Openings created by timber harvest should meet hiding cover requirements of big game before adjacent areas can be harvested – There are treatment units next to existing plantations that currently do not provide hiding cover. These units and adjacent plantations have been surveyed and where necessary buffers will be retained between those areas in order to provide some level of cover between past and proposed treatment units. Buffers would be at least 200 feet wide, although they may be wider if field data indicate that this is necessary.

Management Area W-1

Wildlife habitat improvement practices, including road management, prescribed fire and other techniques, may be used to maintain and/or enhance the quality of big game winter habitat – All new roads would be closed to public use and decommissioned following implementation. Prescribed fire goals include improving forage diversity and production in big game winter ranges.

Maintain adequate thermal cover and hiding cover adjacent to forage areas – Both alternatives would increase forage and remove cover. Approximately 85 percent or more of the existing management area cover would be maintained, unaffected lands would occur in all burn units, and project design features will retain cover adjacent to regeneration harvest. As a result, adequate cover will be maintained adjacent to forage and both alternatives comply with this standard.

Migratory Birds

As described under methodology, effects to migratory birds are addressed in the species and habitat sections of this analysis, in combination with analysis of threatened, endangered, sensitive birds and bird species of conservation concern. The memorandum of understanding (MOU) with the USDI Fish and Wildlife Service on the Migratory Bird Treaty Act identifies key principles and directs the Forest Service to (1) focus on bird populations; (2) focus on habitat restoration and enhancement where actions can benefit specific ecosystems and migratory birds dependent on them; (3) recognize that actions taken to benefit some migratory bird populations may adversely affect other migratory bird populations; and (4) recognize that actions that may provide long-term benefits to migratory birds may have short-term impacts on individual birds. The parties agreed that through the NEPA process, the Forest Service would evaluate the effects of agency actions on migratory birds, focusing first on species of management concern along with their priority habitats and key risk factors.

Migratory birds and their habitats including species with viability concern (TES) and priority species are evaluated in the habitat and species-specific sections. Alternative 1 would maintain habitat over the short term, whereas alternatives 2 and 3 would help to restore declining habitats while maintaining diverse habitat conditions across the landscape. As a result, habitat for migratory birds would be maintained or improved under all alternatives. Also, local populations of all species that currently utilize the project area are expected to be maintained. The action alternatives focus on habitat restoration, and include project design features that are expected to reduce impacts to migratory birds, therefore, all alternatives are in compliance with the Migratory Bird Treaty Act.

Plants

Introduction

There are no threatened, endangered or proposed plant species known to occur on the Helena National Forest (USDI Fish and Wildlife Service 2011b). Therefore, this section is limited to analyzing Region 1(R1) sensitive species and their habitats.

Sensitive species are species identified by the Regional Forester for which population viability is currently of concern, as evidenced by significant current or predicted downward trends in population numbers or density, or by significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution (USDA Forest Service 2005). The Forest Service has established direction in Forest Service Manual 2600 – Wildlife, Fish, and Sensitive Plant Habitat Management (FSM 2600, USDA Forest Service 2005)) to guide habitat management for proposed, endangered, threatened, and sensitive plant species. This direction establishes the process, objectives, and standards for conducting a biological evaluation, and ensures that these species receive full consideration in the decision making process. The Botany Report and Biological Evaluation (Englebert 2015b) incorporated all the information required for a biological evaluation.

Nine sensitive plant species are known to occur on or very near the Helena National Forest. An additional 12 species are suspected to occur on the Forest. Those 21 species are identified in table 128, along with the likelihood of occurrence. Whitebark pine (*Pinus albicaulis*) is the only sensitive species found in the project area. The species listed as 'possible' in the project area may have habitat within the project area. Only those listed as 'known to occur' or 'possible occurrence' are carried forward in this analysis. The remaining species do not have habitat in the project area and therefore no impacts to those species from this project are expected.

Table 128. Region 1 sensitive plant species that occur or may occur on the Helena National Forest

Species **(Family)** **Common Name**	**Known To Occur On Helena National Forest**	**Known To Occur In Stonewall Project Area**	**Likelihood Of Occurrence In Stonewall Project Area**
Amerorchis rotundifolia (Orchidaceae) Roundleaf orchid	No	No	**Possible** – Known from the Rocky Mtn. Front and the NW corner of Montana in spruce forests along seeps and streams
Aquilegia brevistyla (Ranunculaceae) Smallflower columbine	No	No	Unlikely – In Montana, it is known only from the Little Belt Mts in open woods and stream banks at mid-elevations in the montane zone.
Astragalus lackschewitzii (Fabaceae) Lackschewitz's milkvetch	No	No	Unlikely – Restricted to high elevation gravelly and rocky slopes and ridges, this species' habitat is not generally subject to human disturbance
Botrychium crenulatum (Ophioglossaceae) Scalloped moonwort	No	No	**Possible** – Known from the Beaverhead-Deerlodge National Forest and in western Montana, it generally occurs in wet habitats with high cover.
Botrychium paradoxum (Ophioglossaceae) Peculiar moonwort	Yes	No	**Possible** – This diminutive species is known from the Occidental Plateau, and near Irish Mine Hill. On the Helena NF populations are in sagebrush/rough fescue and rough fescue, however other populations have been documented from mesic meadows associated with spruce and lodgepole pine forests in

Species **(Family)** **Common Name**	**Known To Occur On Helena National Forest**	**Known To Occur In Stonewall Project Area**	**Likelihood Of Occurrence In Stonewall Project Area**
			montane and subalpine (MNHP 2007)
Cypripedium parviflorum (Orchidaceae) Lesser yellow lady's slipper	Yes	No	**Possible** -- Known from Divide landscape in fens, damp mossy woods, seepage area, and moist forest-meadow ecotone, in valleys & lower montane.
Cypripedium passerinum (Orchidaceae) Sparrow egg lady's slipper	No	No	**Possible** – This orchid is found in mossy, moist, or seepy places in coniferous forest; in northwestern Montana including Glacier NP.
Drosera anglica (Droseraceae) English sundew	Yes	No	Unlikely – Known from Indian Meadows, this species occurs with sphagnum moss in wet, organic soils of fens. Habitat is specialized.
Drosera linearis (Droseraceae) Slenderleaf sundew	Yes	No	Unlikely – Known from Indian Meadows, in wet, organic soil of nutrient-poor fens
Epipactis gigantea (Orchidaceae) Stream orchid	No	No	Unlikely – This species is associated with seeps and springs, often thermal.
Goodyera repens (Orchidaceae) Lesser rattlesnake plantain	No	No	Unlikely –In Montana, it is known from the Little Belt and Big Snowy Mts. in moist, montane forests with mossy understory.
Grindelia howellii (Asteraceae) Howell's gumweed	No	No	**Possible** –This species is an endemic known only from a cluster of sites northeast of Missoula, and a single county in Idaho.
Juncus hallii (Juncaceae) Hall's rush	Yes	No	**Possible**—Several populations occur on the Forest in the Big Belts and the Divide area. Moist to wet meadows,
Oxytropis podocarpa (Fabaceae) Stalkpod locoweed	No	No	Unlikely – Habitat for this species is in the alpine zone.
Phlox kelseyi var. *missoulensis (Phlox missoulensis)* (Polemoniaceae) Missoula phlox	Yes	No	**Possible** – It is known from east of the analysis area; habitat is rough fescue meadow, exposed, limestone-derived slopes in foothills and montane.
Pinus albicaulis (Pinaceae) Whitebark pine	Yes	Yes	**Known to occur**- This species is known to occur in almost all major mountain ranges of western and central Montana. In the project area it is known to be a component of several of the

Species **(Family)** **Common Name**	**Known To Occur On Helena National Forest**	**Known To Occur In Stonewall Project Area**	**Likelihood Of Occurrence In Stonewall Project Area**
			treatment units.
Polygonum douglasii ssp. *austinae* (Polygonaceae) Austin knotweed	Yes	No	Unlikely—This taxon is known from the Big Belts in open gravelly shale-derived soil of eroding slopes/banks or usually moist, barren shale slopes.
Saxifraga tempestiva (Saxifragaceae) Storm saxifrage	No	No	Unlikely – This species is a Montana endemic known only from vernally moist open sites and rock ledges at high elevations, west of Continental Divide.
Schoenoplectus subterminalis (Cyperaceae) Swaying bulrush	Yes	No	Unlikely – This species is known from Indian Meadows, and sites in the NW primarily west of Continental Divide in open water and boggy margins of ponds, lakes, and sloughs.
Thalictrum alpinum (Ranunculaceae) Alpine meadow-rue	No	No	Unlikely – In Montana, this species is known from sites in the SW corner, in moist alkaline meadows.
Veratrum californicum (Liliaceae) California false hellebore	No	No	Unlikely – In Montana it is known from 4 sites in Bitterroot Valley

Methodology

The Montana Natural Heritage Program (MTNHP) (2010) maintains a statewide database for sensitive species. Data from the MTNHP was applied to known sensitive plant populations in the project area.

Ground reconnaissance was conducted by Forest Service personnel in representative habitats within the project area. Field reconnaissance was conducted throughout the project area, with focus on moist and wetland habitats associated with timber harvest proposals. Those habitats support several sensitive species (USDA Forest Service 1998) and have the highest potential for sensitive plant populations. Wetlands throughout the project area were delineated and no sensitive plant populations were found. Field notes and GPS locations to represent specific field locations can be found in the project record.

Past surveys by the Montana Natural Heritage Program, botanical surveys from the Indian Meadows Research Natural Area as well as past surveys by Forest Service personnel were the focus for the current survey work (Olsen 2010).

In 2005, Cooper and others conducted inventories searching for sensitive vascular plants as well as riparian and wetland associated plant communities in the area of the Snow Talon fire and areas to the west of the fire, which included the Stonewall Project area. No sensitive plant populations were found in this survey. Those survey records can be found in the project record. Barton and Crispin (2002) completed surveys across the Helena National Forest in 2002. The purpose of the surveys was to locate sensitive plant populations in association with noxious weed populations, primarily along roadsides. Some of the

roads in the project area were surveyed. No sensitive plant populations were found in this area during those surveys.

Whitebark pine was added to the Regional Forester's Sensitive Species List in 2011(Weldon 2011a), so was not included as a sensitive species in the previous surveys. Stand exam data for the project area indicate that it is present in several of the prescribed fire treatment units and it is also present in other units as an "occasional" component (Amell and Klug 2015, Milburn et al. 2009).

The methodology used in this analysis includes the best available science gathered from inventory data as well as several geospatial layers using known sensitive plant populations to predict sensitive plant habitat. The specific layers used include the Montana Natural Heritage Program data on sensitive species, the Helena National Forest Soil Survey, digital elevation models, information and experiences from past surveys, personal ground reconnaissance of the project area by Forest Service personnel along with field crew surveys in areas identified as potential habitat.

Assumptions

The following assumptions were used:

- Species on the Regional Forester's Sensitive Species List that occur on, or are suspected to occur on the Helena National Forest have been identified.
- Geospatial systems combined with habitat information, on-the-ground experience and past surveys is useful to screen areas of low probability of species occurrence.
- Reconnaissance of representative habitats is appropriate to determine the presence of sensitive plant populations.
- Known habitats need to be specifically identified and surveyed in the field.

Spatial and Temporal Context for Effects Analysis

Direct effects are those that occur at the same time and place of the proposed actions. Indirect effects are those effects that may occur along roads and stands adjacent to proposed treatments. The cumulative effects analysis area for sensitive plant species is the Stonewall Project area. For the herbaceous sensitive species this analysis is bounded in time by 10 years past and 10 years into the future, which allows for an adequate length of time to record vegetative changes. The analysis for whitebark pine however requires a much greater temporal bounding; please see the Vegetation Section for details of the whitebark pine analysis.

Overview of Issues

Comments pertaining to disclosing the effects of project activities on plants were identified from public scoping as nonsignificant (40 CFR 1501.7), and are addressed by the analyses in this section. Please refer to volume 2, appendix A of this document for a complete listing of the issues and an explanation of how the agency determined their disposition.

Indicators

The following indicators were used to measure the differences between alternatives:

- For whitebark pine we looked at the total acres proposed for treatment in units in which whitebark pine has been identified.

- Because sensitive species habitat can be degraded by noxious weed infestations, we looked at the estimated acres of potential noxious weed infestation due to proposed activities.
- In addition, effects that cannot be easily quantified are described qualitatively. Impacts to sensitive plant species may be direct impacts, such as trampling, defoliation, and mechanical damage; or the impacts may be more indirect such as a change in the microclimate or a change in species composition, both of which may result in a loss of habitat. In general, direct impacts are short-term impacts, occurring immediately, while indirect impacts such as changes to the habitat occur over a longer timeframe.

Affected Environment

Existing Condition

Whitebark pine is the only sensitive species known to occur in the project area, and is carried forward in this analysis. None of the eight species identified as possibly occurring in the project area were located during survey work to date. Additional rationale for carrying these species forward in this analysis includes (Olsen 2010):

- Roundleaf orchid has not been found on the Helena National Forest, but is known from the Rocky Mountain Front, north of the Blackfoot landscape area. Habitat may exist in the wetter parts of the project area.
- Scalloped moonwort is known from the Beaverhead-Deerlodge National Forest, immediately adjacent to the Helena National Forest adjacent to the Divide landscape area. This species has not been found to date on the Helena National Forest. Habitat may exist in the project area for this species along stream bottoms, around seeps, on the edges of marshes, and in wet roadside swales.
- Peculiar moonwort is known from two populations on the Helena National Forest, both in the Divide landscape area. Habitat may occur in the project area in mesic meadows.
- Lesser yellow lady’s slipper was found at one location within the Helena National Forest boundary and at another location just outside the boundary. Neither population has been recently documented in additional sensitive plant surveys. The population occurs in the Divide landscape area. Habitat may occur in the project area in moist coniferous forests, seepage areas and moist ecotones between peatlands and upland forest.
- Sparrow egg lady’s slipper has not been found on the Helena National Forest but is known from Glacier Park and northwest Montana. Habitat for this species is the same as that for lesser yellow lady’s slipper.
- Howell’s gumweed has not been found on the Helena Forest but is known from an area west of the Blackfoot landscape. It may have habitat in the project area in vernally moist, lightly disturbed soil adjacent to ponds and marshes, as well as similar human-created habitats such as roadsides.
- Hall’s rush has 15 populations Forest-wide. The Montana Heritage database identifies eight populations on the Helena National Forest (three of the Heritage Program populations were again documented by Helena National Forest survey crews in 2009). Seven new populations were found by Helena National Forest survey crews in 2009. The populations occur in the Divide and Big Belts landscape areas. This plant may have habitat in the project area in wet to moist meadows.

- Missoula phlox has been found in each of the four landscape areas of the Forest. The Montana Heritage database identifies eight populations on the Helena National Forest. Three new populations were located in 2008 and three additional populations were found in 2009 while the Forest was validating a model which predicts sensitive plant habitat. Details for field survey areas and protocols are available in the project record. There may be habitat for this taxon in the project area along wind-swept ridges and forb-dominated meadows.

Species Unlikely to be Present

All species, except whitebark pine, were included during field surveys, but it was determined that 12 of those species are unlikely to occur in the project area (as indicated in table 128). Those 12 species are not carried forward in this analysis. The following is additional rationale for the elimination of those species (Olsen 2010):

- English sundew, slenderleaf sundew and swaying bulrush are known from the Indian Meadows Research Natural Area, which is in the combination boundary but would not be affected by the proposed treatments. These species are found in fens, which are very rare and specialized habitats. No other fens are known within the project area.
- Lackschewitz's milkvetch, stream orchid, stalkpod locoweed, storm saxifrage, and California false hellebore all have very specialized habitat that does not occur in the project area.
- Smallflower columbine, lesser rattlesnake plantain, and alpine meadow-rue are not likely to occur in the project area as the known populations are not from this area. These species have not been found on the Helena National Forest to date, but the species are searched for in any survey work.

Environmental Consequences

Effects Common to All Alternatives

Effects to herbaceous sensitive species from large, stand-replacing fire

If current management continues (alternative 1), a large stand-replacing fire is a potential reality (Kurtz 2009). The action alternatives cannot eliminate the potential for a large-scale fire; however, the activities proposed are designed to modify fire behavior to enhance community protection while creating conditions that allow the reestablishment of fire as a natural process on the landscape, thereby reducing the risk to resources in the project area. Thus, while the potential for wildfires is common to all three alternatives, there is less risk of effects to herbaceous sensitive species from wildfire under both the action alternatives.

The potential exists for wildfire to have short-term detrimental effects on herbaceous sensitive plant habitats, but long-term effects are not anticipated in most cases. However, there has been a dramatic increase of severe wildfires in the ponderosa pine type in recent decades where fuels have built up due to fire suppression (Agee and Skinner 2005). In these habitats there is potential for long-term damage to sensitive plant habitats (Menges and Dolan 1998, Pendergrass et al. 1999). Plant response to fire is a result of the interaction between severity of the fire and the individual plant species' inherent resistance to injury and ability to recover (Brown and Kapler Smith 2000). Mortality of herbaceous species is more dependent on the length of time plants are exposed to high heat, determined by the amount of duff and woody fuel consumed by the fire, than flame length and fire line intensity (Armour et al. 1984). The effect of wildfire on herbaceous sensitive plant habitats therefore would depend on the surface fuel conditions. The longer fuels build up on the forest floor, the greater the potential damage to herbaceous sensitive plant habitats.

After habitat loss, the spread of invasive species is considered the greatest threat to imperiled species in the United States (Sieg et al. 2003). Large stand-replacing fires are known to increase the risk of infestation by noxious weeds (D'Antonio 2000). Thus included with the potential for large-scale fire is the risk of noxious weed infestation. Of course, fires are not the only cause of weed infestations; any time the ground is disturbed (such as with the activities proposed under the action alternatives) there is the potential for infestation. Noxious weeds cause habitat degradation because they can out-compete desired plant species for water and nutrients. Drift from herbicides sprayed to help control weeds can also have detrimental effects to herbaceous sensitive plants. This risk is reduced by adhering to label instructions for applying specific herbicides, and by application of project design feature NOX-6 that requires a 100-foot buffer around sensitive plant species when applying herbicides. Within this buffer, only hand-pulling of weeds would be allowed (USDA Forest Service 2006c, d).

Effects specific to whitebark pine

Whitebark pine in the Northern Rocky Mountains depends on fire to maintain its dominance or presence on sites where it is a successional species (see the Vegetation section). Therefore if a large, stand-replacing fire occurs, whitebark pine may benefit because sites suitable for regeneration would be created. If, however, no seed source is nearby to facilitate the regeneration, such a fire could largely eliminate this sensitive species from the area. As is noted in the Vegetation section, the increases in fuel loads threaten the survival of even the largest and most fire-resistant whitebark pine trees.

Whitebark pine has been declining throughout major portions of its range for the last 50 years due to the effects of diseases, insects, and succession (Amell and Klug 2015). Although the action alternatives may reduce the effects from these threats they cannot eliminate the threats, therefore effects from diseases, insects and succession are common to all alternatives. Please see appendix B for a detailed discussion of these threats.

Effects Common to All Action Alternatives

The effects of ground disturbance on herbaceous sensitive plant populations would be similar in all action alternatives. There are no known occurrences of herbaceous sensitive species in the project area; however, if unknown occurrences are present those plants may be directly impacted by ground-disturbing activities. Effects from ground disturbance include the risk of noxious weed infestation as discussed earlier in the section *Effects Common to All Alternatives*, as well as direct impacts such as trampling, defoliation, soil and vegetation compaction and mechanical damage. These effects may be detrimental to individual plants as well as to the habitat for the sensitive plants. There is a project design feature in place that would reduce the risk of impacts by requiring appropriate mitigation if a population is located within the project area:

- If sensitive plant populations, except whitebark pine (see SILV-2), are located within the project area appropriate mitigation (e.g., site avoidance, avoid concentration of fuels on sites to be burned) would be followed upon consultation with a Forest Service botanist.

There are known occurrences of whitebark pine in the proposed treatment areas of both action alternatives. Those occurrences would be protected by the project design feature SILV-2, which is designed to protect whitebark pine individuals and enhance habitat for the species. Thus, while there is the potential for individuals to be charred or physically damaged during the treatment, beneficial effects (in the form of habitat enhancement due to the removal of shade-tolerant species and creation of caching sites for Clark's nutcrackers) are expected in the long term. Incorporation of design feature SILV-5 increases the beneficial effects to whitebark pine as the Forest Service seeks opportunities to plant rust-resistant individuals. The Vegetation section states that whitebark pine would increase in the short term with the increase extending into the long term under both action alternatives.

Alternative 1– No Action

Direct and Indirect Effects

There would be no direct effects to any of the sensitive species under alternative 1, since none of the proposed treatments would occur. Current management would continue. Alternative 1 does not propose activities to modify fire behavior to enhance community protection while creating conditions that allow the reestablishment of fire as a natural process on the landscape. Current management activities would not reduce potential for stand-replacing wildfire events in the treated stands or help to break up the structure in the project area. Consequently, there is potential for indirect effects from wildfire as discussed earlier under *Effects Common to All Alternatives*.

Amell and Klug (2015) state in the Silviculture section that whitebark pine are expected to decline with the continuation of current management. Rather than reiterate that information, it is incorporated here by reference.

Irreversible/Irretrievable Commitments

There are no irreversible or irretrievable commitments that would affect sensitive plants under this alternative.

Cumulative Effects

There are policies in place that reduce or eliminate impacts from management activities on sensitive species (USDA Forest Service 2005). Therefore, the effects expected from this alternative when combined with the effects from the other management activities past and future, are not expected to contribute to change in status or viability of sensitive plants. In addition, cumulative effects are not expected to contribute to an increase in current or predicted downward trends in population numbers or habitat capability that would reduce the existing distribution of any of the R1 sensitive plant species discussed in this analysis, under this alternative. This conclusion applies the analysis indicators for direct and indirect effects (i.e. potential for direct physical impacts of trampling and defoliation, and potential for habitat degradation due to infestation of invasive species) from the proposed activities and adds them to expected effects from other management activities.

Cumulative effects from the following activities across the planning area are not anticipated:

- A roadside hazard tree removal projectoccurred along the main roads in this project area. The ground disturbance associated with that activity would be monitored and treated per the Helena National Forest Noxious Weed Record of Decision (2006d).
- Livestock grazing within the analysis area would continue as identified in the Allotment Management Plans for the Stonewall, Keep Cool and Arrastra allotments. There are no known occurrences of sensitive species within these allotments. Known sensitive plant populations on the forest, outside the project area, have not shown adverse effects from grazing and would not be affected by fuel treatment activities from this project.
- Timber harvest and thinning (fuels reduction) has led to changes in forest composition, structure and fire frequency. There are no known sensitive plant species in the project area that occur in areas that have been harvested or thinned. There are areas outside the project area where known sensitive plant species occur within past harvest treatment areas, however, those occurrences would not be affected by treatment activities from this project.
- Motorized and nonmotorized recreational use has led to the development of nonsystem roads and trails, development of dispersed campsites, erosion, and vectoring of noxious weeds into areas not

previously infested. These activities can lead to physical damage to plants and their habitats (biomass removal, vegetation compaction and ground disturbance). Vehicles and people help to spread noxious weeds by carrying weed seeds into new areas. These impacts are controllable through area closures and travel management.

- Road and trail construction and maintenance causes soil disturbance and erosion, fragmentation and destruction of habitat, and noxious weed invasion. It also increases the impacts from recreational activities by allowing improved access for those activities. Known sensitive plant locations outside the project area would not be affected by activities associated with proposed roadwork from this project. If any populations are discovered associated with ground disturbing activities, they would be protected. Populations would also be protected from herbicide application.
- Fire suppression has led to increased fuel loading, canopy closure, and higher intensity wildfire. Fire is a natural disturbance in the ecosystem. In some areas, habitat succession and fire could possibly create or improve habitat for select plant species by opening up meadows or reducing the litter accumulation and competition from other plants. In other areas, wildfires or controlled fires would create high ground temperatures that could sterilize the soil and eliminate fungal species that are necessary for the survival of others. Whitebark pine is dependent on fire to maintain its presence in the project area (Amell and Klug 2015). Fire exclusion has allowed an increase in competition from shade-tolerant species. Fire also tends to favor post-fire germination of nonnative species in environments where nonnatives are abundant and/or native species are stressed.
- Trends in climate change indicate the future precipitation levels will be lower and temperatures will be higher than the current long-term averages. Drier conditions are expected to be detrimental to riparian species that depend on moist habitats. Warmer temperatures are expected to result in a change in the distribution of plants as the elevation at which plants are found shifts upward. This shift appears to be greater for species found in mountain habitats (Lenoir et al. 2008). Modeling predicts a decline in whitebark pine due to global increase in temperature and more frequent summer droughts. However it’s also predicted that there will be an expansion of whitebark pine due to more frequent fire return intervals resulting from global warming (Fryer 2002).
- Noxious weeds would continue to be treated as specified in the Helena National Forest Noxious Weed FEIS and Record of Decision (USDA Forest Service 2006d). While herbicides used in treating noxious weeds may be inherently harmful to herbaceous plants, the existing Forest program as many safeguards in place to prevent detrimental impacts to sensitive species.

The actions and effects described in this section can be both additive and interactive to each other and to the direct and indirect effects described above. As stated earlier, because current management direction is designed to eliminate or reduce negative cumulative impacts by protecting sensitive plants from direct and indirect impacts, the cumulative effects to all species discussed in this analysis are expected to be minimal.

Alternative 2 – Proposed Action

Project Design Features Common to All Action Alternatives

The Stonewall Vegetation Project has been designed with features that are intended to minimize or avoid potential adverse effects while meeting project objectives. In addition to the proposed action treatments described in this section, design features would be implemented where applicable. A description of the project design features relating to plants and other resources is displayed in table 9, chapter 2.

The specific design feature in table 9 pertaining to plants is BOT-1 that addresses all alternatives, all units

This analysis is based on the implementation of all design features. Project design features apply to both action alternatives. Design features that are applicable to sensitive plant species include not only those listed above, designed specifically to protect sensitive plant species but also those designed to protect other resources.

Direct and Indirect Effects

Because no herbaceous sensitive species are known to occur in the proposed treatment areas, direct effects to the herbaceous sensitive species are not expected.

Whitebark pine is known to occur in five units as shown in table 129. Please note the "Acres in Unit" does not reflect total acres of whitebark pine, but rather the total acres of the unit of which whitebark pine is a component. And while it is known that whitebark pine occurs in these units, it may also occur (as scattered individuals) in other units. These acres are used as a basis for comparing alternatives. Under Alternative 2, prescribed fire treatment is proposed on 2,557 acres, in which whitebark pine is a component of the species composition. As discussed under *Effects Common to All Action Alternatives*, those occurrences of whitebark pine would be protected by the project design feature SILV-2 (table 9, chapter 2). Under this alternative whitebark pine is expected to increase in the short term, with the increase extending into the long term (Amell and Klug 2015). Please see appendix B for details of effects to whitebark pine.

Table 129 Treatment units with whitebark pine present – Alternative 2

Unit Id	Acres In Unit	Proposed Treatment
76	123	prescribed fire
79	337	prescribed fire
82	776	prescribed fire
83	457	prescribed fire
88	864	prescribed fire
Total acres	**2,557**	

There is a potential for indirect effects from wildfire as discussed under *Effects Common to All Alternatives*. The risk of effects from wildfire (including the connected noxious weed infestation) is less under alternative 2 than under alternative 1, as the proposed actions are designed to meet the purpose and need by modifying fire behavior to enhance community protection while creating conditions that allow the reestablishment of fire as a natural process on the landscape. The proposed actions are meant to reduce potential for stand-replacing wildfire events in the treated stands, as well as break up the structure in the project area. Reducing potential for stand-replacing events may reduce wildfire impacts to sensitive plants.

Potential habitat degradation due to noxious weed infestation as a result of ground disturbance is greater under alternative 2 than alternative 1. The Invasive Plants section identifies the potential for an additional 427 acres of potential weed infestation due to the proposed activities. This does not mean 427 acres of sensitive species habitat would be infested, but rather the risk of infestation of sensitive species habitat is greater under alternative 2 because of the potential increase of weeds in the area.

Irreversible and Irretrievable Commitments

There are no irreversible or irretrievable commitments that would affect sensitive plants under this alternative when project design features are applied.

Cumulative Effects

The cumulative actions and resulting cumulative effects as discussed under alternative 1 also apply to alternative 2. There would be no cumulative effects for this alternative as no known herbaceous plant populations would be affected, and there is a project design feature in place to protect whitebark pine. See also the discussion of cumulative effects due to indirect effects under alternative 1.

Alternative 3

Direct and Indirect Effects

Direct and indirect effects to sensitive species and their habitats under alternative 3 are expected to be the same as under alternative 2 except as follows:

- The risk of indirect effects from wildfire (including the connected effect of noxious weed infestation because of such fires) is greater under alternative 3 than alternative 2, because fewer acres are proposed for treatment, leaving a slightly greater potential for a large stand-replacing fire.
- Conversely, the risk of habitat degradation due to noxious weed infestation is less under alternative 3 than alternative 2 because ground disturbing activities would occur on fewer acres. Please see the Invasive Plants section for details of potential weed infestation due to proposed activities. Table 130 shows the comparison of potential weed infestation for all alternatives:

Table 130 Comparison of potential weed infestation due to proposed activities

Alternative	Acres Of Potential Weed Infestation Due To Proposed Activities
1	0
2	427
3	307

- Four of the five units which have whitebark pine as a component would be treated with prescribed fire under alternative 3. There is no treatment proposed for Unit 76, so 123 fewer acres would be treated.

Irreversible/Irretrievable Commitments

There are no irreversible or irretrievable commitments that would affect sensitive plants under this alternative when project design features are applied.

Cumulative Effects

The cumulative actions and resulting cumulative effects as discussed under alternative 1 also apply to this alternative. There would be no cumulative effects for this alternative as no known herbaceous plant populations would be affected, and there is a project design feature in place to protect whitebark pine. Please see the discussion of cumulative effects earlier under alternative 1.

Summary of Effects

Alternative 1 would have no new soil disturbing activities that would disturb sensitive plant populations. However, alternative 1 does not propose activities that modify fire behavior to enhance community protection while creating conditions that allow the reestablishment of fire as a natural process on the landscape. Consequently, there remains a higher risk of a large, stand-replacing fire that could result in

effects to herbaceous sensitive species habitat. The Vegetation section notes that under alternative 1 whitebark pine would not increase in the short term and would decline from present levels in the long term.

Alternative 2 has the highest level of soil disturbing activities with the highest level of potential to affect any unknown herbaceous sensitive plant populations. Nevertheless, alternative 2 addresses the purpose and need by proposing the greatest amount of acres of activities that modify fire behavior to enhance community protection while creating conditions that allow the reestablishment of fire as a natural process on the landscape. The proposed actions are meant to reduce potential for stand-replacing wildfire events in the treated stands, as well as break up the structure in the project area. Reducing potential for stand replacing events may reduce wildfire impacts to specific resources. The Vegetation section states that proposed activities under alternative 2 are consistent with recommendations for restoration of whitebark pine ecosystems, and that in the treated areas whitebark pine would increase in the short term with the increase extending into the long term.

Alternative 3 also proposes treatment activities that may disturb unknown occurrences of herbaceous sensitive plants (see description for alternative 2), however on fewer acres than alternative 2. The Vegetation section states that proposed activities under alternative 3 are consistent with recommendations for restoration of whitebark pine ecosystems and that in the treated areas whitebark pine would increase in the short term with the increase extending into the long term.

There are no known occurrences of herbaceous sensitive plants in the project area and there is a project design feature in place to protect whitebark pine; therefore, direct and indirect effects are limited. Cumulative effects are not expected to contribute to change in status or viability of sensitive plants, under any of the alternatives. No downward trend in population numbers or density, or downward trend in habitat capability that would reduce the existing distribution of any of the sensitive plant species discussed in this analysis, is expected under any of the alternatives.

Species-Specific Effects including Determination of Effects

Roundleaf orchid

This species is known from the Rocky Mountain Front and the northwest corner of Montana. Field surveys of potential wetlands within the analysis area did not locate any populations of this species. No other past surveys have located this species on the Helena National Forest. The habitat for this species is spruce forests along moist seeps and springs.

Direct, Indirect, and Cumulative Effects

Wetlands, seeps and springs would be protected from ground disturbance in the design features for this project (table 9); therefore, direct effects are not expected. However, when habitat is present for a species it is possible that unknown individuals are present, therefore, there is the remote chance, albeit very slight, that individuals could be directly affected. Indirect effects would be as described under *Effects Common to All Alternatives*. See *Cumulative Effects* section for alternative 1, and appendix C for specific cumulative effects.

Determination

Based on the analysis for alternatives 1, 2, and 3, detailed in this document, I determine that the activities proposed **may impact individuals but would not contribute toward a trend for federal listing or loss of viability** of roundleaf orchid. This determination is supported by the following rationale:

- None of the known occurrences of roundleaf orchid are within the project area and none would be impacted by this project.
- There may be habitat for roundleaf orchid in the project area and as a result there is a slight possibility that unknown individuals could be impacted
- There are project design features in place to protect this species' habitat.
- There is potential for indirect effects to habitat under all three alternatives. There are no activities associated with alternative 1; nevertheless, there is the possibility of habitat degradation due to the risk of large, stand-replacing fires and the associated habitat degradation from noxious weed infestation.

Scalloped moonwort

This species is known from the Beaverhead-Deerlodge National Forest, immediately adjacent to the Helena National Forest. This species has not been found to date in the project area through numerous surveys. This species is associated with wetland habitats.

Direct, Indirect, and Cumulative Effects

Wetlands, seeps and springs would be protected from ground disturbance in the design features for this project; therefore, direct effects are not expected. Indirect effects would be as described under *Effects Common to All Alternatives*. See *Cumulative Effects* section under alternative 1and appendix C for specific cumulative effects.

Determination

Based on the analysis for the three alternatives detailed earlier in this document, I determine that the activities proposed **may impact individuals but would not contribute toward a trend for federal listing or loss of viability** of scalloped moonwort. This determination is supported by the following rationale:

- None of the known occurrences of scalloped moonwort are within the project area and none would be impacted by this project.
- There may be habitat for scalloped moonwort in the project area and therefore. there is a slight possibility of unknown individuals that could be impacted
- There are project design features in place to protect this species' habitat.
- There is potential for indirect effects to habitat under all three alternatives. There are no activities associated with alternative 1; nevertheless, there is the possibility of habitat degradation due to the risk of large, stand-replacing fires and the associated habitat degradation from noxious weed infestation.

Peculiar moonwort

Peculiar moonwort is known from two populations on the Helena National Forest, both in the Divide landscape area. The habitat for this species on the Helena National Forest is open grassland and open grassland and sagebrush. This habitat does not occur in treatment areas; no populations are known to occur in the project area.

Direct, Indirect, and Cumulative Effects

No treatments are proposed in potential habitat, and there are no known occurrences of this species in the project area, therefore, no direct effects are expected. Indirect effects would be as described under *Effects*

Common to All Alternatives. See *Cumulative Effects* section under alternative 1and appendix C for specific cumulative effects.

Determination

Based on the analysis for the three alternatives detailed earlier in this document, I determine that the activities proposed **may impact individuals but would not contribute toward a trend for federal listing or loss of viability** of peculiar moonwort. This determination is supported by the following rationale:

- None of the known occurrences of peculiar moonwort are within the project area and none would be impacted by this project.
- There may be habitat for peculiar moonwort in the project area and therefore there is a slight possibility of unknown individuals that could be impacted
- There are no activities proposed in this species' habitat.
- There is potential for indirect effects to habitat from surrounding activities. There are no activities associated with alternative 1; nevertheless, there is the possibility of habitat degradation due to the risk of large stand-replacing fires and the associated habitat degradation from noxious weed infestation.

Lesser yellow lady's slipper

Montana Natural Heritage Program has records showing an occurrence of this species just inside the Helena National Forest boundary, and an occurrence just outside the boundary. Neither population has been seen recently. Field surveys in 2009 of potential wetlands did not locate any populations of this species. No other past surveys have located this species on the Helena National Forest. No populations are known to occur in the analysis area. The habitat for this species is fens, damp mossy woods, seepage areas, and moist forest-meadow ecotone, in the valley and lower montane zones.

Direct, Indirect, and Cumulative Effects

Wetlands, seeps and springs would be protected from ground disturbance in the design features for this project; therefore, direct effects are not expected. Indirect effects would be as described under *Effects Common to All Alternatives*. See *Cumulative Effects* section under alternative 1and appendix C for specific cumulative effects.

Determination

Based on analysis for alternatives 1, 2, and 3 detailed in this document, I determine that the activities proposed **may impact individuals but would not contribute toward a trend for federal listing or loss of viability** of lesser yellow lady's slipper. This determination is supported by the following rationale:

- None of the known occurrences of lesser yellow lady's slipper are within the project area and none would be impacted by this project.
- There may be habitat for lesser yellow lady's slipper in the project area and therefore there is a slight possibility of unknown individuals that could be impacted
- There are project design features in place to protect this species' habitat.
- There is potential for indirect effects to habitat under all three alternatives. There are no activities associated with alternative 1; nevertheless, there is the possibility of habitat degradation due to the risk of large stand-replacing fires and the associated habitat degradation from noxious weed infestation.

Sparrow egg lady's slipper

Sparrow egg lady's slipper has not been found on the Helena National Forest but is known from Glacier National Park and northwest Montana. Field surveys in 2009 of potential wetlands did not locate any populations of this species. No other past surveys have located this species on the Helena National Forest. No populations are known to occur in the analysis area. The habitat for this species is mossy, moist or seepy places in coniferous forests.

Direct, Indirect, and Cumulative Effects

Wetlands, seeps and springs would be protected from ground disturbance in the design features for this project; therefore, direct effects are not expected. Indirect effects would be as described under *Effects Common to All Alternatives*. See *Cumulative Effects* section under alternative 1and appendix C for specific cumulative effects.

Determination

Based on the analysis for alternatives 1, 2, and 3 detailed in this document, I determine that the activities proposed **may impact individuals but would not contribute toward a trend for federal listing or loss of viability** of sparrow egg lady's slipper. This determination is supported by the following rationale:

- None of the known occurrences of sparrow egg lady's slipper are within the project area and none would be impacted by this project.
- There may be habitat for sparrow egg lady's slipper in the project area and therefore there is a slight possibility of unknown individuals that could be impacted
- There are project design features in place to protect this species' habitat.
- There is potential for indirect effects to habitat under all three alternatives. There are no activities associated with alternative 1; nevertheless, there is the possibility of habitat degradation due to the risk of large stand-replacing fires and the associated habitat degradation from noxious weed infestation.

Howell's gumweed

This species has not been found in the Helena National Forest to date. It is known from open roadsides in the western Blackfoot area. The Montana Natural Heritage Program was contracted by the Forest Service to survey known noxious weed populations across the Forest (Barton and Crispin 2002). They specifically searched for this species. It was not found during those surveys as well as in 2009 field surveys. Habitat is described as vernally moist, lightly disturbed soils adjacent to ponds and marshes, as well as roadsides and other disturbed areas.

Direct, Indirect, and Cumulative Effects

It is unlikely that this species would occur in heavily forested areas where management activities are proposed; therefore, direct effects are not expected. Indirect effects would be as described under *Effects Common to All Alternatives*. See *Cumulative Effects* section under alternative 1and appendix C for specific cumulative effects.

Determination

Based on the analysis for alternatives 1, 2, and 3 detailed in this document, I determine that the activities proposed **may impact individuals but would not contribute toward a trend for federal listing or loss of viability** of Howell's gumweed. This determination is supported by the following rationale:

- None of the known occurrences of Howell's gumweed are within the project area and none would be impacted by this project.
- There may be habitat for Howell's gumweed in the project area and therefore there is a slight possibility of unknown individuals that could be impacted
- It is unlikely this species would occur in areas where management activities are proposed.
- There is potential for indirect effects to habitat from surrounding activities. There are no activities associated with alternative; nevertheless, there is the possibility of habitat degradation due to the risk of large stand-replacing fires and the associated habitat degradation from noxious weed infestation.

Hall's rush

This species has 15 populations Forestwide. The Montana Heritage database identifies eight populations on the Helena National Forest (three of the Heritage Program populations were located again by HNF crews). Seven new populations were found by Helena National Forest survey crews in 2009 (Bicker field surveys 2009). Habitat is wet to moist meadows.

Direct, Indirect, and Cumulative Effects

No treatments are proposed in potential habitat, and there are no known occurrences of this species in the project area; therefore, no direct effects are expected. Indirect effects would be as described under *Effects Common to All Alternatives*. See the *Cumulative Effects* section for alternative 1, and appendix C for specific cumulative effects.

Determination

Based on the analysis for alternatives 1, 2, and 3 detailed in this document, I determine that the activities proposed **may impact individuals but would not contribute toward a trend for federal listing or loss of viability** of Hall's rush. This determination is supported by the following rationale:

- None of the known occurrences of Hall's rush are within the project area and none would be impacted by this project.
- There may be habitat for Hall's rush in the project area; therefore, there is a slight possibility of unknown individuals that could be impacted
- There are no activities proposed in this species' habitat.
- There is potential for indirect effects to habitat from surrounding activities. There are no activities associated with alternative 1; nevertheless, there is the possibility of habitat degradation due to the risk of large, stand-replacing fires and the associated habitat degradation from noxious weed infestation.

Missoula phlox

This species is located in each of the four landscape areas of the Forest. The Montana Heritage database identifies eight populations on the Helena National Forest. The habitat for this species is open, exposed limestone-derived slopes in the foothills, to exposed ridges in the subalpine zone.

Direct, Indirect, and Cumulative Effects

No treatments are proposed in potential habitat, and there are no known occurrences of this species in the project area, therefore, no direct effects are expected. Indirect effects would be as described under *Effects*

Common to All Alternatives. See the *Cumulative Effects* section under alternative 1, and appendix C for specific cumulative effects.

Determination

Based on the analysis for alternatives 1, 2, and 3 detailed in this document, I determine that the activities proposed **may impact individuals but would not contribute toward a trend for federal listing or loss of viability** of Missoula phlox. This determination is supported by the following rationale:

- None of the known occurrences of Missoula phlox are within the project area and none would be impacted by this project.
- There may be habitat for Missoula phlox in the project area; as a result, there is a slight possibility of unknown individuals that could be impacted
- There are no activities proposed in this species' habitat.
- There is potential for indirect effects to habitat from surrounding activities. There are no activities associated with alternative 1; nevertheless, there is the possibility of habitat degradation due to the risk of large stand-replacing fires and the associated habitat degradation from noxious weed infestation.

Whitebark pine

This species is a hardy conifer that tolerates poor soils, steep slopes, and windy exposures and is found at alpine tree line and subalpine elevations throughout its range (USDI Fish and Wildlife Service 2011a). It is known to occur in almost all major mountain ranges of western and central Montana. In the project area it is known to be a minor component in several of the treatment units. The Vegetation section contains additional information regarding this species; that information is incorporated here by reference,

Direct, Indirect, and Cumulative Effects

This species is known to occur as a minor component in treatment units 76, 79, 82, 83 and 88 (please see the Silviculture section for details). Those occurrences would be promoted by the project design feature SILV-2 which is designed to protect whitebark pine individuals and enhance habitat for the species. And SILV-5 capitalizes on opportunities to plant rust-resistant individuals. Thus, while there is the potential for individuals to be charred or physically damaged during the treatment, beneficial effects (in the form of habitat enhancement due to the removal of shade-tolerant species and creation of caching sites for Clark's nutcrackers) are expected in the long-term. Indirect effects would be as described under *Effects Common to All Alternatives*. The Vegetation section states that whitebark pine would not increase in the short term and would decline from present levels in the long term under alternative 1, and would increase in the short term, with the increase extending into the long term under alternatives 2 and 3. The proposed actions under both alternatives are consistent with recommendations for whitebark pine restoration (see appendix B). See *Cumulative Effects* sections for alternative 1, and appendix C for specific cumulative effects.

Determination

Based on the analysis for alternatives 1, 2, and 3, detailed in this document, I determine that the activities proposed may **impact individuals but would not contribute toward a trend for federal listing or loss of viability** of whitebark pine. This determination is supported by the following rationale:

- Whitebark pine is expected to decline within the project area under alternative 1 (Amell and Klug 2015). However, this project area makes up a very small portion of the range of the species, and a

decline of the individuals in this project area cannot be determined to result in a trend towards federal listing or a loss of viability.

- Whitebark pine occurs as a minor component within some units that are proposed for prescribed burning under both action alternatives. Project design feature SILV-2 was designed to protect the species while incorporating activities to enhance the habitat. While some individuals may be impacted by these activities, overall a beneficial effect is expected in the long term.
- Project design feature SILV-5 allows for opportunities to plant rust-resistant individuals.
- Amell (2012) states that the activities proposed by the action alternatives are consistent with recommendations for restoration of whitebark pine ecosystems and that in the treated areas whitebark pine would increase in the short term with the increase extending into the long term.

Summary of Determinations of Effects

Table 131. Summary of determination of effects

Species **Common Name (Family)**	**Determination Of Effects**		
	Alternative 1	**Alternative 2**	**Alternative 3**
Amerorchis rotundifolia Roundleaf orchid (Orchidaceae)	MII[27]	MII	MII
Botrychium crenulatum Scalloped moonwort (Ophioglossaceae)	MII	MII	MII
Botrychium paradoxum *Peculiar moonwort* (Ophioglossaceae)	MII	MII	MII
Cypripedium parviflorum *Lesser yellow lady's slipper* (Orchidaceae)	MII	MII	MII
Cypripedium passerinum Sparrow egg lady's slipper (Orchidaceae)	MII	MII	MII
Grindelia howellii Howell's gumweed (Asteraceae)	MII	MII	MII
Juncus hallii Hall's rush (Juncaceae)	MII	MII	MII
Phlox kelseyi var. *missoulensis* Missoula phlox (Polemoniaceae)	MII	MII	MII
Pinus albicaulis Whitebark pine	MII	MII	MII

[27] May impact individuals or habitat, but will not likely contribute to a trend towards Federal listing or cause a loss of viability to the population or species.

Species **Common Name (Family)**	**Determination Of Effects**		
	Alternative 1	**Alternative 2**	**Alternative 3**
(Pinaceae)			

Compliance with Forest Plan and Other Relevant Laws, Regulations, Policies and Plans

Whitebark pine is the only sensitive plant species that has been found to date in the project area. All alternatives are consistent with Regional direction, Forest Plan Standards and Guidelines and the *Endangered Species Act*. If any additional species of special concern were verified in the project area, appropriate measures would be taken.

Noxious Weeds

Introduction

This section addresses the effects of the proposed activities on noxious weeds within the Stonewall Project area. Noxious weed infestations are detrimental to native fauna and flora and present the greatest large-scale threat to native ecosystems that exist in the Nation's wild lands today (DiTomaso 2000; Lodge and Shrader-Frechette 2003; Lonsdale 1999; Mack et al. 2000; Pauchard et al. 2003). At high infestation levels, these effects are adverse due to the loss of native plant diversity, reduction of wildlife habitat and forage, increase in erosion and depletion of soil moisture and nutrient levels (DiTomaso 2000). There are approximately 564 acres of weeds mapped on National Forest System land within the Stonewall Project boundary. Figure 97 shows the general distribution of noxious weeds. These infestations are expected to spread, with the amount of spread increasing proportionally with the amount of ground disturbance.

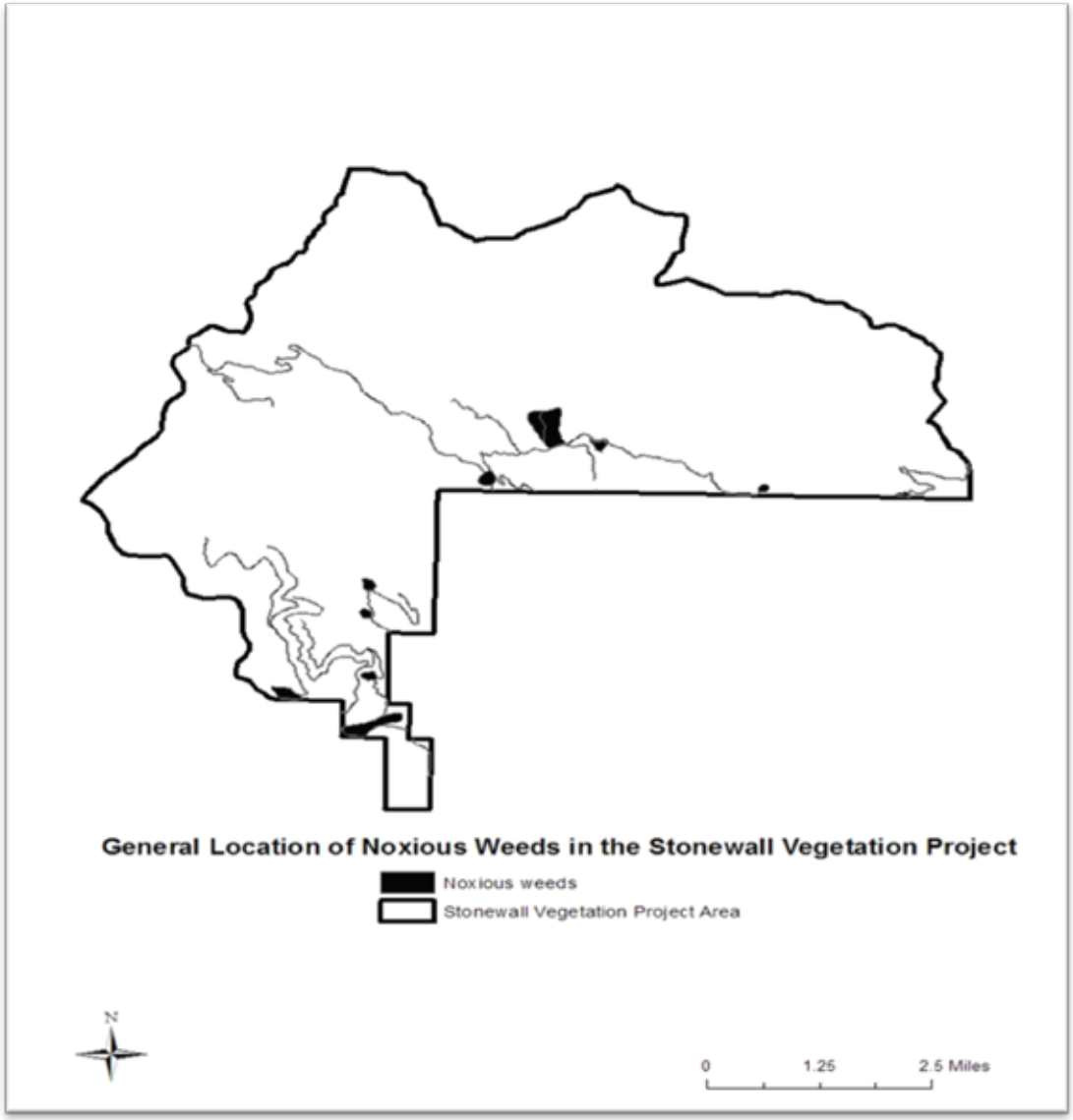

Figure 97. General location of noxious weeds in the Stonewall Vegetation Project area

Methodology

The methodology used in this analysis includes the best available data from the Helena National Forest Weeds Database and Geographic Information System (GIS) datasets. In addition, this analysis incorporates data collected by local Forest Service personnel during ground reconnaissance of the project area, and during vegetation monitoring of past vegetation treatments. Geographic Information Systems combine various datasets to help us understand relationships and the effects of travel routes on weeds and other flora, as well as influences from landform and landtypes.

Information Used

A GIS geodatabase (StonewallNEPA.gdb) contains numerous geospatial layers that provide the base data used in this analysis. This geodatabase is available in the project file located at the Helena National Forest or Lincoln Ranger District in Lincoln, Montana. Those layers include the known locations of weed infestations, watershed and stream information, and habitat types for risk assessment.

Assumptions

The following assumptions apply to this analysis:

- The analysis and decisions made in the record of decision for the Noxious Weed Treatment Project EIS are incorporated in noxious weed analysis and implementation on the Helena National Forest.
- Any soil disturbing activity with mechanized equipment has the potential to increase noxious weed invasion or spread.
- The expected rate of spread of noxious weeds is 14% per year, (Asher and Spurrier1998) without disturbance. The rate of spread could be even higher in areas affected by ground disturbing activities.
- Herbicide use in accordance with the requirements specified in the *Final Environmental Impact Statement: Helena National Forest Noxious Weed Treatment Project* and accompanying *Record of Decision (*USDA Forest Service 2006d) is appropriate for noxious weed management on infested lands.
- The Forest treats approximately one-third of its mapped weeds on an annual basis under its normal weed treatment program; therefore for this analysis it is assumed that one-third of the acres of weeds, would treated annually.
- The paragraphs below define mapped weed acres and weed treatment acres as used in this analysis.
    - **Mapped Weed Acres:** Mapped acres are reflected by polygons containing at least 1percent noxious weed cover. There are weeds outside those polygons that are too scattered to map, or are infestations that have not been discovered yet. The mapped acres are from the weeds layer in the Forest GIS database.
    - **Weed Treatment Acres:** Weed treatment acres for the purposes of this analysis are assumed to be the total polygon acres described above, to assess if any thresholds are being approached. Actual chemical application is reported to the State of Montana annually, as a requirement of a chemical applicator's/operator's license. Pesticide application is also recorded in the National Forest System FACTS database.

Spatial and Temporal Context for Cumulative Effects Analysis

The cumulative effects analysis area is the project area (figure 97). This geographic bounding was determined because activities beyond this boundary would have diminished effects. There are proposed haul routes identified that extend beyond this boundary, but expanding the analysis area to include those routes beyond the project area would result in an analysis of effects that is so subjective and conjectural that it would not contribute useful information. The analysis is bound in time by 10 years into the future, which allows for an adequate length of time to record vegetative changes. Effects associated with various actions are based on literature, known weed infestations and personal experience. Indicators, assumptions and method of analysis are the same as those described earlier.

Overview of Issues

The effects of project activities on noxious weeds were identified from public scoping as significant. Please refer to volume 2, appendix A of this document for a complete listing of the issues and an explanation of how the agency determined their disposition.

Weed Spread/Infestation: Proposed actions, including harvest disturbance and use of haul routes in areas with weeds present, may disturb landscapes allowing existing weed populations to expand or allowing additional species to become established.

Treatment of existing weed infestations would occur under the guidance of the Forestwide effort and treatments to prevent the spread of weeds is included in design features to reduce potential spread.

Issue Indicators

Indicators used to disclose the differences between the alternatives are:

- Predicted acres of invasive plants infestation due to the proposed treatments;
- Associated management cost for weed control activities.

Affected Environment

Existing Condition

Weeds have been expanding on the Helena National Forest for many years. A variety of factors contributed to the spread of noxious weeds. Noxious weeds are invasive by definition, and are able to spread without natural enemies, pathogens or ungulate grazing to keep them in check. Weeds favor disturbance caused by wildfire and ground disturbance of any kind. Increased public use across the Forest in the past few years due in part to off-road vehicle use and recreation displacement from wildfire, as well as travel plan closure areas, places more pressure on the remaining open areas.

Various methods of weed control are used on known weed infestations across the Helena National Forest (please see Appendix A in the Noxious Weeds Report (Englebert 2015a) for an estimate of costs for various control treatments). Herbicide application is the most common form of control used across the Forest. The Forest generally treats approximately 3,900 acres of weeds annually (averaging 2007 through 2009 as typical years). Although herbicide application has been the primary noxious weed treatment method, the Forest has also conducted a number of biological control agent releases and has established numerous insectaries across the Forest.

Partners and volunteers such as the Rocky Mountain Elk Foundation, Backcountry Horsemen, ATV groups, and Powell County and Lewis and Clark County participate with the Forest in weed treatment annually. The budget allocated for noxious weed treatment in 2009 was $335,000 with a target to treat approximately 3,000 acres. In addition, numerous grants and volunteer contributions assist the budget to help the Helena National Forest treat weeds.

Species information

Montana currently has 24 species on the statewide noxious weed list (Grubb et al. 2003). Five of those species are known to occur within the analysis areas: butter and eggs (*Linaria vulgaris*), Canada thistle (*Cirsium arvense*), houndstongue (*Cynoglossum officinale*), St. Johnswort (*Hypericum perforatum*) and spotted knapweed (*Centaurea maculosa*). Common mullein (*Verbascum thapsus*)is listed as a noxious weed by Lewis and Clark County. In addition to the known (mapped) infestations, it is likely that oxeye daisy (*Leucanthemum vulgare* also known as *Chrysanthemum leucanthemum*) and cheatgrass (*Bromus tectorum*) occur along roadways, especially near areas of recent disturbance. The State of Montana lists oxeye daisy as a noxious weed and cheatgrass as a regulated species. Noxious weed infestations throughout the project area range from areas of 5 to 10 individual weed plants to linear patches along roads and trails to large patches of greater than 20 acres. Infestation levels range from light (1 percent

canopy cover) to high (greater than 50% canopy cover). Table 132 shows the acres of weeds that are mapped in the project area. Infestation acres are rounded to the nearest acre.

Table 132. Mapped noxious weed infestation in the analysis areas

Noxious Weed Species (Scientific Name)	Project Area Infested Acres by Species
Butter and eggs – also known as yellow toadflax (*Linaria vulgaris*)	156
Canada thistle (*Cirsium arvense*)	118
Common mullein (*Verbascum thapsus*)	148
Houndstongue – also known as gypsyweed (*Cynoglossum officinale*)	126
St. Johnswort (*Hypericum perforatum*)	8
Spotted knapweed (*Centaurea maculosa*)	554
Total infested acres*	**564**

*Total infested acres do not equal the sum of all acres infested by a particular species. When a polygon is mapped and it contains multiple species, acres are recorded for each species.

Butter and eggs (*Linaria vulgaris*) is also known as yellow toadflax. It has been shown to readily establish on open and disturbed sites where competition from other plants is reduced (Zouhar 2003). Butter and eggs seeds may be dispersed by water, ants, birds, and rodents, but existing infestations appear to expand mainly by vegetative reproduction rather than by seed (Pauchard et al. 2003).

Canada thistle (*Cirsium arvense*) spreads primarily by adventitious root buds that may form new adventitious shoots that can develop along the root at any location (Zouhar 2001a). Canada thistle is present in much of the project area, generally associated with roadside disturbance or harvest disturbance. Its habitat is restricted to open areas of less than 10 percent canopy closure.

Cheatgrass (*Bromus tectorum*) is a serious weed that competes with native vegetation and fuels wildfire (Young et al. 1987). Cheatgrass has not been mapped on the Forest but is established along numerous roadsides and other areas of disturbance. Cheatgrass spread rapidly through sagebrush ranges following World War II and has been expanding its range ever since (Menalled et al. 2008). Cheatgrass is highly adaptable and has increased around the Helena National Forest over the past 30 years as evidenced by data collection (Olsen, personal observation). It is listed in Montana as a regulated plant.

Common mullein (*Verbascum thapsus*) is listed as a noxious weed in Lewis and Clark County. It has recently been mapped along roads in the project area. Gucker (2008) considers common mullein a short-lived member of disturbed communities whose abundance decreases with increased time since disturbance. Common mullein reproduces entirely by seed and has no means of vegetative regeneration. Its seed bank is very persistent, with seeds germinating after 100 years or more in the soil (Gucker 2008).

Houndstongue (*Cynoglossum officinale*) is also known as gypsyflower. This species is common along roads and in logged areas. Houndstongue is spread by large seeds that attach to animals or humans, as well as dispersed by wind (Zouhar 2002). A biennial or short-lived perennial, houndstongue reproduces

only by seed. It is relatively shade tolerant, although it thrives in full sunlight. This species is difficult to map as it may occur in small, scattered patches.

Oxeye daisy (*Leucanthemum vulgare* also known as *Chrysanthemum leucanthemum*) is not mapped in the project area, but quite likely occurs in small infestations, especially near areas of past disturbance. Besides reproducing vegetatively along a rhizome, oxeye daisy is a prolific seed producer. This plant is capable of taking over and modifying natural areas, pasture and rangeland and may increase soil erosion compared to native plant communities (Olson and Wallander 1999).

St. Johnswort (*Hypericum perforatum*) is quite limited in the project area. St. Johnswort is often treated as a grassland plant, but it is also common in many forested areas in North America. It may occur in open forests, natural clearings, or within forests where canopy cover has been reduced or removed by disturbances. In forested areas St. Johnswort is commonly associated with disturbances such as roads, logging, grazing and fire. St. Johnswort reproduces by seed and by sprouting from lateral roots and root crowns. Seeds can remain viable in the soils for several years (Zouhar 2004).

Spotted knapweed (*Centaurea maculosa* also known as *Centaurea stoebe* ssp. *micranthos* and *Centaurea biebersteinii*) has the largest extent of infestation within both the project area and the cumulative effects boundary. The species occurs along roadsides and throughout south-facing areas of past harvest, as well as in the natural grasslands. Spotted knapweed thrives in open areas with forest canopies of less than 20 percent. Spotted knapweed reproduces almost entirely from seed. Plants are also able to extend lateral shoots below the soil surface that form rosettes adjacent to the parent plant. This species has also been shown to have allelopathic properties, secreting toxins that suppress the growth of other plants, although resource competition is just as effective in its ability to dominate areas (Zouhar 2001).

Environmental Consequences

Project Design Features

The Stonewall Vegetation Project has been designed with features that are intended to minimize or avoid potential adverse effects while meeting project objectives. In addition to the proposed action treatments described in this section, design features would be implemented where applicable. A description of the project design features relating to noxious weeds and other resources is displayed in table 9, chapter 2.

The specific design features in table 9 pertaining to noxious weeds are NOX-1, NOX-2, NOX -3, NOX-4 NOX-5, NOX-6 and NOX-7.

This analysis is based on the implementation of all design features. Project design features apply to both action alternatives. Design features that are applicable to noxious weeds include not only those listed above, designed specifically to prevent noxious weed spread, but also those designed to protect other resources such as water and soil.

Effects Common to All Alternatives

The Forest treats approximately one-third of its mapped weeds on an annual basis under its normal weed treatment program (per the Helena National Forest Noxious Weed Treatment Project, USDA Forest Service1996). Therefore for this analysis it is assumed that one-third, or 188 acres of the 564 acres of weeds, would be treated annually. Herbicide treatment of these acres would have an average cost of about $30 per acre for easily accessible sites (up to 200 feet from a road and on slopes less than 40 percent) and $62 per acre for areas with more difficult terrain (farther than 200 feet from a road and on slopes greater than 40 percent). The cost of bio-control is included in these prices. An average cost of $50 per acre is used to calculate costs. Table 133 displays treatment type and cost to treat one-third of the acres in the

project area. This table does not include the cost of monitoring. This cost is not included in further analysis of the alternatives as it is assumed to be a baseline, independent of management actions, and common to all alternatives.

Table 133. Treatment type and cost to treat one-third of the currently infested acres - all alternatives

Treatment Type	Cost/Acre	Acres	Total Cost
Herbicide/Bio-control	$50.00	188	$9,400

Noxious weed infestations adversely affect native fauna and flora and present the greatest large-scale threat to native ecosystems that exist in the nation's wild lands today (DiTomaso 2000; Lodge and Shrader-Frechette 2003; Lonsdale 1999; Mack et al. 2000; Pauchard et al. 2003). At high infestation levels (canopy cover greater than or equal to 25 percent), noxious weeds cause a loss of native plant diversity, reduction of wildlife habitat and forage, increase in erosion, and depletion of soil moisture and nutrient levels (DiTomaso 2000). These effects are common to all alternatives and would vary depending on the level of infestation.

Weeds could potentially spread at a rate of 14 percent per year into dry forest areas as conifer species die and sunlight, nutrients, and moisture are more available to herbaceous plant species (Asher and Spurrier 1998). This is most important in ponderosa pine (*Pinus ponderosa*) forests, and lodgepole pine (*Pinus contorta*)/Douglas-fir (*Pseudotsuga menziesii*)/ponderosa pine mixed forests. The most susceptible forest habitat types would be dry habitat types that have existing infestations of noxious weeds because of the natural openness of such forest types.

Spotted knapweed, cheatgrass, Canada thistle, common mullein and houndstongue may spread rapidly with ground disturbance and may spread at a slower rate without disturbance (Young et al. 1987; Zouhar 2001, 2001a, 2002). Butter and eggs spreads readily without ground disturbance and very rapidly with disturbance (Zouhar 2003). The butter and eggs and oxeye daisy are of primary concern because they are difficult to control. Spotted knapweed is of primary concern across the analysis area because of the amount of infestation. New weed infestations, and spread of current infestations would occur under all alternatives, particularly along roadsides and areas of disturbance (Lonsdale 1999). The HNF Weed Treatment Project FEIS (USDA Forest Service 2006c) provides guidance and environmental requirements for weed control activities that would be applied to this area under any alternative. The Forest currently uses herbicides to treat approximately 30 percent of infestations annually. Roadsides would be treated annually, as they are a major vector for weed invasion. In addition to herbicide treatment, the noxious weed control program on the Forest has been successful in establishing insectaries. Biological control would be used in areas where the biological agents had optimal conditions for survival and expansion. In riparian areas, biological control would be emphasized where conditions for insect establishment are met.

A stand-replacing fire is a current risk in the Stonewall project area because of current fuels conditions (Kurtz 2009). Given the current conditions within the project area, and the dynamics associated with lodgepole and ponderosa pine mortality, untreated areas can be expected to experience uncharacteristically higher intensity fires that consume a considerable portion of duff and litter because of current density, stand structure, red-needled litter, and stand composition (Agee and Skinner 2005; Graham et al. 2004). This disturbance caused by wildfires would result in areas that are highly susceptible to weed invasions. For example, the Snowtalon fire occurred in an adjacent area in 2003. Much of that fire was stand-replacing. Yellow toadflax and spotted knapweed spread rapidly following the fire.

Herbicides and biocontrol were applied aggressively in the three years following the fire, with follow-up treatments since that time.

The data on response of weeds and changes in weed ecology because of climate change are limited. Weeds are genetically diverse and if resources such as light, water, nutrients, or carbon dioxide change within the environment, it is more likely there may be an expansion of weeds. However, very little is known regarding the impact of climate change on the reproductive success of invasive weeds and the potential consequences for their management (Ziska 2006).

Native plant diversity would be impacted by infestations of nonnative plants, especially noxious weeds. Noxious weeds dominate plant communities and tend to form monocultures that negatively influence native biological diversity. This weed competition to individual plants and plant communities can result in loss of species diversity and sensitive native plants. Native grasses used for domestic livestock and wild ungulates have been particularly susceptible to impacts from weeds (Beck 2001).

A review of the mechanisms underlying exotic plant invasions by Levine and others (2003) revealed that although numerous studies have been done examining the effects of invasive plants on community structure and diversity, few studies have examined the underlying processes (e.g. competition, allelopathy, production of flammable biomass, nutrient cycling) that cause the impact. It is well understood that community biodiversity decreases with exotic plant invasion, but the results of changes to soil community diversity, resource allocation, and soil water availability for example have not been examined (Levine et al. 2003).

Some studies have investigated effects on nutrient cycling on invaders that are nitrogen fixers for example, as available nitrogen in that case might be predictable (Vitousek and Walker 1989). Evans et al. (2001) found that cheatgrass invasion can significantly alter nutrient cycling through differences in litter quality and quantity. However, the consequences of altered nitrogen availability for community structure are poorly demonstrated and highly variable (Levine et al. 2003).

Studies of impacts to natural fire processes strongly support the expectation that invader impacts on disturbance regimes (ecosystem process) can strongly and possibly irreversibly affect community structure (Levine et al. 2003). Dramatic alterations of fire frequency in historic shrublands that are now dominated by cheatgrass have been demonstrated (D'Antonio 2000, Ehrenfeld et al. 2001). Other cases of exotic grass and shrub impacts include increasing fuel resulting in greater flame lengths, higher temperatures and greater heat release. In each case, the mechanism through which impact develops depends on whether the invader can out-compete the natives for resources. In most cases, the specific ecophysiological reasons for greater biomass production have not been identified. The effects of cheatgrass strongly support the prediction that invaders affecting disturbance processes have the greatest potential to create large impacts on ecosystems (Vitousek 1990).

Allelopathy is a biological phenomenon by which one organism produces biochemicals that influence the growth, survival and reproduction of other plants. Ridenour and Calloway (2001) showed that spotted knapweed reduced the root growth of Idaho fescue (*Festuca idahoensis*) by 50 percent, showing an adverse allelopathic effect. Additional studies on the effect of arbuscular mycorrhizae on interactions of spotted knapweed—Idaho fescue roots showed an enhancement of the competitive ability of spotted knapweed but direct effects of mycorrhizae were weak (Marler et al. 1999). Unanswered questions in the ecosystem-impacts literature include the degree to which the documented impacts result simply from the addition of new functional traits brought in by the invader, or alternatively the reduction or elimination of native species (e.g., Mack et al. 2001).

The use of herbicides may have positive or negative impacts on native plant diversity. Rice and others (1997) found in a detailed comparison of plant community composition over an eight-year period that plots treated with Tordon®, Transline®, and Curtail® were more similar to the potential natural communities than the no-spray controls (Mueggler and Stewart 1980). On the other hand, the side effects of weed management can vary as a function of local site conditions (Shea et al. 2005). Side effects of management actions include reducing vigor or abundance of native or desirable species, inhibiting overall productivity or diversity, shifting community structure and function, and altering physical conditions (D'Antonio et al. 2004, Hulme 2006, Louda et al. 1997). Therefore, effective weed management requires weighing the success of control measures (e.g., impacts on target weeds and recovery of native species) against the side effects of management actions. This necessitates a thorough understanding of how management tools interact with non-target system components as well as the target weed (Shea et al. 2005).

The *Helena National Forest Weed Treatment Project FEIS* (USDA Forest Service 2006c) provides guidance and environmental requirements for weed control and treatment activities that would apply to this area in any alternative. All personnel using herbicides are appropriately certified by the State of Montana and knowledgeable about the environmental guidelines and requirements of the Noxious Weed EIS.

Effects Common to All Action Alternatives

While the spread of noxious weeds would continue under all alternatives, the rate of spread could potentially be faster in areas proposed for treatments, particularly areas to be thinned and burned. Weed management would continue as in the past, however, activities proposed for the Stonewall Project add a layer of ground disturbance and therefore requires additional management for weeds. Areas of ground disturbance would be monitored for weed infestations and treated as appropriate, in accordance with the *Helena National Forest Weed Treatment Project FEIS* (USDA Forest Service 2006c), Forest Service Manual 2900 (USDA Forest Service 2011), and the Forest Plan. Chemical weed treatment would be the primary treatment method in areas that are accessible by spray equipment. Biological control would apply in areas where the biological agents have optimal conditions for survival and expansion. In riparian areas, biological control would be emphasized where conditions for insect establishment are met. The effect of all treatment methods would be to control and contain existing and new infestations related to vegetation treatments.

The most susceptible habitat types within the project area are the dry habitat types that have existing infestation of noxious weeds. Included are habitat types dominated by Douglas-fir or ponderosa pine. Thinning and burning have been shown to increase the abundance of invasive species in a similar dry (ponderosa pine) forest type in western Montana. Removing the overstory can increase the availability of limiting resources and allow weeds to thrive (Dodson et al. 2008). Metlen and others (2006) found that understory diversity increased following burning, and the increase was in both native and non-native species. Slash burning can also create localized areas that are conducive to the propagation of noxious weeds. Within these dry forest habitat types there are proposed thinning and burning treatment units with existing populations of weeds. These weed populations would likely expand with disturbance, but there are project design features in place to help minimize the likelihood of expansion.

Harvest units in moist forest, subalpine fir (*Abies lasiocarpa*) habitat types that would have closed canopies have a lower probability of weed infestation, particularly spotted knapweed. This species does not tolerate shading (Zouhar 2001). Canada thistle and houndstongue tolerate more shade than spotted knapweed, but the spread of these species is closely associated with ground disturbing activities (Zouhar 2001a, 2002). The probability of weed expansion in these areas would be the lowest of the proposed treatment areas.

Ground disturbance increases susceptibility to weed invasion. The tractor-based treatments would create moderate ground disturbance. It is estimated that 10 percent of acres treated with tractor-based treatments in alternatives 2 and 3 may be susceptible to new weed infestation. This estimate is supported by a study in four Washington Douglas-fir forests, in which exotic species percent cover averaged 10 percent in the first year following overstory thinning treatments (Thysell and Carey 2001). Areas most susceptible are the regeneration and intermediate treatments in the open canopy cover where ground disturbance would occur. Specific effects are described in the sections for alternatives 2 and 3.

The prescribed fire treatment, which is mixed or low severity, as opposed to high severity associated with wildfires, would not require the use of heavy equipment, and therefore would not result in removal of top soil. It is estimated that as a result of the prescribed fire treatment, approximately 1 percent –5 percent (mid-point of 3 percent) of the treated acres may become infested with noxious weeds. Understory burn treatments have been shown to result in a much smaller increase in exotic species infestation than combined thinning and burning (Dodson et al. 2008).

The 2006 EIS for treating weeds on the Helena National Forest (USDA Forest Service 2006c) identified several 6th code HUCs in which herbicide application would be limited based on the amount of herbicide applied, the location of the application, the stream flow, and HUC area. These estimates are shown by HUC, and the rationale for that determination is from the coarse filter calculation to estimate possible concentrations of herbicide in stream waters, shown in in appendix B and appendix C, respectfully, of the Noxious Weed Report (Englebert 2015a)

Soil

Introduction

This section evaluates the soil conditions and discloses the potential direct, indirect and cumulative effects of the alternatives for the Stonewall Vegetation Project.

There has been extensive research into the management impacts on ashcap soils in the intermountain west. Recommendations to reduce compaction in ashcap soils are operating season limitations to periods of dry soils (less than 15 percent soil moisture content) or winter conditions, use of low-ground pressure machinery, and increasing spacing between trails (Page-Dumroese et al. 2007). Earlier reports for this project recommended winter conditions only for areas of ash-cap soils; however based on the research findings, it is recommended that the units be harvested during dry soil (less than 15 percent soil moisture content) or winter conditions as defined in the design criteria.

Landtypes (soils) have been characterized for the Stonewall Vegetation Project area in Soil Survey of Helena National Forest Area, Montana (USDA Forest Service and Natural Resources Conservation Service 2001). There are 15 soil units mapped within the project area, 10 of which would be affected by proposed vegetation treatment activities. A summary of key soil characteristics for the 10 landtypes affected by the Stonewall Vegetation Project area is displayed in table 135.

The Stonewall Project would comply with Region 1 Soil Quality Standards (R1 SQS (1999)) and the Helena National Forest Land and Resource Management Plan (1986) to limit detrimental soil disturbance. The silvicultural and fuels treatments proposed for each action alternative are not expected to adversely affect soil resources with the implementation of project design features as part of each alternative. A full listing of project design features that would be implemented with all action alternatives can be found in chapter 2 (for soils; S/WS/F-1 through 12).

Under alternative 2, twenty-eight proposed units (1, 4, 5, 9, 10, 11, 12, 13, 17, 19, 20, 21, 28, 29, 32, 37, 38, 40, 42, 43, 45, 46, 47, 49, 56, 57, 58, and 74) are anticipated to comply with R1 SQS with implementation of additional design features as described in the cumulative affects section for the alternative. The remainder of the units would comply with R1 SQS as proposed.

Under alternative 3, twenty proposed units (1, 4, 5, 9, 10, 11, 12, 28, 37, 38, 40, 42, 43, 46b, 47b, 47c, 57, 58, and 74) are anticipated to comply with R1 SQS with implementation of additional design features as described in the cumulative affects section for the alternative. The remainder of the units would comply with R1 SQS as proposed.

Analysis Area Temporal and Spatial Boundaries

Proposed treatment units with the same proposed activities (harvest and burning) were grouped together to determine detrimental soil disturbance because logging system design and resulting effects to the soil are the same for the same prescriptions. Detrimental disturbance resulting from roads built then obliterated after harvest was included when determining the anticipated DSD for the unit. This is consistent with the direction given by the Region 1 Approach to Soils Analysis Regarding Detrimental Soil Disturbance in Forested Areas, A Technical Guide – April 2011 (USDA Forest Service 2011).

Detrimental soil disturbance would be a short-term impact because there would be a long-term trend for soil recovery through reclamation measures and/or natural recovery processes (i.e., frost heave bio-perturbation, biomass input and nutrient cycling). Soils would likely take at least 50 years for recovery to pre-disturbance conditions where reclamation measures would be implemented, such as on roads built then obliterated after harvest, and short-term specified roads and log landings. Soils would likely take longer to recover to pre-disturbance conditions, perhaps at least 100 years, where only natural recovery processes would occur such as on main skid trails and cable yarding corridors.

Information Used

Information used in this analysis of soil resources is derived from a number of sources, which are described in detail where they are cited or used in this analysis. Only a summary of the primary sources of information used in this analysis is provided in this section. The reader will find more detail on information used in this analysis where it is cited in the body of this report.

The “Soil Survey of Helena National Forest Area, Montana” (USDA NRCS 2001) provides information on distribution of mapped soil units, which are termed landtypes, within the project area. This published “Soil Survey” meets National Cooperative Soil Survey Standards, and includes descriptions of soil types and their characteristics relevant to management activities.

This analysis uses results of soil monitoring, conducted in the Maudlow Toston Salvage Sale Area and Cave Gulch Salvage Sale Areas (USDA Forest Service 2003a, 2003b, and 2003c; Page-Dumroese et al. 2006), annual monitoring reports, state and national best management practices in order to predict detrimental soil disturbances amounts, evaluate implementation proposals and subsequent effectiveness of Best Management Practices (BMPs). Annual monitoring data across the Helena National Forest has occurred for similar activities on similar landtypes, aspects and positions employing the same or similar resource protection measures are most recently summarized in the FY2012 Soil Monitoring Report, which can be found in the soil project record. Other sources of information for evaluating effectiveness of BMPs are cited in this analysis.

This paragraph contains information added between draft and final versions. There was one change in data collection for the FEIS: due to inconsistencies of field data collection results, detrimental soil disturbance calculations were remade for the final analysis. There were several units with documented

past disturbance in the FACTS database, e.g., timber harvest and associated roads and skid trails, determined recovered to a point that no detrimental soil disturbance was documented following national and regional soil monitoring protocals. A variety of published scientific literature, relating to soils, and effects of timber harvest and prescribed fire, were reviewed for supporting information in this analysis. Literature reviewed for this analysis is listed in the references section in chapter 4.

Methodology and Scientific Accuracy

The Helena National Forest uses the Forest Soil Disturbance Monitoring Protocol (Page-Dumroese et al. 2009) to monitor forest sites before and after ground disturbing management activities for physical attributes that could influence site resilience and long-term sustainability. The attributes describe surface conditions that affect site sustainability and hydrologic function. Monitoring the attributes of surface cover, ruts, compaction, and platy structure can also be used to generate best management practices that help maintain site productivity.

The Helena National Forest uses this protocol when evaluating physical soil disturbance in a forested setting to determine compliance with the Region 1 Soil Quality Standards (USDA Forest Service 2014) and the Helena National Forest Plan (USDA Forest Service 1986). These soil guidelines are to be applied for design and evaluation of management activities to ensure soil function and processes are maintained as outlined in FSM 2550 and FSH 2509.

Field work was conducted in 2009 to document the existing detrimental soil disturbance in units specified for ground-based activity. Units visited were prioritized based on where documented previous activity, as outlined in the FACTS database, overlapped with proposed mechanized harvest units (precommercial and commercial). The concept of prioritization of units by suspected levels of disturbance is consistent with sampling intensities specified in the Region 1 Approach to Soils Analysis Regarding Detrimental Soil Disturbance in Forested Areas, A Technical Guide – April 2011 (USDA Forest Service 2011). Ground work was conducted by Forest Service soil technicians. Additionally, the Forest soil scientist oversaw field work, accompanied the crews in the field regularly and performed quality control/quality assurance investigations on data collected to ensure compliance with all national, regional and Forest regulations. A summary of that field work is located in the project record with the Soils Resource Report (Farr 2014) and serves as the foundation for the cumulative effects analysis.

Surveys were completed in 2010 to collect additional information. Paced transects were used to measure ground cover, coarse woody debris, slopes, and any other pertinent soil observations. Coarse woody debris transects were established using a modified Brown’s line intercept method.

The loss of surface organic matter can cause nutrient and carbon cycle deficits and negatively affect physical and biological soil conditions. The direct benefits of coarse woody material to soils can vary widely, depending on ecological type. Research guidelines such as those contained in Graham et al. 1994 should be used if more specific local guidelines are not available. These soil guidelines are to be applied for design and evaluation of vegetation management activities.

Rills, gullies pedestals and soil deposition are all indicators of detrimental surface erosion. Minimum amounts of ground cover necessary to keep soil loss to within tolerable limits (generally less than 2 tons per acres per year) should be established locally depending on site characteristics.

For this analysis, we used the Water Erosion Prediction Project (WEPP) (Elliot et al. 2000) model to predict sediment movement in proposed burning and harvest units, and to assess erosion potential. WEPP models are accurate to within plus or minus 50 percent (ibid.). We relied on literature reviews, field notes,

geographic information system (GIS) data, Helena National Forest soil surveys (2001) and professional judgment to support reported conclusions.

The following assumptions and calculations were used in estimating detrimental soil disturbance percentages for the project.

Ground Based (Tractor) Harvest/Precommercial Thinning (Tractor)

Predictions of detrimental soil disturbance (DSD) are based on calculations of skid trail disturbance and have been validated by monitoring conducted on the Helena National Forest (FY2012 Soil Monitoring Report). It is assumed that the magnitude of soil disturbance on areas affected by primary skid trails would constitute detrimental soil disturbance. The average spacing between skid trails in tractor harvest units is estimated to be 100 feet except where they converge. With an average width of detrimental soil disturbance at 10-feet, main skid trails would affect about 9.1 percent of the activity area in a tractor harvest unit logged during “summer conditions”. This is calculated using the following equation:

- % DSD = width of the skid trail in feet / [(width of skid trail in feet) + width of spacing between main skid trails in feet)] x 100 9.1% = 10 ft. / (10 ft+100 ft.) x 100

Monitoring conducted on the Helena National Forest in 2012 documented 7 percent detrimental soil disturbance on units that were logged with ground based equipment (tractor) during “summer conditions” (FY2012 Soil Monitoring Report).

Log Landings Associated with Ground Based Harvest

The average size of log landings is estimated ¼ acre (0.25 acres) for tractor logging units. It is assumed that one quarter of an acre log landing is needed for every 10 acres of harvested area. It is assumed that the magnitude of soil disturbance on area affected by log landings would constitute detrimental soil impacts. By calculating the detrimental disturbance with the following equation:

- % DSD = [(area of log landing in acres) ÷ (amount of harvested area per log landing in acres)] ×100 2.5% = [.25÷10] ×100

The detrimental soil disturbance associated with log landings is 2.5 percent which was validated by monitoring conducted on the Helena National Forest (FY2012 Soil Monitoring Report).

Skyline/Cable Yarding

Soil monitoring in the Maudlow-Toston salvage sale area found that detrimental soil disturbance in skyline yarding cable corridors affected approximately 4–5 percent of units when harvest occurred under summer conditions, which did not include areas of disturbance associated with log landings or temporary roads (USDA Forest Service 2003d).

With skyline cable yarding systems, log landings would generally be located on the shoulder of the road used to access the harvest unit. Because the cable yarding equipment would be set-up and operating on the access road prism, there would not be soil impacts from heavy equipment on the log landing sites. Therefore, detrimental soil impacts would be negligible in the log landing sites for cable yarding units.

Winter Logging (Skyline and Tractor)

Monitoring of the Maudlow-Toston and Clancy-Unionville Sale area, observations within skyline cable units harvested under winter conditions, documented that detrimental soil disturbance was negligible (i.e. not enough to be measurable).

For logging under “frozen conditions”, the amount of area impacted by log skidding is predicted to be between 3-4 percent of the activity area based on monitoring conducted on the Helena National Forest (FY2012 Soil Monitoring Report). For the purpose of this analysis, 4 percent anticipated DSD was used in calculations.

Winter tractor logging and suspended log yarding methods (i.e. skyline cable and helicopter yarding) have less impact to soils compared to tractor skidding over bare ground (McIver and Starr 2000, 15-16 and 20).

Prescribed Fire

There are several activities that have varying effects on soils in the prescribed fire category. For all of the burning prescriptions described below, it is assumed that the percent of severely burned soil equates to the percent detrimental soil disturbance.

Slashing is assumed to have no detrimental soil disturbance as a result of mechanical (chainsaw) cutting of small diameter trees by personnel on foot.

Handpile burning focuses on a concentration of fuel accumulations in piles and high severity fire would occur in these piles. Monitoring conducted on the Helena National Forest (USDA FS, Helena FP 2005) documented that pile burning within units resulted in 0-3 percent detrimental soil disturbance. Detrimental soil disturbance associated with pile burning could be as much as 5 percent depending on the concentration of the piles within the activity area. Therefore the amount of detrimental soil disturbance associated with pile burning is predicted to be 5 percent.

Jackpot burning focuses on concentrations of natural fuel accumulations and/or slash after harvest or slashing. High severity fire would occur in the heavy fuel concentration burning locations; however this is predicted to affect no more than 5 percent of an activity area when considering the project design elements. Therefore the detrimental soil disturbance associated with jackpot burning is predicted to be 5 percent.

Broadcast burning/Site Prep is designed to reduce hazardous fuels and includes areas of low severity burn and mixed severity burning. When estimating soil effects resulting from prescribed burning, specifically mixed severity burning, occasionally burn plans will be designed to target the low end of mixed severity fire to ensure adequate soil cover is retained to guard against erosion in excess of 2 tons/acre. Mixed severity burning is designed to expose 5-25 percent bare soil. Targeting the low end of mixed severity burning would be designed to expose 5-10 percent bare soil. It is assumed that less than 2 percent of the area affected by a low severity fire would be severely burned and less than 10 percent of the area affected by a moderate severity fire would be severely burned (DeBano et al. 1998). Therefore a range of 2-10 percent detrimental soil disturbance is associated with broadcast burning.

Under burning is a low severity fire covering a majority of an activity area. Monitoring conducted on the Helena National Forest (USDA Forest Service 2005) documented that detrimental soil disturbance following under burning averaged 4 percent.

All these estimates are based on monitoring of similar activities across the Helena National Forest, occurring on similar landscapes; professional observation and experience in the field gained while evaluating forestry practices in other timber sale areas and prescribed fire projects.

Roads Built then Obliterated after Harvest

For the purpose of calculating predicted area of detrimental soil disturbance resulting from roads built then obliterated after harvest, estimates were made for average widths of specified roads (25 feet), which

includes width of disturbance and the area affected by cut and fill slopes. With a width of 25 feet, 1 mile of road built then obliterated after harvest would equal 3 acres of detrimental soil disturbance.

- 3 acres = [(1 mile x 5280 feet/mile) x 25 feet] / 43560 sq. feet/acre

Data Assumption and Limitations

The existing and estimated values for detrimental soil disturbance are not absolute and best used to compare differences between alternatives. The calculation of 'additional detrimental disturbance from a given activity' is an estimate, because detrimental disturbance is a combination of such factors as existing groundcover, soil texture, timing of operations and equipment used, as well as skill of the equipment operator, the amount of wood to be removed, and sale administration. The DSD estimates assume that best management practices would be applied and that soil recovery occurs over time.

Overview of Issues

Comments pertaining to disclosing the effects of project activities on soils were identified from public scoping as nonsignificant (40 CFR 1501.7), and are addressed by the analyses in this section. Please refer to volume 2, appendix A of this document for a complete listing of the issues and an explanation of how the agency determined their disposition. Some comments indicated concern that roads built then obliterated immediately following timber removal, road reconstruction, and use of existing roads would adversely impact soils through compaction. See the Transportation section for information about roads and soil compaction.

Affected Environment

Existing Condition

Weather

Weather data for the project area is displayed in table 134 in this section. This data is from the Rock: Clime (Rocky Mountain Research Station Climate Generator). Most precipitation falls in the form of snow from November through March and as rain in May and June. Weather patterns are strongly influenced by the surrounding mountains as isolated summer thunderstorms are common. The reported climate is modeled for 4,976 feet in elevation, in the middle of the project area. We used the reported weather data for WEPP (Water Erosion Prediction Project) modeling.

Table 134. Annual weather data for the project area

Month	Average Maximum Temperature (°F)	Average Minimum Temperature (°F)	Precipitation (In)	Number Of Wet Days
January	26	7	2.2	15
February	35	12	1.6	11
March	40	16	1.5	12
April	51	24	1.6	9
May	60	32	2.5	10
June	68	38	2	11
July	78	40	1.2	7
August	78	39	1.5	8
September	67	33	1.4	8

Month	Average Maximum Temperature (°F)	Average Minimum Temperature (°F)	Precipitation (In)	Number Of Wet Days
October	54	27	1.3	8
November	37	19	1.6	13
December	28	11	2.2	15
Annual			**20.6**	**127**

Soil Characteristics

Landtypes have been characterized for the Stonewall Vegetation Project area in *Soil Survey of Helena National Forest Area, Montana* (USDA NRCS 2001). There are 10 landtypes mapped within the project area which would be affected by proposed vegetation treatment activities. A summary of key soil characteristics for the 10 landtypes is displayed in Table 135.

The project area is within moraine-influenced footslopes and headwater areas of the Upper Blackfoot River Watershed. The overall topography of the project area is heavily influenced by glacial activity including scouring of residual bedrock and deposition of till material in valley bottoms and gentle hillslopes. Table 135 displays the characteristics for soils in the project units. These soil characteristics are defined by the Helena National Forest Soil Survey (USDA Forest Service and Natural Resource Conservation Service 2001). Approximately 21 percent of the soils are from glacial till, while the remaining 79 percent are from metasedimentary rock.

The glacial till material is coarse and unconsolidated, forming isolated wet areas that pose operational restrictions. The metasedimentary parent material does not have inherent management restrictions. Most of the soils in the project area are also skeletal in nature,[28] and several of the mapped units have a channery texture.[29] This suggested that the soils are resistant to compaction and resilient due to their coarse texture. However, approximately 44 percent of the area is mapped with a volcanic ashcap, which poses operational limitations due to the compaction potential in these areas. The ashcap soils have a compactable silt-loam texture over the skeletal subsoil. The ashcap soils have a higher water-holding capacity, which tends to extend the wet and productive period for soils into the dry season (Garrison-Johnston et al. 2007). In the project area, the ashcap layer is variable, mainly occurring in protected concavities.

[28] meaning that they consist of greater than 35 percent coarse fragments
[29] meaning they are dominated by flat fragments up to 6 inches in diameter.

Table 135. Characteristics of landtypes for the Stonewall Vegetation Project area

Landtype	Acres	Landform	Family Classification	Topsoil Texture	Sensitive Soil Characteristics
49B	2,371	Mountain Slopes	Typic Cryoboralfs, loamy-skeletal, mixed Typic Cryochrepts, loamy-skeletal, mixed	Channery to very channery loam	Rutting and Compaction due to wet soils.
49-	2,353	Mountain Slopes	Typic Cryoboralfs, loamy-skeletal, mixed Mollic Cryoboralfs, loamy-skeletal, mixed	Cobbly loam to gravelly silt loam	--
12A	1,103	Moraines	Typic Cryoboralfs, loamy-skeletal, mixed	Stony loam	Rutting and Compaction due to wet soils.
59-	517	Mountain Ridges	Typic Cryochrepts, loamy-skeletal, mixed	Channery silt loam to very cobbly sandy loam	Rutting, compaction and erosion prone soils due to the ash-cap parent material.
87-	512	Glacial Trough Walls	Typic Ustochrepts, loamy-skeletal, mixed, frigid	Very channery loam	--
13A	477	Moraines or Glaciated Mountain Ridges	Typic Cryoboralfs, loamy-skeletal, mixed	Cobbly loam	Rutting and Compaction due to wet soils.
90-	458	Glacial Trough Walls	Andic Cryochrepts, loamy-skeletal, mixed Typic Cryoboralfs, loamy-skeletal, mixed	Silt loam to cobbly silt loam	Rutting, compaction and erosion prone soils due to the ash-cap parent material.
80-	236	Cirque Headwalls and Basins (Scree)	--	--	--
790	172	Glaciated Mountain Slopes	Typic Cryoborepts, loamy-skeletal, mixed Typic Cryoboralfs, loamy-skeletal, mixed	Loam	Rutting, compaction and erosion prone soils due to the ash-cap parent material.

Landtype	Acres	Landform	Family Classification	Topsoil Texture	Sensitive Soil Characteristics
59A	124	Mountain Ridges	Andic Cryochrepts, loamy-skeletal, mixed	Loam	Rutting, compaction and erosion prone soils due to the ash-cap parent material.
79-	119	Mountain Slopes	Typic Cryochrepts, loamy-skeletal, mixed	Channery loam	Rutting, compaction and erosion prone soils due to the ash-cap parent material.
69-	60	Mountain Ridges	Typic Cryumbrepts, loamy-skeletal, mixed	Sandy loam	--
791	50	Cirque Basins	Andic Cryochrepts, loamy-skeletal, mixed	Loam	Rutting, compaction and erosion prone soils due to the ash-cap parent material.
49A	11	Mountain Ridges	Argillic Cryobolls, loamy-skeletal, mixed	Loam	--

The project area for the Stonewall Vegetation Project has a lengthy history of land management. There are active mining claims as well as signs of past mining, grazing, and timber harvest. The flatter portions of the project area have an existing network of skid trails and roads. The area borders private land on the south and southwest, making it easily accessible for dispersed uses such as camping and firewood gathering. Effects of past management activities for the project area were determined during field surveys. For a complete history of past management activities see appendix B.

To better formulate an existing condition that takes into account past management activities, indicators of soil quality were drawn from the North American Long-Term-Soil Quality Research Program (LTSP). The LTSP is a Forest Service program developed to meet the objectives of the National Forest Management Act (NMFA) to maintain forest productivity. The two main soil quality properties most influenced by timber extraction and indicative of soil (and forest) productivity are soil organic matter and soil porosity (Powers et al. 1998).

Soil Organic Matter

Soil organic matter (SOM) is one of the most important portions of the soil resource. Soil organic matter is crucial for water holding capacity in the soil. Although the project area receives a high amount of precipitation relative to other areas in western Montana, well-drained soils tend to dry early in the season and limit vegetation growth and soil biological activity. Soil organic matter functions similarly to the ashcap soils as it holds water longer and extends the growing season. Other important physical properties of SOM include aeration, drainage, and cation exchange (Jurgensen et al. 1997).

Soil organic matter is where most of the biological activity takes place; hence the “living” portion of the soil. This portion of the soil contains most of the essential nutrients and carbon stores. Soil organic matter accumulates over decades as plant material (leaf litter and woody debris) falls to the ground and decomposes, eventually forming humus and mixing with the mineral portion of the soils (Jurgensen et al. 1997). Page-Dumroese and Jurgensen (2006) noted that soils in Idaho and Montana have much higher percentages of their nutrient capacity in the SOM of the forest floor and topsoil.

These processes have a direct effect on site productivity, sustainability, and soil quality. Organic matter is the one main component of the soil resource that can be effectively managed to enhance soil quality. Maintaining, and where lacking, increasing SOM levels is critical for sustaining forest health and productivity (Jurgensen et al. 1997). Forest floor organic material includes undecomposed litter and more decomposed duff as well as woody material in various stages of decomposition.

Table 136, contains key soil parameters identified for units during field surveys. Total average depth of organic material (litter and duff) in the project units is included in table 136. Organic material depth ranges from 1 to 7 cm, with the majority of the units (36) having less than 3 cm of organic material. Most sites have a thicker layer of litter with little duff accumulation. Duff is the more desirable organic component in the complex humic material that supports cation exchange capacity and water holding capacity. The thin organic layer in the Stonewall Project area is likely due to the cold nature of the soils and slow decomposition rate as well as removal of the litter/duff layer due to people and activities in the area.

Coarse Woody Debris[30]

Coarse woody debris (CWD) is indicative of soil quality and resiliency. Physically, CWD protects exposed mineral soil from erosion and protects seedlings from grazing (Graham et al, 1994). Coarse woody debris also provides shade and when CWD decay has advanced, it can hold large amounts of water, making it important for dry season vegetation growth (Harvey et al. 1987).

From a chemical perspective, CWD releases several nutrients when it decays or burns, including sulphur, phosphorus, and nitrogen. This is especially true during advanced stages of decay (Graham et al. 1994). Coarse woody debris functions as a site for non-symbiotic nitrogen fixation in the absence of other nitrogen fixing plants (Jurgensen et al. 1997).

The soil biological environment is also enhanced by CWD. During advanced stages of decay, humus and woody material act as a site for the formation of ectomycorrhizal root tips. Ectomycorrhizae help woody plants take up water and nutrients and their fruiting bodies are crucial in the food chains of small rodents and predators (Graham et al. 1994).

The recommended amount of CWD for the project area is 5 to 20 tons per acre, outlined from Brown et al. (2003) and Graham et al. (1994) for maintaining soil quality while minimizing fuel hazards. Coarse woody debris amounts vary by unit in the project area (table 136). There are pockets with well over 100 tons per acre because of fallen trees killed by beetles

In spite of the benefits of CWD to soil quality, too much can degrade soil quality to an extent. As stated earlier, coarse woody debris is a crucial source of soil nutrients and biological activity, particularly in advanced stages of decay. Therefore, when CWD begins to accumulate in the absence of fire, nutrients begin to accumulate in CWD and are no longer available for plant uptake and soil biological activity (Hart et al. 2005). This is likely the case in some of the areas with higher amounts of CWD.

Ground Cover

Ground cover percentages for Stonewall units are in table 136. Soils in the project units should have a very small percentage of ground cover in the form of bare soil. The only naturally occurring bare soil should be associated with tip-up mounds in windthrow areas or recent wildfire areas. As established

[30] generally defined as any woody residue larger than 3 inches in diameter (Graham et al. 1994)

above, organic ground cover (CWD and litter) is a hotbed for biological activity. Bare soil is generally much less productive and in the project area is indicative of impaired soil conditions. As displayed in table 136, there are a few units with high percentages of bare soil but most are in the 0-5 percent range. Units 14 and 15 seem anomalous with the high percentages of bare soil (36 and 32 percent, respectively). However, both of these units, along with units 12 and 13 have piles of bare soil from past mining activity.

The remaining units have mixed distributions of wood, litter, and vegetation. As established previously, soil wood and litter are important for soil quality. If, however, the balance of these components as compared to the vegetative component begins to shift, there is a condition as described above where the majority of the plant-available nutrients are "locked up" in the litter and wood component and not available for vegetation uptake and cycling back into the soil system. This is obviously the case in units 26, 35, 63, and 65 and likely the case in units 1, 17, 19, 22, 32-34, 52-54, and 59.

Soil Porosity

Soil porosity is another important indicator of soil quality and the other main property addressed in the LTSP study. Soil porosity is directly affected by soil compaction and is primarily a physical change in the soil that directly affects soil chemical and biological properties.

Soil compaction occurs as a result of applied load, vibration, and pressure from equipment used for harvest activities and site preparation. Soil compaction breaks down surface aggregates, which leads to a decrease in macropore space with an increase in micropore space and volumetrically more soil as compared to air. This creates an increased bulk density (BD) and resistance to penetration in the soil (Gomez et al. 2002). This decrease in soil macropores can impede root penetration, water infiltration, and gas and nutrient exchange (Quesnel and Curran 2000). All of this in turn has the potential to decrease tree regeneration and growth.

Another effect of increased soil bulk density and decreased water infiltration rates is the potential to alter watershed hydrology and increase soil erosion rates. This occurs primarily because decreased water infiltration causes soils to become saturated much quicker and leads to increases in overland flow, which increases erosion and runoff in a watershed. Primary skid trails and landings show the most extensive and longest lasting of these effects. Working on frozen or dry ground helps soils resist increases in bulk density. Activities on wet soils are the most damaging, as the soil aggregates are more susceptible to compaction. The three primary field measurements taken to assess levels of soil porosity changes and resiliency to compaction are detrimental disturbance, texture, and percent coarse fragments.

The Region 1 technical guide for soil detrimental disturbance analysis (USDA Forest Service 2009) states, *"…new activities would be designed so that they do not create detrimental soil disturbance (DSD) on more than 15% of an activity area (R1 Supplement to FSM 2554.03). In other words, existing DSD plus the DSD predicted for proposed activities would not exceed 15% of a given activity area. In areas where more than 15% DSD exists from prior activities, the cumulative detrimental effects should not exceed the conditions prior to the planned activity and should move toward a net improvement in soil quality."* This therefore sets the threshold value for DSD at 15 percent.

Existing detrimental soil disturbance for the field-surveyed units is in table 136 that follows. As can be seen, there is a variety of results. Units 12-15 had relatively high DSD results due primarily to the presence of previous mining activity in the units. With the exception of those four units, DSD was primarily associated with skid trails and landings from previous harvests.

Soils in the project area are fine-textured with high percentages of clay throughout (table 136). Although these soils also have high percentage of coarse textured sand, the clay portion can be highly compactable and sensitive to ground-based equipment, especially when wet. The percent coarse fragments column in

table 136 displays a measure of rock content in the top 6 inches of mineral soil. Rock content is another indicator of the susceptibility of soil to compaction. Soils with over 35 percent coarse fragments are generally more resilient to compaction. Surveyed soils in the project area range from 13 to 70 percent coarse fragments. Only four units have less than 20 percent coarse fragments, which illustrates that most are fairly resilient. Regardless of the physical characteristics, moisture is an equally important factor in soil compaction. Dry soils are much less likely to compact than wet soils. Even soils with high rock content would compact when wet.

Table 136. Current conditions by unit in the Stonewall Vegetation Project

Unit	CWD (T/A)	Depth of Organic (cm)	Ground Cover Percentage					Current Detrimental Disturbance	Texture	Percent Coarse Fragments
			Bare Soil	Rock	Wood	Litter	Vegetation			
1	6	6	0	2	13	62	23	19	fi sa cl lo	15
3	0	3	2	0	2	3	94	6	sa cl	13
4	0	3	2	0	2	3	94	6	sa cl	13
5	13	3	3	3	10	13	70	3	cl lo	15
6	2	4	3	3	16	38	41	0	sa cl lo	30
7	2	4	3	3	16	38	41	0	sa cl lo	30
8	14	4	3	0	6	25	66	3	sa cl lo	36
9	12	6	0	0	7	27	67	0	sa cl lo	37
10	7	2	0	0	7	27	67	0	fi sa cl	43
11	4	3	0	0	2	30	68	8	cl lo	21
12*	3	3	7	2	2	53	37	18	sa cl lo	33
13*	9	3	4	0	0	35	61	7	sa cl lo	25
14*	0	1	36	0	0	15	49	30	sa cl	70
15*	4	2	32	13	2	42	12	22	sa cl	61
17	4	4	0	0	0	62	38	0	sa cl lo	33
18	0	2	0	2	0	7	92	5	sa cl	43
19	4	3	0	0	3	73	23	0	sa cl	38
20	12	3	0	0	0	27	73	2	sa cl	40
21	0	2	0	0	0	12	88	3	sa cl	33
22	13	4	3	3	13	49	31	0	sa cl lo	28
23	5	5	0	0	10	17	73	0	sa cl lo	36
24	7	3	3	3	7	10	77	0	sa cl	35
25	15	5	0	0	20	27	53	0	sa cl lo	33
26	6	5	4	0	9	67	20	0	sa cl lo	33
27	7	3	3	3	10	17	67	0	sa cl lo	30
28	5	5	0	0	20	13	67	0	sa cl lo	25
29	5	4	0	0	7	17	77	10	sa cl lo	34
30	9	3	2	0	4	20	73	0	cl lo	28
31	9	3	2	0	4	20	73	0	cl lo	28
32	6	3	5	5	7	56	28	0	sa cl lo	38
33	10	5	0	0	16	44	39	2	sa cl lo	41
34	13	6	0	0	30	40	30	0	sa cl lo	48

Unit	CWD (T/A)	Depth of Organic (cm)	Ground Cover Percentage					Current Detrimental Disturbance	Texture	Percent Coarse Fragments
			Bare Soil	Rock	Wood	Litter	Vegetation			
35	7	7	0	0	23	63	13	0	sa cl lo	31
36	18	5	3	0	3	20	73	0	sa cl lo	40
37	16	4	2	0	8	20	70	2	sa cl lo	32
38	16	4	2	0	8	20	70	2	sa cl lo	32
39	9	4	0	0	0	23	77	0	sa cl lo	38
40	18	3	0	0	10	35	55	2	cl sa	39
41	6	3	0	0	3	38	58	8	sa cl lo	51
42	12	3	2	0	2	37	60	2	sa cl	48
43	7	3	2	0	3	43	52	10	sa cl	45
44	6	1	0	0	0	43	57	0	sa cl lo	45
45	3	2	0	0	0	37	63	0	sa cl lo	48
46	3	3	1	0	1	27	71	13	sa cl lo	45
47	3	2	0	2	3	30	65	12	sa cl	41
48	0	3	2	2	0	22	75	12	sa cl	70
49	0	3	0	0	2	21	77	11	fi sa cl lo	28
51	0	2	2	0	0	15	83	15	sa cl	39
52	18	3	4	0	10	62	24	6	sa cl lo	24
53	17	7	0	0	27	40	33	10	sa cl lo	43
54	10	5	0	0	16	44	39	2	sa cl lo	41
55	25	3	3	0	10	13	73	0	sa cl lo	37
56	25	3	3	0	10	13	73	0	sa cl lo	37
59	1	3	7	0	3	57	33	27	sa cl lo	46
62	2	2	5	2	3	8	82	10	sa cl	33
63	0	2	5	0	0	75	20	10	sa cl	25
65	2	4	5	5	8	75	8	25	sa cl lo	34
72	0	4	0	0	0	15	85	12	sa cl lo	40
74	42	3	6	3	26	11	54	0	sa cl lo	29

*Units with past mining activity.

Summary of Current Conditions

The project area has a long management history that includes mining, grazing, and timber harvesting, which contributed to past ground disturbing activities that lead to the current conditions. The amount of detrimental soil disturbance in the units is mixed, but primarily is the result of past log landings and skid trails with the exception of four units that have residual effects from mining. The soils in the project area are generally coarse textured and resilient to compaction and erosion if operations take place during dry or frozen conditions. Ground cover is generally high in the project area and trending toward recovery where a thin organic layer exists. Coarse woody debris levels also vary across units but are mostly within forest standards. There are multiple areas and units where large amounts of CWD signal a build-up of “locked-up” nutrients that are not plant or soil available.

Environmental Consequences

Effects Common to All Alternatives

There are no quantifiable effects common to all alternatives because soil impacts vary from no action (alternative 1), to changing prescriptions under the action alternative within each activity area.

Alternative 1 – No Action

No additional impacts to soil quality would occur. Existing areas with reduced soil quality would continue to recover through natural means (organic matter accumulation, freeze/thaw cycles, root penetration, etc.). There would be a gradual trend toward increased soil quality in units that currently have high detrimental disturbance. Coarse woody debris would slowly accumulate as stands age and begin to die. There would be no cumulative effects.

Direct Effects Common to Alternatives 2 and 3

For the action alternatives (alternatives 2 and 3), the same types of management activities are proposed (table 137). The measurable differences in alternatives are the extent and area of treatment. This section describes each of the proposed activities and the effects to the soil resource. The extent and mitigation measures specific to each alternative is further explained below.

Table 137. Acres of treatment and road miles for each action alternative

Treatments And Road Miles	Alternative 2 (Proposed Action) Acres	Alternative 3 Acres
Hand Treatments	6,541	5,001
Skyline Vegetation Treatments	663	364
Ground-based Vegetation Treatments	1,359	1,198
Total	**8,563**	**6,564**
Broadcast Burn	127	110
Burn Piles	146	94
Jackpot Burn	300	504
Low Severity Fire	449	326
Mixed Severity Fire	5,014	3,302
Site Prep Burn	180	171
Underburn	1,825	1,648
Total	**8,040**	**6,155**
Roads that would be built and then obliterated immediately following timber removal (miles)	2.6	0.4
Road Maintenance (miles)	45.6	43.8
Total	**48.2**	**44.2**

Ground-Based Vegetation Treatments

Ground-based harvesting includes conventional log skidders and feller-bunchers. Log skidders follow designated skidding routes, while the feller-bunchers operate across the unit area. The force from log-loaded machines can compact and displace soil, reducing soil aeration and infiltration capacity. Proper

layout of the skid trail pattern can concentrate these impacts and keep detrimental disturbance within allowable limits (15 percent of each unit).

The planned ground-based harvest operation in Stonewall would follow old skid trails, resulting in an overlap of disturbance. The effects are therefore not necessarily additive. There is little data on the extent of overlap between new operations on old disturbance.

For comparison purposes, past monitoring on the Klamath National Forest showed that 69 percent of new skid trails reuse old skid trails (Laurent 2009). It was further assumed that main skid trails disturbed 10 percent of each unit. The assumption was made that 69 percent of the 10 percent (or 7 percent of each unit) would occur on pre-existing skid trails. Therefore, the assumption from this monitoring is that there would be 3 percent new detrimental disturbance added to the current amount from primary skid trails for units with existing skid trail networks.

The Flathead National Forest had a similar monitoring effort where they measured DSD before and after treatments. The results were mixed, with one unit showing less than 1 percent increase in DSD and another showing 5 percent increase (Archer 2011, personal communication). The average was 3 percent, just as in the Klamath National Forest monitoring.

The Helena National Forest has monitored and assumes that for summer tractor harvesting, there is 9 percent DSD from skid trails (Marr 2011b, personal communication). There has not been an attempt to quantify the additive effects of skid trails versus reuse of old skid trails on the Helena National Forest.

Regardless of the amount, it follows that current DSD is primarily from old skid trails and landings. When a unit has a high existing DSD percentage, there is more of an opportunity to reuse existing skid trails and therefore reduce the additive soil disturbance from the proposed operations. There is negative correlation between existing detrimental disturbance and the amount added to a unit following ground-based treatments. For example, ground-based harvest on an area with no prior mechanical harvest entry would result in 9 percent DSD. However, an area with 25 percent existing detrimental disturbance prior to ground-based harvest could conceivably result in no additional detrimental disturbance because all of the new skid trails are placed on old skid trails. For the current analysis, it was assumed that units with greater than 10 percent DSD would result in an additional 3 percent increase from primary skid trails.

Some compaction would occur in areas outside of main skid trails where machinery makes one or two passes but this increased compaction would not exceed threshold values as documented by Powers (2002). It is possible that in some of the units the combined current detrimental disturbance and projected detrimental disturbance from the activities would exceed 15 percent. These units are disclosed in the section that applies to the individual alternative. Rehabilitation of these units would include subsoiling and placing slash on areas with detrimental disturbance. If subsoiling is required, it would be done under dry soil conditions (dry down to 24 inches) with winged rippers to a depth of at least 18 inches.

Landings

Landings are central processing zones that are essential for logging operations. Landings are approximately 0.25 acre to 0.33 acre in size but are generally larger when accommodating whole-tree yarding. Existing landings would be reused where possible. Landings can produce erosion and sediment if not properly designed and maintained. Project design features provide for sufficient erosion control. Monitoring on the Helena National Forest validates these assumptions and has found landings to average 0.25 acre in size and add 2.5 percent DSD to ground based operations (Marr 2011b, personal communication).

Skyline Vegetation Treatments

Cable harvesting would cause small amounts of soil displacement in the yarding corridors from dragging logs. The cable corridor can vary from 6 to 8 feet wide and would have an area in the center of the corridor that is down cut 9 to 12 inches. The spatial area in yarding corridors has been measured as varying between 3 and 8 percent depending upon the size of trees (Klock 1975). In accordance with monitoring on the Helena National Forest (Marr 2011b, personal communication), it is assumed that 5 percent additional disturbance would occur from cable logging corridors in the Stonewall project area. Skyline harvests do not include the addition of landings, as these are located on National Forest System roads in these units.

Hand Vegetation Treatments

Hand thinning and piling slash would maintain sufficient fine soil cover and would not cause additional ground disturbance.

Prescribed Burning

The risk from prescribed burning is that fire has the potential to create erosion possibilities by removing soil cover and the forest floor, both critical for soil functions. In low severity fire-treated areas, there would be enough forest floor retained to minimize any negative effects. Moderate burn prescriptions would be more severe but the mosaic nature of these burns should create a situation where there are firebreaks sufficient to reduce the erosion potential.

Burning should have a net positive impact by increasing the availability of nutrients for the soil and understory, thereby increasing forest productivity. Revegetation in forest openings would depend upon the seed source and remnant plant communities.

Using low and moderate severity fire would increase the available nutrient base for forest productivity based on studies in the Rocky Mountains (Gundale et al. 2005, DeLuca et al. 2006). The mosaic burn pattern would also ensure soil cover for moisture retention. Short-term nutrient flushes should occur for up to 3 years depending on the burn severity, with long-term nitrate increases up to 50 years (Deluca et al. 2006). Charcoal as a byproduct of fire, becomes functionally important as a stabilizer for soil chemistry against alkaloids that may impair soil nutrient processes, and as a soil conditioner for added water holding capacity and cation exchange sites (Deluca and Aplet 2008). Charcoal would also increase Nitrogen availability (Ball et al. 2010).

In reference to DSD, it is expected that for low severity prescriptions (including underburning), less than 2 percent would be severely burned and result in detrimental soil conditions from loss of groundcover. For the mixed or moderate burn severity prescriptions (including broadcast burns), it is anticipated there would be more severely burned area and hence 10 percent detrimentally disturbed soils (Marr 2011a).

Prescribed Pile Burning

Burning slash piles can have long-lasting negative, soil effects through direct consumption of soil ground cover, and removal of seed sources for revegetation. An indirect effect of pile burning is the potential for introducing invasive plants once native seed sources are removed. These effects are localized, and limited to areas where the slash piles are placed. This includes jackpot burning as these types of burns typically have similar effects as pile burning. Monitoring on the Helena National Forest found that these burns affect less than 5 percent of units analyzed (USDA Forest Service 2005). It is assumed that units where pile and jackpot burns are prescribed would have 5 percent DSD resulting from these activities.

Coarse Woody Debris

Across all activities, coarse woody debris levels, as recommended previously, would be retained at 5-20 tons per acre or additional CWD would be left on site to meet these requirements. The prescribed underburning units were not surveyed for CWD. However, these higher elevation areas do not have an extensive management history and it is unlikely they are lacking in CWD. The underburning as described would create pockets of dead trees and some bare soil. This would provide recruitment for downed CWD on these openings in the long term.

Road Construction

Construction of roads that would be built and then obliterated immediately following timber removal creates detrimental soil disturbance by bulldozing the surface layer aside and exposing non-productive subsoil layers. Roads that would be built and then obliterated immediately following timber removal are assumed to be 25 feet wide. On flat to gentle slopes, soil disturbance can be minimal to shallow cuts (0.5 to 2 feet). On steeper slopes where cut and fill techniques are required, cuts can be 4 to 8 feet high. The fill material is deposited on top of the existing soil, thereby increasing soil depth, which in turn increases soil water holding capacity. Soil organic materials are also incorporated into the soil. Increased water holding capacity and organic matter has a positive effect on site productivity. The increased soil quality does not equal the soil quality lost in the cut portion of the road.

The road surface is compacted by equipment travel during the construction process as well as from log truck travel on the road. Building proposed roads built and then obliterated immediately following timber removal results in short-term degradation of soil hydrology and long-term reduction in soil biological function. Obliteration and reclamation efforts improve soil hydrologic function over leaving roads in place. For the short term, reclamation improves soil infiltration adequately to address erosion potential, though reclaimed soil would have infiltration rates lower than natural forest rates (Luce 1997; Foltz and Maillard 2003). For the long term, infiltration rates improve over time as freeze/thaw and plant roots improve soil porosity, though rates would likely remain lower than adjacent natural forest soil (Switalski et al. 2004). Soil biological function restores as forest floor and native plant communities return.

Indirect Effects Common to Alternatives 2 and 3

Noxious Weeds

An important indirect effect from harvest operations is the potential to spread and introduce noxious weeds. See the Noxious Weed section for a detailed list of weeds found in the area and their current range. Noxious weeds can have a detrimental effect on soil quality through competition for resources such as space, light, water, and nutrients; and through allelopathy.[31] Allelopathic weed species exude chemicals that can have a negative effect on native plant species. Canada thistle, spotted knapweed, and leafy spurge are known to be allelopathic (Foy and Inderjit 2001).

Though the potential exists for adverse impacts to soil quality because of noxious weeds infestation, the actual impact to long-term soil quality is minimal. Project design features would help to reduce the spread of noxious weeds. Units treated in the winter would help to reduce the spread of noxious weeds because weeds are dormant at this time decreasing the transport of viable seeds.

[31] Allelopathy is defined as “chemical interactions among and between plants that do not include positive effects” (Foy and Inderjit 2001).

Soil Erosion

Proposed activities for the action alternatives have the potential to expose mineral soil to overland flow and subsequent erosion. Potential erosion because of project implementation was modeled using Disturbed WEPP. The accuracy of all Disturbed WEPP predictions is plus or minus 50 percent (Elliot et al. 2000). WEPP is most appropriately used to compare alternatives. We selected Units 13, 23, and 84 for modeling because their location on soils with a high erosion hazard and long and sustained slopes represents each of the treatment types (tractor-13, skyline-23, and burn-84). These three units therefore represent the worst-case scenario for erosion potential.

We extrapolated inputs for WEPP modeling from the assumptions in the direct effects above. Specifically, it was assumed that conventional tractor harvesting would result in 12 percent decrease in ground cover, accounting for the detrimental disturbance percentage, moderate intensity prescribed burning would have a 10 percent decrease in ground cover, etc. Other WEPP inputs were gradient, slope length, soil texture, and rock percentage. These were estimated from Geographical Information Systems (GIS) data and soil mapping. All vegetation inputs were mature forest with the exception of the prescribed burning unit being low severity fire.

Table 138 demonstrates that the probability of erosion in the first year following harvest is 3percent for all units across all alternatives. There was no distinction made between alternatives 2 and 3 because they have the same prescriptions for the three units analyzed. The soil quality standards state that the tolerable soil loss rate is generally less than 1 to 2 tons per acre per year (USDA Forest Service 1999). None of the predicted erosion rates here exceeds these soil quality standards. These WEPP results do not take into account pdfs intended to reduce erosion potential. Therefore, it is unlikely that erosion would be an issue from either action alternative.

Table 138. WEPP modeling results for the Stonewall Project, erosion and sedimentation

Alternative	Unit	Drainage	Probability Of Erosion‡	Probability Of Sedimentation‡	Average Erosion Rate (Tons/Acre)*	30-Year Erosion Rate (Tons/Acre)**
No Action	13	Lincoln Gulch	3%	3%	0	0.134
Action	13	Lincoln Gulch	3%	3%	0.09	0.946
No Action	23	Lincoln Gulch	3%	3%	0	0.037
Action	23	Lincoln Gulch	3%	3%	0.03	0.746
No Action	84	Theodore Creek	3%	3%	0.01	0.359
Action	84	Theodore Creek	3%	3%	0.03	0.577

‡The probability of erosion or sedimentation for the no action alternative is the probability of erosion or sedimentation in any given year. For the proposed action, it is the probability of erosion or sedimentation the first year following harvest.

*****There is an equal probability that the erosion rate could be greater than or less than the average value.

****** The 30-year erosion rate represents the amount of erosion anticipated if there were a 30-year rainfall following implementation.

Cumulative Effects Common to Alternatives 2 and 3

Cumulative effects are activities that overlap spatially and temporally within the activity area. For the soils analysis, the unit is the activity area analyzed for cumulative effects (as defined in Forest Service Manual 2500, Supplement number 2500-99-1). Therefore, activities analyzed here would take place inside of units.

The cumulative effects for alternative 2 (the proposed action) and alternative 3 are included in appendix C and includes the cumulative effects of all the previously discussed direct effects in this section. The detrimental disturbance analysis takes into account all proposed activities within a unit in the same

fashion as a cumulative effects analysis. In the detrimental disturbance analysis, the spatial distribution of proposed activities and current conditions was taken into account.

Typical road maintenance and upgrading may have cumulative effects. This includes replacing and adding drainage structures, blading the road surface, brushing the sides of the roads, and placing additional surface material. This generally increases drainage and can decrease erosion off the road surface due to decreased overland flow. Road maintenance is ongoing and would extend beyond the life of this project. This project does not propose to change any road classifications but would utilize existing stored roads for access and vegetation removal. Roads that would be built and then obliterated immediately following timber removal are taken into account with the vegetation treatments. For more detail on the cumulative effects of roads, see the Hydrology Report (McNamara 2015).

There are no proposed changes to recreation management from the current project. There is currently motorized use that would continue throughout the project area. There is the potential to increase illegal off-road motorized use because forest stands would be opened up following the proposed activities. This is covered in more detail in the Recreation Report (Valentine 2015b).

Other recreational activities such as gathering of forest products, hunting, and hiking are likely to continue as they currently are. Effects from these activities are taken into account in the current conditions.

Recovery Rates

The expected recovery rates for proposed activities in the action alternatives are included in table 139. We based these estimates on a combination of published literature, monitoring reports from adjacent forests, field observations, and professional judgment. Recovery of roads that would be built and then obliterated immediately following timber removal is anticipated to be similar to summer tractor harvesting. Recovery depends upon the effectiveness of roots to penetrate compacted soil, leading to a return of porosity and drainage. Implementing the restoration project design features (S/WSF-9, 10, 11, 12, 13) would increase the recovery time for affected soils, particularly the placement of slash on heavily disturbed areas. Organic material amendments cannot be emphasized enough. In addition, contemporary timber harvest operations are less impactful than the historic operations monitored in the studies of table 139. It is therefore likely that recovery time from the proposed activities would be quicker than the best available science cited here.

Table 139. Expected recovery rates for proposed activities in the action alternatives

Activity	Recovery (Years)	References
Summer Tractor Harvest	30−50	Froehlich et al. 1985; Bisbing et al. 2010
Winter Tractor Harvest	10−40	Lolo NF Monitoring (Archer 2008); Flathead NF Monitoring (Basko 2002)
Prescribed Burning	10	Auggie Soils Specialist Report (Archer 2009); Idaho Panhandle NF monitoring (Niehoff 2002)

Project Design Features

The Stonewall Vegetation Project has been designed with features that are intended to minimize or avoid potential adverse effects while meeting project objectives. In addition to the proposed action treatments described in this section, design features would be implemented where applicable. A description of the project design features relating to soil and other resources is displayed in table 9, chapter 2.

The specific design features listed under soil, watersheds and fisheries in table 9 pertaining to soil are S/WS/F-1 through S/WS/F-13.

This analysis is based on the implementation of all design features. Project design features apply to both action alternatives. Design features that are applicable to soil include not only those listed above, designed specifically to protect the soil, but also those designed to protect other resources such as water and fish.

Project Design Features and Restoration Effectiveness

Project design features and best management practices are effective at minimizing the amount of soil disturbance. For example, Han et al. (2006) found logging during dry months can reduce compaction effects in fine textured soils since soil strength is maximized when soil moisture is below field capacity. Harvesting when soils are dry also appears to limit the machinery impact to the wheel track (Williamson and Neilson 2000; Han et al. 2009).

On the Helena National Forest, soil quality monitoring results have previously demonstrated that conservation of soil resources has improved during implementation of forestry activities since adoption of BMPs in 1988. This is documented in the Helena National Forest Annual Monitoring Report Fiscal Year 2004 which reported: *"…forestry practices have generally become more effective in limiting the amount of area affected by detrimental soil disturbance to comply with the Forest Plan measure of soil variability (i.e. 20%) since adoption of forestry Best Management Practices (BMPs) in 1988. Six of the monitoring plots assessed areas harvested prior to adoption of BMPs in 1988. The mean value for aerial extent of moderate to severe soil disturbance on these 6 plots was 19%, and ranged from 8% to 26%. The remaining 4 monitoring plots assessed areas harvested after 1988 and adoption of BMPs. The mean value for aerial extent of moderate to severe soil disturbance on these 4 plots was 13%, and ranged from 5% to 17%"* (USDA Forest Service 2007, p. 80).

Key findings from additional BMP monitoring (USDA Forest Service 2003) for harvest units in the Maudlow-Toston sale area include:

- Adequate amounts of coarse woody material were retained in harvest units, as recommended by researchers (Graham et al. 1994).
- Region 1 soil quality standards (USDA Forest Service 1999) for limiting detrimental soil disturbance, such as compaction and displacement, were met in helicopter, skyline cable (both summer and winter logging), and winter tractor logging units.
- Roads that would be built and then obliterated immediately following timber removal and log landings have been successfully recontoured, with adequate amounts of woody material scattered across reclaimed areas, and then seeded.

The State of Montana and other land managers monitor the implementation and effectiveness of Montana Forestry BMPs within recent forest management activities. This effort is known as BMP Auditing. Results are provided in an annual report. The Montana State Audit found that *"across all ownerships, BMPs were properly applied 93% of the time and overall effectiveness of the implementation was 97%"* (Montana DNRC 2006).

The effectiveness of soil rehabilitation treatments may be low, improving soil conditions by 30-50 percent (Luce 1997; Foltz and Maillard 2003). This implies that erosion control work is effective, and soil compaction has been alleviated; but biological and other physical soil processes are not returned to background levels. For roads built and then obliterated immediately following timber removal rehabilitation, or where slash is left on the skid trail, 50 percent effectiveness has been used. This

acknowledges that biological and physical properties are improved beyond doing no restoration but not to background levels.

Application of slash and other organic materials on skid trails, burn piles, skyline corridors, and log landings helps restore areas denude of vegetation and topsoil to more natural conditions. These additional organic inputs aid biological processes and accelerate recovery. Road decommissioning research (Switalski et al. 2004; Kolka and Smidt 2004) is cited here for effectiveness of these practices. The added slash and other organic materials provide the benefits such as enhanced microbial activity, increased water holding capacity, and erosion control.

British Columbian monitoring of soil restoration showed that standard techniques such as those proposed in (decompacting, placing slash and duff, and seeding) can be effective in re-establishing vegetation and therefore alleviating negative soil effects (Bulmer 1997).

Alternative 2 – Proposed Action

Project Design Features

The Stonewall Vegetation Project has been designed with features that are intended to minimize or avoid potential adverse effects while meeting project objectives. In addition to the proposed action treatments described in this section, design features would be implemented where applicable. A description of the project design features relating to soil and other resources is displayed in table 9, chapter 2.

The specific design features listed under soil, watersheds and fisheries in table 9 pertaining to soil are S/WS/F-1 through S/WS/F-13.

This analysis is based on the implementation of all design features. Design features that are applicable to soil include not only those listed above, designed specifically to protect the soil, but also those designed to protect other resources such as water and fish.

Project Design Features and Restoration Effectiveness

Project design features and best management practices are effective at minimizing the amount of soil disturbance. For example, Han et al. (2006) found logging during dry months can reduce compaction effects in fine textured soils since soil strength is maximized when soil moisture is below field capacity. Harvesting when soils are dry also appears to limit the machinery impact to the wheel track (Williamson and Neilson 2000; Han et al. 2009).

On the Helena National Forest, soil quality monitoring results have previously demonstrated that conservation of soil resources has improved during implementation of forestry activities since adoption of BMPs in 1988. This is documented in the Helena National Forest Annual Monitoring Report Fiscal Year 2004 which reported: *"…forestry practices have generally become more effective in limiting the amount of area affected by detrimental soil disturbance to comply with the Forest Plan measure of soil variability (i.e. 20%) since adoption of forestry Best Management Practices (BMPs) in 1988. Six of the monitoring plots assessed areas harvested prior to adoption of BMPs in 1988. The mean value for aerial extent of moderate to severe soil disturbance on these 6 plots was 19%, and ranged from 8% to 26%. The remaining 4 monitoring plots assessed areas harvested after 1988 and adoption of BMPs. The mean value for aerial extent of moderate to severe soil disturbance on these 4 plots was 13%, and ranged from 5% to 17%"* (USDA Forest Service 2007, p. 80).

Key findings from additional BMP monitoring (USDA Forest Service 2003) for harvest units in the Maudlow-Toston sale area include:

- Adequate amounts of coarse woody material were retained in harvest units, as recommended by researchers (Graham et al. 1994).
- Region 1 soil quality standards (USDA Forest Service 1999) for limiting detrimental soil disturbance, such as compaction and displacement, were met in helicopter, skyline cable (both summer and winter logging), and winter tractor logging units.
- Roads that would be built and then obliterated immediately following timber removal and log landings have been successfully recontoured, with adequate amounts of woody material scattered across reclaimed areas, and then seeded.

The State of Montana and other land managers monitor the implementation and effectiveness of Montana Forestry BMPs within recent forest management activities. This effort is known as BMP Auditing. Results are provided in an annual report. The Montana State Audit found that *"across all ownerships, BMPs were properly applied 93% of the time and overall effectiveness of the implementation was 97%"* (Montana DNRC 2006).

The effectiveness of soil rehabilitation treatments may be low, improving soil conditions by 30-50 percent (Luce 1997; Foltz and Maillard 2003). This implies that erosion control work is effective, and soil compaction has been alleviated; but biological and other physical soil processes are not returned to background levels. For roads built and then obliterated immediately following timber removal rehabilitation, or where slash is left on the skid trail, 50 percent effectiveness has been used. This acknowledges that biological and physical properties are improved beyond doing no restoration but not to background levels.

Application of slash and other organic materials on skid trails, burn piles, skyline corridors, and log landings helps restore areas denude of vegetation and topsoil to more natural conditions. These additional organic inputs aid biological processes and accelerate recovery. Road decommissioning research (Switalski et al. 2004; Kolka and Smidt 2004) is cited here for effectiveness of these practices. The added slash and other organic materials provide the benefits such as enhanced microbial activity, increased water holding capacity, and erosion control. British Columbian monitoring of soil restoration showed that standard techniques such as those proposed in table 140 (decompacting, placing slash and duff, and seeding) can be effective in re-establishing vegetation and therefore alleviating negative soil effects (Bulmer 1997).

This document details the primary effects from the proposed treatments. As stated earlier, the effects from each of the action alternatives are essentially the same with the exception of the degree of activities in each of the alternatives. As can be seen in table 137 alternative 2 proposes more overall treatment acres and more road miles utilized than alternative 3. Alternative 2 would have long- and short-term direct and indirect negative effects on forest soil quality. However, the project would meet the Region 1 Soil Quality Standards by implementing the project design features and restoration measures and help reduce negative impacts to soils.Anticipated detrimental disturbance for the proposed action by unit is shown in table 140. All units are expected to meet Region 1 Soil Quality Standards.

Table 140. Projected detrimental soil disturbance for the proposed action in the Stonewall Project

Unit	Acres	Treatment	Current % Detrimental Disturbance	Projected % Detrimental Disturbance From Treatments	Detrimental Disturbance % After Treatments	Detrimental Disturbance % After Restoration‡	Actions To Meet Soil Standards
1	96	SWD/SPB	19	8.1	27.1	17.0	Restoration/WL
2	146	LSF/<5ac	N/A	2.0	2.0		None
3	37	PCT/HP/BP	6	5.0	11.0		None
4	7	S/S/HP/BP	6	8.0	14.0		WL
5	18	S/S/HP/BP	3	8.0	11.0		WL
6	14	Imp Cut/UB	0	9.0	9.0		None
7	17	Imp Cut/UB	0	9.0	9.0		None
8	62	Imp Cut/UB	3	9.0	12.0		None
9	18	ST/S/HP/BP	0	10.5	10.5		WL
10	18	CLC/UB	0	9.3	9.3		WL
11	23	SWD/UB	8	9.2	17.2	12.6	Restoration/WL
12	80	SWD/UB	18	7.5	25.5	15.8	Restoration/WL
13	41	ST/JB	7	10.5	17.5	12.3	Restoration/WL
14*	11	PCT/HP/BP	30	5.0	35.0	30.0*	Restoration
15*	15	Imp Cut/UB	22	6.5	28.5	22.0*	Restoration
16	3	PCT/HP/BP	N/A	5.0	5.0		None
17	38	CLC/JB	0	10.5	10.5		WL
18	21	PCT/HP/BP	5	5.0	10.0		None
19	15	CLC/JB	0	10.5	10.5		WL
20	32	ST/JB	2	11.4	13.4		WL
21	6	PCT/HP/BP	3	8.9	11.9		None
22	30	SWD/SPB	0	9.0	9.0		None
23	29	Imp Cut/UB	0	9.0	9.0		None
24	5	Imp Cut/UB	0	9.0	9.0		None
25	29	ST/BB	0	9.0	9.0		None

Unit	Acres	Treatment	Current % Detrimental Disturbance	Projected % Detrimental Disturbance From Treatments	Detrimental Disturbance % After Treatments	Detrimental Disturbance % After Restoration‡	Actions To Meet Soil Standards
26	65	Imp Cut/UB	0	9.0	9.0		None
27	31	CLC/SPB	0	9.0	9.0		None
28	22	Imp Cut/UB	0	10.0	10.0		WL
29	25	SWD/S/HP/B	10	12.0	22.0	10.0	Restoration/WL
30	14	Imp Cut/UB	0	11.1	11.1		None
31	16	Imp Cut/UB	0	11.1	11.1		None
32	45	Imp Cut/UB	0	15.1	15.1		None
33	17	Imp Cut/JB	2	12.0	14.0		None
34	12	SWD/JB	0	12.0	12.0		None
35	24	CLC/BB	0	9.0	9.0		None
36	20	CLC/BB	0	9.0	9.0		None
37	8	CLC/BB	2	9.0	11.0		None
38	7	CLC/BB	2	13.5	15.5	14.3	Rip Landings
39	42	ST/UB	0	9.9	9.9		None
40	11	ST/UB	2	13.5	15.5	14.3	Rip Landings
41	12	SWD/UB	7	6.5	13.5		None
42	65	ST/UB	2	13.5	15.5	14.3	Rip Landings
43	104	ST/UB	10	7.5	17.5	7.8	Restoration/WL
44	97	Imp Cut/UB	0	10.3	10.3		None
45	38	Imp Cut/UB	0	10.8	10.8		WL
46	251	Imp Cut/UB	13	7.5	20.5	10.8	Restoration/WL
47	220	Imp Cut/UB	12	7.5	19.5	9.8	Restoration/WL
48	141	PCT/UB	12	2.0	14.0		Handthin
49	49	PCT/UB/PVT	11	2.0	13.0		Handthin
50	49	PCT	N/A	0.0	0.0		None
51	193	PCT/UB/PVT	15	2.0	17.0	16.0	Restoration/Handthin
52	22	CLC/BB	6	9.0	15.0		None

Unit	Acres	Treatment	Current % Detrimental Disturbance	Projected % Detrimental Disturbance From Treatments	Detrimental Disturbance % After Treatments	Detrimental Disturbance % After Restoration‡	Actions To Meet Soil Standards
53	17	SWD/JB	10	12.0	22.0	16.0	Restoration
54	20	Imp Cut/JB	2	12.0	14.0		None
55	29	Imp Cut/UB	0	12.5	12.5		None
56	17	CLC/BB	0	9.0	9.0		None
57	93	SWD/JB	N/A	10.5	10.5		WL
58	15	SWD/JB	N/A	10.5	10.5		WL
59	16	PCT	27	0.0	27.0		Handthin
60	25	PCT	N/A	0.0	0.0		None
61	34	PCT	N/A	0.0	0.0		None
62	37	PCT	10	3.0	13.0		WL
63	17	PCT	10	3.0	13.0		WL
64	30	PCT	N/A	0.0	0.0		None
65	25	PCT	25	0.0	25.0		Handthin
66	26	PCT	N/A	0.0	0.0		None
67	20	PCT	N/A	0.0	0.0		None
68	15	PCT	N/A	0.0	0.0		None
69	31	PCT	N/A	0.0	0.0		None
70	39	PCT	N/A	0.0	0.0		None
71	40	PCT	N/A	0.0	0.0		None
72	85	PCT	12	0.0	12.0		Handthin
73	33	PCT	N/A	0.0	0.0		None
74	23	CLC/SPB	0	13.5	13.5		None
75	148	PCT/UB	N/A	2.0	2.0		None
76	123	LSF/<10ac	N/A	2.0	2.0		None
77	709	MSF/<30ac	N/A	10.0	10.0		None
78	38	LSF/<5ac	N/A	2.0	2.0		None
79	337	MSF/<30ac	N/A	10.0	10.0		None

Unit	Acres	Treatment	Current % Detrimental Disturbance	Projected % Detrimental Disturbance From Treatments	Detrimental Disturbance % After Treatments	Detrimental Disturbance % After Restoration‡	Actions To Meet Soil Standards
80	326	MSF/<20ac	N/A	10.0	10.0		None
81	629	MSF/<30ac	N/A	10.0	10.0		None
82	776	MSF/<75ac	N/A	10.0	10.0		None
83	457	MSF/<75ac	N/A	10.0	10.0		None
84	831	MSF/<30ac	N/A	10.0	10.0		None
85	143	LSF/<5ac	N/A	2.0	2.0		None
86	47	MSF/<10ac	N/A	10.0	10.0		None
87	36	MSF/<5ac	N/A	10.0	10.0		None
88	865	MSF/<30ac	N/A	10.0	10.0		None

‡This value includes restoration detailed in pdfs S/WS/F 9-13 above with the assumption that they have 50% effectiveness in soil restoration (Luce, 1997). These values also assume that units with high existing detrimental disturbance (10%+) have an increase in 3% detrimental disturbance from skid trails due to overlap.

*Final detrimental disturbance values are assuming higher overlap and restoration due to preponderance of mining disturbance.

WL=Winter Logging

CLC/BB=Clearcut with Reserves/Broadcast Burn, **CLC/JB**=Clearcut with Reserves/Jackpot Burn, **CLC/SPB**=Clearcut with Reserves/Site Prep Burn, **CLC/UB**=Clearcut with Reserves/Underburn, **Imp Cut/JB**=Improvement Cut/Jackpot Burn, **Imp Cut/UB**=Improvement Cut/Underburn, **LSF/<5ac**=Low Severity Fire, Openings <5 acres, **LSF/<10ac**=Low Severity Fire, Openings <10 acres, **MSF/<5ac**=Moderate Severity Fire, Openings < 5 acres, **MSF/<10ac**= Moderate Severity Fire, Openings < 10 acres, **MSF/<20ac**=Moderate Severity Fire, Openings <20 acres, **MSF/<30ac**=Moderate Severity Fire, Openings <30 acres, **MSF/<75ac**=Moderate Severity Fire, Openings <75 acres, **PCT**=Precommercial Thin, **PCT/HP/BP**=Precommercial Thin/Handpiling/Burn Piles, **PCT/UB**=Precommercial Thin/Underburn, **PCT/UB/PVT**=Precommercial Thin/Underburn or Slash along Private, **S/S/HP/BP**=Sanitation/Slashing/Handpiles/Burnpiles, **ST/BB**=Seedtree with Reserves/Broadcast Burn, **ST/JB**=Seedtree with Reserves/Jackpot burn, **ST/S/HP/BP**=Seedtree with Reserves/Slashing/Handpiles/Burnpiles, **ST/UB**=Seedtree with Reserves/Underburn, **SWD/JB**=Shelterwood (Group) with Reserves/Jackpot burn, **SWD/S/HP/B**=Shelterwood (Group) with Reserves/Slashing/Handpile/Burn, **SWD/SPB**=Shelterwood with Reserves/Site Prep Burn, **SWD/UB**=Shelterwood with Reserves/Underburn

Units 14 and 15 currently have high detrimental disturbance (30 and 22 percent, respectively). These two units showed signs of past mining activities and have some of the highest bare ground percentages (36 and 32, respectively) as well as low coarse woody debris tonnage (0 and 4). Using the calculations described above, these two units have the potential to have a higher detrimental disturbance after restoration than they do currently. Region 1 Soil Quality Standards state that, *"In areas where more than 15% DSD exists from prior activities, the cumulative detrimental effects should not exceed the conditions prior to the planned activity and should move toward a net improvement in soil quality"* (USDA Forest Service 2009).

In these two units, there is an ample amount of area previously disturbed. Based on professional experience, it is highly likely that the projected disturbance from the proposed action would take place on current detrimental disturbance. This disturbed ground would then be restored and there would be a net decrease in detrimental disturbance. Also, in terms of net improvement, these units would have CWD levels increase to at least 5 tons per acre, many areas with bare soil would be covered with valuable organic material in the form of slash, and introduction of fire would help cycle nutrients locked up in biomass into the soil. These actions would all show a net improvement in soil quality trends within these units and hence meet Region 1 Soil Quality Standards.

Units 51 and 53 are also above the 15 percent threshold using the calculations in table 140. Both of these units are projected to have 16 percent detrimental disturbance after restoration by the calculations above. It should be noted that this is within the accepted range (+/- 5 percent) of accuracy for these measures (Page-Dumroese et al. 2009). The main disturbance that would push these units to the threshold is prescribed burning. Based on professional experience, it is possible to implement the prescribed burning in these units without exceeding thresholds. We would monitor these units for soil conditions following harvest and before burning. A soil scientist would be consulted prior to burning to ensure that soil moisture is high enough to not create excessive detrimental effects.

Compliance with Forest Plan and Other Relevant Laws, Regulations, Policies and Plans

The planned actions for the Stonewall Vegetation Project adhere to the Forest Plan for the Helena National Forest, and the soil quality guidelines for maintaining soil quality from Region 1 with the implementation of design features.

Summary of Alternative 2

Alternative 2 (proposed action) has the most proposed treatment acres. This alternative has the most acreage that would potentially be detrimentally disturbed. However, this alternative also has the most acreage proposed for prescribed fire. Based on research and professional experience, the positive effects of reintroducing fire, as described in the sections previous, far outweigh negative potential from disturbing a larger acreage of land.

Alternative 3

The primary effects from the proposed treatments are detailed in this document. As stated earlier, the effects from each of the action alternatives are essentially the same with the exception of the degree of activities in each of the alternatives. As can be seen in table 141, alternative 3 proposes fewer treatment acres and less road miles utilized overall.Alternative 3 would have long- and short-term direct and indirect negative effects on forest soil quality. However, the project would meet Region 1 Soil Quality Standards by implementing the project design features and restoration measures and help reduce negative impacts to soils. Anticipated detrimental disturbance for alternative 3 is shown by unit in the following table. All units are expected to meet Region 1 Soil Quality Standards.

Table 141. Projected detrimental soil disturbance for alternative 3 in the Stonewall Project

Unit	Acres	Treatment	Current % Detrimental Disturbance	Projected % Detrimental Disturbance From Treatments	Detrimental Disturbance % After Treatments	Detrimental Disturbance % After Restoration‡	Actions To Meet Soil Standards
1	96	SWD/SPB	19.0	8.1	27.1	17.0	Restoration/WL
2	146	LSF/<5ac		2.0	2.0		None
3	37	PCT/HP/BP	6.0	5.0	11.0		None
4	7	S/S/HP/BP	6.0	8.0	14.0		WL
5	18	S/S/HP/BP	3.0	10.5	13.5		WL
6	14	Imp Cut/UB	0.0	6.5	6.5		None
7	17	Imp Cut/UB	0.0	6.5	6.5		None
8	62	Imp Cut/UB	3.0	6.5	9.5		None
9	18	ST/S/HP/BP	0.0	10.5	10.5		WL
10	18	CLC/UB	0.0	9.3	9.3		WL
11	23	SWD/UB	8.0	9.2	17.2	12.6	Restoration/WL
12	80	SWD/UB	18.0	7.5	25.5	15.8	Restoration/WL
13	41	ST/JB	7.0	10.5	17.5	12.3	Restoration/WL
14*	11	PCT/HP/BP	30.0	5.0	35.0	30.0*	Restoration
15*	15	Imp Cut/UB	22.0	6.5	28.5	22.0*	Restoration
16	3	PCT/HP/BP		5.0	5.0		None
17a	38	UB	0.0	2.0	2.0		None
19a	15	UB	0.0	2.0	2.0		None
20a	24	UB	2.0	2.0	4.0		None
22a	22	SWD/SPB	0.0	6.5	6.5		None
23	29	Imp Cut/UB	0.0	6.5	6.5		None
24	5	Imp Cut/UB	0.0	6.5	6.5		None
25	29	ST/BB	0.0	6.5	6.5		None
27	31	CLC/SPB	0.0	6.5	6.5		None
28	22	Imp Cut/UB	0.0	13.5	13.5		None

Unit	Acres	Treatment	Current % Detrimental Disturbance	Projected % Detrimental Disturbance From Treatments	Detrimental Disturbance % After Treatments	Detrimental Disturbance % After Restoration‡	Actions To Meet Soil Standards
29a	25	UB	10.0	2.0	12.0		None
30a	14	UB	0.0	2.0	2.0		None
31a	16	UB	0.0	2.0	2.0		None
32a	45	UB	0.0	2.0	2.0		None
34	12	SWD/JB	2.0	9.5	11.5		None
35	24	CLC/BB	0.0	6.5	6.5		None
36	20	CLC/BB	0.0	6.5	6.5		None
37	8	CLC/BB	2.0	6.5	8.5		None
38	7	CLC/BB	2.0	13.5	15.5	14.3	Rip Landings
39	26	ST/UB	0.0	6.5	6.5		None
40	11	ST/UB	2.0	13.5	15.5	14.3	Rip Landings
41	12	SWD/UB	7.0	6.5	13.5		None
42	65	ST/UB	2.0	13.5	15.5	14.3	Rip Landings
43	104	ST/UB	10.0	7.5	17.5	13.8	Restoration/WL
44a	97	UB	0.0	2.0	2.0		None
45a	38	UB	0.0	2.0	2.0		None
46a	223	UB	13.0	2.0	15.0		None
46b	27	Imp Cut/UB	13.0	7.5	20.5	10.8	Restoration/WL
47a	180	UB	12.0	2.0	14.0		None
47b	9	Imp Cut/UB	12.0	7.5	19.5	9.8	Restoration/WL
47c	31	Imp Cut/UB	12.0	7.5	19.5	9.8	Restoration/WL
48	141	PCT/UB	12.0	2.0	14.0		Handthin
50	49	PCT		0.0	0.0		None
51	193	PCT/UB/PVT	15.0	2.0	17.0	16.0	Restoration/Handthin
52	22	CLC/BB	6.0	6.5	12.5		None
53	17	SWD/JB	10.0	9.5	19.5	14.8	Restoration
57	93	SWD/JB		10.5	10.5		WL

Unit	Acres	Treatment	Current % Detrimental Disturbance	Projected % Detrimental Disturbance From Treatments	Detrimental Disturbance % After Treatments	Detrimental Disturbance % After Restoration‡	Actions To Meet Soil Standards
58	15	SWD/JB		10.5	10.5		WL
59	16	PCT	27.0	0.0	27.0		Handthin
61a	9	PCT/HP/UB		5.0	5.0		None
62	37	PCT	10.0	3.0	13.0		WL
63	17	PCT	10.0	3.0	13.0		WL
66	26	PCT		0.0	0.0		None
67	20	PCT		0.0	0.0		None
68	15	PCT		0.0	0.0		None
69	31	PCT		0.0	0.0		None
70	39	PCT		0.0	0.0		None
71	40	PCT		0.0	0.0		None
72	85	PCT	12.0	0.0	12.0		Handthin
73	33	PCT		0.0	0.0		None
74	23	CLC/SPB	0.0	13.5	13.5		None
75b	20	PCT/HP/UB		5.0	5.0		None
78	38	LSF/<5ac		2.0	2.0		None
79	337	MSF/<30ac		10.0	10.0		None
80a	326	JB		5.0	5.0		None
82	776	MSF/<75ac		10.0	10.0		None
83	457	MSF/<75ac		10.0	10.0		None
84	831	MSF/<30ac		10.0	10.0		None
85	143	LSF/<5ac		2.0	2.0		None
87	36	MSF/<5ac		10.0	10.0		None
88	865	MSF/<30ac		10.0	10.0		None

‡this value includes restoration detailed in pdfs S/WS/F 9-13 above with the assumption that they have 50% effectiveness in soil restoration (Luce, 1997). These values also assume that units with high existing detrimental disturbance (10%+) have an increase in 3% detrimental disturbance from skid trails due to overlap.
* Final detrimental disturbance values are assuming higher overlap and restoration due to preponderance of mining disturbance.

CLC/BB=Clearcut with Reserves/Broadcast Burn, **CLC/JB**=Clearcut with Reserves/Jackpot Burn, **CLC/SPB**=Clearcut with Reserves/Site Prep Burn, **CLC/UB**=Clearcut with Reserves/Underburn, **Imp Cut/JB**=Improvement Cut/Jackpot Burn, **Imp Cut/UB**=Improvement Cut/Underburn, **LSF/<5ac**=Low Severity Fire, Openings <5 acres, **LSF/<10ac**=Low Severity Fire, Openings <10 acres, **MSF/<5ac**=Moderate Severity Fire, Openings < 5 acres, **MSF/<10ac**= Moderate Severity Fire, Openings < 10 acres, **MSF/<20ac**=Moderate Severity Fire, Openings <20 acres, **MSF/<30ac**=Moderate Severity Fire, Openings <30 acres, **MSF/<75ac**=Moderate Severity Fire, Openings <75 acres, **PCT**=Precommercial Thin, **PCT/HP/BP**=Precommercial Thin/Handpiling/Burn Piles, **PCT/UB**=Precommercial Thin/Underburn, **PCT/UB/PVT**=Precommercial Thin/Underburn or Slash along Private, **S/S/HP/BP**=Sanitation/Slashing/Handpiles/Burnpiles, **ST/BB**=Seedtree with Reserves/Broadcast Burn, **ST/JB**=Seedtree with Reserves/Jackpot burn, **ST/S/HP/BP**=Seedtree with Reserves/Slashing/Handpiles/Burnpiles, **ST/UB**=Seedtree with Reserves/Underburn, **SWD/JB**=Shelterwood (Group) with Reserves/Jackpot burn, **SWD/S/HP/B**=Shelterwood (Group) with Reserves/Slashing/Handpile/Burn, **SWD/SPB**=Shelterwood with Reserves/Site Prep Burn, **SWD/UB**=Shelterwood with Reserves/Underburn

Alternative 3 is the same for detrimental disturbance in units 14, 15, and 51 as alternative 2 (table 140). Calculations for alternative 3, however, do not include unit 53 (as seen in alternative 2) because unit 53 does not come above the 15 percent detrimental disturbance threshold in alternative 3 (table 141).

Compliance with Forest Plan and Other Relevant Laws, Regulations, Policies and Plans

Alternative 3 for the Stonewall Vegetation Project adheres to the Forest Plan for the Helena National Forest and the soil quality guidelines for maintaining soil quality from Region 1 with the implementation of design features.

Summary of Alternative 3

Alternative 3 has fewer proposed treatment acres than alternative 2, and therefore, has fewer acres that would potentially be detrimentally disturbed by prescribed fire. Based on research and professional experience, the positive effects of reintroducing fire, as described in the sections previous, far outweigh any negative potential from disturbing a larger acreage of land.

Units 51 and 53 in alternative 2 and unit 51 in alternative 3 would be checked for soil conditions before burning to ensure that soil moisture conditions are high enough to not create additional detrimental disturbance.

Hydrology

Introduction

This section addresses potential project-related and cumulative effects on water resources—specifically, water quality and quantity in the streams within and downstream of the project area, as well as riparian area and wetland condition and function within the project area. Project streams are tributaries to the Blackfoot River.

Existing water quality concerns in the project area are mainly related to sediment delivered from roadways. Undersized culverts on roads in the project area, while not affecting current water quality, are also a concern in that culvert failure during a large flow event would likely result in the entrainment and deposition of large volumes of sediment within stream channels. Sediment is of particular concern in the project watersheds because, although the streams flowing through the project area are not listed as water-quality impaired by the State, they flow to the Blackfoot River, which has a total maximum daily load (TMDL) developed for sediment (for the section downstream of the forest boundary). In an effort to improve watershed and stream water quality conditions in conjunction with the project, extensive road maintenance to meet the State Best Management Practices (BMP) is planned for roads used for the project. In addition, the action alternatives include about 0.4 to 2.6 miles of road that would be built then obliterated immediately following timber removal. Reducing sediment delivery from roads would help meet a target set by the Montana Department of Environmental Quality (DEQ) for the Blackfoot River sediment TMDL for sediment reduction in tributary watersheds (Montana DEQ 2004).

Methodology

Sediment delivery from roads at stream crossings was predicted using an erosion/sedimentation model called WEPP Road (Elliot et al.1999). The newly developed W3 version, a physically based erosion simulation model built on the fundamentals of hydrology, plant science, hydraulics, and erosion mechanics (Laflen et al. 2004), was exclusively designed to evaluate effects of forest projects on stream flows in Region 1 of the Forest Service.

Input data used to run this model were collected in the field in the sediment surveys identified in the next section. Sediment source areas were surveyed along all roads in project watersheds. The W3 WEPP model estimated an annual average sediment delivery to project streams under existing conditions, and then model runs were done assuming surfacing and drainage improvements were implemented at road stream crossings. The physical basis and performance of the WEPP models is discussed in the model documentation (Elliot et al. 1999, 2000) as well as several peer-reviewed papers (e.g., Larsen and MacDonald 2007; Laflen et al. 2004; Elliott 2004). In general, erosion prediction models have difficulty predicting sediment output with precision from a road, hillslope, or watershed at time-scales useful to land managers. This is due mainly to a high degree of variability in site characteristics and climate. An average erosion/sediment delivery rate prediction can encompass this variability to some degree, although this value becomes much more useful when combined with a predicted probability that erosion would occur. The WEPP models incorporate climate data tailored to the individual site using PRISM data (Daly et al. 2001) and simulates daily events for a number of years specified by the user (30 years in this analysis) to determine the probability of sediment leaving the unit. The model incorporates individual precipitation event characteristics and antecedent conditions as well as site characteristics into its prediction of average annual runoff, erosion, and sediment yield values.

The culvert risk analysis was based on field measurements of the culverts within the project area and flood frequency regression curves developed for the state of Montana (Parret and Johnson 2004). Many of the streams within the project area appear to lose water to the subsurface in the downstream sections; thus the predicted flows are probably conservative for culvert flow design.

An equivalent clearcut area (ECA) analysis was completed to evaluate water yield increases due to insect mortality, wildfires, and previous forest management actions. Water yield was also evaluated using the WEPP W3 model. The model was developed to replace the Universal Soil Loss Equation (USLE) and has been widely used in the United States and the world. WEPP requires four inputs, climate, topography, soil, and management (vegetation), and provides various types of outputs including water balance (surface runoff, subsurface flow, and evapotranspiration), soil detachment and deposition at points along the slope, sediment delivery, and vegetation growth.

Water yield increases occur as a result of changes in watershed evapotranspiration, and information used in the analysis is derived from a variety of sources including the timber stand data base, which gives us a reasonable estimate of the equivalent clearcut acres. Water yield increases presented for alternative 1 (current conditions) are relative to an undisturbed, fully-forested condition[32]. The Equivalent Clearcut Area analysis was also used to estimate the impact on water yield of project activities as well as past and present activities throughout the four 6th-field watersheds in the project area (USDA Forest Service 1978, 1980). Water quantity can be an issue as excess water yield may result in accelerated stream bank erosion resulting in habitat degradation and additional sedimentation. The use of water yield and potential impacts on a stream is consistent with EPA guidance for sediment Total Maximum Daily Loads (TMDLs). State water quality standards also recommend limits on water yield and related increased flow—activities increasing mean monthly flows above 15 percent can require an Authorization to Degrade (ARM

[32] Water yield analysis in this report uses, as a baseline, a watershed where mature forest exists and no fire or other vegetation removal has occurred in the recent past. Under natural conditions (or under conditions during which long-term flow records in the region were recorded), it is unlikely that the forests in watersheds in the study area would have been entirely intact over this interval, due to fires or insect infestations. Thus, this method of analysis is conservative—a more realistic baseline would likely consider part of a watershed to be deforested and/or recovering from disturbance at any given point in time. A natural channel would be adjusted to a marginally higher water yield than a conservative analysis would suggest.

17.30.715). Activities resulting in flow increases of less than 15 percent are considered not significant and are not required to undergo review. The indicator used in this analysis is percent annual water yield increase. In keeping with state regulations and other EPA-approved water quality habitat restoration plans and sediment TMDLs, modeled water yield benchmark for non-TMDL streams is 10 percent and for TMDL streams 8 percent is used (e.g., Montana DEQ 2004).

Changes in water yield are difficult to predict at the landscape scale due to the high degree of complexity in the movement of water in mountainous forested environments. Even with exhaustive site data (i.e. transpiration rates, soil moisture and porosity, precipitation, stream flow, groundwater level and flow) available only in experimental settings, water yield estimates are approximate at best. The ECA model has been in use for several decades in the northern Rockies, and provides a reasonable estimation of the impacts of vegetation removal.

Numerous studies have been done on water yield and streamflow changes after forest harvest. In a review and summary of the short-term effects of forest harvest in the United States and other countries, Hibbert (1967) concluded that a “reduction of forest cover increased water yield,” but the “response to treatment is highly variable, and for the most part, unpredictable.” He also found that, in general, the increases in streamflow and water yield decreased over time as vegetation re-grew. In a later review, Bosch and Hewlett (1982) analyzed an additional 55 studies and concluded that increased streamflow is caused by a decrease in forest cover, and that the decrease correlated with the amount of the forest overstory canopy removed. Further, it was found that cutting conifers produced a greater increase in streamflow than cutting deciduous trees. The dense needles and branches of conifers intercept more water than hardwoods, and interception of precipitation occurs all year long. Conifers also actively photosynthesize for a longer period (Swank et al. 1988). Streamflow increases were highest in areas with greater amounts of mean annual precipitation, and were generally short lived as vegetation re-grew.

Physical riparian habitat was assessed as part of the sediment source survey described in the next section, using standard proper functioning condition (PFC) guidelines (Prichard 1998). Streams are considered to be in proper functioning condition when there is adequate vegetation, land form, or large woody debris present to dissipate stream energy associated with high water flows, filter sediment, capture bedload and aid floodplain development; improve flood-water retention and ground water recharge; develop root masses that stabilize stream banks; develop channel characteristics to provide habitat for beneficial uses; and support greater biodiversity (ibid). Streams rated as functional-at-risk are considered functional (see above), but an existing soil, water, or vegetation attribute makes them susceptible to degradation. A stream is considered nonfunctional when it is clear that there is not adequate vegetation, landform, or large woody debris to dissipate stream energy associated with high flows, thus leaving banks subject to accelerated erosion and worsening water quality (ibid).

Information Used

Data Sources

Sediment/Pollutant Source Survey – A sediment/pollutant source survey was completed for the project analysis. This consisted of a detailed, on-the-ground survey of the streams within the project area. Sediment and other pollutants were identified, described, photographed, and located using Global Positioning System (GPS) units. This information was entered in a database and sediment or other pollutant sources were plotted on maps of the drainages within the project area. The survey was done in an effort to assess the condition of streams within the project area as well as identify various pollution sources and causes.

Roads Sediment and Culvert Survey – A detailed roads sediment and culvert survey was also done for the project analysis. Roads within the area were surveyed in detail; sites where sediment was being transported to stream channels were evaluated and located with GPS units. Parameters measured at the sites were those required by the WEPP-Roads model. Data included road design, dimensions, gradient, surface material, buffer dimensions, and overall disturbance width and length.

Roads Analysis Process – A roads analysis was undertaken for the Helena National Forest in 2004. The analysis examined roads in maintenance levels 1 through 5. The analysis includes drainage road densities, road mileage within riparian habitat conservation areas, mileage in wet areas, mileage across erosive and slide-prone soils, mileage within TMDL watersheds, and the number of road-stream interactions. Risk ratings were given to individual roads as well as watersheds on the forest as a result of this analysis

Data Queries from the Timber Stand Database – These queries assess past harvest activities and fire acreage by 6th-field watershed in the project area. This information was used in the analysis of water yield change.

GIS layers and Queries – Numerous GIS layers were used for spatial analysis including proposed harvest units, proposed and existing roads, 6th-field watershed boundaries and streams from the national hydrography dataset (NHD), Helena National Forest (HNF) landtypes, stream buffers and various intersections of these layers with the HNF soil resource inventory. This information was used in various analyses.

Soil Survey, Helena National Forest – The HNF Soil Survey provided data on soil types and characteristics for the study area. This information was used in modeling erosion and sedimentation.

Stonedry NFMA Analysis – The Stonedry NFMA analysis looked at a variety of data including recent water quality data, roads analysis, riparian stream characteristics for reference reaches, and past harvest and fire activity.

Information from past and proposed timber harvest on private property within the project area was also used in the analysis of water yield change.

Assumptions

Water Quality

The project would meet State water quality standards for streams if all reasonable land, soil, and water conservation practices are implemented and those practices “protect present and reasonably anticipate beneficial uses.” Of the beneficial uses designated for project area streams, the proposed activities could possibly affect salmonid habitat through increased delivery of fine sediment to streams. Other beneficial uses for project-area streams are unlikely to be affected by the proposed activities.

In streams with no previously identified water quality impairment, this analysis assumes beneficial uses are being fully met and would continue to be met if project activities do not cause an increase in sediment delivery, as predicted by modeling.

The effects of each alternative are based on the following assumptions related to water quality:

- The potential for sediment delivery from forested areas is highest in the first year following disturbance, and generally recovers to pre-disturbance conditions within three to five years.

- Road improvements (new drainage features, gravel application) may result in elevated erosion shortly after installation, but would remain effective in reducing sediment delivery over a period of at least three to five years.
- Obliteration of roads may result in elevated erosion during and shortly after work, but would become stable and cease to be sediment sources within one to two years following disturbance.
- Proposed roads to be built then obliterated immediately following timber removal would not develop sediment delivery points because they would be located in upland locations without hydrologic connection to any channels.

Water Quantity

Water yield from a watershed is typically defined as the total volume of water leaving the basin via surface flow over a specified length of time. Annual water yield fluctuates based on climatic variability and changes in land use patterns.

Most hydrologic impacts occur during periods of the peak stream flow in a watershed. Stream flow is defined as “the channelized flow of water at the earth’s surface”; peak flow is defined as “the maximum flow rate that occurs within a specified period of time, usually on an annual or event basis.” In the project area, peak flows occur as the snowpack melts in the spring. Occasionally, periods of high stream flow can be caused by rainstorms.

Snow melts from a watershed in a predictable pattern. Melt begins earlier in the season at lower elevations and proceeds upslope. Snow has generally disappeared from the lower elevations some time before the spring stream flows peak. During peak flow, snow is beginning to disappear from the mid-elevations and is actively melting at the higher elevations of a watershed.

After an area has been harvested, both winter snow accumulation and spring melt rates increase. This effect is less important at lower elevations, since the snow disappears before peak flow. At mid-elevations, the additional melt may or may not be important, depending on seasonal variations. Harvesting at high elevations would have the greatest impact and is, therefore, of most concern. The changes in snow accumulation and melt brought about by forest harvesting are reduced as new forests grow. This is commonly referred to as hydrologic recovery.

Second-growth forests are said to be hydrologically recovered when snowpack conditions approximate those prior to logging and, as a result, any impact on stream flow is minimized. The most important influence of vegetation on snow accumulation is the interception of snow by the forest canopy and the subsequent loss of this snow to the atmosphere. This interception effect is a result of the combination of tree height and canopy closure. The rate at which the snowpack melts is affected by the extent to which the snowpack is exposed to solar radiation, and like interception, is also controlled by the canopy. Consequently, canopy closure is one of the main stand characteristics affecting snow accumulation and melt.

The degree of canopy closure is determined by tree species, height, and stocking density. Since tree height data is readily available and is closely correlated with canopy closure, it is the variable used to evaluate hydrologic recovery.

Forest management practices and road construction may increase water yield by removing living trees from treated areas, thus reducing the amount of water removed from the watershed by transpiration and canopy interception, evaporation, and sublimation. Excess water yield can be of concern because it may result in accelerated stream bank erosion resulting in habitat degradation and additional sedimentation. Widespread tree mortality from natural causes, such as insects, disease or fire may similarly increase

water yield. Removal of trees has a greater effect on the water balance than removal of smaller plants such as grasses, forbs, and many shrubs, because large trees are generally more deeply rooted and thus have access to groundwater for a longer period of time. Trees also transpire much more water per unit area of ground coverage than smaller plants. The effects of tree removal on water yield depend on many factors, the most important of which is the percent watershed area with tree removal/mortality. A statistically significant increase in stream flow is generally not measurable until at least 20 to 30 percent of a watershed's forest cover is removed (MacDonald and Stednick 2003). Additionally, annual precipitation must generally exceed 18 to 20 inches in order for a measurable yield increase to occur even with greater forest cover removal (Bosch and Hewlett 1982; MacDonald 1987).

Many of the trees proposed for harvest under alternatives 2 and 3 would be dead or dying from insect infestation. Dead trees do not transpire and are thus not a substantial contributor to water loss in project sub-watersheds. Thus, removing these trees would have no measurable effect on the water balance in any watershed. The area of land proposed for clearing for roads to be built then obliterated immediately following timber removal is negligible at the 6th-HUC basin scale, and the majority of trees that would be removed to facilitate these roads are dead. Thus, road construction would have a minimal effect on overall water yield. Roads typically are compacted surfaces, however, that can create local flow increases that may lead to sedimentation if road drainage is connected to streams.

Road construction, however, can have a significant effect on sedimentation. The construction and maintenance of logging roads and landings exposes soil and increases the susceptibility to erosion and transport of sediment to streams (Kochenderfer et al. 1997; Swift 1985, 1988). The greatest input of sediment from roads generally occurs during construction and active log haul during timber harvest. Stream crossings, wetland crossings, and the approaches of roads to these areas are sources of the majority of sediment contribution to streams and wetlands (Swift 1988) especially where BMPs have not been properly applied (Stuart and Edwards 2006).

Physical Riparian Habitat

Proper functioning condition (PFC) is a qualitative method for assessing the condition of riparian areas (Prichard 1998). The term PFC is used to describe both the assessment process and a defined, on-the-ground condition of a riparian area. The on-the-ground condition termed PFC refers to the functional level of physical riparian processes. Proper functioning condition is a state of resiliency that allows a riparian area to maintain its integrity during high-flow events. This resiliency allows an area to produce desired values over time, such as fish habitat, neotropical bird habitat, forage, and dissipation of flood energy. Riparian areas that are not functioning properly cannot sustain these values. Proper functioning condition is used as the indicator of riparian area condition in this analysis.

Spatial and Temporal Scale of Analysis

The spatial scale of analysis of direct and indirect effects is the 6th-field hydrologic unit code (HUC). The individual 6th-field HUCs range in size from 7,552 acres for Lincoln Creek and11,617 acres for Beaver Creek, to 22,834 acres for Keep Cool Creek. This is an appropriate scale because the types of watershed impacts that are associated with forest management practices (increased sediment delivery and water yield) are generally discernible at the 6th-field HUC scale. Tools available for analysis of watershed impacts were also considered; a smaller scale of analysis would require significantly more data and effort without a commensurate increase in accuracy. The cumulative effects analysis covers the three 6th-field HUCs combined, and is approximately 42,003 acres in size. Cumulative effects from the project were considered along with other management activities and natural fires. Additionally, the mouth of the combined drainages is in the TMDL section of the Blackfoot River Headwaters, and thus is an appropriate point at which to assess cumulative effects.

The temporal bounding of the analysis for direct and indirect effects ranges from 1 to 5 years, referred to as short-term effects. Short-term increases in sediment delivery associated with construction activities (i.e. road improvements and decommissioning) would last as long as soil is disturbed or exposed in locations hydrologically connected to streams. Once the road surfaces have stabilized with aggregate or vegetation has re-established after obliteration, construction-related impacts would not be expected to persist (temporal scale of a few months to one year). After the completion of management activities on treatment units, the potential for sediment delivery is highest in the first year following disturbance and generally recovers to pre-disturbance levels within five years. Therefore, discussion of direct and indirect effects related to treatment units has a temporal scale of five years.

As used in this analysis, “long-term” effects would be expected to last greater than 5 years (e.g., physical obliteration of closed roads). Beneficial effects of application of BMPS and design features may persist longer than the short term.

Overview of Issues

Comments pertaining to disclosing the effects of project activities on hydrology were identified from public scoping as nonsignificant (40 CFR 1501.7), and are addressed by the analyses in this section. Please refer to volume 2, appendix A of this document for a complete listing of the issues and an explanation of how the agency determined their disposition. Comments indicated concern that roads built then obliterated immediately following timber removal, road reconstruction, and use of existing roads would adversely impact water quality. See the Transportation section for more information about roads.

Affected Environment

Introduction

This section describes the affected environment for water resources. Much of the information presented in this analysis comes directly from field examination of the Stonewall Project area, including a stream-by-stream sediment source survey and a road sediment and culvert survey. In addition, project units that have the potential to adversely affect water quality were examined in the field. Table 142 displays watershed information used in this analysis.

Table 142. Watersheds, stream miles, and acres of watershed area

Sixth-Huc Watershed Name	Sixth-Huc Watershed Number	Stream Miles		Area (Acres)		Percent Of Watershed In Project Area
		Watershed	Project Area	Watershed	Project Area	
Beaver Creek	170102030303	34	23	11,617	8,846	76
Keep Cool Creek	170102030304	70	23	22,834	9,270	41
Lincoln Creek	170102030305	21	13	7552	5,777	77
Total		**125**	**59**	**42,003**	**25,898**	**57**

Lincoln Creek (170102030305)

The Lincoln Creek watershed is 7,552 acres in size and flows into the Blackfoot River about a mile downstream of the Forest boundary. This is a 1st-order drainage with 13 miles of streams on the Forest.

Lincoln Creek appears to be a losing stream[33] near the Forest boundary. The average annual precipitation is 26 inches, with approximately 35-40 inches at upper elevations, and 15-20 inches at lower elevations; the wettest months are May and June. Historic land use activities in the drainage are predominantly mining, forestry, and agriculture. Approximately 77 percent of this watershed is within the project boundary, and proposed treatment units occupy about 30 percent. There are no water quality listings in the Lincoln Creek watershed. Lincoln Creek exhibits a typical snowmelt-dominated hydrograph that can occasionally have multiple peaks during the spring due to rain events or warmer periods. The headwaters area consists of glaciated mountainous terrain while the lower portions of the watershed are comprised of mountain slopes and ridges and valley floor, all underlain by Proterozoic sedimentary rock. The stream bottoms run through compact loamy glacial till, moraines and glaciated mountain slopes in the upper portion of the watershed, and colluvial and alluvial flood plains and terraces and mountain slopes and ridges in the lower portion.

Beaver Creek (170102020303)

The Beaver Creek watershed is 11,617 acres in size and is a tributary to the Blackfoot River. The stream is connected to the Blackfoot River through a series of mostly beaver created ponds and lakes located mostly on private lands. This is a 2nd -order drainage with a mixture of 34 miles of intermittent and perennial streams. Theodore, Klondike, and Yukon Creek are mostly perennial headwater streams. Annual average precipitation for the watershed is about 31 inches from PRISM, with 35-40 inches in the upper elevations and about 15-20 inches at lower elevations. May and June are the wettest months. Beaver Creek exhibits a typical snowmelt-dominated hydrograph that can occasionally have multiple peaks during the spring due to rain events. Proterozoic sedimentary rock and Pleistocene glacial deposits underlie the Beaver Creek subwatershed. The predominant landforms are steep mountain slopes and ridges and valley floors. Historic land use activities in the drainage are predominantly mining and forestry. Approximately 76 percent of this watershed is within the project boundary, and about 17 percent is occupied by proposed treatment units. There are no streams in the Beaver Creek watershed with water-quality-limited segments (WQLS) on the Montana 303(d) list (DEQ 2008).

Keep Cool Creek (170102030304)

The Keep Cool Creek watershed is 22,834 acres in size and is a tributary to the Blackfoot River, which is located about half mile below the National Forest boundary. This second-order drainage exhibits a typical snowmelt-dominated hydrograph that can occasionally have multiple peaks during the spring due to rain events. The average annual precipitation is approximately 35-40 inches at higher elevations and 15-20 inches at lower; the wettest months are May and June. Annual average precipitation for the watershed is about 28 inches from PRISM. The drainage is characterized by steep mountainous terrain. The predominant landform is steep mountain slopes and ridges with the lower watershed consisting of alluvial flood plains and terraces. Proterozoic sedimentary rock and Pleistocene glacial deposits underlie the portion of the Keep Cool Creek 6th-HUC watershed covered by the project area. Historic land use activities in the drainage are predominantly forestry and mining. Approximately 41 percent of this watershed is within the project boundary, and proposed treatment units occupy about 16 percent. There are no water quality listings in the Keep Cool Creek watershed.

[33] A losing stream is one that typically loses flow at the edge of the valley because the water in the stream infiltrates to ground water

Water Quality

Project subwatersheds are in the Upper Blackfoot River Headwaters Total Maximum Daily Load planning area. The Blackfoot Headwaters TMDL for sediment was published by the Montana DEQ and cooperators in 2004. Attributes for each of the 6th-HUC watersheds covered by the project area are listed below. All of the project subwatersheds have large areas of beetle-killed trees.

Table 143. Summary of water quality impairments in project area 303(d)-listed streams

6th-Huc Watershed	Stream Segment	Listed Impairments
Blackfoot River—Little Moose Creek	Blackfoot River	Alteration in streamside vegetation, sedimentation, metals

Sedimentation

Roads Analysis Process

There are roughly 86 miles of National Forest System roads in the project area. This project includes up to 2.6 miles of roads to be built then obliterated immediately following timber removal. These proposed road segments are predominantly located in upland areas, or areas with poorly defined drainages, and would likely not pose a risk for sediment delivery to streams.

The proposed road segment number 5, accessing units 10 and 11, crosses a small drainage of a headwater tributary basin to Lincoln Creek. This apparent crossing was reviewed in the field—there is an old abandoned irrigation ditch at this site, but no stream channel or evidence of overland flow. Flow may occur in the ditch during snowmelt. If the decision is made to construct this segment, then appropriate measures (Best Management Practices) such as adequate culverts, proper road drainage, sediment fencing (if appropriate) would be applied, and the road segment would be obliterated soon after the project ends to minimize sediment impacts.

Many of the existing roads used to access the project area are known sources of sediment to streams, and were characterized as moderate-to high-risk in the HNF Roads Analysis Process. The use of these roads for project-related log hauling and other traffic would exacerbate their current sediment delivery. These roads present good opportunities for mitigation of potential sediment delivery from project activities in the form of road maintenance and improvements (e.g. gravel surfacing) and replacing undersized culverts. Mitigation measures sufficient to offset any project-related sediment delivery (from treatment units and haul routes) in the form of road BMPs and project design features have been incorporated into the project action alternatives.

Sedimentation from Roads

A detailed road sediment survey was conducted for the project area watersheds. The survey identified road segments that were hydrologically linked to stream channels and thus had the potential to deliver sediment to channels during runoff events. Road segments identified as such in the survey were modeled using the WEPP Roads model. The model's output consists of predicted annual average sediment yield from the road prism, in terms of tons per year, based on site-specific climate data and road characteristics.

The concept of an average annual sediment load is somewhat misleading in that sediment delivery varies widely from year to year. In WEPP, the average annual value is equivalent to a two-year-return-interval flow event; there is an equal probability that the sedimentation could be greater or less than this value.

Comprehensive sediment management begins by identifying the existing primary sources of sediment and developing a strategy that preferably minimizes or eliminates sources of sediment or the erosive action in

the first place. This can be accomplished by first reviewing all existing road segments posing sediment delivery risk to the stream system, planning preventive measures that reduce or eliminate road-derived sediment, and then implementing those measures. Identification of primary sediment delivery sources to streams on many roads in the Stonewall Project Area has been accomplished and they are detailed in this analysis.

The next step involves evaluating all proposed road reconstruction and roads to be built then obliterated immediately following timber removal to determine the magnitude of potential risks to the stream system. Certainly roads in valley bottoms, roads paralleling streams and within 300 feet of the stream, and roads with live stream crossings generally pose the highest risk. Recommended action can vary from eliminating the road building to relocating or modifying the road design.

The sediment mitigation for the project area requires close coordination and support from engineering and watershed specialists in reducing sediment delivery by applying various BMP standards. Sediment mitigation measures have been developed for all alternatives to reach the goal of no net increase or preferably, a reduction in sediment delivery from current levels for the proposed project. Costs associated with erosion or sediment control measures should be included in the project area plan as well as an implementation schedule. Given the magnitude of other cumulative effects that may arise from ongoing and foreseeable activities, keeping sediment delivery below existing levels may be very difficult—especially during the first 1 to 3 years as the magnitude of ground disturbance required to bring roads up to standard may in itself result in some short-term sediment delivery.

Reducing sediment delivery below current levels over the long term would likely require that some roads be brought up to BMP standards—especially roads rated as high risk to watersheds and fisheries in the Helena National Forest Roads Analysis (map locations available in GIS data files), and in the project area where sediment source surveys have identified problem areas. BMP maintenance should emphasize surfacing of the roads near stream crossings with washed gravel, improved surface drainage of roads, improved cross drainage of roads, and providing for 100-year flood flows for culvert crossings. Upgrading culverts to ensure they have the capacity to pass 100-year flows reduces risk for culvert failure and subsequent loss of road fill material to streams. Culvert crossings of perennial streams in this project area may need to be upgraded to provide for 100-year flows as well as provide for fish passage.

Sedimentation from Stream Bank Erosion

Stream bank erosion was noted in the PFC survey. Streams were surveyed in the Beaver Creek and Keep Cool Creek watersheds. Areas of accelerated erosion were located on a map, described, and photographed. There are no areas with bank alteration over the standard specified in INFISH, which requires streambanks to be 80 percent stable.

Table 144. Road information for the project area by 6th-HUC watershed

6th-Huc Watershed Name	System Roads (Mi)	System Road Density (Mi/Mi^2)	Rap* High-Risk Roads (Mi)	Rap* Moderate-Risk Roads (Mi)	Road Sediment Delivery Points	Culverts (#)	Fords (#)
Beaver Creek	33	1.8	9	16	14	13	0
Keep Cool Creek	36	1.0	2	9	24	19	2
Lincoln Creek	24	2.0	11	8	3	3	0
Total	**93**	**--**	**22**	**33**	**41**	**35**	**2**

*RAP: Helena National Forest Roads Analysis Process Report (USDA Forest Service 2004)

Sedimentation from Other Sources

In addition to accelerated stream bank erosion, other sources of sediment have been assessed in project watersheds. Other than the occasional elk wallow the only other notable sources of sediment are located downstream of Helena National Forest lands. Agriculture including cattle grazing, forestry, and mining occurs on private and State lands in project watersheds, and these activities may be a source of sediment to streams.

Stream Substrate Analysis

Sediment substrate analysis was done to determine cumulative sediment impacts in streams and to evaluate existing levels of fine sediment in stream substrates. Cumulatively, the impacts of disturbances (both natural and human related) throughout the watershed are reflected in the character of stream substrates. The percentage of fine sediment less than 6 mm diameter is used as a measure of condition. Use of sediment as a measure of risk to fisheries is appropriate for this project as it is generally accepted in watershed practice that the stream channel reflects the sum of land use activities; including natural disturbances in a watershed. Fine sediment (less than 0.25 inches diameter) levels for various streams within the project area are in table 145. Natural mean sediment levels from Helena National Forest reference cores from various drainages combined is about 32 percent with 0.66 percent (one standard deviation) of the overall range established near 10 percent each side of the mean). It is likely that reference drainages throughout the Helena National Forest may have mean sediment values of 28 to 30 percent rather than 32 percent. Specifically for streams sampled in roadless areas, sediment levels averaged 31.9 percent on the Helena National Forest. Consequently, for fisheries management goals, 32 percent likely represents a reasonable sediment level to maintain with an objective to reduce further toward the 28 to 30 percent range. As shown in table 145, several streams sampled within the project area have average sediment levels above the 32 percent level and three streams are above 40 percent.

Table 145. Summary of mean percent fines (less than 0.25 inches diameter) in select streams as an indicator of cumulative effects from past and ongoing activities by 6th-field HUC

6th Field HUC sub-watershed (name)	Stream(s) Sampled for Sediment Analysis	Mean Percent Fines in Spawning Habitat *	USEPA reference Standard (%) **	Roadless Area reference (%)
17010203 (Beaver Creek)	Beaver Creek	30.9	32.5	31.9
	Yukon Creek	34.2		
	Tributary to Yukon Creek	35.1		
	Theodore Creek	32.2		
	Klondike Creek	32.7		
17010203 (Stonewall/Park)	Stonewall Creek	31.6	32.5	31.9
	Park Creek	45.4		
17010203 (Lincoln Gulch)		Not sampled as no fishery present in most of the drainage	32.5	31.9
17010203 (Sucker/Liverpool)	Liverpool sw 1/4	42.7	32.5	31.9
	Liverpool nw ¼	25.4	32.5	31.9
	Sucker Creek	Not sampled	32.5	31.9
	Keep Cool Creek	47.2	32.5	31.9

** Reference standard developed from Helena National Forest Data in the Lake Helena Watershed

Water Yield

Past effects to the hydrology of forested areas in the project area was estimated using the equivalent clearcut area (ECA) methodology on lands managed by the Helena National Forest for existing conditions in the Lincoln Creek, Beaver Creek, and Keep Cool Creek watersheds. The current, pre-project existing condition water yield from project sub-watersheds is a result of forest clearing, past fires, insect mortality, forest roads and other activities. There are no stream gauges in project subwatersheds; as a result pre-project baseline stream flows cannot be reliably determined. Equivalent clearcut area can give a general estimate, based on the available literature, what the water yield increases from project activities may be. This estimate is based on comparable paired watershed studies completed in other parts of the intermountain west that investigated water yield effects of timber harvest and other fuels treatments.

Observed changes in the water yield after beetle kill or forest removal in snowmelt-dominated areas in the intermountain west are due to both a decrease in winter interception and a reduction in growing season soil moisture depletion (Potts 1984;Troendle 1987). In the upper part of project subwatersheds, precipitation accumulates over the winter as snow pack, with minimal melt over this accumulation period. When the snowpack begins to melt in spring, the meltwater first recharges the soil by replacing the water depleted during the previous growing season. Once soil moisture storage is filled, the excess meltwater is available to become streamflow. Paired watershed studies have shown that approximately 30 percent of the increase in water yield can be attributed to the decrease in interception and resultant increased amount of water contained in the snowpack. The reduced evapotranspiration during the previous summer also reduces the amount of meltwater needed for soil moisture recharge in the clearcut. This process accounts for approximately 50 percent of the increase in water yield. The remaining 20 percent of the observed increase in water yield results from the reduction in evapotranspiration losses during April and May (Troendle and King 1985). Primary sources of water yield increase for project subwatersheds include past

timber harvest on Helena National Forest System lands and other land ownerships, as well as beetle-killed trees.

Riparian and Wetland Areas

Physical riparian habitat conditions were recorded for streams within the project area as part of the pollutant-source survey. For the most part, streams within the project area were rated to be in proper functioning condition (PFC) with the exceptions of one reach on Beaver Creek and three sites on Keep Cool Creek, which were rated functioning-at-risk. Other wetlands may exist within treatment unit boundaries, although none have been identified.

Table 146. Riparian condition and bank alteration information for the project area, by 6th-HUC watershed

6th-Huc Watershed Name	Riparian Condition*			EXCEED	Allotment(s)
	PFC	FAR	NF	BANK ALT. STANDARDS	
	(# REACHES)	(# REACHES)	(# REACHES)	(# REACHES)	
Beaver Creek	2	1		None	Stonewall
Keep Cool Creek		3		None	Keep Cool-Liverpool
Lincoln Creek	not assessed				

Not every riparian reach was surveyed in 2009—numbers should be considered minimum values.
*PFC: Properly Functioning Condition, FAR: Functioning-At-Risk, NF: Non-Functioning

Environmental Consequences

Alternative 1 – No Action

Sedimentation from Roads

Road work proposed under the action alternatives would not occur under the no-action alternative.

Table 147. Estimated average annual sediment delivery from roads to stream channels for existing condition

Watershed	Sediment Delivered for Total Road Length (Tons)
Lincoln	1
Keep Cool	6
Beaver	4
Total	**11**

Since there would be no additional disturbance to roads under alternative 1, there would be no direct short-term (less than 5 years) or long-term (greater than 5 years) detrimental sediment effects to water quality. Roads would remain in their existing conditions. Project-related road maintenance work would not occur to existing roads. There would be no sediment or water quality impacts from ground disturbing activities such as landings, tractor harvesting, road reconstruction or building, or from increased haul traffic.

Indirectly, the existing road system would continue in the short and long term to risk sediment contribution to streams, currently modeled as 11 tons per year within the project watersheds (table 147). Although old, infrequently used roads would continue to revegetate, reducing the amount of sediment produced and possibly contributed to streams; all of these old roads would continue to have varying degrees of impact to watershed hydrology and water quality. Stream channel and road fill scour, channel aggradations, and risk of sediment contribution from failure of undersized stream crossings would persist until otherwise addressed.

The no-action alternative would likely not contribute to cumulative sediment-related effects to water quality. Existing trends in water quality would likely be maintained.

No mitigation would be required under the no action alternative.

The no-action alternative is consistent with Regulatory and Forest Plan direction and would maintain existing watershed conditions

Sedimentation from Streambank Erosion and Culverts

There would be no direct long-term or short-term effects to stream channels from streambank erosion and culverts under the no action alternative.

Indirectly, the presence of undersized culverts and their continued effects on stream channel stability at and near stream crossings would continue to be a resource concern. Undersized culverts are a long-term risk for sedimentation due to the possibility of failure. There are no conflicts with plans or policies with this alternative and no mitigation would be necessary. This alternative would meet Forest Plan and Regulatory guidance related to stream channels.

Sedimentation from Other Sources

There are several documented small sediment sources in the pollutant source survey, but these sites were determined to be minor sources of sediment to channels. There are no recent burns or other large-scale disturbances identified as sediment sources in the project area.

There is no vegetation manipulation proposed in the Stonewall Project area under alternative 1; consequently, there would be no water yield increase over watershed baseline as a result of this alternative.

Water Yield

Methods for determining the effects of vegetation removal on water yield have been developed for the Helena National Forest (Pfankuch 1973), and reviewed, and refined for USDA Forest Service Region 1. The methods developed were for areas with snowmelt-dominated runoff. The equivalent clear-cut area (ECA) model is a key component of these methods. The basis of the ECA analysis is that water yield increases when vegetation is removed, whether by natural disturbance such as fire, or by human disturbance. The project area harvest history was used to determine the existing, baseline ECA and runoff values on Forest Service lands in the project area by watershed. The GIS database for the Helena National

Forest was queried to obtain all records of documented timber harvest. USGS HUC 6 watersheds were used to delineate the tributary watersheds.

The model was then re-run to estimate forest canopy and run-off changes after the proposed treatments are completed (see alternatives 2 and 3).

Table 148. Existing condition equivalent clearcut area (ECA) due to past alterations in vegetation cover in the project area

Watershed	Existing Equivalent Clearcut Area
Lincoln Creek	
Percent of Drainage Harvested:	16
Percent of Past Harvest Recovered:	31
Percent of Drainage as ECA:	7
Beaver Creek	
Percent of Drainage Harvested:	15
Percent of Past Harvest Recovered:	19
Percent of Drainage as ECA:	4
Keep Cool Creek	
Percent of Drainage Harvested:	13
Percent of Past Harvest Recovered:	28
Percent of Drainage as ECA:	3

Peer-reviewed research has suggested that in areas such as the project area, roughly 20 to 30 percent of a watershed must be treated in order to begin to attain a statistically significant increase in streamflow (MacDonald and Stednick 2003). The percent area in ECA in the Lincoln Creek drainage under current conditions is about 7 percent, and Beaver Creek and Keep Cool Creek watersheds are 4 and 3 percent respectively. Minor streamflow increases may have occurred under existing conditions within the project area watersheds. However, in drier mountains such as the project area, research has suggested that streamflow increases are reduced in that remaining trees after treatment tend to make use of most additional water made available through the reduction in transpiration brought about by tree removal (MacDonald 1987). This same concept applies to both action alternatives to some degree, especially for thinning and salvage harvest of dead trees. Clearcut harvest may have the largest potential water yield increases.

Acres of vegetation removal from timber harvest, roads and fire are converted to ECAs to provide a common datum to compare activities based on the amount of cleared area. ECAs are calculated by summing the appropriate acreage, evaluating the percentage of crown removal then assigning a hydrologic recovery value based on stand age. National Forest System roads are not recovered hydrologically and therefore are assigned a recovery value of zero. For timber harvest there is a continuum of recovery values as the stand ages.

Water yield increase is greatest immediately following vegetation removal. In years subsequent to vegetation removal, the ECA (and water yield increase) declines, or “recovers” because of vegetation regrowth. The rate of regrowth and thus ECA recovery is based on evapotranspiration, snowfall accumulation related to patch dynamics, and the relationship between water yield and changes in vegetation interception. This regrowth relationship is expressed as a recovery curve.

There are limitations of ECA and water yield analysis. Removal of existing vegetation may demonstrate increases in water yield over existing conditions, however the ECA method does not account for the fact that fire suppression has resulted in overstocked forest conditions that may have actually been reducing water yield below “normal” levels. ECA analysis assumes that stands prior to harvest are fully stocked when in reality some stands at historic conditions were not fully stocked. In addition, this analysis does not accurately account for effects of vegetation removal on other land ownerships, which is a known activity, and it does not weight estimates based on elevation and aspect, which are known to influence water yield. ECA analysis is a relative index of change that might occur, not an absolute result. It is used in combination with other information to determine the effects that the proposed activities may have.

Another method used to estimate flow increases is the W3 module of the Water Erosion Prediction Project (WEPP) Model (Laflen 2004). The W3 module is designed to specifically estimate surface water yield from a project. It evaluates drainage and precipitation patterns, and the interactions with watershed soils. The model does not accurately predict flow increases due to groundwater inputs. It is difficult to predict the water yield from water that infiltrates deeply into bedrock layers, which are tied more to groundwater yield. As a result, flow and water yield estimates are focused on surface flow increases

Water yield increase values provided in this analysis are modeled approximations for the increase in runoff volume from vegetation removal. These values do not account for the effect the road system has on routing water and changes to the hydrograph. Although we did not model water yield impacts from roads, research has shown that roads can influence peak flows (Wemple and Jones 2003).

Riparian and Wetland Areas

The effects on physical riparian condition for the no action alternative would be similar to what is depicted in the affected environment. For the most part, streams within the project area were rated to be in proper functioning condition (PFC) with the exceptions of one reach on Beaver Creek and three sites on Keep Cool Creek, which were rated functioning-at-risk. No wetlands have been identified within the project boundaries.

Irreversible and Irretrievable Commitments

An irretrievable commitment represents a temporary loss of a resource that can be replaced over time. An irreversible commitment represents a total loss of a resource that cannot be replaced. An irretrievable commitment under the no action alternative would be continued erosion and sediment delivery from project area roads at existing levels, in the absence of road improvement work of the type specified in this project.

Cumulative Effects

Several past and present Federal and other ownership activities have affected and would continue to affect water quality, water yield, and riparian health and vigor in the cumulative effects analysis area for the foreseeable future. Federal and private roads and culverts constructed at road/stream crossings in the project area have affected streams and riparian areas. There are several sediment delivery points on existing roads as described previously, and culverts represent a permanent grade control in the stream channels where they reside. These existing roads also have several road/stream crossings. Culverts at road/stream crossings in the project area watersheds were analyzed for this analysis. Undersized culverts can affect the stream’s ability to convey water and sediment, and represent an increased risk of failure and subsequent erosion and deposition of sediment into stream channels. Culverts directly interact with channels and can affect channel morphology and channel migration patterns, and local hydraulics that may influence the stream channel.

There has been past timber harvest activity in the analysis area. Land disturbed by prescribed burn and harvest activities with effective BMP application typically recovers within 5 years, based on observations of similar projects in the region. Dead trees cover a considerable area in the project area. Younger understory trees released by overstory tree mortality would eventually after a couple decades create a forest canopy and reduce evapotranspiration.

Continued grazing in riparian areas and cattle trailing along streams within grazing allotments would likely continue to contribute elevated sediment levels to streams in the watershed; although, adaptive management provisions in allotment management plans should be implemented where necessary to reduce livestock impacts. In the absence of other non-project related activities designed to reduce sediment delivery in the watershed, streams in several of the watersheds where treatment is planned would continue to receive sediment from anthropogenic sources near current rates.

In the past, mining has contributed sediment to stream channels in the watersheds. Additionally, abandoned mines can pose chronic or episodic water quality problems to forest streams.

The Stonewall project-area watersheds may be affected by large-scale tree mortality due to insect infestations. Large-scale loss of live trees may affect water yield by reducing the volume of water removed from a watershed by transpiration.

In addition, extensive tree mortality could remove the shade available and increase stream temperature in streams that cross the impacted stands. However, understory vegetation, generally unaffected by insect mortality, would continue to provide shade. Furthermore, understory and riparian vegetation exposed to increased levels of sunlight and moisture (due to overstory mortality or tree removal) can expand and provide additional shade (Gravelle and Link 2007). While an increase in incoming short-wave (solar) radiation is generally considered to be the dominant driver of stream temperature increase, numerous factors influence the extent to which a stream exposed to additional direct sunlight would have an increase in water temperature (Johnson 2004). Thus, the extent of water temperature changes resulting from overstory mortality is difficult to predict.

Alternatives 2 and 3

Alternative 2 treats 8,564 acres within the project area, and alternative 3 treats 6,564 acres. Treatment consists of a mixture of regeneration harvest, commercial thinning, non-commercial thinning, and low and mixed severity prescribed burns.

Project Design Features

The Stonewall Vegetation Project has been designed with features that are intended to minimize or avoid potential adverse effects while meeting project objectives. In addition to the proposed action treatments described in this section, design features would be implemented where applicable. A description of the project design features relating to hydrology and other resources is displayed in table 9, chapter 2.

The specific design features listed under soil, watersheds and fisheries in table 9 pertaining to hydrology are S/WS/F-18 through S/WS/F-26.

This analysis is based on the implementation of all design features. Project design features apply to all action alternatives. Design features that are applicable to hydrology include not only those listed above, designed specifically to protect water quality and water quantity, but also those designed to protect other resources.

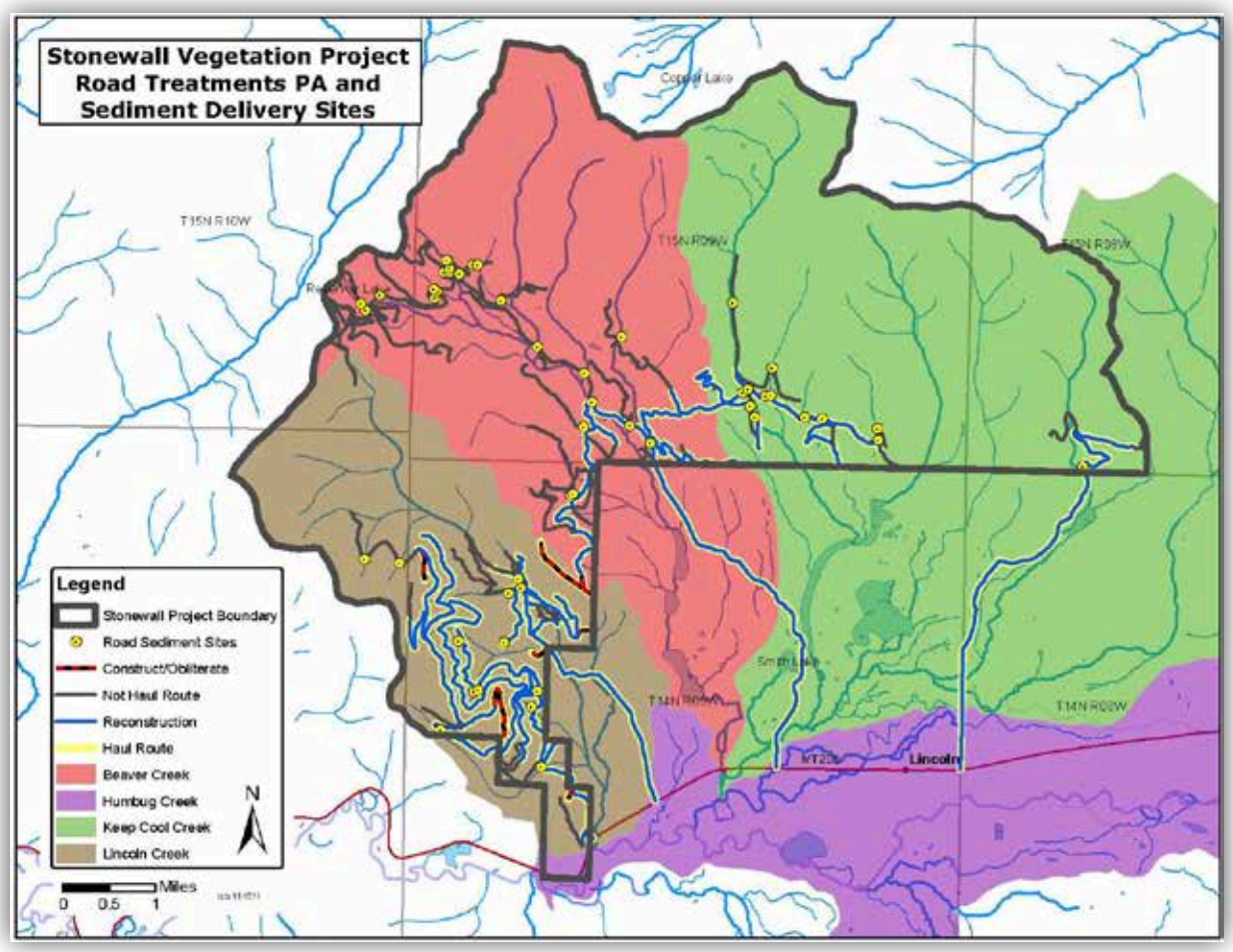

Figure 98. Sediment source areas and proposed road treatments for alternative 2- project watersheds

Effects Common to All Action Alternatives

Road maintenance and improvement best management practices (BMPs) would be applied to all roads used in the project, including application of aggregate at road/stream crossings and other sediment delivery points.

Sedimentation from Roads

WEPP Road models sediment delivery to streams mainly at road/stream crossings, often located at culvert crossings or bridges. Water concentrated on the road surface often flows down the road surface toward the low side of stream crossings, flows down the fill slope, and may enter the stream carrying sediment eroded from the road surface or fill slope. The model determines the amount of runoff that may occur from a road surface adjacent to a channel.

There should be a short-term (up to 5 years) reduction in sediment transport from roads in the project area resulting from road improvements planned in both alternatives (table 149). Forty-eight miles of road used for alternative 2 and 44 miles of road under alternative 3 would receive BMP maintenance. Project-related road improvements include surface grading, re-establishment of drainage features (grade dips and ditch-relief culverts), and application of sorted gravel at stream crossings and other sediment delivery points.

Table 149. Road obliteration and maintenance for project

Action Alternative	Roads Built For Project Use Then Obliterated (Miles)	Road Maintenance (Miles)	Total (Miles)
Alternative 2	2.6	45.6	48.2
Alternative 3	0.4	43.8	44.2

Table 150. Estimated average annual sediment delivery from roads to stream channels by sub-drainage for existing conditions and alternatives 2 and 3

Watershed	Sediment Delivered For Total Road Length (Tons)	Alternative 2&3 Sediment Delivered For Total Road Length	Project Road Sediment After Bmps Maintenance
Lincoln	1	2	1
Keep Cool	6	18	5
Beaver	4	11	3
Total	**11**	**31**	**9**

There are about 2.6 miles of roads that would be built then obliterated immediately following timber removal (new and “new specified”) planned in these alternatives. These proposed road segments are predominantly located in upland areas or areas with poorly defined drainages, and would not likely pose a risk for sediment delivery to streams. The new roads would be obliterated immediately following timber removal. See the transportation report for more information regarding roads (Bielecki 2012).

The proposed new road segment number 1 (see project area map) crosses the drainage of a headwater tributary basin to Lincoln Creek. This apparent crossing was reviewed in the field—there is a vegetated old roadbed at this site, but no stream channel or evidence of overland flow. Channel features were observed roughly 60 feet below the roadbed. Sediment that appeared to be from the old roadbed was observed in this channel, indicating that in the past, this road probably contributed sediment to the uppermost reach of this intermittent stream. If restored, this road represents a potential source of sediment to the stream channel, and should be accounted for in estimates of sediment impacts of the project. If the decision is made to construct this segment, then appropriate measures (Best Management Practices) such as adequate culverts, proper road drainage, sediment fencing (if appropriate) would be applied, and the road segment should be obliterated soon after the project ends to minimize sediment impacts.

The proposed new road segment number 5 crosses a small drainage of a headwater tributary basin to Lincoln Creek. This apparent crossing was reviewed in the field—there is an old abandoned irrigation ditch at this site, but no stream channel or evidence of overland flow. Flow may occur in the ditch during snowmelt. If the decision is made to construct this segment, then appropriate mitigations must be in place (adequate culvert, proper road drainage, and sediment fencing if appropriate) and the segment should be obliterated soon after the project ends, to minimize sediment impacts.

Many of the existing roads used to access the project area are known sources of sediment to streams, and were characterized as moderate-to high-risk in the Helena National Forest Roads Analysis Process (USDA Forest Service 2004). Project-related log hauling and other traffic would exacerbate sediment delivery: therefore, these roads present good opportunities for mitigation of potential sediment delivery from project activities, in the form of road improvements (e.g., gravel surfacing) and replacing undersized culverts.

All required State and Federal permits (e.g., SPA 124, CWA 402/404) would be obtained prior to construction of this new road.

The total reduction in average annual sediment transport from using BMPs for project haul roads was modeled to be roughly 2 tons less than the existing conditions under this alternative, based on proposed BMP maintenance and road improvements. For the road segments to be obliterated, the reduction in sediment delivery would be permanent. Without repeated maintenance, conditions on open roads would likely trend toward pre-project conditions over the next several years once the project is complete.

Sedimentation from Streambank Erosion and Culverts

Proper functioning condition surveys did not identify any areas of unstable stream banks in project watersheds. Unstable stream banks may exist in project watersheds. Where these features exist, sedimentation from accelerated stream bank erosion would continue to occur under these alternatives. Inadequately sized culverts may have a potential for increasing stream sedimentation. Some stream crossing culverts are undersized, and have the potential for removal during large flood events.

Sedimentation from Other Sources

The probability and volume of sediment delivered to stream channels from treatment units was estimated using the Disturbed WEPP model in project alternatives. Sedimentation and delivery of sediment probability reflects the variability in slope, soil type, and treatment type among units. The estimated sediment yield and probability are for the first year following treatment, and would likely return to pre-project (near zero) values within 5 years. See the soils report for more information on sediment sources in project units (Farr 2015).

Water Yield

The project-related and cumulative equivalent clearcut areas and estimated percent water yield increase that would result from proposed activities under the action alternatives are listed in table 151, and table 152. On other drainages within the Helena National Forest the State DEQ has suggested water yield thresholds of concern of 8 percent for TMDL streams and 10 percent for non-TMDL streams (Blackfoot Headwaters Planning Area: Water Quality and Habitat Restoration Plan and TMDL for Sediment, 2003).

Table 151. Equivalent clearcut area (ECA) by alternative

Huc 6 Watershed	Equivalent Clearcut Area		
	Existing	Alternative 2	Alternative 3
Lincoln Creek			
Percent of Drainage Harvested:	16	42	32
Percent of Past Harvest Recovered:	31	12	16
Percent of Drainage as ECA:	7	14	11
Beaver Creek			
Percent of Drainage Harvested:	15	29	25
Percent of Past Harvest Recovered:	19	10	11
Percent of Drainage as ECA:	4	5	5
Keep Cool Creek			
Percent of Drainage Harvested:	13	20	18
Percent of Past Harvest Recovered:	28	18	21
Percent of Drainage as ECA:	3	4	3

Table 152. Estimated percent water yield increase by action alternatives

Watershed	Percent Water Yield Increases	
	Alternative 2	Alternative 3
Lincoln Creek	4.9	3.85
Beaver Creek	1.75	1.75
Keep Cool Creek	1.40	1.05
Overall for Project Watersheds	2.13	1.75

This equivalent clearcut area analysis considered all past harvest and watershed disturbances, and the effects of reduction in forest canopy. Table 151 shows that for the proposed action, alternative 2, ECA values range from 4 percent in Keep Cool watershed, to 14 percent in the Lincoln Creek watershed. For alternative 2, for all project watersheds 23 percent of the project watersheds are in equivalent clearcut condition. For alternative 3, 19 percent of project watersheds would be in equivalent clearcut condition. In areas such as the Stonewall Project area, 20 to 30 percent of a watershed must be treated in order to begin to realize a statistically significant measureable increase in streamflow (MacDonald and Stednick 2003). Furthermore, in drier mountains such as the analysis area, research has suggested that remaining trees tend to make use of additional water made available through the reduction in transpiration brought about by tree removal (MacDonald and Stednick 2003), reducing the likelihood that predicted yield increases would be detectable in any of the study basins.

Given the number of acres that would be treated in the project watersheds under alternative 2 or 3, it is unlikely there would be a cumulative increase in water yield that would be detectable. The estimated water yield increase for project watersheds is below the DEQ-recommended threshold of 10 percent, and below the 15 percent stipulated in ARM 17.30.715. Streams emanating from project watersheds appear to lose flow as they move from steeper areas and encounter deep valley floor sediments. Considering the dry (losing stream) nature of the channels in the Stonewall Project area watersheds, the potential increase in water yield would be unlikely to cause any negative effects (i.e. accelerated bank erosion). In the event of an actual increase in water yield, the trout population could benefit from greater water availability.

Table 153. Percent estimated cumulative water yield increase over baseline conditions (%)

6th-Huc Watershed	Percent Cumulative Water Yield Increase Over Baseline		
	Alternative 1	Alternative 2	Alternative 3
Lincoln Creek	0	4.9	3.8
Beaver Creek	0	1.8	1.8
Keep Cool Creek	0	1.4	1.0

The equivalent clearcut area (ECA) method was used to calculate potential water yield increase given cumulative impacts in the Lincoln, Beaver Creek, and Keep Cool Creek watersheds. Table 153 shows that results for the action alternatives suggests an increase of 4 to 5 percent in the Lincoln watershed, about 2 percent in the Beaver Creek watershed, and 1 to 1.5 percent in the Keep Cool Creek watershed, depending on alternative. The project, when combined with other recent, past and reasonably foreseeable actions was predicted to result in a theoretical combined increase in water yield from project watersheds of 2.1 percent at the confluence with the Blackfoot River. Given the dry/losing character of the stream channels in the project area, any change in water yield as a result of the project would be difficult to detect, particularly considering that the majority of the ECA is from past or existing land use activities. Recent

stream flow records at the nearby Helena National Forest Deep Creek monitoring site have not shown clear evidence of higher stream flow under the existing conditions. The small incremental potential increase posed by this project would likely not measurably change flow conditions. However, if a water yield increase were detectable, it would almost certainly be within acceptable limits for TMDL streams. In other drainages within the Helena National Forest, the State DEQ has suggested water yield thresholds of 8 percent for TMDL streams and 10 percent for non-TMDL streams (Montana DEQ 2004).

The W3 module of the Water Erosion Prediction Project (WEPP) Model was used to estimate unit discharges for different treatment types for the project. Results provide a rough estimate of potential flow increases. The model evaluates drainage and precipitation patterns, and the interactions with watershed soils. The model does not accurately predict flow increases due to groundwater inputs. It is difficult to predict the water yield from water that infiltrates deeply into bedrock layers that are tied more to groundwater yield. As a result, flow and water yield estimates are focused on surface flow increases. These estimates are based on the hydrology of headwater areas in each of the project watersheds, and are likely less than what was calculated in the model. None of these results exceeds Forest Plan standards.

Table 154. WEPP W3 module predicted flow increases for the project area

Watershed	Runoff (Acre-Feet/Year)			
	Alternative 2	Alternative 3	Average Annual Surface Runoff	Percent Runoff From Project
Lincoln Creek	1,611	1,255	15,844	8
Beaver Creek	2,175	569	24,372	2
Keep Cool Creek	2,191	1,793	47,906	4

Riparian and Wetland Areas

For both action alternatives, riparian areas would have at least a 50-foot no-ignition buffer around ephemeral, intermittent, and perennial channels for slopes less than 35 percent, and a 100-foot buffer for slopes more than 35 percent. Additionally, the standard SMZ-law protection prohibits the operation of ground-disturbing equipment within riparian areas. Therefore, activities proposed under these alternatives would not adversely affect riparian areas. Streams within the project area would generally remain at proper functioning condition. The notable exceptions would be the functional-at-risk stream segments. These stream segments are expected to remain in that condition under this alternative.

No wetlands have been identified within the project area boundaries. If wetlands are identified during unit marking, they would be avoided by heavy equipment unless during winter conditions. Wetlands over one acre connected to stream channels would be protected by a no-harvest SMZ buffer. As noted above there would likely be small increases in water yield in project-area streams under this alternative. However, these minor changes are not expected to change the PFC ratings for any of the streams within the Stonewall Project area.

Irreversible/Irretrievable Commitments

An irretrievable commitment represents a temporary loss of a resource that can be replaced over time. An irreversible commitment represents a total loss of a resource that cannot be replaced. Any sediment delivery to streams resulting from implementation of this project would be an irretrievable commitment, in that the stream would recover from the influx of additional sediment over a period of years to decades. However, if all appropriate harvest and road BMPs are carefully and consistently applied, it is unlikely that any irretrievable commitments would result from project implementation (Montana DNRC 2008).

Furthermore, reductions in sediment delivery due to project road improvements were estimated to exceed the potential sediment delivery related to project activities.

Cumulative Effects

Past, present and reasonably foreseeable Federal and other ownership actions within the analysis area are described previously in the section for alternative 1, and can be found in volume 2, appendix C. These impacts include mining, wildfires, timber harvest, and recreation. The cumulative impact of alternatives 2 and 3 in concert with other impacts in the analysis area would be a net reduction in short-term and long-term sediment delivery to stream channels. The short-term reductions would come from road surfacing and drainage improvements. Long-term reductions would result from road obliteration. These reductions in sediment delivery would more than offset the low-probability of the predicted short-term increase from treatment unit erosion, as well as any sediment delivery associated with road improvements and obliteration.

Conclusions

The proposed project identifies two action alternatives. Alternative 2 treats 8,564 acres, and alternative 3 treats 6,564 acres with a range of harvest and burning prescriptions. Primary water resource concerns stemming from this project include potential sediment conveyance to streams from project treatment units, and potential increased water yield due to removal of vegetation. Field sediment surveys identified road segments that were capable of delivering sediment to ephemeral, intermittent, or perennial stream channels. The WEPP:Road model was used to predict the average annual sediment conveyance for each road segment, as well as the probability that sediment would be delivered from the road segment in a given year. The model was run for existing conditions as well as conditions under each action alternative. Under all project alternatives, overall reductions in sediment delivery to stream channels due to application of road BMPs and road obliteration are expected. Results suggest that under existing conditions, roughly 11 tons of sediment is delivered from roads to Lincoln, Beaver, and Keep Cool Creeks in an average year (table 150). With design features proposed in this project, sediment delivery from roads would remain one ton per year for Lincoln Creek, reduced by about one ton each for Beaver and Keep Cool Creeks. Overall sediment delivery reduction for alternatives 2 and 3 during the project is estimated to be about 2 tons. While road improvement and road obliteration activities may temporarily increase sediment delivery to stream channels, the design features proposed in this project would reduce sediment delivery to project area tributaries of the Blackfoot River over the long term (alternatives 2 and 3), leading to improved conditions in project watersheds.

The project has the potential to increase water yield in Lincoln Creek, Beaver Creek, and Keep Cool Creek. A water yield increase above 10 to 15 percent may be of concern in that the flow increase could accelerate bank erosion. Water yield increase is less likely to be an issue in the project area due in part to lower annual precipitation levels, to the dry/losing character of the streams in these watersheds, and to the relatively small footprint of the project. The Equivalent Clearcut Area (ECA) and the WEPP W3 method was used to calculate potential water yield increase given cumulative impacts in the Lincoln, Beaver Creek, and Keep Cool Creek watersheds. Results suggested an increase of up to 8 percent in the Lincoln watershed, 2 percent in the Beaver Creek watershed, and up to 4 percent in the Keep Cool Creek watershed, depending on alternative (table 153 and table 154) and analysis method. The project, when combined with other recent past and reasonably foreseeable actions was predicted to result in a theoretical combined increase in water yield from project watersheds of about 5 percent at the confluence with the Blackfoot River. These levels are within State DEQ recommendations for TMDL and non-TMDL streams elsewhere on the Helena NF. If predicted water yield increases did occur, the modest additional flow would likely improve stream temperature and in-stream physical habitat, rather than cause any degradation. The project is unlikely to significantly affect the condition of riparian areas in the project

area, given the 50- to 100-foot riparian no-ignition buffers in place for all action alternatives. The project is unlikely to affect the condition of any wetlands found in the project area, in that these areas would either be avoided entirely, or would be treated only by hand crews or by equipment during winter operating conditions.

In summary, the proposed project would have relatively minor impacts to water resources in the project watersheds under the action alternatives. Through implementation of design features and application of BMPs, the project alternatives would most likely reduce short- and long-term sediment delivery to stream channels, improving or maintaining water quality in the Blackfoot River headwaters watershed. Alternatives 2 and 3 would also reduce long-term sediment delivery through improving road BMPs at stream crossings. Water yield change due to proposed project activities is predicted to be at the margins of detectability and is not anticipated to have any deleterious effects on channel stability or water quality

Fisheries

Introduction

This section documents existing condition and environmental consequences to aquatic resources from the proposed Stonewall Vegetation Project, and also discusses the potential effects to Forest Service sensitive, management indicator species (MIS), and Endangered Species Act (ESA) listed aquatic species westslope cutthroat trout (*Oncorhynchus clarki lewsi*), bull trout (*Salvelinus confluentus*), and western pearlshell mussel *(Margaritifera falcata).*

Table 155. Analysis area species

Species	Species Status	Present In Project Area: Habitat Or Detections
Fishes		
westslope cutthroat trout (*Oncorhynchus clarki lewsi*)	USFS Sensitive	Yes Habitat and Detections
bull trout (*Salvelinus confluentus*)	ESA Threatened	Yes
Invertebrates		
western pearlshell mussel *(Margaritifera falcata)*	USFS Sensitive	No Detections but predicted habitat

Overview of Issues

Comments pertaining to disclosing the effects of project activities on fisheries were identified from public scoping as nonsignificant (40 CFR 1501.7), and are addressed by the analyses in this section. Please refer to volume 2, appendix A of this document for a complete listing of the issues and an explanation of how the agency determined their disposition. Comments indicated concern that roads built then obliterated immediately following timber removal, road reconstruction, and use of existing roads would adversely impact fisheries. See the Transportation section for more information about roads.

Indicators

Indicators are defined to analyze data regarding the potential for increases to sediment delivery and changes to the timing of peak flows from project activities that may affect cutthroat trout habitat.

Change in stream habitat conditions for westslope cutthroat trout (MIS), bull trout and other aquatic species

1. Changes in stream function
    a. Change in sediment delivery to streams
    b. Change in fines by depth
    c. Change in the timing or increases in the magnitude of stream flows

Change in characteristics of riparian areas

1. Change in miles of motorized routes in RCAs
2. Acres of riparian treatments

Affected Environment

Introduction

This section presents existing conditions and trends for aquatic resources within the Stonewall Vegetation Project planning area. Information is organized under two major subsections: ***fish populations*** and ***fish habitat***. The first discusses the status and distribution of fish populations inhabiting the planning area; this includes discussions about nonnative and native fish populations. The second subsection provides an overview of fish habitat including land-use activities that influence trends in stream habitat conditions.

Analysis Area

The Stonewall Project area encompasses three sub-watersheds (tributaries) of the Blackfoot River watershed. Natural processes and land-use activities unique to each sub-watershed influence local fish populations and their habitats independently of other watershed units of the same scale. The geographic area of preference is the watershed scale delineated at the 6th field hydrologic unit code (HUC), namely Lincoln Gulch, Beaver Creek, and Keep Cool Creek. These boundaries are appropriate for addressing direct, indirect and cumulative effects upon fish populations occurring within each of these 6th field HUCs (sub-watersheds). The cumulative effects area, however, extends to mainstem Blackfoot River because it receives waters from the project planning area.

Existing Condition

Salmonid fishes present within the project area include westslope cutthroat trout, bull trout, brown trout, brook trout and mountain whitefish. Other fish species present include sculpins and suckers. Historically, most project area perennial streams suitable to support a fishery were likely occupied by various native fish. The introduction of nonnative salmonids, including brook, brown and rainbow trout, within portions of the Blackfoot River drainage, has changed the fish species composition somewhat in the project area. The current salmonid fish species composition within the project area is summarized by streams in table 156 that follows. The upper limits of salmonid fish distribution by species, as determined from sampling by Forest Service personnel, is depicted on fish distribution maps included in the project file, and reflected in geographic information system (GIS) maps included with this analysis (Fisheries Report Rief 2012).

Table 156. Fish species by stream in the Stonewall Project area

Stream	Salmonid Fish species present on forest based on sampling *	WCT genetic status	Comments
Lincoln Gulch Unnamed tributary NW ¼ S 20 T14N R9W Unnamed tributary SW ¼ S8 T14N R9W Unnamed tributary SW ¼ S9 T14N R9W	No fish on forest No fish, but does have perennial flow No fish; intermittent flows eb		Intermittent flows and extensive mining impacts limit fishery throughout much of the Lincoln Gulch drainage.
Beaver Creek Theodore Creek Yukon Creek Klondike Cr Unnamed tributary to Yukon Creek	Wct, eb, bt, LL Wct,eb, bt Wct, eb Wct and bt Wct	Genetically pure Assumed pure Assumed pure Assumed pure Assumed Pure	Bull trout are known to have been present in Beaver, Klondike, and Theodore creeks. The probability of bull trout to be present is low in other streams, but because habitat is suitable to support them bull trout are assumed present.
Stonewall Cr	Wct	Genetically Pure	Probability of bull trout to be present is low on Forest but because habitat is suitable to support them bull trout are assumed present. Bull trout may be present off forest. Brook and brown trout present on nonfederal lands.
Park Creek	Wct	Genetically Pure	Probability of bull trout to be present is low on Forest but because habitat is suitable to support them bull trout are assumed present. Bull trout may be present off forest.
Liverpool Creek	Wct	Genetically Pure	Probability of bull trout to be present is low on Forest but because habitat is suitable to support them, bull trout are assumed present. Bull trout may be present off forest.
Sucker Creek	Wct	Assumed pure	Probability of bull trout to be present is low on Forest but because habitat is suitable to support them bull trout are assumed present. Bull trout may be present off forest.
Keep Cool Creek	Wct and eb	Genetically pure	Bull trout are known to be present on nonfederal lands below the Forest.

* Fish Species: wct –westslope cutthroat trout, eb- eastern brook trout, LL-brown trout, bt- bull trout, wf-mountain whitefish

Threatened, Endangered and Sensitive Aquatic Species

Bull Trout

On July 10, 1998 bull trout (*Salvelinus confluentus*), were listed as Threatened within the Columbia River Basin by the U.S. Fish and Wildlife Service (USDI Fish and Wildlife Service 1998). Section 7(a) (2) of the Endangered Species Act (ESA) of 1973 as amended requires all federal agencies to review actions authorized, funded, or carried out by them to ensure such actions do not jeopardize the continued existence of listed species.

The distribution of bull trout is limited to drainages west of the continental divide on the Helena National Forest with the strongest populations being present in the Blackfoot River drainage. Bull trout are present in extremely low numbers within the Little Blackfoot River drainage. Table 156 lists the streams known currently to support bull trout in the project area.

The Inland Native Fish Strategy (USDA 1995), established priority drainages for bull trout, however, none are found within the project area. Importantly, special emphasis watersheds for bull trout were later designated throughout Region 1 of the Forest Service to supplement the INFISH priority watersheds, but none are found within the project area.

Designated critical habitat for bull trout includes reaches of the Blackfoot River and several tributaries in the Blackfoot drainage. All critical habitat for bull trout in the Blackfoot River is located downstream of the project area.

A Draft Bull Trout Recovery Plan was completed in 2005 (USDI Fish and Wildlife Service 2005). The Draft Recovery Plan was revised in 2014 (USDI FWS 2014) and to be finalized in 2015. Under the Draft Recovery Plan, bull trout within various drainages are organized by core populations and then by local populations within those core population areas. It is important to note that there are no local populations of bull trout located currently within the project area, but it is likely that some bull trout from Beaver Creek contribute to the overall Blackfoot Core Population. The information on the bull trout core population that follows is based on information from the U.S. Fish and Wildlife Service as well as knowledge from local fishery biologists from the Forest Service, and Montana Fish, Wildlife, and Parks.

Blackfoot Core Bull Trout Population

Bull Trout in the Blackfoot River are included as a core population in the Draft Bull Trout Recovery Plan (2005 and 2014). There are several local populations identified within the Blackfoot Core Bull Trout Population; including the North Fork of the Blackfoot River, Monture Creek, Landers Fork/Copper Creek, Cottonwood Creek, Belmont Creek, and Gold Creeks.

Based on redd counts and limited electro-fishing efforts, it is likely that there are somewhere between 400 to 500 adult bull trout between the 5 local populations. Additional adult bull trout are in numerous other streams throughout the core population area, and in some of the designated INFISH Priority Watersheds and Special Emphasis Watersheds, as well as in undesignated streams. The overall number of bull trout adults included in all of the streams throughout the Blackfoot drainage is probably less than 800 when combined with the adults in the local populations. Recent redd surveys suggest that four of the five Local Populations are declining somewhat while the Copper/Landers population is improving.

Bull trout may suffer from some competition with brown trout and predation in the main stem Blackfoot River, although there is no field documentation of this hypothesis. Both species occupy some of the same habitat and eat some of the same foods and both species are highly piscivorous. Consequently, the hypothesis seems reasonable. With temperatures in the main stem Blackfoot rising based on information

collected by the Montana Department of Fish, Wildlife and Parks over the last 10 years (Pierce et al. 2008, pp. 32 and 33); brown trout may be gaining some competitive edge over bull trout.

Interactions of bull trout with brook trout occur mostly in tributary streams rather than the main stem Blackfoot River. Brook trout are present in some of the local bull trout populations and many of the other streams in the Blackfoot River drainage, so there is some additional threat of decreased bull trout production due to hybridization. Additional discussion on aspects of bull trout biology and interactions with other species as a function of proposed project activities are addressed further in the biological assessment.

Westslope Cutthroat Trout

Westslope cutthroat trout (WCT) are a designated sensitive fish species by the Forest Service and are included as a management indicator species in the Helena Forest Plan. Westslope cutthroat trout are found within all the streams in the project area known to support a fishery with the exception of the tributary to Lincoln Gulch, which is known to support only brook trout. There is a strong WCT fluvial population functioning in the Blackfoot River drainage. Fluvial WCT may also be using the reaches of other streams in the project area below the Forest Service boundary. Several publications from the Montana Department of Fish, Wildlife and Parks between the mid-1990s and 2007 provide extensive discussions of WCT movements and life history in the Blackfoot drainage.

It is important to maintain viability of the westslope cutthroat trout conservation populations to reduce the risk of the species being listed under the Endangered Species Act (ESA). Currently, the WCT in the Blackfoot River are a conservation population, and with the exception of those above Nevada Creek Reservoir, function as a single meta-population. The population consists of both fluvial and resident components (Pierce et al. 1997, p. 73). Radio tracking of WCT indicates wide-ranging movements and use of various tributaries for spawning (Pierce et al. 2004, pp. 63-78).

The potential for loss of viability for the Blackfoot River WCT conservation population is presumed to be low due to the extensive distribution of WCT throughout the drainage, and the presence of a functioning fluvial population. However, nonnative fish especially brook trout and to some degree brown trout, are likely competing with and sometimes preying on WCT in portions of the Blackfoot River and selected tributaries.

Western pearlshell mussels

Western pearlshell mussels (*Margaritifera falcate*) may be one of the longest living freshwater invertebrates and animals. Specimens have been aged at greater than 90 years (Vannote and Minshall 1982). The western pearlshell mussel has an elongate shell, typically 2.5-4 inches long with a concave ventral edge. The interior shell has a purple to pink hue as the outside shell is dark brown to black. These mussels are found in cool, stable running, generally low to moderate gradient streams and rivers. Swift stream velocities can limit where mussels can occur in streams. They are most commonly found in stable gravel and pebble benthic substrate, but can occur in sand or gravel among cobble and boulders in moderate to higher gradient larger rivers. They usually occupy reaches of stream where the riparian zone is dominated by willows or alders.

The larval stage of this mussel (glochidia) briefly parasitizes a host fish, westslope cutthroat trout, by attaching to the gills. They fall off the host as a juvenile mussel. The larval parasitism on fish enables upstream transport to habitats otherwise difficult to reach by relatively immobile adult mussels. Western pearlshell glochidia are considered highly host specific (Bauer 1987) as they are typically restricted to salmonid fishes.

The western pearlshell mussel continues to experience significant range reductions over the last 100 years. The primary cause of stream habitat deterioration in Montana is high fine sediment load, related to agricultural practices, which is one of the most serious pollutants of streams systems. Excess fine sediment can degrade mussel habitats by decreasing substrate permeability. This has a smothering effect on juvenile mussels and limits successful recruitment (Stagliano 2010).

The Montana Natural Heritage database contains no records for this species in the project area, although they have been found in the Blackfoot River downstream of the project area. Habitat predicted as suitable for western pearlshell mussels is present in a portion of the project area where Westslope cutthroat trout are present. Based on this information, we believe pearlshell mussels could be present in the analysis area.

Aquatic Habitat

Streams currently known to support fisheries located within this analysis area include Beaver Creek, and tributaries to Beaver Creek which include Yukon Creek, Theodore Creek and Klondike Creek. Stonewall Creek also supports a fishery. The lower reaches of Beaver Creek and Stonewall Creek are located on private and State land. Both flow into the Keep Cool drainage within 3 miles above the confluence with the Blackfoot River.

Lincoln Gulch

Lincoln Gulch is a second-order tributary that enters the Blackfoot River at river mile (rm) 103.6. The upper 4.4 miles of Lincoln Gulch watershed is located on the Forest. Lincoln Gulch drains the eastern slopes of Black Mountain. The lower 2.6 miles flows through private agricultural land and a residential housing area. Lincoln Gulch shows impacts from mining, grazing and agricultural activities. In the headwater areas mining impacts and channelization are extensive. Fish surveys found brown trout and sculpin at mile 0.1. Surveys conducted higher in the watershed found no fish (Pierce and Podner 2006).

Beaver Creek

This stream forms near Reservoir Lake and is a third-order tributary to Keep Cool Creek, entering 0.7 miles upstream of the Keep Cool Creek confluence with the Blackfoot River (rm 105.2). Beaver Creek has a total of 20.1 stream miles of which 14.3 miles are perennial. In the Beaver Creek drainage on NFS land, past and present road construction, timber harvest and livestock grazing have influenced habitat conditions by increasing the sediment delivered to the stream. The lower reaches of Beaver Creek are located on private and State lands that support agricultural uses. There are some reaches where livestock grazing has negatively influenced bank stability (Peters 1990) and some isolated bank damage occurs from livestock grazing on the Forest. Bank trampling from livestock is limited in the higher reaches due to the inherent resistance of the stream channel type and the vegetation adjacent to the streambank. A water diversion is present just below the Forest boundary which partially dewaters the stream. This diversion was recently upgraded to provide fish passage. Beaver Creek maintains a moderate gradient originating at Reservoir Lake.

Fish habitat is in relatively good condition with good quality cover for fish present throughout the reaches evaluated. The amount of cover present is somewhat low on some of the reaches with quality pools estimated to be present at around 15 to 20 percent. Past beaver activity has been very important in the formation of habitat on selected reaches of stream downstream of Yukon Creek. Spawning gravels contain an average of 30.5 percent fines. Recreational fishing does occur on this stream within the Forest, but the intensity of fishing and the amount of harvest is unknown. Downstream of NFS lands, Beaver Creek is at least partially dewatered for irrigation and the stream gradient drops to near 1 percent in the vicinity of beaver activity (USDA 1995b).

Discharge was 10.7 cfs 0.50 mile above the mouth on August 31, 1989. Fine sediment levels in spawning gravels were found to average 33 percent in Beaver Creek with a range of 17 to 55 percent. In comparison, an unmanaged drainage of similar geology that had undergone high sediment delivery from fire averaged 27 percent with a range of 19 to 32 percent (Peters 1990).

Theodore Creek

The Theodore drainage shows past timber activity in the lower reaches. The lower reaches are located in the Stonewall allotment. This stream is a tributary to Beaver Creek that originates south of the Scapegoat Wilderness. The entire drainage lies within the Forest. Electro-fishing evaluations have shown that the lower reaches are dominated by cutthroat trout with a few brook trout also present. The upper reaches were found to support cutthroat trout exclusively. Fish distribution extends upstream into section 21 (T15N R9W). Abundance of salmonids over 6 inches in length was estimated at 160 per mile of stream while the maximum size obtained was around seven inches. It is likely that some of the cutthroat trout from Theodore Creek recruit downstream to Beaver Creek. Historical sampling in 1987 documented three bull trout in Theodore Creek below the road culvert on 4106 near the mouth.

Habitat conditions on the reaches evaluated were very good in Theodore Creek. Much of the pool habitat in the stream is formed by large rubble cascades and woody debris. Spawning gravels were found to average 32.1 percent fines. Theodore Creek is too small to support much if any recreational fishing and no evidence of use by anglers was noted during survey evaluations (USDA Forest Service1995b).

Yukon Creek

This drainage is entirely within the Forest and is a tributary to Beaver Creek. The lower reaches show evidence of some timber harvest activity. The lowest reaches are within the Stonewall allotment. Yukon Creek is dominated by cutthroat with some brook trout present in the lower reaches. Abundance was estimated at 220 fish per mile of stream over 6 inches in length. Fish distribution extends upstream into section 17 with the headwater reaches likely supporting only cutthroat trout. This stream is important for providing recruitment of cutthroat trout to Beaver Creek. Walk-through evaluations indicate that habitat is in good condition. Some sediment delivery to the stream is still occurring at the upper culvert site which was constructed several years ago, however seeding the site has helped to mitigate the delivery.

Spawning substrates contain 34.2 percent fine sediment on the average. Yukon Creek is large enough to support some recreational fishing, but no evidence of fishing use was observed. In 1992, two instream pool structures were constructed to increase fish habitat capability (USDA Forest Service 1995b).

Unnamed Tributary to Yukon Creek

This stream is a tributary to Yukon Creek and is located entirely on the Forest. This drainage shows evidence of past timber harvest activity. Only the lowest reach containing the confluence with Yukon Creek is located in the Stonewall allotment. This is a very small stream that was found to support only cutthroat trout. Abundance of fish over 6 inches in length is 70 per mile of stream. The distribution of fish extends upstream in section 19 (T15N R9W). This stream probably provides for recruitment of cutthroat trout to Yukon and Beaver Creeks. Walk-through evaluations indicate that habitat is in relatively good condition. Spawning gravels measure 35.1 percent fines (USDA Forest Service1995b).

Klondike Creek

This drainage shows evidence of past timber harvest activity. The lower reaches are located within the Stonewall allotment. This stream is a tributary to Beaver Creek and is entirely located on the Forest. The stream is dominated by cutthroat trout with an occasional brook trout. Historical sampling in 1987 documented a single bull trout in Klondike Creek. Fish distribution likely extends upstream into section

20. The maximum size of fish obtained during sampling was just less than 7 inches in length. Abundance of fish over 6 inches in length was estimated at 120 per mile of stream. This stream also provides recruitment of cutthroat to Beaver Creek. Walk-through evaluations indicate that habitat conditions are relatively good with numerous small pools formed by large rubble and woody debris. Spawning gravels averaged 32.7 percent fines. Klondike Creek is too small to support recreational fishing, but in an attempt to increase habitat capability eight instream pool structures were constructed in 1992 (USDA Forest Service 1995b).

Stonewall Creek

Stonewall Creek has a total stream length of 9.0 miles of which 3.8 miles are perennial. The Stonewall drainage shows evidence of past timber harvest in the middle reaches. A portion of the lower reaches is located in the Stonewall allotment. A small patented mine is located in the upper reaches. The lowest reaches are located on private ranch land and are seasonally dewatered before reaching Keep Cool Creek. In Stonewall Creek, fine sediment levels were found to average 31 percent with a range of 21 to 50 percent as compared to an undisturbed stream of similar geology having an average of 20 percent with a range of 11 to 26 percent. Other habitat parameters have not been measured. Cutthroat trout are common in the drainage (USDA Forest Service 1995b). On private land, Stonewall Creek shows effects from agricultural uses. Stonewall Creek flows through a large wetland on private land before its confluence with Keep Cool Creek.

Park Creek

Park Creek is a second-order tributary to Stonewall Creek. Park Creek has a total stream length of 6.1 miles, of which 2.9 miles are perennial. The headwaters and upper reaches of Park Creek are located on the Forest; the lower reaches are located on private land. The creek may be dewatered in the lower reaches. Spawning gravel quality has not been measured. Cutthroat trout have been determined to be genetically pure but are uncommon in Park Creek.

Liverpool Creek

The headwaters and upper reaches of Liverpool Creek are located on the Forest, and the lower reaches are located on private land. This drainage is located within the Keep Cool Liverpool allotment. The stream has been channelized by mining on the Forest. Eight drop-log structures have been built in the creek to provide much needed pool habitat. One downed tree was placed in the creek to provide for rearing habitat. A portion of the area mined has been reclaimed, but occasional suction dredging continues in the channel. Spawning gravels are common in the stream. Below the area mined spawning gravel quality measured 42.7 percent fines. Above the mined area spawning gravels measured 25.4 percent fines. Obviously, mining has had negative effects on the quality of spawning habitat in Liverpool Creek. Cutthroat trout are common both above and below the mined area (USDA Forest Service 1995b).

Sucker Creek

Sucker Creek has a total length of 3.0 miles, of which 2.5 miles are perennial. Only the headwaters of Sucker Creek are located on the Forest. The middle and lower reaches are located on private land. Timber harvest and road construction has taken place in the drainage. Sucker Creek drainage is located in the Keep Cool Liverpool allotment. Spawning gravel quality has not been measured. Cutthroat are rare in some reaches and in higher densities in other reaches, and are presumed genetically pure in Sucker Creek (USDA Forest Service 1995b).

Keep Cool Creek

Keep Cool Creek is the largest spring creek in the Lincoln Valley. It forms north of Lincoln from both an alluvial groundwater aquifer and small basin-fed streams in its headwaters. It is joined at the mouth by

Beaver Creek (mile 0.7) and Lincoln Spring Creek (mile 0.5) before entering the Blackfoot River at mile 105.2. The combined flow of this stream system provides a significant percentage of the upper Blackfoot River flow during low flow periods. Excessive livestock access to riparian areas has degraded portions of Keep Cool Creek and its tributaries. Other mainstem fisheries-related impairments include channel alterations and irrigation practices.

Keep Cool Creek has a total length of 10.7 miles, of which 2.0 are perennial. The upper and middle reaches of Keep Cool Creek are located in the Helena Forest. The lower reaches are located in private land. The upper elevations of the drainage show evidence of timber sale activity and are heavily and roaded. The drainage is within the Keep Cool Liverpool allotment. Spawning gravels just above the Forest boundary measure 47.2 percent fines. Spawning gravels are common in this area; however, the flows become very low early in the season. Cutthroat trout are common in Keep Cool Creek (USDA Forest Service 1995b).

Recently, radio telemetry confirmed bull trout from the Blackfoot River use the lower portion of Keep Cool Creek (Pierce et al. 2004). Water temperature monitoring at two locations found maximum summer temperatures of 75.2 ^{o}F in Keep Cool at the Sucker Creek Road compared to a high of 62 ^{o}F downstream at the Beaver Creek Road. This cooling results from large inflows of groundwater between these two sites (Pierce et al. 2004).

Table 157 that follows, lists streams that support resident fish populations in the project area that have been sampled for sediment (less than 6.4 mm) by depth using McNeil core sampling methods to quantitatively establish estimates of fines in fish reproductive habitat.

Table 157. Summary of mean percent fines (<1/4 inch dia.) in spawning habitat of select streams as an indicator of cumulative effects from past and ongoing cumulative effects by 6th-field HUC

6th-Field HUC sub-watershed (name)	Stream(s) sampled for sediment analysis	Mean % fines in spawning habitat *	USEPA reference Standard (%) **	Roadless Area reference (%)
17010203 (Beaver Creek)	Beaver Creek	30.9	32.5	31.9
	Yukon Cr	34.2		
	Tributary to Yukon Cr	35.1		
	Theodore Cr	32.2		
	Klondike Cr	32.7		
17010203 (Stonewall/Park)	Stonewall Cr	31.6	32.5	31.9
	Park Cr	45.4		
17010203 (Lincoln Gulch)		Not sampled as no fishery present in most of the drainage	32.5	31.9
17010203 (Sucker/Liverpool)	Liverpool sw 1/4	42.7	32.5	31.9
	Liverpool nw 1/4	25.4		
	Sucker Cr	Not sampled		
	Keep Cool Cr	47.2		

*Averages for individual years are detailed in Fish Information for Stone Dry Watershed Analysis (Burns 2006).

** Reference standard developed from Helena National Forest Data in the Lake Helena Watershed

Summary of Fish Habitat

Fish habitat in the planning area is basically the product of interactions among underlying geologies, soils, topography, vegetation, climate and hydrology unique to the watershed (Meehan 1991, p. 5; Swanston 1991, p. 139). These drainage characteristics and processes remain fairly constant, setting up conditions for optimum productivity of aquatic life forms (Meehan 1991, p. 5). When natural disturbance reshapes stream channels, the actual effects of such changes on aquatic organisms are often short term. In their natural context, accessory processes like fire, flood flows, insect infestations, and animal activities (e.g. beaver) operate on the stream system to produce improved habitat quality and productivity in the long term (Swanston 1991, p. 139-142).

Human land-use activities can disrupt the balance of these interactions producing persistent changes in habitat that can reduce natural fish production and population viability (Meehan 1991, pp. 1-6; Waters 1995, pp. 1, 17). The Stonewall Project area has historically implemented projects such as timber harvest, livestock grazing, mining, recreation and transportation. Cumulatively, these activities impair stream structure and function to varying degrees by increasing erosion and sedimentation, impacting water quality, altering flows, reducing vegetation cover, and destabilizing or degrading channels. Past and ongoing actions, including the transportation system that has been assessed for hydrologically connected sediment delivery sites and culvert crossings, cumulatively set the stage for existing conditions of sediment in fish reproductive habitat. Without mitigation or other corrective actions to protect and recover habitat, these factors suppress the natural fish production capabilities (carrying capacity) of streams (Hicks et al. 1991, pp. 484-485).

Environmental Consequences

Alternative 1

Direct and Indirect Effects

Under alternative 1 there would be no new road or ground based timber harvest to change the level of sediment delivered to streams. Sedimentation levels may change due to ongoing management. Taking “no action” to address motorized roads and trails in managed watersheds (like those in the project area) almost always results in the same or increased levels of sedimentation over time. Hydrologically linked roads, a significant unnatural source of chronic sedimentation, would remain untreated contributing 11 tons of sediment in excess annually within project watersheds. Although old, infrequently used roads would continue to revegetate, reducing the amount of sediment produced and possibly contributed to streams; all of these old roads would continue to have varying degrees of impact to watershed hydrology and water quality. Stream channel and road fill scour, channel aggradations, and risk of sediment contribution from failure of undersized stream crossings would persist until otherwise addressed.

No timber harvest is proposed under the no-action alternative, and therefore no change in the timing or magnitude of peak flows is expected. Alternatively, there would be no measures taken to promote change in function for any stream within the project area that is not currently at desired conditions.

Alternative 1 would fail to promote improvement in stream habitat conditions for Westslope cutthroat trout (MIS), bull trout or for other aquatic populations that exist in streams. Thus, certain aquatic populations would remain at lower densities than those in streams that are functioning properly and where habitat quality and quantity are nearer potential. Average fine sediments in trout spawning habitat would remain elevated in some of the project area streams (table 157) in contrast to approximately 33 percent average fine-sediment levels determined for reference streams across the Helena National Forest.

Alternative 1 would fail to promote improvement in riparian habitat conditions in the project area. Because there would be “no action” there would be no measures taken to change the function for any riparian area within the project area.

Alternatives 2 and 3

The Stonewall Vegetation Project has been designed with features that are intended to minimize or avoid potential adverse effects while meeting project objectives. In addition to the proposed action treatments described in this section, design features would be implemented where applicable. A description of the project design features relating to fisheries and other resources is displayed in table 9, chapter 2.

The specific design features listed under soil, watersheds and fisheries in table 9 pertaining to hydrology are S/WS/F-15, S/WS/F-16, and S/WS/F-17.

This analysis is based on the implementation of all design features. Project design features apply to all action alternatives. Design features that are applicable to fisheries include not only those listed above, designed specifically to protect fish and fish habitat, but also those designed to protect other resources such as soils and water quality/quantity.

Effects Common to All Action Alternatives

Roads

Road maintenance and improvement best management practices (BMPs) would be applied to all roads used in the project, including application of aggregate at road/stream crossings and other sediment delivery points. Project design features apply to all action alternatives (table 9).

There would be a short-term (5-7 years) reduction in sediment transport from roads in the project area resulting from road improvements planned in this alternative. Forty-eight miles of road proposed for hauling in alternative 2 and 44 miles of road proposed for hauling under alternative 3 would receive BMP maintenance (table 149 in the Hydrology Section). Project-related road improvements include surface grading, re-establishment of drainage features (grade dips and ditch-relief culverts), and application of gravel at stream crossings and other sediment delivery points. Sediment levels would increase during the project as a result of ground disturbance during maintenance and when culverts are installed (table 150 in the Hydrology Section). There are about 2.6 miles of road that would be built then obliterated immediately following timber removal (new and “new specified”) planned in these alternatives. Most of these road segments are not predicted to convey sediment to stream channels, as they would be built in upland locations without surface hydrologic connection to any stream channel. After the project there would be an overall decrease in sediment sources from roads (table 150 in the Hydrology Section).

The proposed new road segment number 4, which would provide access to units 20 and 21, crosses the drainage of a headwater tributary basin to Lincoln Creek (chapter 2). This crossing was reviewed in the field—there is a vegetated old roadbed at this site, but no stream channel or evidence of overland flow. Channel features were observed roughly 60 feet below the roadbed. Sediment that appeared to be from the old roadbed was observed in this channel, indicating that in the past, this road probably contributed sediment to the uppermost reach of this intermittent stream. If restored, this road represents a potential source of sediment to the stream channel, and should be accounted for in estimates of sediment impacts of the project. If the decision is made to construct this segment, then appropriate measures (Best Management Practices) such as adequate culvert, proper road drainage, and sediment fencing (if appropriate) must be applied, and the segment should be obliterated soon after the project ends, to minimize sediment impacts.

The proposed new road segment number 5, which is between units 10 and 11, crosses a small drainage of a headwater tributary basin to Lincoln Creek. This apparent crossing was reviewed in the field—there is an old abandoned irrigation ditch at this site, but no stream channel or evidence of overland flow. Flow may occur in the ditch during snowmelt. If the decision is made to construct this segment, then appropriate measures (Best Management Practices) such as adequate culverts, proper road drainage, and sediment fencing (if appropriate) must be applied, and the segment should be obliterated soon after the project ends, to minimize sediment impacts.

The total reduction in average annual sediment transport from using BMPs for project haul roads was modeled to be roughly 2 tons less than the existing conditions under this alternative, based on proposed BMP upgrades and road improvements. The long-term benefits from decreased annual sediment loads would outweigh the short-term increases during road maintenance activities. For the road segments to be obliterated, the reduction in sediment delivery would be permanent.

BMPS

INFISH (USDA Forest Service 1995) standards would need to be met. A key component of INFISH for this project includes measures to address roads that have high risk for sediment delivery to surface waters, see the Transportation Report (Bielecki 2012) and Hydrology Report (McNamara 2015) in the project file for specific roads and BMP details.

Riparian Areas

Additional measures to reduce risk for negative effects to native fisheries entail restrictions on removal of trees from riparian habitat conservation areas to ensure the potential for woody debris recruitment, pool formation and floodplain function is maintained (table 9)

As provided for with INFISH standard RA-2, trees to be removed as part of salvage, that are not needed for woody debris recruitment or floodplain needs, can be removed. “Green commercial trees within the RHCA that have not been attacked by beetles and are not otherwise at risk of dying in the immediate future cannot be removed unless site-specific rationale discussing why it would be beneficial to fish and watershed is developed for each specific unit. Log landings should not be located in RHCAs.”

Category 1 - Fish bearing streams: The RHCA width is 300 feet on either side of the stream or the 100-year floodplain whichever is greater.

Category 2 - Perennial streams not supporting fish: The RHCA is 150 feet on either side of the stream.

Category 3 - Lakes or wetlands greater than one acre: The RHCA is a minimum of 150 feet but can be larger and extend to the outer limits of riparian vegetation, the extent of seasonally saturated soil, the extent of highly unstable areas, or the distance equal to the height of one site-potential tree.

Category 4 - The project area is not within INFISH priority drainage: For seasonally flowing or intermittent streams, wetlands less than 1 acre, landslides and landslide prone areas, the RHCA boundary is one-half site potential tree from the edges of the stream channel, wetland or landslide, landslide prone area or a 50-foot slope distance, whichever is greatest.

For both action alternatives, riparian areas would have at least a 50-foot no ignition buffer around ephemeral, intermittent, and perennial channels for slopes less than 35 percent, and a 100-foot buffer for slopes more than 35 percent. Fire would be allowed to back into INFISH buffers. Alternatives 2 and 3 would allow for dead trees to be removed from RHCAs. These trees are not providing shade to the stream and not in a position (across the road) to become woody debris. Removal of dead trees and allowing fire to back into RHCAs would allow riparian shrubs and trees to reestablish. Roads to be built and then obliterated are short segments that would be temporary in nature and not likely to change the character or

function or the RHCAs. Therefore, activities proposed under these alternatives would not adversely affect riparian areas. Streams within the project area would generally remain at proper functioning condition.

Fish

Trout use redds (nests dug by fish in streambed gravels) in flowing waters for their reproductive strategy. When excessive sediment accrues to spawning and rearing sites, trout embryo and fry success decline below natural rates. Additionally, other trout life history elements such as juvenile survival, growth, and adult survival also can be at risk if excess sediment reduces cobble spaces in riffle areas and pool volumes. Everest et al.1987, p. 133 concluded that salmonid species can cope with the natural variability in sediments, but their populations can be reduced substantially by persistent sedimentation that exceeds the natural levels under which they evolved. Average fine sediments in trout spawning habitat within project area streams may show short-term increases in fines at depth. In the long term, stream channels would show measurable decreases in the levels of fines as project area roads would deliver roughly 2 tons less sediment per year.

Given the number of acres that would be treated in the project watersheds under alternatives 2 or 3, it is unlikely there would be a cumulative increase in water yield that would be detectable. The estimated water yield increase for project watersheds is below the DEQ-recommended threshold of 10 percent. Streams emanating from project watersheds appear to lose flow as they move from steeper areas and encounter deep valley floor sediments. Considering the dry (losing stream) nature of the channels in the Stonewall Project area watersheds, the potential increase in water yield would be unlikely to cause any negative effects (i.e., accelerated bank erosion).

Therefore, this vegetation treatment proposal may result in short-term impacts to fisheries resources from road maintenance treatments. The project incorporates special design elements that reduce sedimentation risk by incorporating RHCA buffers and use of low-severity burns. Most importantly, long-term sediment reduction (improvement) in trout reproductive habitat is predicted due to road BMP measures and culvert upgrades that also reduce flood hazard risks at these critical road/stream intersections.

Cumulative Effects

A list of past, present and reasonably foreseeable future activities is available in appendix C. Management activities that are most likely to influence aquatic species abundance, distribution and possibly persistence of populations are discussed in this section.

Livestock grazing: There are three Forest Service allotments that affect watersheds in the project area, Beaver Creek HUC (3,510 acres), Keep Cool Creek HUC (785 acres), and in the Lincoln Creek HUC (191 acres).This affects aquatic species because it alters stream morphology and vegetative conditions in the uplands and riparian areas. This changes the capabilities of hydrologic processes and stream morphology changes, reducing stream function. The result is a reduction and simplification in habitats.

Irrigation diversions: The effects on aquatic species occur through the loss of instream flows and possibly temperature increases and loss of individuals in irrigation ditches. In some cases, diversion may benefit WCT because it is limiting upstream movement of nonnative species that would hybridize and/or compete with them.

Noxious weed treatment: Beneficial effects are expected from reversing trends in vegetative conditions. Potential negative effects if herbicides contact individuals directly. Risk is low for this; the HNF weed treatments are applied according to the label and provide mitigations to reduce risks of introduction of herbicide into streams and other water bodies. We expect the balance of effects related to this management to be beneficial.

Mining: Historic mining has had major affects to water quality and stream function in the project area, but there are no known water quality or stream channel conditions caused by historic mining that would be affected by the proposed activities. Placer operations have altered the physical function of some stream channels through the removal of stream gravels and channelization. Several small suction dredge mining operations are proposed or on-going at this time that may have localized stream bottom and bank disturbance.

Prescribed burning: This has some risk of increasing short-term sediment delivery because of the temporary loss of vegetative cover that occurs. Recent prescribed burns occurred in Alice Creek, Hogum Creek, and Poorman Creek. This, however, is effectively mitigated in most situations through the application of treatment buffers around streams and other water bodies. Benefit would occur through longer-term improved vegetation cover in riparian and uplands, which would reduce sediment delivery.

Dispersed recreation: This is common across the analysis area and would continue – and probably increase – in the future. Effects to aquatic species are likely minor. Even though most dispersed camping and other activities occur in close proximity to water, the length of streams disturbed is relatively small. Sediment delivery from dispersed recreation can occur but it is limited enough in scope in most cases to keep it from being a notable concern relative to aquatic populations. Angling probably results in a limited amount of mortality, even though state regulations prohibit anglers from keeping bull and westslope cutthroat trout from streams in the analysis area.

Range improvements: These are expected to help with livestock distribution, decreasing impacts to streams, and so limiting negative effects on stream channel morphology and stream function.

Road and trail construction and maintenance: To support timber removal Alternative 2 proposes approximately 2.6 miles of roads to be built then obliterated immediately following timber removal; alternative 3 proposes 0.4 mile. No permanent roads or trails are proposed. Required maintenance on roads for the project would reduce sources of sedimentation in the long term by 2 tons per year that are negatively affecting aquatic species and habitat. The Blackfoot Travel Plan (non-winter) is currently under analysis. The Travel Plan proposed several miles of road decommissioning and storage project with culvert removals. Implementation of the Plan would have significant reductions in road-related sediment delivery to streams.

Timber Harvest: Private and state trust land timber sales are ongoing in the project area that is primarily tractor logging using existing roads for hauling. The DNRC timber sale (Liverstone) is approximately 260 acres may have the potential to affect watersheds. Montana Stream Management Zone no harvest buffers and use of existing roads would protect sediment delivery to streams, Forest Service timber harvest occurred previously in the area from 2000 to 2010. Use of INFISH buffers and Best Management Practices protect stream channels and reduce sediment delivery and limited negative effects on stream channel morphology and stream functions

Stream Restoration: Stream restoration projects to restore approximately stream channels impacted by past mining activities are planned in Sauerkraut and Stonewall Creeks. Removal of mining waste rock and channel improvement for improving fish habitat and channel stability utilizing primarily natural materials. Riparian and floodplain revegetation will include planting of native grass sod, forbs and shrubs. There would be short-term impacts during project construction activities but long-term benefits as the stream channels and banks stabilize.

Hazard Tree Removal: The Forestwide hazardous tree removal and fuels reduction HFRA project was recently completed. This activity was limited to certain road and trail corridors and recreation sites. Effects to aquatic populations are likely minor.

Alternative 1 (no action) would not promote a change in existing conditions within the analysis area. While this alternative meets the Forest Plan direction of "no measurable effect", it does nothing to help ensure movement toward desired conditions. Because many streams are currently nonfunctioning or functioning at risk, alternative 1, when considered with other current, past and reasonably foreseeable actions could work cumulatively with the management activities/natural events discussed above to limit the potential to achieve healthy population densities in certain populations.

Alternatives 2 and 3 would promote improvement in stream conditions through long-term reductions in sediment delivery and physical impacts to stream channels, which would promote positive shifts in stream function across the analysis area. Therefore, the effects of the Stonewall Vegetation Project proposed actions when considered cumulatively with other past, present and reasonably foreseeable actions should promote the attainment of better habitat conditions, and more abundant and resilient aquatic populations.

Compliance with Forest Plan and Other Relevant Laws, Regulations, Policies and Plans

Alternatives 2 and 3 comply with the Helena National Forest Plan, and other State and local laws, regulations, policies and plans.

Other Relevant Mandatory Disclosures

There are no other relevant mandatory disclosures for the aquatic resources in the Stonewall Vegetation Project

Species Determinations

The Biological Effects Determination for westslope cutthroat trout and western pearlshell mussel, if implementing alternative 2 or 3 is: **May impact individuals or habitat, but will not likely contribute to a trend toward federal listing or loss of viability to the population or species**.

The Biological Analysis Determinations for bull trout and bull trout critical habitat is: **May effect, not likely to adversely affect.**

WCT Population Viability at the Project Level:

Westslope cutthroat trout are the fish "management indicator species" for the Helena National Forest. They represent a measure of the effects of management activities on habitat with the objective of ensuring population viability (Forest Plan p. II-17). Westslope cutthroat trout are found in Stonewall planning area, and therefore, serve as the proxy population for viability analysis in fulfillment of the NFMA viability requirement.

This analysis uses a practical approach outlined in Ruggiero et al. (1994) and Region 1 guidance (Draft 01/30/2004) in conjunction with criteria established by Rieman et al. (1993). Simply put, "…an analysis of population viability is about birth, death, immigration, and emigration rates and how environmental or ecological factors affect these rates over time" (Ruggiero et al. 1994, p. 366). In this exercise, select habitat attributes considered both ecologically significant to fish and sensitive to land management disturbances are borrowed from Overton et al. 1995, p. 1), and Region 1 guidance (USDA Forest Service Draft 1/30/2004).

Table 158 displays these habitat attributes and which ones are affected by this proposal. Projections of change in any habitat attribute provide an indication whether negative effects to species or habitat is occurring.

Table 158. WCT habitat variables from Overton and Region 1 guidance that may be influenced by proposed management in the Stonewall Project area

Habitat Feature	Effects Of Action			Comments
	Maintain	Degrade	Improve	
Bank Stability	X			Special guidance within stream buffers, SMZ regulations
Bank Undercut	X			Special guidance within stream buffers, SMZ regulations
Water temperature	X			Special guidance within stream buffers, SMZ regulations
Width-to-depth ratio	X			Special guidance within stream buffers, SMZ regulations
Width-to-maximum depth ratio	X			
Substrate composition		X	X	Degrade yr-1; improve yr 3+
Large woody debris (LWD)	X			Special guidance within stream buffers, SMZ regulations
Pool frequency	X			Special guidance within stream buffers, SMZ regulations
Invasive species	X			

Sediment in stream substrates was described being the attribute most responsive to disturbance from this project. Other attributes of fish habitat (bank stability, temperature, LWD, etc.) were excluded from further consideration due to specific project design elements—300-foot stream buffers in conjunction with state SMZs and low-severity burn prescriptions that restrict disturbance from important stream corridors.

Research has shown how increasing and decreasing levels of sediment in trout reproductive habitat affect trout embryo and fry survival rates negatively or positively respectively. When fine sediments elevate beyond natural levels in trout spawning habitat, the reproductive quality of that habitat diminishes resulting in a corresponding decrease in fry production. Mathematical equations to estimate existing and predicted embryo survival as a function of changes in sediment suggest success rate of hybrid WCT fry survival for this stream drops to 57 percent (from 62 percent) in year-one, and then improves to 78 percent after year-three as a result of sediment source reduction treatments to road # 423 and 423-D1. Estimates of changes in the rates of embryo survival are not necessarily accurate, but are meant to help determine the amount of changes in sediment yield upon WCT populations in question.

This analysis, therefore, predicts a short-term change in substrate composition risks, some minor downward trend in incubation and fry emergence success (birth rate) to the population before recovering to an improved trend over baseline after 3 years. WCT recruitment is likely more than adequate to offset minor short-term sediment increases near the populations in Beaver Creek and Keep Cool Creek.

In the long term, treating hydrologically connected roads helps recover gravel quality slightly over baseline conditions. Therefore, there is some minimal risk to viability for this WCT population in the short term with a long-term trend of maintaining reproductive habitat within the acceptable range of variation (32.7% ±9.9%).

Recreation

Introduction

This analysis describes the existing recreation activities, settings and opportunities within the Stonewall Vegetation Project area, and describes the potential effects to recreation from proposed activities. Portions of the Stonewall Project area are within the Bear-Marshall-Scapegoat-Swan and Lincoln Gulch Inventoried Roadless Areas (IRAs). The potential effects to roadless and wilderness characteristics of the IRAs and unroaded lands contiguous to the IRAs are in a separate section beginning on page 641.

Overview of Issues

Comments pertaining to disclosing the effects of project activities on recreation were identified from public scoping as nonsignificant (40 CFR 1501.7), and are addressed by the analyses in this section. Please refer to volume 2, appendix A of this document for a complete listing of the issues and an explanation of how the agency determined their disposition.

Indicators

Indicators are defined to analyze data regarding the potential for impacts of vegetation treatments and prescribed fire on recreation opportunities within the project area, and the impacts of prescribed fire on trail conditions within the project area

- Loss of recreation opportunity, displacement of users, or a change in recreation experience due to vegetation treatments/prescribed fire activities (i.e., temporary closure of areas/visitors avoiding the area during the vegetation treatments/prescribed fire, or changes in scenery following the vegetation treatments/prescribed fire that affect the recreation setting)
    - **Measure: Life of the project**
- Increased trail maintenance needs following prescribed fire (i.e., increased erosion due to runoff or fallen trees)
    - **Measure: Miles of trail affected**

Methodology

An interdisciplinary team meeting and field tour of the proposed project area was attended in Lincoln, Montana, by specialists on September 20-24, 2010.

Analysis was accomplished using ArcMap and relevant Geographic Information System (GIS) data layers from the Helena National Forest, Lincoln Ranger District, including trails, roads, recreation sites, inventoried roadless areas, summer and winter ROS classes, winter use, and management areas. Online visitor information provided by the Helena National Forest and other local organizations provided an overview of the recreation opportunities and trends within the analysis area. A review of existing law, regulation and policy relevant to recreation resources within the project area was completed and are referenced where appropriate.