UPPER OREGON CREEK RESTORATION PROJECT MONITORING PLAN

March 2022




Prepared for:

MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY (DEQ)

Prepared by:

BIG HOLE WATERSHED COMMITTEE

Conservation Through Consensus.

APPROVALS

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Table of Abbreviations

BDA	Beaver Dam Analog
BMP	Best Management Practice
BHWC	Big Hole Watershed Committee
MFWP	Montana Fish, Wildlife and Parks
TMDL	Total Maximum Daily Load
UAS	Unmanned Aerial Survey
WMA	Wildlife Management Area
WRP	Watershed Restoration Plan

Background

Oregon Creek is a headwater tributary to the Big Hole River on the Continental Divide (Big Hole River< Deep Creek<French Creek<California Creek<Oregon Creek) and is within the state-owned Mount Haggin Wildlife Management Area (WMA). The area has an extensive history of mining related disturbance. Aerial emissions from smelting activities in Anaconda deposited heavy metals (e.g., Copper, Arsenic, Cadmium, Lead and Zinc) on nearby mountains that killed upland vegetation and, together with intensive logging to fuel the smelters, removed a vast majority of the vegetation community from the upper extents of the WMA. Devoid of vegetation, large areas developed extensive networks of rills and large gullies during heavy rain events, most severely in areas with geologic parent material of highly erodible volcanic tuff. These erosive processes persist on 25 acres of uplands in the upper reaches of Oregon Creek, contributing annual plumes of fine sediment into the creek and eventually into the Big Hole River. These acres were purchased by Montana Fish, Wildlife and Parks (MFWP) in 2020 and added to the WMA.

The Upper Oregon Creek Restoration Project was developed to address both upland sediment sources and enhancement of riparian areas impacted by upland sediment plumes.

The Big Hole Watershed Committee (BHWC) was awarded 319 project funding ($89,000) by the Montana Department of Environmental Quality to address both upland erosion and improve riparian habitat in the headwater reaches of Oregon Creek in order to retore water quality.

Regulatory Framework

Oregon Creek (MT41D003_080) is listed by Montana Department of Environmental Quality as impaired for sedimentation/siltation, Arsenic, Copper, Lead, anthropogenic/physical substrate alterations, and alterations in streamside cover. This area is the highest priority watershed in the BHWC Middle/Lower Big Hole WRP and this upper Oregon Creek sediment source is the last known major source of sediment to the system. The BHWC and partners have invested significant effort in restoring this basin, successfully completing projects on 5 creeks of the French Creek drainage.

This project addresses the sediment priority concerns identified in the TMDL and other guiding documents for this area. The project will reduce metals loading to Oregon Creek by stabilizing the sediment delivery balance in the drainage, though reduction in metals is not a primary objective of this project. Ongoing water sampling is being conducted by Pioneer Technical Services under contract with the Natural Resources Damage Program at a location on California Creek downstream of the confluence with Oregon Creek. Since 2019, no water samples have exceeded chronic water quality standards for metals. Monitoring at this location will be ongoing and overseen by the .

Project Location

Oregon Creek is a headwater tributary of California Creek, which flows into French Creek, and then into Deep Creek, which then feeds into the Big Hole River upstream of Dickie Bridge. The Upper Oregon Creek Restoration Project is located in Deer Lodge County, Montana, approximately 12 miles southwest of the city of Anaconda (**Figure 1**). The project site is located on MFWP property within the Mount Haggin WMA, an area that experienced heavy mining and logging pressure from the mid-1800s to the mid-1900s. The area is bounded by the Beaverhead-Deer Lodge National Forests. The latitude and longitude of the upper extent of the project is 46.0180, -113.0105. The latitude and longitude of the lower extent of the project is 45.9988, -112.9980.

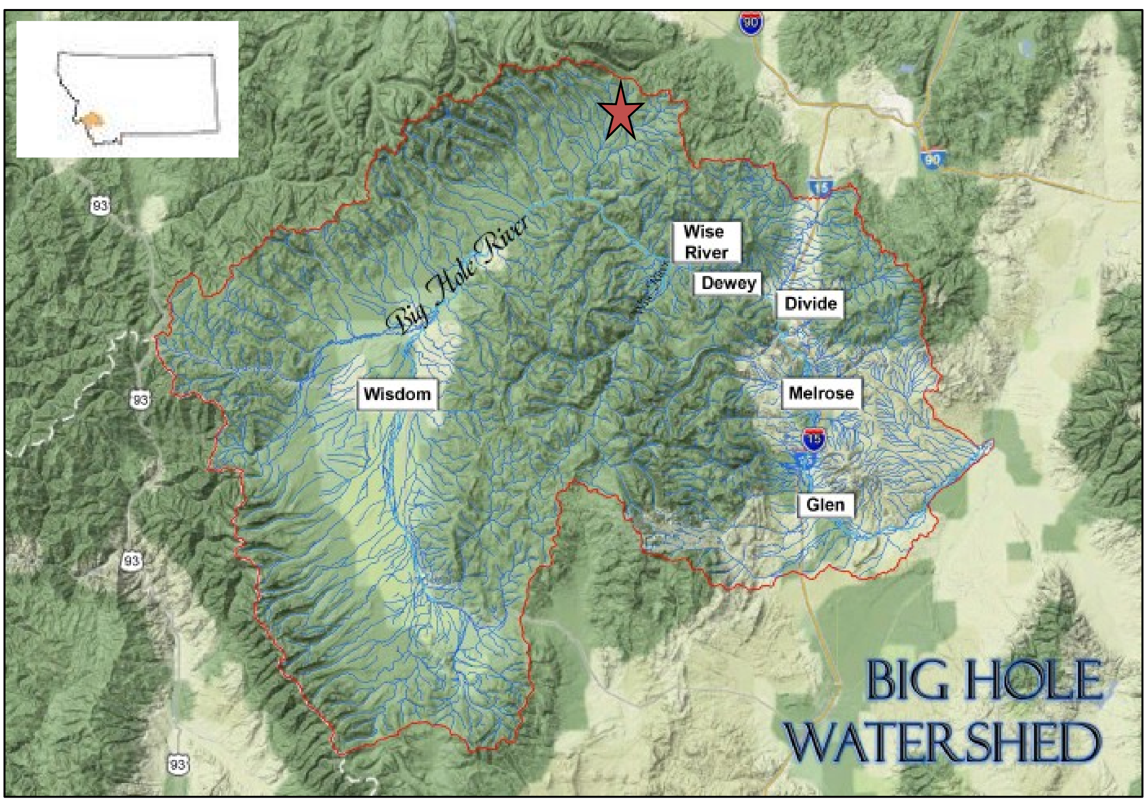

Figure 1. Project site location.

The project consists of three distinct restoration approaches and areas (**Figure 2**).

1. Establish vegetation on 25 acres of upland slopes to prevent sheet erosion (red polygons).
    a. Apply native seed mix and slow-release organic fertilizer (Sustane 8-2-4) by helicopter and hand.
    b. Apply soil scarification and trenching techniques with the use of coconut coir erosion fabric, fastened with stakes and nearby woody debris (i.e., coir “band-aids”).
2. Detain sediment in 15 active gully networks (within red polygons).
    a. Install gully check dams and gully slash filters to capture eroding upland sediment.
    b. Utilize MFWP’s Upper Oregon Aspen Enhancement project’s surplus slash material to fill gullies (mechanically and by hand).
3. Capture sediment on the floodplain and in the stream channel (orange reaches.)
    a. Install in stream check structures (beaver dam analog (BDA)/beavery mimicry structures) to aggrade the stream bed and restore stream function and dynamics.
4. Reconnect 11 acres of floodplain to surface water (pink polygon).
    a. Implement 1,126 feet of “stage 0” cut and fill to restore stream function and dynamics.

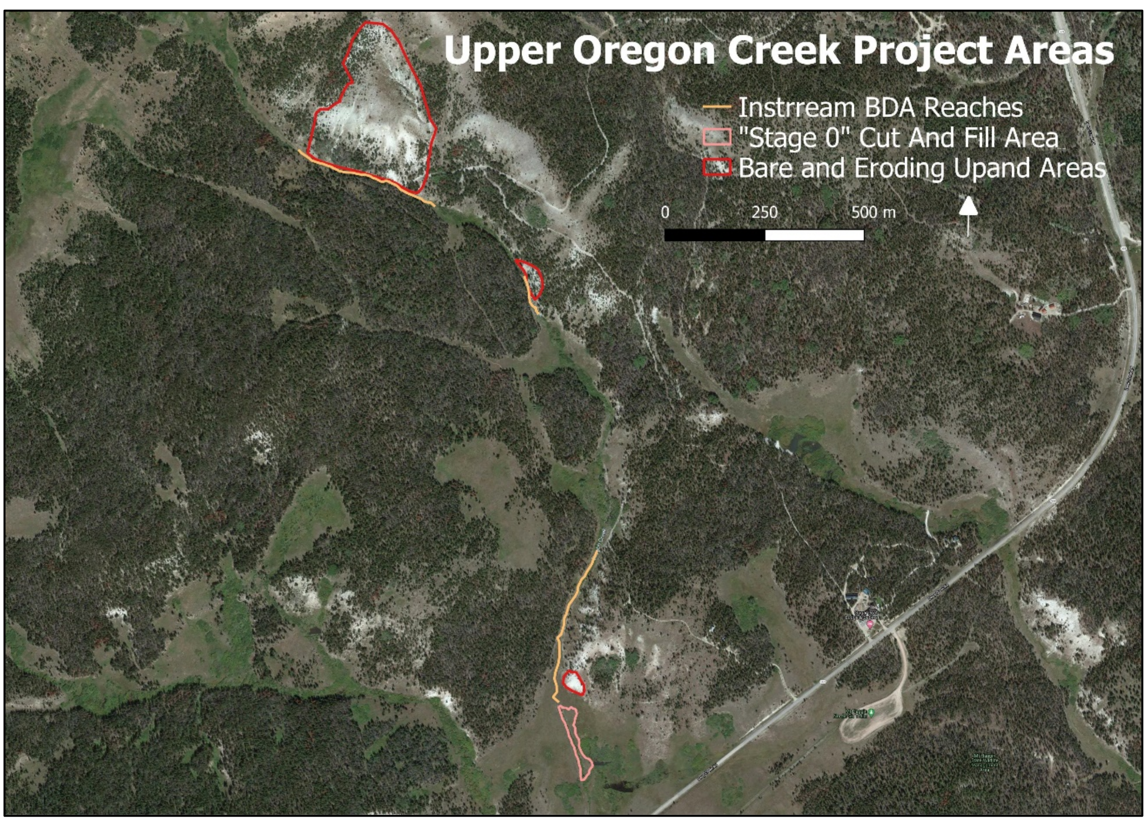

Figure 2. Project reaches and areas.

Uplands Existing Conditions

Figure 3. Existing upland conditions above upper Oregon Creek. Note the formation of rills that form large gullies

Aerial emissions from smelting activities in Anaconda deposited sulphur/sulfur dioxide (SO_2) as well as heavy metals (Copper, Arsenic, Cadmium, among others) on nearby mountains. These emissions killed upland vegetation and, together with intensive logging to fuel the smelters, removed a vast majority of the vegetation community from the upper extents of the Mount Haggin WMA near the continental divide. Devoid of vegetation, these areas developed networks of rills during heavy rain events that transport sediment unimpeded down slope. Rills come together carving out gullies, that in most cases, have cut down 15-20 feet. Once sediment enters these gullies, they progress quickly down gradient. The degree of erosion in the uplands correlates strongly to slope and aspect, but most importantly, parent material. The areas of concern of this project are slopes and gullies where volcanic welded tuff is the main parent material. In these areas, the O and A soil horizons are gone, washed away most likely in the early 1900s following intensive logging and vegetative die-off from smelter emissions. The mineral soil that is left, likely a B3 soil horizon, is essentially welded tuff being broken down slowly by the elements. These soils typically have a sandy-loam texture.

Since the closing of the Anaconda Smelter in 1980 and the cessation of aerial emissions, natural regeneration has increased substantially in the uplands, particularly in the last 20 years, as seed sources from forested areas have begun expanding into the bare areas. However, where welded volcanic tuff is the dominant geologic mineral component, natural vegetation has been slow to re-establish. The welded tuff material is friable, with very low levels of basic plant nutrients, low water-holding capacity, and easily moved by forces of water, wind, and ice. Larger rain events in the spring and summer, more so than annual snowmelt, easily carve rills in this material as overland flow carries sediment off slopes.

The gullies present in the project area fan out at the toe of the slope, and the sediment they carry often deposits directly into Oregon Creek (**Figure 4**). There are 15 identified gullies and correlating sediment plumes being addressed by this project (**Figure 5**). Some of the sediment plumes have raised the floodplain and riparian surface, creating an unnaturally dry riparian environment.

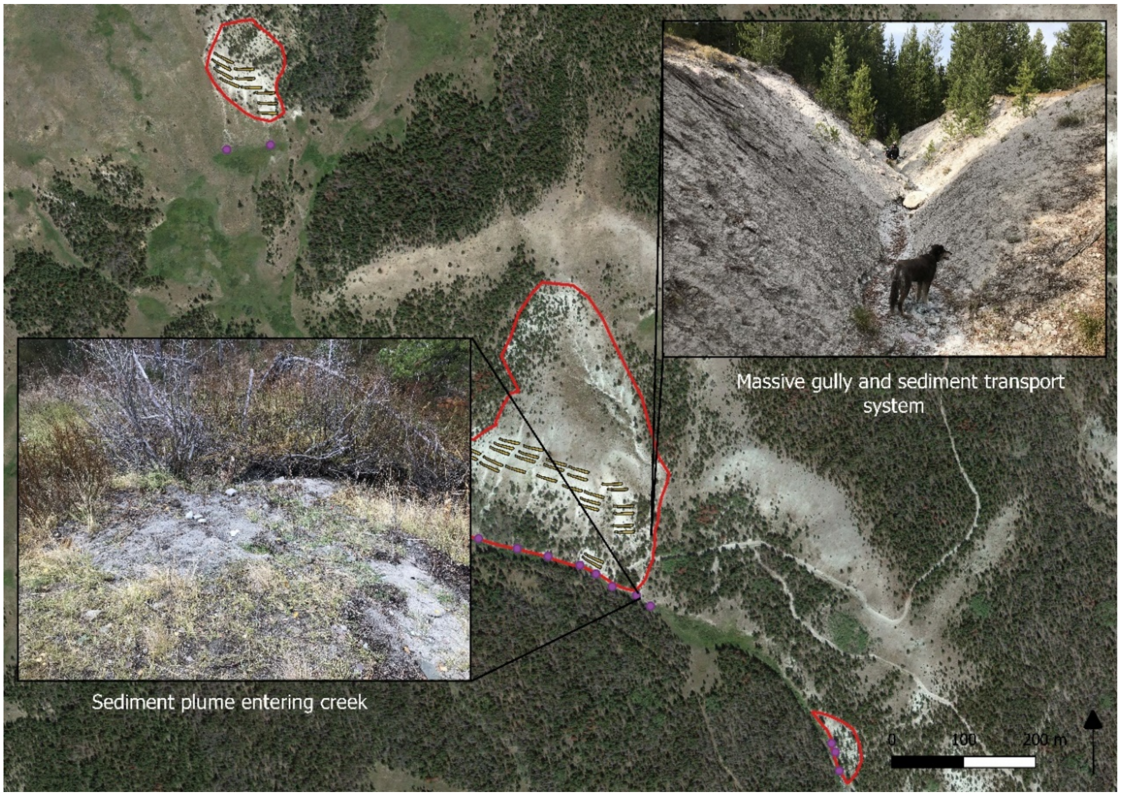

Figure 4. Gullies and sediment plumes present in project area.

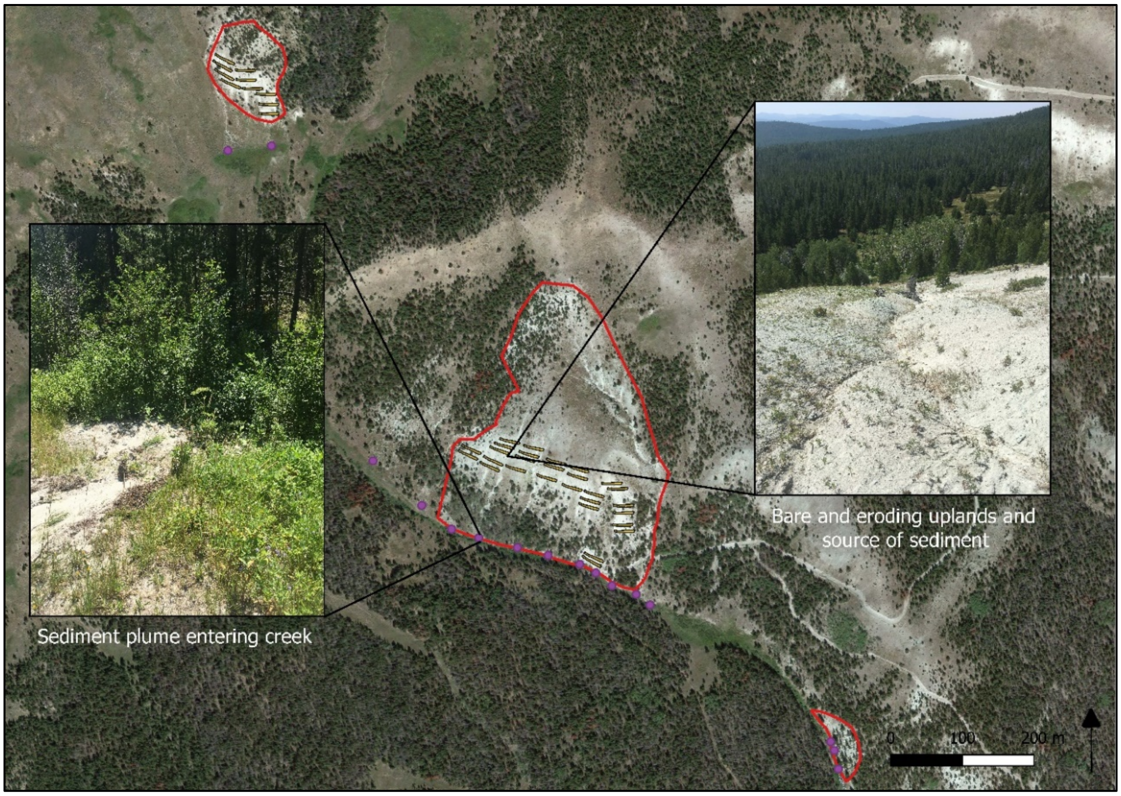

Figure 5. Sediment inputs (purple dots) from upland rills and gully formation.

Stream and Riparian Existing Conditions

The stream exhibits perennial flows in the upper reaches (upper and middle BDA reaches) and goes dry (intermittent) toward the bottom of the project reach (lower BDA and "stage 0" reaches). The stream is a type B stream with little to no sinuosity and is moderately steep (3-4%). One hundred years of sedimentation along with anthropogenic alterations to the stream channel have sections of the stream channel straightened, downcut, lacking in riparian vegetation, and the surrounding floodplain perched and disconnected from the channel. The reaches closest to the active sediment inputs are extremely choked with fine sediment and lack any aquatic habitat. Willows are present along the stream but do not expand away from the stream corridor. Sedge and rush communities are interspersed. Douglas-fir and lodgepole pine dominate the overstory and, in areas, are growing right next to the stream, an indicator of drying floodplain conditions. Currently, most of the stream lacks the hydrologic connection between the stream and the floodplain, especially in the wider, lower gradient, retention reaches (i.e "river beads"). Stream aggradation resulting from the in-stream check structures will increase soil water retention across the floodplain and allow for more frequent overbank flooding events. The increased floodplain connectivity and groundwater recharge can also support and expand desired riparian vegetation.

An MFWP fish survey in 2020 showed no fish above the sediment plumes. In comparison to nearby reference conditions throughout the WMA, this reach of Oregon Creek lacks grade controls or the functional qualities of overbank flood events that attenuate sediment.

Existing Conditions by Stream Reach

The project area encompasses three distinct stream reaches as shown in **Table 1** and **Figure 6**.

Table 1. Project Stream Reach Locations

Reach ID	*Begin Lat*	*Begin Long*	*End Lat.*	*End Long.*
Upper Reach	*46.0141*	*-113.0047*	*46.0110*	*-113.0009*
Middle Reach	*46.0110*	*-113.0009*	*46.0033*	*-112.9979*
Lower Reach	*46.0025*	*-112.9862*	*45.9974*	*-112.9979*

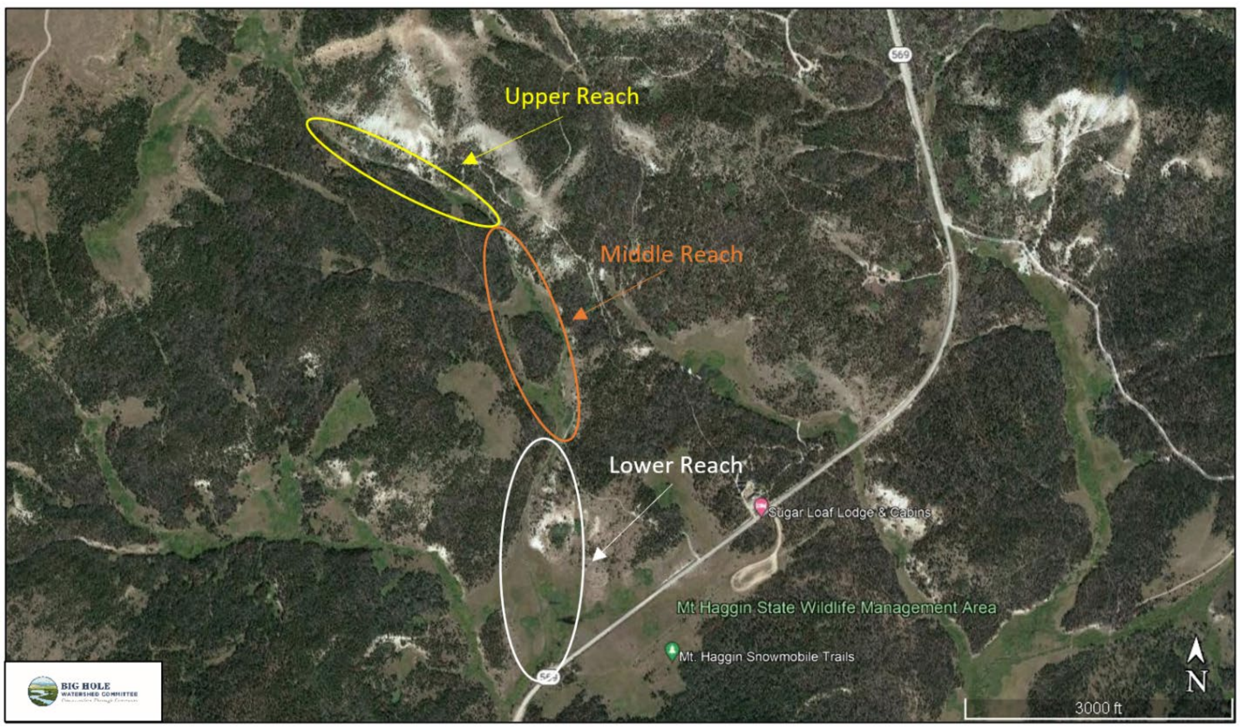

Figure 6. Stream Reaches within the project area.

Lower Reach: The stream is intermittent in this reach, with water drying up in mid-late July. In the "stage 0" project reach, the channel has been straightened, most likely for historic agriculture purposes, and is now in an extremely incised ditch (**Figure 7**). The stream has begun to form a small, inset floodplain with riparian vegetation beginning to establish near the water's edge. The broader floodplain is disconnected from high flows due to the incised condition of the channel.

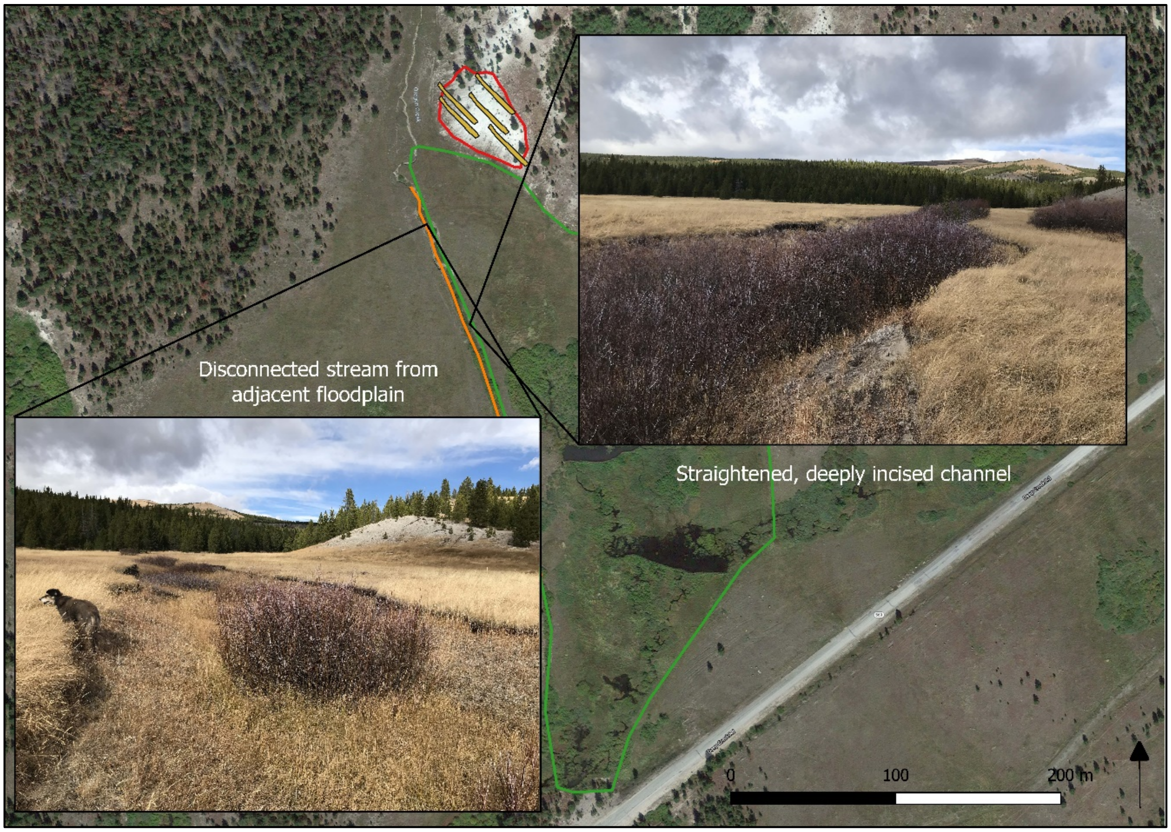

Figure 7. “Stage 0” reach exhibiting straightened and extremely incised channel conditions.

Middle Reach: The stream is perennial in this reach, but the channel is choked with fine sediments from nearby upland sources and little to no aquatic habitat to speak of. Floodplain vegetation consists of healthy willow and riparian vegetation communities. The middle project reach exhibits a straightened stream channel with moderate incision. The perched floodplains typically support upland and introduced/exotic vegetation over riparian vegetation. Toward the top of the middle reach, willows become more sporadic with sedge and rush communities interspersed.

Upper reach: The upper reach exhibits the most severely sediment choked reach in the entire stream. The majority of the sediment inputs come from the adjacent upland gully networks washing directly into the stream. The stream is perennial in this reach. There is an old perched culvert in this reach that will be removed during BDA construction (**Figure 8**). The perched culvert is currently blocking .5 miles of Oregon Creek headwaters. Floodplain vegetation consists of robust willow and riparian vegetation communities.

Figure 8. Perched culvert and sediment choked stream in the upper reaches of project area.

Figure 9. Existing conditions (clockwise from upper left): Large, mostly dry gully above upper reach; One of many gullies above the upper reach that transports sediment directly into Oregon Creek; Sediment plume depositing sediment into Oregon Creek; Sediment choked stream in the upper reach, below bare uplands; Dry, incised stream channel in the lower reach; Severely incised and straightened channel in lower reach/"stage O" site.

Project Scope and Design of the Investigation

This project is designed to improve water quality by reducing sediment loading from upland erosion, improve riparian habitat and vegetation, and remove a fish passage barrier in the headwater reaches of Oregon Creek. The project will also improve the landscape's ability to capture and retain surface and groundwater. This will be accomplished by following a four-pronged strategy:

1. Establish vegetation on 25 acres of upland slopes to prevent sheet erosion.
2. Detain sediment in 15 gully networks with proven Best Management Practices (BMP's).
3. Capture sediment on the floodplain and in the stream channel.
4. Reconnect 11 acres of floodplain to surface water using a "Stage 0" approach.

The techniques used in this project to address both upland and riparian work are shown in **Table 2** below. The Upper Oregon Creek Restoration Project Monitoring Plan is designed to assess the restoration project's effectiveness for sediment reduction and improvement of fluvial and upland habitat. All monitoring efforts are included in this plan. The objective of this Monitoring Plan is to guide the monitoring efforts that will measure and demonstrate the complete (long-term) reduction of sediment loading into Upper Oregon Creek and measure and demonstrate fluvial and upland improvements associated with the restoration efforts. This will be accomplished through a combination of imagery and measurements, including:

1. Before and after photo points, aerial imagery (including Unmanned Aerial System (UAS) drone imagery owned by BHWC) and satellite imagery of the project area will be used to document changes/improvements in the stream and vegetation conditions in the uplands.
2. Quantification of sediment load reductions by measuring representative structures and extrapolating those values to account for all structures, both upland and in-stream.
3. Normalized Difference Vegetation Index (NDVI) readings will be collected for the Stage 0 and upland slope areas using the Google Earth Engine to measure and compare average greenness (i.e., NDVI) before and after the project in the "stage 0" and upland project areas.
4. Channel geometry will be measured in the incised ditch and in the newly wet side channel after the Stage 0 project is completed.

Table 2. Project Scope

Uplands	Riparian
Bare upland slopes: ○ Soil scarification, fertilization and seeding on contour (i.e. coir "band-aids") ○ Aerial fertilization and seeding ○ Rill treatments with slash and coir Gullies: ○ Gully BMPs using available log material and slash (gully check dams) ○ Fill gullies with surplus slash and log material from MFWP's Upper Oregon Creek Aspen Enhancement project.	In-stream structures: ○ Post assisted log structures ○ Beaver Dam Analogues Road crossings: ○ Remove 1 failed culvert Stage 0: ○ Regrade existing valley surfaces (cut/fill) to allow for natural fluvial process. ○ Install large woody debris on floodplain to add surface roughness and complexity.

Monitoring Objectives and Methods

The objectives for monitoring are to document and quantify the work that will be completed and assess ecologic recovery trends, specifically in relation to the sediment loading to the stream, as well as the hydrologic and vegetative response. The primary monitoring objectives are to:

Measure and demonstrate improvement in upland and riparian vegetation conditions

Before and after photo points and aerial imagery of the project will show the changes in riparian and upland vegetation cover, changes in floodplain connectivity, natural stream function, and decrease in sedimentation, all contributing to habitat improvements. Photo points will be compiled into an annual photo log that contains: photo ID, photo date, photographer, subject, latitude, longitude, direction the photo was taken in, JPEG's of the photos, and the intent of the image.

Photos will be taken on an annual basis (2021-2024) starting with before photo documentation in 2021. In the first year (2022), after photos will be taken in the spring and summer to capture full spring runoff and riparian vegetation recovery from BDA installation. In the following years (2023-2024) photos will be taken in the summer.

Drone imagery will also be used to monitor the restoration project's overall performance, particularly showing geomorphic and upland conditions and floodplain function. BHWC will compile drone imagery/video into a digestible format to show improvements in floodplain connectivity and both riparian and upland vegetation conditions.

Using publicly available the Google Earth Engine, Normalized Difference Vegetation Index (NDVI) values will be measured in all project reaches to detect for changes in pre/post project implementation. NDVI values are derived from remote-sensing (satellite) data and quantifies vegetation by measuring the difference between near-infrared and red light. NDVI is used as an index of plant "greenness" or photosynthetic activity and is one of the most commonly used vegetation indices.

A point file of structure locations and a polygon file of the Stage 0 and upland treatment areas will be uploaded to a Google Earth Engine project. A 30x30m buffer will be created for each structure in the point file, which will equate to a single pixel. Average NDVI values for each buffered point will be generated as a baseline and compared to NDVI values post-project. The outputs from the Google Earth engine will be .csv files containing details of the structure type, and the average NDVI values.

To demonstrate the performance of our Stage 0 area, we will compare pre- and post-project cross-section measurements of the incised ditch (which will be filled) and the relic side channel that will be activated. Parameters such as entrenchment, width/depth ratio will be calculated and compared between the pre-and post-project conditions in order to demonstrate improved hydrologic connectivity.

Quantify sediment capture in gullies and in-stream structures.

Monitoring of gully and in-stream BMP effectiveness will involve calculating the volume of sediment captured behind representative structures installed in the project area. To achieve this metric, field crews will walk each treated gully and capture rough measurements of the volume of the gully prism behind a representative structure and of the sediment captured behind each representative structure. Because gully slash filters may interfere with sediment catchment uphill and downhill of each structure, one or two representative gullies will only be treated with gully check structures. These will be the gullies used to extrapolate out on all gully check structures. All other gullies will be treated with both gully check dams and gully slash filters. Measurements will be taken 1 full year post installation, to ensure major runoff/erosion events have been accounted for. Field crews will mark the locations of each structure with a GPS unit, and the following parameters, shown in **Figure 10** and explained in **Table 3** will be captured:

Table 3. Gully BMP Effectiveness Parameters To Be Collected

Parameter	Description
Length	Distance from BMP structure to tail end of fine sediment deposit
Height of gully (h)	Measured from the base of the structure to the top of the gully
Height of fill (h1)	Height of fill material behind structure
Width1 (b1)	Width of gully at bottom of structure

Width2 (b2)	Width of top of gully at grade
Width3 (b3)	Width of gully at top of caught sediment
% Effectiveness (E)	A qualitative estimate of the percentage of sediment retained by the structure vs. passed through or around it. Noticeable by presence of fine or un-embedded sediment below BMP structure
Notes	Any additional notes about the type of structure or location (i.e. constructed dam or just slash piles, log or rock dam, coir fabric included or not)

The gully bottom and top are assumed to be parallel to calculate the volume of the gully, but because of the taper of the prism created by trapped sediment intersecting the gully bottom, the volume of catchment behind structures will be calculated by dividing the volume of the trapezoidal prism in half. The formulas for both gully prism and trapped sediment are:

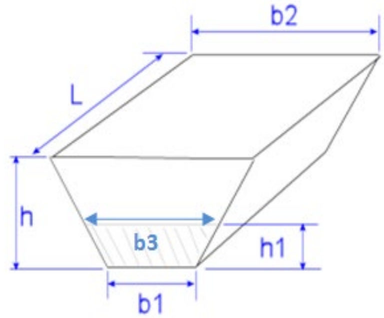

Figure 10. Diagram of trapezoidal prism of gully (h and b2) and trapped sediment (h1 and b3) behind each BMP structure.

Volume of gully (cubic feet) = **1/2h (b1 + b2)*L**

Volume of trapped sediment (cubic feet) =

(1/2h1 (b1 + b3)*L)/2*(E)

These field measurements will be uploaded into a self-calculating spreadsheet that will provide the volume of sediment caught as well as the volume of potential catchment with the installation of additional BMP structures up to the tops of gullies. This approach will also provide data on the effectiveness of these BMP techniques, which may be useful to other practitioners.

The volume of trapped sediment will be summarized for each measured structure and those values converted to an estimated tonnage of sediment. The sediment of concern, namely that originating from bare volcanic tuff uplands, tends to have a sandy loam texture, therefore an average soil weight of 0.065 tons/cubic foot will be used to convert volume to weight of sediment captured, based on a mid-range value of silty sand and gravel taken from standard professional engineering manuals (Lindeburg, 2014). Not every structure will be measured. Representative structures will be measured and those values used to extrapolate to similar un-measured structures, for both in-stream and gully structures. Metrics for both trapped sediment and additional catchment potential will be reported.

Monitoring Schedule

	Spring 2022	Summer 2022	Fall 2022	Spring 2023	Summer 2023	Fall 2023
Uplands						
Gully BMP Sediment Capture						
Photo Points/Aerial Imagery						
NDVI						
Riparian						
Cross Sections						
NDVI						
Photo Points/Aerial Imagery						

Project Team

BHWC Restoration Program Manager, Ben LaPorte will lead all monitoring on Upper Oregon Creek. Executive Director, Pedro Marques and Associate Director, Tana Nulph will assist in monitoring efforts when needed.

References

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

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

Montana Department of Environmental Quality. 2010. *Field Methodology for the Assessment of TMDL Sediment and Habitat Impairments*. Helena, Montana. Montana Department of Environmental Quality.

Watershed Consulting LLC. 2015. *California Creek Riparian Restoration Project Sampling and Analysis Plan (SAP)*. Prepared for the Montana Department of Environmental Quality and the Big Hole Watershed Committee. Missoula, Montana. Watershed Consulting LLC.