French Gulch and Moose Creek Restoration Project
Final Report

February 2018




Prepared by:

BIG HOLE WATERSHED COMMITTEE
Conservation Through Consensus.

In Appreciation

This project is the work of many hands over many years. With persuasion and perseverance, this project marched forward from early concepts in 2011 to final product in 2018. The results are attributed to the funding of both merit based and generous sponsors, the commitment of the individuals representing the partners developing and completing the work, the quality and commitment of many outstanding contractors, and the support of the community, including many conservation organizations and groups.

A sincere thank you to those involved in the partnership effort that brought this project to completion in the name of conservation of water and habitat. The restored ecosystems of French Gulch and Moose Creek now undo years of detrimental mining to benefit the land and people of the Big Hole River long into the future.

This project final report was created, reviewed, and improved by the following:

Big Hole Watershed Committee

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Table of Abbreviations

AG	Arctic Grayling
BHWC	Big Hole Watershed Committee
BLM	Bureau of Land Management
BMP	Best Management Practice
CCAA	Candidate Conservation Agreement with Assurances
HUC	Hydrologic Unit Code
MDEQ	Montana Department of Environmental Quality
DLVCD	Deer Lodge Valley Conservation District
DNRC	Montana Department of Natural Resources and Conservation
MDT	Montana Department of Transportation
MFWP	Montana Fish, Wildlife and Parks
NEPA	National Environmental Protection Act
NPS	Non-point Source
NRCS	Natural Resources Conservation Service
NRDP	Natural Resources Damages Program
TMDL	Total Maximum Daily Load
USFWS	United State Fish and Wildlife Service
WCT	Westslope Cutthroat Trout
WMA	Wildlife Management Area
WRP	Watershed Restoration Plan

Executive Summary

The French Gulch and Moose Creek Restoration Project restored 3.5 miles of stream after historic placer mining altered the channel and floodplain. The project is located on the Mount Haggin Wildlife Management Area in the Big Hole River watershed of southwest Montana. The majority of the project is within state-owned Mount Haggin Wildlife Management Area, under Montana Fish, Wildlife and Parks (MFWP), with a portion of Moose Creek owned by the Bureau of Land Management (BLM). Project design, development and fundraising occurred from 2011 – 2015; construction occurred 2016 – 2017.

The project goals were to restore the stream channel and adjacent floodplain, establish wetlands areas, reduce conifer encroachment in the floodplain, reestablish diverse riparian native vegetation, and remove a fish passage barrier. This project targeted the most severely degraded sections of French Gulch and Moose Creek, where the first gold occurred in the Big Hole River watershed in 1864. The project met many resource improvement interests: improve water quality by reducing sediment and reducing water temperature, improve fish habitat particularly for native Westslope cutthroat trout and Arctic grayling, improve recreation opportunity on public ground, improve wildlife habitat.

More than 30,000 cubic yards of placer tailings were removed from French Gulch and Moose creek, over 11,000 feet (2 miles) of new stream channel and 17 acres of hydrologically active floodplain and wetlands were created, including planting of 35,000 willow stakes and whips and 2,300 container plantings. Pool habitat in the channel increased from 12.4% to 34%, the flood prone width increased from 22 feet to 73 feet, and numerous other measurements included in the final report demonstrated that the project created the functional hydrologic and habitat conditions necessary for complete restoration of the project area to occur naturally.

The project manager for the restoration work was the Big Hole Watershed Committee (BHWC). The BHWC is a multi-stakeholder locally led watershed group that supports water, wildlife and people for the Big Hole River. Total project cost was $1,195,710.45. Funds were provided from 12 funders across 21 funding agreements funneled through three entities.

Project Location

The project lies within the French Creek HUC 12 (12-digit Hydrologic Unit Code) watershed, a large tributary of Deep Creek/Big Hole River, within the Mount Haggin Wildlife Management Area (WMA) near the Continental Divide (**Figure 1**). Taken together, the French Gulch and Moose Creek watersheds comprise 65% of the total drainage area of French Creek Hydrologic Unit Code (HUC) **Figure 2**. Project area elevation ranges between 6103 feet and 6520 feet.

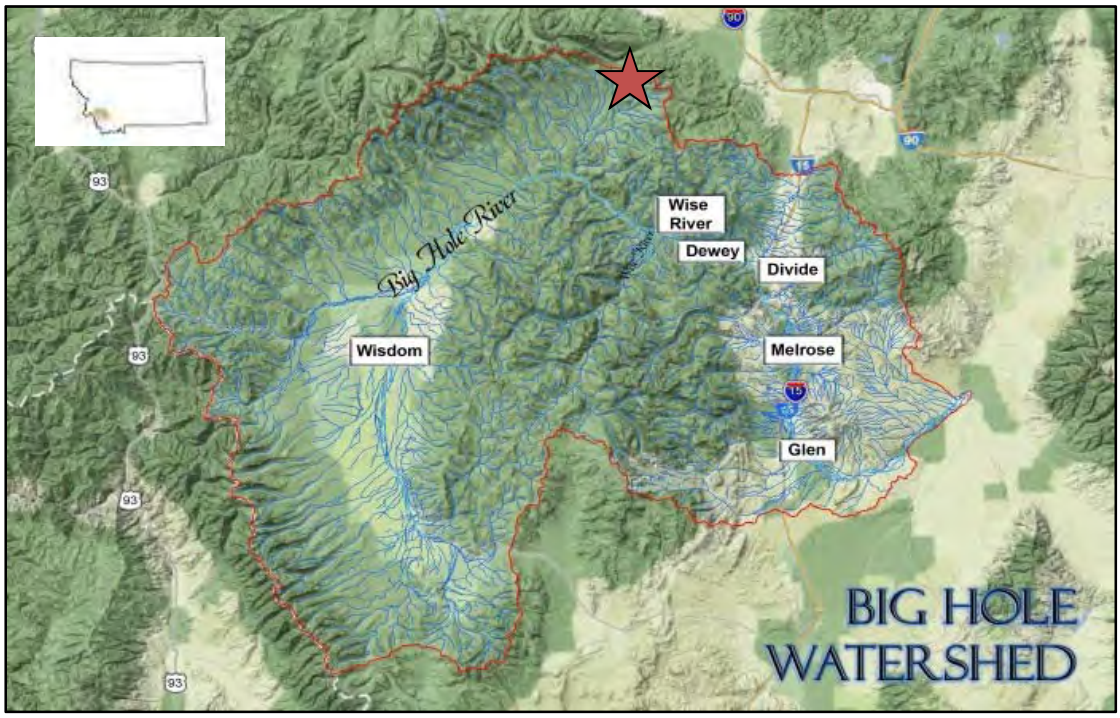

FIGURE 1. PROJECT LOCATION

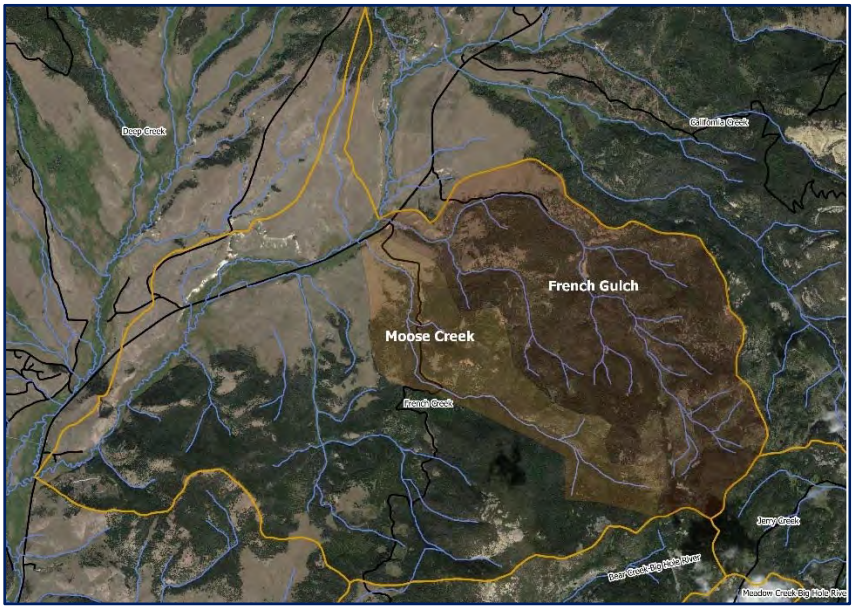

FIGURE 2. FRENCH CREEK HUC12 AND PROJECT AREA

Project Goals

The French Gulch and Moose Creek Restoration Project had clear restoration goals for decreasing the volume of sediment mobilized by the channel. The project also played an important role in advancing the overall objectives of MFWP for the restoration of wildlife and fish habitat in the Mount Haggin Wildlife Management Area as well as the Big Hole River watershed. The project's goals were to:

- Re-establish natural stream channel dimension, pattern & profile
- Reconnect floodplain and wetlands to reduce sedimentation/siltation in French Creek and Moose Creek
- Improve fish habitat conditions, particularly spawning habitats.

Mount Haggin Restoration Areas

The French Gulch and Moose Creek Restoration Project goals contribute to larger initiatives underway both upstream and downstream of the project area and within the Deep Creek drainage of the Mount Haggin WMA. There are 3 main focus areas of restoration in the drainage:

1. *Uplands:* Restoration of uplands affected by the atmospheric deposition from the Anaconda Smelter: The Natural Resource Damage Program (NRDP) is addressing large-scale sediment delivery in California Creek a tributary to French Creek near the Continental Divide. This project is part of NRDP's responsibility to restore smelter-impacted uplands within the Anaconda National Priorities List (Superfund) site.

2. *Habitat Restoration:* Additional projects have been identified in the Deep Creek drainage for future restoration with the same goals in mind, to improve fish and wildlife habitat and improve water quality by repairing historic damages caused by mining, smelting, logging and other land management practices.

3. *Native Fish Restoration:* Downstream of the project area, MFWP is preparing to install a fish barrier on French Creek. The barrier and subsequent native fish restoration would establish a native westslope cutthroat trout and Arctic grayling stronghold on more than 40 miles of stream between the barrier and the Continental Divide. The barrier and native fish restoration work would create one of the largest native fish projects in Montana. The habitat created by the French Gulch and Moose Creek project will improve the success of the native fish restoration work.

History of Mount Haggin & Project

French Gulch and Moose Creek are second order streams. They are tributaries of French Creek, which enters Deep Creek and then the Big Hole River. Deep Creek begins on the Continental Divide in the Pintler Mountains. The majority of lands in the drainage are on publicly owned by the Beaverhead Deer Lodge National Forest, MFWP Mount Haggin Wildlife Management Area, and Bureau of Land Management. There are private inholdings in the upper watershed, many of which are historic, patented mining claims. Private ranches and year-round and recreational homes are present in the lower portions of the drainage. Highway 569 runs through the drainage, connecting travelers between the Big Hole Valley and the Clark Fork Valley. The project area is between 6103 and 6520 feet elevation and sustains long, snow packed winters typically beginning in October and melting out in April or May, and short summers.

The geologic history of the project area resembles that of the rest of the Big Hole Valley Physiographic unit. As stated in the project cultural inventory, "Tertiary Period faulting and subsequent erosion and filling by sediments created the basin. Exposures of basin fill along French Creek appear as dirt white clay and volcanic ash from the Idaho Batholith interbedded with deposits of sand and gravel. Alpine (montane) glaciers extending from the surrounding mountains pushed outwash terraces far into the valley. The last major glacial advance, around 15,000 years ago, shaped the Deep Creek-French Creek basin into its present form. Alpine glaciers scoured huge quantities of material from higher mountain valleys and basins, transporting and depositing these materials in superimposed outwash terraces on the gently sloping outwash plain in the Deep Creek and French Creek basin. Subsequent erosion has created the long, gently sloping ridges between the creeks in this basin. Developed soils consisting of silt and dark gray loam are found intermittently along French Creek, between interceding areas of over-bank deposits of sand and fine, stream worn gravel. The lower terraces contain dark loams in a boggy environment." (Ferguson, 2013)

Mount Haggin is home to typical mountain flora and fauna. Higher elevations are covered in pine and conifer cover, mid elevations rolling sage and grass hills, and riparian bottoms of willow, alder and sedge where able to thrive. Megafauna include healthy populations of elk, moose, mule deer, antelope, coyote, black bear, wolf, and mountain lion. Although not documented in the French Gulch and Moose Creek project area, Grizzly Bear presence is possible as recent documented sightings have occurred nearby. Grasslands provide ample spring wildflowers. Bison are not suspected to historically populated Mount Haggin in large numbers. Birds use the area seasonally with more than 203 documented. Native trout include westslope cutthroat trout, Arctic grayling as well as non-native Brook Trout. Pearlshell mussels are also present in French Creek, a sensitive species with low populations and require westslope cutthroat trout to be present in order to reproduce.

The Big Hole Valley to include Mount Haggin was utilized by Native American tribes for hunting and gathering grounds, including the Nez Perce tribe. Blackfoot, Crow, and Flathead tribes would pass through for fish into the 1870's (Ferguson, 2013). Chert, used for making tools and points for spears and arrows, was quarried in the upper French Creek drainage. There have been multiple camp sites identified along French Creek where the quarried rock was worked into tools and points but none within the French Gulch and Moose Creek project areas (Ferguson 2013).

In 1864 the first gold was discovered in French Gulch, attracting hundreds of people to the area to prospect for gold and minerals and developed the town of French Gulch (**Figure 3**). The town existed for a few decades, but declined after 1868 and completely vacant by 1902 (Ferguson, 2013).

FIGURE 3. THE TOWN OF FRENCH CREEK AND FRENCH GULCH IN 1913

Gold panning and sluicing for the easiest-available gold was exhausted by 1877, at which point more intensive hydraulic mining operations began in the area (**Figure 4**), along with large ditches dug throughout the area to convey water for these operations. Large dredgers were later brought to the French Gulch mining claims in 1895. Streams and floodplains in the drainage that underwent mining operations were completely uplifted, materials sifted through, channels relocated, and massive piles of rock on disturbed ground left behind.

FIGURE 4: EXAMPLE OF HYDRAULIC MINING (FERGUSON, 2013)

WR Allen was born in French Gulch in 1871 and would later become Lieutenant Governor of Montana as well as resource extraction businessman on Mount Haggin. As French Gulch declined, W.R. Allen purchased many of the claims and properties. His company, W.R. Allen Company (as well as other iterations) lead dredging operations in the drainage.

Near 1904, as mining waned, Allen establish large-scale logging activities and timber became the new resource of interest on Mount Haggin. From 1906-1909 a massive sale removed 79 million board feet of timber (**Figure 5**). This sale included construction of the famous log flume which conveyed logs from Mount Haggin over the Continental Divide and into the Clark Fork Valley (Boccadori, 2017). Logs were used to fuel the emerging smelting industry in the town of Anaconda and provide mining stays for underground shafts and other lumber for mining operations.

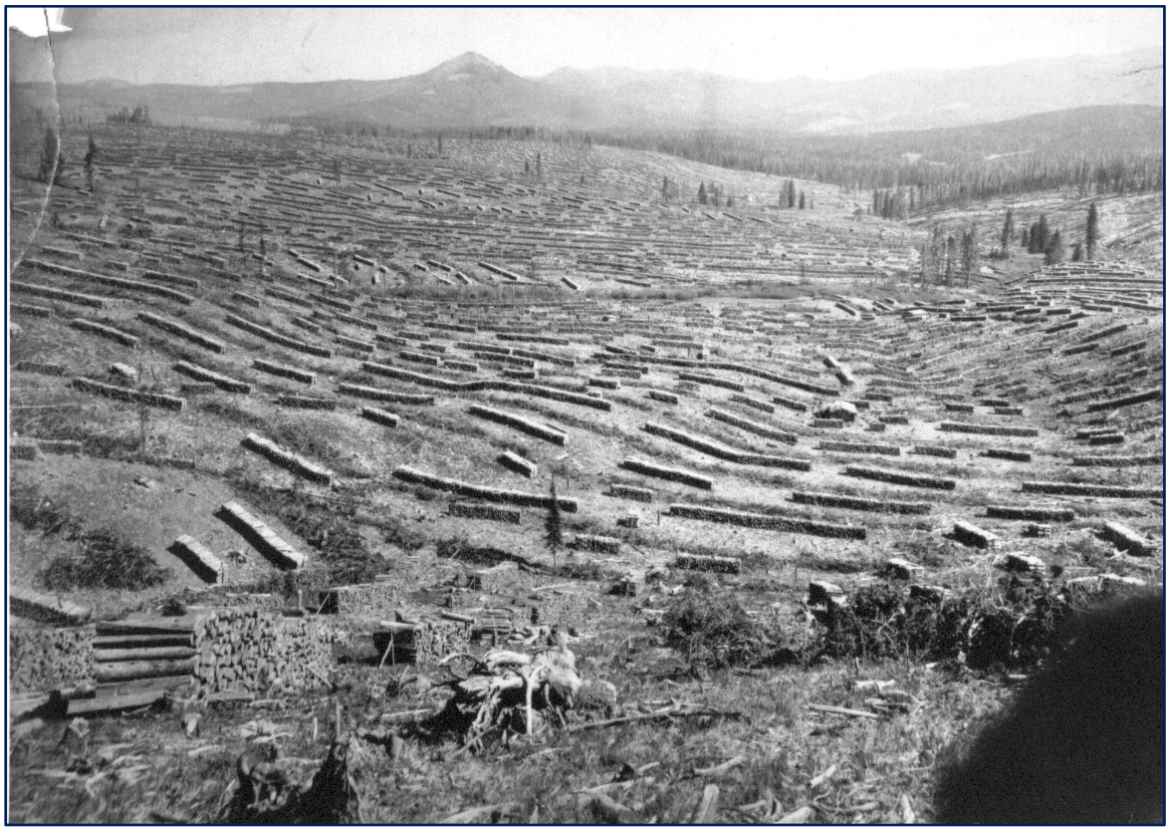

FIGURE 5: 1909 MOUNT HAGGIN TIMBER SALE, REMOVED 79 MILLION BOARD FEET. THE PEAK IN THE CENTER BACK IS SUGARLOAF MOUNTAIN OF MOUNT HAGGIN (BOCCADORI, 2017).

The area around the project became part of National Forest in 1906 as the Big Hole Forest Preserve, later becoming the Beaverhead Deer Lodge National Forest. Gifford Pinchot, who presided over the creation of the national forest visited Mount Haggin in 1908. The timber sale was so expansive and detrimental to the land that many timber sale guidelines and criteria were created as a result. Timber was used to support the growing towns of Butte and Anaconda, mine development, and smelting operations.

The Washoe Smelter, or "stack" located near Anaconda, Montana was built for the Anaconda Mining Company operations (later as companies ARCO and BP-ARCO) and operated from 1918 to 1981. The stack was used to process metals from nearby mining operations primarily in Butte. The effluent from the stack blew around Anaconda and Deer Lodge, and south towards Mount Haggin, depositing heavy metals such as arsenic and copper onto soils that were bare from logging, resulting in widespread erosion and negative impacts to the environment including the Deep Creek drainage. The smelter damage was concentrated in the higher elevations of Mount Haggin, along the Continental Divide near Sugarloaf Mountain and California Creek (**Figure 6**).

FIGURE 6. ANACONDA SMELTER AS SEEN FROM SUGARLOAF MOUNTAIN OF THE MOUNT HAGGIN WMA. REMNANT LOGS AND STUMPS FROM HISTORIC LOGGING LAY ON BARE AND ERODING GROUND AFTER BOTH LOGGING AND SMELTING DECIMATED THE EXISTING VEGETATION COVER.

Lawsuits from local ranchers ensued claiming that smelter emissions were damaging their lands and ability to make a profit ranching. To prove that ranching could co-exist with smelting ARCO created the Mount Haggin Land and Livestock Company. Sheep, cattle and other livestock were extensively grazed on Mount Haggin through the 1960's.

The lands of Mount Haggin were later transferred into public ownership using Land and Water Conservation Funds in the 1970's. Lands were transferred to both federal and state agencies. With help from The Nature Conservancy in 1976, MFWP purchased lands to create the Mount Haggin Wildlife Management Area, which today is 58,800 acres.

The French Gulch and Moose Creek projects were initiated under multiple pretenses. MFWP is charged with managing fish and wildlife populations and their habitat. Restoring habitats impacted by past management on the WMA is a high priority. Further, Arctic graying and westslope cutthroat trout, which are native to the Big Hole River, are sensitive species who's populations have declined from their pre-white settlement populations. French creek presents a unique opportunity to restore native fish species to a large watershed. In 2011, MFWP began planning to install a fish passage barrier on French Creek. Once installed, the fish barrier would prevent upstream passage of non-native trout. The area above the barrier, which would include 40 miles of stream most of which is located on the Mount Haggin WMA, would be restored to native fish and become a stronghold for westslope cutthroat trout and Arctic grayling. This is also a critical move for conservation of pearlshell mussels found in the drainage, which can live more than 80 years. The barrier has been under development and currently is proposed for construction in 2018. The native fishery would take 2-3 years to re-establish through removal of

non-native fish and restocking once the non-native fish are removed. If successful, the project would be the second largest native fish restoration project in the state to date.

Suitable habitat is required for the native fish reestablishment to be successful. French Gulch and Moose Creek both suffered from extensive placer mining. This resulted in a perched culvert acting as a fish passage barrier on French Gulch, large placer piles limiting floodplain function, and a straightened channel lacking pools and spawning habitat with suitable substrate. MFWP was interested in the restoration work to both improve fish habitat, as well as improve habitat for wildlife like moose, elk and other flora and fauna.

The Mount Haggin WMA is within designated critical habitat in the upper Big Hole River Arctic grayling recovery area. Under the Arctic Grayling Recovery Program, a team made up of MFWP, Natural Resources Conservation Service (NRCS), US Fish and Wildlife Service (USFWS), and DNRC work with landowners to restore native Arctic grayling populations. The French Gulch and Moose Creek projects fit within the scope of grayling restoration, particularly with the future hope to expand native fish habitat.

One of the focus areas for the BHWC is improving water quality and quantity for the Big Hole River. MDEQ completed Total Maximum Daily Loads (TMDL's) for the Big Hole River in two parts – Upper and North Fork Big Hole River, and the Middle-Lower Big Hole River (2009). The TMDL's identified drainages where water quality issues were present. One major water quality impairment in the Big Hole Valley is high loads of sediment and high-water temperature, and occasionally high level of nutrients or metals. Mount Haggin had a high concentration of streams with sediment impairments as a result of historic mining and land management practices.

Since its inception in 1995, BHWC's focus has been on water issues, particularly low flows and high-water temperatures. In the early 1980's, river conditions and grayling populations declined as drought set in. Habitat had become degraded in some areas, there was little cooperation among water users, residents and agencies to address these problems. In 1988 the Big Hole River ran dry for 35 consecutive days at Wisdom. The BHWC was formed shortly after and its first mission was to create a voluntary Big Hole River Drought Management Plan in 1997 with the goal of maintain a minimum river flow and protect the fishery – a "Shared Sacrifice, Shared Success" model. Since that time, BHWC has supported restoration projects to improve fish habitat, reduce water use through irrigation upgrades, improve water quality, and enhance the landscape's ability to store water as well as provide outreach and education. With water as a focus, BHWC used the TMDL's to garner funds to improve water quality under the MDEQ 319 program. In 2012 and 2013 BHWC published two Watershed Restoration Plans setting course for water quality improvement mirroring the TMDL's produced a few years earlier. Mount Haggin was included in the Middle-Lower Big Hole River Watershed Restoration Plan (BHWC, Big Hole River Watershed Restoration Plan Part II: Middle-Lower Big Hole River, 2013). As part of the Middle-Lower Watershed Restoration Plan development, BHWC also worked with MDEQ Wetlands program to incorporate wetlands into the plan as a tool for improving water quality, a pilot project. Several areas in the French Creek drainage, California Creek drainage and others showed high potential for restoration that would improve water quality by reducing sediment loads, with secondary benefits to reducing late season water temperature and increasing late season flows, plus a myriad of other ecological gains.

In 2012 MFWP and BHWC began working together to improve Mount Haggin. MFWP would set direction to meet the needs of the WMA and the fishery, BWHC would incorporate improvements for water quality. Together the two entities would pull in additional partners, secure funds, and see the project through. The early design and development phase would occur 2011 – 2014 including soil samples, survey, and preliminary design. The early products were used to secure funds for final design and construction. The final design was completed in 2015-2016, construction was done in 2016-2017, and the project was completed in December 2017. The project was designed, overseen, and guided by engineers from Morrison-Maierle, Inc.

While the French Gulch and Moose Creek project was being developed, Montana Department of Transportation (MDT) was also undergoing planning and development to reconstruct Highway 569. A section of the highway runs through the riparian area and floodplain of French Creek, restricting stream channel and floodplain function. In 2015 MDT moved a 2-mile portion of the highway from the French Creek floodplain to the hillslope above. This project included the replacing of undersized culverts under the highway of several tributary stream with large box culverts that allowed easy passage for fish, including Moose Creek and French Gulch.

French Gulch and Moose Creek Project Entities

Partners, Contractors & Funders

Montana FWP/Mount Haggin Wildlife Management Area: Primary landowner for project area. MFWP sought support, funders and partners for completing this project to improve habitat and fisheries resources, as well as water quality. MFWP initiated the project followed by development, implementation, requesting funding, and sharing results. *Contact: Vanna Boccadori, Wildlife Biologist & Jim Olsen, Fisheries Biologist.*

Big Hole Watershed Committee: Project coordination lead, including requesting funding, hosting funding contracts and contractors, maintaining financial and project records, reporting results, outreach, monitoring, and final reporting. *Contact: Jennifer Downing, Executive Director, Pedro Marques, Restoration Program Manager & Tana Nulph, Conservation Program Coordinator*

Deer Lodge Conservation District: District hosted contracts with DNRC Reclamation & Development Grants Program to support both planning in 2013 and construction in 2016-2017. *Contact: Susie Johnson, District Administrator*

Bureau of Land Management: Landowner for a portion of the Moose Creek project area and funder. *Contact: Scott Haight, Field Manager*

Montana Department of Transportation: Lead for Highway 569 road relocation in 2015, included a matched and coordinated French Gulch and Moose Creek design through mutual engineer Morrison-Maierle.

Contractors

- Morrison-Maierle – Survey, design, permitting assistance, grant assistance, construction oversight.
    - TerraQuatics Inc. – Wetlands design assistance.
- Robert Peccia & Associates, Inc. (Sands Surveying Inc.) – LiDAR.
    - Pioneer Technical – Soils sampling.
- Montana Civil Contractors – Prime restoration construction.
    - Watershed Consulting – Revegetation contractor.
- R & S Johnson Construction – Enhancement construction.
- Montana Conservation Corps – Habitat improvements
- GCM, Inc. – Cultural Inventory
- MSE – Soil Survey

Funding Sources for Project

Funding Source	Purpose	Amount
Montana Department of Natural Resources & Conservation ***Reclamation Development Grants Program***	Preliminary Design, Construction	$661,817
Montana Department of Environmental Quality ***319 Program***	French & Moose Creek Design, Implementation, Monitoring, Outreach	$225,000
Future Fisheries Improvement Program	French Gulch Construction	$201,308
US Fish & Wildlife Service WNTI	Fish Passage on French Gulch	$22,385
Bureau of Land Management	Moose Creek	$24,500
Montana State Wildlife Grant	French Gulch & Moose Creek Design	$15,000
Patagonia	Outreach, Construction	$12,000
George Grant Trout Unlimited	French Gulch & Moose Creek Design & Construction, Outreach	$10,000
Montana Trout Foundation	French Gulch & Moose Creek Design and Construction	$10,000
Montana American Fisheries Society	Design and Construction	$8,000
Montana Department of Environmental Quality ***Wetlands Program***	French Gulch & Moose Creek Design	$4,700
Montana Trout Unlimited	French Gulch Design	$1,000
Total		**$1,195,710**

Economic Case Study

The project funding for a total of $1,195,710.45 spent on the project by several funding sources. The majority of the funding sources were Montana state-sourced or funneled through state government from federal sources.
Figure 7 displays the proportion of funding sources by category and **Table 1** provides income from each funder.

A total of $1,315,116 was raised to support this project. The project ran on time, on schedule, and under budget. A 10% reserve on construction was part of the fundraising and went unused during the regular construction period, and the balance we re-allocated to the project in 2017. A total of $119,405.55 originally allocated to this project was deemed un-needed in 2017 and was either turned back to funders or re-allocated to related projects. The total cost, $1,195,710.45 represents funds spent on the project 2013-2017. The figures and tables below show how spent funds were allocated.

TABLE 1. PROJECT FUNDING SUMMARY

Chart Item	Description
Conservation Groups – 4%	Local conservation groups, including George Grant Trout Unlimited, Montana American Fisheries Society, Patagonia, and Montana Trout Foundation,
DNRC via DLVCD – 55%	State of Montana Department of Natural Resources Conservation Service under the Reclamation and Development Grant Program earmarked for mine related restoration projects. Dollars contracted with a Conservation District: Deer Lodge Valley Conservation District (DLVCD).
DEQ via 319/EPA – 19%	Montana Department of Environmental Quality 319 program for water quality improvement distributes funds from federal EPA for work that improves water quality as described in the TMDL and WRP.
MFWP via FFIP, SWG – 18%	MFWP grants from the Future Fisheries Improvement Program and State Wildlife Grants for improving habitat.
Federal via BLM, USFWS – 4%	Funds direct from federal agencies for the project. USFWS-WNTI funds supported fish habitat and passage. BLM funds supported mine reclamation specific to BLM lands on Moose Creek.

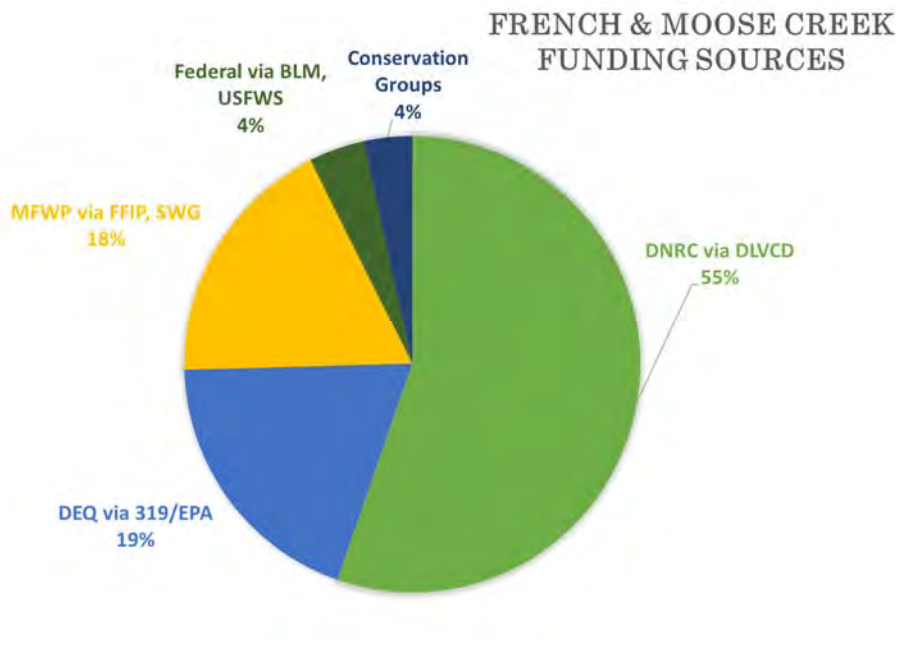

FIGURE 7. FRENCH GULCH AND MOOSE CREEK FUNDING SOURCES

Table 2 Project Income by Funder (next page)

Funding Source	Purpose	Amount
Montana Department of Natural Resources & Conservation Reclamation Development Grants Program	Preliminary Design, Construction	$661,817
Montana Department of Environmental Quality 319 Program	French & Moose Creek Design, Implementation, Monitoring, Outreach	$225,000
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Montana Trout Foundation	French Gulch & Moose Creek Design and Construction	$10,000
Montana American Fisheries Society	Design and Construction	$8,000
Montana Department of Environmental Quality Wetlands Program	French Gulch & Moose Creek Design	$4,700
Montana Trout Unlimited	French Gulch Design	$1,000
Total		**$1,195,710**

Funding was used to support project development 2012 – 2015, and project implementation 2015 – 2017. The allocation of expenses represents total project cost from 2012 – 2015 (see **Figure 8** and **Table 3**).

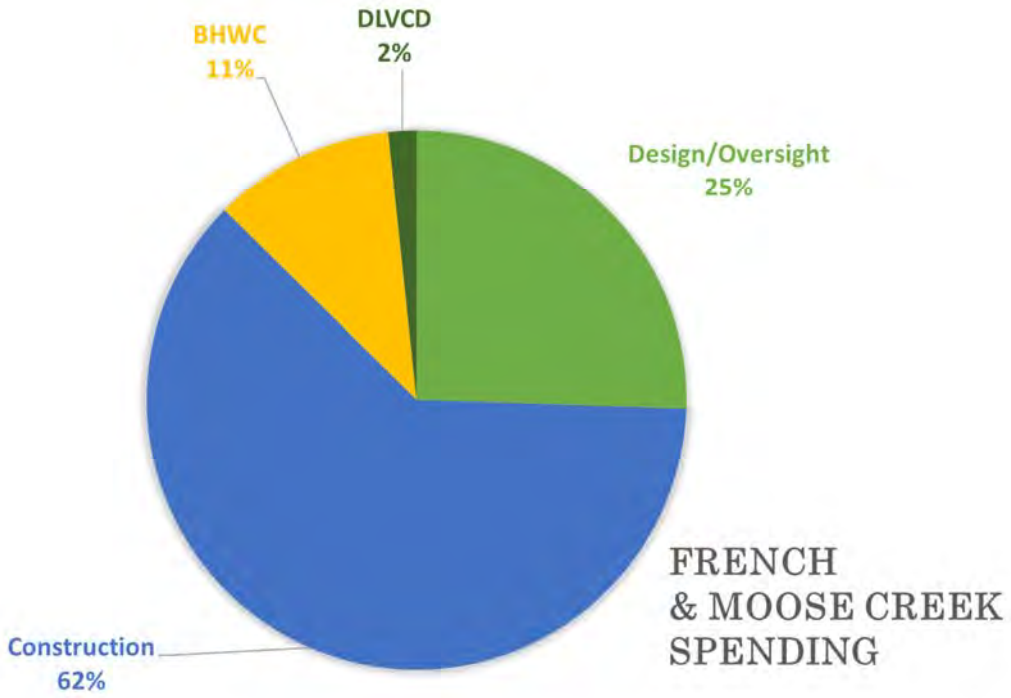


FIGURE 8 FRENCH-MOOSE PROJECT BY RECIPIENT

TABLE 3: FUNDING ALLOCATION BY RECIPIENT

Funding Recipient	Role	Total
Big Hole Watershed Committee	Project Coordination and Host, Monitoring, Outreach, Administration	$130,587.18
Morrison Maierle, Inc.	Design, Oversight, Outreach 2012 - 2017	$272,601.26
Montana Civil Contractors	2016 Construction	$670,996.45
Watershed Consulting	Revegetation	$7,095.00
RS Johnson, Inc.	2017 Construction	$56,575.00
RPA, Inc.	LiDar Survey	$19,925.00
GCM Consulting	Cultural Inventories and SHPO Support	$8,170.40
MSE	Soil Samples	$1,067.00
Montana Conservation Corps	2016 Construction	$5,000.00
Deer Lodge Valley Conservation District	DNRC Contract Host	$20,111.00
Montana Fish, Wildlife & Parks	Funding Host, Materials	$3,582.16
Total Funding Payments to Recipients		**$1,195,710.45**

Creating the French Gulch and Moose Creek Project

Regulatory Framework & Justification

The project is on state ground managed by MFWP. French Gulch and Moose Creek are tributaries of French Creek (MDEQ waterbody Id MT41D003_050) which does not support drinking water and aquatic life beneficial uses and listed as impaired in the 2016 integrated report. TMDLs were created for French Creek for copper, arsenic and sedimentation/siltation.

This project addressed the sediment priority concerns identified in the TMDL and other guiding documents for this area. While metals were not specifically addressed by this project, by creating an active and roughened floodplain environment, the project is expected to capture sediment on the floodplain and promote riparian species which can also uptake metals, thus potentially mitigating some metals contamination to French Creek.

Priority concerns met through this project include:

- ✓ Middle-Lower Big Hole River Total Maximum Daily Load (TMDL) lists Deep, French Creek, for high sediment and metals (MDEQ, Middle and Lower Big Hole Planning Area TMDLs and Water Quality Improvement Plan.M03-TMDL-02A, 2009)
- ✓ Middle-Lower Big Hole Watershed Restoration Plan lists the project area (Deep Creek/French Creek and headwaters) as a high priority for fish, wetlands, water quality (BHWC, Big Hole River Watershed Restoration Plan Part II: Middle-Lower Big Hole River, 2013)
- ✓ Project meets DEQ Nonpoint Source (NPS) action plan numbers R13, R18, and EO3 (MDEQ, Montana Nonpoint Source Management Plan, 2012)
- ✓ The French Gulch and Moose Creek Project supports broader MFWP goals of creating a native fisheries stronghold. The Restoration goal for westslope cutthroat trout (WCT) in the Big Hole River drainage is 20% of historically occupied habitat. This represents about 420 miles of streams. There are 20.5 miles of native WCT populations remaining and another 64 miles that have been restored in the past 8 years. Restoration of French Creek to native species as a result of the fish barrier would result in a 50% increase in the number of miles of native fish habitat.
- ✓ Project supports DNRC goals for reclaiming historic mining-degraded lands
- ✓ Wetlands, as nitrated into the project design.
- ✓ Wildlife, particularly wildlife utilizing riparian habitats.
- ✓ Recreation of the restored area.
- ✓ Natural water storage, including large intact floodplain able to store groundwater.

Existing Conditions and Project Reaches

Preliminary work 2012-2014 included field reconnaissance of existing conditions of the entire project areas of French Gulch and Moose Creek. This effort focused on collecting stream channel surveys and geomorphic data to delineate distinct sections of similar character. Project reaches were classified into one of four categories:

- Priority 1 – highly impacted and degraded section. These sections exhibit observed and measurable signs of degradation from past mining material wasting, straightening, and other consequential impacts like bimodal substrate and lack of accessible floodplains.
- Priority 2 – moderately impacted section with various degrees of degradation. Passive restoration techniques and improvement of adjacent sections likely to succeed in improving aquatic habitat and fluvial function.
- Priority 3 – inaccessible section identified as moderately impacted in localized sections surrounded by functioning sections. Minimal and localized restoration of impacted sections likely required. Impacted section identified using parameters from topographic data like sinuosity, belt width, and entrenchment ratio.
- Reference – this section was identified as having little to no impacts or degradation. This section exhibits typical geomorphologic values for this stream type. Measured values in this section are used to quantify the degree of degradation in impacted sections and to provide design parameters for restoration.

Table 4 below shows the departure of key measurements between Priority 1 and Reference sections (the greatest departure comparison). There was also little to no evidence seen of natural or passive restoration of the stream or floodplain functions. This was likely a result of the large-scale material sorting from past mining efforts in the valley. This created an abundance of large cobble (>1' diameter) material at the surface which neither French Gulch nor Moose Creek have the energy to mobilize at bankfull flows. The material sizes and lack of evident processes indicated that, without restoration efforts, neither French Gulch nor Moose Creek had the potential to restore the natural processes required to meet the project objectives.

In the reference reach a key observation was that streambank stability was almost entirely controlled by riparian vegetation, both woody and sod mat types. In terms of design, this meant a combination of salvage materials and bio-engineering would likely be required to stabilize high stress areas until revegetation could establish sufficiently to provide this stability.

TABLE 4. GEOMORPHIC SECTION COMPARISON				
	Section ID*:			
	Priority 1	**Reference**	**Unit**	**% Difference**
Gradient:	0.0225	0.0176	ft/ft	28%
Sinuosity:	1.14	1.50	ft/ft	24%
Bankfull Width:	7.9	5.9	ft	32%
Floodprone Width:	22	53	ft	59%
Entrenchment Ratio:	2.20	4.84		55%
Width/Depth Ratio:	21.3	20.7		3%
% Pools:	12.0	50.5	%	76%
Res. Pool Depth:	0.50	0.63	ft	20%
Pool Length:	6.0	13.6	ft	56%
Pool Width:	6.5	7.1	ft	8%
Pool-Pool Spacing:	40	29	ft	37%
Radius:	90	14	ft	548%
Meander Length:	224	49	ft	356%
Belt Width:	41	88	ft	53%
Substrate D_{15}:	1.0	2.6	mm	62%
Substrate D_{50}:	17.3	25.8	mm	33%
Substrate D_{84}:	85.3	82.2	mm	4%
Large Woody Debris:				
# per 100'=	1	4		74%
Avg. Length=	5.0	4.2	ft	19%
Avg. Diameter=	0.8	0.9	ft	7%
*Note: Average values used for comparison				

Based on this field data, the restoration design was focused on reaches of French Gulch and Moose Creek with the most need, Priority 1 and 2. The project area for French Gulch was broken into 5 reaches based on the specifics of the work to be completed and natural changes in slope and stream character (see **Figure 9**). For purposes of this report, all project implementation refers back to these reach breaks. A brief description of each reach in French Gulch and Moose Creek is provided below in **Table 5.** Images of the project area prior to implementation are provided in **Figure 10**.

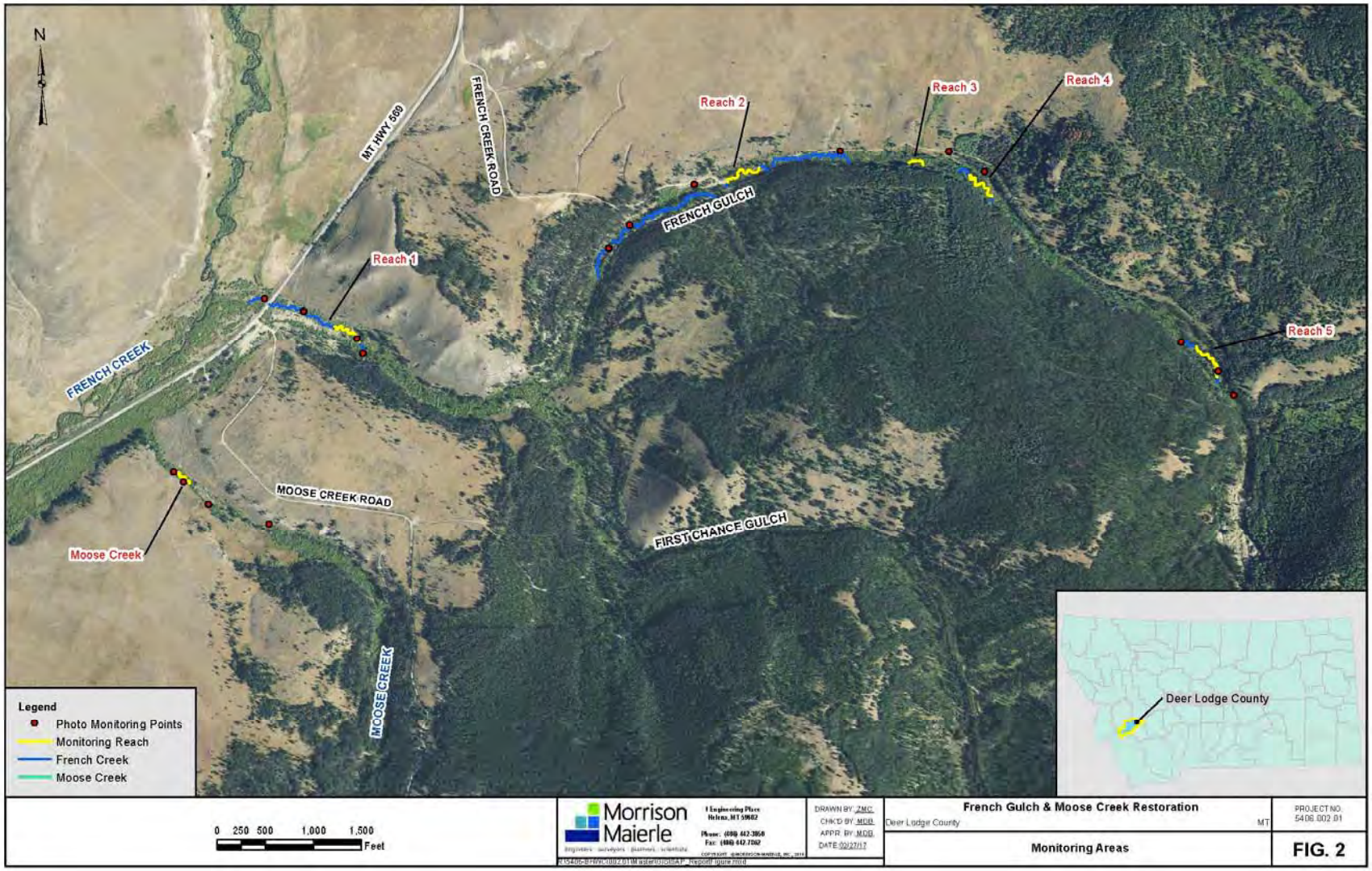


FIGURE 9. FRENCH GULCH AND MOOSE CREEK STREAM REACHES WITH MONITORING LOCATIONS

TABLE 5. PROJECT STREAM REACH DESCRIPTIONS	
Reach Name	**Description**
French Gulch	
Reach 1	Reach extends from below the confluence with First Chance Creek at a grade of between 1-2% to several hundred feet downstream of the new Highway 569 crossing, where the new channel meets the abandoned placer-confined channel at a grade of less than 1%. Extent and depth of placer piles (up to 10-feet) throughout this reach indicate intensive mining operations occurred here in the alluvial fan of the channel. The entire stream channel was confined to a narrow and straightened ditch. A narrow but mature willow community flanked the stream. Outside the narrow riparian corridor, a mix of lodgepole pine, sagebrush, and upland grasses are intermixed with willows in the undulating topography created by placer tailings.
Reach 2	This reach had both highly impaired Priority 1 sections as well as Priority 2 areas further downstream and the stream gradient varies between 1% to just over 2%. In the downstream portion a narrow floodplain existed but there was evidence of overbank deposition, meanders and side channels and diverse riparian vegetation. Further upstream the reach was confined between the hillslope and 15-20 ft. placer piles, leaving the channel straight and absent any in-stream habitat complexity. The existing valley bottom was 50ft. wide in places, less than a third of its potential width due to placer piles. In the upper portion of this reach, the French Gulch Road was located in the valley bottom and regularly flooded during high flow events.
Reach 3	A short and steeper stream reach in a confined location in the valley. The reach has a slope of 2% and existing channel is highly confined between placer tailings and the hillslope. This reach is located between somewhat functional stream reaches not slated for construction and required a small amount of construction to pull the channel out of its confined condition.
Reach 4	A steep reach with a gradient of 2.5%, most of the channel in this reach was pinned against the hillslope behind 3-5ft. placer piles. Substantial sinuosity was designed for this reach to promote natural stream function. Existing vegetation in this reach varied from mature willow and riparian species to Lodgepole pine and Douglas fir. Placer piles in this reach were all substantially vegetated with upland species.
Reach 5	Stream reach has a gradient of 3% in a narrow valley bottom. Vegetation consists of a mix of willow species, some cottonwood and mixed conifers which have grown on placer tailings of varying sizes. The top of this reach is characterized by a perched culvert, three feet above the stream channel. This fish barrier and the 200 feet above the culvert inlet are considered the uppermost reaches of the project.
Moose Creek	
Reach 1	The next downstream drainage to French Creek, Moose Creek is generally in a more functional condition but is flanked by placer piles and a restricted floodplain due to past mining activities. Sagebrush uplands extend to the streamside in some areas, where a narrow riparian corridor of willow and some conifer are abundant. Large beaver pond complexes immediately upstream of the project area dramatically illustrate the departure of the impacted reach of this channel from its reference condition.

FIGURE 10. PRE-PROJECT SITE CONDITION IMAGES

Placer piles in reach 1 and stream channel

Existing channel and width of riparian corridor in reach 1. Nearly 6-feet of artificially elevated floodplain clearly shown

Existing channel in reach 1 (foreground). Small depressions provided opportunities for willow colonization (background)

Extensive placer pilings in upper part of reach 1

Large placer piles in reach 1 limit extent of riparian area

Reach 1 prior to channel construction with box culvert marking location of future channel

Perched culvert at the top of reach 5 shown in 2014 (left) and during pre-construction walk-through in the spring of 2016 (right)

Reach 2 from aerial survey drone July 2016. Noticeable linear placer pile. Existing channel marked by arrow

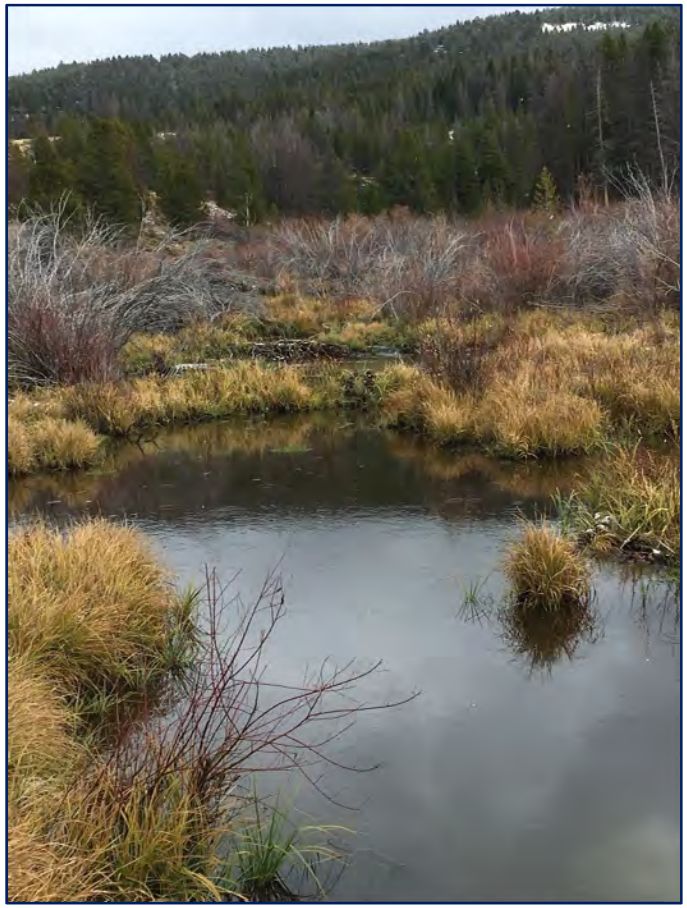
Reach 2 from aerial survey drone July 2016. Road drops into floodplain, relegating stream to straight and narrow channel marked by arrow

Stream channel in Reach 2 constricted by large vegetated placer pile

Old beaver dam and pond in Reach 2

Narrow riparian corridor and placer tailing in background

Location in Reach 2 where stream channel and wetlands connect through two large placer piles



Moose Creek upstream of project reach demonstrating reference conditions: beaver ponds and wide floodplain

Moose creek in project reach. Narrow riparian corridor, sagebrush and placer piles with conifer growing in floodplain

Impairments

The removal of placer tailings and creation of a hydrologically functioning stream and floodplain addressed all of the differing restoration priorities of the funding partners, namely, sediment, fish habitat, and mine reclamation. This section summarizes the existing data of the impaired conditions in the project area prior to project implementation.

Sediment

There is no pre-existing data on sediment delivery in the French Gulch and Moose Creek, but they are sub-watersheds of the HUC12 French Creek drainage. The French Creek TMDL calls for a 22% reduction in total sediment load, or 830 tons of sediment. By drainage area, the two watersheds in this project comprise 65% of the French Creek HUC12 drainage. Sediment loading and TMDL allocations for French Creek, are summarized in **Table 6** below (MDEQ, Middle and Lower Big Hole Planning Area TMDLs and Water Quality Improvement Plan.M03-TMDL-02A, 2009).

TABLE 6. SEDIMENT SOURCES AND TMDL LOAD ALLOCATIONS

Sediment Sources		**Current Estimated Load (Tons/Year)**	**Sediment Load Allocations**
Roads		18	38% reduction
Streambank Erosion	Transportation	62	36% reduction
	Riparian Grazing	1071	
	Mining	17	
	Silviculture	85	
	Other[1]	40	
	Natural Sources	477	N/A
Upland Sediment Sources[2]	Grazing	1787	21% reduction
	Silviculture	1.7	No model increase
	Natural Sources	220	N/A
Total Sediment Load/TMDL		3,773	22% reduction

[1] *The other source of erosion relates to recreation*

[2] *A significant portion of the remaining loads after Best Management Practices (BMPs) is also a component of the "natural upland load", though the assessment methodology didn't differentiate between sediment loads with all reasonable BMPs and "natural" loads.*

The 18 tons/year of sediment from roads during the time the TMDL was developed was likely due in large part to the location of the Mill Creek highway in the valley bottom. A large project by the Montana Department of Transportation in 2015 removed approximately 2 miles of the highway within the French Creek HUC12 from the wetland area and located it on the upland bench on the east side of the valley. New culverts at Panama Creek, Moose Creek and French Gulch were also installed, likely removing a majority of the road-related sediment source to the system. The French Gulch project also removed the French Gulch road from the valley bottom and constructed a new road on the bench, removing another 1,000 feet of road-related sediment source from the watershed. Minus these sources, there are only two small road-related stream crossings remaining in this HUC, in the upper reaches of Moose Creek (see **Figure 2** above).

As this project focused on enhancing stream-side conditions and habitat, it relates directly to the target reduction of 36% of the total streambank sediment produced annually, which is 1275 tons. The target reduction of erosion from streambanks amounts to 459 tons of sediment on an annual

basis for the entire French Creek drainage. The French Gulch and Moose Creek drainages comprise approximately 8,200 acres of the 13,000 acres respectively, or about 65% of the French Creek drainage area. The project therefore established a target of 298 tons/year reduction in sediment to French Creek (65% of 459).

Upland sediment sources are not addressed by this project. However, due to MFWPs efforts in the entire drainage and spurred by the relocation of the highway, an old fence was removed from the valley bottom and a new fence installed to remove restrictions to wildlife movement in the valley bottom and exclude cattle grazing from over 2 miles of the French Creek riparian area (**Figure 11**). With the installation of the new fence, an agreement was reached with the grazing lease holder which will remove grazing from the stream bottom area of French Creek downstream of the project area. That change in grazing patterns will lead to substantive but unquantified reductions in sediment from upland sources to French Creek.

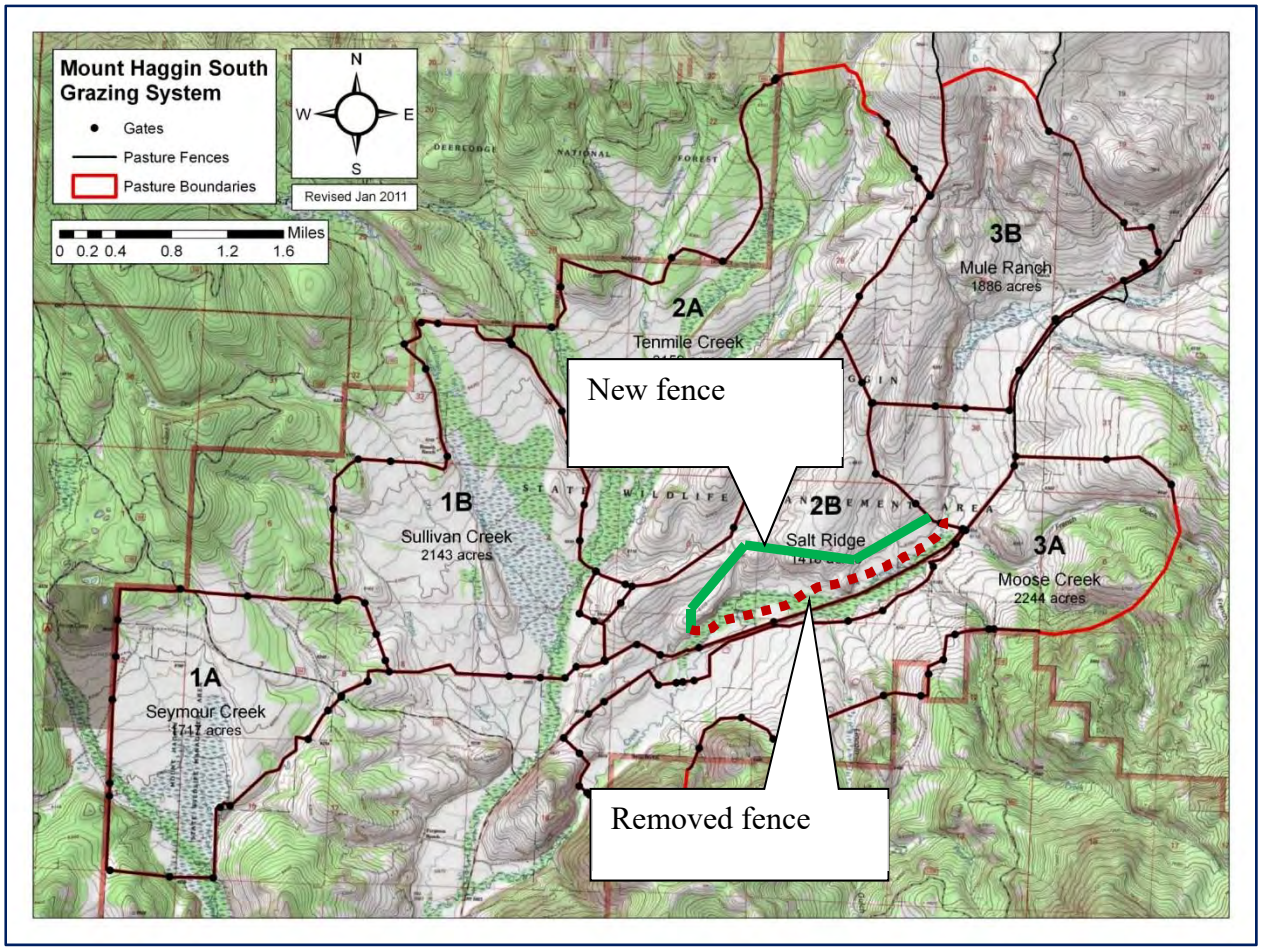


FIGURE 11. MOUNT. HAGGIN SOUTH GRAZING ROTATION PASTURES AND FENCE LOCATIONS

Stream function and geomorphology

Channel geomorphology was severely impacted by mining, causing an imbalance in the sediment load to the system. The 2006 sediment/habitat study conducted in French Creek as part of the TMDL indicated the channel existing in its potential configuration as C3/C4, with some target indicators out of balance (**Table 7).** This data, however, does not directly show conditions on the French Gulch and Moose Creek project reaches, though they are probably impacted by conditions in those streams, specifically from increased sediment transport and stream velocities from the project reaches. The project reaches, which are substantially impaired by placer mining activity, were essentially linear features of continuous riffles pinned between large placer piles and the hillslope. Prior to project implementation, the riparian belt width in many areas was limited to the width of a single willow shrub and the stream channel was highly entrenched, with minimal access to its floodplain. MFWP fish biologists noted pool frequency and quality were severely limited.

TABLE 7. FRENCH CREEK STREAM GEOMORPHOLOGY FROM TMDL

Reach ID	Targets						Supplemental Indicators					
	Pebble Count		Cross Section		Grid Toss		Rosgen Level II		BEHI			
	Reach % <6mm	Riffle % <2mm	W/D Ratio	Entrenchment Ratio	Pool Tail % <6mm	Pool Spacing	Existing	Potential	BEHI	% Non-Eroding Bank	Greenline % Shrubs	Riparian Condition
French 1	19	6	**23**	6.0	**20**	4.8	C4	C4	**35.6**	**76**	**34**	FAR
French (USFS)	11	11	22.7	**1.1**	ND	ND	C3	C3	**27.3**	ND	ND	PFC

ND = no data

Fish habitat

MFWP fish surveys identified non-native Brook trout as the dominant fish species in both French Gulch and Moose Creek. Species estimates from those surveys are shown in **Table 8** and sample locations shown in **Figure 12.** No native Arctic grayling (AG) or Westslope cutthroat trout (WCT) were found in these streams. The TMDL noted that "trout populations in French Creek were below average for streams in the Big Hole watershed. There is a cutthroat trout population described as rare in Moose Creek…" (MDEQ, Middle and Lower Big Hole Planning Area TMDLs and Water Quality Improvement Plan.M03-TMDL-02A, 2009). More important, as shown in the previous section, was the absence of habitat to support a strong fishery in these channels. At the upstream end of the French Gulch project is a perched culvert which created a complete barrier to fish passage. The French Gulch and Moose Creek project is an important part of MFWPs broader objectives to establish a native fishery stronghold in the French Creek drainage on Mount Haggin for WCT and Arctic grayling.

TABLE 8. FISH SAMPLING DATA-FRENCH GULCH AND MOOSE CREEK (DATA: MFWP)													
Sample Locations-Downstream to Upstream	**Moose 1**	**Moose 1**	**Moose 2**	**Moose 3**	**Moose 4**	**French 1**		**First Chance Gulch**	**French 2**	**French 3**	**French**	**French 4**	**French 5**
Sample Date (year/month)	2008/07	2008/07	2008/07	2008/07	2008/07	2015	2016	2008/07			2008/07		
Section Length (Feet)	518	435	800	2000	400	800	800	300	304	334	450	1590	NA
Brook Trout Captured	92	25	63	70	0	63	143	28	64	35	61	Fishless	Fishless
Population Estimate per stream mile		337						500	1251	590	732		
Other species (count)	Sculpin (13)	Sculpin (21)				Sculpin (84)	Sculpin (30); Rainbow Trout (3)		Sculpin (23)	Sculpin (11)	Sculpin (11)		

FIGURE 12. FISH SAMPLE DATA LOCATIONS

Vegetation

Existing vegetation in the French Gulch and Moose Creek project area was largely determined by the locations, size and shape of placer tailings in the watersheds. Along the narrow stream corridors confined by placer tailings, a mix of willow species, Red osier dogwood and occasional Alder trees were intermixed with sedges and rushes. As placer tailings increasingly dominate the floodplain surface, vegetation changes, often abruptly to sagebrush and lodgepole pine. Notably, unimpacted stream systems in this area, most notably French Creek downstream of the project reaches, typically display willow and sedges across the entire valley bottom. Those same conditions do not exist in much of the French Gulch and Moose Creek project areas because large placer tailings impede overbank flows from spreading out across the floodplain and saturating soils, creating the conditions for riparian and wetlands habitats (**Figure 13**). Some sections of the project areas with smaller placer tailings showed more robust and wider riparian areas, with a mixture of riparian shrubs, spruce, aspen and cottonwood. Functioning riparian habitats were not included in project designs involving heavy equipment.

FIGURE 13. TYPICAL VEGETATION CONDITIONS IN UNIMPAIRED STREAM REACHES IN THE MOUNT. HAGGIN WMA (LEFT). FRENCH GULCH REACH 1 WITH MONTANA STATE WETLAND AND RIPARIAN FRAMEWORK LAYER SHOWING PLACER-IMPAIRED AREAS.

Metals

Soil testing was completed for the project area in 2013 and reported in the project file and summarized in **Figure 14.**

Site Name	Date	Field ID	Aluminum (mg/kg)	Arsenic (mg/kg)	Cadmium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Zinc (mg/kg)	Mercury (mg/kg)
French Gulch	8/2/2013	FG-1308-02-001	4160	2.37	0.312	6.97	4.41	15.60	ND
French Gulch	8/2/2013	FG-1308-02-002	10900	18.20	0.772	22.40	9.94	37.90	0.0394
French Gulch	8/2/2013	FG-1308-02-003	18900	14.20	1.740	24.60	11.60	31.40	0.2970
French Gulch	8/2/2013	FG-1308-02-004	8930	26.00	0.545	20.70	11.20	33.10	ND
French Gulch	8/2/2013	FG-1308-02-005	3940	3.78	0.280	8.00	7.46	17.80	ND

FIGURE 14: 2013 SOIL TEST RESULTS

Limited samples exist for French Creek for metals in the water column (total recoverable) and for stream sediment concentrations (samples 1 and 5 above), and the data used in developing the TMDL are all over 10 years old. Based on these limited data, percent reductions of arsenic for French Creek in the TMDL are 62% for high flow and 29% for low flow. Reductions for Copper are 14% for high flow and no reductions targeted for low flow conditions.

The TMDL found that groundwater was the primary pathway for arsenic entering French Creek. Arsenic loading to French Creek is strongly influenced by the confluence with California Creek; existing metals data in the water column above the confluence with California Creek in French Gulch show no exceedance of copper or arsenic, while data below the confluence nearly double for copper and triple for arsenic. Sediment concentrations of arsenic are above targets both above and below the confluence with California Creek. The occurrence of these metals is clearly related to smelter deposition and not the mining from French Gulch and Moose Creek. Mitigation of these metals is outside the scope of this project.

Project Activities

Preliminary Design and Development

Historical and cultural inventory was completed in 2013 and 2014. MFWP developed an Environmental Assessment for restoration of the French Creek drainage, including French Gulch and Moose Creek. Soils data were collected in 2013 and 2014 to test for heavy metals including mercury, arsenic, cadmium, copper, zinc, lead, and aluminum. There were no elevated metals levels in the project area that could be attributed to placer mining. Mercury floatation, a common method of extracting placer gold, can lead to mercury contamination at or near processing areas. No evidence of significant mercury contamination was found in the sediments of French Gulch or Moose Creek. Higher arsenic levels are ubiquitous throughout the project reach and are likely a result of atmospheric deposition from the Anaconda Smelter and not placer mining. Therefore, there was no remediation measures necessary for metals in the project reaches.

Project design was carried out by Morrison-Maierle, who completed field investigations and collected survey data on the existing stream. LiDAR survey data was collected in 2013 and provided the digital terrain model for the French Gulch valley, while the Moose Creek valley was surveyed in the spring of 2014. These data were used to prioritize restoration efforts for maximum benefit and provided reference for restoration design. The basis for the design was to restore the physical dimensions of the stream and floodplain and restore vegetation communities so that appropriate natural processes can occur. The processes that this project specifically intended to restore include stream channel migration, sediment transport equilibrium (mobilization & deposition), floodplain connection, and aquatic habitat complexity. The field data collected was analyzed based on this reference reach approach and hydraulic calculations were completed on the stream survey data to design stable features in the channel and floodplain.

The restoration strategies for French Gulch and Moose Creek differed slightly due to the relative magnitude of the impacts in both creeks. The key features that required restoration in the project reaches on French Gulch were stream channel pattern and profile (alignment & slope), frequency and size of pool habitat, and relative elevation to the adjacent floodplain areas. The Moose Creek stream channel was less impaired and only required restoration for a short distance (1/4 mile). The focus in Moose Creek was re-connecting of the floodplain with much less stream channel work. Similar design drawings and details were used for all reaches with variable dimensions based on the analysis for stable features. For instance, the hydrologic analysis indicated that the lower sections of French Gulch (Reach 1) experienced a larger bankfull flow than upper sections and Moose Creek, so the channel dimensions for riffles and pools and embedment dimensions for woody features were greater in Reach 1 than elsewhere in the project.

Preliminary designs were completed for French Gulch and Moose Creek in 2014. These designs included stream alignments, floodplain construction, details, and a riparian revegetation plan and were used to assist in grant funding efforts for implementation. The preliminary design incorporated a cost-benefit approach. The key features were designed to provide for the natural processes described above and also fit into the landscape to allow economical construction. The bulk of the estimated construction cost came from earthwork such as removing fill to construct

the floodplain and channel. Because of the high costs of moving fill and because of need to preserve the historic character of the mining activities in the watershed, these plans also informed the permitting effort and coordination for construction.

In 2014 and 2015 MDT was also relocating a section of Montana Highway 569 to the east and out of the active French Creek floodplain. Engineers at Morrison-Maierle. were also involved with that project and were able to coordinate efforts between the restoration of Moose Creek and French Gulch and the highway relocation. For instance, a large box culvert was installed by MDT under the new highway to accommodate the proposed new location of the French Gulch stream channel which was approximately 200 ft from the existing crossing. This new crossing was completed before any active channel restoration work in French Gulch had commenced.

Final Design

Final design was completed in early 2016 using updated on-the-ground information and incorporating feedback from agency partners and permitting agencies. The previous design effort was expanded to provide detail on materials and dimensions of the work. Earthwork quantities for each reach were calculated to determine the quantity of excess fill material produced and how and where to dispose of it. Detailed specifications of the work and materials were prepared and included in a final project manual. The final project manual included all required information for project bidding, including state and federal guidelines, permitting, oversight, and construction. The final design (construction contract, specifications, drawings, and permits) was reviewed by internal Morrison-Maierle. principal engineers and others before final approval.

Permitting

- Army Corps of Engineers 404
- Bureau of Land Management Decision of Record and National Environmental Policy Act (NEPA)
- MFWP Environmental Assessment
- MFWP Stream Protection Act 124
- Anaconda Deer Lodge County Floodplain Permit
- MDEQ 318-401 Water Quality Permit

Construction & Oversight

The project was publicly advertised for construction bids in April 2016 and bidding procedures followed all applicable state and federal laws for publicly funded projects. Six construction bids were received from qualified bidders and the construction contract was awarded to Montana Civil Contractors with a bid less than the engineer's estimate.

Construction Notice to Proceed was issued on July 18th, 2016 and work began on French Gulch, Reach 1. Work on floodplain construction and stream channel construction in French Gulch proceeded upstream throughout the summer/fall of 2016 with frequent oversight by Morrison-Maierle personnel. The construction progress generally proceeded ahead of schedule and French Gulch construction was complete by mid-October and Moose Creek construction was complete by late October. The competitive bid price and favorable fall weather in 2016 allowed for 2

additive change orders to expand the mine tailings removal and increase riparian and wetlands area restoration. These areas were within the permitted project and did not require increased permit coordination.

In 2017, remaining project funding was allocated to expand and enhance floodplain restoration s and to augment areas where that had the potential to fail and cause significant channel changes that were observed post-runoff in summer 2017. These included adding fill to an area of dispersed camping where high water left the stream channel flowed through bare area, adding floodplain depression areas with willow cuttings, and re-grading three areas of the abandoned channel to prevent its recapture. Morrison-Maierle prepared a limited project manual and drawings to be used for contracting and construction. This construction contract work was estimated to be less than $80,000 so direct solicitation was completed for bids, ten contractors were contacted for construction bids. Most of the contractors were busy during the fall of 2017 and elected to not submit bids, but three bids were received and R & S Johnson Construction was contracted to complete the enhancement work. Enhancements in French Gulch Reaches 1, 2, 4 and in Moose Creek were completed in November 2017.

The French Gulch and Moose Creek project removed placer tailings from streamside areas of these two channels in order to re-establish natural stream meanders and create a stream system that is hydrologically connected to its floodplain and wetlands. The functional stream systems will provide sediment reductions to French Creek downstream, create a robust riparian and wetland vegetation community and create in-stream habitat conditions that support native fish populations.

A full project chronogram is summarized in **Table 9**. Example project drawings for French Gulch and Moose Creek are provided in **Figure 15** and **Figure 16** on the following page.

TABLE 9. PROJECT IMPLEMENTATION CHRONOGRAM

Project Activity	2013	2014	2015	2016-Winter/Spring	2016- Summer	2016- Fall	2017 Winter/Spring	2017 Summer	2017 Fall	2017-18 Winter
LIDAR Flight	X	X								
Preliminary Design	X	X	X							
Cultural Resource Inventory	X	X	X							
MDT Highway 569 Road Relocation			X							
Final Design			X	X						
2015 Public Tour (Before Construction)			X							
Permitting and Wetland Delineation			X	X	X					
Construction Contractor Procurement					X					
French Gulch: Habitat Improvement Structures-Reaches 2, 3, 4				X						
French Gulch: Clearing, grubbing of floodplain-Reach 1					X					
French Gulch: Road relocation					X	X				
French Gulch: Channel construction					X	X				
French Gulch: Revegetation					X	X				
Moose Creek: Tailing removal, channel reconstruction						X				
2016 Public Tour & WWAG Tour					X					
French Gulch: Revegetation							X			
French Gulch: Additional floodplain excavation and revegetation (Reaches 1,2)						X				
French Gulch: Additional placer tailing removal and plugs (Reaches 1,2,4)									X	
Moose Creek: Additional tailing removal									X	
2017 Public Tour									X	
Project Monitoring								X		
Final Project Report									X	X

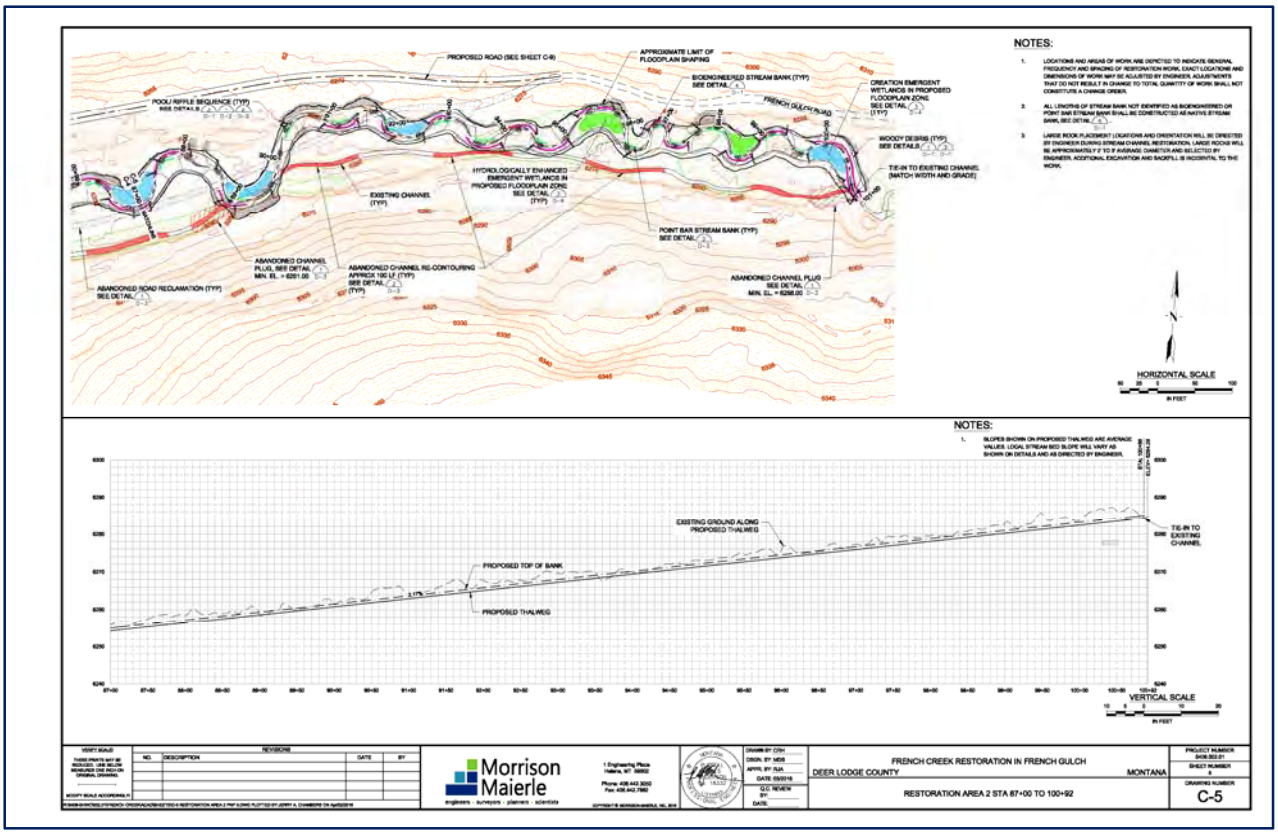


FIGURE 15. FRENCH GULCH EXAMPLE RESTORATION DESIGN SHEET

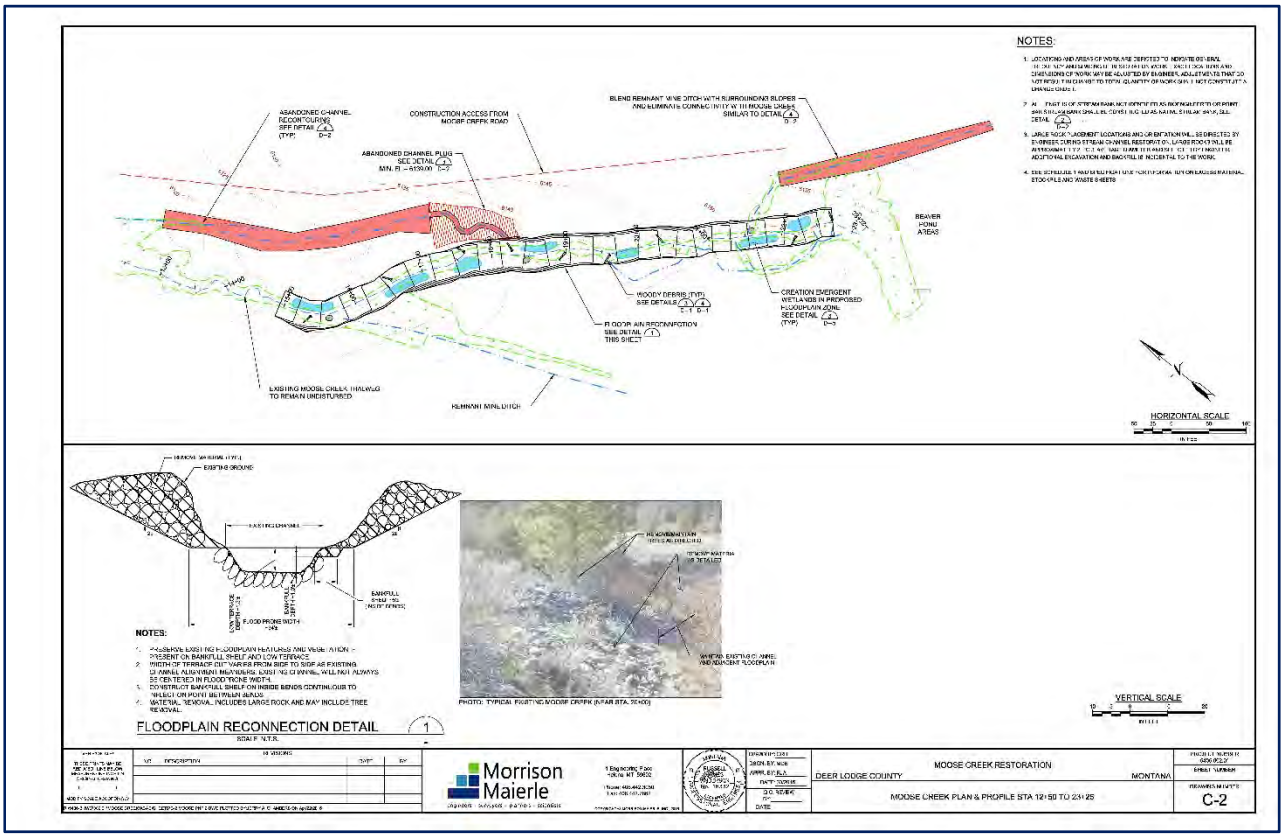


FIGURE 16. MOOSE CREEK EXAMPLE RESTORATION DESIGN SHEET

FIGURE 17. PROJECT IMPLEMENTATION PHOTOS

Morrison-Maierle pre-bid walk through on May 11, 2016 for prospective contractors

BHWC and MFWP staff and volunteers prepare willow whips for use in restoration project. Over 20 volunteers cut 10,000 whips

MFWP fish biologist explaining the project to volunteers and hauling whips

Construction equipment clearing placer piles in Reach 1. Newly created floodplain and mechanically transplanted willows in foreground

Crews install a bioengineered streambank in Reach 1

Bioengineered streambank installation in Reach 1

Contractors measure new streambed elevation during construction in Reach 1

Placer tailings being removed from Reach 1. Laser (left) and excavator (right) show height of placer piles removed from Reach 1 floodplain

Reach 1 channel construction, showing drier floodplain areas higher in the reach (left) and where groundwater was captured (right).

Channel construction at the top of Reach 1 (left) where new channel was tied into existing stream (right).

Building a bioengineered bank at the top of Reach 1.

Same location where new channel was tied into existing stream. Earthen plug installed to prevent stream from returning to old channel

A stream is born. First flows through new channel in Reach 1- August, 2016

MFWP and Montana Conservation Corps constructed 48 fish habitat structures in June, 2016 in less impaired reaches where no mechanization was present. Structures were constructed with logs harvested on site

Contractors install willow stakes along riparian area of new channel- October, 2016

Planted container stock being protected from browse in Reach 2- September, 2016

Channel construction in Moose Creek in progress, October, 2016

Project Outcomes

In August of 2017, Morrison-Maierle and the BHWC conducted monitoring of the project according to the Sampling and Analysis Plan approved by MDEQ. Each of the 5 stream reaches on French Gulch and one stream reach on Moose creek (see **Figure 9** above) were assessed and data was collected for channel morphology, in-stream substrate and habitat, and riparian vegetation. Monitoring objectives were to determine the project's overall effectiveness in reducing sediment and improving fluvial habitat, and how close it mimicked reference conditions. Sediment and stream habitat data were collected to:

- Verify that sediment impairment conditions were improved by the project
- Calculate sediment transport capacity
- Show improvement in fluvial habitat
- Confirm expected vegetation improvements

Photo points were established and aerial survey and video footage was collected with drones. In addition to the specific monitoring objectives of the project Sampling and Analysis Plan (BHWC, French Gulch and Moose Creek Restoration Project Sampling and Analysis Plan, 2016), the BHWC, with support from DNRC hydrologists, installed a flow and temperature monitoring station immediately downstream of the French Gulch project and took flow measurements in several reaches to better understand the stream systems' response to restoration activities.

Project outcomes are summarized in **Table 10**. Images of as-built construction are shown in **Figure 18**.

TABLE 10. PROJECT OUTCOMES SUMMARY

Restoration Item	French Gulch	Moose Creek	Unit
Floodplain Creation/Placer Removal	**28,250**	**2,300**	*Cubic Yards*
New Floodplain Created	**15**	**2**	*Acres*
Stream Channel Restoration	**7,157**	**254**	*Linear Feet*
Bioengineered Streambanks	**3,518**	**110**	*Linear Feet*
Abandoned Channel Conversion to Wetlands	**2,505**	**710**	*Linear Feet*
Fish migration step pools	**10**	**0**	*Individual*
Fish habitat structures	**48**	**0**	*Individual*
Planted container stock	**2,110**	**310**	*Plants*
Planted willow stakes	**12,245**	**381**	*Stakes*
Planted willow whips (brush layers)	**23,255**	**1,105**	*Whips*
Road Reconstruction	**1,101**	**0**	*Linear Feet*

FIGURE 18. PROJECT MAPS: AS-BUILT CHANNEL CONSTRUCTION AND FLOODPLAIN CREATION

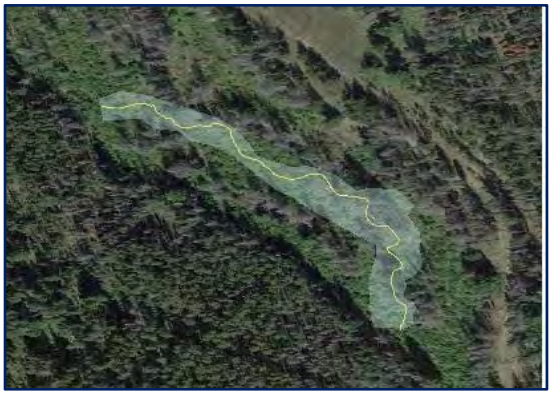
Complete Project

Reach 1

Reach 2

Reach 3&4

Reach 5



Moose Creek

Geomorphic and in-stream structures

The areas targeted for stream construction were determined in pre-project assessments to be severely impaired by placer tailings. In areas of French Gulch that were less impacted by mining and were not actively restored the instream habitat was still lacking diversity. The entire 3.5 miles of French Gulch were mined resulting in significant stream impacts. However, some areas were not severely dredged resulting in a stream channel that has been straightened and lacking in diversity, but a functional floodplain remains. In these areas it was determined in the final design that habitat improvement structures would be installed by hand to diversify the instream habitat without having any significant impacts to riparian vegetation. Non-mechanically constructed reaches were treated with a total of 48 in-stream fish habitat structures. These structures, built by Montana Conservation Corps youth crews with on-site trees, consisted primarily of log pool drop structures where a log was placed across the stream perpendicular to the flow at the stream bed elevation and keyed into streambanks. Erosion control fabric was stapled to the front face of the log and laid on the bed of the stream upstream. A pool was excavated downstream of the log and the fill removed was placed by hand on the fabric upstream of the log to prevent scour underneath. The structures aggraded the stream for 5-10 feet upstream but more importantly created scour pools downstream of the structures. As shown in **Figure 19** below taken in the spring of 2017, fish appeared to respond positively to the in-stream structures. The removal of a perched culvert at the top of the project reach in French Gulch and the installation of a step-pool natural passage structure (**Figure 20**) resulted in the restoration of fish passage to the upper drainage.

FIGURE 19. FISH SPAWNING IN TAIL-OUT OF SCOUR POOL CREATED BY A HABITAT STRUCTURE

FIGURE 20. STEP-POOL FEATURE AT TOP OF PROJECT AFTER CULVERT REMOVAL (INSET IMAGE OF CULVERT FROM 2014)

Impacts to instream conditions after reconstruction are shown more clearly from 2017 field data collected in each of the 6 stream reaches of the project area, particularly as compared to impacted reach data and reference conditions. These data are presented in **Table 11** and **Figure 21** below and images highlighting stream geomorphic responses are shown in **Figure 22**. Metrics in bold show data with most significant improvements, in other words, furthest from impacted reach and closest to reference conditions.

TABLE 11. GEOMORPHIC REACH COMPARISON*

	2014 Data Pre-Construction		2017 Data Post Construction					
Metric	Priority 1 (impacted)	Reference	French Gulch Reach 1	French Gulch Reach 2	French Gulch Reach 3	French Gulch Reach 4	French Gulch Reach 5	Moose Creek
Gradient (ft/ft)	0.0225	0.0176	0.020	0.017	0.024	0.023	0.029	0.032
Sinuosity (ft/ft)	1.14	1.50	1.29	1.54	1.31	1.64	1.29	1.39
Bankfull Width(ft)	7.9	5.9	7.46	8.86	6.89	4.91	5.80	5.21
Floodprone Width (ft)	**22**	**53**	**83.00**	**52.00**	**59.00**	**90.00**	**65.00**	**86.00**
Entrenchment Ratio (ft)	**2.20**	**4.84**	**11.13**	**5.87**	**8.56**	**18.33**	**11.21**	**16.51**
W/D Ratio (ft)	21.3	20.7	8.78	8.60	7.92	4.81	6.44	4.96
Pools (%)	**12.0**	**50.5**	**35.0**	**50.0**	**33.8**	**21.8**	**32.5**	**31.0**
Res. Pool Depth (ft)	0.50	0.63	0.35	0.48	0.40	0.43	0.55	0.36
Pool Length (ft)	**6.0**	**13.6**	**9.9**	**11.9**	**10.3**	**16.6**	**10.2**	**6.4**
Pool-Pool Spacing (ft)	40.0	29.1	18.2	12.2	19.3	50.3	22.1	12.4
Radius (ft)	**90.1**	**13.9**	**12.3**	**15.5**	**15.3**	**14.3**	**9.7**	**12.8**
Meander Length (ft)	**223.7**	**49.0**	**73.0**	**85.7**	**47.5**	**83.0**	**62.3**	**71.0**
Belt Width (ft)	**41.2**	**88.3**	**72.0**	**74.0**	**58.0**	**74.0**	**72.0**	**39.0**
Pool Tail Fines <6 mm (%)	NA	NA	26%	28%	25%	25%	32%	12%
Substrate D_{15} (mm)	1.0	2.6	7.1	4.1	0.8	1.6	1.8	4.8
Substrate D_{50} (mm)	**17.3**	**25.8**	**26.3**	**15.0**	**25.2**	**29.8**	**29.5**	**39.9**
Substrate D_{84} (mm)	85.3	82.2	48.2	48.9	50.0	61.6	72.3	79.8
Large Woody Debris (#/100 ft)	1	4	1	2	1	4	3	0

*Note: Average values used for comparison

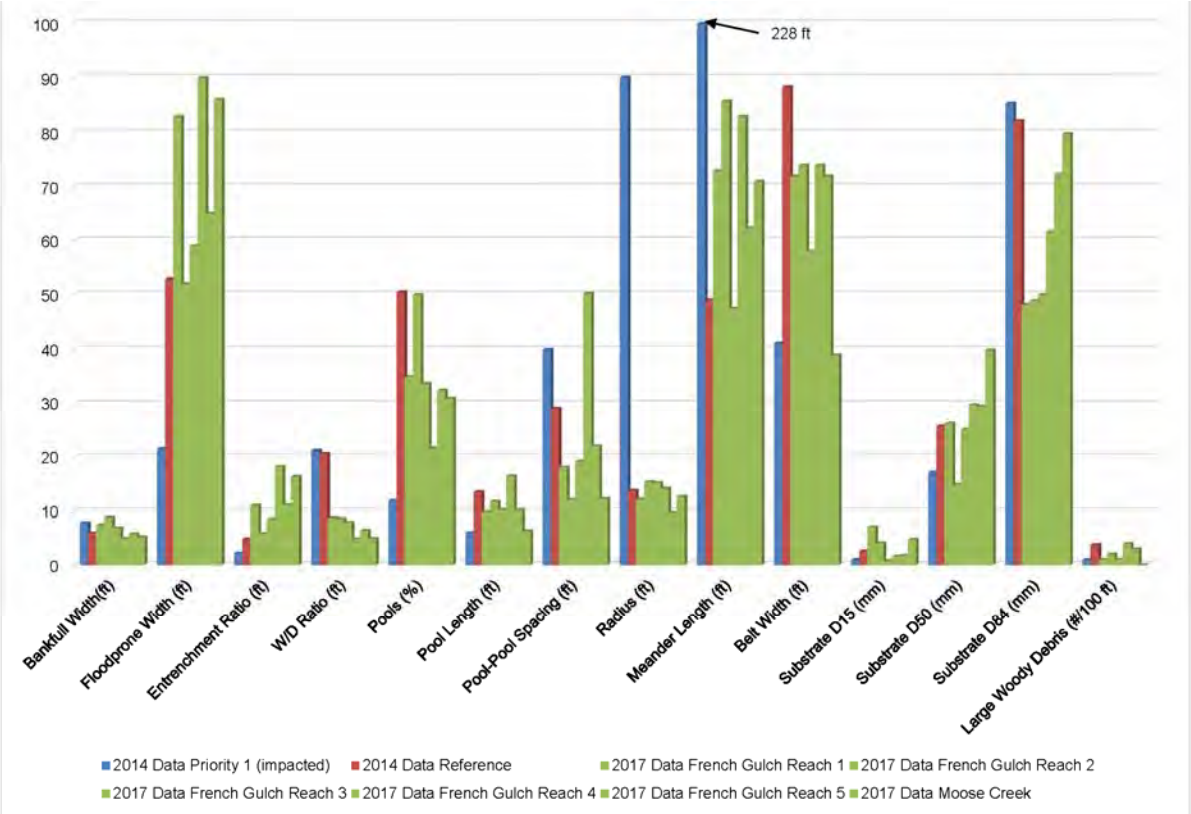


FIGURE 21. GEOMORPHIC DATA COMPARISON AND TREND

It should be noted that a single year of data collection will not represent the long-term success of the restoration effort. Many of the processes this project aims to restore will take several years or longer to reach a state of equilibrium. The runoff in water year 2017 was prolonged and it appears that flows greater than bankfull occurred through mid-June based on preliminary data from a flow logger in French Creek. Although the channel will continue to adjust over the next few years what is notable is the trend of 2017 monitoring data. Most of the data collected indicates a trend towards the reference conditions. As the vegetation becomes more established and sediment mobility moderated, it is expected, based on the 2017 trends, that the substrate and aquatic habitat will become similar to the reference conditions. Substrate composition also dependent on upstream influx of sediment which could change over time with land use practices or further restoration efforts upstream. Some features, primarily related floodplain access, show direct improvement from the constructed project. These will set the stage for the more process-based features like vegetation and substrate to recover over time.

Flow data was collected several times during the 2017 water year and a data logger collected flow and depth data through late July just downstream of the Highway 569 culvert. There are not enough stage-discharge data points yet for a reliable correlation but it appears likely that flows drop into the 1-2 cfs range beginning in late July. With the increased floodplain connection and high flow attenuation it could be expected for base flow quantity to increase and temperature to decrease. The decrease in temperature could come about from increase groundwater connection to base flow. More data from the logger over the next few years will add more understanding of the project's effect on base flow.

FIGURE 22. PHOTOS OF CHANNEL AND FLOODPLAIN RESPONSE

Point bar and floodplain inundation area clearly developing by mid-August, 2017

Point bar formation in mid-August, 2017 on constructed channel in Reach 2

New sediment deposition on inside meander bend, August, 2017 in Reach 1 demonstrate connection between floodplain and stream channel, point bar formation and positive vegetation response. Also noteworthy is decreasing substrate size as channel loses energy

Reach 3 constructed channel section shown in August, 2017 photo. Willow stake in the circle had been planted on a bank, demonstrating channel deformity occurring, as planned

Reach 5 constructed channel showing stream movement onto the floodplain in August, 2017 image. Netted plants denote location of constructed bank in 2016

Example of an inundation feature constructed in the floodplain functioning as designed in this image from May, 2017

Pre-construction conditions in Reach 1, July, 2015 – tree and red line show ground level at top of placer tailings before construction

Beginning of floodplain construction and placer tailing removal, August, 2016

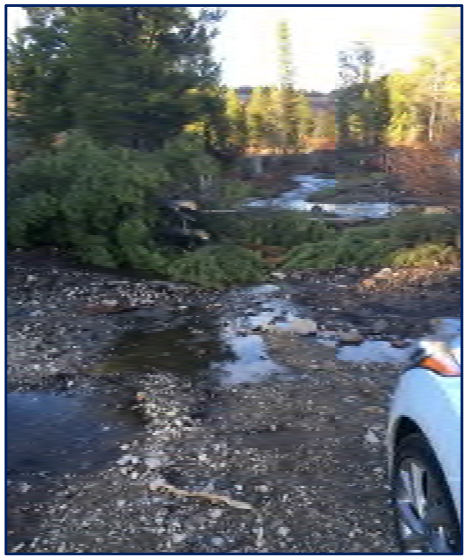
Lower Reach 1 Before/After photos: July, 2016 pre-project (left); August, 2016 (center); May, 2017 (right)

Lower Reach 1 Before/After photos. Arrow shows tailings removal added to construction from original design: August, 2016 (left); October 2016 (center); May 2017 (right)

Reach 1 shown in May, 2017 with flowing water across the floodplain

Upper section of Reach 1in May 2017showing active floodplain wetlands

Reach 1 in October 2017, even late in the season, water is plentiful in lower section of the channel



Overbank flows accessed staging/parking area in Reach 2 in May, 2017 (left) prompting additional work to be implemented in November, 2017 to add over 2 feet of material to the floodplain (right)

Finished floodplain protection plug shown in November, 2017

Vegetation

The goal of the French Gulch and Moose Creek Project was to create conditions for a functional stream system and riparian vegetation community. Upon excavation of the placer tailings and creation of a meandering stream hydrologically connected to its floodplain, those conditions were quickly established. Spring 2017, the first spring after construction, the stream overtopped its banks throughout the project area as designed. Depressions and a roughened floodplain surface dressed with woody debris established a mosaic of floodplain habitat conditions, new wetlands and microtopography ideal for natural revegetation to occur. The removal of conifers from the floodplain opened the canopy for aspen groves to expand and willow, birch, dogwood and other riparian species to establish.

Floodplain clearing and grubbing included salvage of mature willow plants and sod mats and transplanting them into the new floodplain (not quantified). Vegetation was also enhanced with planting of container stock as shown in **Table 12**.

TABLE 12. CONTAINER STOCK PLANTED

Plant Name	Container Size	Moose Creek	French Gulch
		# of plants	
White alder	10T "Plug Stock"	200	1200
Water birch	One Gallon	36	--
Red osier dogwood	One Gallon	36	--
Geyer willow	One Gallon	--	465
Drummond willow	One Gallon	49	445
Total		**321**	**2110**

Vegetation on the landscape was also greatly enhanced by a large number of willow stakes and whips used in stream construction (**Table 13**). Rough estimates were made of willow stake survival while walking the project reaches, and showed an estimated 80% survival after the first season of growth. The least successful vegetative response in the project was the willow whips used inside the bioengineered bank structures; particularly in the earliest-constructed bank. The earth supporting the bioengineered banks settled after installation of the willow whips, leaving several banks with willow underwater. Sustained high flows inundated the willow whips and prevented their establishment in numerous places. Fortunately, these banks and the coir fabric remained intact and functional. Foreseeing this potential issue, BHWC directed contractors to install willow stakes onto the bioengineered banks with the poorest willow whip survival.

TABLE 13. ON-SITE USE OF WILLOW PLANTS				
	Mature Willow Transplants (Linear Feet of Stream)	**Mature Willow Transplants (# Plants)**	**Willow Pole Plantings (# Stakes)**	**Willow Brush Layer (# Stakes)**
Reach 1	3686	18	2765	6350
Reach 2	8552	43	6414	11665
Reach 3	2600	13	300	970
Reach 4			1650	2225
Reach 5	1488	7	1116	2045
French Gulch	**16,326**	**81**	**12,245**	**23,255**
Moose Creek	**2060**	**10**	**381**	**1105**

Three seed mixes were applied in the project area (**Table 14**). Different mixes were developed for emergent wetland, streambank and upland project zones (**Table 15)** were targeted to the following locations:

- Road above the gate to the former culvert site.
- 60 yards of uphill road on the far side of the former culvert site.
- Roadside to creek access routes. Extra seeding on the steep/ slashed slopes.
- Roadside disturbed areas
- All stream corridor disturbed areas from the culvert to the highway.
- All disturbed areas downstream of the highway
- All disturbed areas along the highway, from Moose Creek road intersection North to about 40 yards past the new culvert under the highway.
- Special emphasis on the old culvert area and the new culvert area.
- Entire lower access route from main Moose Creek Road to Moose Creek
- All disturbed areas along Moose up to the beaver ponds

TABLE 14. SEED APPLICATION				
	French Gulch		**Moose Creek**	
Seed Mix	**Lbs PLS**	**Treated Area (acres)**	**Lbs PLS**	**Treated Area (acres)**
Emergent Wetland	17.9	1.2	2.1	0.1
Streambank Zone	6.4	0.3	2.8	0.1
Upland	165.2	5.5	24.2	0.8
Total	**189.5**	**7.0**	**26.1**	**1.0**

TABLE 15. SEED MIXES

CREATION EMERGENT WETLAND SEED MIX		20	Lbs
Genus	**Species**	**Common Name**	**% of Mix**
Beckmannia	syzigachne	American Sloughgrass	3%
Bromus	ciliatus	fringed brome	29%
Calamagrostis	canadensis	blue joint reed grass	4%
Deschampsia	cespitosa	tufted hairgrass	11%
Eleocharis	palustris	creeping spikerush	5%
Glyceria	grandis	fowl mannagrass	5%
Juncus	effusus	common rush	1%
Elymus	trachycaulus ssp, trachycaulus	slender wheatgrass	40%
Poa	palustris	fowl bluegrass	2%
TOTAL			**100%**

STREAMBANK ZONE MIX		9.2	Lbs.
Genus	**Species**	**Common Name**	**% of Mix**
Bromus	ciliatus	fringed brome	22%
Calamagrostis	canadensis	blue joint reed grass	4%
Deschampsia	cespitosa	tufted hairgrass	9%
Elymus	trachycaulus ssp, trachycaulus	slender wheatgrass	28%
Elymus	canadensis	Canada Wildrye	35%
Juncus	balticus	Baltic Rush	1%
Poa	compressa	Canada bluegrass	2%
TOTAL			**101%**

UPLAND ZONE SEED MIX		189.2	Lbs.
Genus	**Species**	**Common Name**	**% of Mix**
Deschampsia	cespitosa	tufted hairgrass	3%
Ericameria	nauseosa	Rubber Rabbitbrush	1%
Elymus	lanceolatus ssp. Lanceolatus	Thickspike wheatgrass	8%
Elymus	glaucus	Blue wildrye	17%
Elymus	trachycaulus ssp, trachycaulus	slender wheatgrass	25%
Festuca	idahoensis	Idaho fescue	6%
Leymus	cinereus	Great Basin Wildrye	7%
Triticum aestivum x Secale cereale		Cert. Tyndall Spring tricale	33%
TOTAL			100%

Greenline Assessment

An assessment of vegetation conditions along the newly constructed stream was conducted in August, 2017 in the monitoring reaches shown above in **Figure 9**. The Greenline assessment outlined in the approved Sampling and Analysis Plan established a baseline post-construction snapshot of vegetation cover (BHWC, French Gulch and Moose Creek Restoration Project Sampling and Analysis Plan, 2016). Predictably, a high percentage of the ground cover was on bare/disturbed ground as a result of the recent construction. Nearly half (43%) of the occurrence of bare ground cover landed on coir fabric as part of treated streambank structures. Also, predictably, there was minimal (< 1%) overstory cover. An important data point from this assessment is the average width of the riparian buffer post-construction. These numbers compare to highly incised channel pre-construction with riparian widths of typically less than 10 feet. Greenline assessment summary results are provided in **Table 16.** Photos of vegetation responses to the project are shown in **Figure 23**.

TABLE 16. RIPARIAN GREENLINE DATA RESULTS

Reach	Cell	Understory Shrubs Cover (%)	Ground Cover (%)				Mean Riparian Width (Feet)
			Bare/Disturbed*	Wetland	Grass	Rock	
M1	1	25	45	25	5	25	75
M2	2	20	55	20	10	15	100
M3	3	0	25	10	10	15	30
Moose Creek (average values)		**15**	**42**	**14**	**6**	**14**	**68**
FG1-1	1	0	50	10	0	40	63
FG1-2	2	0	50	10	10	30	35
FG1-3	3	10	35	10	20	35	38
FG2-1	1	0	10	30	25	25	24
FG2-2	2	10	45	5	40	10	28
FG2-3	3	5	40	10	40	10	45
FG3-1	1	20	20	35	45	0	16
FG3-2	2	5	55	10	5	30	30
FG4-1	1	10	15	45	25	15	45
FG4-2	2	5	35	25	20	20	55
FG4-3	3	0	50	15	25	10	40
FG5-1	1	5	25	45	25	10	40
FG5-2	2	15	5	65	30	5	50
FG5-3	3	20	25	40	20	15	13
French Gulch (average values)		**8**	**33***	**18**	**17**	**13**	**37**

** 43% of bare ground occurrences were on coir fabric- bioengineered banks*

FIGURE 23. PHOTOS OF VEGETATION RESPONSE

Transplanted sedge mats mostly all took and began recolonizing the site in this August, 2017 image

Planted willow thriving and nearly out of its plant protector in August, 2017

Good survival of willow stakes in the new floodplain seen in this August, 2017 image from Reach 4

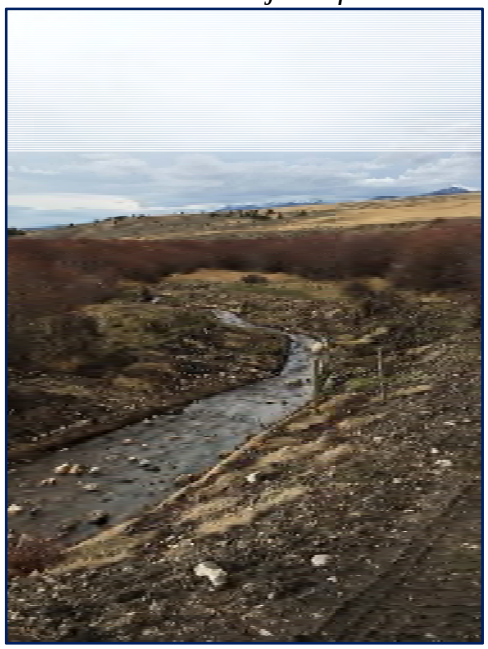
Good survival of willow whips on constructed banks from this August, 2017 image in Reach 5

Good survival of willow whips on constructed bank and sedge mats on opposite bank

Buds set for winter on transplanted willow, September, 2016. Transplanted sod mats thriving in background

Reach 3 stream construction section just after construction in September 2016 (left) and in August 2017 (right)

Reach 5 stream construction just after construction in September 2016 (left) and following planting in October 2016 (right)



Reach 1 downstream of box culvert shows good survival of sod mat transplants between October 2016 (left) and October 2017 (right)

Sediment Load Reduction

The reduction of sediment to French Creek from this project was estimated by comparing the mobile particle sizes at bankfull flow between the pre-restoration data collected in the original stream channel and the same measurements made in 2017 of the newly constructed channel using the critical shear stress estimation method and the Colorado Curve data (Rosgen, Applied River Morphology, 1996). The restored stream channel produces a lower stress with decreased slope and improved floodplain access. The decrease of about 72-77% in mobile particle size results in a reduction of approximately 448 tons/year of sediment **(Table 17**) based on estimate methods described in the approved Sampling and Analysis Plan (BHWC, French Gulch and Moose Creek Restoration Project Sampling and Analysis Plan, 2016), which posited that prior to restoration, sediment was blasted through the French Gulch system, and was not deposited in point bars, pool tailouts and the floodplain.

Additional sediment load reductions from roads were also achieved by this project in concert with MDT project activities in 2015. Road-related sediment is recommended to be reduced by 6.84 tons/year in the TMDL. With the removal of over 2 miles of highway from the valley bottom along French Creek, and the removal of over 1000 feet of road from the French Gulch valley bottom, the majority of road-related sediment sources in the French Creek system have been removed and the target reduction for road sediment should be considered achieved.

TABLE 17. SEDIMENT MOBILITY REDUCTION ESTIMATES

	French Gulch					
	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Moose Creek
Existing Shear Stress (psf)	0.81	0.92	1.15	1.15	1.41	1.62
Post Shear Stress (psf)	0.65	0.50	0.67	0.91	1.11	1.05
Existing Mobile Particle (mm)	130.19	142.98	168.48	168.48	195.73	217.01
Post Mobile Particle (mm)	110.51	91.91	112.88	142.35	164.61	157.36
Reduction Ratio	0.849	0.643	0.670	0.845	0.841	0.725
Average Reduction Ratio	0.770					0.725
Existing Sediment Volume (tons/year)	1201					622
Post Sediment Volume (tons/year)	924					451
Total Estimated Sediment Load Reduction (tons/year)	**448**					
Additional Recommended Road-related sediment reduction to French Creek (tons/year)	**7**					

Demonstrate improvements in floodplain connectivity in incised reaches

The removal of placer tailings, and the stream channel design ensured the stream would have access to its floodplain at a regular interval. The streambank height was set at predicted bankfull elevations for specific project reaches. The first year after the majority of the construction, 2017, proved to be a good test for the system as high flows reached 26 cfs in June. Photographs of the project site in **Figure 22** demonstrate enhanced floodplain function resulting from the work. Aerial survey drone produced overhead images of specific project locations that are Google-earth compatible ortho-mosaics from July 2016, August 2016 and November 2016 (see below).

French Gulch Reach 1

July 2016

May 2017

French Gulch Reach 1

July 2016

May 2017

French Gulch Reach 1

July 2016

May 2017

French Gulch Reach 2

July 2016

November 2016

Project Outreach

Documentation

Documenting project implementation used a variety of platforms and tools. Photographs were taken at all stages of project implementation as well as pre-project walk-throughs and scoping visits. Permanent photo locations were established with metal T-posts in every project reach and these photo locations and images were provided to project partners. Other tools, such as time-lapse photography and two different drone platforms, were used to demonstrate their potential to add value to restoration the documentation of the project.

In 2016 field cameras were set to capture images and video at specified time intervals and attached to stakes which were pounded into the ground to continuously document project construction activities. These cameras captured a series of both still images and videos. Still images were then stitched together in a video editor to show construction progress over time.

Two different drone monitoring platforms were also used during the project. This includes the eBee platform, a survey-grade drone that produces geo-referenced orthomosaic images and a Google-Earth compatible files (KML). Images were collected in July, August and November of 2016. The Phantom IV video drone platform was also used to capture high-resolution videos. Videos using this platform were captured in May, July, August of 2016 and November of 2017.

Public Tours of Project

August 2015 (Before Project)

June, 2016

September, 2017

Newsletters, Online Content

Newsletters – BHWC newsletters, twice per year

You Tube Channel – Drone footage and project videos shared publicly.

Presentations

BHWC Meetings, three presentations provided at meetings, and updates provided monthly.

Association of Montana Floodplain Managers presentation, 2016 in Missoula

Western Division American Fisheries Society presentation, 2017 in Missoula

Press

Montana Standard

Montana Outdoor Report

Awards

American Council of Engineering Companies of Montana, 2018 Honor Award, Environmental Category

Conclusions

The French Gulch and Moose Creek Restoration Project accomplished the following:

Over 17 acres of floodplain/wetlands created
Over 30,000 cubic yards (810,000 cubic feet) of mine tailings removed from floodplain
A new stream channel length over 7,400 feet with pools, woody debris habitat, and bioengineered willow lifts. That's 1800 more feet compared to before!
3,215 linear feet of past channel now converted to new wetlands
48 fish habitat structures installed
More than 1,000 feet of road reconstructed
Increased sinuosity over 30%
Over 200 pounds of wetland seed broadcast
Over 2,200 riparian container plants installed
Thousands of willow stakes in new floodplain.
$1,195,710.45 invested in restoration

Many Hands, Many Minds Made It Happen

The project was developed and implemented with many people and groups, meeting many needs and goals at once. The design elements and project goals primarily met the interests for fish and wildlife habitat from MFWP and water quality and quantity interest of BHWC. The wide range of funding sources drove many of the design, implementation and review as well to meet the directives and needs of the funding sources. The partnerships involved, including the landowners of MFWP and BLM, the project management of BHWC as well as the many stakeholders BHWC represents in the Big Hole, and local communicates and agencies involved all added to the project with their involvement – adding pieces of funding, history, insight, and support.

The Value of Oversight

The professional oversight from Morrison-Maierle. from the design and initial project development, supporting funding requests, final design, soliciting bids, construction, monitoring, and overall support to BHWC to manage the project was invaluable. This was an additional cost that in some projects is seen as an unnecessary or high cost that could be avoided. Their service and professionalism during this project was integral to project success.

Watershed Group Hub

The BHWC served as the project lead for this work, pulling in the needs of the partners involved, funding sources and contracts, hosting contracts for work, compiling results, tracking funds, and being the central resource. This role was key in accomplishing restoration work and the project scope grew and funding sources became more diverse and complex. While the project was directed and supported by many partners, contractors, and funders, it all was compiled in one location through the BHWC. BHWC was able to gain local community buy in and participation while at the same time balancing the needs of the landowner and funding agencies. This model wide ranging model made some transactions complicated, particularly in the funding realm. However, in looking at the entire project, this model both works, makes sense, and helps build and sustain future conservation.

Adding to the Cumulative Effect

One project certainly cannot resolve all water quality and quantity problems for the Big Hole River. However, all projects that restore natural processes by naturally storing water in functional floodplains, wetlands and streams add to improved water quantity. Reduced water temperatures with flows later in the season and shaded with riparian vegetation, reduce sediment loads by removing impairment sources and improve habitat cumulatively add to the improvement of water quality. These projects together help alleviate high water temperature, low late season water flows, and help improve water quality for the Big Hole River sustainably and long into the future. This project adds to the cumulative impact of improved conditions for the Big Hole River.

Go Big, Go Home

The French Gulch and Moose Creek projects were of such magnitude and scale that additional work is not anticipated in the future within the project areas. The work was comprehensive, addressing all habitat and ecosystem needs in one effort and on a large scale. Conservation operating at this level is cost effective – work is only designed, planned, mobilized and implemented once and the results are of great impact to the watershed.

Mount Haggin Future

Several restoration projects are in the works in the Deep and French Creek drainages, several of which restore the impacts of historic mining. The work will continue to utilize the same philosophies – integrate partnerships for support and funding and incorporate a wide range of ecological objectives to maximize the projects benefits. Specifically, NRDP will continue to lead work in the upper areas of the WMA for Smelter impacts, MFWP will lead the French Creek Barrier potential installation, and BHWC will solicit work for the restoration of French Creek downstream of French Gulch. Additional work is also proposed on Oregon Creek and the upper areas of French Gulch (upstream of the project area in this report).

Project File

A project file compiled critical documents for this project. Additional data and files reside with BHWC to support the project.

Project Coordination

- BHWC contracts, Invoices
- MFWP Landowner Agreement

Construction Bid Package and Process

Sampling & Analysis Plan

Data Sheets

Photos and Photo Points

Drone Footage

Design Development

- Project Area Cultural Inventory
- Soil analysis for metals

Project Design, Construction Oversight

- Morrison-Maierle. Invoices
- Morrison-Maierle. Construction Closeout Report 2016

Permits

- Army Corps of Engineers 404
- Bureau of Land Management Decision of Record and NEPA
- MFWP Environmental Assessment
- Anaconda Deer Lodge County Floodplain Permit
- MDEQ 318-401 Water Quality Permit

Construction & Implementation

- Montana Civil Contractors Contract, Notices, and Invoices
- Watershed Consulting Contract, Invoices
- RS Johnson Contract, Invoices

French Gulch and Moose Creek Engineer Closeout Drawings

Funder Contracts

- Montana Department of Environmental Quality 319 Contract 216003
- Montana Department of Natural Resources & Conservation RDGP: French Gulch
- Montana Department of Natural Resources & Conservation RDGP: Moose Creek

Outreach and Publicity

- Press
- BHWC Newsletters
- Photos, video and drone footage

Works Cited

BHWC. (2013). *Big Hole River Watershed Restoration Plan Part II: Middle-Lower Big Hole River.* Divide, MT: Big Hole Watershed Committee.

BHWC. (2016). *French Gulch and Moose Creek Restoration Project Sampling and Analysis Plan.* Divide, MT: Big Hole Watershed Committee.

Boccadori, V. (2017). *History of Mount Haggin, BHWC 2017 Mount Haggin Project Tour.* Butte, MT: Montana Fish, Wildlife and Parks.

Ellis, J. a. (2003). *A Planning Guide for Protecting Montana's Wetlands and Riparian Area.* Helena, MT: Montana Audubon, Montana Watercourse and Department of Environmental Quality.

Ferguson, D. (2013). *A Class III Cultural Resource Inventory and Assessment of the Proposed French Gulch Streambed Rehabilitation Project on the Mount Haggin Wildlife Management Area Deer Lodge County, Montana.* Butte, MT: GCM Services.

Lindeburg, M. (2014). *Civil Engineering Reference Manual for the PE Exam Fourteenth Edition.* Belmont, CA.: Professional Publications Inc.

MDEQ. (2009). *Middle and Lower Big Hole Planning Area TMDLs and Water Quality Improvement Plan.M03-TMDL-02A.* Helena, MT: Montana Department of Environmental Quality.

MDEQ. (2012). *Montana Nonpoint Source Management Plan.* Helena, Montana: Department of Environmental Quality Watershed Protection Section.

Rosgen, D. L. (1996). *Applied River Morphology.* Pagosa Springs, CO: Wildland Hydrology Books.

Rosgen, D. L. (1997). A Geomorphological Approach to Restoration of Incised Rivers. *Proceedings of the Conference on Management of Landscapes Disturbed by Channel Incision.*

USFWS. (2003). *Daubenmire method.* US Fish & Wildlife Service: http://fire.r9.fws.gov/ifcc/monitor/RefGuide/daubenmire_method.htm. Accessed 02.15.15.