United States
Department of
Agriculture

Forest
Service

January 2013

Water Quality and Riparian Areas Specialist's Report

Four-Forest Restoration Initiative

Coconino and Kaibab National Forest
Coconino County, Arizona

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INTRODUCTION

This report documents the affected environment and environmental consequences of implementation of the Four Forest Restoration Initiative on the Coconino National Forest (CNF) and Kaibab National Forest (KNF) riparian ecosystems and water quality.

The objective of Four Forest Restoration Initiative is to re-establish forest structure, pattern, and composition, within the ponderosa pine ecosystem, which will lead to increased forest resiliency and function, thus increasing the ability of the ponderosa pine forest to survive natural disturbances such as insects and diseases, fires, and climate change (FSM 2020.5). Restoration activities proposed with this project will improve vegetation biodiversity, wildlife habitat, soil productivity, and watershed function.

Purpose and Need

The purpose of the Four Forest Restoration Initiative Project is to improve the health and sustainability of forested conditions within the project area by reducing hazardous fuels and moving vegetative conditions toward the desired conditions.

There is a need for:

- Restoring the structure, pattern and composition of fire-adapted ecosystems on the Coconino and Kaibab National Forests, which will provide for fuels reduction, forest health, and wildlife and plant diversity
- Moving stand conditions toward forest structures considered to be more typical of forest structure under pre-settlement fire regimes;
- Reintroducing fire as a natural part of the ecosystem;
- Reducing the risk for stand-replacing wildfires;
- Improving tree vigor and stand resilience;
- Improving the diversity of age classes and structure of woody vegetation;
- Improving ground cover, including down woody debris, fine litter and herbaceous understory composition and productivity;
- moving toward desired conditions in riparian ecosystems by having springs function at, or near, potential
- moving towards desired conditions for degraded ephemeral channels by restoring channel function
- Improve the motorized transportation system to provide for a more sustainable transportation network whereby poorly located roads are reconstructed or obliterated.

Alternatives

Alternative A – No Action

Alternative A is the no action alternative as required by 40 CFR 1502.14(c). There would be no changes in current management and the forest plans would continue to be implemented. Approximately 82,592 acres of vegetation treatments and 96,125 acres of ongoing prescribed fire projects would continue to be

implemented adjacent to the treatment area. Approximately 86,771 acres of vegetation treatments and 142,869 acres of prescribed fire and maintenance burning would be implemented adjacent to the treatment area by the forests in the foreseeable future (within 5 years). Alternative A is the point of reference for assessing action alternatives B-D.

Items Common to All Action Alternatives

- All action alternatives (B-D) propose additional actions including restoring springs and ephemeral channels, constructing protective fencing in select aspen stands, constructing (and decommissioning) temporary roads, reconstructing and improving roads, relocating a minimal miles of road, and decommissioning existing roads and unauthorized routes.

- Design features, best management practices (BMPs), and mitigation to be used as part of alternatives B-D are located in Table 1.

- All action alternatives incorporate key components of the Old Tree Protection Strategy into the alternative's design features, implementation plan, and monitoring and adaptive management. The Forest Service worked collaboratively with stakeholders to develop the monitoring and adaptive management and implementation plan.

- All action alternatives include adaptive management actions that would be taken as needed to restore springs, ephemeral channels, and naturalize decommissioned and unauthorized roads

Alternative B – Proposed Action

The Coconino and Kaibab NFs propose to conduct approximately 587,923 acres of restoration activities over approximately 10 years or until objectives are met. Up to 45,000 acres of vegetation would be mechanically treated annually. Up to 40,000 acres of prescribed fire would be implemented annually across the forests. Two prescribed fires[1] would be conducted on all acres proposed for treatment over the 10-year period. Restoration activities would:

- Mechanically cut trees and apply prescribed fire on approximately 388,489 acres. This includes: (1) mechanically treating up to 16-inch dbh within 18 Mexican spotted owl protected activity centers, (2) cutting 99 acres of trees by hand on slopes greater than 40 percent, and, (3) using low-severity prescribed fire within 72 MSO PACs (excluding core areas)
- Utilize prescribed fire-only on approximately 199,435 acres
- Construct 517 miles of temporary roads for haul access and decommission when treatments are complete (no new permanent roads would be constructed)
- Reconstruct up to 40 miles of existing, open roads for resource and safety concerns (no new permanent roads would be constructed). Of these miles, approximately 30 miles would be improved to allow for haul (primarily widening corners to improve turn radiuses) and about 10 miles of road would be relocated out of stream bottoms. Relocated roads would include rehabilitation of the moved road segment.
- Decommission 770 miles of existing system and unauthorized roads on the Coconino NF
- Decommission 134 miles of unauthorized roads on the Kaibab NF
- Restore 74 springs and construct up to 4 miles of protective fencing
- Restore 39 miles of ephemeral channels
- Construct up to 82 miles of protective (aspen) fencing

[1] The first prescribed fire may include pile burning followed by a broadcast burn.

- Allocate as old growth 40 percent of ponderosa pine and 77 percent of pinyon-juniper woodland on the Coconino NF and 35 percent of ponderosa pine and 58 percent of pinyon-juniper on the Kaibab NF

Three non-significant forest plan amendments would be required on the Coconino NF to implement the proposed action:

- Amendment 1 would allow the use of mechanical treatments to improve habitat structure and allow for mechanical treatment up to 16-inch dbh within 18 MSO PACs to improve nesting and roosting habitat. All Mexican spotted owl monitoring would defer to the project's Biological Opinion issued by US Fish and Wildlife Service.
- Amendment 2 would : 1) add the desired percentage of interspace within uneven-aged stands to facilitate restoration and defines interspace, (2) add the interspace distance between tree groups, (3) add language clarifying where canopy cover is and is not measured, (4) allows 29,017 acres to be managed for an open reference condition (figure 47), which affects canopy cover guidelines for VSS 4 through VSS 6 groups and reserve trees, and (5) add a definition to the forest plan glossary for the terms interspaces, open reference condition, and stands.
- Amendment 3 would allow for managing to achieve a "No Adverse Effect" determination for significant, or potentially significant, inventoried heritage sites.

Two non-significant forest plan amendment would be required on the Kaibab NF to implement the proposed action.

- Amendment 1 would 1) add the desired percentage of interspace within uneven-aged stands to facilitate restoration and defines interspace, (2) add the interspace distance between tree groups, (3) add language clarifying where canopy cover is and is not measured, (4) allows 27,637 acres to be managed for an open reference condition (figure 47), which affects canopy cover guidelines for VSS 4 through VSS 6 groups and reserve trees, and (5) add a definition to the forest plan glossary for the terms interspaces, open reference condition, and stands.
- Amendment 2 would defer all Mexican spotted owl monitoring to the project's Biological Opinion issued by US Fish and Wildlife Service.

Alternative C (Preferred Alternative)

Alternative C responds to issue 2 (conservation of large trees), and issue 4 (increased restoration and research). It adds acres of grassland treatments on the Kaibab NF, incorporates wildlife and watershed research on both forests, and mechanically treats and uses prescribed fire within the proposed Garland Prairie RNA on the Kaibab NF. It proposes mechanically treating up to 18-inch dbh in 18 MSO PACs and includes low-severity prescribed fire within 72 MSO PACs, including 56 core areas. It includes an implementation plan and a monitoring and adaptive management plan.

The Coconino and Kaibab NFs would conduct restoration activities on approximately 593,211 acres over a period of 10 years or until objectives are met. Up to 45,000 acres of vegetation would be mechanically treated annually. Up to 40,000 acres of prescribed fire would be implemented annually across the forests. Two prescribed fires[2] would be conducted on all acres proposed for treatment over the 10-year period. Restoration activities would:

[2] The first prescribed fire may include pile burning followed by a broadcast burn.

- Mechanically cut trees on approximately 434,001 acres. This includes: (1) mechanically treating up to 18-inch dbh within 18 Mexican spotted owl protected activity centers, (2) cutting trees by hand on 99 acres on slopes greater than 40 percent, and, (3) using low-severity prescribed fire within 72 Mexican spotted owl protected activity areas (including 56 core areas).
- Utilize prescribed fire-only on approximately 159,211 acres
- Construct 517 miles of temporary roads for haul access and decommission when treatments are complete (no new permanent roads would be constructed)
- Reconstruct up to 40 miles of existing, open roads for resource and safety concerns (no new permanent roads would be constructed). Of these miles, approximately 30 miles would be improved to allow for haul (primarily widening corners to improve turn radiuses) and about 10 miles of road would be relocated out of stream bottoms. Relocated roads would include rehabilitation of the moved road segment.
- Decommission 770 miles of existing system and unauthorized roads on the Coconino NF
- Decommission 134 miles of unauthorized roads on the Kaibab NF
- Restore 74 springs and construct up to 4 miles of protective fencing
- Restore 39 miles of ephemeral channels
- Construct up to 82 miles of protective (aspen) fencing
- Construct up to 15 weirs and 20 weather stations (up to 3 total acres of disturbance) to support watershed research
- Allocate as old growth 40 percent of ponderosa pine and 77 percent of pinyon-juniper woodland on the Coconino NF and 35 percent of ponderosa pine and 58 percent of pinyon-juniper woodland on the Kaibab NF

Three non-significant forest plan amendments (see appendix C) would be required on the Coconino NF to implement alternative C:

- Amendment 1 would: (1) allow the use mechanical treatments to improve habitat structure and mechanically treat up to 18-inch dbh within 18 MSO PACs, (2) allow the use of low-intensity prescribed fire within 56 PAC core areas, and (4) allow for managing 8,410 acres of restricted target and threshold habitat for a minimum range of 110 to 150 basal area, and, (5) would defer all Mexican spotted owl monitoring to the project's Biological Opinion issued by the US Fish and Wildife Service.
- Amendment 2 would: 1) add the desired percentage of interspace within uneven-aged stands to facilitate restoration and defines interspace, (2) add the interspace distance between tree groups, (3) add language clarifying where canopy cover is and is not measured, (4) allows 29,017 acres to be managed for an open reference condition (figure 47), which affects canopy cover guidelines for VSS 4 through VSS 6 groups and reserve trees, and (5) add a definition to the forest plan glossary for the terms interspaces, open reference condition, and stands.
- (3) Amendment 3 would allow for managing to achieve a "No Adverse Effect" determination for significant, or potentially significant, inventoried heritage sites.

Three non-significant forest plan amendments would be required on the Kaibab NF to implement alternative C:

- Amendment 1 would: 1) add the desired percentage of interspace within uneven-aged stands to facilitate restoration and defines interspace, (2) add the interspace distance between tree groups, (3) add language clarifying where canopy cover is and is not measured, (4) allows 27,675 acres to be managed for an open reference condition (figure 47), which affects canopy cover guidelines for VSS 4 through VSS 6 groups

and reserve trees, and (5) add a definition to the forest plan glossary for the terms interspaces, open reference condition, and stands.

- Amendment 2 would allow for mechanically treating and prescribe burning approximately 400 acres in the proposed Garland Prairie RNA.
- Amendment 3 would defer all Mexican spotted owl monitoring to the project's Biological Opinion issued by US Fish and Wildlife Service.

Alternative D

Alternative D responds to issue 2 (prescribed fire emissions) by decreasing the acres that would receive prescribed fire. All other components of the alternative are the same as described in alternative B.

The Coconino and Kaibab NFs would conduct restoration activities on approximately 567,279 acres over a period of 10 years or until objectives are met. Up to 45,000 acres of vegetation would be mechanically treated annually. Restoration activities would:

- Mechanically cut trees on approximately 388,489 acres. This includes: (1) mechanically treating up to 16-inch dbh within 18 Mexican spotted owl protected activity centers, (2) cutting 99 acres of trees by hand on slopes greater than 40 percent, and, (3) disposing of slash through various methods including chipping, shredding, mastication and removal of biomass off-site
- Utilize prescribed fire-only on approximately 178,790 acres. Up to 40,000 acres of prescribed fire would be implemented annually across the forests. Two prescribed fires would occur over the 10-year treatment period.
- Construct 517 miles of temporary roads for haul access and decommission when treatments are complete (no new permanent roads would be constructed)
- Reconstruct up to 40 miles of existing, open roads for resource and safety concerns (no new permanent roads would be constructed). Of these miles, approximately 30 miles would be improved to allow for haul (primarily widening corners to improve turn radiuses) and about 10 miles of road would be relocated out of stream bottoms. Relocated roads would include rehabilitation of the moved road segment.
- Decommission 770 miles of existing system and unauthorized roads on the Coconino NF
- Decommission 134 miles of unauthorized roads on the Kaibab NF
- Restore 74 springs and construct up to 4 miles of protective fencing
- Restore 39 miles of ephemeral channels
- Construct up to 82 miles of protective (aspen) fencing
- Allocate as old growth 40 percent of ponderosa pine and 77 percent of pinyon-juniper woodland on the Coconino NF, and 35 percent of ponderosa pine and 58 percent of pinyon-juniper on the Kaibab NF

Three non-significant forest plan amendments would be required on the Coconino NF to implement alternative D:

- Amendment 1 would: (1) allow the use of mechanical treatments to improve habitat structure, (2) allow for mechanical treatment up to 16-inch dbh within 18 MSO PACs to improve nesting and roosting habitat, and, .(5) would defer all Mexican spotted owl monitoring to the project's Biological Opinion issued by the US Fish and Wildlife Service.

- Amendment 2 would: 1) add the desired percentage of interspace within uneven-aged stands to facilitate restoration and defines interspace, (2) add the interspace distance between tree groups, (3) add language clarifying where canopy cover is and is not measured, (4) allows 29,017 acres to be managed for an open reference condition (figure 47), which affects canopy cover guidelines for VSS 4 through VSS 6 groups and reserve trees, and (5) add a definition to the forest plan glossary for the terms interspaces, open reference condition, and stands.
- Amendment 3 would allow for managing to achieve a "No Adverse Effect" determination for significant, or potentially significant, inventoried heritage sites.

Two non-significant forest plan amendments would be required on the Kaibab NF to implement the proposed action:

- Amendment 1 would: 1) add the desired percentage of interspace within uneven-aged stands to facilitate restoration and defines interspace, (2) add the interspace distance between tree groups, (3) add language clarifying where canopy cover is and is not measured, (4) allows 27,637 acres to be managed for an open reference condition (figure 47), which affects canopy cover guidelines for VSS 4 through VSS 6 groups and reserve trees, and (5) add a definition to the forest plan glossary for the terms interspaces, open reference condition, and stands.
- Amendment 2 would defer all Mexican spotted owl monitoring to the project's Biological Opinion issued by the US Fish and Wildlife Service.

Methodology and Analysis Process

This section describes the methodology and analysis processes used to determine the environmental consequences to water quality and riparian areas from implementing the alternatives. Environmental consequences are site-specific at the project planning level and will be described with qualitative and quantitative descriptions supported by past studies and observations.

Analyses for environmental consequences to water quality and riparian areas that may result from implementation of each alternative were conducted using information contained in the Terrestrial Ecosystem Survey (TES) of the Coconino National Forest (Miller et al. 1991), the TES of the Kaibab National Forest (Brewer et al. 1991), the Watershed Condition Framework, the Coconino National Forest Plan, as amended (1987), the Kaibab National Forest Land Management Plan, as amended (1988), information obtained from other CNF and KNF resource specialists, the Arizona Department of Environmental Quality (ADEQ), other agency reports, available literature, and input from KNF collaborators and cooperators. Geospatial analysis was used to quantitatively and qualitatively assess soils and watershed conditions using Geographic Information Systems (GIS) data obtained from a variety of sources.

The TES of the Coconino National Forest is available at the Coconino National Forest Supervisor's Office. The TES of the KNF is available at the Kaibab National Forest Supervisor's Office or via the internet at:

http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5138598.pdf.

The TES is the result of the systematic analysis, mapping, classification and interpretation of terrestrial ecosystems, also known as terrestrial ecological units that are delineated and numbered. A TES represents the combined influences of climate, soil and vegetation, and correlates these factors with soil

temperature and moisture along an environmental gradient. It is an integrated survey and hierarchical with respect to classification levels and mapping intensities. It is the only seamless mapping of vegetation and soils available across the CNF and KNF that includes field visited, validated and correlated sites with a stringent Regional and National protocol stemming from decades of work.

Effects to water quality will be assessed qualitatively by alternative by comparing predicted direct, indirect, and cumulative effects by major land disturbing activities (e.g. forest thinning, prescribed burning, ephemeral channel restoration, and spring protection and restoration) within the project area.

The general classification used for surface water quality by ADEQ is attaining, attaining some uses, inconclusive/not assessed, not-attaining, and impaired for the identified uses. The classification designates each waterbody in one of five categories:

Category 1 Surface waters assessed as "attaining all uses." All designated uses are assessed as "attaining."

Category 2 - Surface waters assessed as "attaining some uses." Each designated use is assessed as either "attaining," "inconclusive," or "threatened."

Category 3 - Surface waters assessed as "inconclusive." All designated uses are assessed as "inconclusive" due to insufficient data to assess any designated use (e.g., insufficient samples or core parameters). By default, this category would include waters that were "not assessed" for similar reasons

Category 4 - Surface waters assessed as "not attaining." At least one designated use was assessed as "not attaining" and no uses were assessed as "impaired." A Total Maximum Daily Load[3] (TMDL) analysis will not be required at this time for one of the following reasons:

- **4 A. -** A TMDL has already been completed and approved by EPA but the water quality standards are not yet attained;
- **4 B. -** Other pollution control requirements are reasonably expected to result in the attainment of water quality standards by the next regularly scheduled listing cycle; or
- **4 C. -** The impairment is not related to a "pollutant" loading but rather due to "pollution" (e.g., hydrologic modification).

Category 5 - Surface waters assessed as "impaired." At least one designated use was assessed as "impaired" by a pollutant. These waters must be prioritized for TMDL development.

Water quality is assessed by comparing existing conditions (category 1 to 5) with desired conditions that are set by Arizona under authority of the Clean Water Act. The Arizona Department of Environmental Quality (ADEQ) is the regulating authority for water quality in Arizona as promulgated by EPA. Waters that are not impaired (those not on 303d[4] list or in category 4 or 5) are providing for beneficial uses

[3]A TMDL is a written analysis that determines the maximum amount of a pollutant that a surface water can assimilate (the "load"), and still attain water quality standards during all conditions. The TMDL allocates the loading capacity of the surface water to point sources and nonpoint sources identified in the watershed, accounting for natural background levels and seasonal variation, with an allocation set aside as a margin of safety.

[4] Under section 303(d) of the 1972 Clean Water Act, states, territories, and authorized tribes are required to develop lists of impaired waters. These impaired waters do not meet water quality standards that states, territories, and authorized tribes have set for them, even after point sources of pollution have installed the minimum required levels of pollution control technology. The law requires that these jurisdictions establish priority rankings for waters on the lists and develop TMDLs for these waters. (http://www.epa.gov/region9/water/tmdl/303d.html)

identified for that stream or water body and can be considered in a desired condition until further sampling indicates impairment. Those in category 2 or higher require special attention during site specific project analysis. The ADEQ also interprets its surface water quality standards to apply to "intermittent, non-navigable tributaries." The ADEQ interprets the definition of "surface water" to include tributaries ("the tributary rule") and assigns water quality standards to intermittent surface waters that are not specifically listed by name in Arizona's surface water quality standards rules. ADEQ has determined it is necessary to regulate and protect these types of waters as "waters of the United States" because it is estimated that approximately 95 percent of the surface waters in Arizona are either intermittent or ephemeral.

Effects to water yield will be discussed qualitatively, based on comparison of current activities to projected effects of implementing alternatives. Generally, reducing forest overstory in vegetation types within higher precipitation zones will generate more runoff (Baker 1999).

A watershed condition assessment was recently conducted for all sixth-level subwatersheds in the proposed project area as part of a Forest-level assessment of watershed condition (Potyondy and Geier, 2010) as part of the Watershed Condition Framework. The Watershed Condition Framework establishes a new consistent, comparable, and credible process for improving the health of watersheds on national forests and grasslands. This framework will help focus our efforts in a consistent and accountable manner and facilitate new investments in watershed restoration that will provide economic and environmental benefits to local communities.
Watershed condition was classified using a core set of national watershed condition indicators that were updated with local data and interpreted by a Forest interdisciplinary (ID) team. These indicators are grouped according to four major ecosystem process categories: (1) aquatic physical; (2) aquatic biological; (3) terrestrial physical; and (4) terrestrial biological. These categories represent terrestrial, riparian, and riverine ecosystem processes or mechanisms by which management actions can affect the condition of watersheds and associated resources. Each indicator was evaluated using a defined set of attributes whereby each attribute was scored by the Forest interdisciplinary team as GOOD (1), FAIR (2), or POOR (3) using written criteria, rule sets, the best available data, and professional judgment.

Twelve core watershed condition indicators were evaluated for all sixth-level HUCs. Aquatic physical indicators included: 1) water quality condition, 2) water quantity (flow regime) condition, and 3) stream and habitat condition. Aquatic biological indicators included: 4) aquatic biota condition and 5) riparian vegetation condition. Terrestrial physical indicators included: 6) road and trail condition, and 7) soil condition. Terrestrial biological indicators included: 8) fire effect and regime condition, 9) forest cover condition, 10) rangeland, grassland and open area condition, 11) terrestrial non-native invasive species condition, and 12) forest health condition.

Attribute scores for each indicator were summed and normalized to produce an overall indicator score. The indicator scores for each ecosystem process category were then averaged to arrive at an overall category score. The Watershed Condition scores were tracked to one decimal point and reported as Watershed Condition Classes 1, 2, or 3. Class 1 = scores of 1.0 to 1.7; Class 2 = scores >1.8 and <2.3, and Class 3 = scores from 2.4 to 3.0. Class 1 watersheds are functioning properly. Class 2 watersheds are functional – at risk, and Class 3 watersheds have impaired function. Refer to the Soils and Watershed Specialist's Report (Steinke, 2012) for watershed acreages and condition ratings within the Four Forest Restoration Initiative project area.

The results of the Forest Service Watershed Condition Framework planning work are available through a map viewer website where users can view the priority watersheds, read about why the watershed was selected, download the Watershed Restoration Action Plans and learn about other important planning items, including estimated costs and restoration partners. Each watershed on the map also contains information on the overall watershed condition rating and the individual rating of its 12 watershed condition indicators. The Watershed Condition Framework website can be found at:

US Forest Service - Watershed Condition Classification Maps

The Watershed Condition Classification maps characterize the health and condition of National Forest System lands in the more than 15,000 watersheds across the country. These maps are the culmination of the first step in the agency's Watershed Condition Framework, and represent the baseline condition that will be used along with information on ecological, social and economic factors and partnership opportunities to establish watershed restoration priorities. The interactive watershed condition map can be found online at:

USDA Forest Service Map Viewer (Build 14)

Water Quality and Riparian Area Issues

Water quality and riparian area issues include:

- Potential for sediment delivery to streams, wetlands, riparian areas, and lakes.
- Potential adverse effects to surface water quality through increased turbidity and nutrients
- Soil erosion above tolerance thresholds.
- Road construction, maintenance and obliteration could increase surface runoff, erosion, and sediment delivery to streamcourses.
- The amount of sediment that reaches ephemeral, intermittent, or perennial streams could increase.
- Changes to channel morphology as a consequence of increased flows caused by removal of upland vegetation resulting in increased stormwater runoff.
- Changes to stream temperatures as a result of increased warm water runoff from upland sources and changes to channel morphology that alter diurnal fluctuations of water temperature.
- The amount of sediment, debris, and ash that is introduced to water bodies that serve as municipal water supplies could adversely affect the quality of water entering the public water supply systems.
- Cumulative effects to water quality and riparian areas, when combined with past, present, and reasonably foreseeable future actions could be significant.
- Retention of adequate coarse woody debris, including large logs, necessary to protect soil surfaces from erosion and provide wildlife habitat components for soil micro and macro-fauna.

Water Quality and Riparian Resources Condition Indicators

Units of Measure

For water quality and riparian areas, the units of measure of effects to these resources will be the amount of acres of soil disturbance that exceeds tolerance thresholds, the amount of acres subjected to high severity fire (estimated by Steinke (2012) to be approximately 1 to 3 percent of prescribed fire treatment areas), changes to the extents of riparian areas and changes to riparian vegetative communities, acres of ephemeral streamcourses that are restored, and the number of springs that are restored. Most adverse effects to these resources can be minimized or mitigated through appropriate use of resource protection measures such as Soil and Water Conservation Practices (SWCPs) and Best Management Practices (BMP's) as outlined in Soil and Watershed Conservation Practices Handbook (Forest Service Handbook 2509.22)(USDA 1990) and site-specific BMPs included in Table 1.

For water quality measures, no physical stream measurements will be taken to determine water quality. A narrative description will explain the effects to water quality by Alternatives.

Desired Conditions

Water Quality and Quantity

Water quality is sustained at a level that retains the biological, physical, and chemical integrity of the aquatic systems and benefits survival, growth, reproduction, and migration of native aquatic and riparian species.

Water quality meets or exceeds Arizona water quality standards and supports identified designated beneficial uses and native aquatic species. Coconino National Forest Draft Land Management Plan – February 2011, p. 20.

Adequate quantity and timing of water flows are maintained to retain or enhance ecological functions, including aquatic species and riparian vegetation consistent with existing water rights and claims.

Ephemeral, intermittent, and perennial waters flow in natural patterns and at natural rates, have favorable flood plains, transport bedload adequately, and maintain longer sustained base flows on the landscape, rather than extreme peak flows. This will reduce flood potential.

Instream water rights are maintained or procured so that a minimum sufficient amount of water is guaranteed over time to ensure that long-term wildlife habitat is provided and Forest's needs are met. Channel downcutting is minimized and elevated water tables are maintained.

Springs

Springs and associated streams and wetlands have the necessary soil, water, and vegetation attributes to be healthy and functioning at or near potential. Water flow patterns, recharge rates, and geochemistry are similar to historic levels and persist over time.

Spring water quality and quantity maintain native aquatic and riparian habitats and water for wildlife and designated beneficial uses, consistent with water rights and site capability.

Water rights are maintained or procured to protect in situ (on site) water quality and quantity necessary for maintaining riparian vegetation, fish and wildlife, and domestic livestock grazing use.

Native vegetation around springs exhibit diverse age classes, diverse composition of native species, and include species that indicate maintenance of riparian soil moisture characteristics (e.g., sedges, rushes, willows and other riparian vegetation), consistent with the type of spring.
Plant cover protects the banks, edges, and shorelines of springs. Plant distribution and occurrence are resilient to natural disturbances.

Soil condition is satisfactory on most acres with only minor components in unsatisfactory or impaired conditions. Soil function (i.e., the ability of soil to infiltrate water, recycle nutrients, and resist erosion) is sustained.

Spring riparian zones are capable of filtering sediment, capturing and/or transporting bedload, improving or maintaining water quality and providing ground water recharge within their natural potential.

Springs are resilient to natural disturbances and changing climate conditions and are functioning across the landscape within their type and capability. They are in proper functioning condition as determined by on-site assessment by Forest interdisciplinary teams.

Stream and spring ecosystems are not fragmented by infrastructure or development, consistent with existing water rights and claims. Springs are undeveloped and unaltered by man-made structures such as head boxes, cisterns, and pipelines, consistent with existing water rights and claims.

The physical and biological components provide habitat for a diverse community of plant and wildlife species including cover, forage, available water, microclimate, and nesting/breeding habitat. Riparian dependent plant and animal (including invertebrates) species are abundant and diverse consistent with site capability and water rights. Aquatic and riparian habitats and native species are free of or minimally impacted by invasive exotic plant and animal species.

Riparian Areas

Riparian areas and stream channels are functioning properly or show a trend towards an improving condition where sufficient native vegetation, landforms, soil condition, and woody debris are present to:

- Dissipate water energy, thereby reducing erosion and improving water quality;
- Filter sediment, capture bedload, and contribute to favorable floodplain development;
- Improve flood water retention and ground water recharge;
- Develop fine root biomass that stabilizes ephemeral stream banks against scour, slumping, and erosion;
- Develop diverse ponding characteristics to provide habitat and water depth, duration, and temperature necessary for aquatic/amphibian habitat, waterfowl breeding, and other uses

Where practicable, return springs to their *natural spheres of discharge* (Springer and Stevens 2008) through thinning of dense ponderosa pine stands to increase groundwater recharge, exclosure fencing where warranted to prevent adverse impacts from vertebrate herbivores, controlling human ingress and egress, and ensuring flow from the spring source except where prescribed by adjudicated water rights.

Using the descriptors from the current and draft Forest Plans, the desired condition for springs will be the following: "Springs and associated streams and wetlands have the necessary soil, water, and vegetation attributes to be healthy and functioning at or near potential. Water flow patterns, recharge rates, and geochemistry are similar to historic levels and persist over time".

Roads

Only those roads identified as necessary for the management of the Forests and that provide for recreation needs are retained. Maintenance Level 1 roads are stabilized using BMPs and SWCPs and do not contribute sediment to stream channels. User created and unneeded roads have been obliterated. These desired conditions are consistent with the Travel Management Rule (36 CFR 212, Subpart B, Designation of Roads, Trails, and Areas for Motor Vehicle Use).

Fire Regime Condition Class

Fire Regime Condition Class is returned to Class 1 where possible, which is an indicator for returning vegetation conditions to approximate historic conditions in the ponderosa pine vegetation type. This condition is characterized by a more open overstory, improved herbaceous understory, and is maintained by more frequent low intensity fires rather than through mechanical means.

Watershed and Soil Condition

Improved soil productivity and watershed condition. Both forests have guidelines to improve soil productivity and watershed condition to satisfactory conditions by 2020. Each Forest Plan includes a management emphasis to improve or enhance unsatisfactory soils and watershed conditions.

Resource Protection Measures

Resource protection measures listed below include references to standard SWCPs and BMP's found in the Soil and Watershed Conservation Practices Handbook (USDA, 1990) and the National Best Management Practices for Water Quality Management on National Forest System Lands, Volume 1: National Core BMP Technical Guide (FS990a). Resource protection measures are implemented to minimize nonpoint source pollution as outlined in the intergovernmental agreement between the Arizona Department of Environmental Quality and the Southwestern Region of the Forest Service (ADEQ, 2008). Note that no resource protection measures are required for the No Action Alternative. Table 1 provides a summary of soil and watershed protection measures for the Four Forest Restoration Initiative project area.

Table 1. Resource Protection Measures Required for All Action Alternatives.

BMP #	Mitigation	Why
	BMP's common to all activities	
BMP #1	Implement Best Management Practices prior to project implementation.	To minimize impacts to soil and water resources from project implementation, to minimize non-point source pollution, to adhere to the Clean Water Act, and to adhere to the intergovernmental agreement between Region 3 of the Forest Service and the Arizona Department of Environmental Quality.
BMP #2	Minimize mechanical operations when ground conditions are such that soil compaction can occur. All activities should be limited/restricted to when soils are dry or frozen. If compaction occurs, mitigate through ripping, seeding and covering compacted areas with slash.	To minimize soil compaction, soil detachment & sediment transport. To maintain long-term soil productivity.
BMP #3	All fueling of vehicles will be done on a designated protected, upland site. If more than 1320 of gallons of petroleum products are to be stored on site above ground or if a single container exceeds 660 gallons, then a spill prevention control and countermeasures plan (SPCC) will be prepared as per 40 CFR 112).	To prevent contamination of waters from accidental spills.
BMP #4	The following applies to any personnel implementing ground-disturbing actions: Prior to moving off-road equipment onto a project area, contractor shall identify the location of the equipment's most recent operation. Contractor shall not move any off-road equipment that last operated in an area infested with one or more invasive species of concern onto sale area without having cleaned such equipment of seeds, soil, vegetative matter, and other debris that could contain or hold seeds, and having notified Forest Service, as provided in (iii). If the location of prior operation cannot be identified, then contractor shall assume that the location is infested with invasive species of concern. If the contractor has worked in areas where potential chytrid fungus could occur, contractor shall assume chytrid fungus is present and must disinfect equipment prior to work adjacent to water bodies. (i – intentionally omitted) (ii) Prior to moving Off-road equipment from a cutting unit or cutting area that is shown on contract area or sale area map to be infested with invasive species of concern to, or through any other area that is shown as being free of invasive species of concern, or infested with a different invasive species, contractor shall clean such equipment of seeds, soil, vegetative matter, and other	To minimize the spread of non-native species.

BMP #	Mitigation	Why
	debris that could contain or hold seeds and/or disinfect as necessary, and shall notify the Forest Service, as provided in (iii). (iii) Prior to moving any off-road equipment subject to the cleaning and disinfecting requirements set forth above, contractor, shall advise Forest Service of its cleaning measures and make the equipment available for inspection. Forest Service shall have 2 days, excluding weekends and Federal holidays, to inspect equipment after it has been made available. After satisfactory inspection or after such 2 day period, contractor may move the equipment as planned. Equipment shall be considered clean when a visual inspection does not disclose seeds, soil, vegetative matter, and other debris that could contain or hold seeds. Contractor shall not be required to disassemble equipment unless so directed by the Forest Service after inspection. (iv) If contractor desires to clean off-road equipment on National Forest land, such as at the end of a project or prior to moving to, or through an area that is free of invasive species of concern, contractor shall obtain prior approval from contracting officer as to the location for such cleaning and measures, if any, for controlling impacts.	
BMP #5	If construction crews are to live on-site, then an approved camp and suitable sanitation facilities must be provided.	To protect surface and subsurface water from unacceptable levels of bacteria, nutrients and chemical pollutants.
	Prescribed burning and managed fires	
BMP #6	On areas to be prescribed burned, fire prescriptions should be designed to minimize soil temperatures over the entire area. High intensity fire should occur on 10% or less of the entire area. Fire prescriptions should be designed so that soil and fuel moisture temperatures are such that fire intensity is minimized and soil health and productivity are maintained. If containment lines are put in place, rehabilitate lines after use by either rolling berm back over the entire fireline, spreading slash across the fireline or waterbar the fireline. If line is only to be waterbarred, disguise the first 400 feet of line to discourage use as a trail.	To maintain long-term soil productivity and minimize sediment delivery from containment lines.

BMP #	Mitigation	Why
BMP #7	On areas to be prescribed burned, manage for 5-7 tons/acre of course woody debris in ponderosa pine be left on-site after the prescribed burns to maintain long-term soil productivity on areas to be burned outside of the buffers around private land in. Within the pinyon-juniper cover type, snags would be managed for 1 per acre over 75% of the area and coarse woody debris (CWD) would be managed for an after treatment average of 1 to 3 tons per acre. Where available, a portion of the CWD would include two logs ≥10" and ≥10' in length.	To maintain long-term soil productivity.
BMP #8	On areas to be prescribed burned, establish filter strips (also known as streamside management zones. These stream reaches will be designated as protected streamcourses. The following are recommendations to protect streamcourses. **Riparian streamcourse:** Severe erosion hazard: 120 feet on each side of streamcourse. Moderate erosion hazard: 100 feet on each side of streamcourse. Slight erosion hazard: 70 feet on each side of streamcourse. **Non-riparian streamcourse:** Severe erosion hazard: 100 feet on each side of streamcourse. Moderate erosion hazard: 70 feet on each side of streamcourse. Slight erosion hazard: 35 feet on each side of streamcourse. Do not ignite fuels within this buffer area. Some creep may occur into the buffer.	To minimize sediment and/or ash delivery into drainages and maintain water quality.
BMP #9	Intentionally left blank.	
BMP #10	All burning will be coordinated daily with the Arizona Department of Environmental Quality (ADEQ). Burning will not take place on any portion of the project without prior approval from ADEQ. Coordination with ADEQ will take place through the Kaibab and Coconino National Forest Zone Dispatch Center and the Prescribed Burning Boss.	To ensure that smoke management objectives are met.
	Road Rehabilitation and Channel Restoration	
BMP #11	Complete all required permitting (404 permits) and Water Quality Certification (if necessary), prior to project	To comply with Clean Water Act provisions.

BMP #	Mitigation	Why
	implementation.	
BMP #12	Site rehabilitation on upland sites for stream channel and road rehabilitation projects where ground disturbance occurs: Seed at 5 pounds/acre with native, certified weed free seed mix. Potential vegetation for individual sites should utilize the Kaibab and Coconino National Forest Terrestrial Ecosystem Survey to identify species to be utilized. Where feasible, protect site with slash spread across the disturbed area to create microclimates and protect from grazing ungulates.	To minimize soil erosion and minimize noxious weed spread.
BMP #13	Site rehabilitation on riparian sites for stream channel and road rehabilitation projects where ground disturbance occurs: Seed at 5 pounds/acre with certified weed free native seed mix to rehabilitate the site and minimize impacts of noxious weeds. Potential vegetation for individual sites should utilize the Kaibab and Coconino National Forest Terrestrial Ecosystem Survey to identify species to be utilized. Where feasible, protect site with a variety of methods (e.g ungulate proof fence, spreading slash etc).	To comply with State and Federal water quality standards by minimizing soil erosion through the stabilizing influence of vegetation ground cover. Minimize noxious weed spread.
BMP #14	Install silt fences and/or waddles downstream from ground-disturbing activities in stream channels to minimize the chance of sediment being lost downstream during construction and until revegetation is completed.	To comply with State and Federal water quality standards by minimizing sediment delivery to drainages.
BMP #15	Provide site protection on newly disturbed soils (e.g. hydromulch, erosion mat, spread slash etc) in channel restoration sites on all sites as needed and where feasible.	To comply with State and Federal water quality standards by minimizing sediment delivery to drainages and to create microclimate for regeneration of grass/forb community and minimize noxious weed spread.
BMP #16	Bring rock material from a local upland site to any headcut drop structures that may be installed in channel restoration projects.	To minimize disturbance in drainage systems and minimize sediment production within channel.

BMP #	Mitigation	Why
BMP #17	Site rehabilitation on disturbed sites at and stream channel shaping on previously obliterated roads: Site rehabilitation consists of several revegetation methods, such as, but not limited to: 1) Store sod removed from the initial ground disturbance and replace the sod from the top of the bank on the disturbed site; 2) Seed with a native seed mix (see BMP's above) 3) Protect site with slash spread across the disturbed area to create microclimates and protect from grazing ungulates. Slash placement will be limited to the upper 2/3 of the bank to limit transport downstream of woody material; 4) Fence out ungulates for 1 to 2 years (or until the site has re-established); 5) use mycorhizal inoculum on severely disturbed sites where no topsoil is left, 6) install erosion mat.	To comply with State and Federal water quality standards by minimizing soil erosion through the stabilizing influence of vegetation ground cover. Minimize noxious weed spread.
BMP #18	Do not borrow road fill or embankment materials from the stream channel or meadow surface on road maintenance projects. End-load all material hauled on-site and compact fill.	To minimize disturbance in drainage systems and minimize sediment production within channel.
BMP #19	Where feasible, relocate roads out of filter strips into an upland position. If this is not feasible, use riprap or velocity checks to stabilize or disperse outfall on road maintenance projects when roads are located within filter strips.	To minimize sediment delivery into drainage and to minimize disturbance in drainage systems and minimize sediment production within channel .
BMP #20	At riparian stream reach restoration sites, restore riparian dependent grasses through 1) seeding of native species, 2) planting plugs of rushes, sedges, and spike rushes to improve success of regeneration efforts. Fence with ungulate proof fencing for 1 to 2 years (or until plants are established) if grazing is inhibiting regeneration efforts.	To comply with State and Federal water quality standards by minimizing soil erosion through stabilization of ground cover. Minimize noxious weed spread.
BMP #21	On areas that have had roads previously obliterated and the remaining roadbed will be removed, add slash/or erosion mat and seed to the disturbed areas.	To add surface roughness a To comply with State and Federal water quality standards by minimizing soil erosion through stabilization of ground cover and to diminish the impact of the first rain event and to speed recovery of the site.
	Springs and seeps	
BMP #22	At spring restoration sites, restore riparian dependent species through 1) seeding of native species, 2) planting plugs/cuttings of native plants to improve success of regeneration efforts. Fence with ungulate proof fencing for 1 to 2 years (or until plants are established) if grazing is	To comply with State and Federal water quality standards by minimizing soil erosion through stabilization of ground cover. Minimize

BMP #	Mitigation	Why
	inhibiting regeneration efforts.	noxious weed spread.
	Harvesting operations	
BMP #23	Do not blade roads when the road surface is too dry. If the road surface is too dry, a water truck can apply water, or the project can be scheduled for when adequate moisture occurs to complete the project.	To minimize sediment detachmen and to minimize impacts on .severe erosion soils
BMP #24	In grassland restoration sites, limit skidding and designate skid trails if wood is to be removed. Where material is not to be removed, do not skid logs in meadows and lop and scatter is the preferred method of treating slash. Do not machine pile within meadows. If skidding has to occur across a riparian or non-riparian streamcourse, designate any crossing prior to skidding.	To minimize impacts to streams and soils in meadows from tree harvesting operations.
BMP #25	Skid trails and obliterated roads will have slash placed on the trail or cross-ditched (waterbarred) to break the energy flow of water. Placing slash on skid trails is the preferred method to dissipate the energy flow of water. Waterbars are only to be implemented with equipment with an articulating blade (no skidders) or by hand.	To minimize soil erosion and maintain soil productivity. and to minimize impacts on .severe erosion soils
BMP #26	Landing locations will be in upland positions and out of meadows, riparian and non-riparian filter strips.	To minimize sediment delivery into drainage. and to minimize impacts on .severe erosion soils
BMP #27	Mechanical harvest or mechanical fuel treatment are only allowed on Cinder Cones greater than 25% slope with designated skid trails and slash mats placed on the skid trails. On other sites, mechanized harvesting can occur up to 40% slopes.	To maintain long-term soil productivity on slopes with severe erosion hazard potential
BMP #28	Designated skid trails and log landings will be required within the Integrated Resource Service Contract (**BMP 24.18 in FSH 2509.22**) on all cutting units. Skid trail design should not have long, straight skid trails that would direct water flow. Skid trails should also be located out of filter strips (exceptions are at approved crossings).	To minimize the number of acres disturbed and to minimize impacts on .severe erosion soils .
BMP #29	Felling to the lead will be required within the Integrated Resource Service Contract (IRSC) to minimize ground disturbance from skidding operations (**BMP 24.18**).	Felling of timber should be done to minimize ground disturbance from skidding operations and to minimize impacts on .severe erosion soils .
BMP #30	The IRSC outlines the timing and application of erosion	Minimize soil loss and

BMP #	Mitigation	Why
	control methods to minimize soil loss and sedimentation of streamcourses. Seed mix can include any of the following certified weed free native species at a minimum of 5 lbs/acre pure live seed: Potential vegetation for individual sites should utilize the Kaibab and Coconino National Forest Terrestrial Ecosystem Survey to identify species to be utilized. Corresponding BMP's from FSH 2509.22 to minimize soil loss and sedimentation of include **24.13, 24.21, 24.22, 24.23, 24.24, and 24.25**. The preferred erosion control method on the skid trails in the harvest areas will be by spreading slash. Other acceptable erosion control measures include, but are not limited to, waterbarring (waterbars should not be more than two feet deep and need at least a ten foot leadout. Waterbars are only to be implemented with equipment with an articulating blade (no skidders) or by hand.), removing berms, seeding, mulching and cross-ripping. Erosion control after skidding operations must be timely to minimize the effects of log skidding.	sedimentation of streamcourses from skidding operations and to minimize noxious weed spread and re-establish native vegetation and to minimize impacts on .severe erosion soils
BMP #31	Road drainage is controlled by a variety of methods (**BMP 41.14**), including rolling the grade, insloping outsloping, crowning, water spreading ditches, an contour trenching. Sediment loads at drainage structures can be reduced by installing sediment filters, rock and vegetative energy dissipaters, and settling ponds. Design of roads is included in the transportation plan of the IRSC and T-specs.	To minimize soil movement and maintain water quality and to minimize impacts on .severe erosion soils.
BMP #32	Road maintenance (**BMP 41.25)** through the IRSC should require prehaul and post haul maintenance on all roads to be used for haul.	To minimize soil movement and maintain water quality. and to minimize impacts on .severe erosion soils
BMP #33	The designation of filter strips (also known as streamside management zones) minimizes on-site soil movement from timber harvest activities along streamcourses (**BMP 24.16**). These stream reaches will be designated as protected streamcourses. Locations of protected streamcourses are included in the individual **Task Order Maps** and will be designated with a protected streamcourse designation. The following are recommendations to protect streamcourses within the proposed tree harvest units in relation to riparian and non-riparian streamcourses. The guidelines for filter strip designation are as follows: **Riparian streamcourse:** Severe erosion hazard: 120 feet on each side of streamcourse. Moderate erosion hazard: 100 feet on each side of streamcourse. Slight erosion hazard: 70 feet on each side of streamcourse.	Filtering sediment and/or providing bank stability on all streamcourses and to minimize impacts on .severe erosion soils . To implement the Oak Creek *E. Coli* TMDL and Lake Mary Region Mercury TMDL and to filter sediment and/or provide bank stability.

BMP #	Mitigation	Why
	Non-riparian streamcourse: Severe erosion hazard: 100 feet on each side of streamcourse. Moderate erosion hazard: 70 feet on each side of streamcourse. Slight erosion hazard: 35 feet on each side of streamcourse. Accepted harvest activities within riparian and non-riparian filter strips include mechanical and conventional tree felling and limited skidding on designated skid trails and not across streamcourses. Landings, decking areas, machine piles, and roads (except at designated crossings) are planned outside of riparian and non-riparian filter strips.	
BMP #34	Intentionally left blank.	
BMP #35	Manage for a minimum of 5 to 7 tons per acre in ponderosa pine sites that will be left on-site on all cutting unit sites.	To promote long-term soil productivity.
BMP #36	Mechanical crushing of lopped slash can only occur on 0-25% slopes**.**	To incorporate slash into the soil to promote long-term soil productivity.
BMP #38	Identify landings, staging area for heavy equipment and sites for any in woods processing sites outside of filter strips and meadows. Sites will be rehabilitated after use by methods such as, but not limited to: 1) ripping to remove compaction, 2) seeding with certified weed free native seed to 5 lbs per acre. Potential vegetation for individual sites should utilize the Kaibab and Coconino National Forest Terrestrial Ecosystem Survey to identify species to be utilized; and 3)spreading of slash to disguise the site and provide for a mulch for seeds	To minimize and mitigate impacts from activities that compact sites and to restore long-term soil productivity and to minimize impacts on .severe erosion soils .
BMP #39	Manage for a minimum of 1 to 3 tons per acre in pinyon-juniper sites that will be left on-site on all cutting unit sites. Where available, a portion would include two logs greater than or equal to 10 inches and 10 feet in length.	To promote long-term soil productivity.

Coconino and Kaibab National Forests Land Management Plan Direction

Table 2 summarizes the Forest-wide acreages for each Management Area (MA) of the Coconino National Forest and Geographic Area (GA) of the Kaibab National Forest and associated acreages within the Four Forest Restoration Initiative project area. Table 3 summarizes the standards and guidelines for soil and water resources in the Coconino National Forest Plan (USDA 1987). Table 4 provides a summary of the management direction in the Kaibab National Forest Plan (USDA 1988).

Table 5 summarizes standards and guidelines for soils and water resources from the Kaibab National Forest Plan (USDA 1988) for the Project Area.

Table 2. Management Areas (MA) of the Coconino National Forest and Geographic Areas (GA) of the Kaibab National Forest and their associated forest and project area acreages and Forest Plan emphasis.

CNF Forest Plan Management Areas (MA) and KNF Ecosystem Management Areas (EMA) within the project area	Description	Forest Plan Emphasis	Forest-wide MA and GA acres	MA and GA acres within project area
Coconino National Forest				
MA 3	Ponderosa pine and mixed conifer on less than 40% slope	Sustained yield of timber and firewood, wildlife habitat, grazing, high quality water, dispersed recreation	511,015	236,245
MA 4	Ponderosa pine and MC above 40%	Wildlife habitat, watershed condition, and dispersed recreation	46,382	11,793
MA 5	Aspen	Wildlife habitat, visual quality, sustain yield of firewood production, watershed condition, dispersed recreation	3,450	2,761
MA 6	Unproductive timber lands	Wildlife habitat, watershed condition, grazing	67,146	12,115
MA 7	PJ Woodlands < 40%	Firewood production, watershed condition, wildlife habitat, grazing	273,815	3,206
MA 8	PJ Woodlands > 40 Percent Slopes	Emphasize wildlife habitat, watershed condition, and dispersed recreation. Management intensity is low.		
MA 9	Mountain Grasslands	Livestock grazing, visual quality, wildlife habitat	9,049	7,102
MA 10	Grassland and Sparse PJ Above the Rim	Emphasize range management, watershed condition, and wildlife habitat. Other resources are managed to improve outputs and quality. Emphasis is on prescribed burning to achieve management objectives.	160,494	8,544
MA 12	Riparian and Open Water	Wildlife habitat, visual quality, fish habitat, watershed condition on the wetlands, riparian forest, and riparian scrub, dispersed recreation on the open water portions	20,490	653

CNF Forest Plan Management Areas (MA) and KNF Ecosystem Management Areas (EMA) within the project area	Description	Forest Plan Emphasis	Forest-wide MA and GA acres	MA and GA acres within project area
MA 13	Cinder Hills	OHV recreation opportunities and amenities, scenic integrity, geologic features	13,711	13,732
MA 14	Oak Creek Canyon	Scenery, recreation, wildlife habitat, healthy streams, clean air and water, manage fire hazards and risk	5,388	7
MA 15	Developed Recreation Sites	Developed recreation	874	805
MA 18	Elden Environmental Study Area	Visual resource management, watershed condition, manage for low fire potential with fire re-established	1,577	1,611
MA 20	Highway 180 Corridor	Scenic attraction, access to year-round recreation and Grand Canyon NP	7,608	6,213
MA 28	Schnebly Rim	Seasonal gateway, conserve winter range for deer, elk, turkey	5,090	2,455
MA 31	Craters	Restore natural grasslands, re-establish or maintain fire in pinyon-juniper woodland	29,940	8,969
MA 32	Deadman Wash	Grasslands, un-roaded landscape, grazing, hunting	58,133	11,659
MA 35	Lake Mary Watershed	Maintenance and/or improvement of soil condition and watershed function, reduced fire risk in urban/rural influence zone	62,536	59,301
MA 33	Doney	Reduced fire risk in urban/rural influence zone, recreation, grasslands, scenic quality	40,530	25,779
MA 34	Flagstaff	Reduce risk of catastrophic wildfire, recreation, scenic quality	1,781	1,675
MA 36	Schultz	Reduce wildfire risk, maintain watershed health and water quality	21,289	21,130
MA 37	Walnut Canyon	Reduce fire risk in urban/rural interface zone, progress	20,566	18,030

CNF Forest Plan Management Areas (MA) and KNF Ecosystem Management Areas (EMA) within the project area	Description	Forest Plan Emphasis	Forest-wide MA and GA acres	MA and GA acres within project area
		towards desired forest structure including MSO and goshawk habitats		
MA 38	West	Reduced fire risk in urban/rural influence zone, recreation, scenic quality	36,298	36,134
Kaibab National Forest				
GA 1	Western Williams Woodland	Wildlife habitat, sandstone products, scenic routes and features, grazing, wild burro territory	169,041	4,807
GA 2	Williams Forestland	Suitable timberland, recreation, grazing, wildlife habitat	308,394	299,842
GA 3	Northern Williams Woodland	Winter wildlife habitat, scenic routes and features, grazing	65,533	3,485
GA 8	Tusayan Woodland	Wildlife habitat, scenic routes and features, grasslands, grazing	195,118	1,518
GA 21	Existing Developed Recreation Sites	Existing public and private sector developed recreation sites and other smaller sites (trailheads, interpretive sites, etc.)	1,556	1,049

Table 3. Summary of the Standards and Guidelines from the Coconino National Forest Plan for the Project Area.

MANAGEMENT AREAS (MA)	DESCRIPTION	Standards and Guidelines	FLMP page
Forest-wide	Forest-wide	Use Best Management Practices to reduce nonpoint source pollution	Amendment 3, replacement p. 71
Forest-wide	Forest-wide	Plan for appropriate filter strips adjacent to streamcourses and/or riparian areas	Amendment 3, replacement p. 71
Forest-wide	Forest-wide	Designate streamcourses and riparian areas to receive protection during projects	Amendment 3, replacement p. 72
Forest-wide	Forest-wide	Maintain current satisfactory watershed conditions and improve unsatisfactory conditions to satisfactory by the year 2020.	Page 74
Forest-wide	Forest-wide	Plan projects, parts of projects, and/or management practices for soil and water resources improvement where watershed condition is unsatisfactory. Incorporate plans for soil and water improvements into	Amendment 3, replacement p. 72

MANAGEMENT AREAS (MA)	DESCRIPTION	Standards and Guidelines	FLMP page
		project planning for other resources	
Forest-wide	Forest-wide	Inventory riparian communities and areas capable of supporting riparian species by the end of the first decade. Channel condition and aquatic habitat condition will be included in the survey. Plan and design projects in areas of unsatisfactory or degraded condition to promote channel and streambank stability and to improve flow and timing of water. Meet or exceed eighty percent of Regional requirements above the Rim and ninety percent below the Rim by 2030. Manage to achieve at least 25 percent of the currently unsatisfactory riparian areas will be in satisfactory condition by 2000.	
3,6,9	Ponderosa Pine and Mixed Conifer less than 40% slopes Unproductive Timber Land	Identify each terrestrial ecosystem and assess soil properties to determine: • Soil limitations for soil scarification purposes. • The method of soil scarification best suited for the soils of the project area. • Soil potential for revegetation - Identify soils that are suitable or unsuitable for successful revegetation. Erosion hazard and on-site soil loss - Soils with a potential erosion hazard rating of severe will require specific resource management activities in order to avoid severe impairment of soil productivity.	Amendment 17, replacement p. 120 Forest Plan p. 146 Forest Plan p. 160
3	Ponderosa Pine and Mixed Conifer less than 40% slopes	For each timber sale area, identify each terrestrial ecosystem and assess soil properties to determine: • Soils with severe potential for sheet and gully erosion, such as steep slopes, cinder cones, alluvial bottoms, and swales, that require specific resource management activities in order to avoid severe impairment of soil productivity. • Soil limitations for site preparation - Identify soils that present severe limitations for successful site preparation such as soils with severe erosion hazard and	Amendment 1, replacement p. 136

MANAGEMENT AREAS (MA)	DESCRIPTION	Standards and Guidelines	FLMP page
		shallow soils. Require specific resource management activities where successful site preparation is limited by environmental factors in the terrestrial ecosystem. • Soil potential for reforestation - Identify soils that are suitable or unsuitable for successful reforestation. Adjust stocking levels and require specific resource management activities where successful reforestation is limited by environmental factors in the terrestrial ecosystem. • Whether soils are suitable, unsuitable, or unproductive for timber management. • Soil limitations for timber harvest activities. • Soils with high potential to convert to another vegetative type such as oak, locust, or juniper as a result of timber management activities - Modify timber management activities in these terrestrial ecosystems conversion by approved chemical or mechanical means or by prescribed fire.	
3	Ponderosa Pine and Mixed Conifer less than 40% slopes	Where open meadows in the pine/mixed conifer type are to be maintained, eliminate invading overstory vegetation, stabilize gullies to raise the water table, scarify the soil, and seed with appropriate grass and forage species. Control livestock grazing through management and/or fencing to establish the revegetation.	Amendment 17, replacement p.120
3	Ponderosa Pine and Mixed Conifer less than 40% slopes	Construct landings and decking areas outside of riparian areas.	Amendment 1, replacement p.136
3	Ponderosa Pine and Mixed Conifer less than 40% slopes	Locate or relocate roads out of riparian areas, except at designated crossings. Obliterate unnecessary roads in riparian areas.	Amendment 1, replacement p. 136
3	Ponderosa Pine and Mixed Conifer less than 40% slopes	Avoid or designate stream course crossings for skid trails. Limit to the minimum needed. Choose crossings with stable conditions or stable bed and bank material such as cobble or rock.	Amendment 1, replacement p. 136
3	Ponderosa Pine and Mixed Conifer less than 40% slopes	Restrict skidding and hauling to soil moisture conditions that do not cause excessive soil compaction, displacement, or puddling. Restrict timber sale activities to slopes of 25 percent or less on cinder	Amendment 1, replacement p. 136

MANAGEMENT AREAS (MA)	DESCRIPTION	Standards and Guidelines	FLMP page
		cones under conventional skidding.	
6	Unproductive Timber Land	During the first decade, identify each terrestrial ecosystem and assess soil properties to determine: Whether soils are suitable, unsuitable, or unproductive for timber management. Provide detailed soils input to administrative study plans for reforestation.	Forest Plan, p. 146
9	Mountain Grassland	Manage mountain grasslands to achieve 90 percent of potential ground cover to prevent accelerated surface erosion and gully formation. Areas that presently do not meet these standards are scarified and seeded to bring ground cover to the desired level by the second decade. Restricting livestock may be necessary until revegetation. In areas capable of supporting woody riparian species, maintain and/or improve these species to standards in the Regional Guide, August 1983. Plan and implement cost effective stream channel restoration projects to raise the water table in meadow areas where channel erosion has resulted in a lowering of the water table.	Forest Plan, p. 160
12	Riparian and Open Water	Through coordination with other disciplines, maintain or improve, where necessary, riparian vegetation along streams for moderating water temperature and protecting bank stability. Accomplish promptly after the inventory phase is completed. Investigate and implement where necessary, cost effective structural measures to control channel erosion.	Forest Plan, p. 177
12	Riparian and Open Water	Plan for suitable filter strips between streamcourses and disturbed areas and/or road locations. See Filter Strip Table in Forest-wide Standards and Guidelines under Watershed/Soil/Air, F2. Plan for suitable filter strips between stream courses and ground disturbing activities including roads.	Amendment 1, replacement p. 176
12	Riparian and Open Water	No precommercial thinning or piling slash in riparian areas or areas that have riparian characteristics.	Amendment 1, replacement p. 176

MANAGEMENT AREAS (MA)	DESCRIPTION	Standards and Guidelines	FLMP page
35	Lake Mary Watershed	This area is a high priority for fixing drainage culverts, relocating roads from meadows, and obliterating unnecessary roads so that erosion does not degrade water quality in Lake Mary. Roads, trails, camping, and grazing will be managed to improve watershed condition particularly within mountain meadows, springs, and drainages. Improve watershed conditions in Priest Draw. Cooperate with the City of Flagstaff and National Park Service to develop study proposals and projects designed to evaluate best management practices, reservoir modifications, and/or operational criteria to address the objectives of maintaining the quality of the municipal water supply and increasing the likelihood of flood flows and improvement of the inner-canyon environment in Walnut Canyon National Monument (per the Stipulation Between The City of Flagstaff and the United States on Behalf of the National Park Service and the Forest Service).	Errata #1 – 1/2008 Replacement pgs. 206-100 and 206-101
37	Walnut Canyon	Cooperate with the City of Flagstaff and National Park Service to develop study proposals and projects designed to evaluate best management practices, reservoir modifications, and/or operational criteria to address the objectives of maintaining the quality of the municipal water supply and increasing the likelihood of flood flows and improvement of the inner-canyon environment in Walnut Canyon National Monument (per the Stipulation Between The City of Flagstaff and the United States on Behalf of the National Park Service and the Forest Service).	Errata #1 – 1/2008 Replacement pgs. 206-111

Table 4. Summary of the Management Direction for Soil and Water Resources from the Kaibab National Forest Plan

for the Project Area.

MANAGEMENT AREA	MANAGEMENT DIRECTION
Forest-wide	Produce the maximum amount of forage, consistent with other resource values, for use by wildlife and livestock on a sustained yield basis. Benefits are improved watershed condition, range forage, wildlife habitat, and enhanced visual quality. Chapter 4, page 18
Forest-wide	Concentrate fuelwood programs in the pinyon-juniper woodland to accomplish, wildlife habitat, soil and watershed, and range improvement objectives. Encourage substitution of coniferous residues from commercial timber harvest for preferred fuelwood sources. Chapter 4, page 19
Forest-wide	Maintain soil productivity and watershed condition. Rehabilitate non-productive lands on a planned basis to eliminate unsatisfactory watershed condition by 2020. Maintain a high quality sustained water yield for Forest users and others. Identify and protect wetlands and floodplains. Chapter 4, page 19.
Forest-wide	Ecosystem Management In Northern Goshawk Habitats - Manage the ground surface layer to maintain satisfactory soil conditions i.e. to minimize soil compaction; and to maintain hydrologic and nutrient cycles.
1, 8, 9	Provide for intensive management of soil and watershed resources.
1, 8, 9	Make soil and watershed resource inventories and analyses to ensure the conservation of soil and water resources and to avoid significant and permanent impairment of site productivity.
1, 3, 8, 9	Provide soil and water resource integration and coordination in land and resource management planning.
1, 3, 8, 9	Formulate and execute land treatment measures to (1) close, revegetate, and thereby obliterate, system roads not needed for resource actions and (2) establish ground cover improvements in degraded, unsatisfactory watersheds to return them to satisfactory condition.
1, 8, 9	Provide for the long-term maintenance of vegetative ground-cover improvements.
1, 8, 9	Maintain soil and water inventory and information systems.
3	Provide for intensive management of soil and watershed resources to ensure their conservation and to avoid significant and permanent impairment of site productivity.
3	Provide for the long-term maintenance of vegetative groundcover improvements and the periodic maintenance and replacement of structural improvements.
3	Make soil and water resource analyses and maintain inventory information systems.

Table 5. Summary of the Standards and Guidelines from the Kaibab National Forest Plan.

MANAGEMENT AREA (MA)	DESCRIPTION	APPLICABLE STANDARDS AND GUIDELINES	FLMP page
Forest-wide	Forest-wide	Use the Appendix B “Design Features, Best Management Practices and Mitigation Measures” in the “Final Environmental Impact Statement for Integrated Treatment of Noxious or Invasive Weeds on the Coconino, Kaibab, and Prescott National Forests within Coconino, Gila, Mojave, and Yavapai Counties, Arizona” (2004) for specific mitigation measures.	Chapter 4, page 34-1 (Amended11/ 04)

MANAGEMENT AREA (MA)	DESCRIPTION	APPLICABLE STANDARDS AND GUIDELINES	FLMP page
		Deviance from Appendix B does not trigger the need for a Forest Plan Amendment; however Required Protection Measures from Section 7 consultation (Endangered Species Act) must be followed. If as a result of environmental analysis, Best Management Practices or Mitigation Measures are modified, document the reason(s) in a NEPA decision.	
Forest-wide	Forest-wide	Incorporate measures to control invasive species into project planning, implementation and monitoring.	Chapter 4, page 35
1, 3, 8, 9	Recreation Use Administration	Provide control measures for areas where the following resource damage occurs: (1) soil compaction, (2) loss of vegetative cover, (3) tree damage and mortality, and (4) deterioration of water quality.	Chapter 4, page 73
1, 3, 8, 9	Recreation Use Administration	Implement permanent, temporary or seasonal closures of areas to off-road vehicle traffic to protect soil, vegetation, visual, wildlife, wildlife habitat and cultural and historic resources.	Chapter 4, page 73
1, 3, 8, 9	Recreation Use Administration	Prohibit off-road competitive events.	Chapter 4, page 73
1, 3, 8, 9	Wildlife, Surveys, Planning, Prescriptions, Monitoring, Coop, and Administration	Riparian Vegetation. Riparian areas are geographically delineable areas with distinctive resource values and characteristics that are comprised of aquatic and riparian ecosystems. Riparian ecosystem is a transition between aquatic ecosystems and adjacent terrestrial ecosystem identified by soil characteristics or distinctive vegetation communities that require free or unbound water; terrestrial ecosystems characterized by hydric soils and plant species that are dependent on the water table (saturated zone) and, or its capillary zone. a. Inventory all riparian areas; collect data regarding location, size, classification and condition of the riparian. b. Maintain not less than three age classes of woody riparian species, with ten percent of the woody plant cover in sprouts, suckers, seedlings, and saplings. c. Maintain not less than 90 percent of the potential stream shading from May to September along all perennial cold or cool water streams. Provide shade with tree and other vegetational cover. d. Maintain not less than 90 percent of the potential shrub cover in riparian areas. e. Maintain not less than 90 percent of total linear streambank in stable condition. f. Woody riparian communities in addition to riparian communities which are dominated by shrub and herbaceous	Chapter 4, page 76

MANAGEMENT AREA (MA)	DESCRIPTION	APPLICABLE STANDARDS AND GUIDELINES	FLMP page
		species are to rate in satisfactory or better condition. g. Select riparian areas for treatment based on relative scorecard condition rating with the lowest rating assigned to first treatment.	
1, 3, 8, 9	Range Non-Structural Improvement	Re-treat improved forage areas as determined in project level analysis using mechanical, chemical or fire use means and in accordance with the following guidelines: a. The area to be re-treated is situated on one or more of the following soil mapping units: 8, 16, 17, 18, 19, 23, 27, 30, 32, 40, 112, 162, 250, 251, 254, 255, 256, 257, 258, 260, 261, 263, 264, 272, 273, 280, 289, 502, 503, 507, 513, 514, 520, 543, 588, 590, 599, 632, 633, and 634. b. Opening is not larger than 40 acres excepting that in primary pronghorn antelope range. c. The maximum width of the opening is 10 chains excepting that in primary pronghorn antelope range. d. The maximum sight distance within the opening is 15 chains excepting that in primary pronghorn antelope range. e. The minimum distance between any two openings is 10 chains. f. Exclude livestock from seeded areas for Not less than two growing seasons.	Chapter 4, page 79
1, 3, 8, 9	Improvement	Implement land treatment and structural measures in accordance with project specific analysis and the following guidelines. Land treatment measures are (1) closure and revegetation of system roads identified for obliteration in the transportation inventory; and (2) ground cover improvements in the following soil mapping units: 8, 12, 16, 17, 18, 19, 27, 30, 32, 40, 162, 165, 250, 251, 254, 255, 257, 258, 260, 261, 263, 264, 272, 273, 280, 281, 288, 289, 502, 503, 507, 513, 514, 520, 542, 543, 587, 588, 590, 592, 599, 632, and 634.	Chapter 4, page 82
1, 3, 8, 9	Processing of Oil and Gas Lease Applications	Restrict use and occupancy yearlong on slopes of 15 percent or greater to prevent loss of soil productivity and vegetative cover.	Chapter 4, page 83
1, 3, 8, 9	Transportation System Planning and Inventory	Identify and obliterate all system roads not required for resource management in accordance with the Management Direction for Soil and Water Resources.	Chapter 4, page 85

MANAGEMENT AREA (MA)	DESCRIPTION	APPLICABLE STANDARDS AND GUIDELINES	FLMP page
2, 10	Additional standards applicable only to Ecosystem Management Areas 2, 10 and 13.	Implement resource operations and improvements which contribute to achievement of desired conditions and fulfillment of the Forest Service mission. (Resource operations and improvements are specified in Forest Service Handbook (FSH) 1309.16, National Activity Structure Handbook).	Chapter 4, page 38
2, 10	Additional standards applicable only to Ecosystem Management Areas 2, 10 and 13.	Identify habitat management territories for threatened, endangered, or sensitive plant or animal species that are consistent with the conservation strategy and the recovery plan established for the species through on-the-ground surveys or record searches. Habitat needs for Federally listed species will take precedence over unlisted species, endangered species take precedence over threatened species and sensitive species take precedence over non-sensitive species.	Chapter 4, page 38
2, 10	Additional standards applicable only to Ecosystem Management Areas 2, 10 and 13.	Formulate and portray, describe, or quantify management objectives and desired conditions for the landscape. In landscapes that involve habitat for threatened, endangered, or sensitive plant or animal species, formulate management objectives and desired conditions for each designated management territory. Formulate, design, and implement resource operations or improvements that contribute to the achievement or maintenance of these management objectives and desired conditions.	Chapter 4, page 38
2, 10	Additional standards applicable only to Ecosystem Management Areas 2, 10 and 13	Consult with appropriate tribal, state, county, or local government agencies regarding existing conditions, desired conditions, management objectives, proposed intervention and resource improvement actions for the landscape.	Chapter 4, page 38

MANAGEMENT AREA (MA)	DESCRIPTION	APPLICABLE STANDARDS AND GUIDELINES	FLMP page
2, 10	Additional standards applicable only to Ecosystem Management Areas 2, 10 and 13	Formulate, design, and propose resource operations or improvements that contribute, over time, to the achievement or maintenance of desired resource or ecological conditions in landscapes. Consult when applicable: a. Survey and inventory protocols for TE&S species. b. Recovery plans and conservation strategies for TE&S species. c. Formal Consultation Reports. d. Guidelines for resource operations and improvements. e. Intergovernmental agreements and memoranda of understanding. f. Forest Service Manuals and Handbooks. g. Management review and resource monitoring evaluation reports. h. Technical reports and bulletins, research pape i. Tribal, state, and local government input. j. Public input.	Chapter 4, page 38
2, 10	Additional standards applicable only to Ecosystem Management Areas 2, 10 and 13	Identify, describe, and geographically locate existing conditions in the implementation land area, regarding: a. National Forest lands. b. Research natural areas. c. Wilderness and other administrative designations. d. Ecosystem management areas. e. Landscapes. f. Ad hoc areas. g. Administrative, fire, and other facilities. h. Water locations and water rights. i. Roads, trails, airports, and heliports. j. Fuel loadings. k. Ecological land units (aka TES units or SM units). l. Range allotments and pastures. m. Range utilization, condition and trend. n. Range improvements. o. Heritage resource properties. p. Utility corridors and other special land uses. q. NZ: Visual quality objectives; SZ: Scenic Integrity Objectives. r. Existing vegetation.	Chapter 4, page 39

MANAGEMENT AREA (MA)	DESCRIPTION	APPLICABLE STANDARDS AND GUIDELINES	FLMP page
		s. Meadows and grasslands. t. Management territories for threatened, endangered, or sensitive species. u. Management territories for other plant or animal species. v. Wetlands. w. Recreation opportunity spectrum. x. Recreation sites, including RARE II areas. y. Mineral sites. z. Off-road vehicular closure areas.	
2, 10	Additional standards applicable only to Ecosystem Management Areas 2, 10 and 13	Identify and portray desired forest site conditions for the landscape or ad hoc area at the twenty-year and forty-year timemarks.	Chapter 4, page 39
2, 10	Additional standards applicable only to Ecosystem Management Areas 2, 10 and 13	Identify, interpret, and expose public issues, management concerns, and resource opportunities relevant to the landscape.	Chapter 4, page 39
2, 10	Additional standards applicable only to Ecosystem Management Areas 2, 10 and 13	Describe and geographically locate, using geographic information systems technology, the selected set of proposed intervention or resource improvement actions designed to accelerate progress toward desired conditions or maintain desired conditions. Also: a. Geographically identify and locate, the analysis area (aka affected area) relevant to each proposed intervention or resource improvement action. b. For each analysis area, predict the expected e c. For each analysis area, predict the expected e d. Identify and geographically locate possible con governmental agency interests, missions, or o impact statement or environmental assessmen appropriate decision document. e. Identify and establish monitoring activities for each proposed intervention or resource improv	Chapter 4, page 39
2, 10	Additional standards applicable only to Ecosystem Management Areas 2, 10 and 13	Formulate alternatives to proposed intervention or resource improvement actions not categorically excluded from documentation in an environmental document.	Chapter 4, page 40

MANAGEMENT AREA (MA)	DESCRIPTION	APPLICABLE STANDARDS AND GUIDELINES	FLMP page
2, 10	Additional standards applicable only to Ecosystem Management Areas 2, 10 and 13	Document findings of environmental analysis, disclose the expected environmental effects of proposed actions, and publish implementation decisions as prescribed by NEPA and its implementing regulations or regulations of the Secretary of Agriculture.	Chapter 4, page 40
2, 10	Guidelines for Rangeland Resource Operations and Improvements	Favor native species in all revegetation activities.	Chapter 4, page 40
2, 10	Guidelines for Recreation Resource Operations and Improvements	Formulate and implement control measures where and when the following damage occurs: a. Soil compaction. b. Loss of vegetative cover. c. Tree damage and mortality. d. Deterioration of water quality.	Chapter 4, page 41
2, 10	Guidelines for Recreation Resource Operations and Improvements	Prohibit competitive ORV events.	Chapter 4, page 41
2, 10	Guidelines for Air and Watershed Resource Operations and Improvements	1. Define, geographically identify and locate best management practices for the landscape during landscape planning and analysis. Apply best management practices to mitigate adverse effects of activities and maintain site soil productivity. These practices include: a. Installation of water control structures or seeding lands in poor and very poor condition where the revegetation potential is moderately high to high and the slope is less than 40 percent. b. Designate stream courses during landscape planning and analysis process. c. Rehabilitate areas impacted by wildfire. 2. Exclude domestic livestock from treated area for not less than two growing seasons. 3. Maintain not less than three age classes of woody riparian species with ten percent of the woody plant cover in sprouts, suckers, seedlings, and saplings. 4. Maintain not less than 90 percent of the potential stream shading from May to September along all perennial cold or cool water streams. Provide shade with tree and other vegetation cover. 5. Maintain not less than 90 percent of the potential shrub cover in riparian areas. 6. Maintain not less than 90 percent of total linear streambank in stable condition.	Chapter 4, page 42

MANAGEMENT AREA (MA)	DESCRIPTION	APPLICABLE STANDARDS AND GUIDELINES	FLMP page
		7. Woody riparian communities in addition to riparian communities which are dominated by shrub and herbaceous species are rated in satisfactory or better condition. 8. Select riparian areas for treatment based on relative scorecard condition rating with the lowest rating assigned to first treatment.	
2, 10		4. Personal-use fuelwood standards a. Ponderosa pine, Douglas fir, and spruce: (1) Any dead and down tree. (2) Any standing dead tree less than 12 inches DBH. (3) Any standing dead tree less than 15 feet in total height. b. Juniper: (1) Any dead and down tree. (2) Any standing dead tree without green foliage). c. Pinyon pine: (1) Any dead and down tree. (2) Any standing dead tree less than 12 inches DRC (10"DBH). (3) Any standing dead tree less than 12 feet in height. d. Gambel oak: (1) Any dead and down tree. (2) Any standing dead tree less than 8 inches in DBH. e. Quaking aspen: (1) Any dead and down tree. (2) Any standing dead tree less than 12 inches in DBH.	Chapter 4, page 75

AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This section details the affected environment and environmental consequences for surface water quality, water quantity, and riparian area resources within the analysis area. It establishes the baseline against which the decision maker and the public can evaluate the effects of the action alternative.

This section also describes the direct, indirect, and cumulative effects of implementing each alternative on surface water quality, water quantity, and riparian area resources in the project area. It presents the scientific and analytical basis for the comparison of the alternatives presented in Alternatives section. NEPA requires consideration of "the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity" (40 CFR 1502.16). As declared by Congress, this includes using all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans (NEPA Section 101).

Affected Environment _____

The resource areas within this analysis to be affected by the proposed action or other action alternatives are ephemeral, intermittent, and perennial streamcourses; surface water quality; water quantity; and riparian area conditions.

CLIMATE

The project area occurs within the North central climatological division of Arizona. In this division, the climate is highly variable as a consequence of the uneven topography and the wide range in elevation. Precipitation on the average varies from 16 to 30 inches annually and is bimodal. The wettest season extends from July to October; a second wet season extends from December to March. In the northern and eastern portions of the project area, less than 50 percent of the average annual precipitation occurs during the low-sun half year period of October 1st to March 31st. In the southern portion of the project area more than 50 percent occurs during the same time period. Mean annual snowfall ranges from 0 to over 80 inches. Summer precipitation is irregular, but usually takes place in the form of high-intensity, short duration thunderstorms during the monsoon season (July through September) (Brewer et al. 1991).

Average annual temperatures range from 55° Fahrenheit at lower elevations to 34° Fahrenheit at higher elevations. For the month of January, mean minimum temperatures range from 10° to 20° Fahrenheit; mean maximum temperatures range from 32° to 50° Fahrenheit. For the month of July, mean minimum temperatures range from 45° to 52° Fahrenheit; mean maximum temperatures range from 70° to 105° Fahrenheit.

The NOAA U.S. Seasonal Drought Outlook dated August 16, 2012 indicates that drought will likely improve and drought effects will ease. However, drought could persist or intensify in the northwestern portion of the project area (Figure 1, Appendix A). Currently, the NOAA U.S. Drought Monitor (dated June 5, 2012) indicates that the project area is in moderate to severe drought conditions (Figure 2, Appendix A).

WATER QUALITY & QUANTITY

Watersheds

The Four Forest Restoration Initiative Project occurs within eighty-two sixth-level, or 12-digit hydrologic units (i.e., subwatersheds). As previously noted, a watershed condition assessment was recently conducted for all subwatersheds in the project area as part of a Forest-level assessment of watershed conditions. A summary of watershed conditions for all subwatersheds in the project area is included in Appendix C.

City of Flagstaff Municipal Watersheds and Municipal Water Supplies

Inner Basin (MA 16)
The Inner Basin is a collapsed caldera which was subsequently glaciated. It is 838 acres in size and located on the eastern slopes of the San Francisco Peaks, it provides a variety of recreational, scenic,

and water resources. The Inner Basin is located in the Bear Jaw Canyon subwatershed contributes to the water supply for Flagstaff through an extensive water collection and distribution system. Originally developed by the railroad around the turn of the century, the water system includes spring developments, infiltration galleries, and wells, along with associated access roads and buried pipelines. It is a major component of the Flagstaff Municipal Watershed, an area designated by the Chief of the Forest Service (FSM 2500). The area is open to day-use foot traffic, but closed to domestic livestock and public travel by vehicle. Protecting water quality is the primary management direction.

Lake Mary Watershed (MA 35)

The Lake Mary Watershed is 62,492 acres in size and provides water to the City of Flagstaff water system as part of the municipal water supply. However, the Lake Mary Watershed has not been formally designated by the CNF as a municipal watershed. Surface water from the Lake Mary reservoir system is an important municipal supply for the City of Flagstaff. The 30-year median inflow to the reservoirs from January to May was 5,000 acre-feet, but due to evaporation and seepage losses, the average availability is approximately 2,250 acre-feet (USBOR, 2006). Because surface water availability is affected by drought conditions, it can be unreliable. This has stimulated interest in additional well drilling and development of groundwater supplies in the Flagstaff area. In wet years, Lake Mary has provided up to 70% of the City's water supply (Pinkham and Davis, 2002); however in 1990, 2000 and 2002, there was very little inflow into Lake Mary. Recently, groundwater use has increased and supplies about 70% of the annual demand (Reed, 2005).

Woody Mountain Well Field

The Woody Mountain well field has 10 producing wells and is capable of producing approximately five million gallons per day (City of Flagstaff, 2012). Water production from the Woody Mountain well field in 2010 was 476 million gallons, or 1,461 acre-feet.

City of Williams Municipal Watershed

The City of Williams Municipal Watershed is approximately 26,061 acres in size. Table 6 lists the eight subwatersheds and their associated acreages that occur within the Williams Municipal Watershed. Two of these subwatersheds, Cataract Creek Headwaters and Dogtown Wash, encompass more than 96 percent of the total municipal watershed area.

The objective in managing the Williams Municipal Watershed is to recognize its water supply values and to provide management of its lands and resources to harmonize present and foreseeable resource uses with domestic water supply needs, protection of its water supply facilities and protection of the citizens of Williams from catastrophic floods (Elson 1972).

Table 6. Subwatershed (HUC12) names, acreages, and associated percentages of each that comprise the City of Williams Municipal Watershed. (acres are approximate).

WATERSHED NAME	HYDROLOGIC UNIT NUMBER (HUC12)	TOTAL WATERSHED ACRES	PERCENT OF WILLIAMS MUNICIPAL WATERSHED	ACRES IN PROJECT AREA	PERCENT OF PROJECT AREA
Dogtown Wash	150100040501	10,627	40.8	816.22	8.7
Cataract Creek Headwaters	150100040502	14,616	56.1	5,148.29	33.8
Upper Red Lake Wash	150100040503	681	2.6	0	0

WATERSHED NAME	HYDROLOGIC UNIT NUMBER (HUC12)	TOTAL WATERSHED ACRES	PERCENT OF WILLIAMS MUNICIPAL WATERSHED	ACRES IN PROJECT AREA	PERCENT OF PROJECT AREA
Upper Cataract Creek	150100040504	23	<0.3	0	0
Johnson Creek	150602010302	70	<0.3	2,719.12	17.9
Upper Hell Canyon	150602020204	25	<0.3	1,639.21	10.7
Pitman Valley-Scholz Lake	150602020305	3	<0.3	0	0
Big Spring Canyon	150602020307	9	<0.3	0	0

Runoff impounded in reservoirs serves as the main water supply for the City of Williams. Seven primary reservoirs surrounding the City are the source of surface water for municipal uses. These reservoirs have a combined water storage capacity of 2,755 acre-feet (897 million gallons) of water. Approximately 2,026 acre-feet or 73.6 percent of the available water storage occurs in the two largest impoundments, Dogtown Reservoir and Kaibab Lake. However, the majority of the City's water supply (i.e., approximately 90 percent) originates from Dogtown Reservoir and City Dam. Groundwater from wells located near Dogtown Reservoir supplements surface water in the City municipal water supply. Table 7 below provides a list of reservoirs in the Williams Municipal Watershed and their approximate water storage capacities and percentages of total available surface water supply. Water from these reservoirs originates from snowmelt and summer precipitation.

Table 7. Reservoirs, associated water storage capacities, and percentages of total municipal surface water in the City of Williams Municipal Watershed.

RESERVOIR NAME	WATER STORAGE CAPACITY (Million Gallons)	WATER STORAGE CAPACITY (Acre-Feet)	PERCENT OF TOTAL WATER STORAGE CAPACITY
Dogtown Reservoir	360	1,105	40.2
Kaibab Lake	300	921	33.4
Cataract Lake	109	335	12.2
Santa Fe Reservoir	70	215	7.8
City Dam	36	111	4.0
Upper and Lower Saginaw	22	68	2.4

Some regional water stakeholders, including the Havasupai Tribe, have expressed concern regarding impacts of the City of Williams well development program on springs and seeps in the Grand Canyon area. The City of Williams and the Havasupai Tribe have entered into an agreement regarding regional ground water management and water conservation efforts by the City of Williams. The agreement includes discussions of tribal sovereignty, the significance of the Coconino Plateau to the tribe, the importance of water on the Coconino Plateau, the importance of water conservation, and the effect of drought on the water resources of the City of Williams. Specific agreement clauses address conditions under which the tribe would not contest or may contest well permits from the U.S. Forest Service and the city's right to respond to opposition, monitoring of well levels and production, restrictions on provision of water by the city to residents outside the city, city opposition to Coconino County allowing home development in areas without water supply, mutual support for development of other water supplies, mutual opposition to large-scale development proposals that rely on groundwater development, continuation of water conservation efforts by the City of Williams, and the City's support in principle

for the tribe's position that any decrease to the natural flow of Havasu Creek cannot be tolerated (Pinkham and Davis 2002).

Water Quality

Section 305(b) of the Clean Water Act requires states to assess and report on the water quality status of waters within the states. Section 303(d) requires states to list waters that are not attaining water quality standards. This is also known as the list of impaired waters. This information is reported to Congress on a nationwide basis. The Arizona Department of Environmental Quality (ADEQ) is responsible for conducting monitoring, assessment, reporting under CWA Sections 303(d) and 305(b), and total maximum daily load (TMDL) development for the State of Arizona. Arizona's most recent Integrated Report (305(b) Water Quality Assessment and 303(d) list) is available from the ADEQ. The Arizona Impaired Waters List can be found at:

http://www.azdeq.gov/environ/water/assessment/download/2006_2008.pdf

The ADEQ 2006/2008 Impaired Waters List indicates there are no impaired streams within the project area. However, a segment of Oak Creek that is located approximately 0.25 miles outside of the project boundary and downstream of proposed treatment areas has been listed as impaired in the ADEQ 2006/2008 305(b) Assessment Report for two exceedances of the *Escherichia coliform* (i.e., E. coli) single sample maximum (SSM) water quality standard. This segment of Oak Creek extends from the Arizona State Fish Hatchery for approximately 7.4 miles to the confluence with West Fork Oak Creek. Since 1998, 110 E. coli samples have been collected from this segment. Four samples have exceeded the applicable water quality standard since 2003, resulting in the impairment determination. Two of the exceedances were clearly related to storm flows as they plot on the left hand portion of the Load Duration Curve (LDC) at 0.01 percent flow (ADEQ 2010).

Direct recreational pollution does not appear to be a consistent source of E. coli in the upper watershed (ADEQ 2010). Therefore, indirect anthropogenic pollution may be a contributing factor. Several residential areas and a campground are located within the upper reach in close proximity to the stream. Additionally, pollutants may be introduced via Pumphouse Wash, which drains portions of the watershed southeast of Flagstaff. Cattle grazing, domesticated animals and septic systems are present within the Pumphouse Wash portion of the watershed as is the Kachina Village Wastewater Treatment Plant, which does not discharge to surface water. Increased access to the stream and the potential for greater runoff from these developed sites may contribute pollutants under wet conditions (ADEQ 2010).

ADEQ completed a Pathogen Total Maximum Daily Load (TMDL) in 1999 for Slide Rock State Park, which called for a 30 percent reduction in summer recreational season E. coli values in order to attain the water quality standard of 580 colony forming units per 100 milliliters (cfu/100ml). Subsequently the standard was revised to its current single sample maximum (SSM) value of 235 cfu/100 ml and geometric mean of 126 cfu/100 ml. Continuing exceedances caused ADEQ to undertake a revision to the TMDL beginning in 2003. Sampling occurred on high visitation weekends, during stormwater runoff and snow melt events, and under baseflow conditions.

In 2009 the Oak Creek Watershed Council, a local watershed improvement group, was awarded a Water Quality Improvement Grant by ADEQ. The primary purpose of the grant is to develop a Watershed Improvement Plan (WIP). Several improvement projects have been implemented over the years to

improve the water quality in Oak Creek, however, the effectiveness and necessity of these projects has been questioned. Development of the WIP will include watershed and social surveys aimed at locating and prioritizing future water quality improvement projects. The document will serve as a blueprint for improving water quality in Oak Creek.

The ADEQ has identified Upper and Lower Lake Mary as impaired for the presence of mercury in fish tissue. As outlined in the Lake Mary Regional TMDL (ADEQ 2010) for Mercury in Fish Tissue, ADEQ and the Arizona Game and Fish Department (AGFD) issued fish advisories for Upper and Lower Lake Mary in 2002. In 2002, EPA added five lakes in the Lake Mary Region (LMR) to Arizona's 303(d) List as impaired for mercury in fish tissue. These lakes included Upper and Lower Lake Mary, Soldiers, Soldiers Annex and Lower Long Lakes. The resulting TMDL will use the target of 0.3 mg/kg (wet weight) mercury, the fish tissue standard adopted by ADEQ in January 2009. The LMR is located on the Coconino National Forest, within the Little Colorado River Watershed in north-central Arizona. Land in the LMR is primarily rugged and undeveloped, with 98% under the jurisdiction of the U.S. Forest Service (USFS) and the remaining 2% as private holdings (ADEQ 2010). The TMDL lakes that occur within the project area are listed in Table 8

Table 8. Lakes located in the Lake Mary Region (LMR).

TMDL Lakes	Water Body ID	Background Lakes	Water Body ID
Upper Lake Mary	15020015-0900	Mormon Lake	15020015-0970
Lower Lake Mary	15020015-0890		

All lakes in the LMR, except Mormon Lake, are man-made and were created to provide additional water sources for either people or livestock in the Flagstaff area. Upper and Lower Lake Mary are located approximately 6 miles southeast of Flagstaff. The majority of Upper and Lower Lake Mary watersheds are located to the south of the lakes, with elevations ranging from 6,800 to 8,500 feet. Lower Lake Mary was created in 1904 after an eight-year drought, to support the Arizona Lumber and Timber Company, local community and livestock industry. At full capacity Lower Lake Mary is approximately 765 acres in size, but most years is more accurately characterized as a wetland with a pool above the dam. Upper Lake Mary was constructed in 1940, and at full capacity is 860 acres in size, making it the larger of the two lakes. It is 8 miles long and over one-half mile wide at its widest point. However, due to the shallow depth, the aerial extent of the lake varies widely with precipitation. Upper and Lower Lake Mary are hydraulically connected and support substantial recreational use in the forms of fishing (Upper – largemouth and yellow bass, crappie, sunfish, channel catfish, walleye, tilapia and yellow perch; Lower – rainbow trout, sunfish, channel catfish, and northern pike), camping, wildlife viewing, boating (canoeing, sailing, rafting and power boats) and swimming.

Both Lakes have been assigned the following designated uses according to the Arizona Administrative Code (A.A.C.) Title 18, Chapter 11:

- Domestic Water Source (DWS),
- Aquatic and Wildlife Cold Water (A&W cold),
- Full Body Contact (FBC),
- Fish Consumption (FC), and
- Agricultural Livestock Watering (AgL).

Although Upper and Lower Lake Mary are designated as domestic water sources, the levels of total mercury observed do not approach drinking water maximum contaminant levels.

Ashurst Lake, Mormon Lake, and Willow Springs Lake serve as background lakes because fish tissue mercury results were lower than those measured in the TMDL lakes. According to ADEQ, the original intent of the background lakes was to determine why some lakes in the LMR contained fish with high levels of mercury while others did not. However, since the lakes do not all contain the same fish species, this type of analysis is inconclusive.

Water quality sampling conducted by ADEQ indicate that inputs of mercury from tributaries are comparable among all of the lakes studied, indicating that in-lake processes and the fish species contained within each lake, play an important role in the bioaccumulation of mercury. ADEQ intends to continue fish tissue collection and bioaccumulation studies in the LMR in hope of determining the specific factors leading to mercury methylation.

The ADEQ has concluded that watershed loading can potentially be reduced through management of sedimentation and vegetative stability. Recommendations included a review of upland and drainage conditions, so that areas requiring soil stabilization measures and channel improvements may be identified.

Streamcourses

Streamcourses within the project area are generally low-gradient ephemeral and intermittent streams with dendritic drainage patterns, except in areas with very steep terrain such as mountains (i.e., extinct volcanoes) and cinder cones, which typically have radial drainage patterns with high-gradient ephemeral and intermittent drainages flowing in all directions from upper slopes. Approximately 2,197 miles of streamcourses occur within the analysis area, of which approximately 8.2 miles exhibit perennial flow. Appendix B lists stream reaches that occur within the Four Forest Restoration Initiative analysis area, their associated lengths and flow regimes. It should be noted that the National Hydrography Data (NHD) does not differentiate between ephemeral and intermittent stream flow. As a result, ephemeral streamcourses are classified as intermittent in the NHD.

Three perennial streams occur outside of the Four Forest Restoration Initiative analysis area, although they are in close proximity to proposed treatment areas. These include Oak Creek, West Fork Oak Creek, and Sycamore Creek. Perennial flow in Oak Creek initiates at the Arizona State Fish Hatchery near the confluence with Sterling Spring. Sycamore Creek flows along the bottom of Sycamore Canyon and includes riparian habitat featuring many cottonwoods, walnuts and sycamores.

Three perennial stream segments occur within the project area, including the Rio de Flag, Pumphouse Wash, and Sawmill Wash. The Rio de Flag exhibits perennial flow from the Flagstaff reclaimed water treatment discharge location for approximately 5 miles to the Wildcat Hill Wastewater Treatment Facility where effluent is then dicharged into the Rio de Flag, contributing to perennial flow for an additional 2 miles through perennial wetlands in the Picture Canyon area. Winter snowmelt from the San Francisco Peaks and rainfall during the summer monsoons of July and August also contribute to streamflow in the Rio de Flag. Pumphouse Wash exhibits perennial flow from O'Neil Spring southwestward for approximately 1.2 miles through the Kachina Village area before surface water infiltrates and contributes to wetland conditions that support riparian vegetation. Sawmill Wash exhibits

perennial flow for approximately 0.79 miles from the source at Sawmill Springs, eastward to Forest Service Road 124H, after which surface water infiltrates and contributes to wetland conditions that support riparian vegetation.

Riparian stream segments occur along 92.6 miles of streams within the project area. Of these, approximately 85.1 riparian miles (91 percent) occur on the CNF and 7.5 riparian miles (9 percent) occur on the KNF. Appendix C provides a list of riparian areas by stream reach or name and their associated conditions within the Four Forest Restoration Initiative analysis area. Within the analysis area, approximately 47.5 miles of streams are in proper functioning condition, 38.6 miles are functioning at-risk, and 6.6 miles are non-functional.

There are approximately 77.5 miles of protected streamcourses in the Four Forest Restoration Initiative analysis area. These are areas where specific SWCPs and BMPs have been developed to prevent adverse impacts to streamcourses. Table 1 on page 10 lists BMPs specific to the Four Forest Restoration Initiative project. Appendix G provides a list of the protected stream courses within the project area and their associated functional condition classes and lengths. A map of the locations of protected streamcourses is also included in Appendix G.

Wetlands, Riparian Areas, and Springs

There are 66, natural lakes, reservoirs, and natural wetland depressions within the project boundary that impound water for a sufficient duration to exhibit some wetland characteristics and are therefore listed in the U.S. Fish and Wildlife Service National Wetlands Inventory database. Table 1 in Appendix C lists riparian stream reaches in the Four Forest Restoration Initiative analysis area and their associated lengths, sizes and condition ratings. Tables 1 and 2 in Appendix D list wetland habitats and their associated condition ratings.

There are approximately 145 springs located within the Four Forest Restoration Initiative Project analysis area. Tables 1 and 2 in Appendix E list known springs and their locations within the project area by Forest. Tables 3 and 4 in Appendix E list springs that occur within treatment areas and the associated treatments proposed for the surrounding landscapes. Information regarding historic flow or water quality from these springs is minimal. Most springs within the project area are either rheocrene – they flow directly from the ground within an existing channel, resulting in a small stream, helocrene – they emerge as low gradient wetlands, or hillslope – they emerge from confined or unconfined aquifers on a hillslope (typically 30–60º); often with indistinct or multiple sources. Some of these springs were assessed in 2008 as part of the riparian area assessment conducted by Jeff Hink (Forest Service Hydrologist, retired) in 2008. Information from these assessments is included in Table 3 of Appendix D. Additionally, many springs within the project area were assessed in 2010 and 2011 using the Spring Ecosystem Assessment Protocol (SEAP) developed by Stevens et al. (2012) to inform the KNF Forest Plan revision process. These assessments are ongoing and will continue through 2013 on the Coconino and Kaibab National Forests. Information gathered from these and other spring assessments are included in Table 4 of Appendix D. In general, at least 74 springs within the project area have been adversely affected by human activities including flow regulation through installation of spring boxes and piping of discharge to off-site locations, recreational impacts, urbanization and other construction activities, and grazing by domestic livestock and wildlife herbivores. As a result, many springs exhibit downward trends or static-degraded conditions (MacDonald 2011). Spring restoration has therefore been identified as a need for change within the project area and in the Draft KNF Forest Plan. Figures 1

and 2 below provide an example of spring conditions at a typical developed spring on the KNF within the Four Forest Restoration Initiative Project area.

Figure 1. Clover Spring infrastructure and associated channel on the Williams Ranger District of the KNF.

Figure 2. Clover Spring flow as observed on October 12, 2011. Flow rate was estimated at approximately 4 gallons per hour.

Flood Zones

Approximately 687,608 acres within the Four Forest Restoration Initiative Project area have been surveyed for presence of flood zones. Flood zones are geographic areas defined by the Federal Emergency Management Agency (FEMA) according to varying levels of flood risk. These zones are

depicted on a community's Flood Insurance Rate Map (FIRM) or Flood Hazard Boundary Map. Each zone reflects the severity or type of flooding in the area. Flood hazard areas identified on the FIRM are identified as a Special Flood Hazard Area (SFHA). SFHA are defined as the area that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year. The 1-percent annual chance flood is also referred to as the base flood or 100-year flood. SFHAs are labeled as Zone A, Zone AO, Zone AH, Zones A1-A30, Zone AE, Zone A99, Zone AR, Zone AR/AE, Zone AR/AO, Zone AR/A1-A30, Zone AR/A, Zone V, Zone VE, and Zones V1-V30. Moderate flood hazard areas, labeled Zone B or Zone X (shaded) are also shown on the FIRM, and are the areas between the limits of the base flood and the 0.2-percent-annual-chance (or 500-year) flood. The areas of minimal flood hazard, which are the areas outside the SFHA and higher than the elevation of the 0.2-percent-annual-chance flood, are labeled Zone C or Zone X (unshaded).

Within the Four Forest Restoration Initiative Project area, there are approximately 974,920 acres of flood zone X (minimal flood hazard), 9,098 acres of flood zone A (high flood risk, depth and base flood elevation unknown), 2,414 acres of flood zone AE (high flood risk, depth and base flood elevation known), 22 acres of flood zone AH (areas subject to inundation by 1-percent-annual-chance of shallow flooding, usually areas of ponding, where average depths are 1 to 3 feet), and 55 acres of flood zone AO (areas subject to inundation by 1-percent-annual-chance of shallow flooding, usually sheet flow on sloping terrain, where average depths are between one and three feet). The largest areas of 100-year flood zones within the project analysis area are in the following areas:

- Rio de Flag extending from Fort Valley Experimental Forest, through the City of Flagstaff to the confluence with San Francisco Wash
- Upper and Lower Lake Mary and drainages that flow into the lakes (i.e., Newman Canyon, Walnut Creek, Priest Draw, Howard Draw, and other unnamed ephemeral drainages that flow into the lakes from the south)
- Elk Meadows, northeast of Hoxworth Springs
- Switzer Canyon, north of Flagstaff
- Unnamed drainages in East Flagstaff
- Cataract Creek in the City of Williams
- Other low-lying areas in the City of Williams
- Volunteer Wash in Bellemont and drainages inside Camp Navajo

Roads

Many roads in the project area are inadequately engineered, poorly located on the landscape and are consequently in a state of disrepair. Some of these roads are located adjacent to drainage channels or on ridge tops and are subject to erosion and sediment transport. Roads near drainages are contributing to degradation of surface water quality during snowmelt and following short duration, high intensity monsoon storms. Some roads have eroded to the point where roads surfaces are below the grade of the surrounding landscape, resulting in stormwater runon that then pools on road surfaces or flows down the travelway eroding the roadbed and entraining sediment in the storm flow. Where water pools in road

surfaces, rutting is a problem. Where stormwater flows down road surfaces, rills and gullies are compromising road surfaces and water quality.

Relevant Laws, Regulations, and Policies that Apply

The following list includes applicable laws, regulations, and policies affecting soils and watershed management on the KNF and CNF, the requirements of which are incorporated by reference herein.

The U.S. Forest Service Directives System (FSM/FSH): Forest Service Manuals and Handbooks codify the agency's policy, practice, and procedure. The system serves as the primary basis for the internal management and control of all programs and the primary source of administrative direction to Forest Service employees. The Forest Service Manual (FSM) contains legal authorities, objectives, policies, responsibilities, instructions, and guidance needed on a continuing basis by Forest Service line officers and primary staff in more than one unit to plan and execute assigned programs and activities. Forest Service Handbooks (FSH) are the principal source of specialized guidance and instruction for carrying out the direction issued in the FSM. Specialists and technicians are the primary audience of Handbook direction. Handbooks may also incorporate external directives with related USDA and Forest Service directive supplements.

Forest Service Manual – Service Wide Issuance
Forest Service Manual 2500 – WATERSHED AND AIR MANAGEMENT

Region 3 (Southwestern Region): Regional Issuances
- Forest Service Manual 2504.3 Exhibit 01
- Forest Service Manual 2510 - WATERSHED PLANNING
- Forest Service Manual 2520 - WATERSHED PROTECTION AND MANAGEMENT
- Forest Service Manual 2530 - WATER RESOURCE MANAGEMENT
- Forest Service Manual 2540 - WATER USES AND DEVELOPMENT
- Forest Service Manual 2580 - AIR RESOURCE MANAGEMENT

Forest Service Handbook – Service Wide Issuance
Forest Service Handbook 2500 – Watershed and Air Management
Region 3 (Southwestern Region): Regional Issuances
2509.16 - Water Resource Inventory Handbook
2509.21 - National Forest System Water Rights Handbook
2509.22 - Soil and Water Conservation Handbook
2509.23 - Riparian Area Handbook
2509.24 - National Forest System Watershed Codes Handbook
2509.25 - Watershed Conservation Practices Handbook

The Organic Administration Act: (at 16 U.S.C. 475, 551). States the purpose of the national forests, and directs their control and administration to be in accord with such purpose, that is, "[n]o national forest shall be established, except to improve and protect the forest within the boundaries, or for the purpose of securing favorable conditions of water flows, and to furnish a continuous supply of timber for the use and necessities of citizens of the United States." Authorizes the Secretary of Agriculture to "make such rules and regulations…to preserve the forests [of such reservations] from destruction."

Weeks Law of 1911: as amended (at 16 U.S.C. 515, 552). Authorizes the Secretary of Agriculture to enter into agreements with States for the purpose of conserving forests and water supply, and, to acquire forested, cutover, or denuded lands within the watersheds of navigable streams to protect the flow of these streams or for the production of timber, with the consent of the State in which the land lies.

Knutson-Vandenberg Act of 1930 (16 U.S.C. at 576b). Specifies that the Secretary may require any purchaser of national forest timber to make deposits of money in addition to the payments for the timber, to cover the cost to the United States of planting, sowing with tree seeds, and cutting, destroying or otherwise removing undesirable trees or other growth, on the national forest land cut over by the purchaser, in order to improve the future stand of timber, or protecting and improving the future productivity of the renewable resources of the forest land on such sale area.

Anderson-Mansfield Reforestation and Revegetation Joint Resolution Act of 1949 (at 16 U.S.C. 581j and 581 j). States the policy of the Congress to accelerate and provide a continuing basis for the needed reforestation and revegetation of national forest lands and other lands under Forest Service administration or control, for the purpose of obtaining stated benefits (timber, forage, watershed protection, and benefits to local communities) from the national forests.

Granger-Thye Act of 1950 (16 U.S.C. at 580g-h). Authorizes the Secretary to use a portion of grazing fees for range improvement projects on NFS lands. Specific types of projects mentioned are artificial revegetation, including the collection or purchase of necessary seed and eradication of poisonous plants and noxious weeds, in order to protect or improve the future productivity of the range. Section 11 of the act authorizes the use of funds for rangeland improvement projects outside of NFS lands under certain circumstances.

Surface Resources Act of 1955 (30 U.S.C. 611-614). Authorizes the Secretary of Agriculture to manage the surface resources of unpatented mining claims located under the authority of the 1872 Mining Law as amended, including, but not limited to, reclamation of disturbance caused by locatable mineral activities.

Surface Mining Control and Reclamation Act of August 3, 1977: Authorizes the Secretary of Agriculture to enter into agreements with landowners, providing for land stabilization, erosion, and sediment control, and reclamation through conservation treatment, including measures for the conservation and development of soil, water, woodland, wildlife, and recreation resources, and agricultural productivity of such lands.

U.S. Mining Laws (Public Domain Lands) Act of May 10, 1872 - Provides that all valuable mineral deposits in lands belonging to the United States, both surveyed and unsurveyed, are free and open to exploration and purchase, and the lands in which they are found to occupation and purchase by citizens of the United States and those who have declared their intention to become such, under regulations prescribed by law, and according to the local customs or rules of miners, so far as the same are applicable and not inconsistent with the laws of the United States. There are a number of Acts which modify the mining laws as applied to local areas by prohibiting entry altogether or by limiting or restricting the use which may be made of the surface and the right, title, or interest which may pass through patent.

Sikes Act (Fish and Wildlife Conservation) of September 15, 1960 (16 U.S.C. at 670g). Section 201 directs the Secretary of Agriculture, in cooperation with State agencies, to plan, develop, maintain, coordinate, and implement programs for the conservation and rehabilitation of wildlife, fish and game species, including specific habitat improvement projects, and shall implement such projects on public land under their jurisdiction.

Soil and Water Resources Conservation Act of November 18, 1977 - Provides for a continuing appraisal of the United States' soil, water and related resources, including fish and wildlife habitats, and a soil and water conservation program to assist landowners and land users in furthering soil and water conservation.

Multiple-Use Sustained-Yield Act of 1960 (16 U.S.C. 528-531). States that the National Forests are to be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes, and that establishment and maintenance of wilderness areas are consistent with this Act. This Act directs the Secretary to manage these resources in the combination that will best meet the needs of the American people; providing for periodic adjustments in use to conform to changing needs and conditions; and harmonious and coordinated management of the resources without impairment of the productivity of the land. Sustained yield means achieving and maintaining in perpetuity a high-level annual or regular periodic output of renewable resources without impairment of the productivity of the land.

Water Resources Planning Act of July 22, 1965 - Encourages the conservation, development, and utilization of water and related land resources of the United States on a comprehensive and coordinated basis by the Federal government, states, localities, and private enterprises.

Watershed Protection and Flood Prevention Act of August 4, 1954 - Establishes policy that the Federal government should cooperate with states and their political subdivisions, soil or water conservation districts, flood prevention or control districts, and other local public agencies for the purposes of preventing erosion, floodwater, and sediment damages in the watersheds of the rivers and streams of the United States; furthering the conservation, development, utilization, and disposal of water, and the conservation and utilization of land; and thereby preserving, protecting, and improving the Nation's land and water resources and the quality of the environment.

Water Quality Improvement Act of April 3, 1970 - Amends the prohibitions of oil discharges, authorizes the President to determine quantities of oil which would be harmful to the public health or welfare of the United States; to publish a National Contingency Plan to provide for coordinated action to minimize damage from oil discharges. Requires performance standards for marine sanitation device and authorizes demonstration projects to control acid or other mine pollution, and to control water pollution within the watersheds of the Great Lakes. Requires that applicants for Federal permits for activities involving discharges into navigable waters provide state certification that they will not violate applicable water quality standards

National Environmental Policy Act (NEPA) of 1969: (16 U.S.C. 4321 et seq.). Declares it is the policy of the Federal Government to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans. The Act requires agencies proposing major federal actions significantly affecting the quality of the human environment, to prepare a detailed statement on the environmental impacts of the proposed action, unavoidable adverse environmental impacts, alternatives to the action proposed, the relationship between local short-term uses of the environment and the

maintenance and enhancement of long-term productivity, and any irreversible and irretrievable commitments of resources which would be involved if the proposed action is implemented. The Act also provides that for any proposal which involves unresolved conflicts concerning alternative uses of available resources, an agency must study, develop, and describe appropriate alternatives to recommended courses of action.

Forest and Rangeland Renewable Resources Planning Act (RPA) of 1974, as amended by National Forest Management Act (NFMA) of 1976 (16 U.S.C. 1600-1614, 472a). States that the development and administration of the renewable resources of the National Forest System are to be in full accord with the concepts for multiple use and sustained yield of products and services as set forth in the Multiple-Use Sustained-Yield Act of 1960. It sets forth the requirements for land and resource management plans for units of the National Forest System, including requiring guidelines to provide for the diversity of plant and animal communities based on the suitability and capability of the specific land area.

The Federal Water Pollution Control Act of 1972: Public Law 92-500, as amended in 1977 (Public Law 95-217) and 1987 (Public Law 100-4) (also known as the Federal Clean Water Act (CWA)): This Act provides the structure for regulating pollutant discharges to waters of the United States. The Act's objective is "…to restore and maintain the chemical, physical, and biological integrity of the Nation's waters," and is aimed at controlling both point and non-point sources of pollution. The U.S. EPA administers the Act, but many permitting, administrative, and enforcement functions are delegated to state governments. In Arizona, the designated agency for enforcement of the Clean Water Act is the Arizona Department of Environmental Quality (ADEQ).

Relevant sections of the Clean Water Act:

CWA Sections 208 and 319: recognizes the need for control strategies for non-point source pollution.

CWA Section 303(d): requires waterbodies with water quality determined to be either impaired (not fully meeting water quality standards for designated uses) or threatened (likely to violate standards in the near future) to be compiled by ADEQ in a separate list, which must be submitted to EPA every 2 years. These waters are targeted and scheduled for development of water quality improvement strategies on a priority basis.

Total Maximum Daily Loads (TMDLs): As of May 2006, there were no applicable TMDL requirements in effect for the KNF.

CWA Section 305(b): requires that states assess the condition of their waters and produce a biennial report summarizing the findings.

CWA Section 401: allows states and tribes to review and approve, set conditions on, or deny Federal permits (such as 404 permits) that may result in a discharge to state or tribal waters, including wetlands. Applications for Section 404 permits are often joint 404/401 permits to ensure compliance at both the Federal and state levels.

At this time, there is uncertainty whether a National Pollution Discharge Elimination System (NPDES) permit under Section 402 of the CWA would be required for stormwater discharges from logging roads associated with this project. Although the Environmental Protection Agency has published a final rule exempting logging road stormwater discharge from NPDES permitting requirements, the United States Supreme Court is currently reviewing the matter. Until the Supreme Court rules, it will be uncertain whether a NPDES permit is required for this project.

CWA Section 404: outlines the permitting process for dredging or discharging fill material into waters of the U.S., including wetlands. The U.S. Army Corps of Engineers administers the 404 Program.

Safe Drinking Water Amendments of November 18, 1977: Amended the Safe Drinking Water Act to authorize appropriations for research conducted by the Environmental Protection Agency relating to safe drinking water; Federal grants to states for public water system supervision programs and underground water source protection programs; and grants to assist special studies relating to the provision of a safe supply of drinking water.

Clean Air Act, as amended 1977 and 1990: (42 U.S.C. 7401, 7418, 7470. 7472, 7474, 7475, 7491, 7506, 7602). Establishes a national goal to prevent any future, and remedy existing, visibility impairment in certain wilderness areas the Forest Service manages. It also directs the Forest Service as a Federal land manager to protect air quality related values from man-made air pollution in these same areas. Lastly, it obligates the Forest Service to comply with the Act's many provisions regarding abatement of air pollution to the same extent as any private person.

North American Wetland Conservation Act of 1989 (16 U.S.C. 4401 (note), 4401-4413, 16 U.S.C. 669b (note)). Section 9 (U.S.C. 4408) directs Federal land managing agencies to cooperate with the Director of the U.S. Fish and Wildlife Service to restore, protect, and enhance the wetland ecosystems and other habitats for migratory birds, fish and wildlife within the lands and waters of each agency to the extent consistent with the mission of such agency and existing statutory authorities.

Stewardship End Result Contracting Projects (16 U.S.C. 2104). Grants the Bureau of Land Management (BLM) and the Forest Service ten-year authority to enter into stewardship contracts or agreements to achieve agency land management objectives and meet community needs.

Executive Order 11988 (Floodplain Management (42 CFR 26951, May 25, 1977)**:** The purpose of this Order is "…to avoid to the extent possible the long and short term impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative." Section 1 states: "Each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities for (1) acquiring, managing, and disposing of Federal lands, and facilities; (2) providing Federally undertaken, financed, or assisted construction and improvements; and (3) conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities."

Executive Orders relevant to ecological restoration include:

Executive Order 11514: issued March 5, 1970, as amended by E.O. 11991 issued May 24, 1977. Protection and enhancement of environmental quality (35 FR 4247, March 7, 1970). This order states that the Federal Government shall provide leadership in protecting and enhancing the quality of the nation's environment to sustain and enrich human life. This order provides for monitoring, evaluation, and control on a continuing basis of the activities of each Federal agency so as to protect and enhance the quality of the environment.

Executive Order 11644: issued February 8, 1972. Use of off-road vehicles on the public lands. (37 FR 2877, February 9, 1972). Amended by E.O. 11989 issued May 24, 1977 and E.O. 12608 issued September 9, 1987. This order requires federal agencies to develop and implement procedures that will ensure that the use of off-road vehicles on public lands will be controlled and directed so as to protect the resources of those lands, to promote the safety of all users of those lands, and to minimize conflicts among the various uses of those lands.

Executive Order 11990 (Protection of Wetlands): …"in order to avoid to the extent possible the long and short term adverse impacts associated with the destruction or modification of wetlands… Section 1. (a) *Each agency shall provide leadership and shall take action to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities* for… (3) conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities. Sec. 5: In carrying out the activities described in Section I of this Order, each agency shall consider factors relevant to a proposal's effect on the survival and quality of the wetlands. Among these factors are: (b) maintenance of natural systems, including conservation and long-term productivity of existing flora and fauna, species and habitat diversity and stability, hydrologic utility, fish, wildlife, timber, and food and fiber resources; and (c) other uses of wetlands in the public interest, including recreational, scientific, and cultural uses."

Executive Order 13112 issued February 3, 1999. Invasive Species. (64 CFR 6183, February 8, 1999). This order requires federal agencies whose actions may affect the status of invasive species to, among other things, respond to and control populations of invasive species and provide for restoration of native species and habitat conditions in ecosystems that have been invaded by non-native invasive species.

Travel Management Rule: On December 9, 2005, the Forest Service published the TMR. The agency rewrote direction for motor vehicle use on National Forest Service (NFS) lands under 36 CFR, Parts 212, 251, and 261, and eliminated 36 CFR 295. The rule was written to address at least in part the issue of unmanaged recreation. The rule provides guidance to the Forest Service on how to designate and manage motorized recreation on the Forests. The rule requires each National Forest and Grassland to designate those roads, motorized trails, and Areas that are open to motor vehicle use.

Road System: 36 CFR 212.5 (b): ...the responsible official must identify the minimum road system needed for safe and efficient travel and for administration, utilization, and protection of National Forest System lands. ... The minimum system is the road system determined to be needed to meet resource and other management objectives adopted in the relevant land and resource management plan (36 CFR 219), to meet applicable statutory and regulatory requirements, to reflect long-term funding expectations, to ensure that the identified system minimizes adverse environmental impacts associated with road construction, reconstruction, decommissioning, and maintenance.

Regional Forester's direction: Roads analysis process (RAP) for all other existing roads should be completed in conjunction with implementation of the off-highway vehicle (OHV) Record of Decision, watershed analyses, other project level activities or Forest Plan revisions.

Identification of unneeded roads. Responsible officials must review the road system on each National Forest and Grassland and identify the roads on lands under Forest Service jurisdiction that are no longer

needed to meet forest resource management objectives and that, therefore, should be decommissioned or considered for other uses, such as for trails.

Regional Forester's direction: Roads analysis process (RAP) for all other existing roads should be completed in conjunction with implementation of the off-highway vehicle (OHV) Record of Decision, watershed analyses, other project level activities or Forest Plan revisions.

Memorandum of Agreement on Fostering Collaboration and Efficiencies to Address Water Quality Impairments on National Forest System Lands: Agreement between U.S. Forest Service and the U.S. Environmental Protection Agency signed in 2007. Purpose: to coordinate between agencies and address issues of water quality impairment regarding 303d list, as well as TMDLs. The leading cause of water quality impairments on National Forest lands includes temperature, excess sediment, and habitat modification. These issues are to be addressed via BMPs to the greatest extent possible. In terms of this project analysis area, BMPs can be applied to soil and watershed condition and are applicable everywhere on the KNF.

33 CFR 323 Permits for Discharges of Dredged or Fill Material into Waters of the United States - This regulation prescribes those special policies, practices and procedures to be followed by the Corps of Engineers in connection with the review of applications for permits to authorize the discharge of dredged or fill material into waters of the United States.

36 CFR 219 Planning - Sets forth a process for developing, adopting, and revising land and resource management plans for the National Forest System.

40 CFR 121-135 Water Programs - Sets forth the provisions for the administration of water programs including: state certification of activities requiring a Federal license or permit; EPA administered permit programs; state program requirements; procedures for decision making; criteria and standards for the National Pollutant Discharge Elimination System; toxic pollutant effluent standards; water quality planning and management; water quality standards; water quality guidance for the Great Lakes System; secondary treatment regulation; and, prior notice of citizen suits. See Title 40 (Protection of Environment), Chapter 1 (Environmental Protection Agency), subchapter D (Water Programs).

40 CFR 1500 Council on Environmental Quality - Council on Environmental Quality regulations implementing the National Environmental Policy Act.

Environmental Consequences _____

Direct, Indirect, and Cumulative Effects

Direct effects of an action are caused by the action and occur on site and affect only the area where they occur. Indirect effects are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. In general, direct and indirect effects to water quality and riparian areas as a result of the Action Alternatives include:

- Reduction of the forest canopy would decrease interception (precipitation captured by leaves, branches, and boles) and increases net precipitation reaching the soil surface. Where disturbance is recent, surface runoff could reach waterbodies and affect water quality.
- Partial removal of the forest overstory reduces transpiration (water lost from plants to the atmosphere), increasing soil moisture and runoff (Baker 1999, Ffolliott et al. 1989), which may improve riparian conditions.
- Increased soil moisture and loss of root biomass could reduce slope stability and increase soil erosion resulting in adverse effects to water quality.
- Increases in water yield after forest thinning are transitory and decrease over time as forests regrow unless subsequent treatments maintain initial post-treatment conditions.
- When young, dense forests with high interception rates (or higher annual transpiration losses) replace mature forests with lower interception rates (or lower transpiration losses), water yield is reduced until the young forest matures and thins naturally or is thinned in treatments.
- Impervious surfaces (roads and trails) and altered hillslope contours (cutslopes and fillslopes) modify water flowpaths, increase overland flow, and deliver overland flow directly to stream channels.
- Impervious native surfaces increase soil erosion.

Table 16 provides a comparative summary of direct and indirect effects to water quality and riparian areas by Alternative for the Four Forest Restoration Initiative Project.

Table 9. Comparison of direct and indirect effects of each Alternative considered for the Four Forest Restoration Initiative Project.

Resource and Unit of Measure	ALTERNATIVES			
	A No Action	**B Proposed Action**	**C**	**D**
--- WATER QUALITY AND WATER YIELD ---				
Water quality (unit of measure are acres of soil disturbance that exceed tolerance thresholds, acres subjected to high severity burn, acres of ephemeral streamcourses restored, and number of springs restored)	There would be no changes to surface water quality under the No Action Alternative. However, adverse effects to water quality, quantity, and riparian condition are possible under the No Action Alternative. A high severity wildfire would have the potential to increase flood flows of sediment and debris-laden stormwater in streamcourses within and downstream of burned areas. These conditions would adversely affect riparian areas along streamcourses through deposition of large amounts of sediment and debris with the potential to damage or overwhelm riparian systems,	Minor, short term changes (i.e., 1-2 years) in water quality are possible in water bodies adjacent to or downstream from mechanical vegetation treatments, areas subjected to prescribed burning, areas of temporary road construction and decommissioning, and where stream channel restoration activities are conducted. However, long term surface water quality is expected to improve through more resilient forest conditions that minimize uncharacteristic fire behavior and through improved vegetative ground cover that minimizes soil erosion and sediment transport to connected streamcourses and other waterbodies. Since soil disturbance at the 6th HUC level would average 3.3% and range from 0.1 to 11.2% (Steinke, 2012), adverse effects to water quality are minimal. Protective fencing around springs would improve surface water quality at the	There would be more acres of mechanical vegetation and grassland restoration treatments and fewer acres of prescribed burning under Alternative C as compared to Alternative B. As a result, minor, short term adverse effects to water quality are possible in water bodies within and adjacent to mechanical vegetation and grassland restoration treatment areas. Steinke (2012) estimates soil disturbance of 3.4% at the 6th HUC level and 10.9% across the treatment area. Overall effects to surface water quality from implementation of Alternative C would therefore be similar to the Proposed Action. Best Management Practices and SWCPs as outlined in Table 1 would minimize or mitigate most adverse effects to water quality or riparian areas.	Substantially fewer acres would receive prescribed burning treatments as compared to the Proposed Action since slash/biomass would be treated through chipping, shredding, or mastication or removed rather than burned. Soil disturbance that could adversely affect surface water quality is estimated to be 2.9% at the 6th HUC level (Steinke, 2012). While Alternative D would result in the lowest level of soil disturbance that could adversely affect surface water quality of all Action Alternatives, this alternative would not meet the purpose and need of achieving resilient forest conditions that promote high surface water quality through protection of forested ecosystems from uncharacteristic fire behavior. Additionally, restoration of natural fire regimes to fire-dependent

Resource and Unit of Measure	ALTERNATIVES			
	A No Action	**B Proposed Action**	**C**	**D**
		individual spring scale. Additionally, BMPs and SWCPs as outlined in Table 1 would minimize or mitigate most adverse effects to water quality or riparian areas.		landscapes and vegetation types would not occur under this Alternative. Best Management Practices and SWCPs as outlined in Table 1 would minimize or mitigate most adverse effects to water quality or riparian areas.
Water yield (units of measure are increases in stream flow as measured at downstream gaging stations, and increases in snowpack retention as measured at SNOTEL sites and snow courses)	Water yield originating from the ponderosa pine vegetation type would continue to decline as a result of forest ingrowth that increases stand density. Increased stand density results in a corresponding increase in interception of precipitation and evapotranspiration by trees, both of which would reduce soil moisture.	Water yield would be expected to increase only slightly in areas where vegetation treatments remove from 25 to 50 percent of the overall tree canopy cover within a given watershed (Troendle et al. 2001; Burton 1997; Swank 1989; Baker 1999; Ffolliott et al. 1989, Miller 2007). Snow interception by tree canopies would be reduced, leading to increased snowpack in forest openings.	Under this alternative, more acres would receive mechanical vegetation treatments than Alternative B and more trees would be removed from within MSO PACs since trees up to 18 inches DBH would be removed. Water yield is therefore expected to be slightly higher than under Alternative B since there would be more forest openings and less dense forest conditions. Snow interception by tree canopies would be reduced more under this Alternative than under the proposed action, therefore potentially increasing winter snowpack more than would occur under Alternative B.	Mechanical vegetation treatments would result in similar effects as Alternative B. Since there would be fewer acres subjected to prescribed burning under this Alternative, there would be reduced potential for runoff and sediment delivery to streamcourses under Alternative D.
--- SPRING, RIPARIAN AREA, AND WETLAND CONDITION ---				
Spring Functional Condition (units of measure are initiation of spring discharge from springs	There would be no changes to spring conditions under the No Action Alternative	Spring conditions would improve for up to74 springs within the analysis area.	Same as Alternative B	Same as Alternative B

Resource and Unit of Measure	ALTERNATIVES			
	A No Action	**B Proposed Action**	**C**	**D**
that currently do not flow and increases in spring discharge from currently flowing springs following restoration treatments)		Additionally, vegetation treatments at the watershed scale combined with prescribed burning could restore or improve hydrologic function of springs that currently have reduced discharge due to evapotranspirational losses of soil water that could otherwise recharge groundwater in perched, or shallow aquifers.		
Riparian Area and Wetland Function (units of measure are changes to the extents of riparian areas and changes to riparian vegetative communities)	Reduced riparian area and wetland function are possible under the No Action Alternative Ongoing reduction in water yield from the ponderosa pine vegetation type would decrease moisture reaching riparian areas since spring discharge rates would be further reduced and water would not reach streamcourses or recharge shallow, or perched aquifers.	Riparian and wetland function are expected to improve through increased groundwater recharge and improved surface flows. Decommissioning of roads that have altered flow patterns through increased drainage density (i.e. road ditches that intercept water and lead-out ditches that discharge concentrated ditch flow onto the forest floor) or redirected stormwater runoff (i.e., roads and ditches that intersect streamcourses and discharge stormwater runoff directly to streamcourses) would improve overall watershed hydrology, thus improving water flow to riparian ecosystems. Restoration of 74 springs would improve riparian	Riparian and wetland function are expected to improve slightly more than under Alternatives B and D since more acres would receive mechanical vegetation treatments than Alternative B and more trees would be removed from within MSO PACs since trees up to 18 inches DBH would be removed. More acres would be subjected to low severity prescribed fire, decreasing rainfall interception and evapotranspirational losses. As a result, groundwater recharge and stormwater runoff would be slightly higher than under Alternatives B and D. Decommissioning of roads that have altered flow patterns	Riparian and wetland function are expected to improve under Alternative D, but to a lesser degree than under Alternatives B and C since fewer acres would be subjected to prescribed fire which would otherwise reduce vegetative cover and therefore rainfall interception and evapotranspirational losses. Decommissioning of roads that have altered flow patterns or redirected stormwater runoff would have the same effect as Alternative B. Restoration of 74 springs would improve riparian vegetation communities in these areas. Restoration of grassland ecosystems would have the

Resource and Unit of Measure	ALTERNATIVES			
	A No Action	**B Proposed Action**	**C**	**D**
		vegetation communities in these areas. Restoration of grassland ecosystems through removal of encroaching trees would improve hydrologic function in meadow ecosystems, potentially increasing riparian vegetation in these areas.	or redirected stormwater runoff would have the same effect as Alternative B. Restoration of 78 springs would improve riparian vegetation communities in these areas. Since more acres of grassland would be restored under Alternative C than Alternative B, there is increased potential for improvement in riparian ecosystem function where wetland or riparian species occur in restored grasslands ecosystems.	same effect as Alternative B.

Alternative A – No Action

Direct and Indirect Effects

Since no activities are proposed under Alternative A, there would be no direct effects to water quality or riparian area conditions as a result of this Alternative. However, indirect effects of the No Action Alternative are likely.

Much of the ponderosa pine forest is in Fire Regime Condition Class 3 and trends indicate that fuel loading would continue to increase in both living biomass and woody detritus through natural forest ingrowth and tree encroachment into existing openings, resulting in increased risk of high severity wildfire. Ingrown understories can create 'ladder fuels' which allow ground fires to ascend and spread quickly as crown fires. Fine and coarse woody debris are expected to increase over time as small, medium, and large diameter material falls to soil surfaces and begins to decay. While the increased organic matter would improve soil quality in some regards (organic matter accumulation in subsurface horizons, microhabitat for soil organisms, increased short-term water holding capacity, improved nutrient status in part) it would also result in decreased herbaceous plant productivity and soil nutrient cycling and an increased risk of high severity wildfires where fuel loading becomes excessive and pose risk to water quality. A dense forest litter layer (i.e., duff) has displaced much of the herbaceous vegetation. Vegetative ground cover provides even greater benefits to soil ecological function than forest litter alone through improved nutrient cycling due to fine root turnover, increased fine litter, improved soil porosity and aggregate stability, and increased water holding capacity (NRCS 1996). The location, size and intensity of future wildfires cannot be estimated with reasonable accuracy, although some generalizations can be made. High intensity wildfires tend to occur in areas where fuel loading and fuel distributions are sufficient to carry a fire. Typically, uncontrolled wildfires occur during the drier times of the year, yielding higher severity fires than would occur under prescribed fire conditions. The adverse effects of a high severity fire to water quality and riparian areas such as soil erosion above tolerance thresholds, sediment delivery to connected streamcourses, increased stream bedload, stream channel incision and bank failure, increased water turbidity, and downstream flooding would be more widespread in an uncontrolled wildfire situation than under prescribed fire conditions where the size and intensity of the fire can be controlled. Soil erosion models indicate that approximately 24% of all soils left untreated could be subject to soil erosion above tolerable levels from severe wildfires if all soils burned under condition of high burn severity

Uncharacteristic fires on the Coconino National Forest historically have ranged from about 20-45% of the burn acreage resulting in high severity fire. While large stand-replacing fires on the Kaibab National Forest historically have 10-25% of the burn acreage exhibiting high severity fire conditions. Lata, (2012) suggests that up to 33% of ponderosa pine forest could burn under high burn severity conditions. Therefore, if a 10,000 acre wildfire were to occur within the analysis area, approximately 1,000 to 3,000 acres of high severity fire would be expected to adversely affect water quality and riparian conditions.

There have been many examples of recent stand replacing wildfires occurring in the southwestern United States in areas that were originally open, fire-maintained forests (e.g., Rodeo-Chediski, Schultz, Horseshoe 2, Wallow, Las Conchas, Whitewater-Baldy, etc.). Such events can have profound negative effect to water quality and riparian conditions including: a) soil hydrophobicity (i.e. the inability of soils to absorb water following precipitation resulting in increased overland flow, b) increased sediment, ash,

debris, and nutrient delivery to water bodies, and c) downstream flooding resulting in changes to stream geomorphology (i.e. increased bedloads, channel downcutting/incision, and channel aggradation), to name a few.

Soil hydrophobicity occurs naturally in soils (DeBano 1981, Doerr et al. 2000). It is the result of leaching of hydrophobic compounds, such as aliphatic hydrocarbons, from the litter and humus layers. Under unburned conditions, soil hydrophobicity below the soil surface is commonly associated with fungal mycelia (Savage et al. 1969). However, high fire intensity can volatize hydrophobic compounds in the litter, humus, and soil organic matter (DeBano et al. 1966). These compounds can then enter the soil atmosphere and condense on cooler soil particles at or below the soil surface (DeBano 1981). The condensation of these compounds forms a hydrophobic layer on the soil particles (DeBano and Krammes, 1966; Savage, 1974).

The formation of a strong hydrophobic layer after natural or prescribed fires can inhibit infiltration (Scott and van Wyk, 1990). When ash and soil above a hydrophobic layer become saturated, any additional precipitation will become runoff. The rate of runoff from forested areas can therefore increase dramatically after burning if a hydrophobic layer is present; and this surface runoff, when combined with the loss of a protective litter layer, can cause even larger increases in surface erosion and sediment yields (Scott and van Wyk, 1990).

Sediment yields in the first year after a wildfire can range from very low in relatively flat topography with minimal rainfall to extreme on steep landscapes affected by high-intensity thunderstorms (Robichaud et al. 2000). Hendricks and Johnson (1944) observed wildfire induced sediment yields ranging from 71Mg per ha per year on 42 percent slopes to 202 Mg per ha per year on 66 percent slopes, and 370 Mg per ha per year on 78 percent slopes in Upper Pocket Creek in central Arizona. Following the North 25 Fire in in 1998, Robichaud and others (2006) observed first year mean erosion rates of 16 Mg per ha, with most erosion occurring during short duration, moderate intensity summer storms.

The physical, chemical and biological characteristics of surface water can be adversely affected by post fire conditions. The discussion in this report is limited to the physical and chemical changes to surface water resulting from fire. Biological effects are therefore inferred from the changes in the physical and chemical properties of surface waters following fire.

Increased sediment loads are the primary physical impacts to surface waters following fire. The bulking effect of sediment and ash in runoff increases the risk to surface water impoundments, infiltration basins, and public water treatment systems. Sediment and debris flows can damage water supply infrastructure. Sedimentation of impoundments can decrease their effective life, resulting in a need for dredging and other mitigation measures. Biological pathogens are easily adsorbed to sediment and ash, which can overload public drinking water treatment facilities, increasing the cost of water treatment. The large quantities of post-fire sediment can overwhelm the biological habitats of aquatic organisms such as fish, as well as organisms that depend on water for some life stage, such as amphibians and invertebrates.

Altered solute and debris content in surface waters following wildfire can also change nutrient dynamics, light, and temperature regimes (i.e., thermal pollution) (Betts and Jones 2009). When riparian vegetation is removed by fire or other means, the stream surface is exposed to direct solar radiation, and

stream temperatures increase (Neary et al. 2005). Reduced concentrations of dissolved oxygen (O_2) that can occur as a result of increased surface water temperatures can result in fish mortality.
Elevated pH values of soils following wildfires have been shown to increase pH values in streamflow (DeBano et al. 1998, Landsberg and Tiedemann 2000). The combustion process releases bound nutrients, many in elemental form. Some cations (i.e., positive ions), are stable at typical combustion temperatures and remain onsite after burning. They subsequently infiltrate into the soil or are transported in runoff where they exchange with H^+ ions; the resulting decrease in H+ ions in solution increases the pH. Nutrient availability is related to soil acidity (Tisdale and Nelson, 1975). Bicarbonates (HCO_3^-) and carbonates (CO_3^{2-}) may also contribute to surface water alkalinity (pH) levels.

Nitrate (NO_3^-), nitrite (NO_2^-), ammonium (NH_4^+) and ammonia (NH_3) are the forms of nitrogen that can be altered after fire. Values for nitrate generally increase after fire. Stream nitrate responses to prescribed fire are generally lower than for wildfire. In an undisturbed ponderosa pine and Gambel oak watershed in Arizona, Gottfried and DeBano (1990) observed slight, but significant increases in nitrate in surface water following fire. The potential for increased NO_3^- in streamflow after fire is attributed mainly to increased mineralization and nitrification (Vitousek and Melillo 1979, Covington and Sackett 1986, DeBano and others 1998) and reduced plant demand (Vitousek and Melillo 1979). This increase is the result of the conversion of organic N to available forms, mineralization (Covington and Sackett 1992), or mobilization by microbial biomass through the fertilizing effect of ash nutrients and improved microclimate (Ojima et al. 1994). These postfire effects are usually short lived, lasting only a year or two (Kovacic and others 1986, Monleon and others 1997)

The mobility of phosphorus (P) increases after wildfires, and to a lesser extent after prescribed fires since phosphorus is easily adsorbed to sediment and ash and is therefore readily transported in runoff. Most of the increase in P concentrations in surface water is therefore due to higher post-fire erosion rates.

The introduction of weeds and unwanted flora following a wildfire could lead to increased competition between less desirable invasive and noxious weeds and desirable native vegetation. Weeds can increase erosion by reducing soil moisture and deplete nutrient levels (DiTomaso 2000), leading to a less vigorous plant community. The resulting erosion can degrade surface water quality and increase bedloads and channel scour in riparian areas.

Under the No Action alternative, there would be no relocation or obliteration of roads that are currently contributing to loss of soil productivity and degradation of water quality. Roads proposed for relocation would continue to be used as they have in the past, resulting in ongoing soil erosion and sediment delivery to watercourses. Roads proposed for obliteration would remain at risk of unauthorized use, further contributing to soil destabilization, loss of productivity, and adverse impacts to surface water quality. Ongoing road maintenance of ML-2 and ML-3 roads within the project area would continue as it has in the past.

Under the No Action Alternative, there would no restoration of springs and no restoration of ephemeral channels. These areas would continue to exhibit downward trends in functional condition or remain in static condition for the foreseeable future.

This alternative would result in no additional acres of ground disturbance from mechanical vegetation treatments, piling of activity-related woody debris, construction and maintenance of temporary roads,

road obliteration, fence construction, and the use of prescribed fire. Soils with erosion rates that are exceeding tolerance thresholds would likely continue to erode at current rates. Sediment delivery to streamcourses and waterbodies would continue at current rates. Surface water quality would not be improved.

The No Action Alternative would not meet the purpose and need of forest restoration that would provide for more resilient forest conditions that would better protect forested ecosystems and watersheds from uncharacteristic fire behavior and improve ecosystem function in grassland vegetative communities, spring ecosystems, ephemeral streamcourses, and perennial waterbodies.

Forest Plan Amendments

There would be no forest plan amendments required to implement the No Action Alternative. There would therefore be no effects to water quality or riparian areas as a result of forest plan amendments under this alternative.

Cumulative Effects

The cumulative effects analysis area includes the eighty-four 6th-level (HUC12) subwatersheds, which total 2,067,000 acres. The timeframe for past actions is 10 years, based on vegetative and course woody debris recovery of treated areas. Vegetative recovery following fuel reduction treatments is generally rapid, with erosion rates typically returning to pre-treatment levels within 1 to 2 years (Elliot 2000). Because no actions are proposed, no direct cumulative effects would occur.

Direct and Indirect Effects to Water Quality and Riparian Resources Common to All Action Alternatives

Mechanical forest vegetation treatments have the potential to adversely affect water quality and riparian areas through delivery of sediment and additional nutrients from decomposing woody debris, particularly from vegetation treatments adjacent to stream courses.

The effects of the proposed forest restoration activities on sediment yields and water quality depend on methods and equipment used, skills of the equipment operators and personnel conducting the treatments, site-specific conditions, storm event timing and intensity, prescribed fire locations and burn severities, and adaptive management strategies.

The risk of sediment delivery to streamcourses is expected to increase in areas where forest thinning and use of prescribed fire results in soil disturbance or complete removal of vegetative ground cover in close proximity to drainages. Such areas would include designated stream crossing, skid trails, log landings, temporary access roads, obliterated roads, installed firelines, existing National Forest System roads, and areas burned at high severity near streamcourses. With appropriate and effective implementation of BMPs and SWCPs as outlined in Table 1, most adverse effects to water quality and riparian conditions caused by forest vegetation treatments would be minimized or mitigated.

The removal of forest cover can decrease raindrop interception and evapotranspiration, which can increase water yields from treated areas (Bosch and Hewlett 1982, Stednick 1996). In areas where the annual precipitation is less than 20 in (500 mm), removal of the forest canopy does not typically

increase annual water yields (Bosch and Hewlett 1982). In these drier areas, the decrease in interception and transpiration caused by forest thinning is usually offset by the increase in soil evaporative losses, resulting in no net change in runoff as long as factors affecting runoff processes are not changed (for example, soil compaction which causes a shift from subsurface flow to overland flow) (MacDonald and Stednick 2003). Evapotranspiration rapidly recovers with vegetative regrowth in partially thinned forests. Increases in runoff due to thinning operations rarely persist for more than 5 to 10 years, unless post-treatment conditions are maintained. However, long-term studies conducted in the central Arizona highlands in a variety of ecotypes (i.e., chaparral, riparian, ponderosa pine, mixed conifer, and pinyon-juniper) indicate that increases in water yield can be achieved, although the duration and intensity of effects vary considerably. In general, the largest increases in water yield were associated with the highest reductions in tree basal area and canopy cover within treated watersheds (Baker 1999, Brown et al. 1974, Rich et al. 1976).

Thinning of forest cover on soils currently characterized as unsatisfactory would improve soil conditions over the long-term by improving soil moisture and allowing greater sunlight penetration to the forest floor (i.e., sunflecks) resulting in an increase in grasses, forbs and shrubs in the forest understory. The increased herbaceous vegetation would reduce soil erosion and associated sediment delivery rates by providing vegetative and litter ground cover that would intercept rain before it can reach soil surfaces and detach and entrain soil particles in runoff water. The long term result is improved surface water quality and improved stream and riparian function.

Prescribed fire has the potential to impact water quality by increasing sediments, ash, dissolved solids, and nutrients in streams. Dissolved nutrients in streamflow primarily originate from weathering of parent materials and soils, decomposition of plant material and other organic matter, and anthropogenic sources. Fire can disrupt nutrient cycling and cause nutrient volatilization, leaching, and transformations. When vegetation is consumed by fire, some of the soil nutrients contained in the organic matter such as nitrogen, phosphorus, copper, iron, manganese, and zinc are volatilized and lost from the system, while other nutrients such as calcium, magnesium, and potassium are converted into oxides and accumulated in ash (DeBano et al. 1998). These materials either can contribute to increased soil productivity or be entrained in runoff resulting in increased nutrient loads in streams and a corresponding degradation of surface water quality.

The mobility and concentration of nutrients in soils determines whether nearby water sources are at risk of contamination through increased nutrient loads when prescribed fire is used. Nitrate is highly mobile and is therefore subject to risk of being leached from burned areas and transported to either surface or ground water. Phosphorus adsorbs readily to sediment and organic materials. Thus, phosphorus is usually transported to streams and water bodies through soil erosion. Rates of soil erosion and phosphorus contamination are generally dependent on soil characteristics and topographic relief of the site.

Prescribed fire has the potential to alter short- and long-term soil productivity and moisture content by changing the amount and type of vegetation, the amount of forest floor organic matter, and surface soil texture and wettability. Prescribed fires typically leave greater amounts of organic matter (duff, forest litter, and large and small woody debris) on soil surfaces than uncontrolled fires. These materials serve as nutrient sinks, prevent soil particle detachment caused by raindrop impact, and capture sediments that would otherwise be transported to stream channels and waterbodies. Following low-intensity prescribed fires, an increase in grasses and other herbaceous vegetation often occurs. This rapid regrowth of

vegetative ground cover further immobilizes nutrients in plant material and prevents soil erosion and sediment delivery to streamcourses, thus protecting surface water quality.

Prescribed fires that remove large amounts vegetation from a site have potential to alter watershed hydrology. As vegetation is removed, evapotranspiration in the watershed decreases, thus providing greater stream flow and overall water yield within the watershed. Water uptake from trees is species-specific. Conifers, which are the dominant vegetation type within the Four Forest Restoration Initiative Project area, generally transpire greater quantities of water than hardwoods such as oaks and aspen. Dense foliage and longer growing seasons promote the higher overall water uptake in conifers. Additionally, conifers have relatively dense crowns that intercept rainfall and allow for greater evaporative losses.

Once a site has undergone loss of vegetation and removal of the litter layer, stormwater runoff and rapid snowmelt can cause erosion problems and result in higher stream discharges. Fires not only consume portions of the litter layer, but at high temperatures fires can also cause short term hydrophobic soil conditions, thus making soils more susceptible to erosion. DeBano and Krammes (1966) and Robichaud (2000) observed that water repellency was dependent on the heating temperatures of the soils. At typical wildfire soil profile temperatures (less than 500°F) when the soil was dry, soil hydrophobicity occurs at shallow depths (less than 1 inch). When soils are moist (i.e. conditions that commonly occur during prescribed fire in the spring and fall), soil hydrophobicity was less pronounced and only occurred after long heating times, which would typically only occur during smoldering fires. Therefore, soil hydrophobicity under a prescribed fire scenario would likely be minimal throughout the majority of the treatment area. Compared to soils with moderate or high soil hydrophobicity, lower soil hydrophobicity results in faster soil water infiltration rates, thus protecting surface water quality and riparian systems by minimizing surface runoff and erosion.

Where existing spring infrastructure is in disrepair or is non functional, these conditions should be repaired and maintained in a manner that conforms with existing water rights. Where opportunities exist for removal of spring infrastructure to restore spring integrity, such opportunities should be considered in spring restoration analyses. Finally, adverse recreational impacts to springs should be minimized or mitigated through such actions as control of ingress and egress to spring ecosystems and public education efforts.

Runoff from road surfaces can detach and transport the fine material from road prisms and ditches. Sediment delivery directly from road surfaces to water courses is difficult to estimate since it occurs as non-point source runoff. Sediments delivered to streams from roadside ditches may have originated from sheet or rill erosion prior to entering road surfaces or drainage ditches. In the absence of vehicle traffic, sediment concentrations in road runoff decreases over time. However, vehicle traffic, particularly trucks, can pulverize road surface aggregates, resulting in more fine particles that are easily transported in runoff. Additionally, the pressure of vehicular tires on saturated road surfaces can force fine particles from below the surface to move upward to the surface (Truebe and Evans 1994). Road proximity and connectivity to drainages can strongly influence sediment delivery to watercourses and peak flows in streams. Roads within the project area intersect numerous ephemeral drainages. These points of intersection occur as both culverted crossings and low-water crossings. Road-stream intersections are the primary location where sediments are delivered to stream courses.

A total of approximately 904 miles (1,314 acres, based on an average road width of approximately12 feet) of existing system roads and unauthorized roads would be decommissioned under all Action Alternatives. Road decommissioning would entail obliteration whereby road surfaces could be ripped and seeded or mulched, inside ditches would be filled, road prisms outsloped, culverts and fill materials removed, stream crossings re-contoured, unstable sidecast or cutslopes removed or stabilized, and entrances blocked to prevent future access. These activities would return unproductive acreage to a more stable, productive status over the long term by improving water infiltration, naturalizing water flow, increasing vegetative ground cover and reducing erosion. Upon completion of road obliteration activities, long term erosion rates for decommissioned roads are expected to approach natural erosion rates for TEUs where these roads occur. With implementation of appropriate BMPs and SWCPs as outlined in Table 1, water quality and riparian ecosystem conditions would be improved. At this time, there is uncertainty whether a National Pollution Discharge Elimination System (NPDES) permit under Section 402 of the CWA would be required for stormwater discharges from logging roads associated with this project. Although the Environmental Protection Agency has published a final rule exempting logging road stormwater discharge from NPDES permitting requirements, the United States Supreme Court is currently reviewing the matter. Until the Supreme Court rules, it will be uncertain whether a NPDES permit is required for this project.

Approximately 10 miles of roads would be reconstructed to reduce adverse effects to surface water quality. These legacy roads are located in close proximity to, or within streamcourses. By relocating these roads to upland locations, sediment delivery directly to streamcourses would be minimized.

Approximately 272 miles of temporary roads with widths of 12 feet (i.e., 395 acres) would be temporarily reopened to conduct vegetation treatments. These roads would be constructed using BMPs and SWCPs as outlined in Table 1, thus minimizing adverse impacts to surface water quality. No riparian areas would be adversely affected by temporary road construction as none are proposed within riparian areas.

Thirty-nine miles (508 acres, based on an average channel width of 107.5 feet) of ephemeral streamcourses would be returned to a more natural condition, thus reducing channel and bank scour, downcutting, aggradation, and uncharacteristic levels of sediment transport. Initially, ephemeral streamcourse restoration would likely exhibit slight increases in short-term sediment production and transport since stream banks and channels would be disturbed during the reshaping and restoration process. As restored areas stabilize, these ephemeral streamcourses would return to a more natural state with banks having more gentle angles of repose that would support vegetative cover, more favorable floodplains to increase soil water storage, and reduced stream velocities; thus decreasing sediment transport, channel downcutting, and stream bank undercutting that results in bank failure.

There would likely be some minor, short-term, localized adverse effects to water quality from the Action Alternatives in the project area in the form of increased runoff from treated areas, increased sediment delivery to ephemeral drainages, increased surface water turbidity, and increased nutrient loads in surface waters. Implementation of action alternatives is expected to improve water quality in the long term due to greater ground cover of grasses, forbs, and shrubs which would improve soil stability, water holding capacity, increase sediment capture in surface runoff, and minimize runon to travelways and roadside ditches. Since treatments would be temporally sequenced (i.e., not occurring simultaneously, but instead implemented over time), the likelihood of large-scale soil erosion or large sediment pulses delivered to streams is minimal.

Four Forest Restoration Initiative treatments will decrease basal area of ponderosa pine which has been shown in past studies to increase water yield at least temporarily. The Beaver Creek Experimental Watersheds (BCEW) study found that initial water yield increases of 15 to 40% are realistic on shallow, basalt-derived soils when the basal area of ponderosa pine forest is reduced by 30 to 100%, due largely to reduced evapotranspiration (Baker 1999). Areas with a northern exposure or deeper soil mantle generally provide increased water yield for longer periods of time than south-facing slopes or sites with shallow soil development (Gottfried and DeBano 1990). Given that ponderosa pine yielded an average of about 0.25 acre-feet per acre annually from the late 1950s to the early 1980s (this amount would be less in recent drought years), water yields increased by approximately 0.375 to 0.10 acre-feet per acre following strip cut, patch cut, shelterwood and clear cut treatments on the BCEW. Following treatments, water yield increases diminished due to vegetative regrowth and increasing ET, so that after 6 to 10 years there was no significant difference in water yield.

Under the Proposed Action, approximately 388,489 acres of restoration treatments are expected to result in some increased water yield. If 30,000 acres are consistently treated per year and the treatment effect on water yield diminishes each year for a period of 6 years, (depending on weather conditions) water yields may increase through the first 6 years and then remain static for as long as 30,000 acres per year are treated, after which they will naturally decline. Prescribed burning treatments that mimic the natural fire return interval might extend the period of increased water yield. One of the objectives of the paired watershed study in Alternative C is evaluate the effects of treatments on water yield.

Cumulative Effects Common to All Action Alternatives

Cumulative effects include the impacts on the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other action (40 CFR § 1508.7). The geographic setting for the cumulative effects analysis for soils and watersheds includes all of the 6th-level (HUC12) hydrologic unit watersheds that intersect the Four Forest Restoration Initiative analysis area, which comprises approximate 2,067,000 acres. The timeframe for past actions is 10 years, based on soil productivity, vegetative response, and coarse woody debris recovery within treated areas. Surface disturbing activities that are older than 20 years are assumed to be contributing negligible or no measurable cumulative effects within the analysis area.

Following is a partial listing of actions considered in the cumulative effects analysis for this project:

- Activities such as vegetation/fuels management, livestock grazing, and noxious weeds treatments have occurred in the past, are occurring, and are reasonably foreseeable actions within the analysis area. These activities could occur on private lands as well.
- Firewood cutting has occurred in the past and would likely continue in the foreseeable future on both Forests
- Other landowners (state and private) may harvest timber on their lands for lumber, fuelwood, or to reduce fire hazards.
- Urban development and interface growth will continue on private lands.
- Road construction, maintenance and right-of-way clearing can be expected to continue on non-National Forest System land.

- Road maintenance, reconstruction, or decommissioning will occur with future vegetation management projects on National Forest System land.
- Recreation activities are expected to continue to increase on the Forests. Future recreation projects may be developed.

Vegetation Management/Fuels Management

Vegetation management projects such as commercial timber harvesting, precommercial forest thinning, and fuelwood gathering reduce overstory cover in the short-term but typically result in an increase in understory vegetation within three to five years following treatment. These projects typically cause an initial increase in soil organic matter in the form of residual woody debris from tree harvesting activities that improves surface roughness and soil nutrient cycling. As grasses and forbs increase in numbers, fine root material contributes to soil organic matter accumulation, improves soil aggregate stability and soil porosity, and protects soil surfaces from erosion. Reduction of tree canopy and fuel loads would reduce the threat of high severity wildfire that could remove plant and litter cover, consume soil seed banks, sterilize soils, and create erosion and flooding hazards. Decreased interception of precipitation (rain and snow) would result in increased soil moisture and surface runoff following vegetation treatments. Improved understory vegetation that serves as a filter for stormwater runoff, increased soil organic matter content that improves soil stability and nutrient cycling, reduced fuel loads that prevent uncharacteristic fire behavior, and reduced interception of precipitation by trees would all contribute to improved surface water quality and riparian function by minimizing sediment delivery to streamcourses, and decreasing channel degradation (i.e., downcutting, aggradation, sediment transport, channel embeddedness, bank scour, etc.).

From 2000 to 2010, the CNF has focused forest vegetation treatments on areas with smaller diameter trees (i.e., 12 inches dbh or less). Such projects include: Rocky Park Fuels Reduction (5,561 acres thinned up to 12” dbh, 2001), Eastside Fuels Reduction (3,404 acres thinned up to 12” dbh, 2006), and East Clear Creek Watershed Health Project (1,645 acres thinned up to 9” dbh, 2006). The Kaibab NF has also focused vegetation treatments on smaller diameter trees (generally 9 inches dbh and lower) on approximately 6,514 acres. Projects on the KNF include the Williams High Risk Project (756 acres, 2001), Scott (421 acres, 2001), Pineaire Fuels Reduction Project (650 acres, 2004), Topeka Fuels Reduction (1,100 acres, 2004), Ten X Pre-Commercial Thinning Project (1,780 acres, 2004), and City Project (2,366 acres, 2005). Approximately 3 percent of the total project area has therefore received beneficial vegetation treatments. While improving forest conditions on a localized scale, and therefore risk of uncharacteristic fire behavior on these treated acres, treatments have not effectively reduced forest ingrown at the landscape scale. As a result, elevated risk of uncharacteristic fire behavior that would cause degradation of surface water quality and riparian function remains throughout much of the project area.

On both Forests, vegetation management/fuels reduction projects have typically included the construction and subsequent decommissioning of temporary roads as well as decommissioning of NFS roads. Since 2000, approximately 47 miles of temporary roads have been constructed and decommissioned to facilitate vegetation management/fuels reduction treatments and 251 miles of NFS roads have been decommissioned. Of these, approximately 117 miles were on the KNF and 44 miles were on the CNF).

Livestock Grazing

Currently, livestock grazing is authorized on approximately 790,985 acres, or 38 percent of the overall analysis area. While grazing results in discontinuous fuel patterns in grass, forb and shrub vegetative communities, it has not effectively reduced the densities of seedlings and saplings in ponderosa pine stands. As a result, excessive stand densities in the ponderosa pine vegetation type are causing a shift in understory vegetative communities toward more shade tolerant species such as bromes and mountain muhly.

Based on historic range monitoring data, Brewer (2011) concluded that cool season species increased in numbers through the 1990's in response to an increase in cool season moisture. However, over the last 10 years, reduced cool season moisture and increased warm season moisture has resulted in a corresponding shift toward dominance of warm season species. Since increased livestock grazing is not proposed under any alternative, the increased herbaceous understory would provide improved protection of soil surfaces from erosion, thus improving water quality.

Many riparian areas on the CNF and KNF have already been fenced to exclude domestic livestock grazing. Riparian conditions would continue to improve over time in these areas as soil compaction is naturally reduced through freeze-thaw and wetting-drying cycles.

Since livestock grazing would be excluded from fenced springs, these areas would improve over time. Riparian vegetation extent and condition associated with spring ecosystems would therefore improve under all Action Alternatives.

Noxious Weeds Treatments

Existing conditions within the project area indicate that weeds have expanded to 187,500 acres or 3 percent of the land area within the Coconino, Kaibab and Prescott National Forests (USDA 2005). Bull thistle, leafy spurge, various knapweed species, and Dalmatian toadflax have increased dramatically over the past 20 years. Riparian corridors, especially the Verde River, exhibit increases in tamarisk, Russian olive and tree of Heaven, as well as some of the knapweeds. There are currently 25 known weed species found within the 3 national forests and 4 species adjacent to them. The desired condition is to prevent any new weeds from becoming established on NFS lands. Eleven species (98 percent of the infested acres) have been assigned a contain/control objective; an additional 10 species are targeted for complete eradication; and 1 species (representing about 1 percent of the infested acres) is assigned an eradicate/control objective. The control of these plants promotes ecosystem health and prevents loss of the productive capacity of the land. These actions also prevent decline in riparian values within the project area.

Firewood Cutting

Firewood cutting typically reduces stand densities, thereby improving understory vegetative production. Adverse effects such as soil compaction, puddling, displacement, and erosion are short term, minor, and localized. Within 3 to 5 years, ground cover typically improves in areas where firewood collection has occurred due to increased sunlight reaching the forest floor, increased organic matter from residual fine woody debris, and improved nutrient availability.

Forest Management Activities on Private Property, State, and Other Non-Forest Service Lands

The Rural Communities Fuels Management Partnership has resulted in reduction of tree density on more than 200 acres of private property in the Parks, Sherwood Forest Estates, and Williams communities adjacent to the KNF from 2001 through 2004. These treatments have decreased the risk of high severity fires in these areas. By reducing the risk of uncharacteristic fire behavior, overall watershed condition is improved thereby protecting water quality and riparian area conditions.

The Camp Navajo Multi-Service Training Site in Bellemont borders both the Kaibab and Coconino National Forests and is within the project area. Camp Navajo implemented forest thinning treatments on 350 acres in 2011to complete post-tornado recovery. Vegetation treatments on 349 acres is foreseeable in 2012 (Camp Navajo 2012 data) and 968 acres are proposed for thinning and prescribed burning in 2013 as part of the Westside Thinning and Prescribed Fire Project.

The Greater Flagstaff Forest Partnership (GFFP) and Arizona State Forestry Division cost-share program has resulted in hazardous fuels reduction treatments on approximately 78,184 acres (GFFP Report 2010). The GFFP boundary comprises approximately 180,000 acres within the project boundary. Recent vegetation treatments include the City of Flagstaff Well-field Project (80 ac.), the Airport Project (134 ac.), NAU (1,893 ac.), Sunset Crater (316 ac.), Arizona Department of Game and Fish (54,988 ac.), and Flagstaff Fire Department (9,203 ac.). Treatments were designed to improve forest conditions and/or community protection within the wildland-urban interface. Current projects include vegetation thinning and prescribed fire on approximately 100 acres of private property made up of 20 parcels within the GFFP boundary in 2012.

Foreseeable fuels reduction treatments in the GFFP boundary include treating (thinning/prescribed burning) 245 acres on 5 private land parcels in 2013, 190 acres on 4 to 10 parcels in 2014, and 100 acres of prescribed burning through 2014 (Childs 2012).

These projects improve water quality and riparian health by reducing the risk of uncharacteristic fire behavior that can lead to soil erosion and delivery of excessive amounts of sediment, debris, ash, and nutrients to water bodies and adjacent riparian areas. Reduced canopy densities would improve precipitation throughfall that to the soil surface, thereby improving soil moisture content. Excess soil moisture (i.e., gravitational water) would improve either groundwater recharge or streamflow.

Urban Development

Continued urbanization is likely, particularly in the wildland-urban interface where there is greater opportunity for expansion than existing urbanized areas. These activities generally have adverse effects to surface water quality and riparian conditions as a result of construction activities and subsequent contaminated urban stormwater runoff. Vegetation/fuels reduction treatments that reduce wildfire hazard in these areas protects structures from damage or destruction by wildfires, thus minimizing the potential for contaminants (i.e. burned materials, household chemicals, etc.) to be transported to surface waters.

Road Construction, Maintenance, and Rights-of-Way Clearing – Non-NFS Lands

Road construction, maintenance, and rights-of-way clearing is expected to continue on non-NFS lands. These activities generally result in adverse effects to water quality and riparian conditions, depending on road locations, road geometries, and frequency of maintenance. Roads that intersect streamcourses or

are in close proximity to them pose the greatest risk to water quality. Stormwater runoff from road surfaces has the potential to deliver sediment and other contaminants directly to surface waters, including riparian areas. Road stream crossings often require infrastructure or modification that regulates in-channel flow (i.e., culverts, bridges, stream bank stabilization measures, channelization, channel realignment, etc.). These activities can have short- and long-term adverse effects to water quality as a result of initial destabilization of stream beds and banks, permanent changes to flow patterns, and artificial flow regulation. It should be noted that implementation of construction stormwater pollution prevention measures, or BMPs minimizes or mitigates most adverse effects of road construction and maintenance activities on surface water quality, but does not usually eliminate them entirely.

Road Construction and Maintenance on NFS land

Road construction and maintenance on NFS land would result in similar effects to surface water quality and riparian condition as outline above for non-NFS roads. Temporary road construction would disturb approximately 356 acres of NFS land. Soil denudation, displacement and compaction would occur as roads are bladed and surfaces prepared for traffic. All action alternatives would result in 356 acres of soil disturbance that has the potential to adversely affect water quality as a result of temporary road construction. Roads have been shown to increase drainage network density as a result of concentrated runoff from road surfaces (Croke and Mockler 2001; Montgomery 1994; Wemple and others 1996). If wheel ruts form on temporary road running surfaces or grading results in a small berm at the edge of road surfaces, runoff will be concentrated on the running surface (Robichaud 2010) However, implementation of BMPs and SWCPs as outlined in Table 1 would minimize or mitigate most adverse effects of road construction and maintenance of NFS roads on surface water quality.

Recreation

Developed recreation sites are found within the project area in close proximity to surface water bodies and a variety of recreational activities with potential to affect surface water quality occur within the project boundaries. The primary impacts to water quality related to recreation management are turbidity, sedimentation, and introduction of contaminants and pollutants such as petroleum hydrocarbons, fecal coliform, and solid waste. Construction projects, dispersed camping, driving on roads, etc. can result in decreased vegetative ground cover and increased soil erosion, thus contributing to sediment delivery and increased turbidity. Motorized boating has the potential to introduce petroleum hydrocarbons and other contaminants directly to surface waters. Full body water contact (i.e., swimming) has the potential to introduce fecal coliform bacteria. Cumulative impacts to water quality from the proposed activities would include minor, short-term, increases in sediment and turbidity in surface water following treatment activities.

Alternative B – Proposed Action

Direct and Indirect Effects

Grassland Restoration

Under the Proposed Action, grassland restoration treatments would be conducted using mechanized equipment or manual methods to treat vegetation on approximately 11,185 acres within forty 6^{th}-level HUCs. Treatment acreages within each HUC12 subwatershed range from one acre (Pumphouse Wash)

up to a maximum of 1,735 acres (Upper Red Lake Wash). Steinke (2012) estimates soil disturbances of approximately 3 percent as a result of restoration treatments in grasslands. A threshold of 15 percent areal extent for soil disturbance within treatment areas has been established as a guideline (USDA, 1991, FSM 2509.18). Soil disturbance rates of 3 percent in areal extent would therefore not exceed established disturbance thresholds. Total estimated ground disturbance from grassland restoration is 336 acres. Additionally, soil erosion models indicate that grassland restoration treatments would not result in soil erosion that exceeds tolerance limits. Since soil disturbance from grassland restoration treatments would not exceed disturbance thresholds and consequential soil erosion rates would not exceed soil erosion tolerance limits that indicate long term loss of soil productivity, it is unlikely that adverse impacts to water quality or riparian areas would occur as a result of grassland restoration treatments. Grassland restoration treatments are expected to improve long term soil stability and watershed condition, thereby improving surface water quality and riparian area condition.

Ponderosa Pine Restoration – Low Intensity Thinning

Under the Proposed Action, approximately 175,000 acres would be treated using low intensity thinnings to restore the ponderosa pine vegetation type. Of these acres, approximately 24,400 acres have severe erosion hazard ratings. Tree felling would be conducted using either chain saws or harvesting machinery with mechanized skidding of logs to landings. Soil disturbance resulting from forest thinning and subsequent treatment of residual woody debris would vary by type of harvesting method and woody debris treatment. Treatment acreages at the HUC12 subwatershed level range from 1 acre (Curley Wallace Tank) to 18,630 acres (Coconino Wash Headwaters). Estimated disturbance at the HUC12 subwatershed level ranges from 4 acres (Smoot Lake) to 2,236 acres (Coconino Wash Headwaters). Soil disturbance is estimated to be approximately 22,300 acres or 10-15 percent of the total low intensity thinning treatment acreage. This represents approximately 3.8 percent of the entire treatment area. As previously noted, a threshold of 15 percent areal extent for soil disturbance is assigned as a guideline. Also, it is important to understand that low intensity thinning treatments would not occur simultaneously, but would instead be distributed both temporally and spatially within each treated watershed. Steinke (2012) determined that soil disturbance from low intensity thinning treatments would therefore not pose a risk to soil resources. Since soil resources would not be adversely affected by low intensity thinning treatments followed by woody debris management, it is unlikely that water quality and riparian conditions would be adversely affected. Resource protection measures, including BMPs and SWCPs outlined in Table 1 would minimize or mitigate potential adverse effects to water quality and riparian areas. Harvesting operation BMP's specific for ponderosa pine restoration that would be implemented include the following, 23-33, 35, and 36.

There would likely be short term adverse effects to water quality where transportation systems (i.e., permanent National Forest System roads, temporary access roads, and skid trails) intersect or cross stream channels. These areas pose the greatest risk of causing adverse effects to surface water quality since stormwater runoff from road and skid trail surfaces can deliver sediment from disturbed areas directly to streamcourses. Adverse effects to water quality would be mitigated, but not eliminated entirely with implementation of BMPs and SWCPs as specified in Table 1.

Water quality and riparian areas would be expected to improve over the long term (i.e. greater that 2 years) as a result of increased understory vegetative production following low intensity thinning treatments. This is partly because vegetative and litter ground cover serve as a filter for stormwater runoff and snowmelt, increase water infiltration and percolation into and through soil profiles, and improve soil aggregate stability. Additionally, thinning would increase forest openings thereby

improving snowpack retention in these areas and reducing net annual evapotranspiration since fewer trees would be evapotranspiring year-round. The expected outcome would be slight improvement in riparian vegetation and surface water quality in streamcourses adjacent to thinned area.

Ponderosa Pine Restoration on Slopes Greater than 40%.

Approximately 99 acres of the proposed project area occur on slopes exceeding 40 percent. Steeper slopes can have greater erosion hazard when soils are disturbed. However, suitable logging practices can be employed to minimize soil disturbance, and therefore sediment delivery to streamcourses. These include helicopter logging or cable yarding. With implementation of helicopter logging, disturbance (and therefore bare areas subject to erosion and sediment delivery to streamcourses) would be minimized since disturbance from helicopter logging is limited to the areas where trees are felled and yarded by the helicopter, a log landing of approximately 2 acres, and a service landing for helicopter fueling and maintenance of approximately 1 acre. Cable yarding corridors would result in slightly more disturbance since a cable yarding road would be required and corridors are estimated to be 12 feet wide with 80 feet between corridors. Potential erosion and sediment delivery would therefore be slightly greater under cable yarding than helicopter. However, the overall acreage with slopes exceeding 40 percent is minimal and disturbance would be less that 10 percent using cable yarding. Additionally, with implementation of BMPs and SWCPs as specified in Table 1, potential adverse effects to water quality and riparian areas would be minimized. Finally, leaving residual woody debris incidental to vegetation treatments in disturbed areas such as log landings and cable corridors would protect soil surfaces and minimize potential soil erosion and sediment delivery to streamcourses.

Ponderosa Pine Restoration – High Intensity Thinning

This treatment type is proposed on approximately 154,700 acres in the ponderosa pine vegetation type. Of these acres, approximately 15,700 acres are on soils having severe erosion hazard ratings. Treatment acreages at the HUC12 subwatershed scale ranges from 7 acres (Little Red Horse Wash) to 8,334 acres (Walnut Creek-Upper Lake Mary). Ground disturbance associated with this treatment type is expected to range from one acre (Little Red Horse Wash) to 1,250 acres (Walnut Creek-Upper Lake Mary). Total soil disturbance is estimated to be approximately 23,205 acres or 15 percent of the overall high intensity thinning treatment acreage. This represents approximately 3.9 percent of the entire proposed treatment area. Approximately 2,400 acres of soil disturbance from high intensity thinning treatments is expected to occur on soils that have severe erosion hazard ratings. However, soil erosion models indicate that erosion would not exceed tolerance thresholds. As under low intensity thinning treatments, high intensity thinning treatments would not occur simultaneously, but would instead be distributed both temporally and spatially within each treated watershed.

Short-term, localized adverse effects to surface water quality are possible in ephemeral drainages within or adjacent to high intensity treatment areas, Subwatersheds with greater treatment acreages, such as Walnut Creek-Upper Lake Mary (8,334 treatment acres), Upper Spring Valley Wash (7,369 treatment acres, and Volunteer Canyon (6,249 treatment acres) pose the highest risk of short term, localized adverse effects to water quality. Potential adverse effects include increases in turbidity, total dissolved solids, total suspended solids, and nutrients. Implementation of BMPs and SWCPs as specified in Table 1 would minimize adverse effects to surface water quality and riparian ecosystem function.

It is possible that thinning ponderosa pine stands to a lower residual basal area would increase groundwater recharge or streamflow, particularly in riparian areas having shallow or perched aquifers.

Subwatersheds with the largest high intensity thinning treatment acreages have the greatest potential to respond hydrologically to treatments. The change in groundwater recharge would not likely exceed 1 cm of annual precipitation (Springer and Kolb 2000). However, this increased groundwater could be permanent as tree residual basal area is maintained with prescribed fire where ingrowth occurs. Prescribed burning following ponderosa pine thinning treatments and herbaceous vegetation recovery in upland areas adjacent to riparian ecosystems would likely play a larger role in increasing available soil moisture by reducing evapotranspiration by herbaceous plant communities (Springer et al. 2006).

Savanna Treatment

Approximately 45,469 acres are proposed for savanna restoration treatments in the ponderosa pine vegetation type. Of these acres, approximately 3,628 acres would be on soils with severe erosion hazard ratings. Soil disturbance as a result of savannah restoration treatments is estimated to be 10 to 20 percent areal extent (Steinke 2012) within treatment areas. At the HUC12 subwatershed scale, savanna treatment acreages are expected to range from 15 acres (Lower Sycamore Creek) to 4,444 acres (Walnut Creek-Upper Lake Mary). Soil disturbance is therefore expected to range from 2 acres (Lower Sycamore Creek) to 667 acres (Walnut Creek-Upper Lake Mary). Total disturbance from savanna restoration treatments is estimated to be 6,820 acres, or 1.1 percent of the entire proposed treatment area.

Removal of trees that have encroached in savannas would decrease annual evapotranspiration by trees. Loss of evapotranspiration by trees would result in an initial increase in soil moisture available to herbaceous plant communities in treated areas. As herbaceous ground cover improves in treated areas, water iniltration and percolation would improve since herbaceous ground cover and associated litter would improve soil macropore space, aggregate stability, and porosity. Soil moisture that exceeds field capacity would become gravitational water and would either increase groundwater recharge or contribute to stream baseflow. Minor, localized areas of soil disturbance, including compaction, displacement, puddling, and erosion are likely in treatment areas. These conditions would be expected to occur primarily where roads, skid trails, and landing are located. Implementation of BMPs as specified in Table 1 would minimize or mitigate adverse effects to surface water quality, and riparian conditions from savanna restoration teatments.

Aspen Treatments

Aspen treatments are proposed on 1,229 acres. Of these acres, approximately 234 acres of treatment would occur on soils with severe erosion hazard ratings. Soil disturbance in aspen treatments is estimated to be 184 acres, or between 10 and 20 percent areal extent (Steinke 2012). At the HUC12 subwatershed scale, aspen treatment acreages are expected to range from 6 acres (Pittman Valley-Scholz Lake) to 383 acres (Upper Deadman Wash). Soil disturbance is therefore expected to range from 1 acre (Pittman Valley-Scholz Lake) to 57 acres (Upper Deadman Wash). Total disturbance from aspen treatments is estimated to be 0.03 percent of the entire proposed treatment area. Thinning of encroached ponderosa pine and other conifers would be conducted to improve aspen vigor and natural regeneration potential. Prescribed burning would be implemented to improve aspen regeneration in treated stands. These treatments are not expected to result in adverse effects to surface water quality or riparian conditions since treatments would occur primarily in upland locations and ground disturbance would be minimal from removal of encroaching conifers and prescribed burning.

Pine Sage Treatments

Approximately 5,261 acres of ponderosa pine thinning and prescribed burning are proposed in the pine-

sage vegetation type. Effects to soils from mechanical thinning are expected to be similar to low intensity ponderosa pine thinning. Streamcourses in the pine-sagebrush vegetation type are generally ephemeral and only flow during and immediately following monsoon storms or during extreme snowmelt runoff. There are no riparian areas in the pine-sagebrush vegetation type. There would therefore be no adverse effects to riparian areas as a result of this treatment type. Treatments that are conducted in accordance with BMPs and SWCPs as specified in Table 1 would not result in adverse impacts to surface water quality.

Pinyon-Juniper (P-J) Wildland-Urban Interface (WUI) Treatments

Approximately 535 acres are proposed for thinning and prescribed burning in the pinyon-juniper vegetation type. These treatments would occur south of the Village of Tusayan in Rain Tank Wash and Coconino Wash Headwaters 6-level (HUC12) subwatersheds. Treatments would improve protection of the Village of Tusayan from catastrophic wildfire by reducing hazardous fuels in the wildland-urban interface. There are no riparian areas in close proximity to proposed treatments so there would be no adverse effects to riparian areas from proposed pinyon-juniper wildland-urban interface treatments. Soils in thse proposed treatment areas are currently in satisfactory condition. Steinke (2012) estimates that no more than 80 acres within the proposed treatment area would be subjected to soil disturbance. This level of soil disturbance is not expected to contribute to adverse impacts to surface water quality. Additionally, implementation of BMPs and SWCPs as specified in Table 1 would minimize or mitigate potential adverse effects to water quality. Best Management Practice No. 7 in Table 1 would require retention of 1 to 3 tons of coarse woody debris (CWD) per acre. Coarse woody debris would create surface roughness that prevents runoff from reaching velocities that cause soil particles to become entrained and delivered to streamcourses. There are therefore no anticipated adverse impacts to surface water quality from P-J WUI treatments.

Prescribed Fire Treatment

Prescribed burning is proposed for 587,923 acres. Prescribed burning only is proposed on approximately 199,435 of the total treatment acres, with the remaining 388,489 acres having a combination of prescribed burning and mechanical treatments proposed. Additionally, the entire 587,923 acres will have maintenance burning as well over 10-20 year timeframe. Soil disturbance as a result of high severity burn conditions is estimated to vary between 1 and 3 percent areal extent of the proposed treatment acreage (Steinke 2012). At the HUC12 subwatershed scale, soil disturbance acreage is expected to range from 2 acres (Curley Wallace Tank) to 629 acres (Munds Canyon). Total soil disturbance from prescribed burning is estimated to be 11,900 acres, or 2 percent of the entire proposed treatment area. The primary factor that determine the effects of prescribed burning on stormwater runoff and erosion is the amount of removal of surface and mineral soil organic matter that protects mineral soil surfaces, soil structure, and aggregate stability. The effects of burning can vary from partial removal of the litter (low burn severity) to total consumption of surface organic material and organic matter contained in the upper portion of the mineral soil layers (high burn severity). If the soil organic fraction is completely consumed by a fire, the mineral soil is exposed to rain splash, particle detachment, and entrainment in surface flow. Any loss of organic matter in the upper part of soil profiles will alter the soil structure, and the resultant disaggregation of the soil particles can greatly increase its susceptibility erosion (Brown et al. 1985, DeBano et al. 1998; Robichaud and Waldrop 1994). Robichaud and others (1994) observed total sediment yields from three 30-minute rainfall simulations that were an order of magnitude higher at high burn severity versus low burn severity. Similar differences in sediment yields were observed by Benavides-Solorio and MacDonald (2005).

Prescribed fire has potential to adversely affect water quality through increased soil hydrophobicity that results in a consequential increase in delivery of sediment and dissolved nutrients and ash to stream channels. The mobility and concentration of nutrients determines whether or not nearby water sources are at risk of contamination when prescribed fire is used. Nitrate is highly mobile and is therefore subject to risk of being leached from burned areas and transported to either surface or ground water. Phosphorus adsorbs readily to sediment and organic materials. Thus, phosphorus is usually transported to streams and water bodies through soil erosion.

Prescribed fires typically leave greater amounts of organic matter on soil surfaces than uncontrolled fires. These materials serve as a nutrient sink, prevent soil particle detachment caused by raindrop impact, and capture sediments that would otherwise be entrained and transported to streamcourses and waterbodies. Following low severity prescribed fires, an increase in grasses and other herbaceous vegetation often occurs, particularly where forests have been thinned prior to prescribed burning. This rapid growth of ground cover further immobilizes nutrients in plant material.

As vegetation is removed following prescribed fires, evapotranspiration in the watershed initially decreases, thus increasing surface runoff that can contribute to increased stream baseflow and overall water yield within the watershed. Water uptake from trees is species-specific. Conifers, which are the dominant vegetation type within the Four Forest Restoration Initiative analysis area, generally transpire more water than hardwoods such as oaks and aspen. Dense foliage and longer growing seasons promote the higher overall water uptake in conifers. Additionally, conifers have relatively dense crowns that intercept rainfall and allow for greater evaporative losses. Over time, herbaceous vegetation would increase in openings, causing a proportional increase in evapotranspirational loss.

Since prescribed burning treatments would be phased temporally and spatially, it is unlikely that large pulses of sediment would be mobilized and transported from treated areas to drainages or downslope locations. Also, since forest thinning would be conducted in many of the prescribed fire treatment areas prior to burning, resulting in increased size and extent of forest openings and increased ground cover of grasses and forbs that help to carry fire and provide a mosaic of fire effects, recovery of areas treated with low severity prescribed fire is expected to be rapid.

Low severity fire rarely consumes all of the forest floor litter, leaving some protective ground cover intact. Some of the nutrients contained in the organic matter would be converted to inorganic forms which are then available for plant uptake. The increase in plant available nutrients would improve short-term soil productivity, resulting in a rapid growth response of herbaceous vegetative cover. Low severity prescribed fire is therefore expected to result in minor, localized, short-term increases in soil erosion rates followed by long-term improvement in the stability, function, and productivity of forest soils in the project area. Since low severity fire has historically been a natural occurrence in these ecosystems, these impacts do not necessarily need to be construed as negative, as they could also occur after a naturally-caused wildfire. These vegetation types and associated soils are thus ecologically adapted to low severity fire, and to resulting fire impacts.

The potential for moderate severity prescribed fire increases in areas where excessive fuel loads currently exist, where forest thinning does not adequately reduce tree density, and where forest thinning results in large amounts of woody debris within a given treatment area. There would be an increased risk of accelerated soil erosion where moderate severity prescribed fire occurs. A likely scenario for

prescribed burning would be the occurrence of small areas (0.10 – 3 acres) that exhibit moderate burn severity intermingled with areas dominated by low burn severity conditions. It cannot be predicted with accuracy where such conditions would occur within proposed treatment areas. With appropriate fuels management techniques such as lopping and scattering of activity-related woody debris and piling and burning debris where necessary, adverse impacts to soils caused by moderate severity fire would be minimized.

High severity prescribed fire would result in considerable risk of accelerated soil erosion where such conditions occur. While very unlikely, this would represent a worst case scenario with regard to the use of prescribed fire and would more accurately reflect watershed response to wildfire. It is possible that small, isolated occurrences of high severity burn conditions would occur where excessive fuel loads exist or where conditions result in atypical fire behavior for brief periods. Such areas would likely exhibit accelerated soil erosion for longer periods and at greater rates than low or moderate soil burn severity areas due to high levels of consumption of surface and mineral soil organic matter, vegetative cover, and soil seed banks, leaving such areas unprotected and potentially hydrophobic.

Steinke (2012) esimates that soil disturbance would amount to approximately 11,900 acres or about 2% of entire treatment area. Furthermore, burned soils on slopes less than 40 percent are not expected to erode above tolerable or threshold levels. Long term soil productivity would therefore be maintained. Given the minimal estimated acres that would be disturbed with soil erosion levels that would not exceed tolerance thresholds, it is unlikely that adverse impact to water quality would occur. With proper implementation of BMPs and SWCPs as outlined in Table 1 adverse impacts to water quality and riparian area condition from prescribed burning would be minimized or mitigated. Best Management Practices ans SWCPs specific to prescribed fire include 6, 7, 8, and 10.

It should be noted that riparian areas adjoining the ponderosa pine vegetation type are generally adapted to minor pulses of sediment and ash in stormwater runoff as a result of low severity fires. These minor pulses of sediment and ash deliver nutrients and new substrate which supports riparian vegetation. Riparian areas are therefore expected to respond in a positive manner to low severity prescribed fire as a result of increased available water and nutrients.

Mexican Spotted Owl Protected Activity Center (MSO PAC) Fuels Reduction

Treatments in MSO PACs would include fuel reduction thinning to decrease the risk of catastrophic wildfire by removing trees up to 9 inches dbh. Steinke (2012) estimates soil disturbance levels would be similar to those of low intensity treatments. There would therefore be no adverse effects to water quality or riparian areas as a result of fuels reductions in MSO PACs.

No Treatment Areas

Some MSO or goshawk sensitive treatment sites (Noble 2012) are not proposed for any mechanical treatments, nor are most steep slopes or mixed conifer sites. These areas would remain at risk of uncharacteristic fire behavior where heavy fuel loads persist. There is therefore an increased risk of sediment and other pollutants to be delivered to streamcourses causing water quality degradation. Riparian areas that are downstream and in close proximity to no treatment areas having excessive fuel loads would be at greater risk of sedimentation, downcutting, aggradation, streambank failure, and other hydrogeomorphic processes that can be accelerated following high severity fires. Since these areas comprise a small percentage of the total proposed project area, adverse effects to water quality and

riparian areas would be relatively minor and proportional to acres of moderate and high burn severity in the event of an uncharacteristic wildfire.

Temporary Road Construction and Decommissioning

Approximately 906 miles of existing system roads and unauthorized routes would be decommissioned on the Coconino and Kaibab National Forests. Total disturbance from road decommissioning would therefore amount to 1,800 acres. Approximately 38 miles, or 70 acres of road decommissioning would occur on soils having severe erosion hazard ratings, reducing the acreage of severe erosion hazard soils that are continuously exposed to raindrop impact and subject to accelerated erosion.

System roads convert productive soils to an essentially non-productive condition in the long-term (i.e., greater than fifty years). Most precipitation that falls on compacted road surfaces becomes surface runoff. Implementation of effective Best Management Practices (BMPs) and Soil and Water Conservation Practices (SWCPs) during road decommissioning would improve surface water quality since these road segments would no longer be redirecting surface flows via ditches and delivering sediment and other pollutants directly o streamcourses. Decommissioning of 904 miles of roads would improve surface water quality, particularly where stream crossings would become naturalized over time.

Approximately 10 miles (15 acres) of existing open roads would be reconstructed for natural resource protection, watershed health, and human safety reasons.

Approximately 272 miles (395 acres) of existing closed roads would be reopened in order to conduct vegetaton treatments. These roads would then be decommissioned (closed and rehabilitated/naturalized) upon completion of vegetation treatments. Existing closed roads that are reopened would be at risk of increased sediment delivery to streamcourses when traffic is reintroduced. Many of these roads have not recovered since they were closed, indicating that reopening them would require blading and other road construction activities to reestablish a servicable road since vegetation has not established to prevent erosion.

Many of these roads are inadequately engineered, poorly located on the landscape and are consequently in a state of disrepair. Some of these roads are located near drainage channels or on ridge tops and are subject to erosion and sediment transport. Roads near drainages are contributing to degradation of surface water quality during snowmelt and following short duration, high intensity monsoon storms. Some roads have eroded to the point where roads surfaces are below the grade of the surrounding landscape, resulting in stormwater runon that then pools on road surfaces or flows down the travelway eroding the roadbed and entraining sediment in the storm flow. Where water pools in road surfaces, rutting is a problem. Where stormwater flows down road surfaces, rills and gullies are compromising the integrity of road surfaces and water quality.

Compacted road surfaces generate large amounts of surface runoff as a result of low infiltration rates (Luce and Cundy 1992, Reid and Dunne 1984, Robichaud et al. 2010). Road surfaces are subjected to rainsplash that results in soil particle detachment. When combined with large amounts of surface runoff, erosion rates are often several orders of magnitude greater than the adjacent undisturbed forest (for example, MacDonald and others 2005; Megahan 1978). Research has consistently shown that roads have the greatest effect on erosion of all practices associated with forest management (Robichaud 2010). Soil erosion rates from road surfaces are the dominant source of sediment in most managed forests (Brown and MacDonald 2005).

Decommissioning of 904 miles of existing NFS roads and unauthorized routes would improve surface water quality, particularly where roads intersect or cross stream channels. Road decommissioning also improves watershed condition by eliminating the amount of compacted surface area and sources of concentrated flow to connected stream channels. While road decommissioning is expected to produce an initial spike in sediment delivery to connected connected , this increase would be of short duration. Foltz and others (2008) measured the sediment delivery resulting from culvert removal at stream crossings in central Idaho. Peak suspended sediment concentrations ranged from 2.9 to 68,400 mg L^{-1}, depending on the number of straw bales placed in the stream and the flow diversion channel. Foltz and Yanosek (2005) observed sediment yields of 2 to 170 kg resulting from the removal of each of three corrugated metal pipe (CMP) culverts in central Idaho.

Temporary road construction will be required for implementation of vegetation treatments. Roads will then be decommissioned after use. Thus, disturbance to soils resulting from temporary roads will be short-term. This is expected to occur on about 524 miles of road (950 acres). Of these roads, the majority will be located on soils with slight or moderate erosion hazard ratings, with about 22 miles of road (40 acres) occurring on soils with severe erosion hazard ratings.

Approximately 10 miles of roads would be reconstructed to reduce adverse effects to surface water quality. These legacy roads are located in close proximity to, or within streamcourses. By relocating these roads to upland locations, sediment delivery directly to streamcourses would be minimized.

Channel Restoration

Approximately 39 miles of degraded ephemeral channels would be restored under Alternative B. Steinke (2012) estimates that ground disturbance from mechanized equipment and bank shaping and stabilization activities would amount to approximately 516 acres, or less than 1 percent of the total proposed treatment area. At the HUC12 subwatershed scale, disturbance acreages are expected to range from 2 acres (Johnson Creek) to 108 acres (Walnut Creek-Lower Lake Mary). Channel restoration activities would likely cause an initial, short term increase in sediment production from disrutbed areas following restoration activities. With implementation of BMPs and SWCPs specific to channel restoration listed in Table 1 (i.e., BMP numbers 11 through 21, and 33), adverse impacts to surface water quality and riparian conditions would be minimized or mitigated. Long-term improvement in surface water quality and riparian conditions are expected as a result of channel restoration activities through improved surface water storage and naturalized flow patterns.

Protective Fencing for Aspen and Springs

Approximately 82 miles of aspen fencing for protection of natural regeneration in aspen stands is proposed. Although there are no quantifiable data regarding the impacts that vertebrate herbivores and OHV traffic have on aspen stands and springs of the KNF and CNF, it is generally accepted that adverse effects to aspen stands and spring habitats from these activities are occurring.

Construction and maintenance of the proposed vertebrate herbivore exclosures in aspen stands and spring habitats would result in short-term, minor soil compaction and trampling or removal of native vegetation in areas where fence construction occurs. Native vegetation would reestablish in these areas soon after construction is completed (i.e., 1 to 3 years). Soil stability and productivity within exclosures would improve over time through elimination of impacts to aspen regeneration and wetland vegetation

by vertebrate herbivores (i.e., browsing and trampling). Additional benefits include reduced susceptibility of sites to invasion by noxious weeds by increasing native vegetation recruitment over time. Increased native plant cover would reduce the amount of open, ruderal sites susceptible to weed invasion. A slight improvement in water quality and riparian vegetation conditions would be expected as a result of protective fence installation in aspen and spring habitats.

Spring Restoration

Spring restoration is proposed on 74 springs within the project area. Springs have an important role at the landscape scale for hydrologic function of watersheds and they are very important for wildlife and plant diversity. Fifty-one developed springs on the Coconino NF are known to be not functioning at or near potential and 27 springs on the Kaibab NF have reduced function. The desired condition is to have the necessary soil, water, and vegetation attributes for springs to be healthy and functioning at or near potential.

Changes to spring discharge and ecological function following vegetation treatments and the locations of springs that exhibit such changes cannot be predicted with accuracy. Additionally, changes to the frequency and duration of spring discharge cannot be predicted with certainty as a result of vegetation treatments. However, some generalizations can be made. The hydrologic response of springs in the project area to proposed treatments will depend on the summed effect of the changes in evaporation, transpiration, soil moisture storage, snowpack accumulation and melt processes, and presence or absence of drought conditions. Additionally, changes to spring ecosystem function could result from possible changes to the physicochemical characteristics of groundwater following vegetation treatments.

Precipitation accumulates in the winter over most of the analysis area as snowpack, with melting and sublimation occurring during warm phases throughout the winter. Much of the winter snowfall is currently intercepted by tree canopies. Some of this moisture evaporates or sublimates without contributing to soil moisture, while some is blown off of intercepting vegetation or simply falls off, thus reaching soil surfaces. When the remaining snowpack begins to melt in spring, melt water first recharges the soil by replacing the water that was depleted during the previous growing season. Once soil moisture storage capacity is at its maximum, remaining melt water either becomes surface runoff that may contribute to stream flow, or is available for groundwater recharge. On north facing slopes, some of the snowpack remains almost continuously from December to April. While the evaporation rate is lower than south facing slopes, the relatively large surface area of snow permits a substantial amount of evaporative loss to occur. In contrast, on south facing slopes, intercepted snow quickly leaves the less dense forest canopy, thus allowing less interception and evaporative loss. For the first 1 to 3 years following vegetation treatments, a slight increase in groundwater recharge and runoff is expected since snowpack interception would be reduced; there would be fewer trees to create evapotranspirational demand for soil moisture during the growing season; and understory vegetation of grasses, forbs and shrubs will not have reached maximum ground cover levels. These conditions have potential to increase spring discharge.

Higher intensity forest thinning treatments would likely have the greatest potential to improve spring discharge by reducing evapotranspiration rates in treated areas. Soil moisture would likely improve in these areas for the first 1-3 years following treatments. Soil moisture that is not utilized by remaining trees and developing understory vegetation would contribute to groundwater recharge. As grass, forb,

and shrub communities increase, evapotranspiration would also increase. Groundwater recharge would therefore be slightly reduced as water demand by understory vegetation increases.

Prescribed fire has the potential to improve spring discharge and ecosystem function through introduction of low intensity fire that partially consumes vegetation and litter. The reduction in vegetative cover would reduce overall evapotranspiration rates in treated areas. This has the potential to increase both surface runoff and groundwater recharge rates.

An important consideration for restoration of springs is to restore discharge from the spring source except where prescribed by existing water rights adjudicated. This would allow discharge from springs to resume flow through their historic spheres of discharge as described by Springer and Stevens (2008).

Tables 1 and 2 in Appendix E list known springs of the CNF and KNF that occur within the analysis area. Table 3 lists springs within each restoration unit for each Forest and the entire analysis area. Tables 4 and 5 list springs by Forest within each proposed treatment type. Table 6 is a matrix that describes the adaptive management strategies for Spring Restoration.

Forest Plan Amendments

Coconino National Forest Plan Amendment 1 would result in removal of more trees in 18 MSO PACs since trees up to 16 inches dbh could be removed in these areas. Removal of additional trees would improve vegetative ground cover over the long term by increasing light interception at the forest floor and providing conditions conducive to the establishment of a more vigorous understory of grasses, forbs and shrubs. Increased vegetative ground cover would improve soil stability by reducing soil erosion rates. Reduced stand densities would also provide for improved protection of treated areas from the effects of high severity fire, further improving overall soil stability and watershed conditions. Reduced evapotranspiration resulting from removal of trees up to 16 inches dbh would likely improve soil moisture status. With implementation of BMPs and SWCPs as outlined in Table 1, adverse effects to water quality and riparian function would be minimized. Overall, these effects would provide greater protection of water quality and riparian areas by reducing the potential for sediment delivery to streamcourses and riparian habitats, improving soil moisture in upland areas, and improving snowpack retention in treated areas. Without implementation of CNF Plan Amendment 1, maintenance of soil productivity and therefore water quality and riparian conditions would not be to the level provided through implementation of the Plan amendment. There would be 18 MSO PACs that would remain at risk of high severity fire which could degrade soil stability and productivity increasing the risk of adverse effects to water quality and riparian function. Without implementation of this proposed amendment, soil productivity and watershed function including downstream water quality would remain at risk from high severity wildfire and pose risk to the sustainability of PACs, core areas, restricted habitat and threshold habitat. Deferring monitoring (and incremental treatment of habitat) of Mexican spotted owls to the USFWS Biological Opinion would not affect water quality or riparian areas on the CNF since no activities would occur that have potential to adversely affect these resources.

Coconino National Forest Plan Amendment 2 would improve soils and watershed conditions on 29,017 acres within the CNF since these treatment areas would be returned to open stand condition representative of historic, or reference condition. The lower stand densities and increased interspaces would provide conditions conducive to the establishment of a more vigorous understory of grasses, forbs and shrubs, thus providing greater soil protection than litter alone. The increased interspaces would

likely improve snowpack retention and therefore, soil moisture status. Lower stand densities would provide greater protection of soils and watershed resources in treated areas from the effects of high severity wildfire. These conditions would improve water quality and riparian area conditions by reducing sediment delivery to streamcourses and riparian areas. Implementation of BMPs and SWCPs as outlined in Table 1, would minimize or mitigate any adverse effects to water quality and riparian function. Without implementation of CNF Plan Amendment 2, approximately 29,017 acres on the CNF would remain at an elevated risk of high severity wildfire. If such a fire were to occur, surface water quality would likely be adversely affected through increased sediment deliver and turbidity. Sediment delivery to riparian areas could degrade riparian function.

Coconino National Forest Plan Amendment 3 is intended to ensure that no adverse effects occur to significant, or potentially significant, inventoried heritage sites. By doing so, this amendment would improve soils and watershed resources, and therefore water quality and riparian area conditions by minimizing disturbance of these sites. While inventoried heritage sites comprise a relatively small proportion of each watershed, reduced ground disturbance would prevent destabilization of soils resources and therefore sediment delivery to streamcourses and riparian areas. Implementation of BMPs and SWCPs that are designed to minimize or mitigate adverse impacts to soils and water quality would further prevent degradation of soil stability and productivity and therefore minimize adverse effects to riparian areas.Without implementation of CNF Plan Amendment 3, adverse effects to inventoried heritage sites, and therefore soil stability could occur. If soils are destabilized, sediment delivery to connected streamcourses and riparian habitats could occur.

Kaibab National Forest Amendment 1 would have similar effects as CNF Amendment 2 under this alternative although slightly fewer acres (i.e., 27,637) on the KNF would be managed for open conditions that are representative of historic, or reference conditions that are conducive to the establishment of a more vigorous understory of grasses, forbs and shrubs that then protect soil surfaces and reduce sediment delivery to streamcourses and riparian areas. Without implementation of KNF Plan Amendment 1, maintenance of soil productivity and therefore water quality and riparian conditions would not be to the level provided through implementation of the proposed Plan amendment. Approximately 27,637 acres would remain at risk of adverse effects of high severity fire which could degrade soils stability and productivity and adversely affect surface water quality and riparian habitats.

Kaibab NF Amendment 2 would have no effect to water quality or riparian areas on the KNF since it strictly relates to monitoring, definitions, and the incremental treatment of habitat. Managing for less than 10% threshold habitat for MSO would have minimal effect on soils, watershed condition, water quality and riparian areas as this represents a difference of only 2% from the current level of 8%.

Cumulative Effects

As previously noted, the cumulative effects analysis area includes the eighty-one 6th-level (HUC12) subwatersheds, which total 2,067,000 acres. The timeframe for past actions is 10 years, based on soil productivity, vegetative response, and coarse woody debris recovery within treated areas.

Past, present projects and reasonably foreseeable future actions are listed in the document entitled Four-Forest Restoration Coconino and Kaibab NF Environmental Analysis (EIS) Cumulative Effects Analysis Baseline (USDA, 2012) and are included in the Soils Specialist report.

Past Actions

Vegetative recovery after fuels reduction treatments is generally rapid, with erosion rates typically returning to pre-treatment levels within 1 to 2 years (Elliot et al. 2010). Vegetative ground cover that protects soil surfaces from erosive forces of wind and water is therefore expected to have recovered in areas that were disturbed more than 3-5 years ago. It is therefore unlikely that past treatments contributed measurable amounts of sediment and other non-point source pollution to streamcourses, springs, other water bodies (i.e., stock tanks and impoundments) and riparian areas. These areas are therefore not expected to contribute to adverse cumulative effects to water quality or riparian area conditions.

Recent activities (i.e., within the last 1-3 years), including fuels reduction treatments, commercial timber harvests, juniper clipping, prescribed burning, and road obliteration are continuing to revegetate and are therefore at a slightly elevated risk of contributing in a cumulative manner to adverse impacts to water quality if new treatments are implemented adjacent to above these areas. By delaying subsequent treatments in these areas until after vegetative recovery is sufficient to protect soil surfaces from erosion and sediment delivery to streamcourses, springs, or riparian areas, cumulative impacts to water quality and riparian vegetation from proposed treatments would be minimized or mitigated. The magnitude of effects to water quality and riparian vegetation resulting from past actions is expected to be similar to the proposed action since BMPs and SWCPs would have been implemented in a similar manner as proposed under the Action Alternatives of this project.

This cumulative effects analysis does not attempt to quantify the effects of past human actions by summing the effects of all prior actions. Instead, existing forest conditions within the 84 HUC12 subwatersheds on the CNF and KNF that include the Four Forest Restoration Initiative analysis area are considered to be representative of the effects of past actions when combined with current actions and natural disturbances. Proposed treatments under Alternative B are expected to result in a total of 60,995 acres of disturbance, or 3 percent of the analysis area acreage of 2, 032,080.

Present Actions

Present actions that are occurring within the cumulative effects analysis area include additional fuels reduction projects, developed and dispersed recreation, road maintenance, fire suppression, permitted hunting, livestock grazing and special uses. Tables 1 and 2 in Appendix F and Attachment 4 in the soils specialist report list current vegetation management projects by HUC12 subwatershed and their associated acreages. These ground disturbing activities have occurred from 2009 to the present. The use of the last three years for current and ongoing is tied to the 1-2 year recovery time for vegetation as stated in Elliot et al., 2010. All listed activities use a 15% disturbance factor, so the acreages for ground disturbance resulting from prescribed burning treatments are overestimated while acreages for ground disturbance from mechanical treatments reflect reasonable maximum ground disturbance rates.

Reasonably Foreseeable Future Actions

Attachment 4 in the soils specialist report lists the future and foreseeable projects and their associated acreages by HUC 12 subwatersheds. Recreational activities include: hiking, wildlife viewing, hunting, dispersed car-camping, backpack camping, orienteering, horseback riding, caving, rock climbing, photography, picnicking, taking scenic drives, ORV/ATV use, bicycling, shooting, and gathering in family or social groups. Snowmobile use and cross-country skiing are increasing as popular uses in the area. During normal winters, snowmobiles are the only vehicles that access the area.

Other uses of forest resources within the project area include firewood gathering, post and pole cutting, collecting boughs and cones, collecting and transplanting wildlings, gathering antlers, collecting food and medicinal resources such as berries, nuts, mushrooms, and ferns, and collecting biological specimens for research.

Implementation of Travel Management Rule throughout the Four Forest Restoration Initiative analysis area has effectively reduced the density of roads currently in use by visitors to both Forests. However, roads that remain in use can be expected to continue to deliver sediment as non-point source pollution to connected streamcourses within the project boundary. However, implementation of BMPs and SWCPs as specified in Table 1 would reduce potential non-point source pollution from roads.

Stock tank use by domestic and wildlife ungulates would continue to contribute adverse effects to surface water quality. Domestic livestock grazing would continue to remove biomass that protects soil surfaces from erosion and resulting sediment delivery to streamcourses. Trampling and trailing by domestic livestock would result in minor, localized adverse effects to soil stability in ephemeral drainages.

Continued prescribed fire use and wildfires are likely to occur within and outside the Four Forest Restoration Initiative analysis area. Analysis from Burned Area Reports indicates that between 1 and 5 percent of soils in the project area have had adverse effects from wildfires. Until such soils have recovered from fire, they are often a source of sediment and nutrient delivery to streamcourses.

Summary of Cumulative Effects

The total acres of past, present are future and foreseeable treatment acres within the cumulative effects project area are roughly 282,400 acres, or about 14%% of the cumulative boundary area. Of these treatment acres, we are assuming that there will be about 15% of these acres having ground disturbance, or about 42,400 acres, or just under 2% of the cumulative effects analysis area are expected to have ground disturbance from past, present and future or foreseeable projects. The 4FRI EIS will add an additional 61,000 acres of ground disturbance for a total acreage of ground disturbance across the cumulative effects analysis area, for a total acreage of disturbed ground of nearly 103,400 acres, or about 5% of the cumulative effects boundary area (see table below). As such, the threshold of 15% aerial extent disturbance guideline (USDA, 1991) where soil impairment and productivity is measurable and may be appreciably reduced is not exceeded.

Table 10. Summary of cumulative effects-Alternative B

	EIS			Future Foreseeable		Current/Ongoing		PROJECT TOTAL	
6th code	**TOTAL EIS**	**TOTAL EIS**	**TOTAL EIS**	**TOTAL**	**TOTAL Future/Fore**	**TOTAL**	**TOTAL Current**	**TOTAL CUM EFFECTS**	**TOTAL CUM EFFECTS**

acres	Ground Disturb	treat% ground disturb	%6th code Ground Disturb	TREAT ACRES	Ground Disturb	TREAT ACRES	Ground Disturb	Ground Disturb	% Ground Disturb
2,032,080	60,995	10.4%	3.0%	149,561	22,434	132,837	19,926	103,355	5.1%

No threshold for ground disturbance occurs within the Coconino National Forest Plan. However, Forest Service Manual 2509.18 recommends a guideline of a 15 percent reduction in inherent soil productivity potential as a basis for setting threshold values for measurable or observable soil properties or conditions. Although not accurately quantified for all past, present and reasonably foreseeable actions, based on the estimated minor extent and low magnitude of soil disturbance, the 15% threshold of soil disturbance where soil productivity crosses a negative threshold would not be exceeded with this project within the cumulative effects boundary. Further protection of soil resources is provided by the use of Best Management Practices that minimize the potential for soil disturbance. In addition to the use of BMP's, the completion and implementation of the Travel Management EIS will further reduce the number of acres disturbed by closing and decommissioning roads within the cumulative effects boundary. Because of these facts, this Alternative should not provide a detrimental cumulative effect to soil resources within the Cumulative Effects boundary.

Alternative C

Direct and Indirect Effects

Direct and indirect effects from implementation of Alternative C are only discussed for treatments with different acreages under each Action Alternative. Treatments having the same acreage under this Action Alternative are assumed to have similar direct and indirect effects as Alternative B.

Grassland Restoration

Under the Alternative C, grassland restoration treatments would be conducted using mechanized equipment or manual methods to treat vegetation on approximately 59,463 acres within sixty six 6th-level HUCs as opposed to 11,222 acres for all other Action Alternatives. Of these acres, approximately 550 acres are on soils with severe erosion hazard ratings Treatment acreages within each HUC12 subwatershed range from 4 acres (Redhorse Wash Headwaters) up to a maximum of 8,953 acres (Garland Prairie). Steinke (2012) estimates soil disturbances of approximately 3 percent as a result of restoration treatments in grasslands. A threshold of 15 percent areal extent for soil disturbance within treatment areas has been established as a guideline (USDA, 1991, FSM 2509.18). Soil disturbance rates of 3 percent in areal extent would not exceed established disturbance thresholds. Estimated disturbance from grassland restoration under Alternative C is estimated to amount to 1,784 acres. Additionally, soil erosion models indicate that grassland restoration treatments would not result in soil erosion that exceeds tolerance limits. Since soil disturbance from grassland restoration treatments would not exceed disturbance thresholds and consequential soil erosion rates would not exceed soil erosion tolerance limits that indicate long term loss of soil productivity, it is unlikely that adverse impacts to water quality or riparian areas would occur as a result of grassland restoration treatments.

Ponderosa Pine Restoration – Low Intensity Thinning

Under the Alternative C, approximately 167,311 acres would be treated using low intensity thinnings to

restore the ponderosa pine vegetation type. Treatments would be conducted as described under the Proposed Action with soil disturbance resulting from forest thinning and subsequent treatment of residual woody debris varying by type of harvesting method and woody debris treatment. Treatment acreages at the HUC12 subwatershed level range from 1 acre (Curley Wallace Tank) to 18,625 acres (Coconino Wash Headwaters). Estimated disturbance at the HUC12 subwatershed level ranges from 4 acres (Smoot Lake) to 2,235 acres (Coconino Wash Headwaters). Soil disturbance is estimated to be approximately 20,077 acres or 12 percent of the total low intensity thinning treatment acreage. This represents approximately 3.4 percent of the entire 587,924 acre proposed treatment area. As previously noted, a threshold of 15 percent areal extent for soil disturbance is assigned as a guideline. Also, as under the Proposed Action, low intensity thinning treatments would not occur simultaneously, but would instead be distributed both temporally and spatially within each treated watershed. Steinke (2012) determined that soil disturbance from low intensity thinning treatments would therefore not pose a risk to soil resources. Since soil resources would not be adversely affected by low intensity thinning treatments followed by woody debris management, it is unlikely that water quality and riparian conditions would be adversely affected. Resource protection measures such as BMPs and SWCPs outlined in Table 1 would minimize or mitigate potential adverse effects to water quality and riparian areas.

Effects to water quality and riparian areas would be approximately the same as the Proposed Action, with only minor differences based on treatment acreages.

Ponderosa Pine Restoration – High Intensity Thinning

This treatment type is proposed on approximately 149,703 acres in the ponderosa pine vegetation type. Treatment acreages at the HUC12 subwatershed scale ranges from 7 acres (Little Red Horse Wash) to 9,192 acres (Walnut Creek-Upper Lake Mary). Ground disturbance associated with this treatment type under Alternative C would be the same as the Proposed Action. Total soil disturbance is estimated to be slightly higher than the proposed action at approximately 22,455 acres. The overall disturbance remains the same as the Proposed Action at 15 percent of the overall high intensity thinning treatment acreage. This represents approximately 3.4 percent of the entire 587,924 acre proposed treatment area. However, soil erosion models indicate that erosion would not exceed tolerance thresholds. As under low intensity thinning treatments, high intensity thinning treatments would not occur simultaneously, but would instead be distributed both temporally and spatially within each treated watershed.

Effects to water quality and riparian areas would be approximately the same as under the Proposed Action with a minor exception of additional soil disturbance of approximately 3 acres for installation of up to 15 weirs and 20 weather stations (3 total acres of disturbance) to support watershed research. Although some these instruments (i.e. weirs) would be installed directly in stream channels, adverse effects to water quality are not anticipated. Minor, localized disturbance from installing and accessing instruments is expected.

Savanna Treatment

Approximately 45,469 acres are proposed for savanna restoration treatments in the ponderosa pine vegetation type. Soil disturbance as a result of savannah restoration treatments is estimated to be 15 percent areal extent (Steinke 2012). At the HUC12 subwatershed scale, savanna treatment acreages are expected to range from 15 acres (Lower Sycamore Creek) to 4,444 acres (Walnut Creek-Upper Lake Mary). Soil disturbance, and therefore effects to water quality and riparian areas is approximately the

same as the Proposed Action.

Prescribed Fire Treatment

Prescribed burning is proposed for the entire project area, or 593,211 acres, or approximately 5,287 more than the Proposed Action. As previously noted, Steinke (2012) estimates soil disturbance as a result of high severity burn conditions to vary between 1 and 3 percent areal extent of the proposed treatment acreage. At the HUC12 subwatershed scale, soil disturbance acreage is expected to range from 2 acres (Curley Wallace Tank) to 643 acres (Munds Canyon). Total soil disturbance from prescribed burning under Alternative C is estimated to be 11,863 acres, or 105 acres more than the Proposed Action. Direct and indirect effects to water quality and riparina areas would there be approximately the same as the Proposed Action.

Forest Plan Amendments

Coconino National Forest Plan Amendment 1 would have similar effects as CNF Plan Amendment 1 under alternative B. However,under this alternative, soils and watershed resources would be further improved in 56 MSO PAC core areas as a result of reintroduction of low-intensity prescribed fire to these PACs. Reduced stand densities followed by improved vegetative ground cover would increase fine root biomass of grasses, forbs and shrubs that protect soils from erosion. Reintroduction of low-intensity fire would improve nutrient cycling and increase understory vegetative vigor. These conditions would improve water quality and riparian area conditions by reducing sediment delivery to streamcourses and riparian areas. Overall, CNF Forest Plan amendment 1 under Alternative C would provide greater improvement in water quality and riparian health that under Alternative B. Without implementation of of this proposed Forest Plan Amendment, reintroduction of low-severity prescribed fire would not occur in 56 MSO PACs, leaving soils and watershed resources at risk of uncharacteristic wildfire that could damage soil stability and productivity and therefore adversely affect surface water quality and riparian area conditions.

Mechanical vegetation treatments within the 6,321 acres of MSO restricted habitat (target/threshold) to achieve a residual basal area ranging from 110 to 150 sq. ft. would improve soils and watershed conditions and therefore water quality by reducing stand densities that are otherwise conducive to high severity fire. Vegetative ground cover would improve in these areas, reducing soil erosion potential and protecting surface water quality.

Deferring monitoring (and the incremental treatment of habitat) of Mexican spotted owls to the USFWS Biological Opinion would not affect water quality or riparian areas on the CNF since no activities would occur that have potential to adversely affect these resources.

Coconino National Forest Plan Amendment 2 under alternative C is the same as under alternative B. The effects under alternative C would therefore be the same as those described under alternative B.

Coconino National Forest Plan Amendment 3 under alternative C is the same as under alternative B. The effects under alternative C would therefore be the same as those described under alternative B.

Kaibab National Forest Plan Amendment 1 is similar to KNF Plan Amendment 1 under alternative B, although 38 more acre on the KNF would be managed for open conditions that are representative of historic, or reference conditions that are conducive to the establishment of a more vigorous understory

of grasses, forbs and shrubs that then protect soil surfaces from erosion and reduce sediment delivery to streamcourses and riparian areas under this alternative. Approximately 38 additional acres would be improved under alternative C than alternative B. Without implementation of this proposed Forest Plan Amendment, 27,675 acres on the KNF would remain at an elevated risk of high severity wildfire that could adversely affect water quality and riparian habitats through increased sediment delivery to streamcourses and increased water turbidity.

Kaibab National Forest Plan Amendment 2 would improve soils and watershed conditions in the Garland Prairie RNA by returning the RNA to a grassland condition. Removal of encroached trees would improve vegetative ground cover in this treatment area, reducing the potential for soil erosion and sediment delivery to streamcourses. There would be minimal effect to riaprian areas from implementation of this Forest Plan Amendment as there are no riparian in close proximity to to the RNA. Reintroduction of low-intensity prescribed fire would improve nutrient cyclying and herbaceous understory vigor, further contributing to improved vegetative ground cover. Without implementation of this Forest Plan amendment, encroached trees in the Garland Prairie RNA would continue to pose a risk of high severity fire and therefore risk to water quality in connected ephemeral drainages.

Kaibab National Forest Plan Amendment 3 would allow mechanical vegetation treatments within the 2,090 acres of MSO restricted habitat (target/threshold) to achieve a residual basal area ranging from 110 to 150 sq. ft. This Plan Amendment would improve soils and watershed conditions and therefore water quality by reducing stand densities that are otherwise conducive to high severity fire. Vegetative ground cover would improve in these areas, reducing soil erosion potential and protecting surface water quality. Managing for less than 10% threshold habitat for MSO would have minimal effect on soils, watershed condition, water quality and riparian areas as this represents a difference of only 2% from the current level of 8%.

The amendment adds defintions and defers monitoring of Mexican spotted owls and the incremental treatment of habitat to the USFWS Biological Opinion. Under alternative C would not affect water quality or riparian areas on the KNF since it is strictly related to monitoring of Mexican spotted owls and no activities would occur that have potential to adversely affect water quality or riparian habitats.

Summary of Cumulative Effects

The total acres of past, present are future and foreseeable treatment acres within the cumulative effects project area are roughly 282,400 acres, or about 14 percent of the cumulative boundary area. Of these treatment acres approximately 15 percent are expected to exhibit ground disturbance. Approximately 42,400 acres, or just under 2 percent of the cumulative effects analysis area are expected to have ground disturbance from past, present and future (i.e., reasonably foreseeable) projects. The 4FRI EIS will add an additional 66,400 acres of ground disturbance for a total acreage of ground disturbance across the cumulative effects analysis area of approximately 108,700 acres, or about 5% of the cumulative effects boundary area (see Table 11 below). As such, the threshold of 15% areal extent disturbance guideline (USDA, 1991) where soil impairment and productivity is measurable and may be appreciably reduced is not exceeded.

Table 11. Summary of cumulative effects-Alternative C

	EIS	Future Foreseeable	Current/Ongoing	PROJECT TOTAL

6th code acres	TOTAL EIS Ground Disturb	TOTAL EIS treat % ground disturb	TOTAL EIS 6th code% Ground Disturb	TOTAL TREAT ACRES	TOTAL Future/Fore Ground Disturb	TOTAL TREAT ACRES	TOTAL Current Ground Disturb	TOTAL CUM EFFECTS Ground Disturb	TOTAL CUM EFFECTS % Ground Disturb
2,032,080	66,358	11.2%	3.3%	149,561	22,434	132,837	19,926	108,718	5.1%

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No threshold for ground disturbance occurs within the Coconino National Forest Plan. However, Forest Service Manual 2509.18 recommends a guideline of a 15 percent reduction in inherent soil productivity potential as a basis for setting threshold values for measurable or observable soil properties or conditions. Although not accurately quantified for all past, present and reasonably foreseeable actions, based on the estimated minor extent and low magnitude of soil disturbance, the 15% threshold of soil disturbance where soil productivity crosses a negative threshold would not be exceeded with this project within the cumulative effects boundary. Further protection of soil resources is provided by the use of BMPs and SWCPs that minimize the potential for soil disturbance and sediment delivery to streamcourses and other waterbodies. In addition to the use of BMP's and SWCPs, implementation of the Travel Management Rule will further reduce the number of acres disturbed by closing and decommissioning roads within the cumulative effects boundary. Because of these facts, this Alternative will not result in a detrimental cumulative effect to water quality or riparian resources within the Cumulative Effects boundary.

Alternative D

Direct and Indirect Effects

Ponderosa Pine Restoration – Low Intensity Thinning

Under Alternative D, approximately 174,462 acres would be treated using low intensity thinnings to restore the ponderosa pine vegetation type. Treatments would be conducted as described under the Proposed Action with soil disturbance resulting from forest thinning and subsequent treatment of residual woody debris varying by type of harvesting method and woody debris treatment. Treatment acreages at the HUC12 subwatershed level range from 1 acre (Curley Wallace Tank) to 18,630 acres (Coconino Wash Headwaters). Estimated disturbance at the HUC12 subwatershed level ranges from 4 acres (Smoot Lake) to 2,236 acres (Coconino Wash Headwaters).
With only slightly more acres to be treated using low intensity thinning, direct and indirect effects to water quality and riparian areas would be approximately the same as the Proposed Action.

Prescribed Fire Treatment

Prescribed burning is proposed for the entire project area, or 178,790 acres, substantially fewer acres than the Proposed Action. At the HUC12 subwatershed scale, soil disturbance acreage is expected to range from 1 acre (Government Canyon) to 262 acres (Doney Park). Total soil disturbance from prescribed burning under Alternative D is estimated to be 3,578 acres. While Alternative D results in fewer acres of disturbance from prescribed fire, it would not meet the purpose and need of returning fire to fire adapted ecosystems.

Forest Plan Amendments

Coconino National Forest Plan Amendment 1 under alternative D is the same as under alternative B. The effects under alternative D would therefore be the same as those described under alternative B.

Coconino National Forest Plan Amendment 2 under alternative D is the same as under alternatives B and C. The effects under alternative D would therefore be the same as those described under alternatives B and C.

Coconino National Forest Plan Amendment 3 under alternative D is the same as under alternatives B and C. The effects under alternative D would therefore be the same as those described under alternatives B and C.

Kaibab National Forest Plan Amendment 1 under alternative D is the same as under alternative B. The effects under alternative D would therefore be the same as those described under alternative B.

Kaibab National Forest Plan Amendment 2 under alternative D is the same as Amendment 2 under alternative B and Amendment 3 under alternative C. The effects under alternative D would therefore be the same as those described under alternative B, Amendment 2, and alternative C, Amendment 3.

Summary of Cumulative Effects

The total acres of past, present are future and foreseeable treatment acres within the cumulative effects project area are roughly 282,400 acres, or about 14 percent of the cumulative boundary area. Of these treatment acres, approximately 15 percent of these acres will exhibit ground disturbance, or about 42,400 acres. Therefore, less than 2 percent of the cumulative effects analysis area are expected to have ground disturbance from past, present and reasonably foreseeable future actions. The 4FRI EIS will add approximately an additional 52,800 acres of ground disturbance for a total acreage of ground disturbance across the cumulative effects analysis area of 95,200 acres, or about 5 percent of the cumulative effects boundary area (see Table 12 below). As such, the threshold of 15% aerial extent disturbance guideline (USDA, 1991) where soil impairment and productivity is measurable and may be appreciably reduced is not exceeded. There will therefore be no long-term adverse effects tosurface water quality or riparian areas.

Table 12. Summary of cumulative effects-Alternative D

	EIS			Future Foreseeable		Current/Ongoing		PROJECT TOTAL	
6th code **acres**	**TOTAL EIS** **Ground Disturb**	**TOTAL EIS** **treat % ground disturb**	**TOTAL EIS 6th code% Ground Disturb**	**TOTAL** **TREAT ACRES**	**TOTAL Future/ Fore** **Ground Disturb**	**TOTAL** **TREAT ACRES**	**TOTAL Current** **Ground Disturb**	**TOTAL CUM EFFECTS** **Ground Disturb**	**TOTAL CUM EFFECTS** **% Ground Disturb**
2,032,080	52,814	10.0%	2.6%	149,561	22,434	132,837	19,926	95,173	4.7%

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No threshold for ground disturbance occurs within the Coconino National Forest Plan. However, Forest Service Manual 2509.18 recommends a guideline of a 15 percent reduction in inherent soil productivity potential as a basis for setting threshold values for measurable or observable soil properties or conditions. Although not accurately quantified for all past, present and reasonably foreseeable actions, based on the estimated minor extent and low magnitude of soil disturbance, the 15% threshold of soil disturbance where soil productivity crosses a negative threshold would not be exceeded with this project within the cumulative effects boundary. Further protection of soil resources is provided by the use of Best Management Practices that minimize the potential for soil disturbance. In addition to the use of BMP's, the completion and implementation of the Travel Management EIS will further reduce the number of acres disturbed by closing and decommissioning roads within the cumulative effects boundary. Because of these facts, this Alternative will not provide a detrimental cumulative effect to soil resources within the Cumulative Effects boundary.

Conclusion

Effects of Action Alternatives

In summary, the Proposed Action and other Action Alternatives are expected to result in areal disturbance of approximately 3% of the cumulative effects boundary area. Cumulative soil disturbance from past, present and reasonably foreseeable actions is not well quantified but estimated to be between 1 to 3 percent for past actions, 1 to 2 percent for present actions, and 1 to 3 percent for reasonably foreseeable actions within the cumulative effects boundary for a total estimated range for soil disturbance of 3 to 8 percent (Steinke 2012). When combined with any of the Action Alternatives, total cumulative soil disturbance is estimated to range between 6 and 11 percent. Cumulative acres of disturbance when combined with any of the Action Alternatives is therefore expected to range from approximately 121,924 acres to 223,528 acres.

There is no threshold for ground disturbance within the CNF or KNF Forest Plans. However, Forest Service Manual 2509.18 provides a general guideline of 15 percent for soil disturbance that results in reduction of the inherent productivity of a soil as a measurable value of adverse disturbance.

Ephemeral and intermittent drainages in the project area typically respond to seasonal runoff events (i.e., spring snowmelt and short duration, high intensity summer monsoon storms). Surface runoff has the potential to entrain and sediment and other pollutants, contributing to short term surface water quality degradation. Turbidity (total suspended sediment) is the water quality standard that is most likely to be affected by proposed treatment activities. Turbidity is a measure of particulate matter in suspension. Typically, in wildland settings, turbidity is the existence of fine to very fine soil particles and organic matter in water. Sediment delivery ratios normally decline with increasing watershed area, resulting in dilution of sediment delivered to streams from a given activity. It is unlikely that any of the Action Alternatives would contribute enough sediment or other pollutants to ephemeral or intermittent drainages within the project area to result in impairment of any downstream waterbodies.

Climate Change

While it is currently not possible to discern climate change effects of the Proposed Action or other Action Alternatives, given the lack of effects that can be meaningfully evaluated under current science and modeling, one would expect an initial, short-term increase in atmospheric CO_2 and other

greenhouse gases from the proposed treatments through burning of hydrocarbons to conduct mechanical vegetation treatments, rapid oxidation of vegetation and woody debris during prescribed burning, and increased decomposition of woody debris. However, long-term effects would be positive as the ground cover of grasses and forbs increases. Woody debris would provide long-term nutrient sources and contribute to surface roughness, decreasing potential erosion. Nutrients released in ash during prescribed burning and through decomposition of residual woody debris from forest thinning would also improve soil quality. As previously noted the increase in ground cover of grasses, forbs, and shrubs, which have higher fine root turnover rates than large woody plants would result in greater soil organic matter content over time. Soils within the project area would therefore sequester more CO_2 over the long term.

The U.S. Environmental Protection Agency (EPA) has asserted that scientists know with virtual certainty that human activities are changing the composition of the Earth's atmosphere. It is also documented that "greenhouse" gases, including CO_2, methane (CH_4), nitrous oxide (N_2O), and hydro fluorocarbons have been increasing (EPA, 2010). The atmospheric increase of these gases is largely the result of human activities such as the burning of fossil fuels. Greenhouse gases absorb infrared energy that would otherwise be reflected from the earth. As this infrared energy is absorbed, the air surrounding the earth is heated (CARB 2007).

The Southwestern Region of the Forest Service recently released "Southwestern Region Climate Change – Trends and Forest Planning: A guide for addressing climate change in forest planning on southwestern National Forests and Grasslands. The following information is summarized from excerpts of this publication:

In the Southwest, climate modelers agree there is a drying trend that will continue well into the latter part of 21st century (IPCC 2007; Seager et al. 2008). Climate modelers predict increased precipitation, but believe that the overall balance between precipitation and evaporation would still likely result in an overall decrease in available moisture. Regional drying and warming trends have occurred twice during the 20th century (1930s Dust Bowl, and the 1950s Southwest Drought). Current drought conditions "may very well become the new climatology of the American Southwest within a time frame of years to decades". According to recent model results, the slight warming trend observed during the last 100 years in the Southwest may continue into the next century, with the greatest warming to occur during winter. Climate models predict temperatures to rise approximately 5 to 8 degrees Fahrenheit by the end of the century (IPCC 2007). This trend would likely increase demand on the region's already limited water supplies, as well as increase energy demand, alter fire regimes and ecosystems, create risks for human health, and affect agriculture (Sprigg et al. 2000).

Average ambient air temperatures are rising, and it is possible that continued warming will increase the temperature difference between the Southwest and the tropical Pacific Ocean, enhancing the strength of westerly winds that carry moist air from the tropics into the Southwest region during the monsoon season. This scenario may increase the monsoon's intensity, or its duration, or both, in which case floods would occur with greater frequency (Guido 2008). While the region is generally expected to dry, it is possible that extreme weather patterns leading to more frequent destructive flooding would occur. Along with monsoons of higher intensity, hurricanes and other tropical depressions are projected to become more intense overall. Arizona typically receives 10 percent or more of the annual precipitation from storms that begin as tropical depressions in the Pacific Ocean. In fact, some of the largest floods in the Southwest have occurred when remnant tropical storms intersect frontal storms from the north or

northwest (Guido 2008). Most global climate models are not yet accurate enough to apply to land management at the ecoregional or National Forest scale. This limits regional and forest-specific analysis of the potential effects of climate change.

Due to the spatial and temporal limitations of climate models, as stated above, site-specific analysis of climate change at the Forest level with regard to implementing fuels reduction treatments remains impractical. Several unknown factors further limit discussion and analysis of climate change at the Forest level. These include: lack of data on emissions from prescribed fire and wildfires, lack of data on emissions from logging machinery and traffic increases due to transportation of logs to processing facilities, limited data on emissions from machinery used to construct, maintain, or obliterate roads, and limited knowledge of the contributions of surrounding areas to current and future climate impacts at the Forest level necessary to analyze cumulative effects. Impacts to climate change from implementation of the proposed project are therefore discussed in a qualitative manner.

Projected future climate change could affect Arizona in a variety of ways. Public health and safety could be compromised due to an increase in extreme temperatures and severe weather events. Agriculture would be vulnerable to altered temperature and rainfall patterns, increasing plant stress and susceptibility to insects and diseases. Forest ecosystems could face increased occurrences of high severity wildfires and may be more susceptible to insects and diseases. Snowpack could decrease and snowmelt may occur earlier.

While the future of climate change and its effects across the Southwest remains uncertain, it is certain that climate variability will continue to occur throughout the region. Forest management activities should strive to promote ecosystem resilience and resistance to impacts of climate change. Forest management activities should focus on maintenance and restoration of native ecosystems, thereby reducing the vulnerability of these ecosystems to variations in climate patterns. Ecological diversity remains an integral component in native ecosystems. Projects should promote connected landscapes and endeavor to restore significantly altered biological communities, thus restoring their resilience to changes in climate.

Recommendations

In order to ensure that desired conditions are achieved and remain consistent with the CNF and KNF Forest Plans, monitoring of soil disturbance caused by timber harvesting; use of prescribed fire; precommercial thinning (both mechanized and non-mechanized); road construction, maintenance and obliteration; and commercial and personal fuelwood gathering is advised. Best Management Practices (BMP) implementation monitoring and soil disturbance monitoring should be conducted following treatment activities in order to ensure proper implementation of BMPs to prevent soil erosion and delivery of sediment and other pollutants to waterbodies and to ensure activities are consistent with Forest Plans Standards and Guidelines. A recommended soil and watershed monitoring plan is summarized below.

Phase 1 – During Timber Harvest Activities
The timber sale administrator will monitor the implementation of BMP's during timber harvesting activities. Notes taken by the timber sale administrator will be used to track any issues or problems with BMP implementation. The Forest Soils and Watershed Specialists will provide assistance as needed by

the timber sale administrator to provide clarification of BMP's specified in the Environmental Impact Statement (EIS).

Phase 2 – Timber Sale Closure
The timber sale administrator will verify that the timber sale purchaser has implemented all erosion control measures prior to the closure of the timber sale. Primary responsibility will be that of the timber sale administrator with assistance from the Forest Soils and Watershed Specialists if needed.

Phase 3 – Broadcast and Pile Burning
The District Fire Management Officers will verify that all erosion control measures associated with all burning activities has been implemented. The Forest Soils and Watershed Specialists will provide assistance, if needed.

Phase 4 – Effectiveness Monitoring
Within the first 5 years following timber sale closure, BMP's are evaluated for effectiveness. Monitoring will concentrate on such items as erosion control measures for skid trails, log landing or decking areas, road maintenance, road obliteration, and burned areas. The Forest Soils and Watershed Specialists will conduct a soil condition evaluation within treatment units. The focus of evaluations will be on such items as vegetative ground cover, coarse woody debris, soils erosion, soil compaction, and soil displacement. All monitoring results should be documented. Primary responsibility is with the District Ranger and the Forest Soils and Watershed Specialists.

Phase 5 – Follow Up
Documented information obtained from monitoring is used to adjust BMP's as necessary, to improve implementation and effectiveness of BMP's. Information regarding monitoring results and recommended changes to BMP's will be made available to the Arizona Department of Environmental Quality (ADEQ) for review as specified in the Intergovernmental Agreement between the State of Arizona and U.S Department of Agriculture, Forest Service Southwestern Region. Primary responsibility is with the District Ranger and the Forest Soils and Watershed Specialists.

Certification_____

Kit MacDonald prepared the report considering the Best Available Science and locally gathered data. Much of the information related to the effects of fire on water quality and riparian attributes were attained through research of peer reviewed scientific publications and publications from the Rocky Mountain Research Station, including RMRS GTR-42, volume 4 *Wildland Fire in Ecosystems Effects of Fire on Soil and Water* (Neary et al, 2005) and RMRS-GTR-231 *Cumulative Watershed Effects of Fuel Management in the Western United States*. Local data include the *Terrestrial Ecosystem Survey of the Kaibab National Forest* (Brewer et al, 1991) and the *Terrestrial Ecosystem Survey of the Coconino National Forest* (Miller et al. 1995).

My experience includes a Master's Degree in Forestry with an emphasis in soil science and completion of coursework toward a Ph.D. in Forestry, again with an emphasis in soil science from Stephen F. Austin State University. Prior to working for the U.S. Forest Service, I worked as an environmental consultant and environmental scientist in the forest products industry throughout the southeastern U.S. in areas of forest soils classification and mapping, wetland delineation and functional assessment,

wetland restoration, wetland mitigation banking, disturbed land remediation and reclamation, forest management practices certification ,and forestry best management practices (BMP) implementation and effectiveness monitoring related to timber harvesting and silvicultural operations such as site preparation, reforestation, prescribed fire, timber stand improvement, forest road construction and obliteration, and forestland acquisitions. Since my employment with the USFS in 2010, I have worked in areas of soils management analysis, watershed analysis, and burned area emergency response.

Prepared by: /s/ *Kit MacDonald* Date: January 8, 2013

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Kaibab National Forest

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Appendix A
National Oceanic and Atmospheric Administration (NOAA)
U.S. Drought Monitor and Seasonal Drought Outlook

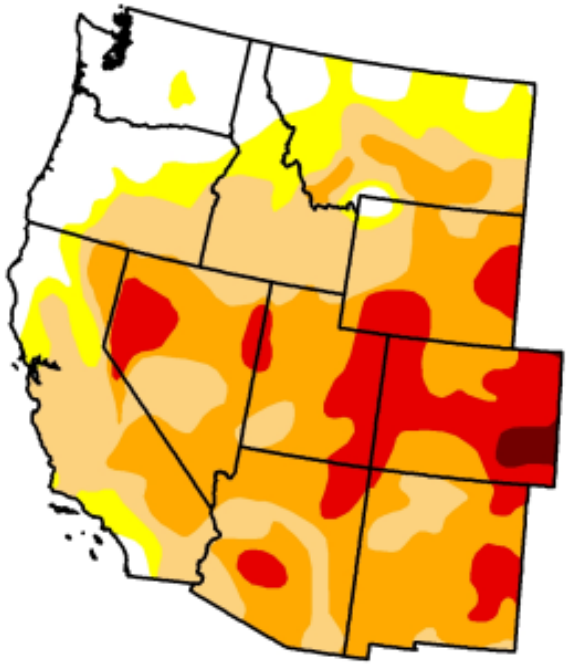
U.S. Drought Monitor

August 21, 2012
Valid 7 a.m. EST

West

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	15.32	84.68	74.24	48.34	14.68	0.85
Last Week (08/14/2012 map)	16.88	83.12	69.22	50.43	16.95	0.81
3 Months Ago (05/22/2012 map)	30.25	69.75	52.87	30.72	4.66	0.00
Start of Calendar Year (12/27/2011 map)	48.49	51.51	20.05	12.22	2.67	0.78
Start of Water Year (09/27/2011 map)	66.72	33.28	19.04	14.99	9.30	3.81
One Year Ago (08/16/2011 map)	75.03	24.97	18.93	15.21	10.62	4.65



Intensity:

- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://droughtmonitor.unl.edu

Released Thursday, August 23, 2012
Michael Brewer, National Climatic Data Center, NOAA

Figure 1. National Drought Monitoring Center, U.S. Drought Monitor

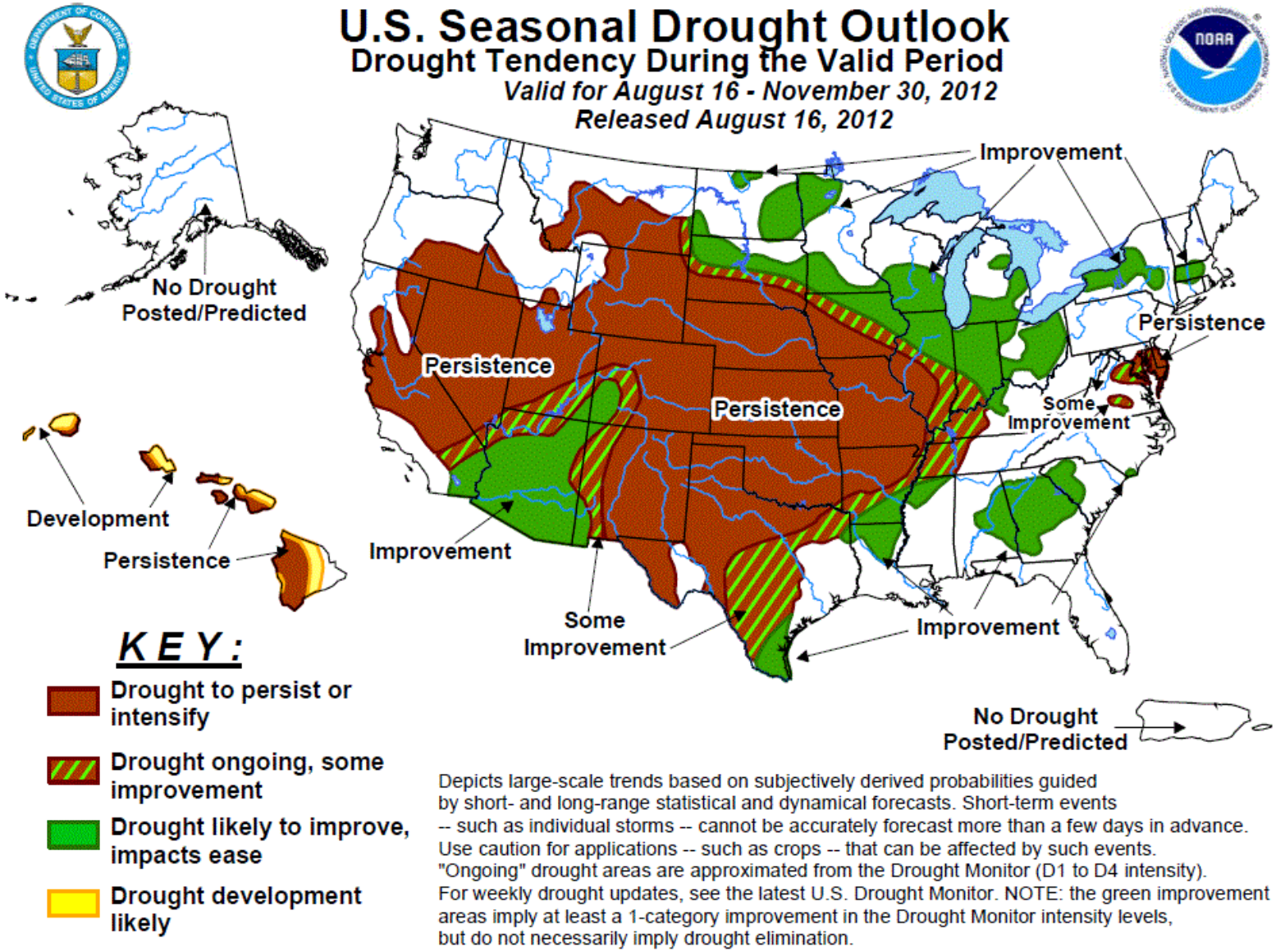


Figure 2. U.S. Seasonal Drought Outlook.

Appendix B

Stream reaches in the Four Forest Restoration Initiative analysis area and their associated lengths and flow regimes

Table 1. Stream Reaches in the Four Forest Restoration Initiative Analysis Area from the National Hydrography Dataset of the U.S. Geological Survey.

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15010004000111	Cataract Creek	Stream/River	Intermittent	0.035
15010004000119		Stream/River	Intermittent	0.029
15010004000179		Stream/River	Intermittent	0.020
15010004000219	Dogtown Wash	Stream/River	Intermittent	0.046
15010004000221	Dogtown Wash	Stream/River	Intermittent	0.021
15010004000221	Dogtown Wash	Stream/River	Intermittent	0.017
15010004000224	Dogtown Wash	Stream/River	Intermittent	0.015
15010004000276		Stream/River	Intermittent	0.018
15010004000276		Stream/River	Intermittent	0.014
15010004000276		Stream/River	Intermittent	0.010
15010004000276		Stream/River	Intermittent	0.017
15010004000277		Stream/River	Intermittent	0.015
15010004000278		Stream/River	Intermittent	0.014
15010004000278		Stream/River	Intermittent	0.014
15010004000281		Stream/River	Intermittent	0.012
15010004000281		Stream/River	Intermittent	0.013
15010004000282		Stream/River	Intermittent	0.031
15010004000282		Stream/River	Intermittent	0.014
15010004000283		Stream/River	Intermittent	0.013
15010004000284		Stream/River	Intermittent	0.013
15010004000287		Stream/River	Intermittent	0.036
15010004000292		Stream/River	Intermittent	0.012
15010004000292		Stream/River	Intermittent	0.021
15010004000294		Stream/River	Intermittent	0.031
15010004000392		Stream/River	Intermittent	0.021
15010004000395		Stream/River	Intermittent	0.029
15010004000395		Stream/River	Intermittent	0.034
15010004000396		Stream/River	Intermittent	0.015
15010004000398		Stream/River	Intermittent	0.015
15010004000399		Stream/River	Intermittent	0.028
15010004000400		Stream/River	Intermittent	0.061
15010004000400		Stream/River	Intermittent	0.024
15010004000401		Stream/River	Intermittent	0.077
15010004000403		Stream/River	Intermittent	0.012
15010004000403		Stream/River	Intermittent	0.010
15010004000404		Stream/River	Intermittent	0.040
15010004000404		Stream/River	Intermittent	0.015
15010004000405		Stream/River	Intermittent	0.056
15010004000406	Cataract Creek	Stream/River	Intermittent	0.020

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15010004000414		Stream/River	Intermittent	0.012
15010004000419		Stream/River	Intermittent	0.014
15010004000419		Stream/River	Intermittent	0.015
15010004000467		Stream/River	Intermittent	0.022
15010004000890		Stream/River	Intermittent	0.021
15010004000897	West Cataract Creek	Stream/River	Intermittent	0.045
15010004000899		Stream/River	Intermittent	0.022
15010004000906		Stream/River	Intermittent	0.027
15010004000908		Stream/River	Intermittent	0.016
15010004000908		Stream/River	Intermittent	0.052
15010004000909		Stream/River	Intermittent	0.047
15010004000920		Stream/River	Intermittent	0.017
15010004000922		Stream/River	Intermittent	0.020
15010004000922		Canal/Ditch	Canal/Ditch	0.011
15010004000989		Stream/River	Intermittent	0.032
15010004000990		Stream/River	Intermittent	0.011
15010004000990		Stream/River	Intermittent	0.029
15010004000993		Stream/River	Intermittent	0.017
15010004000994		Stream/River	Intermittent	0.020
15010004000995		Stream/River	Intermittent	0.012
15010004000995		Stream/River	Intermittent	0.017
15010004000996		Stream/River	Intermittent	0.032
15010004000996		Stream/River	Intermittent	0.022
15010004001539	Spring Valley Wash	Stream/River	Intermittent	0.030
15010004001540	Spring Valley Wash	Stream/River	Intermittent	0.020
15010004001541		Stream/River	Intermittent	0.011
15010004001542		Stream/River	Intermittent	0.045
15010004001543	Spring Valley Wash	Stream/River	Intermittent	0.021
15010004001544		Stream/River	Intermittent	0.014
15010004001544		Stream/River	Intermittent	0.011
15010004001544		Stream/River	Intermittent	0.011
15010004001545	Spring Valley Wash	Stream/River	Intermittent	0.042
15010004001546	Spring Valley Wash	Stream/River	Intermittent	0.012
15010004001547	Spring Valley Wash	Stream/River	Intermittent	0.028
15010004001547	Spring Valley Wash	Stream/River	Intermittent	0.012
15010004001551		Stream/River	Intermittent	0.024
15010004001648	Coconino Wash	Stream/River	Intermittent	0.015
15010004001649	Coconino Wash	Stream/River	Intermittent	0.021
15010004001653	Coconino Wash	Stream/River	Intermittent	0.020
15010004001654		Stream/River	Intermittent	0.019
15010004001656		Stream/River	Intermittent	0.021

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15010004001657		Stream/River	Intermittent	0.028
15010004001658		Stream/River	Intermittent	0.038
15010004001660		Stream/River	Intermittent	0.018
15010004001662		Stream/River	Intermittent	0.021
15010004001663		Stream/River	Intermittent	0.027
15010004001664		Stream/River	Intermittent	0.021
15010004001665		Stream/River	Intermittent	0.028
15010004001666		Stream/River	Intermittent	0.060
15010004001667		Stream/River	Intermittent	0.049
15010004001667		Stream/River	Intermittent	0.010
15010004001669		Stream/River	Intermittent	0.020
15010004001669		Stream/River	Intermittent	0.042
15010004001670		Stream/River	Intermittent	0.015
15010004002216	Dogtown Wash	Stream/River	Intermittent	0.021
15010004002217		Pipeline	Underground	0.015
15010004002511		Stream/River	Intermittent	0.016
15010004002512		Stream/River	Intermittent	0.012
15010004002513		Stream/River	Intermittent	0.018
15010004002514		Stream/River	Intermittent	0.013
15010004002515		Stream/River	Intermittent	0.015
15010004002516		Stream/River	Intermittent	0.025
15010004002517		Stream/River	Intermittent	0.021
15010004002519		Stream/River	Intermittent	0.012
15010004002521		Stream/River	Intermittent	0.018
15010004002522		Stream/River	Intermittent	0.014
15010004002523		Stream/River	Intermittent	0.014
15010004002527		Stream/River	Intermittent	0.034
15010004002531		Stream/River	Intermittent	0.034
15010004002627		Stream/River	Intermittent	0.046
15010004003678		Stream/River	Intermittent	0.019
15010004003680		Stream/River	Intermittent	0.018
15010004003682		Stream/River	Intermittent	0.014
15010004003685		Stream/River	Intermittent	0.015
15010004003688		Stream/River	Intermittent	0.012
15010004003689		Stream/River	Intermittent	0.015
15010004003690		Stream/River	Intermittent	0.011
15010004003691		Stream/River	Intermittent	0.021
15010004003692		Stream/River	Intermittent	0.012
15010004003694		Stream/River	Intermittent	0.011
15010004003695		Stream/River	Intermittent	0.019
15010004003696		Stream/River	Intermittent	0.011

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15010004003697		Stream/River	Intermittent	0.015
15010004003760	Rain Tank Wash	Stream/River	Intermittent	0.018
15010004003761		Stream/River	Intermittent	0.038
15010004003762	Coconino Wash	Stream/River	Intermittent	0.014
15010004003767		Stream/River	Intermittent	0.014
15010004003770		Stream/River	Intermittent	0.016
15010004003771		Stream/River	Intermittent	0.012
15010004003772		Stream/River	Intermittent	0.011
15010004003774		Stream/River	Intermittent	0.015
15010004004316		Pipeline	Underground	0.018
15010004004316		Pipeline	Underground	0.017
15010004004325		Stream/River	Intermittent	0.019
15010004004365		Stream/River	Intermittent	0.017
15010004004379		Stream/River	Intermittent	0.016
15010004004818		Stream/River	Intermittent	0.015
15010004004819		Stream/River	Intermittent	0.014
15010004004822		Stream/River	Intermittent	0.014
15010004004823		Stream/River	Intermittent	0.011
15010004004824		Stream/River	Intermittent	0.011
15010004004826		Stream/River	Intermittent	0.019
15010004004827		Stream/River	Intermittent	0.025
15010004004828		Stream/River	Intermittent	0.043
15010004004829		Stream/River	Intermittent	0.011
15010004004830	Coconino Wash	Artificial Path	Artificial Path	0.013
15010004004832		Stream/River	Intermittent	0.027
15010004004833		Stream/River	Intermittent	0.011
15010004004834		Stream/River	Intermittent	0.015
15010004004836		Stream/River	Intermittent	0.021
15010004004837		Stream/River	Intermittent	0.033
15010004004838	Coconino Wash	Artificial Path	Artificial Path	0.011
15010004004839		Stream/River	Intermittent	0.015
15010004004840		Stream/River	Intermittent	0.019
15010004004841		Stream/River	Intermittent	0.023
15010004004842		Stream/River	Intermittent	0.011
15010004004843		Stream/River	Intermittent	0.011
15010004004844		Stream/River	Intermittent	0.020
15010004004845		Stream/River	Intermittent	0.013
15010004004846		Stream/River	Intermittent	0.029
15010004004847		Stream/River	Intermittent	0.011
15010004004848		Stream/River	Intermittent	0.045
15010004004849		Stream/River	Intermittent	0.029

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15010004004850		Stream/River	Intermittent	0.011
15010004004851		Stream/River	Intermittent	0.012
15010004004852		Stream/River	Intermittent	0.015
15010004004853		Stream/River	Intermittent	0.013
15010004004855		Stream/River	Intermittent	0.023
15010004004856		Stream/River	Intermittent	0.011
15010004004858		Stream/River	Intermittent	0.019
15010004004860		Stream/River	Intermittent	0.032
15010004004862		Stream/River	Intermittent	0.014
15010004004864		Stream/River	Intermittent	0.051
15010004004865		Stream/River	Intermittent	0.020
15010004004866		Stream/River	Intermittent	0.022
15010004004867		Stream/River	Intermittent	0.023
15010004004869		Stream/River	Intermittent	0.029
15010004004870		Stream/River	Intermittent	0.017
15010004004875		Stream/River	Intermittent	0.017
15010004004922		Stream/River	Intermittent	0.013
15010004004930		Stream/River	Intermittent	0.013
15010004005074		Stream/River	Intermittent	0.012
15010004005077		Pipeline	Underground	0.019
15010004005105		Stream/River	Intermittent	0.022
15010004005109		Stream/River	Intermittent	0.010
15010004005117		Stream/River	Intermittent	0.012
15010004005118		Stream/River	Intermittent	0.016
15010004005119		Stream/River	Intermittent	0.013
15010004005120		Stream/River	Intermittent	0.018
15010004005121		Stream/River	Intermittent	0.017
15010004005125		Stream/River	Intermittent	0.013
15010004005127		Stream/River	Intermittent	0.022
15010004005128		Stream/River	Intermittent	0.011
15010004005129		Stream/River	Intermittent	0.014
15010004005131		Stream/River	Intermittent	0.012
15010004005132		Stream/River	Intermittent	0.014
15010004005133		Stream/River	Intermittent	0.018
15010004005134		Stream/River	Intermittent	0.014
15010004005135		Stream/River	Intermittent	0.020
15010004005136		Stream/River	Intermittent	0.011
15010004005138	Dogtown Wash	Stream/River	Intermittent	0.015
15010004006202		Stream/River	Intermittent	0.014
15010004006223	Dogtown Wash	Artificial Path	Artificial Path	0.018
15020015000015	Rio de Flag	Stream/River	Intermittent	0.021

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15020015000025	Rio de Flag	Stream/River	Intermittent	0.014
15020015000028		Stream/River	Intermittent	0.040
15020015000036	Walnut Creek	Stream/River	Intermittent	0.010
15020015000038		Stream/River	Intermittent	0.011
15020015000038		Stream/River	Intermittent	0.011
15020015000038		Stream/River	Intermittent	0.016
15020015000075		Stream/River	Intermittent	0.010
15020015000105		Stream/River	Intermittent	0.017
15020015000113	Sawmill Wash	Stream/River	Intermittent	0.012
15020015000113	Sawmill Wash	Stream/River	Intermittent	0.021
15020015000113	Sawmill Wash	Stream/River	Perennial	0.011
15020015000124	Sinclair Wash	Stream/River	Intermittent	0.011
15020015000126		Stream/River	Intermittent	0.053
15020015000126		Stream/River	Intermittent	0.012
15020015000127		Stream/River	Intermittent	0.065
15020015000128		Stream/River	Intermittent	0.036
15020015000128		Stream/River	Intermittent	0.027
15020015000129		Stream/River	Intermittent	0.013
15020015000129		Stream/River	Intermittent	0.056
15020015000130		Stream/River	Intermittent	0.046
15020015000131		Stream/River	Intermittent	0.034
15020015000131		Stream/River	Intermittent	0.014
15020015000131		Stream/River	Intermittent	0.011
15020015000133		Stream/River	Intermittent	0.012
15020015000134		Stream/River	Intermittent	0.015
15020015000136		Stream/River	Intermittent	0.011
15020015000137		Stream/River	Intermittent	0.022
15020015000139		Stream/River	Intermittent	0.013
15020015000153		Stream/River	Intermittent	0.025
15020015000155		Stream/River	Intermittent	0.022
15020015000156		Stream/River	Intermittent	0.019
15020015000162		Stream/River	Intermittent	0.015
15020015000166		Stream/River	Intermittent	0.028
15020015000170		Stream/River	Intermittent	0.015
15020015000170		Stream/River	Intermittent	0.017
15020015000171		Stream/River	Intermittent	0.013
15020015000171		Stream/River	Intermittent	0.015
15020015000174		Stream/River	Intermittent	0.059
15020015000174		Stream/River	Intermittent	0.013
15020015000175		Stream/River	Intermittent	0.027
15020015000175		Stream/River	Intermittent	0.035

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15020015000175		Stream/River	Intermittent	0.011
15020015000176		Stream/River	Intermittent	0.024
15020015000177		Stream/River	Intermittent	0.024
15020015000177		Stream/River	Intermittent	0.011
15020015000182	Ashurst Run	Stream/River	Intermittent	0.020
15020015000184		Stream/River	Intermittent	0.019
15020015000185		Stream/River	Intermittent	0.021
15020015000186		Stream/River	Intermittent	0.017
15020015000188		Stream/River	Intermittent	0.024
15020015000195		Stream/River	Intermittent	0.011
15020015000195		Stream/River	Intermittent	0.013
15020015000195		Stream/River	Intermittent	0.015
15020015000196		Stream/River	Intermittent	0.075
15020015000197		Stream/River	Intermittent	0.034
15020015000197		Stream/River	Intermittent	0.048
15020015000198		Stream/River	Intermittent	0.026
15020015000199		Stream/River	Intermittent	0.017
15020015000206	San Francisco Wash	Stream/River	Intermittent	0.010
15020015000209		Stream/River	Intermittent	0.017
15020015000210		Stream/River	Intermittent	0.015
15020015000211		Stream/River	Intermittent	0.014
15020015000212		Stream/River	Intermittent	0.024
15020015000213		Stream/River	Intermittent	0.015
15020015000214		Stream/River	Intermittent	0.012
15020015000214		Stream/River	Intermittent	0.013
15020015000214		Stream/River	Intermittent	0.016
15020015000215	Walnut Creek	Stream/River	Intermittent	0.022
15020015000215	Walnut Creek	Stream/River	Intermittent	0.014
15020015000220	Walnut Creek	Stream/River	Intermittent	0.013
15020015000220	Walnut Creek	Stream/River	Intermittent	0.021
15020015000221		Stream/River	Intermittent	0.028
15020015000223		Stream/River	Intermittent	0.014
15020015000224		Stream/River	Intermittent	0.020
15020015000225		Stream/River	Intermittent	0.013
15020015000226		Stream/River	Intermittent	0.021
15020015000227		Stream/River	Intermittent	0.034
15020015000227		Stream/River	Intermittent	0.028
15020015000227		Stream/River	Intermittent	0.013
15020015000228		Stream/River	Intermittent	0.027
15020015000229		Stream/River	Intermittent	0.023
15020015000229		Stream/River	Intermittent	0.019

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15020015000231		Stream/River	Intermittent	0.021
15020015000231		Stream/River	Intermittent	0.017
15020015000233		Stream/River	Intermittent	0.021
15020015000233		Stream/River	Intermittent	0.023
15020015000234		Stream/River	Intermittent	0.018
15020015000234		Stream/River	Intermittent	0.033
15020015000235		Stream/River	Intermittent	0.016
15020015000235		Stream/River	Intermittent	0.021
15020015000236		Stream/River	Intermittent	0.013
15020015000236		Stream/River	Intermittent	0.016
15020015000238		Stream/River	Intermittent	0.025
15020015000239		Stream/River	Intermittent	0.010
15020015000239		Stream/River	Intermittent	0.012
15020015000239		Stream/River	Intermittent	0.020
15020015000239		Stream/River	Intermittent	0.015
15020015000241		Stream/River	Intermittent	0.025
15020015000244		Stream/River	Intermittent	0.018
15020015000248		Stream/River	Intermittent	0.013
15020015000248		Stream/River	Intermittent	0.025
15020015000248		Stream/River	Intermittent	0.013
15020015000249		Stream/River	Intermittent	0.032
15020015000250		Stream/River	Intermittent	0.010
15020015000250		Stream/River	Intermittent	0.010
15020015000251		Stream/River	Intermittent	0.028
15020015000254		Stream/River	Intermittent	0.034
15020015000255		Stream/River	Intermittent	0.015
15020015000256		Stream/River	Intermittent	0.017
15020015000257		Stream/River	Intermittent	0.014
15020015000257		Stream/River	Intermittent	0.018
15020015000258		Stream/River	Intermittent	0.019
15020015000259		Stream/River	Intermittent	0.011
15020015000265		Stream/River	Intermittent	0.033
15020015000348		Stream/River	Intermittent	0.050
15020015000362		Stream/River	Intermittent	0.026
15020015000374		Stream/River	Intermittent	0.015
15020015000374		Stream/River	Intermittent	0.010
15020015000416		Stream/River	Intermittent	0.013
15020015000416		Stream/River	Intermittent	0.031
15020015000417		Stream/River	Intermittent	0.010
15020015000426	Schultz Creek	Stream/River	Intermittent	0.028
15020015000426	Schultz Creek	Stream/River	Intermittent	0.015

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15020015000427	Schultz Creek	Stream/River	Intermittent	0.010
15020015000432		Stream/River	Intermittent	0.029
15020015000433		Stream/River	Intermittent	0.015
15020015000435		Stream/River	Intermittent	0.036
15020015000436		Stream/River	Intermittent	0.037
15020015000440		Stream/River	Intermittent	0.020
15020015000448		Stream/River	Intermittent	0.014
15020015000450		Stream/River	Intermittent	0.018
15020015000451		Stream/River	Intermittent	0.020
15020015000451		Stream/River	Intermittent	0.017
15020015000451		Stream/River	Intermittent	0.017
15020015000452		Stream/River	Intermittent	0.036
15020015000456		Stream/River	Intermittent	0.019
15020015000458		Stream/River	Intermittent	0.011
15020015000458		Stream/River	Intermittent	0.017
15020015000459		Stream/River	Intermittent	0.022
15020015000569		Stream/River	Intermittent	0.023
15020015000577	Walnut Creek	Stream/River	Intermittent	0.011
15020015005559		Stream/River	Intermittent	0.020
15020015005560		Stream/River	Intermittent	0.014
15020015005562		Stream/River	Intermittent	0.025
15020015005566		Stream/River	Intermittent	0.062
15020015005570		Stream/River	Intermittent	0.011
15020015005571		Stream/River	Intermittent	0.022
15020015005572		Stream/River	Intermittent	0.011
15020015005573		Stream/River	Intermittent	0.020
15020015005574		Stream/River	Intermittent	0.010
15020015005575		Stream/River	Intermittent	0.017
15020015005577		Stream/River	Intermittent	0.012
15020015005579		Stream/River	Intermittent	0.011
15020015005580		Stream/River	Intermittent	0.012
15020015005581		Stream/River	Intermittent	0.011
15020015005582		Stream/River	Intermittent	0.045
15020015005583		Stream/River	Intermittent	0.012
15020015005584		Stream/River	Intermittent	0.010
15020015005585		Stream/River	Intermittent	0.021
15020015005587		Stream/River	Intermittent	0.014
15020015005588		Stream/River	Intermittent	0.013
15020015005590		Stream/River	Intermittent	0.010
15020015005593		Stream/River	Intermittent	0.016
15020015005595		Stream/River	Intermittent	0.026

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15020015005598		Stream/River	Intermittent	0.017
15020015005599		Stream/River	Intermittent	0.033
15020015005604		Stream/River	Intermittent	0.014
15020015005611	Schultz Creek	Stream/River	Intermittent	0.015
15020015005614		Stream/River	Intermittent	0.016
15020015005615		Stream/River	Intermittent	0.013
15020015005616		Stream/River	Intermittent	0.025
15020015005618		Stream/River	Intermittent	0.028
15020015005619		Stream/River	Intermittent	0.015
15020015005620		Stream/River	Intermittent	0.019
15020015005621		Stream/River	Intermittent	0.012
15020015005623		Stream/River	Intermittent	0.016
15020015005625		Stream/River	Intermittent	0.022
15020015005626		Stream/River	Intermittent	0.014
15020015005630		Stream/River	Intermittent	0.014
15020015005635		Stream/River	Intermittent	0.020
15020015005635		Stream/River	Intermittent	0.013
15020015005639		Stream/River	Intermittent	0.012
15020015005642		Stream/River	Intermittent	0.020
15020015005644		Stream/River	Intermittent	0.011
15020015005648		Stream/River	Intermittent	0.017
15020015005649		Stream/River	Intermittent	0.013
15020015005651		Stream/River	Intermittent	0.013
15020015005653		Stream/River	Intermittent	0.025
15020015005658		Stream/River	Intermittent	0.010
15020015005659		Stream/River	Intermittent	0.012
15020015005667		Stream/River	Intermittent	0.021
15020015005669		Stream/River	Intermittent	0.020
15020015005671		Stream/River	Intermittent	0.016
15020015005686		Stream/River	Intermittent	0.014
15020015005689		Stream/River	Intermittent	0.022
15020015005693		Stream/River	Intermittent	0.017
15020015005695		Stream/River	Intermittent	0.018
15020015005696		Stream/River	Intermittent	0.013
15020015005699		Stream/River	Intermittent	0.015
15020015005701		Stream/River	Intermittent	0.022
15020015005707		Stream/River	Intermittent	0.016
15020015005715		Stream/River	Intermittent	0.014
15020015005717		Stream/River	Intermittent	0.013
15020015005718		Stream/River	Intermittent	0.016
15020015005761		Stream/River	Intermittent	0.013

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15020015005766		Stream/River	Intermittent	0.014
15020015005774		Stream/River	Intermittent	0.020
15020015005776		Stream/River	Intermittent	0.011
15020015005779		Stream/River	Intermittent	0.014
15020015005788		Stream/River	Intermittent	0.016
15020015005789		Stream/River	Intermittent	0.017
15020015005795		Stream/River	Intermittent	0.015
15020015005798		Stream/River	Intermittent	0.012
15020015005801		Stream/River	Intermittent	0.017
15020015005802		Stream/River	Intermittent	0.014
15020015005803		Stream/River	Intermittent	0.015
15020015005811		Stream/River	Intermittent	0.017
15020015005812		Stream/River	Intermittent	0.016
15020015005814		Stream/River	Intermittent	0.011
15020015005820		Stream/River	Intermittent	0.019
15020015005822		Stream/River	Intermittent	0.012
15020015005823		Stream/River	Intermittent	0.017
15020015005826		Stream/River	Intermittent	0.012
15020015005827		Stream/River	Intermittent	0.012
15020015005828		Stream/River	Intermittent	0.011
15020015005832		Stream/River	Intermittent	0.020
15020015005836		Stream/River	Intermittent	0.018
15020015005838		Stream/River	Intermittent	0.024
15020015005846		Stream/River	Intermittent	0.011
15020015005849		Stream/River	Intermittent	0.015
15020015005851		Stream/River	Intermittent	0.022
15020015005853		Stream/River	Intermittent	0.012
15020015005857		Stream/River	Intermittent	0.011
15020015005858		Stream/River	Intermittent	0.010
15020015005861		Stream/River	Intermittent	0.031
15020015005872		Stream/River	Intermittent	0.012
15020015005882		Stream/River	Intermittent	0.011
15020015005884		Stream/River	Intermittent	0.016
15020015005887		Stream/River	Intermittent	0.013
15020015005896		Stream/River	Intermittent	0.011
15020015005898		Stream/River	Intermittent	0.014
15020015005899		Stream/River	Intermittent	0.030
15020015005903		Stream/River	Intermittent	0.023
15020015005904		Stream/River	Intermittent	0.013
15020015005905		Stream/River	Intermittent	0.019
15020015005906		Stream/River	Intermittent	0.025

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15020015005907		Stream/River	Intermittent	0.020
15020015005908		Stream/River	Intermittent	0.011
15020015005912	Walnut Creek	Stream/River	Intermittent	0.014
15020015005914		Stream/River	Intermittent	0.019
15020015005915		Stream/River	Intermittent	0.012
15020015005917		Stream/River	Intermittent	0.020
15020015005920		Stream/River	Intermittent	0.012
15020015005922		Stream/River	Intermittent	0.018
15020015005931		Stream/River	Intermittent	0.016
15020015005932		Stream/River	Intermittent	0.022
15020015005934		Stream/River	Intermittent	0.010
15020015005940		Stream/River	Intermittent	0.020
15020015005945		Stream/River	Intermittent	0.015
15020015005949		Stream/River	Intermittent	0.014
15020015005950		Stream/River	Intermittent	0.035
15020015005952		Stream/River	Intermittent	0.021
15020015005953	Walnut Creek	Stream/River	Intermittent	0.012
15020015005954		Stream/River	Intermittent	0.016
15020015005957		Stream/River	Intermittent	0.017
15020015005960		Stream/River	Intermittent	0.036
15020015005961		Stream/River	Intermittent	0.020
15020015005976		Stream/River	Intermittent	0.017
15020015005982		Stream/River	Intermittent	0.017
15020015005983		Stream/River	Intermittent	0.016
15020015005985		Stream/River	Intermittent	0.015
15020015006003		Stream/River	Intermittent	0.015
15020015006004		Stream/River	Intermittent	0.018
15020015006005		Stream/River	Intermittent	0.015
15020015006006		Stream/River	Intermittent	0.018
15020015006007		Stream/River	Intermittent	0.010
15020015006011		Stream/River	Intermittent	0.016
15020015006012		Stream/River	Intermittent	0.011
15020015006016		Stream/River	Intermittent	0.016
15020015006019		Stream/River	Intermittent	0.021
15020015006023		Stream/River	Intermittent	0.012
15020015006024		Stream/River	Intermittent	0.016
15020015006032		Stream/River	Intermittent	0.019
15020015006034		Stream/River	Intermittent	0.017
15020015006035		Stream/River	Intermittent	0.015
15020015006046		Stream/River	Intermittent	0.048
15020015006047		Stream/River	Intermittent	0.014

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15020015006060		Stream/River	Intermittent	0.018
15020015006061		Stream/River	Intermittent	0.012
15020015006068		Stream/River	Intermittent	0.017
15020015006092		Stream/River	Intermittent	0.022
15020015006122		Stream/River	Intermittent	0.012
15020015006125		Stream/River	Intermittent	0.015
15020015006135		Stream/River	Intermittent	0.019
15020015006137		Stream/River	Intermittent	0.017
15020015006177		Stream/River	Intermittent	0.014
15020015006197		Stream/River	Intermittent	0.010
15020015006203		Stream/River	Intermittent	0.011
15020015006206		Stream/River	Intermittent	0.025
15020015006211		Stream/River	Intermittent	0.018
15020015006215		Stream/River	Intermittent	0.011
15020015006217		Stream/River	Intermittent	0.016
15020015006218		Stream/River	Intermittent	0.017
15020015006245		Stream/River	Intermittent	0.017
15020015006250		Stream/River	Intermittent	0.013
15020015006251		Stream/River	Intermittent	0.014
15020015006253		Stream/River	Intermittent	0.011
15020015006258		Stream/River	Intermittent	0.018
15020015006260		Stream/River	Intermittent	0.010
15020015006263		Stream/River	Intermittent	0.012
15020015006279		Stream/River	Intermittent	0.010
15020015006287		Stream/River	Intermittent	0.014
15020015006292		Stream/River	Intermittent	0.018
15020015006298		Stream/River	Intermittent	0.013
15020015006304		Stream/River	Intermittent	0.021
15020015006324		Stream/River	Intermittent	0.014
15020015006429	Sawmill Wash	Stream/River	Intermittent	0.012
15020015007155	Walnut Creek	Artificial Path	Artificial Path	0.013
15020015007156	Walnut Creek	Artificial Path	Artificial Path	0.027
15020015007160	Walnut Creek	Artificial Path	Artificial Path	0.021
15020015007164	Walnut Creek	Artificial Path	Artificial Path	0.013
15020015007195		Stream/River	Intermittent	0.021
15020016000110		Stream/River	Intermittent	0.023
15020016000138	Deadman Wash	Stream/River	Intermittent	0.024
15020016000138	Deadman Wash	Stream/River	Intermittent	0.026
15020016000139	Deadman Wash	Stream/River	Intermittent	0.030
15020016000140		Stream/River	Intermittent	0.012
15020016000269		Stream/River	Intermittent	0.027

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15020016000270		Stream/River	Intermittent	0.025
15020016000271		Stream/River	Intermittent	0.038
15020016000272		Stream/River	Intermittent	0.020
15020016000274		Stream/River	Intermittent	0.036
15020016000276		Stream/River	Intermittent	0.027
15020016000307		Stream/River	Intermittent	0.012
15020016000307		Stream/River	Intermittent	0.033
15020016000309		Stream/River	Intermittent	0.072
15020016000360		Stream/River	Intermittent	0.037
15020016000362		Stream/River	Intermittent	0.025
15020016000362		Stream/River	Intermittent	0.012
15020016000368		Stream/River	Intermittent	0.013
15020016000369		Stream/River	Intermittent	0.027
15020016000370		Stream/River	Intermittent	0.015
15020016000371		Stream/River	Intermittent	0.013
15020016000373		Stream/River	Intermittent	0.010
15020016000374		Stream/River	Intermittent	0.011
15020016000527	Cedar Wash	Stream/River	Intermittent	0.022
15020016000801		Stream/River	Intermittent	0.024
15020016000802		Stream/River	Intermittent	0.012
15020016000802		Stream/River	Intermittent	0.013
15020016000802		Stream/River	Intermittent	0.016
15020016000803		Stream/River	Intermittent	0.046
15020016000803		Stream/River	Intermittent	0.050
15020016000805		Stream/River	Intermittent	0.024
15020016000810		Stream/River	Intermittent	0.022
15020016000810		Stream/River	Intermittent	0.031
15020016000811		Stream/River	Intermittent	0.073
15020016000812		Stream/River	Intermittent	0.034
15020016000812		Stream/River	Intermittent	0.010
15020016000814		Stream/River	Intermittent	0.011
15020016000814		Stream/River	Intermittent	0.014
15020016000819		Stream/River	Intermittent	0.013
15020016000820		Stream/River	Intermittent	0.011
15020016001137		Stream/River	Intermittent	0.030
15020016001137		Stream/River	Intermittent	0.022
15020016001142		Stream/River	Intermittent	0.025
15020016001167		Stream/River	Intermittent	0.024
15020016001168		Stream/River	Intermittent	0.010
15020016001168		Stream/River	Intermittent	0.026
15020016001172		Stream/River	Intermittent	0.021

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15020016001200		Stream/River	Intermittent	0.012
15020016001200		Stream/River	Intermittent	0.015
15020016001200		Stream/River	Intermittent	0.011
15020016001209		Stream/River	Intermittent	0.022
15020016005112		Stream/River	Intermittent	0.013
15020016005182		Stream/River	Intermittent	0.037
15020016005183		Stream/River	Intermittent	0.013
15020016005184		Stream/River	Intermittent	0.042
15020016005185		Stream/River	Intermittent	0.019
15020016005261		Stream/River	Intermittent	0.012
15020016005262		Stream/River	Intermittent	0.013
15020016005264		Stream/River	Intermittent	0.021
15020016005266		Stream/River	Intermittent	0.024
15020016005271		Stream/River	Intermittent	0.021
15020016005274		Stream/River	Intermittent	0.022
15020016005275		Stream/River	Intermittent	0.015
15020016005315		Stream/River	Intermittent	0.010
15020016005317		Stream/River	Intermittent	0.012
15020016005318		Stream/River	Intermittent	0.013
15020016005320		Stream/River	Intermittent	0.023
15020016005321		Stream/River	Intermittent	0.013
15020016005322		Stream/River	Intermittent	0.013
15020016005323		Stream/River	Intermittent	0.010
15020016005324		Stream/River	Intermittent	0.012
15020016005325		Stream/River	Intermittent	0.018
15020016005328		Stream/River	Intermittent	0.021
15020016005330		Stream/River	Intermittent	0.014
15020016005335		Stream/River	Intermittent	0.014
15020016005338		Stream/River	Intermittent	0.026
15020016005339		Stream/River	Intermittent	0.015
15020016005340		Stream/River	Intermittent	0.015
15020016005341		Stream/River	Intermittent	0.017
15020016005342		Stream/River	Intermittent	0.010
15020016005649		Stream/River	Intermittent	0.011
15020016005650		Stream/River	Intermittent	0.014
15020016005651		Stream/River	Intermittent	0.018
15020016005654		Stream/River	Intermittent	0.014
15020016005655		Stream/River	Intermittent	0.016
15020016005656		Stream/River	Intermittent	0.016
15020016005657		Stream/River	Intermittent	0.013
15020016005659	Deadman Wash	Stream/River	Intermittent	0.026

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15020016005662		Stream/River	Intermittent	0.023
15020016005664	Deadman Wash	Stream/River	Intermittent	0.017
15020016005665		Stream/River	Intermittent	0.022
15020016005666		Stream/River	Intermittent	0.020
15020016005902		Stream/River	Intermittent	0.017
15020016005903		Stream/River	Intermittent	0.017
15020016006390		Stream/River	Intermittent	0.027
15060201000423	Johnson Creek	Stream/River	Intermittent	0.014
15060201000431		Stream/River	Intermittent	0.020
15060201000431		Stream/River	Intermittent	0.011
15060201000432		Stream/River	Intermittent	0.027
15060201000433		Stream/River	Intermittent	0.036
15060201000453		Stream/River	Intermittent	0.010
15060201003860		Stream/River	Intermittent	0.011
15060201003864		Stream/River	Intermittent	0.019
15060201003926		Stream/River	Intermittent	0.011
15060201003954		Stream/River	Intermittent	0.014
15060201003966		Stream/River	Intermittent	0.026
15060201003969		Stream/River	Intermittent	0.010
15060201003972		Stream/River	Intermittent	0.023
15060202000079		Stream/River	Intermittent	0.048
15060202000140	Pumphouse Wash	Stream/River	Intermittent	0.011
15060202000140	Pumphouse Wash	Stream/River	Intermittent	0.016
15060202000141	Pumphouse Wash	Stream/River	Intermittent	0.018
15060202000143		Stream/River	Intermittent	0.013
15060202000143		Stream/River	Intermittent	0.015
15060202000143		Stream/River	Intermittent	0.011
15060202000143		Stream/River	Intermittent	0.020
15060202000148		Stream/River	Intermittent	0.010
15060202000157	West Fork Oak Creek	Stream/River	Intermittent	0.044
15060202000157	West Fork Oak Creek	Stream/River	Intermittent	0.015
15060202000253		Stream/River	Intermittent	0.010
15060202000255		Stream/River	Intermittent	0.010
15060202000255		Stream/River	Intermittent	0.012
15060202000256		Stream/River	Intermittent	0.026
15060202000260		Stream/River	Intermittent	0.020
15060202000261		Stream/River	Intermittent	0.011
15060202000261		Stream/River	Intermittent	0.019
15060202000264		Stream/River	Intermittent	0.019
15060202000274	Tule Tank Wash	Stream/River	Intermittent	0.020
15060202000274	Tule Tank Wash	Stream/River	Intermittent	0.017

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15060202000274	Tule Tank Wash	Stream/River	Intermittent	0.026
15060202000307		Stream/River	Intermittent	0.012
15060202000307		Stream/River	Intermittent	0.041
15060202000315		Stream/River	Intermittent	0.022
15060202000316		Stream/River	Intermittent	0.027
15060202000345		Stream/River	Intermittent	0.014
15060202000346		Stream/River	Intermittent	0.018
15060202000346		Stream/River	Perennial	0.013
15060202000347		Stream/River	Perennial	0.014
15060202000349		Stream/River	Perennial	0.024
15060202000350		Stream/River	Intermittent	0.013
15060202000354		Stream/River	Intermittent	0.032
15060202000354		Stream/River	Intermittent	0.011
15060202000354		Stream/River	Intermittent	0.014
15060202000474	JD Dam Wash	Stream/River	Intermittent	0.016
15060202000481	Volunteer Wash	Stream/River	Intermittent	0.029
15060202000481	Volunteer Wash	Stream/River	Intermittent	0.086
15060202000482	Volunteer Wash	Stream/River	Intermittent	0.034
15060202000482	Volunteer Wash	Stream/River	Intermittent	0.022
15060202000486	Volunteer Wash	Stream/River	Intermittent	0.026
15060202000488	Volunteer Wash	Stream/River	Intermittent	0.025
15060202000490	Volunteer Wash	Stream/River	Intermittent	0.015
15060202000490	Volunteer Wash	Stream/River	Intermittent	0.012
15060202000500		Stream/River	Intermittent	0.012
15060202000501		Stream/River	Intermittent	0.030
15060202000503		Stream/River	Intermittent	0.033
15060202000504		Stream/River	Intermittent	0.018
15060202000505		Stream/River	Intermittent	0.018
15060202000507		Stream/River	Intermittent	0.011
15060202000508		Stream/River	Intermittent	0.010
15060202000508		Stream/River	Intermittent	0.017
15060202000509		Stream/River	Intermittent	0.041
15060202000512		Stream/River	Intermittent	0.011
15060202000513		Stream/River	Intermittent	0.034
15060202000517		Stream/River	Intermittent	0.028
15060202000575	Volunteer Wash	Stream/River	Intermittent	0.108
15060202000575	Volunteer Wash	Stream/River	Intermittent	0.033
15060202000575	Volunteer Wash	Stream/River	Intermittent	0.020
15060202000576		Stream/River	Intermittent	0.022
15060202000577		Stream/River	Intermittent	0.030
15060202000580		Stream/River	Intermittent	0.019

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15060202000702		Stream/River	Intermittent	0.059
15060202000706		Stream/River	Intermittent	0.018
15060202000707		Stream/River	Intermittent	0.014
15060202000724		Stream/River	Intermittent	0.048
15060202000725		Stream/River	Intermittent	0.011
15060202000725		Stream/River	Intermittent	0.014
15060202000727		Stream/River	Intermittent	0.021
15060202000728		Stream/River	Intermittent	0.015
15060202000728		Stream/River	Intermittent	0.011
15060202000730		Stream/River	Intermittent	0.020
15060202000730		Stream/River	Intermittent	0.013
15060202000731		Stream/River	Intermittent	0.020
15060202000732		Stream/River	Intermittent	0.038
15060202000733		Stream/River	Intermittent	0.020
15060202000733		Stream/River	Intermittent	0.032
15060202000733		Stream/River	Intermittent	0.037
15060202000734		Stream/River	Intermittent	0.017
15060202000735		Stream/River	Intermittent	0.042
15060202000739		Stream/River	Intermittent	0.016
15060202000740		Stream/River	Intermittent	0.049
15060202000741		Stream/River	Intermittent	0.021
15060202000745		Stream/River	Intermittent	0.033
15060202000747		Stream/River	Intermittent	0.021
15060202000747		Stream/River	Intermittent	0.024
15060202000748		Stream/River	Intermittent	0.026
15060202000750		Stream/River	Intermittent	0.043
15060202000751		Stream/River	Intermittent	0.016
15060202000751		Stream/River	Intermittent	0.017
15060202000752		Stream/River	Intermittent	0.011
15060202000752		Stream/River	Intermittent	0.013
15060202000831		Stream/River	Intermittent	0.014
15060202000832		Stream/River	Intermittent	0.017
15060202000841		Stream/River	Intermittent	0.013
15060202000841		Stream/River	Intermittent	0.045
15060202000842		Stream/River	Intermittent	0.015
15060202000846		Stream/River	Intermittent	0.021
15060202000849		Stream/River	Intermittent	0.015
15060202000849		Stream/River	Intermittent	0.015
15060202000850		Stream/River	Intermittent	0.021
15060202000850		Stream/River	Intermittent	0.011
15060202000851		Stream/River	Intermittent	0.027

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15060202000852		Stream/River	Intermittent	0.016
15060202000852		Stream/River	Intermittent	0.012
15060202000853		Stream/River	Intermittent	0.012
15060202000853		Stream/River	Intermittent	0.032
15060202000854		Stream/River	Intermittent	0.019
15060202000855		Stream/River	Intermittent	0.012
15060202000856		Stream/River	Intermittent	0.040
15060202000858		Stream/River	Intermittent	0.016
15060202000859		Stream/River	Intermittent	0.027
15060202000860		Stream/River	Intermittent	0.018
15060202000861		Stream/River	Intermittent	0.030
15060202000861		Stream/River	Intermittent	0.042
15060202000861		Stream/River	Intermittent	0.018
15060202000865		Stream/River	Intermittent	0.041
15060202000866		Stream/River	Intermittent	0.013
15060202000867		Stream/River	Intermittent	0.010
15060202000868		Stream/River	Intermittent	0.026
15060202000869		Stream/River	Intermittent	0.014
15060202000870		Stream/River	Intermittent	0.012
15060202000870		Stream/River	Intermittent	0.010
15060202000870		Stream/River	Intermittent	0.017
15060202000871		Stream/River	Intermittent	0.024
15060202000872		Stream/River	Intermittent	0.014
15060202000872		Stream/River	Intermittent	0.014
15060202000873		Stream/River	Intermittent	0.010
15060202000874		Stream/River	Intermittent	0.016
15060202000874		Stream/River	Intermittent	0.010
15060202000875		Stream/River	Intermittent	0.016
15060202000877		Stream/River	Intermittent	0.029
15060202000878		Stream/River	Intermittent	0.022
15060202000879		Stream/River	Intermittent	0.031
15060202000880		Stream/River	Intermittent	0.036
15060202000881		Stream/River	Intermittent	0.017
15060202000882		Stream/River	Intermittent	0.019
15060202000883		Stream/River	Intermittent	0.019
15060202000886		Stream/River	Intermittent	0.016
15060202000888		Stream/River	Intermittent	0.022
15060202000888		Stream/River	Intermittent	0.020
15060202000889		Stream/River	Intermittent	0.023
15060202000891		Stream/River	Intermittent	0.015
15060202000892		Stream/River	Intermittent	0.011

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15060202000892		Stream/River	Intermittent	0.020
15060202000892		Stream/River	Intermittent	0.014
15060202000893		Stream/River	Intermittent	0.028
15060202000893		Stream/River	Intermittent	0.021
15060202000893		Stream/River	Intermittent	0.011
15060202000894		Stream/River	Intermittent	0.016
15060202000895		Stream/River	Intermittent	0.018
15060202000896		Stream/River	Intermittent	0.029
15060202000896		Stream/River	Intermittent	0.018
15060202000896		Stream/River	Intermittent	0.016
15060202000897		Stream/River	Intermittent	0.014
15060202000897		Stream/River	Intermittent	0.011
15060202000898	Pumphouse Wash	Stream/River	Intermittent	0.011
15060202000905	Pumphouse Wash	Stream/River	Intermittent	0.014
15060202000907		Stream/River	Intermittent	0.020
15060202000908		Stream/River	Intermittent	0.010
15060202000908		Stream/River	Intermittent	0.014
15060202000908		Stream/River	Intermittent	0.018
15060202000908		Stream/River	Intermittent	0.012
15060202000910		Stream/River	Intermittent	0.011
15060202000915		Stream/River	Intermittent	0.018
15060202000919		Stream/River	Intermittent	0.018
15060202000921	Woody Wash	Stream/River	Intermittent	0.032
15060202000923		Stream/River	Intermittent	0.023
15060202000929		Stream/River	Intermittent	0.015
15060202000931		Stream/River	Intermittent	0.017
15060202000932		Stream/River	Intermittent	0.011
15060202000933		Stream/River	Intermittent	0.013
15060202000934		Stream/River	Intermittent	0.013
15060202000935		Stream/River	Intermittent	0.016
15060202000936		Stream/River	Intermittent	0.017
15060202000939		Stream/River	Intermittent	0.012
15060202000941		Stream/River	Intermittent	0.010
15060202000942		Stream/River	Intermittent	0.018
15060202000944		Stream/River	Intermittent	0.010
15060202000947		Stream/River	Intermittent	0.010
15060202000947		Stream/River	Intermittent	0.016
15060202000949		Stream/River	Intermittent	0.042
15060202000950		Stream/River	Intermittent	0.020
15060202000951		Stream/River	Intermittent	0.015
15060202000953		Stream/River	Intermittent	0.019

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15060202000956		Stream/River	Intermittent	0.018
15060202000981		Stream/River	Intermittent	0.012
15060202000981		Stream/River	Intermittent	0.015
15060202000988		Stream/River	Intermittent	0.011
15060202000990		Stream/River	Intermittent	0.019
15060202001026		Stream/River	Intermittent	0.012
15060202001083		Stream/River	Intermittent	0.014
15060202001087		Stream/River	Intermittent	0.029
15060202001093		Stream/River	Intermittent	0.016
15060202001093		Stream/River	Intermittent	0.017
15060202001093		Stream/River	Intermittent	0.012
15060202001094		Stream/River	Intermittent	0.019
15060202001095		Stream/River	Intermittent	0.010
15060202001097		Stream/River	Intermittent	0.014
15060202001098		Stream/River	Intermittent	0.018
15060202001098		Stream/River	Intermittent	0.018
15060202001099		Stream/River	Intermittent	0.014
15060202001100		Stream/River	Intermittent	0.013
15060202001100		Stream/River	Intermittent	0.029
15060202001101		Stream/River	Intermittent	0.015
15060202001101		Stream/River	Intermittent	0.017
15060202001102		Stream/River	Intermittent	0.030
15060202001102		Stream/River	Intermittent	0.016
15060202001104		Stream/River	Intermittent	0.013
15060202001105		Stream/River	Intermittent	0.023
15060202001110		Stream/River	Intermittent	0.020
15060202001115		Stream/River	Intermittent	0.034
15060202001116		Stream/River	Intermittent	0.023
15060202001117		Stream/River	Intermittent	0.012
15060202001117		Stream/River	Intermittent	0.023
15060202001118		Stream/River	Intermittent	0.021
15060202001120		Stream/River	Intermittent	0.011
15060202001120		Stream/River	Intermittent	0.014
15060202001121		Stream/River	Intermittent	0.046
15060202001122		Stream/River	Intermittent	0.012
15060202001123		Stream/River	Intermittent	0.017
15060202001124		Stream/River	Intermittent	0.019
15060202001128		Stream/River	Intermittent	0.027
15060202001128		Stream/River	Intermittent	0.019
15060202001128		Stream/River	Intermittent	0.059
15060202001129		Stream/River	Intermittent	0.013

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15060202001129		Stream/River	Intermittent	0.013
15060202001129		Stream/River	Intermittent	0.023
15060202001131		Stream/River	Intermittent	0.020
15060202001133		Stream/River	Intermittent	0.017
15060202001134		Stream/River	Intermittent	0.067
15060202001134		Stream/River	Intermittent	0.016
15060202001135		Stream/River	Intermittent	0.010
15060202001136		Stream/River	Intermittent	0.010
15060202001136		Stream/River	Intermittent	0.029
15060202001136		Stream/River	Intermittent	0.015
15060202001137		Stream/River	Intermittent	0.031
15060202001138		Stream/River	Intermittent	0.021
15060202001139		Stream/River	Intermittent	0.028
15060202001139		Stream/River	Intermittent	0.011
15060202001140		Stream/River	Perennial	0.016
15060202001141		Stream/River	Intermittent	0.015
15060202001141		Stream/River	Intermittent	0.022
15060202001141		Stream/River	Intermittent	0.021
15060202001141		Stream/River	Perennial	0.038
15060202001142		Stream/River	Intermittent	0.012
15060202001142		Stream/River	Intermittent	0.015
15060202001143		Stream/River	Intermittent	0.015
15060202001144		Stream/River	Intermittent	0.023
15060202001144		Stream/River	Intermittent	0.046
15060202001145		Stream/River	Intermittent	0.012
15060202001145		Stream/River	Intermittent	0.011
15060202001146		Stream/River	Intermittent	0.011
15060202001146		Stream/River	Intermittent	0.026
15060202001148		Stream/River	Intermittent	0.048
15060202001149		Stream/River	Intermittent	0.019
15060202001149		Stream/River	Intermittent	0.029
15060202001150		Stream/River	Intermittent	0.015
15060202001152		Stream/River	Intermittent	0.014
15060202001152		Stream/River	Intermittent	0.030
15060202001152		Stream/River	Intermittent	0.012
15060202001152		Stream/River	Intermittent	0.042
15060202001153		Stream/River	Intermittent	0.016
15060202001153		Stream/River	Intermittent	0.021
15060202001154		Stream/River	Intermittent	0.043
15060202001155		Stream/River	Intermittent	0.013
15060202001155		Stream/River	Intermittent	0.041

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15060202001156		Stream/River	Intermittent	0.018
15060202001156		Stream/River	Intermittent	0.019
15060202001156		Stream/River	Intermittent	0.036
15060202001157		Stream/River	Intermittent	0.014
15060202001158		Stream/River	Intermittent	0.012
15060202001191		Stream/River	Intermittent	0.038
15060202001192		Stream/River	Intermittent	0.021
15060202001194		Stream/River	Intermittent	0.043
15060202001195		Stream/River	Intermittent	0.011
15060202001196		Stream/River	Intermittent	0.015
15060202001196		Stream/River	Intermittent	0.020
15060202001197		Stream/River	Intermittent	0.011
15060202001202		Stream/River	Intermittent	0.044
15060202001203		Stream/River	Intermittent	0.013
15060202001203		Stream/River	Intermittent	0.016
15060202001203		Stream/River	Intermittent	0.016
15060202001205		Stream/River	Intermittent	0.014
15060202001206		Stream/River	Intermittent	0.022
15060202001206		Stream/River	Intermittent	0.015
15060202001206		Stream/River	Intermittent	0.018
15060202001207		Stream/River	Intermittent	0.025
15060202001208		Stream/River	Intermittent	0.011
15060202001212		Stream/River	Intermittent	0.012
15060202001212		Stream/River	Intermittent	0.015
15060202001228		Stream/River	Intermittent	0.011
15060202001229		Stream/River	Intermittent	0.011
15060202001230		Stream/River	Intermittent	0.013
15060202001231		Stream/River	Intermittent	0.016
15060202001232		Stream/River	Intermittent	0.014
15060202001232		Stream/River	Intermittent	0.011
15060202001233		Stream/River	Intermittent	0.016
15060202001234		Stream/River	Intermittent	0.041
15060202001235		Stream/River	Intermittent	0.012
15060202001235		Stream/River	Intermittent	0.018
15060202001236		Stream/River	Intermittent	0.045
15060202001237		Stream/River	Intermittent	0.048
15060202001252		Stream/River	Intermittent	0.010
15060202001252		Stream/River	Intermittent	0.019
15060202001564		Stream/River	Intermittent	0.011
15060202001564		Stream/River	Intermittent	0.013
15060202001567		Stream/River	Intermittent	0.023

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15060202001567		Stream/River	Intermittent	0.011
15060202001568		Stream/River	Intermittent	0.012
15060202001568		Stream/River	Intermittent	0.011
15060202001570		Stream/River	Intermittent	0.020
15060202001571		Stream/River	Intermittent	0.011
15060202001571		Stream/River	Intermittent	0.015
15060202001588		Stream/River	Intermittent	0.034
15060202001595		Stream/River	Intermittent	0.017
15060202001595		Stream/River	Intermittent	0.014
15060202001607		Stream/River	Intermittent	0.017
15060202001616		Stream/River	Intermittent	0.028
15060202001616		Stream/River	Intermittent	0.013
15060202001741		Artificial Path	Artificial Path	0.012
15060202001891		Stream/River	Intermittent	0.027
15060202001905		Stream/River	Intermittent	0.013
15060202001906		Stream/River	Intermittent	0.010
15060202001918		Stream/River	Intermittent	0.016
15060202001924		Stream/River	Intermittent	0.014
15060202001925		Stream/River	Intermittent	0.013
15060202001928		Stream/River	Intermittent	0.012
15060202001929		Stream/River	Intermittent	0.012
15060202001933		Stream/River	Intermittent	0.034
15060202001934		Stream/River	Intermittent	0.015
15060202001935		Stream/River	Intermittent	0.020
15060202001944		Stream/River	Intermittent	0.013
15060202001952		Stream/River	Intermittent	0.013
15060202001953		Stream/River	Intermittent	0.027
15060202001956		Stream/River	Intermittent	0.013
15060202001958		Stream/River	Intermittent	0.020
15060202001993		Stream/River	Intermittent	0.011
15060202001997		Stream/River	Intermittent	0.014
15060202002003		Stream/River	Intermittent	0.012
15060202002005		Stream/River	Intermittent	0.013
15060202002015		Stream/River	Intermittent	0.027
15060202002024		Stream/River	Intermittent	0.016
15060202002030		Stream/River	Intermittent	0.014
15060202002044		Stream/River	Intermittent	0.026
15060202002058		Stream/River	Intermittent	0.013
15060202002059		Stream/River	Intermittent	0.011
15060202002065		Stream/River	Intermittent	0.017
15060202002072		Stream/River	Intermittent	0.012

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15060202002077		Stream/River	Intermittent	0.021
15060202002082		Stream/River	Intermittent	0.018
15060202002107		Stream/River	Intermittent	0.013
15060202002117		Stream/River	Intermittent	0.015
15060202002142		Stream/River	Intermittent	0.022
15060202002151		Stream/River	Intermittent	0.012
15060202002157		Stream/River	Intermittent	0.018
15060202002165		Stream/River	Intermittent	0.017
15060202002169		Stream/River	Intermittent	0.020
15060202002199		Stream/River	Intermittent	0.011
15060202002211		Stream/River	Intermittent	0.010
15060202002211		Stream/River	Intermittent	0.012
15060202002257		Stream/River	Intermittent	0.012
15060202002266		Stream/River	Intermittent	0.015
15060202002274		Stream/River	Intermittent	0.017
15060202002284		Stream/River	Intermittent	0.017
15060202002300		Stream/River	Intermittent	0.012
15060202002307		Stream/River	Intermittent	0.014
15060202002322		Stream/River	Intermittent	0.033
15060202002330		Stream/River	Intermittent	0.015
15060202002339		Stream/River	Intermittent	0.017
15060202002352		Stream/River	Intermittent	0.013
15060202002366		Stream/River	Intermittent	0.020
15060202002367		Stream/River	Intermittent	0.015
15060202002370		Stream/River	Intermittent	0.035
15060202002374		Stream/River	Intermittent	0.011
15060202002379		Stream/River	Intermittent	0.013
15060202002385		Stream/River	Intermittent	0.015
15060202002388		Stream/River	Intermittent	0.011
15060202002406		Stream/River	Intermittent	0.016
15060202002411		Stream/River	Intermittent	0.017
15060202002413		Stream/River	Intermittent	0.016
15060202002416		Stream/River	Intermittent	0.049
15060202002419		Stream/River	Intermittent	0.018
15060202002420		Stream/River	Intermittent	0.017
15060202002420		Stream/River	Intermittent	0.015
15060202002432		Stream/River	Intermittent	0.049
15060202002439		Stream/River	Intermittent	0.014
15060202002439		Stream/River	Intermittent	0.036
15060202002444		Stream/River	Intermittent	0.021
15060202002447		Stream/River	Intermittent	0.014

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15060202002459		Stream/River	Intermittent	0.010
15060202002459		Stream/River	Intermittent	0.010
15060202002467		Stream/River	Intermittent	0.013
15060202002469		Stream/River	Intermittent	0.019
15060202002472		Stream/River	Intermittent	0.010
15060202002474		Stream/River	Intermittent	0.011
15060202002479		Stream/River	Intermittent	0.012
15060202002487		Stream/River	Intermittent	0.013
15060202002489		Stream/River	Intermittent	0.012
15060202002492		Stream/River	Intermittent	0.031
15060202002493		Stream/River	Intermittent	0.023
15060202002505		Stream/River	Intermittent	0.013
15060202002506		Stream/River	Intermittent	0.017
15060202002514		Stream/River	Intermittent	0.013
15060202002516		Stream/River	Intermittent	0.022
15060202002527		Stream/River	Intermittent	0.032
15060202002536		Stream/River	Intermittent	0.011
15060202002537	JD Dam Wash	Stream/River	Intermittent	0.017
15060202002541		Stream/River	Intermittent	0.022
15060202002545		Stream/River	Intermittent	0.019
15060202002547		Stream/River	Intermittent	0.022
15060202002553		Stream/River	Intermittent	0.017
15060202002566		Stream/River	Intermittent	0.014
15060202002572		Stream/River	Intermittent	0.014
15060202002575		Stream/River	Intermittent	0.020
15060202002578		Stream/River	Intermittent	0.034
15060202002579		Stream/River	Intermittent	0.033
15060202002588	JD Dam Wash	Stream/River	Intermittent	0.022
15060202002589		Stream/River	Intermittent	0.015
15060202002597		Stream/River	Intermittent	0.018
15060202002619		Stream/River	Intermittent	0.024
15060202002620		Stream/River	Intermittent	0.010
15060202002629		Stream/River	Intermittent	0.019
15060202002633		Stream/River	Intermittent	0.039
15060202002634		Stream/River	Intermittent	0.031
15060202002634		Stream/River	Intermittent	0.012
15060202002637		Stream/River	Intermittent	0.019
15060202002669		Stream/River	Intermittent	0.021
15060202002677		Stream/River	Intermittent	0.022
15060202002678		Stream/River	Intermittent	0.012
15060202002683		Stream/River	Intermittent	0.010

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15060202002688	Sycamore Creek	Stream/River	Intermittent	0.016
15060202002688	Sycamore Creek	Stream/River	Perennial	0.033
15060202002692		Stream/River	Intermittent	0.014
15060202002738		Stream/River	Intermittent	0.012
15060202002758		Stream/River	Intermittent	0.012
15060202002813		Stream/River	Intermittent	0.013
15060202002813		Stream/River	Intermittent	0.014
15060202002813		Stream/River	Intermittent	0.013
15060202002820		Stream/River	Intermittent	0.017
15060202002832		Stream/River	Intermittent	0.013
15060202002834		Stream/River	Intermittent	0.011
15060202002849		Stream/River	Intermittent	0.018
15060202002858		Stream/River	Intermittent	0.016
15060202002869		Stream/River	Intermittent	0.013
15060202002916		Stream/River	Intermittent	0.011
15060202002960		Stream/River	Intermittent	0.016
15060202002960		Stream/River	Intermittent	0.017
15060202002963		Stream/River	Intermittent	0.021
15060202002989		Stream/River	Intermittent	0.012
15060202002993		Stream/River	Intermittent	0.011
15060202003019		Stream/River	Intermittent	0.017
15060202003040		Stream/River	Intermittent	0.011
15060202003050		Stream/River	Intermittent	0.013
15060202003068		Stream/River	Intermittent	0.011
15060202003099		Stream/River	Intermittent	0.027
15060202003143		Stream/River	Intermittent	0.021
15060202003157		Stream/River	Intermittent	0.018
15060202003180		Stream/River	Intermittent	0.014
15060202003185		Stream/River	Intermittent	0.019
15060202003198		Stream/River	Intermittent	0.018
15060202003207		Stream/River	Intermittent	0.010
15060202003210		Stream/River	Intermittent	0.019
15060202003212		Stream/River	Intermittent	0.017
15060202003240		Stream/River	Intermittent	0.021
15060202003244		Stream/River	Intermittent	0.010
15060202003248		Stream/River	Intermittent	0.017
15060202003249		Stream/River	Intermittent	0.011
15060202003253		Stream/River	Intermittent	0.013
15060202003254		Stream/River	Intermittent	0.012
15060202003266		Stream/River	Intermittent	0.014
15060202003272		Stream/River	Intermittent	0.015

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15060202003280		Stream/River	Intermittent	0.014
15060202003292		Stream/River	Intermittent	0.022
15060202003298		Stream/River	Intermittent	0.017
15060202003325		Stream/River	Intermittent	0.014
15060202003354		Stream/River	Intermittent	0.019
15060202003359		Stream/River	Intermittent	0.016
15060202003365		Stream/River	Intermittent	0.010
15060202003380		Stream/River	Intermittent	0.014
15060202003381		Stream/River	Intermittent	0.015
15060202003411		Stream/River	Intermittent	0.014
15060202003417		Stream/River	Intermittent	0.026
15060202003418		Stream/River	Intermittent	0.011
15060202003426		Stream/River	Intermittent	0.012
15060202003430		Stream/River	Intermittent	0.011
15060202003431		Stream/River	Intermittent	0.016
15060202003437		Stream/River	Intermittent	0.021
15060202003440		Stream/River	Intermittent	0.013
15060202003473		Stream/River	Intermittent	0.017
15060202003493		Stream/River	Intermittent	0.011
15060202003528		Stream/River	Intermittent	0.017
15060202003549		Stream/River	Intermittent	0.010
15060202003552		Stream/River	Intermittent	0.013
15060202003562		Stream/River	Intermittent	0.011
15060202003577		Stream/River	Intermittent	0.016
15060202003586		Stream/River	Intermittent	0.014
15060202003588		Stream/River	Intermittent	0.011
15060202003596		Stream/River	Intermittent	0.012
15060202003601		Stream/River	Intermittent	0.023
15060202003624		Stream/River	Intermittent	0.011
15060202003626		Stream/River	Intermittent	0.014
15060202003636		Stream/River	Intermittent	0.013
15060202003665		Stream/River	Intermittent	0.022
15060202003666		Stream/River	Intermittent	0.013
15060202003690		Stream/River	Intermittent	0.010
15060202003698		Stream/River	Intermittent	0.013
15060202003699		Stream/River	Intermittent	0.020
15060202003706		Stream/River	Intermittent	0.019
15060202003715		Stream/River	Intermittent	0.012
15060202003771		Stream/River	Intermittent	0.013
15060202003783		Stream/River	Intermittent	0.012
15060202003810		Stream/River	Intermittent	0.015

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15060202003865		Stream/River	Intermittent	0.012
15060202003885		Stream/River	Intermittent	0.011
15060202003913		Stream/River	Intermittent	0.010
15060202003919		Stream/River	Intermittent	0.012
15060202003926		Stream/River	Intermittent	0.011
15060202003937		Stream/River	Intermittent	0.026
15060202003938		Stream/River	Intermittent	0.013
15060202003940		Stream/River	Intermittent	0.016
15060202003959		Stream/River	Intermittent	0.015
15060202003961		Stream/River	Intermittent	0.017
15060202003970		Stream/River	Intermittent	0.018
15060202003974		Stream/River	Intermittent	0.013
15060202003987		Stream/River	Intermittent	0.012
15060202003998		Stream/River	Intermittent	0.012
15060202004006		Stream/River	Intermittent	0.014
15060202004016		Stream/River	Intermittent	0.014
15060202004022		Stream/River	Intermittent	0.011
15060202004023		Stream/River	Intermittent	0.016
15060202004032		Stream/River	Intermittent	0.016
15060202004050		Stream/River	Intermittent	0.014
15060202004052		Stream/River	Intermittent	0.019
15060202004071		Stream/River	Intermittent	0.019
15060202004077		Stream/River	Intermittent	0.017
15060202004108		Stream/River	Intermittent	0.012
15060202004110		Stream/River	Intermittent	0.011
15060202004134		Stream/River	Intermittent	0.012
15060202004135		Stream/River	Intermittent	0.014
15060202004144		Stream/River	Intermittent	0.027
15060202004169		Stream/River	Intermittent	0.022
15060202004175		Stream/River	Intermittent	0.015
15060202004201		Stream/River	Intermittent	0.010
15060202004224		Stream/River	Intermittent	0.010
15060202004227		Stream/River	Intermittent	0.010
15060202004277		Stream/River	Intermittent	0.014
15060202004288		Stream/River	Intermittent	0.028
15060202004289		Stream/River	Intermittent	0.015
15060202004290		Stream/River	Intermittent	0.011
15060202004305		Stream/River	Intermittent	0.010
15060202004322		Stream/River	Intermittent	0.011
15060202004324		Stream/River	Intermittent	0.037
15060202004341		Stream/River	Intermittent	0.023

Reach Code	Name	Flow Type	Flow Code	Length (mi.)
15060202004344		Stream/River	Intermittent	0.011
15060202004348		Stream/River	Intermittent	0.013
15060202004351		Stream/River	Intermittent	0.030
15060202004369		Stream/River	Intermittent	0.014
15060202004371		Stream/River	Intermittent	0.013
15060202004376		Stream/River	Intermittent	0.011
15060202004394		Stream/River	Intermittent	0.010
15060202004395		Stream/River	Intermittent	0.010
15060202004400		Stream/River	Intermittent	0.018
15060202004401		Stream/River	Intermittent	0.012
15060202004410		Stream/River	Intermittent	0.016
15060202004413		Stream/River	Intermittent	0.017
15060202004415		Stream/River	Intermittent	0.012
15060202004419		Stream/River	Intermittent	0.014
15060202004426		Stream/River	Intermittent	0.039
15060202004433		Stream/River	Intermittent	0.010
15060202004438		Stream/River	Intermittent	0.010
15060202004455		Stream/River	Intermittent	0.013
15060202004479		Stream/River	Intermittent	0.019
15060202004533		Stream/River	Intermittent	0.018
15060202004546		Stream/River	Intermittent	0.017
15060202004589		Stream/River	Intermittent	0.014

Appendix C

Riparian stream reaches in the Four Forest Restoration Initiative analysis area and their associated lengths, sizes and condition ratings

RIPARIAN REACH	FUNCTIONAL CLASS	LENGTH (mi.)
1502001514D002	PROPER FUNCTIONING CONDITION	1.8

RIPARIAN REACH	FUNCTIONAL CLASS	LENGTH (mi.)
1502001514D001	AT RISK	2.3
1502001513A002	AT RISK	5.3
1502001513A002	AT RISK	2.2
1506020286D003	AT RISK	1.7
1506020286D002	AT RISK	0.7
1506020286C003	PROPER FUNCTIONING CONDITION	0.7
1502001513A003	AT RISK	1.3
1506020286C004	AT RISK	0.3
1506020286C005	AT RISK	2.0
1506020286D002	AT RISK	3.0
1502001513A004	AT RISK	2.2
1506020287H009	PFC	1.5
1506020287H010	PROPER FUNCTIONING CONDITION	1.7
1506020287H008	AT RISK	1.7
1506020287H008	AT RISK	0.9
1502001513C001	AT RISK	0.4
1502001513C001	AT RISK	0.4
1502001513C002	AT RISK	0.2
1502001513B001	NON-RIPARIAN	2.4
1502001513B002	AT RISK	0.2
1506020287H005	PROPER FUNCTIONING CONDITION	1.8
1506020287G001	PROPER FUNCTIONING CONDITION	1.8
1502001513B003	PROPER FUNCTIONING CONDITION	2.4
1502001513B002	AT RISK	0.1
1502001513B002	AT RISK	0.3
1506020287H006	PROPER FUNCTIONING CONDITION	1.3
1506020287H005	PROPER FUNCTIONING CONDITION	0.3
1506020287G002	PROPER FUNCTIONING CONDITION	1.2
1506020287F004	AT RISK	0.9
1506020287H007	PROPER FUNCTIONING CONDITION	3.8
1502001513C005	PROPER FUNCTIONING CONDITION	0.8
1502001513C003	NON-FUNCTIONAL	2.6
1506020287H002	PROPER FUNCTIONING CONDITION	1.9
1506020287H004	PROPER FUNCTIONING CONDITION	0.9
1506020287H002	PROPER FUNCTIONING CONDITION	0.3
1506020287H005	PROPER FUNCTIONING CONDITION	1.6
1506020287F005	AT RISK	0.2
1506020287F005	AT RISK	0.1
1506020287H003	PROPER FUNCTIONING CONDITION	0.5
1506020287F005	AT RISK	0.8
1506020287F002	PROPER FUNCTIONING CONDITION	1.8
1502001513C004	PROPER FUNCTIONING CONDITION	1.0
1506020287F003	PROPER FUNCTIONING CONDITION	0.2
1506020287H001	PROPER FUNCTIONING CONDITION	1.7
1502001513C006	AT RISK	4.8
1502001513C006	AT RISK	0.3

RIPARIAN REACH	FUNCTIONAL CLASS	LENGTH (mi.)
1506020287F002	PROPER FUNCTIONING CONDITION	0.3
1502001513C006	AT RISK	0.4
1506020287J003	PROPER FUNCTIONING CONDITION	0.4
1506020288E007	PROPER FUNCTIONING CONDITION	1.4
1506020288E006	PROPER FUNCTIONING CONDITION	1.7
1506020288E005	PROPER FUNCTIONING CONDITION	1.2
1506020288F002	PROPER FUNCTIONING CONDITION	2.5
1506020288E004	AT RISK	0.4
1506020288F002	PROPER FUNCTIONING CONDITION	5.8
1506020288F001	PROPER FUNCTIONING CONDITION	1.3
1506020288E003	PROPER FUNCTIONING CONDITION	1.0
1502001515B002	AT RISK	1.2
1502001515B001	AT RISK	0.6
1506020288G003	PROPER FUNCTIONING CONDITION	2.9

Appendix D

Wetland Habitats in the Four Forest Restoration Initiative analysis area and their associated extents and USFWS wetland classifications

Table 1. Wetland areas on the CNF within the Four Forest Restoration Initiative analysis area and associated condition assessment information from 2002 riparian area proper functioning condition assessment conducted by Dick Fleishman and Jim Keller.

NAME	CLASS	ACRES	PFC Assessment	Latitude	Longitude
Slate Lakes	Seasonal	0.38	PFC	35.48	-111.80
Slate Lakes	Seasonal	0.56	PFC	35.48	-111.81
Crater Lake	Seasonal	0.88	PFC	35.42	-111.81
Walker Lake	Semi-permanent	10.32	Functional At-risk	35.39	-111.73
Bismark Lake	Seasonal	1.50	PFC	35.36	-111.72
Crater Lake (pvt)	Seasonal	5.27	NA	35.32	-111.77
Dry Lake	Seasonal	13.83	Functional At-risk	35.17	-111.72
Rogers Lake	Seasonal	1201.23	Functional At-risk	35.15	-111.79
Marshall Lake	Semi-permanent	131.68	PFC	35.12	-111.53
Little Dry Lake	Semi-permanent	8.87	PFC	35.11	-111.53
Lower Lake Mary	Reservoir	148.69	PFC	35.11	-111.57
Upper Lake Mary	Reservoir	662.42	NA	35.06	-111.49
Antelope North	Seasonal	5.30	PFC	35.03	-111.44
Antelope Tank	Seasonal	8.31		35.02	-111.44
Indian Tank	Seasonal	13.30	Functional At-risk, PFC	35.01	-111.43
Perry Lake	Semi-permanent	27.48	PFC	34.99	-111.44
Mormon Lake	Semi-permanent	5228.99	PFC	34.97	-111.47
Tonys Tank	Seasonal	9.09	Functional At-risk	34.93	-111.41
Pine Lake	Seasonal	52.76	PFC	34.93	-111.37
Camillo Tank	Seasonal	45.85	PFC	34.92	-111.38

NAME	CLASS	ACRES	PFC Assessment	Latitude	Longitude
Wallace Lake	Seasonal	8.85	Functional At-risk	34.92	-111.43

Table 2. Riparian areas on the KNF within the Four Forest Restoration Initiative analysis area and associated condition assessment information from 2008 riparian area proper functioning condition assessment conducted by Jeff Hink.

Location	Type	East	North	SIZE	Category	Riparian Vegetation	PFC Assessment	Trend	Rationale	Comments
JD DAM WASH	Ephemeral streams with riparian vegetation	406570	3880726		Ephemeral drainage	carex	PFC	Static	Conditions appear similar between 1990 and 2008	
JD DAM	Reservoirs	406223	3880970	29.0	Semi-permanent wetland / reservoir	bulrush, cattail, cottonwood, spikerush and broadleaved pondweed	PFC	Static	Conditions appear similar between 1990 and 2008	
UPPER BEAR CANYON	Ephemeral streams with riparian vegetation	392211	3883094		Ephemeral stream	willow, spikerush, juncus, carex	PFC	Static	Conditions appear similar between 1990 and 2008	
BEAR SPRING	Perennial Springs with riparian vegetation	392230	3883130		Perennial Spring	juncus, tall spikerush, willow	Functional at risk	Downward	Vegetative conditions have deteriorated from 1990. Grazing impacts from ungulates are far more evident.	Spring is not fenced from livestock as reported in Kaibab Master.
MC CANYON	Ephemeral streams with riparian vegetation	388176	3884240		Ephemeral drainage	few willow	PFC	Static	Conditions appear similar between 1990 and 2008	

Location	Type	East	North	SIZE	Category	Riparian Vegetation	PFC Assessment	Trend	Rationale	Comments
HITT SPRING	Perennial Springs with riparian vegetation	401788	3885976		Perennial spring	Riparian plants include medium and tall spike rush and juncus.	PFC	Static	Little basis from photo comparison to make call other than static.	
WHITE HORSE LAKE	Reservoirs	407543	3886706	42.0	reservoir	bulrush	PFC	Upward	Based on photo comparison, riparian vegetation appears much improved from 1990 and 2008.	
SUNFLOWER FLAT	Semi-permanent wetland / stock tank	405485	3887362	33.0	Semi-permanent wetland / stock tank	bulrush, spikerush	PFC	Static	Conditions appear similar between 1990 and 2008	Appears to be an excellent bald eagle site.
MC TANK DRAINAGE	Intermittent streams	383775	3887432		Intermittent stream	willow, spikerush	PFC	Upward	Fencing has significantly improved the willow. Unstable stream banks are improving.	
MCDOUGAL SPRING	Springs with little or no riparian vegetation	398255	3888195		Ephemeral Spring	spikerush	Non functional.	Downward	McDougal Spring is an historic spring that currently has little riparian characteristics. Unlike the 1990 era photos, no water is present and only tall spike rush occupies the site.	
WILLOW SPRING	Perennial Springs with riparian vegetation	406375	3888215		perennial spring	A-1946	PFC	Static	Conditions appear similar between 1990 and 2008	

Location	Type	East	North	SIZE	Category	Riparian Vegetation	PFC Assessment	Trend	Rationale	Comments
JD CANYON 1	Ephemeral streams with riparian vegetation	403805	3889178		Ephemeral drainage	spikerush, willow	Functional at risk	Static	Conditions appear similar between 1990 and 2008	
COLEMAN LAKE	Seasonal wetlands	392701	3890197	79.0	Seasonal wetland	carex, low medium and tall spikerush, reedgrass, bulrush	PFC	Static	Veg. conditions appear to be similar over the 18 year period.	Complete livestock exclosure, duck nesting islands. Islands do not appear to be effective in providing protection to nesting ducks.
HELL CANYON 1	Ephemeral streams with riparian vegetation	383734	3891400		Ephemeral stream	willow	PFC	Slightly downward	Probably increased elk impacts to willow.	
COUGAR PARK DRAINAGE	Intermittent streams	397273	3892687	11.0	ephemeral drainage	spike rush, carex and reedgrass	PFC	Static	Conditions appear similar between 1990 and 2008	The stream course is fairly well evolved from gully formation in the past to a laterally and vertically stable C channel. Some stream bank erosion continues on steeper, poorly vegetated stream banks.
ROSILDA SPRING	Perennial Springs with riparian vegetation	403241	3892984	1.0	Perennial spring - intermittent stock tank	spikerush, reedgrass, pondweed	PFC	Static	Although water is present in the tank in 2008, conditions appear similar	

Location	Type	East	North	SIZE	Category	Riparian Vegetation	PFC Assessment	Trend	Rationale	Comments
									between 1990 and 2008	
SCHOLZ LAKE	Reservoirs	408210	3895033	34.0	Semi-permanent wetland / reservoir	reedgrass bulrush, spikerush, cattail, pondweed	PFC	Static	Conditions appear similar between 1990 and 2008	Excellent riparian developed below dam. Might be a good frog site.
DOGTOWN LAKE	Reservoirs	397179	3896993	94.0	Reservoir	little riparian veg.	PFC	Static	Conditions appear similar between 1990 and 2008	Water level fluctuation appears to have a more pronounced effect on shoreline vegetation than other lakes (Whitehorse, Cataract, etc.
MINERAL LAKE	Seasonal wetlands	406642	3898790	22 tank=0.5	Seasonal wetland	low spike rush, pondweed	PFC	Downward	bulrush is absent in 2008, heavy grazing impacts in unfenced area. Semi permanent wetland was probably a stretch in 1990 classification.	
LOWER McDERMIT SPRING	Springs with little or no riparian vegetation	416501	3902025		Historic Spring	No riparian vegetation	Non functional.	Downward	Condition of trough and vegetation has degraded since 1990. No evidence that 2008 was abnormally dry.	

Location	Type	East	North	SIZE	Category	Riparian Vegetation	PFC Assessment	Trend	Rationale	Comments
DAVENPORT LAKE	Temporary wetland / stock tank	402263	3903046	285.0	Temporary Wetland with stock tank	scattered low, tall spikerush	PFC	Static	Veg. conditions appear to be similar over the 18 year period.	
ROCK TANK (Keyhole)	Intermittent streams	407663	3903322	0.1	intermittent stream	spikerush, carex	PFC	Static	Conditions appear similar between 1990 and 2008	
DT WASH 2	Ephemeral streams with riparian vegetation	395974	3903394	1.0	Ephemeral stream	little riparian veg. spikerush	Functional at risk	Static	Conditions appear similar between 1990 and 2008	Water level fluctuation limits establishment of shoreline riparian vegetation.
DT WASH 1	Ephemeral streams with riparian vegetation	395924	3903502	1.0	Ephemeral stream	little riparian veg. spikerush	Functional at risk	Static	Conditions appear similar between 1990 and 2008	Water level fluctuation limits establishment of shoreline riparian vegetation.
UPPER McDERMIT SPRING	Springs with little or no riparian vegetation	416859	3903816	0.0	Perennial spring - piped trough	spikerush, juncus	Non functional.	Downward	No water in 2008, drought, tree encroachment. Non functional due to piping and to heavy grazing.	
DRY LAKE	Temporary wetland / stock tank	401343	3904100	27.0	Temporary wetland / stock tank	Very little riparian vegetation	PFC - stock tank; functional at risk - riparian	Static	Riparian conditions appear to be consistently absent over the years.	
DUCK LAKE	Temporary wetland / stock tank	407079	3904285	51.0	Temporary wetland/ stock tank	Very little riparian vegetation	Functional at risk	Upward	Rated "upward" only because disturbance from trenching has somewhat healed.	Examples of this duck "habitat improvement" technique on both the Kaibab and Coconino suggest

Location	Type	East	North	SIZE	Category	Riparian Vegetation	PFC Assessment	Trend	Rationale	Comments
										that the effort does not provide any positive improvement, and often causes irreparable damage to the natural system.
KAIBAB LAKE	Reservoirs	394985	3905256	45.0	Reservoir	little riparian veg.	PFC	Static	Conditions appear similar between 1990 and 2008	
EAST ELK SPRING	Perennial Springs with riparian vegetation	410305	3915252		Perennial Spring	Spikerush, Carex, and Juncus	PFC	Static	Source not flowing in 2008 survey	
WEST ELK SPRING	Springs with little or no riparian vegetation	410177	3915589	1.0	intermittent spring - historic	none	Non functional.	Static	Conditions appear similar between 1990 and 2008	
RAYMOND LAKE	Temporary wetlands	412926	3918806	11.0	Temporary wetland	no riparian vegetation	PFC	Static	Conditions appear similar between 1990 and 2008	
MORITZ LAKE	Temporary wetlands	413557	3919905	52.0	Temporary wetland	no riparian vegetation	PFC	Static		
FAY LAKE	Temporary wetlands	411781	3920280	16.0	Temporary Wetland	No riparian vegetation	PFC	Static	Riparian conditions appear to be consistently absent over the years.	

Appendix E

Spring Habitats and Spring Restoration Adaptive Management Plan for the Four Forest Restoration Initiative Project analysis area

Table 1. Springs of the Coconino National Forest and their associated locations that occur within the Four Forest Restoration Initiative Analysis Area.

NAME	Northing	Easting
Gooseberry Springs	3852636.76	463224.66
Seven Anchor Spring	3852795.78	462209.65
Fain Spring	3853020.87	452022.60
Roundup Park Spring	3853591.89	455427.61
NONE	3854578.23	459776.64
Tinny Spring	3854862.84	461203.65
Van Deren Spring	3854904.87	459219.64
Lee Spring	3854976.90	449262.59
Sawmill Springs	3855074.09	465510.67
Rock Top Spring	3856829.46	449903.69
Mint Spring	3857927.71	462494.56
NONE	3858058.40	462238.47
Bristow Spring	3858568.78	447387.89
Free Spring	3858676.09	454263.62
Tree Spring	3858676.09	454263.62
Dove Spring	3859157.85	465837.67
Railroad Spring	3859243.01	458781.64
Bristow Seep Spring	3860486.98	445564.56
Iowa Camp Spring	3861440.01	461125.34
Navajo Spring	3862011.03	456094.54
Sedge Spring	3862280.02	461508.65
T-Six Spring	3862883.04	445550.55
Bootlegger Spring	3863562.18	450908.60
Sheep Spring	3863872.19	450937.60
Munds Spring	3864390.00	447781.47
Wallace Spring	3864805.28	455107.64
Smith Spring	3866100.30	455616.65
Double Springs	3866624.34	454888.65
Mud Spring	3868678.32	450333.59
Mayflower Spring	3869361.42	455403.65
Weimer Spring	3870163.72	451701.43
Willard Spring	3870272.97	437835.38
Lockwood Spring	3870317.46	455006.66
Howard Spring	3871403.16	443173.46
Ritter Spring	3873426.93	435575.30
Buzzard Spring	3874121.88	424602.34
Scott Spring	3876176.88	434198.24

NAME	Northing	Easting
NONE	3876262.73	435125.94
Thomas Spring	3877338.21	444597.41
Mortgage Spring	3877399.92	435274.25
Hoxworth Springs	3877665.30	447563.45
Lockwood Spring	3878563.96	421245.38
NONE	3880011.48	437181.65
Babbit Spring	3880596.36	450899.45
Limbergh Spring	3885217.40	434267.95
Griffiths Spring	3886274.30	435372.74
Garden Spring	3887742.88	432815.10
Black Spring	3888076.97	437245.14
Poison Spring	3888328.18	411180.61
Railroad Spring	3888531.28	412529.48
Lion Spring	3889314.16	446746.22
Upper Hull Spring	3889483.17	412157.58
Paterson Spring	3890531.95	426359.20
Elsie Spring	3896054.93	429262.08
Elden Spring	3898405.05	445389.05
Paradies Spring	3898940.02	443136.03
Oak Spring	3900251.04	446356.02
Chimney Spring	3902516.10	438624.94
Little Elden Spring	3903905.05	447314.09
Pearson Spring	3904305.02	426626.22
Maxwell Spring	3904697.01	427538.20
Taylor Spring	3905026.96	432216.09
Little Leroux Spring	3905127.98	434990.10
Orion Spring	3905406.83	442059.62
Big Leroux Spring	3905810.98	434086.12
Leroux Spring	3905810.98	434086.12
Aspen Spring	3906992.02	441368.16
Doyle Spring	3910051.04	440024.25
Snowslide Spring	3910090.04	439070.25
NONE	3910754.66	434132.19
Flagstaff Spring	3910934.92	439285.78
NONE	3910967.66	434197.19
Raspberry Spring	3911090.42	441057.59
Bear Paw Spring	3911186.36	440054.69
Jack Smith Spring	3911519.17	441149.48
Beard Spring	3911619.67	439475.89
Philomena Spring	3912072.05	437975.31
Jack Smith Spring Number Two	3912855.06	445522.32

NAME	Northing	Easting
Lockett Meadow Spring	3913179.56	443603.42
Little Spring	3914806.07	434079.41
Alto Spring	3915087.69	443629.48
Pat Spring	3916777.09	437365.05
NONE	3922347.78	430704.99
Kendrick Spring	3922596.12	423770.77
NONE	3924190.31	432658.31

Table 2. Springs of the Kaibab National Forest that occur within the Four Forest Restoration Initiative Analysis Area and associated spring survey information (Stevens et al. 2011).

Name	Source	Inv	Quad Name	District	Easting	Northing	Elevat	Description
Andrews Spring	GEO	0	McLellan Reservoir	SKNF	385577	3891421	1997	This rheocrene spring is included in the Arizona State Land Office shapefile.
Bard Spring	GEO	0	McLellan Reservoir	SKNF	383546	3896440	2017	This spring is listed on the DRG, and included in the Arizona State Land Office shapefile.
Beale Spring	DLG	0	Parks	SKNF	417162	3913613	2255	This named spring is in a shallow drainage south of Beale Mountain, near a road. It is depicted on the DRG.
Bear Canyon upper unnamed spring	NHD	0	May Tank Pocket	SKNF	392611	3884714	2047	This unnamed spring is depicted on the DRG, and is included in the NHD database.
Bear Springs	NHD	1	May Tank Pocket	SKNF	392429	3883314	2013	According to the NPS, this is a perennial Spring with riparian vegetation. This named spring is depicted on the DRG.
Bennett Spring	NHD	0	Williams South	SKNF	389622	3899376	2178	This named site is depicted on the DRG.
Big Spring SKNF	NHD	0	Davenport Hill	SKNF	401566	3891102	2080	This named site is depicted on the DRG.
Bill Williams Loop unnamed spring	NHD	0	May Tank Pocket	SKNF	387545	3885837	1982	This site is located toward the head of a canyon, is marked on the DRG, and is included on the NHD Database.
Buck Spring	GEO	0	Davenport Hill	SKNF	404849	3894493	2087	This named site is depicted on the DRG.

Name	Source	Inv	Quad Name	District	Easting	Northing	Elevat	Description
Calcord Spring	NHD	1	Sycamore Point	SKNF	411067	3882166	1928	This is likely an excavated spring that forms a perennial pool. According to Glenn Rink, the pool supported frogs, bullfrogs, and fish; he also found several more pools within 200 m upstream from the site.
Camp Navajo pipe unnamed spring	NHD	2	Bellemont	SKNF	421661	3899093	2167	This spring is marked on the DRG and included in the NHD Database. It is in a heavily developed area within the military reservation boundary. This is a piped spring that emerges under a gravel road and flows into two troughs, then 50 m into a LGC.
Campbell Spring SKNF	NHD	0	Williams South	SKNF	387433	3890385	1999	This named spring is depicted on the DRG.
Clover Spring SKNF	GEO	0	Williams South	SKNF	390478	3899382	2198	This named site is depicted on the DRG.
Dow Spring	DLG	0	Garland Prairie	SKNF	410241	3890717	2050	This named site is located in the headwaters of Sycamore Canyon, and is depicted on the DRG.
East Elk Spring	GEO	1	Moritz Ridge	SKNF	410308	3915233	2219	This named spring, depicted on the DRG, was said to be a perennial spring with riparian vegetation, but the spring was dry during a USFS 2008 survey.
Fues Spring	NHD	0	Williams North	SKNF	396205	3906818	2075	This named site is depicted on the DRG.
Garland Spring	DLG	0	Garland Prairie	SKNF	409150	3894351	2052	This named site is depicted on the DRG.

Name	Source	Inv	Quad Name	District	Easting	Northing	Elevat	Description
Hat Tank lower unnamed spring	GEO	0	May Tank Pocket	SKNF	392754	3883968	2029	This unnamed site is depicted on the DRG, and is included in the NHD Database.
Hat Tank upper unnamed spring	NHD	0	May Tank Pocket	SKNF	393295	3884260	2059	This unnamed site is depicted on the DRG, and is included in the NHD Database.
Hausman Spring	GEO	0	Parks	SKNF	412463	3907881	2250	This site is not listed on the DRG, but was included in the AZ State Land Office layer.
Hitt Spring	NHD	1	White Horse Lake	SKNF	401784	3885959	2096	According to the NPS, this is a perennial Springs with riparian vegetation. This named spring is depicted on the DRG.
Holloway Spring	DLG	0	White Horse Lake	SKNF	400847	3886007	2100	This named site is depicted on the DRG.
Indian Seeps Tank	NHD	0	Sitgreaves Mountain	SKNF	400533	3914013	2045	This spring is depicted on the DRG as Indian Seeps Tank, and is included as an unnamed spring in the NHD Database.
Isham Spring	GEO	0	Davenport Hill	SKNF	405262	3895719	2079	This named site is included on the DRG, but labeled as dry.
Kaufman Spring	DLG	0	Parks	SKNF	410193	3907412	2229	This named spring is depicted on the DRG.
Klostermeyer Spring	GEO	0	Parks	SKNF	418621	3907146	2264	This named site is depicted on the DRG, on the northeast base of Klostermeyer Hill.
L O Spring	DLG	0	Garland Prairie	SKNF	410343	3890488	2041	This named site is located in the headwaters of Sycamore Canyon, and is depicted on the DRG.

Name	Source	Inv	Quad Name	District	Easting	Northing	Elevat	Description
Lee Canyon unnamed spring	NHD	-2	White Horse Lake	SKNF	401816	3883221	2072	Glenn Rink walked from the bottom of this draw to the top and back again and found no evidence of a spring. There is an old log cabin (401692, 3882903) and a 20' steel pipe that has been washed down the draw. There are abundant elk trails, but no H_2O or H_2O improvements.
Lee Canyon unnamed spring	NHD	-2	White Horse Lake	SKNF	399470	3885608	2153	This site is depicted as two springs on the DRG, located in a meadow. During fall survey 2010, Glenn Rink found no water.
Lee Canyon upper unnamed spring	NHD	-2	White Horse Lake	SKNF	398588	3884859	2139	There are two large elk exclosures in this meadow. Glenn Rink found no evidence of a spring. Two springs are depicted on the DRG, and they are included in the NHD database.
Little Spring SKNF	GEO	1	Parks	SKNF	412938	3907077	2234	This named spring is on the north base of Wright Hill. It is depicted on the DRG, and was included in the AZ State Land Office shapefile.
Lockett Spring	NHD	0	Williams South	SKNF	395020	3890149	2158	This named site is depicted on the DRG.
Lost Spring	GEO	0	Moritz Ridge	SKNF	419996	3925679	2198	This site is included in the AZ Land Office springs layer, and is depicted as a water tank on the DRG.
Lower McDermit Spring	DLG	1	Parks	SKNF	416545	3902041	2177	According to the USFS, this spring has little or no riparian vegetation. This named spring is depicted on the DRG.

Name	Source	Inv	Quad Name	District	Easting	Northing	Elevat	Description
McDermit Spring	DLG	0	Parks	SKNF	416944	3903258	2204	This named site is depicted on the DRG and included in the AZ State Land Office shapefile.
McDougal Spring	DLG	1	Williams South	SKNF	398255	3888184	2141	According to the USFS, this named spring, depicted on the DRG, has little or no riparian vegetation.
Mineral Spring	NHD	0	Garland Prairie	SKNF	409170	3900429	2096	Located near railroad tracks, this site is not depicted on the DRG, but is included in the NHD Database.
Mud Springs	NHD	0	May Tank Pocket	SKNF	391853	3886434	2115	This named site is depicted on the DRG.
NE Spring	GEO	0	Parks	SKNF	410232	3904753	2184	This named spring is located near a pipeline, and is depicted on the DRG.
Newman Spring	GEO	0	Kendrick Peak	SKNF	421519	3918267	2581	Located at the base of the west side of Kendrick Peak, this named site is depicted on the DRG.
Pitman Valley unnamed spring	NHD	0	Davenport Hill	SKNF	405442	3901245	2098	This site is not depicted on the DRG, although there are several tanks marked in the area. It is included in the NHD Database.
rocky Tule spring unnamed	NHD	1	White Horse Lake	SKNF	397604	3879880	2012	The spring has been heavily manipulated, with a vertical pipe about 20 inches in diameter. Glenn Rink surveyed the site in September 2010.
Ross Spring	GEO	0	Davenport Hill	SKNF	407215	3896187	2081	This named spring is depicted on the DRG, and labeled as dry.

Name	Source	Inv	Quad Name	District	Easting	Northing	Elevat	Description
Round Mountain unnamed spring	NHD	-2	White Horse Lake	SKNF	401764	3881492	2024	Glenn Rink explored upstream and downstream 200 m both ways from UTMs given and found no evidence of a spring.
Sawmill Spring	DLG	0	Parks	SKNF	412722	3905386	2211	This named spring is depicted on the DRG, and was included in the AZ State Land Office shapefile.
Spitz Spring lower	DLG	0	Parks	SKNF	411352	3902378	2128	This spring is the lower of two named springs depicted on the DRG, and included in the AZ State Land Office layer.
Spitz Spring upper	NHD	0	Parks	SKNF	411372	3902461	2130	This spring is the lower of two named springs depicted on the DRG, and included in the AZ State Land Office layer.
Stage Tank spring	GEO	0	Matterhorn	SKNF	384322	3884371	1969	This spring is included in the AZ State Land Office layer, and is depicted as Stage Tank on the DRG.
Stewart Spring	DLG	0	May Tank Pocket	SKNF	394475	3885558	2135	This named spring is depicted on the DRG, and was included in the AZ State Land Office shapefile.
Summitt Spring	NHD	0	May Tank Pocket	SKNF	395946	3887395	2214	This named site is depicted on the DRG, and may merge from more than one source.
Triangle Spring	NHD	0	Garland Prairie	SKNF	412723	3892376	2059	This site is not shown on the DRG.
Twin Springs	GEO	0	Williams South	SKNF	388450	3892396	2129	This named site is depicted on the DRG, and is included in the AZ State Land Office layer.

Name	Source	Inv	Quad Name	District	Easting	Northing	Elevat	Description
Twin Springs Rd unnamed spring	DLG	0	Williams South	SKNF	389263	3892429	2149	This unnamed spring is depicted on the DRG, and was included in the AZ State Land Office shapefile.
Upper McDermit Spring	DLG	1	Parks	SKNF	416891	3903774	2207	According to the USFS, this spring has little or no riparian vegetation.
Wade Spring	DLG	0	Sitgreaves Mountain	SKNF	405799	3906995	2148	This named spring is depicted on the DRG, and was included in the AZ State Land Office shapefile.
weed unnamed spring	NHD	-2	White Horse Lake	SKNF	398763	3884347	2146	There are two very large and recently built elk exclosures in this meadow. Glenn Rink found no evidence of a spring in September 2000.
West Elk Spring	GEO	0	Moritz Ridge	SKNF	410186	3915601	2195	This named spring is depicted on the DRG and was included in the AZ State Land Office shapefile.
Wild Horse Spring	DLG	0	May Tank Pocket	SKNF	393854	3883749	2048	This site is not depicted on the DRG, but was included in the AZ State Land Office shapefile.
Willow Spring SKNF	DLG	1	Davenport Hill	SKNF	406333	3888376	1980	This is a small pool-forming perennial spring, emerging from a basalt ledge orifice. Glenn Rink confirmed the site in September 2010.

Table 3. Springs by restoration unit and Forest for the Four Forest Restoration Initiative analysis area.

Analysis Area		**Coconino NF**		**Kaibab NF**	
Restoration Unit/Spring Name	**No. of springs**	**Restoration Unit/Spring Name**	**No. of springs**	**Restoration Unit/Spring Name**	**No. of springs**
1	**32**	**1**	**32**	**3**	**16**
Babbit Spring	1	Babbit Spring	1	Andrews Spring*	1
Bootlegger Spring	1	Bootlegger Spring	1	Bear Springs	1
Bristow Spring	1	Bristow Spring	1	Big Spring	1
Broken Spring	1	Broken Spring	1	Bill Williams Loop unnamed spring*	1
Clarks Well	1	Clarks Well	1	Hat Tank lower unnamed spring	1
Dairy Spring	1	Dairy Spring	1	Hat Tank upper unnamed spring	1
Double Springs	2	Double Springs	2	Lee Canyon upper unnamed spring	1
Dove Springs	1	Dove Springs	1	McDougal Spring	1
Howard Spring	1	Howard Spring	1	Mineral Spring	1
Hoxworth Springs	3	Hoxworth Springs	3	rocky Tule spring unnamed	1
Lee Spring	1	Lee Spring	1	Rosilda Spring	1
Mint Spring	1	Mint Spring	1	Stewart Spring	1
Mud Spring	1	Mud Spring	1	Triangle Spring*	1
Munds Spring	1	Munds Spring	1	weed unnamed spring	1
Railroad Spring	1	Railroad Spring	1	Wild Horse Spring	1
Rock Top springs	1	Rock Top springs	1	Willow Spring	1
Sawmill Springs	1	Sawmill Springs	1	**4**	**11**
Sedge Spring	1	Sedge Spring	1	Beale Spring*	1
Seven Anchor Spring	1	Seven Anchor Spring	1	Fues Spring	1
Sheep Spring	1	Sheep Spring	1	Kaufman Spring	1
Smith Spring	1	Smith Spring	1	Lost Spring	1

Analysis Area		**Coconino NF**		**Kaibab NF**	
Restoration Unit/Spring Name	**No. of springs**	**Restoration Unit/Spring Name**	**No. of springs**	**Restoration Unit/Spring Name**	**No. of springs**
Thomas Spring	1	Thomas Spring	1	Lower McDermit Spring	1
Tinny Spring	1	Tinny Spring	1	NE Spring	1
Tree Spring	1	Tree Spring	1	Sawmill Spring	1
T-Six Spring	1	T-Six Spring	1	Spitz Spring lower	1
unnamed	1	unnamed	1	Spitz Spring upper	1
Van Deren Spring	1	Van Deren Spring	1	Upper McDermit Spring	1
Weimer Spring	1	Weimer Spring	1	Wade Spring	1
Willard Spring	1	Willard Spring	1	**Grand Total**	**27**
3	**28**	**3**	**12**		
Andrews Spring*	1	Barney Spring	1		
Barney Spring	1	Black Spring	1		
Bear Springs	1	Garden Spring	1		
Big Spring	1	Griffiths Spring	1		
Bill Williams Loop unnamed spring*	1	Lockwood Spring	1		
Black Spring	1	Lower Hull Spring	1		
Garden Spring	1	Poison Spring	1		
Griffiths Spring*	1	Railroad Spring	1		
Hat Tank lower unnamed spring	1	Ritter Spring	1		
Hat Tank upper unnamed spring	1	Scott Spring	1		
Lee Canyon upper unnamed spring	1	unnamed	1		
Lockwood Spring	1	Upper Hull Spring	1		
Lower Hull Spring	1	**4**	**3**		
McDougal Spring	1	Curley Seep	1		
Mineral Spring	1	Howard Seep	1		

Analysis Area		**Coconino NF**		**Kaibab NF**	
Restoration Unit/Spring Name	**No. of springs**	**Restoration Unit/Spring Name**	**No. of springs**	**Restoration Unit/Spring Name**	**No. of springs**
Poison Spring	1	Kendrick Spring	1		
Railroad Spring	1	**5**	**4**		
Ritter Spring	1	Alto Spring	1		
rocky Tule spring unnamed	1	Chimney Springs	1		
Rosilda Spring	1	Little Elden Spring	1		
Scott Spring	1	Pat Spring	1		
Stewart Spring	1	**Grand Total**	**51**		
Triangle Spring	1				
unnamed	1				
Upper Hull Spring	1				
weed unnamed spring	1				
Wild Horse Spring	1				
Willow Spring	1				
4	**14**				
Beale Spring	1				
Curley Seep	1				
Fues Spring	1				
Howard Seep	1				
Kaufman Spring	1				
Kendrick Spring	1				
Lost Spring	1				
Lower McDermit Spring	1				
NE Spring	1				
Sawmill Spring	1				

Analysis Area		**Coconino NF**		**Kaibab NF**	
Restoration Unit/Spring Name	**No. of springs**	**Restoration Unit/Spring Name**	**No. of springs**	**Restoration Unit/Spring Name**	**No. of springs**
Spitz Spring lower	1				
Spitz Spring upper	1				
Upper McDermit Spring	1				
Wade Spring	1				
5	**4**				
Alto Spring	1				
Chimney Springs	1				
Little Elden Spring	1				
Pat Spring	1				
Grand Total	**78**				

*Springs with inadequate flow information to determine restoration needs

Table 4. Springs of the Coconino National Forest that occur within Four Forest Restoration Initiative treatment areas.

Name	**Forest**	**Meadow**	**Comment**	**Acres**	**Working**	**Possible Mech**	**Cover Type**	**ImpCovType**
Seven Anchor Spring	yes	no		101.4	IT10	Yes	TPP	PP
Broken Spring	yes	no		62.6	UEA40	Yes	TPP	PP
	edge	edge		18.1	Operational Burn	No	GRA	
Tinny Spring	yes	no		22.9	UEA25	Yes	TPP	PP
Van Deren Spring	yes	yes		350.2	MSO Restricted Trt	Yes	TPP	PP
Lee Spring	edge	yes	tree succession in meadow	50.5	Pot PAC Trt	Yes	TPP	PP
Sawmill Springs	yes	edge	Bebb's willow , riparian reach	66.5	MSO Restricted Trt	Yes	TPP	PP
Rock Top springs	yes	no		61.0	Pot PAC Trt	Yes	TPP	PP

Name	Forest	Meadow	Comment	Acres	Working	Possible Mech	Cover Type	ImpCovType
Mint Spring	yes	no		71.8	UEA40	Yes	TPP	PP
Tree Spring	no	yes		12.7	Operational Burn	No	GRA	
Dove Springs	yes	no	345 kV powerline corridor	76.9	UEA40	Yes	TPP	PP
Railroad Spring	yes	edge		7.6	UEA40	Yes	TPP	PP
Bristow Spring	yes	no		52.8	SI40	Yes	TPP	PP
Sedge Spring	yes	no		35.8	MSO Restricted Trt	Yes	TPP	PP
T-Six Spring	edge	yes	next to private	36.6	UEA40	Yes	TPP	PP
Bootlegger Spring	yes	no		29.0	Aspen Treatment	No	TAA	AA
Sheep Spring	yes	no		19.0	Savanna	No	TPP	AA
Munds Spring	no	yes		364.0	Operational Burn	No	GRA	
Smith Spring	edge	yes	edge of Mormon Lake	61.8	MSO Restricted Trt	Yes	TPP	PP
Double Springs	yes	no	next to campground	57.5	MSO Restricted Trt	Yes	TPP	PP
Double Springs	edge	edge	next to campground	57.5	MSO Restricted Trt	Yes	TPP	PP
Dairy Spring	yes	edge	next to Mormon Lake	73.4	MSO Restricted Trt	Yes	TPP	PP
Mud Spring	yes	edge		7.6	Operational Burn	No	GRA	
Weimer Spring	edge	edge	heavy recreation use	4.0	Operational Burn	No	GRA	
Willard Spring	yes	no		18.8	UEA25	Yes	TPP	PP
Howard Spring	yes	no		13.8	MSO Restricted Trt	Yes	TPP	PP
Ritter Spring	yes	no	sparse canopy	24.1	MSO Restricted Trt	Yes	TPP	PP
Scott Spring	no	yes		81.5	MSO Restricted Trt	Yes	TPP	PP
Thomas Spring	edge	edge		2.4	Operational Burn	No	GRA	
Lockwood Spring	yes	no		3.6	MSO Restricted Trt	Yes	TPP	PP
Babbit Spring	yes	edge		34.7	SI40	Yes	TPP	PP
Clarks Well	edge	yes	Elk Park project	32.2	Operational Burn	No	GRA	

Name	Forest	Meadow	Comment	Acres	Working	Possible Mech	Cover Type	ImpCovType
Griffiths Spring	edge	edge		46.0	UEA25	Yes	TPP	OS
Poison Spring	yes	no	next to private	59.2	UEA40	Yes	TPP	PP
Railroad Spring	no	yes		29.6	Operational Burn	No	GRA	
Lower Hull Spring	edge	edge	next to private land	344.1	UEA40	Yes	TPP	PP
Upper Hull Spring	no	yes		30.3	Operational Burn	No	GRA	
Chimney Springs	yes	no		12.4	IT25	Yes	TPP	PP
Little Elden Spring	yes	no	Cultural site, large oak	2.6	Operational Burn	No	GRA	
Alto Spring				30.0	UEA10	Yes	TPP	PP
Pat Spring	yes	no		130.4	Operational Burn	No	GRA	
Curley Seep	yes	no	Hochderffer Fire	19.4	Savanna	Yes	TPP	PP
Kendrick Spring	yes	no		35.1	UEA40	No	TPP	AA
Howard Seep	yes	no	Hochderffer Fire	171.6	Operational Burn	No	GRA	

Table 5. Springs of the Kaibab National Forest that occur within Four Forest Restoration Initiative treatment areas.

NAME	forest	meadow	Acres	Working	Poss_Mech	Cov_Type	ImpCovTyp
rocky Tule spring unnamed			23.5	MSO Restricted Trt	Yes	TPP	PP
Bear Springs			6.6	UEA10	Yes	TPJ	PP
Wild Horse Spring			26.8	MSO Restricted Trt	Yes	TMH	OS
Hat Tank lower unnamed spring			41.2	MSO Restricted Trt	Yes	TPP	OS
Hat Tank upper unnamed spring			174.6	MSO Restricted Trt	Yes	TPP	PP
weed unnamed spring			53.0	MSO Restricted Trt	Yes	TPP	PP
Lee Canyon upper unnamed spring			9.6	Aspen Treatment	Yes	TAA	PP
Stewart Spring			11.5	MSO Restricted Trt	Yes	TPP	PP
Bill Williams Loop unnamed spring			24.3	UEA40	Yes	TPP	PP
McDougal Spring			10.3	Savanna	Yes	TPP	PP
Willow Spring			13.7	UEA40	Yes	TPP	PP
Big Spring			29.9	Savanna	Yes	TPP	PP

NAME	forest	meadow	Acres	Working	Poss_Mech	Cov_Type	ImpCovTyp
Andrews Spring	yes/canyon	no	85.5	IT10	No	TPP	PP
Triangle Spring			2087.6	Operational Burn	No	GRA	
Rosilda Spring			9.1	Operational Burn	No	GRA	
Mineral Spring			6.0	Operational Burn	No	GRA	
Lower McDermit Spring			92.6	MSO Restricted Trt	Yes	TPP	PP
Spitz Spring lower			19.5	Operational Burn	No	GRA	
Spitz Spring upper			52.0	UEA40	Yes	TPP	PP
Upper McDermit Spring			78.2	Savanna	Yes	TPP	PP
NE Spring			20.1	IT40	Yes	TPP	PP
Sawmill Spring			11.0	UEA40	Yes	TPP	PP
Fues Spring			730.8	Operational Burn	No	GRA	
Wade Spring			48.3	UEA25	Yes	TPP	PP
Kaufman Spring			55.7	UEA40	Yes	TPP	PP
Beale Spring			41.7	IT10	Yes	TPP	PP
Lost Spring			133.7	UEA25	No	TPP	PJ

Table 6. Spring Restoration Adaptive Management Plan.

Evaluation Criteria	Desired Condition (forest plan, policy, etc.)	Existing Condition (what, where, how much?)	Possible Management Actions	Monitoring Measure	Trigger Indicating Additional Action is Needed (What – When)	Adaptive Options	Effects	Design Features/ Mitigations
Spring is not developed and occurs in a forested setting. Vegetation and soils range from satisfactory condition and water flow is occurring to vegetation/soils are below potential or are impaired/unsatisfactory and no evidence of water flow from spring.	Springs and associated streams and wetlands have the necessary soil, water, and vegetation attributes to be healthy and functioning at or near potential. Water flow patterns, recharge rates, and geochemistry are similar to historic levels and persist over time. Water quality and quantity maintain native aquatic and riparian habitat and water for wildlife and designated beneficial uses, consistent with water rights and site capability. Plant distribution and occurrence are resilient to natural disturbances. Soils are in satisfactory condition.	Many springs on the Coconino and Kaibab National Forests have been adversely affected through constructed modifications, ungulate grazing, and recreational activities. Other springs occur on the 2 national forests that are not developed and occur in a forested setting. There are 6 springs on the Coconino that are located in forested areas, but the status of development is unknown.	If vegetation/soils are satisfactory: Remove tree canopy to pre-settlement condition within 2-5 chains of the spring; apply for water right if none exists; prescribe burn, no action. If vegetation/soils are below potential or are impaired/unsatisfactory. Remove tree canopy to pre-settlement condition within 2-5 chains of the spring; apply for water right if none exists; remove noxious weeds; prescribe burn, identify stressor and provide protection measure for the stressor (fence, jackstraw, remove/relocate road/trail etc) and/or other methods designed to meet the desired conditions.	PFC, MNA level 1 monitoring, water flow (possible new direction for spring monitoring from FS), photo points	Drop in PFC class, monitoring displays a dropping trend-monitoring every 1-10 years	ID stressor, protect from stressor (fence/jackstraw, close road, relocated road etc) and/or no action.	Effects of initial action are related to tree removal---short-term ground disturbance will occur from felling and skidding operations and possible sediment detachment and movement off-site, short-term noise disturbance to wildlife species from all implementation activities. Long-term establishment of vegetation, improved dissipation of stream energy, improve water storage, decreased peak flows and transported sediments.	To be added as BMP's---designated skid trails, no decking or piling of material within 100 feet of spring source or outflow. Protect Bebb's willow from rx burn. Design any fencing to minimize impacts to avian species and provide small animal passage; mitigate any cultural resource concerns through avoidance of sites, prevent the spread of noxious weeds through any management activities by prescribing

Evaluation Criteria	Desired Condition (forest plan, policy, etc.)	Existing Condition (what, where, how much?)	Possible Management Actions	Monitoring Measure	Trigger Indicating Additional Action is Needed (What – When)	Adaptive Options	Effects	Design Features/ Mitigations
								equipment cleaning; prevent chytrid fungus spread at spring sites by prescribing chytrid prevention methodologies.
Spring is developed and is in a forested setting. Vegetation and soils range from satisfactory condition and water flow is occurring to vegetation/soils are below potential or are impaired/unsatisfactory and no evidence of water flow from spring.	Springs and associated streams and wetlands have the necessary soil, water, and vegetation attributes to be healthy and functioning at or near potential. Water flow patterns, recharge rates, and geochemistry are similar to historic levels and persist over time. Water quality and quantity maintain native aquatic and riparian habitat and water for wildlife and designated beneficial uses, consistent with water rights and site capability. Plant	There are 26 springs on the Kaibab that are located in forested areas, X of these are developed, the status of development on X springs is unknown. There are 40 springs on the Coconino that are located in forested areas and are developed. There are 6 springs on the Coconino that are located in	Negotiate with holders of water rights that are non-Forest Service at Alto, Chimney, Dairy, Double, Garden, Griffiths, Howard, Little Elden, Lower Hull, Mud, Pat, Sawmill, Seven Anchor and Upper Hill Springs on the Coconino National Forest and xxxx springs on the Kaibab National Forest to explore the possibility of releasing water above their water right for riparian conditions. If vegetation/soils are satisfactory: Remove tree canopy to pre-	PFC, MNA level 1 monitoring, water flow (possible new direction for spring monitoring from FS), photo points	Drop in PFC class, monitoring displays a dropping trend-monitoring every 1-10 years	ID stressor, protect from stressor (fence/jackstraw, close road, relocated road etc) and/or no action.	Effects of initial action are related to tree removal---short-term ground disturbance will occur from felling and skidding operations and possible sediment detachment and movement off-site, short-term noise disturbance to wildlife species from all implementation activities. Long-term establishment of vegetation, improved dissipation of stream energy, improve water	To be added as BMP's---designated skid trails, no decking or piling of material within 100 feet of spring source or outflow. Protect Bebb's willow from rx burn (if it occurs). Design any fencing to minimize impacts to avian species and provide small animal passage;

Evaluation Criteria	Desired Condition (forest plan, policy, etc.)	Existing Condition (what, where, how much?)	Possible Management Actions	Monitoring Measure	Trigger Indicating Additional Action is Needed (What – When)	Adaptive Options	Effects	Design Features/ Mitigations
	distribution and occurrence are resilient to natural disturbances. Soils are in satisfactory condition.	forested areas, but the status of development is unknown.	settlement condition within 2-5 chains of the spring; prescribe burn, re-plumb spring to allow for water above existing water right to be released to expand current riparian conditions, and/or other methods designed to meet the specific conditions associated. If vegetation/soils are below potential or are impaired/unsatisfactory. Remove tree canopy to pre-settlement condition within 2-5 chains of the spring; prescribe burn; remove noxious weeds; re-plumb spring to allow for water above existing water right to be released to expand current riparian conditions; identify stressor and provide protection measure for the stressor (fence, jackstraw, remove/relocate road/trail etc) and/or other methods designed to meet the desired				storage, decreased peak flows and transported sediments. Fencing would cause short-term disturbance from construction activities, may have impact on avian mortality for the life of the fence. Road/trail removal/re-alignment would have short-term disturbance to soils and possible sediment detachment.	mitigate any cultural resource concerns through avoidance of sites, prevent the spread of noxious weeds through any management activities by prescribing equipment cleaning; prevent chytrid fungus spread at spring sites by prescribing chytrid prevention methodologies.

Evaluation Criteria	Desired Condition (forest plan, policy, etc.)	Existing Condition (what, where, how much?)	Possible Management Actions	Monitoring Measure	Trigger Indicating Additional Action is Needed (What – When)	Adaptive Options	Effects	Design Features/ Mitigations
			conditions.					
Spring is not developed and occurs in a meadow setting. Vegetation and soils range from satisfactory condition and water flow is occurring to vegetation/soils are below potential or are impaired/unsatisfactory and no evidence of water flow from spring.	Springs and associated streams and wetlands have the necessary soil, water, and vegetation attributes to be healthy and functioning at or near potential. Water flow patterns, recharge rates, and geochemistry are similar to historic levels and persist over time. Water quality and quantity maintain native aquatic and riparian habitat and water for wildlife and designated beneficial uses, consistent with water rights and site capability. Plant distribution and occurrence are resilient to natural disturbances. Soils are in satisfactory condition.	X # of springs occurs on the 2 national forests that are not developed and occur in a meadow setting. There is 1 spring on the Coconino (Scott Spring) that is located in meadow areas, but the status of development is unknown. There is 1 spring on the Kaibab that is located in meadow areas, but the status of development is unknown.	If vegetation/soils are satisfactory: apply for water right if none exists; prescribe burn, no action. If vegetation/soils are below potential or are impaired/unsatisfactory: Apply for water right if none exists; remove noxious weeds; prescribe burn, identify stressor and provide protection measure for the stressor (fence, jackstraw, remove/relocate road/trail etc) and/or other methods designed to meet the desired conditions.	PFC, MNA level 1 monitoring, water flow (possible new direction for spring monitoring from FS), photo points	Drop in PFC class, monitoring displays a dropping trend-monitoring every 1-10 years	ID stressor, protect from stressor (fence/jackstraw, close road, relocated road etc) and/or no action.	Effects of ground disturbing activities are possible sediment detachment and movement off-site, short-term noise disturbance to wildlife species from all implementation activities. Long-term establishment of vegetation, improved dissipation of stream energy, improve water storage, decreased peak flows and transported sediments. Fencing would cause short-term disturbance from construction activities, may have impact on avian mortality for the life of the fence.	To be added as BMP's--- Protect Bebb's willow from rx burn (if it occurs). Design any fencing to minimize impacts to avian species and provide small animal passage; mitigate any cultural resource concerns through avoidance of sites, prevent the spread of noxious weeds through any management activities by prescribing equipment cleaning;

Evaluation Criteria	Desired Condition (forest plan, policy, etc.)	Existing Condition (what, where, how much?)	Possible Management Actions	Monitoring Measure	Trigger Indicating Additional Action is Needed (What – When)	Adaptive Options	Effects	Design Features/ Mitigations
								prevent chytrid fungus spread at spring sites by prescribing chytrid prevention methodologies.
Spring is developed and is in a meadow setting. Vegetation and soils range from satisfactory condition and water flow is occurring to vegetation/soils are below potential or are impaired/unsatisfactory and no evidence of water flow from spring.	Springs and associated streams and wetlands have the necessary soil, water, and vegetation attributes to be healthy and functioning at or near potential. Water flow patterns, recharge rates, and geochemistry are similar to historic levels and persist over time. Water quality and quantity maintain native aquatic and riparian habitat and water for wildlife and designated beneficial uses, consistent with water rights and site capability. Plant distribution and occurrence are resilient to natural disturbances. Soils are in satisfactory condition.	X # of springs occur on the 2 national forests that are developed and occur in a meadow setting. There are 4 springs on the Coconino that are located in meadow areas and are developed.	If vegetation/soils are satisfactory: prescribe burn, re-plumb spring to allow for water above existing water right to be released to expand current riparian conditions, and/or other methods designed to meet the specific conditions associated. If vegetation/soils are below potential or are impaired/unsatisfactory. prescribe burn; remove noxious weeds; re-plumb spring to allow for water above existing water right to be released to expand current riparian conditions; identify stressor and provide protection measure for the stressor (fence, jackstraw, remove/relocate	PFC, MNA level 1 monitoring, water flow (possible new direction for spring monitoring from FS), photo points	Drop in PFC class, monitoring displays a dropping trend-monitoring every 1-10 years	ID stressor, protect from stressor (fence/jackstraw, close road, relocated road etc) and/or no action.	Effects of ground disturbing activities are possible sediment detachment and movement off-site, short-term noise disturbance to wildlife species from all implementation activities. Long-term establishment of vegetation, improved dissipation of stream energy, improve water storage, decreased peak flows and transported sediments. Fencing would cause short-term disturbance from construction activities, may have impact on avian mortality for the life of the fence.	To be added as BMP's--- designated skid trails, no decking or piling of material within 100 feet of spring source or outflow. Protect Bebb's willow from rx burn (if it occurs). Design any fencing to minimize impacts to avian species and provide small animal passage; mitigate any cultural resource concerns through avoidance of

Evaluation Criteria	Desired Condition (forest plan, policy, etc.)	Existing Condition (what, where, how much?)	Possible Management Actions	Monitoring Measure	Trigger Indicating Additional Action is Needed (What – When)	Adaptive Options	Effects	Design Features/ Mitigations
			road/trail etc) and/or other methods designed to meet the desired conditions.					sites, prevent the spread of noxious weeds through any management activities by prescribing equipment cleaning; prevent chytrid fungus spread at spring sites by prescribing chytrid prevention methodologies.

Appendix F

Current Projects in the Four Forest Restoration Initiative Analysis Area

Table 1. Current or ongoing projects on the Coconino National Forest by HUC12 subwatershed within the Four Forest Restoration Initiative Analysis Area.

HUC12 Subwatershed/treatment type	**Acres**
Anderson Canyon	**2,608**
Broadcast Burning - Covers a majority of the unit	1,810
Thinning for Hazardous Fuels Reduction	399
Tree Encroachment Control	399
Babbitt Lake	**436**
Control of Understory Vegetation	77
Thinning for Hazardous Fuels Reduction	222
Wildland Fire Use	136
Bar M Canyon	**3,026**
Broadcast Burning - Covers a majority of the unit	629
Burning of Piled Material	165
Commercial Thin	209
Piling of Fuels, Hand or Machine	59
Thinning for Hazardous Fuels Reduction	7
Wildland Fire Use	1,957
Bear Jaw Canyon	**247**
Broadcast Burning - Covers a majority of the unit	247
Cherry Canyon-Walnut Creek	**9,359**
Broadcast Burning - Covers a majority of the unit	1,273
Burning of Piled Material	2,011
Commercial Thin	1,773
Permanent Land Clearing	150
Piling of Fuels, Hand or Machine	1,859
Thinning for Hazardous Fuels Reduction	1,859
Tree Encroachment Control	104
Wildlife Habitat Mechanical treatment	330
Dent and Sayer Tank	**1,943**
Control of Understory Vegetation	0
Thinning for Hazardous Fuels Reduction	0
Wildland Fire Use	1,943
Doney Park	**948**
Broadcast Burning - Covers a majority of the unit	566
Burning of Piled Material	86
Chipping of Fuels	106
Site Preparation for Natural Regeneration - Manual	104
Thinning for Hazardous Fuels Reduction	86
Double Cabin Park-Jacks Canyon	**2,871**
Broadcast Burning - Covers a majority of the unit	2,511

HUC12 Subwatershed/treatment type	**Acres**
Wildfire - Natural Ignition	204
Wildland Fire Use	157
Fry Canyon	**1,620**
Broadcast Burning - Covers a majority of the unit	306
Burning of Piled Material	907
Commercial Thin	407
Kinnikinick Canyon	**2,667**
Broadcast Burning - Covers a majority of the unit	1,167
Commercial Thin	500
Piling of Fuels, Hand or Machine	500
Thinning for Hazardous Fuels Reduction	500
Lower Rio de Flag	**2,649**
Broadcast Burning - Covers a majority of the unit	565
Burning of Piled Material	762
Liberation Cut	0
Piling of Fuels, Hand or Machine	687
Thinning for Hazardous Fuels Reduction	597
Tree Encroachment Control	21
Yarding - Removal of Fuels by Carrying or Dragging	16
Lower Woods Canyon	**272**
Broadcast Burning - Covers a majority of the unit	272
Middle Oak Creek	**4**
Burning of Piled Material	2
Thinning for Hazardous Fuels Reduction	2
Mormon Canyon	**488**
Broadcast Burning - Covers a majority of the unit	488
Mormon Lake	**7,296**
Broadcast Burning - Covers a majority of the unit	2,079
Burning of Piled Material	1,171
Commercial Thin	3,203
Piling of Fuels, Hand or Machine	353
Thinning for Hazardous Fuels Reduction	330
Wildland Fire Use	161
Munds Canyon	**2,267**
Burning of Piled Material	13
Piling of Fuels, Hand or Machine	256
Thinning for Hazardous Fuels Reduction	269
Wildfire - Natural Ignition	1,729
Porcupine Canyon-Walnut Creek	**33**
Burning of Piled Material	11

HUC12 Subwatershed/treatment type	**Acres**
Piling of Fuels, Hand or Machine	11
Thinning for Hazardous Fuels Reduction	11
Pumphouse Wash	**10,528**
Broadcast Burning - Covers a majority of the unit	2,180
Burning of Piled Material	3,797
Commercial Thin	3,784
Piling of Fuels, Hand or Machine	303
Thinning for Hazardous Fuels Reduction	357
Tree Encroachment Control	107
Rabbit Canyon	**193**
Control of Understory Vegetation	1
Thinning for Hazardous Fuels Reduction	1
Wildland Fire Use	191
Rattlesnake Canyon	**1,584**
Wildfire - Natural Ignition	1,222
Wildland Fire Use	362
Sinclair Wash	**103**
Broadcast Burning - Covers a majority of the unit	53
Burning of Piled Material	25
Commercial Thin	25
Telephone Tank	**1,813**
Broadcast Burning - Covers a majority of the unit	833
Burning of Piled Material	444
Commercial Thin	536
Upper Deadman Wash	**842**
Broadcast Burning - Covers a majority of the unit	842
Upper Kana-a Wash	**991**
Wildfire - Natural Ignition	768
Wildland Fire Use	223
Upper Oak Creek	**711**
Broadcast Burning - Covers a majority of the unit	533
Burning of Piled Material	124
Thinning for Hazardous Fuels Reduction	54
Upper Padre Canyon	**4,131**
Broadcast Burning - Covers a majority of the unit	3,955
Commercial Thin	59
Piling of Fuels, Hand or Machine	59
Thinning for Hazardous Fuels Reduction	59
Upper Rio de Flag	**4,152**
Broadcast Burning - Covers a majority of the unit	2,014

HUC12 Subwatershed/treatment type	**Acres**
Burning of Piled Material	1,459
Commercial Thin	498
Permanent Land Clearing	4
Piling of Fuels, Hand or Machine	79
Site Preparation for Natural Regeneration - Manual	10
Thinning for Hazardous Fuels Reduction	79
Wildlife Habitat Regeneration cut	10
Upper San Francisco Wash	**687**
Broadcast Burning - Covers a majority of the unit	299
Burning of Piled Material	318
Piling of Fuels, Hand or Machine	42
Thinning for Hazardous Fuels Reduction	28
Upper Woods Canyon	**1,575**
Wildfire - Natural Ignition	375
Wildland Fire Use	1,200
Volunteer Canyon	**3,323**
Broadcast Burning - Covers a majority of the unit	1,116
Burning of Piled Material	964
Commercial Thin	1,244
Volunteer Wash	**686**
Broadcast Burning - Covers a majority of the unit	506
Site Preparation for Natural Regeneration - Manual	90
Wildlife Habitat Regeneration cut	90
Walnut Creek-Lower Lake Mary	**2,200**
Broadcast Burning - Covers a majority of the unit	2,103
Piling of Fuels, Hand or Machine	96
Walnut Creek-Upper Lake Mary	**416**
Thinning for Hazardous Fuels Reduction	8
Wildfire - Natural Ignition	408
Grand Total	**72,670**

Table 2. Current or ongoing projects on the Kaibab National Forest by HUC12 subwatershed within the Four Forest Restoration Initiative Analysis Area.

HUC12 Subwatershed/treatment type	**Acres**
Bear Canyon	**85**
Wildfire - Fuels Benefit	85
Big Spring Canyon	**2,746**
Broadcast Burning - Covers a majority of the unit	709
Burning of Piled Material	900
Commercial Thin	719
Group Selection Cut (UA/RH/FH)	249
Piling of Fuels, Hand or Machine	168
Cataract Creek Headwaters	**1,461**
Broadcast Burning - Covers a majority of the unit	683
Burning of Piled Material	64
Piling of Fuels, Hand or Machine	713
Cedar Creek	**872**
Wildfire - Fuels Benefit	872
Coconino Wash Headwaters	**4,971**
Broadcast Burning - Covers a majority of the unit	2,741
Burning of Piled Material	276
Piling of Fuels, Hand or Machine	335
Wildfire - Fuels Benefit	391
Wildfire - Natural Ignition	1,229
Curley Wallace Tank	**5,541**
Wildfire - Natural Ignition	5,541
Dent and Sayer Tank	**6,443**
Wildfire - Fuels Benefit	4,245
Wildlife Habitat Mechanical treatment	2,198
Devil Dog Canyon	**70**
Broadcast Burning - Covers a majority of the unit	70
Dogtown Wash	**865**
Broadcast Burning - Covers a majority of the unit	202
Burning of Piled Material	286
Piling of Fuels, Hand or Machine	377
Garland Prairie	**272**
Burning of Piled Material	180
Piling of Fuels, Hand or Machine	91
Government Canyon	**142**
Wildfire - Fuels Benefit	142
Government Prairie	**435**
Burning of Piled Material	75

HUC12 Subwatershed/treatment type	**Acres**
Piling of Fuels, Hand or Machine	273
Wildfire - Natural Ignition	87
Grindstone Wash	**1,235**
Broadcast Burning - Covers a majority of the unit	1,235
Johnson Creek	**1,455**
Broadcast Burning - Covers a majority of the unit	1,022
Burning of Piled Material	103
Piling of Fuels, Hand or Machine	330
Juan Tank Canyon	**13**
Piling of Fuels, Hand or Machine	13
Little Red Horse Wash	**3,360**
Broadcast Burning - Covers a majority of the unit	11
Burning of Piled Material	58
Piling of Fuels, Hand or Machine	54
Wildfire - Fuels Benefit	3,160
Wildfire - Natural Ignition	77
Lower Sycamore Creek	**38**
Wildfire - Fuels Benefit	38
MC Canyon	**193**
Broadcast Burning - Covers a majority of the unit	193
Meath Wash	**127**
Broadcast Burning - Covers a majority of the unit	127
Miller Wash Headwaters	**5,936**
Wildfire - Fuels Benefit	1,301
Wildfire - Natural Ignition	848
Wildlife Habitat Mechanical treatment	3,786
Pitman Valley-Scholz Lake	**1,792**
Broadcast Burning - Covers a majority of the unit	359
Burning of Piled Material	956
Commercial Thin	195
Group Selection Cut (UA/RH/FH)	68
Piling of Fuels, Hand or Machine	214
Rabbit Canyon	**58**
Wildfire - Fuels Benefit	58
Rain Tank Wash	**2,144**
Broadcast Burning - Covers a majority of the unit	789
Burning of Piled Material	205
Wildfire - Fuels Benefit	1,151
Rattlesnake Wash	**313**
Broadcast Burning - Covers a majority of the unit	313

HUC12 Subwatershed/treatment type	**Acres**
Red Horse Wash Headwaters	**897**
Wildfire - Natural Ignition	897
Sawmill Tank	**78**
Burning of Piled Material	78
Tule Canyon	**7,064**
Broadcast Burning - Covers a majority of the unit	260
Burning of Piled Material	223
Wildfire - Fuels Benefit	6,580
Upper Cataract Creek	**116**
Burning of Piled Material	12
Piling of Fuels, Hand or Machine	104
Upper Hell Canyon	**1,700**
Broadcast Burning - Covers a majority of the unit	1,628
Burning of Piled Material	37
Piling of Fuels, Hand or Machine	35
Upper Lee Canyon	**1,765**
Burning of Piled Material	25
Piling of Fuels, Hand or Machine	25
Wildfire - Natural Ignition	1,715
Upper Red Lake Wash	**1**
Burning of Piled Material	1
Upper Spring Valley Wash	**7,979**
Broadcast Burning - Covers a majority of the unit	239
Burning of Piled Material	1,148
Piling of Fuels, Hand or Machine	113
Thinning for Hazardous Fuels Reduction	57
Wildfire - Natural Ignition	6,421
Grand Total	**60,167**

Appendix G

Protected streamcourses that occur in the Four Forest Restoration Initiative Project Area

Table 1. Protected streamcourses within the Four Forest Restoration Initiative Analysis Area.

Riparian Reach	Functional Class	Length (miles)
1502001514D002	PFC	1.8
1502001514D001	AT RISK	2.1
1502001513A002	AT RISK	2.0
1502001513A002	AT RISK	2.2
1506020286D003	AT RISK	1.7
1506020286D002	AT RISK	0.7
1506020286C003	PFC	0.7
1502001513A003	AT RISK	1.3
1506020286C004	AT RISK	0.3
1506020286C005	AT RISK	1.4
1506020286D002	AT RISK	3.0
1502001513A004	AT RISK	2.1
1506020287H009	PFC	1.3
1506020287H010	PFC	0.5
1506020287H008	AT RISK	0.5
1506020287H008	AT RISK	0.9
1502001513C001	AT RISK	0.4
1502001513C001	AT RISK	0.4
1502001513C002	AT RISK	0.2
1502001513B001	NON-RIPARIAN	1.5
1502001513B002	AT RISK	0.2
1506020287H005	PFC	1.8
1506020287G001	PFC	1.8
1502001513B003	PFC	2.4
1502001513B002	AT RISK	0.1
1502001513B002	AT RISK	0.3
1506020287H006	PFC	1.3
1506020287H005	PFC	0.3
1506020287G002	PFC	1.2
1506020287F004	AT RISK	0.2
1506020287H007	PFC	3.8
1502001513C005	PFC	0.8
1502001513C003	NON-FUNCTIONAL	1.5

Riparian Reach	Functional Class	Length (miles)
1506020287H002	PFC	1.9
1506020287H004	PFC	0.9
1506020287H002	PFC	0.3
1506020287H005	PFC	1.6
1506020287F005	AT RISK	0.2
1506020287F005	AT RISK	0.1
1506020287H003	PFC	0.5
1506020287F005	AT RISK	0.8
1506020287F002	PFC	1.8
1502001513C004	PFC	1.0
1506020287F003	PFC	0.2
1506020287H001	PFC	1.7
1502001513C006	AT RISK	4.8
1502001513C006	AT RISK	0.3
1506020287F002	PFC	0.3
1502001513C006	AT RISK	0.4
1506020287J003	PFC	0.3
1506020288E007	PFC	1.4
1506020288E006	PFC	1.7
1506020288E005	PFC	0.9
1506020288F002	PFC	2.5
1506020288E004	AT RISK	0.3
1506020288F002	PFC	5.8
1506020288F001	PFC	1.3
1506020288E003	PFC	1.0
1502001515B002	AT RISK	1.2
1502001515B001	AT RISK	0.6
1506020288G003	PFC	2.9
		77.5

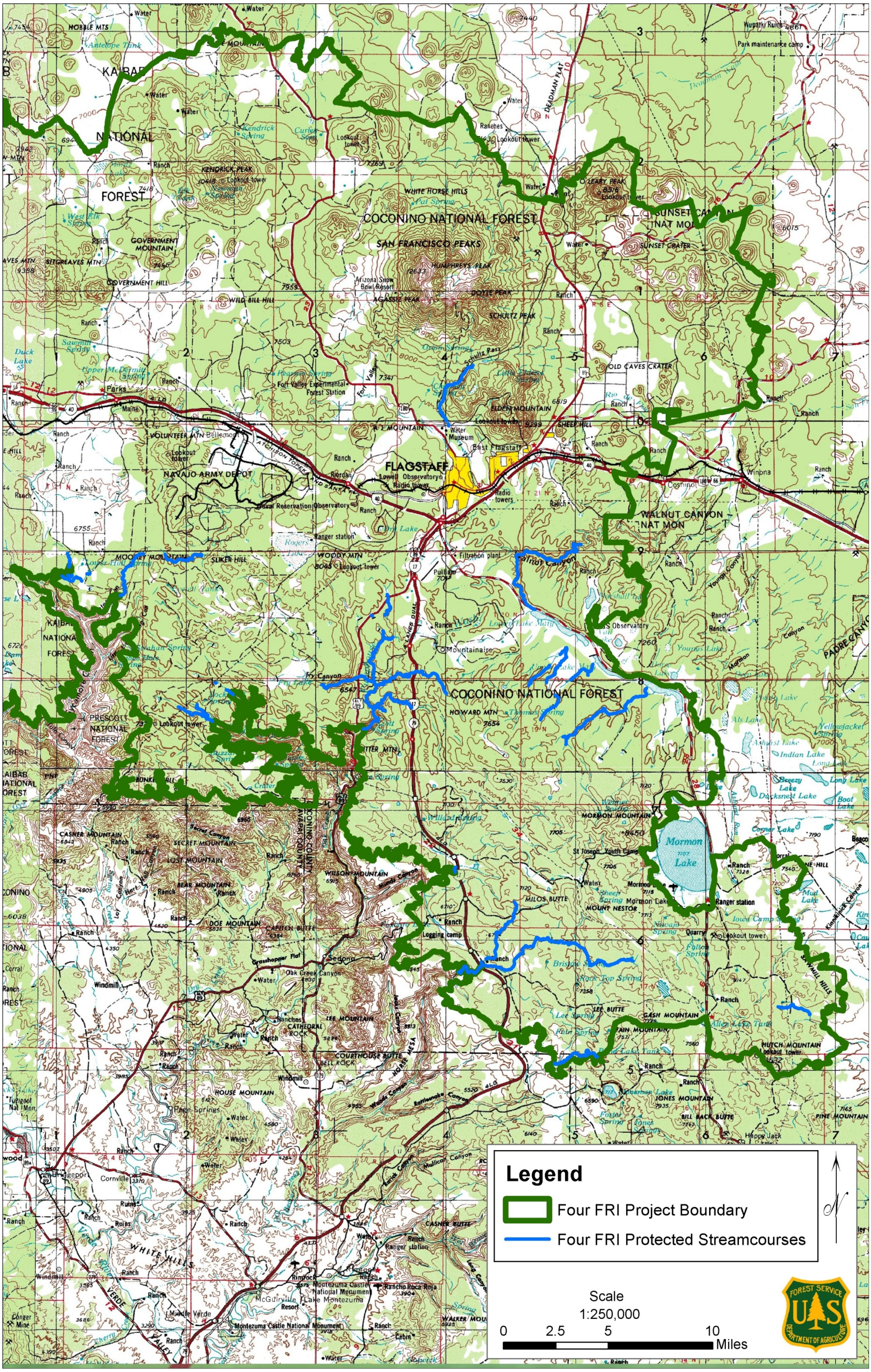


Figure 1. Locations of protected streamcourses in the Four Forest Restoration Initiative Project Area.