Anaconda Smelter NPL Site
Mount Haggin Uplands (RDU 15)

Remedy and Restoration Work Plan

PREPARED BY:
MONTANA DEPARTMENT OF JUSTICE
NATURAL RESOURCE DAMAGE PROGRAM

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1720 9TH AVENUE
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Acronyms

Acronym	Definition
ARCO	Atlantic Richfield Company
BHWC	Big Hole Watershed Committee
BMP	Best Management Practice
CD	Consent Decree
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
DCRP	Draft Conceptual Smelter Hill Area Uplands Resources Restoration Plan
EPA	Environmental Protection Agency
IA	Injured Area
NRDP	Natural Resources Damages Program
MDEQ	Montana Department of Environmental Quality
MFWP	Montana Fish, Wildlife and Parks
MHTWG	Mt. Haggin Technical Working Group
NPL	National Priorities List (i.e., Superfund)
OU	Operable Unit
RAWP	Remedial Action Work Plan
RDU	Remedial Design Unit
ROD	Record of Decision
RRA	Remedy and Restoration Area (= Injured Area + other smelter degraded areas in California Creek, Upper Willow Creek)
SHOP	Smelter Hill Opportunity Ponds
SSR	Steep Slope Reclamation
UAS	Unmanned Aerial System (drones)
WMA	Wildlife Management Area (refers to Mt. Haggin WMA)

Introduction

Natural resource damages under the Comprehensive Environmental Response, Compensation and Liability Act, 42 U.S.C. § 9601 et seq., (CERCLA) are designed to compensate trustees[1] for injury[2] to natural resources[3] that are residual to CERCLA response actions.[4] In 1995, the State of Montana (State) issued a Restoration Determination Plan (RDP) as part of its natural resource damage assessment, which quantified the amount of natural resource damages to which the State was entitled in order to restore injured natural resources in the Upper Clark Fork River Basin (UCFRB). The RDP, was revised in 1999, and again in 2002, and provided initial characterization of the Mount Haggin Uplands Injured Areas (IA), reference areas, and specifications of restoration treatments and cost estimates for those prescriptions. A Consent Decree (CD) was filed between the State, the United States and ARCO in 2008[5]. In the same year, the Natural Resource Damage Program (NRDP) presented the State's plan for the restoration of the IA in a Draft Conceptual Smelter Hill Area Uplands Resources Restoration Plan (DCRP), a document which relied on the findings of the initial RDP. As the IA are included in the Anaconda Smelter National Priorities List (NPL) Site, the State also relied on certain EPA Final Design Reports / Remedial Action Workplans (RAWPs/FDRs) in the development of the DCRP.

Over the past seven years (2010-2016) the Natural Resource Damage Program (NRDP) has undergone further assessment of the IA and implemented restoration/remediation projects and experimental design trials in challenging terrain to field-test the prescriptions of the 2007 DCRP. This work was completed on State-owned land within the Mt. Haggin Wildlife Management Area (WMA), owned and managed by Montana Fish, Wildlife and Parks (MFWP) and includes land within the IA as well as other lands, collectively referred to as Remediation and Restoration Areas (RRA), described in the following section.

Work accomplishments and the evolving conceptual approach to the restoration of these lands has been presented annually to a multi-stakeholder group (MHTWG) since 2012[6]. In 2016 supervisors at Montana Department of Environmental Quality (DEQ) and the Environmental Protection Agency (EPA), as well as NRDP and MFWP managers endorsed the strategy and techniques applied to date, prompting the development of this plan.

This document details the State's plan for surface water control actions to be implemented over the next 3-5 years as well as design justification and discussion to support a consolidated and coordinated effort to remediate and restore the RRAs.

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[1] The State of Montana is a trustee of natural resources within the state. CERCLA Section 107(f)(1), 42 U.S.C. § 9607 (f)(1).

[2] As trustee, the State is entitled to "damages for injury to, destruction of, or loss of natural resources, including the reasonable costs of assessing such injury, destruction or loss resulting from "the release of a hazardous substance. CERCLA Section 107(a)(4)(C), 42 U.S.C. § 9607(a)(4)(C).

[3] "The term 'natural resources' means land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by" the State. CERCLA Section 101(16), 42 U.S.C. § 9601(16).

[4] "The term 'respond' or 'response' means remove, removal, remedy, and remedial action." CERCLA Section 101(25), 42 U.S.C. § 9601(25).

[5] Consent Decree for the Clark Fork River Operable Unit and for Remaining State of Montana Clark Fork Basin Natural Resource Damages Claims. No. V-83-317-HLN-SEH

[6] An ad hoc group comprised of NRDP and EPA contractors, oversight personnel and state agencies to guide the remediation and restoration of the Mt. Haggin Uplands IA (see Partners section).

Background

This plan is based on six years of remediation and restoration implemented by the NRDP program in the uplands, including five years of work at Cabbage Gulch (RDU 15) and Stucky Ridge (RDU 1), and numerous demonstration projects in the RRAs between 2013 and 2016. Observed successes and failures as well as numerous assessments, reports and demonstration projects completed in the project area over the past 10 years contribute to polygon-specific conditions, including soil pH, erosion conditions and general limiting factors on the landscape as well as restoration objectives for the area. Beginning in 2013 a series of field trials demonstrated the response of the landscape to specific restoration techniques. The approaches defined in this plan were grounded in those assessments, demonstration projects, and extensive monitoring of vegetation conditions, riparian and hydrologic function and measures of sediment delivery and capture. Technical review and project planning was guided by the MHTWG. The assessments and projects conducted to date include:

- DCRP (2007)[7]
- Soil and Land Reclamation Assessments for Mt. Haggin Uplands and Stucky Ridge (2009)[8]
- Upland Sediment Source Assessment (2012)[7]
- Sediment Capture and Storage Assessment (2012)[7]
- Vegetation Map (2013)[7]
- California Creek Restoration Project (2014-2016)[9]
- California Creek Upland Demonstration Project (2013)[7]
- Upland Seeding and Amendment Trials (2013-2015)[10]
- Joyner Gulch Gully Demonstration Project (2014-2015)[7]
- Uplands Revegetation Demonstration Project (2015-2016) [11]
- Muddy Gulch Demonstration Project (2016-2017) [7]
- Willow Creek Technical Memo (2016)[7]

Additional studies and reports by the Anaconda Richfield Company (ARCO) of surface water and sediment contamination in the Mill Creek drainage were also considered in this plan[12], with guidance and cross-over information provided by EPA oversight contractors. Additional projects funded by DEQ and the Montana Department of Natural Resources and Conservation (DNRC) in the California Creek drainage contributed to agency objectives as well as NRDP remedial objectives. The management objectives for fish and wildlife habitat and vegetation conditions also benefitted from this work. These studies and project results demonstrated key ecological trends on the landscape that led management teams to adopt an iterative, adaptive and incremental strategy to addressing long-term sediment and surface water controls.

[7] Natural Resource Damage Program
[8] Northern Rockies Soil and Water and Bighorn Environmental Sciences, Inc.
[9] Montana Department of Environmental Quality
[10] KC Harvey, Bozeman MT
[11] Department of Natural Resources and Conservation
[12] Atlantic Richfield Company 2017 (see References)

Description and Status of 6 Drainages Considered in Plan

This plan, like the 2007 DCRP, addresses bare and degraded areas and presents the locations and acreages/linear extents of slope reclamation controls that will be implemented to improve surface water quality across six different hydrologic systems (drainages), all within the boundaries of the WMA to the west of State Highway 569. Four of these drainages, Joyner Gulch, Muddy Gulch, Cabbage Gulch, and Mill Creek are within the IA boundary. Additional areas addressed in this plan include California Creek and upper polygons of the Willow Creek drainage. Taken together, these areas cover nearly 6000 acres and comprise the RRAs addressed by this plan.

Activities for these drainages include engineered and non-engineered controls, steep slope reclamation (SSR) and storm water best management practices (BMPs), as well as vegetation enhancement activities, all of which have been tested and proven by NRDP and partner agencies in projects completed over five years between 2012-2017 across these six drainages. A general characterization of each of the six drainages is provided in this section.

Maps of the IA boundary are shown in **Figure 1** and **Figure 2.** Within this boundary, drainages were sub-divided into polygons based on visual indicators from aerial imagery and field photographs including parent material and vegetation conditions. Additional input layers such as slope and aspect were used to break polygons along features that had the most relevance for management and remedial and restoration prescriptions.

Injured Area Drainages

The Mount Haggin Injured Area was established by NRDP in 1992 during the injury assessment phase of negotiations between the State of Montana and ARCO and appears in initial work plan documents (NRDP 2007). This area remains unchanged by this plan and contains 4 distinct hydrologic drainages. Substantial soil and water quality data beyond those presented in this plan are summarized by ARCO in its proposed TI Waiver evaluation document (ARCO, 2017) and are not repeated here[13]. The NRDP has been focused on field trials of restoration and reclamation techniques to begin addressing site degradation. Demonstration projects, design trials and projects supported by partner agencies have been implemented to varying degrees in these drainages prior to 2018, as described below.

[13] The EPA has not finalized the TI waiver evaluation as a TI waiver at this time.

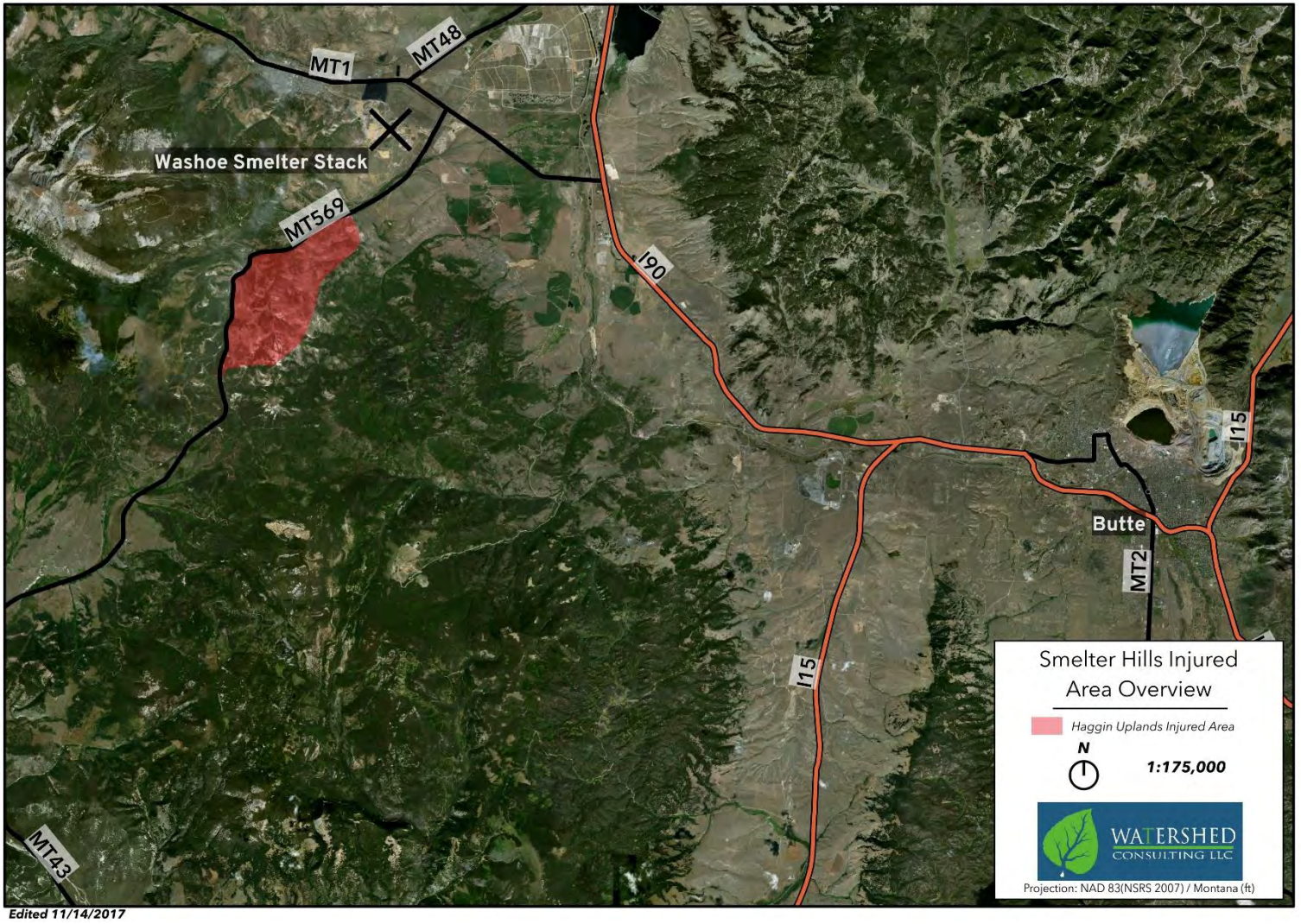


Figure 1. Injured Area Location

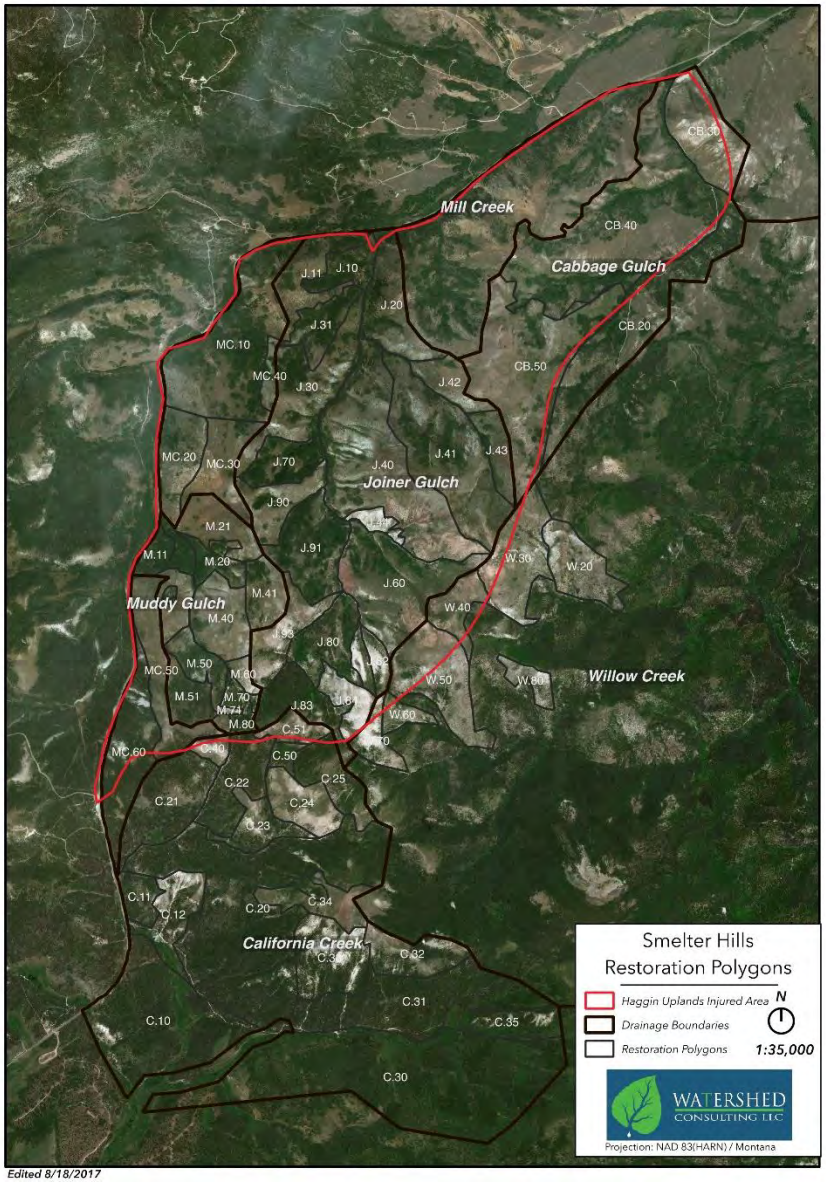


Figure 2: Injured Area and RRA restoration polygons

Joyner Gulch

The largest of the IA drainages, Joyner Gulch contains 1658 acres, extending from MT Highway 569 to the continental divide, a distance of nearly 3 miles. The upper extent of this drainage is in the most degraded state of the entire IA, with over 145 acres of bare areas displaying minimal vegetated cover. For over a mile in the downstream reach of the drainage, beaver complexes provide substantial flood attenuation and sediment capture, supporting robust riparian and wetland vegetation. Completed work in this drainage includes a 3-acre vegetation enhancement project in the uplands as well as the installation of 3700 feet of gully check structures and slash filters beginning at the uppermost extent of the drainage. Completed work in Joyner Gulch is shown in **Figure 20** and **Figure 23** below and summarized in **Table 7** and **Table 8**.

Muddy Gulch

The Muddy Gulch drainage comprises 425 acres, extending from MT Highway 569 to forested uplands often bisected by deep erosive gullies, likely marking the locations of log and mining-related infrastructure from the turn of the 20th century. Muddy Gulch is in a deeply incised condition in its upper reaches, going dry in mid-summer. Historic and active beaver pond complexes and mature aspen stands characterize the lower reaches of the channel. Most of the stream channel was treated in 2016 with a mechanized approach that demonstrated the conversion of an incised channel to a series of stepped pools to maximize sediment capture on the landscape. An additional 3 acres of bare upland slopes and several hundred feet of gullies were also amended with high nitrogen fertilizer and seeded. Completed work in Muddy Gulch is shown in **Figure 20**, **Figure 23** and **Figure 28** below and summarized in **Table 7, Table 8** and **Table 10**.

Cabbage Gulch

The Cabbage Gulch drainage was specifically identified in RDU 15 work plans (ARCO 2007a, 2007b) for remedial activities due to several factors, including elevated levels of contaminants, its proximity to the source of aerial pollution and accessibility to heavy equipment. RDU 15 documents mapped specific remediation polygons, titled SHOP-19 and SHOP-20, as shown in **Figure 3**. The NRDP implemented extensive BMPs and SSR treatments in the SHOP-19 polygons between 2012-2016 and substantial sediment capture and vegetation establishment has been achieved (**see Figure 4**). Included in this completed work is a small tree and shrub planting effort from 2012 in two of the SHOP 20 polygons, which had limited success. Results of those trials were important in leading remedial actions away from containerized planting stock. The SHOP-19 polygons are not addressed in this plan as they are addressed in a construction completion report being drafted for NRDP review in 2017. The SHOP 20 polygons are not addressed specifically in this plan and are considered part of the RRA polygons in the Cabbage Gulch and Mill Creek drainages.

As part of NRDP actions, the SHOP 20 polygons were assessed for their erosion potential and vegetation conditions in order to determine if remedial actions were warranted within the specific polygons. The assessment, shown in **Appendix E: Cabbage Gulch Shop 20 Conditions Report**, found the polygons were mostly not sediment sources and recommended not targeting these specific areas for treatment. The 972 acres in the Cabbage Gulch drainage considered in this plan end at the northern extent of the Cabbage Gulch stream channel and do not include the SHOP-19 polygons. Some weed control activities have been ongoing in lower elevation polygons in Cabbage Gulch and continued weed control is proposed until performance standards are met.

Figure 3. Cabbage Gulch SHOP Polygons

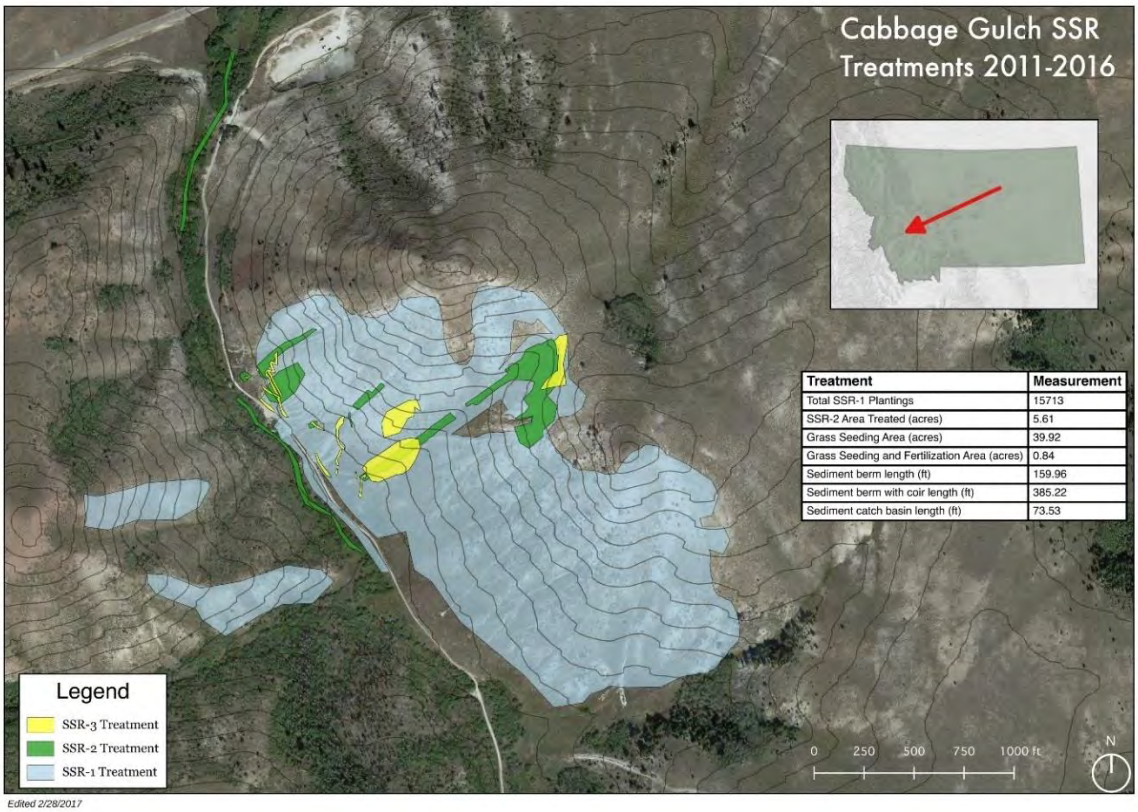


Figure 4. Cabbage Gulch Treated Areas (2012-2016)

Mill Creek

The Mill Creek drainage comprises 1192 acres of steep slopes along Highway 569. These slope areas are predominantly degraded grasslands, with a mixture of sparse shrublands and aspen colonies. In areas Mill creek flows through narrow valley bottoms between hillslopes and the highway, occasionally marked by beaver ponded wetlands. In 2012 a substantial planting effort was undertaken on steep slopes of loose granitic soils identified as SHOP-20 polygons. Several amendment trials and gully check structures have also been installed near the continental divide to demonstrate SSR technique feasibility. Completed work in the Mill Creek polygons are shown in **Figure 20** and **Figure 23** below and summarized in **Table 7** and **Table 8**.

Additional Drainages

Adjacent drainages to the IA were identified by NRDP, MFWP and EPA as similarly degraded and water quality sampling confirmed high-flow chronic and acute exceedance of water quality standards for some of the COCs. Polygons were delineated for this plan for a large area of the California Creek drainage and the upper slopes of the Willow Creek drainage. These areas, together with the IAs, are referred to here as the Remedial and Restoration Areas to be addressed by the NRDP in this plan.

California Creek

Stream sampling sponsored by the NRDP as well as sample data compiled by ARCO in the California Creek drainage found exceedance of metals during storm flows. In consultation with EPA, MFWP and DEQ, the State committed to addressing sediment delivery in the upper reaches of this drainage. NRDP contractors leveraged State commitments to this drainage to bring additional restoration dollars from the DEQ and DNRC to address sediment contamination.

In 2014 the Big Hole Watershed Committee (BHWC), in partnership with the NRDP program, secured funding from DEQs 319 grant program to address sediment contamination in the California Creek watershed. The California Creek Restoration Project brought a total investment of nearly $400,000.00 into the watershed and has mitigated some of the sediment pathways in the watershed from accessing the stream channel (BHWC, 2017). In 2015, a planning grant from the DNRCs mine reclamation program was also secured by the BHWC to demonstrate an expanded upland soil amendment technique (BHWC and DLVCD, 2016). These projects expanded on earlier demonstration projects funded by the NRDP in 2013 that included soil amendment trials, the construction of engineered rock check dams and gully check structures. The partnership approach developed in the California Creek drainage also demonstrates an added dimension of the NRDP program that supports the achievement of various and overlapping resource goals of the different agency and nonprofit partners involved in the uplands (see **Partners** section). Completed work in California Creek is shown in **Figure 20**, **Figure 23** and **Figure 28** below and summarized in **Table 7, Table 8** and **Table 10.**

Willow Creek

The Willow Creek drainage comprises nearly 9000 acres of mostly intact forest and riparian area. Due to its large scale and near reference conditions, this drainage is mostly not included in this plan, other than a few upland polygons. General Willow Creek conditions are addressed separately in **Appendix A: Willow Creek Watershed**. Remedial and restoration actions in the Willow Creek drainage will provide equivalent sediment reduction to the recommended actions in the RAWP. No actions have been taken in this drainage aside from some weed treatment trials.

Objectives

The objective of this plan is to outline the NRDP-led remedial actions (RAs) in the RRAs of the Mount Haggin uplands. The plan is based on proven approaches and consistent with FWP management objectives for the landscape over the long term as well as NRDP objectives for remediation and restoration of degraded lands in the short and medium-term. The major components of the 2007 DCRP are all accounted for in this plan, specifically aerial fertilization, seeding, dozer basins, BMPs (which include all the components of **Table 6**), sediment basins[14], weed control and tree and shrub planting.[15] All RAs are consistent with MFWP management goals and objectives for the area, which are shown in **Figure 5.**

This document presents an alternative remedial strategy to the engineered sediment controls provided in ARCOs remedial prescriptions in the RAWP (ARCO 2007a) and the proposed TI Waiver evaluation document (ARCO 2017). Those prescriptions would encumber MFWP with an untenable Operation and Maintenance obligation and would damage the natural character of the landscape. The strategy developed in this plan will provide an equal amount of surface water and sediment controls but in a manner that enhances natural processes of sediment capture and surface water control to maximize ecological resilience into the future. The approaches prescribed by this plan have been endorsed by the state agencies responsible for managing the resources of the area.

Existing Landowner

Management of the WMA is the responsibility of MFWP, while remedial commitments are the responsibility of the NRDP per two CDs. Cooperation between the NRDP program and MFWP is facilitated through the MHTWG. Restoration within the Wildlife Management Area achieves NRDP objectives but also supports broader wildlife management objectives of the land managers. Soil stabilization, fertilization and seeding, in-stream treatments to enhance floodplain connection and water capture will enhance wildlife habitat for game and non-game species. Sediment capture efforts on California Creek, while meeting NRDP objectives are also the first step in a plan to re-establish a native trout and grayling fishery in 40 miles of tributary streams in the WMA. This effort by fisheries biologists at MFWP required sediment sources to be controlled first, before a large-scale re-introduction effort and fish barrier are installed.

Restoration of impairments on other streams outside of the RRA, including Oregon Creek, American Creek, French Creek, may provide benefit to NRDP and ARCO water quality objectives and should be considered part of the restoration solution for the injured area. For example, natural water storage projects that create natural detention basins could be created in a number of areas outside of the immediate zone of smelter fallout providing additional areas for the retention of contaminated sediments from the uplands.

[14] As stated on page 35, "The NRDPs remediation and restoration plan provides for an **equal or greater amount of sediment retention** as the ARCO-proposed mechanized basins and with more desirable long-term results for habitat conditions across the landscape."

[15] Tree and shrub planting intensity has been decreased due to cost/benefit analysis and results of earlier efforts. Other techniques described in Tables 5 and 6, such as the use of native willow cuttings and promoting the germination of the existing native seed bed, are preferred in this plan.

Figure 5. MFWP Management Goals and Objectives for Mt. Haggin WMA

Objective 1 (Fish and Wildlife Habitat): Manage for ecologically intact and functioning fish and wildlife habitat.

- Improve deteriorated areas and return all lands and waterways to a more natural state
- Manage all habitat types (forest, shrubland, grassland, riparian, hardwood, etc.) for long-term sustainability
- Implement weed management that is effective in scope and design to minimize impacts to native vegetation.
- Implement management tools that are appropriate and retain the natural character of the landscape (e.g. grazing).

Objective 2 (Recreation): Manage for dispersed public recreation consistent with the area's ability to support it without degrading the innate value of the landscape.

- Implement travel management that does not damage or disturb the natural resources of the area
- Recreation consistent with the values of the Mt Haggin WMA include but are not limited to hunting, fishing, trapping, camping, wildlife watching, photography, hiking, skiing, snowmobiling, snow-kiting and gold panning.

The RRAs to be treated through this plan consists of the original boundaries of the IA with the addition of the California Creek drainage and some upland polygons in the Willow Creek drainage. **Figure 6** below shows the spatial extent of the RRA drainages within the larger WMA.

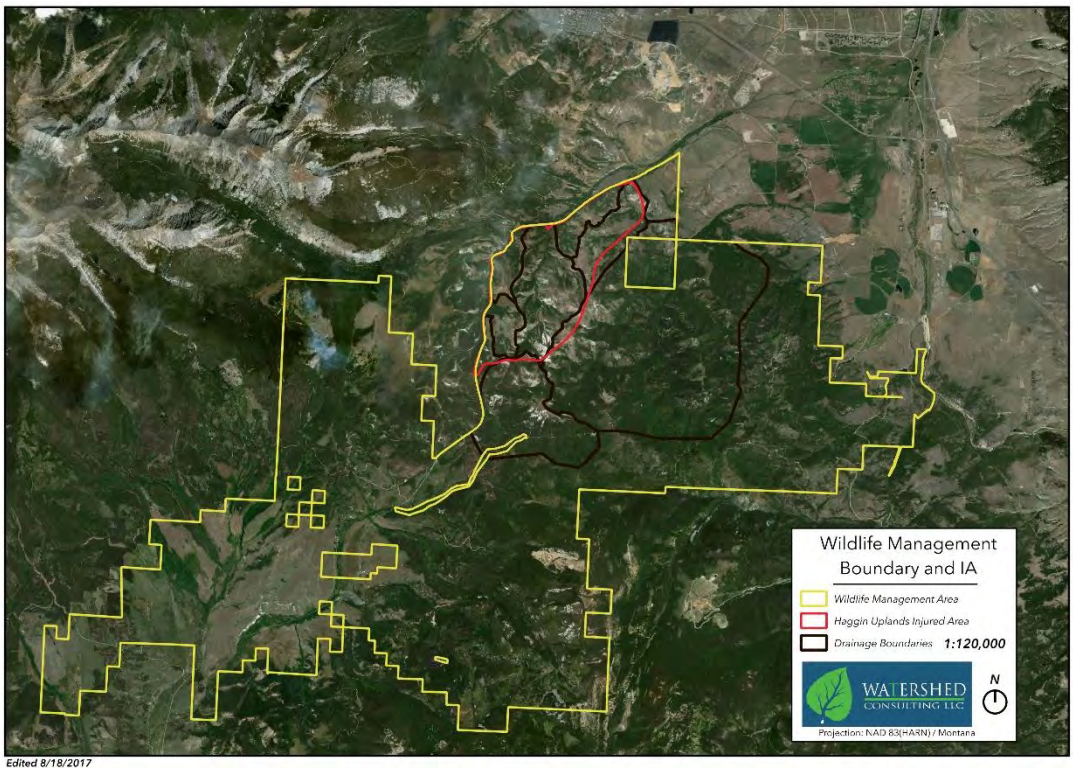


Figure 6. Extent of RRAs within the state-managed WMA.

Partnerships

Though clear responsibilities for remediation actions lie with the NRDP, remedial and restoration activities within the WMA have been and will continue to be undertaken in the context of partnerships and guided by MFWP management goals and objectives for the WMA. The MHTWG has been convening since 2012 on an annual basis to review work plans and progress in the uplands, as well as providing updates on the progress of ARCO work plans, which are also being overseen by the EPA. The venue of the MHTWG includes the BHWC, which has secured substantial restoration dollars from state grant sources for restoration work that supports multiple resource objectives in the WMA, MFWP biologists who guide land management decisions, the NRDP project manager and their engineer Pioneer Technical, EPA contractors and Montana DEQ. These partners play a role in the successful treatment and ultimate success of reclamation and restoration of the Mt. Haggin Uplands:

The Big Hole Watershed Committee

The BHWC plays a critical role in coordinating multiple agency efforts and leveraging restoration commitments to bring more resources to the area in support of numerous objectives. The Big Hole Watershed Committee (BHWC) is the lead entity for coordinating, managing, funding, and reporting work accomplishments within the WMA as a subcontractor to NRDP, acting as the Project Manager for steep slope remediation and restoration. BHWC is also the project owner of most supporting grant dollars in the area, which total over $1.5 million of project dollars put to work in the WMA outside of NRDP funds since 2012. BHWC provides long-term placement/employment for key personnel involved in the restoration of the Mt. Haggin uplands and downstream streams.

BHWC is a non-profit watershed group operating across the entire Big Hole River watershed and occasionally in neighboring watersheds. Established in 1995, the group has primarily focused on water quantity, water temperature and benefits to the unique fishery of the watershed. BHWC is led by a Governing Board that represents diverse interests including ranching, utilities, local government, sportsmen, conservationists, tourism, and outfitters. Representatives from local, state, and federal agencies participate as technical advisors.

Upper Big Hole River Arctic Grayling Recovery/CCAA – The Mt. Haggin WMA is included in the CCAA program's territory. Future reintroduction of Artctic grayling is a planned action by MFWP and successful restoration in the WMA is integral to their reintroduction, and likewise, successful reintroduction is a symptom of successful restoration. Arctic grayling are present in the Deep Creek drainage downstream of the WMA and believed to be once present throughout the WMA prior to damages. The CCAA is operated by MFWP. Their work includes inventorying presence and population of grayling, improving habitat, working with enrolled landowners for improving and maintaining habitat conditions, and monitoring results.

Montana Department of Environmental Quality – State agency responsible for setting and meeting water quality standards, including metals and sediment. The agency supported the BHWC to develop its Watershed Restoration Plans in 2013 and 2014, which created an inventory of past, present and proposed priority areas for improving water quality as well as targets and goals for measuring success. The WMA is and continues to be a key area of work for improving water quality in the Middle-Lower Big Hole Watershed Restoration Plan. As part of this plan, Mt. Haggin has and will continue to be eligible for receiving Montana Department of Environmental Quality 319 funds, funds specifically allocated for implementing Watershed Restoration Plans next steps for improving non-point source water quality.

Montana Department of Natural Resources and Conservation – State agency operates two grant programs for reclamation of mine-impacted sites. The agency has funded large and small projects within the WMA and within RRAs between 2014-2017.

Bureau of Land Management – Federal agency manages lands within and adjacent to the Mt. Haggin Wildlife Management Area and provide funding. Their work includes directives that relate directly to this plan.

Beaverhead Deer Lodge National Forest – Federal agency manages lands neighboring the Mt. Haggin Wildlife Management Area. Their work includes directives that relate directly to this plan, as defined in the Forest Plan.

Deer Lodge Conservation District – Mt. Haggin is within the Deer Lodge Conservation District jurisdiction for stream permitting and conservation work.

Anaconda Deer Lodge County – Mt. Haggin is within this county, including their need to oversee floodplain regulation, Highway 569 access and improvements, and connection with the city of Anaconda.

Existing Conditions

Figure 7. Typical conditions in the uplands. Dozens of small rills easily transport volcanic material and form increasingly deeper gullies.

The RRAs were injured due to releases of hazardous substances from mineral processing activities. Aerial emissions from smelting activities in Anaconda deposited heavy metals (Copper, Arsenic, Cadmium, Lead, Zinc) 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 WMA near the continental divide. Extensive log transportation networks, including log flumes, cables and rail lines spanned the IA. Devoid of vegetation, large areas developed networks of rills during heavy rain events, most severely in areas with a geologic parent material of volcanic welded tuff (**Figure 7**). The formation of rills and gullies was also exacerbated by regular leaking of water from overhead log flumes (Losensky pers. comm.) Rills came together and have carved out gullies and incised the main perennial and intermittent channels in the Muddy, Joyner, California, Mill and Cabbage drainages and upper reaches of Willow Creek. Throughout the landscape the gullies have cut down 15-20 feet and overland flows run unimpeded on friable bedrock material.

Once sediment enters these gullies, they progress quickly down gradient. Natural grade controls are mostly absent in the most bare areas of the landscape, limiting overbank deposition or natural water retention. Evidence of sediment plumes in different stages of natural revegetation are common throughout the RRA. The degree of erosion in the uplands correlates strongly to slope and aspect, but most importantly, parent material. Aerial contamination and the resulting erosion have caused injury to soils, vegetation, wildlife habitat, and wildlife. Contaminated soils are also sources of on-going releases of hazardous substances into streams, predominantly when mobilized during storm events. The elimination of upland vegetation communities in the most bare areas has caused a severe disruption to the ecosystem, most notably to a reduction in the quantity and quality of wildlife habitat.

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 **(Figure 8, Figure 9, Figure 10).**

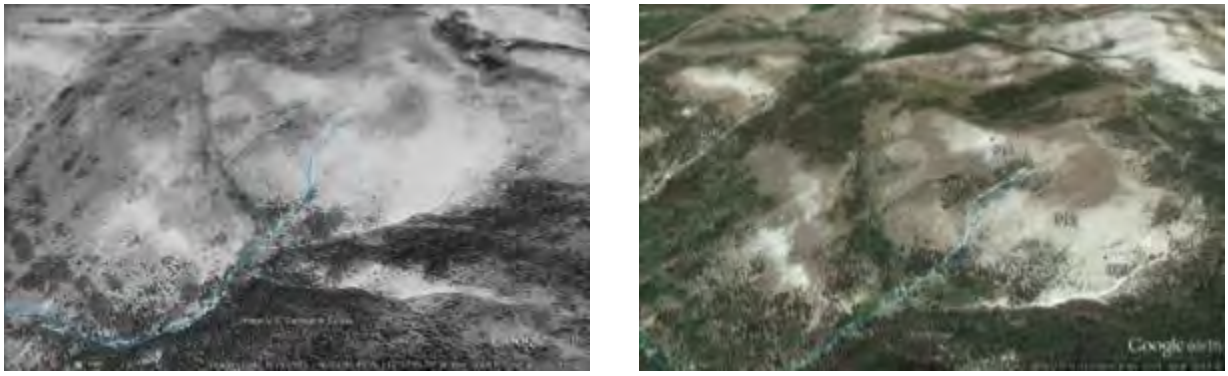


Figure 8. Upper NF California Gulch in 1995 (left) and 2013 (right). The increase in vegetation cover, particularly conifers and upland shrubs, is noticeable. Darker brown areas are upland grasses, primarily red top (Agrostis stolonifera).

Figure 9. Typical upland conditions on volcanic soils. Root system of tree shows where original soil level was and the degree of erosion. Trees likely cut around 1900.

Figure 10. Looking north into Joyner Gulch. Mix of natural revegetation conditions and erosion typical of the broader landscape.

Natural revegetation is generally progressing up-gradient from the lower elevations, with the most mature and functional plant communities and soil formation processes occurring where the drainages intersect the Montana Highway 569. Lower elevations in all RRA drainages are dominated by beaver dams, ponds and wetland ecosystems. These systems are seen as a natural remedial resource in this plan as they capture and store substantial sediment from upland sources and the hyporheic flux and redux conditions they promote are conducive to metal attenuation (Tucci 2014). The stored woody debris and organic matter (leaf litter) as well as riparian vegetation they promote have also been shown to uptake COCs (ibid.). The beaver communities in these areas, demonstrated in **Figure 11**, are monitored and managed by MFWP.

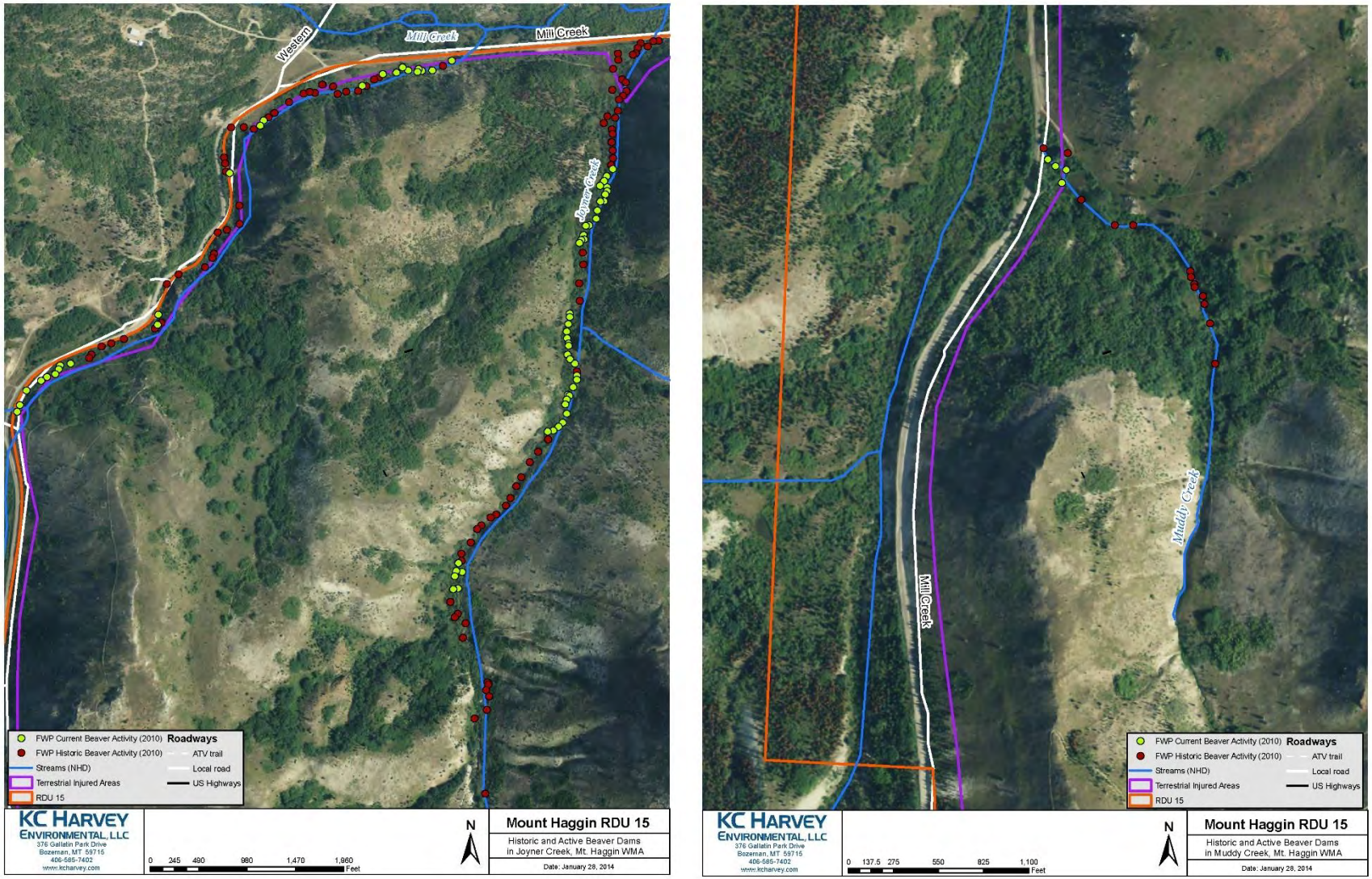


Figure 11. Prevalence of beaver activity in Joyner and Muddy Gulch drainages

Proceeding upstream, stream channels become increasingly incised, leaving narrow to non-existent riparian plant communities to provide attenuation of COCs or stream flows. Absent the ponding effects of beaver, the riparian community often consists of upland shrubs and sparse to dense conifer forests perched above channel bottoms. Where welded volcanic tuff is the dominant geologic mineral component, natural vegetation has been slow to re-establish. The welded tuff material is friable, silty-sand-textured, 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.

Figure 12. Soil pit in California Creek sediment plume. Lack of a visible soil horizon to depth of 26" shows lack of soil formation.

The riparian areas and floodplains of the RRA are built, for a large part, upon sediment deposits originating from bare upland slopes. Sediment plumes are visible from aerial photographs where gullies lose gradient and have deposited tons of sediment across the toe of the slope, into the floodplain and riparian areas. These sediment plumes are in differing stages of natural recovery depending on their proximity to the major gullies in the system. Soil pits dug in both active plume areas as well as revegetated floodplain areas show uniform layers of volcanic tuff material down to 2 feet **(Figure 12**). In some areas, where sediment loading from uphill gullies has diminished over time or been dispersed over the landscape, native seed sources have established and riparian and upland plant communities are returning, as shown in **Figure 13.** In the plume areas that see regular delivery of fresh sediment, vegetation is scarce.

Figure 13. Sediment plume and gully above California creek. The more active plume area shown in the red circle and the historic plume shown in the orange and the contributing gullies were treated by NRDP and DEQ in 2014.

Vegetation in the uplands consists of dense stands of lodgepole pine (*Pinus contorta)* with an understory of grouse whortleberry (*Vaccinium scoparium*) and elk sedge (*Carex geyeri*). Limber pine (*Pinus flexilis*) is also slowly returning to higher elevations. The shrubs that remain in the uplands are decadent Scouler's willow (*Salix scouleriana*), serviceberry (*Amelanchier alnifolia*) and snowberry (*Symphoricarpos albus*), which show signs of intense browse pressure (mostly from moose), with clubbed growth forms and decadent outer branches. Aspen colonies are also present, sometimes into bare areas and even gully sidewalls. In many areas outside of valley bottoms aspen stands are transitioning to conifer forest. Other species beginning to colonize the site include Oregon grape (*Mahonia aquifolium*), goldenrod (*Solidago sp.*), fireweed *(Chamerion angustifolium)*, Silver-leafed phacelia (*Phacelia hastata*) and wild strawberry (*Fragaria virginiana*). The dominant grass in the uplands is redtop (*Agrostis stolonifera*), which, though not a native, is tolerant to the harsh soil conditions of the uplands and the first to colonize bare slopes. The most significant factor to the presence of these plants is that they all reproduce from underground tillers, a strategy which avoids the numerous climatic and physical impediments to seed-based reproduction in the uplands.

The Natural Heritage Program produced the first vegetation map of the IA, used in the DCRP, in 2007 (**Figure 15**). NRDP contractors produced a second map in 2013 to better qualify conditions in the IA Field assessments and photographs were combined with aerial imagery to determine the extent of natural revegetation and identify the likely sediment sources on the landscape (**Figure 14)**. This mapping exercise found that many areas determined to be bare and erosive were actually heavily armored rock surfaces and not contributing sediment to the system. Mapping also showed the extensive riparian recolonization that had occurred since the closure of the Washoe smelter in 1980. An updated map was created in 2017 including vegetation for the California Creek and Willow Creek drainages, as shown in **Figure 16**. Vegetation cover by drainage is shown below in **Table 1** by acre and in **Table 2** by percent.

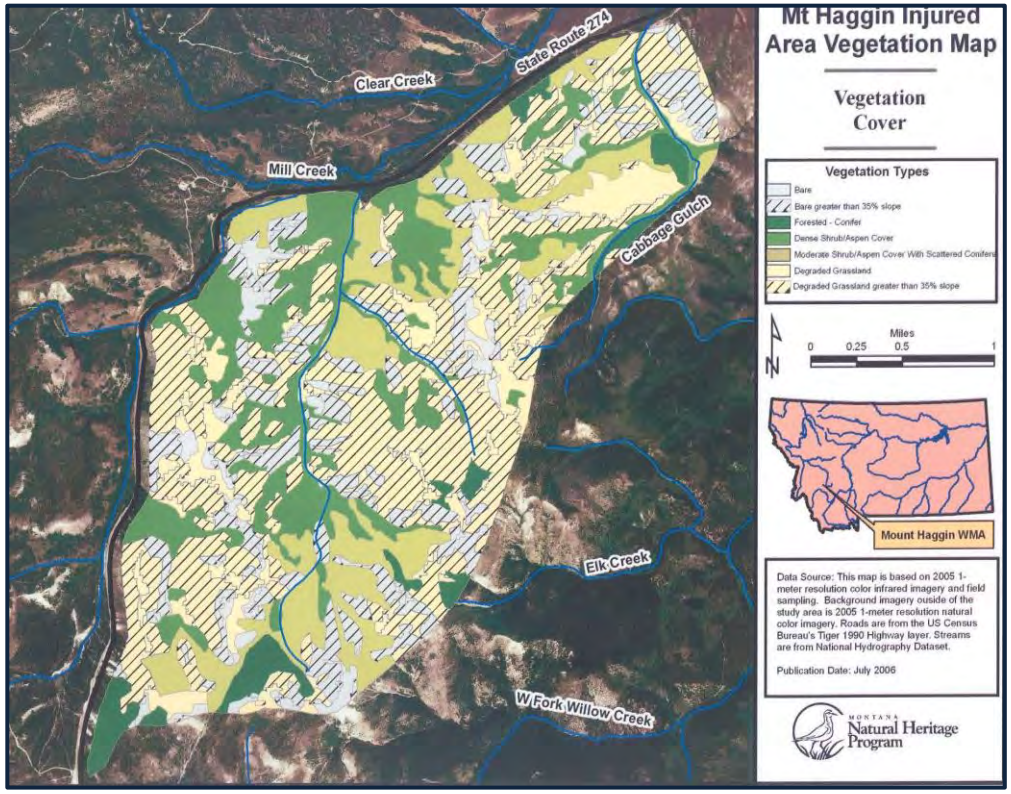


Figure 15. Injured Area Vegetation Map 2007

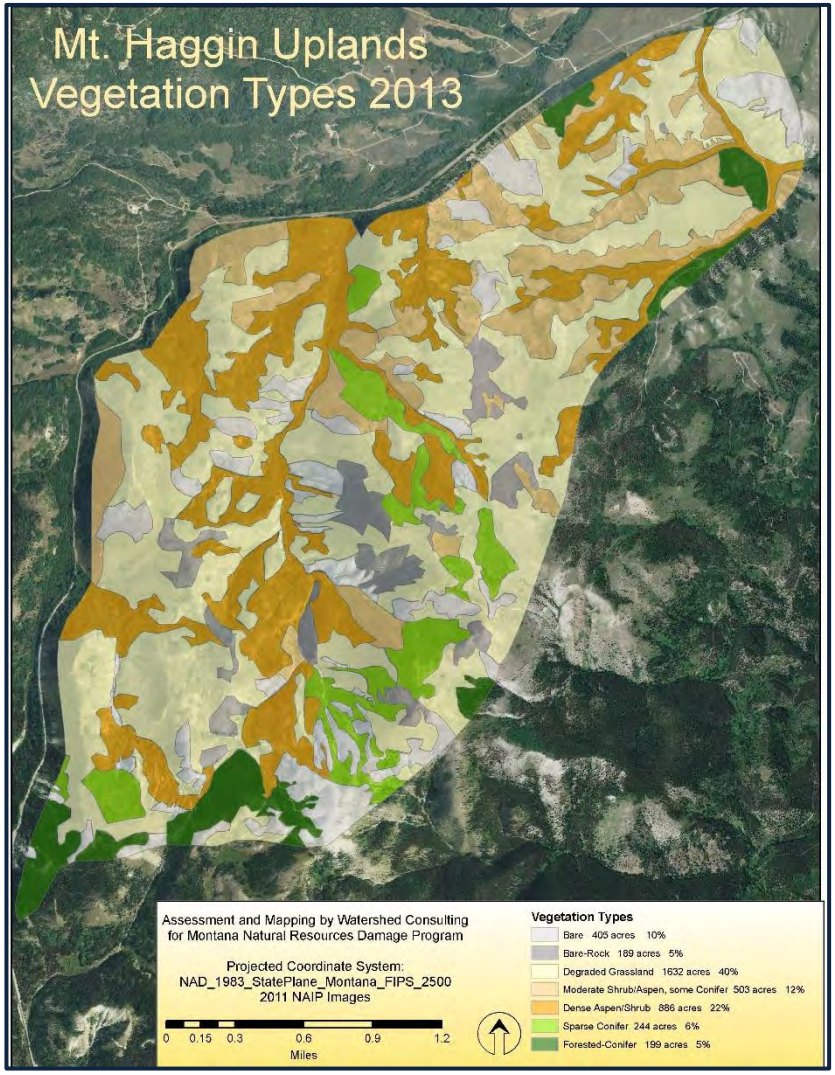


Figure 14. Injured area vegetation map 2013

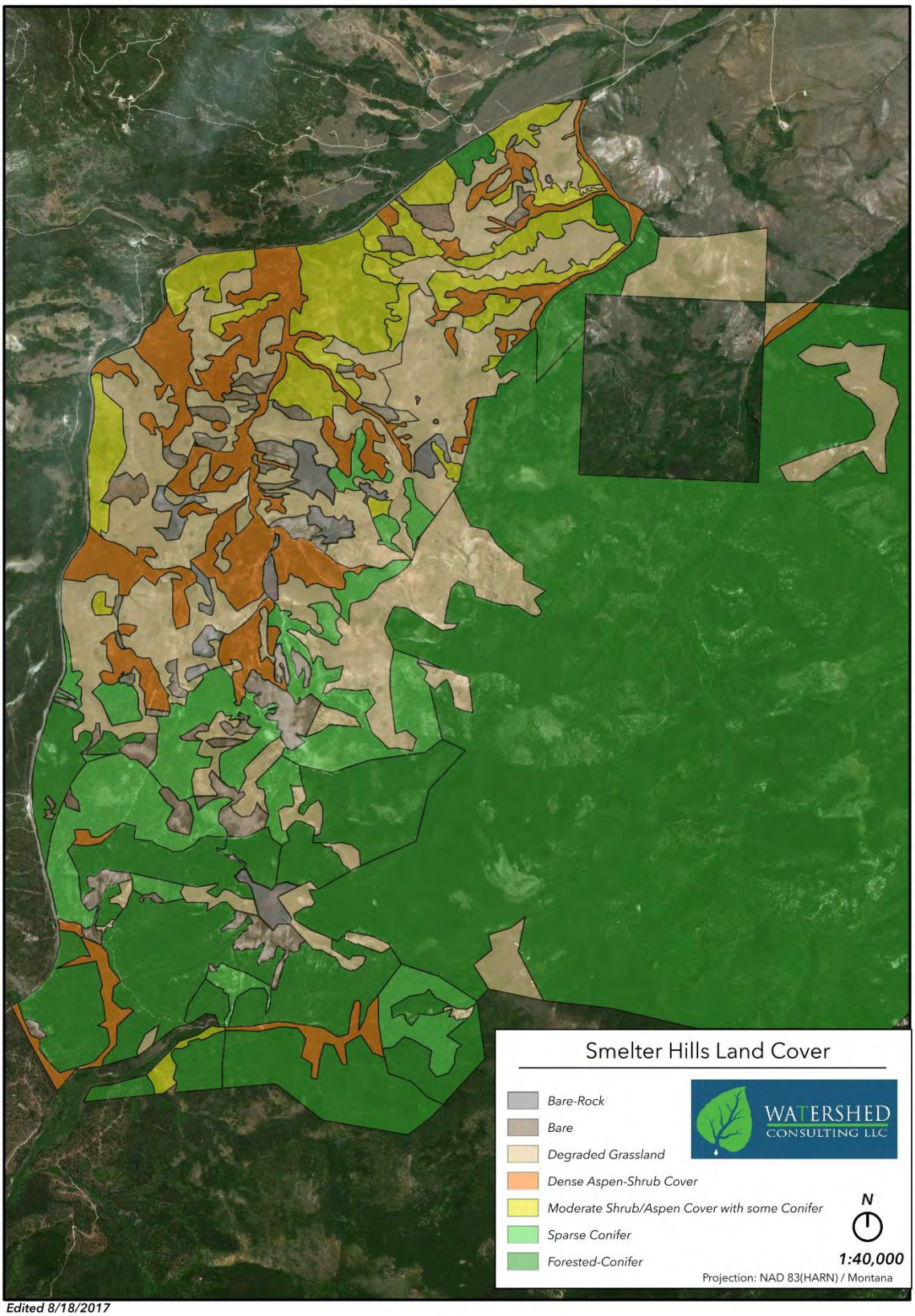


Figure 16. Vegetation Cover Map, all Remedy and Restoration Areas, 2017

Table 1. Vegetation Cover by Acre

Drainage	Total Acres	Bare-Rock	Bare[16]	Degraded Grassland[17]	Moderate Shrub	Dense Shrub	Sparse Conifer	Forested Conifer	% Steep Slopes*
	Injured Area Polys								
Joyner Gulch	1657	70	175	563	175	473	202	0	66
Muddy Gulch	425	13	19	217	8	128	40	0	64
Mill Creek	1121	11	71	386	375	133	18	127	63
Cabbage Gulch	858	8	5	371	164	109	0	200	52
Total IA	**4061**	**161**	**270**	**1537**	**722**	**843**	**260**	**328**	**61^**
Willow Creek	8234	0	28	759	0	12	186	7249	NA
California Creek	2221	28	168	132	23	117	460	1293	25
Total RR Area	**14516**	**189**	**466**	**2428**	**745**	**971**	**905**	**8870**	**43^**

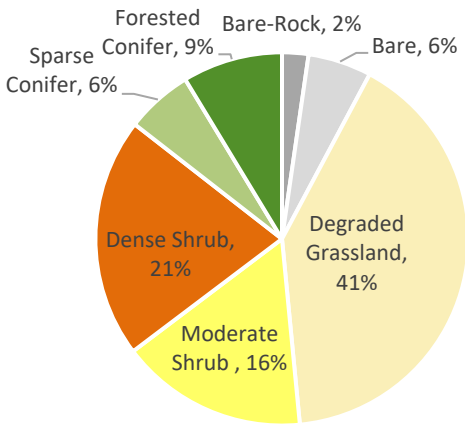
* Defined as slopes >15°
^ Average values

[16] The threshold for bare vs. degraded grassland is an approximation of vegetation cover equal to or less than 10%.

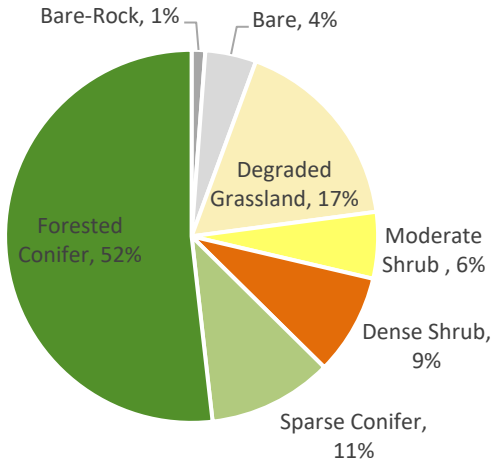
[17] Vegetation types in this assessment are consistent with the type codes used in original vegetation cover maps produced by MNHP. Cover maps, therefore do not contain a category for functional grasslands, of which there are numerous examples within the RRAs. Functional grasslands are accounted for in the numerous acres prescribed as Monitor-Well Vegetated within degraded grassland land cover types.

Table 2. Vegetation cover type by drainage (%)

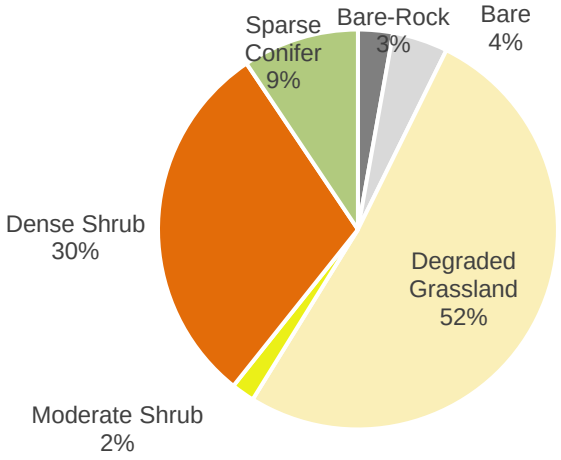
Injured Area Total



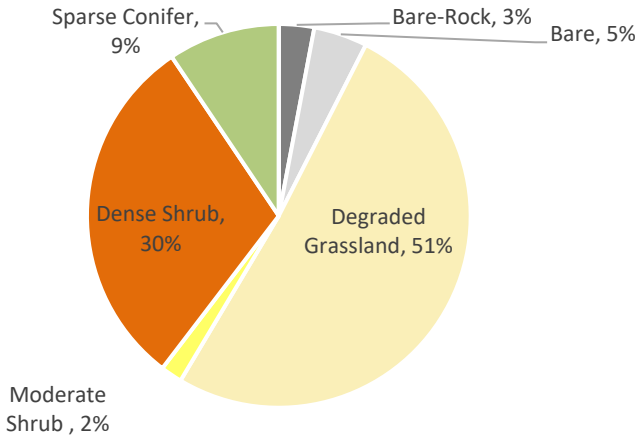
Remedy and Restoration Area Total



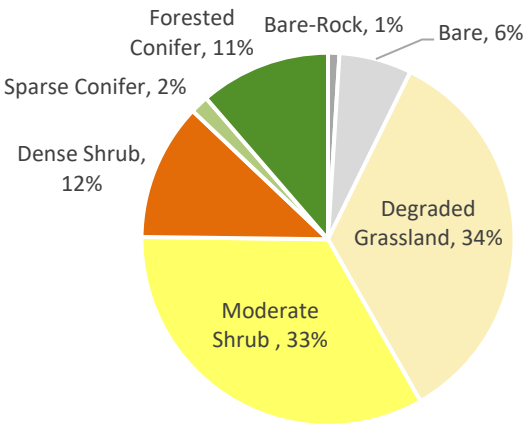
Joyner Gulch



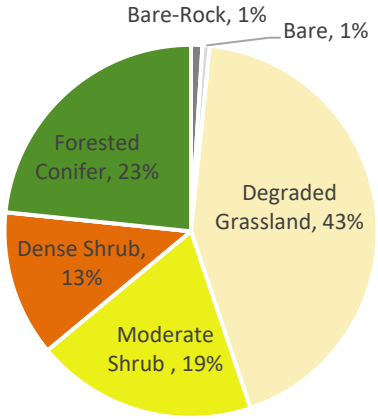
Muddy Gulch



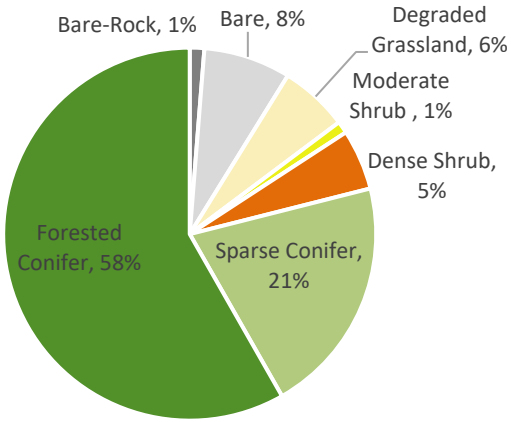
Mill Creek



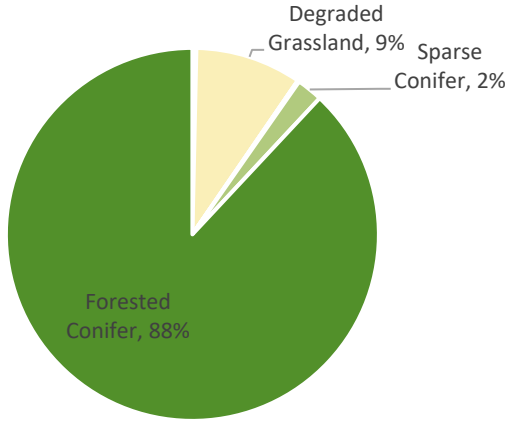
Cabbage Gulch



California Creek



Willow Creek



Soils

There are multiple ecological constraints impeding the rapid recovery of the uplands, many relating primarily to soil conditions, as well as generally harsh climatic conditions. In highly eroded slopes of welded tuff, the A and B soil horizons are gone, washed away most likely in the early 1900's following intensive logging and vegetative die-off from smelter emissions. The mineral soil that is left is essentially welded tuff being broken down slowly by the elements. It is a silty-sand textured soil with high percentage of coarse fragment and very low levels of basic plant nutrients water-holding capacity. Between 2013 and 2014 soil samples were taken in different habitat types to determine basic soil characteristics for plant growth, such as pH, organic matter and Cation Exchange Capacity, as shown in **Table 3**.

Table 3. Soil sample results taken from different locations in California Creek and Joyner Creek

Sample Location	Location description	Sample Depth (inches)	Sample Date	Organic Matter (%)	pH	Cation Exchange Capacity (meq/100g)	Nitrogen	
							Fertilizer Recommendation (% NPK)	Estimated N release (lb/Ac)
Sediment Plume	Bare, low-elevation	0-2	May, 2013	0.1	5.9	11.3	N- 35; P-40; K-0	N.A.
		2-4	May, 2013	0.3	5.9	10.4	N- 35; P-40; K-0	N.A.
		0-12	August, 2014	<.1	5.8	10.94	N.A.	8
		12-24	August, 2014	<.1	5.5	16.04	N.A.	16
Partially Vegetated Floodplain	degraded grassland, low-elevation	0-6	August, 2014	2.7	6	13.7	N.A.	74
		6-12	August, 2014	2.5	6	14.2	N.A.	140
		12-24	August, 2014	0.67	6.2	15.57	N.A.	36
Partially Vegetated Upland-Mid Slope	degraded grassland, mid-elevation	0-2	May, 2013	2.5	5.2	9	N- 35; P-0; K-0	N.A.
		2-4	May, 2013	1.8	5	8.5	N- 35; P-0; K-0	N.A.
Bare Upland	Bare, high-elevation	0-2	May, 2013	0.5	5.5	13.4	N- 35; P-0; K-0	N.A.
		2-4	May, 2013	0.8	5.5	14.9	N- 35; P-0; K-0	N.A.
		0-6	August, 2014	0.45	5	13.2	N.A.	18
		6-12	August, 2014	0.62	5.3	12.07	N.A.	25
Forested Upland	Conifer, high-elevation	0-2	May, 2013	4.4	5	7.5	N- 35; P-0; K-0	N.A.
		2-4	May, 2013	1.8	5	5.6	N- 35; P-0; K-0	N.A.

Earlier soil samples taken in 2007 across the RRA showed similar pH readings **(Figure 17)**.

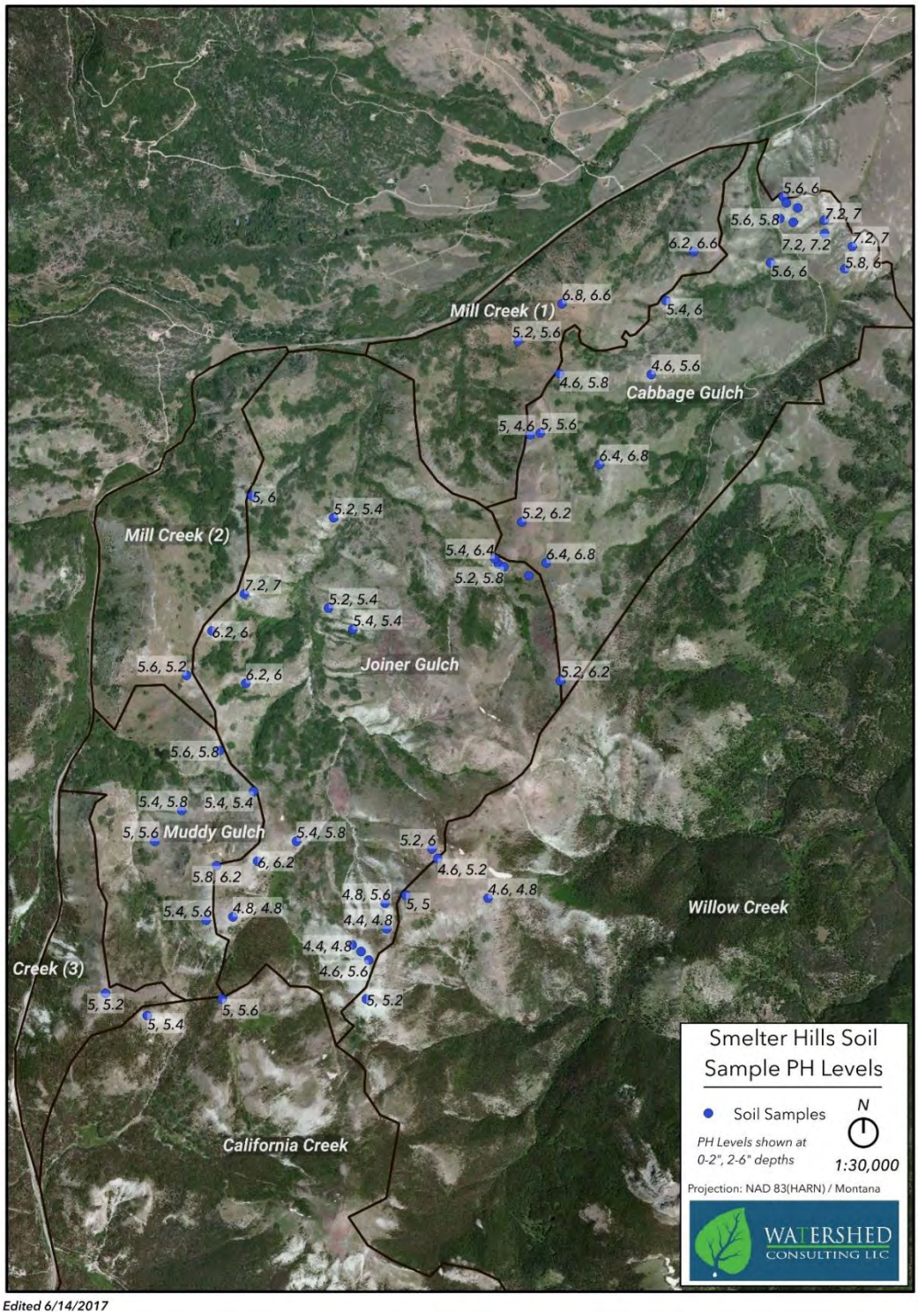


Figure 17. Soil pH at 0-2 and 2-6 inch depths from (Keck, 2007)

Additional soils analysis work by ARCO between 2014 and 2016 provides a more nuanced understanding of the relationship between soils and metals on the landscape (see ARCO, 2017). The graphic shown in **Figure 18** illustrates that metals concentrations increase with decreasing soil particle size. These finer-textured soils are typically located on the landscape in valley bottoms and lower gradient areas, alongside streams. These are typically the areas where natural revegetation is occurring the most rapidly across the RRA. Conversely, bare and highly erosive slopes, while covering a larger percentage of the landscape, typically transport fewer metals to waterways. ARCO's findings state, "the largest potential source of arsenic and metals to surface waters is soil

eroded from well vegetated slopes. Sediment and/or soil in the stream corridor, which are derived from erosion of adjacent slopes, appear to be secondary, lesser sources of COCs to surface waters" (ARCO 2017).

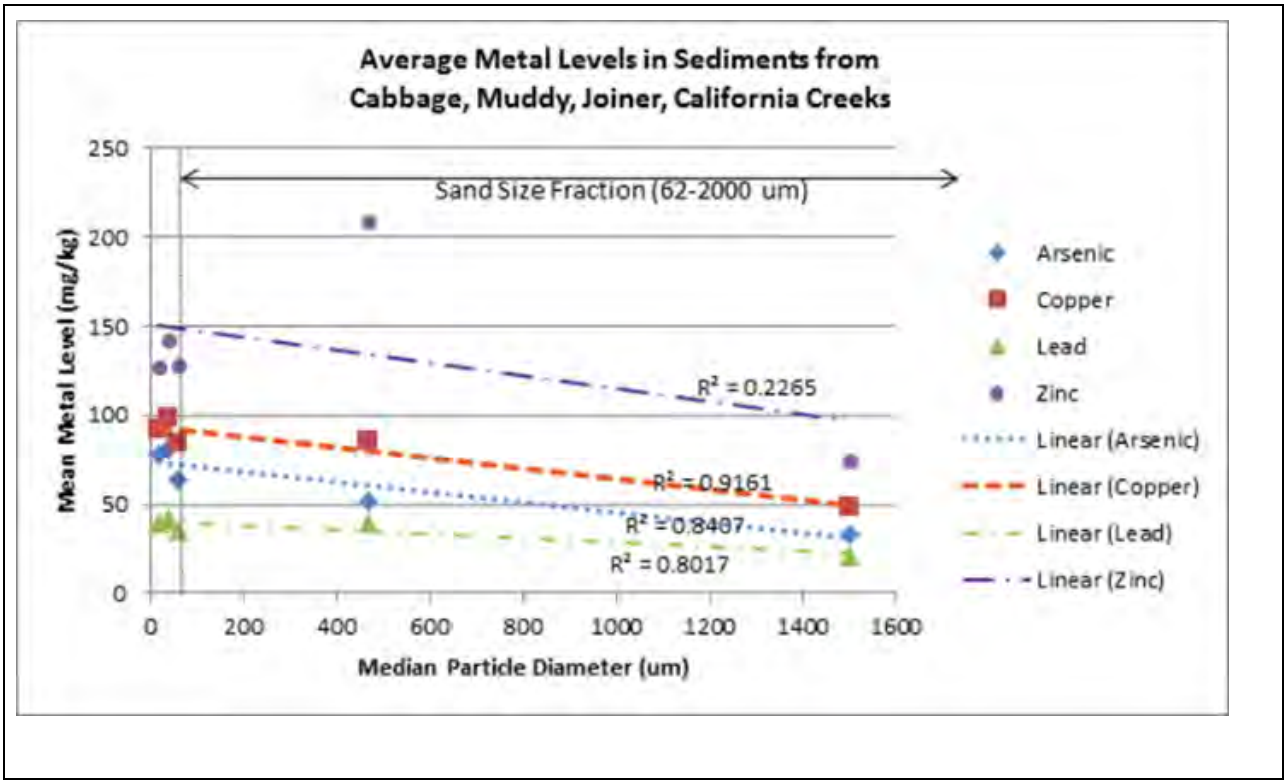


Figure 18. Average metal levels in RRA drainages by median particle size

Contaminant loading to the Mill Creek drainage is well documented from extensive study by ARCO. Findings from that study indicate that contaminated soils from tributaries account for most of the downstream COC loads in the mainstem of Mill Creek. Further, ARCO found that approximately 90% of the mass load for each COC is present on vegetated slopes, with minimal loading coming from bare slopes (ARCO 2017). The primary contaminant pathway identified in the ARCO study for most metals (besides arsenic) is surface water runoff of contaminated soils into surface water (ibid.). Arsenic is found mostly in the dissolved phase in surface waters, while other COCs are bound to soil particles and are detected during high flows in suspended sediments. The metals-laden sediments are carried downgradient during large storm events and spring snowmelt, particularly through large gully pathways.

This nuanced understanding of metals contamination and soils is important to the overall remediation objectives in the RRAs but also illustrates the limitations of traditional remedial approaches both existing and planned in other OUs of the larger Superfund area, particularly on state-owned lands. Specifically, this data makes clear that excavating and hauling-off all contaminated sediments and installing large sediment-catchment basins is not a viable remediation strategy on state-owned lands and would do more harm than good to the landscape's ecological integrity and processes. The use of sediment detention basins would not only diminish the natural character of the landscape, but would create a large maintenance requirement for current landowners, MFWP. With the above conditions and management goals in mind, a number of projects have been implemented across the RRAs between 2011 and 2017, with each project demonstrating efficacy of different treatments at increasing scales. These demonstration projects are monitored annually and help inform the remedies recommended in this plan.

Weeds

Monitoring and treatment of weeds is a primary component of the proposed remedy and restoration of the RRA. Weeds have been identified and mapped throughout the RRAs and shown below in **Figure 19.** Weeds are nature's way of covering disturbed or bare ground and, in the context of this project, are seen as a part of vegetative succession. While undesired, they can play an important role in holding soil on the landscape until native vegetation becomes established. In some areas weed populations have been monitored for 10 years and biological weed control organisms have been dispersed on the landscape in different locations. Chemical weed control has also taken place along the Mill Creek road. The weed plan for the RRA including detailed maps for each drainage are presented in **Appendix B: Noxious Weed Treatment.**

Project Monitoring

Project monitoring and documentation have been integral to the adaptive management approach employed in this ongoing work. Implementation effectiveness will be determined by measures of vegetation cover, active erosion on the landscape and sediment catchment described below. Regular monitoring activities can include soil sample analysis, vegetation assessments, calculation of erosion rates and sediment capture, as well as field photographs, aerial imagery and video. Project managers are working closely with Montana MFWP to develop monitoring activities that are consistent with landowner management objectives while meeting NRDP criteria for in-situ remediation and restoration. The individual polygon sheets presented in **Appendix D: Polygon Data Sheets** provide baseline information on a per unit basis. These sheets will be updated regularly as work progresses and made available to land managers. Notes on implementation effectiveness will also be contained in these polygon sheets. Further monitoring protocol may be included in this report as an Appendix at a later date. The following long-term monitoring measures will be undertaken.

- Establishment of long-term photo points
- Bi-annual sediment capture analysis from Unmanned Aerial System (UAS) imagery
- Bi-annual vegetation cover analysis from UAS imagery
- Annual oversight of all construction activities
- Annual Weed monitoring
- Annual Stream flow monitoring
- Annual assessment of upland vegetation and amendments (study underway by Montana Tech)
- Soil studies as needed to refine revegetation techniques
- Annual maintenance of geospatial database of work completed

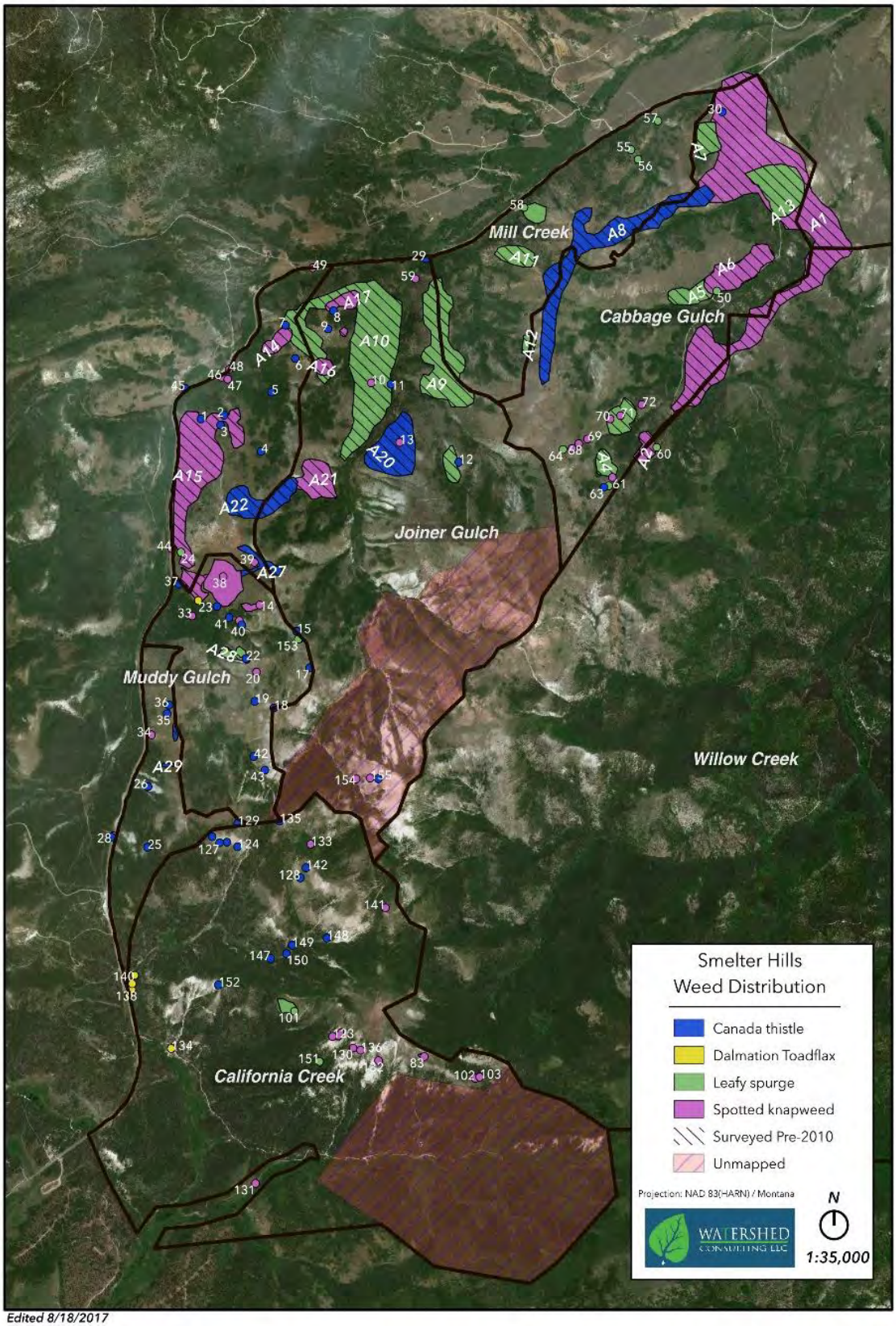


Figure 19. Weed distribution in Mount Haggin Remedy and Restoration Area

Remedy and Restoration Design

The NRDP has been implementing steep slope work based on some of the guidance set in work plan documents (ARCO 2007a, 2007b). These documents identify progressive levels of Steep Slope Reclamation (SSR) treatment types, as shown in **Table 4** below. Steep slope remediation prescriptions in those plans for the Mt. Haggin Uplands were minimally defined and included planting of 450 stems/acre of container plants and installing sediment detention basins (SSR-4) at the base of many tributaries to Mill Creek. Some of those detention basins remain in the recommended remedial actions in ARCO's latest planning document, the proposed TI Waiver evaluation (ARCO 2017).

Table 4. Steep Slope Remedy (SSR) Treatment Prescription from RAWP

SSR Intensity	**Short Description**
SSR-1	Revegetation
SSR-2	Revegetation plus hand-installed slope BMPs
SSR-3	Revegetation plus slope equipment installed BMPs without engineered controls
SSR-4	Revegetation plus slope equipment installed BMPs with engineered controls and amendments
SSR-5	Revegetation plus slope BMPs, plus engineered controls, plus amendments, plus coversoil
M-WV	Monitor- Well vegetated with positive ecologic trends
RNA	Rock no Action: Talus or heavily armored slope. No sediment contribution

In 2012, the NRDP and MFWP convened the MHTWG to explore alternatives to the remedy prescriptions in those work plan documents. In particular, the prescription for detention basins was seen by land managers as an un-sustainable solution due to impacts to existing conditions on the landscape as well as the prohibitive maintenance costs of such a solution into the future. Equal quantities of sediment capture can confidently be achieved with the techniques described in this report, rendering sediment basins unnecessary. Initial assessments for the IA was begun in 2012 with landscape-scale assessment designed to determine priority sediment delivery locations across the landscape. Physical characteristics of the landscape such as surface roughness, soil type, vegetation type, slope and aspect were shown to be important factors in the erosive character of the upland landscape (Watershed Consulting 2012a). Across the riparian areas, field observations showed significant sediment buffering capacity where vegetation had ready access to limited water resources (Watershed Consulting 2012b).

Over the course of several years implementing demonstration projects and field trials, a suite of SSR techniques was developed by NRDP and EPA contractors. These techniques are shown in **Table 5** and described in detail in the following sections.

Table 5. Steep Slope Remediation techniques used for final design

Name	Description	Notes	Technique also includes		
SSR-1 Revegetation					
SSR-1a	Broadcast Seeding				
SSR-1b	Broadcast Seeding with Fertilization	organic or inorganic fertilizer			
SSR-1c	Soil Scarification/Trenching	Includes hand-broadcast and coir blanket			
SSR-1d	Woody Plant Establishment	includes willow stakes and/or container plants			
SSR-1e	Other Soil Amendment	lime, compost, other			
SSR-2 Hand-installed slope and stream/gully BMPs					
SSR-2a	Slope stabilization	coffee bags, slash, coir/straw wattles	1b		
SSR-2b	In-stream check structures (brush, straw bale)	for wetland and riparian enhancement, stream aggradation, beaver mimicry	1d		
SSR-2c	Gully slash filters	Not constructed structures			
SSR-2d	Gully Check Dams	rock, log, geobag, coir fabric			
SSR-2e	Anchored brush bundles/brush boxes	higher intensity construction- includes metal support in banks or mechanical trenching for brush trenches	1d		
SSR-3 Mechanical earth-moving and BMPs without engineered controls and designed to enhance natural revegetation					
SSR-3a	Slope pitting and roughing	dozer pits, "rough and loose", woody debris	1b	2a	
SSR-3b	Earthen sediment retention	contour berms (Cabbage Gulch); includes native sod and shrub transplant	1d	2a	
SSR-3c	Gully grading and filling	typically involves channel creation (Muddy Gulch)	1b,1d	2a	
SSR-3d	Rock check dams	Mechanized; may or may not require engineering		2a	
SSR-3e	Hydroseeding	Can include amendments	1b	2a	
SSR-4 Large-scale earth-moving and soil re-construction involving engineered controls and/or long-term maintenance					
SSR-4a	Slope grading	Large-scale terraforming	1b,d	2a	3b
SSR-4b	Compost tillage	Tillage up to 18”	1b,d	2a	3b
SSR-4c	Lime tillage	Tillage up to 18”, requires extensive soil sampling	1b,d	2a	3b
SSR-4d	Sediment detention pond	Requires permanent access road construction and maintenance	1b,d	2a	
SSR-4e	Soil and earth removal	Requires extensive soil analysis	1b,d	2a	

These initial observations, taken with agency and landowner management priorities over the long term led to the overarching design strategies. With these conditions in mind, the remedial and restoration design presented here was developed around the design strategies shown in **Table 6** below. The NRDPs remediation and restoration plan provides for an **equal or greater amount of sediment retention** as the ARCO-proposed mechanized basins and with more desirable long-term results for habitat conditions across the landscape. In contrast to the single-solution remedy, this plan calls for an **iterative and adaptive management approach** based on site-specific monitoring. The RAs being implemented will be monitored annually, sites revisited and approaches adapted as needed in order to push natural ecologic recovery of the landscape in the right direction for long-term resilience and the State’s land management objectives.

A main objective of work in the uplands, riparian areas and sediment plumes is to:

> **Create conditions for self-perpetuating vegetative growth and soil-formation processes in the uplands** and to **expand riparian and wetland buffers to retain sediment on the landscape. Both of these endpoints will enhance wildlife habitat.**

Table 6. Design strategies

Uplands	Riparian
Create islands of fertility by enhancing surface roughness on bare slopes to create more locations for sediment capture and seed germination. Provide nitrogen fertilization to enhance root mass and promote seed production. Provide missing soil nutrients and micro-nutrients to promote soil biological processes that support natural recolonization. Create grade controls throughout sediment pathways, beginning with rill formation on bare uplands and degraded grasslands as well as gullies. Preserve the natural character of the landscape. All access routes for equipment will be reclaimed upon completion of work. No haul roads will be constructed. Approaches that require long-term maintenance or use of foreign materials into the area are discouraged by the landowner.	Slow water velocities and decrease erosive stream energy in all channels and gullies. Aggrade incised stream reaches to promote over-bank deposition of storm water and sediment catchment on the landscape. Stop sediment delivery via gully pathways. Enhance wetland and riparian acreage to maximize sediment buffering capacity and uptake of metals by plants.

Design Assumptions, Considerations and Constraints

Certain design assumptions were necessary to complete the SSR treatments prescribed in this plan. These assumptions include:

- Metals are in sediments across the landscape and large-scale removal or tilling is not an acceptable option for remedy;
- Landowners and project managers recognize that the establishment of naturally functioning landscapes is the desired long-term condition of the RRAs;
- The controls and BMPs have been proven to be feasible to implement in this landscape based on prior work completed[18];
- Most of the erosion-control techniques in the SSR-1,2 and 3 categories are field-fit in nature and designed for the least harmful impact to existing conditions;
- The volume of sediment produced in the sub-drainages was not quantified as part of the evaluations.

[18] Recent research in Cabbage Gulch demonstrated capacity for beaver pond systems to attenuate metals, capture sediment and provide hydrologic stability (see Tucci 2014).

Remedy and Restoration Completed Work

SSR-1 Completed Work Summary

SSR-1 work includes all active revegetation activities, from addition of soil amendments to planting of native vegetation. A series of successful revegetation efforts from 2012 through April of 2017 demonstrated the feasibility of these approaches, and are summarized in **Table 7** and **Figure 20.** These efforts, which include projects funded from other state agencies, have not only demonstrated their efficacy, but project managers have also better understood the benefits and costs associated with different techniques applied on this landscape. Images of SSR-1 efforts are shown in **Figure 21.**

Table 7. SSR-1 Completed Work Summary

Drainage	Remedial/Restoration Completed Work (acres)			
	SSR-1b	SSR-1c	SSR-1d	Total SSR-1
Injured Area Drainages				
Joiner Gulch	37.1	4.3	0.0	41.4
Muddy Gulch	9.5	0.5	0.0	10.0
Mill Creek	2.3	0.0	26.5	28.8
Cabbage Gulch[19]	3.1	0.0	5.9	9.0
Total IA	51.9	4.9	32.4	89.2
Willow Creek	9.2	0.1	0.0	9.3
California Creek	26.5	4.1	8.7	39.3
Total RR Areas	87.6	9.1	41.0	137.8

[19] Extensive Cabbage Gulch work completed is not reflected in table but documented in a Construction Completion Report being drafted for the NRDP and EPA, winter 2017.

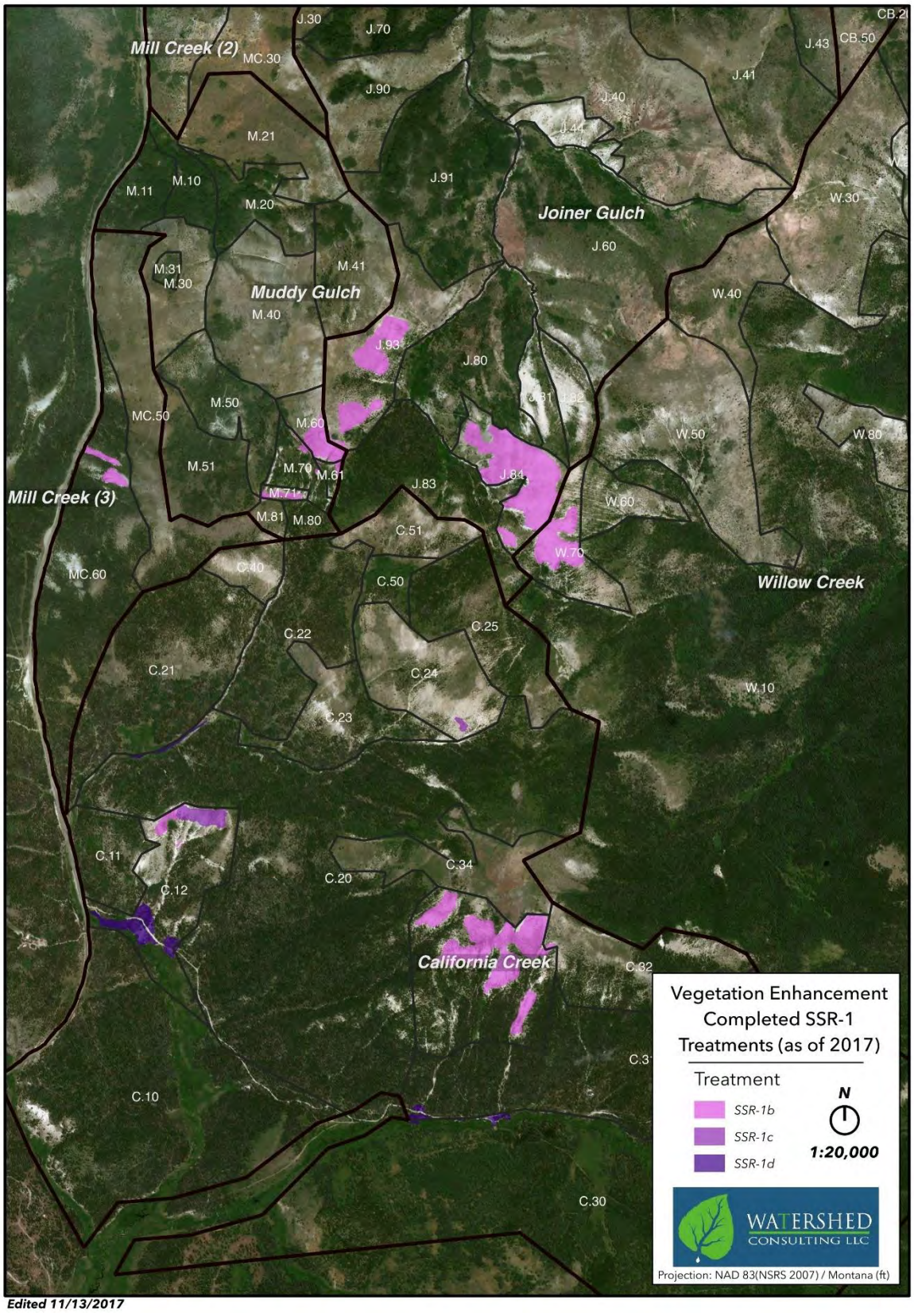


Figure 20. Completed SSR-1 to April 2017 (see Table 6 for SSR treatment definitions)

Figure 21. SSR-1 Images

Installing willow stakes below beaver analog structure in May 2016 (above) and in June 2015 (right) in California Creek

May, 2014, snowmelt from gully crosses California Creek road and adds to sediment plume (left); June, 2016 beginning of vegetation establishment after installation of culvert gully plugs and container plants (right)

Vegetation establishment in a California Creek plume area (June, 2016)

Willow stakes along stream in California Creek (June, 2016)

Protected willow plantings in California Creek (June, 2016)

Installation of willow brush trench in California Creek. Disturbed soil was seeded and capped with brush to minimize soil loss (October 2016)

SSR- 1b, aerial fertilization operation, 2016

SSR-1c Upland vegetation enhancement by MCC crew, June 2014

Compost soil amendment in trench

May, 2015 early results from trenching vegetation enhancement trials

August 2014

July 2017

Joyner Gulch polygon treated with SSR-1c, 2000lb/acre organic fertilizer and erosion control fabric

SSR-2 Completed Work Summary

SSR-2 activities involve the installation of grade control and sediment retention BMPs in the gullies and stream systems of the RRAs. Functionally, these structures serve to capture sediment in erosive gully pathways, which decreases erosive bank slope lengths, decreases erosive energy and also establishes more suitable seed germination substrate in the areas of captured fines behind structures. Captured sediment is a priority outcome for remedy and restoration work, as some of these sediments hold contaminants of concern. A summary of SSR-2 completed work is provided in **Table 8**. In the California Creek watershed, significant funding was provided by Montana DEQ to address stream sediments in that drainage. Efforts were taken to calculate captured sediment in SSR-2 structures in that drainage, results of which are shown in **Table 9.** That table also shows volumes and Tons captured per unit of treated area, numbers which were used to estimate total sediment captured across the RRA, which is shown in **Figure 22.** A map of completed SSR-2 work is provided in **Figure 23**[20] and images of installed structures are shown in **Figure 24, Figure 25, Figure 26,** and **Figure 27.**

Table 8. SSR-2 Remedial/Restoration Completed Work *(2013-2017)*

Drainage	**Remedial/Restoration Completed Work**					
	SSR-2a (acres)	**SSR-2b** (feet of channel)	**SSR-2c/d** (feet of gully)	**SSR-2e** (feet of gully)	**SSR-2 Total** (Feet Treated)	**SSR-2 Total (Miles Treated)**
Injured Area Drainages						
Joiner Gulch	0.0	1418	3714	0	5131	**1.0**
Muddy Gulch	0.1	1602	2297	0	3899	**0.7**
Mill Creek	0.0	0	0	0	0	**0.0**
Cabbage Gulch	0.0	1960	0	0	1960	**0.4**
Total IA	**0.1**	**4979**	**6011**	**0.0**	**10990**	**2.1**
Willow Creek	0.0	0	0	0	0	**0.0**
California Creek	17.1	8327	14843	504	23674	**4.5**
Total RRA	**17.2**	**13307**	**20853**	**504**	**34664**	**6.6**

[20] Not shown in Figure is over 2700 feet of SSR-2d gully plugs in upper Joiner Gulch between J.80 and J.83

Table 9. California Creek Sediment Capture Estimates

SSR Technique	# structures	Volume Captured (yd3)	Volume at capacity (yd3)	Tons Captured	**Tons at capacity**		Volume Captured per treated length (feet)	Volume at capacity per treated length (feet)	Tons Captured per treated length (feet)	**Tons at capacity per treated** length (feet)
SSR-2a	75	1.5	2.6	46.0	**82.4**		0.09*	0.15*	2.69*	4.82*
SSR-2b	315	54.0	444.6	94.8	**780.3**		0.01	0.06	0.01	0.10
SSR-2c	24	48.5	1019.2	85.2	**1788.8**		0.02	0.37	0.03	0.65
SSR-2d	166	157.8	1074.5	316.8	**2000.2**		0.02	0.15	0.04	0.28
SSR-3d	3	59.5	238.0	3.9	**15.5**		NA	NA	NA	NA
Total	**583**	**321.4**	**2779.0**	**546.7**	**4667.1**					
							* measured per treated acre			

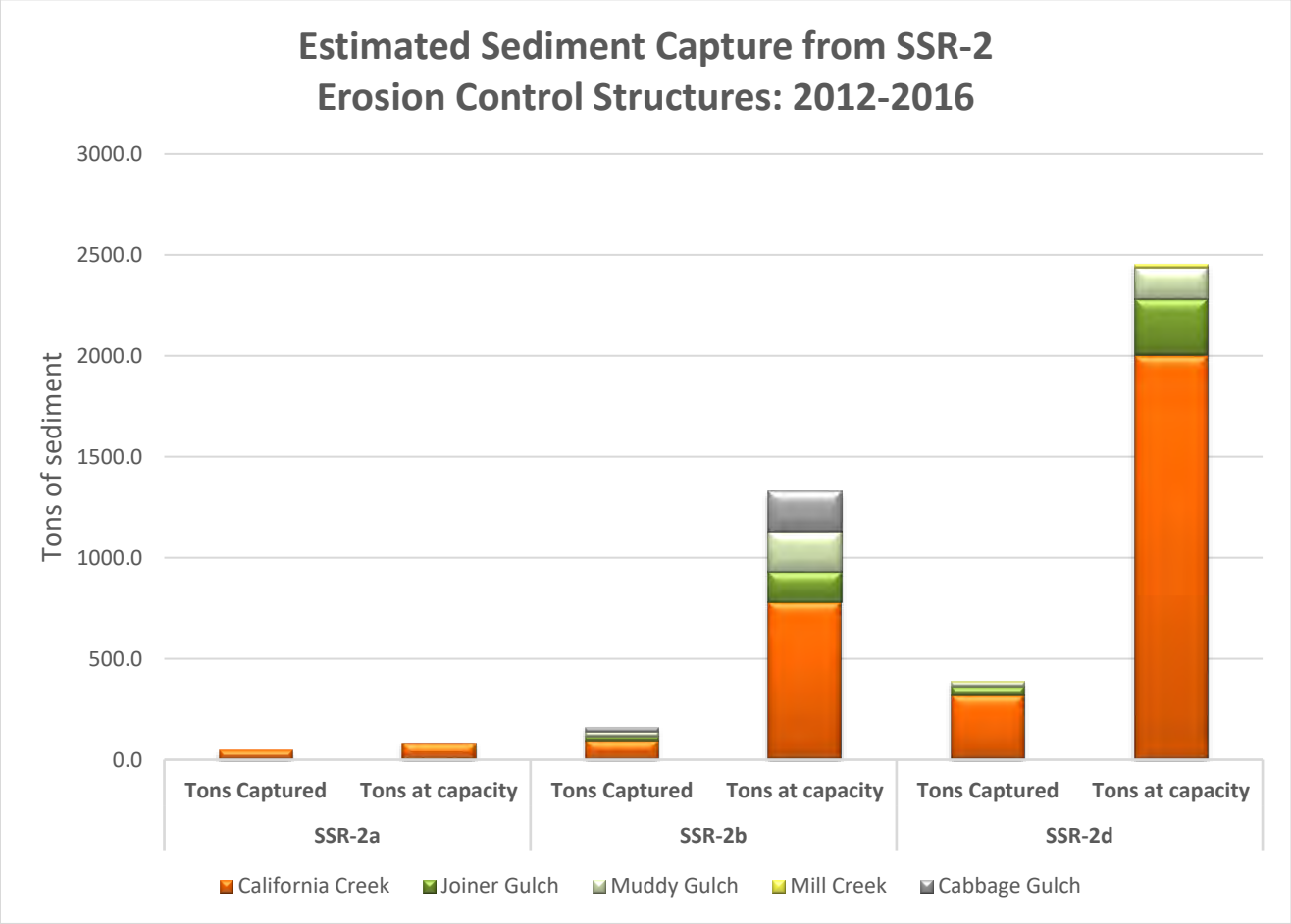


Figure 22. Estimated Sediment Capture in RRAs from SSR-2 Completed Work

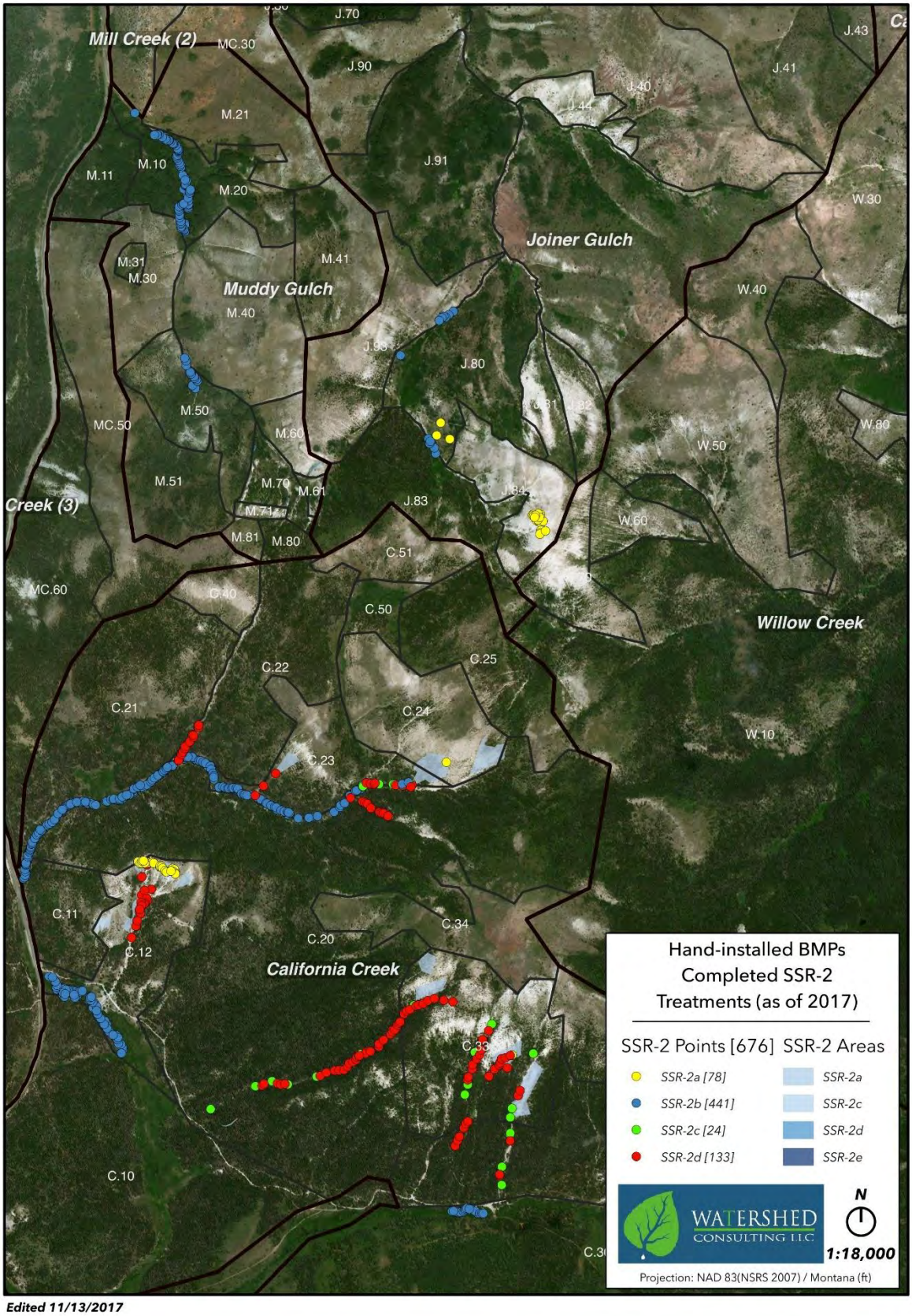


Figure 23. Completed SSR-2 to April 2017 (see Table 6 for SSR treatment definitions)

Figure 24. SSR-2a Rill Treatment examples

Rill treatments high in bare area high above California Creek. Before and after (above) showing sediment catchment. Structures below (left) filled and sediment cut around soft bank. Filled structure (below right) provided germination substrate for native seed to establish.

Rill treatment structures installed by MCC crews, June 2014

Figure 25. SSR-2d (Gully BMP structures) examples

(Above) Structure installed by MCC June, 2014 (left) and completely filled, July, 2015(right)

Gully structures using coir fabric after 1 year of sediment delivery in upper California Creek

Coir-lined fabric in gully above California Creek taken in Fall 2015 (left) and Spring 2016 (right). This gully captured overland flow and gully structures below held back water and promoted vegetation establishment previously non-existent. Bank slope lengths also reduced from slash filters.

Example of gully structures. Some filled structures were re-visited in 2016 and gullies were brought up to grade (bottom right).

Example of enhanced SSR-2d structure previously filled (above) and SSR-2c slash filters in gully bottom and bank walls (below)

SSR-2d structure progression in 2014 (top left), Spring 2015 (top right), June 2017 (bottom)

SSR-2d structure before (top) during (bottom left) and immediately after installation in 2014 and one year later with some sediment catchment (bottom right)

SSR-2d structure during construction in 2014 (above) and after enhancement in 2017 (below)

Mechanized enhancement to eroding banks in 2017, including deposition of erosion into existing structures

Figure 26. SSR-2e (Anchored brush bundles) examples

Example of brush bundle installation and mechanical enhancement in California Creek: Summer 2013 (top left); Spring 2015 (top right); Spring 2017 (bottom and next page)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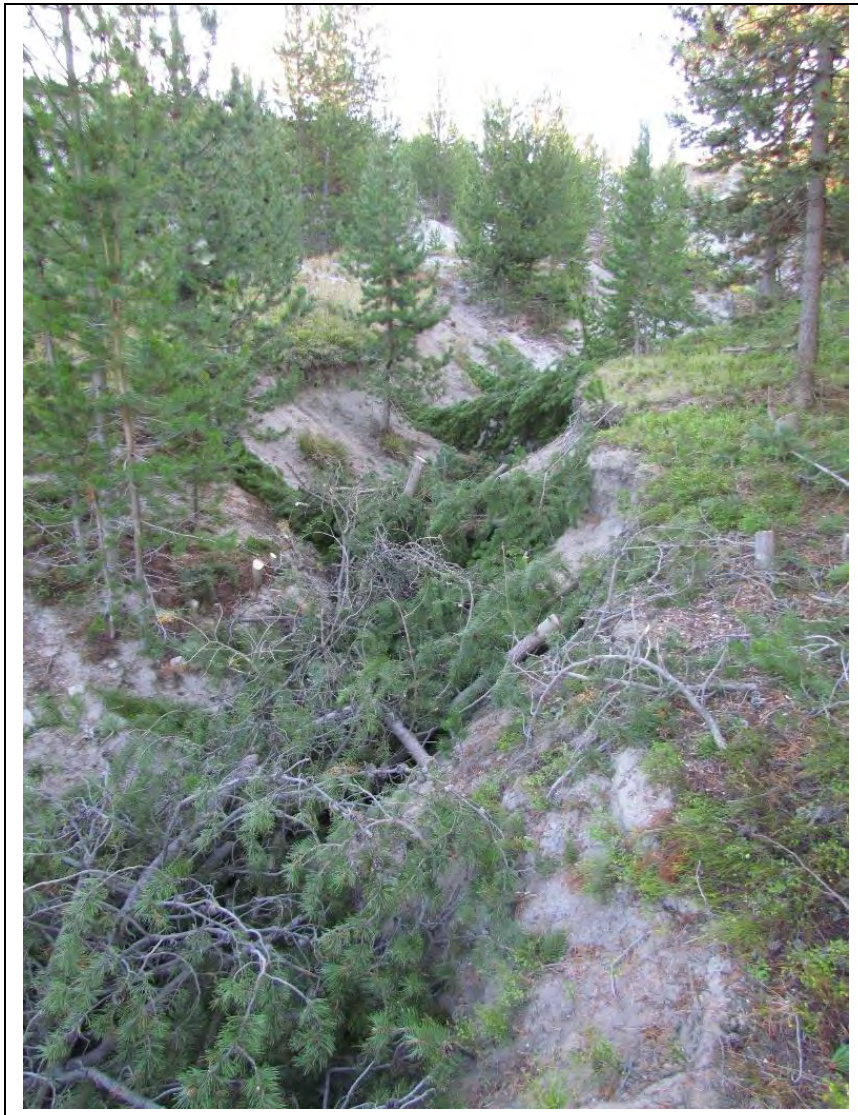
Anchored brush bundles examples before and after installation



Gully slash filters in gullies above California Creek soon after installation in 2014

Figure 27. SSR-2b (Beaver Mimicry structures) examples

Progress of a beaver mimicry structure over time: Spring 2015 (top); Spring 2016 (bottom right); Spring 2017 (bottom left)

Progress of a beaver mimicry structure over time: Spring 2015 (top left); Spring 2017 (top right); and in another area just downstream in Summer 2016 after enhancements to filled structures (bottom left); and Spring 2017 (bottom right)

Progress of a beaver mimicry structure over time (top): Spring 2015 (left); Spring 2017 (right)
Progress of beaver mimicry structure over time (bottom): Spring 2015 (left); Spring 2017 (right)

Progress of a beaver mimicry structure over time: Spring 2015 (top left); Spring 2016 (top right); Summer 2016 (bottom left); Spring 2017 (bottom right)

Sediment catchment from beaver mimicry structure installed in incised reach of California Creek in 2015 (above) and in Spring 2016 (right)

Progress of a beaver mimicry structure in California Creek from installation in Spring 2015 (left) and in Spring 2016 (right)

Progress of a beaver mimicry structure in California Creek from installation in Spring 2014 (left) and in Spring 2017 (right)

SSR-3 Completed Work Summary

This work includes more aggressive, mechanized approaches to sediment reduction. The techniques accomplish similar functions to those described for SSR-2 techniques above but mechanized practices necessarily involve some impacts to the landscape. All vehicle access areas are reclaimed after work is completed and seeded with native species mix. Weed control is always included with SSR-3 activities to avoid incursions from equipment. Summary of all SSR-3 work is shown in **Table 10** below. A visual summary of completed SSR-3 work is shown in **Figure 28** and images of work completed are shown in **Figure 29** and **Figure 30.**

Table 10. SSR-3 completed work summary

Drainage	Remedial/Restoration Completed Work (acres)				
	SSR-3a	SSR-3d	SSR-3e	SSR-3f	Total SSR-3
Injured Area Drainages					
Joiner Gulch	0.0	0.0	0.0	0.0	**0.0**
Muddy Gulch	0.2	0.0	0.5	0.4	**1.0**
Mill Creek	0.0	0.0	0.0	0.0	**0.0**
Cabbage Gulch[21]	0.0	0.0	0.0	0.0	**0.0**
Total IA	**0.2**	**0.0**	**0.5**	**0.4**	**1.0**
Willow Creek	0.0	0.0	0.0	0.0	**0.0**
California Creek	0.0	0.2	0.1	0.0	**0.3**
Total RR Area	**0.2**	0.0	**0.6**	**0.4**	**1.3**

[21] Extensive SSR-3 work in Cabbage Gulch is documented in Construction Completion Report document

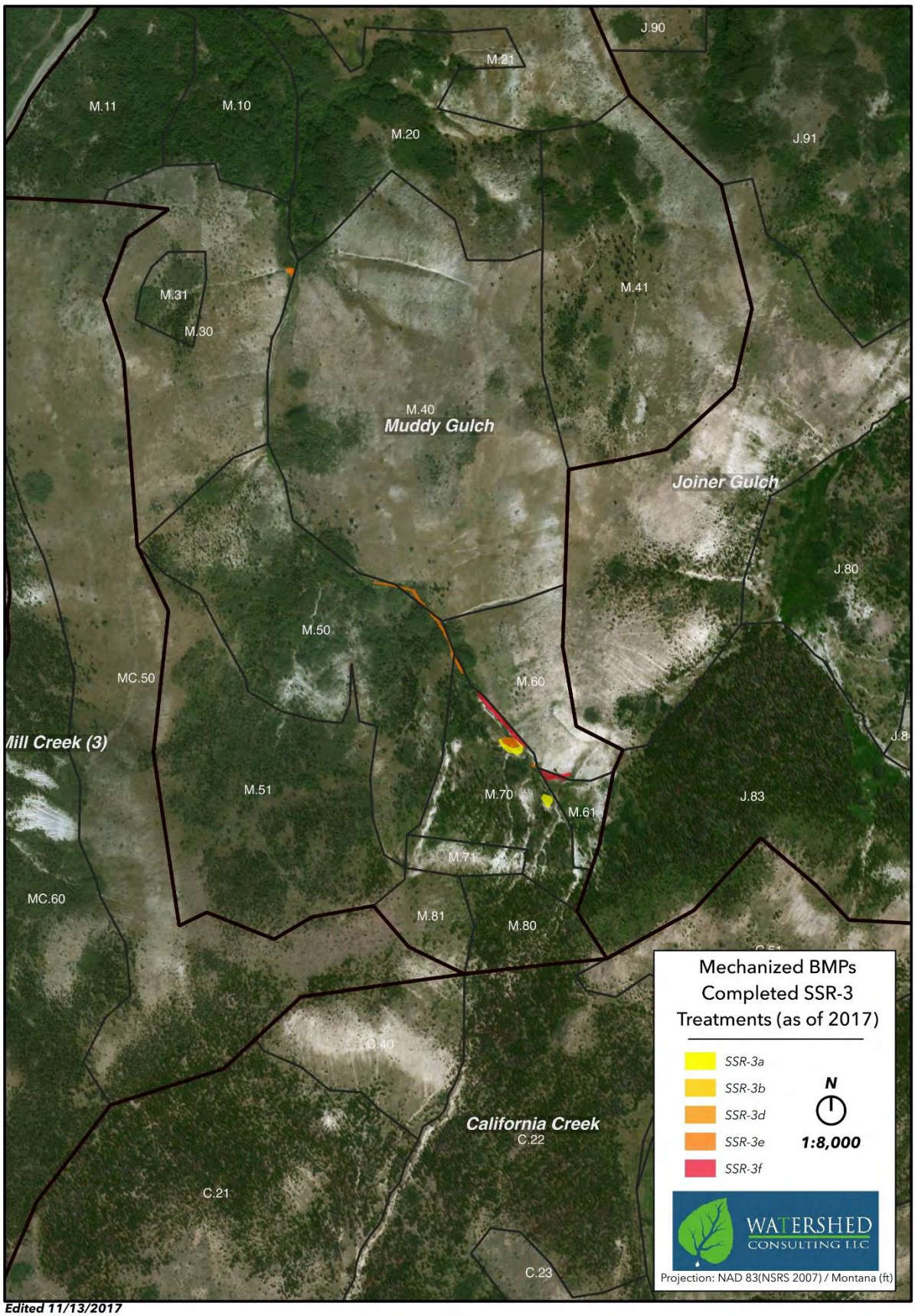


Figure 28. SSR-3 completed work (see Table 6 for SSR treatment definitions)

Figure 29. SSR-3d Engineered Rock Check Dams

Engineered rock structures installed by NRDP in two gullies above California Creek.
Images (top row) looking upstream at structures from below and looking upstream at structures from above (bottom row)

Figure 30. Road Work Images

Digging catchment beside plume area (top left) and view across road where large rill used to cross (top right) in California Creek. Road work area 3 (below) right showing ditch and culvert crossing

Road work area in California Creek (above) showing ditch and catchment basin.
Another road work area (below) with sediment deposition from 2015 (left) and 2016 (right) spring flows

Road work area (above) with improved roadside drainage and expanded catchment area at base. Culvert remains plugged and will be addressed by MFWP in the future. Culvert removal from stream in California Creek shown below and on next page

Figure 31. Muddy Gulch stream reconstruction Summer 2016 (left), March 2017 (right)

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SSR Remedy and Restoration Toolbox

This section describes all the SSR techniques developed in over the last 5 years by the NRD program. This section can be used as a stand-alone manual for steep slope restoration in a variety of contexts.

SSR 1a: Broadcast Seeding

Broadcast seeding of grasses and forbs has been shown to successfully colonize the Mt. Haggin uplands where there is a lack of a natural seed source. Seed can be hand-applied as well as aerially broadcast via helicopter. Seed mixes should emphasize metals and low-pH tolerant cultivars, species common to the area, and species with high wildlife forage, soil stabilization and varietal hardiness characteristics.

Broadcast seeding via hand-operated belly seeder on freshly worked soil adjacent to a gully.

Broadcast seeding is appropriate under certain conditions:

- Soil has been shown to lack natural seed source
- Slope has relatively uniform features without excessive gullying
- Grasses and forbs will aid in soil stabilization and wildlife forage

Design & Application Considerations

- In areas <5 acres, hand application via belly seeder is appropriate. Treatment areas >5 acres should be applied via helicopter to maximize distribution and efficiency
- Low pH- and metals-tolerant native seed varieties have been developed for use in this project area through the Bridger Plant Materials Center and have shown high success in the Mt. Haggin WMA under the right conditions
- Seed should be applied on calm days (low wind), in late fall or early spring to maximize germination potential
- Seed mix should consist of drought-tolerant, native perennial species with extensive root systems
- Seed mix should emphasize species with vegetative growth characteristics (i.e. tillers and runners)
- In high traffic wildlife areas, consider species that are not preferred as wildlife forage to reduce browse pressure

Cautions:

- Exceptionally exposed areas (ridgelines, high wind areas, scree fields) should be avoided
- Noxious weed-infested areas will have lower rates of success when seeded with a native mix
- Slopes of 50% (~25°) or greater should be prepped with micro-topography to improve germination rates

SSR 1b: Seeding & Fertilization

The parent material throughout the Mt. Haggin WMA has tested exceptionally low in plant available nitrogen due to the nature of the volcanic tuff that formed the soils. Inorganic and organic fertilizers provide a much-needed boost to seed establishment. Fertilizer application also boosts the growth potential of existing vegetation throughout the project area.

Broadcast seed and inorganic fertilizer visible alongside established Berberis repens in the Mt. Haggin Uplands.

Seeding & fertilization is appropriate under certain conditions:

- Slope is within appropriate parameters for seed germination success (see above)
- Fertilizer is applied 200+ feet from stream systems
- Slopes are considered unlikely to experience overland sheeting or other extensive erosion

Design & Application Considerations

- In areas <5 acres, hand application via belly seeder is appropriate. Treatment areas >5 acres should be applied via helicopter to maximize distribution and efficiency
- Slow-release organic fertilizers, such as Sustane or Biosol at 2000 lbs/acre have been proven effective.
- Fertilizers should have high N:P:K ratios – from 7:3:2 up to 42:0:0
- Compost products can be incorporated in areas where organic material is desired
- Fertilizer should be applied in early spring (after snowmelt) to maximize growth potential
- Fertilizer alone can be applied in areas with established vegetation to promote growth potential
- Seed and fertilizer can be used in combination with light earthworks, BMP structures and in between woody transplants

Cautions:

- Fertilizer should not be applied at high concentrations within 30’ of stream systems, wetlands or ponds
- Fertilizer should not be applied in noxious weed infested areas without aggressive weed treatment in those areas
- Fertilizer should not be applied in areas of extensive rilling or gullying unless check dams or other BMP structures are incorporated to reduce downslope impacts

SSR 1c: Soil Scarification & Trenching

Soil scarification and trenching, typically across contours are an effective means towards improving germination rates and water holding capacity on bare eroding slopes. Trenches and grade breaks in the micro-topography of a slope act as natural sinks for seed establishment and water infiltration. Trenching along contour lines promotes snowmelt infiltration, reduces sheet erosion, and provides ideal microclimates for plant establishment and success. This treatment aims to create islands of vegetation that can spread into otherwise bare areas.

Seeded and fertilized micro-swales (trenches) are installed before being covered by coconut coir erosion fabric and fastened with stakes and woody debris in Joyner Gulch

Soil scarification & trenching are appropriate under certain conditions:

- Slope exhibits a relatively uniform topography and minimal roughness
- Slope is exposed and subject to heavy wind erosion
- Trenching follows contour lines to maximize water retention and reduces soil mobility

Design & Application Considerations

- Contour lines are followed to maximize efficacy of water retention and infiltration
- Trenches can be effective at a variety of soil depths – from 3” for seed establishment to 18” for large sediment sources
- Excavated soils should form a berm on the downhill side of the trench to act as a barrier to seed, soil and water movement
- Consider covering trenches and scarified areas with erosion blankets, fabrics or forest byproducts (downed woody debris, slash, etc.) to improve seed and water retention, increase shade, and reduce potential blowouts

Cautions:

- Trenches that dip below contour lines and down the slope can act as channels that may funnel surface water and form new rills and gullies

SSR 1d: Woody Vegetation Establishment

Woody vegetation establishment is the ultimate goal of the restoration efforts in the Mt. Haggin WMA due to its ability to stabilize eroding soils, build soil complexity and health, and provide wildlife habitat. While much of the surrounding area has been reclaimed by *Pinus* and *Populus* stands, many steep slopes have yet to establish woody plant communities.

Woody vegetation establishment is a crucial step towards the end goal of the Mt. Haggin restoration efforts. Above,* Pinus contorta *saplings being planted at the Stucky Ridge site.

Woody vegetation establishment is appropriate under certain conditions:

- Species are selected based on site specific tolerances to elevation, aspect and soil conditions
- Costs to mobilize materials are low, i.e., planting location is near existing roads or live stakes are used from local sources
- Woody transplants respond best on North and East aspects

Design & Application Considerations

- Woody vegetation establishment can be approached in several ways:
  - Live (dormant) transplants of nearby individuals
    - Transplant live rootwads and clumps of young *Populus tremuloides, Rosa woodsii, Prunus virginiana* and *Salix scouleriana*, among others
    - *Salix spp.* cuttings installed along ephemeral streams and draws
  - Nursery-raised containerized plants should be installed with browse protection nets
  - Install wildlife exclosures around existing woody vegetation to promote faster development and colonization – particularly aspen colonies
- Locate favorable planting areas in drainage areas and draws to maximize water availability and soil stability benefits

Cautions:

- Exceptionally exposed areas (ridgelines, high wind areas, scree fields) should be avoided due to difficulty of plant establishment
- Wildlife browse pressure can drastically impact plantings – protect with fencing as needed
- Use of plant protection should be limited to avoid maintenance issues, particularly in remote locations
- Water is the limiting factor on these slopes. Locate plantings where they will have the best chance of accessing ground water or areas of higher soil moisture

SSR 1e: Additional Soil Amendments

Due to the denuded nature of the soils in the Mt. Haggin WMA, additional amendments may be considered necessary for site specific applications. While nitrogen is typically the limiting nutrient, organic matter, soil biological components and micronutrients are highly desired. Lime in generally considered unnecessary for plant establishment but may be considered for some applications where soil pH is below 5.0.

Two forms of bagged fertilizer, – one organic, the other inorganic – are staged on a ridgeline via helicopter or ATV

Possible alternative soil amendments include:

- Compost
- Lime
- Borrow material
- Mycorrhizae
- Woody debris- from shredded bark to large trees

Design & Application Considerations

- Compost will greatly improve local soil biota if applied by tilling into the A and B horizons of the soil column
- Lime will help to neutralize acidic soils to provide better seed germination conditions
- Borrow material, such as sod mats from sources within the Mt. Haggin WMA will introduce local soil biota, seed sources and organic matter as well as provide erosion control
- Mycorrhizae, when applied through containerized plantings, can improve survival
- Woody debris adds organic matter over time, can improve water holding capacity, add stability to soils, and provide microclimates for plant establishment

Cautions:

- Compost and other soil amendments will readily blow away unless tilled into the soil or covered with erosion fabric or woody debris
- Over-application of lime can make a soil too basic for plant establishment
- Borrow pits disturb established vegetation and promote noxious weeds – seed as necessary
- Mycorrhizae is best applied during the early stages of plant establishment

SSR 2a: Slope Stabilization

Initial efforts to stabilize upland slopes focused on installing low-cost, low-tech check structures where rill formation begins to slow sediment transport and overland sheeting. These structures are made from available forest resources, rocks or biodegradable materials and placed in rills, or scattered on the soil surface to increase roughness, slow water and promote natural vegetation establishment.

Woody debris from nearby slopes can be re-located to eroding rills to capture sediment and promote regeneration

Appropriate conditions for steep slope stabilization:

- Active or historic rills no deeper than 2 feet are best locations for these structures
- Slash filter windrows and straw wattles are appropriate treatments for many SSR-3 activities to stabilize disturbed soils.

Design & Application Considerations

- Forest slash (branches, limbs and trunks) can be processed and laid throughout channelized gullies to aid in sediment retention or on bare slopes to add roughness, micro-site locations
- Burlap coffee bags are filled with parent material from on site, amended with fertilizer and seed, and placed as a series of check dams in rills and small gullies to act stop sediment transport, promote water infiltration and encourage vegetation establishment
- Coir and straw wattles should be utilized in lower-elevation settings where sediment delivery is less significant and the opportunity to spread surface water horizontally across floodplains is more easily achieved
- Revegetation – in the form of seed, *Salix* cuttings, or transplants – should be incorporated into this approach

Cautions:

- Coffee bag material readily decomposes within two years in exposed areas of the steep slopes
- On steeper areas, wattles can fill and overtop in a single rain event. Caution needs to be taken when placing wattles to prevent significant blowouts and subsequent headcuts
- Forest slash is not always readily available and should not be transported long distances by hand
- Revegetation should be incorporated into these structures to support long term success of structures

SSR 2b: In-Stream Check Structures

In-stream structures are assembled in incised channels using local materials. The structures are placed in the stream channel to capture sediment and aggrade the channel bed. Installed in series, structures promote overbank flows during high water that slows water and deposits its bedload on the landscape. The increased floodplain connectivity and groundwater recharge support desired riparian plant communities.

In-stream beaver dam analogues (BDAs) successfully stopping sediment transport and reactivating floodplain in previously incised creek system in the Mt. Haggin WMA

Appropriate conditions for In-Stream Check Structures:

- In incised channels where bank-full stage does not spill out of the channel
- In high- and low- turbidity settings to reduce sediment loading
- In perennial or intermittent channels, typically no more than 2% grade

Design & Application Considerations

- Ideal locations are in lower gradient breaks in slope, where floodplain can be accessed and a series of 3 structures can be built to slow and spread water over a large area
- Begin by driving ~30" wooden posts into the stream channel, perpendicularly, on 12" centers
- Pine boughs and willow whips are then tightly woven through the posts and pressed into placed to form a leaky dam
- Stream aggregate can be backfilled along the bottom of the structure to prevent under scour, and transplanted clumps of sedge are placed along the banks to seal the edges and prevent lateral channel migration cuts
- Hydrologic function can be restored to deeply incised systems with annual maintenance and building of new structures on top of filled structures
- In areas being constructed with heavy equipment, large straw bales can be installed with 6-foot willow stakes driven through them into native earth

Cautions:

- The use of solid wood or large rock in these structures promotes lateral cutting and should be carefully considered
- Preventing scour under the structures is crucial. Ensure the bottom of the structure is flush with the channel bottom by backfilling with sediment, sod or mud
- Headcuts can be created if structures overtop and create a 'waterfall' effect. Prevent this by padding the downstream side of the structure with slash or large cobble
- When a structure fills up with sediment, the stream will create a new channel. Consider directing the high water into older channels or into vegetated areas to reduce the risk of additional headcuts

SSR 2c: Gully Slash Filters

Gully slash filters utilize the byproducts of traditional forest thinning efforts to fill erosion channels with organic material. Placing this material in the channels helps to reduce sediment transport, increase water retention and infiltration, and establish vegetation by acting as a microclimate and browse protection structure.

Appropriate conditions for Gully Slash Filters:

- Nearly all gullies in the RRA are appropriate settings for slash filters
- Materials should be close by or easily mobilized (road or skid trail accessible)

Two examples of slash filters utilizing forest thinning byproducts to capture sediment and fill erosion gullies.

Design & Application Considerations

- Construction of gully slash filters is cost-effective as long as conifer material is growing along the edge of the gully
- Adjacent timber stands are thinned – removing standing dead trees, non-merchantable trees and small-diameter slash and diseased or damaged trees can be targeted, adding a forest health component
- Stands of aspen are ideal locations for harvesting log material, promoting underground vegetative growth and promoting appropriate wildlife habitat values.
- Several feet of limbs, slash and immature trees are laid lengthwise along the bottom of the channel to maximize contact with the ground and minimize porosity of structure (water & sediment mobility)
- Large stems and logs are piled on top to weigh the structure down and increase structural integrity
- Incorporate additional SSR treatments to promote vegetation establishment and soil stabilization

Cautions:

- Do not thin trees that are directly adjacent to gully walls or whose root structures act as structural support for surrounding soil
- Do not allow large air gaps or spaces between the bottom of the channel and the slash filter
- Living limbs and slash are preferred materials for lining the bottom of the gully
- Trained professionals should oversee forest thinning to avoid over harvesting

SSR 2d: Gully Check Dams

Check dams are strategically placed and carefully constructed Best Management Practices consisting of a mix of logs, rock and sometimes erosion control fabric. Structures are positioned across the gully bottom to capture eroding sediment, raising the gully base height and decreasing gully slope length. Like in-stream structures, these are monitored annually and new structures built on top of captured sediment. Where possible, structures are built up until overland flows can be directed out of gully and spread across vegetated landscape.

A log and slash check dam that filled with sediment over the course of one year in the Mt. Haggin WMA

Appropriate conditions for Gully Check Dams:

- Large and small gullies, active or not, in volcanic welded tuff soils
- Where construction materials are available nearby
- Where there is safe access to the gully bottom

Design & Application Considerations

- Check dams should be located in areas where large volumes of sediment can be impounded upslope with the aim of bringing the gully back up to grade
- Check dams should be built in series – 3 to 5 per 300 linear feet – to add resiliency and a 'step pool' effect to channelized gully
- For log and slash check dams, pack slash along the bottom of the channel and secure logs across the channel with posts and backfill. Align logs to provide a spillway on the downhill side
- Rock check dams should be backfilled during construction to fill pore space and prevent under scour. Pad with slash or cobble immediately below structure to prevent additional channel incising
- Forest slash or erosion fabric (coir) can be laid across the bottom of the channel and underneath check dams to aid in fine sediment capture and bank stabilization
- Incorporate additional SSR treatments with each structure to provide further stabilization and improve revegetation potential

Cautions:

- Check dams can fill with sediment during a single rain event. Monitor annually
- Do not place check dams where significant 'waterfall effects' may occur to reduce the risk of under scour and headcuts
- As structures fill, impounded sediment should be stabilized with vegetation or additional SSR treatments to minimize mobility and reconnect gully to surrounding grade

SSR 2e: Anchored Brush Bundles & Brush Boxes

Brush bundles and boxes are constructed using forest slash anchored to banks, slopes and gullies to trap sediment, stabilize soils, and catch sloughing vegetation, seed and fertilizer. Brush bundles and boxes provide structural integrity, increase organic matter, and act as terracing to aid in slope stabilization and revegetation.

Brush bundles being installed in a large erosion gully in the Mt. Haggin WMA

Appropriate conditions for Anchored Brush Bundles and Boxes:

- Eroding banks of streams, creeks and channelized gullies
- Where forest slash is easily accessible
- On moderately steep slopes with mild rilling

Design & Application Considerations

- Tight bundles of slash are strung on contour along gully walls and creek banks and fastened with duck bill anchors or posts driven perpendicularly into the slope
- Logs with diameters greater than 6" are laid in trenches dug along contour of gully walls and fastened with driven posts. Backfill and slash are tucked underneath and upslope of log to provide a germination platform along bank wall
- On longer slopes, install a series of staggered brush bundles on contour intervals of 10'
- Where available, place sloughing vegetation directly on top of brush bundles and boxes to expedite vegetation establishment
- Incorporate additional SSR treatments with each structure to provide further stabilization and revegetation potential

Cautions:

- Once needles dry and shed, structures lose substantial volume and increase in porosity. Ensure bundles are secured as tight as possible to minimize the chance of blowouts and failure
- Working on unstable banks can exacerbate erosion. Take care to minimize disturbance and work from the bottom up to minimize sediment loading to gully or creek channel
- Most effective if sod mats from eroding bank are cut and placed on newly created brush bundle

SSR 3a: Slope Pitting and Roughening

Slope pitting and roughening utilizes heavy equipment to increase microtopography on steep slopes in an attempt to reduce overland sheeting, increase water retention and infiltration, promote seed germination and planting success, and reduce soil mobility. Pits can be large, from 3-8 feet from pit bottom to top of pile. Microtopography provides ideal settings for fertilization retention, seed germination and success, and snow and rainwater collection and infiltration.

Appropriate conditions for Slope Pitting and Roughening:

- Eroding slopes accessible to machinery
- Occurs prior to seeding, fertilization or planting efforts

Several acres of slope pitting and roughening adds microtopography which improves water retention, planting success, and soil stability; Stucky Ridge

Design & Application Considerations

- Slopes must be selected based on access, stability and perceived benefits. Choose moderately steep slopes and aspects with high potential for seed germination and planting success
- Excavators descend a slope from the ridgeline or other access point, roughening and pitting the soil as they work downslope
- Typically utilized to treat borrow areas for gully filling activities
- Fertilization, seeding and woody plantings should be installed immediately after earthwork to rapidly colonize loose soil and stabilize the slope
- Incorporate woody debris (logs, slash, beetle kill) and live woody transplants (*Populus, Salix spp.)* into newly worked slopes

Cautions:

- Steep slopes are safety concerns for equipment operation. Take necessary steps to ensure safe access and working conditions
- Consider the use of a winch system attached to machinery to reduce the risks of rollovers or soil sloughing
- Minimize compaction of soils by preventing machinery access after slopes have been worked

SSR 3b: Earthen Sediment Retention Basins

Earthen sediment retention basins are swales dug across contour that catch overland sediment flows. Filled basins become terraces with improved conditions for natural revegetation, including seed germination and moisture retention. These are constructed with an excavator or skid steer- as older swales fill, newer ones are constructed upstream.

A newly constructed earthen sediment basin with broadcast seed and erosion fabric, prior woody shrub plantings; Cabbage Gulch

Appropriate conditions for Earthen Sediment Retention Basins:

- Eroding slopes less than 40°
- Accessible to medium size excavator or bulldozer
- Prior to seeding, fertilization or planting
- Across rills, gullies and at the toe of large sediment plumes

Design & Application Considerations

- Slopes must be selected based on access, stability and perceived benefits. Choose moderately steep slopes and aspects with high potential for seed germination and planting success
- Excavators ascend the slope and work downhill, pulling soil and excavated material downhill to form a trench and subsequent berm. Transplant existing sod and vegetation to toe of earthen berm to stabilize loosened soils
- These can be U-shaped berms at the toe of slope or can tie into gullies to direct sediment and water across the contour
- Erosion control fabric should be used over berm where water velocities in structure are higher
- Small water bars or earthen checks are installed throughout the trench to reduce the velocity of transported sediment
- Seed and fertilizer should be applied before laying erosion fabric over disturbed soil
- Woody plantings or live transplants should be installed after equipment has finalized earthwork

Cautions:

- Steep slopes are safety concerns for equipment operation. Take necessary steps to ensure safe access and working conditions
- Consider the use of a winch system attached to machinery to reduce the risks of rollovers or soil sloughing
- Minimize compaction of soils by preventing machinery access after slopes have been worked
- Careful consideration of grade, slope and sediment loading is required to prevent overtopping of earth berm
- Large areas of disturbed soil invite noxious weeds – apply seed accordingly to prevent invasive weeds

SSR 3c: Gully Grading & Filling

The strategy of filling and grading gullies is accomplished with heavy equipment to reduce sediment by re-contouring the landscape and eliminating entire gullies.
Gullies are filled by pushing material from surrounding areas and creating even grades throughout the landscape to reduce channelization and overland sheeting. Additional SSR treatments are incorporated to minimize soil mobility and promote water infiltration. Check structures ensure water does not re-cut old channel.

Filled gully matches existing slope angle. Stream here was redirected to old channel through sedge mat at new low point in valley

Appropriate conditions for Gully Grading & Filling:

- Accessible to medium size excavator and bulldozer
- Prior to seeding, fertilization or planting
- Across rills, gullies and at the toe of large sediment plumes
- Requires construction of new channel or existence of stable historic channel
- Requires a readily available borrow area

Design & Application Considerations

- Slopes must be selected based on access, stability and perceived benefits. Choose moderately steep slopes and aspects with high potential for seed germination and planting success
- Topsoil and existing vegetation is removed and staged for later reapplication
- Subsoil is bulldozed into the gully to bring it up to the grade of the surrounding slopes
- Reinforced channels are built to accommodate drainage patterns across the landscape
- Additional SSR treatments are installed to act as sediment breaks, water bars and microtopography
- Sod mat, woody debris and vegetation are transplanted onto newly graded areas
- Erosion fabric, seed and woody plantings are installed to aid in stabilization of disturbed soils

Cautions:

- Steep slopes are safety concerns for equipment operation. Take necessary steps to ensure safe access and working conditions
- Topsoil and existing vegetation is especially important to finalize earthwork. Designate areas to source from and minimize disturbance
- Grading must be monitored carefully and reinforced to prevent overland sheeting, channelization and headcuts

SSR 3d: Rock Check Dams

Where large sediment point-sources exist, rock check dams have been utilized to capture and settle all transported materials and runoff. Located at the toe of sediment plumes and large gullies, rock check dams are a mix of earthen berms, rock-reinforced spillways, and settling ponds. Geotextiles are often used to stabilize the earthen berms while rock is used to reinforce spillways to prevent under scour and headcuts.

Rock check dams filled with sediment and runoff in California creek drainage.

Appropriate conditions for Rock Check Dams:

- Accessible to medium size excavator, roller and dozer
- At the confluence of several large channelized gullies or sediment plumes

Design & Application Considerations

- Determine the siting for rock check dams based on machine access, availability of large rock, and appropriate levels of sediment loading
- Locate check dams at the toe slope of large sediment-contributing slopes, gullies and plumes
- Build an access road for machines and dump trucks to bring in fill material and large rock
- Dig a retention basin upslope of the proposed rock check and build an appropriate sized earthen berm across channel with excavated material. Source fill material from upslope if needed
- Install geotextile fabric over compacted earthen berm to stabilize soils
- Install reinforced spillway with 6”+ stone and cobble - minimum of 18”depth.
- Monitor rock check dams for incising, headcuts and blowouts

Cautions:

- May require engineered plans to accommodate volumes of water and sediment for larger drainages
- Overtopping of check dams is possible. Construct with the intention of each dam filling over the course of several years
- Many truckloads of large cobble are necessary for each structure. Dump truck access is required
- Until completely filled and overtopped, structures do not promote natural vegetation establishment

SSR 3e: Hydro-seeding

After construction efforts are completed, large areas of bare soil can be seeded, mulched and fertilized with various hydraulic applications. Hydro-seeding combines mulch, seed and soil amendments into a slurry that is then applied directly onto bare soil. It is often used for erosion control on road construction sites and can include customized recipes for site specific applications.

Hydroseeding applications are restricted to roadsides and can extend upwards of 300- 500 feet from pull-out.

Appropriate conditions for Hydro-seeding:

- Bare soil
- Accessible by truck and trailer
- Near water source

Design & Application Considerations

- Hydroseeding is a common strategy for vegetating bare soil with mixed grasses and perennials, but is limited to sites accessible by road with truck and trailer for tank
- Mulch can be sourced from shredded newspaper, cellulose, or other biodegradable products
- Seed mix is customizable and should be selected based on regional hardiness, root development and beneficial wildlife habitat/forage
- Fertilizer must be dissolvable or small enough to flow through application nozzle system

Cautions:

- Road access limits the use of hydro seeding
- While hoses can be strung to reach several hundred feet, access to water is an additional limiting factor
- Species of seed mix must be tolerable to soaking in application system prior to application and germination

SSR 4

The suite of techniques in SSR-4 include Slope Grading (4a), Compost (4b) and Lime tillage (4c), sediment detention ponds (4d) and soil and earth removal (4e). These techniques are highly mechanized and intensive, typically requiring the existence of haul roads. Due to the following limitations of the RRA, these techniques are not currently prescribed for RRA polygons:

- Soil toxicity and metals contamination is low in the soils of the RRA
- Existing natural conditions and ecological functions have been improving over the last 40 years, providing sediment capture functions which support EPA goals for the injured areas
- More harm than good wood be done in most locations by grading, tilling or removing existing soils, with substantial increases in weeds
- Long-term maintenance of these techniques is required
- Vegetation conditions post-treatment would likely result in a decrease of species composition and biodiversity
- More resilient and sustainable techniques have been demonstrated in the uplands that fit with landowner long-term management objectives
- Opportunities to create natural sediment capture downstream of the RRAs may be explored by project partners to enhance the landscape's ability to attenuate sediment delivery, as well as provide benefits to fish habitat and water quality.
- Locations identified by ARCO for sediment detention ponds (ARCO 2017), including lower California Creek, Oregon Creek or other drainages on private land could be graded to create a series of stepped wetlands and functionally become a sediment trapping reach. This conceptual alternative, illustrated in **Figure 32.**

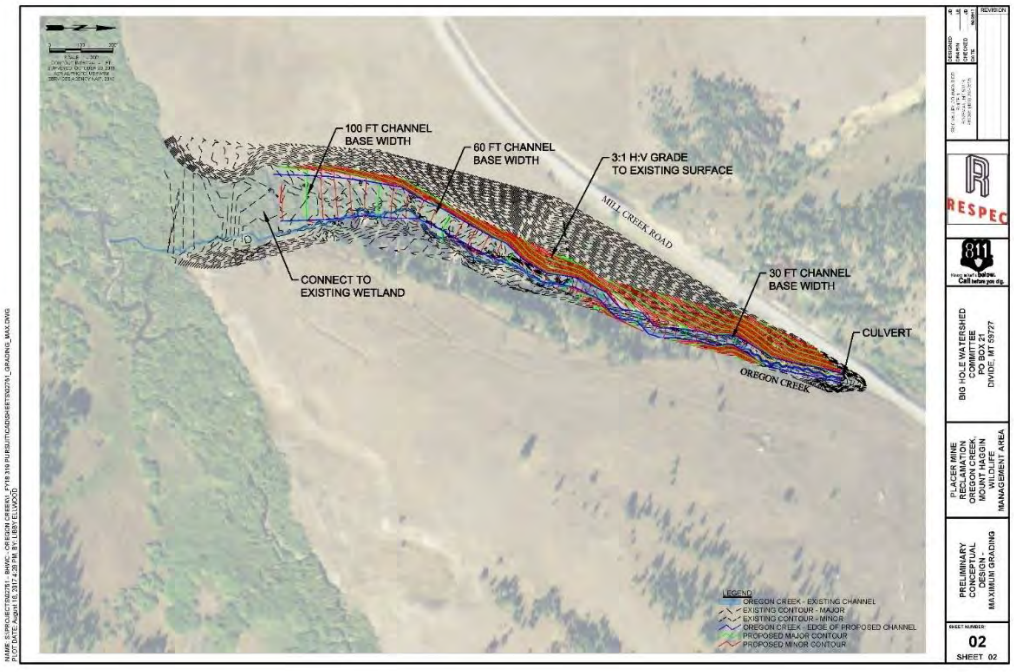

Figure 32. Proposed Oregon Creek Sediment Capture Design

Other Prescriptions used in Plan

Outside of the SSR toolbox other prescriptions are needed to account for all different conditions and approaches used in the RRAs. Many areas in the RRAs have revegetated naturally and are considered completely or mostly functional from the perspective of erosion control and the establishment of vegetation cover. Prescriptions of Monitor-Well Vegetated (M-WV) are applied to portions of polygons with substantial vegetation and positive ecologic trends where remedy activity would likely do more harm than good. The M-WV designation includes vegetation monitoring and weed treatment as part of the weed plan presented below and is the predominant remedy prescribed across the RRAs.

Other areas that may appear bare from aerial imagery have been found from field observations to be tallus or scree slopes that are not actual erosion sources. For areas heavily armored by colluvium a prescription of Rock-No Action (RNA) is applied. These areas are not erosion sources, are unlikely to become sources, and show minimal to no substrate for plant growth. RNA areas should be monitored for weeds as part of the weed plan presented in **Appendix B: Noxious Weed Treatment.**

Remedial and Restoration Actions

This section presents the proposed remediation and restoration actions for the RRAs to be implemented over the next 3-5 years across the WMA. This plan directs the long-term execution of remedial actions in the Mount Haggin RRAs and will capture sediment on the landscape, leading to both a reduction in metals-contaminated soils being mobilized into waterways as well as the promotion of natural revegetation establishment, bioaccumulation of COCs and enhanced ecologic function across the landscape. The plan identifies critically bare or degraded areas needing enhanced vegetation efforts (SSR-1) and gully and sediment pathways where significant sediment retention can be achieved through hand-installed BMPs (SSR-2). The design for mechanized erosion control measures (SSR-3) are considered conceptual in this plan and will require more investigations of feasibility and potential negative impacts before being implemented. The tables presented below (**Table 11**, **Table 12)** show treatment totals by unit of measure (acres or linear feet) and percentage of drainage area, respectively.

Table 11. Prescriptions by drainage (Acres)

Drainage	***Treatment Types***					
	Revegetation acres (SSR-1)	**Rill treatments acres (SSR-2a)**	**Hand-Installed BMPs linear feet (SSR-2)**	**Mechanized BMPs acres (SSR-3)**	**R-NA acres**	**M-WV acres**
Injured Area						
Joiner Gulch	230	48	19449	38	70	1304
Muddy Gulch	103	12	4786	0	13	301
Mill Creek	39	13	5802	30	71	947
Cabbage Gulch	0	0	9215	2	8	825
Subtotal IA	**371**	**73**	**39252**	**71**	**161**	**3377**
Willow Creek	99	36	10103	6	0	8043
California Creek	149	44	18373	3	28	1963
Total RR Area	**619**	**153**	**67728**	**80**	**189**	**13383**

Table 12. Prescriptions by drainage (% of drainage area)

Drainage	***Treatment Types***					
	Revegetation acres (SSR-1)	**Rill treatments acres (SSR-2a)**	**Hand-Installed BMPs linear feet (SSR-2)**	**Mechanized BMPs acres (SSR-3)**	**R-NA acres**	**M-WV acres**
Injured Area						
Joiner Gulch	14%	3%	NA	2%	4%	79%
Muddy Gulch	24%	3%	NA	0%	3%	71%
Mill Creek	3%	1%	NA	3%	6%	84%
Cabbage Gulch	0%	0%	NA	0%	1%	96%
Subtotal IA	**10%**	**2%**	NA	**1%**	**4%**	**83%**
Willow Creek	1%	0%	NA	0%	0%	99%
California Creek	7%	2%	NA	0%	1%	88%
Total RR Area	**18%**	**1%**	**NA**	**1%**	**2%**	**90%**

Specific treatments within each SSR type are shown in more detail by polygon in **Appendix D: Polygon Data Sheets.** Given the adaptive and iterative approach of the remedial strategy presented in this plan, treatment quantities and locations are subject to change depending on site conditions and performance of the applied remedies. Tasks and contracting related to the implementation of this plan will be specified in more detail through task orders, annual work plans and contracting documents to be drafted between NRDP and its contractors and in coordination with the MHTWG. Treatment areas are shown by SSR type in **Figure 33, Figure 34** and **Figure 35**

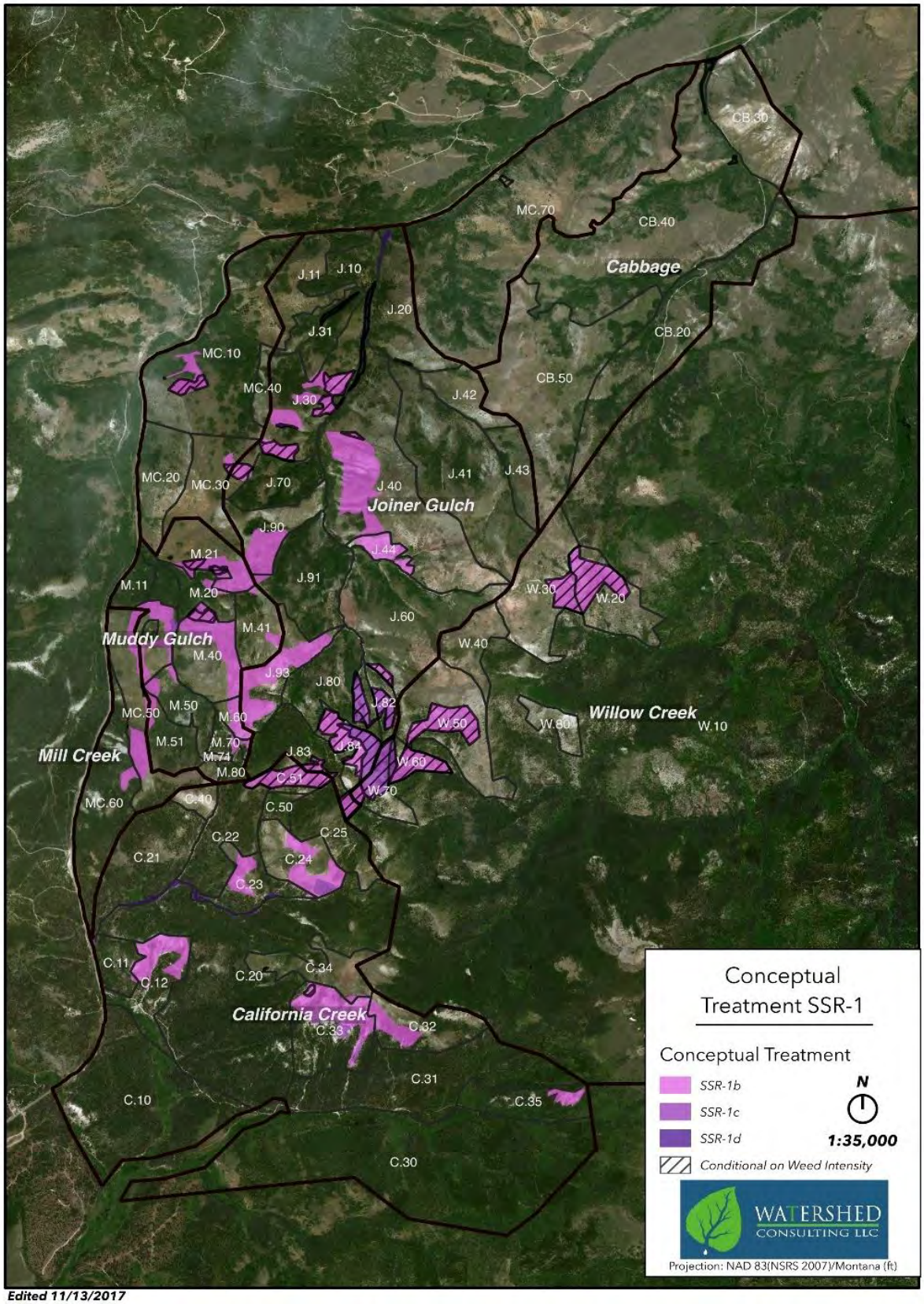

Figure 33. SS-1 Remedial Design

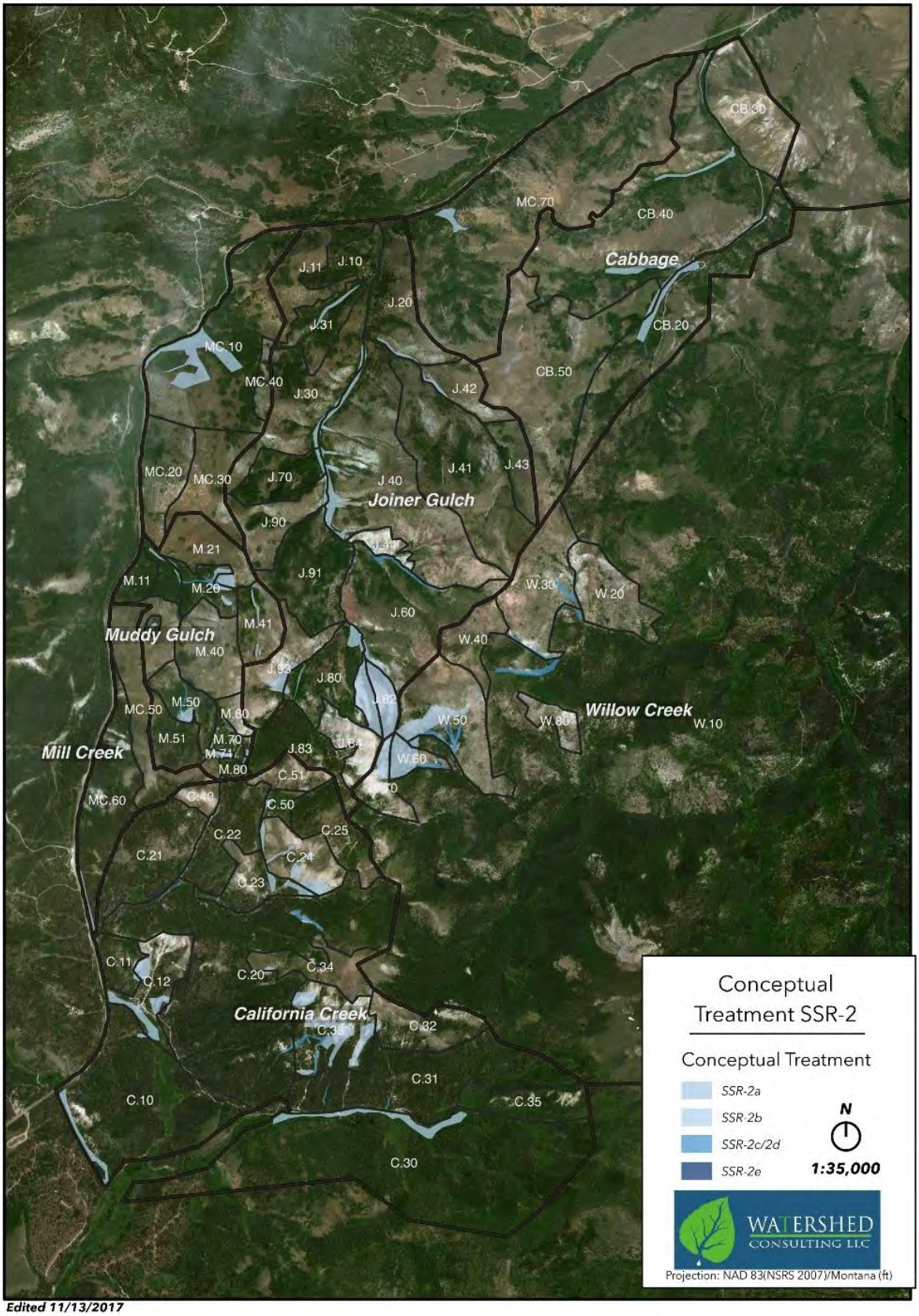

Figure 34. SSR-2 Remedial Design

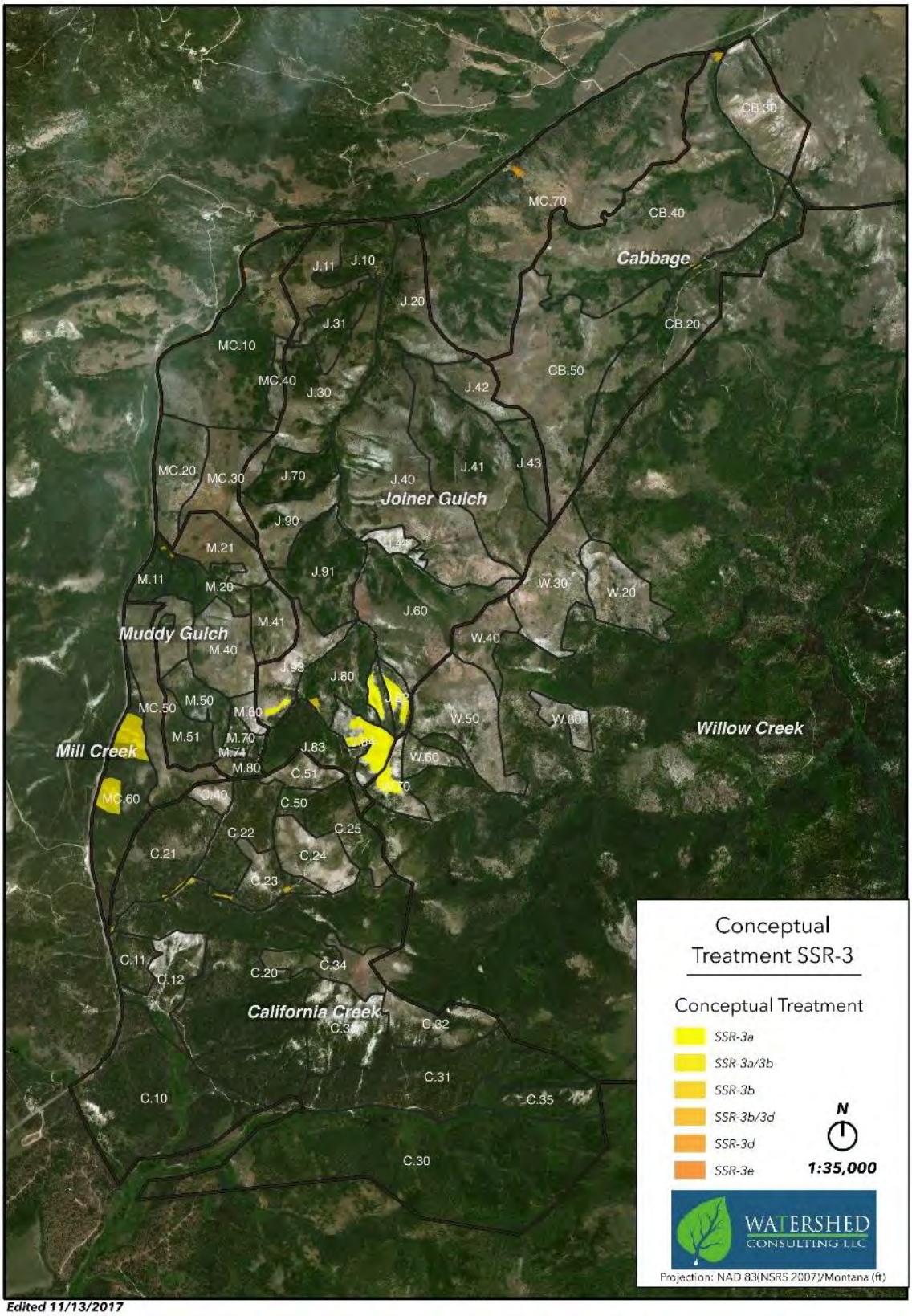

Figure 35. SSR-3 Remedial design

Table 13. Proposed SSR-1 Remediation/Restoration Treatments

Drainage	***Treatment Types (acres)***			
	Seeding and Fertilization SSR-1b[22]	Soil Scarification and Trenching SSR-1c	Woody Vegetation Establishment SSR-1d[23]	SSR-1 Total
Joiner Gulch	193.8	29.4	6.4	**229.5**
Muddy Gulch	100.4	2.3	0.0	**102.7**
Mill Creek	39.1	0.0	0.0	**39.1**
Cabbage Gulch	0.0	0.0	0.0	**0.0**
Subtotal IA	**333.3**	**31.6**	**6.4**	**371.3**
Willow Creek[24]	80.6	18.2	0.0	**98.8**
California Creek	131.1	8.3	9.4	**148.8**
Total RR Area	**545.0**	**58.1**	**15.8**	**618.9**

Table 14. SSR-2 Remedial Design

Drainage	***Treatment Types (linear feet)***			
	Rill treatments SSR-2a (acres)	In-stream BMPS SSR-2b[25]	Gully slash filters SSR-2c/2d	**SSR-2 Total**
Joiner Gulch	48.0	12220.1	7180.9	**19449.1**
Muddy Gulch	12.0	2225.0	2548.7	**4785.8**
Mill Creek	13.0	4032.3	1756.5	**5801.9**
Cabbage Gulch	0.0	9215.0	0.0	**9215.0**
Subtotal IA	**73.1**	**27693**	**11486.1**	**39251.7**
Willow Creek	36.2	0.0	10066.6	**10102.9**
California Creek	44.1	9828.4	8500.7	**18373.2**
Total RR Area	**153.5**	**37521**	**30053**	**67727.8**

Table 15. SSR-3 Remedial Design

Drainage	***Treatment Types (acres)[26]***						
	Slope pitting and roughing SSR-3a	SSR-3a/3b	Earthen sediment retention basins SSR-3b	SSR-3b/3d	Rock check dams SSR-3d	Hydro-seeding SSR-3e	**SSR-3 Total**
Joiner Gulch	36.9	0.0	1.2	0.0	0.0	0.0	**38.1**
Muddy Gulch	0.0	0.0	0.0	0.4	0.0	0.0	**0.4**
Mill Creek	0.0	28.8	0.1	0.0	1.0	0.3	**30.2**
Cabbage Gulch	0.0	0.0	1.5	0.0	0.0	0.5	**2.0**
Subtotal IA	**36.9**	**28.8**	**2.8**	**0.4**	**1.0**	**0.8**	**70.7**
Willow Creek	6.4	0.0	0.0	0.0	0.0	0.0	**6.4**
California Creek	0.0	0.0	3.3	0.0	0.0	0.0	**3.3**
Total RR Area	**43.3**	**28.8**	**6.1**	**0.4**	**1.0**	**0.8**	**80.4**

[22] Seeding and fertilization is conditional on weed presence and treatment. No fertilization will occur if actions are seen to enhance weed coverage and all areas will be site verified prior to implementation

[23] Most woody vegetation establishment will come from willow stakes

[24] Remote location of Willow Creek uplands needs to be ground-verified before prescriptions are implemented. Numbers subject to change upon field verification

[25] Much work has been completed with these structures. Treatment lengths include re-visiting filled structures to assess whether new structures should be installed

[26] All SSR-3 options will be evaluated for equipment access and potential damage caused. Landowner will approve all mechanized activity prior to implementation

Performance Standards for Determination of Operational and Functional

Due to the complex and evolving nature of remedial activities to achieve water quality standards, water quality monitoring for COCs falls outside the scope of this plan. Water quality monitoring for RRAs will be ongoing and led by the EPA as achievement of water quality targets relies on the completion of work on both state lands under NRDP direction and as provided for in this plan, as well as on private land under the responsibility of ARCO.

Upon completion of the remedial activities in this plan, site assessments will be conducted by EPA personnel to determine if the landscape is meeting performance standards relating to sediment transport and vegetation. Polygons determined to be achieving the targets outlined in **Table 16** will become Operational and Functional[27].

Table 16. Performance Targets for Steep Slope Treatment Areas

Area	Performance Target	Objective
Slopes	Numeric Target: 20% live perennial, non-weedy cover	Reestablishment of stabilizing vegetation cover to promote infiltration and evapotranspiration of precipitation; to promote protection of the soil surface from erosion with both live and dead plant litter; to retard or eliminate sediment movement on barren or sparsely vegetated slopes.
Gullies	Narrative Target: gullies inactive or infrequently active showing little to no evidence of recent sediment transport	Through revegetation and stabilization of upgradient slopes in combination with sediment control BMPs, sediment should be detained or retained in gullies to prevent transport to surface water resources.

[27] NRDP and EPA are discussing performance standard targets regarding some slopes that are too steep for treatment. Due to grade and difficulty of access, some slopes are understood to likely remain bare for the foreseeable future. Treatments in these areas will focus on capturing all sediment from these slopes and enhancing vegetation at the toe of the slope.

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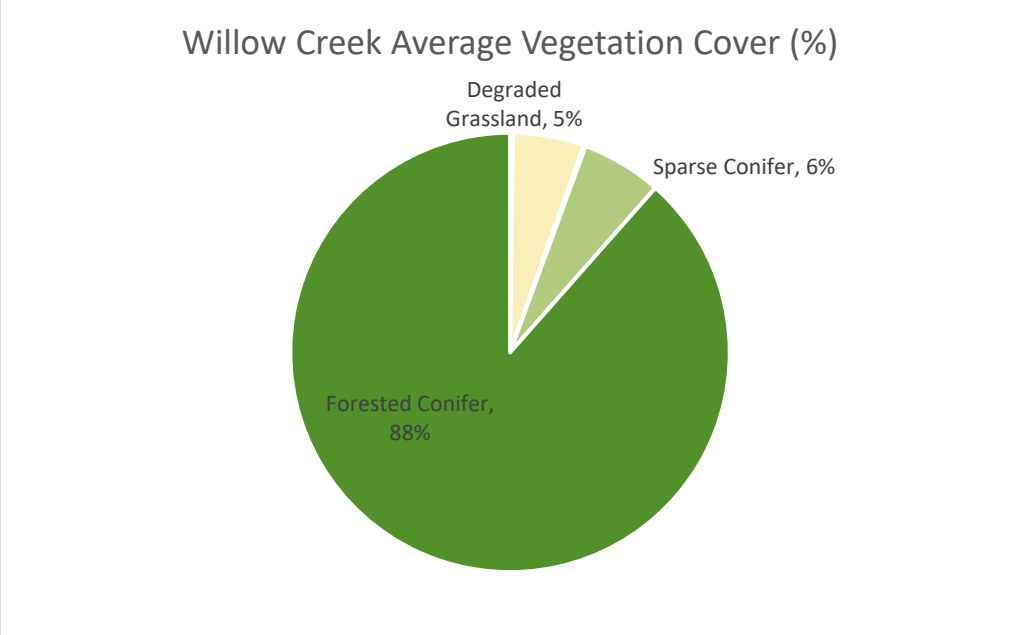
Appendix A: Willow Creek Watershed

Willow Creek Watershed

The uplands of the Willow Creek watershed comprise nearly 9000 acres of predominantly conifer forestland ranging from nearly 8000' at the top of Sugarloaf peak to the Mount Haggin Wildlife Management Area boundary near 5500' elevation. Willow Creek is fed by high altitude springs and snowmelt within bedrock uplands. The channel flows North over private land east of the Opportunity Ponds Waste Management Area and is diverted entirely into Yellow Ditch for irrigation before being channelized into the Mill-Willow bypass along I-90, which diverts surface flows around the Warm Springs Ponds before its confluence with Silverbow Creek, the beginning of the Clark Fork River. The entire Willow Creek watershed drains approximately 24 square miles (ARCO 2017). The stream channel is classified "B-1" by the Montana DEQ, which is to maintained as suitable for drinking, culinary, and food processing purposes after conventional treatment; bathing, swimming, and recreation; growth and propagation of salmonid fisheries and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

A rapid aerial assessment of vegetation cover in the upper watershed was conducted by NRDP in 2017, shown in the figure below. Due to the inaccessibility of much of the upper watershed, more precise vegetation estimates were not conducted. A more precise survey, based on photographs taken in the area, would likely show more acreage of dense shrub as well as moderate shrub cover, as well as sparse conifer, while estimates of bare slopes and degraded grasslands have a higher degree of certainty.

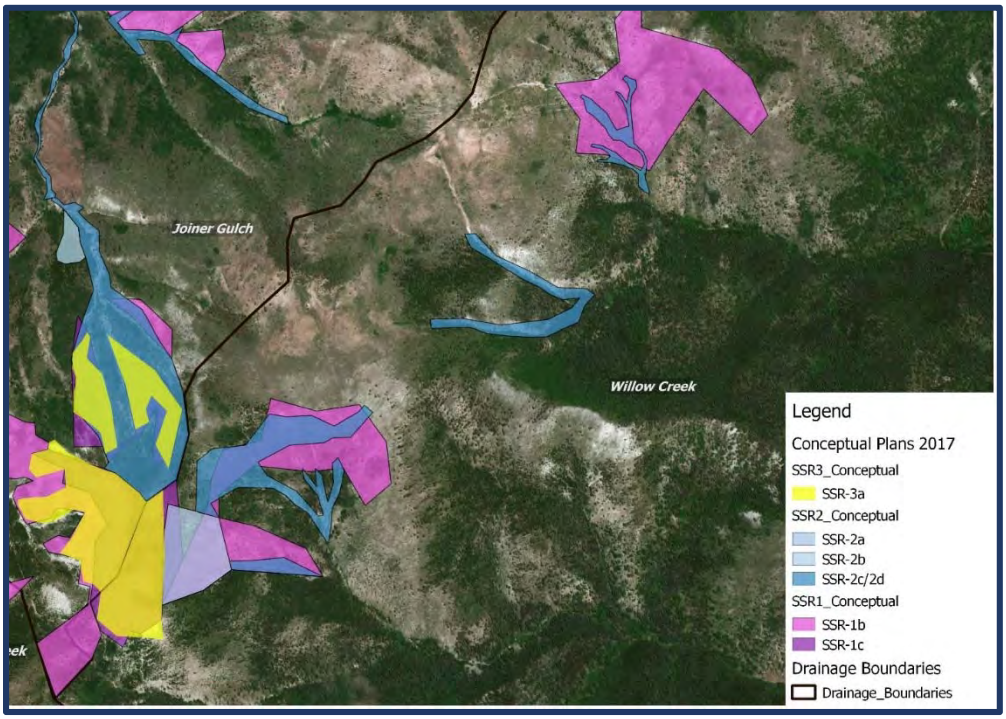


Drainage	Total Acres	Bare-Rock	Bare	Degraded Grassland	Moderate Shrub	Dense Shrub	Sparse Conifer	Forested Conifer
Willow Creek	8234	0	18	431	0	12	488	7286

In the valley bottom of Upper Willow Creek, a robust vegetation community was observed and documented in a technical memo to NRDP personnel. This area is in a near reference condition. The 2017 TI evaluation by ARCO suggested the construction of lined sediment catchment basins in the valley bottom. Remedial actions in these areas were determined to likely cause extensive damage to a highly functioning system and were not included in remedial or restoration actions in this plan. Mechanized sediment detention ponds will also require long-term maintenance fees, costs which will be absorbed by the land manager, MFWP, who oppose incurring such costly maintenance fees to their annual budgets.

Treatment prescriptions for Willow Creek were determined based on most likely sediment sources to the system and were limited by the inaccessibility of most of the watershed to mechanized or even hand labor. Treatments comprise a minimal percentage of total area. All prescriptions are considered conditional on a complete site evaluation to determine on-the-ground conditions and plan feasibility and are subject to landowner final approval before implementation.

Treatment Types (% of total area)	SSR-1 Total	SSR-2 Total	SSR-3-Total	Rock No Action	Monitor-Well Vegetated
Willow Creek	1.1%	0.5%	0.2%	0.0%	98.2%



To: Greg Mullen, Natural Resource Damage Program
From: Pedro Marques, Project Manager, Big Hole Watershed Committee

October 11, 2017

Re: Willow Creek Rapid Site Assessment, Mt. Haggin Wildlife Management Area (WMA)

On Wednesday, May 18th, 2016, NRDP and a Watershed Consulting ecologist visited the lower reaches of the Willow creek drainage to document existing conditions and assess potential remedy and restoration options for the watershed.

The Willow creek valley bottom in the area surveyed is in reference condition. Mature, often 12-foot tall and dense stands of willow (*Salix sp.,*) alder (*Alnus rubra*), dogwood (*Cornus sericea*) blanket the valley bottom as far as can be seen from the road. Aerial imagery shows an average width of 180 ft. of mature willow bottom for the first 1.3 miles of Willow creek inside the WMA. Below the dense canopy, the creek braids often, with abundant side channels and pools providing moisture throughout the valley bottom. Aerial imagery from 2014 shows active beaver dams over 1.5 miles into the WMA. Beaver have likely been a consistent part of this ecosystem for at least the past 40-60 years.

This dense willow bottom is providing numerous ecological services, which are also desirable from the point of view of remediation. These include nutrient cycling, water storage, and primarily sediment capture, which substantially increases metals capture. Any attempt to install a sediment detention basin, as proposed in ARCO's 2017 TI evaluation plan, would have to destroy an abundance of high functioning wetland systems along Willow creek, destroying a process of natural regeneration that has taken decades. These willow bottoms should be considered part of the remedial solution for Willow creek; to destroy them would clearly do significant harm to the system's ability to continue healing itself.

Figure 1. Willow bottom looking north (above) and west (Below) inside the WMA boundary. These conditions persist for 1.2 miles.

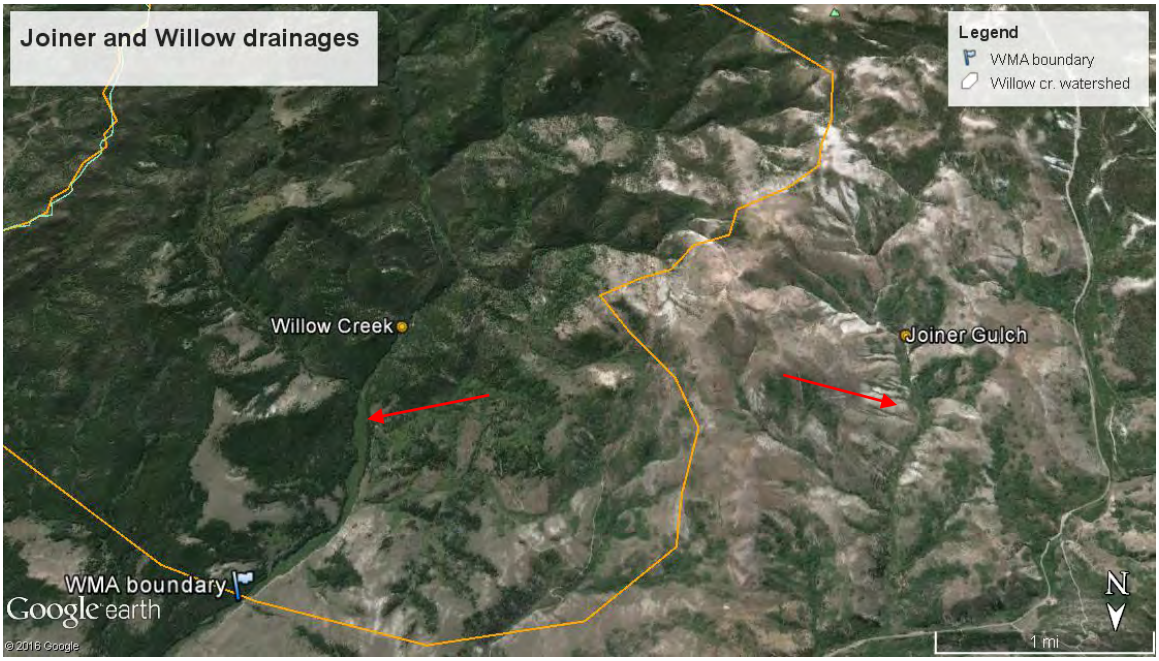


Figure 2. Willow creek and Joiner gulch. Note dense state of wetland habitats (arrows) in Willow creek in comparison to Joiner. Upland vegetation recovery is also far more advanced in Willow creek.

Figure 3. Understory by small side channel. Dense willow, alder, dogwood stands and noticeable litter/duff and soil accumulation.

Figure 4. Perched willow show evidence of past inundation from beaver ponds and also demonstrate thick litter and duff accumulation, reduction of water velocity and sediment trapping.

Figure 5. Dense willow bottom and confluence with un-named creek. Side channels also show abundant shrub growth and excellent natural recovery trends.

Appendix B: Noxious Weed Treatment

Key for Weed Codes used in polygon sheets

Steep Slope Remediation Techniques	
SSR-1a	Broadcast Seeding
SSR-1b	Broadcast Seeding with Fertilization
SSR-1c	Soil Scarification/Trenching
SSR-1d	Woody Plant Establishment
SSR-1e	Other Soil Amendment
SSR-2a	Slope stabilization
SSR-2b	In-stream check structures
SSR-2c	Gully slash filters
SSR-2d	Gully Check Dams
SSR-2e	Anchored brush bundles/brush boxes
SSR-3a	Slope pitting and roughing
SSR-3b	Earthen sediment retention
SSR-3c	Gully grading and filling
SSR-3d	Rock check dams
SSR-3e	Hydroseeding
SSR-4a	Slope grading
SSR-4b	Compost tillage
SSR-4c	Lime tillage
SSR-4d	Sediment detention pond
SSR-4e	Soil and earth removal

WEEDS	
Code	**Full Name**
SK	Spotted knapweed
LS	Leafy spurge
CT	Canada thistle
YT	Yellow toadflax
DT	Dalmation toadflax
WT	Whitetop
MANAGEMENT	
C	Contain infestations
E	Eradicate infestations
P	Prevent establishment
TREATMENT	
B	Biocontrol
H	Herbicide
M	Monitor
S	Survey

Mount Haggin Wildlife Management Area
Injured Area (IA) Weed Management Plan

2017

Contents

Introduction

Goals

The following weed management plan is designed to meet objectives of the Remedial Action Work Plan (RAWP) for Remedial Design Unit (RDU) 15 of the Anaconda National Priorities List (Superfund) Site, as well as manage Noxious Weeds in a manner that supports the land and natural resource management goals of Montana Fish, Wildlife and Parks (FWP) and the restoration goals of the Natural Resource Damage Program (NRDP) of the Montana Department of Justice, and is in accordance with the State of Montana and the Deer Lodge County laws and regulations.
Performance standards for successful reclamation of land include minimal weed presence in the uplands. This weed management plan is designed with the goal of contributing to the establishment of self-perpetuating plant communities capable of stabilizing soils, as well as significant canopy cover, plant species richness, with low Noxious Weed coverage.

Specific goals in creating this plan include:

- A usable, understandable, and effective methodology for controlling noxious weeds within the parameters described above.
- A vegetation monitoring methodology to objectively measure noxious weed infestations and their control, as well as changes in other vegetation, in order to guide management.

Overview

The Mount Haggin Uplands of the Anaconda National Priorities List Superfund Site (RDU 15) consists of land located within the state-owned Mount Haggin Wildlife Management Area, managed by the Montana Fish, Wildlife and Parks. The area was impacted by smelter emissions and logging from the early twentieth century, which removed large amounts of vegetative cover, resulting in soil erosion and sediment transport. Since the smelter stopped operation in 1980 natural revegetation has occurred to varying degrees, including the establishment of a number of noxious weed species. Management of these noxious weeds is required as a component of ongoing reclamation efforts.

The area addressed by this weed management plan includes Cabbage Gulch, Joyner Gulch and Muddy Gulch in the Clark's Fork drainage, and portions of California Gulch in the Big Hole drainage, ranging from approximately 5,400 ft. to over 7,000 ft. elevation, along the Continental Divide.

Summary

Guidelines for managing Noxious Weed infestations in the MHWMA Injured Area consist of three sections:

1) An Infestation Criteria Key to guide decision-making for Management/Control Actions, based on characteristics of each weed incursion: species, size, distribution, location and other geographical features, as well as the Injured Area Restoration Treatments designated for the area of the weed infestation.

2) A description of the various management and control actions recommended by the Key, ranging from monitoring; containment and monitoring; or targeting for eradication and monitoring.

3) Methodology for mapping and monitoring noxious weed infestations and other vegetation in order to gauge the effectiveness of management and control and guide future management decisions.

More specific weed management guidelines, detailing what actions to take for specific areas and infestations, will be based on individual IA polygons and shown in Appendix D.

Noxious Weed Management Criteria Key

Prioritizing Criteria for Determining Management/Control Actions by IA Polygon

The following Infestation Criteria Key describes the geographical features of noxious weed infestations in the MHWMA that guide the management/control actions, including the treatment/restoration approaches for the polygon in which the infestation is located; the species, size, and location in the WMA of the infestation; as well as the existing vegetation, proximity to riparian areas, and other characteristics of the infestation that should be considered when determining management. In general, none of the criteria take priority, but instead should all be considered equally. However, **Criteria 1 Polygon Treatments and Restoration Approaches** should be considered first for areas contained in Polygons, as noxious weed management is an element in the restoration/remediation of the MHWMA Injured Area.

Key

I. Polygon Treatments and Restoration Approaches

Restoration/Remedial actions for individual IA polygons are important factors in determining noxious weed management/control actions. Upland Polygon Treatments are coded using EPA and NRDP Steep Slope Reclamation (SSR) guidance (see Table 1). Areas receiving fertilization treatments (SSR-1b) will be monitored closely for Noxious Weeds.

A. Seeding and fertilizer application (Upland Polygon Treatments SSR-1a, 1b). Infestations of noxious weeds in these areas should be controlled with herbicides, with follow-up monitoring and herbicide application to ensure successful control.

B. Monitor- Well Vegetated (M – WV). Noxious Weeds in these areas should be mapped, with Management/Control Actions determined by following the guidelines presented below, using the species of noxious weeds, its location in the WMA, and other factors to determine if the infestations should be targeted for eradication, containment, or monitoring, as well as what methods for control should be used.

Table 1. Upland Polygon Treatment Codes

SSR Type	Title	Description	SSR Subtype 1	SSR subtype 2	SSR Subtype 3
SSR-1a	**Broadcast Seeding**	Typically broadcast by ground crews			
SSR-1b	**Broadcast Seeding with Fertilization**	Fertilization can be slow-release organic or NPK, typically helicopter applied over large areas			
SSR-1c	**Soil Scarification/Trenching**	Hand-dug trenches and broadcast application of seed, fertilizer, other amendments and coir blanket			
SSR-1d	**Woody Plant Establishment**	Can include live willow stakes and/or container plants			
SSR-1e	**Other Soil Amendment**	Lime, compost and other soil amendments			
SSR-2a	**Slope stabilization**	Stabilization of bare slopes and rill formation. Can include coffee bags, slash, coir/straw wattles, downed logs	**SSR-1b**		
SSR-2b	**In-stream check structures (brush, straw bale)**	Installed to slow water, capture sediment and enhance wetlands	**SSR-1d**		
SSR-2c	**Gully slash filters**	Available conifer material used to fill gully bottom			
SSR-2d	**Gully Check Dams**	Keyed-in structures made of rock, log, geobag, and/or coir fabric			
SSR-2e	**Anchored brush bundles/brush boxes**	Bundles of slash anchored to ground or gully side slope to capture sediment	**SSR-1d**		
SSR-3a	**Slope pitting and roughing**	Can include dozer pits, "rough and loose" surfacing, addition of woody debris	**SSR-2a**	**SSR-1b**	
SSR-3b	**Earthen sediment retention**	Large berms constructed to divert and/or catch sediment flows. Can include native sod and shrub transplants	**SSR-2a**	**SSR-1d**	
SSR-3c	**Gully grading and filling**	Can include clearing/grubbing, filling of gullies and construction of new channel	**SSR-2a**	**SSR-1b, 1d**	
SSR-3d	**Engineered rock check dams**	Lined earthen berms topped with large boulders	**SSR-2a**		
SSR-3e	**Hydroseeding**	Limited to roadside polygons. Can include amendments, seed, fertilizer	**SSR-2a**	**SSR-1b**	
SSR-4a	**Slope grading**	Land-forming to control runoff.	**SSR-3b**	**SSR-2a**	**SSR-1b,d**
SSR-4b	**Compost tillage**	Slope grading plus incorporation of compost to soil	**SSR-3b**	**SSR-2a**	**SSR-1b,d**
SSR-4c	**Lime tillage**	Slope grading plus incorporation of compost and lime to soil	**SSR-3b**	**SSR-2a**	**SSR-1b,d**
SSR-4d	**Sediment detention pond**	Lined catchment basin with outlet	**SSR-2a**	**SSR-1b,d**	
SSR-4e	**Soil and earth removal**	Remove soil from location	**SSR-2a**	**SSR-1b,d**	

II. Infestation Species, Size, Location

The Montana Noxious Weed List details different management criteria for different species, ranging from eradication; eradication/containment where less abundant; or eradication/containment where less abundant as prioritized by Weed Control District (see Table 2. Montana Noxious Weed List). Based on these guidelines, management actions should be based on the species, and the size and location of the infestations, as described below:

A. Species

Sulphur cinquefoil, hoary alyssum, and houndstongue. These species are common throughout the MHWMA as well as adjacent public and private land. Management actions should be to **monitor these species** according to Infestation Size and Location criteria, discussed below.

Spotted knapweed, leafy spurge and Canada thistle. These species are common in much of the lower elevation areas of the MHWMA in the Clark Fork river drainage. These species are also common and widespread on adjacent public and private land. Management action where the species are common and widespread should be to **contain these species**, while using biocontrol insects for long term control. Leafy Spurge has been successfully controlled using biocontrol insects in large areas of the WMA. Small infestations found beyond the containment areas and at higher elevations, as discussed below under B. Size, and C. Location, should be targeted for eradication.

Whitetop, Whitetop is a rhizomatous perennial in the mustard family found in isolated infestations in limited areas, but appears to be spreading rapidly. Management goals should be long term eradication. Small infestations should be targeted for eradication with herbicides, with yearly surveys to ensure the infestation is controlled, including new plants germinating from the seed bank.

Dalmatian toadflax. Dalmation toadflax is found in isolated infestations in the WMA. Management goals should be **eradication**, as well as **surveying** for new infestations, and **monitoring** known infestations for control success.

Yellow toadflax is found throughout the WMA in small, isolated infestations, often in riparian areas where control with herbicides is problematic. Yellow toadflax is a rhizomatous perennial, which also makes mechanical control (cutting, mowing, or pulling) unsuccessful. Since this plant is also found throughout Southwestern Montana, management goals should include **containment** of existing infestations and **surveying** for new infestations that can be controlled before they grow and spread.

B. Size

Small infestations, if located in areas where control is recommended and/or of species recommended for control, should be targeted for **eradication**.

C. Location in the WMA*

Lower elevation infestations of spotted knapweed and leafy spurge, in areas that have been heavily infested with noxious weeds for long time periods, should be low priority for eradication.

Instead, these areas should be monitored to stop the spread and expansion of the infested areas. Higher elevation infestations should be more actively managed and monitored to prevent the spread of these species into un-infested areas. In the higher elevation areas of the WMA, as well as throughout the portion of the WMA in the Big Hole drainage, management criteria should be **eradication**. See Figure 1. Noxious Weed Map, which shows areas of the IAs where infestations of leafy spurge and spotted knapweed should be targeted for eradication. The methods used for eradication should be based on the Control Actions described below.

* Location of the infestation in terms of physical geography, such as aspect, relationship to riparian areas, and other factors are discussed in other sections.

III. Vegetation

The existing vegetation (or lack thereof) growing among the targeted noxious weed infestations should be considered:

A. Desired plant species. Noxious weeds growing in areas without desired plant species should only be controlled when revegetation or reseeding actions are also initiated (See Appendix A. Restoration, Reclamation and Revegetation Guidelines from the Montana Noxious Weed Plan 2017 Draft).

Alternatively, sensitive native forbs and woody species can be harmed by herbicide use, which should be considered when determining Management and Control Actions. If possible, herbicides should be applied using spot spraying techniques to avoid damaging desirable plant species.

B. Erosion prevention. Infestations of noxious weeds can be important in preventing erosion where other plants are insufficient. Noxious Weeds should be controlled only after considering the possibility of erosion of existing soil, with negative consequences for sediment.

IV. Physical Geography

A. Soil – In areas where the noxious weeds are the primary vegetation cover, and therefore play a significant role in building soil by providing organic material, herbicide control of noxious weed infestations should be limited and conducted in conjunction with revegetation or other reclamation activities.

B. Aspect – Biocontrol of noxious weeds with insects is generally more successful in sunny areas with southern exposure.

V. Proximity to riparian areas

Riparian areas are particularly sensitive in the management of noxious weeds and impacts to waterways should always be considered in terms of protecting natural resources and complying with all relevant laws. Herbicide guidelines call for buffer zone from riparian areas. Herbicide guidelines are legal requirements. Herbicides, pesticides and fertilizer are considered hazardous or toxic materials and must be applied in strict compliance with all label instructions and other laws.

VI. Other Infestation Characteristics

A. Density. Infestation density can be used to determine management actions to pursue for some species. Dense infestations of leafy spurge and spotted knapweed, if other characteristics (size and location) are also met (in general, large and sunny infestations located in areas of the WMA where eradication in not required), should be targeted by biocontrol insects.

B. Existing biocontrol agents. Infestations should be surveyed for biocontrol insects. Leafy spurge, spotted knapweed, and Canada thistle have biocontrol insects that have shown success at controlling infestations (see below).

Management and Control Actions

Management and control of noxious weeds consists of three components: 1) Monitoring, 2) Containment, and 3) Eradication. Successful management and control requires both knowledge about the specific noxious weeds targeted for management and the techniques and methods to control them, as discussed below.

More basic land and natural resource management strategies that help control noxious weeds are part of the responsibilities and mission of the Montana Fish, Wildlife and Parks and include regulating motorized use of roads and trails to limit the introduction of seeds and reduce disturbance of vegetation.

Monitoring

Monitoring existing noxious weed infestations requires current maps and accompanying tables detailing infestation characteristics (see Figure 1. Noxious Weed Map, Table 3. Noxious Weed Table). Mapping and monitoring methodology are discussed below.

Containment

Containment entails allowing noxious weed infestations to remain in place, while preventing the spread of the noxious weed to un-infested areas. As discussed above, the Montana Noxious Weed List identifies a number of species that are widespread and well established to be contained without requiring eradications. Infestations identified for containment should be mapped and monitored to track changes in size and other factors that may change the management goals. Mapping and monitoring methodology is discussed below.

Eradication

If eradication is chosen, select either 1) herbicides, 2) biological control methods, or 3) mechanical/cultural, as recommended by The Weed Control Methods Handbook (Tu et al. 2001), and other resources.

1) Herbicides

Herbicides are the primary management tool for controlling noxious weeds, and when used properly can be very effective at killing noxious weeds. These herbicides can be transported to the work site in liquid form or transported dry and mixed on-site with available water[1]. However, management of noxious weed

[1] This technique is preferred by the Montana Conservation Corps for backcountry application and has been used on Muddy Gulch. In 2016, MCC crews treated all known weeds in the Muddy Gulch drainage in 4 days, approximately 100 acres/day using dry chemicals.

infestations consists of three components and killing the existing noxious weeds is only the first component. The second component is preventing the reestablishment of the target weed or other noxious weed species. The third component is replacing the targeted noxious weed with desirable vegetation cover. This can be achieved by utilizing the following general guidelines:

- Herbicides, while often the most effective and cost-effective method of killing broad-leaf plants, should only be used in a manner that considers impacts to non-target species, proximity to riparian areas, and other negative impacts.
- Herbicide applicators should be able to identify the target species, as well as what species to avoid spraying.
- Spot spraying, although the most expensive application method, is preferred in order to avoid impacts to non-target species.
- What species are going to replace the species killed by the herbicides should be considered before the herbicide application, and in some cases herbicides should only be used when restoration, reclamation, or revegetation is planned (See Appendix A. Restoration, Reclamation and Revegetation Guidelines from the Montana Noxious Weed Plan 2017 Draft).
- Vegetation disturbance resulting from equipment or from herbicides, which allows seeds in the soil seed bank to germinate, should be avoided.
- Areas sprayed should be mapped before the application in order to guide the applicators and gauge impacts. After the application the area should be surveyed to gauge the effectiveness, with follow-up mapping and monitoring to assess long term results.

Actual products, application techniques, and other methodologies are beyond the scope of this plan but should follow guidelines, and legal and regulatory requirements, as required by the Montana Department of Agriculture Pesticide Applicator License Program (Center for Invasive Species and Ecosystem Health; Montana Department of Agriculture 2017; Tu et al. 2001).

Leafy Spurge:

Herbicide control of leafy spurge is problematic: 1) leafy spurge is difficult to control with herbicides, 2) attempts at control often result in damage to non-target plant species which are often more susceptible to herbicides, and 3) the resulting disturbance to existing vegetation can result in the establishment of other noxious weed species.

Spotted Knapweed:

Spotted knapweed has been well established throughout much of the MHWMA within the Clark Fork Drainage, including Cabbage Gulch, for decades. Herbicides have been sprayed to treat spotted knapweed since at least the 1980s, with many areas targeted multiple times over the decades. Although spotted knapweed is susceptible to herbicides, the lack of competition resulting from the lack of a healthy native plant habitat and the successful recruitment of new spotted knapweed plants from the seed bank resulting from the disturbance of herbicides, has resulted in spotted knapweed continuing to dominate the sprayed area, as well as move into new areas.

Since the early 2000s the seed bank of spotted knapweed seeds has been decreasing due to the biocontrol insects that can reduce seed production by 90% or more (Story 2008, Figure 1.). At the same time, other plants have been slowly establishing, primarily grasses, both native and non-native, since the herbicides kill broadleaf forb species.

As a result, control of spotted knapweed is now possible, as shown in Cabbage Gulch, where the knapweed is apparently not coming back after the last round of herbicide spraying. However, the resulting plant cover is composed primarily of grass and grass-like species, while broad-leaf forbs have been suppressed by herbicides. Where herbicide control of spotted knapweed infestations is chosen as the preferred control action, revegetation should be considered (See Appendix B. Revegetation, Montana Department of Agriculture 2017).

In order to assess changes in noxious weeds and other vegetation in Cabbage Gulch and other areas of the MHWMA, a study consisting of applying herbicides to portions of the area, while leaving adjacent and similar areas unsprayed, and monitoring over time to assess the vegetation cover, should was initiated in the 2017 field season.

2) Biocontrol

Noxious weeds widely established in the MHWMA with biocontrol insects approved for use, and proven to establish, in Montana include Canada thistle, spotted knapweed, leafy spurge, and yellow toadflax (see Appendix C. Biocontrol Insects Established in Montana). Infestations of these species should be surveyed for establishment and impact of the insects, and wherever large infestations appropriate for biocontrol are found, available insects that have proven capable of establishing successfully in the area, should be released in order to establish populations where they are not already established. (Although biocontrol insects have been successfully introduced to control Dalmatian toadflax, Dalmatian toadflax is designated for eradication on the MHWMA with herbicides).

Leafy Spurge:

Biocontrol of leafy spurge with insects has proven highly successful at controlling large and dense infestations of leafy spurge in the MHWMA, although Leafy spurge continues to be a significant noxious weed in the higher elevations. Control of smaller infestations in riparian areas or in shadier locations with biocontrol has been less successful. In order to better quantify the success of leafy spurge biocontrol, leafy spurge infestations mapped in 2003 should be mapped again in 2017.

Although a number of insect species contribute to successful control of leafy spurge in the MHWMA, the leafy spurge root flea-beetle *Apthona lacertosa* has proven the most successful and should be the primary insect released on appropriate infestations when found.

Spotted Knapweed:

A number of biocontrol insects are well established in Montana, including on the Mount Haggin WMA (Appendix C. Biocontrol Insects Approved for Use and Established in Montana). Although spotted knapweed is still widespread, common, and occupies large areas in Western Montana, biocontrol is beginning to be effective in many areas, with significant declines in the sizes and density of infestations in many locations (see Figure 2. Summary of Spotted Knapweed Biocontrol Research). Successful biocontrol of spotted knapweed requires a number of years in order for the seed bank of viable spotted knapweed seeds to decline. Many spotted knapweed infestations have now had the most successful biocontrol insect species, including the seed head weevil *Larinus minutus*, and the root weevil *Cyphocleonus achates*, well established for 8 years or more, which research shows is the minimum time needed for biocontrol efforts to show success.

In order to better measure the success of biocontrol on spotted knapweed in IA, areas with established populations of spotted knapweed biocontrol insects that are designated as containment areas, without

plans for herbicide application, should be mapped every year to document changes in the location, size, density and other characteristics of the infestation.

Figure 1. Summary of Spotted Knapweed Biocontrol Research (Story et al. 2008)

- From 1974 to 2005, spotted knapweed seed production decreased by about 93% and density by 71% at sites in western Montana where the available biocontrol insects are established.
- The combined impact of the seed-head and root-feeding insects appears to be successfully controlling this invasive alien weed in a region where it was most dense.
- A delay in decrease of knapweed populations relative to the abundance of the seed head insects because the plant is perennial and seeds persist in the soil for about eight years.
- The combined effect of all these insects appears to be achieving effective control of the weed in western Montana.

Canada thistle:

A number of biocontrol insects have been introduced in Montana to control Canada thistle and are now well established, including on the MHWMA (See Appendix C. Biocontrol Insect Approved and Established in Montana). Since these insects are already established in the area and are known to find and colonize new infestations rapidly, no further biocontrol of Canada thistle is recommended until new agents are introduced.

3) Mechanical/Cultural

Physical and mechanical control, including mowing and pulling, as well as cultural control, including burning, should only be utilized where herbicides cannot be utilized effectively or safely. Based on control guidelines, pulling is the only technique recommended for noxious weeds currently established in the MHWMA IAs (Center for Invasive Species and Ecosystem Health; Tu et al 2001).

Pulling: Pulling is only recommended for non-rhizomatous species, including spotted knapweed and houndstongue or in areas of smaller infestations that can be controlled by pulling. The disturbance resulting from pulling will often result in the germination of seeds stored in the seed bank. Multiple treatments over a number of years are often required. Monitoring is recommended to assess the success of the action.

Mapping and Monitoring Methodology

Mapping

GPS/GIS Noxious weed mapping in the MHWMA IAs, will use hardware, software, and a methodology that is compatible with the mapping used for mapping the Injured Area Restoration Treatments (see Figure 1. MHWMA IA Noxious Weed Map, Table 3. Noxious Weed Map Data Table). The MHWMA IA should be surveyed periodically to document changes in noxious weed infestations, and other features that could change the management of noxious weeds.

Monitoring

Vegetation monitoring will assess changes in noxious weed infestations as well as changes in desirable vegetation diversity and cover, in order to gauge the impact of noxious weed management and other natural resource management actions. The monitoring methodology will vary depending on a number of factors, including what noxious weed management actions are pursued. Whenever herbicides, pulling, or

other eradication actions are taken, the area will be mapped and monitored before and after to assess the effectiveness of the control actions.

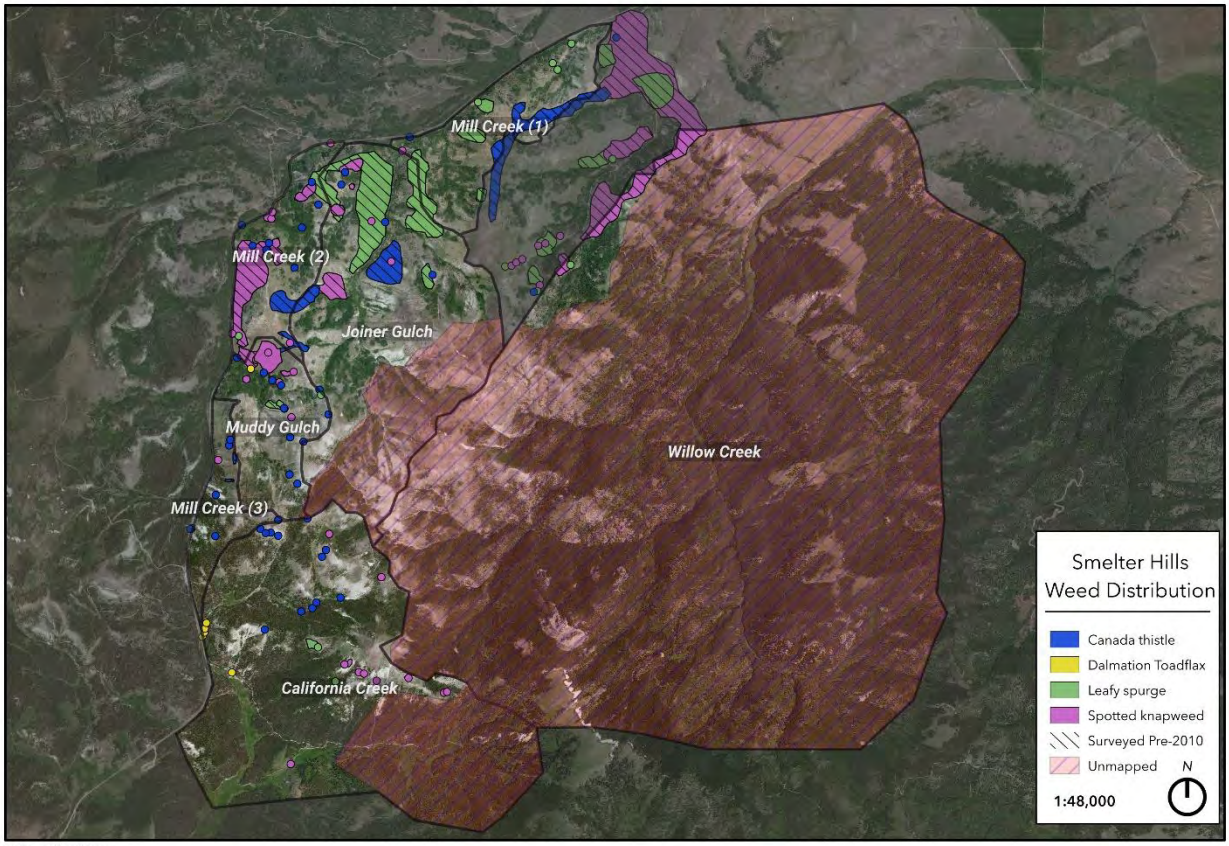
Monitoring can range from a visual inspection to determine changes in small infestations of Noxious Weeds, to the establishment of long term vegetation monitoring transects and plots to establish baseline data, and measure changes in plant diversity, density, and canopy cover for larger infestations and areas.

Table 2. Montana and Deer Lodge County Noxious Weed List

Effective: July 2015
PRIORITY 1A These weeds are not present or have a very limited presence in Montana. Management criteria will require eradication if detected, education, and prevention:
Yellow starthistle (*Centaurea solstitialis*)
Dyer's woad *(Isatis tinctoria*)
Common Reed *(Phragmites australis ssp. australis)*
PRIORITY 1B These weeds have limited presence in Montana. Management criteria will require eradication or containment and education:
Knotweed complex (*Polygonum cuspidatum, P. sachalinense, P. × bohemicum, Fallopia japonica, F. sachalinensis, F. × bohemica, Reynoutria japonica, R. sachalinensis, and R.× bohemica*)
Purple loosestrife (*Lythrum salicaria*)
Rush skeletonweed (*Chondrilla juncea*)
Scotch broom (*Cytisus scoparius*)
PRIORITY 2A These weeds are common in isolated areas of Montana. Management criteria will require eradication or containment where less abundant. Management shall be prioritized by local weed districts:
Tansy ragwort (*Senecio jacobaea, Jacobaea vulgaris*)
Meadow hawkweed complex (*Hieracium caespitosum, H. praealturm, H. floridundum, and Pilosella caespitosa*)
Orange hawkweed (*Hieracium aurantiacum, Pilosella aurantiaca*)
Tall buttercup (*Ranunculus acris*)
Perennial pepperweed (*Lepidium latifolium*)
Yellowflag iris (*Iris pseudacorus*)
Blueweed (*Echium vulgare*)
Eurasian watermilfoil (*Myriophyllum spicatum*)
Flowering rush (*Butomus umbellatus*)
PRIORITY 2B These weeds are abundant in Montana and widespread in many counties. Management criteria will require eradication or containment where less abundant. Management shall be prioritized by local weed districts:
Canada thistle (*Cirsium arvense*)

Field bindweed (*Convolvulus arvensis*)
Leafy spurge (*Euphorbia esula*)
Whitetop (*Cardaria draba, Lepidium draba*)
Russian knapweed (*Acroptilon repens, Rhaponticum repens*)
Spotted knapweed (*Centaurea stoebe, C.maculosa*)
Diffuse knapweed (*Centaurea diffusa*)
Dalmatian toadflax (*Linaria dalmatica*)
St. Johnswort (*Hypericum perforatum*)
Sulfur cinquefoil (*Potentilla recta*)
Common tansy (*Tanacetum vulgare*)
Oxeye daisy (*Leucanthemum vulgare*)
Houndstongue (Cynoglossum officinale)
Yellow toadflax (*Linaria vulgaris*)
Saltcedar (*Tamarix spp*.)
Curlyleaf pondweed (*Potamogeton crispus*)
Hoary alyssum (*Berteroa incana*)
Priority 3 Regulated Plants: (NOT MONTANA LISTED NOXIOUS WEEDS) **These regulated plants have the potential to have significant negative impacts. The plant may not be intentionally spread or sold other than as a contaminant in agricultural products. The state recommends research, education and prevention to minimize the spread of the regulated plant.**
Cheatgrass (*Bromus tectorum*)
Hydrilla (*Hydrilla verticillata*)
Russian olive (*Elaeagnus angustifolia*)
Brazilian waterweed (*Egeria densa*)
Parrot feather watermilfoil (*Myriophyllum aquaticum or M. brasiliense*
Deer Lodge County Noxious Weed List
Baby's breath (*Gypsophila paniculata*)
Black henbane (*Hyoscyamus niger*)
Common mullein (*Verbascum Thapsus*)
Curly dock (*Rumex crispus*)
Kochia (*Kochia scoparia*)
Musk thistle (*Carduus nutans*)
Perennial sowthistle (*Sonchus arvensis*)

Figure 1. Mount Haggin Injured Area Weed Map



Edited 5/11/2017

Table 3. Mount Haggin Injured Area Noxious Weed Points

ID	YEAR	SPECIES	DRAINAGE[2]	CANOPY COVER*	POLYGON VEGETATION COVER	SIZE*
1	2005	Canada thistle	Mill Creek	L		3
2	2005	Canada thistle	Mill Creek	L		2
3	2005	Canada thistle	Mill Creek	L		2
4	2005	Canada thistle	Mill Creek	M		2
5	2005	Canada thistle	Mill Creek	M		2
6	2005	Canada thistle	Mill Creek	L		2
7	2005	Canada thistle	Mill Creek	L		1
8	2005	Canada thistle	Joiner	L		2
9	2005	Canada thistle	Joiner	L		3
10	2005	Spotted knapweed	Joiner	L		2
11	2005	Canada thistle	Joiner	L		2
12	2005	Canada thistle	Joiner	L		2
13	2005	Spotted knapweed	Joiner	T		1
14	2016	Spotted knapweed	Muddy	M		3
15	2016	Canada thistle	Muddy	L		3
16	2016	Leafy spurge	Muddy	M		3
17	2016	Canada thistle	Muddy	L		3
18	2016	Canada thistle	Muddy	L		2
19	2016	Canada thistle	Muddy	L		2
20	2016	Spotted knapweed	Muddy	M		2
21	2016	Leafy spurge	Muddy	L		3
22	2016	Canada thistle	Joiner	L		2
23	2003	Yellow toadflax	Muddy	H		1
24	2003	Leafy spurge	Mill Creek	L		3

[2] All Muddy Gulch known weed infestations were treated in 2016 with herbicide. Follow-up treatments will be on-going in 2017

25	2003	Canada thistle	Mill Creek	L		2
26	2003	Canada thistle	Mill Creek	L		2
27	2003	Spotted knapweed	Mill Creek	M		1
28	2003	Canada thistle	Mill Creek	L		2
29	2003	Canada thistle	Mill Creek	L		2
30	2003	Canada thistle	Cabbage	L		2
31	2003	Canada thistle	Muddy	L		2
32	2003	Spotted knapweed	Muddy	L		1
33	2003	Spotted knapweed	Muddy	T		1
34	2003	Spotted knapweed	Mill Creek	L		2
35	2003	Canada thistle	Mill Creek	L		2
36	2003	Canada thistle	Mill Creek	L		2
37	2003	Canada thistle	Muddy	L		2
38	2003	Spotted knapweed	Muddy	L		2
39	2003	Spotted knapweed	Muddy	L		1
40	2003	Canada thistle	Muddy	L		2
41	2003	Canada thistle	Muddy	L		2
42	2003	Canada thistle	Muddy	L		2
43	2003	Canada thistle	Muddy	M		2
44	2003	Spotted knapweed	Mill Creek	L		3
45	2003	Canada thistle	Mill Creek	L		3
46	2003	Spotted knapweed	Mill Creek	M		2
47	2003	Spotted knapweed	Mill Creek	L		3
48	2003	Spotted knapweed	Mill Creek	L		2
49	2003	Spotted knapweed	Mill Creek	L		2
50	2003	Leafy spurge	Cabbage	L		2
51	2003	Canada thistle	Mill Creek	L		1
52	2003	Canada thistle	Mill Creek	L		2

53	2003	Canada thistle	Mill Creek	L		2
54	2003	Yellow toadflax	Mill Creek	L		1
55	2003	Leafy spurge	Mill Creek	L		3
56	2003	Leafy spurge	Mill Creek	M		3
57	2003	Leafy spurge	Mill Creek	L		3
58	2003	Leafy spurge	Mill Creek	L		3
59	2003	Spotted knapweed	Cabbage	L		3
60	2003	Leafy spurge	Cabbage	L		3
61	2003	Spotted knapweed	Cabbage	L		2
62	2003	Leafy spurge	Cabbage	L		3
63	2003	Canada thistle	Cabbage	L		2
64	2003	Leafy spurge	Cabbage	L		3
65	2003	Spotted knapweed	Cabbage	H		3
66	2003	Spotted knapweed	Cabbage	M		3
67	2003	Spotted knapweed	Cabbage	L		2
68	2003	Spotted knapweed	Cabbage	L		3
69	2003	Spotted knapweed	Cabbage	L		2
70	2003	Spotted knapweed	Cabbage	L		2
71	2003	Spotted knapweed	Cabbage	L		2
72	2003	Spotted knapweed	Cabbage	L		3
83	2014	Spotted knapweed	California Gulch	M		1
101	2014	Leafy spurge	California Gulch	L		1
102	2014	Spotted knapweed	California Gulch	L		1
103	2014	Spotted knapweed	California Gulch	L		2
123	2014	Spotted knapweed	California Gulch	M		1
124	2014	Canada thistle	California Gulch	L		1

125	2014	Canada thistle	California Gulch	L		1
126	2014	Canada thistle	California Gulch	M		3
127	2014	Canada thistle	California Gulch	L		3
128	2014	Canada thistle	California Gulch	M		5
129	2014	Canada thistle	California Gulch	T		3
130	2014	Spotted knapweed	California Gulch	L		1
131	2014	Spotted knapweed	California Gulch	M		1
132	2014	Spotted knapweed	California Gulch	L		3
133	2014	Spotted knapweed	California Gulch	L		1
134	2014	Yellow toadflax	California Gulch	M		2
135	2014	Canada thistle	California Gulch	M		1
136	2014	Spotted knapweed	California Gulch	L		1
137	2014	Yellow toadflax	California Gulch	M		3
138	2014	Yellow toadflax	California Gulch	M		3
139	2014	Yellow toadflax	California Gulch	M		1
140	2014	Yellow toadflax	California Gulch	M		3
141	2014	Spotted knapweed	California Gulch	L		1
142	2014	Canada thistle	California Gulch	L		3
143	2014	Canada thistle	California Gulch	L		2
144	2014	Canada thistle	California Gulch	M		2
145	2014	Canada thistle	California Gulch	M		2
146	2014	Canada thistle	California Gulch	L		2
147	2015	Leafy spurge	California Gulch	L		3

148	2015	Canada thistle	California Gulch	L		2

*Point Size Categories

When noxious weed infestations are smaller than 100 meters in size, GPS mapping will designate 3 size categories, measured as diameter at widest, as follows:

1: < 1 m

2: 1 – 10 m

3: 10 – 100 m

Table 4. Mount Haggin Injured Area Noxious Weed Areas[3]								
ID	**CANOPY COVER***	**ASSOCIATED VEGETATION**	**SPECIES**	**DISTRIBUTION**	**YEAR**	**POLYGON VEGETATION TYPE**	**DRAINAGE**	**ACRES**
A1	M	Grass	Spotted knapweed	Clumped	2003	Moderate Shrub/Aspen Cover with some Conifer	Cabbage	257.19
A2	L	Grass	Spotted knapweed	Clumped	2003	Degraded Grassland	Cabbage	6.82
A3	M	Grass	Leafy spurge	Clumped	2003	Degraded Grassland	Cabbage	11.43
A4	L	Grass	Leafy spurge	Scattered	2003	Dense Aspen-Shrub Cover	Cabbage	6.3
A5	L	Grass	Leafy spurge	Scattered	2003	Forested-Conifer	Cabbage	32.93
A6	L	Grass/shrub	Spotted knapweed	Clumped	2003	Forested-Conifer	Cabbage	24.82
A7	M	Grass/barren	Leafy spurge	Clumped	2003	Moderate Shrub/Aspen Cover with some Conifer	Cabbage	9.96
A8	L	Grass/barren	Canada thistle	Clumped	2003	Degraded Grassland	Mill/Cabbage	75.16
A9	L	Shrub/barren	Leafy spurge	Clumped	2003	Bare	Joiner	56.54

[3] Infestations determined in the field to be larger than 100x100 feet were described as areas and shown as polygons on maps

A10	L	Aspen/shrub	Leafy spurge	Continuous	2003	Moderate Shrub/Aspen Cover with some Conifer	Joiner	132.24
A11	L	Shrub/barren	Leafy spurge	Clumped	2003	Moderate Shrub/Aspen Cover with some Conifer	Mill	9.71
A12	L	Barren	Leafy spurge	Clumped	2003	Moderate Shrub/Aspen Cover with some Conifer	Mill	3.56
A13	L	Barren	Leafy spurge	Clumped	2003	Bare	Cabbage	30.22
A14	H	Grass/shrub	Spotted knapweed	Clumped	2003	Degraded Grassland	Mill Creek	6.93
A15	M	Grass/shrub	Spotted knapweed	Clumped	2003	Bare	Mill Creek	70.91
A16	M	Grass/shrub	Spotted knapweed	Continuous	2003	Degraded Grassland	Joiner	4.1
A17	M	Grass/shrub	Spotted knapweed	Continuous	2003	Degraded Grassland	Joiner	6.51
A18	L	Barren	Spotted knapweed	Scattered	2003	Degraded Grassland	Joiner	0.8
A19	M	Barren	Leafy spurge	Gradient	2003	Dense Aspen-Shrub Cover	Joiner	6.58
A20	L	Barren	Canada thistle	Scattered	2003	Moderate Shrub/Aspen Cover with some Conifer	Joiner	32.88
A21	M	Barren	Spotted knapweed	Continuous	2003	Bare	Joiner	19.39

A22	L	Grass	Canada thistle	Clumped	2003	Bare	Mill Creek	23.78
A23	L		Spotted knapweed		2003			3.37
A24	M		Spotted knapweed		2003			137.12
A25	L	Grass	Leafy spurge	Clumped	2003			16.33
A32	M		Dalmation Toadfl	Continuous	2005			9.82
A33	L		Canada thistle	Scattered	2005			32.77
A34	L		Spotted knapweed	Scattered	2005			119.81
A35	L		Canada thistle	Scattered	2005			28.11
A36	L		Spotted knapweed	Clumped	2005			15.88
A37	L		Dalmation Toadfl	Scattered	2005			22.78
A38	M		Leafy spurge	Continuous	2005	Moderate Shrub/Aspen Cover with some Conifer	Mill	5.51
A39	L		Spotted knapweed	Clumped	2005			7.61
A40	M		Spotted knapweed	Patchy	2005			86.35
A26	L		Spotted knapweed	Clumped	2003	Degraded Grassland	Mill Creek	7.57
A27	L		Canada thistle		2003	Degraded Grassland	Mill Creek	6.75

A28	L		Leafy spurge	Isolated	2003	Degraded Grassland	Muddy Gulch	3.12
A29	L		Canada thistle		2003	Degraded Grassland	Mill Creek	0.62
A30	L		Canada thistle		2003	Degraded Grassland	Mill Creek	1.16
A31	L		Canada thistle		2003			14.16
A32_'16	L		Leafy spurge		2016	Degraded Grassland	Muddy Gulch	1.36
A33_'16	L		Spotted knapweed		2016	Degraded Grassland	Muddy Gulch	1.54
A34_'16	L		Spotted knapweed		2016	Degraded Grassland	Muddy Gulch	18.92
A35_'14	M	Bare	Leafy spurge		2014	Bare	California Creek	3.21
A36_'14	M	Bare	Spotted knapweed	Scattered	2014	Bare	California Creek	1.18
A37_'14	M	Bare	Spotted knapweed	Scattered	2014	Bare	California Creek	0.28

*Cover Class

Cover class categories are a way of categorizing canopy cover percentage for noxious weed infestations, as follows:

T: Trace, < 1%

L: Low, 1-5%

M: Medium, 5-25%

H: High, >25%

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Appendix A. State of Montana Recommendations for Revegetation

'Revegetation is to cause desirable vegetation to grow again. Soil or ecological site-adapted desired plants should be restored onto a site where invader species are to be eradicated. Restoration planning to reoccupy the site with desired vegetation should be an integral component of a weed management program when loss or displacement of desirable species has occurred. Without restoration of desired plants, the area is likely to become re-infested with either the same or a new weed species. Disturbed areas, where protection and restoration projects may protect critical habitat or important natural features, should have the highest priority. Areas where restoration has a good chance of success should also be a high priority.

In some cases, revegetation may not be necessary to restore a desired plant community. For example, if a moderately healthy component of the desired vegetation remains on the site, restoration may be achieved through other weed management techniques such as multi-species grazing, herbicide applications, and/or the integration of techniques applied in a manner that addresses how plant communities change naturally. Before revegetation occurs, sites should be evaluated for the presence and composition of desired species to determine if revegetation is necessary. The need for revegetation should be determined before weed treatments occur so that seeding can be done soon after the weeds have been removed and before the treated species or other weed species recolonize the site. Monitoring is required to determine which native species establish well and whether a second seeding is desirable.

Although efforts to restore appropriate desired plant communities are being used on disturbed sites, such as rights-of-way, mining areas, and power and transmission lines, there is limited work of this kind being done on degraded range, pasture, and woodland sites. The state of Montana supports more restoration activities on the above types of lands. Range, pasture, and woodland sites are home to a majority of the noxious weed infestations in the state. Land managers across Montana are encouraged to increase restoration efforts on these lands (Montana Department of Agriculture 2017, p.33-34).'

Appendix B. Biocontrol Insects Approved and Established in Montana

Species

Leafy spurge (*Euphorbia esula*)

Aphthona lacertosa (root-mining flea-beetle)

Oberea erythrocephala (stem-boring beetle)

Spotted knapweed (*Centaurea maculosa*)

Cyphocleonus achates (root weevil)

Larinus minutus (seed-head weevil)

Canada thistle (*Cirsium arvense*)

Ceutorhynchus litura (stem weevil)

Urophora caardui (stem gall fly)

Mount Haggin Wildlife Management Area Injured Area Upland Polygon Weed Management Guidelines

Introduction

Weed management plans for specific Injured Area Upland Restoration Polygons in the Cabbage, Muddy and California Gulch's, based on the guidelines and infestation criteria key found in the Mount Haggin Injured Areas Weed Management Plan (MHWMP 2017), are described below. Infestations of noxious weeds found in other Polygons should be managed based on the MHWMP (2017).

Guidelines

Cabbage Gulch

Cabbage Gulch is the most severely injured and degraded of the three drainages discussed below, and correspondingly is the most infested with noxious weeds, including spotted knapweed, leafy spurge, Canada thistle, and whitetop (see Figure 1). However, since the drainage was mapped in 2003-2005, significant changes in the infestations and other vegetation have occurred. The drainage should be mapped in 2017-2018 in order to better understand and document these changes, and guide management actions in Cabbage Gulch and other areas.

Whitetop

The mouth of Cabbage Gulch on the west side of the Creek is heavily infested with whitetop, and it appears to be spreading throughout the drainage in small and scattered infestations.

Management: The goal of managing whitetop should ultimately be eradication, but this will be a long term goal. After mapping and assessing the severity of the infestation, control with herbicides should be initiated. In the short run (2017-2018), the outlying satellite infestations should be targeted with herbicide, while the large infestations at the bottom of the drainage should be targeted if resources are available. The upper reaches of the drainage, as well as adjacent areas, should be surveyed to prevent the species from spreading.

Leafy spurge

Leafy spurge has declined significantly since 2003-2005, resulting from biocontrol with the *Apthona* species flea beetle and other biocontrol agents, and now occurs sporadically in small isolated infestations, mostly limited to shady areas.

Management: The drainage should be mapped in order to quantify the changes in infestations and locate current infestations. Larger infestations in sunny areas should be targeted with biocontrol agents, while smaller infestations in appropriate areas should be targeted for eradication while those found in areas off limits to herbicides should be monitored (see MHWMP 2017 for guidelines).

Leafy spurge is difficult to control with herbicides, and attempts at eradication often result in damage to non-target vegetation, creating opportunities for re-invasion by other noxious weeds. Monitoring and revegetation should be emphasized when herbicides are used.

Spotted knapweed

Spotted knapweed continues to be the most abundant and widespread noxious weed in Cabbage Gulch, although it has declined in many areas. These declines have occurred in areas where grass species have become well established. Herbicides have been sprayed to treat spotted knapweed since at least the 1980s,

with many areas targeted multiple times over the decades. Although spotted knapweed is susceptible to herbicides, the lack of competition resulting from the lack of a healthy native plant habitat and the successful recruitment of new spotted knapweed plants from the seed bank resulting from the disturbance of herbicides, had resulted in spotted knapweed continuing to dominate the sprayed area, as well as move into new areas.

Since the early 2000s the seed bank of spotted knapweed seeds has been decreasing due to the biocontrol insects that can reduce seed production by 90% or more (Story 2008, Figure 1.). At the same time, other plants have been slowly establishing, primarily grasses, both native and non-native, since the herbicides kill broadleaf forb species.

As a result, control of spotted knapweed is now possible, as shown in Cabbage Gulch. However, the resulting plant cover is composed primarily of grass and grass-like species, while broad-leaf forbs have been suppressed by herbicides.

Management: spotted knapweed should continue to be controlled in Cabbage Gulch with a combination of biocontrol and herbicides, along with revegetation with a mixture of native forbes and grass species. Sunny areas with dense infestations of spotted knapweed should be targeted with biocontrol agents and monitored to assess changes over time.

Muddy Gulch

Bordering the Continental Divide, Muddy Gulch is relatively free of noxious weeds, and the management goals should be to prevent their establishment and spread. Small isolated infestations (see Figure 1) were targeted with herbicides in 2017. These infestations should be monitored in the future, with additional control if the infestations are not eradicated. Mapping and monitoring should be conducted to prevent establishment and spread of noxious weeds.

Polygon M21:

Spotted knapweed: the large spotted knapweed infestations on the south-facing slopes of Polygon M21 are the focus of an herbicide experiment, initiated in 2017, where a portion of the area was targeted with the spot application of herbicide, another portion targeted with broadcast herbicide, and a third portion left herbicide free. Vegetation monitoring will start in July/August 2017, and continued into 2018 and subsequent years.

Whitetop: A small infestation of whitetop was found in 2016. Although herbicides were applied in the same year, the infestation was found again in 2017, in an area disturbed by heavy equipment used for restoration activities. Herbicides were applied in early June of 2017. The infestations should continue to monitored and controlled with herbicides until eradicated

Polygon M40:

The two leafy spurge infestations found in Restoration Polygon M40 and mapped in 2015 have expanded up the slope, increasing in overall size, although the leafy spurge infestations mapped in 2003 and targeted with biocontrol insects have declined significantly (see Figure 1). This suggests that while biocontrol of leafy spurge can prove as effective at these higher elevations as it has in the lower elevation areas of the MHIAs, the barren hillsides where the leafy spurge is found are prone to colonization by the noxious weed.

Management: biocontrol insects should be released in 2017, while herbicides should be used to prevent the infestation from spreading.

California Gulch

California Gulch, located in the Big Hole drainage, is the least infested with noxious weeds of the IA drainages, while the Big Hole drainage in general is relatively free of many noxious weed species. In order to prevent the spread of noxious weeds into adjacent un-infested areas, eradication is the primary management goal for spotted knapweed, leafy spurge, Dalmation toadflax, and whitetop. Small isolated infestations (see Figure 1) were targeted with herbicides in 2017. These infestations should be monitored in the future, with additional control if the infestations are not eradicated. Mapping and monitoring should be conducted to prevent establishment and spread of noxious weeds.

Polygon C34:

The leafy spurge infestations in Polygon C34 (see Figure 1) have been targeted with biocontrol insects and should be monitored for control, and to prevent the infestations from spreading. Other infestations of leafy spurge and other noxious weed species should be targeted for eradication with herbicides

Appendix C: Completed and Proposed Work Data Tables

All SSR Proposed Work- Acres (SSR-1, SSR-2a, SSR-3)

Drainage	Restoration Polygon	Treatment	Area (Acres)	Restoration Poly Size (Acres)	Treatment % Coverage
California Creek	C.11	SSR-1b	0.9	31.6	2.9%
California Creek	C.11	SSR-1d	0.2	31.6	0.6%
California Creek	C.11	SSR-2a	0.9	31.6	2.9%
California Creek	C.11	SSR-3b	0.0	31.6	0.1%
California Creek	C.12	SSR-1b	23.8	68.4	34.7%
California Creek	C.12	SSR-2a	7.0	68.4	10.3%
California Creek	C.20	SSR-1b	0.4	465.8	0.1%
California Creek	C.20	SSR-1c	0.0	465.8	0.0%
California Creek	C.20	SSR-1d	4.4	465.8	1.0%
California Creek	C.20	SSR-2a	1.0	465.8	0.2%
California Creek	C.20	SSR-3b	0.9	465.8	0.2%
California Creek	C.21	SSR-1d	1.9	113.9	1.6%
California Creek	C.21	SSR-3b	1.3	113.9	1.2%
California Creek	C.22	SSR-1b	0.0	80.2	0.0%
California Creek	C.22	SSR-1d	0.2	80.2	0.3%
California Creek	C.22	SSR-3b	0.0	80.2	0.0%
California Creek	C.23	SSR-1b	10.4	49.1	21.2%
California Creek	C.23	SSR-1d	2.7	49.1	5.5%
California Creek	C.23	SSR-2a	2.6	49.1	5.3%
California Creek	C.23	SSR-3b	1.0	49.1	2.0%
California Creek	C.24	SSR-1b	20.9	61.8	33.8%
California Creek	C.24	SSR-1c	3.8	61.8	6.2%
California Creek	C.24	SSR-2a	8.0	61.8	13.0%
California Creek	C.25	SSR-1b	0.1	63.9	0.1%
California Creek	C.31	SSR-2a	0.0	200.3	0.0%
California Creek	C.31	SSR-2b	0.7	200.3	0.3%
California Creek	C.32	SSR-1b	13.7	67.3	20.3%
California Creek	C.32	SSR-2a	0.4	67.3	0.6%
California Creek	C.33	SSR-1b	36.0	97.8	36.8%
California Creek	C.33	SSR-1c	4.5	97.8	4.6%
California Creek	C.33	SSR-2a	23.7	97.8	24.2%
California Creek	C.34	SSR-1b	1.2	52.7	2.2%
California Creek	C.34	SSR-2a	0.5	52.7	0.9%
California Creek	C.35	SSR-1b	5.3	61.0	8.6%
California Creek	C.50	SSR-1b	0.0	13.7	0.1%
California Creek	C.51	SSR-1b	18.6	27.2	68.2%
Cabbage Gulch	CB.20	SSR-3b	0.4	192.4	0.2%
Cabbage Gulch	CB.20	SSR-3e	0.3	192.4	0.2%
Cabbage Gulch	CB.40	SSR-3b	1.1	397.0	0.3%
Cabbage Gulch	CB.40	SSR-3e	0.1	397.0	0.0%
Joiner Gulch	J.10	SSR-1d	1.6	40.5	3.9%
Joiner Gulch	J.20	SSR-1d	3.0	93.1	3.2%

Joiner Gulch	J.30	SSR-1b	36.8	134.2	27.4%
Joiner Gulch	J.30	SSR-1d	1.4	134.2	1.1%
Joiner Gulch	J.31	SSR-1b	0.6	49.5	1.3%
Joiner Gulch	J.40	SSR-1b	49.2	281.3	17.5%
Joiner Gulch	J.40	SSR-1d	0.4	281.3	0.1%
Joiner Gulch	J.44	SSR-1b	16.1	18.0	89.5%
Joiner Gulch	J.60	SSR-1b	3.0	169.8	1.8%
Joiner Gulch	J.60	SSR-2a	3.1	169.8	1.8%
Joiner Gulch	J.70	SSR-1b	0.6	54.1	1.0%
Joiner Gulch	J.80	SSR-1b	0.2	74.2	0.2%
Joiner Gulch	J.80	SSR-1c	2.0	74.2	2.7%
Joiner Gulch	J.80	SSR-2a	2.8	74.2	3.8%
Joiner Gulch	J.80	SSR-3a	0.1	74.2	0.1%
Joiner Gulch	J.80	SSR-3b	1.2	74.2	1.6%
Joiner Gulch	J.81	SSR-1c	7.0	16.8	42.0%
Joiner Gulch	J.81	SSR-2a	16.7	16.8	99.4%
Joiner Gulch	J.81	SSR-3a	6.1	16.8	36.6%
Joiner Gulch	J.82	SSR-1b	0.2	20.3	1.2%
Joiner Gulch	J.82	SSR-1c	8.0	20.3	39.7%
Joiner Gulch	J.82	SSR-2a	20.2	20.3	99.8%
Joiner Gulch	J.82	SSR-3a	7.5	20.3	36.9%
Joiner Gulch	J.83	SSR-1b	8.6	70.8	12.1%
Joiner Gulch	J.83	SSR-2a	0.0	70.8	0.0%
Joiner Gulch	J.83	SSR-3a	0.1	70.8	0.1%
Joiner Gulch	J.83	SSR-3b	0.0	70.8	0.0%
Joiner Gulch	J.84	SSR-1b	17.8	39.1	45.5%
Joiner Gulch	J.84	SSR-1c	12.3	39.1	31.4%
Joiner Gulch	J.84	SSR-2a	0.0	39.1	0.1%
Joiner Gulch	J.84	SSR-3a	21.0	39.1	53.8%
Joiner Gulch	J.90	SSR-1b	19.9	59.6	33.5%
Joiner Gulch	J.91	SSR-1b	1.8	106.4	1.7%
Joiner Gulch	J.91	SSR-2a	0.0	106.4	0.0%
Joiner Gulch	J.93	SSR-1b	38.9	64.9	60.0%
Joiner Gulch	J.93	SSR-2a	5.2	64.9	8.0%
Joiner Gulch	J.93	SSR-3a	2.1	64.9	3.2%
Muddy Gulch	M.10	SSR-3b/3d	0.4	18.3	2.3%
Muddy Gulch	M.11	SSR-3b/3d	0.0	22.5	0.0%
Muddy Gulch	M.20	SSR-1b	5.0	34.4	14.5%
Muddy Gulch	M.20	SSR-2a	3.3	34.4	9.6%
Muddy Gulch	M.21	SSR-1b	21.5	58.6	36.7%
Muddy Gulch	M.21	SSR-2a	3.2	58.6	5.4%
Muddy Gulch	M.30	SSR-1b	15.9	34.2	46.6%
Muddy Gulch	M.30	SSR-1c	2.0	34.2	5.8%
Muddy Gulch	M.31	SSR-1b	0.0	3.8	0.0%
Muddy Gulch	M.31	SSR-2a	0.2	3.8	5.1%
Muddy Gulch	M.40	SSR-1b	34.0	76.7	44.2%

Muddy Gulch	M.40	SSR-1c	0.3	76.7	0.4%
Muddy Gulch	M.41	SSR-1b	3.8	46.8	8.2%
Muddy Gulch	M.41	SSR-2a	0.4	46.8	0.9%
Muddy Gulch	M.50	SSR-1b	4.8	41.5	11.7%
Muddy Gulch	M.50	SSR-2a	2.5	41.5	6.0%
Muddy Gulch	M.51	SSR-1b	3.5	42.0	8.3%
Muddy Gulch	M.51	SSR-2a	0.1	42.0	0.2%
Muddy Gulch	M.60	SSR-1b	8.6	12.8	67.2%
Muddy Gulch	M.60	SSR-2a	0.0	12.8	0.1%
Muddy Gulch	M.61	SSR-1b	1.4	2.8	50.9%
Muddy Gulch	M.61	SSR-2a	0.5	2.8	17.9%
Muddy Gulch	M.70	SSR-1b	1.9	14.4	12.9%
Muddy Gulch	M.70	SSR-2a	0.3	14.4	2.2%
Muddy Gulch	M.71	SSR-1b	0.0	3.0	0.0%
Muddy Gulch	M.71	SSR-2a	1.5	3.0	51.0%
Muddy Gulch	M.80	SSR-1b	0.0	7.7	0.0%
Muddy Gulch	M.80	SSR-2a	0.0	7.7	0.3%
Muddy Gulch	M.81	SSR-2a	0.0	5.1	0.3%
Mill Creek	MC.10	SSR-1b	11.7	237.8	4.9%
Mill Creek	MC.10	SSR-2a	11.7	237.8	4.9%
Mill Creek	MC.10	SSR-3e	0.3	237.8	0.1%
Mill Creek	MC.30	SSR-1b	2.4	73.5	3.3%
Mill Creek	MC.40	SSR-1b	0.0	17.4	0.0%
Mill Creek	MC.50	SSR-1b	21.1	89.4	23.6%
Mill Creek	MC.50	SSR-3a/3b	0.0	89.4	0.0%
Mill Creek	MC.60	SSR-1b	3.8	118.6	3.2%
Mill Creek	MC.60	SSR-2a	1.3	118.6	1.1%
Mill Creek	MC.60	SSR-3a/3b	28.8	118.6	24.3%
Mill Creek	MC.60	SSR-3b	0.1	118.6	0.1%
Mill Creek	MC.70	SSR-3d	1.0	511.4	0.2%
Willow Creek	W.10	SSR-1b	0.2	7806.0	0.0%
Willow Creek	W.10	SSR-1c	0.0	7806.0	0.0%
Willow Creek	W.10	SSR-2a	1.3	7806.0	0.0%
Willow Creek	W.10	SSR-3a	0.0	7806.0	0.0%
Willow Creek	W.20	SSR-1b	26.6	75.6	35.2%
Willow Creek	W.30	SSR-1b	12.0	107.8	11.2%
Willow Creek	W.50	SSR-1b	23.6	120.0	19.6%
Willow Creek	W.50	SSR-2a	14.5	120.0	12.1%
Willow Creek	W.60	SSR-1b	15.5	21.7	71.5%
Willow Creek	W.60	SSR-1c	3.4	21.7	15.9%
Willow Creek	W.60	SSR-2a	13.7	21.7	63.4%
Willow Creek	W.70	SSR-1b	2.6	32.6	7.9%
Willow Creek	W.70	SSR-1c	14.8	32.6	45.3%
Willow Creek	W.70	SSR-2a	6.7	32.6	20.6%
Willow Creek	W.70	SSR-3a	6.4	32.6	19.8%

All SSR Proposed Work- Linear Feet (SSR-2b, 2c, 2d, 2e)

name	Treatment	Length (ft)
C.10	SSR-2b	2697
C.12	SSR-2b	1766
C.20	SSR-2c/2d	2013
C.20	SSR-2e	400
C.23	SSR-2c/2d	978
C.24	SSR-2c/2d	1998
C.30	SSR-2b	5366
C.31	SSR-2c/2d	906
C.33	SSR-2c/2d	2026
C.50	SSR-2c/2d	581
CB.20	SSR-2b	900
CB.40	SSR-2b	8315
J.20	SSR-2b	1317
J.30	SSR-2b	1790
J.30	SSR-2c/2d	35
J.31	SSR-2b	1759
J.40	SSR-2b	2970
J.40	SSR-2c/2d	2813
J.41	SSR-2b	7
J.42	SSR-2b	1250
J.44	SSR-2b	446
J.60	SSR-2b	104
J.60	SSR-2c/2d	3956
J.70	SSR-2b	658
J.70	SSR-2c/2d	28
J.80	SSR-2b	1529
J.90	SSR-2b	306
J.91	SSR-2b	85
J.91	SSR-2c/2d	343
J.93	SSR-2c/2d	5
M.10	SSR-2b	926
M.20	SSR-2b	333
M.20	SSR-2c/2d	897
M.21	SSR-2c/2d	71
M.30	SSR-2c/2d	419
M.40	SSR-2c/2d	200
M.41	SSR-2b	966
M.50	SSR-2c/2d	962
MC.10	SSR-2b	3383
MC.10	SSR-2c/2d	1756
MC.70	SSR-2b	650

W.10	SSR-2c/2d	2572
W.20	SSR-2c/2d	208
W.30	SSR-2c/2d	3141
W.50	SSR-2c/2d	3214
W.60	SSR-2c/2d	932

All SSR Completed Work- Acres (SSR-1, SSR-2a, SSR-3)

Drainage	Restoration Polygon	Treatment	Area (Acres)	Total Restoration Poly area (Acres)	Treatment % Coverage
California Creek	C.11	SSR-1d	0.00	32	0.01%
California Creek	C.11	SSR-2a	0.04	32	0.13%
California Creek	C.11	SSR-2e	0.00	32	0.00%
California Creek	C.12	SSR-1b	1.35	68	1.97%
California Creek	C.12	SSR-1c	3.62	68	5.30%
California Creek	C.12	SSR-1d	6.00	68	8.77%
California Creek	C.12	SSR-2a	3.24	68	4.73%
California Creek	C.12	SSR-2e	0.01	68	0.01%
California Creek	C.12	SSR-3d	0.10	68	0.14%
California Creek	C.12	SSR-3e	0.06	68	0.09%
California Creek	C.20	SSR-1b	0.10	466	0.02%
California Creek	C.20	SSR-1c	0.00	466	0.00%
California Creek	C.20	SSR-1d	1.01	466	0.22%
California Creek	C.20	SSR-2a	0.19	466	0.04%
California Creek	C.20	SSR-2e	0.02	466	0.00%
California Creek	C.20	SSR-3a	0.01	466	0%
California Creek	C.21	SSR-1d	0.03	114	0.03%
California Creek	C.23	SSR-1c	0.02	49	0.03%
California Creek	C.23	SSR-2a	2.05	49	4.19%
California Creek	C.23	SSR-3a	0.00	49	0.00%
California Creek	C.23	SSR-3b	0.00	49	0.01%
California Creek	C.24	SSR-1c	0.49	62	0.80%
California Creek	C.24	SSR-2a	4.57	62	7.40%
California Creek	C.30	SSR-1d	0.80	499	0.16%
California Creek	C.30	SSR-3a	0.01	499	0.00%
California Creek	C.30	SSR-3e	0.02	499	0.00%
California Creek	C.31	SSR-1d	0.82	200	0.41%
California Creek	C.31	SSR-3d	0.07	200	0.03%
California Creek	C.31	SSR-3e	0.01	200	0.01%
California Creek	C.32	SSR-1b	0.25	67	0.37%
California Creek	C.33	SSR-1b	24.81	98	25.37%
California Creek	C.33	SSR-2a	6.97	98	7.13%
California Creek	C.34	SSR-1b	0.00	53	0.00%
Cabbage Gulch	CB.40	SSR-1b	3.09	397	0.78%
Cabbage Gulch	CB.40	SSR-1d	5.87	397	1.48%
Joiner Gulch	J.80	SSR-1b	0.05	74	0.07%
Joiner Gulch	J.80	SSR-2e	0.00	74	0.01%

Joiner Gulch	J.83	SSR-1b	0.19	71	0.26%
Joiner Gulch	J.83	SSR-1c	0.00	71	0.00%
Joiner Gulch	J.84	SSR-1b	24.67	39	63.07%
Joiner Gulch	J.84	SSR-1c	4.14	39	10.58%
Joiner Gulch	J.93	SSR-1b	12.20	65	18.78%
Joiner Gulch	J.93	SSR-1c	0.21	65	0.32%
Joiner Gulch	J.93	SSR-2e	0.00	65	0.00%
Muddy Gulch	M.30	SSR-3e	0.04	34	0.12%
Muddy Gulch	M.40	SSR-1b	0.01	77	0.01%
Muddy Gulch	M.40	SSR-2a	0.03	77	0.04%
Muddy Gulch	M.40	SSR-3e	0.09	77	0.11%
Muddy Gulch	M.50	SSR-1b	0.17	41	0.40%
Muddy Gulch	M.50	SSR-2a	0.04	41	0.10%
Muddy Gulch	M.50	SSR-3e	0.15	41	0.37%
Muddy Gulch	M.51	SSR-1b	0.06	42	0.14%
Muddy Gulch	M.60	SSR-1b	6.84	13	53.39%
Muddy Gulch	M.60	SSR-1c	0.53	13	4.17%
Muddy Gulch	M.60	SSR-2a	0.03	13	0.26%
Muddy Gulch	M.60	SSR-3e	0.01	13	0.09%
Muddy Gulch	M.60	SSR-3f	0.03	13	0.25%
Muddy Gulch	M.61	SSR-1b	0.57	3	20.48%
Muddy Gulch	M.61	SSR-2a	0.05	3	1.65%
Muddy Gulch	M.61	SSR-3e	0.01	3	0.28%
Muddy Gulch	M.61	SSR-3f	0.09	3	3.33%
Muddy Gulch	M.70	SSR-1b	0.65	14	4.50%
Muddy Gulch	M.70	SSR-3a	0.20	14	1.37%
Muddy Gulch	M.70	SSR-3e	0.19	14	1.35%
Muddy Gulch	M.70	SSR-3f	0.23	14	1.60%
Muddy Gulch	M.71	SSR-1b	1.12	3	37.81%
Muddy Gulch	M.81	SSR-1b	0.07	5	1.31%
Mill Creek	MC.60	SSR-1b	2.26	119	1.90%
Mill Creek	MC.70	SSR-1d	26.50	511	5.18%
Willow Creek	W.10	SSR-1b	0.04	7807	0.00%
Willow Creek	W.70	SSR-1b	9.14	33	28.05%
Willow Creek	W.70	SSR-1c	0.11	33	0.35%

All SSR Completed Work- Linear Feet (SSR-2b, 2c, 2d, 2e)

name	**Treatment**	**Length (ft)**
C.10	SSR-2b	52
C.11	SSR-2b	282
C.12	SSR-2b	2037
C.12	SSR-2d	1886
C.12	SSR-2e	259
C.20	SSR-2b	3542
C.20	SSR-2c	1257

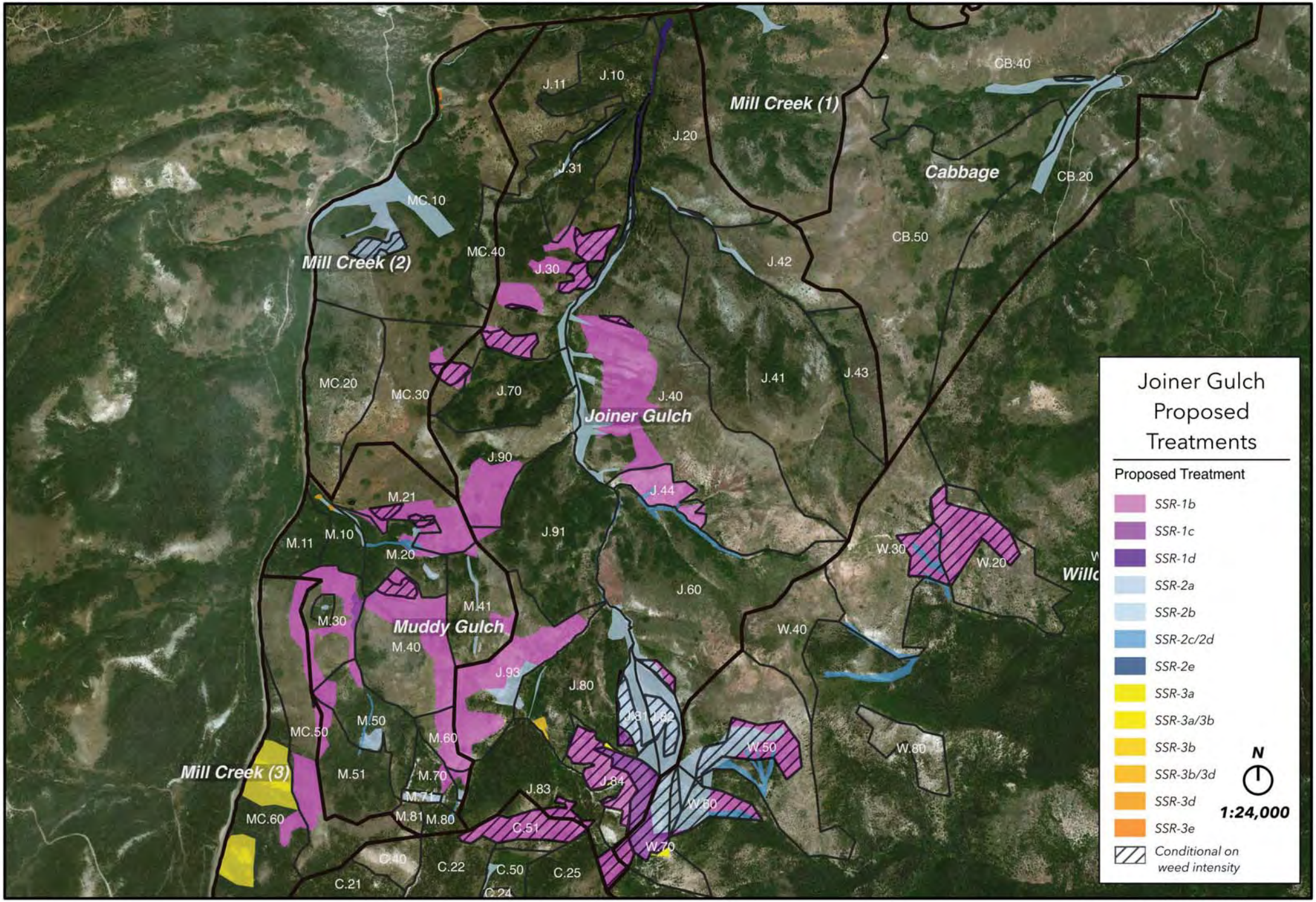
C.20	SSR-2d	2670
C.20	SSR-2e	245
C.21	SSR-2b	317
C.21	SSR-2d	333
C.22	SSR-2d	1569
C.23	SSR-2b	1651
C.23	SSR-2c	88
C.23	SSR-2d	726
C.30	SSR-2b	446
C.31	SSR-2c	1024
C.31	SSR-2d	361
C.33	SSR-2c	2583
C.33	SSR-2d	2346
CB.40	SSR-2b	1960
J.80	SSR-2b	697
J.80	SSR-2d	539
J.60	SSR-2c	989
J.83	SSR-2b	642
J.83	SSR-2d	551
J.84	SSR-2d	1603
J.91	SSR-2d	27
J.93	SSR-2b	78
J.93	SSR-2d	5
M.10	SSR-2b	981
M.20	SSR-2b	783
M.30	SSR-2b	115
M.30	SSR-2d	327
M.40	SSR-2b	75
M.40	SSR-2d	887
M.50	SSR-2b	629
M.50	SSR-2d	347
M.60	SSR-2a	98
M.60	SSR-2d	238
M.61	SSR-2a	224
M.70	SSR-2d	452
M.71	SSR-2d	46
MC.60	SSR-2d	64

Appendix D: Polygon Data Sheets

Key for Weed Codes used in polygon sheets

Steep Slope Remediation Techniques	
SSR-1a	Broadcast Seeding
SSR-1b	Broadcast Seeding with Fertilization
SSR-1c	Soil Scarification/Trenching
SSR-1d	Woody Plant Establishment
SSR-1e	Other Soil Amendment
SSR-2a	Slope stabilization
SSR-2b	In-stream check structures
SSR-2c	Gully slash filters
SSR-2d	Gully Check Dams
SSR-2e	Anchored brush bundles/brush boxes
SSR-3a	Slope pitting and roughing
SSR-3b	Earthen sediment retention
SSR-3c	Gully grading and filling
SSR-3d	Rock check dams
SSR-3e	Hydroseeding
SSR-4a	Slope grading
SSR-4b	Compost tillage
SSR-4c	Lime tillage
SSR-4d	Sediment detention pond
SSR-4e	Soil and earth removal

WEEDS	
Code	**Full Name**
SK	Spotted knapweed
LS	Leafy spurge
CT	Canada thistle
YT	Yellow toadflax
DT	Dalmation toadflax
WT	Whitetop
MANAGEMENT	
C	Contain infestations
E	Eradicate infestations
P	Prevent establishment
TREATMENT	
B	Biocontrol
H	Herbicide
M	Monitor
S	Survey



Edited 11/13/2017

Projection: NAD 83(NSRS 2007)/ Montana (ft)

RRA Polygon: J.10
Acres: 41

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Area is dominated by large beaver complexes, ponds and wetlands. Area is high-functioning and providing significant sediment capture

RRA Status

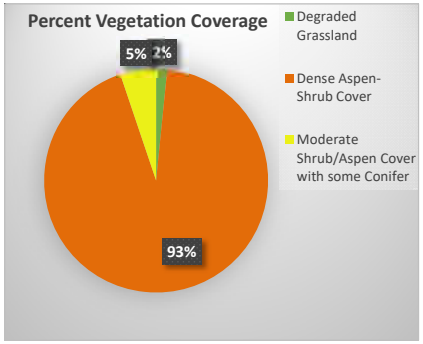
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b					
SSR-1d			1.6		
SSR-2b					
SSR-3b					
SSR-3e					
Monitor- Well Vegetated			262		
Rock-No Action			8		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
91.8°	14.3	13.4°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK			X	C	B, M
LS			X	C	B. M
CT		X		C	M
YT	X			P	S
DT	X			P	S
WT	X			P	S

RRA Polygon: J.11
Acres: 72

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Area includes aspen groves in lowlands and degraded grasslands. Weed treatment is primary activity in unit due to proximity to road

Image 1: Mature riparian vegetation moving up slope from wet valley bottom

RRA Status

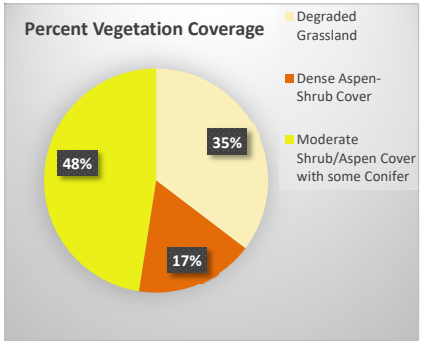
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b					
SSR-1d					
SSR-2b					
SSR-3b					
SSR-3e					
Monitor- Well Vegetated			72		
Rock-No Action			0		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
136°	40	19°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK			X	C	B, M
LS			X	C	B, M
CT		X		C	M
YT	X			P	S
DT	X			P	S
WT	X			P	S

RRA Polygon: J.20
Acres: 93

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Area includes large beaver complexes, ponds and wetlands and extends upland to a west and south-facing slope. Tributary will be treated with in-stream structures to promote sediment catchment.

Image 1: Mature riparian vegetation in valley bottom due to beaver activity

RRA Status

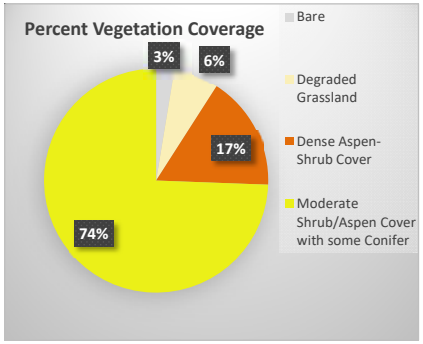
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			3.0		
SSR-1d					
SSR-2b				1317	
SSR-3b					
SSR-3e					
Monitor- Well Vegetated			88		
Rock-No Action			0		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
258°	64	22°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK			X	C	B, M
LS			X	C	B, M
CT		X		C	M
YT	X			P	S
DT	X			P	S
WT	X			P	S

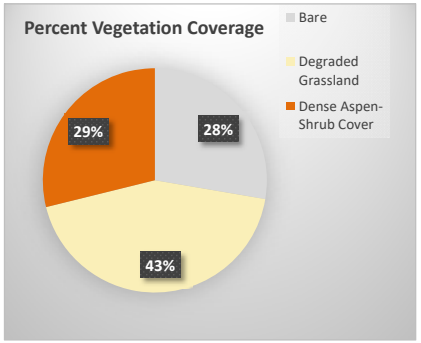
RRA Polygon: J.30
Acres: 134

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Area includes large beaver complexes, ponds and wetlands and extends upland to a east-facing slopes of degraded grasslands and bare areas. Bare and degraded slopes will be treated with fertilization and vegetation enhancement and in-stream structures will be installed to increase sediment catchment on landscape.

Image 1: Beaver pond complex in low-lying area

Image 2: Strong shrub and aspen regeneration



RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			36.8		
SSR-1d			1.4		
SSR-2b				1790	
SSR-2c				35	
SSR-2d					
Monitor- Well Vegetated			92		
Rock-No Action			0		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
104°	98	21°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK			X	C	B., M
LS			X	C	B. M
CT		X		C	M
YT	X			P	S
DT	X			P	S
WT	X			P	S

RRA Polygon: J.31
Acres: 49

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Area comprises largely well-vegetated ephemeral draw to lower Joiner. In-channel structures will be installed to ensure storm events deposit sediment on landscape

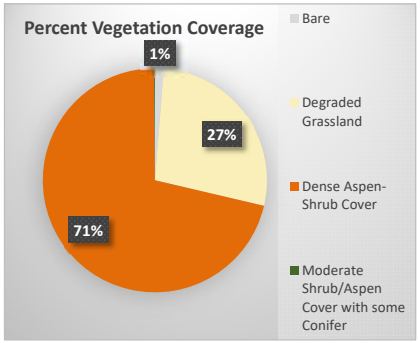
Image 1: Mature riparian vegetation in draw characteristic of unit

RRA Status					
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			0.6		
SSR-1d					
SSR-2b				1759	
SSR-2c					
SSR-2d					
Monitor- Well Vegetated			46		
Rock-No Action			0		

Vegetation & Erosion Condition:		
Average Aspect	Acres with slope >15°	Average Slope
215°	30	17°

Soils Data:			
Parent Material	Soil pH	Slope	Date
no soils data available.			

Weed Presence and Treatment Prescription					
Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK			X	C	B, M
LS			X	C	B, M
CT		X		C	M
YT	X			P	S
DT	X			P	S
WT	X			P	S



RRA Polygon: J.40
Acres: 281

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Large area spanning beaver pond bottoms to bare eroding steep slopes. Entire length of reach bottom will be checked with in-stream structures and numerous gullies treated with BMPs to slow erosion. Fertilization will enhance vegetation on steep slopes.

Image 1: Upper reaches of unit in background- mix of welded tuff and rhyolite parent materials

RRA Status

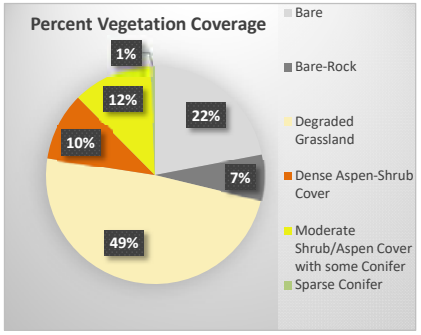
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			49.2		
SSR-1d			0.4		
SSR-2b				2970	
SSR-2c				2813	
SSR-2d					
Monitor- Well Vegetated			198		
Rock-No Action			0		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
267°	228	23°

Soils Data:

Parent Material	Soil pH	Slope	Date
tuff	5.4	56°	2009
rhy, wt	5.2-5.4	22°	2009



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK			X	C	B, M
LS		X		C	B, M
CT		X		C	M
YT	X			P	S
DT	X			P	S
WT	X			P	S

RRA Polygon: J.41
Acres: 211

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Large upland area shows minimal sign of erosion and will be monitored and treated for weeds

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b					
SSR-1d					
SSR-2b					
SSR-2c					
SSR-2d					
Monitor- Well Vegetated			206		
Rock-No Action			5		

Vegetation & Erosion Condition:

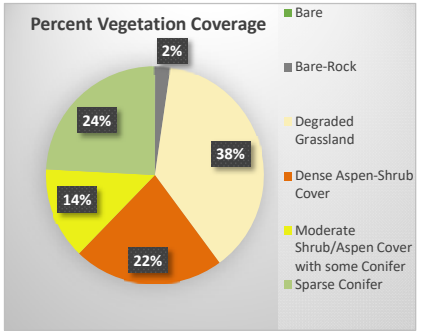
Average Aspect	Acres with slope >15°	Average Slope
145°	149	21°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK			X	C	B, M
LS		X		C	B, M
CT		X		C	M
YT	X			P	S
DT	X			P	S
WT	X			P	S



RRA Polygon: J.42
Acres: 42

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Mostly upland area constains ephemeral tributary to Joiner that will be treated with in-stream structures to ensure sediment catchment during high flow events.

Image 1: Typical Upland conditions of J42

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b					
SSR-1d					
SSR-2b				1250	
SSR-2c					
SSR-2d					
Monitor- Well Vegetated			40		
Rock-No Action					

Vegetation & Erosion Condition:

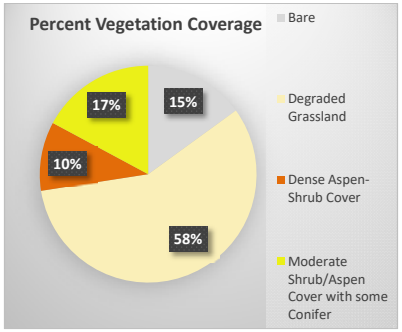
Average Aspect	Acres with slope >15°	Average Slope
260°	27	18°

Soils Data:

Parent Material	Soil pH	Slope	Date
wt, rhy	5.4 - 6.4	52°	2009
wt, rhy	5.2 - 5.8	50°	2009
wt, rhy	5.6 - 6.4	55°	2009

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	NOT SURVEYED				
LS					
CT					
YT					
DT					
WT					



RRA Polygon: J.43
Acres: 40

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Small area is not a contributing sediment source and natural revegetation is occurring. Weed monitoring and treatment will be carried out.

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b					
SSR-1d					
SSR-2b					
SSR-2c					
SSR-2d					
Monitor- Well Vegetated			31		
Rock-No Action			9		

Vegetation & Erosion Condition:

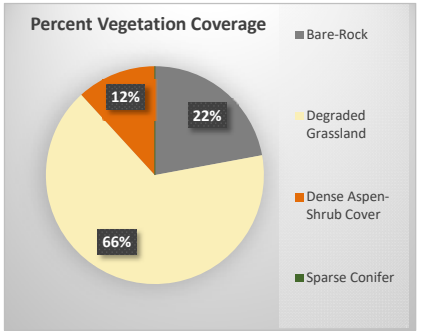
Average Aspect	Acres with slope >15°	Average Slope
276°	35	22°

Soils Data:

Parent Material	Soil pH	Slope	Date
rhy	6.0-6.4	44°	2009
rhy	5.2-6.2	23°	2009

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	NOT SURVEYED				
LS					
CT					
YT					
DT					
WT					



RRA Polygon: J.44
Acres: 18

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Mostly bare slopes are steep and major sediment source to the system. Most of the unit will be fertilized and accessible parts of gullies will have check structures installed

Image 1: Bare area of unit distinct from surrounding areas

Image 2: Extremely steep slopes beyond scope of any BMP

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			16.1		
SSR-1d					
SSR-2b				446	
SSR-2c					
SSR-2d					
Monitor- Well Vegetated			2		
Rock-No Action					

Vegetation & Erosion Condition:

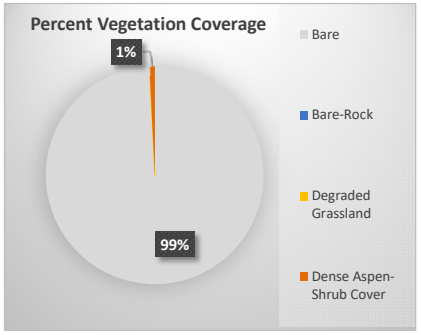
Average Aspect	Acres with slope >15°	Average Slope
236°	16	24°

Soils Data:

Parent Material	Soil pH	Slope	Date
rhy	6.0-6.4	44°	2009
rhy	5.2-6.2	23°	2009

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	NOT SURVEYED				
LS					
CT					
YT					
DT					
WT					



RRA Polygon: J.60
Acres: 170

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Vegetation in unit is establishing in lowlands and uplands. Gully bottoms will be targeted for sediment check structures to capture fines and aggrade incised systems

Image 1: Robust riparian shrub growth extending into grasslands and talus slopes

Image 2: Degraded grasslands and mixed vegetation on west-facing slopes

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			3.0		
SSR-1d			3.1		
SSR-2b				104	
SSR-2c				3956	
SSR-2d					
Monitor- Well Vegetated			149		
Rock-No Action			12		

Vegetation & Erosion Condition:

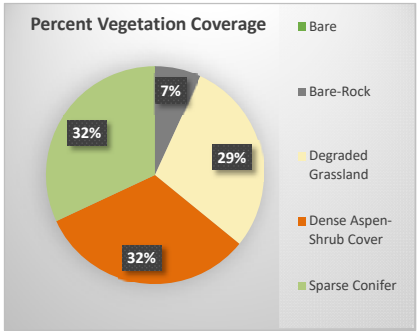
Average Aspect	Acres with slope >15°	Average Slope
285°	139	23°

Soils Data:

Parent Material	Soil pH	Slope	Date
rhy	5.2 - 6.0	30°	2009
tuff	4.6 - 5.2	54°	2009

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	NOT SURVEYED				
LS					
CT					
YT					
DT					
WT					



RRA Polygon: J.70
Acres: 54

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Area mostly well vegetated. Stream bottom will be treated with check structures to enhance sediment capture.

Image 1: Mature shrub growth has colonized most of hillslope

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			0.6		
SSR-1d					
SSR-2b				658	
SSR-2c				28	
SSR-2d					
Monitor- Well Vegetated			52		
Rock-No Action					

Vegetation & Erosion Condition:

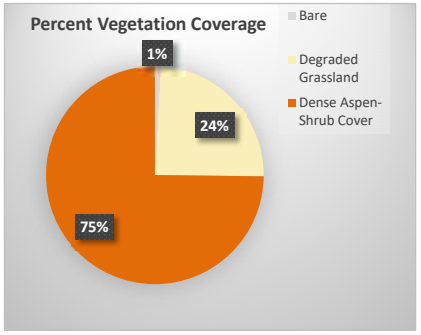
Average Aspect	Acres with slope >15°	Average Slope
88°	38	20°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available			

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	NOT SURVEYED				
LS					
CT					
YT					
DT					
WT					



RRA Polygon: J.80
Acres: 74

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
The area is a mix of vegetation conditions. The most bare uplands will be treated for vegetation enhancement and low-lying areas where sediment can be captured on the landscape will be treated with hand-installed and mechanized slope BMPs

Image 1: Mix of shrub and conifer forest cetnter of image typical of unit

Image 2: Crews treating gully at bottom of unit in 2015

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b	0.05		0.2		
SSR-1c			2.0		
SSR-2a			2.8		
SSR-2b		697		1529	
SSR-2d		539			
SSR-3a			0.1		
SSR-3b			1.2		
Monitor- Well Vegetated			65		
Rock-No Action					

Vegetation & Erosion Condition:

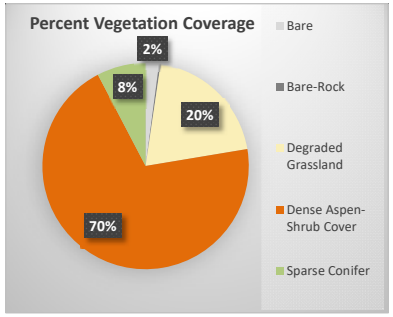
Average Aspect	Acres with slope >15°	Average Slope
189°	29	14°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available			

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	NOT SURVEYED				
LS					
CT					
YT					
DT					
WT					



RRA Polygon: J.81
Acres: 17

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Slopes in this area are considered a substantial sediment source and will be treated with aerial fertilization to enhance vegetation establishment. Slash and rill treatments will also be applied to slow erosion.

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b					
SSR-1c			7.0		
SSR-2a			16.7		
SSR-2b					
SSR-2d					
SSR-3a			6.1		
SSR-3b					
Monitor- Well Vegetated			0		
Rock-No Action			0		

Vegetation & Erosion Condition:

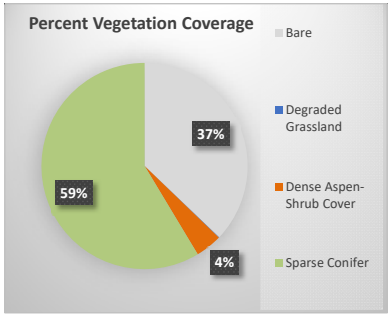
Average Aspect	Acres with slope >15°	Average Slope
203°	13	20°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available			

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK					
LS					
CT					
YT					
DT					
WT					



RRA Polygon: J.82
Acres: 20

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Area is in upper elevations of Joyner gulch and is an active sediment source. The entire unit will be treated with rill treatments to stop the beginning of erosion, using some of the conifer in the area.

Image 1: Bare, actively eroding slopes

RRA Status

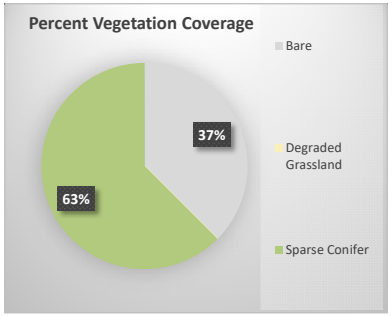
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			0.2		
SSR-1c			8.0		
SSR-2a			20.2		
SSR-2b					
SSR-2d					
SSR-3a			7.5		
SSR-3b					
Monitor- Well Vegetated			0		
Rock-No Action			0		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
241°	1	19°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available			



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	NOT SURVEYED				
LS					
CT					
YT					
DT					
WT					

RRA Polygon: J.83
Acres: 71

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Area is predominantly forested with some contributing erosion sources and gullies. Not all gullies have been identified in this area. Some slopes will be aerially fertilized to enhance vegetation growth.

Image 1: Conifer forest typical of unit conditions

RRA Status

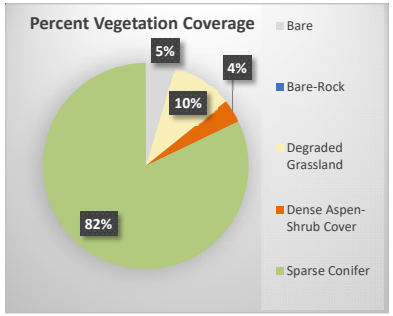
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b	0.19		8.6		
SSR-1c					
SSR-2a					
SSR-2b		683			
SSR-2d		20			
SSR-3a			0.1		
SSR-3b					
Monitor- Well Vegetated			62		
Rock-No Action			0		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
205°	28	14°

Soils Data:

Parent Material	Soil pH	Slope	Date
rhy, wt	5.0 - 5.6	37°	2009



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	NOT SURVEYED				
LS					
CT					
YT					
DT					
WT					

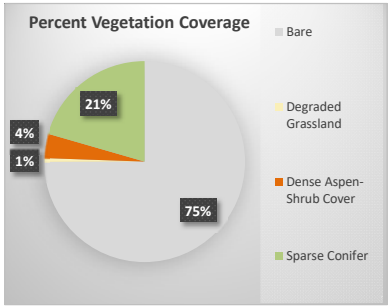
RRA Polygon: J.84
Acres: 39

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Large bare area is largest active sediment source in drainage. A 4-acre SSR-2c project established nearly 50% vegetation cover. Mechanized and hand-approaches will be employed to across remaining acreage to create suitable conditions for vegetation growth.

Image 1: 4 acre treatment of SSR-1c in bare slopes, October 2015

Image 2: 4 acre treatment of SSR-1c July, 2017



RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b	24.70		17.8		
SSR-1c	4.10		12.3		
SSR-2a			0.0		
SSR-2b					
SSR-2d		393			
SSR-3a			21.0		
SSR-3b					
Monitor- Well Vegetated			8		
Rock-No Action			0		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
248°	26	18°

Soils Data:

Parent Material	Soil pH	Slope	Date
tuff	4.4 - 4.8	37°	2009
tuff	4.6 - 5.2	47°	2009
tuff	4.6 - 5.6	6°	2009

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	NOT SURVEYED				
LS					
CT					
YT					
DT					
WT					

RRA Polygon: J.90
Acres: 60

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Steep, east-facing slope is dominated by the non-native Redtop grass, which provides stability against erosion. Additional fertilization will enhance natural recovery and in-stream structures at the base of the unit will capture sediment

Image 1: Typical grassland conditions with some shrubs in J90

RRA Status

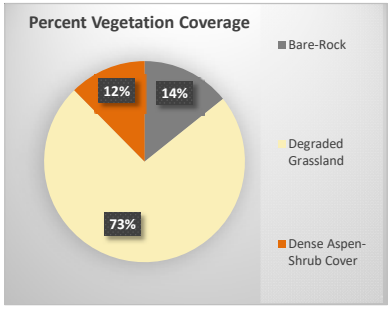
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			19.9		
SSR-1c					
SSR-2a					
SSR-2b				306	
SSR-2d					
SSR-3a					
SSR-3b					
Monitor- Well Vegetated			30		
Rock-No Action			9		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
96°	49	22°

Soils Data:

Parent Material	Soil pH	Slope	Date
tuff	6.0 - 6.2	54°	2009



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	NOT SURVEYED				
LS					
CT					
YT					
DT					
WT					

RRA Polygon: J.91
Acres: 104

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Large, mostly vegetated unit of aspen and shrub communities above two drainages. Spot treatments in eroding gullies will be applied to limited areas where sediment catchment can be enhanced

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			1.8		
SSR-1c					
SSR-2b				85	
SSR-2c					
SSR-2d		27		343	
SSR-3a					
SSR-3b					
Monitor- Well Vegetated			104		
Rock-No Action			1		

Vegetation & Erosion Condition:

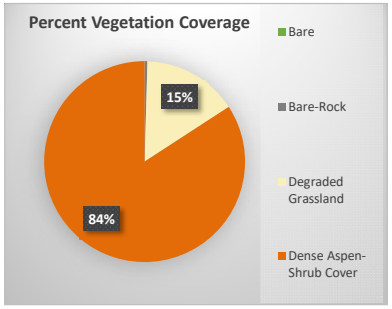
Average Aspect	Acres with slope >15°	Average Slope
120°	76	19°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available			

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	NOT SURVEYED				
LS					
CT					
YT					
DT					
WT					



RRA Polygon: J.93
Acres: 19

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Large area of this unit is highly degraded grassland that will be targeted for aerial fertilization to enhance vegetation cover and prevent onset of erosion. Rill treatments will enhance fertilization with physical barriers to sediment movement.

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b	12.20		38.9		
SSR-1c	0.21				
SSR-2a			5.2		
SSR-2c					
SSR-2d					
SSR-3a			2.1		
SSR-3b					
Monitor- Well Vegetated			19		
Rock-No Action			16		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
114°	25	13°

Soils Data:

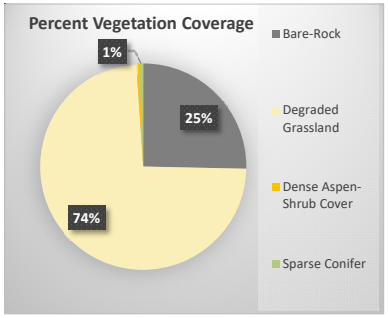
Parent Material	Soil pH	Slope	Date
no soils data available			

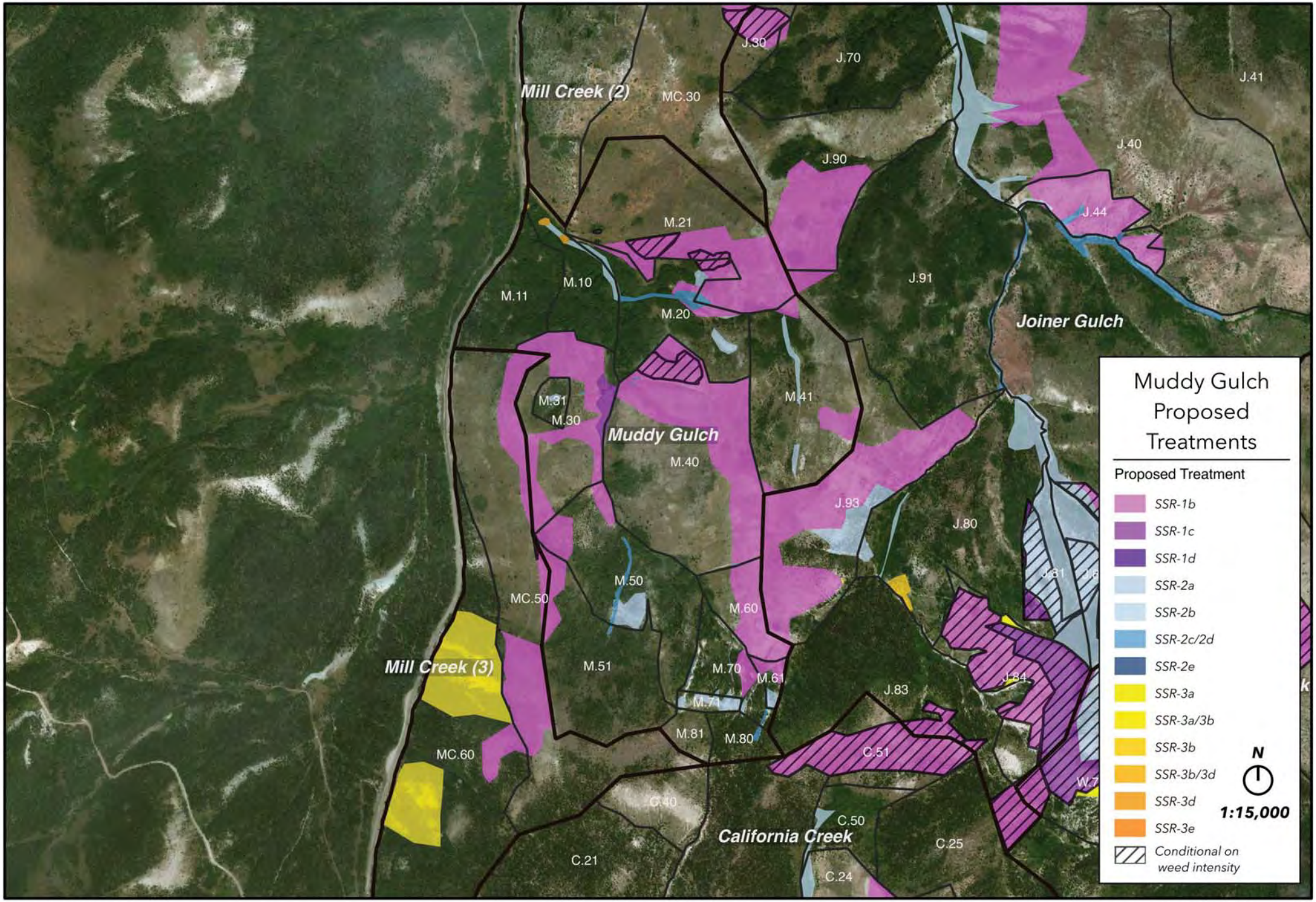
Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK					
LS	NOT SURVEYED				
CT					
YT					
DT					
WT					

Image 1: Typical degraded grassland conditions

Image 2: Typical degraded grassland conditions





Edited 11/13/2017

Projection: NAD 83(NSRS 2007)/ Montana (ft)

RRA Polygon: M.10
Acres: 18

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Well vegetated willow and aspen bottom with large potential for natural water storage and sediment capture. Channel will be aggraded with in-stream structures. Natural catchment will be enhanced with mechanized retention berms

Image 1: Wetland vegetation and incised stream channel

Image 2: Dense Wetland vegetation at outlet of drainage

RRA Status

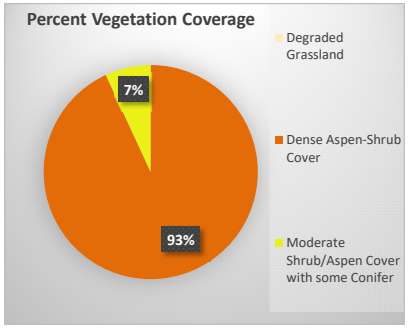
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b					
SSR- 1d					
SSR-2a					
SSR-2b		981		926	
SSR-3b/3d			0.4		
Monitor- Well Vegetated			17		
Rock-No Action					

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
84°	8	15°

Soils Data:

Parent Material	Soil pH	Slope	Date



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	X			P	
LS	X			P	
CT	X			P	
YT	X			P	
DT	X			P	
WT	X			P	

RRA Polygon: M.11
Acres: 22

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Mature riparian community at base of drainage. No treatments prescribed. Weeds will be monitored.

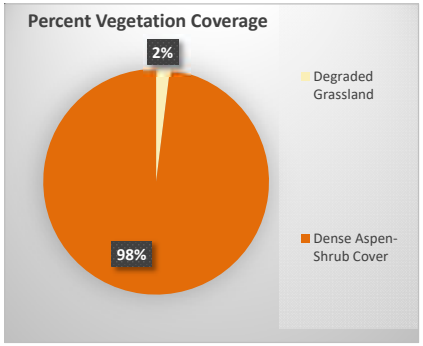
Image 1: Dense riparian vegetation characteristic of the unit

RRA Status					
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b					
SSR- 1d					
SSR-2a					
SSR-2b					
SSR-2c/2d					
Monitor- Well Vegetated			22		
Rock-No Action					

Vegetation & Erosion Condition:		
Average Aspect	Acres with slope >15°	Average Slope
289°	15	18°

Soils Data:			
Parent Material	Soil pH	Slope	Date

Weed Presence and Treatment Prescription					
	Presence			Treatment	
Weed Code	Not seen	Present	Abundant	Management	Treatment
SK	X			P	
LS	X			P	
CT	X			P	
YT	X			P	
DT	X			P	
WT	X			P	



RRA Polygon: M.20
Acres: 34

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Area contains expansive riparian and wetland areas extending into degraded grassland slopes with some gullies. Fertilization and gully treatments are prescribed to slow sediment delivery

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			5.0		
SSR- 1d					
SSR-2a			3.3		
SSR-2b		783		333	
SSR-2c/2d				897	
Monitor- Well Vegetated			27		
Rock-No Action					

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
270°	19	17°

Soils Data:

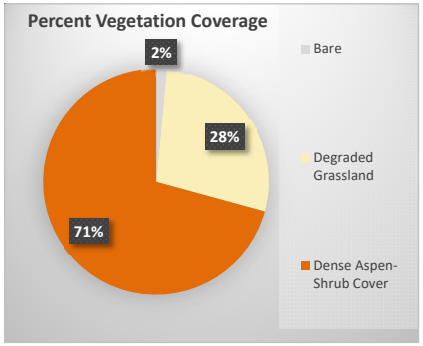
Parent Material	Soil pH	Slope	Date

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK		X		E	H
LS	X			P	
CT		X		E	H
YT	X			P	
DT	X			P	
WT	X			P	

Image 1: Upland areas of the unit are degraded grasslands

Image 2: In the large aspen grove characteristic of most of unit



RRA Polygon: M.21
Acres: 59

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Upland area has large area covered in knapweed and native grasslands and forbs. After weed treatment, fertilization will boost native vegetation. Small gully areas will also be treated to prevent further erosion.

Images 1 and 2: Upland grasslands typical of unit.

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			21.5		
SSR- 1d					
SSR-2a			3.2		
SSR-2b					
SSR-2c/2d				71	
Monitor- Well Vegetated			33		
Rock-No Action			4		

Vegetation & Erosion Condition:

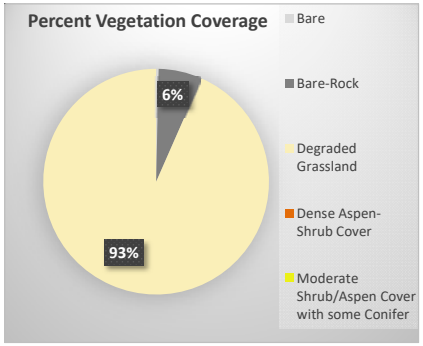
Average Aspect	Acres with slope >15°	Average Slope
224°	36	17°

Soils Data:

Parent Material	Soil pH	Slope	Date
rhy, wt	5.6 - 5.8	20°	2009

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK			X	C	H, B, M
LS	X			P	S
CT		X		C	H, M
YT		X		E	H
DT	X			P	S
WT		X		E	H, M



RRA Polygon: M.30
Acres: 34

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Steep east-facing slope has been historically de-stabilized by channel below eroding away toe of the slope. Most erosive areas will be aerially fertilized and trenched to enhance vegetation establishment.

Image 1: Bare areas of unit on steep slopes

RRA Status

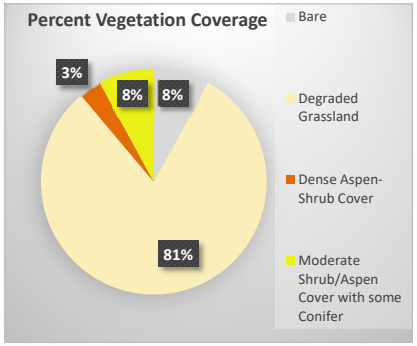
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			15.9		
SSR- 1c			2.0		
SSR-2a					
SSR-2b		327			
SSR-2c/2d				419	
SSR- 3e	0.04				
Monitor- Well Vegetated			16		
Rock-No Action			0		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
104°	28	24°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available			



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	X			P	
LS	X			P	
CT	X			P	
YT	X			P	
DT	X			P	
WT	X			P	

RRA Polygon: M.31
Acres: 4

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Small patch of mixed vegetation, includes aspen and conifers. Some rill treatments will stem beginning of erosion from area

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b	1.0				
SSR- 1c					
SSR-2a			0.2		
SSR-2b					
SSR-2c/2d					
SSR- 3e					
Monitor- Well Vegetated			4		
Rock-No Action			0		

Vegetation & Erosion Condition:

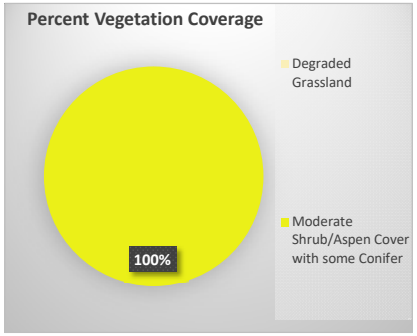
Average Aspect	Acres with slope >15°	Average Slope
79°	3	19°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available			

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	X			P	
LS	X			P	
CT	X			P	
YT	X			P	
DT	X			P	
WT	X			P	



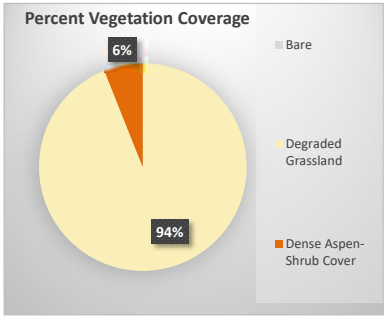
RRA Polygon: M.40
Acres: 77

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Large degraded grassland slope is revegetating from the bottom up, including aspen groves and native grasses/forbs. Upper, most bare extents will be aerially fertilized. Spot treatments in eroding gullies will target continuing erosion sources. Channel at bottom of unit regraded in 2016 to enhance channel function and riparian conditions

Image 1: Thriving aspen from test planting in 2011

Image 2: Grasslands of unit on right side of valley



RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b	0.0		34.0		
SSR- 1c			0.3		
SSR-2a	0.03				
SSR-2b		75			
SSR-2c/2d				200	
SSR- 2d		887			
SSR- 3e	0.09				
Monitor- Well Vegetated			43		
Rock-No Action			0		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
265°	57	20°

Soils Data:

Parent Material	Soil pH	Slope	Date
rhy	5.0 - 5.6	31°	2009
rhy, wt	5.4-5.8	46°	2009

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK		X		E	H
LS		X		E, C	H, B
CT		X		E	H
YT	X			P	
DT	X			P	
WT	X			P	

RRA Polygon: M.41
Acres: 47

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Selected areas will be treated with fertilization to enhance vegetation. Area not a large contributing source. Ephemeral draw will be treated with BMPs to slow water and capture sediment

Image 1: Typical grassland conditions at top of unit

Image 2: Shrub community typical of unit

RRA Status

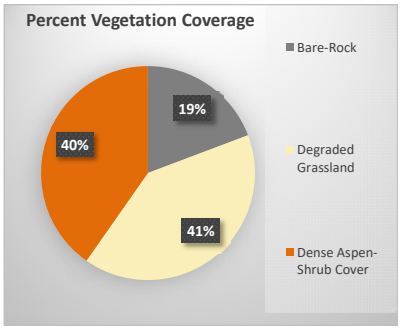
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			3.8		
SSR- 1c					
SSR-2a			0.4		
SSR-2b				966	
SSR-2c/2d					
SSR- 2d					
SSR- 3e					
Monitor- Well Vegetated			32		
Rock-No Action			9		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
186°	29	17°

Soils Data:

Parent Material	Soil pH	Slope	Date
rhy, wt	5.4	39°	2009



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	X			P	
LS	X			P	
CT		X		E	H
YT	X			P	
DT	X			P	
WT	X			P	

RRA Polygon: M.50
Acres: 41

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Unit is a mix of shrub cover, grasslands and forest cover, bisected by gullies. Some areas have been treated with fertilization and erosion control structures have been installed and the stream system has been mechanically graded to control sediment delivery. New structures will be created and additional fertilization applied.

Images 1&2: Shrub vegetation and bare erosive gullies mixed with conifer

RRA Status

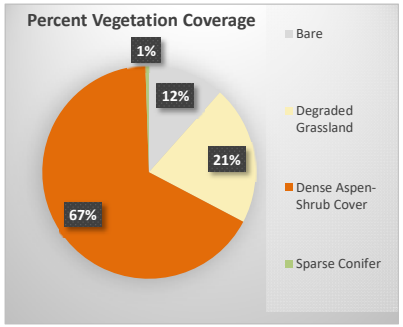
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b	0.17		4.8		
SSR- 1c					
SSR-2a	0.04		2.5		
SSR-2b		629			
SSR-2c/2d				962	
SSR- 2d		347			
SSR- 3e	0.15				
Monitor- Well Vegetated			34		
Rock-No Action			0		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
114°	38	19°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available			



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	X			P	
LS	X			P	
CT	X			P	
YT	X			P	
DT	X			P	
WT	X			P	

RRA Polygon: M.51
Acres: 42

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Area is dominated by naturally regenerating conifer forest, with some bare and degraded areas on the margins. These areas will be treated to prevent weed incursion and promote vegetation establishment

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b	0.06		3.5		
SSR- 1c					
SSR-2a			0.1		
SSR-2b					
SSR-2c/2d					
SSR- 2d					
SSR- 3e					
Monitor- Well Vegetated			38		
Rock-No Action			0		

Vegetation & Erosion Condition:

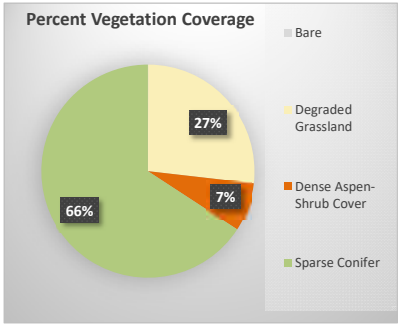
Average Aspect	Acres with slope >15°	Average Slope
220°	24	17°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available			

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK		X		E	H
LS	X			P	
CT		X		E	H
YT	X			P	
DT	X			P	
WT	X			P	



RRA Polygon: M.60
Acres: 13

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Area is a predominantly bare and degraded upland slopes heavily impaired by past logging, mining and smelter activities. These areas were treated in 2016, setting the landscape for natural processes to halt erosion. Areas not treated in 2016 will be fertilized.

Image 1: Degraded and bare steep slope of unit. Southern end was treated with fertilization in 2016

RRA Status

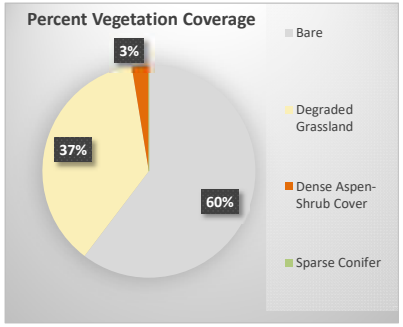
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b	6.84		8.6		
SSR- 1c	0.5				
SSR-2a	0.03				
SSR-2b					
SSR-2c/2d		238			
SSR- 3e	0.01				
SSR- 3f	0.03				
Monitor- Well Vegetated			4		
Rock-No Action			0		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
251°	11	26°

Soils Data:

Parent Material	Soil pH	Slope	Date
rhy, wt	5.4-5.8	46°	2009



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	X			P	
LS	X			P	
CT		X		E	H
YT	X			P	
DT	X			P	
WT	X			P	

RRA Polygon: M.61
Acres: 3

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Area is a small forested area bisected by deep gullies. The base of the area was treated in 2016 and substantial sediment catchment has been installed in unit.

RRA Status

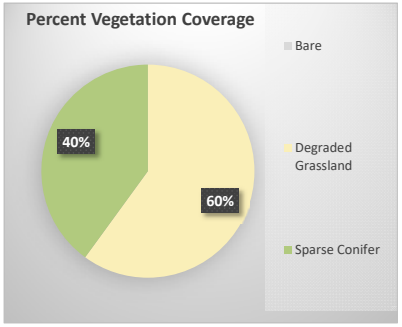
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b	0.57		1.4		
SSR- 1c					
SSR-2a	0.05		0.5		
SSR-2b					
SSR-2c/2d					
SSR- 3e	0.01				
SSR- 3f	0.09				
Monitor- Well Vegetated			1		
Rock-No Action			0		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
267°	1.7	16°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available			



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	X			P	
LS	X			P	
CT	X			P	
YT	X			P	
DT	X			P	
WT	X			P	

RRA Polygon: M.70
Acres: 14

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Well vegetated north-eastern slope holds snowpack into mid-June. Area is bisected by gullies and was treated in 2016 with check structures and mechanized sediment catchment below. Follow-up fertilization and rill treatments are prescribed.

Image 1: Forest with gullies to left of image

RRA Status

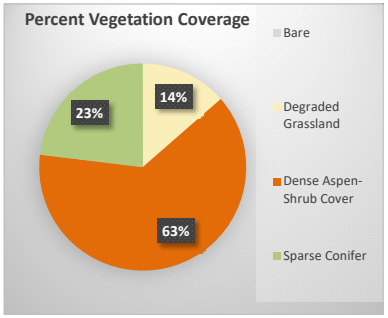
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b	0.65		1.9		
SSR- 1c					
SSR-2a			0.3		
SSR-2b					
SSR-2c/2d		452			
SSR- 3a	0.20				
SSR- 3e	0.19				
SSR- 3f	0.23				
Monitor- Well Vegetated			12		
Rock-No Action			0		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
59°	9	19°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available			



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	X			P	
LS	X			P	
CT	X			P	
YT	X			P	
DT	X			P	
WT	X			P	

RRA Polygon: M.71
Acres: 3

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Small bare area is source of gully formation below. Worst area was treated in 2016 with fertilization and gully check structures. Additional rill treatments are proposed.

Image 1: Bare strip at top of image characterizes unit. 1 acre treated in 2016 with organic fertilization

RRA Status

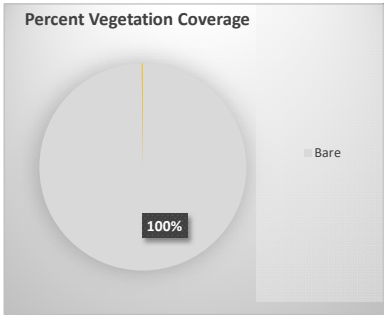
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b	1.12				
SSR- 1c					
SSR-2a			1.5		
SSR-2b					
SSR-2c/2d		46			
SSR- 3a					
SSR- 3e					
SSR- 3f					
Monitor- Well Vegetated			1		
Rock-No Action			0		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
42°	3	30°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available			



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	X			P	
LS	X			P	
CT	X			P	
YT	X			P	
DT	X			P	
WT	X			P	

RRA Polygon: M.80
Acres: 8

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Forested upland at top of drainage. No treatments prescribed as gully bisecting unit is treated downgradient in other units

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b					
SSR- 1c					
SSR-2a					
SSR-2b					
SSR-2c/2d					
SSR- 3a					
SSR- 3e					
SSR- 3f					
Monitor- Well Vegetated			8		
Rock-No Action			0		

Vegetation & Erosion Condition:

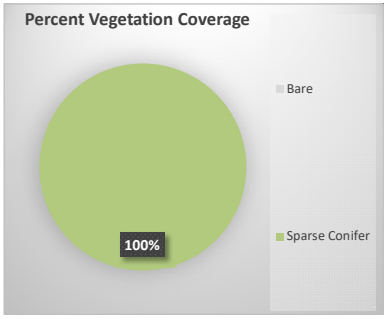
Average Aspect	Acres with slope >15°	Average Slope
58°	1	11°

Soils Data:

Parent Material	Soil pH	Slope	Date
rhy, wt	5.4-5.8	46°	2009

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	X			P	
LS	X			P	
CT	X			P	
YT	X			P	
DT	X			P	
WT	X			P	



RRA Polygon: M.81
Acres: 5

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Forested upland at top of drainage. No treatments prescribed. Weeds will be monitored and treated as needed

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b	0.07				
SSR- 1c					
SSR-2a					
SSR-2b					
SSR-2c/2d					
SSR- 3a					
SSR- 3e					
SSR- 3f					
Monitor- Well Vegetated			5		
Rock-No Action			0		

Vegetation & Erosion Condition:

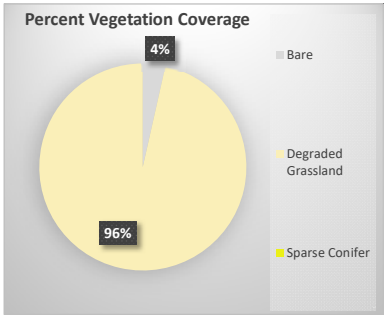
Average Aspect	Acres with slope >15°	Average Slope
81°	1	14°

Soils Data:

Parent Material	Soil pH	Slope	Date
rhy, wt	5.4-5.8	46°	2009

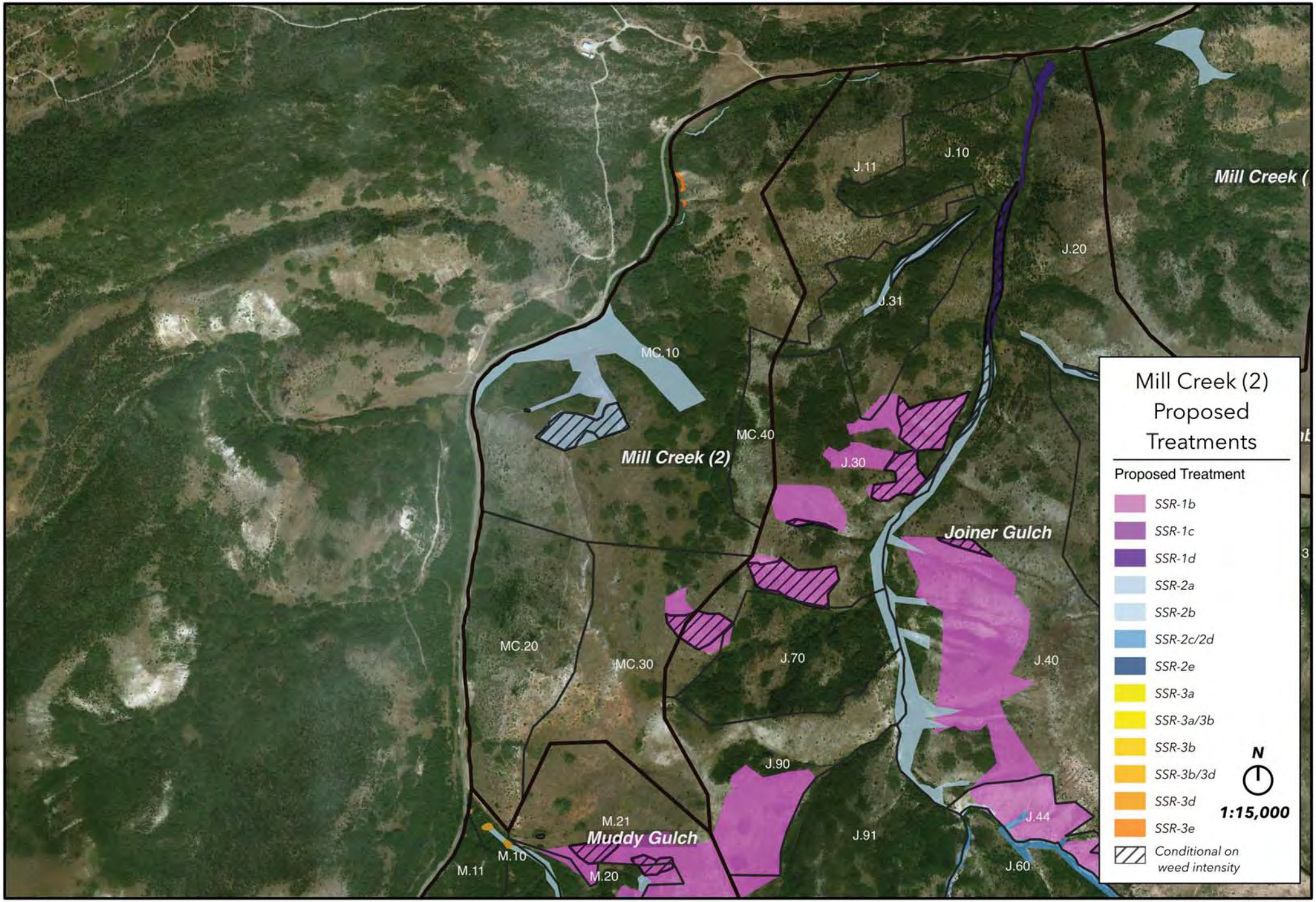
Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	X			P	
LS	X			P	
CT	X			P	
YT	X			P	
DT	X			P	
WT	X			P	



Edited 11/13/2017

Projection: NAD 83(NSRS 2007)/ Montana (ft)



Edited 11/13/2017

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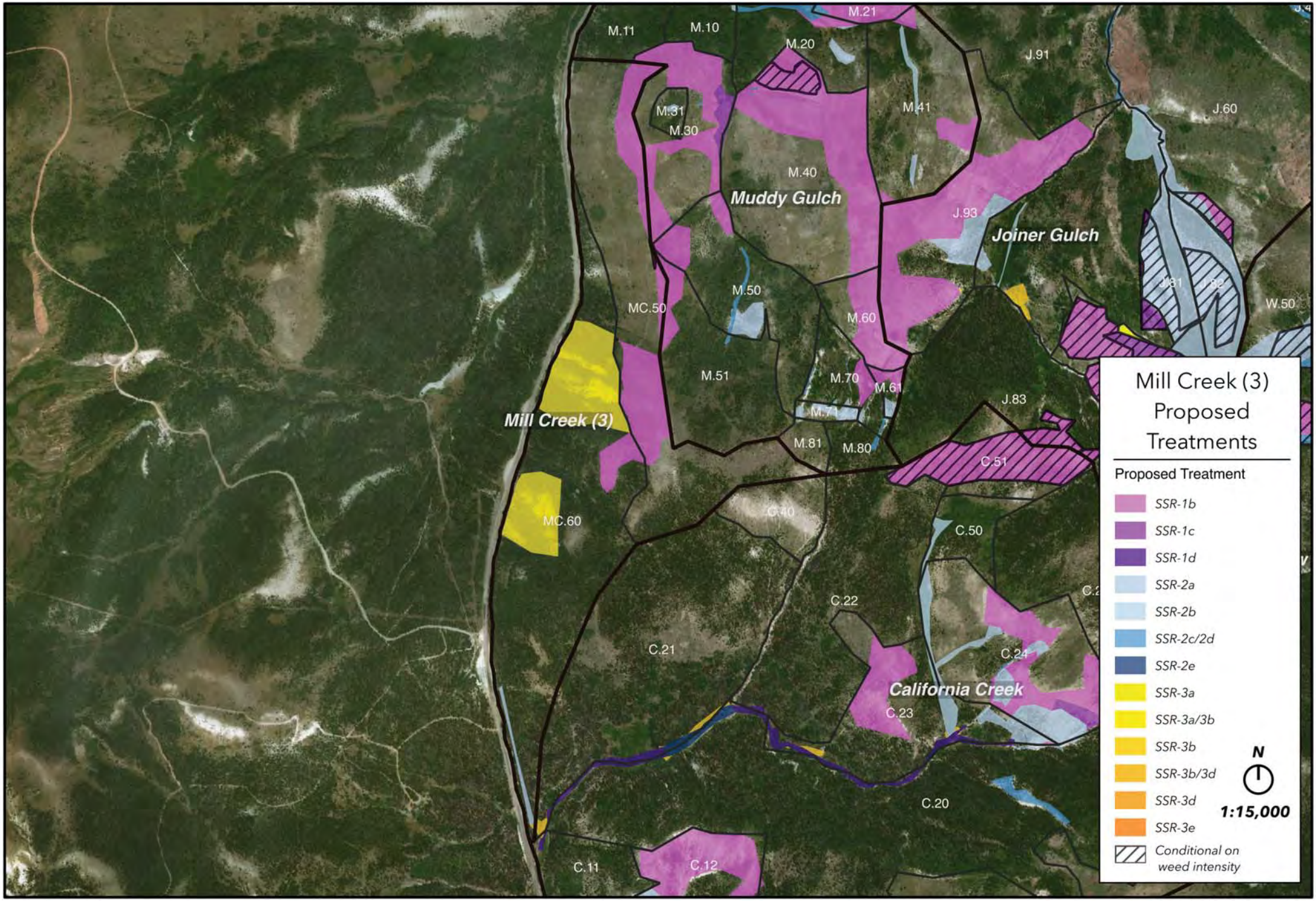


Edited 11/13/2017

Projection: NAD 83(NSRS 2007)/ Montana (ft)

RRA Polygon: MC.10
Acres: 238

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Large area along Mill Creek highway also contains portions of log flume and old transportation corridors. Areas of flume will be mitigated with fertilization and slash treatments to establish vegetation. Areas of Mill creek by highway will be targeted for in-stream structures to enhance sediment capture

Image 1: Beaver dam and riparian vegetation near highway

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			11.7		
SSR-2a			11.7		
SSR-2b				3383	
SSR-2c/2d				1756	
SSR-3e			0.3		
Monitor- Well Vegetated			210		
Rock-No Action			0		

Vegetation & Erosion Condition:

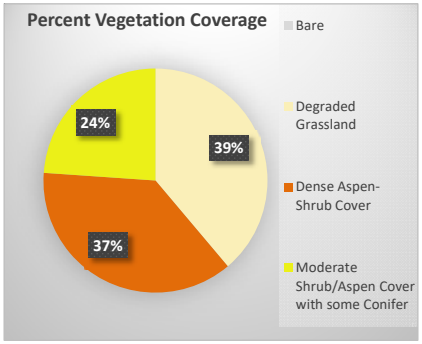
Average Aspect	Acres with slope >15°	Average Slope
200°	132	17°

Soils Data:

Parent Material	Soil pH	Slope	Date
rhy, wt	5.0 - 6.0	7°	2009

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK					
LS	NOT SURVEYED				
CT					
YT					
DT					
WT					



RRA Polygon: MC.20
Acres: 73

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
No treatments prescribed for unit. Weeds will be monitored and treated

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b					
SSR-2a					
SSR-2b					
SSR-2c/2d					
SSR-3e					
Monitor- Well Vegetated			73		
Rock-No Action			0		

Vegetation & Erosion Condition:

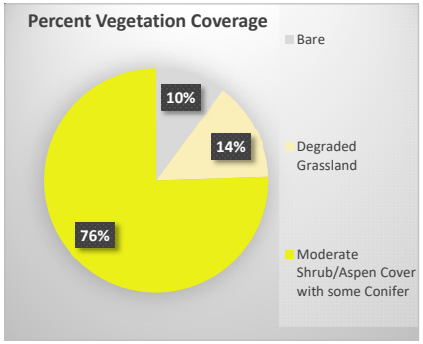
Average Aspect	Acres with slope >15°	Average Slope
273°	68	26°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available			

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK			X	C	B. H, M
LS			X	C	B, H, M
CT			X	C	H, M
YT	X			P	S
DT	X			P	S
WT	X			P	S



RRA Polygon: MC.30
Acres: 74

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Predominantly degraded grassland area with mix of bare and bare-rock. One small area of bare will be treated with aerial fertilization in conjunction with treatment in adjoining polygons

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			2.4		
SSR-2a					
SSR-2b					
SSR-2c/2d					
SSR-3e					
Monitor- Well Vegetated			63		
Rock-No Action			8		

Vegetation & Erosion Condition:

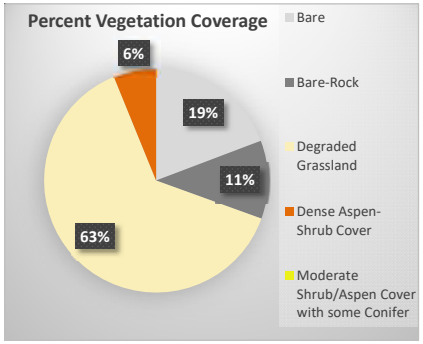
Average Aspect	Acres with slope >15°	Average Slope
160°	27	14°

Soils Data:

Parent Material	Soil pH	Slope	Date
tuff	5.2 - 5.6	18°	2009

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK					
LS	NOT SURVEYED				
CT					
YT					
DT					
WT					



RRA Polygon: MC.40
Acres: 17

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Ridgetop polygon, though bare, is not an active contributor of sediment to the system. No treatments prescribed except weed monitoring and treatment.

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b					
SSR-2a					
SSR-2b					
SSR-2c/2d					
SSR-3e					
Monitor- Well Vegetated			17		
Rock-No Action					

Vegetation & Erosion Condition:

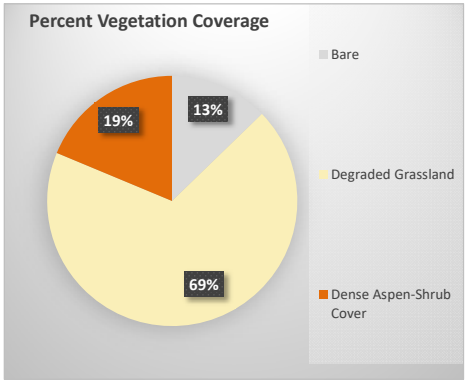
Average Aspect	Acres with slope >15°	Average Slope
288°	11	19°

Soils Data:

Parent Material	Soil pH	Slope	Date
rhy, wt	5.0 - 6.0	7°	2009

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK					
LS	NOT SURVEYED				
CT					
YT					
DT					
WT					



RRA Polygon: MC.50
Acres: 89

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Upper slopes to ridgeline above Mill Creek highway. Most erosion-prone and poorly vegetated areas will be enhanced with aerial fertilization

Image 1: Conifer regeneration on armored rhyolite slopes

RRA Status

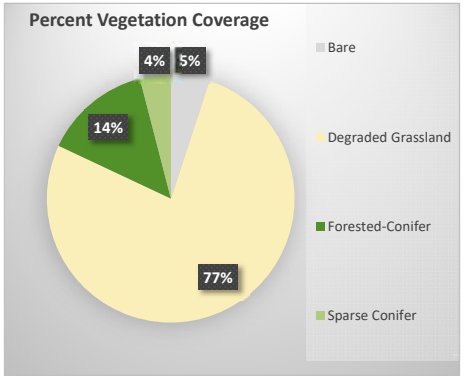
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			21.1		
SSR-2a					
SSR-2b					
SSR-2c/2d					
SSR-3e					
Monitor- Well Vegetated			68		
Rock-No Action					

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
263°	64	21°

Soils Data:

Parent Material	Soil pH	Slope	Date
rhy, wt	5.0 - 5.2	28°	2009



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK			X	C	B, H, M
LS		X		C	B ,H, M
CT			X	C	H, M
YT				P	S
DT				P	S
WT				P	S

RRA Polygon: MC.60
Acres: 119

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification

Mostly forested slopes above Mill Creek highway but contains large bare areas of highly erosive material and deep gullies which deliver sediment directly to Mill creek through culverts under the highway. Ease of equipment access facilitates mechanical slope treatments

Image 1: Bare areas and Gullies drain under highway to Mill Creek

Image 2: Gullies become less severe further North in unit

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b	2.3		3.8		
SSR-2a			1.3		
SSR-2d		64			
SSR-3a/3b			29.0		
SSR-3b			0.1		
Monitor- Well Vegetated			85		
Rock-No Action					

Vegetation & Erosion Condition:

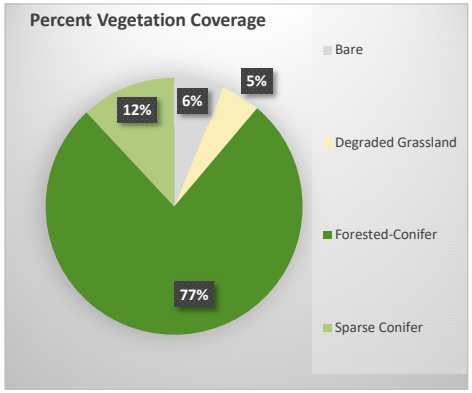
Average Aspect	Acres with slope >15°	Average Slope
267°	60	15°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soil data available			

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK			X	C	B, H, M
LS		X		C	B, H, M
CT		X		C	H, M
YT	X			P	S
DT	X			P	S
WT	X			P	S



RRA Polygon: MC.70
Acres: 511

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Large area contains many of the SHOP 20 polygons from previous studies, determined to not be sediment sources. Two drainage outlets will be treated to enhance sediment catchment and enhance vegetation establishment

Image 1: Granitic parent material above highway prior to 2010 planting

Image 2: Upland conditions in granitic parent material above highway

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b					
SSR- 1d	26.5				
SSR-2a					
SSR-2b				650	
SSR-3d			1.0		
Monitor- Well Vegetated			504		
Rock-No Action			3		

Vegetation & Erosion Condition:

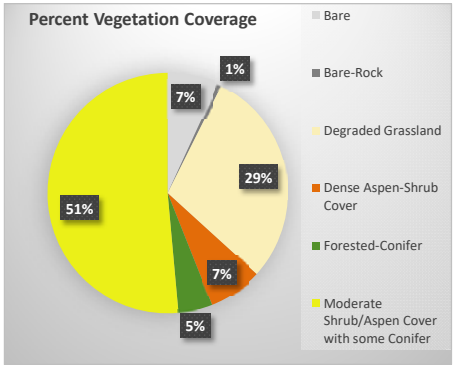
Average Aspect	Acres with slope >15°	Average Slope
221°	370	20°

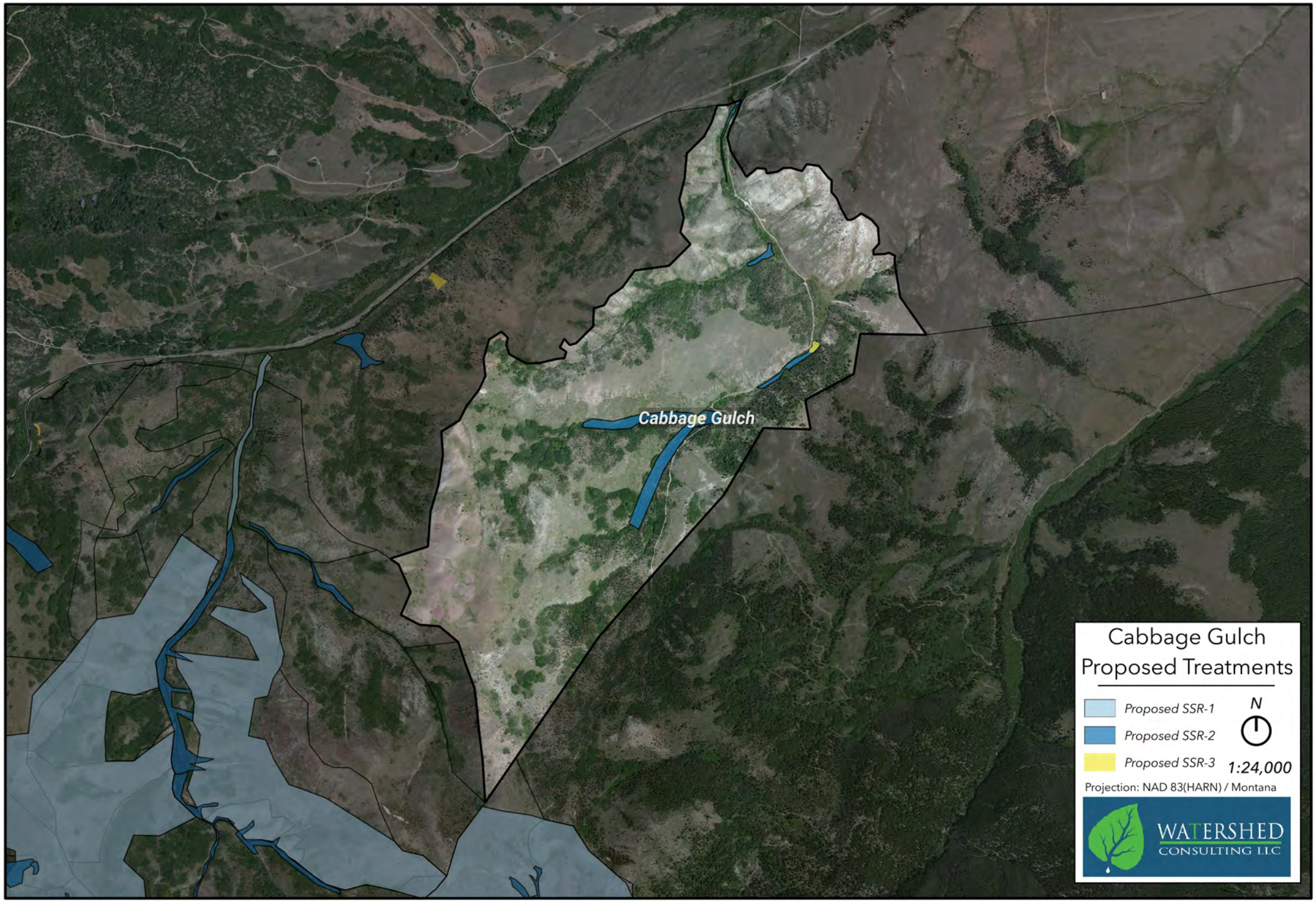
Soils Data:

Parent Material	Soil pH	Slope	Date
granite	5.2 - 5.6	43°	2009
granite	6.6 - 6.8	43°	2009
rhy, wt	4.6 - 5.0	65°	2009
rhy, wt	6.2 - 6.6	36°	2009

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK			X	C	B. H, M
LS			X	C	B, H, M
CT			X	C	H, M
YT	X			P	S
DT	X			P	S
WT	X			P	S





Edited 5/22/2017

RRA Polygon: Cb.20
Acres: 192

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Most of the area is forested. Stream system is in incised condition. In-stream structures will be installed to create hydrologic connectivity and promote sediment catchment.

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-2b				900	
SSR-3b			0.4		
SSR-3e			0.3		
Monitor- Well Vegetated			183		
Rock-No Action			0		

Vegetation & Erosion Condition:

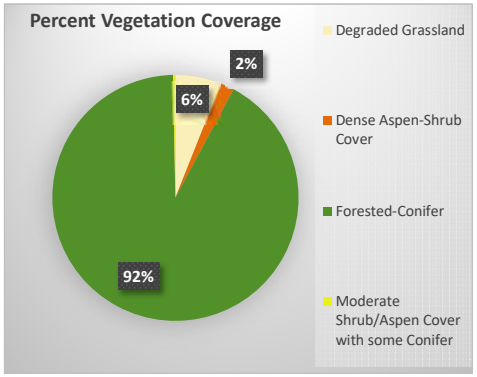
Average Aspect	Acres with slope >15°	Average Slope
187°	106	17°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK			X	C	B, H, M
LS		X		C	B, H, M
CT		X		E	H
YT	X			P	S
DT	X			P	S
WT			X	E	H



RRA Polygon: Cb.40
Acres: 397

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Mixed vegetation unit with high substantial weed incursion. In-stream structures will be installed to create hydrologic connectivity and promote sediment catchment.

Image 1: North-facing slope of unit above Cabbage Gulch road

RRA Status

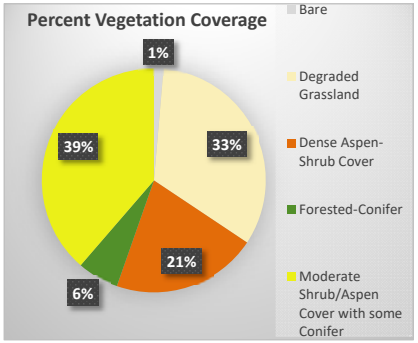
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b	3.09				
SSR-1d	5.87				
SSR-2b		1960		8315	
SSR-3b			1.1		
SSR-3e			0.1		
Monitor- Well Vegetated			383		
Rock-No Action			0		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
128°	181	15°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK			X	C	B, H, M
LS		X		C	B, H, M
CT		X		E	H
YT	X			P	S
DT	X			P	S
WT			X	E	H

RRA Polygon: Cb.50
Acres: 270

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Area is predominantly degraded grassland with dense shrub cover in low-lying areas.

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b					
SSR-1d					
SSR-2b					
SSR-3b					
SSR-3e					
Monitor- Well Vegetated			262		
Rock-No Action			8		

Vegetation & Erosion Condition:

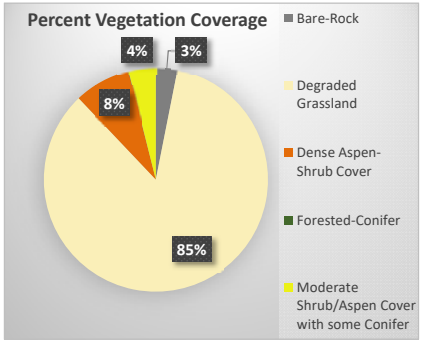
Average Aspect	Acres with slope >15°	Average Slope
126°	159	17°

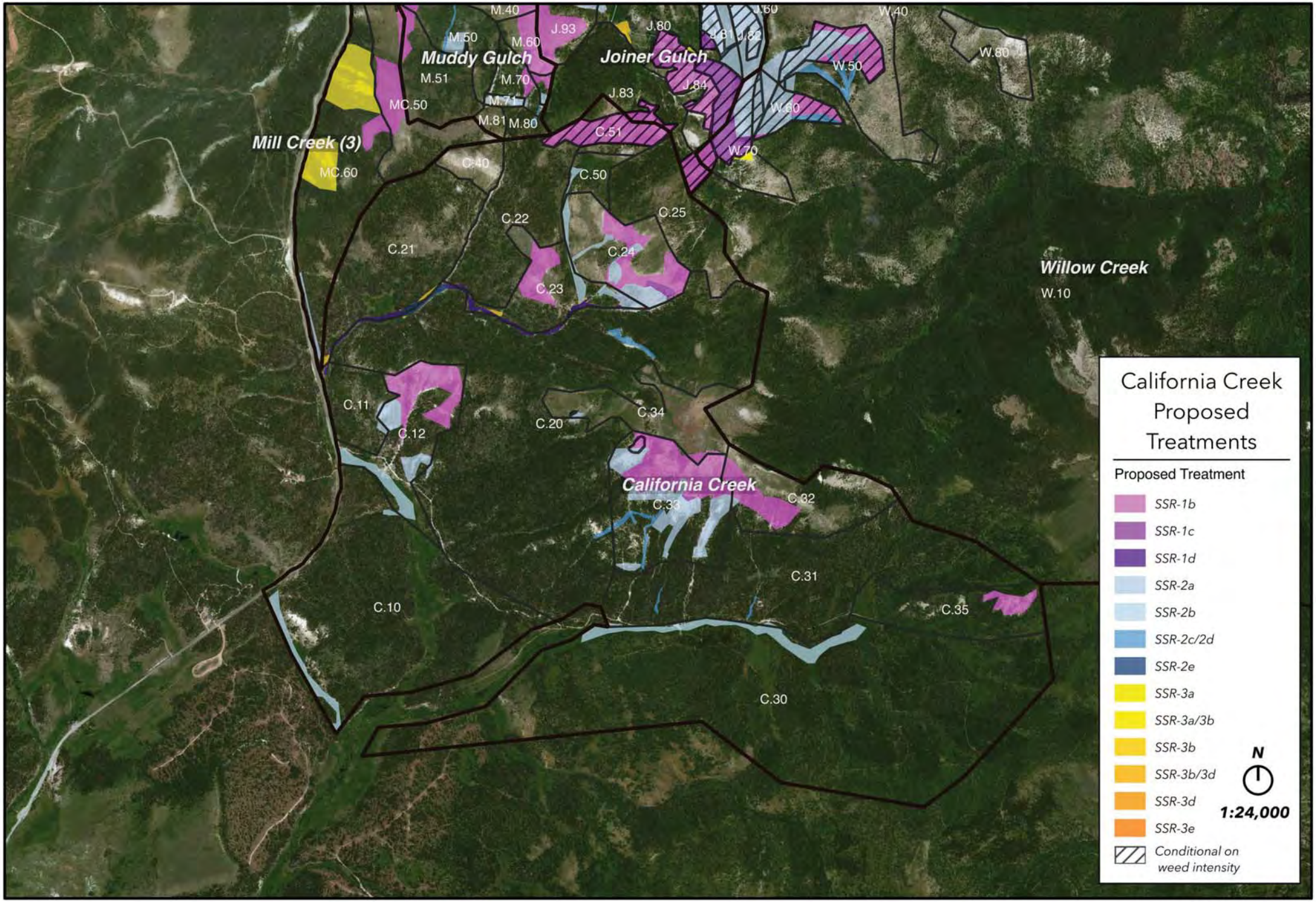
Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK			X	C	B, H, M
LS		X		C	B, H, M
CT		X		E	H
YT	X			P	S
DT	X			P	S
WT			X	E	H





Edited 11/13/2017

Projection: NAD 83(NSRS 2007)/ Montana (ft)

RRA Polygon: C.10
Acres: 251

Remedy and Restoration Area Status and Design Criteria Summary

Design Justification
Most of the area is forested. Stream system is in incised condition. In-stream structures will be installed to create hydrologic connectivity and promote sediment deposition.

Image 1: Forested upland and valley bottom of unit

RRA Status

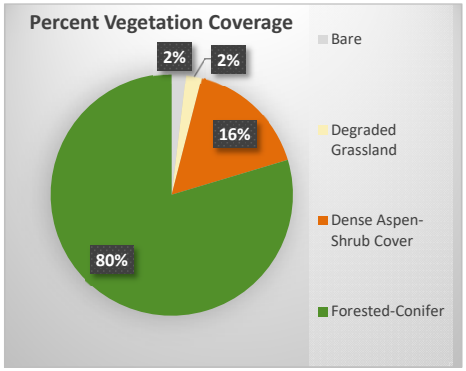
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-2b		54		2697	
Monitor- Well Vegetated			243		
Rock-No Action			0		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
207°	13	6°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	X			P	
LS	X			P	
CT	X			P	
YT	X			P	
DT	X			P	
WT	X			P	

RRA Polygon: C.11
Acres: 32

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Forested south-facing slope with one bare area to be treated with fertilization and slash. Gully along Mill Creek highway to be treated with earthen sediment basin

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			0.9		
SSR-1d			0.2		
SSR-2a			0.9		
SSR-2b		282			
SSR-3b			0.0		.04 acres
Monitor- Well Vegetated			30		
Rock-No Action			0		

Vegetation & Erosion Condition:

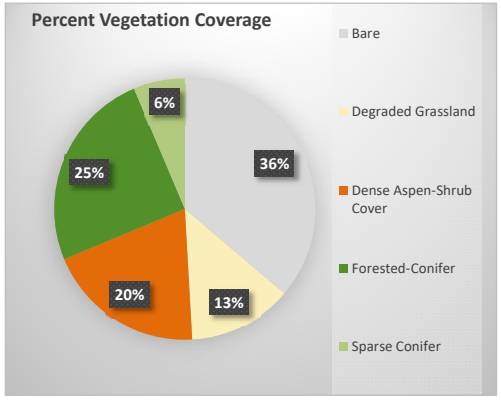
Average Aspect	Acres with slope >15°	Average Slope
230°	7	12°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	X			P	
LS	X			P	
CT	X			P	
YT	X			P	
DT	X			P	
WT	X			P	



RRA Polygon: C.12
Acres: 68

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Area comprises bare area and associated gully pathway above California Creek road. Projects in 2013 and 2015 demonstrated effective techniques for erosion control and vegetation establishment. Additional fertilization and erosion control prescribed

Image 1. C.12 Bare slopes prior to treatment

RRA Status

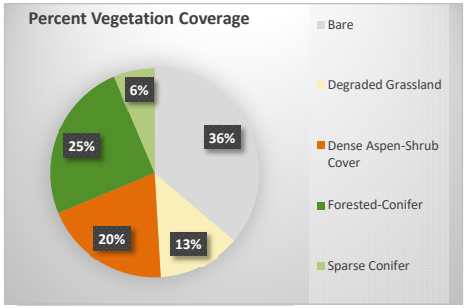
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			23.8		
SSR-1c`	3.62				
SSR-1d	6.00				
SSR-2a	3.24		7.0		
SSR-2b		2037		1766	
SSR-2d		1886			
SSR-2e		259			
SSR-3d	0.10				
SSR-3e	0.06				
Monitor- Well Vegetated			34		
Rock-No Action			0		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
232°	22	13°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	X			P	
LS	X			P	
CT		X		E	H
YT	X			P	
DT	X			P	
WT	X			P	

RRA Polygon: C.20
Acres: 466

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Most of the area is forested but large gully networks are prevalent. Bare ground will be seeded and fertilized to restore native plant growth. Slash will be installed on slopes and gullies will be treated for stabilization to reduce erosion.

Image 1. C.20 Bare and degraded grassland slopes

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b	0.10		0.4		
SSR-1d	1.01		4.4		
SSR-2a	0.19		1.0		
SSR-2b		3542			
SSR-2c		1257		2013	
SSR-2d		2670			
SSR-2e		245		400	
SSR-3a	0.01				
SSR-3b			0.9		
Monitor- Well Vegetated			457		
Rock-No Action			0		

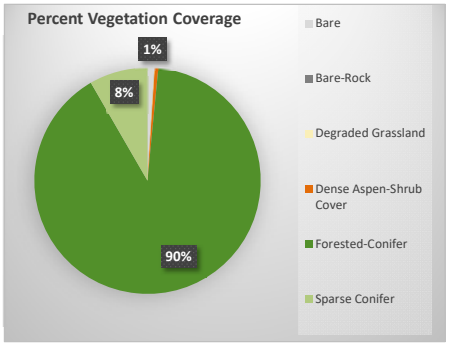
Image 2. C.20 Degraded Grasslands

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
225°	154	13°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	X			P	
LS		X		E	H
CT	X			P	
YT		X		E	H
DT	X			P	
WT	X			P	

RRA Polygon: C.21
Acres: 114

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Mostly forested area with one meadow area that will be treated to capture overland flows and sediment, reconnect floodplain and surface hydrology

Image 1. C.21 bare areas on forested hillslopes.

RRA Status

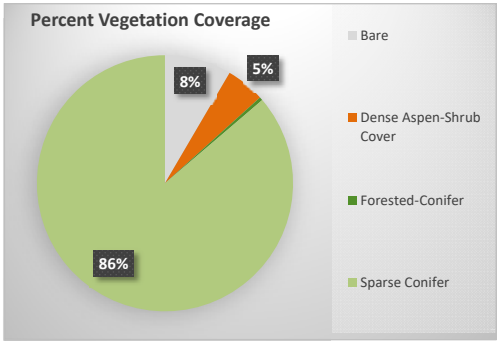
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1d	0.03		1.9		
SSR-2b		317			
SSR-2d		333			
SSR-2e			0.6		
SSR-3b			1.3		
Monitor- Well Vegetated			111		
Rock-No Action			0		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
171°	30	12°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	X			P	
LS	X			P	
CT	X			P	
YT		X		C, E	M, H
DT	X			P	
WT	X			P	

RRA Polygon: C.22
Acres: 80

Remedy and Restoration Area
Status and Design Criteria Summary

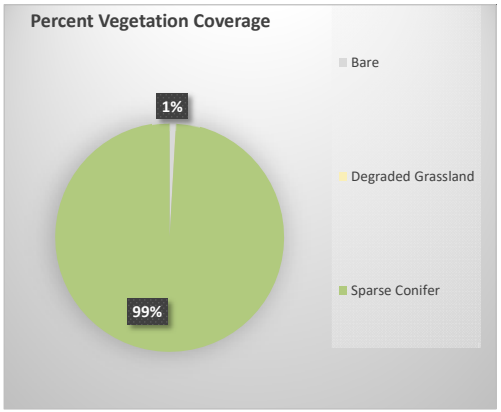
Design Justification
Area is mostly vegetated with conifer forest

Image 1. C.22 sparsely forested hillslopes.

RRA Status					
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b					
SSR-1d			0.2		
SSR-2d		1569			
SSR-2e					
SSR-3b					
Monitor- Well Vegetated			80		
Rock-No Action			0		

Vegetation & Erosion Condition:		
Average Aspect	Acres with slope >15°	Average Slope
206°	52	11°

Soils Data:			
Parent Material	Soil pH	Slope	Date
no soils data available.			



Weed Presence and Treatment Prescription					
Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	NOT SURVEYED				
LS					
CT					
YT					
DT					
WT					

RRA Polygon: C.23
Acres: 49

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Area consists of one bare area and erosive gullies forming through sparse conifer forest. Area will be treated with fertilization and gully control structures to enhance vegetation and stop erosion

Image 1. C.23 gully formation through sparse conifer forest

RRA Status

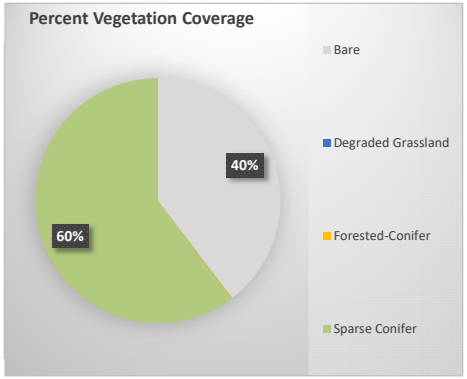
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			10.4		
SSR-1c	0.02				
SSR-1d			2.7		
SSR-2a	2.05		2.6		
SSR-2b		1651			
SSR-2c		88		978	
SSR-2d		726			
SSR-3b			1.0		
Monitor- Well Vegetated			31		
Rock-No Action			0		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
198°	21	14°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	X			P	
LS	X			P	
CT		X		E	H
YT	X			P	
DT	X			P	
WT	X			P	

RRA Polygon: C.24
Acres: 62

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Bare ground will be aerially and broadcast seeded and fertilized to restore native plant communities on upland slopes. Rills and gullies will be treated to stop sediment delivery from uplands to the stream below

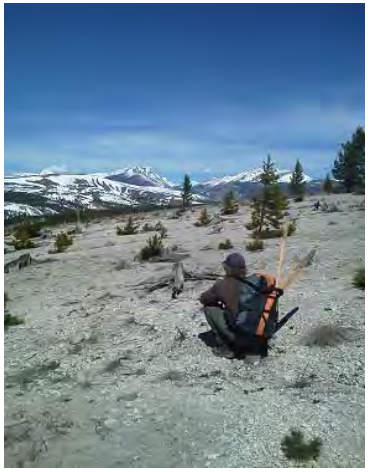


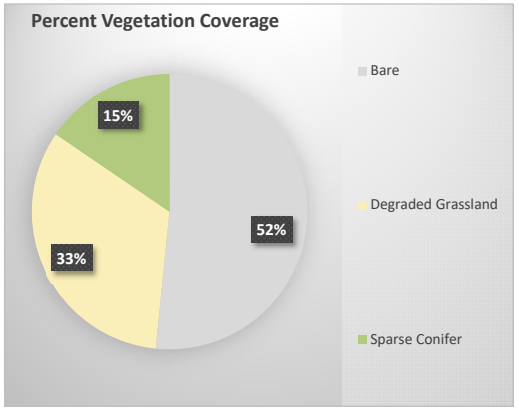
Image 1. Bare uplands in C.24

RRA Status					
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			20.9		
SSR-1c	0.49		3.8		
SSR-2a	4.57		8.0		
SSR-2c				1998	
SSR-2d					
Monitor- Well Vegetated			33		
Rock-No Action			0		

Vegetation & Erosion Condition:		
Average Aspect	Acres with slope >15°	Average Slope
229°	23	13°

Soils Data:			
Parent Material	Soil pH	Slope	Date
no soils data available.			

Weed Presence and Treatment Prescription					
Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	X			P	
LS	X			P	
CT		X		E	H
YT	X			P	
DT	X			P	
WT	X			P	



RRA Polygon: C.25
Acres: 64

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Area is well vegetated and does not require treatments. Fertilization in this unit may occur from fertilization in neighboring units

Image 1. Grasslands in C.25

RRA Status

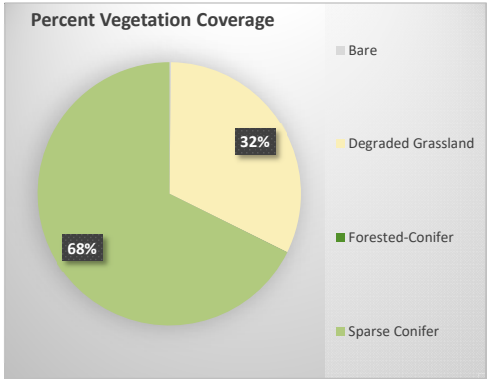
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			0.1		
SSR-1c					
SSR-2a					
SSR-2c					
SSR-2d					
Monitor- Well Vegetated			64		
Rock-No Action			0		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
216°	15	11°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK		X		E	H
LS	X			P	
CT	X			P	
YT	X			P	
DT	X			P	
WT	X			P	

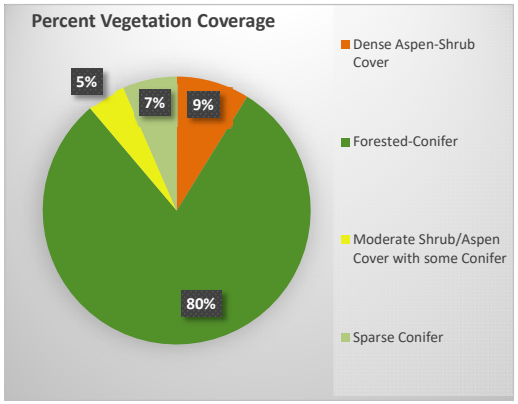
RRA Polygon: C.30
Acres: 499

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Area is comprised of conifer forest and high-functioning wetland complexes. Stream channel is incised and will be treated to enhance overbank deposition of sediment during high flows

Image 1. C.30 Well vegetated lowlands

Image 2. C.30 Functioning wetlands



RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1d	0.80				
SSR-2b			446	5366	
SSR-3a	0.01				
SSR-3d	0.02				
Monitor- Well Vegetated			482		
Rock-No Action			0		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
235°	68	10°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	X			P	
LS	X			P	
CT	X			P	
YT	X			P	
DT	X			P	
WT	X			P	

RRA Polygon: C.31
Acres: 200

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Area consists ofconifer forest bisected by large gully networks, most of which have been treated. Untreated gullies will be treated and filled structures will be enhanced with gully BMPs

Image 1. C.31 Steep gullie slopes being stabilized with SSR-2d structures

RRA Status

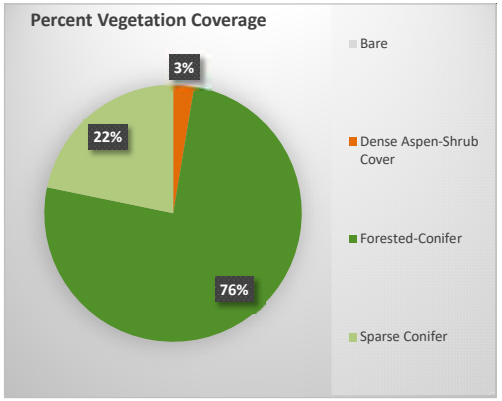
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1d	0.82				
SSR-2a			0.02		
SSR-2c		1024		906	
SSR-2d		361			
SSR-3d	0.07				
SSR-3e	0.01				
Monitor- Well Vegetated			199		
Rock-No Action			0		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
199°	30	11°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	X			P	
LS	X			P	
CT	X			P	
YT	X			P	
DT	X			P	
WT	X			P	

RRA Polygon: C.32
Acres: 67

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Area comprises upland slopes with mixed conifer forest and bare areas where erosion and gully formation begin. Bare area will be treated with aerial fertilization and seeding as well as rill treatments

Image 1: Forested slopes and grasslands on north facing slopes (with snow)

RRA Status

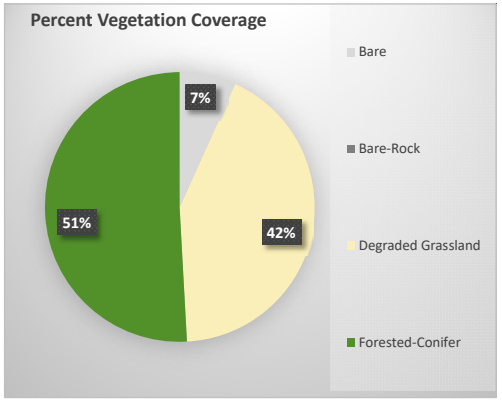
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b	0.25		13.7		
SSR-2a			0.40		
SSR-2c					
SSR-2d					
SSR-3d					
SSR-3e					
Monitor- Well Vegetated			53		
Rock-No Action			0		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
184°	41	18°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	X			P	
LS		X		E	H
CT	X			P	
YT	X			P	
DT	X			P	
WT	X			P	

RRA Polygon: C.33
Acres: 98

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
The largest degraded area in the drainage, due to large acreage of bare and erosive upland slopes leading to long gully networks bisecting conifer forests. Uplands will be treated with fertilization to enhance vegetation cover and gullies will be filled with erosion control BMPs

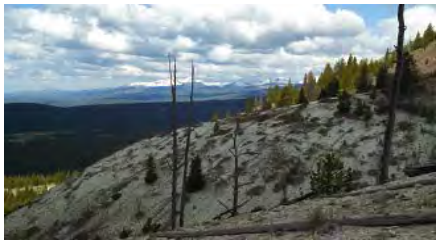


Image 1. C.33 steep and bare slopes

Image 2. C.33 mix of bare slopes and sparse conifer forest

RRA Status

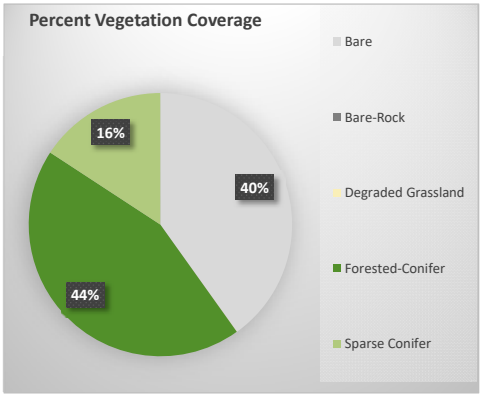
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b	25.00		36.0		
SSR-1c			4.5		
SSR-2a	6.97		23.70		
SSR-2c		2583		2026	
SSR-2d		2346			
SSR-3d					
SSR-3e					
Monitor- Well Vegetated			53		
Rock-No Action			0		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
190°	56	17°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	X			P	
LS		X		E	H
CT	X			P	
YT	X			P	
DT	X			P	
WT	X			P	

RRA Polygon: C.34
Acres: 53

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Half of unit is rock outcrop of Sugarloaf mountain. Degraded grasslands will be aerially fertilized to enhance vegetation growth and rill formations will be treated to stop erosion

Image 1. C.34 rock outcrop at top of Sugarloaf mountain

Image 2. C.34 rock outcrop degraded grasslands in background

RRA Status

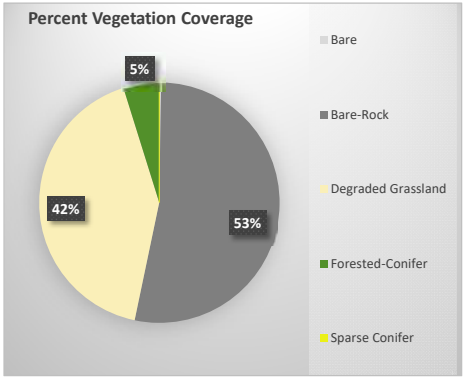
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b	0.00		1.2		
SSR-2a			0.5		
SSR-2c					
SSR-2d					
SSR-3d					
SSR-3e					
Monitor- Well Vegetated			24		
Rock-No Action			28		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
216°	24	44°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	X			P	
LS		X		E, C	H, B
CT	X			P	
YT	X			P	
DT	X			P	
WT	X			P	

RRA Polygon: C.35
Acres: 61

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Half of unit is rock outcrop of Sugarloaf mountain. Degraded grasslands will be aerially fertilized to enhance vegetation growth and rill formations will be treated to stop erosion

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			5.3		
SSR-2a					
SSR-2c					
SSR-2d					
SSR-3d					
SSR-3e					
Monitor- Well Vegetated			0		
Rock-No Action			56		

Vegetation & Erosion Condition:

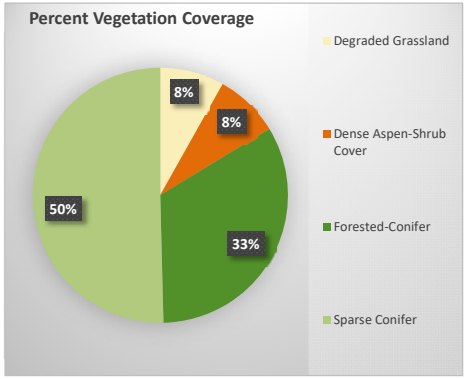
Average Aspect	Acres with slope >15°	Average Slope
232°	22	13°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	X			P	
LS	X			P	
CT	X			P	
YT	X			P	
DT	X			P	
WT	X			P	



RRA Polygon: C.40
Acres: 16

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Area is a mix of sparse and dense conifer forest with one bare area that will be treated with aerial fertilization and seed to promote vegetative recovery

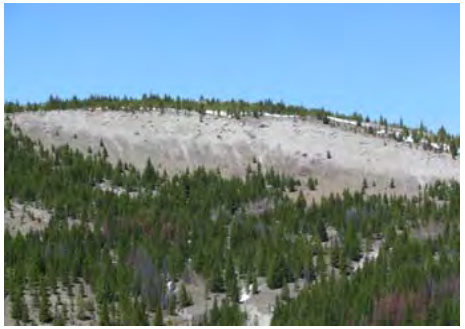


Image 1: Eroding slopes seen in May 2014 photo

RRA Status

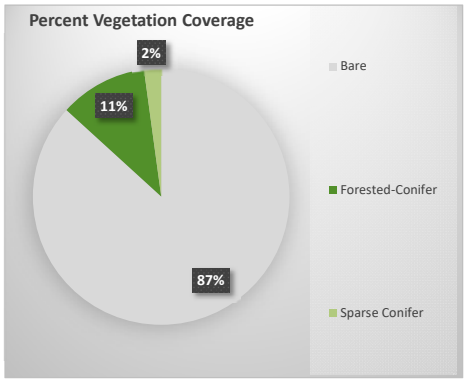
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			5.3		
SSR-2a					
SSR-2c					
SSR-2d					
SSR-3d					
SSR-3e					
Monitor- Well Vegetated			10.7		
Rock-No Action					

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
232°	22	13°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	X			P	
LS	X			P	
CT	X			P	
YT	X			P	
DT	X			P	
WT	X			P	

RRA Polygon: C.50
Acres: 13.7

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Grassland area consists of a mix of bare to sparsely vegetated forest and in low-lying area is a wetland meadow of sedges and some willow. Bare areas and degraded grasslands will be fertilized to enhance vegetation establishment

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			5.3		
SSR-2a					
SSR-2c					
SSR-2d				581	
SSR-3d					
SSR-3e					
Monitor- Well Vegetated			13		
Rock-No Action					

Vegetation & Erosion Condition:

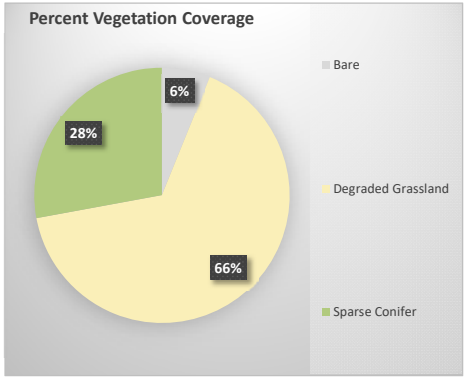
Average Aspect	Acres with slope >15°	Average Slope
253°	0.3	6.6°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK		X		E	H
LS	X			P	
CT	X			P	
YT	X			P	
DT	X			P	
WT	X			P	



RRA Polygon: C.51
Acres: 27

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Area consists of mix of sparse conifer, bare areas and degraded grasslands. Aerial fertilization will enhance vegetation establishment

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			18.6		
SSR-2a					
SSR-2c					
SSR-2d					
SSR-3d					
SSR-3e					
Monitor- Well Vegetated			9		
Rock-No Action					

Vegetation & Erosion Condition:

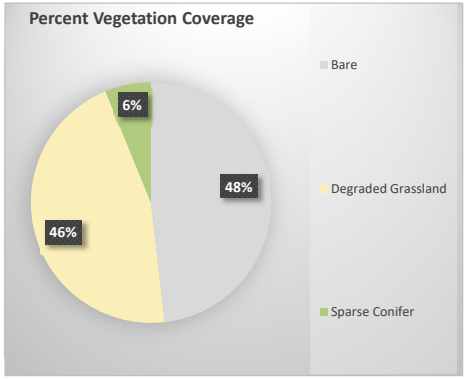
Average Aspect	Acres with slope >15°	Average Slope
199°	30	11°

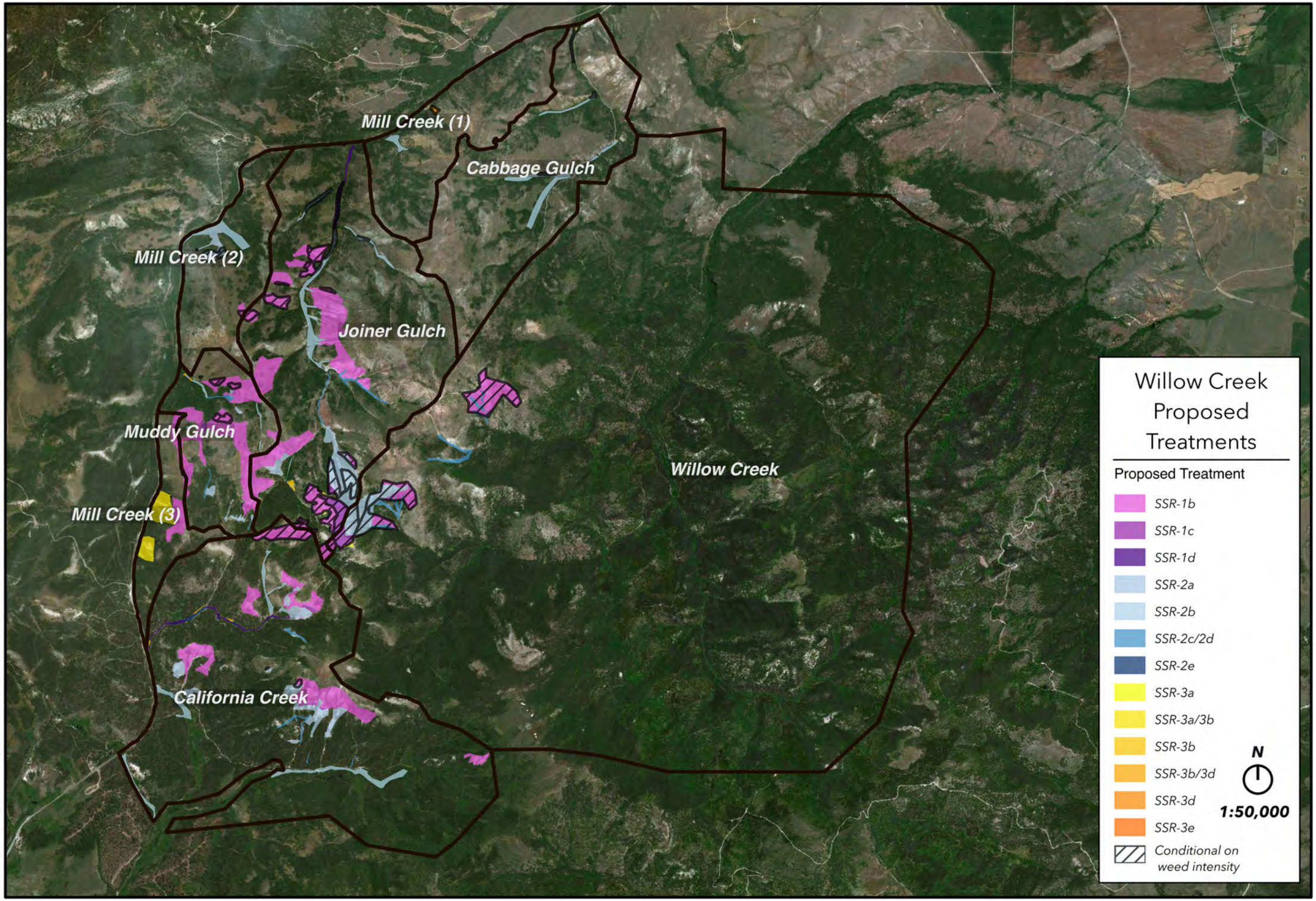
Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK	X			P	
LS	X			P	
CT	X			P	
YT	X			P	
DT	X			P	
WT	X			P	





Edited 12/01/2017

Projection: NAD 83(NSRS 2007)/ Montana (ft)

RRA Polygon: W.10
Acres: 7798

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Large, predominantly forested area spanning majority of drainage. Area has not been thoroughly ground-truthed but is largely not a sediment contributor. Some upland gullies and rills will be treated after field-truthing.

RRA Status

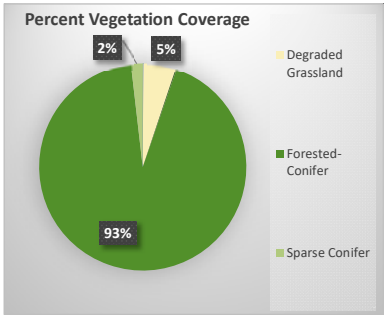
Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b	0.04				
SSR- 1c					
SSR-2a			1.3		
SSR-2b					
SSR-2c/2d				2572	
SSR- 3a					
SSR- 3e					
SSR- 3f					
Monitor- Well Vegetated			7806		
Rock-No Action			0		

Vegetation & Erosion Condition:

Average Aspect	Acres with slope >15°	Average Slope
171°	5788	19°

Soils Data:

Parent Material	Soil pH	Slope	Date
tuff	5.0 - 5.2	14°	2009



Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK					
LS					
CT					
YT					
DT					
WT					

RRA Polygon: W.20
Acres: 76

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Remote unit has not been ground-truthed but appears to be a combination of bare and forested slopes. Aerial fertilization and some gully treatments are prescribed, pending ground verification

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			26.6		
SSR- 1d					
SSR-2a					
SSR-2c/2d				208	
SSR- 3a					
Monitor- Well Vegetated			49		
Rock-No Action					

Vegetation & Erosion Condition:

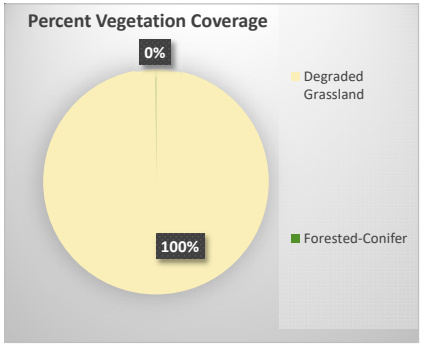
Average Aspect	Acres with slope >15°	Average Slope
191°	65	26°

Soils Data:

Parent Material	Soil pH	Slope	Date
tuff	5.0 - 5.2	14°	2009

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK					
LS					
CT					
YT					
DT					
WT					



RRA Polygon: W.30
Acres: 108

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Area has not been ground-truthed but appears to have some gully formation which may contribute sediment to downstream reaches. Aerial fertilization and gully treatments will be applied after ground verification

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			12.0		
SSR- 1d					
SSR-2a					
SSR-2c/2d				3141	
SSR- 3a					
Monitor- Well Vegetated			94		
Rock-No Action					

Vegetation & Erosion Condition:

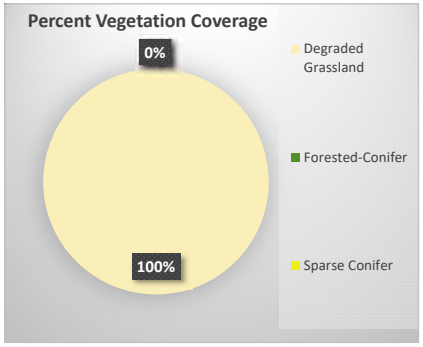
Average Aspect	Acres with slope >15°	Average Slope
118°	97	25°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK					
LS					
CT					
YT					
DT					
WT					



RRA Polygon: W.40
Acres: 46

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Area is degraded grasslands on the back side of a rhyolite cliff and is revegetating naturally. No treatments are prescribed but weeds will be monitored

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b					
SSR- 1d					
SSR-2a					
SSR-2c/2d					
SSR- 3a					
Monitor- Well Vegetated			46		
Rock-No Action					

Vegetation & Erosion Condition:

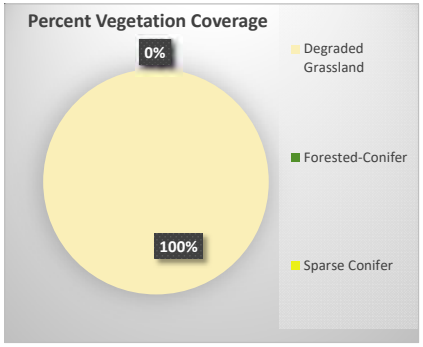
Average Aspect	Acres with slope >15°	Average Slope
146°	20	32°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK					
LS					
CT					
YT					
DT					
WT					



RRA Polygon: W.50
Acres: 120

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Mostly south-facing slope has not been ground-truthed. Appears to be forming rills and gullies, which will be treated with combination of fertilization and rill and gully structures to stop erosion from progressing downstream

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			23.6		
SSR- 1d					
SSR-2a			14.5		
SSR-2c/2d				962	
SSR- 3a					
Monitor- Well Vegetated			88		
Rock-No Action					

Vegetation & Erosion Condition:

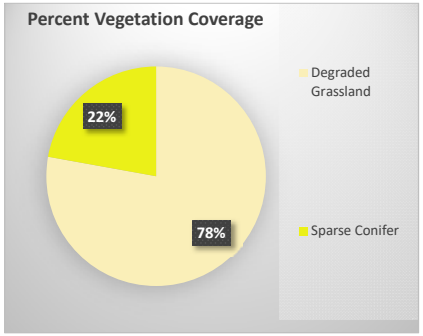
Average Aspect	Acres with slope >15°	Average Slope
184°	95	22°

Soils Data:

Parent Material	Soil pH	Slope	Date
tuff	5	51°	2009
rhy, wt	4.6 - 4.8	25°	2009

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK					
LS					
CT					
YT					
DT					
WT					



RRA Polygon: W.60
Acres: 22

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Area is in top of watershed and has not been ground-truthed for actual conditions. Aerial imagery shows potential bare areas and degraded grasslands requiring aerial fertilization, more intensive trenching and rill treatments to stop erosion and enhance native vegetation establishment

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b			15.5		
SSR- 1c			3.4		
SSR-2a			13.7		
SSR-2c/2d				932	
SSR- 3a					
Monitor- Well Vegetated			0		
Rock-No Action			0		

Vegetation & Erosion Condition:

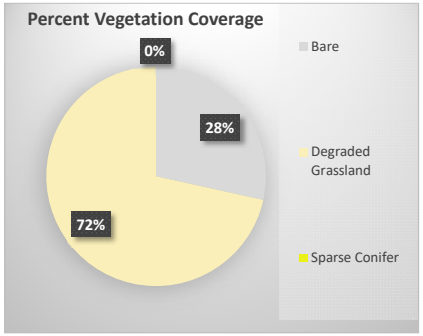
Average Aspect	Acres with slope >15°	Average Slope
114°	19	21°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK					
LS					
CT					
YT					
DT					
WT					



RRA Polygon: W.70
Acres: 33

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
Area is at the top of the watershed and contains bare areas, some of which have been treated with fertilization. More intensive fertilization efforts including rill treatments will be implemented.

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b	9.1		2.6		
SSR- 1c	0.1		14.8		
SSR-2a			6.7		
SSR-2c/2d		452			
SSR- 3a			6.4		
Monitor- Well Vegetated			15		
Rock-No Action			0		

Vegetation & Erosion Condition:

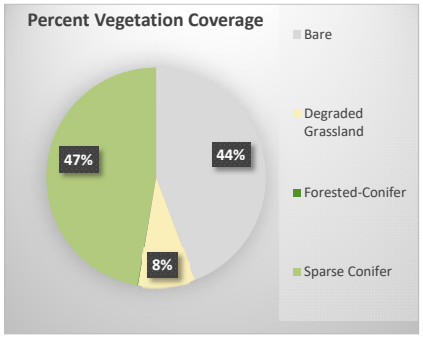
Average Aspect	Acres with slope >15°	Average Slope
148°	10	13°

Soils Data:

Parent Material	Soil pH	Slope	Date
tuff	5.0 - 5.2	14°	2009

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK					
LS					
CT					
YT					
DT					
WT					



RRA Polygon: W.80
Acres: 24

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
This area has not been ground-truthed but appears to be more degraded than the surrounding hillslopes. No treatment is prescribed, but the area will be ground-truthed and weeds will be monitored.

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b					
SSR- 1c					
SSR-2a					
SSR-2c/2d					
SSR- 3a					
Monitor- Well Vegetated			24		
Rock-No Action			0		

Vegetation & Erosion Condition:

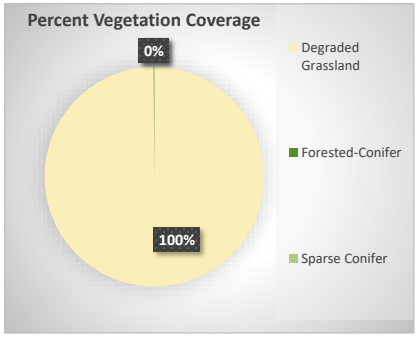
Average Aspect	Acres with slope >15°	Average Slope
118°	17	21°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK					
LS					
CT					
YT					
DT					
WT					



RRA Polygon: W.90
Acres: 24

Remedy and Restoration Area
Status and Design Criteria Summary

Design Justification
No treatments are prescribed for this area

RRA Status

Remedy Type	Completed Treatments		Proposed Treatments		Notes
	Acres Treated	Linear Feet Treated	Acres Treated	Linear Feet Treated	
SSR-1b					
SSR- 1c					
SSR-2a					
SSR-2c/2d					
SSR- 3a					
Monitor- Well Vegetated			24		
Rock-No Action			0		

Vegetation & Erosion Condition:

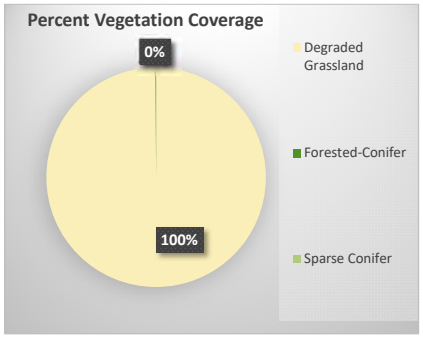
Average Aspect	Acres with slope >15°	Average Slope
182°	11	31°

Soils Data:

Parent Material	Soil pH	Slope	Date
no soils data available.			

Weed Presence and Treatment Prescription

Weed Code	Presence			Treatment	
	Not seen	Present	Abundant	Management	Treatment
SK					
LS					
CT					
YT					
DT					
WT					



Appendix E: Cabbage Gulch Shop 20 Conditions Report

MT. HAGGIN UPLANDS
REMEDIATION POLYGONS CONDITION REPORT

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Introduction

ARCO work documents (FDR, RAWP) drew attention to 14 polygons designated "SHOP 20" within the Mt. Haggin injured area (RDU 15) to the southwest of Cabbage Gulch. This report summarizes site conditions of those polygons based on field reconnaissance performed in 2012 and 2013, with particular attention to sediment delivery issues. The SHOP 20 polygons are located in the northeast section of the Mt. Haggin Injured Area, as shown in Figures 1 and 2 below.

Figure 1. Location of Mt. Haggin Upland Polygons

Figure 2. SHOP 20 Polygons, Mt. Haggin Uplands

Remedial prescriptions for these areas were provided in the Final Design Report for RDU 15 (ARCO, 2007) and include the range of SSR activities established under the RAWP[1]. Table 1 below summarizes the polygon treatment recommendations.

Table 1. Mt. Haggin Upland SSR Polygons from ARCO Documents

Polygon	Steep Slope Reclamation	Veg. Cover	FDR Treatment Recommendations	Acres
SHOP 20-01	SSR-1/SSR-2	5-10%	Fertilization; tree/shrub planting; broadcast seed	6.5
SHOP 20-02	SSR-1	5-10%	Fertilization; tree/shrub planting; broadcast seed	2.3
SHOP 20-03	SSR-1/SSR-2	5-10%	Fertilization; tree/shrub planting; broadcast seed	6.7
SHOP 20-04	SSR-1/SSR-2	5-10%	Fertilization; tree/shrub planting; broadcast seed	7.5
SHOP 20-05	Monitor-Well Vegetated	5-10%	None	575.4
SHOP 20-06	SSR-1	5-10%	Fertilization; tree/shrub planting; broadcast seed	1.5
SHOP 20-07	SSR-1/SSR-2	5-10%	Fertilization; tree/shrub planting; broadcast seed	1.9
SHOP 20-08	SSR-1	5-10%	Fertilization; tree/shrub planting; broadcast seed	0.7
SHOP 20-09	SSR-1	5-10%	Fertilization; tree/shrub planting; broadcast seed	1.9
SHOP 20-10	SSR-1/SSR-2	5-10%	Fertilization; tree/shrub planting; broadcast seed	14.0
SHOP 20-11	SSR-1	5-10%	Fertilization; tree/shrub planting; broadcast seed	3.5
SHOP 20-12	SSR-1/SSR-2	5-10%	Fertilization; tree/shrub planting; broadcast seed	2.2
SHOP 20-13	SSR-1	5-10%	Fertilization; tree/shrub planting; broadcast seed	2.7
SHOP 20-14	SSR-1/SSR-2	5-10%	Fertilization; tree/shrub planting; broadcast seed	14.9
SHOP 20-15	SSR-1/SSR-2	5-10%	Fertilization; tree/shrub planting; broadcast seed	1.9
SHOP 20-16	SSR-1/SSR-2	5-10%	Fertilization; tree/shrub planting; broadcast seed	2.9
SHOP 20-17	SSR-1/SSR-2	5-10%	Fertilization; tree/shrub planting; broadcast seed	3.0

Discussion

The remedies prescribed above were the departure point from which activities ensued beginning in the spring of 2010. To date, five of the above units have been treated as prescribed (including no actions in 20-05).

Design requirements for nearly all units contain most of the following justifications (Arco, 2007):

- Approximately <5% of this polygon is steeper than 2H:1V.
- Slope steepness and topographic roughness are the primary factors effecting the remedy choice.
- Natural recovery in this polygon and in adjacent polygons suggest that Douglas-fir, Limber Pine, and Rocky Mountain juniper could be successful if planted.
- Remedy will focus on areas with little vegetation.
- PTSG planting will include broadcast seeding.
- On-slope BMPs that do not require mechanized equipment (i.e. brush boxes) will be implemented to control erosion as appropriate

In addition, the following question is attached to each polygon's summary page: **"**Was percent vegetation cover determined by measurement (M), aerial photography (A) or Field Observation (F)?"

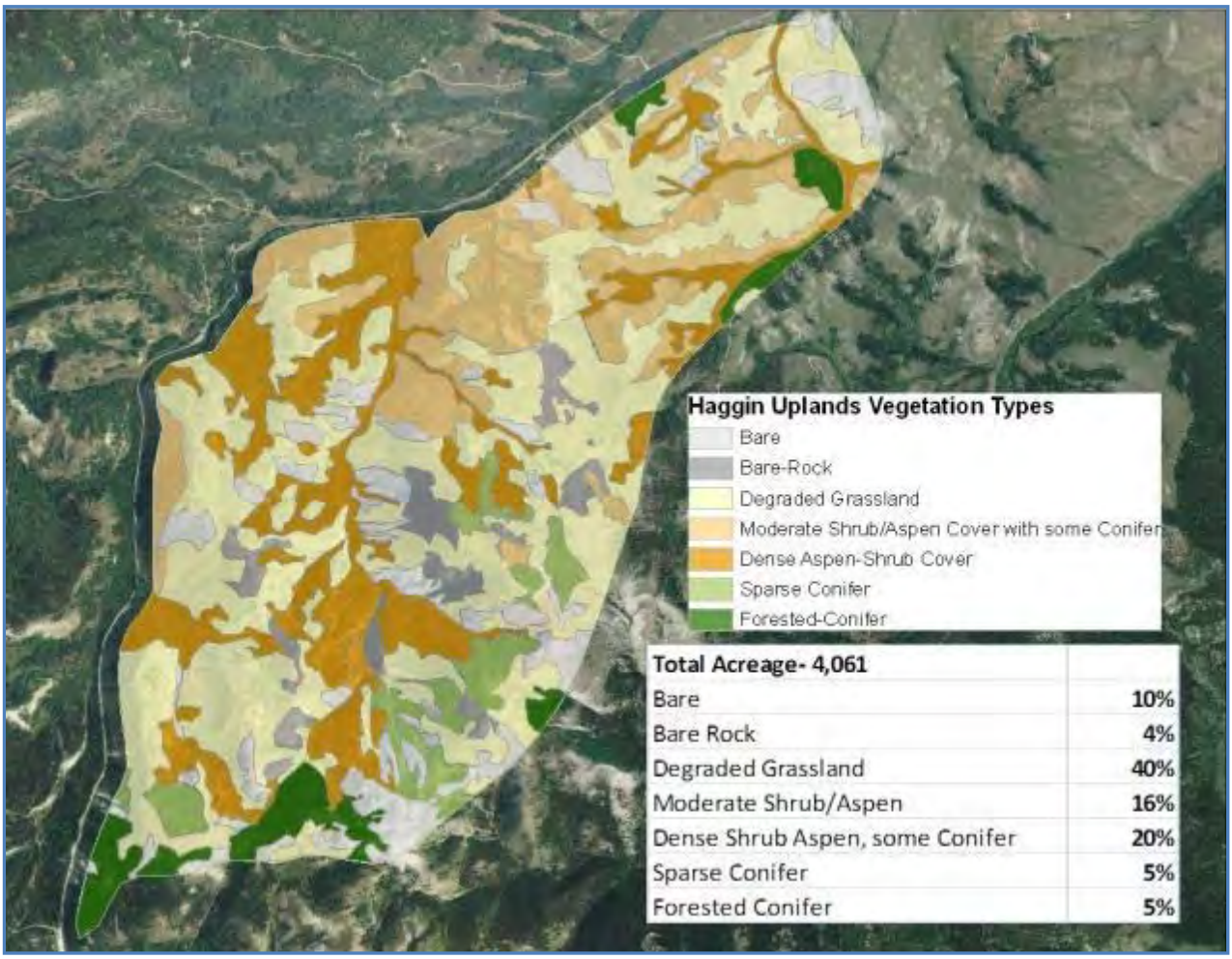
Our understanding is that polygons boundaries were determined by aerial photo interpretation with some field observation and soil samples (Keck, 2007). Keck visited the most bare areas, as determined by the NRDP and found, after analyzing over 50 samples, that the average pH reduction was, "less than expected"- 0.7 pH points below reference at the 0-2 in. depth and .5 pH points below for 2-6 in. depths. The report also summarizes,

[1] The Arsenic action level for all polygons was established at 1000 mg/kg. None of the samples for these polygons showed levels of arsenic at or above this benchmark.

"Other soil and landscape factors appear to be of greater concern for reclamation success," which include shallow soils, steep slopes and weed incursions.

In our assessment of the Mt. Haggin uplands, we have also found that factors besides pH say more about the reclamation and revegetation potential of these areas than pH readings. Parent material, surface armoring, slope, rainfall, and riparian buffering capacity play a big role in achieving remediation objectives of stopping sediment delivery.

In the process of assessing these areas, Watershed Consulting re-mapped vegetation conditions in the entire Mt. Haggin uplands area, based on field observations and field photos. This new vegetation map provides NRDP with a more accurate picture of the existing character of vegetation in this area. This map is shown below, with estimates of vegetation types. Vegetation has been naturally recovering in these uplands for decades, with dramatic improvements in vegetation cover in the last 5-10 years. These upland environments tend to be healing from the bottom up, showing dense stands of aspen and willow in riparian areas and gully bottoms. Upland areas have increased their grass cover, mostly from redtop (agrostis stolonifera) and rhizomatous shrub species such as woods rose (rosa woodsii), oregon grape (mahonia aquifolium), chokecherry (prunus virginiana) and antelope bitterbrush (purshia tridentada) as well as aspen colonies and scouler willow. Conifer forests exist in both dense and sparse stands, consisting mainly of lodgepole pine (pinus contorta), limber pine (pinus flexilis), and some douglas fir (pseudopseuga menzesei).



Total Acreage- 4,061	
Bare	10%
Bare Rock	4%
Degraded Grassland	40%
Moderate Shrub/Aspen	16%
Dense Shrub Aspen, some Conifer	20%
Sparse Conifer	5%
Forested Conifer	5%

Assessment

We assessed 14 polygons in the spring and summer of 2012 to ground-truth field conditions and assess the real remedial needs of these areas, specifically as they relate to sediment contribution to streams in this system. Soil samples, field photographs and vegetative cover estimates were collected, and observations were made about overall sediment delivery and natural recovery from these polygons. We considered existing vegetation, surface armoring, parent material and the extent of riparian buffering capacity immediately downhill from the polygons.

Soil samples were taken in 9 of these polygons, showing an average pH of 6.0 at the 0-6" depth. Organic matter in all soil samples was considered low to very low (<2.2%).

We also considered the restoration activities recommended in ARCO work documents and the logistics of carrying those out in these upland environments. Taking cost and logistics into consideration, as well as ecological condition, we have determined that all SHOP-20 polygons in the Mt. Haggin uplands are on a natural recovery trajectory and that natural buffering of riparian areas below these polygons are sufficiently containing sediments on-slope.

The following pages describe each polygon. Figures show typical conditions in each polygon as well as the polygons overlaid on the new vegetation maps.

SHOP 20.01
6.5 acres

This site was treated with weed spraying in 2010 and 2011 and was also planted in 2011 with nearly 1300 trees and shrubs. The unit has a southeast aspect and approximately 55% slope.

Soils of this unit are shallow and well drained rhyolite with some areas of volcanic tuff. Completely bare areas are few and far between in this unit, occurring in small patches of several square inches as in the photo below.

Soil Data from Keck (2007) showed pH of 5.6 and 6.0 at the 0-2 and 2-6 in. depths, respectively.

Aspen, antelope bitterbrush, rubber rabbitbrush, great basin wildrye, and snowberry are abundant on this site, as well as redtop as the dominant grass. Spotted knapweed and some leafy spurge were common on site until weed spraying began. The lower photo shows sprayed knapweed and live spurge among bitterbrush and rabbitbrush. On our vegetation map, this unit is considered 60% sparse shrub and 40% degraded grassland.

Most importantly is the dense riparian buffer of willow and aspen below this unit (image to right). There was no indication of soil erosion from this unit into the creek below. From a remediation standpoint this polygon should not be considered a contributing sediment source.

SHOP 20.02
2.3 acres

Soils of this unit are deep, course, sandy and stony loam colluviums from granite parent material and are considered excessively drained. Our experience in other units with this soil type showed active rooting depths of tree and shrub species to be 20 in. down, due to water availability.

No treatments have been implemented on this unit, which has a northwest aspect and approximately 15% slope. Soil samples taken here (2013) show a pH of 7.1 at depths of 0-6".

Vegetation on this unit consists of aspen colonies, dense at the top and bottom of the polygon and slowly colonizing the middle, where the dominant vegetation is redtop with sparse woods rose, antelope bitterbrush and some scouler willow. The unit is approximately 40% degraded grassland and 60% sparse shrub in our mapping (image below).

Leafy spurge is prevalent on this unit.

Below this site is a thick riparian of aspen. There is no active rilling or sign of any sediment delivery issues from this unit.

From a restoration perspective, the major limiting factor to plant establishment here is wildlife browse which stunts the potential of natural regeneration.

SHOP 20.03
6.7 acres

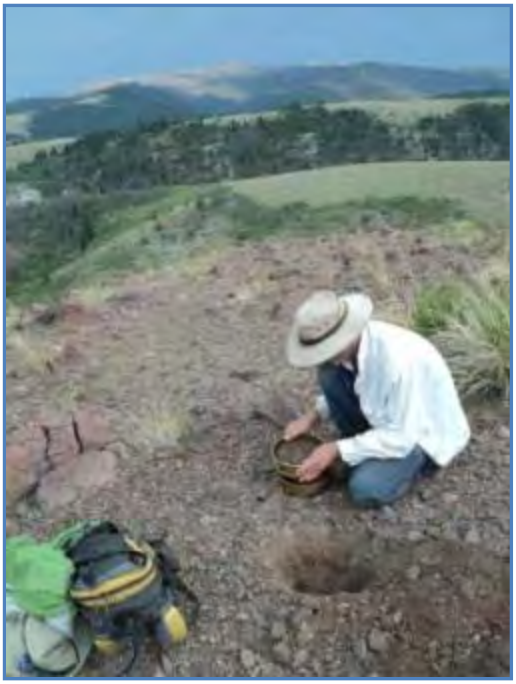
This unit contains the southwest face and ridgeline of a knob that hovers above Cabbage Gulch. Soils are a gravelly, ashy, well-drained sandy loam from colluvium and residuum of both rhyolite and tuff. Organic soil horizons are between 18-35" deep.

The bare knob at the top of this unit is well armored and shows no signs of active rilling or sediment delivery (bottom image). Great basin wildrye and bitterbrush surround the knob.

The majority of the polygon is a winding ridgeline that appears to be in a healthy state of recovery. Silver buffaloberry, horizontal juniper, common juniper are among the dominant shrub and tree species present, while redtop and great basin wildrye are the primary grasses. The unit is primarily considered degraded grassland in our vegetation map.

Soil samples by Keck (2007) were taken here in 2006, and showed pH's of 6.2 and 6.6 at the 0-2" and 0-6" depths, respectively. These samples were taken from the southwest corner of the unit. Our soil samples showed a pH of 5.7 from 0-6", taken from the top of the bare knob. Slopes range from flat to 36 degrees.

Leafy spurge and knapweed are present in this unit, particularly on the south face.



Ecological trends in this polygon are on a recovering trajectory. Bare areas (dark gray in vegetation map below) are armored with rhyolite colluviums and are not considered a sediment source.

SHOP 20.05

This unit comprises the general area encircling the polygons in the northeastern corner of the Mt. Haggin Uplands. Conditions vary across this unit, ranging from densely vegetated riparian areas to bare slopes similar to conditions found in polygons, and everything in between.

As no action was required on this unit, no change to the recommended approach is necessary.

SHOP 20.06
1.5 acres

Soils in this unit are a gravelly, ashy, well-drained sandy loam from colluvium and residuum of both rhyolite and tuff. Organic soil horizons are between 18-35" deep. Slopes here are 28% and the unit is southwest facing.

This unit is located between two fingers of aspen colonies moving uphill from a lush draw. Vegetative cover in this unit is close to 60%, predominantly degraded grassland, with few large areas lacking vegetation. Great basin wild rye and redtop are the primary vegetation, with snowberry, antelope bitterbrush and some oregon grape coming in. As seen in the image below, and to the right, the unit is flanked by aspen colonies on both sides.

Leafy spurge and knapweed are also present in this unit.

Soil samples taken just outside of this unit in 2007 (Keck) showed pH values of 5.4 and 6.0 at the 0-2" and 0-6" depths respectively. Soil samples taken in 2012 showed pH levels of 6.3 from 0-6".

Though vegetation cover could be improved, the system is well on its way to recovering on its own and is not a sediment source.

SHOP 20.07
1.9 acres

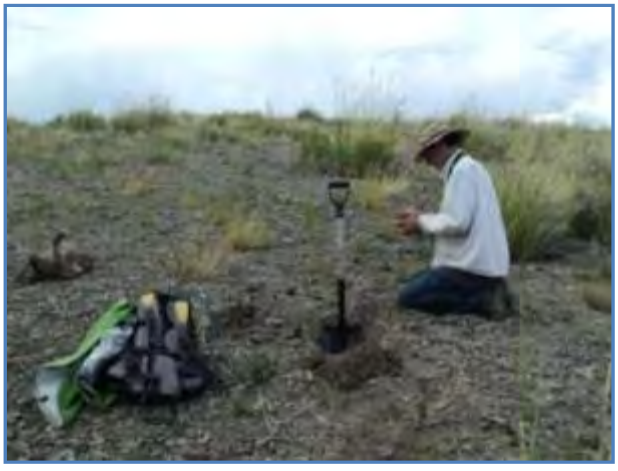
This unit, south facing and on a 20% slope, has gravelly loam soils derived from volcanic parent material. Digging our soil pit, we reached parent material 6" down. Vegetation on this site was sparse compared to other units, with some larger patches of bare earth showing nothing but a few tufts of bunch grasses (lower left photo).

In better vegetated areas in and around this polygon, great basin wildrye and antelope bitterbrush are the dominant grass and shrub species, respectively. Leafy spurge is present throughout the unit.

Bare areas are lightly armored with gravel-size substrate and did not show any rills or signs of noticeable sediment delivery. More importantly, the riparian buffer below this unit is extensive and slowly moving uphill toward this polygon.

Soil samples in 2007 (Keck) showed pH values of 4.6 and 5.6 at the 0-2" and 0-6" depths respectively. The soil sample taken in 2012 showed pH of 5.0 at the 0-6" depth. The soil here was low in calcium relative to other units.

Though pH levels may indicate persistent problems in this polygon, it is not a contributing sediment source to the system (see unit in image at right).

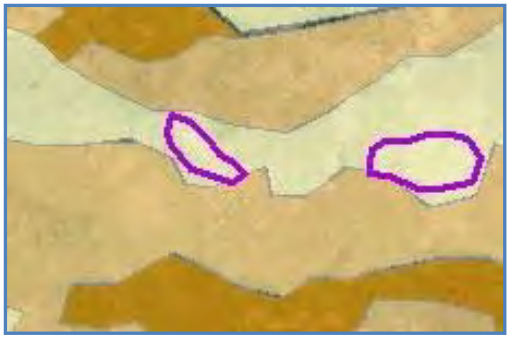


SHOP 20.08
0.7 acres

This unit sits just above the top of a draw that feeds Cabbage Gulch, along the south face of a ridge that has ample vegetation on either side of it.

The unit itself is approximately 50% vegetated, predominantly by great basin wild rye, antelope bitterbrush, some horizontal juniper and some oregon grape.

Leafy spurge and some knapweed are present.



Soils of this unit are ashy, gravelly, sandy loam. Generally, water retention on this site is poor and parent material is between 18-35". Due to inclement weather no soil sample was taken at this site. It would be reasonable to assume soil properties are similar to those in SHOP 20.07.

Like SHOP 20.07, soils are lightly armored, there is no sign of active rilling or sediment delivery, and a large riparian buffer below this polygon is reassurance that this unit is not a sediment source.

SHOP 20.09

Soils of this unit are ashy, gravelly, sandy loam. Generally water retention on this site is poor and parent material is between 18- 35".

The polygon is northwest-facing and has a slope of nearly 30%, facing the Mill creek road. Between this polygon and the road is a buffer of regenerating aspen and scouler willow.

Aerial photos show part of an old road network below this unit, and evidence of where sediment used to transport through this unit and into the right-of-way. This erosion, however is historic and there are no signs of active sediment transport reaching any waterways.

Existing vegetation in the unit is redtop and great basin wildrye, with oregon grape, antelope bitterbrush and scouler willow. Vegetation cover is approximately 30-40% over the whole unit, with the lower portion considered bare and the upper a degraded grassland condition.

Soil samples here showed pH levels of 6.1 from 0-6". Organic content is very low, while potassium and phosphorous levels are very high, as with all other polygons in the uplands.

SHOP 20.11

This unit is on a convex saddle landform. Soils of this unit are ashy, gravelly, sandy loam with poor water retention. The parent material is mostly volcanic tuff, evidenced by the typical plated gravel-sized substrate on the surface.

Existing vegetation on the site is sparse- it is easy to see how this area was identified as a potential sediment source from aerial imagery. However, adjacent areas in all directions are well vegetated and on a positive vegetative recovery trajectory, as shown in the center, right image. Particularly important to remediation goals are the well vegetated slopes to the east and west from the bare saddle. There is no indication of significant erosion from this area.

Species present include aspen, antelope bitterbrush, redtop, oregon grape, with a vegetative cover ranging from approximately 20% to 40%.

pH readings taken in 2007 (Keck) showed levels of 5.4 and 6.0 at depths of 2" and 6", respectively. Samples taken in late 2012 showed pH of 5.6 from 0-6".

SHOP 20.12

Soils of this unit are ashy, gravelly, sandy loam with poor water retention. This polygon, with a northeastern aspect, used to be forested, most likely with lodgepole pine, but, similar to other areas in the uplands, was logged extensively.

In 2011, 487 trees and shrubs were planted in this polygon. Backpack weed control also took place in 2011 for the leafy spurge and knapweed present in the unit.

The site is patchy with great basin wildrye and redtop, with aspen stands slowly colonizing the hillslope from the bottom up. The toe of the slope below this unit is stable and filling in with riparian vegetation around the Cabbage Gulch creek.

No soil samples were collected at this site, but we estimate pH levels to be in the 6.0 range from 0-6", similar to readings in SHOP 20.13, adjacent to this unit to the north.

There have not been any signs of erosion from this unit entering waterways, and ecological trends point to natural regeneration recovering this site within the foreseeable future, provided adequate climatic and rainfall conditions, which ultimately are the most significant determining factors for revegetation success.

SHOP 20.13

This unit exhibits similar characteristics of SHOP 20.12, with a northwestern aspect, well vegetated toe slope and a mix of great basin wildrye, weeds and aspen regeneration.

It appears that backpack spraying was done for weeds here within the last two years, though leafy spurge and knapweed are present, but not overwhelming.

Soil samples taken here show pH of 6.0 from 0-6". Organic matter, though only 2.2%, was highest on this site than the other upland polygons. Cation Exchange Capacity (23.8 meq/100g) was also high in relation to other polygons, indicating a higher percentage of clay in the soil and improved water-holding capacity, likely due to its protected north-eastern aspect.

Potassium levels on this unit were nearly two to three times those of other units sampled.

There were no signs of active erosion threatening the creek below and this polygon should not be considered a sediment source to the system.

SHOP 20.16

This polygon has an almost due north aspect, and like other polygons with this aspect, contain soils described as “granitic sand”. These soils are characterized by very thin (0-1”) organic horizons and very stony sandy loam beneath. Slopes on this unit range from 15-60%.

Vegetation in this unit consists of douglas fir forest, with some red osier dogwood and aspen in places. Leafy spurge, redtop, fireweed, serviceberry and a fescue species, along with antelope bitterbrush, were the dominant species in the unit.

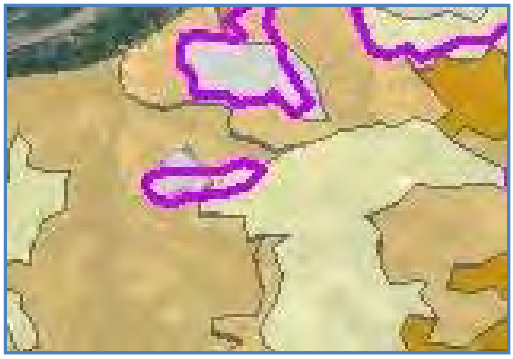
Soil samples taken in 2012 show pH values of 6.5 from 0-6”, likely indicating a smaller presence of contaminants in the soil profile. Organic matter is very low in these soils.

Areas below this unit are thick with shrubs and trees, forming a dense buffer between this unit and the road and/or creek below. There are no signs of active rilling or sediment delivery through this system. The vegetation map shows this unit as approximately 30% forested and 70% degraded grassland.

SHOP 20.17
3.0 Acres

This unit is the southernmost upland polygon, characterized by a "granitic sand" ridgeline with a west-facing aspect and 30-60% slopes. Soils here are "gravelly" loam, turning to sandy loams along one thin strip. Both soil types are considered excessively well-drained.

Vegetation is varied on this unit, from large bare sections to colonies of aspen, clumps of bitterbrush, regenerating chokecherry, snowberry and patches of grass, particularly where slopes are less steep. Different than other bare slopes with the same soil characteristics, this site had many cobbles on the surface.



Precipitation from this unit flows into a small gully to the south, which dumps into a creek that features a lush riparian area. There were no active rills or evidence of erosion other than the un-entrenched cobbles on the surface that slowly move downhill every year.

Spotted knapweed and leafy spurge are present in this unit, as was one specimen of toadflax, seen at the top of the unit. This toadflax should be eliminated as soon as possible and is documented in other weed reports provided to NRDP.

No soil samples were taken in this unit in 2007. Samples taken here in 2012 showed very low organic matter and a pH of 5.9 down to 6 inches.

SHOP 20.10, 20.14 (CG-1)
24.8 Acres

In 2010, the boundaries of these two units were adjusted and the units were combined to form unit CG-1. This re-drawing was well documented in project plans and summary reports submitted to NRDP in 2010, and was based on field verification of actual erosion areas, for example by eliminating rock outcrops from the original polygons.

This unit is an ice cream cone shape that funnels westward toward Mill creek road. The slope in this unit varies from 15-30% at the top to nearly 60% in the tight lower funnel.

Soils are stony and coarse sandy loams and well drained. Soil samples taken at the top of this unit in 2007 show pH values of 6.8 and 6.6 at the 0-2 and 2-6" depths, respectively.

Existing vegetation here is varied. At the top of the "cone" is a flat swale dominated by redtop, with some snowberry, scouler willow and limber pine. The unit's southwestern flank is a protected northern aspect with abundant regeneration of aspen, chokecherry, scouler willow, snowberry, lodgepole and limber pine. Proceeding downhill in the larger bare areas of the unit, there are sparse clumps of woods rose, antelope bitterbrush and horizontal juniper, as well as goldenrod, fireweed, and oregon grape. The grape is a relatively new occurrence on this site, and has advanced uphill over the past few years. However, leafy spurge has also colonized this site and is making a similarly aggressive push up-slope.

Historic erosion from this unit was clearly visible, in the form of a large fan of sediment at the base of the funnel along Mill Creek Road. Aspen trees and other vegetation have re-colonized some of this fan area (image lower right), which appears to be perched 3-5 feet above grade. Sediment flows out of the funnel have not been significant recently, as evidenced by fragile succulent plants colonizing the flat area below the funnel (ongoing erosion would quickly bury these plants).

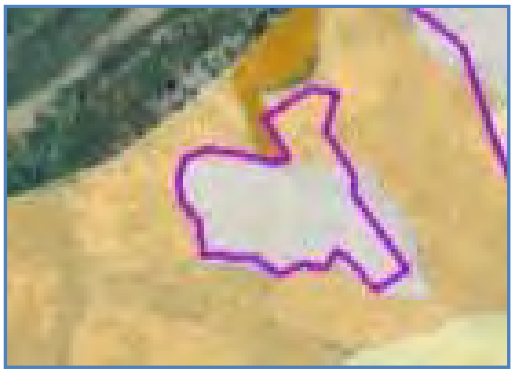
As the creek is on the other side of the highway from the funnel, there is no immediate risk of sediment being delivered into water from this unit. The steepness of the funnel leaves few viable options for catching or holding eroding sediments on the hillslope.

In 2010, 5500 trees and shrubs were planted throughout unit CG-1, and the area was grass seeded. Approximately 25% of the plants installed were protected from browse. Plant monitoring after 1 growing season showed survival rates of 57-72% for installed plantings. Grass seeding results were not monitored.

SHOP 20.04 (CG-2)
7.5 Acres

Similar to unit CG-1, two polygons were combined and re-contoured to form a new unit in 2010. Rationale for these changes are similar to above, including ground-truthing of actual sediment sources and eliminating bare rock areas from the polygons.

Soils of this unit are similar to CG-1, comprised of deep, coarse sandy loam, varying from over 30% slopes toward the bottom to 15-30% slopes toward the top. The unit also has both a western and southern aspect, with the west face draining to a flat toe-slope area adjacent to Mill creek road and the southern aspect draining to a well-vegetated riparian area.



Soil samples taken in 2007 showed pH values of 5.2 and 5.6 from 0-2" and 2-6," respectively. No samples were taken in 2012.

Vegetation on this unit is similar to CG-1: limber pine and some scouler willow at the top, but with more shrub growth throughout, including chokecherry, serviceberry, horizontal juniper, woods rose, snowberry. Oregon grape and leafy spurge appear to be in a similar upward-spreading trajectory in this unit as well.
An emerging stand of aspen borders this unit to the southwest, forming its bottom boundary. Below the aspen is a thick riparian.

To date, the area has been treated with planting of 1448 trees and shrubs, including plant protection of approximately 25% of those. Plant protection from dead plants were re-installed on live plantings in 2012. In addition, 16 exclosures were installed on natural revegetation to provide some relief from intense browse pressure, also in 2012.