrigation diversion improvement projects. Water temperature monitoring will primarily occur where existing summer water temperatures threaten trout populations and where restoration actions are expected to improve water temperatures by increasing instream flows, increasing shading of the channel, or by increasing the area of deep water habitats that will maintain lower water temperatures.

Table 7. Summary of habitat-related watershed effectiveness monitoring and the key metrics that will be evaluated by either compiling project scale data or by collecting data for larger reaches or throughout the watershed.

	Monitoring Metrics				
Watersheds	**Riparian habitat condition score** Riparian habitat condition evaluation and prioritization	**Fish passage evaluation** – irrigation diversion and culvert Irrigation diversion and culvert evaluation and prioritization	**Fish entrainment evaluation** Irrigation diversion evaluation and prioritization	**Instream habitat condition score** Instream habitat condition evaluation and prioritization	**Instream flow** **Water temperature**
Blacktail Creek	X	X		X [2]	
Browns Gulch	X	X		X	
Cottonwood Creek	X	X	X	X	X
Dempsey Creek	X [1]	X [1]	X [1]	X [2]	
Flint Creek	X	X	X		X
German Gulch	X				
Harvey Creek	X	X	X		X
Little Blackfoot River	X	X	X	X [2]	
Lost Creek					
Mill-Willow	X [1]		X [1]	X [2]	
Racetrack Creek	X [1]	X [1]	X [1]	X [2]	
Warm Springs Creek	X	X	X	X [2]	

[1] Proposed restoration actions will only be implemented after instream flows have been addressed
[2] Proposed restoration actions will only be implemented after other restoration actions have been implemented in the watershed, primarily before flow and riparian restoration actions

4.3 Project Monitoring

The 2012 Restoration Plan describes proposed projects and their component restoration actions within the 12 priority watersheds. Each restoration project may include one or more restoration actions. The 2012 Restoration Plan also describes project monitoring as evaluating individual projects for whether the project was completed as proposed and whether the project is functioning as proposed. Compliance and implementation monitoring will document that projects are completed as proposed. Effectiveness monitoring will document whether projects are functioning as proposed. The ***Adaptive Management Framework*** section describes how results of project scale monitoring will be integrated with watershed and basin scale monitoring.

4.3.1 Developing a Project Specific Monitoring Plan

This section describes the content and general framework for assembling a detailed project monitoring plan based on the restoration actions that will be implemented to address limiting factors. Detailed project monitoring plans will be developed as a collaborative effort between the NRDP and each project's proponents. The development of the detailed project monitoring plans corresponds with landowner agreements that will assign responsibilities for project level monitoring data collection. These plans will also include maintenance needs that are described in more detail in Section 5 below.

The project development process includes identifying limiting factors within a project area and determining appropriate restoration actions to address these limiting factors in association with specific goals for the project area. Monitoring metrics and performance targets should be developed that are the linked the restoration goals. Once a project has been developed, the following list shows the general organization for the project monitoring plan with descriptions of the information that should be included in each section of the plan and references for where this information can be found throughout this document.

Example project monitoring plan document outline:

- Introduction:
  - Summary descriptions of this information for the 12 priority watersheds are included in Section 3.2 above and the 2012 Restoration Plan. This section of the project monitoring plan describes the project background and development in the context of the watershed, important resources in and around the project area, and other information that provides context for the purpose of the project.
- Limiting Factors and Restoration Actions:
  - Examples of project scale limiting factors and restoration actions are described in Table 2 (Section 3.3.1) above. This section of the project monitoring plan describes the specific limiting factor(s) present in the project area and the restoration action(s) that are being implemented to address them.
- Restoration Goals:
  - Examples of restoration goals linked to limiting factors and restoration actions described in Table 2 (Section 3.3.1) above. This section of the project monitoring plan describes specific goals of the restoration project related to the restoration actions.

- Components of the Monitoring Plan:
    - This section generally describes each type of monitoring that will occur for the project and identifies existing data sets that will be used to support project monitoring and new data collection that will be conducted for each type of monitoring.
        - Project scale baseline monitoring is described in Section 4.3.2 below. This section of the project monitoring plan describes existing data or new data to be collected that describes the baseline condition or pre-project condition.
        - Project scale compliance monitoring is described in Section 4.3.3 below. This section of the project monitoring plan describes monitoring requirements from permits or other construction monitoring.
        - Project scale implementation monitoring is described in Section 4.3.4 below. This section of the project monitoring plan describes methods to document locations, extents, and materials used to implement the restoration treatments.
        - Project scale effectiveness monitoring is described in Section 4.3.5 below. This section of the project monitoring plan describes monitoring metrics that will be used to evaluate whether goals of the restoration project are being achieved using performance targets established for various timeframes following project implementation. This section will also include identify necessary control or reference sites depending on the study design.
- Sampling and Analysis Plan:
    - This section includes detailed descriptions of new data collection that will generally occur for effectiveness monitoring, but may also include data collection for baseline, compliance, and implementation monitoring.
    - The sampling and analysis plan will identify data collection protocols, specific sampling locations and the frequency of monitoring data collection efforts throughout the monitoring timeframe. In the process of selecting monitoring metrics and associated monitoring methods, the precision, or ability of the monitoring methods to accurately answer the question of the whether the goals are being achieved should be considered. Appendix C includes descriptions of some potential monitoring methods that may be used for project effectiveness monitoring.
- Maintenance Plan:
    - Section 5 below describes potential maintenance needs based on implemented restoration actions.
- Monitoring and Maintenance Schedule
    - This section of the project monitoring plan describes the monitoring and maintenance tasks that will be completed each year following project implementation.
- Monitoring and Maintenance Reports
    - Section 4.4 below describes the general format, content, frequency, and timing of monitoring reports. This section of the project monitoring plan will describe the specific reporting details that are agreed upon by the NRDP and project proponents.

Appendix A. Example Project Scale Monitoring Plan Template – Harvey Creek includes an example monitoring plan for restoration actions being implemented in the Harvey Creek watershed using this framework.

4.3.2 Project Baseline Monitoring

Project baseline data may include existing assessments or evaluations completed within the basin, watershed, or project area as well as project-specific assessments that will be completed as part of the project planning process. Identifying baseline data needs should be closely coordinated with identifying effectiveness monitoring metrics to ensure that appropriate data are available to compare the pre- and post-project conditions.

Many projects will include additional baseline data collection to support project development and design.

Additional baseline data collection for specific restoration actions or projects may include the following:

- Riparian habitat protection or enhancement projects –
    - Mapping or surveying existing fence locations
    - Mapping existing vegetation communities
    - Noxious weed surveys
    - Streambank erosion assessments and inventories
    - Geomorphic monitoring of channel conditions (longitudinal profile, cross-sections)
- Fish Passage and Fish Entrainment projects –
    - Survey terrain around existing irrigation diversion structures or culvert
- Instream habitat improvement projects–
    - Detailed geomorphic surveys including longitudinal profile, channel cross-sections, planform, pebble counts, and others
    - Instream habitat assessments
    - Streambank erosion assessments and inventories

Details of these monitoring methods are described in Appendix C.

4.3.3 Project Compliance Monitoring

Many of the proposed restoration projects will require construction permits for potential impacts to aquatic, wetland, and/or riparian habitats and resources. These permits may include special provisions that require monitoring as part of the construction process. Required permits or other construction planning may include, but is not limited to:

- 310 Permit
- Stream Protection Act (SPA) 124
- Floodplain Permit
- Section 404 Permit
- Section 10 Permit
- 318 Authorization
- 401 Certification

- Navigable Rivers Land Use License or Easement
- Other

Most of these permits are acquired through the *Joint Application for Proposed Work in Montana's Streams, Wetlands, Floodplains, and other Water Bodies*; however, some permits may require additional applications.

Several common compliance monitoring metrics that may be included as requirements of permits being issued for projects are summarized below.

- Water quality monitoring (turbidity)
- Documenting work dates if permits limit work windows for species protection
- Stormwater BMP's
- Wetland delineations
- Others

Permits generally require documenting the as-built condition and conducting effectiveness monitoring which is described in the subsequent sections.

4.3.4 Project Implementation Monitoring

Implementation monitoring will occur as individual restoration projects are completed to document treatment locations and extents, materials quantities, and other treatment specific information to show how the as-built condition compares to the designed restoration actions. The specific data to be collected is determined by the restoration actions that were implemented. Examples of as-built monitoring are summarized below by restoration action:

- Riparian fencing
  - Map fence lines, gates, water gaps
  - Document vegetation community composition inside the fence (vegetation canopy cover, natural recruitment/regeneration of woody species, browse, noxious weeds)
  - Streambank erosion
  - Channel geomorphology (longitudinal profile, cross-section)
- Revegetation (planting and seeding)
  - Total number of plants installed
  - Map locations and extents of planting units
  - Document numbers of browse protectors and weed mats installed
  - Map seeded areas
- Weed management
  - Pre-treatment weed mapping
  - Map treatment locations and document control method(s) used for each target species
- Irrigation diversion improvements for fish passage
  - Document existing conditions
  - Survey of as-built condition
- Fish screen installation
  - Document existing conditions

    - Survey of as-built condition
- Streambank construction
    - Document existing conditions
    - Survey or map new bankline
    - Record total number of plants installed
    - Map seeded areas
- Channel construction
    - Document existing conditions
    - Survey as-built longitudinal profile
    - Survey channel cross-sections
    - Survey or map channel planform

Photo monitoring should document the as-built condition of all treatments. Photo monitoring is described in Appendix C.

In addition to documenting the final status of restoration actions, as-built monitoring may also serves as the basis for effectiveness monitoring comparisons for several of the metrics that will be evaluated at the project-scale. For example, channel construction effectiveness monitoring may use performance targets relative to the percent change in channel dimensions from the project design and as-built condition. Other restoration actions, such as riparian planting, require establishing monitoring plots such as plant survival plots that will be used to count plant survival during the short-term monitoring timeframe. Appendix C includes descriptions for establishing monitoring plots, transects, or points that will be used throughout the effectiveness monitoring timeframe.

4.3.5 Project Effectiveness Monitoring

Project effectiveness monitoring will document the physical conditions within the project area resulting from restoration actions. For example, irrigation diversion improvements that will be implemented to improve fish passage will be evaluated to document whether the structure physically allows fish passage. These monitoring data will be compiled for watershed and basin monitoring to determine actual fish usage related to overall restoration goals for the specific watersheds and the UCFRB.

Table 8 summarizes potential project effectiveness monitoring metrics and performance target for proposed restoration actions to address limiting factors. As project-specific monitoring plans are developed, the actual list of metrics used to evaluate project success may be modified based on the project's goals and the actual restoration actions that were implemented.

Table 8. Summary of project limiting factors, restoration actions to address limiting factors, proposed effectiveness monitoring metrics and performance targets.

Project Scale Limiting Factor	Restoration Goals	Restoration Actions	Monitoring Metric	Performance Target
Water quantity	• Increase flow in the watershed and the mainstem • Improve riparian habitat conditions and floodplain connectivity • Improve fish passage • Improve aquatic habitat conditions • Reduce water temperatures	• Purchase and/or lease water rights • Others	• Instream flow • Water temperatures	• Short-, Mid-, and Long-term: ○ Maintained or improved stream flows entering the mainstem ○ Decreased summer water temperature of water delivered to mainstem
Riparian habitat	• Improve riparian habitat conditions • Improve streambank conditions and reduce erosion • Improve aquatic habitat conditions • Reduce noxious weed density • Increase vegetation structural diversity • Reduce livestock browse • Support natural woody vegetation recruitment • Provide sustainable water sources for livestock	• Riparian fencing	• Riparian habitat condition score	• Mid- to Long-term (no short-term): • Improved riparian habitat condition score (rating of 'Sustainable')
			• Woody vegetation recruitment (stem density)	• Short-term: ○ Recruitment is occurring and new plants are surviving • Mid- to Long-term: ○ Multiple age classes are present in the floodplain
			• Plant composition: ○ Structural diversity (herbaceous, tree, and shrub) – greenline survey ○ Native composition versus noxious/introduced species	• Mid- to Long-term (no short-term): ○ Multiple vegetation life forms are present (tree, shrub, herbaceous) ○ Native species dominate the vegetation community
			• Noxious weed canopy cover	• Short-, Mid-, and Long-term: ○ Noxious weeds are absent or less than 10% of vegetation canopy cover
			• Streambank erosion	• Short- to Mid-term: ○ Streambank erosion decreases • Long-term: ○ Streambank erosion occurs within expected ranges for natural channel migration processes
			• Channel geomorphology	• Mid- to Long-term (no short-term): ○ Streambank and floodplain vegetation provides stability and natural channel process allow for some channel migration
			• Water temperature	• Mid- to Long-term: ○ Decreased summer temperature of water delivered to mainstem

Project Scale Limiting Factor	Restoration Goals	Restoration Actions	Monitoring Metric	Performance Target
Riparian habitat (cont.)	REPEAT FROM ABOVE • Improve riparian habitat conditions • Improve streambank conditions and reduce erosion • Improve aquatic habitat conditions • Reduce noxious weed density • Increase vegetation structural diversity • Reduce livestock browse • Support natural woody vegetation recruitment • Provide sustainable water sources for livestock	• Revegetation (planting, seeding)	• Survival (%) (short-term only) • Woody vegetation canopy cover (mid- to long-term) • Native plant cover (herbaceous, tree, and shrub) – greenline survey • Noxious weed canopy cover (%)	• Short-term: ○ Majority of installed plants survive • Mid- to Long-term: ○ Planted species establish and form diverse native vegetation communities • Short-, Mid-, and Long-term: ○ Noxious weeds are absent or less than 10% of vegetation canopy cover
		• Weed management	• Noxious weed canopy cover (%)	• Short-, Mid-, and Long-term: ○ Noxious weeds are absent or less than 10% of vegetation canopy cover
		• Grazing management strategies & off- or on-stream water source development	• Grazing management plan in place and in compliance • Water source present • Bank erosion (length, area, and source) • Woody vegetation browse	• Short-, Mid-, and Long-term: ○ Compliance with grazing management plan ○ Water sources are in place and effectively providing water to livestock ○ Reduced bank erosion, particularly due to hoof shear ○ Less than 5 percent of second year stems are browsed
Fish passage	• Improve fish passage to support recruitment to the mainstem • Preserve select passage barriers to protect pure native trout populations that are currently isolated	• Improve irrigation infrastructure • Culvert and bridge improvements	• Fish passage at structure – Modified NIAP assessments [1]	• Short-, Mid-, and Long-term: ○ Improved diversion structures or culverts are physically capable of allowing fish passage and functioning as needed to move water
Fish entrainment	• Reduce fish entrainment	• Install fish screens • Alternative irrigation systems	• Fish entrainment numbers	• Short-, Mid-, and Long-term: ○ Fish screen is properly maintained and operational to prevent fish entrainment ○ Irrigation canal surveys shows no fish entrainment
Instream habitat	• Reduce streambank erosion and excessive sediment input • Improve aquatic habitat (i.e. pool spacing/density)	• Streambank construction	• Woody vegetation canopy cover	• Mid- to Long-term (no short-term): ○ Woody vegetation canopy cover is increasing
			• Streambank erosion • Pebble counts (sedimentation)	• Short- to Mid-term: ○ Streambank erosion decreases • Long-term: ○ Streambank erosion occurs within expected ranges for natural channel migration processes
			• Floodplain connectivity	• Short-, Mid-, and Long-term: ○ Evidence of overbank flows is present in the floodplain

Project Scale Limiting Factor	Restoration Goals	Restoration Actions	Monitoring Metric	Performance Target
		• Channel construction	• Channel cross-section • Channel slope & sinuosity (longitudinal profile) • Average pool width/depth • Pool frequency • Channel migration rates • Pebble counts	• Short- to Mid-term: ○ Channel remains stable • Long-term: ○ Streambank and floodplain vegetation provides stability and natural channel process allow for some channel migration

[1] Metrics and methods described in WRC-TU 2012.

4.4 Monitoring Reports

Two types of monitoring reports will be prepared at the project scale for the aquatic resource restoration actions implemented as part of the 2012 Restoration Plan: Implementation Monitoring Reports and Effectiveness Monitoring Reports.

Implementation Monitoring Reports will be prepared after project completion to document the as-built condition of implemented restoration actions. These reports will also document all Compliance Monitoring measures and data that were collected during project implementation. Project permits may require additional reporting that will be submitted to the permit-issuing agency. Implementation reports will generally be completed by the project proponents which may be the landowner or an organization that is sponsoring the project such as local conservation groups.

Effectiveness monitoring reports will be prepared according to the monitoring schedule for each project generally beginning one year after project implementation is complete. The content of effectiveness monitoring reports will vary from year to year depending on the timeframe since project completion including short-, mid-, and long-term timeframes. During the first five years, effectiveness monitoring reports will summarize project monitoring data and document whether restoration goals are being achieved or are showing trends toward being achieved based on the specific performance targets identified for each project during project development. Project scale effectiveness monitoring reports will generally be completed by the project proponents. Watershed and basin scale monitoring reports will be completed by the NRDP or their representative, in coordination with project stake holders that will review compiled monitoring data and make decisions as a team as to whether monitoring data are showing that restoration goals are being achieved.

Watershed and Basin scale effectiveness monitoring includes data that will occur at annual to five-year interval frequencies. These data, along with project scale monitoring data will be compiled annually by the NRDP or their representative. At five year intervals, the NRDP and project partners will review the compiled monitoring data to evaluate the effectiveness of restoration actions at the project, watershed, and basin scale and use the adaptive management framework to determine if changes in restoration actions, performance targets, monitoring metrics, or other aspects of the monitoring plan are necessary.

Baseline monitoring will be integrated into as-built reports and effectiveness monitoring reports to describe changes resulting from, and evaluate the effectiveness of the restoration actions.

Appendix B of this document includes example outlines for monitoring report format and content.

5 Maintenance Plan

Maintenance will occur at the project-scale associated with restoration actions. Some maintenance actions described in this section will only be needed for a relatively short duration of time after restoration actions are implemented to ensure their success. Other maintenance actions such as irrigation infrastructure maintenance will be required for the lifetime of the structure. Some restoration actions are considered maintenance actions by themselves, such as weed management. Maintenance tasks described below associated with restoration actions should be integrated into project specific monitoring and maintenance plan documents.

The ***Adaptive Management Framework*** section addresses repair needs for damage associated with natural events such as flooding or other disturbances that change the riparian and/or instream environment; as well as other actions to address non-achievement of performance targets.

5.1 Maintenance Logs

A maintenance log should be kept for each project describing the findings of site inspections, resulting maintenance needs, and completed maintenance actions. The dates of inspections and maintenance work should be recorded with notes about the general site conditions and other observations about the function of the restoration action. These maintenance logs will be used to evaluate the effectiveness of restoration actions and inform adaptive management decisions. For example, a properly functioning fish screen should prevent any fish entrainment within irrigation canals from the diversion point where it is installed. Rather than electrofishing the irrigation canals below screened diversion points to evaluate changes to fish entrainment, first, the maintenance log will be used to determine if the screen was properly maintained and functioning during irrigation operations. If the maintenance log shows that there were operational issues that may have resulted in the potential for fish entrainment, then the adaptive management framework would be utilized to determine potential corrective measures.

5.2 Fencing

Several types of fencing may be installed to protect riparian habitats including: basic livestock fencing, electric fencing, wildlife exclosure fencing, and others as determined by specific project designs. General fence maintenance will include inspections for functionality at least twice a year; after spring run-off and during and/or after the winter in case of excessive snow loading. The entire length of the fence should be inspected including any gates. Additional maintenance needs will depend on the specific type of fence installed and maintenance needs are described below for the most commonly used fences.

5.2.1 Livestock Fencing

Basic livestock fencing may include both smooth wire and barbed wire fence and may include on-channel water gaps to accommodate livestock watering needs. The following maintenance and repair task may be needed through the year for both livestock fencing and water gaps:

- Tighten loose or sagging wire
- Repair or replace of damaged wires
- Repair or replace of damaged posts or gates

5.2.2 Electric Fence

Electric fence may include wire or other electrified tape material on one or more strands of fencing. The power supply and grounding wires should be checked frequently throughout the year to ensure they are working as expected. The following maintenance and repair tasks may be needed throughout the year:

- Clear debris from fence line
- Tighten loose or sagging wires
- Repair or replace of damaged lines
- Repair or replace of damaged posts
- Repair or replace of electrical supply parts

5.2.3 Wildlife Exclosure Fence

Wildlife fence materials vary and manufacturers typically have maintenance specifications that should be followed. However, general maintenance for wildlife exclosure fencing may include:

- Re-secure fence materials to posts
- Tighten sagging fence material
- Re-secure ground staples
- Replacement of any portions of the fence that have been removed or no longer function

5.2.4 Off-Stream Livestock Water Systems

Maintenance for off-stream livestock watering systems depends on the system that is installed, but may include maintenance of mechanical parts such as pumps and ensuring that other parts such as tanks are intact and properly functioning. These systems should be checked while livestock are in the area to ensure that water is being delivered.

5.3 Weed Management

Weed management is an ongoing maintenance need in most locations. Accurate weed mapping should be completed following project implementation and as part of other project monitoring thereafter to document locations and extents of weed infestations, including the species, and abundance of each noxious weed species in the form a percent canopy cover. The current state and county noxious weed lists should be consulted to ensure all regulated species are being mapped and managed. The Montana Department of Agriculture maintains the state list and county extension offices or weed districts can be contacted for county noxious weed lists. These agencies may also be contacted for information on appropriate control methods and resources for landowners and land managers.

Weed management treatments will depend on the species to be treated, the size and density of the infestation, the presence of sensitive resource such as shallow groundwater or surface water, and the presence of non-target species. In general weed management options may include chemical control, biological controls, manual or mechanical removal, and targeted grazing. Often, combinations of control methods will improve weed management effectiveness. Examples include mowing and removing above ground plant parts of appropriate species to reduce further seed inputs and provide better contact with remaining plant parts for herbicide applications. An integrated management strategy that involves prevention and revegetation in addition to active control will provide the best long-term results.

5.3.1 Chemical Control

Proper chemical control involves using appropriate herbicides for the target species and location of infestation as well as application method and timing of application. The use of some herbicides requires a certified applicator. All labels, manufacturer specifications, and laws will be followed for any herbicide use. Application methods may include broadcast application using vehicle-mounted sprayer, handline application from a vehicle mounted tank, or backpack application.

5.3.2 Biological Controls

Biological controls use living organisms, such as insects, to control a weed species. The type of insect depends on the target species. Current state-listed noxious weeds that have bio-control agents include: Canada thistle, spotted knapweed, Dalmatian toadflax, tansy ragwort, St. Johnswort, leafy spurge, purple loosestrife, and diffuse knapweed.

5.3.3 Manual or Mechanical Removal

Some weed species can be effectively treated using manual or mechanical removal methods such as: hand pulling, digging, cutting and removing above ground plant parts, or mowing.

Hand pulling or digging is most effective for small populations and generally works best for tap rooted annual or biennial species. The entire root system should be removed if possible. For some species, even small pieces of remaining roots may be viable and result in continued plant growth. Soil disturbance should be minimized and all biomass should be removed from site and be properly disposed. Care should be taken not to transport weed seeds on clothing or through improper handling of pulled weedy material. Follow-up treatments will likely be necessary if plants regrow from remaining root fragments or the soil seed bank.

Mowing can be an effective weed management tool to remove flowers reducing seed inputs, but it generally does not eliminate weedy population. The timing and frequency of mowing varies for the targeted weed species as well as whether it is combined with other weed management treatments.

5.3.1 Targeted Grazing

Targeted livestock grazing, generally using sheep can be effective at controlling some noxious weed species such as leafy spurge, spotted knapweed, Dalmatian toadflax, and Canada thistle. Grazing should occur prior to seed maturation. Proper management and timing are also necessary to cause significant damage to the target plant while limiting damage to the surrounding vegetation. Grazing is usually used in combination with other control methods as part of an integrated weed management strategy.

5.3.1 Prevention

Preventing the spread of noxious weeds through the use of best management practices during implementation of restoration projects is the first line of defense against weed infestations. Access routes that are needed during the implementation phase should be located to avoid any existing weed infestations where possible. During other on-site activities such as assessments, inspections or maintenance visits, walking through weed infestations should be avoided where possible and weed seeds or plant parts that may regrow should be removed from clothing or gear and properly disposed.

5.3.2 Revegetation

Establishing a diverse and healthy native vegetation community is a long-term weed prevention strategy. Revegetation actions may be implemented as part of riparian enhancement projects that will be monitored through this Monitoring and Maintenance Plan.

5.4 Riparian Planting

Planted trees, shrubs, and herbaceous material will generally require maintenance such as deep watering and browse protection during the first two to five growing seasons as plants establish. Each of these maintenance tasks is described below.

5.4.1 Watering

Planted vegetation typically requires supplemental water during at least the first two growing seasons and possibly longer depending on the climate, seasonal weather patterns, and location of plantings. Plants should be watered-in immediately after installation. During the first years after installation, plants should be watered at least twice during the driest part of the year, typically from late July to early September. Additional watering may be necessary if seasonal weather conditions are exceptionally dry and plants appear to be showing signs of drought stress such as early leaf loss or wilting and drooping stems. Regular deep watering is more effective than frequent light watering and plants should be deep watered to moisten the soil to a depth of 12 to 18 inches.

5.4.2 Browse Protection

Wildlife exclosure fences, mentioned above, are intended to reduce browse pressure on newly planted material or existing vegetation communities. Without this type of fencing, newly planted material may be susceptible to wildlife browse damage and additional browse protection measures may be installed that require proper maintenance to ensure healthy plant growth. Individual browse protection measures may include physical barriers such as plastic netting or metal cages, or chemical deterrents such as PlantSkydd.

Metal or plastic netting browse protectors require straightening or re-securing netting material to posts and around the plant to effectively protect plants from browse and not restrict plant growth. As plants establish, protectors may need to be expanded to accommodate plant growth until they reach a size where they are more resistant to browse pressure. Browse protector removal without any additional protection measures is generally recommended for willows when they are more than three feet taller than the browse protector height and for other species that are more than one foot taller than the browse protector height. Plants should be evaluated at least one time each year, typically in the spring, to determine browse protector maintenance needs.

Chemical deterrents generally require multiple applications during the growing season for optimal effectiveness. Manufacturer's specifications should be followed for all mixing and treatment applications. Plants are typically treated every 3 to 6 months depending on the climate, level of browse, and chosen product.

5.4.3 Weed Barrier Maintenance

Individual weed mats that are typically installed at the base of planted trees and shrubs to limit competition from grasses need to be checked at least once per year for maintenance needs. Weed mats will typically need to be re-secured to the ground so they are not covering the plant or allowing grasses to grow around the base of the plant. Some weed mats photo-degrade overtime and therefore do not require removal. Other non-degradable weed mats should be removed once plants are well established and taller than the surrounding herbaceous vegetation.

5.5 Irrigation Diversion Maintenance

Maintenance of irrigation diversion structures depends on the type of structure. In general, structures should be inspected at the beginning and end of the irrigation season as startup and winterization tasks are completed. Diversion structures should be inspected throughout the irrigation season to ensure they are working properly. For some diversions, water control structures may need periodic adjustments to ensure the proper diversion rates are maintained. Maintenance tasks may include:

- Greasing and general maintenance of mechanical parts
- Removal of debris
- Replacement of non-functioning parts

5.6 Fish Screen Maintenance

Maintenance requirements for fish screens depend on the type of screen. In general, fish screens need to be inspected at the start and end of irrigation seasons as well as periodically throughout the season to ensure they are in proper working condition and tampering has not occurred. During high flow events, daily checks or maintenance may be needed to prevent damage to the screens. At the beginning and end of the irrigation season fish screen maintenance may include:

- Greasing of mechanical parts (manufacturers specifications should be followed)
- Changing of oil
- Cleaning debris from screen and pipes
- Unclogging drain pipes

5.7 Streambank Construction Maintenance

Streambank construction treatments are variable and may include sod placement, bioengineering treatments, toe protection, and other treatments. If plant material such as container grown trees and shrubs are planted or willow cuttings are installed, the plant material should be maintained as described above in the ***Riparian Planting*** section. Constructed streambanks will require little maintenance and any repair needs will generally be addressed through the adaptive management framework. General maintenance task that may be needed for constructed streambanks include:

- Re-securing anchors, including wooden stakes and metal earth anchors
- Re-seeding areas with poor native seed germination
- Installation of supplemental woody vegetation cuttings if cutting survival is low

5.8 Channel Construction

Channel structures generally require little to no maintenance; however, they require annual evaluations to assess their effectiveness and functionality. Channel effectiveness monitoring is described in Section 4.3. Channel structures may require repair or replacement if they are damaged or not functioning properly. Section 8 describes the decision pathway that will be used to evaluate the need for repair of channel structures if they are damaged or effectiveness monitoring shows that they are not trending toward meeting identified performance targets.

6 Monitoring and Maintenance Timeframe and Anticipated Costs

The 2012 Process Plan states an expected 20 year timeframe for funding expenditures associated with the Upper Clark Fork River Basin Restoration Fund.

6.1 Timeframe

The 2012 Restoration Plan specifies that basin-scale monitoring will be implemented twice at five-year intervals (2017 and 2022). This timeframe will apply to both basin and watershed effectiveness monitoring. Basin and watershed effectiveness monitoring data may be collected at variable intervals in the years between these five year timeframes, but formal evaluation of the data collected to date will occur at five and ten years to evaluate the effectiveness of the NRDP's restoration program in the UCFRB tributaries.

Project effectiveness monitoring will generally occur on an annual basis for at least the first five years. Each year, project effectiveness monitoring will be compiled for review using the adaptive management framework to make decisions for maintenance and/or repair needs; determine the success or failure or restoration actions; and evaluate trends that may inform the status of watershed and basin conditions.

Project baseline monitoring will be conducted prior to project implementation. As discussed in Section 4, existing data may be used for documenting baseline conditions in a project area where it is available. Additional project baseline data will be collected where needed to support prioritizing and selecting restoration actions. Existing data are generally summarized in published reports. If additional baseline data are collected to support project development, they may be summarized in project planning documents and will also be summarized or referenced in effectiveness monitoring reports.

Project compliance monitoring will be conducted during project construction. Project implementation monitoring will be conducted immediately following project completion. An As-Built monitoring report will be prepared for each restoration project following completion of construction. The As-Built Monitoring report will summarize compliance monitoring data and reference any additional reports that were required by construction permits.

6.2 Costs

Actual costs to implement this Monitoring and Maintenance Plan will not exceed the NRDP's fund value of $1,500,000. To accomplish these tasks within the given budget the NRDP will attempt to develop cooperative agreements between other state agencies, conservation groups, landowners, and others to provide matching funds or identify sources for additional funding. These agreements may also include sharing data and other related information describing conditions in the UCFRB. For basin and watershed monitoring, agreements may be possible between other state agencies and conservation groups. For project monitoring and maintenance, agreements will also involve landowners and specific terms of cost sharing agreements will be agreed upon during the project development process.

To further control costs while providing sufficient and relevant monitoring and maintenance actions, more costly items, such as using rotary screw traps to monitor fish outmigration from tributaries may not be included in all the watersheds. Instead, expensive monitoring such as rotary screw traps may be limited to watersheds with active restoration projects and where restoration is expected to result in significant changes.

Anticipated cost items to implement this Monitoring and Maintenance Program may include, but are not limited to, the following:

- Funding a Coordinator Position to further develop and implement this Monitoring and Maintenance Program;
- Developing detailed monitoring plans for the basin, watershed, and projects;
- Conducting field data collection according to the detailed monitoring plans;
- Data entry and analysis, including preparing monitoring reports;
- Developing a data management framework;
- Developing and implementing an adaptive management framework, and
- Conducting maintenance activities.

Assigning a Monitoring and Maintenance Coordinator role that will develop a detailed program budget will be necessary to guide the implementation of this Monitoring and Maintenance Program.

Appendix D includes estimated costs for monitoring data collection and maintenance activities that are proposed and described in this document. These estimated data collection and maintenance costs may be used to facilitate landowner agreements related to developing cost share agreements. However, these costs are approximate and should be updated with more accurate costs as monitoring and maintenance of completed restoration projects begins.

7 Monitoring Data Management

This section provides general guidance on managing data collected as part of the monitoring program. A more comprehensive plan for developing and managing monitoring data will need to be developed. Monitoring data will be collected in the field using protocols described in Appendix C or from other sources identified as detailed monitoring plans are developed. These data will be entered into an electronic format such as a Microsoft Excel spreadsheet that allows for easy access to and sharing of data. A standard template will be used for data entry to ensure that data are entered consistently over time and between individual restoration projects. Using a standard spreadsheet template will facilitate compiling data from multiple projects to summarize results within the watersheds and to use for basin-wide effectiveness monitoring.

Spatial data including GPS points, lines, or polygons may be collected to document monitoring data collection locations. These spatial data will include attributes that link the spatial data to the monitoring data in the spreadsheets.

All project monitoring data and reports will be delivered to the NRDP on an annual basis. These data will be compiled into a standard database format such as a MySQL or other database format. All monitoring reports will be compiled in a central location.

In addition to collecting and entering data in a standard and repeatable format, data and reports should be stored and/or accessible through a central repository. This will allow members of an interdisciplinary monitoring team or adaptive management team to have access to monitoring data for interpreting monitoring results at the watershed and basin scale and make maintenance and adaptive management recommendations.

8 Adaptive Management Framework

In order to evaluate the overall effectiveness of tributary restoration actions in the UCFRB, the results of monitoring data from basin, watershed, and individual restoration projects will be compiled to provide a comprehensive picture of the changing conditions in the UCFRB. Understanding the direct effects of tributary restoration actions will be complicated by the corresponding effects of mainstem remediation and restoration actions on the Clark Fork River and Silver Bow Creek as well as variability that is inherent in natural systems. An effective adaptive management framework will guide evaluations of monitoring results and facilitate interpreting these results in light of expected and unexpected natural variability.

The adaptive management process will utilize an interdisciplinary team representing multiple natural resources and concerns in the UCFRB to evaluate and interpret monitoring results to make management decision for the monitoring and maintenance program. The team may include representatives from management agencies, biologists, engineers, hydrologist, ecologists, representatives from conservation groups, landowners, or others.

Although monitoring data will be collected on variable schedules as described in the ***Monitoring Plan*** and the ***Timeframe*** sections, the adaptive management framework will identify regular review schedules when the interdisciplinary team will review and evaluate monitoring results and progress toward achieving restoration goals. To support these reviews, a Monitoring and Maintenance Coordinator designated by the NRDP will compile effectiveness monitoring results and reports from project, watershed, and basin monitoring.

These reports and findings will be reviewed to determine if individual projects appear to be achieving their identified restoration goals and if watershed and basin restoration goals are being achieved.

The project evaluations will look at the effectiveness of each restoration action as well as the project as a whole. The following questions will be used to evaluate restoration projects and their treatments:

- Do effectiveness monitoring results show that projects are meeting the performance targets or trending toward meeting the performance targets?

- Are there site conditions that are preventing the restoration actions from meeting the performance targets?

For all three scales, the adaptive management framework should ask the following questions to determine if monitoring is showing progress toward achieving restoration goals:

- Are the correct data being collected to evaluate the performance of the restoration actions?
- Are additional data needed to evaluate the effectiveness of the restoration actions?
- What are the risks to the physical environment and biological populations if the restoration action does not achieve the performance target?
- What corrective actions could be implemented to address non-achievement of the performance targets?
- Should corrective actions be implemented?
- Can lessons be learned from other restoration projects where treatments did meet the performance targets?

Some proposed restoration actions rely on interpreting effectiveness monitoring data to determine if they will be implemented in a watershed, such as instream habitat actions. For example, in many of the watersheds, instream habitat restoration actions are proposed for implementation only if flows are restored and/or riparian habitat protection and enhancement measures are not effectively improving the instream habitat. Project effectiveness monitoring should evaluate the need for these actions each year after other restoration actions have been implemented.

Watershed and basin trends will also be evaluated using data collected for each scale along with project effectiveness monitoring data as a guide for the trends that may be occurring at these larger scales. At the watershed scale, the effectiveness of all restoration actions within a particular watershed should be evaluated to see if the physical environment is changing related to the identified limiting factors for that watershed. At the basin scale, the compiled effects of restoration within all the watersheds should be evaluated to see if key watershed selected as the focus for monitoring certain metrics such as trout migration to the mainstem, are showing signs of addressing limiting factors.

As population and migration data are collected, this information will be used to verify whether achieving performance targets for restoration actions is influencing biological populations.

9 Next Steps

This Monitoring Plan is a working document that will be updated as needed during the monitoring timeframe to ensure that it effectively supports the NRDP's effort to evaluate their restoration program in the UCFRB tributaries. Uncertainties exist with developing and implementing the monitoring plan because restoration projects and associated actions are still being identified throughout the UCRFB. The monitoring metrics and methods identified for this plan are based on the best estimate of the types and locations of restoration projects that are anticipated to occur in the UCFRB. As specific restoration projects are identified, prioritized, and implemented, details of monitoring locations, metrics, frequency of sampling and others will be revised as needed and incorporated into detailed monitoring plans that will be developed.

Specific roles and next steps that will support necessary updates to the monitoring plan and to implement the Monitoring Program include:

- Roles:
  - Monitoring and Maintenance Coordinator. This role may be filled through existing NRDP staff, new NRDP staff, or consultants or other representative of the NRDP.
  - Monitoring Team. Different individuals or groups will fill this role for developing detailed monitoring plans and others may fill this role for conducting data collection as specified in the plans depending on the type of data being collected and the monitoring scale. See the tasks below for additional information.
  - Adaptive Management Team. This role will be filled by an interdisciplinary team as described in Section 8.
  - Data Management Coordinator. This role may be filled, in part by the Monitoring and Maintenance Coordinator, but it may also be a separate role that is overseen by the Monitoring and Maintenance Coordinator.
  - Maintenance Operations. This role may be filled by project proponents or landowners, but may also be filled by skilled laborers on behalf of the NRDP if maintenance tasks require specialized skills or licenses or as specified in project agreements.
  - Peer Reviewers. This role may be filled by academic professionals from Universities or resource professionals from state or federal agencies, organizations, or private industry.
- Tasks:
  - Develop an Implementation Plan for this Monitoring and Maintenance Program. This will be completed by the Monitoring and Maintenance Coordinator
  - Develop a comprehensive budget for the Monitoring and Maintenance Program. Refine costs for specific monitoring and maintenance tasks based on the actual restoration actions implemented and their associated maintenance and monitoring requirements; and integrating cost share agreements developed between the NRDP and project proponents and partners. This will be completed by the Monitoring and Maintenance Coordinator
  - Develop the Adaptive Management Framework. This will be completed by the Monitoring and Maintenance Coordinator and the Adaptive Management Team
  - Develop the Data Management Framework. This will be directed by the Monitoring and Maintenance Coordinator and may include identifying a Data Management Coordinator that will develop and implement a framework for storing and managing monitoring data.
  - Develop Detailed Monitoring Plans for the basin, watersheds, and projects. At the basin and watershed scale this will be completed by the Monitoring and Maintenance Coordinator in coordination with a Monitoring Team that may include resource managers, stakeholders, or other representatives of the NRDP. At the project scale this will be completed by the Monitoring and Maintenance Coordinator in coordination with the Monitoring Team that may include project proponents, landowners, resource managers, stakeholders. Outside peer reviewers may review or contribute to

developing detailed monitoring plans by providing input on methods to evaluate the precision of selected monitoring metrics, offering feedback on appropriate sample designs, and other support as requested by the NRDP.

- Conduct monitoring according to the detailed monitoring plans. The MFWP will conduct fish sampling that is proposed at the basin and watershed scale. Other monitoring at the basin and watershed scale will generally be conducted by resource professionals from other agencies, organizations, universities or private industry on behalf of the NRDP. Project scale monitoring may be conducted by project proponents, landowners, or representatives of the NRDP as specified in project agreements.
- Data entry, analysis, and reporting. This role will generally be completed by the Monitoring Team that is conducting the monitoring data collection. However, the NRDP may assign this task to a different group as needed. The Monitoring and Maintenance coordinator will provide an oversight role for this task ensuring that all monitoring data are integrated into the data management framework and that monitoring reports are delivered on schedule.
- Develop annual monitoring and maintenance task lists and schedules. This will be completed by the Monitoring and Maintenance coordinator. This task may also be completed in coordination with the Monitoring Team for each scale and type of data being collected to identify specific monitoring needs. Maintenance needs will be determined in coordination with project proponents and the Monitoring Teams for each project.
- Conduct annual maintenance. This will be completed by landowners, project proponents, or skilled laborers on behalf of the NRDP as specified in project agreements.
- Coordinate scheduled reviews of monitoring findings by the Adaptive Management Team. This will be completed by the Monitoring and Maintenance coordinator with participation from the Adaptive Management Team.

Identify coordinating monitoring efforts and opportunities to share data that will inform decision making and findings related to this Monitoring and Maintenance Program. This will be completed by the Monitoring and Maintenance coordinator.

10 References

Allen, S.T., Thomson, C., and R. Carlson, eds. 2004. Proceedings of the Salmon Habitat Restoration Cost Workshop. Gladstone, OR: Pacific States Marine Fisheries Commission. Session Five: Oregon Department of Fish and Wildlife Fish Screening Program: Fish Screen Types and Costs. Available online: http://www.st.nmfs.noaa.gov/st5/abstracts/Salmon_Habitat_Restoration_Cost_Workshop_2000.htm

Archer, Eric K., Scully, Rebecca A., Henderson, Richard, Roper Brett B., and Heitke, Jeremiah D. 2012. Effectiveness Monitoring for Streams and Riparian Areas: Sampling Protocol for Stream Channel Attributes. PACFISH/INFISH Biological Opinion Effectiveness Monitoring Program (PIBO-EMP) Staff, Multi-federal Agency Monitoring Program; Logan, UT. Unpublished paper on file at: http://www.fs.fed.us/biology/fishecology/emp

Der Hovanisian, J. A. 1997. Project 7. Irrigation diversion fish loss reduction: Subproject 1. South Fork Snake River Canal Investigations. Idaho Department of Fish and Game. Annual Performance Report, Project F-73-R-18, Subproject No. 1. Boise, Idaho. Available online: https://collaboration.idfg.idaho.gov/FisheriesTechnicalReports

Environmental Laboratory. 1987. Corps of Engineers Wetlands Delineation Manual, Technical Report Y-87-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Harrelson, Cheryl C., C. L. Rawlins, and J. P. Potyondy. 1994. Stream channel reference sites: an illustrated guide to field technique. General Technical Report RM-245. Fort Collins, Colorado: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61p.

Iowa State University (ISU). 2014. Estimated Costs for Livestock Fencing. Iowa State University Extension and Outreach Ag Decision Maker. Available online at: http://www.extension.iastate.edu/agdm/livestock/html/b1-75.html

Liermann, B., J. Lindstrom, R. Kreiner. 2009. An Assessment of Fish Populations and Riparian Habitat in Tributaries of the Upper Clark Fork River Basin: Phase II. Montana Fish, Wildlife, and Parks.

Lindstrom, J. 2013. Upper Clark fork River Basin, Stream Fish Sampling 2010-2012. Montana Fish, Wildlife, and Parks.

Lindstrom, J. 2011. An Assessment of Fish Populations and Riparian Habitat in Tributaries of the Upper Clark Fork River Basin – 2009 Report. Montana Fish, Wildlife, and Parks.

Lindstrom, J. B. Liermann, R. Kreiner. 2008. An Assessment of Fish Populations and Riparian Habitat in Tributaries of the Upper Clark Fork River Basin. Montana Fish, Wildlife, and Parks.

Lipton, J., D. Beltman, H. Bergman, D. Chapman, T. Hillman, M. Kerr, J. Moore, and D. Woodward. 1995. Aquatic Resources Injury Assessment Report, Upper Clark Fork River Basin. State of Montana, Natural Resource Damage Litigation Program.

Mayfield, M.P. 2013. Limiting factors for trout populations in the Upper Clark Fork River Superfund Site, Montana. Submitted in partial fulfillment of M.S. degree, Montana State University.

Monitoring Methods. 2014a. Monitoring Methods, a Monitoring Resource Tool. Protocol: KTOI - Kootenai River Habitat Restoration Program Monitoring and Evaluation v1.0. Sponsored by Pacific Northwest Aquatic Monitoring Partnership. Online: https://www.monitoringmethods.org/Protocol/Details/532

Monitoring Methods. 2014b. Monitoring Methods, a Monitoring Resource Tool. Sponsored by Pacific Northwest Aquatic Monitoring Partnership. Protocol: CTWS Hood River M&E - Water temperature monitoring in the Hood River subbasin v1.0. Online: https://www.monitoringmethods.org/Protocol/Details/761

Monitoring Methods. 2014c. Monitoring Methods, a Monitoring Resource Tool. Sponsored by Pacific Northwest Aquatic Monitoring Partnership. Protocol: YRWP discharge measurements (1996-035-01) v1.0. Online: https://www.monitoringmethods.org/Protocol/Details/699

Monitoring Methods. 2014d. Monitoring Methods, a Monitoring Resource Tool. Sponsored by Pacific Northwest Aquatic Monitoring Partnership. Protocol: Monitoring Stream Flow and Discharge v1.0. Online: https://www.monitoringmethods.org/Protocol/Details/1852

Montana Fish, Wildlife and Parks (MFWP). 2014. Montana Fisheries Information System.

Montana Fish, Wildlife, and Parks and Natural Resource Damage Program (MFWP and NRDP). 2011a. Prioritization of Areas in the Upper Clark Fork River Basin for Fisheries Enhancement. Prepared by P. Saffel, B. Liermann, J. Lindstrom, L. Knotek, T. Mostad, and C. Fox.

Montana Fish, Wildlife, and Parks and Natural Resource Damage Program (MFWP and NRDP). 2011b. Upper Clark Fork River Basin Terrestrial Wildlife Resource Prioritization. Prepared by K. DuBois, R. Vinkey, S. Story, C. Fox, and G. Mullen.

Montana Fish, Wildlife, and Parks and Natural Resource Damage Program (MFWP and NRDP). 2010a. Upper Clark Fork River Basin Terrestrial Resource Assessment Final Report. Prepared by R. Vinkey, K. DuBois, C. Fox, and G. Mullen.

Montana Fish, Wildlife, and Parks and Natural Resource Damage Program (MFWP and NRDP). 2010a. Rating Summaries for the Prioritization of Tributaries of the Upper Clark Fork River Basin for Fishery Enhancement, Draft Final. Prepared by B. Liermann, J. Lindstrom, L. Knotek, P. Saffel, T. Mostad, and C. Fox.

Montana State University (MSU). 2002. Sheep Institute a natural step toward weed control. MSU-Bozeman News Service. Online at: http://www.montana.edu/news/330/sheep-institute-a-natural-step-toward-weed-control

Montana State University (MSU) Extension Service. 2002. Montana Noxious Weed Survey and Mapping System. MontGuide MT199613 AG 7/2002. By Diana Cooksey and Roger Sheley.

Natural Resource Damage Program (NRDP). 2012a. Final Upper Clark Fork River Basin Aquatic and Terrestrial Resources 2012 Restoration Plans. December 2012.

Natural Resource Damage Program (NRDP). 2012b. Final Upper Clark Fork River Basin Interim Restoration Process Plan. Prepared by the State of Montana, Natural Resource Damage Program.

Natural Resource Damage Program (NRDP). 2011 Final Upper Clark Fork River Basin Long Range Priorities and Fund Allocation Guidance Plan. Prepared by the State of Montana, Natural Resource Damage Program.

Naughton, J.P. 2013. Salmonid response to superfund remediation in Silver Bow Creek, Montana. Submitted in partial fulfillment of M.S. degree, Montana State University.

Naughton, J. P., R. E. Gresswell, and T. E. McMahon. 2011. 2010 Project Activities for Silver Bow Creek Fisheries Study: Effects of hypoxia and ammonia toxicity on the spatial distribution of salmonids and catostomids within the remediated portion of Silver Bow Creek. Montana State University

Overton, C. Kerry, S.P. Wollrab, B.C. Roberts, M.A. Radko. 1997. R1/R4 (Northern/Intermountain Regions) Fish and Fish Habitat Standard Inventory Procedures Handbook. USDA Forest Service, Intermountain Research Station, General Technical Report GTR-346.

Rosgen, Dave. 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, CO.

Schreck, W., R. Kreiner, B. Liermann, and J. Lindstrom. 2011. An Inventory of Irrigation Structures in the Upper Clark Fork River Drainage, Montana. Final Report 2011, USFWS Agreement Number-601818J270. Montana Fish, Wildlife, and Parks.

Schreck, W., R. Kreiner, B. Liermann, and J. Lindstrom. 2010. An Inventory of Irrigation Structures in the Upper Clark Fork River Drainage, Montana. 2010 Annual Progress Report. USFWS Agreement Number - 601818J270. Montana Fish, Wildlife, and Parks.

United States Army Corps of Engineers. 2010. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region (Version 2.0), ed. J.S. Wakeley, R.W. Lichvar, and C. V. Noble. ERDC/EL TR-10-3. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

United States Department of Agriculture, Natural Resources Conservation Service (NRCS). 2012. Riparian Assessment Using the NRCS Riparian Assessment Method. United States Department of Agriculture, Natural Resource Conservation Service. Environmental Technical note No MT-2 (Rev. 1).

United States Department of Agriculture, Natural Resources Conservation Service. 2010. Field Indicators of Hydric Soils in the United States, Version 7.0. L.M. Vasilas, G.W. Hurt, and C.V. Noble (eds.). USDA, NRCS, in cooperation with the National Technical Committee for Hydric Soils.

United States Department of Agriculture, Natural Resources Conservation Service (NRCS). 2004. Riparian Assessment Using the NRCS Riparian Assessment Method. United States Department of Agriculture, Natural Resource Conservation Service.

US Fish and Wildlife Service (USFWS). 2010. Endangered and Threatened Wildlife and Plants; Revised Designation of Critical Habitat for Bull Trout in the Coterminous United States; Final Rule. FR 75: 63898-64070.

US Fish and Wildlife Service (USFWS). 2008. Draft Rotary Screw Trap Protocol for Estimating Production of Juvenile Chinook Salmon. U.S. Fish and Wildlife Service, Sacramento Fish & Wildlife Office, Comprehensive Assessment and Monitoring Program. Online:

http://www.fws.gov/sacramento/es/Survey-Protocols-Guidelines/Documents/2008_draft_CAMP_Rotary_Screw_Trap_Protocol.pdf

Watershed Restoration Council (WRC). 2013. Project Effectiveness Monitoring: UCF Tributaries Riparian Health and Water Conservation Projects. DEQ NPS Project #210116, April.

Watershed Restoration Council (WRC). 2012. Upper Clark Fork Tributary Assessment for Restoration Planning, Watershed Health Monitoring Report. DEQ NPS Project #210116, August.

Watershed Restoration Council and Trout Unlimited (WRC-TU). 2012. Upper Clark Fork Diversion Inventory. Prepared by Trout Unlimited. Prepared for Watershed Restoration Coalition.

Weedbusters Biocontrol. 2014. Online: http://weedbustersbiocontrol.com/index.html

Winward, A.H. 2000. Monitoring the vegetation resources in riparian areas. Gen. Tech. Rep. RMRS-GTR-47. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 49 p.

Wolman, M. G. 1954. A method of sampling coarse riverbed material. Transactions of the American Geophysical Union. 35(6): 951-956.

Workman, D. 2009. Qualitative Assessment of Habitat in Eight Tributaries to Upper Clark Fork River. Prepared by Dennis Workman. Prepared for Montana Natural Resource Damage Program and Montana Fish, Wildlife, and Parks.

Appendix A. Example Project Scale Monitoring Plan Template – Harvey Creek

[*This page intentionally left blank*]

Introduction

Harvey Creek is a Priority 2 stream according to the *2011 Final Upper Clark Fork River Basin Long Range Priorities and Fund Allocation Guidance Plan* (NRDP 2011). Harvey Creek is a perennial stream that flows north from the Deer Lodge National Forest through a mix of National Forest and private land before entering the Clark Fork River east of the Bearmouth exit on Interstate 90 (Liermann et al. 2009).

The fish population in the Harvey Creek watershed consists exclusively of native bull trout and genetically pure westslope cutthroat trout that are isolated by a grade control structure upstream from the mouth of the creek. A mixed fishery of native fish and non-native brown and rainbow trout are found in the reach below the grade control structure (barrier) (Liermann et al. 2009). Harvey Creek is also designated as Critical Bull Trout Habitat by the US Fish and Wildlife Service.

Limiting Factors and Restoration Actions

Limiting factors identified for the Harvey Creek watershed in the *Final Upper Clark Fork River Basin Aquatic and Terrestrial Resource Restoration Plans* (Restoration Plan) (NRDP 2012) include the following (in order of priority): riparian habitat, fish entrainment, fish passage, and water quantity.

Proposed restoration actions to address the limiting factors in Harvey Creek include the following:

- Install a riparian fence and improve grazing management on private lands on the lower 3 miles of Harvey Creek.
- Install a siphon and fish screen at the diversion structure located on State land near the mouth of Harvey Creek.
- Install a fish screen, headgate and improved diversion structure at the uppermost Harvey Creek Ranch diversion that allows for year-round fish passage and prevents fish entrainment.
- Consolidate all seven Harvey Creek Ranch irrigation diversions to the screened and improved diversion structure. Install gravity-fed pipeline and sprinkler irrigation system to improve irrigation efficiency and protect instream flow in lower Harvey Creek.
- Evaluate the integrity of the fish barrier/grade control structure and culvert at the Mullan Trail road crossing. Consider improvements as necessary to protect the stream and the fishery.

To date, a riparian exclosure fence has been installed along approximately two miles of Harvey Creek on the west side of the channel. Other proposed restoration actions listed above may be implemented in the future. This plan includes specific monitoring and maintenance actions related to the installation of the riparian fence and example monitoring and maintenance actions for potential future projects that may address fish entrainment and passage issues. The example monitoring and maintenance actions for potential additional restoration would be revised as needed based on final locations and designs for these treatments. The NRDP's Flow Restoration Program will address water quantity projects and monitoring in the Harvey Creek watershed.

Restoration Goals

The Harvey Creek watershed currently supports a high quality fishery and one of the main goals of the restoration program for this watershed is to maintain and protect this resource. Restoration goals specific to the implemented and proposed restoration actions that will guide project monitoring and maintenance are summarized in Table A- 1.

Table A- 1. Limiting factors, restoration actions and goals for the Harvey Creek restoration project

Limiting Factors	Restoration Actions	Restoration Goals
Riparian Habitat	Riparian fence	• Improve riparian habitat conditions • Improve streambank conditions and reduce erosion • Improve aquatic habitat conditions • Reduce noxious weed density • Increase vegetation structural diversity • Reduce livestock browse • Support natural woody vegetation recruitment • Provide sustainable water sources for livestock
Fish Entrainment	Fish screen installations	• Reduce fish entrainment
Fish Passage	Diversion structure improvements and consolidation	• Improve fish passage to support recruitment to the mainstem • Preserve passage barrier at Mullan Road to protect pure native trout populations that are currently isolated
Fish Passage	Siphon	• Reduce water temperatures below the diversion structure • Reduce mixing of Clark Fork River irrigation water and Harvey Creek water • Reconnect spawning habitat below the barrier

Components of the Monitoring Plan

This section describes monitoring related to restoration actions that have or will be implemented in the Harvey Creek watershed. Using the restoration goals for the treatments, monitoring metrics are identified for each type of monitoring: baseline monitoring, compliance monitoring, implementation monitoring, and effectiveness monitoring.

Baseline Monitoring

Resource data have been collected in the Harvey Creek watershed that can be used to document the pre-project condition related to the restoration goals summarized in Table A- 1 above. Table A- 2 below summarizes these existing data sources related to restoration goals. Additional data that has been collected in the Harvey Creek watershed is also summarized in the *2012 Upper Clark Fork River Basin Aquatic Resources Restoration Plan, Monitoring and Maintenance Plan* (NRDP pending).

Riparian and aquatic habitat assessments were completed by Montana Fish, Wildlife, and Parks (MFWP) (Liermann et al. 2009) during September 2008 within short reaches of Harvey Creek associated with fish sampling locations. Sampling sites evaluated by MFWP at river miles 0.6 and 2.0 are within the extents of the riparian fence and these data will be used to describe baseline conditions for this area. Montana FWP completed assessments using the NRCS Riparian Assessment method (2012), with supplemental attributes 1 and 2 (USDA NRCS 2004), and a fish habitat assessment metric created and used by MFWP (Liermann et al. 2009 and Lindstrom et al. 2008). The NRCS Assessment (2012 and 2004) includes questions that evaluate vegetation structural diversity and natural recruitment based on the age class diversity, along with questions that evaluate browse levels and noxious weed abundance at a coarse scale. The supplemental attribute questions from the NRCS Riparian Assessment and the MFWP habitat question provide information about aquatic habitat substrate and fish habitat. Where MFWP sampling sites occur within a larger assessment area these datasets can be used to document and compare habitat conditions over time. Additional baseline monitoring data for the riparian fence related to riparian and aquatic habitat conditions will be collected during the first year of effectiveness monitoring because the fence is already installed.

Montana FWP conducted electrofishing surveys in the diversion canal near the mouth of Harvey Creek on DNRC property to evaluate fish entrainment in 2010 and 2011 (Schreck et al. 2010 and 2011). Similar methods were used to evaluate fish entrainment at six irrigation diversions on the private land upstream of the fish barrier to establish baseline data for these structures on Harvey Creek. A radiotelemetry study in the UCFRB found a radio-tagged bull trout was entrained in the downstream-most canal in 2009 when trying to enter the Harvey Creek drainage. This study also documented westslope cutthroat trout movement and spawning activity in the Harvey Creek watershed (Mayfield 2013 and Schreck et al. 2011).

Trout Unlimited evaluated fish passage issues at all seven irrigation diversion structures and one pump location on Harvey Creek using methods adapted from the US Forest Service's National Assessment and Inventory Protocol for Assessing Stream Road Crossings (NIAP) (WRC-TU 2012). These assessments include: measuring the physical characteristics of diversion structures, water surface elevation difference across the structure, water velocities through the structure, plunge height, plunge pool depth, and distance from plunge pool to plunge (WRC-TU 2012).

Table A- 2. Baseline monitoring information.

Limiting Factor	Restoration Goals	Monitoring Metrics	Existing Baseline Information	Additional Baseline Monitoring Needs
Riparian Habitat	Improve riparian habitat conditions	NRCS Riparian Habitat Condition Assessment	Liermann et al. 2009	None
		Greenline survey	None	None [a]
	Improve streambank conditions and reduce erosion	WRC bank erosion inventory	None	None [a]
	Improve aquatic habitat conditions	NRCS Riparian Habitat Condition Assessment	Liermann et al. 2009	None
	Reduce noxious weed density	Noxious weed inventory	Liermann et al. 2009	None
	Increase vegetation structural diversity	Vegetation canopy cover	Liermann et al. 2009	None
	Reduce livestock browse	Browse evaluation	Liermann et al. 2009	None
	Support natural woody vegetation recruitment	Woody vegetation recruitment	Liermann et al. 2009	None
	Provide sustainable water sources for livestock	Riparian fence & water gap conditions	None	None [a]
Fish Entrainment	Reduce fish entrainment	Entrainment risk – Modified NIAP assessments	WRC-TU 2012 and Schreck et al. 2010 and 2011	None
Fish Passage	Improve fish passage to support recruitment to the mainstem	Fish passage – Modified NIAP assessments	WRC-TU 2012	None
	Preserve passage barrier at Mullan Road to protect pure native trout populations that are currently isolated	Fish passage – Modified NIAP assessments	WRC-TU 2012	None

[a] The riparian exclosure fence was installed in Fall 2013 and the first round of effectiveness monitoring data collection will document both pre-project and post-project condition.

Compliance Monitoring

Permits were not required to construct the riparian fence and therefore no compliance monitoring has occurred to date. However, permits may be required to improve water gaps associated with the riparian fence. Construction permits will be required for future project elements including the siphon and fish screen construction at the downstream-most diversion; other fish screen installation projects; and diversion or culvert improvement projects for fish passage. Specifics of compliance monitoring needs will be determined as designs for these projects are completed and necessary construction permits are acquired. Anticipated compliance monitoring metrics to meet conditions of 404, 310, and/or 124 permits may include the following:

- Water quality monitoring (turbidity)
- Documenting work dates if construction permits limit work windows for species protection
- Stormwater BMP's

Anticipated as-built documentation required by construction permits is described in the Implementation Monitoring section below.

Implementation Monitoring

Implementation monitoring documents the locations, extents, and materials used to implement the restoration treatments. Specific implementation monitoring that will be completed for Harvey Creek restoration actions are listed below.

Riparian exclosure fence:

- Location of the fence (GPS or drawn on map)
- Type of fence and materials used
- Length of fence installed
- Linear feet of channel within the fence
- Number and location of water gaps (GPS or drawn on map)
- Type of water gap and materials used
- Establish photo points showing the as-built condition of the fence

Siphon and fish screen at the downstream-most diversion structure and other fish screen installations:

- Location of the fish screen (GPS or drawn on map)
- Type of screen and materials used
- Establish photo points showing the as-built condition of the fish screen

Diversion improvements or culvert replacements for fish passage:

- Location of the diversion or culvert (GPS or drawn on map)
- Type of improvement and materials used
- Establish photo points showing the as-built condition of the diversion or culvert improvements

Effectiveness Monitoring

Effectiveness monitoring documents the physical conditions within the project area resulting from restoration actions including changes from the pre-project condition and the post-implementation condition. Table A- 3 below incorporates similar monitoring metrics as the baseline monitoring data in Table A- 2, but also includes measurable performance targets that will be used to determine if the restoration actions are achieving the identified restoration goals. Expectations of project performance vary over time which is reflected in performance targets that are develop for three timeframes, including:

- Short-term – the first five years following implementation when results of restoration actions may not be very apparent;
- Mid-term – five to fifteen years following implementation when results of restoration actions are becoming more apparent; and
- Long-term – more than fifteen years following implementation when riparian and aquatic habitats are expected to reflect natural conditions and support dynamic channel and floodplain processes.

Details of effectiveness monitoring methods, locations, frequency, and performance targets are described below for the effectiveness monitoring metrics listed in Table A- 3. The sampling and analysis plan in the following section includes detailed monitoring information related to the riparian fence that was installed in fall 2013. Effectiveness monitoring described for fish entrainment and fish passage projects will be updated as projects are identified and final designs are completed.

The riparian fence is a passive restoration action where changes in the riparian and aquatic habitat conditions are expected to change over a longer period of time compared to active restoration techniques such as channel reconstruction or floodplain revegetation. The NRCS Riparian Assessment monitoring metric is intended to capture the long-term, reach-scale changes associated with the riparian fence and changes in habitat conditions. Other effectiveness monitoring metrics described below for specific riparian and channel conditions (i.e. bank erosion, noxious weeds, browse, longitudinal profile, and others) will provide trend information during the short- and mid-term timeframes. These trends will help guide maintenance actions and feed into an adaptive management framework to inform planning for future restoration actions within the Harvey Creek watershed and within the larger Upper Clark Fork River Basin.

Table A- 3. Harvey Creek project effectiveness monitoring details.

Limiting Factor	Restoration Goals	Monitoring Metrics	Performance Targets	Monitoring Schedule
Riparian Habitat	Improve riparian habitat conditions	NRCS Riparian Habitat Condition Assessment	Short- and Mid-term: • None Long-term: • Improved riparian condition	Years 1 and 10 or 15
		Repeat photograph points	None	Annually
	Improve streambank conditions and reduce erosion	WRC bank erosion inventory	Short- and Mid-term: • Reduced length and area of eroding banks Long-term: • No human induced bank erosion, streambank erosion occurs within expected ranges for natural channel migration processes	Years 1, 3, 5, and 10 or 15
	Improve aquatic habitat conditions	NRCS Riparian Habitat Condition Assessment	Short- and Mid-term: • None Long-term: • Improved aquatic habitat condition	Years 1 and 10 or 15
		Longitudinal profile	Mid-to Long-term: • Maintained or increased channel length • Distribution of pools, riffles, runs, and glides similar to reference conditions for the channel type	Years 1, 5, 10, and 15
		Channel cross-section	Mid- to Long-term: • Cross-section dimensions appropriate for channel type	Years 1, 5, 10, and 15
		Water temperature	Mid- to Long-term: • Decreased water temperatures	Years 1, 3, 5, 10, and 15
	Reduce noxious weed density	Noxious weed inventory	Short-, Mid-, and Long-term: • Less than 10% cover of noxious weeds	Years 1, 2, 3, 5, 10, and 15

Limiting Factor	Restoration Goals	Monitoring Metrics	Performance Targets	Monitoring Schedule
	Increase vegetation structural diversity	Greenline survey	Short- and Mid-term: • Distribution and diversity of plant communities is trending toward desired condition Long-term: • Distribution and diversity of plant communities matches desired condition	Years 1, 3, 5, and 10 or 15
	Reduce livestock browse	Browse evaluation	Short-, Mid-, and Long-term: • 0 to 5% of available second year and older stems are browsed	Years 1, 3, 5, 10, and 15
	Support natural woody vegetation recruitment	Woody vegetation recruitment/regeneration	Short-term: • Seedling recruitment is occurring and new plants are surviving Mid- to Long-term: • Multiple age classes are present in the floodplain	Years 1, 3, 5, 10, and 15
	Provide sustainable water sources for livestock	Riparian fence & water gap conditions	Short-, Mid- and Long-term: • Fence and water gaps are maintained and functioning as intended	Per landowner/maintenance agreement
Fish Entrainment	Reduce fish entrainment	Observations and maintenance of fish screen	Short-, Mid-, and Long-term: • Fish screen is properly maintained and operational to prevent fish entrainment	Annually
Fish Passage	Improve fish passage to support recruitment to the mainstem	Fish passage – Modified NIAP assessments [c]	Short-, Mid-, and Long-term: • Improved diversion structures or culverts are physically capable of allowing fish passage and functioning as needed to move water	Year 1 and as needed
		Observations and maintenance of diversion structure or culvert		Annually
	Preserve passage barrier at Mullan Road to protect pure native trout populations that are currently isolated	Observations and maintenance of fish barrier structure	Short-, Mid-, and Long-term: • Upstream fish passage barrier is maintained	Annually

Sampling and Analysis Plan

Figure A- 1 below shows the locations of the riparian fence and water gaps that were installed along the west side of Harvey Creek during fall 2013. This figure also shows proposed locations for the monitoring listed in Table A- 3 above. The exact locations of monitoring sites will be determined in the field during the first year of effectiveness monitoring. The location of the downstream-most irrigation diversion structure is also shown in Figure 1 where the siphon and fish screen may be installed in the future. As baseline data are collected and priorities for additional fish screens and fish passage improvement projects are developed, these locations will be added to the sampling plan.

__Riparian Habitat Assessment__

The NRCS Riparian Assessment method (2012), supplemental attributes 1 and 2 (NRCS 2004), and a fish habitat assessment metric created and used by MFWP (Liermann et al. 2009 and Lindstrom et al. 2008) will be used to evaluate the riparian and aquatic habitat conditions within the riparian fence along Harvey Creek. Specifically, questions 1 through 10 of the NRCS Riparian Assessment will be used to evaluate riparian conditions. Supplemental attributes 1 and 2 along with the fish habitat metric developed by MFWP will be used to evaluate aquatic habitat conditions.

At least one assessment reach will be established within the riparian fence that includes the channel and the floodplain area within the fence. Sub-reaches may be established within the riparian fence if unique conditions are present within portions of the fenced riparian area such as: structures (e.g. headgates, bridges, culverts, etc.), riparian vegetation condition or type, land management practices, or confluences with tributary streams. The start and end points of the assessment reach or reaches will be recorded with a GPS device if possible, and/or noted on a map. The same reach extents should be used for all assessments during the effectiveness monitoring timeframe. Data will be recorded on the forms provided in the Riparian Assessment document (2012), the supplemental attribute forms from the 2004 version of the Riparian Assessment document, and the fish habitat assessment metric that is provided in the ***Supporting Information*** section below.

__Photo Monitoring__

Permanent photo monitoring points will be established starting at the upstream extent of the riparian fence. Photo points will be established along the channel to show channel and riparian conditions throughout the fenced riparian area to the downstream extent of the fence. The locations of photo points will be recorded with a GPS device if possible or noted on a map. The latitude and longitude of each photo point will also be recorded to facilitate repeated photographs at the same location over time. Photos will be taken looking both upstream and downstream at each photo point capturing both the channel and riparian conditions. If site conditions change over time where the photo point no longer accurately captures riparian and aquatic habitat conditions due to events such as channel avulsions or natural channel realignment; a new photo point will be established along the new channel location. The previous photo point should remain and continue to be used to capture the changes over time.

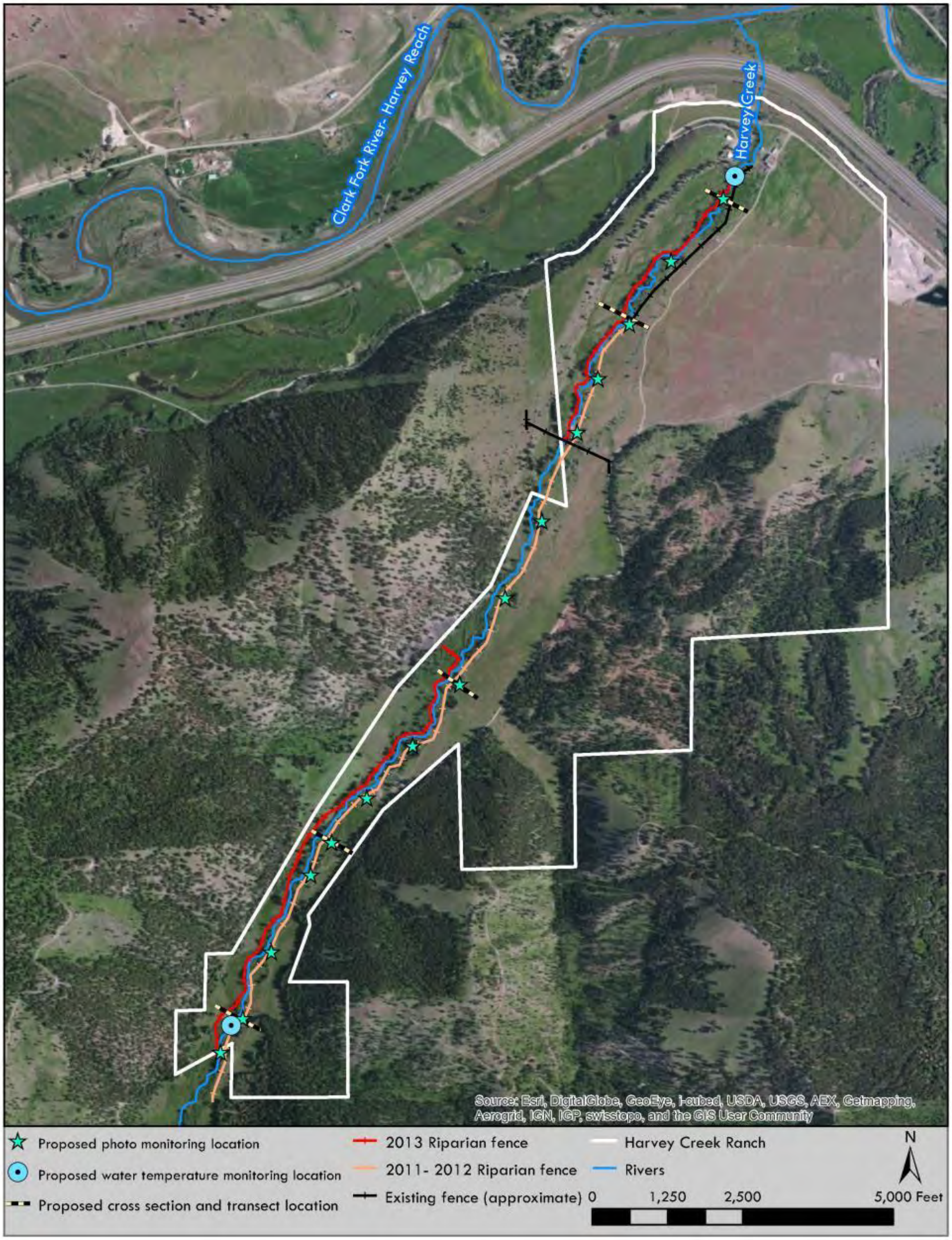


Figure A- 1. Overview of proposed monitoring locations at Harvey Creek within the riparian fence. Monitoring metrics collected throughout the length of the project area are not on the figure including: riparian and instream habitat assessments, bank erosion inventories, longitudinal profile survey, and noxious weed mapping.

No performance targets are associated with photo monitoring. However, these photos provide important documentation of changes in site conditions that will be useful for interpreting findings from other monitoring metrics. Photo monitoring will occur annually during the growing season throughout the effectiveness monitoring timeframe. A photo log will be generated each year that documents the following:

- Photo point ID for the specific location,
- Photo number from the camera for upstream and downstream view,
- Latitude and longitude of the photo point, and
- Notes about general site conditions observed at each photo point.

Bank Erosion

The Watershed Restoration Coalition (WRC) developed methods to measure bank erosion which will be used to measure actively eroding banks along both banks of Harvey Creek within the riparian fence. These assessments will be coordinated with greenline composition surveys described below to determine if there is a correlation with changes in vegetation composition along the streambanks and measured erosion.

Bank erosion assessments will be conducted during the summer months when flows are at or near base flow. The Bank Erosion Inventory methods will measure the height and length in feet of all eroding banks within the riparian fence using a measuring tape or stick. Eroding banks include any areas that deliver sediment to the stream by light prodding of the bank with a wading staff. The location (left or right edge of water) and cause of erosion will be recorded for each measured eroding bank. The total length (linear feet) and area of bank erosion (square feet) will be quantified for the left streambank, right streambank, and entire length of channel within the riparian fence. The field data form that will be used to record Bank Erosion Inventory data is located in the ***Supporting Information*** section below.

Longitudinal Profile Survey

A longitudinal survey will be completed throughout the length of Harvey Creek within the riparian fence using methods described by Harrelson et al. 1994. The start and end points of the longitudinal profile will be the upstream and downstream extents of the riparian fence, with the upstream extent of the fence noted as station 0+00. A laser level and survey rod will be used to measure elevations at the thalweg, water's edge, and bankfull at important features such as: pools, glides, riffles, and runs. The location of each measurement point will be recorded with a GPS device if possible and stations for each point will be generated by creating a line feature that connects points and measures the distance of each point from the starting point. If a GPS device is not available, the distance of each point from the starting point will be measured using a measuring tape or other measuring device. Data will be recorded in a field notebook including: station or distance of the point from the starting point; the channel feature (pool, glide, etc.); and elevations at the thalweg, water's edge, and bankfull.

The stream channel type or geomorphology as described by Rosgen (1996) is documented in the NRCS Riparian Assessment methods. This channel type will be used to compare measured longitudinal data against average values described by Rosgen (1996) to determine the status of channel conditions.

Channel Cross-Sections

Channel cross-sections will be established throughout the length of Harvey Creek within the riparian fence using methods described by Harrelson et al. 1994. The location of cross-sections will be recorded with a GPS device if available or noted on a map. Additionally, the location of each cross-section will be permanently marked in the field using rebar or wooden stakes labeled with a unique identification number. The exact locations of cross-sections will be established in the field during the first year of monitoring. At least five cross-sections will be established, with one cross-section at or near the upstream extent of the fence and another at or near the downstream extent of the fence. Other cross-sections will be located approximately 0.5 miles apart. Additional cross-sections may be established to capture changes based on specific conditions within the riparian fence. For example, cross-sections may be established to document locations where livestock use may have resulted in an overwidened reach of the channel, entrenched reaches, herbaceous-dominated vegetation communities versus woody-vegetation communities, locations of diversion structures or other structures, or other conditions that are expected to change as result of the fence installation.

A laser level and survey rod will be used to measure elevations along the channel cross-section. The cross-section will begin on the left side of the channel and span the floodprone width. Elevation measurements will be recorded at important feature breaks including: low terrace features, bankfull, edge of water, and at regular intervals throughout the wetted channel. Data will be recorded in a field notebook.

The stream channel type or geomorphology as described by Rosgen (1996) is documented in the NRCS Riparian Assessment methods. This channel type will be used to compare measured cross-section data against average values described by Rosgen (1996) to determine the status of channel conditions within the riparian fence.

Water Temperature Monitoring

Water temperature monitoring will occur at the upstream and downstream extents of the riparian fence using thermographs (such as ONSET Computer Corp, Model: HOBO Water Temp Pro V2 or other similar device). Water temperature monitoring will also occur below the new siphon near the mouth of Harvey Creek before it enters the Clark Fork River.

A water temperature data logger will be securely deployed in the channel and left in place to collect water temperature data during the warmest months of the year from approximately July to September. The data logger will be checked periodically during this timeframe to ensure that it remains in place and is functioning as intended. These data will be compared with previous temperature monitoring at this location by MFWP (Liermann et al. 2009) and Trout Unlimited (unpublished data).

Noxious Weeds

Noxious weeds will be evaluated throughout the project area annually as part of project maintenance activities that will also estimate the percent cover of noxious weed observed within the riparian fence. The Montana Department of Agriculture maintains the state noxious weed list, which is available online at: http://agr.mt.gov/agr/Programs/Weeds/. County extension offices or weed districts can be contacted for county noxious weed lists. The location, species, area and density of infestation will be recorded on aerial photographs or maps showing the area within the riparian fence each year during the growing season. Detailed noxious weed inventories are scheduled for years 1, 2, 3, 5, 10, and 15 following implementation. However, the riparian area should be visually inspected each year during photo monitoring or when other maintenance tasks are completed to note any changes in noxious weed conditions within the riparian fence.

Greenline Survey

Greenline composition surveys measure vegetation community diversity and abundance following methods described in Winward (2000). Vegetation communities will be measured (1) along cross-sections oriented perpendicular to the channel and (2) along transects that parallel the edge of the channel. Greenline composition surveys will occur at channel cross-sections described above so that measured channel conditions and streambank and riparian vegetation conditions can be compared. Vegetation compositions cross-sections will occur at the same location as the channel cross-sections and will extend outward from the channel to the edges of the riparian fence. Greenline composition transects will be located upstream and/or downstream of the vegetation composition cross-sections and should be at least 363 feet long as described in the assessment methods (Winward 2000).

Along each vegetation composition cross-section and transect, the number of steps or distance within each distinct vegetation community type is recorded and compared with the total number of steps or distance along the cross-section or transect. Appendix B in Winward (2000) includes a detailed list of riparian communities of the Intermountain Region. For the purposes of this assessment, the Nez Perce Riparian Community Types will be used (***Supporting Information*** section of this document) (Overton et al. 1997). The Nez Perce Riparian community types have been used for previous and ongoing NRCS Riparian Assessments in the Upper Clark Fork River Basin.

To determine if the vegetation community is trending toward the desired condition and achieving the performance target, the measured vegetation community types and abundance are compared to the desired condition. For the purposes of these assessments, desired community types include a matrix of broadleaf deciduous with shrub/forb understory (BB2), riparian willow/alder with wet site grasses and sedges (SR2), riparian willow/alder with wet side forbs/grasses/sedges (SR4), and potentially Douglas-fir/ponderosa pine with midshrub/forb understory (CD1). The broadleaf deciduous community type will be the most abundant community with the others representing minor components of the overall vegetation community. The desired condition will not include any riparian grasses/forbs with grazing indicators (GRD) and will not likely contain any upland vegetation communities.

Browse

The NRCS Riparian Assessment Method (USDA NRCS 2012), Question 9 addresses browse which will be evaluated throughout the Harvey Creek riparian area within the riparian fence. Browse levels upstream and downstream from the fence should also be noted for comparison over time. This question evaluates browse levels on second year and older woody growth. The source of browse should be noted if possible, including: wildlife, beaver, and potentially livestock.

Woody Vegetation Recruitment/Regeneration

Woody vegetation regeneration will be measured using methods described by Winward (2000) in association with greenline composition transects described above. To measure woody vegetation recruitment and regeneration, the number of woody stems within a 6 foot band along the vegetation composition transect (described above) is recorded by age class including: sprout (1 to 2 growth rings and less than ¼ height of mature individuals), young (3 to 10 growth rings and less than ½ the height of mature individuals), mature (more than 10 growth rings and near full height), and dead (Winward 2000).

Riparian Fence and Water Gap Observations

Periodic evaluations of the fence and water gaps will be completed to ensure they are functioning as expected with additional details described for the maintenance actions below. General observations of the fence and water gap will occur during effectiveness monitoring data collection in addition to maintenance site visits.

Observations and Maintenance of Fish Screens

Maintenance needs of fish screens are described below and notes will be recorded throughout the year to document operations of the screen and completed maintenance to ensure that structures are functioning properly to prevent fish entrainment.

Fish Passage Assessments – Modified NIAP Assessments

Methods described in *The Upper Clark Fork Diversion Inventory* (WRC-TU 2012) and summarized above in the ***Baseline Monitoring*** section will be used to document that fish passage is possible after diversion structures or culvert improvements are complete. These assessments will document the channel conditions following construction. Repeat assessments will only be completed if general observations show the diversion structure or culvert have undergone significant changes that may again result in fish passage restrictions. If fish passage improvements include modifying irrigation diversion structures, operations and maintenance should be recorded as described below.

Observations and Maintenance of Improved Diversion Structures and Culverts

Maintenance needs of improved diversion structures and culverts will be recorded throughout the year. In addition, operations of diversion structures will be noted to ensure that improved structures are performing as designed to allow fish passage in the watershed.

Maintenance Plan

Maintenance needs for the riparian fence will include periodic inspections at least twice a year, following spring runoff and during the winter in case of excessive snow loading. The entire length of the fence should be inspected including any gates or water gaps. When livestock are pastured near the fence, more frequent inspections may be necessary to ensure that the fence is intact and preventing livestock from entering the riparian area and to ensure that water gaps or other water sources are functioning properly and providing adequate water for livestock. The following maintenance and repair task may be needed throughout the year for both livestock fencing and water gaps:

- Tighten loose or sagging wire
- Repair or replace of damaged wires
- Repair or replace of damaged posts or gates

Weed control will be conducted as needed to target noxious weeds within the riparian fence. Weed control methods will vary depending on the target species, the location and density of the infestation, the presence of other non-target species, and other sensitive resources in the area. In general weed management options may include chemical control, biological controls, manual or mechanical removal, and targeted grazing. Often, combinations of control methods will improve weed management effectiveness. Examples include mowing and removing above ground plant parts of appropriate species to reduce further seed inputs and provide better contact with remaining plant parts for herbicide applications. A more detailed weed management plan will be developed following year 1 monitoring data collection. Some herbicides used for chemical weed control require application by a certified or licensed applicator. For any herbicide applications, all labels, manufacturer specifications, and laws will be followed.

Maintenance needs for fish screens and irrigation diversion structures will vary depending on the types of screens and diversion structures that are installed. In general, fish screens need to be inspected at the start and end of irrigation seasons as well as periodically throughout the season to ensure they are in proper working condition and tampering has not occurred. Daily maintenance may be needed during high flow events for some fish screens. At the beginning and end of the irrigation season fish screen maintenance may include:

- Greasing of mechanical parts (manufacturers specifications should be followed)
- Changing of oil
- Cleaning debris from screen and pipes
- Unclogging drain pipes

In general, irrigation diversion structures should be inspected at the beginning and end of the irrigation season as startup and winterization tasks are completed. Diversion structures should be inspected throughout the irrigation season to ensure they are working properly. For some diversions, water control structures may need periodic adjustments to ensure the proper diversion rates are maintained. Maintenance tasks may include:

- Greasing and general maintenance of mechanical parts

- Removal of debris
- Replacement of non-functioning parts

As final designs are completed for fish screens and irrigation diversion improvement projects, specific maintenance needs will be updated in this plan.

Monitoring and Maintenance Schedule

Table A- 4 below summarizes the monitoring and maintenance task that will be completed each year throughout the effectiveness monitoring timeframe. Effectiveness monitoring is conducted more frequently during the short-term timeframe to detect trends early and identify maintenance needs, or determine additional restoration needs if monitoring results do not appear to be trending toward meeting performance targets. During the mid-term effectiveness monitoring timeframe, year 10 monitoring may show significant changes in the site conditions and some metrics may have met the identified performance targets. If performance targets are met, the project team will determine if the site is actually performing as desired and if additional monitoring is warranted.

Table A- 4. Harvey Creek effectiveness monitoring and maintenance schedule.

Timeframe	Year	Monitoring	Maintenance Tasks
Short-term	2014 (year 1)	• NRCS Riparian Habitat Condition Assessment • Photo points • Bank erosion inventory • Longitudinal profile • Channel cross-section • Water temperature • Noxious weed inventory • Greenline survey • Browse evaluation • Woody vegetation recruitment/regeneration • Riparian fence & water gap conditions	Inspect and repair riparian fence and water gaps as needed Noxious weed control as needed
	2015 (year 2)	• Photo points • Noxious weed inventory • Riparian fence & water gap conditions	Inspect and repair riparian fence and water gaps as needed Noxious weed control as needed
	2016 (year 3)	• Photo points • Bank erosion inventory • Water temperature • Noxious weed inventory • Greenline survey • Browse evaluation • Woody vegetation recruitment/regeneration • Riparian fence & water gap conditions	Inspect and repair riparian fence and water gaps as needed Noxious weed control as needed

Timeframe	Year	Monitoring	Maintenance Tasks
	2017	• Photo points • Riparian fence & water gap conditions	Inspect and repair riparian fence and water gaps as needed Noxious weed control as needed
	2018 (year 5)	• Photo points • Bank erosion inventory • Longitudinal profile • Channel cross-section • Water temperature • Noxious weed inventory • Greenline survey • Browse evaluation • Woody vegetation recruitment/regeneration • Riparian fence & water gap conditions	Inspect and repair riparian fence and water gaps as needed Noxious weed control as needed
Mid-term	2019	• Photo points • Riparian fence & water gap conditions	Inspect and repair riparian fence and water gaps as needed Noxious weed control as needed
	2020	• Photo points • Riparian fence & water gap conditions	Inspect and repair riparian fence and water gaps as needed Noxious weed control as needed
	2021	• Photo points • Riparian fence & water gap conditions	Inspect and repair riparian fence and water gaps as needed Noxious weed control as needed
	2022	• Photo points • Riparian fence & water gap conditions	Inspect and repair riparian fence and water gaps as needed Noxious weed control as needed

Timeframe	Year	Monitoring	Maintenance Tasks
	2023 (year 10)	• NRCS Riparian Habitat Condition Assessment • Photo points • Bank erosion inventory • Longitudinal profile • Channel cross-section • Water temperature • Noxious weed inventory • Greenline survey • Browse evaluation • Woody vegetation recruitment/regeneration • Riparian fence & water gap conditions	Inspect and repair riparian fence and water gaps as needed Noxious weed control as needed
	2024	• Photo points • Riparian fence & water gap conditions	Inspect and repair riparian fence and water gaps as needed Noxious weed control as needed
	2025	• Photo points • Riparian fence & water gap conditions	Inspect and repair riparian fence and water gaps as needed Noxious weed control as needed
	2026	• Photo points • Riparian fence & water gap conditions	Inspect and repair riparian fence and water gaps as needed Noxious weed control as needed
	2027	• Photo points • Riparian fence & water gap conditions	Inspect and repair riparian fence and water gaps as needed Noxious weed control as needed
	2028 (year 15) [a]	• NRCS Riparian Habitat Condition Assessment • Photo points • Bank erosion inventory • Longitudinal profile • Channel cross-section • Water temperature • Noxious weed inventory • Greenline survey • Browse evaluation • Woody vegetation recruitment/regeneration • Riparian fence & water gap conditions	Inspect and repair riparian fence and water gaps as needed Noxious weed control as needed
Long-term	2029	None	None

[a] – If monitoring shows that the identified goals have been achieved prior to year 15, additional monitoring may not be necessary.

Monitoring and Maintenance Reports

Annual reports will be prepared that summarize all maintenance and monitoring actions completed within the project area with details of monitoring data collected for the year. The reports should include all data collection forms, GPS data if available, maps of the monitoring locations, and photographs. Observational notes recorded throughout the year should also be provided in annual reports. The report will include a summary of the monitoring findings, a status update of whether the project is trending toward meeting performance targets and restoration goals, and additional management needs to meet performance targets and restoration goals.

References

Harrelson, Cheryl C., C. L. Rawlins, and J. P. Potyondy. 1994. Stream channel reference sites: an illustrated guide to field technique. General Technical Report RM-245. Fort Collins, Colorado: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61p.

Liermann, B., J. Lindstrom, R. Kreiner. 2009. An Assessment of Fish Populations and Riparian Habitat in Tributaries of the Upper Clark Fork River Basin: Phase II. Montana Fish, Wildlife, and Parks.

Lindstrom, J. B. Liermann, R. Kreiner. 2008. An Assessment of Fish Populations and Riparian Habitat in Tributaries of the Upper Clark Fork River Basin. Montana Fish, Wildlife, and Parks.

Mayfield, Mariah P. 2013. Limiting Factors for Trout Populations in the Upper Clark Fork River Superfund Site, Montana. MS thesis, Montana State University, Bozeman, Montana.

Natural Resource Damage Program (NRDP). Pending. DRAFT 2012 Upper Clark Fork River Basin Aquatic Resources Restoration Plan, Monitoring and Maintenance Plan.

Natural Resource Damage Program (NRDP). 2012. Final Upper Clark Fork River Basin Aquatic and Terrestrial Resources 2012 Restoration Plans. December 2012.

Overton, C. Kerry, S.P. Wollrab, B.C. Roberts, M.A. Radko. 1997. R1/R4 (Northern/Intermountain Regions) Fish and Fish Habitat Standard Inventory Procedures Handbook. USDA Forest Service, Intermountain Research Station, General Technical Report GTR-346.

Rosgen, D. L. 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, CO, 246 p.

Schreck, W., R. Kreiner, B. Liermann, and J. Lindstrom. 2011. An Inventory of Irrigation Structures in the Upper Clark Fork River Drainage, Montana. Final Report 2011, USFWS Agreement Number-601818J270. Montana Fish, Wildlife, and Parks.

Schreck, W., R. Kreiner, B. Liermann, and J. Lindstrom. 2010. An Inventory of Irrigation Structures in the Upper Clark Fork River Drainage, Montana. 2010 Annual Progress Report. USFWS Agreement Number - 601818J270. Montana Fish, Wildlife, and Parks.

USDA NRCS. 2012. Riparian Assessment Using the NRCS Riparian Assessment Method. United States Department of Agriculture, Natural Resource Conservation Service. Environmental Technical note No MT-2 (Rev. 1).

USDA NRCS. 2004. Riparian Assessment Using the NRCS Riparian Assessment Method. United States Department of Agriculture, Natural Resource Conservation Service.

Watershed Restoration Council and Trout Unlimited (WRC-TU). 2012. Upper Clark Fork Diversion Inventory. Prepared by Trout Unlimited. Prepared for Watershed Restoration Coalition.

Winward, A.H. 2000. Monitoring the vegetation resources in riparian areas. Gen. Tech. Rep. RMRS-GTR-47. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 49 p.

Supporting Information

Montana Fish, Wildlife, and Parks fish habitat metric to be used with NRCS Riparian Assessment

(Liermann et al. 2009 and Lindstrom et al. 2008):

FISH HABITAT ASSESSMENT WORKSHEET

Name of Stream __________________________ Reach Loc or ID_______________________

Date ____________ Reach Length __________ Observer(s) ____________________________

Question 1. Fish habitat quality as related to available cover*

10 = Excellent – A reach exhibits EXCELLENT fish habitat when there is an even mix of cover components including large woody debris, large pools, root wads, overhanging vegetation, boulders and undercut banks. A reach with EXCELLENT fish habitat should also have a fair amount of shallow areas and small side channels at the stream margins that provide habitat for young-of-the-year and juvenile fish.

7 = Good – A reach exhibits GOOD fish habitat when the above cover components are present but may be somewhat lacking in quantity or quality in one or more of those components.

3 = Fair – A reach exhibits FAIR fish habitat when one or more of the above cover components is severely limited in quantity or quality or is completely absent from the reach.

0 = Poor – A reach exhibits POOR fish habitat when all or most of the above cover components are absent or are severely limited.

SCORE: Potential ___________________ Actual _____________________

Notes: Be sure to note instream cover components present within the surveyed reach as well as their general quantity and quality. Note the potential for future recruitment of large woody debris to the channel (i.e. are there trees within one tree length of the channel?). Also, note if the reach appears to provide potential spawning habitat (i.e. glide/run habitats with well sorted and clean gravels).

____
____
____
____
____
____
____

*** Some channel types may not require all cover components to be considered healthy. For example, E channels typically do not require abundant large woody debris or boulders as critical components of fish habitat, and healthy A and B channels do not necessarily require a significant proportion of undercut banks. It is best to think about what cover components would be expected under pristine conditions given the channel type and riparian vegetation present (THIS IS THE POTENTIAL)**

Watershed Restoration Coalition bank erosion inventory form:

Bank Inventory Assessment							
Erosion Sources: RD: Road; BR: Bridge; CR: Cropland encroachment and/or lack of riparian vegetation; LS-P: Physical livestock; TP: Trampled (no height); I: Geomorphic incisement; NC: New channel; C: Corrals; and HS: Hillside, cutting into valley walls.							
Left Edge of Water				**Right Edge of Water**			
Height (ft)	**Length (ft)**	**Area (ft^2)**	**Erosion Source**	**Height (ft)**	**Length (ft)**	**Area (ft^2)**	**Erosion Source**
Total bank erosion area (ft^2):				**Total bank erosion area (ft^2):**			
Total Reach erosion area (ft^2):							

Nez Perce Riparian Community Type Codes (Overton et al. 1997):

Nez Perce Riparian Community Type Codes

CM1 Upland grand fir/cedar community with midshrub/forb understory

CM2 Riparian grand fir/cedar community with wetland shrub/forb understory

CM3 Upland grand fir/cedar community with upland forb understory

CM4 Riparian grand fir/cedar community with wetland forb understory

CC1 Upland subalpine fir/lodgepole community with upland midshrub/forb understory

CC2 Riparian subalpine fir/lodgepole community with wetland midshrub/forb understory

CC3 Upland subalpine fir/lodgepole community with upland forb understory

CCR Riparian subalpine fir/lodgepole community with riparian/wetland forb or graminoid understory

CD1 Douglas-fir/ponderosa pine with midshrub/forb understory

CD3 Douglas-fir/ponderosa pine with forb/graminoid understory

BB2 Broadleaf deciduous with shrub/forb understory

BB4 Broadleaf deciduous with forb understory

SR2 Riparian willow/alder (and so forth) with wet site grasses and sedges

SR4 Riparian willow/alder (and so forth) with wet site forbs/grasses/sedges

SD1 Upland shrub species

GR2 Grass and forb cover dominated by riparian sedges

GR4 Riparian grasses/forbs

GRD Riparian grasses/forbs with grazing indicators

GD1 Upland grass dominated

HD1 Upland forb/grass dominated

XX1 Plant cover less than 10 percent (unvegetated)

[*This page intentionally left blank*]

Appendix B. Example Monitoring Report Outlines

[*This page intentionally left blank*]

Example Outline for As-Built Monitoring Report

As-built monitoring reports describe the results of compliance and implementation monitoring that will occur as restoration actions are applied at the project scale.

1. Introduction –
   1.1. Briefly describe the restoration project including: the project location, project intent (goals), restoration actions that were implemented, and implementation dates.
2. Compliance Monitoring Results
   2.1. List all permits that were obtained to construct the project and list their requirements for construction and/or monitoring.
   2.2. Summarize the results of any compliance monitoring data that were collected based on the requirements above. Examples of data that may be required are described in Section 4.3.3.
3. Implementation Monitoring Results
   3.1. List each restoration action that was implemented and describe details of the completed condition for each action. Section 4.3.4 includes example as-built data that may be reported for the restoration actions that are anticipated to be applied through the NRDP's tributary restoration program.
   3.2. Describe and briefly explain differences between the designed and completed condition of the restoration actions. Include notes that may inform future planning, design, and implementation of restoration projects.

Example Outline for Project Scale Effectiveness Monitoring Report

Effectiveness monitoring reports describe the results of monitoring that will occur following the completion of a restoration project. Reports will generally be prepared on an annual basis. The content of the reports will vary from year to year, depending on the timeframe since project completion and the metrics that were evaluated each year through the monitoring program.

1. Introduction –
   - 1.1. Project Background– Briefly describe the restoration project including: the project location, project intent (goals), and restoration actions that were implemented.
   - 1.2. Limiting Factors, Goals, Monitoring Metrics, and Performance Targets– Briefly describe the limiting factors, restoration goals to address the limiting factors, monitoring metrics that will be used to evaluate the goals, and the identified performance targets associated with each monitoring metric. This information will typically be developed during the restoration planning process and should be included in the Monitoring Plan developed for each project. Section 3.3 includes examples of project scale limiting factors, goals, and restoration actions. Section 4.3.5 includes examples of monitoring metrics and performance targets for potential restoration actions.
   - 1.3. List the metrics that were evaluated during the current monitoring period.
2. Effectiveness Monitoring Results
   - 2.1. Summarize and describe the results of each monitoring metric that was evaluated. Where possible, the current year's data should be compared to previous year's data to show trends in performance over time.
3. Discussion
   - 3.1. Describe whether the effectiveness monitoring results show that performance targets are being achieved or are trending toward or away from being achieved.
4. Maintenance and Adaptive Management
   - 4.1. Describe any maintenance and adaptive management actions that were previously implemented that may have influenced the reported effectiveness monitoring results.
   - 4.2. Based on the current year's effectiveness monitoring results, describe any new recommendations for maintenance actions that may be necessary for project success. Examples of possible maintenance actions are described in Section 5.
   - 4.3. Describe any recommendations for subsequent monitoring. For example, if monitoring results show that a performance target has been achieved, the frequency of data collection for that monitoring metric may be modified to occur less frequently.
5. Appendices
   - 5.1. Photographic monitoring results. Include a time series of all photographs taken at each photo location.
   - 5.2. Include details of collected data such as tables, charts, or graphs. Data collection forms may also be included.

Appendix C. Monitoring Methods

[*This page intentionally left blank*]

This appendix describes monitoring metrics and associated methods referenced in the ***Monitoring Metrics*** section of this document. Additional monitoring methods are included in this appendix that may be used in addition or in place of methods mentioned in the ***Monitoring Metrics*** section.

Fish Population Surveys

Monitoring Scale: Basin monitoring

Methodology Reference: MFWP

Timing: Summer months (July to August)

Frequency: Per existing MFWP monitoring schedule and Table C- 1**Error! Reference source not found.**

Duration: through 2022

Basin scale fish population surveys that will be used for effectiveness monitoring will follow methods used previously by MFWP to collect data stored in the MFISH system including: depletion estimates, mark-recapture surveys, and catch per unit effort. Data will be collected at established monitoring sites between Turah and upstream to Warm Springs Ponds to evaluate the Clark Fork River; and at established data collection sites between Warm Springs Ponds and upstream to Rocker, Montana to evaluate Silver Bow Creek. Specific locations proposed for basin scale fish population monitoring are summarized in Table C- 1**Error! Reference source not found.** and shown in Figure C- 1**Error! Reference source not found.**, Figure C- 2, and Figure C- 3. Annual monitoring is proposed for many locations to ensure the dataset has enough power to show that restoration projects are having a significant effect on population numbers. Annual monitoring is proposed for up to three years. After three years, the data will be evaluated to determine if trends or significant changes in population numbers or composition are evident and sampling frequency may be adjusted to every other year if appropriate. Large scale, continuous sampling of the Clark Fork River is proposed every five years to provide a comprehensive view of the overall conditions in the mainstem river and a more accurate picture of how species composition changes throughout the length of river within the UCFRB.

Table C- 1. Proposed locations for basin scale fish population monitoring along Silver Bow Creek and the Clark Fork River.

Location ID	Stream	Survey Section	Section Length	Survey Type [1]	Proposed Frequency [4]
		Mainstem Silver Bow Creek			
SBC01	Silver Bow Creek	Lower Area One	300 meters	Depletion	Annually
SBC02	Silver Bow Creek	Rocker	300 meters	Depletion	Annually
SBC03	Silver Bow Creek	Ramsay	300 metes	Depletion	Annually
SBC04	Silver Bow Creek	Top of Durant Canyon	300 meters	Depletion	Annually
SBC05	Silver Bow Creek	Below German Gulch	300 meters	Depletion	Annually
SBC06	Silver Bow Creek	Fairmont	300 meters	Depletion	Annually
SBC07	Silver Bow Creek	Opportunity	300 meters	Depletion	Annually
		Mainstem Clark Fork River			
CFR01	Clark Fork River	Continuous [2]	60 miles	M&R Trout	Every 5 years
CFR02	Clark Fork River	pH Shack	1.6 miles	M&R Trout	Annually
CFR03	Clark Fork River	Below Sager Lane	3.2 miles	M&R Trout	Annually
CFR04	Clark Fork River	Above Deer Lodge	1 mile	CPUE All	Annually
CFR05	Clark Fork River	Williams-Tavenner	2.1 miles	M&R Trout	Annually
CFR06	Clark Fork River	Phosphate	2.5 miles	M&R Trout	Annually
CFR07	Clark Fork River	Above Jens	1 mile	CPUE All	Annually
CFR08	Clark Fork River	Continuous [3]	50 miles	M&R Trout	Every 5 years
CFR09	Clark Fork River	Mouth of Flint Creek	5 miles	M&R	Annually

Location ID	Stream	Survey Section	Section Length	Survey Type [1]	Proposed Frequency [4]
CFR10	Clark Fork River	Bearmouth	6 miles	M&R	Annually

[1] Population survey methods include: Depletion estimates (depletion), mark and recapture (M&R and M&R Trout), and catch per unit effort (CPUE).
[2] Survey section starts at Warm Springs and extends downstream to Jens.
[3] Survey section starts at Jens and extends downstream to approximately Rock Creek.
[4].Annual monitoring is proposed for at least three years after which, monitoring frequency may be modified to every other year.

Monitoring Scale: Watershed monitoring

Methodology Reference: MFWP – Lindstrom et al. 2008, Liermann et al. 2009, Lindstrom 2011, and Lindstrom 2013

Timing: Summer months (July to August)

Frequency: Each watershed will be assessed every 3 to 5 year or as described in Table C- 2

Duration: through 2022

Watershed scale fish population surveys will follow methods used previously by MFWP for fish population assessments in the 12 Priority tributary watersheds that are the focus of this plan to maintain consistency in the type of data being collected. MFWP selected sample reaches for fish population surveys based on multiple factors including channel type, gradient, and obvious changes in riparian vegetation and condition. If new sample reaches are needed these new sample reaches should be spaced apart longitudinally so that sites reflect changes in species composition. Single-pass, catch-per-unit (CPUE) electrofishing should be used as a standard procedure to assess species composition, size (and indirectly age structure) and general abundance at a broad scale; however, if more precise abundance estimate of fish in a specific reach are necessary multiple-pass electrofishing techniques can be used with an associated standard error. Mark-recapture population estimates may also be used in larger river environments where depletion estimates are not effective (i.e. Clark Fork River and Little Blackfoot River). The scale at which fish abundance data is necessary will also help determine the type of survey used. Within each sample reach, captured fish should be identified to species, weighed, measured and then released. Genetic samples may be collected in reaches suspected to contain pure westslope cutthroat trout or bull trout/brook trout hybrids. Refer to Section **Error! Reference source ot found.** for additional genetic sampling information. Specific MFWP electrofishing protocols are available in the 2008 and 2009 fish population assessments for the Upper Clark Fork River Basin Report (Lindstrom et al. 2008 and Liermann et al. 2009).

Proposed monitoring locations and data collection methods for this plan are summarized in Table C-2**Error! Reference source not found.**. Figure C- 1**Error! Reference source not found.**, Figure C- 2, and Figure C- 3 show an overview and details of proposed fish population sampling locations. Many of the proposed data collection sites are existing MFWP population sampling locations that have some level of existing data that will be used as baseline data. Proposed sampling locations include sections where restoration work is anticipated to occur and others will serve as controls where no restoration actions are implemented. Sampling locations were also selected to capture changes in habitat or fish distribution within a watershed. The number of sample location within a watershed is also intended to provide enough data to capture changes in fish populations and distribution over time.

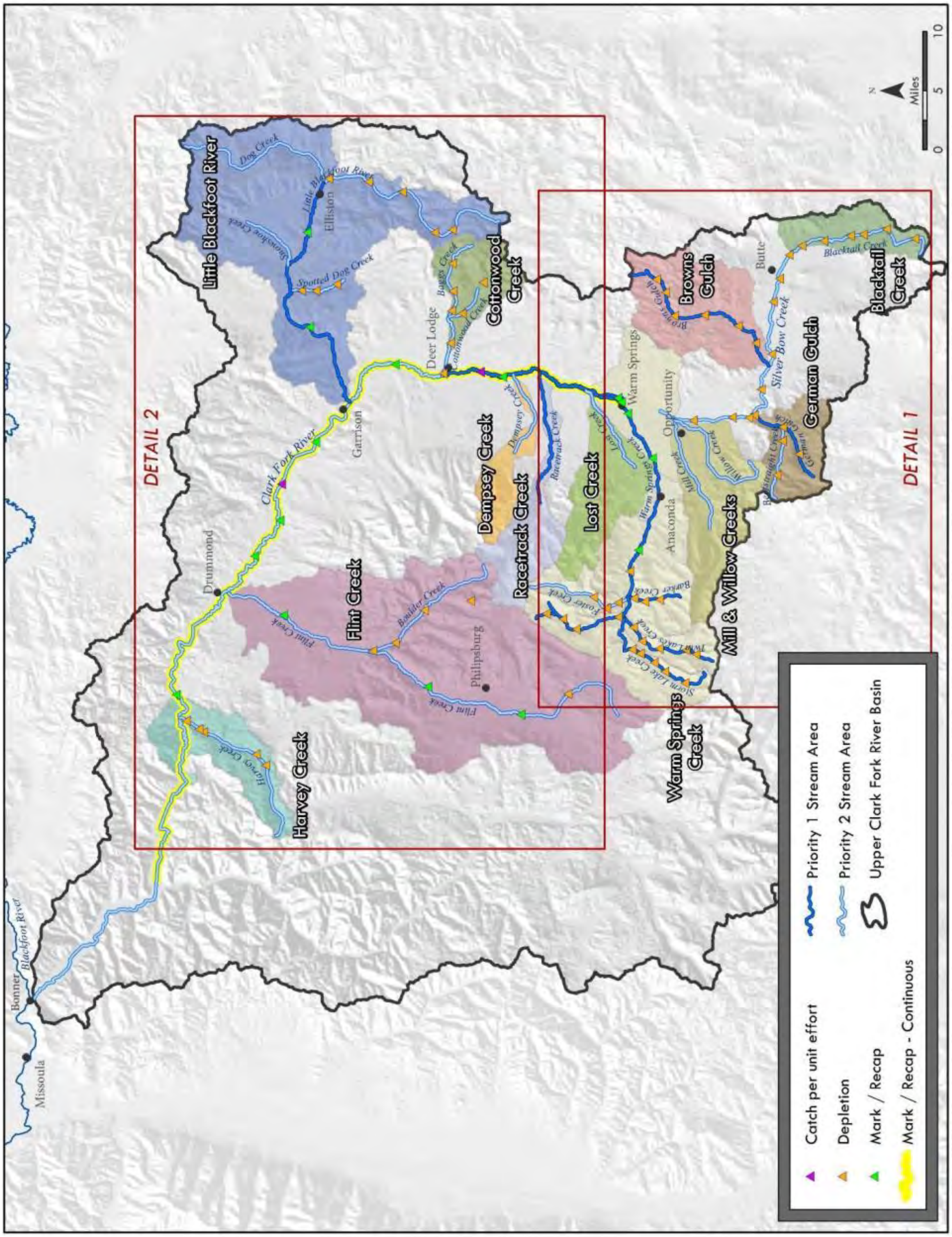


Figure C- 1. Overview of proposed fish sampling locations for basin and watershed effectiveness monitoring.

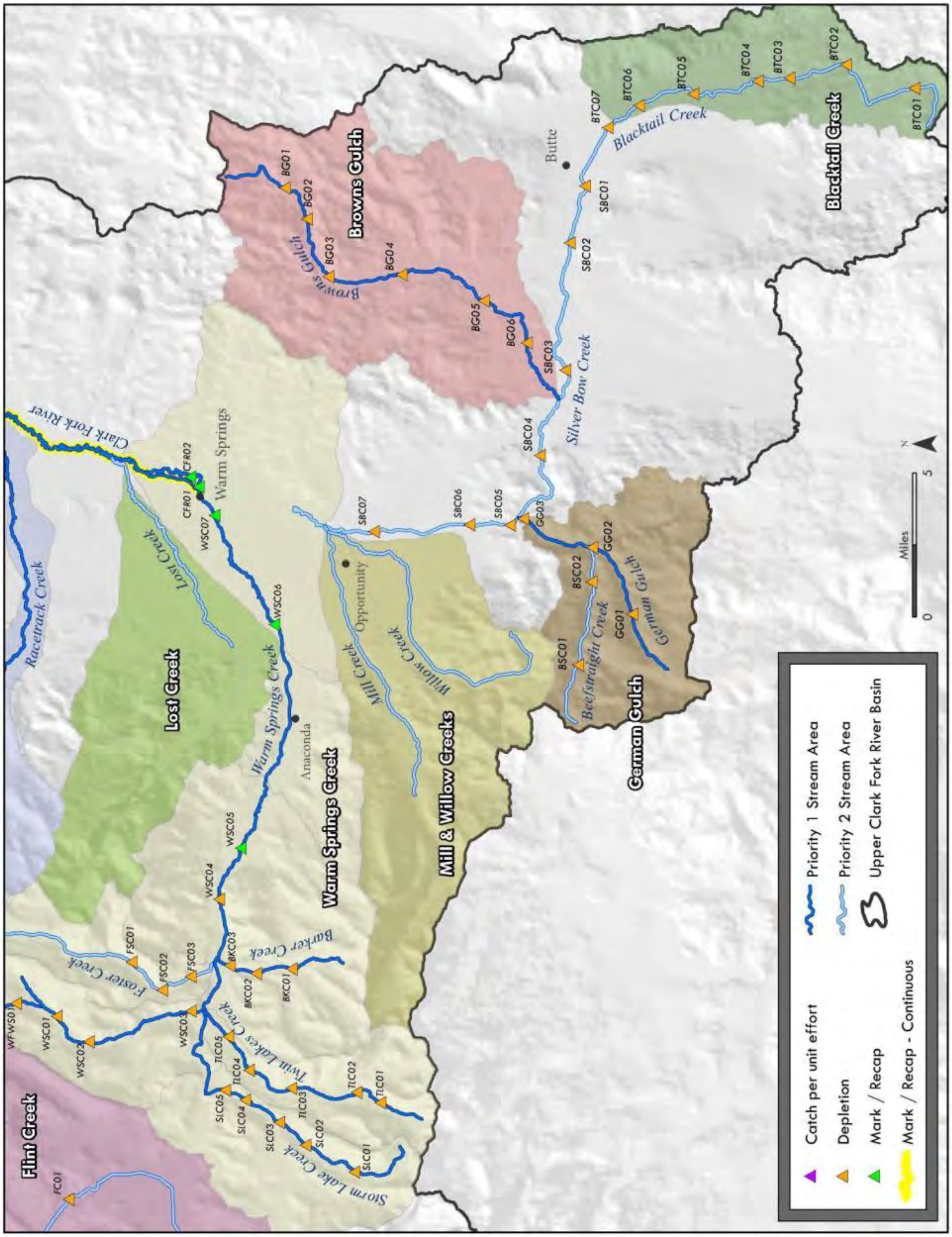


Figure C- 2. Detail 1 showing proposed fish sampling locations for basin and watershed effectiveness monitoring.

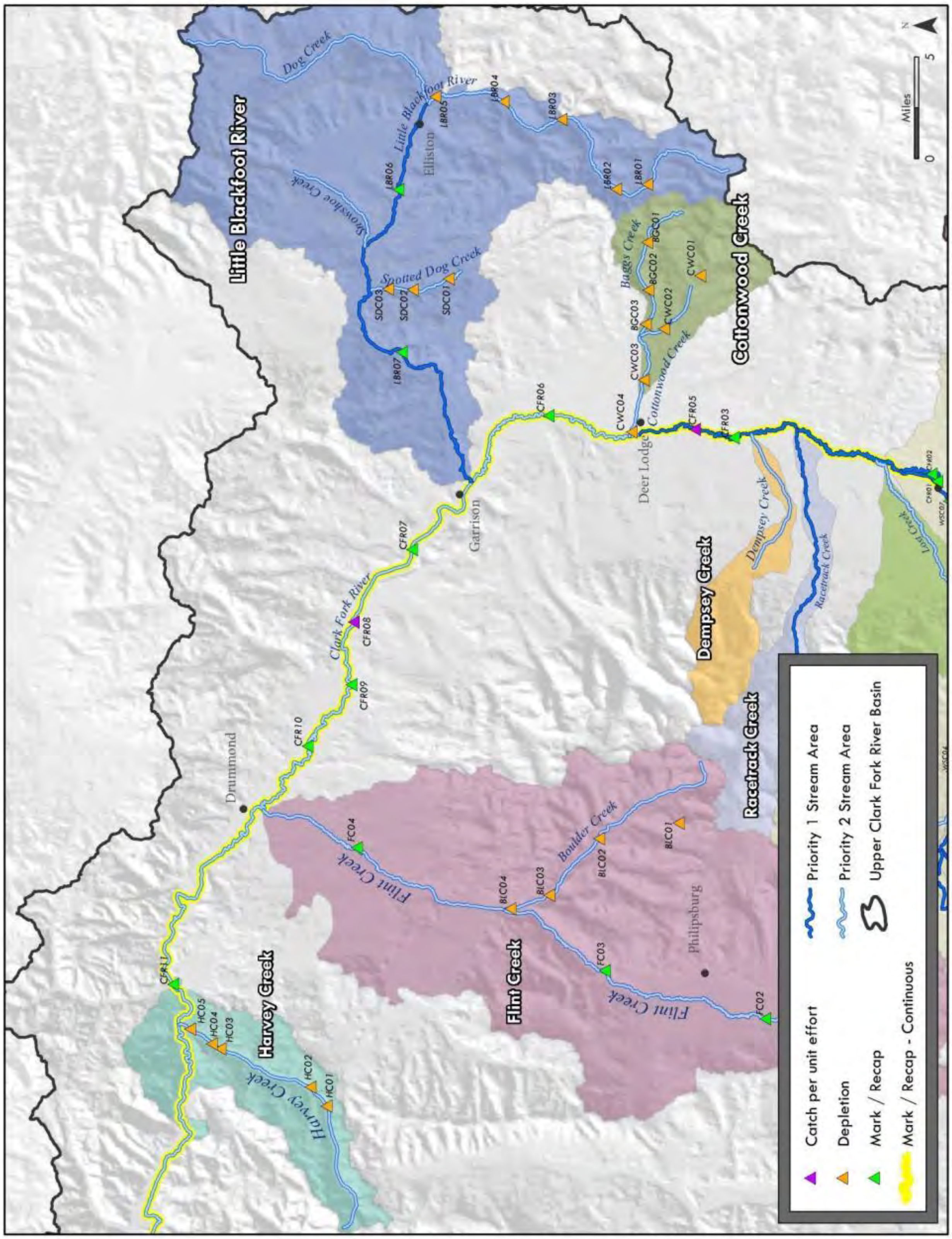


Figure C- 3. Detail 2 showing proposed fish sampling locations for basin and watershed effectiveness monitoring.

Table C- 2. Summary of proposed watershed fish population sampling locations in the UCFRB.

Location ID	Stream	Survey Section [1]	Section Length	Survey Type [2]	Proposed Frequency
		Blacktail Creek			
BTC01	Blacktail Creek	Headwaters	200 meters	Depletion	Annually
BTC02	Blacktail Creek	Upper Thompson Park	200 meters	Depletion	Annually
BTC03	Blacktail Creek	Above Nine Mile	200 meters	Depletion	Annually
BTC04	Blacktail Creek	Below Nine Mile	200 meters	Depletion	Annually
BTC05	Blacktail Creek	Above Blacktail Loop	200 meters	Depletion	Annually
BTC06	Blacktail Creek	Golf Course	200 meters	Depletion	Annually
BTC07	Blacktail Creek	Father Sheehan Park	200 meters	Depletion	Annually
		Browns Gulch			
BG01	Browns Gulch	RM 15.4	200 meters	Depletion	Annually
BG02	Browns Gulch	RM 13.9	200 meters	Depletion	Annually
BG03	Browns Gulch	RM 11.6	200 meters	Depletion	Annually
BG04	Browns Gulch	RM 8.8	200 meters	Depletion	Annually
BG05	Browns Gulch	RM 5.3	200 meters	Depletion	Annually
BG06	Browns Gulch	RM 2.6	200 meters	Depletion	Annually
		Cottonwood Creek			
BGC01	Baggs Creek	RM 5.1	200 meters	Depletion	Annually
BGC02	Baggs Creek	RM 2.5	200 meters	Depletion	Annually
BGC03	Baggs Creek	RM 0.6	200 meters	Depletion	Annually
CWC01	Middle Fork Cottonwood Creek	RM 0.7	200 meters	Depletion	Annually
CWC02	Cottonwood Creek	RM 6.9	200 meters	Depletion	Annually
CWC03	Cottonwood Creek	RM 3.0	200 meters	Depletion	Annually
CWC04	Cottonwood Creek	RM 0.2 or nearby	200 meters	Depletion	Annually
		Flint Creek			
BLC01	Boulder Creek	Near mouth of Copper Creek	100 meters	Depletion	Annual
BLC02	Boulder Creek	Above Princeton	100 meters	Depletion	Annual
BLC03	Boulder Creek	Downstream of South Fork	100 meters	Depletion	Annual
BLC04	Boulder Creek	Near Maxville	100 meters	Depletion	Annual
FC01	Flint Creek	Below Dam	100 meters	Depletion	Annual
FC02	Flint Creek	Chor Ranch	1/2 mile	M&R	Annual
FC03	Flint Creek	Six Mile- Johnson	1/2 mile	M&R	Annual
FC04	Flint Creek	Hall	1/2 mile	M&R	Annual
		German Gulch			
BSC01	Beefstraight Creek	RM 4.5	200 meters	Depletion	Annually
BSC02	Beefstraight Creek	RM 1.3	200 meters	Depletion	Annually
GG01	German Gulch	RM 6.0	200 meters	Depletion	Annually
GG02	German Gulch	RM 3.0	200 meters	Depletion	Annually
GG03	German Gulch	RM 0.2	200 meters	Depletion	Annually
		Harvey Creek			
HC01	Harvey Creek	Above 8 Mile	100 meters	Depletion	Annual
HC02	Harvey Creek	Below 8 mile	100 meters	Depletion	Annual
HC03	Harvey Creek	Below Stimson	100 meters	Depletion	Annual
HC04	Harvey Creek	Middle Harvey Ranch	100 meters	Depletion	Annual
HC05	Harvey Creek	Lower Harvey Ranch	100 meters	Depletion	Annual
		Little Blackfoot River			
LBR01	Little Blackfoot River	RM 42.0	300 meters	Depletion	Annually
LBR02	Little Blackfoot River	RM 40.1	300 meters	Depletion	Annually
LBR03	Little Blackfoot River	RM 34.9	300 meters	Depletion	Annually
LBR04	Little Blackfoot River	RM 31.1	300 meters	Depletion	Annually
LBR05	Little Blackfoot River	RM 26.7	300 meters	Depletion	Annually
LBR06	Little Blackfoot River	RM 21.3	1,000 meters	M&R	Annually
LBR07	Little Blackfoot River	RM 9.6	1,200 meters	M&R	Annually

Location ID	Stream	Survey Section [1]	Section Length	Survey Type [2]	Proposed Frequency
SDC01	Spotted Dog Creek	RM 4.6	200 meters	Depletion	Annually
SDC02	Spotted Dog Creek	RM 2.5	200 meters	Depletion	Annually
SDC03	Spotted Dog Creek	RM 1.2	200 meters	Depletion	Annually
		Warm Springs Creek			
BKC01	Barker Creek	RM 2.9	200 meters	Depletion	Annually
BKC02	Barker Creek	RM 1.6	200 meters	Depletion	Annually
BKC03	Barker Creek	RM 0.5	200 meters	Depletion	Annually
FSC01	Foster Creek	RM 3.9	200 meters	Depletion	Annually
FSC02	Foster Creek	RM 2.3	200 meters	Depletion	Annually
FSC03	Foster Creek	RM 1.1	200 meters	Depletion	Annually
SLC01	Storm Lake Creek	RM 6.3	200 meters	Depletion	Annually
SLC02	Storm Lake Creek	RM 4.2	200 meters	Depletion	Annually
SLC03	Storm Lake Creek	RM 3.0	200 meters	Depletion	Annually
SLC04	Storm Lake Creek	RM 1.4	200 meters	Depletion	Annually
SLC05	Storm Lake Creek	RM 0.6	200 meters	Depletion	Annually
TLC01	Twin Lakes Creek	RM 8.5	200 meters	Depletion	Annually
TLC02	Twin Lakes Creek	RM 7.2	200 meters	Depletion	Annually
TLC03	Twin Lakes Creek	RM 4.7	300 meters	Depletion	Annually
TLC04	Twin Lakes Creek	RM 2.8	300 meters	Depletion	Annually
TLC05	Twin Lakes Creek	RM 1.4	300 meters	Depletion	Annually
WFWS01	West Fork Warm Springs Creek	RM 1.0	200 meters	Depletion	Annually
WSC01	Warm Springs Creek	RM 29.1	200 meters	Depletion	Annually
WSC02	Warm Springs Creek	RM 27.4	300 meters	Depletion	Annually
WSC03	Warm Springs Creek	RM 23.3 or 23.5	300 meters	Depletion	Annually
WSC04	Warm Springs Creek	RM 18.6	300 meters	Depletion	Annually
WSC05	Warm Springs Creek	RM 16.4	1,000 meters	M&R Trout	Annually
WSC06	Warm Springs Creek	RM 7.4 or nearby	1,000 meters	M&R Trout	Annually
WSC07	Warm Springs Creek	RM 1.8	1,000 meters	M&R Trout	Annually

[1] River mile (RM) is the distance measured from the mouth of the stream.
[2] Population survey methods include: Depletion estimates (depletion) and mark and recapture (M&R and M&R Trout).

Angler Surveys

Monitoring Scale: Basin and Watershed monitoring

Methodology Reference: MFWP

Timing: Monthly

Frequency: Monthly

Duration: through 2022

The MFWP conducts statewide angling surveys following standard methods developed by the Agency. These surveys consist of a mailed questionnaire sent to a random sample of resident and non-resident anglers each month who either purchased a two or ten day fishing license valid for use in the previous month or to anglers who purchased or held a season fishing license valid for use in the previous month. Results from mailed in questionnaires are compiled to develop angler pressure estimates. The results of these surveys will be used as they are available for basin and watershed scale effectiveness monitoring.

Fish Migration

Fish migration monitoring will be conducted for watershed scale monitoring; however, results from these data will be used to inform interpretation of both basin and watershed monitoring results. Two methods of monitoring fish migration are described below. Genetic sampling (Section **Error! Reference ource not found.**) may also be used to monitor fish migration using unique genetic markers for trout populations in select watersheds and the mainstems.

Radio Telemetry and Passive Integrated Transponder (PIT) Tags

Monitoring Scale: Watershed monitoring

Methodology Reference: examples include Mayfield (2013)

Timing: Year-round

Frequency: As needed

Duration: through 2022

The survival and movement of fish can be assessed through the monitoring of fish using radio or PIT tags. Adult fish may be outfitted with radio tags following methods used by Mayfield (2013). These methods include capturing fish using a boat mounted electro-fisher and then anesthetizing captured fish so that they can be identified, weighed, and measured. Radio tags are then surgically inserted into the fish abdomen. Radio-tagged fish are then relocated weekly, except during winter months when surveys are conducted every other week.

Rotary Screw Trap

Monitoring Scale: Watershed monitoring

Methodology Reference: USFWS (2008) and others

Timing: Spring and Fall migration

Frequency: Annually or as needed

Duration: through 2022

Rotary screw traps can be used to determine fish production in a stream as well as emigration rates from tributary streams. Rotary screw traps consist of a funnel shaped cone that is screened with a three-millimeter diameter perforated plate. The trap cone is then suspended above the water between two aluminum pontoons. Baffles in the trap cone cause it to rotate as water flows past the trap. As the trap cone rotates, fish swimming downstream are guided into a livebox attached to the rear of the trap cone. Field methods for deploying rotary screw traps are described in detail in the Draft Rotary Screw Protocol for Estimating Production of Juvenile Chinook Salmon (USFWS 2008). In general rotary screw traps will be deployed in select tributaries during the spring and fall when peak outmigration of salmonids generally occurs. Traps will be closely monitored throughout their deployment as described in the methods, but particularly during runoff, when they may be removed from the channel as needed to prevent damage. In smaller streams where a screw trap may not be practical, alternative trapping methods may include weir traps, hoop nets, or others.

Table C- 3**Error! Reference source not found.** summarizes proposed watersheds and sampling locations for evaluating fish migration using rotary screw traps or other similar, appropriate sampling equipment. These locations are shown in Figure C- 2 and Figure C- 3. Migration sampling using rotary screw traps has not been completed within the UCFRB and initial sampling would establish baseline conditions and subsequent data would be used to evaluate effectiveness of the restoration actions. Approximately three years of baseline data would be collected for each site if possible. A limited number of rotary screw traps would be deployed each year and sites would be sampled on a rotating basis throughout the monitoring time period.

Table C- 3. Proposed fish migration sampling locations using rotary screw traps or other appropriate sampling equipment.

Location ID	Stream	Survey Section	Section Length	Migration Sampling
Blacktail Creek Watershed				
BTC07	Blacktail Creek	Father Sheehan Park	200 meters	Yes
Browns Gulch Watershed				
BG06	Browns Gulch	RM 2.6	200 meters	Yes
Cottonwood Creek Watershed				
CWC04	Cottonwood Creek	RM 0.2 or nearby	200 meters	Yes
Flint Creek Watershed				
FC04	Flint Creek	Hall	1/2 mile	Yes
German Gulch Watershed				
GG03	German Gulch	RM 0.2	200 meters	Yes
Little Blackfoot River Watershed				
LBR07	Little Blackfoot River	RM 9.6	1,200 meters	Yes
Warm Springs Creek Watershed				
WSC06	Warm Springs Creek	RM 7.4 or nearby	1,000 meters	Yes

Genetic Sampling

<u>Monitoring Scale</u>: Basin and Watershed monitoring

<u>Methodology Reference</u>: MFWP

<u>Timing</u>: In coordination with fish population sampling

<u>Frequency</u>: baseline data collection beginning 2014 or 2015; effectiveness monitoring in 2017

<u>Duration</u>: through 2022

Genetic data will be collected in association with fish population sampling at both the basin and watershed scale. As fish are captured during population surveys, described above, fin clip samples will be taken from selected individuals. These samples will be collected and preserved following standard procedures before being sent to a lab for analysis. MFWP will develop a detailed sampling protocol prior to starting baseline data collection that indicates the number of individuals to samples, species to sample, and specific protocols for harvesting, storing, and transporting samples. This sampling protocol will also identify specific types of genetic analyses to be conducted.

Riparian Habitat Assessment

Monitoring Scale: Watershed and Project monitoring

Methodology Reference: NRCS (2012)

Timing: Summer months, during the growing season

Frequency: Generally years 1 and 10 or 15 following implementation of restoration projects in the watershed

Duration: through 2022

The NRCS Riparian Assessment Method (2012) is used to characterize physical and ecological attributes that represent thresholds for sustainability in stream systems and their associated riparian areas. This assessment was designed so that ratings over a period of time on the same reach can be used to evaluate trends and management effectiveness. Ratings of a reach can only be compared to similar reaches in the local area. The assessment includes ten questions related to the geomorphic, vegetative, and functional aspects of streams and their associated riparian areas. Detailed instructions for the NRCS Riparian Assessment Method and a field worksheet are included in an NRCS Montana Technical Note available online.

The assessment is intended to be completed in the field by an interdisciplinary team with knowledge of riparian systems. The assessment relies on the judgment of the evaluation team to select the most appropriate rating criterion for each question. To ensure consistent, comparable results from these assessments over time the NRDP will include quality control/quality assurance measures for completing these assessments. For example, the NRDP may provide initial training for interdisciplinary teams prior to conducting new riparian assessments. These training may include input from practitioners that completed earlier assessments in the UCFRB regarding how site conditions and potential were interpreted for each question. The NRDP may also have an independent, interdisciplinary team review these assessments.

Fish Passage Assessment

Monitoring Scale: Watershed and Project monitoring

Methodology Reference: WRC-TU (2012)

Timing: Summer months

Frequency: 2017 and 2022, or as needed

Duration: through 2022

Fish passage will be assessed using a protocol that was adapted from the US Forest Service's National Assessment and Inventory Protocol for Assessing Stream Road Crossings (NIAP) by Trout Unlimited, Idaho Department of Fish and Game, and the US Forest Service. This modified NIAP approach was used to evaluate the impacts of irrigation diversions on fish in the Upper Clark Fork watershed in a study conducted by Trout Unlimited (2012). The original NIAP protocol evaluates fish passage through culverts by evaluating culvert slope, constriction ratio, outlet drop, and pool configuration. This approach was modified to include an evaluation of water velocities and plunges over irrigation diversions; the two primary factors affecting upstream passage of fish at diversion structures. The evaluation includes measuring physical characteristics of each diversion structure, water surface elevation difference across the structure, water velocities through the structure, plunge height, plunge pool depth, and distance from plunge pool to plunge. This information is then used to determine a qualitative assessment of barrier and entrainment potential at each survey location.

Fish Entrainment Assessment

Fish entrainment assessments will count or estimate the number of fish observed in irrigation canals or use other methods to evaluate whether entrainment is occurring. Three possible methods of evaluating fish entrainment are described below.

Electrofishing Irrigation Canals

Monitoring Scale: Watershed and Project monitoring

Methodology Reference: Schreck and others (2010 and 2011)

Timing: Irrigation operation season

Frequency: 2017 and 2022, or as needed

Duration: through 2022

During operation of irrigation canals, electrofishing may be used to estimate fish entrainment numbers. Schreck and others (2010) describe electrofishing methods previously used to evaluate fish entrainment in irrigation canals in the UCFRB. These methods included a single pass assessment through an approximately 100 meter reach to document the composition of fish species entrained in the irrigation canals. Resulting data include species composition, length, frequency, and catch-per-unit-effort. Sampling multiple locations down-gradient of the headgate or multiple-pass depletion assessments may be conducted for locations where high fish entrainment numbers are suspected and where more extensive data collection is necessary.

Radio Telemetry and Passive Integrated Transponder (PIT) Tags

Monitoring Scale: Watershed and Project monitoring

Methodology Reference: examples include Mayfield (2013)

Timing: Year-round

Frequency: As needed

Duration: through 2022

The radio telemetry and PIT tag methods described above for fish migration would also be used to track the numbers of fish that are relocated in irrigation canals. If possible, the point of entrainment should be noted.

Fish Screen Bypass Traps

Monitoring Scale: Watershed and Project monitoring

Methodology Reference: examples include Der Hovanisian (1997) and Allen et al. (2004)

Timing: Irrigation Season

Frequency: As needed

Duration: through 2022

Bypass traps may be installed in association with fish screens to estimate the number of fish that are effectively saved by the fish screen. The type of bypass trap will depend on the type of fish screen installed on irrigation diversion structures. Bypass traps will need to be closely monitored to inventory and release trapped individuals. The inventory of trapped fish may include the number of fish by species and their age class. Additional metrics may be collected as needed depending on the specific location of the trap, restoration goals for the watershed, and existing fish population resources in the watershed.

Photographic Monitoring

Monitoring Scale: Project monitoring

Methodology Reference: Winward (2000), Archer et al. (2012), and others

Timing: As needed and in association with other project monitoring

Frequency: Annually or as needed

Duration: through 2022

Photographs of the stream and its bordering riparian area (i.e. greenline) can be used to document baseline conditions and trends over time. Greenline photo points should be established at incremental distances along a sample reach so that there are sufficient photo points to capture the entire sample reach. Photo points may be monumented using rebar and flat rebar caps or other permanent marker or their locations should be noted on a map or recorded with a GPS device. In order to accurately replicate greenline photos, the relative location (reach and bank), photo height, azimuth, and notes regarding landmarks from which the photo point can be found, should all be recorded. Subsequent monitoring of the greenline should be performed at least on an annual basis by locating each established photo point and replicating the camera height, azimuth, and field of view. Large-scale interpretations of changes between photos taken over multiple years will provide valuable information regarding the response of the riparian area and stream to implemented management or restoration actions.

Instream Flow Monitoring

Monitoring Scale: Project monitoring

Methodology Reference: Archer et al. (2012), and others

Timing: As needed and in association with other project monitoring

Frequency: As needed

Duration: through 2022

Portable water flow meters will be used to measure discharge. The specific meter and methods to collect flow data will depend on the size of the stream channel at the monitoring site.

Water Temperature Monitoring

Monitoring Scale: Project monitoring

Methodology Reference: Lindstrom et al. (2008), Liermann et al. (2009), and others

Timing: As needed and in association with other project monitoring

Frequency: Years 1, 3, 5, 10, and/or 15 following implementation or as needed

Duration: through 2022

Stream temperature can be monitored using one or more thermographs (such as ONSET Computer Corp, Model: HOBO Water Temp Pro V2) placed in target tributaries. If only one thermograph will be used, it should be placed near the mouth of the tributary. If multiple thermographs will be used, they should be placed throughout the watershed with one located near the mouth. Thermographs can be set to record temperature at varying increments, however MFWP typically measures temperature every half hour to hour as part of their population fish surveys within the Upper Clark Fork River assessments (Lindstrom et al. 2008 and Liermann et al. 2009).

Vegetation Canopy Cover

Herbaceous and Small Woody Vegetation

Monitoring Scale: Project monitoring

Methodology Reference: Geum unpublished methods and Monitoring Methods (2014a)

Timing: Summer months during the growing season

Frequency: Years 1, 3, 5, 10, and/or 15 following implementation

Duration: through 2022

Herbaceous and small woody vegetation canopy cover data can be collected within plots located along transects that are oriented perpendicularly to the channel. Transect should span the distance from the edge of the channel outward to the approximate extent of the riparian vegetation community which will vary depending on the channel size, geomorphology at a site, or the project width. Plots should be located at equal distances along each transect of approximately 10 feet. A 0.5 by 0.5 meter sampling frame represents the plots where vegetation data are collected. The number of transects and their spacing will vary depending on the size of the project area. Transects should be strategically placed to capture the range of variability throughout a project area and spaced as evenly as possible throughout the site.

Within each plot, record the names of all herbaceous and small woody species observed and their estimated percent canopy cover class, using ECODATA cover class categories (USDA Forest Service) (Table C- 4**Error! Reference source not found.**). Plants should be identified using scientific names for the genus and species; however, if plants are not identifiable to the species level, the genus should be recorded. If plants cannot be accurately identified in the field, a specimen should be collected and/or accurately described in a field notebook to allow for accurate identification later.

Table C- 4. ECODATA cover class categories from the USDA Forest Service.

Cover Class	Percent Cover	Mid-point value
T	<1%	0.5%
P	1 to 5%	3%
1	5 to 15%	10%
2	15 to 25%	20%
3	25 to 35%	30%
4	35 to 45%	40%
5	45 to 55%	50%
6	55 to 65%	60%
7	65 to 75%	70%
8	75 to 85%	80%
9	85 to 95%	90%
F	>95%	97%

Woody Vegetation Canopy Cover

Monitoring Scale: Project monitoring

Methodology Reference: Monitoring Methods (2014a)

Timing: Summer months during the growing season

Frequency: Years 1, 3, 5, 10, and/or 15 following implementation

Duration: through 2022

Woody vegetation is recorded in floodplain plots to document the percent cover of large shrubs and trees. Plot size may vary depending on the topography and floodplain conditions, and this example describes data collection using a 50-foot square plot (Figure C- 4**Error! Reference source not found.**).

A rebar or wooden stake is placed at the zero corner of the plot and 200-foot measuring tape is anchored to the stake. The tape is extended outward 50 feet when a 90 degree corner is established by placing a rock or other material on the tape to hold it in place. This is repeated with the 200 foot measuring tape until the perimeter of the plot is created. Then, measuring tapes are laid out in a grid at ten foot increments creating horizontal and vertical transect lines within the plot. Woody vegetation canopy cover presence or absence is measured at 5-foot increments from 5 feet to 50 feet for horizontal transect lines and in 5-foot increments from 3 feet to 48 feet for vertical transect lines (including the perimeter). Staggering the horizontal and vertical increments avoids collecting canopy cover data twice in the same location. Woody vegetation canopy cover presence is determined by looking directly down or up at the transect point depending on vegetation height and determining if the point was within the canopy of a woody plant. The total number of points intercepting woody vegetation canopy cover is divided by the total number of possible points (120) to calculate the total percent cover for the plot.

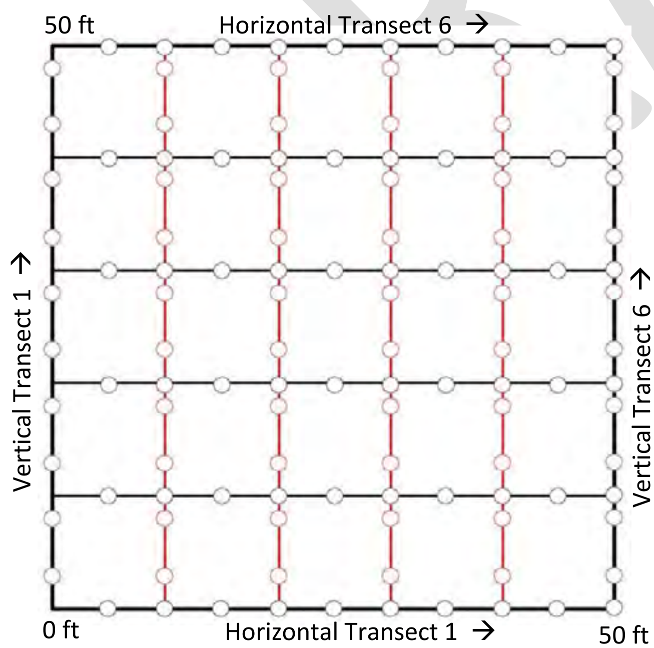


Figure C- 4. Example woody vegetation canopy cover plot layout.

Woody Plant Survival

Monitoring Scale: Project monitoring

Methodology Reference: Monitoring Methods (2014a)

Timing: Summer months during the growing season

Frequency: Years 1, 3, and 5 following implementation

Duration: through Year 5 following project implementation, then Woody Vegetation Canopy Cover through 2022

Within planted areas, establish permanent monitoring plots that are large enough to represent approximately 10 percent of the total number of plants installed for the project. The corners of the survival plots should be monumented using a piece of rebar with flat rebar cap or other marker. Each survival plot should be assigned a unique identifier and the location of survival plots should recorded on as-built map using the identifier. If possible, a GPS unit should be used to record the location of the survival plot including all the corners of the plot.

Record every planted plant that occurs within the monitoring plot using a survival plot data collection form. The plant species and its survival status should be recorded for each plant (1 = alive, 0 = dead).

Record a list of dominant herbaceous species present in the plot in the as well as all noxious weeds observed. Record any additional notes on the monitoring plot such as information or details relating to revegetation trends, hydrologic function, and indicators of animal presence that may be influencing plant survival in the plot or other plant community development trends.

Natural Woody Vegetation Recruitment

Monitoring Scale: Project monitoring

Methodology Reference: Geum unpublished methods and Winward (2000)

Timing: Late summer months, end of July through August

Frequency: Years 1, 3, 5, 10, and/or 15 following implementation

Duration: through 2022

Natural recruitment is recorded within herbaceous and small woody vegetation canopy cover plots described above. Within these plots, the number of stems of each woody vegetation species is recorded. The average height of each woody species is also recorded and measured in feet. The percent cover of bare ground should be noted as well as the type of substrate (sand, rock, or boulder) (Geum, unpublished methods).

Woody vegetation regeneration may also be measured using methods described by Winward (2000) in association with greenline composition transects described below. To measure woody vegetation recruitment and regeneration, the number of woody stems within a 6 foot band along vegetation composition transects (described below) is recorded by age class including: sprout (1 to 2 growth rings and less than ¼ height of mature individuals), young (3 to 10 growth rings and less than ½ the height of mature individuals), mature (more than 10 growth rings and near full height), and dead (Winward 2000).

Greenline Surveys

Monitoring Scale: Project monitoring

Methodology Reference: Winward (2000)

Timing: Summer months during the growing season

Frequency: Years 1, 3, 5, 10, and/or 15 following implementation

Duration: through 2022

Greenline composition surveys measure vegetation community diversity and abundance following methods described in Winward (2000). Vegetation communities will be measured (1) along cross-sections oriented perpendicular to the channel and (2) along transects that parallel the edge of the channel. Greenline composition surveys will occur at channel cross-sections described above where possible so that measured channel conditions and streambank and riparian vegetation conditions can be compared. Vegetation composition cross-sections will extend outward from the channel to the edges of the floodplain. Greenline composition transects will be located upstream and/or downstream of the vegetation composition cross-sections and should be at least 363 feet long as described in the assessment methods (Winward 2000).

Along each vegetation composition cross-section and transect, the number of steps or distance within each distinct vegetation community type is recorded and compared with the total number of steps or distance along the cross-section or transect. Appendix B in Winward (2000) includes a detailed list of riparian communities of the Intermountain Region. For the purposes of this assessment, the Nez Perce Riparian Community Types (Appendix A of this document) (Overton et al. 1997) will be used. The Nez Perce Riparian community types have been used for previous and ongoing NRCS Riparian Assessments in the UCFRB.

To determine if the vegetation community is trending toward the desired condition and achieving the performance target, the measured vegetation community types and abundance are compared to the desired condition.

Noxious Weed Canopy Cover

Monitoring Scale: Project monitoring

Methodology Reference: MSU Extension Service (2002)

Timing: Summer months during the growing season

Frequency: Years 1, 3, 5, 10, and/or 15 following implementation

Duration: through 2022

Noxious weeds will be evaluated throughout project areas annually as part of project maintenance activities that will also estimate the percent cover of noxious weeds observed. The Montana Department of Agriculture maintains the state noxious weed list, which is available online at: http://agr.mt.gov/agr/Programs/Weeds/. County extension offices or weed districts can be contacted for county noxious weed lists. The location, species, area and density of infestation will be recorded on aerial photographs showing the area within the riparian fence each year during the growing season. Detailed noxious weed inventories are scheduled at regular intervals following implementation; however, the riparian area should be visually inspected each year during photo monitoring or when other maintenance tasks are completed to note any changes in noxious weed conditions in the project area.

Browse Assessment

Monitoring Scale: Project monitoring

Methodology Reference: NRCS (2012)

Timing: Summer months during the growing season

Frequency: Years 1, 3, 5, 10, and/or 15 following implementation

Duration: through 2022

The NRCS Riparian Assessment (2012) includes a metric to evaluate browse; Question 9 'Utilization of Trees and Shrubs'. This question specifically evaluates whether use or damage of woody vegetation is severe enough to limit the plants potential for regrowth.

Browse should be documented for all plants in survival monitoring plots described above. Browse may also be monitored for riparian fencing projects where the goal is to reduce livestock and/or wildlife browse to encourage recovery of woody vegetation canopy cover.

Wetland Delineation and Functional Assessment

Monitoring Scale: Project monitoring

Methodology Reference: USACE (2010)

Timing: Summer months during the growing season

Frequency: Years 1, 5, and/or 10 following implementation

Duration: through 2022

Wetland delineations may be required by U.S. Army Corps of Engineers permits. Wetland delineations may also be used for effectiveness monitoring where restoration goals are to increase wetland area or improve wetland function. Baseline wetland delineations should be completed according to the U.S. Army Corps of Engineers *Wetland Delineation Manual* (Environmental Laboratory 1987). Data collection methods and wetland boundary delineations should follow methods described in the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region* (USACE 2010) and *Field Indicators of Hydric Soils in the United Sates Version 7.0* (USDA 2010). Follow up wetland delineations should be conducted five years following a management action to determine if wetland area has changed or as required by Corp permits.

Streambank Erosion

Monitoring Scale: Project monitoring

Methodology Reference: WRC (2013)

Timing: Summer months

Frequency: Years 1, 3, 5, 10, and/or 15 following implementation

Duration: through 2022

The Watershed Restoration Coalition (WRC) developed methods to evaluate streambank erosion that measures the length and height of eroding banks and notes the potential cause of erosion such as lack of vegetation, trampling of banks, and others. These assessments may be coordinated with greenline composition surveys to determine if there is a correlation with changes in vegetation composition along the streambanks and measured erosion.

Streambank Woody Vegetation Canopy Cover

Monitoring Scale: Project monitoring

Methodology Reference: Monitoring Methods (2014a)

Timing: Summer months during the growing season

Frequency: Years 1, 3, 5, 10, and/or 15 following implementation

Duration: through 2022

Woody vegetation canopy cover is measured in plots on newly constructed streambank structures, such as vegetated soil lifts or other bioengineered structures that include live woody vegetation. A piece of rebar with flat rebar cap or other marker is installed on the top surface of the streambank structure, approximately 12 to 18 inches behind the front edge of the structure/river bank line. This monument serves as a permanent origin point for establishing monitoring plots along the length of the structure. The location of the rebar or other marker should be recorded with a GPS device if it is available using the unique identifier to name the GPS point.

A measuring tape is secured to the origin rebar using a spring clamp ensuring that the 0-foot mark is flush with the rebar. The measuring tape is then placed as close as possible to the front edge of the streambank structure, ensuring that installed willow cuttings will not interfere with the tape laying flush on the structure surface. The measuring tape is extended along the structure, leaving the tape lying on the surface of the lift as monitoring is performed to allow the observer to identify the location of each monitoring plot at the prescribed distance interval along the structure.

The size of the sampling plot will vary depending on the as-built conditions for each streambank, but typical plot dimensions may be 6-foot by 3-foot plot. Plot spacing will also vary on the as-built site conditions, but typical plots spacing is approximately every 30-feet along the measuring tape.

Within each plot, record percent cover of woody vegetation by standing on the top surface of the structure and establishing a visual plane that corresponds to the plot dimensions. Within this plane, assess the percent cover of leafy material growing from woody species (do not include cover provided by woody stems). Record cover according to the following resolution: for cover less than 10%, use 1% resolution; for cover greater than or equal to 10%, use 10% resolution. For other non-woody species, record a list of all herbaceous species found within the plot on the data form.

Photographs should be taken from the upstream end of the structure looking downstream and from the downstream end of the structure looking upstream. Additional photographs may be taken of each sampling plot along the length of the structure as needed. A detailed photo log should be maintained noting photo numbers and the unique identification number for the streambank structure.

Instream Habitat

Monitoring Scale: Project monitoring

Methodology Reference: NRCS (2004), Lindstrom et al. (2008), Liermann et al. (2009), Overton et al. (1997)

Timing: Summer months during the growing season

Frequency: Years 1, 3, 5, 10, and/or 15 following active channel restoration project implementation; Years 1, 5, 10, and/or 15 for passive restoration such as riparian fencing

Duration: through 2022

The NRCS Riparian Assessment Method includes supplemental attributes (NRCS 2004) that characterize the condition of aquatic habitat and water quality within a sample reach. The supplemental questions address 1) aquatic life substrate habitat; 2) fish habitat; 3) water temperature; 4) impacts to flow; and 5) nutrients.

Additional instream habitat monitoring may utilize protocols developed by the U.S. Forest Service in their *R1/R4 Fish and Fish Habitat Standard Inventory Procedures Handbook*. These protocols include evaluating channel width, depth, and length, as well as the type and number of pools, substrate conditions, bank conditions, water temperature, air temperature, large wood debris, and riparian conditions (Overton et al. 1997).

For restoration projects with a goal to improve instream habitat, the project proponents will decide which specific monitoring metrics and methods to use prior to implementing the project. These metrics and methods will be used for both baseline and project effectiveness monitoring data collection to ensure that consistent information is being used to compare habitat conditions over time.

Channel Cross Section

Monitoring Scale: Project monitoring

Methodology Reference: Harrelson et al. (1994)

Timing: Summer months

Frequency: Years 1, 5, 10, and/or 15 following implementation

Duration: through 2022

Wading or boat surveys will document channel cross section measurements following standard data collection methods such as those in Harrelson et al. 1994. The location of channel cross section measurements will be monumented in the field using rebar or wooden stakes labeled with the cross-section identification number to ensure that data are collected from the same location over time. Cross-section locations should also be collected with a GPS unit if possible or drawn on a map or aerial photograph of the project area. Photographs should be taken at the cross section location to document the conditions at the time data are collected.

Channel Longitudinal Profile

Monitoring Scale: Project monitoring

Methodology Reference: Harrelson et al. (1994)

Timing: Summer months

Frequency: Years 1, 5, 10, and/or 15 following implementation

Duration: through 2022

Wading or boat surveys will document the elevations of the channel bed noting the horizontal distance from the starting point of the survey. Harrelson et al. 1994 describe standard methods for collecting longitudinal profile measurements. The start and end point location of channel longitudinal measurements should be collected with a GPS unit if possible or drawn on a map or aerial photograph of the project area. Photographs should be taken at the start and end points of the profile and at representative locations throughout the longitudinal distance profiles to document the conditions at the time data are collected.

For on the ground longitudinal surveys, methods should follow those described by Harrelson et al. 1994. The start and end points of the longitudinal profile will be recorded with a GPS device and/or marked on a field map, with the upstream extent of the profile noted as station 0+00. A laser level and survey rod will be used to measure elevations at the thalweg, water's edge, and bankfull at important features such as: pools, glides, riffles, and runs. The location of each measurement point will be recorded with a GPS device if possible and stations for each point will be generated by creating a line feature that connects points and measures the distance of each point from the starting point. If a GPS device is not available, the distance of each point from the starting point will be measured using a measuring tape or other measuring device. Data will be recorded in a field notebook including: station or distance of the point from the starting point; the channel feature (pool, glide, etc.); and elevations at the thalweg, water's edge, and bankfull.

The stream channel type or geomorphology as described by Rosgen (1996) is documented in the NRCS Riparian Assessment methods. This channel type will be used to compare measured longitudinal data against average values described by Rosgen (1996) to determine the status of channel conditions.

Channel Planform

Monitoring Scale: Project monitoring

Methodology Reference: Rosgen (1996)

Timing: Summer months

Frequency: Years 1, 5, 10, and/or 15 following implementation

Duration: through 2022

Channel planform will be surveyed or recorded using a GPS device to document the channel location. If no channel reconstruction has occurred and the channel has not recently migrated, the channel planform may be estimated using aerial photographs. Changes in the channel planform will be used to estimate channel migration rates.

Pebble Counts

Monitoring Scale: Project monitoring

Methodology Reference: Wolman (1954), Overton et al. (1997)

Timing: Summer months near base flow

Frequency: Years 1, 5, 10, and/or 15 following implementation

Duration: through 2022

Pebble counts and other substrate assessment methods either measure or visually estimate the size of the bed material in a stream. These measurements inform evaluations of instream habitat conditions and may also provide information on streambank erosion rates.

[*This page intentionally left blank*]

Appendix D. Estimated Monitoring Data Collection and Maintenance Costs

[*This page intentionally left blank*]

The costs presented below for monitoring data collection are coarse-scale estimates based on current market costs and labor rates which are expected to change over the duration of this Monitoring and Maintenance program. Some costs are derived from similar monitoring efforts in the UCFRB or nearby areas. As monitoring and maintenance is conducted in the UCFRB tributaries, these cost estimates should be updated to reflect actual accrued costs to inform budgets for future project planning.

To assist with developing detailed budgets for conducting field data collection, estimated monitoring costs for the monitoring metrics described in this framework are included below for basin, watershed and project monitoring scales. At the basin scale, the NRDP and MFWP will develop a cost share agreement for conducting fish population survey monitoring. Angler surveys are a normal function of MFWP operations and unless additional data collection is requested as part of this Monitoring Plan, NRDP funds will not be used to collect these data. Table D- 1 below summarizes estimated basin scale monitoring data collection costs.

Table D- 1. Estimated basin scale monitoring costs.

Basin Scale Monitoring Metric	Unit of Measure	Cost	Notes
Fish population surveys	Annual estimates at mainstem sites	--	Normal function of MFWP
	5-year population survey	To be determined	Cost share agreement between NRDP and MFWP
Angler Surveys	Annual survey	--	Normal function of MFWP

At the watershed scale, monitoring data collection includes some normal functions of MFWP, such as angler surveys that will not be paid for with NRDP funds unless additional data collection is requested. The NRDP and MFWP will develop a cost share agreement for conducting fish population, migration, and genetic sampling data collection. Other data collection metrics for riparian habitat assessments, fish passage, fish entrainment, instream habitat assessment, water temperature, and flow will generally utilize project scale monitoring data and compile these data for each of the priority watersheds. Table D- 2 summarizes estimated watershed scale monitoring data collection costs.

Table D- 2. Estimated watershed scale monitoring costs.

Watershed Scale Monitoring Metric	Unit of Measure	Cost	Notes
Migration – radio telemetry and PIT Tag monitoring	Multi-year study	To be determined	Cost share agreement between NRDP and MFWP.
Outmigration – rotary screw trap	Annual deployment of each unit	To be determined	Cost share agreement between NRDP and FWP
Tributary fish population surveys	Tributary population sampling	To be determined	Cost share agreement between NRDP and MFWP
Genetic sampling	Multi-year study	To be determined	Samples will be collected during fish population sampling surveys. Level of effort and cost share agreement to be developed between NRDP and MFWP
Tributary angler surveys	Annual survey	--	Normal function of MFWP
NRCS Riparian Habitat Assessments	River mile cost	$1,000	Estimate includes field preparation, travel, and assessment
Fish passage assessment	Per structure evaluation	--	Cumulative evaluation of project scale fish passage assessments
Fish entrainment – electrofishing surveys and fish screen bypass traps	Per irrigation canal or fish screen evaluation	--	Cumulative evaluation of project scale fish entrainment surveys
Instream habitat assessment	River mile cost	***	*** Cost is included with NRCS Riparian Habitat Assessment Evaluation
Water temperature monitoring	Annual deployment of 1 thermograph data logger	<$1,000	Cost estimate derived from similar methods described at Monitoring Methods (2014b)
Instream flow measurements	Each discharge measurement	$1,000 to $2,500	Cost estimate derived from similar methods described at Monitoring Methods (2014c and 2014d)

At the project scale, landowner agreements developed for each project will specify the distribution of monitoring responsibilities and costs between the NRDP and the project proponent(s). The level of effort for project scale monitoring depends on the size of the project area and the number of restoration actions that are implemented. However, the intended level of effort for project scale monitoring is approximately one to three days each year that monitoring is conducted. Each person day of monitoring is expected to cost approximately $1,000. This cost may vary slightly depending on who completes the monitoring (consultants, landowners, conservation groups, or others), travel costs to reach the site, and how many trips are needed to complete the monitoring each year. Table D- 3 summarizes the approximate level of effort in person days to complete project scale monitoring.

Table D- 3. Estimated project scale monitoring costs.

Project Scale Monitoring Metric	Unit of Measure	Level of Effort or Cost	Notes
NRCS Riparian Habitat Assessments	River mile cost	$1,000/river mile	Estimate includes field preparation, travel, and assessment
Fish passage assessment	Per structure evaluation	1 to 2 hours/structure	Dependent on channel dimensions and flow discharge rates
Fish entrainment – electrofishing surveys	Per irrigation canal evaluation	1 to 2 hours/canal survey	Dependent on channel and canal dimensions and flow discharge rates
Fish entrainment – fish screen bypass traps	Per fish screen structure	1 to 2 hours/structure	Dependent on the type of screen
Instream habitat assessment	River mile cost	*	*Cost is included with NRCS Riparian Habitat Assessment Evaluation
Water temperature monitoring	Annual deployment of 1 thermograph data logger	<$1,000/year	Cost estimate derived from similar methods described at Monitoring Methods (2014b)
Instream flow measurements	Each discharge measurement	$1,000 to $2,500	Cost estimate derived from similar methods described at Monitoring Methods (2014c and 2014b)
Vegetation canopy cover – herbaceous cover	Transect	1 to 2 transects/hour	Dependent on transect length and number of plots
Vegetation canopy cover – large wood vegetation	Plot	2 to 4 plots/hour	Dependent on project area size and terrain
Woody plant survival	Plot	1 to 2 plots/hour	Dependent on project area size and terrain
Woody vegetation recruitment	Transect	**	**Combined with herbaceous cover plots
Greenline surveys	Transects and cross sections	1 to 2 transects or cross sections/hour	Dependent on transect or cross section length and terrain
Noxious weed mapping	Project area	1 to 2 days/project area	Dependent on project area size and terrain. Weed mapping will be combined with other monitoring data collection over the estimated 1 to 2 days.
Browse assessment	Plot	***	***Included in survival monitoring cost and NRCS assessments
Streambank woody vegetation cover	Linear feet of streambank	500 to 1,000 feet/hour	Dependent on vegetation density and species diversity
Wetland delineation and functional assessment	Project area	1 to 3 days/project area	Dependent on project area size and diversity. Delineation plots data collection can be combined with other monitoring data collection over the estimated 1 to 3 days.
Channel cross section	Each cross section	1 cross section/per hour	Dependent on channel dimensions, access, and equipment requirements
Channel profile	River mile of channel	0.25 to 0.5 miles/hour	Dependent on channel dimensions, access, and equipment requirements
Channel planform	River mile of channel	0.25 to 0.5 miles/hour	Dependent on channel dimensions, access, and equipment requirements

Table D- 4 summarizes the estimated unit costs for maintenance tasks proposed in this Monitoring and Maintenance Plan. Estimated costs include materials and equipment, personnel costs, travel, field preparation, and reporting of findings. These costs may vary between sites depending on specific project locations, material needs, and distances. Costs may also change over time as labor rates and material costs change. These costs should be updated as restoration projects are implemented and maintenance actions occur to inform future project maintenance planning.

Table D- 4. Estimated maintenance costs associated with some of the proposed actions.

Maintenance Task	Unit of Measure	Level of Effort or Cost	Notes
Maintenance Log	Annual updates	1 to 2 hours/update	Assumes documenting maintenance tasks at least three times per year
Fence repair	Linear feet of fence	$0.07 to $0.35/linear foot	Assumes livestock fence with maintenance cost of 5 to 8% of installation cost (ISU 2014). Wildlife exclosure fence maintenance cost vary depending on materials and manufacturers specifications
Weed management - Broadcast herbicide application	Acre	$30-$50/acre	Includes equipment and chemical costs; however chemical costs may vary depending on the target species and treatment location
Weed management - handline herbicide application	Hour	$80/hour	Includes equipment and chemical costs; however chemical costs may vary depending on the target species and treatment location
Weed management – backpack herbicide application	Hour	$100/hour	Includes equipment and chemical costs; however chemical costs may vary depending on the target species and treatment location
Weed management – biological controls	Per Release	$80 to $190/release	Dependent on the target weed species and species of biological control to be used (Weedbusters Biocontrol 2014)
Weed management – Mowing	Acre	$100/acre	Costs vary depending on terrain and equipment requirements
Weed management –digging or pulling	Labor per hour	$80/hour	Cost estimate does not include travel and other overhead
Weed management – targeted grazing	Acre	$1/head/acre	Estimated cost from MSU (2002)
Plant watering	Per plant	$5/plant	Dependent on plant size, distance to water source, and terrain
Browse protector and weed mat maintenance	Per plant	$10 to 25/plant	Varies depending on the type of browse protector and maintenance need (i.e. repair, replace, or remove)
Irrigation diversion	Annual maintenance	To be determined	Varies depending on the type of diversion structure
Fish screen	Annual maintenance	To be determined	Varies depending on the type of fish screen installed

Appendix D Wetlands/Riparian Areas Restoration Costs Incurred to Date

NRDP Expenditures	Org	Fiscal Year	Amount
	10111 NRD FWP wetlands		**0.00**
		2007	0.00
	10127 NRD FWP admin coordinator		**80,000.00**
		2004	80,000.00
	10164 NRD Dutchman		**133,169.83**
		2005	3,157.41
		2006	8,338.62
		2007	9,299.60
		2008	10,109.90
		2009	25,543.75
		2010	42,135.84
		2011	25,394.90
		2012	9,014.00
		2013	(0.87)
		2014	176.68
	10177 NRD Willow Creek Restoration		**81,399.77**
		2006	34,689.25
		2007	15,226.62
		2008	4,712.50
		2009	26,771.40
	10178 NRD Warm Springs Cr Restor.		**177,109.38**
		2006	56,218.72
		2007	52,831.86
		2008	26,527.56
		2009	28,268.44
		2010	5,305.60
		2011	7,957.20
Grand Total			**471,678.98**

Budget	$	3,200,000.00
Expended	$	(471,678.98)
Remaining	**$**	**2,728,321.02**