Four Forest Restoration Initiative, Rim Country EIS

Soils and Watershed Resource Report

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for:
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Introduction/Project Information

This report is the specialist report for soils and watershed resources relevant to the proposed Four Forest Restoration Initiative Rim Country Project. The report contains the current conditions of soil and watershed resources within the project area as well as the effects of each alternative on soils and watershed resources.

The Four-Forest Restoration Initiative (4FRI) is a planning effort designed to restore forest resiliency and function in ponderosa pine forests across four National Forests in Arizona including the Coconino, Kaibab, Apache-Sitgreaves and Tonto. This environmental analysis focuses on soils and watershed resources on portions of the Coconino National Forest (hereafter referred to as Coconino NF), the Apache-Sitgreaves National Forests (hereafter referred to as the A-S NFs) and the Tonto National Forest (hereafter referred to as the Tonto NF) with a project area totaling approximately 1,240,000 acres on the Mogollon Rim and Red Rock Ranger Districts of the Coconino NF, the Black Mesa and Lakeside Districts of the Apache-Sitgreaves NFs, and the Payson and Pleasant Valley Districts of the Tonto NF.

This analysis focuses on soils resources and watershed condition and function on the Coconino NF, A-S NFs and Tonto NF. It discloses the affected environment and predicted environmental effects on soils resources and watershed conditions from implementation of each alternative.

Purpose and Need

The purpose and need for the Rim Country Project was determined by comparing the existing conditions in the project area to the desired conditions in the land and resource management plans (forest plans) related to forest and ecosystem function and resiliency. In addition, relevant research, the best available science and information, and the landscape restoration criteria found in the Omnibus Public Land Management Act of 2009 (P.L. 111-11, Title IV Forest Landscape Restoration) were used to develop the purpose and need. These criteria for landscape-scale restoration address community, wildlife habitat, and forest protection while retaining as many large trees as possible. National direction found in Forest Service Manuals 2020 and 4000 was used to evaluate the needs for the Long Valley Experimental Forest.

The purpose of the Rim Country Project is to reestablish and restore forest structure and pattern, forest health, and vegetation composition and diversity in ponderosa pine ecosystems to conditions within the natural range of variation, thus moving the project area toward the desired conditions. The outcome of improving structure and function is increased ecosystem resiliency. Resiliency increases the ability of an ecosystem to survive natural disturbances such as fire, insects and disease, and climate change (FSM 2020.5) without changing its inherent function (SER 2004). This project is needed to:

- Increase forest resiliency and sustainability
- Reduce risk of undesirable fire effects
- Improve terrestrial and aquatic species habitat
- Improve the condition and function of streams and springs
- Restore woody riparian vegetation
- Preserve cultural resources
- Support sustainable forest products industries.

Forest Resiliency and Sustainability. Resiliency increases the ability of the ponderosa pine and mixed conifer-frequent fire forest types (target cover types) to survive natural disturbances and stressors such as fire, insect and disease outbreaks, and climate change (FSM 2020.5). There is a need to restore the frequent low-severity fire regimes in which the forest in the Rim Country project area evolved. The Rim Country Project is expected to move over 1,000,000 acres toward comprehensive, landscape-scale restoration.

There is a need to move tree group pattern, interspaces, and stand density toward the natural range of variation. This is a sum of reference conditions that provides a mix of open, moderately closed, and closed canopy conditions at the fine (group) to landscape (ponderosa pine ecosystems) scales as defined by the Forest Plans. There is a need to manage forest density, structure, and composition to increase forest health and reduce adverse effects from epidemic levels of bark beetles and dwarf mistletoe, while also providing a diversity of habitat types and features. In the oak woodland and shrubland cover types, there is a need to stimulate new growth, maintain vigor in large-diameter trees, encourage faster growth in young smaller oaks, and provide for a variety of shapes and sizes of trees across the forest cover types.

Where aspen is found in the frequent fire forest cover types, there is a need to stimulate growth, reduce conifer encroachment, and increase individual tree recruitment. In grassland cover types, there is a need to reduce or remove trees and other woody species that have encroached, which has decreased the size and function of these systems that were historically grasslands and functionally connected montane meadows.

There is a need to improve the condition of native plant communities and the resiliency of rare species. There is also a need to improve the abundance, diversity, distribution, and vigor of native understory vegetation to provide food and cover for wildlife where it is absent under dense forest stands where fire has been excluded.

In the Long Valley Experimental Forest, there are needs to (1) learn more about restoration through experimentation; (2) restore the composition, structure, function, and structure of the forest overstory and understory; (3) increase resilience to disturbances and climate change; and (4) restore the natural fire regime.

The Rim Country Project includes extensive areas where the ponderosa pine and mixed conifer cover types interface with the pinyon-juniper and oak woodland types. Because of this close association, some facilitative operations may be needed in these other, non-target cover types (such as pinyon-juniper) to support, increase the safety and effectiveness of, and minimize surface disturbance of treatments to restore the frequent-fire forest structure in the target cover types (ponderosa pine types). Facilitative operations would support the safe and effective use of prescribed fire in the cover types targeted for restoration treatments. Where prescribed fire alone would not be safe or effective in a non-target cover type, limited mechanical operations may be needed to create conditions safe for personnel and to ensure prescribed fire meets objectives when entering the target cover types. The expectation is that the majority of the area available for facilitative operations would be for prescribed fire only, with mechanical treatments being the exception. The effects of facilitative operations on the non-target cover types is expected to be maintenance of current conditions or movement toward desired conditions per the applicable forest plan.

Undesirable Fire Effects. There is a need to reduce the risk of undesirable fire behavior and effects, which currently pose a threat to ecosystem function and services, and human safety, lives, and values. Restoring fire regimes in forests and grasslands will decrease the risks of post-fire flooding and debris flows that cause loss of soil productivity, water quality, and watershed function. Reducing the potential for undesirable fire effects and reducing excessive fuel loadings will protect terrestrial and aquatic species habitat as they increase resiliency to fires, including areas within and adjacent to Mexican spotted owl habitat. Protected activity centers (PACs) currently contain high fuel loadings because of past management and a century of wildfire suppression efforts.

Terrestrial and Aquatic Species Habitat. There is a need to move the Rim Country project area toward desired conditions for snags, coarse woody debris, forest structural stages, and stream habitat complexity. There is a need to retain as many old and large trees as possible, recognizing the ecological and socio-political importance of these trees. Where restoration activities occur in the ponderosa pine and dry mixed conifer cover types, there is a need to maintain and promote the development of old growth characteristics and components. There is a need to maintain or improve aquatic habitats to meet needs for fish, frogs, and garter snakes, recognizing the ecological and socio-political importance of these streams and associated riparian areas.

Streams and Springs. There is a need to improve the condition and function of riparian areas, wet meadows, streams, and springs in the Rim Country project area in order to sustain these features for terrestrial and aquatic habitat, as well as for human use. Reducing road density and improving road and stream crossings would maintain natural flow regimes, provide connectivity for aquatic species and habitats, and reduce sediment delivery to streams and other water bodies.

Woody Riparian Vegetation. Restoring native riparian vegetation, including large conifers and willows in some cover types, would reduce sedimentation to stream habitat, provide stream shading, maintain cool-water conditions, and provide large wood recruitment to streams to improve habitat complexity. This may include maintaining and promoting existing vegetation, reducing conifer tree encroachment and noxious weeds, planting desirable species such as willows where they have been extirpated, and returning fire to riparian areas. Re-establishment of woody riparian vegetation will also benefit aquatic and terrestrial fish and wildlife species.

Roads. There is a need to have adequate access for project implementation, but then decommission temporary roads after use to restore these areas once project activities are completed. In addition, there is a need to decommission unneeded routes identified during the forest Travel Management Rule review processes as part of the restoration of the landscape in the project area.

Cultural Resources. There is a need to reduce threats to cultural resources caused by overly dense vegetation and soil erosion. Though most archaeological sites can tolerate low-severity fire, all are very vulnerable to the effects of high severity fire in unnaturally high fuel loads and to the soil loss that occurs in post-fire flooding. In particular, there is a need to reduce fuels accumulation around cultural resources to reduce threats to these non-renewable resources.

Forest Products Industries. As a primary tool to conduct accelerated forest restoration, there is a need to support appropriately-scaled, sustainable, forest products industries that strengthen local economies, while conserving natural resources and aesthetic values. Appropriately-scaled businesses would play a key role in achieving the goals of 4FRI by harvesting, processing, and selling wood products, thereby reducing treatment costs and providing economic opportunities. Engaging industry would offer the opportunity to cover all, or nearly all, of the cost of removal of forest restoration byproducts by the value of the products removed. Restoration that proceeds with enough predictability and social support would allow significant, long-term investment by industry partners.

Desired Conditions for Soils and Watersheds

- Long-term soil productivity is protected by maintaining or improving soil condition and function.
- Soil condition and function is maintained or improved toward satisfactory condition.
- The vegetative ground cover is adequate to protect against accelerated erosion resulting in maintenance of soil stability, and soil and vegetative productivity. Soil loss is below tolerance levels,

and no visible signs of excessive or accelerated erosion are present.

- Adequate vegetative ground cover is present to reduce the threat to life, property, soil productivity and water quality from post wildfire storm events (flooding and debris flows).
- Surface soil hydrologic function is in satisfactory condition with well aggregated, granular surface soil structure and tubular pores with sufficient porosity to effectively infiltrate water.
- Soil nutrient cycling is in satisfactory condition. Vegetative ground cover, plant basal area, species composition and forage productivity and herbaceous understory approaches natural conditions in PPC.
- Forests are restored at the landscape-scale and will provide for sustainable, forest health, wildlife and plant diversity while at the same time maintain and improve long-term soil productivity. The resultant forests are fire-adapted with the majority of fires occurring as low soil burn severity ground fires.
- Watershed function is maintained or improved towards functioning properly and exhibit high geomorphic, hydrologic, and biotic integrity relative to their natural potential condition. Fire regime condition class and tree density is reduced and moves towards FRCC 1 (historical range), unneeded roads are decommissioned or restored to natural condition, soil and riparian condition and function is improved and moving towards satisfactory and properly functioning.

Structure of Report:

This Soil and Watershed Specialist report analysis follows the table of contents and includes a description of the affected environment which describes the current condition of soils and watershed resources for the Rim Country project area. Following the description of the affected environment, a section describing the predicted environmental consequences (effects) to soil and watershed resources of implementing the no action and all action alternatives is described.

Appendix A displays the TES map unit stratification, TES Map Units in each stratum, Soil Taxonomic Classifications, Approximate Acreages and Soil Interpretations. Appendix B is the need for change matrix and displays existing soil conditions by strata, desired conditions, need for change and potential management strategies to achieve soil desired conditions. Appendix C displays and predicts soil erosion modeling results including pre-harvest, unburned, and high soil burn severity associated with an uncharacteristic wildfire. Appendix D provides a summary of watershed condition based on indicator and attribute scores.

Relevant Law, Regulation, and Policy

All alternatives are designed to guide management activities toward meeting all applicable Federal and State laws, regulations, and policies.

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

The Land and Resource Management Plan (LRMP) for each Forest provide desired conditions, standards and guidelines for forest ecosystems, including soils and watershed resources. Plan components for terrestrial ecosystems are grouped by Terrestrial Ecosystem Survey (TES) map unit or Ecological Response Units (ERUs). For each ERU, desired conditions, standards and guidelines are defined. A description of the relevant desired conditions, standards and guidelines for soil and water resources are considered in this analysis and discussed when relevant to provide information on compliance with forest-level management direction.

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 581j (note). 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 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.

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 Nations 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 effects of the proposed action, unavoidable adverse environmental effects, 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.

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.

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.

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 (note)). 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 effects 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 effects 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 Order 11990 (Protection of Wetlands): …"in order to avoid to the extent possible the long and short term adverse effects 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. The Coconino National Forest issued a Record of Decision on September 28, 2011 identifying a system of designated routes and areas throughout the Forest. Since the record of decision was issued, the Coconino National Forest has been using education, signage, physical closure of undesignated roads and enforcement to reduce motorized use in undesignated areas that are most likely to lead to user conflict or effects to forest resources.

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.

Land Management Direction

Apache-Sitgreaves, Coconino and Tonto National Forest Land Management Plan Direction

Tables 1 through 11 summarize the management direction, desired condition, standards, guidelines and objectives for soils and watershed resources on the Apache-Sitgreaves (USDA 2016) the Coconino Draft (USDA, 2016) and the Tonto (USDA 1985) National Forest Land and Resource Management Plans.

Table 1. A-S NF Forest Plan Forest-wide standards and guidelines.

Resource Section within Forest Plan	Plan Component	Plan Direction
Motorized Opportunities	Guideline (GL)	Roads and motorized trails removed from the transportation network should be treated in order to avoid future risk to hydrologic function and aquatic habitat.
Motorized Opportunities	GL	New roads, motorized trails, or designated motorized areas should be located to avoid meadows, wetlands, seeps, springs, riparian areas, stream bottoms, sacred sites, and areas with high concentrations of significant archaeological sites. The number of stream crossings should be minimized or mitigated to reduce effects to aquatic species.
Riparian Areas	GL	Ground-disturbing projects (including prescribed fire) which may degrade long term riparian conditions should be avoided.
Riparian Areas	GL	Wet meadows, springs, seeps and cienegas should not be used for concentrated activities (e.g., equipment storage, forest product or mineral stockpiling, livestock handling facilities, special uses) that cause damage to soil and vegetation.

Resource Section within Forest Plan	Plan Component	Plan Direction
Riparian Areas	GL	Storage of fuels and other toxicants should be located at least 100 feet outside of riparian areas to prevent spills that could impair water quality or harm aquatic species.
Riparian Areas	GL	Equipment should be fueled or serviced at least 100 feet outside of riparian areas to prevent spills that could impair water quality or harm aquatic species.
Riparian Areas	GL	Construction or maintenance equipment service areas should be located at least 100 feet from riparian areas, and treated to prevent gas, oil, or other contaminants from washing or leaching into streams.
Water Resources	GL	Projects with ground-disturbing activities should be designed to minimize long and short term effects to water resources. Where disturbance cannot be avoided, project specific soil and water conservation practices and BMPs should be developed.
Water Resources	GL	Streams, streambanks, shorelines, lakes, wetlands, seeps, springs and other bodies of water should be protected from detrimental changes [11] in water temperature and sediment to protect aquatic species and riparian habitat.
Water Resources	GL	Aquatic management zones should be in place between streams and disturbed areas and/or road locations to maintain water quality and suitable stream temperatures for aquatic species.
Water Resources	GL	As State of Arizona water rights permits (e.g., water impoundments, diversions) are issued, the base level of instream flow should be retained by the Apache-Sitgreaves NFs.
Water Resources	GL	To protect water quality and aquatic species, heavy equipment and vehicles driven into a water body to accomplish work should be completely clean of petroleum residue. Water levels should be below the gear boxes of the equipment in use. Lubricants and fuels should be sealed such that inundation by water should not result in leaks.
Water Resources	Standard (ST)	Consistent with existing water rights, water diversions or obstructions shall at all times allow sufficient water to pass downstream to preserve minimum levels of water flow that maintain aquatic life and other purposes of national forest establishment.
Water Uses	GL	Constructed features should be maintained to -- or removed when no longer needed.

Resource Section within Forest Plan	Plan Component	Plan Direction
All Forested PNVTs	ST	On lands suitable for timber production, timber harvest activities shall only be used when there is reasonable assurance of restocking within 5 years after final regeneration harvest. This also applies where wildland fire is used to create openings for tree regeneration purposes on suitable timber lands. Restocking level is prescribed in a site specific silvicultural prescription for a project treatment unit and is determined to be adequate depending on the objectives and desired conditions for the plan area. In some instances, such as when lands are harvested or prescribed burned to create openings for firebreaks and vistas or to prevent encroaching trees, it is appropriate not to restock.
All Forested PNVTs	ST	Harvesting systems shall be selected based on their ability to meet desired conditions and not strictly on their ability to provide the greatest dollar return.
All Forested PNVTs	ST	Clearcutting shall be used only where it is the optimum method for meeting desired conditions.
All PNVTs	GL	Landscape scale restoration projects should be designed to spread treatments out spatially and/or temporally within the project area to reduce implementation effects and allow reestablishment of vegetation and soil cover.
All PNVTs	GL	Wildfire may be used to meet desired resource conditions, maintain or promote desired vegetation species, and enable natural fires to return to their historic role.
All PNVTs	GL	Project plans should include quantitative and/or qualitative objectives for implementation monitoring and effectiveness monitoring to assist in moving toward or maintaining desired conditions.
All PNVTs	ST	Within each PNVT, vegetation management activities shall be designed to maintain or move plant composition towards a moderate to high plant community similarity as compared to site potential.
All PNVTs	ST	Vegetation treatments shall include measures to reduce the potential for introduction of invasive plants and animals and damage from nonnative insects and diseases.
Minerals and Geology	GL	Streambed and floodplain alteration or removal of material should not occur if it prevents attainment of riparian, channel morphology, or streambank desired conditions.

Table 2. A-S NF Forest Plan Forest-wide Desired Conditions.

Resource Section within Forest Plan	Plan Component	Plan Direction
Overall Ecosystem Health	Desired Condition (DC)	Ecological components (e.g., soil, vegetation, water) are resilient to disturbances including human activities, and natural ecological disturbances (e.g., climate variability, fire, drought, wind, insects, disease, and pathogens).
Overall Ecosystem Health	DC	Natural ecological disturbances return to their characteristic roles within the ecosystem. Fire, in particular, is restored to a more natural function.
Overall Ecosystem Health	DC	Natural ecological cycles (i.e., hydrologic, energy, nutrient) facilitate shifting of plant communities, structure, and ages across the landscape. Ecotone shifts are influenced at both the landscape and watershed scale by ecological processes. The mosaic of plant communities and the variety within the communities are resilient to disturbances.
Overall Ecosystem Health	DC	Ecological conditions for habitat quality, distribution, and abundance contribute to self-sustaining populations of native and desirable nonnative plants and animals that are healthy, well distributed, connected, and genetically diverse. Conditions provide for the life history, distribution, and natural population fluctuations of the species within the capability of the landscape.
Overall Ecosystem Health	DC	Habitat quality, distribution, and abundance exist to support the recovery of federally listed species and the continued existence of all native and desirable nonnative species.
Overall Ecosystem Health	DC	Healthy ecosystems provide a wide range of ecosystem services.
Overall Ecosystem Health	DC	Watersheds exhibit high geomorphic, hydrologic, and biotic integrity relative to their natural potential condition.
Riparian Areas	DC	Riparian-wetland conditions maintain water-related processes (e.g., hydrologic, hydraulic, geomorphic). They also maintain the physical and biological community characteristics, functions, and processes.

Resource Section within Forest Plan	Plan Component	Plan Direction
Riparian Areas	DC	Natural ecological disturbances (e.g., flooding, scouring) promote a diverse plant structure consisting of herbaceous, shrub, and tree species of all ages and size classes necessary for the recruitment of riparian-dependent species.
Riparian Areas	DC	Stream (lotic) riparian-wetland areas have vegetation, landform, and/or large coarse woody debris to dissipate stream energy associated with high water flow.
Riparian Areas	DC	Streams and their adjacent floodplains are capable of filtering, processing, and storing sediment; aiding floodplain development; improving floodwater retention; and increasing groundwater recharge.
Riparian Areas	DC	Vegetation and root masses stabilize streambanks, islands, and shoreline features against the cutting action of water.
Riparian Areas	DC	Ponding and channel characteristics provide habitat, water depth, water duration, and the temperatures necessary for maintaining populations of riparian-dependent species and for their dispersal.
Riparian Areas	DC	Beavers occupy capable stream reaches and help promote the function and stability of riparian areas.
Riparian Areas	DC	Lentic riparian areas (e.g., wet meadows, fens, bogs) have vegetation and landform present to dissipate wind action, wave action, and overland flow from uplands.
Riparian Areas	DC	Wetland riparian areas are capable of filtering sediment and aiding floodplain development that contribute to water retention and groundwater recharge.
Riparian Areas	DC	Willows (e.g., Bebb, Geyer, Arizona, Goodding's) are reproducing with all age classes present, where the potential exists.
Riparian Areas	DC	The spatial extent of wetlands is maintained [20].
Riparian Areas	DC	Soil compaction from forest activities (e.g., vehicle use, recreation, livestock grazing) does not negatively affect riparian areas.

Resource Section within Forest Plan	**Plan Component**	**Plan Direction**
Riparian Areas	DC	Riparian vegetation consists mostly of native species that support a wide range of vertebrate and invertebrate species and are free of invasive plant and animal species.
Riparian Areas	DC	Diversity and density of riparian forest vegetation provides for breeding, escape, hiding, and resting cover for wildlife and provides travelways between other habitat areas and seasonal ranges.
Riparian Areas	DC	The ecological function of riparian areas is resilient to animal and human use.
Riparian Areas	DC	Riparian obligate species within wet meadows, around springs and seeps, along streambanks, and active floodplains provide sufficient [15] vegetative ground cover (herbaceous vegetation, litter, and woody riparian species) to protect and enrich soils, trap sediment, mitigate flood energy, stabilize streambanks, and provide for wildlife and plant needs.
Riparian Areas	DC	Riparian soil productivity is optimized as described by the specific TES map unit as indicated by the vigor of the herbaceous vegetation community. Based on species composition, ungrazed plant heights range from 10 inches to 36 inches.
Riparian Areas	DC	Floodplains and adjacent upland areas provide diverse habitat components (e.g., vegetation, debris, logs) as necessary for migration, hibernation, and brumation (extended inactivity) specific to the needs of riparian-obligate species (e.g., New Mexico meadow jumping mouse, Arizona montane vole, narrow-headed gartersnake).
Riparian Areas	DC	Large coarse woody debris provides stability to riparian areas and stream bottoms lacking geologic control (e.g., bedrock) or geomorphic features (e.g., functioning floodplains, stream sinuosity, width/depth ratio).

Resource Section within Forest Plan	**Plan Component**	**Plan Direction**
Riparian Areas	DC	Vegetation is structurally diverse, often dense, providing for high bird species diversity and abundance, especially neotropical migratory birds. It includes large trees and snags in the cottonwood-willow and mixed broadleaf deciduous riparian forests to support species such as beaver, yellow-billed cuckoo, bald eagles, Arizona gray squirrel, and various bat species.
Water Resources	DC	Water quality, stream channel stability, and aquatic habitats retain their inherent resilience to natural and other disturbances.
Water Resources	DC	Water resources maintain the capability to respond and adjust to disturbances without long term adverse changes.
Water Resources	DC	Vegetation and soil conditions above the floodplain protect downstream water quality, quantity, and aquatic habitat.
Water Resources	DC	Instream flows provide for channel and floodplain maintenance, recharge of riparian aquifers, water quality, and minimal temperature fluctuations.
Water Resources	DC	Stream flows provide connectivity among fish populations and provide unobstructed routes critical for fulfilling needs of aquatic, riparian dependent, and many upland species of plants and animals.
Water Resources	DC	Water quantity meets the needs for forest administration and authorized activities (e.g., livestock grazing, recreation, firefighting, domestic use, road maintenance).
Water Resources	DC	Stream channels and floodplains are dynamic and resilient to disturbances. The water and sediment balance between streams and their watersheds allow a natural frequency of low and high flows.
Water Resources	DC	Stream condition is sufficient to withstand floods without disrupting normal stream characteristics (e.g., water transport, sediment, woody material) or altering stream dimensions (e.g., bankfull width, depth, slope, sinuosity).
Water Resources	DC	Floodplains are functioning and lessen the effects of floods on human safety, health, and welfare.

Resource Section within Forest Plan	**Plan Component**	**Plan Direction**
Water Resources	DC	Water quality meets or exceeds Arizona State standards or Environmental Protection Agency water quality standards for designated uses.
Water Resources	DC	Water quality meets the needs of desirable aquatic species such as the California floater, northern and Chiricahua leopard frog, and invertebrates that support fish populations.
Water Uses	DC	Water developments contribute to fish, wildlife, and riparian habitat as well as scenic and aesthetic values.
Water Uses	DC	Apache-Sitgreaves NFs water rights are secure and contribute to livestock, recreation, wildlife, and administrative uses.
Water Uses	DC	Dams, diversions, or other water control structures are designed, maintained, and operated to conserve water resources.
All PNVTs	DC	Each PNVT contains a mosaic of vegetative conditions, densities, and structures. This mosaic occurs at a variety of scales across landscapes and watersheds. The distribution of physical and biological conditions is appropriate to the natural disturbance regimes affecting the area.
All PNVTs	DC	The vegetative conditions and functions are resilient to the frequency, extent, and severity of ecological disturbances (e.g., fire, insects and disease, flood, climate variability). The landscape is a functioning ecosystem that contains all its components, processes, and better able to cope with climate change.
All PNVTs	DC	Natural processes and human and natural disturbances (e.g., wildland fire, mechanical vegetation treatments) provide desired overall tree density, structure, species composition, coarse woody debris, and nutrient cycling. Natural fire regimes are restored. Uncharacteristic fire behavior is minimal or absent on the landscape.
All PNVTs	DC	Wildfire maintains and enhances resources and, as nearly as possible, is allowed to function in its natural ecological role.

Resource Section within Forest Plan	Plan Component	Plan Direction
All PNVTs	DC	Native plant communities dominate the landscape.
All PNVTs	DC	The range of species genetic diversity remains within native vegetation and animal populations, thus enabling species to adapt to changing environmental and climatic conditions.
All PNVTs	DC	Vegetation characteristics (e.g., density, litter) provide favorable conditions for water flow and quality.
All PNVTs	DC	Organic soil cover and herbaceous vegetation protect soil, facilitate moisture infiltration, and contribute to plant and animal diversity and ecosystem function.
All PNVTs	DC	Diverse vegetation structure, species composition, densities, and seral states provide quality habitat for native and desirable nonnative plant and animal species throughout their life cycle and at multiple spatial scales. Landscapes provide for the full range of ecosystem diversity at multiple scales, including habitats for those species associated with late seral states and old growth forests.
All PNVTs	DC	Vegetation conditions allow for transition zones or ecotones between riparian areas, forests, woodlands, shrublands, and grasslands. Transition zones may shift in time and space due to changing site conditions from disturbances (e.g., fire, climate variability).
All PNVTs	DC	Disjunct populations of Chihuahua pine, Arizona cypress, and Rocky Mountain maple are present with the ability to reproduce on capable sites.
All PNVTs	DC	Shrub components contain a diverse array of native vegetation that is well distributed across the landscape to provide nutritional needs for browsers.
All PNVTs	DC	Vegetation provides products—such as wood fiber or forage—to help meet local and regional needs in a manner that is consistent with other desired conditions on a sustainable basis within the capacity of the land.
All PNVTs	DC	Ecosystem services are available as forests, woodlands, grasslands, and riparian communities successfully adapt to a changing and variable climate.

Resource Section within Forest Plan	Plan Component	Plan Direction
All PNVTs	DC	Stand densities and species compositions are such that vegetation conditions are resilient under a variety of potential future climates.
All PNVTs	DC	Vegetative ground cover (herbaceous vegetation and litter cover) is optimized [15] to protect and enrich soils and promote water infiltration. There is a diverse mix of cool and warm season grasses and desirable forbs species.
All PNVTs	DC	Grasses, forbs, shrubs, and litter are abundant and continuous to support natural fire regimes.
All PNVTs	DC	The composition, density, structure, and mosaic of vegetative conditions reduce uncharacteristic wildfire hazard to local communities and forest ecosystems.
All PNVTs	DC	Rare or unique plant communities (e.g., agaves, Chihuahuan pine) are intact and persisting.
Wet Mixed Conifer	DC	The wet mixed conifer forest is a mosaic of structural stages and seral states ranging from young to old trees. The landscape arrangement is an assemblage of variably sized and aged groups and patches of trees and other vegetation associations similar to reference conditions.
Dry Mixed Conifer	DC	Coarse woody debris, including logs, ranges from 5 to 15 tons per acre. Logs average 3 per acre within the forested area of the landscape.
Ponderosa Pine	DC	Coarse woody debris, including logs, ranges from 3 to 10 tons per acre. Logs average 3 per acre within the forested area of the landscape.
Ponderosa Pine	DC	Grasses, forbs, shrubs, needles, leaves, and small trees support the natural fire regime. The larger proportion (60 percent or greater) of soil cover is composed of grasses and forbs as opposed to needles and leaves.
Minerals and Geology	DC	Naturally occurring geological features (e.g., caves, sinkholes) remain intact to support wildlife habitat, recreation opportunities, and unique vegetation.

Table 3. A-S NF Forest Plan Forest-wide Objectives.

Resource Section within Forest Plan	Plan Component	Plan Direction
Overall Ecosystem Health	Objective (OBJ)	During the planning period, improve the condition class on at least 10 priority 6th level HUC watersheds by removing or mitigating degrading factors [2].
Riparian Areas	OBJ	Annually, move 200 to 500 acres toward desired composition, structure, and function of streams, floodplains, and riparian vegetation.
Riparian Areas	OBJ	Within the planning period, relocate, repair, improve, or decommission a minimum of 4 miles of National Forest System roads or trails that add sediment to streams, damage riparian vegetation, erode streambanks, cause gullies, and/or compact floodplain soils.
Riparian Areas	OBJ	Annually, remove an average of 2 miles of unauthorized roads or trails that add sediment to streams, damage riparian vegetation, erode streambanks, cause gullies, and/or compact floodplain soils.
Riparian Areas	OBJ	Within the planning period, enhance or restore 5 to 25 wet meadows, springs, seeps or cienegas to proper hydrologic function and native plant and animal species composition.
Riparian Areas	OBJ	Annually, work with partners to reduce animal damage to native willows and other riparian species on an average of 5 miles of riparian habitat.
All Forested PNVTs	OBJ	Annually, treat 5,000 to 35,000 acres to reduce tree densities, restore natural fire regimes, promote species habitat and ecosystem health, reduce fire hazard, maintain desired conditions, initiate recovery from uncharacteristic disturbance, and provide forest products, leaving a desired mix of species with the range of desired densities that are resilient to changing climatic conditions.

Table 4. A-S NF Forest Plan Management Area Direction.

Forest Plan Management Areas (MA) within the project area	Description/ Management Approach	Landscape or MA Scale Forest Plan Desired Condition, Standards, Guidelines	Forest-wide MA acres[1]	Acres and percent within 4FRI East project area
Apache-Sitgreaves NF – 506,889 acres				
General Forest	The emphasis of this area is to restore priority 6th level HUC watersheds, restore fire-adapted ecosystems, reduce the threat from uncharacteristic wildfire, and provide forest products. A wide variety of management activities occur and a wide variety of forest products are available within this management area. Lands identified as suitable for timber production have a regularly scheduled harvest of commercial timber.	**Objectives:** see forest-wide **DC:** Watershed condition rating is at satisfactory. **No standards or guidelines**	1, 224,071	417,565
Community-Forest Intermix	Forest managers work toward achieving the goals outlined in the CWPPs for the counties within the Apache-Sitgreaves NFs. A higher degree of temporary ground disturbance may occur. The amount of snags and residual large coarse woody debris is generally lower than in the General Forest Management Area.	**Objectives:** see forest-wide **DC**: The Community-Forest Intermix Management Area is composed of smaller, more widely spaced groups of trees than the general forest. These conditions result in fires that burn primarily on the forest floor and rarely spread as crown fire. **DC**: As a result of forest management, most wildfires are low to mixed severity surface fires resulting in limited loss of structures or ecosystem function. **DC**: Native grasses, forbs, shrubs, and litter (i.e., fine fuels) are	60,564	23,365

[1] Forest-wide acres does not include lands that are not National Forest System lands. MA acres as presented in the draft forest plan includes all acres.

Forest Plan Management Areas (MA) within the project area	Description/ Management Approach	Landscape or MA Scale Forest Plan Desired Condition, Standards, Guidelines	Forest-wide MA acres[1]	Acres and percent within 4FRI East project area
	In addition, forest openings are larger and basal areas are lower than in the General Forest Management Area. The management approach within this management area is to complete initial treatments to reduce fire hazard.	abundant enough to maintain and support natural fire regimes, protect soils, and support water infiltration. **DC**: The composition, density, structure, and mosaic of vegetative conditions reduce uncharacteristic wildfire hazard to local communities and forest ecosystems. **DC**: Ponderosa pine and dry mixed conifer forest structure is similar to forestwide conditions or is composed of smaller and more widely spaced tree groups than in the general forest. **DC**: Wet mixed conifer and spruce-fir PNVTs are growing in an overall more open condition than the wet mixed conifer PNVT outside of the Community-Forest Intermix Management Area. These conditions result in fires that burn primarily on the forest floor and rarely spread as crown fire. **DC:** Grasslands have less than 10 percent woody canopy cover. **DC**: Piñon-juniper stands are represented by savanna-like conditions. **Standards: N/A** **Guidelines:** **GL**: Retention of fire-resistant tree species (e.g., ponderosa pine, Douglas-fir, pure aspen) should be emphasized in the wet mixed conifer and spruce-fir forested PNVTs to reduce fire hazard.		

Forest Plan Management Areas (MA) within the project area	Description/ Management Approach	Landscape or MA Scale Forest Plan Desired Condition, Standards, Guidelines	Forest-wide MA acres[1]	Acres and percent within 4FRI East project area
Wildlife Quiet Area	There is an emphasis on improving wildlife habitat and maintaining existing wildlife developments. Management of habitat within WQAs may provide a benchmark for assessing effects of activities on generally undisturbed wildlife populations. The road in the Open Draw WQA is managed as open on a seasonal basis.	**None applicable to soils** **Objectives:** see forest-wide **Standards**: N/A **Guidelines:**	50,173	22,401
Wild Horse Territory	The forests work….. to keep grazing use in balance with available forage.	**Objectives:** see forest-wide DC – Not applicable Guidelines – Not applicable	18,761	18,761
Natural Landscape	The management emphasis is to retain the natural appearing character of these areas. Management activities occur mostly for ecological restoration because of natural ecological events or previous management actions. Management activities may include restoration of ecological conditions or habitat components, soil stabilization, planned and unplanned ignitions,	**None applicable to soil, water and riparian except temporary and existing roads** **Guidelines:** GL Temporary road construction and motorized equipment may be used in order to achieve ecological desired conditions. GL: Existing roads should be maintained to the minimum standard to meet the objective maintenance level.	404,802	13,191

Forest Plan Management Areas (MA) within the project area	Description/ Management Approach	Landscape or MA Scale Forest Plan Desired Condition, Standards, Guidelines	Forest-wide MA acres[1]	Acres and percent within 4FRI East project area
	hazardous fuels reduction, and invasive species reduction. Livestock grazing may occur where appropriate.			
High Use Developed Recreation Area	In addition to recreation use, other uses (including livestock grazing, timber management, and wildlife management) may occur in combination with surrounding recreation and scenic desired conditions.	**None applicable to Soil and Water**	16,549	8,096
Energy Corridor	Energy corridors are generally not managed to provide recreation opportunities. They are managed for very low scenic integrity where vegetation and structural changes may attract attention and dominate the landscape when viewed from nearby.	**Objectives:** see forest-wide DC: Vegetation consists predominantly of grasses, forbs, shrubs, low-growing trees, and sapling-sized trees. **Guidelines:** GL: Within and adjacent to energy corridors, vegetation should be managed similarly to the Community-Forest Intermix Management Area so that facilities stay operational and reduce the hazards of human-caused damage, wildfire ignition, damage from wildland fire, and falling trees. GL: Trees and shrubs in riparian areas should only be removed when there is an imminent threat to facilities and, in these cases, trees should be left for large coarse woody debris recruitment to the stream and riparian system. GL: When planning and implementing vegetation	2,547	1,511

Forest Plan Management Areas (MA) within the project area	Description/ Management Approach	Landscape or MA Scale Forest Plan Desired Condition, Standards, Guidelines	Forest-wide MA acres[1]	Acres and percent within 4FRI East project area
		treatments (e.g. corridor maintenance), vegetation within riparian zones that provide rooting strength important for bank stability should be encouraged.		

Table 5. Coconino NF Plan Direction Applicable to Soils.

Forest Plan Management Areas (MA) within the project area	Description/ Management Approach	Landscape or MA Scale Forest Plan Desired Condition, Standards, Guidelines	Forest-wide MA acres[i]	Acres within 4FRI East project area
Coconino National Forest: 370,415 acres				
Long Valley	Dominantly ponderosa pine, but also includes grasslands, riparian forest, pinyon juniper, mixed conifer, and wetlands, springs, Designated wilderness, eligible WSR, IRAs, National Trails, proposed RNA	**Objectives:** see forest-wide **Standards:** N/A **Guidelines:** N/A	164,055	155,370
Acres of Non-Forest System lands within MA:2,665 acres				
Pine Belt	Ponderosa pine: but also includes 8 other ERUs within 4FRI boundary?, designated wilderness, no recommended wilderness, has eligible WSR, IRAs, Gus Pearson RNA, Red Mtn. Geologic Area, Scenic Roads, National Trails, Riparian forest , streams, wetlands, springs	**Objectives:** see forest-wide **Landscape Scale DC:** Mosaic of trees with varying age classes and understory vegetation which provide habitat for a variety of species, including Mexican spotted owls and northern goshawks, and ground fuels conducive to low-severity fires. **DC 1**. Roads, trails, and recreation use have minimal effects to woody riparian vegetation and riparian habitat in Pumphouse Wash.	426,832	89,663

Forest Plan Management Areas (MA) within the project area	Description/ Management Approach	Landscape or MA Scale Forest Plan Desired Condition, Standards, Guidelines	Forest-wide MA acres[i]	Acres within 4FRI East project area
		Check for any seasonal closure areas that overlap analysis area **Standards:** N/A would be included if seasonal closures overlap **Guidelines:** N/A (specific to Pumphouse Wash/Oak Creek Canyon) See landscape character description document		
Acres of Non-Forest System lands within MA:42,829 acres				
East Clear Creek	Vegetation is predominantly ponderosa pine and mixed conifer with scattered pinyon juniper, high elevation grasslands, riparian forest, and wetlands, springs. No designated or recommended wilderness. Includes tributaries to, and portions of, East Clear Creek - key habitat for the Little Colorado spinedace (endemic, threatened), eligible WSR, IRA, National Trails, Riparian	**Objectives:** see forest-wide **Standards: N/A** **Guidelines:** **GL 1: N/A – specific to camping and motorized recreation**	53,124	53,124
Acres of Non-Forest System lands within MA:1,835 acres				
C.C. Cragin Watersheds	Ponderosa pine and mixed conifer with scatter pockets of riparian, grasslands, and wetlands, springs. Eligible WSR, designated Botanical Area and National Trails	**Objectives:** see forest-wide **DC 1**: There is low risk of substantial damage from uncharacteristic fire and recreation to municipal water supply, infrastructure, water quality, visual quality, and cultural integrity (e.g., tribes and local communities). **Standards: N/A**	45,711	45,711

Forest Plan Management Areas (MA) within the project area	Description/ Management Approach	Landscape or MA Scale Forest Plan Desired Condition, Standards, Guidelines	Forest-wide MA acres[i]	Acres within 4FRI East project area
		Guidelines: **GL1**: The C. C. Cragin Watersheds MA should be managed to reduce the threat of uncharacteristic wildfires, flooding, and sedimentation, and to maintain water quality and quantity. **GL 2**: Roads and trails within the C.C. Cragin Watersheds MA should be maintained to prevent erosion and sedimentation and to protect existing infrastructure. **Note**: there is both riparian areas and riparian forest		
Acres of Non-Forest System lands within MA: 290 acres				
Anderson Mesa	Dominated by pinyon juniper, grassland, and ponderosa pine vegetation, also mixed con with aspen and is an important pronghorn habitat area. No designated or proposed wilderness, has eligible WSR, IRAs, Scenic Roads, Riparian	**Objectives:** see forest-wide Other Plan components not applicable to soils.		23,370
Acres of Non-Forest System lands within MA:4,986 acres				
Verde Valley	Vegetation is dominantly desert, grassland, chaparral, and pinyon juniper, some ponderosa pine, with riparian forests along stream channels. Perennial waters include portions of the Verde River, Oak Creek, Wet Beaver Creek, West Clear Creek, and Fossil Creek. Streams, wetlands, springs. Has designated	**Objectives**: see forest-wide **DC 1**: Watersheds are managed to reduce the risk of uncharacteristic flooding and sedimentation into downstream communities, perennial streams and their tributaries, wildernesses, and other special areas. This would include watersheds that affect drainages such as Beaver Creek, Dry Beaver Creek, Red Tank Draw, Russell Wash, Walker Creek, West Clear Creek, and Oak Creek.	323,455	1,052

Forest Plan Management Areas (MA) within the project area	Description/ Management Approach	Landscape or MA Scale Forest Plan Desired Condition, Standards, Guidelines	Forest-wide MA acres[i]	Acres within 4FRI East project area
	and proposed wilderness, designated WSR, eligible WSR, proposed West Clear Creek RNA, 3 botanical areas, 1 geologic area, IRAs, National Trails, Riparian	**Standards: N/A** **Guidelines:** **GL 1**: Projects and activities should be designed and implemented to maintain or improve watershed and riparian function and/or prevent the introduction or spread of disease, invasive, or undesirable species. **GL 2-4:** N/A		
Acres of Non-Forest System lands within MA: 35,115 acres				

Table 6. Coconino NF Forest Plant Forest-wide Standards and Guidelines.

Resource Section within Forest Plan	Plan Component	Plan Direction
Water	Guidelines (GL)	Watersheds should have enough vegetative ground cover to recover rapidly from natural and human disturbances and to maintain long-term soil productivity.
Water	GL	Watershed restoration and maintenance, and vegetation treatments should focus on priority 6th code watersheds to ensure that ecosystem processes, resilient vegetation conditions, and natural disturbance regimes are functioning properly.
Water	GL	Instream flow water rights should be procured for those streams without instream water rights to ensure that sufficient flow is provided for aquatic species, habitat, and recreation.
Water	GL	Best management practices for management activities should be identified, implemented, and monitored to maintain water quality, quantity, and timing of flows, and to prevent or reduce accelerated erosion.

Resource Section within Forest Plan	**Plan Component**	**Plan Direction**
Water	GL	For impaired waters or non-attaining waters, approved total maximum daily load (TMDL) recommendations or implementation plans should be implemented to maintain or improve water quality to meet or exceed Arizona water quality standards and support identified designated beneficial uses.
Water	GL	Within existing water rights, excess water should remain in or be allowed to flow freely back into the natural channel, spring, and riparian habitat to maintain and improve ecological function, water quality, quantity, and timing of flows, and to benefit native species and their habitat.
Constructed Waters	GL	For new projects and management activities, a site-specific aquatic management zone should be identified and maintained around reservoirs to protect water quality and to avoid detrimental changes in water temperature or chemical composition, blockages of streamcourses, or sediment deposits that would seriously and adversely affect water conditions or aquatic habitat. Soil and vegetation disturbance from management activities should be minimized to meet this intent, but is not necessarily excluded in this zone.
Constructed Water	GL	Earthen stock ponds determined to be important for threatened, endangered, and Southwestern Region sensitive species, should be managed to maintain water and habitat needed for species' survival and reproduction, consistent with existing water rights.
Riparian and Stream	GL	In perennial and intermittent riparian streamcourses, projects and management activities should be designed and implemented to retain or restore natural streambank stability, native vegetation, and riparian and soil function.

Resource Section within Forest Plan	Plan Component	Plan Direction
Riparian and Stream	GL	An aquatic management zone for non-riparian, intermittent streamcourses should be identified and maintained to reduce sedimentation, maintain functioning of the channel within its floodplain, and maintain downstream water quality and riparian habitat and function. This management zone would also avoid detrimental changes in water temperature or chemical composition; blockages of streamcourses; or sediment deposits that would seriously and adversely affect water conditions, fish habitat, or connected downstream cave, karst, and lava tube resources. Soil and vegetation disturbance from management activities should be managed to meet these intents, but is not necessarily excluded in this zone. The general starting points for widths of aquatic management zones are shown: Erosion Hazard Width of Zone in Nonriparian Intermittent Streamcourses Severe 100 feet each side of streamcourse Moderate 70 feet each side of streamcourse Slight 35 feet each side of streamcourse
Riparian Springs	GL	Spring recharge areas, where known, should be managed to maintain or improve spring discharge.
Riparian Springs	GL	Water rights should be maintained or procured to protect in situ (onsite) water quantity where no water rights exist.
Riparian Springs	GL	Projects and activities should be designed and implemented to maintain or improve soil and riparian function; maintain or improve native vegetation; and/or prevent the introduction or spread of disease, invasive, or undesirable species. Design features could include road, recreation, and/or livestock management.

Resource Section within Forest Plan	**Plan Component**	**Plan Direction**
Riparian Springs	GL	Where there is a structure in place to use water from a spring as a water source or when designing restoration projects, priority should be given to the protection of spring source areas and riparian habitat to safeguard the unique ecological and biophysical characteristics, higher biodiversity, endemic species, and cultural values associated with spring sources. For example, water could be piped out of the riparian area to avoid negative effects to soil, water, and vegetation or if water is to be diverted, a flow-splitter could be installed to maintain some flow at the source.
Riparian All	GL	Management activities such as vegetation treatments or other restoration actions should be designed to maintain or move toward desired conditions for soil, riparian vegetation, and water quality.
Riparian All	GL	Riparian areas should be managed to promote natural movement of water and sediment, to maintain ecological functions, and to maintain habitat and corridors for species.

Resource Section within Forest Plan	Plan Component	Plan Direction
Riparian All	GL	An aquatic management zone should be identified and maintained in riparian areas to protect water quality and to avoid detrimental changes in water temperature or chemical composition, blockages of streamcourses, or sediment deposits that would seriously and adversely affect water conditions, fish habitat, or connected downstream cave, karst, and lava tube resources. Soil and vegetation disturbance from management activities should be managed to meet these intents, but is not necessarily excluded in this zone. The general starting points for widths of aquatic management zones are shown: Erosion Hazard Width of Zone in Riparian Areas Severe 150 feet each side of streamcourse or riparian area Moderate 125 feet each side of streamcourse or riparian area Slight 100 feet each side of streamcourse or riparian area
Riparian Forest Type	GL	Water diversions and groundwater pumping should not lower the water table to prevent loss of or undesired changes to composition, structure, or function to riparian forests or mesquite bosques.
Riparian Forest Type	GL	In riparian forests, recreation activities, permitted uses, and management activities should occur at levels that maintain or allow improvement of soil function, riparian vegetation, and water quality at the stream reach scale. This guideline would not apply to fine-scale activities and facilities such as intermittent livestock crossing locations, water gaps, or other infrastructure used to manage effects to riparian areas at a larger scale.
Soils	GL	The forest should implement and monitor best management practices (BMPs) for all activities with the potential to impair water quality in accordance with the intergovernmental agreement between ADEQ and the Forest Service Southwestern Regional Office to control and manage nonpoint source pollution.

Resource Section within Forest Plan	Plan Component	Plan Direction
Roads and Facilities	GL	Soil and water BMPs should be implemented to protect water quality while designing, constructing, reconstructing, or relocating new and existing roads, parking areas and pullouts. For example, permanent and temporary road construction and relocation should: • Occur outside of streamcourses and aquatic management zones, except where crossing is required. • Avoid wetlands, springs, seasonally wet meadows, and montane meadows. • Avoid soils that are unstable and highly erodible where connected to streamcourses.

Table 7. Coconino NF Forest Plan Forest-wide Desired Conditions.

Resource Section within Forest Plan	Plan Component	Plan Direction
Water	Desired Conditions (DC)	Watersheds are functioning properly and are resilient to natural and human disturbances.
Water	DC	Watersheds exhibit high geomorphic, hydrologic, and biotic integrity within their inherent capability. Natural hydrologic, hydraulic, geomorphic, and biologic processes function at a level that allows retention of their unique physical and biological properties to maintain or improve downstream water quality.
Water	DC	Vegetation and soil conditions in watersheds support important ecosystem services such as clean water, base flow, riparian communities, and long-term soil productivity. These conditions also help moderate climate variability and change. Soil and vegetation function to facilitate precipitation infiltration and groundwater recharge.

Resource Section within Forest Plan	Plan Component	Plan Direction
Water	DC	Watersheds exhibit a high degree of connectivity along streams, laterally across the floodplains and valley bottoms and vertically between surface and subsurface flows. Streamcourses and other links between aquatic and upland components provide access to food, water, cover, nesting areas, and protected pathways for aquatic and upland species.
Water	DC	Water quantity (base flows) of intermittent and perennial streams are sustained to mimic seasonal flow regimes. Peak flows and flood potential occur within the historic range of variability for that stream system. For baseflows, this means that during low-flow periods (fall and winter, generally), water flow is sustained within its natural capability.
Water	DC	Water quality, water quantity and the timing of water flows support ecological functions, habitat for aquatic and riparian species, and water sources for municipalities. Water quality, water quantity, and the timing of flows are sustained at levels that retain the biological, physical, and chemical integrity of associated systems and benefit survival, growth, reproduction, and migration of native species.
Water	DC	Water quality meets or exceeds Arizona water quality standards and supports identified designated beneficial uses.
Riparian Streams	DC	Perennial and intermittent riparian streamcourses maintain their natural sinuosity and have access to their floodplains so that when floods do occur, energy can be dissipated without causing damage to the streambanks of the channel. Stream channel stability is maintained or restored.
Riparian Streams	DC	Flooding is the primary natural disturbance in perennial, intermittent, and ephemeral streamcourses. In some streamcourses, flooding creates a mix of stream substrates for fish habitat, and sites for germination and establishment of riparian vegetation.

Resource Section within Forest Plan	Plan Component	Plan Direction
Riparian Streams	DC	Perennial and intermittent riparian streamcourses, and associated floodplains, are capable of filtering sediment, capturing and/or transporting bedload, aiding floodplain development, improving floodwater retention, improving or maintaining water quality, and providing groundwater recharge within their natural potential.
Riparian Streams	DC	Streams maintain a natural hydrograph, or waterflow over time, including periodic flooding, which promotes natural movement of water, sediment, nutrients, and woody debris.
Riparian Wetlands	DC	Wetlands provide functional soil and water resources on most acres, consistent with their flood regime and flood potential, and provide diverse habitats for native species. Wetlands are in or trending toward proper functioning condition.
Riparian Wetlands	DC	Consistent with the natural hydrologic cycle, wetland vegetation has a variety of age classes ranging from young to old and a composition of native species that reflects the individual wetland types. Plant composition can vary considerably at the fine- and mid-scales depending on site potential (as determined by TEUI or other appropriate ecological classification system) and geomorphology, elevation, climate, topography, soils, and smaller scale disturbances. Wetlands include vegetation that indicates maintenance of riparian soil moisture characteristics
Riparian Springs	DC	Springs have functional soil, water, and vegetative resources consistent with natural waterflow patterns, recharge rates, and geochemistry appropriate for the site.
Riparian Springs	DC	Spring vegetation has young, mid, and late seral stages and a composition of native aquatic and riparian species consistent with spring type, slope, aspect, natural disturbances, and natural solar energy budget (amount of radiation during different times of the year[2]).
Riparian Springs	DC	Spring riparian zones are capable of filtering sediment, capturing and/or transporting bedload, improving or maintaining water quality, providing groundwater recharge and supporting perched water-bearing zones within their natural potential, consistent with the spring type.

[2] The number of species and the number of endemic species are correlated with solar energy.

Resource Section within Forest Plan	Plan Component	Plan Direction
Riparian Springs	DC	Consistent with existing water rights and claims, springs are rarely developed and altered by human-made structures such as head boxes, cisterns, and pipelines.
Riparian Springs	DC	The physical and biological components of springs provide habitat for narrowly endemic species and those with restricted distributions.
Riparian All	DC	Within their type and capability, riparian ecosystems and corridors promote the natural role of water, sediment, woody debris, and root masses, and maintain water tables. This includes perennial and intermittent riparian streamcourses. The associated water table supports riparian vegetation.
Riparian All	DC	Instream flows provide for channel and floodplain maintenance, recharge of alluvial aquifers, water quality, and temperature fluctuations within the natural range of variability.
Riparian All	DC	Riparian areas exhibit connectivity between and within aquatic, riparian and upland components that reflects their natural range of variability and linkages. Naturally isolated springs remain isolated. Riparian areas are connected vertically between surface and subsurface flows. Streamcourses and other links between aquatic and upland components support ecological functions, and provide habitat and movement corridors for aquatic and upland species.
Riparian All	DC	Riparian areas are managed consistent with designated beneficial uses associated with existing claimed or certified water rights. Water quality is maintained or improved so it fully supports State water quality standards or designated beneficial uses identified by ADEQ.
Riparian All	DC	Where the potential exists, vegetation, root masses, and woody debris stabilize and protect banks, edges, and shorelines of riparian areas from disturbances. Plant distribution and occurrence are resilient to natural disturbances.

Resource Section within Forest Plan	Plan Component	Plan Direction
Riparian Forest Type	DC	Riparian forests provide the composition and structure to filter sediments, ash, and contaminants; build and stabilize banks; reduce the effects of flooding; store and release water; and recharge aquifers. Riparian forests provide habitat and help maintain temperatures necessary for maintaining populations of native aquatic and riparian-dependent species and for their dispersal. At the landscape scale, overall plant composition is similar to site potential (greater than 66 percent). Plant composition can vary considerably at the fine- and mid-scales, depending on site potential (as determined by TEUI or other appropriate ecological classification system) and climate, elevation, geomorphology, topography, soils, and smaller scale disturbances.
Riparian Forest Type	DC	Root masses and herbaceous vegetation stabilize banks, filter sediment, and maintain or improve water quality.
Riparian Forest Type	DC	Collectively, Cottonwood Willow Riparian Forest, Mixed Broadleaf Deciduous Riparian Forest, and mesquite bosques provide a unique vegetation community favored by bird species such as the western yellow-billed cuckoo and Bell's vireo. When water tables are high, mesquite bosques persist on upland terraces. In mesquite bosques, a variety of age classes are present, including seedling, sapling, mature, and overmature trees. The understory is comprised of native grasses and forbs.
Soils	DC	Soil productivity and functions are sustained and functioning properly within site potential, so the soil has the ability to resist erosion, infiltrate water and recycle nutrients. Coarse woody debris, including downed logs, provide for long term soil productivity. Soil productivity and functions contribute to the resiliency and adaptability of terrestrial and riparian ecosystems to climate change.

Resource Section within Forest Plan	Plan Component	Plan Direction
Soils	DC	Vegetative ground cover is maintained at levels that contribute to suitable hydrologic function, soil stability, and nutrient cycling. Soils are protected by adequate vegetative ground cover on the soil surface to prevent erosion from exceeding natural rates of soil formation (soil tolerance), within their inherent capability. Soils are permeable and capable of infiltrating water to reduce instances of overland flows during precipitation events. The composition of grass and forb species and presence of plant litter and grass, forb, shrub, and tree basal area surface cover reduce occurrences of compaction and erosion.
Soils	DC	Localized short-term accelerated soil erosion occurs following high-severity fires (Fire Regimes IV and V), but it does not occur to the extent that it risks long-term impairment to connected waters downstream or causes loss of soil productivity over major portions of the 5th or 6th code watershed.
Ecosystems	DC	Within their type and capability, ecosystems are functioning properly, provide habitat for native species, and are resilient to natural disturbances (such as flooding, fire, and periodic drought) and climate change. Ecosystem processes and contributions (for example, nutrient cycling, water infiltration, and wildlife habitat) are sustained, as vegetation on the Forest adapts to a changing climate.
Ecosystems	DC	Uncharacteristic fires are infrequent as is the associated flooding and sedimentation into downstream communities, perennial streams and their tributaries, headwaters, wildernesses, and other areas and resources.
Biophysical Geology	DC	Karst landscapes and cave formations continue to develop or erode under natural conditions. Water flowing into, from, or within these systems contains naturally fluctuating background levels of water, sediment, organic matter, and dissolved minerals; and is not polluted.

Resource Section within Forest Plan	Plan Component	Plan Direction
Biophysical Geology	DC	If previously undiscovered caves are encountered above the zone of saturation for the regional water aquifer during drilling operations, precautions should be taken to protect the cave, including sealing the casing above and below the cave to prevent airflow and water leakage to maintain sensitive ecosystem conditions.
Roads and Facilities	DC	The transportation system (roads) provides reasonable motorized access to the public, city, county, State, and other Federal entities for permissible uses such as recreation, fire management, wildlife management, and access to infrastructure or neighboring land. The transportation system expands and contracts commensurate with use and needs, and it balances the desire for access with management activities and ecological effects. An economical system of sustainable, well maintained, and marked roads provides diverse opportunities to explore the forest while protecting watershed conditions, recreation opportunities, scenery, heritage resources, rare plants, fisheries, and wildlife habitat and movement. However, the transportation system does not necessarily provide for user comfort or all-weather access on all roads.
Roads and Facilities	DC	Temporary increases in roads are appropriate for projects associated with watershed protection and restoration. Temporary roads that support ecosystem restoration activities, fuels management, or other short-term projects are rehabilitated promptly after project completion.
Roads and Facilities	DC	The minimum road system necessary for public, administrative, and private access within areas that affect water supplies, such as the Inner Basin, C.C. Cragin Reservoir, and Upper and Lower Lake Mary, protects water quality and quantity.

Resource Section within Forest Plan	Plan Component	Plan Direction
Terrestrial ERU-Ponderosa Pine	DC	The composition, structure, and function of vegetation conditions are resilient to the frequency, extent, and severity of disturbances and climate variability. The landscape is a functioning ecosystem that contains its components, processes, and conditions that result from natural levels of disturbances (e.g. insects, diseases, fire, and wind), including snags, downed logs, and old trees. Grasses, forbs, shrubs, and needle cast (e.g., fine fuels), and small trees maintain the natural fire regime. Vegetative ground cover provides protection from accelerated soil erosion, promotes water infiltration, and contributes to soil nutrient cycling, plant and animal diversity, and to ecosystem function.
Terrestrial ERU-Mixed Conifer	DC	Mixed Conifer ERUs have a mosaic of trees with varying age classes and understory vegetation which provide habitat for wildlife species, including Mexican spotted owls and northern goshawks; ground cover for functional soil and watersheds; and fuel for fire to occur according to historic ranges of frequency and severity.
Terrestrial ERU-Grasslands	DC	In Montane Grasslands, soil surface structure is granular or well aggregated to promote water infiltration and reduce runoff. Natural surface drainages and subsurface flow patterns maintain water flow into connected waterbodies or streams.

Table 8. Coconino NF Forest Plan-Forest-wide Objectives.

Resource Section within Forest Plan	Plan Component	Plan Direction
Riparian Springs	Objective (OBJ)	Restore riparian function to at least 25 springs identified as not in proper functioning condition to provide water quantity and aquatic habitat for the recovery of plant and animal species during each 10-year period during the life of the plan.
Riparian Springs	OBJ	Restore the function of 200 to 500 acres of nonfunctioning and functioning-at-risk riparian areas during each 10-year period over the life of the plan, with emphasis on priority 6th code watersheds, so that they are in or moving toward proper functioning condition.

Resource Section within Forest Plan	Plan Component	Plan Direction
Riparian Wetland	OBJ	Restore 5 to 10 wetlands currently not in proper functioning condition so that they are in, or are trending toward, proper functioning condition during each 10-year period over the life of the plan.

Table 9. Coconino NF Forest Plan Management Area Direction

Forest Plan Management Areas (MA) within the project area	Description/ Management Approach	Landscape or MA Scale Forest Plan Desired Condition, Standards, Guidelines	Forest-wide MA acres[3]	Acres and percent within 4FRI East project area
Coconino National Forest: 370,415 acres				
Long Valley	predominantly ponderosa pine, but also includes grasslands, riparian forest, pinyon juniper, mixed conifer, and wetlands, springs Designated wilderness, eligible WSR, IRAs, National Trails, proposed RNA	**Objectives:** see forest-wide **Standards:** N/A **Guidelines:** N/A	164,055	155,370/
Acres of Non-Forest System lands within MA:2,665 acres				
Pine Belt	Ponderosa pine: but also includes 8 other ERUs within 4FRI boundary?, designated wilderness, no recommended wilderness, has eligible WSR, IRAs, Gus Pearson RNA, Red Mtn. Geologic Area, Scenic Roads, National Trails, Riparian forest , streams, wetlands, springs	**Objectives:** see forest-wide **Landscape Scale DC:** Mosaic of trees with varying age classes and understory vegetation which provide habitat for a variety of species, including Mexican spotted owls and northern goshawks, and ground fuels conducive to low-severity fires. **DC 1**. Roads, trails, and recreation use have minimal effects to woody riparian vegetation and riparian habitat in Pumphouse Wash. **Check for any seasonal closure areas that overlap analysis area**	426,832	89,663

[3] Forest-wide acres does not include lands that are not National Forest System lands. MA acres as presented in the draft forest plan includes all acres.

		Standards: N/A would be included if seasonal closures overlap **Guidelines:** N/A (specific to Pumphouse Wash/Oak Creek Canyon) See landscape character description document		
Acres of Non-Forest System lands within MA:42,829 acres				
East Clear Creek	Vegetation is predominantly ponderosa pine and mixed conifer with scattered pinyon juniper, high elevation grasslands, riparian forest, and wetlands, springs. No designated or recommended wilderness. Includes tributaries to, and portions of, East Clear Creek - key habitat for the Little Colorado spinedace (endemic, threatened), eligible WSR, IRA, National Trails, Riparian	**Objectives:** see forest-wide **Standards: N/A** **Guidelines:** **GL 1: N/A – specific to camping and motorized recreation**	53,124	53,124
Acres of Non-Forest System lands within MA:1,835 acres				
C.C. Cragin Watersheds	Ponderosa pine and mixed conifer with scatter pockets of riparian, grasslands, and wetlands, springs. Eligible WSR, designated Botanical Area and National Trails	**Objectives:** see forest-wide **DC 1**: There is low risk of substantial damage from uncharacteristic fire and recreation to municipal water supply, infrastructure, water quality, visual quality, and cultural integrity (e.g., tribes and local communities). **Standards: N/A** **Guidelines:** **GL1**: The C. C. Cragin Watersheds MA should be managed to reduce the threat of uncharacteristic wildfires, flooding, and sedimentation, and to maintain water quality and quantity. **GL 2**: Roads and trails within the C.C. Cragin Watersheds MA should be maintained to prevent erosion	45,711	45,711

		and sedimentation and to protect existing infrastructure. **Note**: there is both riparian areas and riparian forest **Management Approaches for C.C. Cragin Watersheds Management Area** Coordinate with the Salt River Project, National Forest Foundation, Town of Payson, the Bureau of Reclamation, U.S. Fish and Wildlife Service, Arizona Game and Fish Department, Arizona Elk Society, the local community, and other stakeholders to proactively improve the health and resiliency of the C.C. Cragin Watersheds Management Area.		
Acres of Non-Forest System lands within MA: 290 acres				
Anderson Mesa	Dominated by pinyon juniper, grassland, and ponderosa pine vegetation, also mixed con with aspen and is an important pronghorn habitat area. No designated or proposed wilderness, has eligible WSR, IRAs, Scenic Roads, Riparian	**Objectives:** see forest-wide		23,370
Acres of Non-Forest System lands within MA:4,986 acres				
Verde Valley	Vegetation is predominantly desert, grassland, chaparral, and pinyon juniper, some ponderosa pine, with riparian forests along stream channels. Perennial waters include portions of the Verde River, Oak Creek, Wet Beaver Creek, West Clear Creek, and Fossil Creek. Streams, wetlands, springs. Has designated and proposed wilderness, designated WSR, eligible WSR,	**Objectives**: see forest-wide **DC 1**: Watersheds are managed to reduce the risk of uncharacteristic flooding and sedimentation into downstream communities, perennial streams and their tributaries, wildernesses, and other special areas. This would include watersheds that affect drainages such as Beaver Creek, Dry Beaver Creek, Red Tank Draw, Russell Wash, Walker Creek, West Clear Creek, and Oak Creek. **Standards: N/A** **Guidelines:** **GL 1**: Projects and activities should be designed and implemented to	323,455	1,052/

	proposed West Clear Creek RNA, 3 botanical areas, 1 geologic area, IRAs, National Trails, Riparian	maintain or improve watershed and riparian function and/or prevent the introduction or spread of disease, invasive, or undesirable species. **GL 2-4:** N/A		
Acres of Non-Forest System lands within MA: 35,115 acres				

Table 10. Tonto NF Forest Plan Forest-wide Goals.

Forestwide/ Resource Unit	Resource	Goals
Forestwide Goals	Air, water, soil, & riparian.	(1) Meet minimum air and water quality standards, (2) Emphasize improvement of soil productivity, air and water quality, (3) Augment water supplies when compatible with other resources, (4) Enhance riparian ecosystems, by improved management. All major riparian areas under intensive management by 1995, (5) obtain water rights necessary to ensure orderly resource development,
	Riparian Habitat	Management emphasis in riparian areas will feature wildlife needs over recreation and grazing.
	Soil and Water	During the planning period there will be high opportunity for maintenance or enhancement of watershed condition and soil productivity. The impetus to this will be the range program, which will provide for improving range forage conditions and putting all allotments under appropriate levels of management.

Table 11. Tonto NF Forest Plan Forest-wide Standards and Guidelines. NF Forest Plan Forest-wide Standards and Guidelines.

Resource Section within Forest Plan	Plan Component	Plan Direction
Wildlife, Fish, and Rare Plants	Standard and Guideline	Maintain a minimum of 30% effective ground cover for watershed protection and forage production, especially in primary wildlife forage producing areas. Where less than 30% exists, it will be the management goal to obtain a minimum of 30% effective ground cover.

Resource Section within Forest Plan	Plan Component	Plan Direction
Wildlife, Fish, and Rare Plants	Standard and Guideline	All Riparian Areas- Rehabilitate and maintain, through improved management practices, mixed broadleaf riparian to achieve 80% of the potential overstory crown coverage. Natural regeneration is anticipated to achieve most of this goal. Artificial regeneration may be necessary in some areas.
Wildlife, Fish, and Rare Plants	Standard and Guideline	Re-establish riparian vegetation in severely degraded but potentially productive riparian areas. Natural regeneration is anticipated to achieve this goal, but artificial regeneration may be necessary in some areas.
Wildlife, Fish, and Rare Plants	Standard and Guideline	Manage riparian areas to the level needed to provide protection and improvement.
Wildlife, Fish, and Rare Plants	Standard and Guideline	Where possible, locate roads on natural benches, ridges, flat slopes near ridges or valley bottoms, and away from stream channels.
Wildlife, Fish, and Rare Plants	Standard and Guideline	Where channel crossings are necessary, select an area where the channel is straight and cross the channel at right angles.
Wildlife, Fish, and Rare Plants	Standard and Guideline	Avoid channel changes or disturbance of stream channels and minimize effects to riparian vegetation.
Wildlife, Fish, and Rare Plants	S&G (1996 amendments)	Riparian Areas: Emphasize maintenance and restoration of healthy riparian ecosystems through conformance with forest plan riparian standards and guidelines. Management strategies should move degraded riparian vegetation toward good condition as soon as possible. Damage to riparian vegetation, stream banks, and channels should be prevented.
Wildlife, Fish, and Rare Plants	S&G (1996 amendments)	Basin and Range - West: Emphasize restoration of lowland riparian habitats.
Wildlife, Fish, and Rare Plants	S&G (1996 amendments)	Manage road densities at the lowest level possible. Where timber harvesting has been prescribed to achieve desired forest condition, use small skid trails in lieu of roads.

Table 12. Tonto National Forest Decision Unit Standard and Guidelines.

Forestwide/ Resource Unit	Resource	Standards and Guidelines
Decision Units DU 10, 11, 12, 13, 32 Activities C01, E00	Soil and Water	Maintain a minimum of 30% effective ground cover for watershed protection and forage production, especially in primary wildlife forage producing areas. Where less than 30% exists, it will be the management goal to obtain a minimum of

Forestwide/ Resource Unit	Resource	Standards and Guidelines
		30% effective ground cover.
Decision Units DU 10, 11, 12, 13, 32 Activities C01, E00	Riparian Areas	Coordinate with range to achieve utilization in the riparian areas that will not exceed 20% of the current annual growth by volume of woody species. Coordinate with range to achieve at least 80% of the potential riparian overstory crown coverage. Coordinate with range to achieve at least 50% of the cottonwood-willow and mixed broadleaf acres in structural Type 1 by 2030. Rehabilitate at least 80% of the potential shrub cover in riparian areas through the use of appropriate grazing systems and methods. Any surface or vegetation disturbing projects in riparian areas will be coordinated and will specify protection or rehabilitation of riparian dependent resources.
Decision Units 14,15,16 Activities C03	Riparian Areas	Rehabilitate and maintain, through improved management practices, mixed broadleaf riparian to achieve 80% of the potential overstory crown coverage. Natural regeneration is anticipated to achieve most of this goal. Artificial regeneration may be necessary in some areas. Re-establish riparian vegetation in severely degraded but potentially productive riparian areas. Natural regeneration is anticipated to achieve this goal, but artificial regeneration may be necessary in some areas
Decision Unit 33 Activity F05 and Decision Unit 63 Activity F05	Soil and Water	Water resource improvement projects to be implemented as needed.
Decision Unit 34 Activity F01	Soil and Water	Minimize effects on soil and water resources from all ground disturbing activities. When developing water for National Forest purposes, preference should be given to those types of developments that waste the least amount of water. Manage vegetation to achieve satisfactory or better watershed conditions.
Decision Unit 34 Activity F01	Soil and Water	As needed, prepare water resource improvement plans for high priority watersheds and problem areas.
Decision Unit 34 F02	Soil and Water	Inventory watershed condition. This will include an assessment of the Forest once per decade, and smaller areas on an as needed basis. Prepare flood hazard analyses on proposed projects in flood prone areas per Executive Order 11988. Mitigate the adverse effects of planned activities on the soil and water resources through the use of Best Management Practices.

Forestwide/ Resource Unit	Resource	Standards and Guidelines
Decision Unit 34 Activity F03	Soil and Water	Water quality will be monitored in key locations to aid in the identification and correction of resource problems.
Decision Units 33, 63 Activity F05	Water Resources	Water resource improvement projects to be implemented as needed.
Decision Unit 46 Activity K01	Soil and Water	Lands which require erosion control measures will be identified, mapped, and cataloged.
Decision Unit 46, 62 Activities K05, K06	Soil and Water	Implement and maintain soil resource improvement projects as needed.
Decision Unit DU 1, Activities A01, C01, D01, E00, F01, G01, J01, L04	Cave Management	All surface-disturbing activities planned near or within a known cave area will be examined for potential effects to the cave(s) and the area around each cave entrance(s), (plus feeder drainages and surface areas immediately over cave passages). The cave area will also be evaluated to determine protection measures needed. Protection measures for caves will be incorporated into project planning, and may include (but not be limited to) education, seasonal closures, and installation of entrance gates.
Decision Unit DU 1, Activity A01	Cave Management	Develop a Forest-wide Cave Implementation Plan and use it as a basis for preparation of prescriptions for significant caves and any other selected cave. Evaluate appropriateness of recreation activities as a part of the plan.
Decision Unit DU11 Activity C09	Cave Management	Bat roosts and other sensitive biological resources within caves will be managed using all appropriate means identified in the Cave Implementation Plan.
Decision Unit Du 36 Activity G02	Cave Management	Potential effects to cave resources will be considered in reviewing all proposed Notices of Intent/Plans of Operation. Appropriate land will be withdrawn from mineral entry when necessary to provide cave protection.
Decision Unit 41 Activity J01	Cave Management	When compatible with identified resource values, research activity within caves will be permitted.
Management Area 5G Decision Unit 3 Activity 01	Cave Management	Develop implementation plan for Red Lake Cave.
MANAGEMENT AREA 4D Payson Ranger District – Mogollon Rim Area	This management area includes the ponderosa pine forested area below the Mogollon Rim.	Management Emphasis: Manage for a variety of renewable resource outputs with primary emphasis on intensive, sustained yield timber management, timber resource protection, creation of wildlife habitat diversity, increased populations of emphasis harvest species, and recreation opportunity. Timber harvesting methods and timing will include improvement of wildlife habitat quality and watershed condition, and will consider effects on intensive range and recreation management. Mining activities are authorized in conformance with existing laws and regulations. Visual

Forestwide/ Resource Unit	Resource	Standards and Guidelines
MANAGEMENT AREA 5D - Pleasant Valley Ranger District – Mogollon Rim-Sierra Ancha Area	Description: This management area includes the ponderosa pine forested area below the Mogollon Rim and in the Sierra Ancha Mountains. In 1984, 56,698 acres were classified as operable/suitable for timber harvest. The area includes 3 developed (total of 20 acres) and a 1 acre public service site.	quality protection will be emphasized in the area (Analysis Area 5542) of the Highline Trail, a National Recreation Trail. Standard and Guidelines for both 4D and 5D Resource Area : Forestry and Forest Health 1) Timber sale road systems should be designed to minimize effects on stream channels and water quality. Roads should be located on slopes less than 60%, and should have sustained gradients of less than 8%. Roads should not be located on unstable slopes where mass movement is likely to occur. 2) Slash and debris should be kept out of protected stream channels. 3) Raise lead end of logs when skidding to minimize gouging. Restrict skidding during wet weather if necessary to prevent watershed damage. Rehabilitate skid trails and landings when logging is completed (provide drainage, repair ruts and gullies, and seed if necessary). Standard and Guidelines for 4D only Resource Area : Forestry and Forest Health An Interdisciplinary (I.D.) team will evaluate the need for buffer strips adjacent to water bodies within proposed commercial saw timber sale areas. Where a buffer strip is deemed necessary, the I.D. team will recommend the width of strip needed to achieve adequate protection of aquatic and riparian resources. The width of the buffer strip will depend upon such factors as channel stability, side-slope steepness, erodibility of soils, existing ground cover conditions, and existing aquatic conditions. Logging vehicles will not be allowed to operate within any such designated buffer strips, except at designated crossings. Resource Area : Fire Management Use prescribed fire to treat vegetation for water yield, forage, and wildlife habitat improvement.

Project-Specific Desired Conditions for Soil and Watersheds

Soils

- Long-term soil productivity is protected by maintaining or improving soil condition and function.
- Soil condition and function is maintained or improved toward satisfactory.
- The vegetative ground cover is adequate to protect against accelerated erosion resulting in maintained soil stability, soil and vegetative productivity. Soil loss is below tolerance, and no visible signs of excessive erosion are present.
- Adequate vegetative ground cover is present to reduce the threat to life, property, soil productivity and water quality from post wildfire storm events (flooding and debris flows).
- Surface soil hydrologic soil function is in satisfactory condition with well aggregated, granular surface soil structure and tubular pores with sufficient porosity to effectively infiltrate water.
- Soil nutrient cycling is in satisfactory condition. Vegetative ground cover, plant basal area, species composition and forage productivity and herbaceous understory approaches natural conditions in PPC.
- Forests are restored at the landscape-scale that will provide for sustainable, forest health, wildlife and plant diversity while at the same time maintain and improve long-term soil productivity. The resultant forests are fire-adapted with the majority of fires occurring as ground fires at low fire severity to watershed.

Watersheds:

- Watershed function is maintained or improved towards functioning properly and exhibit high geomorphic, hydrologic, and biotic integrity relative to their natural potential condition. Fire regime condition class and tree density is reduced and moves towards FRCC 1 (historical range), unneeded roads are decommissioned or restored to natural condition, soil and riparian condition and function is improved and moving towards satisfactory and properly functioning.

Assumptions and Methodology

This section describes the methodology and analysis processes used to determine the environmental consequences to soils and watershed resources from implementing the alternatives. Environmental consequences will be described with qualitative and quantitative descriptions supported by past studies and relevant literature.

Analyses for environmental consequences to soils and watershed resources that may result from implementation of each alternative were conducted using information contained in the Terrestrial Ecosystem Survey of the Apache-Sitgreaves National Forest, Coconino National Forest and Tonto National Forest, the Watershed Condition Framework, Ecological Response Unit (ERU) inventory maps (Triepke et al., 2014a and b), Forest Land Management Plans, Arizona Department of Environmental Quality (ADEQ), information obtained from other resource specialists, other agency reports, available literature, and input from collaborators, cooperators, and stakeholders. 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.

Soils

Soils throughout the project area were mapped as part of the Terrestrial Ecosystem Survey (TES) of each forest. This information is available at the respective Forest Supervisor’s Offices.

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 Rim Country analysis area that includes field visited, validated and correlated sites with a stringent Regional and National protocol stemming from decades of work. Major field work for the TES was completed from 1979 through 1986, although some mapping and classification is ongoing on the Tonto National Forest.

It is important to understand that differences in ecosystem properties including soil and vegetation can occur within short distances. The TES was mapped at a scale of 1:24,000 across the landscape. Generally, small vegetation types (i.e., smaller than about 40 acres) were not mapped and are therefore included in larger TES map units.

The TES follows National Cooperative Soil Survey Standards similar to Soil Surveys conducted by the Natural Resource Conservation Service (NRCS). There has therefore been strict quality assurance including Project Leader field reviews, Regional Office reviews, and annual progressive and final field reviews to approve map unit design and mapping.

The system of soil classification used during Terrestrial Ecosystem Unit Inventory (TEUI) was adopted by the National Cooperative Soil Survey in 1965. The TEUI process utilizes five categories of this system: order, suborder, great group, subgroup and family. Classification is based, on observed and/or inferred data from the field of soil science and other related disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. Categories of the system are discussed below.

ORDER. Ten soil orders were recognized as categories. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil-forming processes that have taken place. Each order is identified by a word ending in "sol". An example is Alfisol.

SUBORDER. Each order is divided into suborders based primarily on properties that influence soil genesis and are important to growth or that reflect the most important variables within the orders. The last syllable in the suborder name indicates the order. An example is Boralf (Bor, meaning cool, plus alf, meaning Alfisol).

GREAT GROUP Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and a prefix that suggests something about properties of the soil. An example is Cryoboralfs, (Cry, indicating cool summers, plus boralf, the suborder of the Alfisols that have cryic or frigid temperature regimes).

SUBGROUP. Each great group may be divided into subgroups: (1) The central (typic) concept of the great group, which is not necessarily the most extensive subgroup; (2) The intergrades, or transitional forms to other orders, suborders, or great groups; and (3) the extragrades, which have some properties that are representative of the great groups but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. An example is Typic Cryoboralfs.

FAMILY. Families are established within a subgroup-on the basis of similar physical and chemical properties that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties considered are particle size class, mineral content, temperature regime, depth of rooting zone, consistence, moisture equivalent, slope and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentia. An example is loamy-skeletal, mixed, Typic Cryoboralfs.

Soil taxonomic classification information is included in Appendix A.

The TES is used to evaluate and adjust land uses to the limitations and potentials of natural resources and the environment. It presents important properties pertaining to the natural, physical, and behavioral characteristics of the terrestrial ecosystems and provides the background for making interpretations. Interpretations based upon TES incorporate 1) soil physical and chemical properties, 2) climatic considerations, 3) topographic position and slope, 4) vegetation and anthropogenic influences as well as animal effects, 5) productive and successional potentials, and 6) geologic influences. As such the TES can form the ecological basis for describing existing conditions for resource areas including watershed, wildlife, fire, and timber.

There were 186 TES map units from the 3 forests that were aggregated into 30 landscape unit strata (Appendix A). These strata have similar soils and vegetation types with similar limitations, hazards and production potentials to management activities. The strata were used in part to design treatments, analyze effects, identify similar BMPs and are based on the potential plant community and capability of the soils.

A need for change matrix (Appendix B) has been crafted to disclose the existing and desired condition for soils by strata and the need for change and potential management strategies. The following is a summary of existing condition.

Soil condition is based on the primary soil functions of soil hydrology, soil stability, and nutrient cycling.

Erosion Modeling

Soil erosion and sediment delivery rates for undisturbed forest, forest thinning, prescribed fire, wildfire, and road use were modeled using FS WEPP Interfaces. The FS WEPP interface allows users to easily describe numerous disturbed forest erosion conditions. The interfaces present the results as a summary and extended WEPP outputs, and also present the probability of a given level of erosion occurring the year following a disturbance. Values for predicted soil erosion rates by water movement are determined from rainfall simulations and field research of natural rainfall effects conducted by scientists within the USDA and other organizations (Elliot and Foltz 2001). The WEPP model has been further validated for use in the Southwest (i.e., Arizona and New Mexico) through research on hydrologic processes to predict responses of soils to disturbances (Bolton et al. 1991, Paige et al. 2003).

The Erosion Risk Management Tool (ERMiT) was used to model predicted erosion and sediment delivery from low, moderate, and high severity fire conditions in order to cover the range of possible soil burn severitiesfrom both wildfire and prescribed fire. Sediment yield rates for forest thinning treatments were modeled for each soil stratum using the WEPP Fuel Management (FuME) model. The WEPP FuME tool was developed to estimate sediment generated by fuel management activities. WEPP FuME estimates sediment generated for 12 fuel-related conditions from a single input. These conditions include: undisturbed forest, wildfire, prescribed fire, forest thinning, and access roads. The tool is designed to be used by erosion specialists for detailed analysis of effects of proposed fuel treatments, or by fuel management specialists for a quick estimate of potential sedimentation effects from a given stand treatment. Erosion rates for constructed forest roads were also modeled using the WEPP:Road interface. WEPP:Road is an interface to the WEPP soil erosion model that allows users to easily describe numerous road erosion conditions.

WEPP:Road is designed to predict runoff and sediment yield from roads, compacted landings, compacted skid trails, and compacted foot, cattle, or off-road vehicle trails.

The term “sensitive soils” for te purpose of this analysis refers to the the expected response of a soil to a given “stressor”, whether such stressor is physical, chemical, or biological. Some examples of soil stressors include compaction caused by vehicular traffic, fire, denudation, pollution, and acid deposition.

Watersheds

Effects to watershed conditions will be discussed qualitatively, based on comparison of current activities to projected effects of implementing alternatives.

A watershed condition assessment was completed in 2011 for all sixth-level subwatersheds in the proposed project area as part of a Forest-level assessment of watershed condition (Potyondy and Geier, 2010). Watershed conditions were re-evaluated in 2016 to account for changes in watershed conditions due to restoration treatments, road decommissioning, wildfires and other agents of change since the initial assessment. 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.

The indicator ratings are summarized into three classes and are described below.

- **Indicator Rating 1** is synonymous with “GOOD” condition. It is the expected indicator value in a watershed with high geomorphic, hydrologic, and biotic integrity relative to natural potential condition. The rating suggests that the watershed is functioning properly with respect to that attribute.
- **Indicator Rating 2** is synonymous with “FAIR” condition. It is the expected indicator value in a watershed with moderate geomorphic, hydrologic, and biotic integrity relative to natural potential condition. The rating suggests that the watershed is functioning at risk with respect to that attribute.

- **Indicator Rating 3** is synonymous with "POOR" condition. It is the expected indicator value in a watershed with low geomorphic, hydrologic, and biotic integrity relative to natural potential condition. The rating suggests that the watershed is impaired or functioning at unacceptable risk with respect to that attribute.

Figure 1 below displays the watershed condition indicators and how each attribute contributes to indicator ratings and overall evaluation of watershed condition classification.

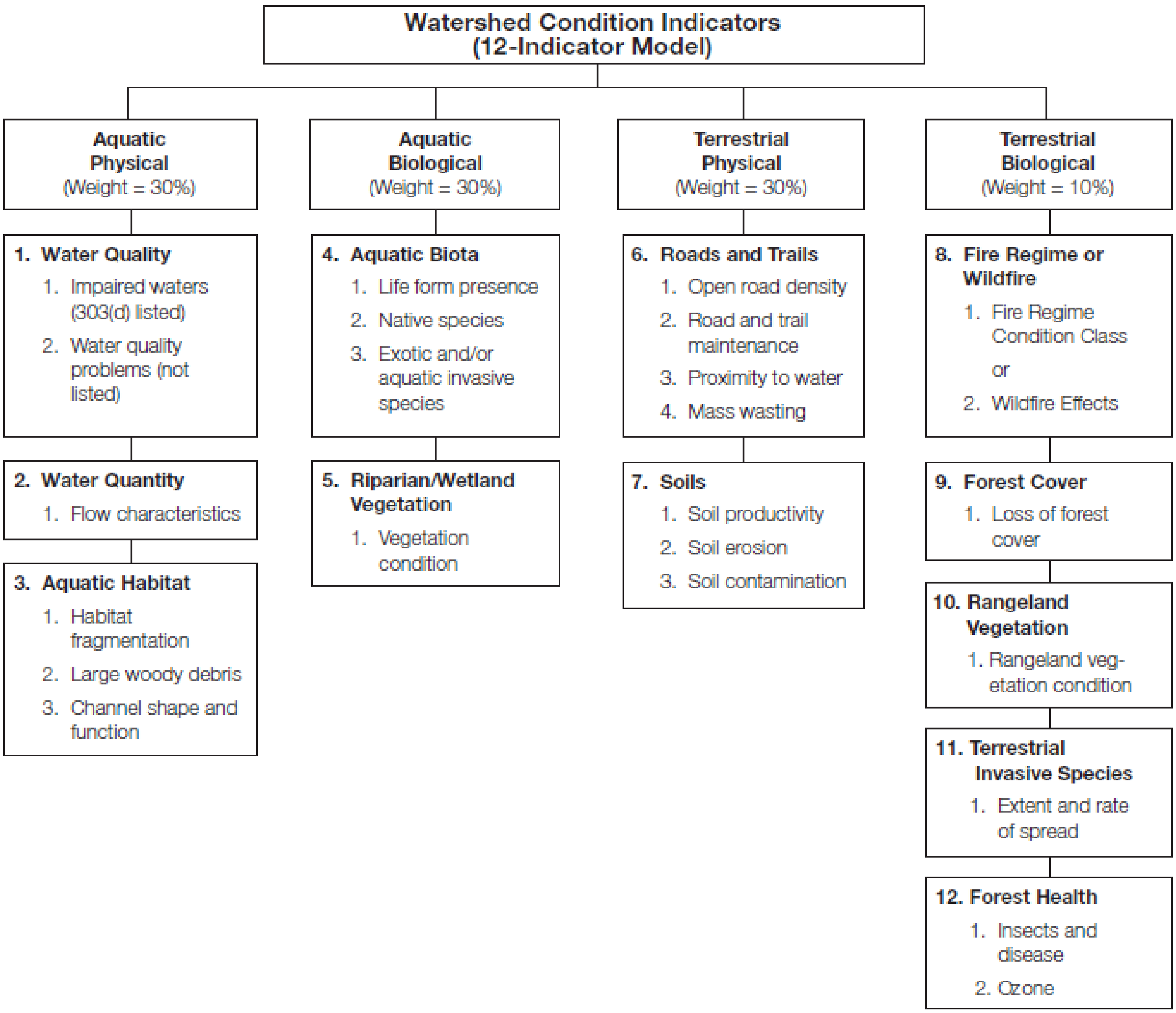

Figure 1. Core national watershed condition indicators.

Table 13 below provides a list of watershed condition indicators and their descriptions.

Table 13. Description of watershed condition indicators included in the Watershed Condition Framework scoring. (USDA Forest Service 2011, FS-977).

Aquatic Physical Indicators	
Water Quality	This indicator addresses the expressed alteration of physical, chemical and biological components of water quality.
Water Quantity	This indicator addresses changes to the natural flow regime with respect to the magnitude, duration, or timing of natural streamflow hydrograph.
Aquatic Habitat	This indicator addresses aquatic habitat condition with respect to habitat fragmentation, large woody debris, and channel shape and function.
Aquatic Biological Indicators	
Riparian/Wetland Vegetation	This indicator addresses the function and condition of riparian vegetation along streams, water bodies, and wetlands.
Terrestrial Physical Indicators	
Roads and Trails	This indicator addresses changes to the hydrologic and sediment regimes because of the density, location, distribution, and maintenance of the road and trail network.
Soils	This indicator addresses alteration to natural soil condition, including productivity, erosion, and chemical contamination.
Terrestrial Biological Indicators	
Fire Regime or Wildfire	This indicator addresses the potential for altered hydrologic and sediment regimes because of departures from historical ranges of variability in vegetation, fuel composition, fire frequency, fire severity, and fire pattern.
Forest Cover	This indicator addresses the potential for altered hydrologic and sediment regimes because of the loss of forest cover on forest lands.
Rangeland Vegetation	This indicator addresses effects on soil and water because of vegetative health of rangelands.
Forest Health	This indicator addresses forest mortality effects on hydrologic and soil function because of major invasive and native forest insect and disease outbreaks and air pollution.

Watershed condition information is provided in a readily accessible online map viewer where users can review watershed condition information including attribute and indicator ratings, selected priority watersheds, review Watershed Restoration Action Plans and associated essential project necessary for successful watershed restoration and including estimated costs and restoration partners.

Watershed Condition Class and Prioritization Information

It is important to note that the condition class of a watershed integrates the effects of all activities within a watershed, including those of other landowners. The Watershed Condition Framework therefore provides an ideal mechanism for interpreting the cumulative effects of a multitude of management actions on soil and hydrologic function (USDA, 2011).

It is reasonable to expect and is therefore assumed that treatments resulting from implementation of the proposed action or other action alternatives would result in some short-term, localized negative effects due to soil disturbance caused by use of heavy machinery for forest restoration treatments. These conditions may also occur on soils where previously completed projects overlap proposed or future activities in watersheds across the project. However, no long-term, cumulative adverse effects from ground disturbance (compaction, topsoil displacement, extensive areas of high soil burn severity, etc.) are anticipated to occur at a severity or spatial extent to negatively affect overall watershed condition. In general, proposed restoration treatments are expected to result in improvement in overall watershed condition in proportion to the areal extent of the restoration treatments within each watershed. However, proposed processing sites and gravel pits for road surfacing materials are expected to exhibit longer term negative effects due to long term use of processing sites and extractive operations in gravel pits. With implementation of applicable Best Management Practices, design features and mitigation measures, most adverse effects can be ameliorated, reducing long term degradation of these sites.

Affected Environment

This section provides information about the existing conditions of the affected environment for soils and watershed resources within the project area of about 1,238,658 (with potential restoration treatment area of 950,000 acres). It also includes an analysis of watershed conditions at the 6^{th} Hydrologic Unit Code (HUC) level. This section establishes the baseline against which the decision maker and the public can compare the effects of all action alternatives.

Appendix A displays the Terrestrial Ecosystem Survey (TES) map unit stratification and soil interpretations based on similar soils properties and behavioral characteristics, vegetation communities and management risks, limitations and potentials. Appendix B displays the existing and desired conditions, need for change and potential management strategies in tabular format by TES map unit stratum.

Affected environment of riparian resources, water quality, and water quantity is analyzed in the Water and Riparian Resources Specialist Report (Brown, 2018).

Climate

The project area occurs within the North central climatological division of Arizona. Precipitation on the average varies from 18 to 30 inches annually and is bimodal. The majority of the precipitation falls from Late July through early September as monsoon rain and November through March as winter snowfall, Winters are cold and soil temperatures are classified as mesic to frigid and therefore subject to freezing and thawing. Summer precipitation is irregular, but usually takes place in the form of high-intensity, short duration thunderstorms.

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 climate in the ponderosa pine pinyon-juniper transition is similar except annual precipitation is less ranging from about 16 – 20 inches per year with cold winters. The climate in pinyon-juniper vegetation types is dryer with precipitation ranging from about 14-18 inches per year with cold (HSC) or mild (LSM) winters.

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 carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and hydrofluorocarbons 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).

In 2010, the Southwestern Region of the Forest Service 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 or forest restoration 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 effects at the Forest level necessary to analyze cumulative effects. Effects 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 also 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 as it has in the past. Forest management activities should therefore strive to promote ecosystem resilience and resistance to effects 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. Forest management should also consider future climate scenarios that could affect precipitation patterns, changes in vegetative community patterns, and changes to inherent soil properties and changes to surface and groundwater dynamics. Ecological diversity remains an integral component in native ecosystems. Projects should promote connected landscapes and endeavor to restore significantly altered biological communities in a manner that promotes resilience to climate changes.

Soils

There were 186 TES map units from the 3 forests that were aggregated into 30 landscape unit strata. Each stratum has similar soils properties, slopes, climate regimes and vegetation communities. These soils also have similar limitations, hazards, suitabilities for various management activities and production potentials. The strata were used in part to design treatments, analyze effects and are based on the potential plant community and capabilities of the soils.

Existing Soil Condition

A soil condition category is assigned to each ecological unit following protocol from USDA Forest Service, FSH 2509.18, R3 Supplement No 2509.18-99-1 and the soil condition ratings are based on interpretations of the three primary soil functions: soil hydrologic function, soil stability and nutrient cycling. Under this broad scale level of analysis (landscape scale by strata), it is important to note that soil conditions within a given ecological unit may vary somewhat but most strata are one single soil condition class.

Soil condition classes used are Satisfactory, Impaired, Unsatisfactory and Inherently Unstable. The following are definitions describe each class.

Satisfactory: Indicators signify that soil function is being sustained and soil is functioning properly and normally. The ability of the soil to maintain resource values and sustain outputs is high.

Impaired: Indicators signify a reduction in soil function. The ability of the soil to function properly and normally has been reduced and/or there exists an increased vulnerability to degradation. An impaired category indicates there is a need to investigate the ecosystem to determine the cause and degree of decline in soil functions. Changes in land management practices or other preventative measures may be appropriate.

Unsatisfactory: Indicators signify that a loss of soil function has occurred. Degradation of vital soil functions result in the inability of the soil to maintain resource values, sustain outputs or recover from effects. Unsatisfactory soils are candidates for improved management practices or restoration designed to recover soil functions.

Inherently Unstable or Unsuited: These soils have natural erosion exceeding tolerable limits. Based on the Universal Soil Loss Equation (USLE) these soils are eroding faster than they are renewing themselves but are functioning properly and normally.

Within the project area, there are approximately 1,044,718 acres of soils in satisfactory condition, 57,159 acres of soils in impaired condition, 11,838 acres of soils in unsatisfactory condition. There are 41,310 acres of soils that are characterized as being in satisfactory condition, although they are inherently unstable (meaning that natural, or geologic erosion rates exceed the rates of soil formation). There are also 109,499 acres of soils for which soil condition is unknown.

It's important for the reviewer to understand that there can be varying soil condition ratings within a given stratum, depending on locations and intensities of historic management practices, presence of wildfires that altered soil condition ratings, and landscape or forest conditions (e.g., encroachment or densification) that have altered soil condition ratings.

Most soils strata in the ponderosa pine and mixed conifer vegetation types currently exhibit relatively closed stand structures due to forest ingrowth and densification. The increase in canopy cover and stand densities on these strata that have reduced understory vegetative productivity. Areas that have received forest thinning or prescribed fire treatments generally have more robust understory vegetative communities. Trends indicate that loss of understory vegetative cover and increased fuel loading will occur as a result of the increase in woody biomass and forest detritus (needles, leaves, twigs, branches, and boles) caused by continued forest ingrowth and tree encroachment into existing openings followed by forest decadence caused by intraspecific and interspecific tree competition. Additionally, the ingrowth of forest midstories has created 'ladder fuels' which allow ground fires to ascend and spread quickly as crown fires. These conditions are conducive to an increased risk of moderate or high soil burn severity due to more extreme fire behavior conditions, particularly where Fire Regime Condition Classes (FRCC) are dominated by class 2 and 3. Fires resulting in moderate or high burn severity pose substantial risk to soil productivity and downstream water quality in connected streamcourses on soils with moderate or high erosion hazard ratings due to elevated risk of soil particle detachment, entrainment, and delivery of sediment to streamcourses. However, most soils in ponderosa pine and mixed conifer PNVs are in satisfactory soil condition and have the ability to resist accelerated erosion due to high amounts of protective litter cover.

Most soils in the ponderosa pine PNVs on slopes less than 40 percent are in satisfactory condition and have the ability to resist accelerated erosion due to high amounts of protective litter cover. Although most soils are rated satisfactory, nutrient cycling and water movement are not optimal in dense stands that have high litter content and reduced vegetative ground cover (including those in FRCC 3). This is because fine root biomass associated with most understory vegetation (e.g., grasses and forbs) is not present. Fine root biomass improves soil condition in a variety of ways including: a) increased soil stability due to the ability of fine roots to bind soils and increase aggregation, b) improved water infiltration through increased macropore space and root channels that convey water vertically and laterally, and c) enhanced nutrient cycling as fine roots decompose and are consumed by soil organisms, d) moderation of soil surface temperature regimes, e) suitable plant-water relations conducive to establishment of additional vegetation. The amount of coarse woody debris is not quantified but maintenance of 5-7 tons per acre provides material that contributes long term nutrient supplies, surface roughness and habitat for soil meso and microfauna.

On strata with slopes greater than 40 percent (strata 4, 17, and 29) soils are either inherently unstable (strata 4) or are dominated by severe erosion hazard ratings (17 and 29). These soils are not suitable for mechanical tree harvesting unless machinery designed specifically for steep slope harvesting is used and identified design features and BMP's are effectively implemented during mechanical tree harvesting and prescribed fire.

Soils of Montane Meadows (strata 1, and 2) are either impaired (A-S) or unsatisfactory (CNF) due to reduced vegetative ground cover or compacted soil conditions resulting in hydrologic dysfunction. These strata have reduced ability to effectively infiltrate water and have relatively low vegetative productivity compared to conditions identified for the PNVT associated with these strata. Livestock and wildlife ungulate grazing and browsing have either reduced vegetation density or stature in these area, leading to compacted soils, eroding soils, or sod-bound conditions that inhibit water infiltration, contributing to reduced soil moisture.

Soil condition on pinyon juniper vegetation types on slopes less than 40% (strata 46) is variable and has areas of satisfactory, impaired and a few areas have unsatisfactory soil condition. The amount of coarse woody material is not quantified but maintenance of coarse woody material identified in table 3, BMPs should improve soil nutrient cycling and soil condition (Huffman, 2010).

Soil Erosion Processes and Erosion Hazard Ratings

Soil erosion is defined as (1) the wearing away of the land surface by running water, wind, ice, or other geologic agents, including such processes as gravitational creep, or (2) detachment and movement of soil or rock fragments by water, wind, ice or gravity.

Accelerated erosion is much more rapid than normal, natural, or geologic erosion, primarily as a result of the influence of the activities of man or in some cases of other animals or natural catastrophes that expose soil surfaces, leaving them subject to erosional forces. An example would be a high severity wildfire on steep terrain where soils are poorly consolidated.

Forest soils generally have very low erosion rates unless they are disturbed. Common disturbances include prescribed fire, wildfire, and timber harvesting operations or mechanized fuels treatments. Vegetative recovery after fuel treatments is generally rapid if soil disturbance is minimized through effective implementation of BMPs, with erosion rates typically dropping to pre-treatment levels within 1 to 2 years. The rapid regrowth of vegetation provides protective ground cover and plant litter, and potential erosion is quickly reduced. In one study, Robichaud and Brown (1999) reported that erosion rates dropped from almost 40 Mg ha^{-1} the first year after a fire to 2.3 Mg ha^{-1} the second, and 1 Mg ha^{-1} the third year. If the year is normal or dry, then it is unlikely there would be any significant erosion (Elliot et al, 1999).

Soil loss tolerance thresholds refer to the rates of soil loss than can occur while sustaining inherent site productivity (Miller et al. 1995). Soils in each TES ecological unit are assigned tolerance soil loss rates based on individual soil and climate properties and approximate annual soil development rates. Maintaining soil erosion below soil tolerance levels assures soil productivity will be maintained with regard to activity-related soil erosion.

The TES defines erosion hazard (USDA 1984) as the probability of soil loss resulting from the complete removal of vegetation and litter. Three classes are used. A slight rating indicates that all vegetative ground cover could be removed from the site and the resulting soil loss will not exceed "tolerance" soil loss rates. A moderate rate indicates that predicted rates of soil loss will result in a reduction of site productivity *if left unchecked*. Conditions in moderate erosion hazard sites are such that reasonable and economically feasible mitigation measures can be applied to reduce or eliminate soil loss. A severe rating indicates that predicted rates of soil loss have a high probability of reducing site productivity before mitigating measures can be applied.

Most soils and strata on slopes less than 15% have slight erosion hazard and soils and strata on slopes greater than 15% generally have moderate to severe erosion hazard. Disturbances on soils that remove appreciable amounts of effective ground cover on soil with moderate and severe erosion hazard increase the risk of accelerated soil erosion and loss of long term soil productivity.

Within the project area, the following strata (Appendix A) are dominated by soils with moderate or severe erosion hazard 4, 7-10, 12, 14, 16, 17, 19, 20, 26, 28, 29, and 30 (a total of about 452,500 acres or about

37 percent of the analysis area or 43% of ponderosa pine or mixed conifer vegetation types). The remaining strata including, 1, 2, 3, 5, 6, 11, 13, 15, 18, 21-25 and 27 have soils dominated with slight erosion hazard (about 786,200 acres, or about 63 percent of the analysis area). Identified resource protection measures and BMPs are required to assure accelerated soil erosion does not occur at levels that would adversely affect or impair soil productivity on soils with moderate or severe erosion hazard.

Current Soil Erosion

Current and predicted soil erosion rates were modeled for all alternatives using the Water Erosion Prediction Project (WEPP), Fuels Management (FuME) and Erosion Risk Management Tool (ERMiT) (USDA 2006) models. The FuME model is designed to predict sediment delivery from a variety of conditions, including undisturbed forest, wildfire, prescribed fire, thinning, and forest access roads. The ERMiT model is used to predict soil erosion and sediment delivery rates for undisturbed forest conditions and for post-fire scenarios of low, moderate and high soil burn severities. Table 14 below provides the predicted sediment delivery rates for each TES stratum for each of the forest conditions for which WEPP FuME is designed to model. Model outputs are included in Appendix C.

Table 14. Predicted sediment delivery rates for each TES stratum under conditions expected to occur within the project area.

TES Stratum	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed Forest		0
	Wildfire	83.2	3.3
	Prescribed Fire	6.4	0.4
	Thinning	0	0.0
	Low Traffic Roads	0.0 to 2.8	0.0 to 2.8
	High Traffic Roads	0.0 to 5.4	0.0 to 5.4
2	Undisturbed Forest		0
	Wildfire	83.2	3.3
	Prescribed Fire	6.4	0.4
	Thinning	0	0.0
	Low Traffic Roads	0.0 to 2.8	0.0 to 2.8
	High Traffic Roads	0.0 to 5.4	0.0 to 5.4
3	Undisturbed Forest		0
	Wildfire	83.2	3.3
	Prescribed Fire	6.4	0.4
	Thinning	0	0.0
	Low Traffic Roads	0.0 to 2.8	0.0 to 2.8
	High Traffic Roads	0.0 to 5.4	0.0 to 5.4
4	Undisturbed Forest		0
	Wildfire	1689.6	67.6
	Prescribed Fire	275.2	18.3
	Thinning	0	0.0
	Low Traffic Roads	0.0 to 11.6	0.0 to 11.6
	High Traffic Roads	0.0 to 25.1	0.0 to 25.1

TES Stratum	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
5	Undisturbed Forest		0
	Wildfire	416	16.6
	Prescribed Fire	32	2.1
	Thinning	0	0.0
	Low Traffic Roads	0.0 to 2.4	0.0 to 2.4
	High Traffic Roads	0.0 to 3.1	0.0 to 3.1
6	Undisturbed Forest		0
	Wildfire	134.4	5.4
	Prescribed Fire	6.4	0.4
	Thinning	0	0.0
	Low Traffic Roads	0.0 to 2.4	0.0 to 2.4
	High Traffic Roads	0.0 to 3.1	0.0 to 3.1
7	Undisturbed Forest		0
	Wildfire	550.4	22.0
	Prescribed Fire	51.2	3.4
	Thinning	0	0.0
	Low Traffic Roads	0.0 to 6.2	0.0 to 6.2
	High Traffic Roads	0.0 to 11.7	0.0 to 11.7
8	Undisturbed Forest		0
	Wildfire	160	6.4
	Prescribed Fire	12.8	0.9
	Thinning	0	0.0
	Low Traffic Roads	0.0 to 2.8	0.0 to 2.8
	High Traffic Roads	0.0 to 5.5	0.0 to 5.5
9	Undisturbed Forest		0
	Wildfire	576	23.0
	Prescribed Fire	76.8	5.1
	Thinning	0	0.0
	Low Traffic Roads	0.0 to 3.0	0.0 to 3.0
	High Traffic Roads	0.0 to 8.1	0.0 to 8.1
10	Undisturbed Forest		0
	Wildfire	198.4	7.9
	Prescribed Fire	12.8	0.9
	Thinning	0	0.0
	Low Traffic Roads	0.0 to 2.8	0.0 to 2.8
	High Traffic Roads	0.0 to 5.5	0.0 to 5.5
11	Undisturbed Forest		0
	Wildfire	243.2	9.7
	Prescribed Fire	19.2	1.3
	Thinning	0	0.0
	Low Traffic Roads	0.0 to 2.8	0.0 to 2.8
	High Traffic Roads	0.0 to 5.5	0.0 to 5.5
12	Undisturbed Forest		0
	Wildfire	313.6	12.5
	Prescribed Fire	25.6	1.7
	Thinning	0	0.0

TES Stratum	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
	Low Traffic Roads	0.0 to 4.0	0.0 to 4.0
	High Traffic Roads	0.0 to 8.1	0.0 to 8.1
13	Undisturbed Forest		0
	Wildfire	249.6	10.0
	Prescribed Fire	19.2	1.3
	Thinning	0	0.0
	Low Traffic Roads	0.0 to 2.8	0.0 to 2.8
	High Traffic Roads	0.0 to 5.5	0.0 to 5.5
14	Undisturbed Forest		0
	Wildfire	992	39.7
	Prescribed Fire	134.4	9.0
	Thinning	0	0.0
	Low Traffic Roads	0.0 to 8.8	0.0 to 8.8
	High Traffic Roads	0.0 to 17.9	0.0 to 17.9
15	Undisturbed Forest		0
	Wildfire	281.6	11.3
	Prescribed Fire	19.2	1.3
	Thinning	0	0.0
	Low Traffic Roads	0.0 to 2.8	0.0 to 2.8
	High Traffic Roads	0.0 to 5.5	0.0 to 5.5
16	Undisturbed Forest		0
	Wildfire	684.8	27.4
	Prescribed Fire	70.4	4.7
	Thinning	0	0.0
	Low Traffic Roads	0.0 to 8.8	0.0 to 8.8
	High Traffic Roads	0.0 to 17.3	0.0 to 17.3
17	Undisturbed Forest		0
	Wildfire	889.6	35.6
	Prescribed Fire	102.4	6.8
	Thinning	6.4	0.3
	Low Traffic Roads	0.0 to 14.6	0.0 to 14.6
	High Traffic Roads	0.0 to 26.7	0.0 to 26.7
18	Undisturbed Forest		0
	Wildfire	198.4	7.9
	Prescribed Fire	19.2	1.3
	Thinning	0	0.0
	Low Traffic Roads	0.0 to 2.4	0.0 to 2.4
	High Traffic Roads	0.0 to 3.1	0.0 to 3.1
19	Undisturbed Forest		0
	Wildfire	736	29.4
	Prescribed Fire	76.8	5.1
	Thinning	0	0.0
	Low Traffic Roads	0.0 to 9.5	0.0 to 9.5
	High Traffic Roads	0.0 to 17.6	0.0 to 17.6
20	Undisturbed Forest		12.8
	Wildfire	729.6	29.2

TES Stratum	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
	Prescribed Fire	96	6.4
	Thinning	19.2	0.8
	Low Traffic Roads	0.0 to 6.3	0.0 to 6.3
	High Traffic Roads	0.0 to 13.0	0.0 to 13.0
21	Undisturbed Forest		0
	Wildfire	204.8	8.2
	Prescribed Fire	12.8	0.9
	Thinning	0	0.0
	Low Traffic Roads	0.0 to 2.8	0.0 to 2.8
	High Traffic Roads	0.0 to 5.5	0.0 to 5.5
22	Undisturbed Forest		0
	Wildfire	211.2	8.4
	Prescribed Fire	19.2	1.3
	Thinning	0	0.0
	Low Traffic Roads	0.0 to 2.4	0.0 to 2.4
	High Traffic Roads	0.0 to 3.1	0.0 to 3.1
23	Undisturbed Forest		0
	Wildfire	243.2	9.7
	Prescribed Fire	19.2	1.3
	Thinning	0	0.0
	Low Traffic Roads	0.0 to 2.8	0.0 to 2.8
	High Traffic Roads	0.0 to 5.5	0.0 to 5.5
24	Undisturbed Forest		0
	Wildfire	505.6	20.2
	Prescribed Fire	51.2	3.4
	Thinning	0	0.0
	Low Traffic Roads	0.0 to 6.2	0.0 to 6.2
	High Traffic Roads	0.0 to 11.5	0.0 to 11.5
25	Undisturbed Forest		0
	Wildfire	243.2	9.7
	Prescribed Fire	19.2	1.3
	Thinning	0	0.0
	Low Traffic Roads	0.0 to 2.8	0.0 to 2.8
	High Traffic Roads	0.0 to 5.5	0.0 to 5.5
26	Undisturbed Forest		0
	Wildfire	646.4	25.9
	Prescribed Fire	83.2	5.5
	Thinning	0	0.0
	Low Traffic Roads	0.0 to 5.5	0.0 to 5.5
	High Traffic Roads	0.0 to 11.2	0.0 to 11.2
27	Undisturbed Forest		0
	Wildfire	256	10.2
	Prescribed Fire	25.6	1.7
	Thinning	0	0.0
	Low Traffic Roads	0.0 to 2.4	0.0 to 2.4
	High Traffic Roads	0.0 to 3.1	0.0 to 3.1

TES Stratum	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
28	Undisturbed Forest		0
	Wildfire	524.8	21.0
	Prescribed Fire	64	4.3
	Thinning	0	0.0
	Low Traffic Roads	0.0 to 3.0	0.0 to 3.0
	High Traffic Roads	0.0 to 8.1	0.0 to 8.1
29	Undisturbed Forest		0
	Wildfire	1216	48.6
	Prescribed Fire	166.4	11.1
	Thinning	0	0.0
	Low Traffic Roads	0.0 to 12.7	0.0 to 12.7
	High Traffic Roads	0.0 to 28.9	0.0 to 28.9
30	Undisturbed Forest		6.4
	Wildfire	307.2	12.3
	Prescribed Fire	32	2.1
	Thinning	6.4	0.3
	Low Traffic Roads	0.0 to 1.9	0.0 to 1.9
	High Traffic Roads	0.0 to 5.3	0.0 to 5.3

Table 15 provides a summary of predicted sediment delivery rates from the ERMiT WEPP interface for low, moderate and high soil burn severity conditions.

Table 15. Predicted sediment delivery for each TES stratum from the WEPP ERMiT Interface for unburned conditions and low, moderate, and high soil burn severities.

TES Stratum	Soil burn severity	Sediment delivery in year of disturbance (ton mi^{-2})				
		Year following fire				
		1	2	3	4	5
1	Unburned	0	0	0	0	0
	Low	0	0	0	0	0
	Moderate	0.02	0.01	0	0	0
	High	0.32	0.1	0	0	0
2	Unburned	0	0	0	0	0
	Low	0	0	0	0	0
	Moderate	0.02	0.01	0	0	0
	High	9.12	7.61	3.78	2.57	1.33
3	Unburned	0	0	0	0	0
	Low	0.18	0.16	0.03	0.02	0.02
	Moderate	0.63	0.6	0.03	0.02	0.02
	High	1.42	0.78	0.05	0.03	0.02
4	Unburned	0.03	0.03	0.03	0.03	0.03
	Low	12.82	11.84	4.95	4.35	3.81

TES Stratum	Soil burn severity	Sediment delivery in year of disturbance (ton mi^{-2})				
		Year following fire				
		1	2	3	4	5
	Moderate	17.87	14.16	4.95	4.35	3.81
	High	19.71	18.24	8.44	7.47	3.81
5	Unburned	0.01	0.01	0.01	0.01	0.01
	Low	3.04	2.85	0.71	0.63	0.61
	Moderate	4.81	4.51	0.71	0.63	0.61
	High	6.47	4.9	1.96	1.22	0.61
6	Unburned	0.01	0.01	0.01	0.01	0.01
	Low	0.09	0.08	0	0	0
	Moderate	0.36	0.33	0	0	0
	High	0.97	0.82	0.03	0	0
7	Unburned	0.02	0.02	0.02	0.02	0.02
	Low	3.51	3.13	1.39	1.17	1.1
	Moderate	4.75	4.69	1.39	1.17	1.1
	High	7.16	4.8	2.26	1.44	1.1
8	Unburned	0.01	0.01	0.01	0.01	0.01
	Low	0.68	0.63	0.32	0.3	0.29
	Moderate	1.37	1.25	0.32	0.3	0.29
	High	1.77	1.43	0.58	0.51	0.29
9	Unburned	0.02	0.02	0.02	0.02	0.02
	Low	3.28	3.06	0.85	0.79	0.74
	Moderate	5.28	4.84	0.85	0.79	0.74
	High	7.18	5.38	2.02	1.55	0.74
10	Unburned	0	0	0	0	0
	Low	0.71	0.64	0.32	0.31	0.3
	Moderate	1.4	1.35	0.32	0.31	0.3
	High	2	1.64	0.64	0.54	0.3
11	Unburned	0	0	0	0	0
	Low	0.82	0.76	0.38	0.36	0.35
	Moderate	1.6	1.54	0.38	0.36	0.35
	High	2.41	1.87	0.7	0.6	0.35
12	Unburned	0.02	0.02	0.02	0.02	0.02
	Low	3.41	2.73	1.18	0.89	0.89
	Moderate	4.86	3.65	1.18	0.89	0.89
	High	6.77	4.88	1.94	1.44	0.89
13	Unburned	0.01	0.01	0.01	0.01	0.01
	Low	1.72	1.49	0.72	0.6	0.49
	Moderate	2.47	2.16	0.72	0.6	0.49
	High	3.25	2.47	1.15	0.82	0.49
14	Unburned	0.02	0.02	0.02	0.02	0.02
	Low	7.64	7.12	2.7	2.46	2.05
	Moderate	10.55	8.6	2.7	2.46	2.05
	High	10.55	8.6	2.7	2.46	2.05
15	Unburned	0	0	0	0	0
	Low	1.35	1.04	0.37	0.35	0.32
	Moderate	2.23	1.79	0.37	0.35	0.32
	High	2.9	2.34	0.72	0.46	0.32

TES Stratum	Soil burn severity	Sediment delivery in year of disturbance (ton mi^{-2})				
		Year following fire				
		1	2	3	4	5
16	Unburned	0	0	0	0	0
	Low	3.63	3.13	1.13	0.96	0.63
	Moderate	5.11	5.09	1.13	0.96	0.63
	High	7.92	5.75	2.26	1.52	0.63
17	Unburned	0.02	0.02	0.02	0.02	0.02
	Low	4.82	4.26	1.75	1.45	1.41
	Moderate	6.93	6.77	1.75	1.45	1.41
	High	10.34	7.34	2.98	2.07	1.41
18	Unburned	0.03	0.03	0.03	0.03	0.03
	Low	1.31	1.21	0.33	0.31	0.31
	Moderate	2.2	1.89	0.33	0.31	0.31
	High	2.96	2.24	0.84	0.55	0.31
19	Unburned	0.02	0.02	0.02	0.02	0.02
	Low	3.46	2.65	0.74	0.49	0.48
	Moderate	5.26	4.09	0.74	0.49	0.48
	High	8.67	5.65	1.77	1.24	0.48
20	Unburned	0.02	0.02	0.02	0.02	0.02
	Low	2.3	2.05	0.36	0.31	0.11
	Moderate	5.99	5.41	0.36	0.31	0.11
	High	8.08	6.04	1.79	0.47	0.11
21	Unburned	0	0	0	0	0
	Low	0.01	0	0	0	0
	Moderate	0.01	0	0	0	0
	High	0.18	0.09	0	0	0
22	Unburned	0.02	0.02	0.02	0.02	0.02
	Low	1.35	1.23	0.34	0.33	0.3
	Moderate	2.31	2.01	0.34	0.33	0.3
	High	2.97	2.36	0.87	0.49	0.3
23	Unburned	0.02	0.02	0.02	0.02	0.02
	Low	1.27	1.07	0.39	0.39	0.38
	Moderate	2.21	1.84	0.39	0.39	0.38
	High	2.61	2.27	1.03	0.83	0.38
24	Unburned	0	0	0	0	0
	Low	2.76	2.3	0.88	0.68	0.48
	Moderate	3.89	3.8	0.88	0.68	0.48
	High	5.73	3.98	1.71	1.16	0.48
25	Unburned	0.02	0.02	0.02	0.02	0.02
	Low	1.12	1	0.36	0.34	0.31
	Moderate	1.75	1.52	0.36	0.34	0.31
	High	2.35	1.89	0.65	0.4	0.31
26	Unburned	0.02	0.02	0.02	0.02	0.02
	Low	1.12	1	0.36	0.34	0.31
	Moderate	1.75	1.52	0.36	0.34	0.31
	High	2.35	1.89	0.65	0.4	0.31
27	Unburned	0.01	0.01	0.01	0.01	0.01
	Low	1.69	1.58	0.43	0.41	0.4

TES Stratum	Soil burn severity	Sediment delivery in year of disturbance (ton mi^{-2})				
		Year following fire				
		1	2	3	4	5
	Moderate	2.78	2.42	0.43	0.41	0.4
	High	3.77	2.82	1.09	0.62	0.4
28	Unburned	0.03	0.03	0.03	0.03	0.03
	Low	3.07	2.86	0.78	0.71	0.67
	Moderate	4.89	4.46	0.78	0.71	0.67
	High	6.68	4.98	1.86	1.29	0.67
29	Unburned	0.02	0.02	0.02	0.02	0.02
	Low	8.57	8.39	3	2.8	2.24
	Moderate	10.73	10.04	3	2.8	2.24
	High	13.96	12.86	5.97	4.26	2.24
30	Unburned	0.01	0.01	0.01	0.01	0.01
	Low	0.82	0.74	0.28	0.12	0.11
	Moderate	1.48	1.17	0.28	0.12	0.11
	High	1.91	1.5	0.48	0.37	0.11

Erosion tends to exceed tolerance soil loss rates where soils have been exposed to high burn severity in wildfires. High burn severity is more likely to occur where forests are untreated (alternative A) and risk of soil loss above tolerance levels resulting in loss of soil productivity and sediment delivery to streamcourses.

As shown in Tables 14 and 15, both the FuME and ERMiT erosion models predict soil loss rates and sediment delivery rates on undisturbed or unburned soils to be well-below tolerance soil loss thresholds for all TES strata in the project area. The models show that, in general, soil productivity is maintained as long as no uncharacteristic, high severity wildfire or other extreme disturbances occur. The reason current erosion and sediment delivery rates in the ponderosa pine vegetation type are so low is due to high amounts of litter or other ground cover (vegetation, rock and gravel) that provides surface roughness and dissipates water energy, reducing runoff velocities and protecting soil surfaces against accelerated erosion. However, in cases where the protective ground cover is substantially reduced or disturbances such as rutting, compaction, and displacement occur, as may be the case on natural surface roads, soil erosion and sediment delivery rates can be quite high (Table 14).

Where uncharacteristic, or high severity wildfires have occurred, eleven of the TES strata (strata numbers 2, 4, 7, 9, 12, 14, 16, 17, 19, 20, and 29), or 36 percent tend to exhibit erosion and sediment delivery rates above soil loss tolerance thresholds. This represents a significant short- and long-term loss of soil productivity where wildfires have occurred. These conditions can been seen in several historic wildfire scars throughout Northern Arizona, including the Schultz, Wallow, Pumpkin, and Rodeo-Chediski wildfires.

Runoff, soil erosion, and sediment delivery rates tend to be higher on steeper slopes, particularly when these slopes have burned at moderate to high burn severity or where high level of soil disturbance occur. Table 16 below displays acreages for three slope classes within the project area. Slopes of 0-15 percent are very gentle and tend to exhibit the lowest erosion rates since runoff velocities are minimal in comparison to steeper slope classes. Slopes of 15-40 percent have somewhat greater runoff velocities and therefore higher erosion and sediment delivery rates. Historically, slopes of 40% have represented the steepness threshold at which timber harvesting was practiced. Slopes exceeding 40 percent tend to have the highest runoff velocities and therefore highest erosion and sediment delivery rates. These also tend to be the areas where higher soil burn severities are more likely as wildfire tend to make runs as active crown fire on these steeper slopes.

Table 16. Slope Classes on Soils in Project Treatment Acres

Forest	TEUI Slope Class	Acres
Apache-Sitgreaves	0-15%	358,775
Apache-Sitgreaves	15-40%	147,225
Apache-Sitgreaves	40-120%	32,752
Total		**538,753**
Coconino	0-15%	270,903
Coconino	15-40%	97,988
Coconino	40-120%	29,111
Total		**398,001**
Tonto	0-15%	83,141
Tonto	15-40%	75,945
Tonto	40-120%	139,341
Total		**298,427**

Currently, the highest erosion rates in the ponderosa pine vegetation type are associated with natural surface roads and steep slopes in the most recent wildfire scars where high soil burn severity has occurred.

Soil Interpretations

Soil Interpretations are based on models used to predict soil behavior for specified soil uses and under specified soil management practices. Soil properties inform the models that are used to develop management and use ratings.

Appendix A and B lists existing soil interpretations for each TES map unit and by strata that have similar soil properties and therefore similar limitations, hazards, suitabilities and production potentials for forest management.

Timber Harvest Limitation

Timber harvest limitations are limits to be considered when evaluating the effect of timber harvesting by equipment use with regard to maintenance of soil productivity. It includes slope, erosion hazard, soil strength and surface rock fragment factors. A slight rating does not restrict the kind or time of year for harvesting and has low risk of soil productivity impairment.

Almost all strata within ponderosa pine PPC's are dominated with severe timber harvest limitations due to low soil strength (high clay content) or high erosion hazard. Identified resource protection measures and BMPs are required to assure accelerated soil erosion, compaction, and displacement do not impair soil productivity on soils with moderate or severe timber harvest limitations. It is important to note that not all of the TES map units have been rated for timber harvest limitations. This is due to some map units that don't support commercially merchantable trees.

Ponderosa Pine Production Potentials (Site Index)

The potential productivity of marketable ponderosa pine on a terrestrial ecosystem is expressed as site index. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Site index for ponderosa pine within the Rim Country analysis is quite variable. The most productive soils in the Rim Country analysis are in strata 18, 27 and 28, some of which have site indices of 80 feet of height growth in 100 years. There are approximately 888,050 acres of moderately productive soils for ponderosa pine timber where site indices are between 50 and 75 feet. These site indices are found in strata 15-23, 25, 26, and 29, and 29. There are approximately 10,734 acres that have site indices of less than 50 feet of height growth in 100 years. These lower productivity soils for ponderosa pine are primarily found in strata 12 and 13. There are 87,218 acres for which site index information for ponderosa pine does not exist. These acres are dominantly grasslands and pinyon-juniper vegetation types.

Natural Regeneration Potential

Natural regeneration potential refers to the probable success in the establishment and survival of trees under inherent site conditions and alerts the land manager to sites that have the most desirable soil and climate properties for successful natural regeneration. This rating is influenced primarily by climate and soil characteristics. A high natural regeneration potential rating indicates there are no substantial soil limitations that restrict establishment and growth of natural regeneration of trees. A moderate rating has reduced potential for natural regeneration due to some inherent soil properties that adversely affect natural regeneration, while a low rating has soil limitations that can severely limit successful establishment and growth of naturally regenerated ponderosa pine. Soils associated with a high rating offer the best opportunity for ponderosa pine regeneration success followed by moderate then low.

Within the project area, the following strata with ponderosa pine or mixed conifer potential vegetation are dominated by soils with low natural regeneration potential for ponderosa pine or mixed conifer (11, 12, 13, 17, 23 and 29). This equates to about 224,075 acres or about 18% of the project area of 1,238,534. Reasons for low regeneration potential include droughty soil conditions, soils that are too rocky/stony, and high levels of competition from other vegetation. The remaining strata have moderate or high natural regeneration potential and are well-suited for natural regeneration following mechanical treatment. Pine transition zones to pinyon-juniper types are too dry and therefore have low natural regeneration potential. Shrub understories including evergreen oak and alligator juniper would be expected to compete aggressively with ponderosa pine seedlings upon opening of the forest canopy through commercial timber harvesting of ponderosa pine. Steep, shallow and very rocky soils also inhibit establishment of ponderosa pine seedlings.

Vegetation

Vegetative communities are based on Ecological Response Units (ERUs) or Potential Natural Vegetation (PNV).

ERUs are map unit constructs, or technical groupings of finer vegetation classes. The suite of vegetation classes that make up any given ERU share similar disturbance dynamics, plant species dominants, and theoretical succession sequence (potential vegetation)

Ecological Response Units (ERUs) facilitate landscape analyses and planning. The framework represents all major ecosystem types of the southwest region, and represents a stratification of biophysical themes. ERUs are used to define historic/reference conditions within a mapping unit by integrating site potential (soil physical and chemical properties, geology, geomorphology, aspect, slope, climate variables, and geographic location), fire regime (historic and contemporary), neighboring vegetation communities, and seral state sequence.

Potential Natural Vegetation (PNV) mapping units delineate areas having similar biophysical environments (e.g., similar climate and soil characteristics). There are a variety of definitions of PNV (Carrión 2010). Common definitions include: (a) PNV represents the plant community that "would become established if all successional sequences were completed without interference by man under the present climatic and edaphic conditions (including those created by man) (Farris et al. 2010); (b) PNV is generally defined as steady plant community which should be present in an area, as a consequence of the progressive succession, if there were not human influences humans) (Rivas -Martinez et al., 2002); and (c)) the PNV concept has been formulated more in terms o f a hypothesis than a prediction; it has never been intended to be a prophecy of what vegetation would be certain to establish in the absence or removal of human impact (Loidi et al., 2010).

As previously noted, soils were grouped into 30 strata for the purpose of simplifying this analysis. These strata were based primarily on inherent soil properties and behavioral characteristics and, to a lesser degree, vegetative communities. As a result, vegetation communities within a given stratum may not be perfectly aligned with ERUs.

Ponderosa Pine Vegetation Types/Strata/PNVT/or ERUs and Soils

The Ponderosa pine vegetation type are forest soils dominated by the Alfisol order (boralfs, ustalfs and udalfs suborder) and some Mollisols order (borolls suborder). Mollisol soil orders with ponderosa pine vegetation type are found on strata 9, 11 and 12 and have stands that were historically very open (<30% canopy cover) with large trees and dense, herbaceous understories that support development of a thick, dark organic soil surface horizon (epipedon) common in grasslands and montane meadows (Abella et al. 2010). Tree stand densities in these Mollisols have greatly increased with most now having closed stand structures (>30% tree canopy). Abella found that soils classified as Mollisols in ponderosa pine vegetation types have evidence of historic large interspaces and much lower tree density. The local study by Abella et al. (2013) on the Coconino NF suggest that the vast majority of ponderosa pine patches occur on forest soils (i.e., non-Mollisol) and herbaceous vegetation interspace patches within the ponderosa pine occur on grassland type soils (Mollisols). Soils in strata 9, 11, and 12 are also among the most productive of all soils in the project area (Site Class 1) and are well-suited to timber production. This said, stand densities should be managed so as to retain the mollic epipedons of these soils, meaning stand densities should be low, with large innerspaces dominated by robust herbaceous understories in order to encourage continued development of an organic matter rich surface horizon.

Steinke (2007) in a local study, found evidence of open tree stand structures on soils classified as Mollisols and on Mollic intergrade soils on the 4FRI 1 footprint with historic canopy covers below 30%.

Historically, Mollisols were dominated by dense, herbaceous understories capable of out competing trees for soil moisture and nutrients and carrying ground fires that resulted in tree seedling and sapling mortality, thereby maintaining open canopy structures, grassy interspaces and fewer trees. Currently, many deep soils (>40 inches to bedrock) within Mollisols in the Ponderosa Pine type have closed canopies (>30 percent) and lack open area interspaces stemming from decades of fire suppression and grazing disturbance. Grazing reduces herbaceous ground cover, allowing ponderosa pine seedlings to become established due to less vegetative competition while aggressive fire suppression prevented wildfires from reducing seedling and sapling densities.

There are other strata in the ponderosa pine-PJ transition zone, (HSC, 5, -1) that are not dominated by

Mollisols where ponderosa pine canopy covers are very open (10-20%).

Most other strata within the ponderosa pine vegetation type are dominated by Alfisols, or forest soils. Stand densities have also increased in these PNVs/ERUs over time as a result of livestock grazing, fire suppression, and other disturbances but based on soil classification alone, it is not known if these stands were open (<30% canopy cover) or closed (see Appendix A).

Most soils in other strata containing ponderosa pine are classified as Alfisols, which have thin organic soil surfaces indicating development under forest vegetative cover with less herbaceous understory than the Mollisol and Mollisol intergrade soils.

A few strata on steep slopes greater than 40% have ponderosa pine, mixed conifer and pinyon-juniper PNV that are classified as Inceptisols or Entisols soil orders and are less developed soils with thinner organic soil surfaces than Mollisols. These soils are generally shallow to bedrock with soil depths less than 20 inches).

It is important for the reviewer to understand that the Coconino NF classification of boralfs in LSC 5 climate class is based on outdated soil taxonomy. These soils have largely been reclassified as ustalfs or udalfs. Soils on the A-S and Tonto NF are classified using more recent soil taxonomy. Alfisols in the project area are typical of forest soils and have thin organic surface horizons which overlie a developed argillic horizon (i.e., a zone of high accumulation of silicate clays). Most forest soils in the project area on slopes less than 40% are either deep (> 40 inches to bedrock) or moderately deep (20-40 inches to bedrock.

Mixed Conifer

Soils found in the Mixed Conifer vegetation types (strata 27 through 29) are forest soils dominated by the Alfisols order (udalfs or boralfs suborder) generally found on slopes of less than 40% and some soils of the Inceptisols order (suborder ochrepts and udepts) found on steep slopes greater than 40%. Acres are approximately 151,663 or about 12% of the total project area. The Alfisols are well developed soils with thin, organic surfaces and heavy clay accumulation in the subsoil. The Inceptisols are more recent and less developed soils, with very thin organic surfaces and less developed subsoils. Many of the Alfisols are classified with a glossic horizon typical in coarse textured soils (sandy loams) in this precipitation zone (>24 inches). Glossic horizons show evidence of albic soil materials (light colored E horizons) tonguing and interfingering throughout the subsoils.

Wetlands and Wet Meadows

Soils in Stratum 1 are wet Mollisols (aquolls) common to wetlands or wet meadows. These soils are dominated by dense, herbaceous, riparian vegetation with water tables at or near the soil surface during throughout most years. They are generally fine textured soils (typically > 35% clay) throughout their profile. The majority of the soils in this strata are on the A-S NF and are expected to be in satisfactory soil condition. Where these soils occur on the Coconino NF, they are in unsatisfactory condition where unfenced due to excessive current and historical grazing. These soils typically have compacted surfaces, and current vegetation composition and productivity is poor. These soils do not typically support conifer vegetation when they are in satisfactory condition or functioning properly.

Many of the wet meadows, or slope wetlands in the project area exhibit erosion features such as gully erosion or development of channels in the meadows where they did not originally exist. Gullies and channels in wet meadows have resulted in drying of meadow systems since the channels tend to behave as drainage ditches.

Montane Meadows

Stratum 2 soils are Mollisols of montane meadows with grassland potential natural vegetation communities (PNV or ERU). Stratum 2 is dominated by fine-textured clayey soils while stratum 3 is dominated by medium textured soils (i.e., fine-loamy family). As previously discussed, soils classified as Mollisols indicate that historically, the soil was likely dominated by a dense, competitive, herbaceous understory of grasses with high fine root turnover rates that contributed to development of a thick (often greater than 16 inches depth), organic horizon over time, especially on deep soils (> 40 inches to bedrock). True Mollisols have thicker organic surfaces than the Mollic integrade soils (near Mollisol soils). The deeper Mollisols have the ability to support more biomass in the form of herbaceous understories than the rocky or shallow Mollic integrade soils due to their greater water holding capacities. These soils should have only incidental percentages of conifers (i.e., much less than 10% tree canopy cover), which would occur on patchy rocky soil inclusions within the overall map unit. Some areas currently have appreciable numbers of ponderosa pine invasion or encroachment especially along meadow edges due to either long term drought or conditions that have led to drainage of meadow soils such as channelized flow patterns that drain meadows or gully formation caused by historic livestock grazing and browsing by wildlife ungulates (i.e., elk).

Pinyon-Juniper Vegetation Types/Strata/PNVT/ERUs:

Acres of pinyon-juniper vegetation types in the Rim Country project area is limited (about 107,000 acres) or about 9% of the total project area. Pinyon-juniper vegetation types include the following strata (4, 5, 6, 7 and 9). These soils have thin organic surface horizons and are classified mostly as Alfisols and Inceptisols (Ustochrepts suborder). Most Alfisols fall into the Haplustalfs great group and range from shallow to moderately deep and are characterized as having minimal horizon development and clay accumulation in the subsoil.

Most Ustochrepts (less developed soils than Alfisols) are typically calcareous (i.e., contain calcium carbonate) and have pH values close to 8.2. These soils are subject to high wind erosion rates and have low nutrient availability due to the high pH. The herbaceous understory generally include calciphiles such as needle and thread grass.

Currently many PJ stands exhibit dense, closed canopy conditions (> 50 percent canopy cover) with little or no herbaceous understory as a result of fire suppression, grazing disturbance and frequent drought conditions. PJ Woodlands in less disturbed sites provide herbaceous interspaces under a more open canopy (10 – 30 percent). Personal observations indicate where PJ Woodland canopy cover exceeds 40 percent, there is little to no herbaceous understory (regardless of grazing intensity) and soil condition is impaired due to erosion rates that exceed the rates of soil formation.

Great Basin Grasslands

Great basin grasslands are found in strata 8 and 10 and soils are of the order Mollisols and are fine-textured. These soils do not generally support conifer vegetation above 10% canopy cover. Some of these area have encroached pinyon, juniper or ponderosa pine over time due to historic effective fire suppression.

Riparian Areas

Riparian areas are found in strata 3 and have relatively young, or recently developed soils (Entisols or fluvents that are subject to flooding) that generally lack development of distinguishable soil horizons. These soils also do not support conifer vegetation above 10% canopy cover, but do support riparian-dependent tree species. These soils are the most recently developed and subject to rapid and frequent changes as flooding erodes and deposits sediment. These soils and their associated vegetation communities are very minor in extent and occupy less acreage than all other vegetation types (about 11,493 acres) or approximately 0.10% of the total project area. There are likely many more riparian areas present but at the scale of TEUI mapping, these were not included. Please see the water specialist report (Brown, 2018) for a more detailed description of riparian areas.

Please refer to Appendices A and B for tabular details of soil, vegetation type, strata, soil interpretation, existing and desired conditions, need for change and potential management strategies needed to move towards identified desired conditions.

Watersheds and Watershed Condition

The Rim Country Project analysis area intersects 141 sixth-level (HUC12) hydrologic units (i.e., subwatersheds), 28 fifth-level (HUC10) hydrologic units (i.e., watersheds) and 11 fourth-level (HUC8) hydrologic units (i.e., sub-basins).

A watershed condition assessment was completed in 2011 for all subwatersheds where National Forest System lands comprise most of the subwatershed area as part of an Agency level assessment of subwatershed conditions for each Forest. Subwatersheds having less than 10 percent areal extent of Forest Service owned lands were not assessed for subwatershed condition in 2011 and are therefore not described in detail for this project. As a result, 128 of the 141 subwatersheds that intersect the project area have been assessed for subwatershed condition.

Result of the analysis of all subwatersheds in the project analysis area indicate that 20 (15%) are rated as Functioning Properly, 111 (83%) are rated as Functioning at risk, and 2 (2%) were rated as impaired. Subwatershed condition information is presented in Appendix D. Many of attributes and indicators could be improved over time with implementation of the suite of restoration actions such as those proposed in the action alternatives, assuming effective implementation of all design criteria and BMPs.

Across the planning area, the following indicators have the greatest influence on overall subwatershed condition scores. Many of the functioning at risk and impaired watersheds have fair or poor ratings for these indicators.

- Water Quantity – This indicator addresses changes to the natural flow regime with respect to the magnitude, duration, or timing of the natural streamflow hydrograph. Modification of natural hydrologic processes disrupts the dynamic equilibrium between the movement of water and the movement of sediment that exists in free-flowing streams (Dunne and Leopold 1978). This disruption alters physical habitat characteristics, including water temperature, oxygen content, water chemistry, and substrate composition, and adversely changes the composition, structure, or function of aquatic, riparian, and wetland ecosystems (Bain et al. 1988). Infrastructure such as impoundments, water diversions, detention/retention basins, and groundwater withdrawal can adversely affect stream base flows, sediment transport, water chemistry, wetland habitat and other important watershed condition parameters.
- Aquatic Habitat – This indicator relates to habitat continuity and fragmentation, channel shape and function, and presence or absence of large woody debris. This rating is affected by habitat fragmentation caused by such activities as diversions, mines, roads, inadequate culverts, and increased stream temperatures that prevent fish from moving freely throughout the aquatic systems. Stream crossings that serve as barriers to native aquatic organism migrations as well as the condition of riparian vegetation along stream channels that controls recruitment of large woody debris, moderates stream temperatures and sediment transport characteristics and the

condition of stream channels (Data for approximately 170 stream channel reaches within the Rim Country Restoration project area on the Tonto NF exists to assess channel conditions). These conditions are described in detail in the Riparian and Water Quality Specialist's Report (Brown 2018).

- Aquatic Biota – This indicator addresses distribution, structure, and density and assemblages as well as exotic and/or invasive aquatic species. Native fish and other native aquatic biota have been adversely affected by land and watershed development, habitat loss, direct human harvest, and increased competition from introduced exotic and/or aquatic invasive species. Introduced species and stocks are major threats to native fishes and aquatic biota by way of predation, competition, introduction of diseases and parasites for which native species lack resistance, environmental modification, inhibition of reproduction, and hybridization (Moyle and Light 1996, Nehlsen et al. 1991). Most of the perennial streams on the Tonto NF support populations of non-native fish and invertebrate species (including crayfish and bullfrogs).
- Riparian/Wetland Vegetation – This indicator addresses the function and condition of riparian vegetation along streams, water bodies, and wetlands. Riparian and wetland areas are the interface between terrestrial and aquatic ecosystems and are an integral part of the watersheds. Consequently, the health of these areas is closely interrelated to the condition of the surrounding watershed (Debano and Schmidt 1989, Hornbeck and Kochenderfer 2000). Photo points, riparian surveys, and channel condition surveys were used to assess riparian conditions on the National Forest System lands. The conditions of riparian areas and wetlands are described in detail in the Riparian and Water Quality Specialist's Report (Brown 2018).
- Roads and Trails – This indicator addresses changes to the hydrologic and sediment regimes due to the density, location, distribution, and maintenance of the road and trail network. This indicator is most influenced by improperly located roads (i.e., roads that are proximal to streamcourses), infrequent road maintenance of native surface roads, and, to a lesser degree the areal extent of the road network.
- Soil Condition – This indicator addresses soil productivity, erosion, and chemical contamination. Soil condition is related to watershed condition because of significant water supply benefits associated with developing forest soils that promote infiltration and high-quality water. Forest soils, with litter layers, high organic content, and large macropore fraction, promote rapid infiltration and minimize erosive overland flow (Ice 2004). Determining natural soil condition includes evaluating erosion, nutrients, productivity, and the physical, chemical, and biological characteristics of the soil (USDA Forest Service 2009). The Region 3 Soil Condition Field Evaluation Form and Soil Condition Rating Guide (FSH2509.18) is the primary tool used to rate soils as satisfactory, impaired of unsatisfactory.

Other indicators, such as fire regime condition class (FRCC) and rangeland vegetation condition also influence watershed condition ratings.

Class 2 and Class 3 subwatersheds (i.e., those that are functioning-at-risk or are impaired) typically exhibit the following attributes or indicators that are contributing to subwatershed dysfunction: a) dense forest conditions that are outside the natural range of variation of the fire regime condition classes, b) high road densities (measured as miles of roads per square mile of land area) that alter natural drainage patterns by concentrating flow and redirecting surface flows or are hydrologically connected to streamcourses and are chronic sources of sediment and other pollutants, c) infrequent or inadequate road maintenance that results in accelerated soil erosion, sediment delivery, and runoff diversion potential, d) riparian habitat condition ratings of functioning-at-risk and non-functioning condition; loss of viable native fish or aquatic organism assemblages in watersheds having perennial stream reaches, and e) impaired or unsatisfactory soil conditions where accelerated erosion is contributing sediment to streamcourses and waterbodies.

Dense and ingrown forest conditions are common in many subwatersheds in the Rim Country analysis area. The result in increased fuel loading in both living biomass and woody detritus caused by natural forest ingrowth and tree encroachment into existing openings followed by forest decadence resulting from intraspecific and interspecific competition among trees. These ingrown understories create ‘ladder fuels’ which allow ground fires to ascend and spread quickly as crown fires. Coarse woody debris has been increasing as small, medium, and large diameter material begins to decay and fall to soil surfaces. While these conditions may improve soil quality in some regards (e.g., organic matter accumulation in subsurface horizons, microhabitat for soil organisms, increased short-term water holding capacity, etc.) they also contribute to an elevated risk of uncharacteristic, or high severity wildfire when fuel loading becomes excessive. Uncharacteristic wildfires in many cases result in soils with high burn severities that pose significant risk to watershed condition. High soil burn severity results in water repellent soils (i.e., hydrophobic conditions), loss of protective vegetative ground cover and accelerated erosion and sediment delivery during storm events. Consequently, accelerated erosion and sediment delivery into connected stream courses leads to loss of soil productivity, adverse effects to water quality, and loss of important watershed functions.

The watershed condition process category ratings for each subwatershed in the Rim Country Project analysis area are presented in Appendix D along with a general map depicting watershed condition graphically and the locations of priority watersheds. Overall, ratings indicate that water quality was best of the three indicators, with 70% of subwatersheds having good ratings. This is followed by Water Quantity with 48 percent of subwatersheds good ratings. Riparian/Wetland condition had the lowest rating with most subwatersheds (58 percent) having ratings of ‘Fair’ condition and a greater percentage of ‘Poor’ ratings than ‘Good’. This suggests that the Riparian /Wetland indicator is most departed from desired conditions and among the most critical to address for restoration.

Priority Watersheds

The Watershed Condition Framework (WCF) is a comprehensive approach for classifying watershed condition, proactively implementing integrated restoration in priority watersheds on national forests and grasslands, and tracking and monitoring outcome-based program accomplishments for performance accountability (USDA 2011).

The prioritization of watersheds is a forest-based interdisciplinary process with the goal of aligning watershed restoration work with both internal and external priorities. The identification of priority watersheds is based on the following:

- Agency watershed restoration policies and priorities that have been established at other scales, including national- and regional-scale restoration strategies.
- The importance of water and watershed resources (resource value), the urgency of management action to address conditions and threats, and economic considerations.
- Alignment with other Forest Service strategic objectives and priorities.
- Alignment with the strategies and priorities of other Federal and State agencies, tribes, community and collaborative efforts, nongovernmental conservation organizations, and public desires.

Priority watersheds are the designated watersheds where restoration activities will concentrate on the explicit goal of maintaining or improving watershed condition with watershed condition framework process (USDA, 2011).

For priority watersheds, forests are required to develop a Watershed Restoration Action Plan (WRAP) that identifies specific projects necessary to improve watershed condition class.

Table 17 below displays the four priority watersheds that occur in the Rim Country project area. Long Tom Canyon-Chevelon Canyon and Upper Wildcat Canyon on the Apache-Sitgreaves National Forest are rated as Class 1 (Functioning Properly) while East Clear Creek-Blue Ridge Reservoir on the Coconino National Forest and Parallel Canyon-Cherry Creek on the Tonto National Forest were rated as Class 2 (Functioning at Risk). The other watersheds were rated as Functioning at Risk and are located on the Coconino and Tonto National Forest. Subwatershed process category scores are shown on Appendix D.

Table 17. Priority watershed within the Rim Country Restoration project area.

Hydrologic Unit Number (HUC12)	Subwatershed Name	National Forest	Percent of priority watershed within project boundary	Condition Class
150200100102	Long Tom Canyon-Chevelon Canyon	Apache-Sitgreaves National Forests	99.9%	Functioning Properly
150200100103	Upper Wildcat Canyon	Apache-Sitgreaves National Forests	99.9%	Functioning Properly
150200080303	East Clear Creek-Blue Ridge Reservoir	Coconino NF	100.0%	Functioning at Risk
150601030401	Parallel Canyon-Cherry Creek	Tonto National Forest	94.4%	Functioning at Risk

Municipal Watersheds

The C.C. Cragin Management area occurs in the southeastern portion of the Coconino NF and adjoins the East Clear Creek and Long Valley Management Areas, as well as Tonto NF. It is accessed by forest roads that intersect Highway 87 and is characterized by C.C. Cragin Reservoir and Forest Road 300 along the Mogollon Rim. C.C. Cragin supplies water via a pipeline for the Town of Payson and other communities in northern Gila County. The subwatersheds (HUC12) that support the C.C. Cragin Reservoir are: Bear Canyon 150200080302, Miller Canyon 150200080301, and East Clear-Blue Ridge 150200080303. C.C. Cragin reservoir also provides water-based recreation.

Desired conditions in the Coconino NF Land and Resource Management Plan for C.C. Cragin Watershed Management Area include:

1. There is low risk of substantial damage from uncharacteristic fire and recreation to water supply, infrastructure, water quality, visual quality, and cultural integrity (such as tribes and local communities).
2. The canyons in this MA provide solitude and more primitive non-motorized recreation opportunities than surrounding areas. These areas also provide low-disturbance wildlife habitat.
3. For scenery desired conditions, see the forestwide section on Scenic Resources and map 13 for SIOs.

Guidelines for C.C. Cragin Watersheds Management Area include:

1. The C.C. Cragin Watersheds MA should be managed to reduce the threat of uncharacteristic wildfires, flooding, and sedimentation, and to maintain water quality and quantity.
2. Roads and trails within the C.C. Cragin Watersheds MA should be maintained to prevent erosion and sedimentation and to protect existing infrastructure.

The Management Approach for C.C. Cragin Watersheds Management Area is to coordinate with the Salt River Project, National Forest Foundation, Town of Payson, the Bureau of Reclamation, U.S. Fish and Wildlife Service, Arizona Game and Fish Department, Arizona Elk Society, the local community, and other stakeholders to proactively improve the health and resiliency of the C.C. Cragin Watersheds Management Area.

Streamcourses and Stream Conditions

The majority of streamcourses within the project area are low-gradient ephemeral and intermittent streams with dendritic drainage patterns. Based on the most recent U.S. Geological Survey (USGS) National Hydrography Dataset dated 2017, there are approximately 4,206 miles of streamcourses within the project boundary. Of these, approximately 3,271 miles are ephemeral drainages, 667 miles are intermittent streams, and 169 miles are perennial streams. Appendix E lists perennial stream reaches that occur within the Four Forest Restoration Initiative analysis area, their associated names and lengths.

Water Quality

Water quality information, including affected environment and environmental consequences is discussed in detail in the Water and Riparian Resource Report (Brown 2018).

Surface water quality standards provide the regulatory basis for permit limits in the Arizona Pollutant Discharge Elimination System (AZPDES) permits to ensure standards are not exceeded in the receiving waters and designated uses are protected. Standards are also used to determine if the waterbody has good water quality. Waters that are meeting all standards and have healthy biological communities are considered to be supporting their designated uses. Waters that are not meeting surface water quality standards are prioritized for further investigation and development of management strategies to bring the waterbody back to meetings standards to protect its designated uses.

Water quality criteria are used to establish numeric and narrative standards necessary to protect and ensure that water quality for designated uses is attained. A surface water may have more than one designated use assigned to it and more than one standard for a given pollutant that applies based on the designated uses (ADEQ 2018). Designated uses include: Full Body Contact (FBC), Agriculture Irrigation (AGI), Agriculture Livestock Watering (AGL), Aquatic and Wildlife (cold water) (A&Wc)

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[4]) development for the State of Arizona. Arizona's most recent Integrated (305(b)) Water Quality Assessment Report and 303(d) list (2012/2014) are available from the ADEQ. These reports can be found in electronic format at the ADEQ website at the link below:

[4] A Total Maximum Daily Load (TMDL) is a regulatory term in the U.S. Clean Water Act, describing a plan for restoring impaired waters that identifies the maximum amount of a pollutant that a body of water can receive while still meeting water quality standards

http://legacy.azdeq.gov/environ/water/assessment/index.html

In the Little Colorado Basin on the Apache-Sitgreaves NFs and Coconino NFs, water quality is currently attaining some uses on 108 miles (67%) and data are inconclusive on 53.3 miles (33%) of assessed streams. In addition, nine lakes were assessed within the project area. Two lakes with a total of 149 acres are attaining some uses, one lake totaling 111 acres is attaining some uses but not attaining all, and two lakes that total 91 acres are impaired. Data were inconclusive for four lakes totaling 387 acres.

On the Tonto National Forest portion of the Rim Country Restoration Project area, which includes portions of the Salt and Verde River Basins, water quality is attaining all uses in approximately 13.8 miles (12%), attaining some uses in 48 miles (42%), is inconclusive in 32.8 miles (29%) streams and is not attaining/impaired in 18.2 miles (16%) of assessed streams.

The Upper Tonto Creek watershed includes stream reaches that are impaired for nutrients, including Nitrogen and Phosphorous, Low Dissolved Oxygen (D.O.), and *E. coli*. bacteria. TMDLs were imposed for Nitrogen and *E. coli* in 2006 for Tonto Creek and Christopher Creek. Primary sources of contamination were identified as inadequate septic systems and recreational sources. The Forest Service has installed new bathrooms, restricted vehicle access to provide an undisturbed buffer along the creek, and converted some overnight camping areas to day-use only. A TMDL for Phosphorous has not yet been imposed and is a low priority for ADEQ.

The Upper Tonto Creek watershed is identified as one of Arizona's Targeted Watersheds. These watersheds are a priority in the state for receiving Clean Water Act (CWA) Section 319 Water Quality Improvement Grants and development of other strategies to improve surface water quality. Development of a TMDL for Low Dissolved Oxygen impairment in the Headwaters of Tonto Creek is identified as a low priority by ADEQ

Bear Canyon and Black Canyon lakes are currently impaired. These lakes have moderate priority for additional sampling and analysis to evaluate the need for imposing TMDLs and to determine sources of impairment and to develop appropriate pollutant mitigation strategies. Some streams have exceeded state water quality standards, however, insufficient data exists for most of the water bodies to determine mitigation strategies.

Implementation of site specific Best Management Practices (BMPs) has been shown to effectively mitigate or minimize adverse effects to water quality, and the development, implementation and monitoring of BMPs are FS requirements under the Memorandum of Understanding between the State of Arizona, Department of Environmental Quality and USFS Southwestern Region (USFS, 2013).

Issues/Indicators/Analysis Topics

Soils and Watershed Issues

Soils and watershed issues include:

- Percent of soil exposure across treatment areas
- Percent of soil disturbance across the treatment areas
- Severity of soil disturbance across treatment areas
- Construction of new roads could increase surface runoff, erosion, and sediment delivery to ephemeral drainages.

- Construction of fire lines, and piling and burning of activity-related debris could disturb, destabilize, and compact soils and expose them to erosion.
- Burning of large debris piles can create enough heat to sterilize the underlying soils and create hydrophobic conditions, exposing those sites to erosion for an extended period of time.
- The amount of vegetation removed through fuels treatments and the use of prescribed fire could increase short-term erosion rates.
- Potential for soil rutting, compaction, and puddling caused by mechanical fuels treatments and fuelwood gathering.
- The amount of sediment that reaches ephemeral streams or drainages (displayed as embeddedness) could increase.
- The amount of sediment, debris, and ash that is introduced to municipal water supplies could adversely affect the quality of water entering public water supply systems
- Prescribed burning will result in increased ash filling livestock and wildlife waters.
- Cumulative effects to soils and watershed resources, when combined with past, present, and reasonably foreseeable future actions could be significant.
- There is need to retain adequate amounts of coarse woody debris, including large logs, necessary to protect soil surfaces from erosion and provide wildlife habitat components for soil micro and macro-fauna.

Soil and Water Resources Condition Indicators

For soil resources, the units of measure of effects to soil resources will be the acres and severity of ground disturbance from equipment use and acres subjected to high severity fire. Most adverse effects to soils and water resources can be minimized or mitigated through appropriate use of resource protection measures and design features 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), the National Core BMP Technical Guide (FS990a)(USDA 2012), and other relevant BMP guidance.

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.

Summary of Alternatives

Alternative 1 – No Action

Alternative 1 is the no action alternative as required by 40 CFR 1502.14(c).[5] It represents no changes to current management, and current forest plans would continue to be implemented. Ongoing vegetation treatments and fire management activities, as well as road maintenance, recreation, firewood gathering, authorized livestock grazing, and other activities already authorized in separate NEPA decisions would continue. There would be no other restoration activities approved with the Rim Country Project. The potential direct, indirect, and cumulative effects from no action will be analyzed. The no action alternative is the baseline for assessing the action alternatives (Alternatives 2 and 3).

[5] http://ww.nepa.gov/nepa/regs/ceq/1502.htm#1502.14

Alternative 2 – The Modified Proposed Action

Alternative 2 is the Proposed Action as presented for scoping, with additional detail, clarifications, corrections, and modifications in response to public comments received. Changes made to the Proposed Action in response to public comment include:

- Modifications to acreages and mileage of treatments based on additional modeling.
- Additional clarity, details, and definitions of key terms used.
- Elimination of even-aged shelterwood silvicultural prescriptions to address dwarf mistletoe infections, replaced with regular restoration treatments. Design features will focus mechanical treatments on addressing dwarf mistletoe infections. This change was a result of additional collaboration with the 4FRI Stakeholder Group and the public.

In addition, the proposal to mechanically thin trees and implement prescribed fire on approximately 1,260 acres in the Long Valley Experimental Forest was dropped from this alternative, as well as from the Rim Country Project. In discussions with researchers with the Rocky Mountain Research Station, it was decided that experimental treatments for the experimental forest would be analyzed in a separate NEPA analysis.

This alternative, as modified, responds to the Dwarf Mistletoe Mitigation issue through the use of regular restoration treatments that focus on dwarf mistletoe infections. The restoration activities listed for Alternative 2 include vegetation treatments (mechanical thinning and burning), using the Flexible Toolbox Approach for Mechanical Treatments ; as well as comprehensive restoration treatments for meadows, springs, streams, riparian habitat, using the Flexible Toolbox Approach for Aquatic and Watershed Restoration Activities, wildlife habitat, and rare species restoration. Proposed activities include:

- Mechanically thin trees and/or implement prescribed fire up to 953,130 acres.
  - Implement mechanical thinning and prescribed fire on approximately 517,950 acres including –
    - Approximately 150,790 acres of intermediate thinning
    - Approximately 71,280 acres of stand improvement
    - Approximately 12,510 acres of single tree selection
    - Approximately 283,370 acres of uneven-aged group selection
    - Approximately 63,930 within ½ mile of non-FS lands with structures and critical infrastructure, including –
      - Approximately 16,970 acres of intermediate thinning
      - Approximately 8,560 acres of stand improvement
      - Approximately 38,390 acres of uneven-aged group selection
  - Implement prescribed fire alone on approximately 54,070 acres.
  - Mechanically thin and/or implement prescribed fire on approximately 82,280 acres of Mexican spotted owl (MSO) protected activity centers (PACs) including --
    - Approximately 23,550 acres of mechanical thinning and/or prescribed fire
    - Approximately 58,730 acres of prescribed fire only
    - Approximately 7,180 acres of facilitative operations
  - Mechanically thin and/or implement prescribed fire on approximately 25,290 acres of MSO replacement nest/roost recovery habitat.
  - Conduct facilitative operations in non-target cover types to support treatments in target cover types, including –
    - Approximately 123,400 acres of facilitative thinning and prescribed fire
    - Approximately 1,260 acres of facilitative prescribed fire only
    - Approximately 6,880 acres of facilitative prescribed fire only in PACs
    - Approximately 300 acres of facilitative thinning and prescribed fire in PACs

- Restore aspen on approximately 1,230 acres, including about 30 acres in PACs.
    - Restore approximately 132,340 acres that have experienced severe disturbance, including about 3,610 acres in PACs.
    - Restore approximately 18,570 acres of savanna.
    - Restore approximately 36,320 acres of grassland, including –
        - Maintaining or restoring montane meadow connectivity in pronghorn corridors.
    - Restore hydrologic function and vegetation on approximately 6,720 acres of meadows.
    - Restore approximately 14,560 acres of riparian areas for aquatic stream habitat.

- Restore approximately 184 springs.
- Restore function and habitat in up to 777 miles of streams, including stream reaches with habitat for threatened, endangered, and sensitive aquatic species.
- Decommission up to 200 miles of existing system roads on the Coconino and Apache-Sitgreaves NFs, and up to 290 miles on the Tonto NF.
- Decommission up to 800 miles of unauthorized roads on the Apache-Sitgreaves, Coconino, and Tonto NFs.
- Construct or improve approximately 330 miles of new temporary roads or existing non-system roads to facilitate mechanical treatments; decommission all temporary roads when restoration treatments are completed.
- Relocate and reconstruct existing open roads adversely affecting water quality and natural resources, or of concern to human safety.
- Construct up to 200 miles of protective barriers around springs, aspen, native willows, and big-tooth maples, as needed for restoration.

Table 18. Alternative 2 Mechanical and Fire Treatments.

Treatment Type	Treatment Description/Objective	Acres
Intermediate Thin (IT) 10-25 (10 to 25% interspace)	Mechanical and fire treatments that thin stands that are up to moderate infection levels of dwarf mistletoe, thins tree groups to an average of 70 to 90 square feet of basal area (BA) in pine cover types and 40-100 BA in dry mixed conifer cover type, and establishes non-forested grass/forb interspace/openings between residual tree groups or individual randomly-spaced trees. Manages for improved tree vigor and growth by retaining the best growing dominant and co-dominant trees with the least amount of dwarf mistletoe and as many old and/or large trees as possible.	30,210
IT 25-40 (25 to 40% interspace)		53,620
IT 40-55 (40 to 55% interspace)		49,980
IT 55-70 (55 to 70% interspace)		16,970
Single Tree Selection (ST)	Mechanical and fire treatments that leaves fewer tree groups and more randomly spaced trees. Designed to increase or maintain age class diversity and reduce understory brush and shrub response, creating small openings less than or equal to ¼-acre in size where seedlings and saplings are underrepresented and brush cover is greater than 40%. Maintains higher basal area where brush competition is expected to be strong to suppress woody understory response.	12,510
Stand Improvement (SI) 10-25 (10 to 25% interspace)	Mechanical and fire treatments that thin young, even-aged stands dominated by trees less than 8.5 inches in diameter.	13,660

Treatment Type	Treatment Description/Objective	Acres
SI 25-40 (25 to 40% interspace)	Establishes tree groups and interspace adjacent to tree groups. Manages for improved tree vigor and growth by retaining the best growing dominant and co-dominant trees within each group and as many old and/or large trees as possible, and establishes non-forested grass/forb interspace/openings between residual tree groups or individual randomly-spaced trees. Begins conversion to uneven-aged structure.	34,590
SI 40-55 (40 to 55% interspace)		14,460
SI 55-70 (55 to 70% interspace)		8,560
Uneven-aged (UEA) 10-25 (10 to 25% interspace)	Mechanical and fire treatments designed to develop uneven-aged structure and a mosaic of interspaces and tree groups of varying sizes. Thins tree groups to an average of 20-80 BA in pine cover types and 30-100 BA in dry mixed conifer cover type, and establishes non-forested grass/forb interspace/openings between residual tree groups or individual randomly-spaced trees. Manages to enhance growing space for younger trees, while retaining as many old or large trees as possible. Establishes regeneration openings where seedlings and saplings are underrepresented. Locates interspace in currently non-forested areas and lacking pre-settlement evidence.	77,820
UEA 25-40 (25 to 40% interspace)		106,210
UEA 40-55 (40 to 55% interspace)		39,490
UEA 55-70 (55 to 70% interspace)		56,850
Prescribed Fire Only	Prescribed burning to improve structure, maintain and develop large trees, and reduce risk of high-severity. Retain old growth attributes, protect large oaks, and ensure snags and coarse woody debris post-fire.	54,070
Aspen Restoration	Mechanical treatment that removes post-settlement conifers within 66 feet (one chain) of the aspen clone. Managed to stimulate suckering by removing aspen, disturbing the ground, and/or applying fire as needed. Accompanied by prescribed fire.	1,200
Aspen Restoration in PACs		30
Facilitative Operations (FO) Mechanical	Mechanical treatment in non-target cover types to support the use of prescribed fire in cover types targeted for restoration. Includes mastication/chipping; lop and scatter; thinning/limbing; and moving, rearranging, or removal of jackpots or excessive surface fuels. Designed to improve safety, improve treatment effectiveness, expand burn windows, decrease undesirable fire behavior and effects, and minimize disturbance from fireline construction. Accompanied by prescribed fire.	123,400
FO Mechanical in PACs		300
FO Prescribed Fire Only	Fire treatment in non-target cover types to support the use of prescribed fire in cover types targeted for restoration. Includes broadcast burning, jackpotting, pile burning, and blacklining. Designed to improve safety, improve treatment effectiveness, expand burn windows, decrease undesirable fire behavior and effects, and minimize disturbance from fireline construction.	1,260
FO Prescribed Fire Only in PACs		6,880

Treatment Type	Treatment Description/Objective	Acres
MSO Recovery – Replacement Nest/Roost	Mechanical and fire treatments designed to develop uneven-aged structure, irregular tree spacing, and a mosaic of interspace and tree groups of varying size. Intent is to continue to develop replacement Nest/Roost where possible, and to develop a diverse mix of heterogeneous stand structures and densities to provide for owl dispersal and foraging.	25,290
MSO PAC Mechanical	Mechanical treatment outside core areas that thins to improve structure, maintain and develop large trees, and reduce risk of high-severity fire in PACs. Designed to increase tree vigor and health, to promote irregular tree spacing, and to create canopy gaps more conducive to fire treatment (reduce fire risk). Retain old growth attributes, protect large oaks, and ensure snags and coarse woody debris post-treatment. Accompanied by prescribed fire.	17,460
MSO PAC Prescribed Fire Only	Prescribed burning to improve structure, maintain and develop large trees, and reduce risk of high-severity fire in PACs. Fire may be implemented in core areas. Retain old growth attributes, protect large oaks, and ensure snags and coarse woody debris post-fire.	50,830
Savanna Restoration (70 to 90% interspace)	Mechanical and fire treatments that restore pre-settlement tree density and pattern by removing encroaching post-settlement conifers. Manages for a range of 70 to 90 percent interspace (grass/forb) between tree groups or individual trees using pre-settlement tree evidence as guidance. Retains all pre-settlement trees and the largest post-settlement trees as replacement trees adjacent to pre-settlement tree evidence (stumps, dead and down).	18,570
Severe Disturbance Area Treatment	Combination of restoration treatments: reforestation, prescribed fire, lopping/scattering, mastication, and other mechanical methods. Objective is to identify treatments that would be effective in restoring the fuel structure that produces the types of fire to which ponderosa pine is adapted.	128,630
Severe Disturbance Area – MSO PAC		3,610
Grassland Restoration	Mechanical and fire treatments to reduce or eliminate tree encroachment (pines and junipers). Remove trees established since interruption of the historic fire regime. Promote and re-establish the historic meadow edge. Retain all pre-settlement trees and leave replacement trees where evidence of historical large trees exist.	36,320
Wet Meadow Restoration		6,720
Riparian Restoration	Combination of restoration treatments, including mechanical and fire treatments to maintain riparian vegetation and habitat. Remove encroaching upland tree and shrub species. Remove noxious or invasive plants. Promote, protect, or plant native aquatic or riparian species. Prescribed fire to regenerate riparian species and reduce fuels.	14,560

Spring Restoration

Specific treatments to restore springs would be identified prior to mechanical and fire treatments in the vicinity, using the Flexible Toolbox Approach for Aquatic and Watershed Restoration Activities. Treatments could include: removing tree canopy close to the spring, applying fire, re-plumbing the spring improvements to conserve water, protecting the spring with fencing, and removing or relocating adjacent roads or trails.

Stream Restoration

Specific treatments to restore riparian streams and stream channels and their function would be identified prior to mechanical and fire treatments in the vicinity, using the Flexible Toolbox Approach for Aquatic and Watershed Restoration Activities. Treatments could include: reestablishing former drainage patterns, stabilizing slopes, restoring vegetation, protecting sites from grazing ungulates, removal of upland species that compete with riparian species, returning fire to the system (prescribed fire), and/or removing stock tanks. The emphasis will be on non-structural rather than structural methods.

Riparian Habitat Restoration

Proposed stream habitat treatments may be needed within all or some portion of the fish-bearing streams. Specific treatments to restore riparian streams and stream channels and their function would be identified prior to mechanical and fire treatments in the vicinity, using the Flexible Toolbox Approach for Aquatic and Watershed Restoration Activities. Restoration treatments may include channel restoration (one rock dams, grade control or induced meandering) and channel structural improvements (felling or girdling trees to provide large woody debris for cover and habitat complexity).

Road and Trail Relocation/Reconstruction

Specific treatments for roads, trails, and unauthorized routes that are affecting water resources would be evaluated prior to mechanical and fire treatments in the vicinity, using the Flexible Toolbox Approach for Aquatic and Watershed Restoration Activities. Generally, routes crossing and those within 300 feet of streams and waterbodies are the highest priority for evaluation and treatment. Treatments could include: adding gravel to the road surface of existing authorized routes, stabilizing slopes, and restoring vegetation; closing roads, trails, or unauthorized routes by blocking the entrance or installing water bars; removing culverts, reestablishing drainages, removing unstable fills, pulling back road shoulders, and scattering slash on the roadbed; and obliterating the roadbed by restoring natural contours and slopes.

Specific treatments for improving stream crossings that are affecting water resources would be evaluated prior to mechanical and fire treatments in the vicinity. Treatments could include: armoring downstream outlets of culverts, upsizing existing culverts, installing culverts or additional culverts, installing culvert arrays to mimic existing channel width, installing low water crossings, installing bridges, restoring downstream channels created from crossings, using sediment reduction methods on connected disturbed areas upstream from roads that connect to the drainage, paving crossings, and relocating the segment of the road that has the crossing issue out of the stream.

Alternative 3 – Focused Restoration

This alternative is designed to focus restoration treatments in areas that are the most highly departed from the natural range of variation (NRV) of ecological conditions, and/or that put communities at risk from undesirable fire behavior and effects. High value assets will be better protected and burn boundaries will be designed to create conditions safe for personnel and to ensure fire can meet objectives. Treatment areas would be chosen to optimize ecological restoration, those areas that are most important to treat and can be moved the furthest toward desired conditions. Focusing on the higher priority ecological restoration will result in fewer acres being treated.

The restoration treatments proposed in Alternative 3 will be used to address moderate and high levels of mistletoe infection, but to a lesser extent on the fewer acres proposed for mechanical treatment and fire. The presence of dwarf mistletoe will not be used to prioritize areas for treatment, but it will be addressed where it exists, using the same types of treatments as Alternative 2. Design features will be developed to focus activity on addressing dwarf mistletoe infestations during implementation of mechanical treatments.

Alternative 3 responds to the Smoke/Air Quality, Economics, Roads, and Dwarf Mistletoe Mitigation issues. The restoration activities listed for Alternative 3 include vegetation treatments (mechanical thinning and burning), using the Flexible Toolbox Approach for Mechanical Treatments; as well as the same comprehensive restoration treatments as proposed in Alternative 2 for grassland and meadows, springs, streams, riparian habitat, using the Flexible Toolbox Approach for Aquatic and Watershed Restoration Activities, wildlife habitat, and rare species restoration. Proposed activities include:

Mechanically thin trees and/or implement prescribed fire on up to 529,060 acres.

- o Implement mechanical thinning and prescribed fire on approximately 311,800 acres including –
    - ▪ Approximately 112,090 acres of intermediate thinning
    - ▪ Approximately 37,300 acres of stand improvement
    - ▪ Approximately 5,630 acres of single tree selection
    - ▪ Approximately 156,780 acres of uneven-aged group selection
    - ▪ Approximately 46,260 within ½ mile of non-FS lands with structures and critical infrastructure, including –
        - Approximately 16,970 acres of intermediate thinning
        - Approximately 14,040 acres of stand improvement
        - Approximately 27,200 acres of uneven-aged group selection
- o Implement prescribed fire alone on approximately 40,630 acres.
- o Mechanically thin and/or implement prescribed fire on approximately 61,700 acres of Mexican spotted owl (MSO) protected activity centers (PACs) including --
    - ▪ Approximately 19,650 acres of mechanical thinning and/or prescribed fire
    - ▪ Approximately 42,050 acres of prescribed fire only
    - ▪ Approximately 3,370 acres of facilitative operations
- o Mechanically thin and/or implement prescribed fire on approximately 19,590 acres of MSO replacement nest/roost recovery habitat.
- o Conduct facilitative operations in non-target cover types to support treatments in target cover types, including –
    - ▪ Approximately 47,580 acres of facilitative thinning and prescribed fire
    - ▪ Approximately 630 acres of facilitative prescribed fire only
    - ▪ Approximately 3,070 acres of facilitative prescribed fire only in PACs
    - ▪ Approximately 300 acres of facilitative thinning and prescribed fire in PACs
- o Restore aspen on approximately 1,010 acres, including about 30 acres in PACs.
- o Restore approximately 31,750 acres that have experienced severe disturbance, including about 1,420 acres in PACs.
- o Restore approximately 2,470 acres of savanna.
- o Restore approximately 36,320 acres of grassland, including –
    - ▪ Maintaining or restoring montane meadow connectivity in pronghorn corridors.
- o Restore hydrologic function and vegetation on approximately 6,720 acres of meadows.
- o Restore approximately up to 14,560 acres of riparian areas for aquatic stream habitat.

- Restore approximately 184 springs.
- Restore function and habitat in up to 777 miles of streams, including stream reaches with habitat for threatened, endangered, and sensitive aquatic species.
- Decommission up to 200 miles of existing system roads on the Coconino and Apache-Sitgreaves NFs, and up to 290 miles on the Tonto NF.
- Decommission up to 800 miles of unauthorized roads on the Apache-Sitgreaves, Coconino, and

Tonto NFs.

- Construct or improve approximately 170 miles of new temporary roads or existing non-system roads to facilitate mechanical treatments; decommission all temporary roads when restoration treatments are completed.
- Relocate and reconstruct existing open roads adversely affecting water quality and natural resources, or of concern to human safety.
- Construct up to 200 miles of protective barriers around springs, aspen, native willows, and big-tooth maples, as needed for restoration.

Table 19. Alternative 3 Mechanical and Fire Treatments.

Treatment Type	Treatment Description/Objective	Acres
Intermediate Thin (IT) 10-25 (10 to 25% interspace)	Mechanical and fire treatments that thin stands that are up to moderate infection levels of dwarf mistletoe, thins tree groups to an average of 70 to 90 square feet of basal area (BA) in pine cover types and 40-100 BA in dry mixed conifer cover type, and establishes non-forested grass/forb interspace/openings between residual tree groups or individual randomly-spaced trees. Manages for improved tree vigor and growth by retaining the best growing dominant and co-dominant trees with the least amount of dwarf mistletoe and as many old and/or large trees as possible.	24,260
IT 25-40 (25 to 40% interspace)		34,530
IT 40-55 (40 to 55% interspace)		39,260
IT 55-70 (55 to 70% interspace)		14,040
Single Tree Selection (ST)	Mechanical and fire treatments that leave fewer tree groups and more randomly spaced trees. Designed to increase or maintain age class diversity and reduce understory brush and shrub response, creating small openings less than or equal to ¼-acre in size where seedlings and saplings are underrepresented and brush cover is greater than 40%. Maintains higher basal area where brush competition is expected to be strong to suppress woody understory response. Accompanied by prescribed fire.	5,630
Stand Improvement (SI) 10-25 (10 to 25% interspace)	Mechanical and fire treatments that thin young, even-aged stands dominated by trees less than 8.5 inches in diameter. Establishes tree groups and interspace adjacent to tree groups. Manages for improved tree vigor and growth by retaining the best growing dominant and co-dominant trees within each group and as many old and/or large trees as possible, and establishes non-forested grass/forb interspace/openings between residual tree groups or individual randomly-spaced trees. Begins conversion to uneven-aged structure.	7,480
SI 25-40 (25 to 40% interspace)		17,120
SI 40-55 (40 to 55% interspace)		7,690
SI 55-70 (55 to 70% interspace)		5,010
Uneven-aged (UEA) 10-25 (10 to 25% interspace)	Mechanical and fire treatments designed to develop uneven-aged structure and a mosaic of interspaces and tree groups of varying sizes. Thins tree groups to an average of 20-80 BA in pine cover types and 30-100 BA in dry mixed conifer cover type, and establishes non-forested grass/forb interspace/openings between residual tree groups or individual randomly-spaced trees. Manages to enhance growing space for younger trees, while retaining as many old or large trees as possible. Establishes	48,500
UEA 25-40 (25 to 40% interspace)		53,740
UEA 40-55 (40 to 55% interspace)		11,110

Treatment Type	Treatment Description/Objective	Acres
UEA 55-70 (55 to 70% interspace)	regeneration openings where seedlings and saplings are underrepresented. Locates interspace in currently non-forested areas and lacking pre-settlement evidence.	43,440
Prescribed Fire Only	Prescribed burning to improve structure, maintain and develop large trees, and reduce risk of high-severity. Retain old growth attributes, protect large oaks, and ensure snags and coarse woody debris post-fire.	40,630
Aspen Restoration	Mechanical and fire treatments that remove post-settlement conifers within 66 feet (one chain) of the aspen clone. Managed to stimulate suckering by removing aspen, disturbing the ground, and/or applying fire as needed.	980
Aspen Restoration in PACs		30
Facilitative Operations (FO) Mechanical	Mechanical treatment in non-target cover types to support the use of prescribed fire in cover types targeted for restoration. Includes mastication/chipping; lop and scatter; thinning/limbing; and moving, rearranging, or removal of jackpots or excessive surface fuels. Designed to improve safety, improve treatment effectiveness, expand burn windows, decrease undesirable fire behavior and effects, and minimize disturbance from fireline construction. Accompanied by prescribed fire.	47,580
FO Mechanical in PACs		300
FO Prescribed Fire Only	Fire treatment in non-target cover types to support the use of prescribed fire in cover types targeted for restoration. Includes broadcast burning, jackpotting, pile burning, and blacklining. Designed to improve safety, improve treatment effectiveness, expand burn windows, decrease undesirable fire behavior and effects, and minimize disturbance from fireline construction.	630
FO Prescribed Fire Only in PACs		3,070
MSO Recovery – Replacement Nest/Roost	Mechanical and fire treatments designed to develop uneven-aged structure, irregular tree spacing, and a mosaic of interspace and tree groups of varying size. Intent is to continue to develop replacement Nest/Roost where possible, and to develop a diverse mix of heterogeneous stand structures and densities to provide for owl dispersal and foraging.	19,590
MSO PAC Mechanical	Mechanical treatment outside core areas that thins to improve structure, maintain and develop large trees, and reduce risk of high-severity fire in PACs. Designed to increase tree vigor and health, to promote irregular tree spacing, and to create canopy gaps more conducive to fire treatment (reduce fire risk). Retain old growth attributes, protect large oaks, and ensure snags and coarse woody debris post-treatment. Accompanied by prescribed fire.	15,750
MSO PAC Prescribed Fire Only	Prescribed burning to improve structure, maintain and develop large trees, and reduce risk of high-severity fire in PACs. Fire may be implemented in core areas. Retain old growth attributes, protect large oaks, and ensure snags and coarse woody debris post-fire.	37,960

Treatment Type	Treatment Description/Objective	Acres
Savanna Restoration (70 to 90% interspace)	Mechanical and fire treatments that restore pre-settlement tree density and pattern by removing encroaching post-settlement conifers. Manages for a range of 70 to 90 percent interspace (grass/forb) between tree groups or individual trees using pre-settlement tree evidence as guidance. Retains all pre-settlement trees and the largest post-settlement trees as replacement trees adjacent to pre-settlement tree evidence (stumps, dead and down).	2,470
Severe Disturbance Area Treatment	Combination of restoration treatments: reforestation, prescribed fire, lopping/scattering, mastication, and other mechanical methods. Objective is to identify treatments that would be effective in restoring the fuel structure that produces the types of fire to which ponderosa pine is adapted.	30,340
Severe Disturbance Area – MSO PAC		1,420
Grassland Restoration	Mechanical and fire treatments to reduce or eliminate tree encroachment (pines and junipers). Remove trees established since interruption of the historic fire regime. Promote and re-establish the historic meadow edge. Retain all pre-settlement trees and leave replacement trees where evidence of historical large trees exist.	36,320
Wet Meadow Restoration		6,720
Riparian Restoration	Combination of restoration treatments, including mechanical and fire treatments to maintain riparian vegetation and habitat. Remove encroaching upland tree and shrub species. Remove noxious or invasive plants. Promote, protect, or plant native aquatic or riparian species. Prescribed fire to regenerate riparian species and reduce fuels.	14,560

Resource Protection Measures

Resource protection measures are practices designed to minimize or mitigate adverse effects of mechanical forest thinning, road construction, prescribed fire, and other restoration activities to soil productivity, water quality, wetland and riparian habitat functionality, stream condition, road infrastructure, and to prevent the spread of invasive or noxious weeds on NFS Lands. Resource protection measures referenced for this project includes standard Soil and Watershed Conservation Practices (SWCPs) and BMPs 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)(USDA, 2012). Resource protection measures are implemented to minimize nonpoint source pollution as required in the 2013 Memorandum of Understanding (MOU) between the Arizona Department of Environmental Quality (ADEQ) and the U.S. Forest Service Southwestern Region. Note that no specific resource protection measures are required for the No Action Alternative. A comprehensive list and description of resource protection measures is provided in Appendix F.

Environmental Consequences

This section describes the direct, indirect, and cumulative effects of implementing each alternative on the soil and water resources in the Rim Country Restoration Project analysis area. It presents the scientific and analytical basis for the comparison of the alternatives presented in Alternatives section and establishes the baseline against which the decision maker and the public can evaluate the effects of the action alternatives. 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 the 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).

Direct effects of proposed activities 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.

Cumulative effects include the effects on the environment which result from the incremental effect 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).

Alternative 1 – No Action

The No Action Alternative would result in no changes to current rates of vegetation management, commercial timber harvesting, pre-commercial vegetation treatments, or other mechanical or non-mechanical fuels reduction treatments; no changes to road construction, maintenance, decommissioning or obliteration; and no changes to prescribed fire implementation or wildfires managed for multiple resource benefits within the Rim Country Restoration project area. Therefore, there would be no changes to current direct effects to soils, water quality, ephemeral or intermittent stream channels, or watershed condition as a result of the no-action alternative. Other proposed activities such as restoration of springs, riparian habitats, grasslands, and meadows would continue at current rates rather than the accelerated rate proposed in the action alternatives. These important landscape features and wildlife habitats would be expected to remain in degraded or impaired conditions for longer periods than under the action alternatives.

Due to the substantially extended temporal timeframe and reduced scale under which restoration actions would occur under the No Action alternative (i.e., individual projects rather than landscape-scale restoration), it is reasonable to expect that short term adverse effects to soils and watershed conditions that result from mechanical and prescribed fire treatments would also occur at a reduced rate and scale.

Absence of Upland Vegetation Treatments and Prescribed Fire

Since tree basal area or density reduction of currently overstocked stands within the project area would not occur at the same rate as under the action alternatives, increased fuel loading in both living biomass and woody detritus would be expected through natural forest ingrowth and tree encroachment into existing openings followed by forest decadence caused by intraspecific and interspecific competition. Additionally, forest ingrowth would continue to increase "ladder fuels" which allow ground fires to ascend and spread quickly as crown fires. Coarse woody debris would be expected to increase over time as small, medium, and large diameter material begins to fall to soil surfaces and decay. While these conditions may improve soil quality in some regards (organic matter accumulation in subsurface horizons, microhabitat for soil organisms and increased organism populations, increased water holding capacity) they would also result in an increased risk of high severity wildfires where fuel loading becomes excessive.

The location, size and severity of future wildfires cannot be estimated with accuracy, although some generalizations can be made. High severity 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 wildfire, such as the loss of forest floor organic matter, increased soil erosion and sediment delivery to waterbodies, and changes in soil habitat and biota would be more widespread in an uncontrolled wildfire than under prescribed fire conditions. The primary effect of high severity wildfire on soil productivity is the removal of understory vegetative cover and surface organic matter (i.e., loss of protective cover and nutrient stores), exposure of soil surfaces to erosion by wind and water, and exposure of soils to solar radiation, which increases soil temperatures and reduces soil moisture. If surface organic matter is reduced (as happens under high-severity, long-duration fire) the cation exchange capacity of the soil is also reduced and the ability of the soils to retain nutrients leached from ash also decreases.

Lata, (2012) suggests that up to 33% of ponderosa pine forest could burn under high burn severity conditions. Historically, large stand-replacing wildfires on the Coconino National Forest have resulted in 10-25 percent of the burned acreage exhibiting high severity fire. Therefore, if a 10,000 acre wildfire were to occur within the analysis area, approximately 1,000 to as much as 3,300 acres of high severity fire could adversely affect soils and watershed conditions.

There have been many examples of high severity wildfires occurring in the southwestern United States in areas that were originally open, fire-adapted forests. Such events can have profound negative effect to soil properties including: a) decreased soil productivity through loss of nutrient sources b) soil hydrophobicity (i.e. the inability of soils to absorb water following precipitation resulting in increased overland flow, and c) increased susceptibility of soils to erosion by both wind and rainfall.

In the absence of mechanical vegetation and fuels treatments and prescribed fire, a high severity wildfire would very likely result in increased surface runoff and downstream flooding, soil erosion, and sediment delivery to streamcourses as a result of loss of effective ground cover at the soil surface, reduced rainfall interception, and reduced soil water infiltration rates. The infrequent nature of ephemeral stream flow results in the potential for sediment and ash to be stored within these stream channels and then transported during the larger surface runoff events. This, in turn, could pose detrimental effects to surface water quality and water storage capacity in livestock and wildlife waters.

This alternative would result in no additional acres of ground disturbance over current levels from tree felling, piling of activity-related woody debris, use of prescribed fire, temporary road construction, or expansion of gravel pits. Risk of uncharacteristic wildfire would not be reduced at the same rate as the action alternatives. No improvement would be realized in forested areas, woodlands, savannas, and grassland vegetative types where vegetative ground cover conditions are departed from desired conditions. No road decommissioning, or rehabilitation of unauthorized routes or stream crossings would occur above current levels. The project area would therefore not move toward desired conditions as outlined in the Apache -Sitgreaves, Coconino, and Tonto Forest Plans as rapidly as under the Action Alternatives.

Historic land management activities, including livestock grazing and fire suppression have resulted in changing vegetative conditions over the last 100 years. These conditions have produced an uncharacteristic accumulation of fuels and increased forest density within the project area, resulting in increased the risk of high severity wildfire in many areas within the Rim Country Restoration Project and increasing the difficulty and risk of wildfire suppression. Additionally, the resulting loss of natural fire regimes and characteristic fire behavior throughout the analysis area has resulted in drainages and meadow systems that are starved of sediment, meaning the lack of sediment delivery to these areas makes meadow restoration difficult where gullies had channels have formed in meadows.

The No Action alternative would not adequately contribute to reduced forest vegetation densities, desired fire regimes, and forested conditions that would provide resilience against uncharacteristic disturbances such as high severity wildfire, insect and disease outbreaks, and prolonged drought or climate change induced mortality. Much of the ponderosa pine forest in the Rim Country Restoration Project analysis area is currently in Fire Regime Condition Class 3. Under dense forested condition, litterfall has resulted in thick forest floor litter layers that have displaced native plant communities. These native plant communities provided greater benefits to watershed condition and soil hydrologic function than litter alone through improved fine root turnover rates, increased fine litter, improved soil porosity and aggregate stability, increased water holding capacity, and increased organic carbon sequestration.

The effects of high severity wildfires on soils, watershed condition, water quality and water quantity are well understood (DeBano et al. 1976, 1996, 1998, USDA 2005). High severity wildfires can cause damaging flows to streams resulting in high levels of sediment and ash inputs as well as increased risk to riparian areas and other downstream values at risk, including forest infrastructure. It is likely that under any conditions, a wildfire entering these untreated watersheds under the no action alternative would have considerably greater effects to soil productivity, water quality and channel stability than wildfire occurring after implementation of the action alternatives. 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. 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 soil productivity, water quality, stream morphology, and riparian conditions. Increased sediment loads are the primary physical effects to surface waters following fire. The bulking effect of sediment, ash, and debris 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.

In areas of high stand densities, long-term improvement in hydrologic processed will occur in the absence of mechanical treatment and/or prescribed fire. The soils in these areas have reduced moisture storage and infiltration capacity and are easily overwhelmed by high intensity summer monsoon precipitation events, producing runoff with relatively high peak flows of short duration.

Other potential detrimental effects to hydrologic conditions in the project area and downstream locations could include the destabilization of the geomorphic conditions of stream channels due to excessive sediment delivery and debris loading, increased peak flows, and overall increases in average annual water yield resulting from loss of upslope interception, infiltration, and evapotranspiration. Ephemeral stream channels within high burn severity areas would lose their ability to buffer runoff from large rainfall events, resulting in increased channel scour and incision caused by accelerated runoff and erosion from severely burned watershed areas. Increased bedloads in stream channels effectively raises the elevation of stream bottoms, causing flood flows to exceed channel capacities, resulting in overland flooding. These conditions could result in increased flooding risk within the 100-year floodplain of Cataract Creek located in the City of Williams and other downstream locations.

Another effect is sediment and ash deposition in downstream roads, stock tanks and meadows, even if such areas may not have burned. In addition, sediment and ash-laden overland flows may damage low lying roads by eroding road traveled ways and filling culverts and low water crossings with sediment and debris. These are examples of why post-wildfire watershed conditions are significantly different from pre-fire or low-severity prescribed fire conditions.

Additional cumulative effects of the No Action alternative include ongoing erosion and sediment delivery to ephemeral channels from roads proposed for obliteration under the Action Alternatives that would not be obliterated under this Alternative. When combined with other activities in the proposed project area, sediment production from these roads could contribute to adverse effects to downstream surface water quality if these roads remain in an unstable, eroding condition.

In the absence of proposed vegetation treatments proposed in Alternative 2, including prescribed fire, approximately 982,780 acres of soils resources and watersheds would not be improved.

In the absence of proposed vegetation treatments proposed in Alternative 3, including prescribed fire, approximately 548,880 acres of soils resources watersheds would not be improved.

Absence of Riparian Area, Wet Meadow and Stream Restoration Treatments

Watershed condition is dependent on the condition of the riparian communities that exist within the watershed. The benefits of riparian areas in the project area cannot be over emphasized. Riparian areas help capture pollutants including sediment and nutrients, contribute to channel stability by providing protective vegetative cover and root biomass that anchors soils, regulate water temperatures by providing shade, provide areas for floodwater storage and dissipation and are important wildlife habitat features. As noted in the Riparian and Water Quality Specialist's Report (Brown 2018), several stream reaches within the Rim Country EIS analysis area are experiencing increased water flows and sediment delivery from the effects of poor upland conditions, some of which are the result of historic wildfires. The increased flows have resulted in vertical and lateral channel instability in many intermittent and perennial stream reaches. Riparian vegetation has either been scoured away or reduced through increased channel incision that has detached riparian communities from adjacent floodplains. Stream channel substrates have been altered through increased runoff and in-channel transport. In the absence of proposed riparian, wet meadow, and stream restoration activities, watershed condition would not be improved on 21,280 acres of riparian areas, wet meadows and stream channels. As a result, these areas will continue to not meet desired conditions as outlined in Forest plans and existing risks to water quality would persist.

Absence of Road Decommissioning:

As shown in Table 14, roads are a major contributor to surface water quality degradation. Under the No Action alternative, decommissioning of up to 200 miles of existing system roads on the Coconino and Apache-Sitgreaves NFs, and up to 290 miles on the Tonto NF and 800 mile of unauthorized road would not occur. Based on an average width of 12 feet, there are approximately 1,877 acres of roads planned for decommissioning (713 acres of NFS system roads and 1,164 acres of unauthorized roads). These roads would remain on the landscape as unproductive sites and as chronic sources of sediment to streamcourses. Existing open roads and unauthorized routes would continue to be used for motorized travel and would remain as chronic sources of pollution, including sediment to stream channels throughout the Rim Country area, especially where the roads are poorly located in stream bottoms or hydrologically connected to streamcourses or have inadequate stormwater control or drainage.

Absence of Rock Pits and In Woods processing sites.

Alternative A - No Action would have slightly more potential of increased sediment delivery to waterbodies than the action alternatives since road improvements proposed under the Action Alternatives would not occur. Selection of Alternative A would mean that road improvements would continue to occur at existing levels, which are currently insufficient to maintain road infrastructure adequately. Roads would therefore continue to serve as chronic sources of sediment to streamcourses and downstream waterbodies.

Expansion of rock pits under the Action Alternatives constitutes an irreversible and irretrievable commitment of resources since productive land is permanently altered and converted to an unproductive condition in perpetuity and through the extraction of rock for road surfacing. Irreversible is a term that describes the loss of future options. It applies primarily to the effects of use of nonrenewable resources, such as minerals or cultural resources, or to those factors, such as soil productivity, that are renewable only over long periods of time. Irretrievable is a term that applies to the loss of production, harvest, or use of natural resources. Rock extraction limits future options for use of the converted sites and for of the material extracted. The No Action Alternative would mean that 629 acres of rock pit expansion would not occur, thereby eliminating this irreversible and irretrievable commitment of natural resources.

Alternative A would eliminate the need for 13 wood processing sites (129 acres). Activities such as drying, debarking, chipping stems and bark, cutting logs, manufacturing and sorting logs to size, scaling and weighing logs and creating poles from suitable sized logs would therefore not occur. These sites constitute an irretrievable commitment of soils and vegetation resources since they remove soils and vegetation from productive status for several years while the sites exist. Selection of Alternative A would eliminate the need for this irretrievable commitment of soils and vegetation resources.

Effects Common to All Action Alternatives

Upland Vegetation Treatments

Potential effects of the Action Alternatives on soil productivity would include localized soil compaction, puddling, displacement, erosion, loss of soil organic matter, short-term changes in soil moisture content or retention, changes in nutrient cycles, changes in soil fauna, and introduction of invasive and noxious weeds. These effects can result from both mechanical and non-mechanical vegetation treatments (i.e., forest thinning), mechanical and non-mechanical piling of activity-related debris, and road construction and maintenance activities necessary to support mechanical vegetation treatments. Mechanical forest vegetation treatments have the potential to adversely affect water quality through introduction of sediment and additional nutrients from decomposing woody debris, particularly where mechanical vegetation treatments occur in areas adjacent to stream courses. Implementation of design features and BMPs as specified in Appendix F would minimize or mitigate adverse effects to soils and water quality from these activities.

Soil compaction, puddling and displacement would primarily be limited to the transportation systems and high traffic areas within mechanical vegetation treatments such as existing National Forest System roads, temporary access roads, skid trails, log landings, debris piling areas, and areas where fireline construction occur. Road closures and curtailment of mechanical vegetation treatments during wet weather conditions and designation of authorized access routes (skid trails and temporary roads) and log landings prior to project implementation would minimize adverse effects to soil productivity caused by these activities. With implementation of applicable design features and BMPs as outlined in Appendix F, most adverse effects to soils would be minimized or mitigated, although not totally eliminated. Additionally, pedoturbation of soils caused by seasonal wetting and drying, freezing and thawing, and soil organism activity would naturally ameliorate some adverse effects to soils caused by the proposed Action Alternatives.

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

The risk of short-term accelerated soil erosion would be highest in areas where forest thinning and use of prescribed fire results in soil disturbance or complete removal of vegetative ground cover. These areas are expected to include skid trails, log landings, temporary access roads, obliterated roads, installed firelines and fuels treatment areas to support prescribed burning efforts, and National Forest System roads.

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). 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.

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 where litter is currently the dominant soil cover. The increased herbaceous vegetation would reduce soil erosion rates by providing vegetative ground cover that would intercept rain before it can reach soil surfaces and detach and entrain soil particles in runoff. Woody debris from forest thinning (i.e., slash) would be lopped and scattered where doing so would not result in excessive fuel loads and increased wildfire risk, further mitigating potential adverse effects to soils and watershed resources. Finer litter and woody debris that is incidental to forest vegetation treatments (i.e., needles, leaves, twigs, cones, bark, etc.) would also remain on the ground following mechanical treatments to protect soil surfaces from wind and water erosion.

Prescribed Fire

Prescribed fire has the potential to affect water quality by increasing sediment, dissolved solids, and nutrients in streams. Dissolved nutrients in stream flow primarily originate from weathering of parent materials and soils, decomposition of plant material and other organic matter, and anthropogenic sources. Vegetative communities accumulate and cycle nutrients (Tiedemann et al. 1979, 1987). Fire can disrupt nutrient cycling and cause nutrient volatilization, leaching, and transformations. When vegetation is consumed by fire, some of the soil and organic matter nutrients 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 accumulate in ash (DeBano et al. 1998).

The mobility and concentration of nutrients in soils 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. 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 ground cover further immobilizes nutrients in plant material.

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 throughout the Rim Country analysis 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, surface water 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 hydrophobic soil conditions (water repellant soils), 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 in most cases.

Fire in southwestern ponderosa pine forests has been shown to generally increase soil moisture content (Ryan and Covington 1986, Ower 1985, Haase 1986). In a review of literature, Hungerford and others (1991) reported that burning can kill many kinds of bacteria, fungi and arthropods but the extent of this effect is dependent on the amount of heat generated by the fire and soil moisture content. To what extent these changes result in an impairment or degradation of soil productivity is not clearly understood. Hungerford suggests that low to moderate intensity prescribed fires may have minimal long-term negative effect on soil microorganisms. Kaye and Hart (1998) found that microbial nitrogen transformation rates increased under restored forest conditions, relative to the controls, suggesting higher microbial activity in the restored areas. Neary and others (1999) caution against the adverse effects to soil microorganisms caused by fires that become intense or are too frequent. Researchers have recommended maintaining soil carbon pools to maintain biologic activity (Stark and Hart, 1997), and recommend maintaining heterogeneity in burned areas to provide suitable sites from which the microflora and microfauna can reestablish in burned areas (Moldenke, 1999). Prescribed fires proposed under the action alternatives are expected to be dominantly low soil burn severity with small areas of medium and high soil burn severity, retaining unburned islands and creating a mosaic of fire effects. Low and medium severity fires burn only a portion of the surface organic matter – leaving adequate soil cover over much of the burned area. In general, low severity prescribed fire does not cause excessive erosion or sediment transport since some soil cover is retained in a discontinuous pattern across the landscape. This type of prescribed fire would not have a long-term adverse affect on soil moisture content or biota. The increase in understory vegetation would improve long term soil structure and porosity through increased fine root volume and vegetative litter, which are important habitat components for soil fauna that then incorporate organic matter into soil profiles and facilitate nutrient cycling.

Installation of firelines where they do not currently exist would expose soil surfaces, increasing the risk of erosion by both wind and rain. Areas of high severity fire may consume forest floor organic matter, leaving soil surfaces hydrophobic (i.e., repellant to water) and susceptible to erosion. Initially, the greatest risk of soil erosion would be expected to occur in areas where prescribed fire is implemented prior to forest thinning treatments. This is due to greater amounts of woody debris on the ground, higher stand densities and crown bulk densities at these locations, resulting in increased risk of high severity fire. Rehabilitation of firelines installed during prescribed burning would minimize adverse affects to soil productivity from fireline installation. Implementing prescribed burning under conditions that would minimize high severity fire would minimize areas where soil organic matter is totally consumed and prevent hydrophobic soil conditions.

Piling of activity-related debris (slash) would disturb soil surfaces, exposing them to direct raindrop impact and wind. On steep terrain this would increase localized, short-term erosion rates in areas where pile burning is conducted. These areas would constitute a very small percentage of overall treatment area (i.e., less than 10 percent), so these effects are expected to be minor. Use of appropriate design features and BMPs as outlined in Appendix F would mitigate most adverse effects from piling of woody debris created during forest thinning operations. Additionally, use of excavators with hydraulic bucket thumb attachments would minimize soil disturbance resulting from machine piling more effectively than dozer piling.

Burning of slash piles has been shown to negatively affect soil biotic and chemical properties due to intense soil heating (Korb et al, 2004 and Seymour and Tecle, 2004). It can result in soil sterilization, increased erosion risk and an increased risk of invasive and noxious weeds that displace native vegetation. Pile burning sites would constitute a very small portion of the project area (i.e., less than 10 percent). Employing piling techniques that would minimize soil burn severity (e.g., rack-and-pile technique) whereby the pile is elevated on a grid of logs would reduce soil of these sites for the presence of invasive or noxious weeds following pile burning, and treatment of any infestations found would mitigate most adverse effects to soils caused by pile burning of slash.

Soil organic matter serves as the long-term nutrient supply for all vegetation occupying a site. It also provides microhabitat for most soil organisms and improves soil chemical and physical properties including soil aggregate stability, increased porosity, improved water holding capacity, lower bulk densities, and nutrient cycling. Initially, there would be an expected short-term increase in soil organic matter as a result of mechanical vegetation treatments as fine litter and woody debris are deposited on soil surfaces during treatments. Forest thinning would also allow greater light penetration to soil surfaces resulting in warmer soil temperatures. The reduction in tree vegetative cover as a result of forest thinning would decrease evapotranspiration rates and therefore increase soil moisture. Warmer soil temperatures and greater soil moisture content would result in increased soil biological activity. Increased soil biological activity results in a proportional decrease in soil organic matter as organisms consume soil detritus. The eventual increase in understory vegetation would result in increased litterfall and deposition of organic matter onto soil surfaces. Broadcast prescribed fire would result in rapid oxidation of surface organic matter and living understory biomass, causing a release or transformation of some soil nutrients. Over time, a balance would occur between soil organism activity and soil organic matter content. This balance is readjusted whenever fire is reintroduced. Low severity fire typically results in beneficial relationships between soil organism populations and soil organic matter content.

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 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.

Temporary Road Construction and Road Improvements

Temporary road construction constitutes an irretrievable commitment of soils and vegetation resources to a project. This is because they commit soils to nonproductive status for the duration of the road's existence and for several years afterwards, soil profiles are permanently altered from the *in situ* conditions, and vegetation (timber and forage) is removed from the traveled way. However, temporary roads are not an irreversible commitment of these resources, since soils eventually return to productive status after the road has been decommissioned and vegetation, including trees, typically returns to the road corridor.

Temporary roads are minimum design standard roads and therefore have fewer negative environmental effects that permanent roads. Typically, temporary roads are native surface roads that are simply "bladed" soil surfaces to smooth the soil surface sufficiently for log transport for short distances (i.e., usually less than a mile). Temporary roads usually do not have culverted stream crossings or long segments of fill material.

Both Action Alternatives will require installation of temporary roads. Alternative 2 would require approximately 330 miles of temporary roads in order to access areas for mechanical vegetation treatments, while Alternative 3 would require 140 miles of temporary roads.

Depending on temporary road locations and timing of use, these roads can adversely affect soil productivity for the duration of the road use and for several years following decommissioning and abandonment. Design criteria and BMPs in Appendix F would limit adverse effects of temporary roads by preventing them from being located in sensitive areas (Aquatic Management Zones, near spring ecosystems, and in riparian habitats) except where designated stream crossings are necessary. Upon decommissioning, temporary roads would have water control features installed as needed, would be stabilized using logging slash to protect soil surfaces from raindrop impacts, minimize soil erosion, and prevent visitors from using the road for motorized travel.

Temporary roads are therefore expected to have minimal long-term effects to soil productivity, water quality, and vegetation and therefore watershed condition.

Existing system roads may be improved or realigned to provide serviceable and safe access for forest mechanical vegetation and prescribed fire treatments. These improvements will protect soil productivity and surface water quality by: a) preventing roadbed erosion through application of aggregate to provide a more stable and reliable running surface, b) provide road drainage that prevents erosion and sediment delivery to streamcourses, c) reduce effects of stream crossings through improved road stream crossing designs.

Road Use

Forest roads are classified by Maintenance Levels (ML) in accordance with Forest Service Handbook (FSH) 7709.58,10,12.3. Maintenance levels are defined by the USDA FSH as the level of service provided by, and maintenance required for, a specific road. Maintenance levels must be consistent with road management objectives, and maintenance criteria. The following criteria are considered when selecting road maintenance levels:

a. Resource program needs, environmental and resource protection requirements, visual quality objectives, and recreation opportunity spectrum classes.

b. Road investment protection requirements.
c. Service life and current operational status.
d. User safety.
e. Volume, type, class, and composition of traffic.
f. Surface type.
g. Travel speed.
h. User comfort and convenience.
i. Functional classification.
j. Traffic service level.

Table 20 below provide a summary of Road Maintenance Levels and their associated miles.

Table 20. Road Maintenance Levels and associated miles in the Rim Country analysis area.

Maintenance Level	A-S	Coconino	Tonto	Total
1- Basic Custodial Care (closed)	1,747	189	140	2,076
2 - High Clearance	856	1,417	591	2,864
3 - Suitable for Passenger Vehicles	347	240	82	669
4 - Moderate Degree of User Comfort	22	11	38	71
5 - High Degree of User Comfort	0	0	2	2
Total System Roads	2,972	1,857	853	5,682

Maintenance level 1 roads are closed to vehicular traffic. The closure period must exceed 1 year. Basic custodial maintenance of roads is performed to keep damage to adjacent resources to an acceptable level and to perpetuate the road to facilitate future management activities. Emphasis is normally given to maintaining drainage facilities and runoff patterns. Planned road deterioration may occur at this level. Appropriate traffic management strategies are "prohibit" and "eliminate." Roads receiving level 1 maintenance may be of any type, class or construction standard, and may be managed at any other maintenance level during the time they are open for traffic. However, while being maintained at level 1, they are closed to vehicular traffic, but may be open and suitable for nonmotorized uses. Maintenance level 1 roads have the following attributes:

- Vehicular traffic is eliminated, including administrative traffic.
- Physically blocked or entrance is disguised.
- Not subject to the requirements of the Highway Safety Act.
- Maintenance is done only to minimize resource impacts.
- No maintenance other than a condition survey may be required so long as no potential exists for resource damage.

Maintenance level 2 roads are open for use by high-clearance vehicles. Passenger car traffic is not a consideration. Traffic is normally minor, usually consisting of one or a combination of administrative, permitted, dispersed recreation, or other specialized uses. Log hauling may occur at this level. Appropriate traffic management strategies are either to (1) discourage or prohibit passenger cars or (2) accept or discourage high-clearance vehicles. Maintenance level 2 roads have the following attributes:

- Roads have low traffic volume and low speed.
- Typically local roads.
- Typically connect collectors or other local roads.
- Dips are the preferred drainage treatment.

• Not subject to the requirements of the Highway Safety Act.
• Surface smoothness is not a consideration.
• Not suitable for passenger cars.

Maintenance level 3 roads are open and maintained for travel by prudent drivers in standard passenger cars. User comfort and convenience are low priorities. Roads in this maintenance level are typically low speed, single lane with turnouts, and spot surfacing. Some roads may be fully surfaced with either native or processed material. Appropriate traffic management strategies are either "encourage" or "accept." "Discourage" or "prohibit" strategies may be employed for certain classes of vehicles or users. These roads have the following attributes:

• Subject to the requirements of Highway Safety Act and MUTCD.
• Roads have low- to moderate-traffic volume.
• Typically connect to arterial and collectors roads.
• A combination of dips and culverts provide drainage.
• May include some dispersed recreation roads.
• Potholing or washboarding may occur.

Maintenance Level 4 roads provide a moderate degree of user comfort and convenience at moderate travel speeds. Most roads are double lane and aggregate surfaced. However, some roads may be single lane. Some roads may be paved and/or dust abated. The most appropriate traffic management strategy is "encourage." However, the "prohibit" strategy may apply to specific classes of vehicles or users at certain times. These roads have the following attributes:

• Subject to the requirements of the Highway Safety Act and MUTCD.
• Roads have moderate traffic volume and speeds.
• May connect to county roads.
• Culverts provide drainage.
• Usually a collector.
• May include some developed recreation roads.

Maintenance Level 5 roads provide a high degree of user comfort and convenience. These roads are normally double-lane, paved facilities. Some may be aggregate surfaced and dust abated. The appropriate traffic management strategy is "encourage."
These roads have the following attributes:

• Subject to the requirements of Highway Safety Act and Manual of Uniform Traffic Control Devices (MUTCD).
• Highest traffic volume and speeds.
• Typically connect to State and county roads.
• Culverts provide drainage.
• Usually arterial and collector.
• May include some developed recreation roads.
• Usually paved or chip-sealed.

Approximately 5,682 miles of National Forest System roads would be needed to implement the Action Alternatives. Vehicle traffic associated with project implementation, particularly trucks, tend to pulverize road surface aggregates, resulting in more fine particles that are easily transported in runoff. Runoff from road surfaces can also detach and transport the fine material from road prisms and ditches. 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 alter flow regimes in streams. Road-stream intersections are the primary location where sediments are delivered to stream courses. Sediment production from roads diminishes over time after proper closure and non-use (Beschta 1978). Roads induce surface runoff patterns and can alter subsurface flow on hillslopes as a result, and this can affect the magnitude and timing of surface runoff.

It is likely that traffic associated with mechanical restoration treatments and commercial timber sales would have short term adverse effects to surface water quality through sediment delivery to streamcourses and other water bodies and increases in turbidity. These effects would typically occur as a result of vehicular traffic during rain events or shortly before them. Use of Resource Protection Measures and applicable road BMPs would minimize and mitigate most adverse effects from road use, but would not eliminate them entirely. As previously noted, forest roads are typically one of the major sources of surface water quality degradation from forest operations.

Once mechanical treatments are completed and transportation of forest products and machinery no longer occur on a given road, adverse effects to water quality typically diminish and return to background level proportional to historic road use levels.

Road Decommissioning

Approximately 490 miles of poorly located and infrequently maintained system roads would be decommissioned under the Action Alternatives (200 on the Coconino NF and A-S NF and 290 miles on the TNF). Additionally, approximately 800 miles of unauthorized roads would be decommissioned on the A-S and Coconino NFs.

Road decommissioning actions will vary, depending on road locations, conditions, and effects on other resources (e.g., soils, water quality and watershed conditon), but could include activities such as ripping, seeding, mulching, filling inside ditches, outsloping road prisms, removal of culverts and fill material, re-contouring of stream crossings, removal of unstable sidecast material or cutslope stabilization, and blocking of entrances to prevent future access. These activities would return unproductive or marginally productive soils to a more stable, productive status over the long term by improving water infiltration and vegetative ground cover and reducing erosion hazards. Stream crossings would be returned to a more natural condition, thus reducing runoff and sediment delivery into ephemeral stream channels or intermittent or pernnial waterbodies. Adverse effects to surface water quality caused by stormwater runoff from road surfaces would also be minimized. Current erosion rates of roads proposed for obliteration are, to a large degree, at or above tolerance erosion rates.

Road decommissioning improves watershed condition by reducing open road densities within affected watersheds. Reducing the number of roaded miles per unit area of watershed reduces hydrologic impacts that roads have on that watershed. Hydrologic impacts such as stream crossings and hydrologic diversions that result from road ditches, cross drainages, etc. are therefore reduced. Road decommissioning typically results in improved soil productivity and water quality.

Rock Pits and Wood Processing Sites

Rock Pits

As previously noted, expansion of rock pits under the Action Alternatives constitutes an irreversible and irretrievable commitment of 629 acres of soils, and geologic resources since productive land is permanently altered from its natural condition and converted to an unproductive condition in perpetuity and through the extraction of rock for road surfacing. Irreversible is a term that describes the loss of future options. It applies primarily to the effects of use of nonrenewable resources, such as minerals or cultural resources, or to those factors, such as soil productivity, that are renewable only over long periods of time. Irretrievable is a term that applies to the loss of production, harvest, or use of natural resources. Rock pit expansion limits future options for use of the converted sites and rock extraction eliminates future options for use of the extracted material. Both Action Alternatives would mean that 629 acres of rock pit expansion would occur, thereby making an irreversible and irretrievable commitment of natural resources.

Wood Processing Sites

The Action Alternatives would include 13 wood processing sites totaling 129 acres. The criteria for selection of sites suitable for wood processing included the following: flat uplands having less than 5% slope, more than 200 feet distance from ephemeral and intermittent stream channels, and more than 300 feet from meadows and springs. These design criteria, in addition to applicable Resource Protection Measures, would reduce the potential for adverse effects to surface water quality, stream channels, riparian resources, and spring ecosystems. However, these sites constitute an irretrievable commitment of soils and vegetation resources since soils would be committed to nonproductive status for the duration of each wood processing site's existence and vegetation removal would be required for establishing sites, reducing the areal extent of available forage or forest cover. The scale of this irretrievable commitment of soils and vegetation resources for the establishment of wood processing sites in the context of the total project area is minimal at 129 acres and would not likely have detectable adverse effects at the watershed scale.

Riparian, Spring and Stream Restoration

Comprehensive restoration activities included in the Action Alternatives and described in the Aquatic and Watershed Flexible Toolbox would directly improve stream channel morphology, riparian and slope wetland conditions, floodplain functionality and spring ecosystems. Restoring stream channel gradients and increasing channel sinuosity, restoring width-to-depth ratios and reconnecting stream channels to their historic floodplains would improve hydrogeological conditions at the watershed level. Surface flows, floodplain water storage, and sediment transport would all be improved. Activities such as installation of grade control structures has been shown to be effective for dissipating runoff energy, improving sediment storage, aggrading incised stream channels and reconnecting them to historic floodplains. Wet meadows would be effectively restored through implementation of these, and similar practices that eliminate single-thread streams and gullies that are drying out these wetlands. Planting native herbaceous riparian species, stabilizing stream banks, reducing bank steepness of entrenched channels and reconstructing riffle and pool formations would contribute to improved hydrologic function of stream channels.

There would likely be short-term, adverse effects to surface water quality through implementation of these restoration actions since they are often in-channel restoration practices, occur in wetland areas, or are in riparian areas immediately adjacent to stream channels and wetlands. With implementation of Resource Protection Measures and BMPs, adverse effects can be minimized or mitigated. Native riparian and wetland vegetation is expected reestablish in these areas soon after restoration activities are completed (i.e., 1 to 3 years). In some areas, reestablishment of wetland or riparian vegetation would be hastened by planting of appropriate wetland or riparian herbaceous and woody species. Installation of protective exclosures around restored sites would reduce browsing and trampling by both domestic and wildlife ungulates.

Effects Unique to Each Action Alternative and Differences Among Them

Mechanical Forest Restoration Treatments (Thinning)

One of the primary differences between Alternative 2 – Modified Proposed Action and Alternative 3-Focused Restoration is the number of acres and intensity of mechanical forest restoration treatments. Alternative 2 proposes to mechanically thin trees and/or implement prescribed fire on up to 953,130 acres, while Alternative 3 would mechanically treat slightly more than half (55 percent) of those acres at 529,060 acres. Alternative 2 addresses landscape-scale mechanical forest restoration across the majority of the Rim Country analysis area more effectively than Alternative 3. Alternative 3 is designed to focus restoration treatments in areas that exhibit the greatest departure from the natural range of variation (NRV) of ecological conditions, and/or that put communities at risk from undesirable fire behavior and effects. Therefore, Alternative 3 would leave the greatest number of acres that are moderately departed from desired ecological conditions and would benefit from mechanical restoration treatments to restore forest vegetation health and resilience.

Alternative 2 - The Modified Proposed Action

Since Alternative 2 would provide the greatest areal extent of forest mechanical restoration treatments, it would correspondingly result in a higher proportion of acres that are resilient and fire adapted. As a result, Alternative 2 would improve soil and watershed condition to a much larger degree that Alternative 3.

The greater number of acres that would be treated mechanically also means there would be a corresponding increase in short term adverse effects to soils, water quality and watershed condition. With the higher number of acres to be treated mechanically, adverse effects such as soil compaction, puddling, displacement, erosion, loss of soil organic matter, short-term changes in soil moisture content or retention, changes in nutrient cycles, changes in soil fauna, and risk of introduction of invasive and noxious weeds are likely. The extent and locations of such effects cannot be predicted with accuracy, although some generalizations can be made. Mechanical forest vegetation treatments under Alternative 2 would require more disturbance through construction of temporary roads and road use (330 miles of temporary roads under Alternative 2 vs. 170 miles of temporary roads under Alternative 3), and more log landings and skid trails. More frequent road maintenance would be required since there would be substantially more truck traffic under Alternative 2 than Alternative 3.

As previously noted, soil compaction, puddling and displacement would primarily be limited to the transportation systems and high traffic areas within mechanical vegetation treatments such as existing National Forest System roads, temporary access roads, skid trails, log landings, and debris piling areas.

At the watershed scale, it is possible that the greater areal extent of mechanical vegetation treatments under Alternative 2 would result in increased water yield from watersheds where large percentages of the watershed are mechanically treated in a short timeframe. However, any increases in water yield would be short lived (i.e., 5 to 10 years) since understory vegetation would increase and the water uptake by grasses, forbs and shrubs and warmer soil temperatures would soon offset evapotranspiration lost from forest thinning.

Forest thinning 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 where litter is currently the dominant soil cover.

Alternative 3 – Focused Restoration

Alternative 3 would result in substantially fewer acres being treated mechanically. There would therefore be correspondingly fewer acres that would exhibit adverse effects from mechanical forest restoration treatments such as soil compaction, puddling, displacement, erosion, loss of soil organic matter, short-term changes in soil moisture content or retention, changes in nutrient cycles, changes in soil fauna, and risk of introduction of invasive and noxious weeds. Adverse effects to surface water quality would also be reduced under Alternative 3. However, over the long term, there would be a much greater number of acres that would remain departed from vegetation and fuels desired conditions. These areas would likely remain at risk of high severity wildfire due to high fuel load levels.

Prescribed Fire

Alternative 2 – Modified Proposed Action

Alternative 2 proposed substantially more acres of prescribed fire than Alternative 3. Prescribed fire has the potential to impact soil productivity and surface water quality by increasing soil erosion rates and delivery of sediment, dissolved solids, and nutrients to streams and other waterbodies. Since more acres would be treated with prescribed fire under Alternative 2, it is reasonable to expect that there would be greater areal extent of short term adverse effects to soil productivity and water quality and therefore watershed condition. However, adverse effects of prescribed fire on soils, water quality and watershed condition would not be nearly as great as an uncontrolled wildfire.

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 ground cover further immobilizes nutrients in plant material.

The mobility and concentration of nutrients in soils determines whether or not nearby water sources are at risk of contamination when prescribed fire is used. Fire can disrupt nutrient cycling and cause nutrient volatilization, leaching, and transformations. When vegetation is consumed by fire, some of the soil and organic matter nutrients 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).

Prescribed fires can adversely affect watershed hydrology. As vegetation is removed, evapotranspiration in the watershed decreases, thus increasing stream flow and overall water yield within the watershed. The increase in water yield may result in a corresponding increase in sediment and nutrient loads in surface waters.

Trends indicate that fuel loading would continue to increase in areas that are not thinned mechanically. Increased fuel loads would be in the form of both living forest vegetation and woody detritus. Ingrown forest conditions would facilitate the existence of ‘ladder fuels’ which allow ground fires to ascend into the canopy and spread quickly as crown fires.

High severity 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, such as the loss of forest floor organic matter, increased soil erosion, and changes in soil biota would be more widespread in an uncontrolled wildfire than under prescribed fire conditions where the size and intensity of the fire can be controlled. The primary impact of high severity wildfire on soil productivity is the removal of surface organic matter, exposing soils to erosion by wind and rain. If surface organic matter is reduced (as happens with a high severity wildfire) the cation exchange capacity, a measure of soil fertility, is also reduced and the ability of the soil to retain nutrients leached from ash decreases.

Cumulative Effects

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 subwatersheds that include the Rim Country project area, which comprises approximate 137,153 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 effect within the analysis area.

Appendix G provides a list of past, present and reasonably foreseeable future actions considered in the cumulative effect that this project could have on soils and watershed condition.

Table 21 provides a summary of the cumulative effects to soils and watershed condition from implementing each alternative, including the No Action Alternative.

Table 21. Summary of cumulative effects of each action considered, including the No Action Alternative in the Rim Country project area.

Resource and Unit of Measure	ALTERNATIVES		
	1 No Action	2 Modified Proposed Action	3 Focused Restoration
--- SOILS AND WATER QUALITY ---			
Soil disturbance / displacement	No new authorized soil disturbance or displacement would occur. There would therefore be no cumulative effect to soil disturbance or displacement beyond existing projects for which NEPA analysis have been completed.	This alternative would result in the greatest areal extent of soil disturbance and displacement. Short term negative effective effects from soil disturbance and displacement are likely throughout much of the Rim Country analysis area.	This alternative would result in less areal extent of soil disturbance and displacement than Alternative 2, thereby resulting in less short term adverse effects to soils. However, as a result of proposed restoration treatments, Alternative 3

Resource and Unit of Measure	ALTERNATIVES		
	1 No Action	2 Modified Proposed Action	3 Focused Restoration
		However, as a result of proposed restoration treatments, Alternative 2 would achieve desired condition for soils and watershed over the long term by removing sufficient canopy cover to allow sunlight to penetrate to the forest floor, increasing the growth response of grasses, forbs and shrubs. Fine roots and vegetative ground cover of grasses and forbs would more effectively protect soils from erosion by wind and water than forest litter alone.	would not achieve desired condition for soils and watershed over the long term since it would result in treatment of only highest priority areas.
Soil erosion	No soil erosion above current levels would occur. The 490 miles of system roads and 800 miles of unauthorized routes would not be decommissioned and would therefore continue to be a chronic source of sediment to drainages and waterbodies, further decreasing soil productivity where road surface erosion and sediment delivery is occurring.	Erosion potential is expected to increase on 10 to 15 percent of areas treated mechanically due to removal or displacement of ground cover. This erosion would be short term (1 to 5 years), localized, and mitigated with implementation of Resource Protection Measures and BMPs.	Erosion potential would be slightly lower than Alternative 2 on areas treated mechanically Since fewer acres would be treated mechanically and through prescribed fire, overall traffic by logging machinery throughout the project area and areal extent of burned soils would be reduced. Erosion would be short term (1 to 5 years), localized, and mitigated with implementation of Resource Protection Measures and BMPs. Erosion potential on TES strata in unsatisfactory condition would be reduced due to introduction of additional CWD on soil surfaces in these strata.
Soil compaction	No additional areas of soil compaction would	Approximately 15 percent (142,969 acres) are	Approximately 15 percent, or 229,335 acres

Resource and Unit of Measure	ALTERNATIVES		
	1 No Action	2 Modified Proposed Action	3 Focused Restoration
	occur. Soil compaction levels would remain high on roads proposed for decommissioning under the Action Alternative. Compacted soils have higher erosion potential since infiltration and percolation are reduced, increasing overland flow volumes and velocities.	estimated to exhibit varying degrees of soil compaction, depending on the number and locations of skid trails, landings, and roads, timing of activities, and types of machinery employed. Some dispersed soil compaction would likely occur in areas where trees are mechanically felled and bunched prior to skidding, and landing. Skid trails and log landings would likely exhibit soil compaction which can be mitigated through implementation of Resource Protection Measures and BMPs.	are expected to exhibit soil compaction under Alternative 3. This is substantially less than Alternative 2. Soil compaction would be slightly less than Alternative 2.
Soil Nutrient Cycling	No changes to nutrient cycling are anticipated under the No Action Alternative.	Soil nutrient cycling would progress toward desired conditions as litter layers are replaced with vegetative cover and CWD is increased. Fine roots of grasses, forbs, and shrubs would improve soil aggregate stability, water infiltration, and decrease soil bulk densities.	Soil nutrient cycling would progress toward the desired condition, but only in treated areas, which are substantially less than Alternative 2. Untreated areas would continue to have less sunlight penetration to the forest floor, resulting in a sparse understory vegetative community. The litter layer, or duff would continue to provide soil nutrients and contribute to soil profile development, but not to the extent provided by grasses, forbs, and shrubs.
Herbaceous ground cover	Herbaceous ground cover would continue to decline as forest canopies continue to close and litter layers continue to increase in areal extent and thickness.	Herbaceous ground cover would be greater than the No Action Alternative within one to five years following thinning and prescribed fire treatments since more open stand structures contribute would to understory development through increased soil	Herbaceous ground cover would not improve as well as under Alternative 2 since fewer acres would be restored than under Alternative 2.

Resource and Unit of Measure	ALTERNATIVES		
	1 No Action	2 Modified Proposed Action	3 Focused Restoration
		moisture and improved organic matter content through introduction of coarse and fine woody debris.	
Soil CWD component	TES strata that do not currently have adequate CWD would exhibit a gradual increase in CWD over a long period of time through tree mortality and decadence. These strata would not benefit directly from the introduction of CWD that would occur rapidly through vegetation treatments proposed under Alternatives 2 and 3. TES strata that currently have excessive CWD (i.e., greater than 7 tons per acre) would continue to be at elevated risk of high severity wildfire in the absence of treatments to control fuel loads.	Vegetation treatments will increase CWD in unsatisfactory TES strata, improving nutrient stores and protecting soil surfaces from erosion by wind and water. On TES strata that currently have excess CWD, prescribed burning or piling followed by pile burning or use of prescribed fire would bring CWD levels to desired conditions.	Soil CWD would be expected to increase in mechanical forest thinning treatment areas. However, since this alternative has reduced areal of mechanical restoration treatments, overall CWD would be less than under Alternative 2.
Soil heating and water repellency (hydrophobicity)	There would be no soil heating or additional soil water repellency (hydrophobicity) under the No Action Alternative. However, conditions would be conducive to increased hazard of high severity wildfire that would result in large areas of soil heating and hydrophobic soils that would be prone to erosion and sediment delivery to ephemeral	Areas where pile burning is conducted, and some areas where prescribed fire is implemented would exhibit hydrophobic soil conditions and damage to soil structure caused by rapid oxidation of soil minerals and organic matter. The occurrence of these conditions would depend primarily on the timing, duration, type, and intensity of fire use. Vegetation treatments would produce more open	The effects of this Alternative are similar to those of Alternative 2. However, there would be substantially fewer acres treated with prescribed fire, limiting the areal extent of soil heating under Alternative 3 in comparison with Alternative 2. While this alternative would reduce the risk of high severity wildfire and associated adverse impacts to soils and

Resource and Unit of Measure	ALTERNATIVES		
	1 No Action	2 Modified Proposed Action	3 Focused Restoration
	and intermittent drainages.	stand conditions, including canopy gaps that would reduce fire burn severity and minimize areas of hydrophobic soils in the future. The greatest risk of increased areas of hydrophobic soils would be where prescribed burning is conducted prior to forest thinning. Over the long term, these treatments would reduce the risk of high severity wildfire and associated adverse impacts to soils through soil heating.	watersheds, it would not do so to the extent provided by Alternative 2.
Soil Organisms	No changes to soil organism populations would occur as a result of the No Action Alternative.	Soil organism populations are expected to decline for short periods (1 to 3 years) in areas of soil disturbance, compaction and where fire is introduced. Soil organism populations are expected to recover rapidly under this alternative as greater sunlight would reach the forest floor, increasing soil biological activity.	Soil organism populations are expected to decline for short periods (1 to 3 years) in areas of soil disturbance, compaction and where fire is introduced. Soil organism populations are expected to recover rapidly under this alternative as greater sunlight would reach the forest floor, increasing soil biological activity. However, since this condition would only occur in treated areas and the areal extent of treatments under this alternative is substantially less than Alternative 2, the beneficial effect would be less under this alternative.
Water quality	There would be no changes to surface water quality as a result of the No Action Alternative.	No detectable change in downstream water quality is anticipated.	No detectable change in downstream water quality is anticipated.
Water yield	There would be no changes to water yield	Only minor, short term increases in water yield are	Only minor, short term increases in water yield

Resource and Unit of Measure	ALTERNATIVES		
	1 No Action	2 Modified Proposed Action	3 Focused Restoration
	as a result of the No Action Alternative	expected. Within the project area, increased soil moisture and groundwater recharge can be expected as tree basal area is reduced. However, evapotranspiration would increase as grasses, forbs and shrubs begin to occupy sites that were previously occupied by forest cover.	are expected. Within the project area, increased soil moisture and groundwater recharge can be expected as tree basal area is reduced. However, evapotranspiration would increase as grasses, forbs and shrubs begin to occupy sites that were previously occupied by forest cover. Since this alternative has reduced areal extent of mechanical and prescribed fire restoration treatments in comparison to Alternative 2, the overall beneficial effects would be less.
Watershed Condition	There would be no discernable change in watershed condition as a result of the No Action alternative. Current rates of watershed restoration are insufficient to fully restore watershed functionality at the landscape scale.	This alternative has the greatest potential to improve watershed condition through the suite of proposed restoration actions.	This alternative would improve watershed condition throughout the Rim Country analysis area. However, not to the extent provided by Alternative 2.

Alternative 1 – No Action

The No Action Alternative would result in no additional mechanical forest vegetation or prescribed fire treatments, no additional road construction, realignment or decommissioning, no additional spring or riparian restoration, no stream channel restoration, no rock pit expansion, and no wood processing site beyond what has been planned under separate NEPA analyses. Therefore, there would be no cumulative effects to soils or watershed condition as a result of the No Action Alternative beyond those already planned or being implemented under separate NEPA decisions. As can be seen in Appendix G, the majority of past, present and reasonably foreseeable future actions consist of forest restoration and fuels reduction treatments. Other restoration actions such as grassland and meadow restoration, spring restoration, and fire rehabilitation are occurring, have occurred in the past or may occur in the future. However, land management activities and changing vegetative conditions throughout the last 100 years have produced an uncharacteristic accumulation of fuels and increased trees density throughout much of the project area and restoration actions undertaken to-date have been insufficient to restore conditions to their natural and historic range of variation. These conditions make future high severity wildfires a possibility and suppression very difficult.

A high-severity fire is not certain to occur within the project area during any given timeframe. However, the occurrence of a high-severity wildfire would have an increased potential for profound adverse impacts to hydrologic systems in project area watersheds and downstream locations. As previously discussed in this report, such a fire event would likely result in increased runoff and potential for soil erosion and sediment delivery to intermittent and ephemeral streams as a result of loss of forest interception of rainfall, reduced soil water infiltration rates, and the reduction of effective ground cover at the soil surface. The infrequent nature of ephemeral stream flow results in the potential for sediment and ash to be stored within these stream channels and then transported during surface runoff events. This, in turn, could pose detrimental effects to surface water quality, stream channel morphology and water storage capacity in downstream livestock waters and other impoundments.

Other potential detrimental effects to hydrologic conditions in the project area and downstream locations could include the destabilization of the geomorphic conditions of stream channels due to excessive sediment delivery and debris loading, increased peak flows, and overall increases in average annual water yield resulting from loss of upslope interception, infiltration, and evapotranspiration. Ephemeral stream channels within high burn severity areas would lose their ability to buffer runoff from large rainfall events, resulting in increased channel scour and incision caused by accelerated runoff and erosion from severely burned watershed areas. Increased bedloads in stream channels effectively raises the elevation of stream bottoms, causing flood flows to exceed channel capacities, resulting in overland flooding.

Another effect is sediment and ash deposition in downstream roads, stock tanks and meadows, even if such areas may not have burned. In addition, sediment and ash-laden overland flows may damage low lying roads by eroding road traveled ways and filling culverts and low water crossings with sediment and debris. These are examples of why post-wildfire watershed conditions are significantly different from pre-fire or low-severity prescribed fire conditions.

Additional cumulative effects of the No Action alternative include ongoing erosion and sediment delivery to ephemeral channels from roads proposed for obliteration under the Action Alternatives that would not be obliterated under the No Action Alternative. When combined with other activities in the Rim Country project area, sediment production from these roads could contribute to adverse impacts to downstream surface water quality if these roads remain in an unstable, eroding condition.

When combined with past, present and reasonably foreseeable future actions, the No Action alternative would not contribute to appreciable improvement in soils or watershed conditions in watersheds that encompass the Rim Country analysis area.

Alternative 2 – Modified Proposed Action

Mechanical Forest Restoration Treatments, including Timber Harvesting

Forest restoration projects that include commercial timber harvesting and precommercial forest thinning, 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 would also cause an initial increase in soil organic matter in the form of residual woody debris from tree harvesting activities that improves surface roughness, improves nutrient cycling, and contributes to soil organic carbon sequestration. As grasses and forbs increase in numbers, fine root material would contribute to soil organic matter accumulation, improve soil aggregate stability and soil porosity, and protect soil surfaces from erosion by wind and rain. Reduction of tree canopy and fuel loads would reduce the threat of high severity wildfire that could remove plant and litter cover, consume seed banks, sterilize soils, and create erosion and flooding hazards to downstream areas. Decreased interception of precipitation (rain and snow) would result in increased surface runoff following vegetation treatments.

Project objectives are designed to improve forest health by thinning overstocked stands and reducing the potential for high severity wildfire. These activities usually require the use of logging machinery with potential to disturb soils. Overall, forest thinning improves tree vigor, increases the diversity, distribution, and amount of herbaceous understory vegetation (including effective vegetative ground cover), and reduces the risk of uncharacteristic wildfire. Effects on soil productivity and stability are common to all mechanical vegetation treatment activities, but vary by silvicultural treatments, fuel treatments, and acres treated. Adverse effects are generally related to roads, skid trails, log landings and fuels treatments resulting in varying degrees of soil displacement, compaction, and soil loss due to short-term reduction or complete removal of vegetative ground cover. Adequate vegetative ground cover is the primary component that protects soils from accelerated erosion.

It is assumed that between harvest and fuel reduction treatment activities, every acre in each proposed treatment unit would be affected. Therefore, the total project acreage is assumed to be at risk for some level of soil disturbance. The risk of accelerated erosion from soil disturbance is expected to last until vegetative ground cover is sufficient to protect soil surfaces, which typically occurs within 3 to 5 years after fuel reduction treatments are completed. Erosion models indicate that few TES strata would experience erosion above tolerance thresholds as a result of mechanical vegetation treatments. It is important that the reader understand that not all soil disturbance is detrimental. For example, a low severity prescribed fire disturbs soils by partially consuming and redistributing the surface organic fraction. This changes short term carbon-nitrogen ratios and increases available short term nutrient supplies, resulting in increased understory response which in turn provides improved protection of soils from erosion by wind and rain.

Implementation of Resource Protection Measures and site-specific BMPs prior to and during project implementation, adverse effects to soils and watershed resources are minimized and mitigated and are generally short term (3 to 5 years). Best Management Practices are designed to maintain soil productivity and surface water quality by minimizing soil loss and associated sediment delivery to waterbodies.

Soil Stability and Erosion Processes

Gullies, headcuts, and roads are primary sources of sedimentation. They channelize and accelerate sediment-laden water, resulting in soil movement to downslope locations or into drainages. Areas which are sensitive to gully erosion are long, narrow alluvial plains, alluvial fans, and low lying areas with moderate slopes and deep, fine-textured soils. Gullies are typically the result of historic management practices and many are now in varying degrees of recovery. Proposed meadow and riparian restoration and stream channel restoration will improve soil stability and therefore watershed condition.

Poorly located roads proposed for decommissioning are, in some cases acting in a similar manner as gullies, channelizing runoff into ephemeral and intermittent drainages and other waterbodies. Decommissioning of 490 miles of system roads and 800 miles of unauthorized routes will contribute to improved watershed condition at the landscape scale through reduction of roaded miles per unit of land area. When combined with other past, present and reasonably foreseeable future actions, road decommissioning under Alternative 2 would improve watershed condition throughout most of the project area more effectively than is currently occurring under the No Action Alternative or would occur under Alternative 3.

Nutrient Cycling

Soil nutrient cycling would improve over time throughout all watersheds where restoration treatments are proposed. The project would improve vegetative cover of grasses and forbs in treated areas. This would increase fine root biomass which serves as a nutrient supply when roots slough off and decompose. In addition, up to 1-3 tons per acre of fine fuels would be left as needles, twigs, small limbs, and other small woody material. The addition of CWD and other fine fuels would have a beneficial effect to long-term soil productivity. The effectiveness of woody debris retention has been proven to reduce and control adverse impacts to soil resources and water quality (Graham et al. 1994, Ice 2004, Seyedbagheri 1996).

Soil Hydrology

Historic evidence indicates that existing landings, skid trails, and roads constitute approximately 5 to 10 percent of the total project area. As previously noted, roads proposed for obliteration tend to be compacted and rutted, and are often channelizing surface runoff to surface waters and are not exhibiting substantial recovery. In order to mitigate any additional compaction and displacement of soils, temporary roads, skid trails, and landings would be stabilized using Resource Protection Measures and BMPs, which may include ripping or decompacting and seeding to alleviate reductions in porosity and infiltration capacity. Therefore, it is not expected that the percentage of compacted areas would increase substantially (i.e., beyond an additional 1 to 2 percent over the current condition). Any soil compaction resulting from mechanical vegetation treatments would be ameliorated over time through pedoturbation caused by soil freezing and thawing and wetting and drying cycles, and root elongation.

Areas of water repellency, which form as a result of the prescribed fire use are expected to recover within 1 to 3 years as natural pedoturbation processes described above occur.

Watershed Response

The magnitude of change in water yield resulting from vegetation treatments and prescribed burning is most strongly related to the amount of precipitation and intensity of the treatments.

The hydrologic response of watersheds in the Rim Country area to proposed restoration activities would depend on the summed effect of the changes in evaporation, transpiration, soil moisture storage, and snowpack accumulation and melt processes. This includes the degree to which vegetation treatments influence net precipitation that reaches soil surfaces through reduced canopy interception, changes to soil moisture evaporation rates, and changes to the amount of transpiration and soil water depletion. Changes to streamflow would depend on whether precipitation or snowmelt exceeds the combined evapotranspiration demand, soil moisture holding capacity, and groundwater recharge rates.

Changes in evapotranspiration following vegetation treatments would be the result of reduced soil moisture depletion during the growing season and decreased winter snowfall interception. Precipitation accumulates in the Rim Country area as snowpack, with melting and sublimation occurring during warm phases throughout the winter. Much of the winter precipitation is 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 is available to become stream flow. 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 loss. For the first 1 to 3 years following vegetation treatments, a slight increase in stormwater runoff is expected since understory vegetation of grasses, forbs and shrubs would not have reached maximum ground cover levels, snowpack interception would be reduced, and there would be fewer trees to create evapotranspirational demand for soil moisture during the growing season.

When combined with other past, present and reasonably foreseeable future projects, Alternative 2 would be beneficial to watershed response. In the absence of maintenance treatments this benefit would decrease over time as a result of forest ingrowth that would increase evapotranspirational demand.

Recreational Activities

Recreational activities within the proposed project area include: hiking, viewing wildlife, hunting, dispersed car-camping, backpack camping, orienteering, horseback riding, photography, picnicking, taking scenic drives, ORV/ATV use, bicycling, shooting, and gathering in family or social groups. Other common uses within the project area include firewood cutting, Christmas tree cutting, collecting boughs and cones, gathering antlers, and collecting food and medicinal resources such as berries, nuts, mushrooms, and medicinal plants. Of these, ORV/ATV use, dispersed camping, firewood collection and Christmas tree cutting have the greatest potential to result in adverse cumulative effects to soils through compaction, puddling, erosion, and displacement. These conditions would be limited to areas where such activities take place. In combination with past, present and reasonably foreseeable recreation activities, Alternative 2 would improve soils and watershed condition throughout the Rim Country analysis area.

Livestock Grazing

Cumulative effects from livestock grazing include minor, generally localized soil compaction, puddling, displacement and erosion from livestock trailing and in areas where animals congregate such as livestock waters and areas where mineral supplements are placed. Livestock trails make up a very small portion of the total project area and therefore have a negligible effect on soils or watershed condition. Livestock grazing is not expected to increase the area of soils characterized as unsatisfactory within the project area. Overall, in combination with ongoing livestock grazing and in the absence of increasing livestock numbers being grazed, Alternative 2 would benefit soils and watershed conditions

Invasive and Noxious Weeds

The cumulative effect of the increased risk of spread on noxious weeds on soil productivity can only be described in general terms because of the large number of unknown variables. Areas where soil disturbance includes compaction, displacement, erosion, and excessive heating are at the greatest risk of invasion by noxious weeds. These include temporary roads, areas where concentrated harvesting operations occur and pile burning sites. Monitoring of these areas for the presence of invasive and noxious weeds and treating observed populations in a timely manner would mitigate these adverse effects. To minimize cumulative adverse effects of invasive and noxious weeds, observed infestations would be managed in accordance with the Final Environmental Impact Statement for Integrated Treatment of Noxious or Invasive Weeds.

Fire Effects

In low burn severity areas, effects are mainly light ground char where the litter is scorched, charred, or partially consumed. The litter layer, or duff is largely intact, although it may be charred on the surface. Woody debris accumulations are partially scorched, charred, or consumed. Mineral soil properties are not adversely affected. In fact, low severity fire releases nutrients stored in surface organic matter and live vegetation. These nutrients facilitate rapid reestablishment of vegetative ground cover since root to shoot ratios are improved for grasses and forbs that survive fire, resulting in protection of soils from accelerated soil erosion soon after fire has occurred. Evidence of sheet and rill erosion as a result of low severity fire is typically very minor or nonexistent. In forested areas, much of the tree overstory is green with some scorch at the base of the trees and in the lower branches following low severity fire. Most trees survive; however, pockets of seedlings, saplings, and mature trees can be killed or consumed where moderate to high severity fires occur. While most of the shrubs, forbs and grasses are affected under low severity fire conditions, in most cases, much of this vegetation survives. Areas identified as low burn severity may also contain large unburned areas, resulting in a mosaic of burned and unburned conditions across the landscape or within a subwatershed. When combined with other past, present and reasonably foreseeable prescribed fire project, Alternative 2 would have beneficial effects on soils and watershed conditions.

Cumulative watershed effects

In summary, cumulative watershed effects from implementation of the Alternative 2 would include improved soils and watershed condition and restoration of the ecological interrelationships of soils, vegetation, and watersheds throughout the Rim Country project area. Streams, meadows and riparian areas that depend on stable upland soils would be better protected from potential adverse effects of high severity wildfire as a result of restoration treatments. The transportation system would provide necessary access for future management and would be more sustainable than the current transportation system.

Alternative 3 – Focused Restoration

Cumulative effects of Alternative 3 would be similar to those of Alternative 2, but would occur at a substantially reduced areal extent with regard to forest mechanical thinning and prescribed fire treatments. Other restoration actions (stream channel restoration, spring restoration, road decommissioning, etc. would be the same as Alternative 2.

Irreversible and Irretrievable Commitments of Resources

Expansion of 12 rock pits totaling 629 acres constitutes an irreversible and irretrievable commitment of soils and mineral resources under both action alternatives. This activity permanently alters or removes currently productive soils where the expansions would occur and commits them nonproductive status in perpetuity. It also commits rock material to a current use (road aggregate) thereby eliminating future opportunity to use those materials for another purpose.

Wood processing sites totaling up to 128 acres commits soils to an unproductive status throughout the duration that wood processing sites exist and for several years following decommissioning of wood processing sites since it would likely take several years for recovery to be fully realized. This activity therefore constitutes an irretrievable commitment of soils and vegetation resources for the creation of wood processing sites.

Reactivation of system roads that are currently in storage (i.e., ML-1) and relocating or realignment of existing system roads constitutes an irretrievable commitment of soils and vegetation resources since roads commit soils to an unproductive status for the duration of the road’s existence and vegetation is removed from the area where the road is constructed and used.

Overall, rock pits, wood processing sites and roads constitute a small percentage of the total Rim Country project area. Adverse effects to soils, vegetation, water quality and watershed condition would be relatively small in areal extent when viewed in the context of the total project area.

Unavoidable Adverse Effects

Unavoidable adverse effects to soils resources include temporary road construction that commits soils resources to nonproductive status for the duration that the road exists, expansion of rock pits to provide road surface material, and commitment of soils resources to nonproductive status for the purpose of establishing wood processing sites. Where vegetation cover and soils are disturbed, there is likely to be some short-term soil erosion. Activities involving vehicles or heavy equipment cause soil compaction that reduces soil productivity for a short duration (i.e., less than 5 years). Road construction, timber harvesting, and prescribed burning, would cause temporary and localized adverse effects to air quality due to dust, exhaust fumes, and smoke.

Short-term Uses and Long-term Productivity

Adverse effects to soil productivity from mechanical forest restoration treatments, prescribed fire, road relocations and realignments, temporary road construction and other activities under the proposed actions would generally be of short duration (i.e., 3-5 years). Soil condition would be maintained to the greatest extent practicable through implementation Resource Protection Measures and BMPs. Alternative 2 would have the greatest areal extent of soil disturbance, but would also contribute to the greatest overall benefit to long term soil productivity. Alternative 3 would result in a reduced areal extent of detrimental soil disturbance from proposed activities, but would also contribute to fewer acres of improved long term soil productivity. The No Action Alternative would result in the fewest acres of detrimental soil disturbance, but would also not appreciably contribute to long term soil productivity since the risk of high severity wildfire would be widespread throughout the Rim Country analysis area.

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Certification

Kit MacDonald prepared the report considering the Best Available Science and locally gathered data. A majority of the effects of fire on soil and water attributes were attained through research review, including RMRS GTR-42, volume 4 *Wildland Fire in Ecosystems Effects of Fire on Soil and Water* (Neary et al, 2005). Local data include the *Terrestrial Ecosystems Survey of the Coconino National Forest* (Miller et al, 1995) and relevant geospatial data.

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 from Stephen F. Austin State University. Since 1999, I have worked in areas of soils classification and mapping, wetland delineation and functional assessment, wetland restoration, disturbed land remediation and reclamation, and forestry best management practices (BMP) implementation and effectiveness monitoring related to silvicultural operations including timber harvesting, site preparation, reforestation, and forest road construction and decommissioning.

Prepared by: /s/ *Kit MacDonald* Date: November 1, 2018

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Appendix A. TES Strata, Map Units, Slope Classes, Taxonomic Classifications, Climate Classes, Potential Natural Vegetation, and Soil Interpretations (all acres are approximate).

Stratum Number	TES Map Units	Acres per TESU	Slope %	Taxonomic Classification and Parent Material	Climatic Class	PPC	Soil Condition	Erosion Hazard	Timber Harvest Limitations	Natural Regen Potential	Ponderosa Pine Site Index
1	CNF 50	162.7	0-5	Vertic Haplaquolls, fine, montmorillonitic, frigid, deep, clay, ponded. Basalt and cinders alluvium	LSC, 5,0	Caaq, Elma3, Pola4, Alge	Unsatisfactory	Slight	NA	NA	NA
1	A-S 4	86	0-5	Pachic Argiudolls, fine, mixed, frigid, deep, clay loam. Basalt and cinders alluvium Typic Argiaqualls, fine, mixed, frigid, deep, loam	LSC 5, 6	Popr Fear2 Irmi	Satisfactory	Slight	NA	NA	NA
1	A-S 16	1461	0-5	Typic Argiaquolls, fine, montmorillonitic, frigid, silty clay loam, frequently flooded. Basalt and cinders alluvium	LSC 5, 0	Popr Muwr CAREX	Satisfactory	Slight	NA	NA	NA
2	CNF 41	142.4	0-5	Cumulic Haplustolls, fine-loamy, mixed, mesic, deep, fine sandy loam and Pachic Argiustolls, fine, mixed, mesic, deep, loam. Mixed alluvium	HSC, 4,	Agsm, Muwr, ---, ---	Impaired	Slight	NA	NA	NA
2	CNF 53	2972.9	0-5	Cumulic Haploborolls, fine-loamy, mixed, deep, loam. Mixed alluvium	LSC, 5	Popr, Fear2, ---, ---	Impaired	Slight	NA	NA	NA
2	CNF 55	3186.4	0-5	Pachic Argiborolls, fine, montmorillonitic, deep, loam and Vertic Argiborolls, fine, montmorillonitic, deep, clay loam. Basalt and cinders alluvium	LSC, 5, 0	Popr, Fear2, ---, ---	Impaired	Slight	NA	NA	NA
2	A-S 515	6643	0-15	Udic Haplustalfs/Argiustolls, fine, montmorillonitic, mesic, clay loam. Basalt and cinders.	HSC 5 -1	Agsm Bogr2 Pipos	Satisfactory -	Slight	Severe Low Strength	Low Too dry	50
3	CNF 60	34.7	0-5	Fluventic Haploborolls, sandy-skeletal, mixed, deep, very bouldery, fine sandy loam, occasionally flooded and Aquic Haploborolls, loamy-skeletal, mixed, deep, very boulder loamy coarse sand. Mixed alluvium	LSC, 6	Poan3, Juma, Psmeg, ---	Satisfactory	Slight	NA	NA	NA
3	A-S 198	3187	0-5	Cumulic Haplustolls, fine-loam, mixed, deep, sandy loam and Oxyaquic Usifluvents, mixed mesic, frigid, deep, sandy loam, frequently flooded. Mixed alluvium.	LSC 5 0	Poan3 Pipos (Jude2) Quga Poan3 Salix	Impaired	Slight	Severe Seasonally wet	Low Too wet	NA
3	A-S 208	1066	0-5	Cumulic Hapludolls, fine-loamy, mixed, frigid, deep, loam, well drained, rarely flooded and Aquic Hapludoll, mixed, frigid, loam, frequently flooded and Fluvaquentic Hapludolls, mixed, frigid, loam frequently flooded. Mixed alluvium	LSC 6, 0	Popr Fear2 Bran CAREX Poan3 Alob SALIX (Psmeg Pipos)	Impaired	Slight	Severe Seasonally wet	Low Too wet	NA

Stratum Number	TES Map Units	Acres per TESU	Slope %	Taxonomic Classification and Parent Material	Climatic Class	PPC	Soil Condition	Erosion Hazard	Timber Harvest Limitations	Natural Regen Potential	Ponderosa Pine Site Index
3	TNF 22	1223.9	0-10	Cumulic Haplustolls, frigid, water table near surface	LSC 5	Poan3	Impaired	Slight	Severe Seasonally Flooded	High	N/A
3	TNF 26	5392.0	0-10	Udifluventic Haplustepts, mesic, deep	LSM 5	Poan3	Satisfactory	Slight	N/A	N/A	N/A
3	TNF 40	579.1	0-5	Oxyaquic Ustifluvents, loamy and sandy-skeletal, mixed, deep, extremely stony and very cobbly sandy loam and loam, occasionally or frequently flooded.	LSM 4	Plwr2/Pofr2/Sala3/Frve2		Slight	NA	NA	NA
3	TNF 60	9.9	0-5	Fluventic Hapludolls, , fine-loamy, mixed, superactive, mesic, deep, extremely stony, very fine sandy loam	LSM 6	Plwr2, Juma, Acgr3		Slight	NA	NA	NA
4	CNF 430	56.7	40-120	Typic Haplustalfs, moderately deep, extremely cobbly clay loam and Lithic Haplustalfs, shallow, extremely stony loam. Basalt and cinders	LSM, 4	Juos, ---, ---, ----	Sat. Inh. Unstable	Severe	NA	NA	NA
4	CNF 435	331.4	15-40	Lithic Ustochrepts, loamy-skeletal, carbonatic, mesic, shallow, very cobbly, fine sandy loam. Limestone or sandstone	HSC, 4, 0	Pied, Jumo, Comes, Stco4	Sat. Inh. Unstable	Severe	NA	NA	NA
4	CNF 455	3066.8	40-120	Lithic Calciustolls, loamy-skeletal, carbonatic, mesic, shallow, extremely cobbly, fine sandy loam and Calcic Ustochrepts, loamy-skeletal, mixed, mesic, moderately deep, extremely cobbly, fine sandy loam. Limestone or sandstone	HSC, 4, 0	Pied, Jumo, Comes, Stco4	Sat. Inh. Unstable	Severe	NA	NA	NA
4	A-S 55	2137	40-120	Lithic Calciustolls, loamy-skeletal, mixed, mesic, shallow, extremely cobbly, sandy loam. Limestone	HSC 4, -1/ 4, 0	Jumo Bogr2 Hene5/ Pied Jude2 Jumo Comes	Sat. Inh. Unstable	Severe	NA	NA	N/A
4	TNF 502	5245.6	40-120	Lithic Haplustalfs, mesic, shallow and Lithic Argiustolls, mesic, shallow - Rock Outcrop	LSM 4, +1	Pimof, Jude2, Qutu2	Sat. Inh. Unstable	Severe	NA	NA	N/A
4	TNF 3712	7.9	40-80	Typic Haplustalfs, clayey-skeletal, smectitic, mesic, deep, very cobbly loam	LSM 4, 0	Pimof, Juos Hibe	Satisfactory, Inh. Unstable	Severe	N/A	NA	N/A
4	TNF 4176	4588.8	40-80	Typic Haplustalfs, clayey-skeletal, mixed, superactive, mesic, deep, extremely cobbly loam	LSM 4, +1	Pimof, Jude2, Qugr3, Qutu2, Arpu5	Sat., Inh. Unstable	Severe	N/A	NA	N/A

Stratum Number	TES Map Units	Acres per TESU	Slope %	Taxonomic Classification and Parent Material	Climatic Class	PPC	Soil Condition	Erosion Hazard	Timber Harvest Limitations	Natural Regen Potential	Ponderosa Pine Site Index
4	TNF 4242	3548.6	40-80	Typic Haplustepts, loamy-skeletal, mixed, superactive, mesic, moderately deep, very gravelly sandy loam	LSM 4, +1	Pimof, Jude2, Quem, Qugr3, Qutu2, Arpu5	Sat., Inh. Unstable	Severe	N/A	NA	N/A
4	TNF 9175	3047.6	40-120	Typic Haplustalfs, mesic	LSM 4, 0	Quem, Cemo2	Sat., Inh. Unstable	Severe	N/A	NA	N/A
4	TNF 9349	950.4	40-120	Haplustalfs, mesic	LSM 4	Juos	Sat., Inh. Unstable	Severe	N/A	NA	N/A
4	TNF 9459	2961.8	40-120	Typic Haplustepts, mesic	LSM 4, +1	Pimof, Jude2, Qugr3, Qutu2, Arpu5	Sat., Inh. Unstable	Severe	N/A	N/A	N/A
4	TNF 436	1382.5	40-120	Typic Haplustalfs and Argiustolls	LSM 4	Qutu2		Severe	NA	NA	NA
4	TNF 451	1459.6	40-120	Typic Haplustalfs and Argiustolls	LSM 4	Juco11		Severe	NA	NA	NA
4	TNF 479	1197.2	40-120	Lithic Argiustolls and Haplustalfs, shallow	LSM 4 and LSM 5	Juco11 and Pipos		Severe	Severe, high erosion on Pipos	Low, too shallow	
4	TNF 482	1062.1	40-120	Typic Haplustalfs and Argiustolls	LSM 4	Jude2		Severe	NA	NA	NA
5	CNF 436	0.1	0-15	Lithic Ustochrepts, loamy-skeletal, carbonatic, mesic, shallow, gravelly, fine sandy loam and Calcic Ustochrepts, loamy-skeletal, carbonatic, mesic, moderately deep, gravelly, fine sandy loam. Limestone or sandstone	HSC, 4, 0	Agcr, Bogr2, Comes, Stco4	Satisfactory	Moderate	NA	NA	NA
5	CNF 437	1442.7	0-15	Lithic Ustochrepts, loamy-skeletal, carbonatic, mesic, shallow, very cobbly, fine sandy loam and Calcic Ustochrepts, fine-loamy, carbonatic, mesic, moderately deep, gravelly, fine sandy loam. Limestone or sandstone	HSC, 4, 0	Pied, Jumo, Comes, Stco4	Impaired	Moderate	NA	NA	NA
5	A-S 51	8269	0-15	Lithic Haplustepts, (calcareous), loamy skeletal, mixed, mesic, shallow, very gravelly, sandy loam and Lithic Haplustalfs, loamy-skeletal, mixed, mesic, shallow, very gravelly, fine sandy loam. Sandstone and limestone.	HSC 4, 0	Pied Jumo Comes	Satisfactory -	Slight	NA	NA	N/A

Stratum Number	TES Map Units	Acres per TESU	Slope %	Taxonomic Classification and Parent Material	Climatic Class	PPC	Soil Condition	Erosion Hazard	Timber Harvest Limitations	Natural Regen Potential	Ponderosa Pine Site Index
5	A-S 52	2935	16-40	Lithic Calciustolls, loamy-skeletal, mixed, mesic, shallow, extremely cobbly, fine sandy loam and Lithic Haplustepts, (calcareous), loamy skeletal, mixed, mesic, shallow, extremely cobbly, sandy loam. Sandstone and limestone.	HSC 4, 0	Pied Jumo Comes	Impaired	Moderate	NA	NA	N/A
6	CNF 438	3.9	0-15	Typic Argiustolls, fine and clayey-skeletal, montmorillonitic, mesic, deep, very cobbly loam. Basalt and cinders	HSC, 4, 0	Pied, Jude2, Jumo, Bogr2	Impaired	Moderate	NA	NA	NA
6	CNF 465	539.7	0-15	Typic and Vertic Haplustalfs, fine, montmorillonitic, mesic, deep, cbly, clay loam. Basalt and cinders	HSC, 4, 0	Pied, Jumo, Bogr2, ---	Unsatisfactory	Moderate	NA	NA	NA
6	CNF 490	4047.7	0-15	Typic Haplustalfs, fine, montmorillonitic, obmesic, moderately deep, gravelly, fine sandy loam and Lithic Haplustalfs, clayey-skeletal, montmorillonitic, mesic, shallow, very cobbly, fine sandy loam. Sandstone	HSC, 4, +1	Pied, Jude2, Jumo, Quga	Satisfactory	Slight	NA	NA	NA
6	CNF 495	474.8	0-15	Typic Haplustalfs, fine, montmorillonitic, mesic, moderately deep, very cobbly, loam. Basalt and cinders	LSM, 4, +1	Pifa, Jude2, Qutu2, Bogr2	Satisfactory	Slight	NA	NA	NA
6	A-S 53	3871	0-15	Typic Haplustalfs, fine, mixed, mesic, deep, very gravelly, sandy loam. Sandstone and limestone	HSC 4, 0	Pied Jude2 Jumo/Bogr2 Plja Pied	Satisfactory -	Slight		NA	N/A
6	A-S 061	2774	0-15	Lithic Haplustalfs, clayey-skeletal, mixed, mesic, shallow, gravelly sandy loam and Lithic Haplustalfs, clayey, mixed, mesic, shallow, sandy loam. Sandstone and limestone	HSC 4, +1	Pied Jude2 Jumo Quga	Satisfactory	Slight			
6	A-S 503	2565	0-15	Typic Haplustalfs, fine, montmorillonitic, mesic, moderately deep, very gravelly silty clay loam and Typic Argiustolls, fine, montmorillonitic, mesic, moderately deep, very gravelly silt loam. Basalt and cinders.	HSC 4, 0	Pied Jude2 Jumo	Satisfactory	Slight	NA	NA	N/A
6	TNF 493	700.6	0-15	Typic Argiustolls, clayey-skeletal mixed, superactive, mesic, extremely stony, sandy clay loam and Pachic Argiustolls, clayey-skeletal, smectitic, mesic sandy clay loam.	LSM 4, +1	Pimof, Jude2, Qugr3, Erin		Slight	NA	NA	NA
6	TNF 494	3152.9	0-15	Typic Haplustalfs, clayey-skeletal mixed, superactive, mesic, moderately deep, sandy clay loam and Typic Argiustolls, clayey-skeletal mixed, superactive, mesic, moderately deep, extremely cobbly sandy clay loam.	LSM 4, +1	Pimof, Jude2, Qugr3, Bogr2		Slight	NA	NA	NA

Stratum Number	TES Map Units	Acres per TESU	Slope %	Taxonomic Classification and Parent Material	Climatic Class	PPC	Soil Condition	Erosion Hazard	Timber Harvest Limitations	Natural Regen Potential	Ponderosa Pine Site Index
6	TNF 495	444.3	0-15	Typic Haplustalfs, fine, mixed, superactive, mesic, deep, extremely gravelly sandy loam and Lithic Haplustalfs, fine-loamy, mixed, superactive, mesic, shallow, extremely gravelly sandy loam.	LSM 4, +1	Pimof, Jude2		Slight	NA	NA	NA
6	TNF 496	1188.3	0-15	Typic Haplustalfs, LSM 4, +1, clayey-skeletal mixed, superactive, mesic, moderately deep, sandy clay loam and Pachic Argiustolls, clayey-skeletal mixed, superactive, mesic, deep, extremely stony fine sandy loam.	LSM 4, +1	Pimof, Jude2, Qugr3		Slight	NA	NA	NA
6	TNF 497	1459.9	0-15	Typic Haplustalfs, clayey-skeletal, smectitic, mesic, moderately deep extremely gravelly sandy loam and Typic Argiustolls, clayey-skeletal, smectitic, mesic, moderately deep extremely gravelly sandy loam	LSM 4, +1	Pimof, Jude2, Qutu2		Slight	NA	NA	NA
6	TNF 4170	1585.2	0-15	Typic Haplustalfs, fine, mixed, superactive, mesic, gravelly loam	LSM 4, +1	Pimof, Jude2, Qugr3	Impaired - Unsatisfactory	Slight	NA	NA	NA
6	TNF 4240	23.9	0-15	Typic Haplustepts, loamy-skeletal, mixed, superactive, mesic, deep, gravelly, sandy loam, gullied	LSM 4, +1	Pimof, Jude2, Qugr3, Qutu2 Arpu5	Impaired - Unsatisfactory	Slight	NA	NA	NA
6	TNF 4451	451.7	0-15	Typic Haplustalfs, fine, mixed, superactive, mesic, moderately deep, very cobbly loam	LSM 4, +1	Pimof, Jude2, Juos, Qugr3, Qutu2 Arpu5	Unsatisfactory	Slight	NA	NA	NA
6	TNF 3710	40.5	0-15	Typic Haplustalfs, fine, smectitic, mesic, deep, gravelly loam	LSM 4, 0	Pimof, Juos, Hibe	Impaired to Unsatisfactory	Slight	NA	NA	NA
6	TNF 4140	1130.8	0-15	Typic Haplustalfs, fine, smectitic, mesic, deep, gravelly loam	LSM 4, +1	Jude2, Bogr2	Impaired to Unsatisfactory	Slight			
6	TNF 492	4876.7	0-15	Lithic Haplustalfs, clayey-skeletal, mixed, superactive, mesic, very flaggy, fine sandy loam and Lithic Haplustepts, loamy-skeletal, mixed, superactive, mesic, extremely flaggy fine sandy loam	LSM, 4, +1	Pimof, Jude2, Qugr3, Arpu5					
6	TNF 501	6232.7	0-15	Udertic Haplustalfs, fine, smectitic, mesic, deep, cobbly clay loam, and Lithic Haplustalfs, clayey-skeletal, smectitic, mesic, shallow, very cobbly clay loam,	LSM, 4, +1	Pimof, Jude2, Qugr3					
6	TNF 421	867.4	0-15	Typic Haplustalfs, fine-loamy and sandy, very deep.	LSM 4, +1	Juco11/Qutu2		Slight			
6	TNF 455	169.4	0-15	Lithic Haplustalfs and Argiustolls, clayey-skeletal,	LSM 4, +1	Qutu2/Arpr		Slight			

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6	TNF 461	20.7	0-15	Typic Haplustalfs, fine or clayey-skeletal.	LSM 4, +1	Pimo/Jude2/Qugr3/Arpu5		Slight			
7	CNF 439	56.4	15-40	Typic Haplustalfs, fine and clayey-skeletal, montmorillonitic, mesic, deep, very and extremely cobbly loam. Basalt and cinders	HSC, 4, 0	Pied, Juos, Jumo, Bogr2	Impaired	Moderate			
7	A-S 54	2209	16-40	Typic Haplustalfs, fine, mixed, mesic, deep, very gravelly, sandy loam. Sandstone and limestone	HSC 4, 0	Pied Jude2 Jumo	Satisfactory -	Moderate			
7	A-S 540	45	16-40	Typic Haplustalfs, fine, mixed, superactive, mesic, deep, extremely cindery clay loam and Typic Argiustolls, fine, mixed, superactive, mesic, deep, extremely cindery clay loam. Cinders and basalt	HSC 4 0	Pied/Jude2 Juos/Jumo	Impaired	Mod - Sev	Moderate-Severe Mod-Sev EHAZ and Low Soil Strength	NA	N/A
7	A-S 575	317	16-40	Typic Argiustolls, fine, montmorillonitic, mesic, extremely cobbly clay loam and Typic Argiustolls, clayey-skeletal, montmorillonitic, extremely cobbly clay loam. Cinders and basalt.	HSC 4 0	Pied Jude2 Juos/Jumo	Impaired	Mod - Sev	Moderate-Severe Mod-Sev EHAZ and Low Soil Strength	NA	N/A
8	CNF 453	2758.1	0-15	Vertic Haplustalfs, fine, montmorillonitic, mesic, deep, cobbly, clay loam and Typic Argiustolls, clayey-skeletal, montmorillonitic, mesic, moderately deep, very cobbly, loam. Basalt and cinders	HSC, 4, 0	Agsm, Bogr2, ---, ---	Unsatisfactory	Moderate	NA	NA	NA
8	CNF 454	130.3	0-15	Typic Haplustalfs, fine, montmorillonitic, mesic, deep, gravelly, loam and Calcic Ustochrepts, fine-loamy, mixed, calcareous, mesic, moderately deep, gravelly, loam. Sandstone, limestone, conglomerate	HSC, 4, 0	Agcr/Bogr2/Stco4	Satisfactory	Slight	NA	NA	NA
8	CNF 492	7808.9	0-15	Vertic Haplustalfs, fine, montmorillonitic, mesic, deep, very cobbly, clay loam and Typic Argiustolls, clayey-skeletal, montmorillonitic, mesic, moderately deep, very stony, clay loam. Basalt and cinders	LSM, 4, +1	Agsm, Bogr2, ---, ---	Impaired	Moderate	NA	NA	NA
8	A-S 58	38	0-5	Fluventic Haplustolls, fine-loamy, mixed, mesic, deep, sandy loam and Typic Ustifluvents (calcareous), coarse-loamy, mixed, mesic, deep, sandy loam, well drained. Mixed alluvium	HSC 4, 0	Pied JUNIP Ernans (Fapa)	Impaired	Slight	Severe Low Strength	NA	N/A

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8	A-S 502	1834	0-15	Vertic Haplustalfs, fine, montmorillonitic, mesic, deep, gravelly silty clay loam and Typic Haplustalfs, fine, montmorillonitic, mesic, moderately deep, very gravelly silty clay loam. Basalt and cinders.	HSC 4, 0	Pasm Bogr2 Jude2 Pied	Impaired	Slight	NA	NA	N/A
8	A-S 580	658	0-15	Vertic Argiustolls, fine, montmorillonitic, mesic, deep, clay loam and Typic Chromusterts, fine, montmorillonitic, mesic, deep, clay loam and Lithic Argiustolls, clayey-skeletal, montmorillonitic, shallow, very stony loam. Basalt and cinders.	HSC 4, 0	Pasm Bogr2 Jude2 Pied	Impaired	Slight	Severe Low Strength	NA	NA
9	CNF 493	550.3	15-40	Lithic Haplustalfs, clayey-skeletal, montmorillonitic, mesic, shallow, extremely stony, loam and Typic Haplustalfs, fine, montmorillonitic, mesic, moderately deep, very stony, loam. Basalt and cinders	LSM, 4, +1	Pifa, Jude2, Qutu2, Bogr2	Satisfactory	Moderate	NA	NA	NA
9	TNF 441	85	15-60	Typic Haplustalfs, clayey-skeletal, mixed, deep, very stony sandy clay loam	LSM 4, 0 and LAM 4, -1	Pimof/Juco11/ Qutu2 and Juco11/Qutu2		Severe	NA	NA	NA
9	TNF 462	264.9	15-60	Lithic Haplustolls, loamy, mixed, shallow	LSM 4, +1	Pimif/Jude2/Q utu2/Arpu5 and Qutu2/Arpu5		Severe	NA	NA	NA
9	TNF 473	389.1	15-60	Typic Paleustalfs and Typic Argiustolls, fine and clayey-skeletal, mixed, very deep and moderately deep, extremely stony sandy loam.	LSM 4, +1	Jude2/Qugr3/ Quem/Muem			NA	NA	NA
9	TNF 477	991.2	15-40	Lithic Haplustolls, loamy, mixed, shallow, and Typic Ustorthents, loamy-skeletal, mixed, shallow	LSM 4, +1	Quem/Qutu2			NA	NA	NA
9	TNF 481	27.8	0-40	Lithic and Typic Haplustafs, loamy-skeletal, mixed, shallow and moderately deep, extremely bouldery coarse sandy loam	LSM 4, +1	Pimof/Jude2/ Quem/Arpu5			NA	NA	NA
9	TNF 484	1738.1	15-60	Typic Haplustalfs and Udic Argiustolls, loamy-skeletal, mixed, moderately deep	LSM 4, +1 and LSM, 5, -1	Pimof/Jude2/ Quem and Pipos/Pimof/J ude2/Quem		Severe	Moderate-high, High Erosion	Low on Pipos, Too dry	
9	TNF 486	1420	0-40	Typic Haplustalfs, fine, mixed, moderately deep, extremely gravelly sandy loam	LSM 4, +1	Pimof/Jude2/B ohi2 and Pimof/Jude2/ Arpu5/Bohi2			NA	NA	NA

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9	TNF 488	1975.5	15-60	Typic Ustipsamments, sandy and Typic Ustorthents, sandy-skeletal, deep and moderately deep, stony sandy loams	LSM, 4, +1	Jude2/Quem/ Qutu2/Arpu5		Severe	NA	NA	NA
9	TNF 491	2250.2	15-60	Typic Haplustalfs, clayey-skeletal, mixed, superactive, mesic, extremely cobbly sandy clay loam and Udic Haplustalfs, clayey-skeletal, superactive, mesic, mixed, extremely cobbly sandy loam	LSM, 4, +1	Pimof, Jude2, Qugr3, Mulo, Pipos			NA	NA	NA
9	TNF 499	5345.5	15-60	Typic Haplustalfs, fine, smectitic, mesic, deep extremely gravelly sandy clay loam and Udic Haplustalfs, clayey-skeletal, smectitic, mesic, deep, extremely cobbly sandy loam	LSM, 4, +1	Pimof, Jude2, Quem, Qugr3,			NA	NA	NA
9	TNF 4161	1010.4	15-40	Typic Haplustalfs, fine, smectitic, mesic, moderately deep very gravelly loam	LSM, 4, +1	Pimof, Jude2, Qugr3, Qutu2, Arpu5	Satisfactory - Impaired	Moderate	N/A	NA	N/A
9	TNF 4175	3103.4	15-40	Typic Haplustalfs, clayey-skeletal, mixed, superactive, mesic, deep, very cobbly loam	LSM, 4, +1	Pimof, Jude2, Qugr3, Qutu2, Arpu5	Satisfactory - Impaired	Severe	N/A	NA	N/A
9	TNF 4241	1429.0	15-40	Typic Haplustalfs, loamy-skeletal, mixed, superactive, mesic, gravelly, sandy loam	LSM 4, +1	Quem, Qugr3, Qutu2, Arpu5	Satisfactory to Impaired	Severe	N/A	NA	NA
9	TNF 4457	495.3	15-40	Typic Haplustepts, loamy-skeletal, mixed, superactive, mesic, moderately deep, very gravelly sandy loam	LSM, 4, +1	Pimof, Jude2, Quem, Qugr3, Qutu2, Arpu5	Impaired - Unsatisfactory	Moderate	N/A	NA	N/A
9	TNF 4468	130.8	15-40	Lithic Haplustepts, loamy-skeletal, mixed, superactive, mesic, shallow, very gravelly loam	LSM 4, 0	Cuara, Pimof, Qutu2, Arpu5	Satisfactory	Severe	N/A	NA	N/A
9	TNF 5471	0.5	15-40	Typic Haplustalfs, fine, mixed, superactive, mesic, deep, extremely cobbly sandy loam	LSM, 4, +1	Pimof, Jude2, Juos, Qugr3, Qutu2, Arpu5	Satisfactory	Severe	N/A	NA	55
10	CNF 515	12132.4	0-15	Vertic Argiborolls, fine, montmorillonitic, deep, cobbly, clay loam. Basalt and cinders	HSC, 5, -1	Agsm, Chna2, ---, ---	Impaired	Moderate	NA	NA	NA
11	CNF 500	12191.0	0-15	Mollic Eutroboralfs, fine, montmorillonitic, moderately deep, fine sandy loam. Limestone or sandstone	HSC, 5, -1	Pipos, Pied, Jude2, Quga	Satisfactory	Slight	Severe, low strength	Low, too dry	55
11	CNF 523	7276.5	0-15	Mollic Eutroboralfs, fine, montmorillonitic, deep, very cobbly, clay loam. Basalt and cinders	HSC, 5, -1	Pipos, Pied, Jumo, Quga	Satisfactory	Slight	Severe, low strength	Low, too dry	55
11	A-S 178	14295	0-15	Udic Haplustalfs, fine, mixed, frigid, moderately deep, very gravelly sandy loam, Sandstone and limestone	HSC 5, -1	Pipos, Pied, Jude2, Jumo	Satisfactory -	Slight	Severe Low Strength	Low,too dry	55

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11	A-S 186	13753	0-15	Lithic Haplustalfs, clayey, mixed, frigid, shallow, gravelly fine sandy loam and Udic Haplustalfs, fine, mixed, frigid, moderately deep, gravelly fine sandy loam. Sandstone and limestone	HSC 5, -1	Pipos, Pied, Jude2, Jumo	Satisfactory -	Slight	Severe Low Strength	Low, too dry	50
11	A-S 187	13295	0-15	Udic Haplustalfs, fine, mixed frigid, deep, very gravelly sandy loam and Udic Haplustalfs, clayey-skeletal, mixed, frigid, deep, very gravelly sandy loam and Lithic Haplustolls, calcareous, loamy-skeletal, mixed, frigid, shallow, very gravelly loam. Sandstone and limestone	HSC 5 -1	Pipos Pied Jude2 Quga	Satisfactory -	Moderate	Severe Low Strength	Low, too dry	55
11	A-S 523	10268	0-15	Udic Haplustalfs, fine, montmorillonitic, frigid, very very cobbly silty clay loam and Udic Argiustolls, fine, montmorillonitic, frigid, very gravelly clay loam. Basalt and cinders	HSC 5 -1	Pipos Pied Jude2 Jumo	Satisfactory -	Slight	Severe Low Strength	Low, too dry	45
12	CNF 524	2,933.5	15-40	Typic Argiborolls, fine, montmorillonitic, moderately deep, very cobbly, loam and Mollic Eutroboralfs, clayey-skeletal, montmorillonitic, moderately deep, very stony, loam. Basalt and cinders	HSC, 5, -1	Pipos, Pied, Jumo, Quga	Satisfactory	Severe	Severe, high erosion	Low, too dry	45
12	CNF 527	6580.6	15-40	Lithic Haploborolls, loamy-skeletal, mixed, calcareous, shallow, extremely cobbly, fine sandy loam and Typic Haploborolls, loamy-skeletal, mixed, calcareous, moderately deep, extremely cobbly, fine sandy loam. Limestone	HSC, 5, -1	Pipos, Pied, Jude2, Comes	Satisfactory	Moderate	Moderate, high erosion	Low, too dry	50
12	A-S 592	218	16-40	Udic Argiustolls, clayey-skeletal, mixed, superactive, frigid, moderately deep, extremely cobbly silt loam and Lithic Argiustolls, clayey-skeletal, mixed, superactive, shallow, extremely cobbly silt loam. Basalt and cinders	HSC 5 -1	Pipos Pied Jude2 Jumo	Impaired	Severe	Severe	Low, too dry	55
12	A-S 624	376	16-40	Lithic Haplustalfs, clayey-skeletal, mixed, superactive, frigid, very cobbly loam and Lithic Argiustolls, clayey-skeletal, mixed, superactive, frigid, very cobbly loam. Cinders an basalt.	HSC 5 -1	Pipos Pied Jude2 Jumo	Impaired	Mod - Sev	Moderate-Severe Mod-Sev EHAZ and Low Soil Strength	Low, too dry	50
13	CNF 520	4722.8	0-15	Udic Haplustalfs, fine, montmorillonitic, mesic, moderately deep, very cobbly, loam and Lithic Haplustalfs, clayey-skeletal, montmorillonitic, mesic, shallow, very stony, loam. Basalt and cinders	LSM, 5, -1	Pipos, Pifa, Jude2, Qutu2	Satisfactory	Slight	Severe, low strength	Low, too dry	45

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13	TNF 500	3295.3	0-15	Udic Haplustalfs, clayey-skeletal, smectitic, mesic, moderately deep, very cobbly silt loam and Lithic Haplustalfs, clayey-skeletal, mixed, superactive, mesic, shallow, very cobbly silt loam	LSM 5, -1	Pipos, Pifa, Jude2, Quar,		Slight			
13	TNF 5350	791.3	0-15	Udic Haplustepts, loamy-skeletal, mixed, superactive, mesic, gravelly sandy loam	LSM 5, -1	Pipos, Pimof, Jude2, Quem, Qutu2, Arpu5, Arpr	Satisfactory	Moderate	Severe, Low strength	Low	55
14	TNF 504	57.8		Correlated to 505 or other TBD							
14	TNF 505	11782.6	15-60	Udic Paleustalfs, fine, mixed, superactive, mesic, deep, and Pachic Calciustolls, mixed, superactive, mesic, deep	LSM 5, -1	Pipos, Jude2, Pimof, Arpr					
14	TNF 5075	1505.6	15-80	Udic Haplustalfs, clayey-skeletal, mixed, superactive, mesic, deep, very cobbly loam	LSM 5, -1	Pipos, Pimof, Jude2, Qugr3, Arpu5, Arpr	Satisfactory, Inherently Unstable	Severe	Severe, Low Strength	Low, Too Dry	55
14	TNF 5351	2171.7	15-40	Udic Haplustepts, loamy-skeletal, mixed, superactive, mesic, gravelly sandy loam	LSM 5, -1	Pipos, Pimof, Jude2, Quem, Qutu2, Arpu5, Arpr	Satisfactory	Severe	Moderate, Low Strength	Moderate	55
15	CNF 572	2977.0	0-15	Udic Haplustalfs, fine, montmorillonitic, mesic, moderately deep, very stony, fine sandy loam. Sandstone	LSM, 5, 0	Pipos, Jude2, Quar, Arpu5	Satisfactory	Slight	Severe, low strength	Low, plant competition	
15	TNF 530	691.0	0-15	Udic Argiustolls, mixed, superactive, mesic, very deep, Udic Haplustalfs, mixed, superactive, mesic, very deep, Complex	LSM 5, 0	Pipos Jude2 Quem, Qugr3		Slight			
15	TNF 535	2195.2	0-15	Udic Haplustalfs, fine and clayey-skeletal, moderately deep, very gravelly	LSM 5, 0	Pipos Jude2 Quem, Qugr3		Slight			
15	TNF 5165	2081.5	0-15	Udic Haplustalfs, fine-loamy, mixed, superactive, mesic, deep, gravelly loam	LSM 5, 0	Pipos, Jude2, Qugr3, Arpr,	Satisfactory	Slight	Severe, Low strength	High	75
15	TNF 5250	14101.0	0-15	Udic Haplustalfs, fine, mixed, superactive, mesic, deep, gravelly loam	LSM 5, 0	Pipos, Jude2, Qugr3, Arpu5, Arpr,	Satisfactory	Slight	Severe, Low strength	High	70
15	TNF 5550	7696.1	0-15	Udic Haplustalfs, fine, smectitic, mesic, deep, gravelly loam	LSM 5, 0	Pipos Jude2 Qugr3	Satisfactory	Slight	Severe Low Strength	Moderate	70
15	TNF 5650	9720.6	0-15	Udic Haplustalfs, fine, mixed, superactive, mesic, deep gravelly loam	LSM 5, +1	Pipos Jude2 Qugr3, Rone, Arpr	Satisfactory	Slight	Severe Low Strength	Moderate	70

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16	CNF 530	3756.5	15-40	Udic Haplustalfs, clayey-skeletal, montmorillonitic, mesic, moderately deep, very stony, loam and Lithic Haplustalfs, clayey-skeletal, montmorillonitic, mesic, shallow, very stony, loam. Basalt and cinders	LSM, 5, 0	Pipos, Jude2, Qutu2, ---	Unsatisfactory	Severe	Severe, high erosion	Low, plant competition	55
16	TNF 510	19377.2	15-60	Udic Argiustolls, mixed, superactive, mesic, and Typic Argiustolls, mixed, superactive, mesic,	LSM, 5, 0 and LSM, 4, +1	Pipos, Jude 2, Qugr3, Quem					
16	TNF 524	1319.2	15-40	Udic Paleustalfs, fine-loamy, mixed, superactive, mesic, shallow, consociation	LSM 5, 0	Pipos, Quem, Qugr3, Muhle				Moderate	
16	TNF 536	3870.3	0-40	Udic Paleustolls, Udic Argiustolls, fine, mixed, superactive, mesic, deep, gravelly, fine sandy loam, Udic Haplustalfs, clayey-skeletal, mixed superactive, mesic, deep, sandy loam	LSM 5, 0	Pipos, Jude 2, Quem, Arpu5					
16	TNF 550	3690.4	15-60	Udic Haplustalfs, fine, smectitic, mesic, very deep,very stony, sandy clay loam, and Udic Argiustolls, fine, smectitic, mesic, very deep, boulder, silt loam	LSM, 5, 0	Pipos, Jude2, Qugr3				Moderate	70
16	TNF 5074	946.2	15-40	Udic Haplustalfs, fine, smectitic, mesic, deep, cobbly loam	LSM, 5, +1, -1	Pipos, Pimof, Jude2, Quar, Bogr2	Satisfactory	Moderate	Severe, low strength	Low	55
16	TNF 5251	21835.9	15-40	Udic Haplustalfs, fine, mixed, superactive, mesic, deep, gravelly loam	LSM 5, 0	Pipos, Jude 2, Qugr3, Arpu5	Satisfactory	Severe	Severe, Low Strength	Moderate	70
16	TNF 5551	4075.9	15-40	Udic Haplustalfs, fine, smectitic, mesic, deep, gravelly loam. Basalt	LSM 5, 0	Pipos, Jude2, Qugr3	Satisfactory	Severe	Severe, Low Strength	Moderate	70
16	TNF 5651	10465.4	15-40	Udic Haplustalfs, clayey-skeletal, mixed, superactive, mesic, deep, cobbly loam	LSM 5, +1	Pipos, Jude2, Qugr3, Arpr	Satisfactory	Severe	Moderate	Moderate	75
17	TNF 5252	1950.6	40-80	Udic Haplustalfs, fine, mixed, superactive, mesic, deep, gravelly loam	LSM 5, 0	Pipos, Jude2, Qugr3, Arpu5, Arpr	Satisfactory	Severe	Severe, Low strength	Low	70
17	TNF 5352	3250.9	40-80	Udic Haplustepts, loamy-skeletal, mixed, superactive, mesic, gravelly, sandy loam	LSM 5, -1	Pipos, Pimof, Jude2, Quem, Qutu2, Arpu5, Arpr	Satisfactory	Severe	Severe, low strength	Low, too dry	55
17	TNF 5368	8241.5	15-80	Udic Haplustepts, loamy-skeletal, mixed, superactive, mesic, deep, gravelly loam, calcareous	LSM 5, 0	Pipos, Jude2, Qugr3, Arpr, Pust	Satisfactory, Inherently Unstable	Severe	Slight	Moderate	65
17	TNF 5452	1657.4	40-80	Udic Haplustalfs, loamy-skeletal, mixed, superactive, mesic, deep, gravelly loam	LSM 5, +1	Pipos, Jude2, Qugr3, Rone, Arpr	Satisfactory, Inherently Unstable	Severe	Moderate	Low	75

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18	CNF 546	43128.1	0-15	Typic Eutroboralfs, fine, montmorillonitic, deep, gravelly, fine sandy loam, high precipitation. Limestone or sandstone	LSC, 5, 0	Pipos, Quga, Muvi2, ---	Satisfactory	Slight	Severe, low strength	High	80
18	A-S 191	31447.5	0-15	Udic Haplustalfs, fine, mixed, frigid, deep, sandy loam, high precipitation. Sandstone and limestone.	LSC, 5, 0	Pipos Quga	Satisfactory	Slight	Severe, low strength	High	75
18	A-S 193	31299	0-15	Udic Haplustalfs, fine, mixed, frigid, moderately deep, gravelly loam, high precipitation and Lithic Haplustalfs, clayey, mixed, frigid, shallow, gravelly sandy loam, high precipitation. Sandstone and limestone	LSC 5 0	Pipos Quga	Satisfactory	Moderate	Severe Low Strength	High	65, 75
18	A-S 196	33999	0-15	Udic Haplustalfs, fine, montmorillonitic, frigid, deep, gravelly sandy loam, high precipitation. Sandstone, limestone, and chert.	LSC, 5, 0	Pipos Quga	Satisfactory	Slight	Slight-Severe, low strength	High	80
18	A-S 197	31502	0-15	Udic Haplustalfs, clayey-skeletal, mixed, frigid, moderately deep, very stony sandy loam, high precipitation and Lithic Haplustalfs, clayey, mixed, frigid, shallow, very stony sandy loam, high precipitation. Sandstone and limestone	LSC 5 0	Pipos Quga	Satisfactory	Moderate	Severe Low Strength	High	70, 75
18	TNF 5078	9150.3	0-15	Mollic Hapludalfs, fine, mixed, superactive, frigid, deep loam	LSC 5, 0	Pipos, Quga	Satisfactory	Moderate	Moderate, Low strength	High	70
19	CNF 549	10754.7	15-40	Glossic Eutroboralfs, fine, montmorillonitic, deep, very gravelly, fine sandy loam, high precipitation and Typic Paleboralfs, fine, montmorillonitic, deep, very gravelly, fine sandy loam, high precipitation. Limestone	LSC, 5, 0	Pipos, Quga, Muvi2, ---	Satisfactory	Moderate	Moderate, high erosion	High	75
19	CNF 550	30938.3	15-40	Mollic Eutroboralfs, clayey-skeletal, montmorillonitic, deep, cobbly, fine sandy loam and Typic Eutroboralfs, fine, montmorillonitic, deep, cobbly, fine sandy loam. Limestone or sandstone	LSC, 5, 0	Pipos, Quga, ---, ---	Satisfactory	Moderate	Moderate, low strength	High	70
19	CNF 565	5768.5	15-40	Mollic Eutroboralfs, clayey-skeletal, mixed, moderately deep, very cobbly, loam. Cinders and basalt	LSC, 5, 0	Pipos, Quga, ---, ---	Satisfactory	Severe	Severe, high erosion	High	70
19	CNF 584	18139.2	15-40	Mollic Eutroboralfs, clayey-skeletal, montmorillonitic, moderately deep, very stony, loam and Typic Argiborolls, fine, montmorillonitic, deep, very cobbly, loam. Basalt and cinders	LSC, 5, 0	Pipos, Quga, ---, ---	Satisfactory	Moderate-Severe	Severe, low strength	High	70

Stratum Number	TES Map Units	Acres per TESU	Slope %	Taxonomic Classification and Parent Material	Climatic Class	PPC	Soil Condition	Erosion Hazard	Timber Harvest Limitations	Natural Regen Potential	Ponderosa Pine Site Index
19	A-S 182	37249.5	16-40	Udic Haplustalfs, fine, mixed, frigid, deep, very cobbly sandy loam, high precipitation and Udic Haplustalfs, clayey-skeletal, mixed, frigid, moderately deep, very cobbly sandy loam, high precipitation. Sandstone and limestone	LSC 5, 0	Pipos Jude2 Quga	Satisfactory -	Moderate	Severe Low Strength	Moderate, plant competition	70
19	A-S 192	50254	15-40	Udic Haplustalfs, fine, mixed, frigid, very cobbly sandy loam, high precipitation and Udic Haplustalfs, clayey-skeletal, mixed frigid, very gravelly sandy loam, high precipitation. Sandstone and limestone.	LSC, 5, 0	Pipos Quga	Satisfactory	Moderate	Severe, low strength	High	75
19	A-S 199	18608	15-40	Udic Haplustalfs, fine, montmorillonitic, frigid, deep, gravelly sandy loam, high precipitation and Udic Paleustalfs, fine, mixed, frigid, deep, very gravelly sandy loam, high precipitation. Sandstone, limestone, chert	LSC, 5, 0	Pipos Quga	Satisfactory	Moderate	Severe, low strength	High	70
19	A-S 534	1287	15-40	Udic Haplustalfs, fine, mixed, superactive, frigid, very cindery loam. Basalt and cinders	LSC, 5, 0	Pipos Quga	Satisfactory	Moderate	Severe Low Strength	High	70
19	A-S 538	3076	15-40	Udic Haplustalfs, clayey-skeletal, mixed, superactive, frigid, moderately deep, very stony clay loam and Lithic Argiustolls, clayey-skeletal, mixed, superactive, frigid, shallow, very stony loam. Basalt and cinders	LSC, 5, 0	Pipos Quga	Satisfactory	Moderate	Severe Low Strength	High	65, 70
19	A-S 591	2036	16-40	Lithic Argiustolls, clayey-skeletal, mixed, superactive, frigid, shallow, very cobbly loam and Udic Argiustolls, clayey-skeletal, mixed, superactive, moderately deep, extremely stony loam. Basalt and cinders	LSC 5, 0	Pipos Quga	Impaired	Severe	Severe	Moderate	65-70
19	TNF 5079	4013.0	15-40	Typic Hapludalfs, clayey-skeletal, mixed, superactive, frigid, deep loam	LSC, 5, 0	Pipos, Quga	Satisfactory	Severe	Moderate, Low Strength	Moderate	70
19	TNF 5080	3908.1	15-80	Typic Hapludalfs, clayey-skeletal, mixed, superactive, frigid, deep, very gravelly loam	LSC 5, 0	Pipos, Quga	Satisfactory, Inherently Unstable	Severe	Severe, Low strength	Moderate	70
19	TNF 5161	5111.0	15-40	Typic Hapludalfs, fine, mixed, superactive, frigid, deep, Cobbly clay loam	LSC, 5, 0	Pipos, Quga	Satisfactory	Severe	Moderate, Low Strength	Moderate	70
19	TNF 5162	15217	15-80	Typic Hapludalfs, fine, mixed, superactive, frigid, deep, Cobbly clay loam	LSC 5, 0	Pipos, Quga	Satisfactory	Severe	Moderate, too steep	Moderate	70

Stratum Number	TES Map Units	Acres per TESU	Slope %	Taxonomic Classification and Parent Material	Climatic Class	PPC	Soil Condition	Erosion Hazard	Timber Harvest Limitations	Natural Regen Potential	Ponderosa Pine Site Index
20	A-S 505	1810	16-40	Udic Haplustalfs, clayey-skeletal, mixed, superactive, frigid, very cindery clay loam. Basalt and cinders	HSC 5 -1	Pipos Pied Jude2 Jumo	Impaired	Mod - Sev	Moderate-Severe Mod-Sev EHAZ and Low Soil Strength	Low, too dry	55
20	A-S 536	3675	16-40	Vitrandic Haplustalfs, cindery, frigid, deep, very cindery loam and Udic Haplustalfs, clayey-skeletal, mixed, superactive, frigid, deep, very cindery clay loam. Cinders and basalt	LSC 5, 0	Pipos/Quga	Impaired	Severe	Severe – Severe EHAZ, Low Soil Strength	Low-Mod Low Water Holding Cap	60, 65
21	CNF 582	44367.3	0-15	Typic Argiborolls, fine, montmorillonitic, deep, gravelly, loam and Mollic Eutroboralfs, clayey-skeletal, montmorillonitic, moderately deep, cobbly, loam. Basalt and cinders	LSC, 5, 0	Pipos, Quga, ---, ---	Satisfactory	Slight	Severe, low strength	High	75
21	CNF 586	2883.3	0-15	Mollic Eutroboralfs, fine and clayey-skeletal, montmorillonitic, moderately deep, very stony, loam. Basalt and cinders	LSC, 5, 0	Pipos, Quga, ---, ---	Satisfactory	Slight	Severe, low strength	High	65
21	A-S 532	32356	0-15	Udic Haplustalfs, fine, montmorillonitic, frigid, moderately deep, clay loam and Udic Argiustolls, fine, montmorillonitic, frigid, moderately deep, clay loam. Basalt and cinders	LSC, 5, 0	Pipos Quga	Satisfactory	Slight	Severe Low Strength	High	70, 75
21	A-S 537	10754	0-15	Udic Haplustalfs, clayey-skeletal, montmorillonitic, frigid, moderately deep, very cobbly clay loam and Udic Argiustolls, clayey-skeletal, montmorillonitic, frigid, moderately deep, stony clay loam. Basalt and cinders	LSC, 5, 0	Pipos Quga	Satisfactory	Slight	Severe Low Strength	High	70, 75
22	CNF 567	27283.2	0-15	Typic Eutroboralfs, fine, montmorillonitic, moderately deep, stony, fine sandy loam and Mollic Eutroboralfs, fine, montmorillonitic, deep, fine sandy loam. Limestone or sandstone	LSC, 5, 0	Pipos, Jude2, Quga, ---	Satisfactory	Slight	Severe, low strength	Moderate, plant competition	65
22	CNF 578	37550.5	0-15	Mollic Eutroboralfs, fine, montmorillonitic, deep, cobbly, loam and Typic Argiborolls, fine, montmorillonitic, deep, cobbly, loam. Basalt and cinders	LSC, 5, 0	Pipos, Jude2, Quga, ---	Satisfactory	Slight	Severe, low strength	Moderate, plant competition	65
22	A-S 179	29318	0-15	Udic Haplustalfs, fine, mixed, frigid, moderately deep, gravelly sandy loam, high precipitation. Sandstone and limestone.	LSC 5, 0	Pipos, Jude2, Quga	Satisfactory	Slight	Severe Low Strength	Moderate, plant competition	70

Stratum Number	TES Map Units	Acres per TESU	Slope %	Taxonomic Classification and Parent Material	Climatic Class	PPC	Soil Condition	Erosion Hazard	Timber Harvest Limitations	Natural Regen Potential	Ponderosa Pine Site Index
22	A-S 181	27960	0-15	Udic Haplustalfs, fine, mixed, frigid, deep, sandy loam, high precipitation and Udic Haplustalfs, fine, mixed, frigid, shallow, loam, high precipitation. Sandstone and limestone	LSC 5, 0	Pipos Jude2 Quga	Satisfactory	Slight	Severe Low Strength	Moderate, plant competition	70
22	A-S 183	33301	0-15	Udic Haplustalfs, fine, mixed, frigid, moderately deep, very gravelly sandy loam, high precipitation and Lithic Haplustalfs, clayey, mixed, frigid, shallow, gravelly sandy loam, high precipitation. Sandstone and limestone	LSC 5, 0	Pipos,Jude2, Quga	Satisfactory	Slight	Severe Low Strength	Moderate, plant competition	65, 70
23	CNF 579	7409.8	0-15	Lithic Eutroboralfs, clayey-skeletal, montmorillonitic, shallow, extremely stony, loam and Mollic Eutroboralfs, fine, montmorillonitic, moderately deep, very cobbly, loam. Basalt and cinders	LSC, 5, 0	Pipos, Jude2, Quga, ---	Satisfactory	Slight	Moderate, too rocky	Low, too shallow, plant competition	60
23	CNF 585	22058.5	0-15	Lithic Eutroboralfs, clayey-skeletal, montmorillonitic, shallow, extremely stony, loam and Mollic Eutroboralfs, fine, montmorillonitic, moderately deep, very cobbly, loam. Basalt and cinders	LSC, 5, 0	Pipos, Quga, ---, ---	Satisfactory	Slight	Severe, low strength	Low, too shallow	60
24	TNF 6250	2873.8	0-15	Glossic Hapludalfs, fine, mixed, superactive, mesic, deep loam	LSM 6, -1	Psmeg, Pipos, Jude2, Qugr3, Arpr (Dry Mixed Conifer)		Slight			
24	TNF 6251	13528.2	15-40	Glossic Hapludalfs, fine, mixed, superactive, mesic, deep, gravelly loam	LSM 6, -1	Psmeg, Pipos, Jude2, Qugr3, Arpr (Dry or Wet MC)					
25	CNF 611	1145.7	0-15	Udic Argiborolls, fine-loamy, mixed, deep, loam and Udic Argiborolls, loamy-skeletal, mixed, moderately deep, gravelly, loam. Andesite	LSC, 6, -1	Potr5, Psmeg, Pipos, (Dry MC)--	Satisfactory	Moderate	Moderate, high erosion	High	70
25	A-S 561	1311	0-15	Typic Glossudalfs, clayey-skeletal, mixed, superactive, frigid, moderately deep, cobbly loam. Basalt and cinders	LSC, 6, -1	Psmeg Pipos Quga (Dry MC)	Satisfactory	Slight	Moderate, low strength	High	60, 65
26	A-S 567	3031	16-40	Vitrandic Eutrudepts, cindery, frigid, deep, very cindery loam and Typic Glossudalfs, loamy-skeletal, mixed superactive, frigid, deep, very cindery sandy loam. Cinders and basalt	LSC 6 -1	Psmeg Pipos Quga (Wet MC)	Satisfactory	Severe	Severe – Severe EHAZ, Low Soil Strength	Low-Mod Low Water Holding Cap	65

Stratum Number	TES Map Units	Acres per TESU	Slope %	Taxonomic Classification and Parent Material	Climatic Class	PPC	Soil Condition	Erosion Hazard	Timber Harvest Limitations	Natural Regen Potential	Ponderosa Pine Site Index
27	CNF 650	10088.0	0-15	Typic Glossoboralfs, fine and clayey-skeletal, mixed, deep, very gravelly, fine sandy loam, high precipitation. Limestone	LSC, 6, 0	Abco, Psmeg, Pipos, Quga (Dry MC)	Satisfactory	Slight	Moderate, low strength	High	80
27	CNF 652	6765.5	0-15	Eutric Glossoboralfs, loamy-skeletal, mixed, moderately deep, stony, fine sandy loam, high precipitation and Lithic Glossoboralfs, loamy-skeletal, mixed, shallow, very stony, fine sandy loam, high precipitation. Sandstone	LSC, 6, 0	Abco, Psmeg, Pipos, Quga (Dry MC)	Satisfactory	Slight	Moderate, too stony	High	55
27	CNF 653	338.6	0-15	Eutric Glossoboralfs, clayey-skeletal, mixed, moderately deep, cobbly, loam. Andesite/basalt	LSC, 6, 0	Abco, Psmeg, Pipos, Quga (Dry MC)	Satisfactory	Moderate	Moderate, high erosion	High	70
27	A-S 201	7919	0-15	Typic Glossudalfs, fine/clayey-skeletal, mixed, superactive, frigid, gravelly loam, high precipitation and Typic Glossudalfs, clayey-skeleteal, mixed, superactive, frigid, gravelly loam, high precipitation. Sandstone and limestone	LSC 6, 0	Abco Psmeg Pipos Quga (Dry MC)	Satisfactory	Slight	Severe Low Strength	High	75
27	A-S 207	2228	0-15	Typic Glossudalfs, loamy-skeletal, mixed, superactive, frigid, shallow, very stony sandy loam, high precipitation and Typic Glossudalfs, loamy-skeletal, mixed, superactive, frigid, moderately deep, cobbly sandy loam, high precipitation. Sandstone and limestone	LSC 6, 0	Abco Psmeg Pipos Quga (Dry MC)	Satisfactory	Slight	Severe Low Strength	High	65, 75
27	TNF 612	133.8	0-5	Pachic Argiustolls, fine-loamy and loamy-skeletal, mixed, superactive, frigid, deep, loamy sand	LSC 6, +1, LSC 6, 0	Abco, Psmeg, Quga, Pipos, Jude2, Quga		Slight		Moderate, plant competition	
28	CNF 651	15834.8	15-40	Typic Paleboralfs, loamy-skeletal, mixed, deep, very gravelly, fine sandy loam, high precipitation and Typic Paleboralfs, fine, mixed, deep, very gravelly, fine sandy loam, high precipitation. Limestone/sandstone	LSC, 6, 0	Abco, Psmeg, Pipos, Quga (Wet MC)	Satisfactory	Severe	Severe, high erosion	High	75
28	CNF 654	1231.5	15-40	Eutric Glossoboralfs, loamy-skeletal, mixed, deep, very stony, loam. Andesite/basalt	LSC, 6, 0	Abco, Psmeg, Pipos, Quga (Wet MC)	Satisfactory	Moderate	Moderate, high erosion	High	70
28	A-S 202	12700	16-40	Typic Glossudalfs, fine, mixed, superactive, frigid, deep, gravelly loam, high precipitation and Typic Glossudalfs, clayey-skeletal, mixed, superactive, frigid, deep very gravelly sandy loam, high precipitation. Sandstone and limestone	LSC 6, 0	Abco Psmeg Pipos Quga (Wet MC)	Satisfactory	Moderate	Severe Low Strength	High	80

Stratum Number	TES Map Units	Acres per TESU	Slope %	Taxonomic Classification and Parent Material	Climatic Class	PPC	Soil Condition	Erosion Hazard	Timber Harvest Limitations	Natural Regen Potential	Ponderosa Pine Site Index
28	A-S 203	6917	15-40	Typic Glossudalfs, fine mixed, superactive, frigid, deep, very gravelly sandy loam, high precipitation and Typic Paleudalfs, fine, mixed, superactive, frigid, deep, very gravelly sandy loam, high precipitation and Typic Paleudalfs, loamy-skeletal, mixed, superactive, frigid, deep, very gravelly loam, high precipitation. Sandstone, limestone, chert.	LSC 6 0	Abco Psmeg Pipos Quga (Wet MC)	Satisfactory	Moderate	Moderate, low strength	High	75
28	TNF 652	<0.1	0-40	Only a Sliver	LS 6						
29	CNF 555	24676.9	40-120	Typic Dystrochrepts, frigid, moderately deep, very stony, fine sandy loam, Rock Outcrop and Mollic Eutroboralfs, mode deep, fine sandy loam. Sandstone or limestone	LSC, 6 and LSC, 5	Psmeg, (Wet MC and Pipos)	Satisfactory	Severe	Severe, high erosion	Low, plant competition	55
29	CNF 575	1024.3	40-120	Mollic Eutroboralfs, moderately deep, very cobbly, loam and Lithic Eutroboralfs, shallow, extremely stony, loam and Rock Outcrop. Basalt and cinders	LSC, 5, 0	Pipos, ---, ---, ---	Satisfactory	Severe	Severe, high erosion	Low, too shallow	45
29	CNF 613	268.0	40-80	Eutric Glossoboralfs, loamy-skeletal, mixed, moderately deep, very boulder, sandy loam. Andesite/cinders	LSC, 6	Psmeg, (Wet MC)	Satisfactory	Severe	Severe, high erosion	Low, too bouldery	60, 65
29	TNF 6405	20418	40-120	Rock outcrop, Typic Udorthents, sandy-skeletal, mixed, frigid. Sandstone	LSC-LSM 6-6-5, 0, -1, 1	Abco, Psmeg, Pipo, Pist2, Quga (Wet MC and Pipos))	Satisfactory	Slight	N/A	N/A	55
29	A-S 189	17301	40-80	Typic Glossudalfs, mixed, frigid and Udic Haplustalfs, mixed, frigid. Sandstone and Limestone	LSC 6, -1 LSC 5, 0	Pipos (Quga) (Wet MC and Pipos))	Satisfactory	Severe	Severe Low Strength	Low, too stony	
29	A-S 206	13278	40-80	Typic Dystrudepts, mixed, frigid and Typic Eutrudepts, mixed, frigid and Udic Haplustalfs, mixed frigid. Sandstone and limestone.	LSC 6	(Abco) Pipos Psmeg (Quga) (Wet MC)	Satisfactory	Severe	Severe Low Strength	Low, too stony	65
29	TNF 613	1219	40-80	Typic Argiudolls, frigid, deep, and Typic Argiudolls, mesic, deep	LSC 6, LSM 6	Psmeg, Quga, Qugr3 (Wet MC)					50
29	TNF 6252	1455.0	40-80	Glossic Hapludalfs, fine, mixed, superactive, mesic, deep, cobbly loam	LSM 6, -1	Psmeg, Pipos, Jude 2, Qugr3, Arpr (Wet MC)	Satisfactory	Severe	Severe, Low strength	Low	45, 65

Stratum Number	TES Map Units	Acres per TESU	Slope %	Taxonomic Classification and Parent Material	Climatic Class	PPC	Soil Condition	Erosion Hazard	Timber Harvest Limitations	Natural Regen Potential	Ponderosa Pine Site Index
29	TNF 6368	6149	40-80	Glossic Hapludalfs, loamy-skeletal, mixed, superactive, mesic, deep, gravelly loam	LSM 6, -1	Psmeg, Pipos, Jude 2, Qugr3, Arpr (Wet MC)	Satisfactory	Severe	Severe, Low strength	Low	65
29	TNF 6652	2019	40-120	Typic Eutrochrepts, loamy-skeletal, mixed, frigid	LSM 6, -1	Psmeg/Pipos/Jude2/Quar/Arpr		Severe	Severe, high erosion	Low, plant competition	
30	TNF 470	21.5	0-15	Typic Argiustolls, fine, deep	LSM 4, +1	Pimo/Jude2/Bogr2		Slight	NA	NA	NA
30	TNF 478	227.3	0-15	Typic and Pachic Argiustolls, fine, deep, gravelly sandy clay loam	LSM 4, +1	Bogr2/Bohi2		Slight	NA	NA	NA
30	TNF 485	121.3	0-15	Lithic and Pachic Argiustolls, clayey-skeletal.	LSM 4, +1	Bohi2/Bogr2					
30	TNF 490	491.4	0-15	Vertic Paleustolls, fine, smectitic, mesic, very cobbly sandy clay loam and Vertic Paleustolls, clayey-skeletal, smectitic, mesic, VD, GRX-SL, BOHI2/BOCU/JUDE2 - Vertic Argiustolls, LSM, 4, +1, cl-sk, sm, me, VD, CBV-CL, BOHI2/BOCU complex, 0-15% slope (Grasslands)	LSM 4, +1	Bohi2, Bocu, Jude2	Impaired	Slight	NA	NA	NA
	997	3		Quarry							
	998	847		Water							
	999	340		Private Land inholdings							
	Lake	881.2									

Appendix B. Soil Existing Condition, Desired Condition, Need for Change and Potential Management Strategies.

Strata (Aggregated Terrestrial Ecological Units)	Existing Condition	Desired Condition	Need For Change	Potential Management Strategies
1 - CNF TES Map Unit 50, A-S TES Map Units 4, 16. Total acres =1,709.1* **Wetland Riparian Areas (Lentic) on Deep, Fine- or Very Fine-textured, Hydric Soils** **Potential Plant Community (PPC): CAAQ/ELMA3/POLA4/ALGE ; POPR/FEAR2/IRMI ; POPR/MUWR/CAREX** ***CNF has only 163 acres or 9% of total.**	- Overall soil condition is impaired on A-S and unsatisfactory on CNF, but CNF has only 163 acres (9%) of total so it is minor in extent and appears to be improving (more fencing) since documented. - Current soil loss is below tolerance and soil stability (ability of soil to resist erosion) is slightly impaired from sheet erosion as evidenced by grass / forb pedestaling and localized, minor extents of bare soil exposure. - Soil hydrologic function is impaired on A-S and unsatisfactory on CNF with compacted soil surfaces. Blocky and some platy soil surface structure is present, there is a lack of adequate tubular pore distribution to effectively infiltrate water, and less than desirable vegetative ground cover (VGC – litter + plant basal area + soil biotic crusts). - Soil nutrient cycling is slightly impaired with VGC slightly below PPC. PPC species composition and production slightly below potential as well. Many/common roots are present in the surface soil. - Localized encroachment of young pine trees especially along wet meadow edges.	- Overall soil condition is satisfactory. - Soil loss below tolerance and no visible signs of excessive erosion. - Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling. - Grassland free of or limited cover of encroached trees (tree canopy cover < 10%).	- On both the CNF and A-S there is a need to improve VGC, improve surface soil structure and porosity, and reduce encroachment tree canopy cover to meet the desired condition of < 10%.	- Select removal of encroachment trees to meet the desired condition of < 10% canopy cover. - Allow maintenance prescribed fires under proper soil, fuel, and weather conditions. - On CNF, coordination of elk hunting permits with G&F to maintain and improve soil conditions. - Deferral of livestock grazing and/or conservative allowable use (25 – 35%). - Construct elk fencing exclosures. - Site-specific determinations for potential native grass seeding locations where prescribed fire was ineffective in rejuvenating herbaceous productivity. Relocate and naturalize roads or improve drainage.
2 - CNF TES Map Units 41, 53, 55, A-S Map unit 515. Total acres =12,944.2*	- Overall soil condition is impaired on both the CNF and A-S. - Current soil loss is above tolerance and soil stability (ability of soil to resist	- Overall soil condition is satisfactory. - Soil loss below tolerance and no visible signs of excessive erosion.	- On both the CNF and A-S there is a need to improve VGC, improve surface soil structure	- Select removal of encroachment trees to meet the desired condition of < 10% canopy cover. Lop and

Strata (Aggregated Terrestrial Ecological Units)	Existing Condition	Desired Condition	Need For Change	Potential Management Strategies
Montane Meadows on Deep, Fine-textured Soils **Potential Plant Community (PPC): AGSM/MUWR ; POPR/FEAR2 ; AGSM/BOGR2/PIPOS** ***About equal acreages on both forests.**	erosion) is impaired. Sheet erosion is evident from contiguous grass and forb pedestaling in some locations. Rills are present in some locations and gullies and channel incision have also occurred in some meadows. - Soil hydrologic function is impaired with compacted soil surfaces. Blocky and some platy soil surface structure is present and there is a lack of adequate tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling is slightly impaired with VGC slightly below PPC. PPC species composition and production is below potential as well. Many/common roots are present in the surface soil (below platy structure or water-compacted surface crusting if present). - Localized encroachment of young pine trees especially along edges of meadows.	- Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling. - Grassland free of or limited cover of encroached trees (tree canopy cover < 10%).	and porosity, and increase species diversity and production to be more aligned with the PPC. - There is also a need to reduce encroachment tree canopy cover to meet the desired condition of < 10%.	scatter/ Relocate or naturalize roads or improve drainage - Allow maintenance prescribed fires under proper soil, fuel, and weather conditions. - On CNF, coordination of elk hunting permits with G&F to maintain and improve soil conditions. - Deferral of livestock grazing and/or conservative allowable use (25 – 35%). - Construct elk fencing exclosures. - Site-specific determinations for potential native grass seeding locations where prescribed fire was ineffective in rejuvenating herbaceous productivity.
3 - CNF TES Map Unit 60, A-S TES Map Units 198, 208. TNF TES Map Units 22, 26, 40, 60. Total acres = 11,666.4* **Streamside Riparian Areas (Lotic) on Channel, Terrace, and Floodplain Soils**** **Potential Plant Community (PPC): POAN3/JUMA/PSMEG ; POAN3/PIPOS/JUDE**	- Overall soil condition is impaired on A-S and satisfactory on CNF, but CNF has only 35 acres (1%). - On A-S, Current soil loss is below tolerance and soil stability (ability of soil to resist erosion) is impaired. Sheet erosion is evident from contiguous grass and forb pedestaling in some locations. Minor, discontinuous rilling is present in some locations. On CNF, soil loss is below tolerance and soil stability is satisfactory. - Soil hydrologic function is satisfactory on CNF and impaired on A-S with compacted soil surfaces. Blocky and some platy soil surface structure is present and there is a lack of adequate	- Overall soil condition is satisfactory. - Soil loss below tolerance and no visible signs of excessive erosion. - Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling. - Diverse composition and structure for riparian woody species and abundant / vigorous riparian herbaceous component.	- On A-S, there is a need to reduce ungulate (elk and livestock) trampling of soils. – - There is also a need to improve riparian species composition, production, and overall VGC to better align with PPC and to improve site stability / hydrology.	- Deferral of livestock grazing and/or conservative allowable use (25 – 35%). - Construct elk fencing exclosures. - Site-specific determinations for potential riparian woody species planting and native, riparian grass seeding locations. - Consider allowing maintenance prescribed fires under proper soil, fuel, and weather conditions where tree density and fuels are greatly departed from desired condition. Road relocation, improve drainage, naturalize.

Strata (Aggregated Terrestrial Ecological Units)	Existing Condition	Desired Condition	Need For Change	Potential Management Strategies
2/QUGA ; POAN3/ALOB/SALIX ; PLWR2/POFR2/SALA3/FRVE2, POPR/FEAR2/BRAN/CAREX ***CNF has only 35 acres or <5% of total.** ****Some soil types are hydric.**	tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling is satisfactory on CNF and on A-S it is slightly impaired with VGC slightly below PPC. PPC species composition and production is below potential as well. Many/common roots are present in the surface soil (below platy structure or water-compacted surface crusting if present). - On A-S, riparian woody species diversity and size class distribution is below potential in some locations. Riparian herbaceous species abundance and vigor is slightly below potential as well.			
4 - CNF TES Map Units 430, 435, 455, A-S Map Unit 55. TNF TES Map Units 502, 3712, 3753, 4176, 4242, 9175, 9349, 9459, 436, 451, 479, 482. Total acres = 31,098.4 **Steep (> 40% slope) Pinyon-Juniper Woodland Mountains and Escarpments on Shallow, Rocky Soils** **Potential Plant Community (PPC): PIED/JUMO/COMES/STCO4 ; PIED/JUDE2/JUMO/COMES ; JUMO/BOGR2/HENE5**	- Overall soil condition is inherently unstable or unsuited. - Current soil loss is above tolerance and soil stability (ability of soil to resist erosion) is inherently unstable due to natural conditions (excessive slopes > 40%). - Soil hydrologic function is unrated, but likely satisfactory with surface soils well aggregated with sufficient porosity to effectively infiltrate water. - Soil nutrient cycling is unrated. VGC inadequate to protect against accelerated erosion in inherently unstable conditions. - Natural regeneration potential is low due to steep slopes, shallow, rocky soils, and inherently low effective VGC. - Ultimately, cannot achieve sufficient cover due to erosion and soil loss inherent to the very steep slopes. - Overall, sites are not suitable for timber harvest because of severe erosion hazards and potential juniper competition.	- Soil loss close to natural conditions. - Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling. - Limit unacceptable risk of excessive moderate / high burn severity within large portions of watershed.	- Reduce risk of moderate or high burn severity to watershed from wildfire.	- Consider allowing maintenance or operational prescribed fires under proper soil, fuel, and weather conditions where tree density and fuels are greatly departed from desired condition.

Strata (Aggregated Terrestrial Ecological Units)	Existing Condition	Desired Condition	Need For Change	Potential Management Strategies
	- Risk of moderate or high severity fire where tree stand density and canopy cover exceed PPC.			
5 - CNF TES Map Units 436, 437, A-S Map Units 51, 52, TNF TES Map Unit 208. Total acres = 12,643.2* **Pinyon-Juniper Woodlands (< 40% slopes) on Calcareous Soils** **Potential Plant Community (PPC): PIED/JUMO/COMES/STCO4 ; ACGR/BOGR2/COMES/STCO4**** ***Only 1443 acres or 11% are on CNF. Rest is on A-S. ** only 0.1 acres of unit with this PPC.**	- Overall soil condition is variable from impaired to satisfactory. - Current soil loss is below tolerance and soil stability (ability of soil to resist erosion) is generally satisfactory. Some locations may be slightly impaired as evidenced by minor grass and forb pedestaling and bare soil exposure (particularly on moderately steep grades with slopes > 15%) - Soil hydrologic function is largely unknown but likely satisfactory with surface soils well aggregated and sufficient porosity to effectively infiltrate water on CNF. On A-S, soil hydrologic function is slightly impaired from sheet erosion on slopes > 15 – 20% evidenced by water-compacted surface soil crusting. On slopes < 15 percent, soil hydrologic function is satisfactory on A-S. - Soil nutrient cycling is impaired with reduced VGC, vegetation composition, and production. Sufficient root distribution and turnover is reduced as well. - Stand canopy cover > 40% typically contributes to degraded herbaceous veg. productivity from overstory vs understory competition for site resources (e.g. sunlight, water, soil nutrients, etc.). - Overall, sites are not suitable for timber harvest since the veg. type is PJ Persistent Woodland. - Risk of moderate or high severity fire where tree stand density and canopy cover exceed PPC.	- Overall soil condition is satisfactory. - Soil loss below tolerance and no visible signs of excessive erosion. - Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling. - Desired stand structure is tree canopy covers below PPC or below 35%.	- Improve understory VGC, including herbaceous plant basal area.. - Consider reduction in tree stand density to improve understory productivity. - Reduce risk of moderate or high burn severity to watershed from fire.	- PJ restoration including thinning, lop and scatter and other identified silvicultural treatments where tree canopy cover exceeds PPC or 35%. - Allow maintenance/operational prescribed fires under proper soil, fuel, and weather conditions where needed. - Site-specific determinations for potential native grass seeding where PJ thinning and prescribed fire were not successful in rejuvenating herbaceous understory. - Consider livestock deferral and/or conservative allowable use (25 - 35%).

Strata (Aggregated Terrestrial Ecological Units)	Existing Condition	Desired Condition	Need For Change	Potential Management Strategies
6 - CNF TES Map Units 438, 465, 490, 495, A-S Map Units 53, 61, 503, TNF TES Map Units 493, 494, 495, 496, 497, 4170, 4240, 4451, 3710, 4140, 492, 501, 421, 455, 461. Total acres = 36,660.2 **Pinyon-Juniper Woodlands (< 40% slopes) on Fine-textured Soils** **Potential Plant Community (PPC): High productivity PJ Woodlands. PIED/JUDE2/JUMO/JUOS/BOGR2 ; PIED/JUDE2/JUMO/QUGA ; Pimo/Jude2/Qutus or Qugr3**	- Overall soil condition is variable (satisfactory to unknown). - Current soil loss is below tolerance and soil stability (ability of soil to resist erosion) is satisfactory. - Soil hydrologic function is satisfactory to impaired with surface soils well aggregated and sufficient porosity to effectively infiltrate water except some compacted soils on A-S. - Soil nutrient cycling is satisfactory to impaired with VGC near PPC and vegetation composition/ diversity near PPC. Many/common roots are present in the soil surface. - Some areas have canopy cover > 40 percent contributing to poor veg. productivity from overstory vs. understory competition for site resources (e.g. sunlight, water, soil nutrients, etc.). - Risk of moderate or high burn severity to watershed from wildfire where canopy cover is higher than PPC. - TEUI unit 455 is a fire climax Qutu2/Arpr. Unit 502 is Vertic.	- Overall soil condition is satisfactory. - Soil loss below tolerance and no visible signs of excessive erosion. - Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling. - Desired stand structure is tree canopy covers below PPC or between 10 – 20%.	- Improve understory VGC including herbaceous plant basal area. - Consider reduction in tree stand density to improve vegetation productivity where canopy cover exceeds PPC or 20%. - Reduce risk of moderate or high burn severity to watershed from areas of high PJ canopy cover density.	- PJ restoration including thinning, lop and scatter and other identified silvicultural treatments where tree canopy cover exceeds PPC. Mollisols thin for more openness (438, 493). TNF map unit 455 is fire climax so maintain as shrub dominated PPC Qutu2/Arpu5. - Allow maintenance or operational prescribed fires under proper soil, fuel, and weather conditions where needed. - Site-specific determinations for potential native grass seeding where PJ thinning and prescribed fire were not successful in rejuvenating herbaceous understory.
7 - CNF TES Map Units 439, A-S Map Units 54, 540, 575 Total acres = 3,113.2 **Pinyon-juniper woodlands (< 15% slopes) on Fine-textured Soils**	- Overall soil condition is mostly satisfactory and some impaired. Current soil loss is below tolerance but soil stability is impaired. Accelerated sheet erosion is evident from areas of contiguous grass / forb pedestaling and bare soil exposure. Minor rilling is common and connected in some	- Overall soil condition is satisfactory. - Soil loss below tolerance and no visible signs of excessive erosion. - Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water.	- Improve understory VGC including herbaceous plant basal area. - Improve herbaceous vegetation composition and production. - Improve surface soil structure and surface	- PJ restoration including thinning, lop and scatter, and other identified silvicultural treatments where tree canopy cover exceeds PPC. - Allow maintenance prescribed fires under proper soil, fuel, and weather conditions where needed.

Strata (Aggregated Terrestrial Ecological Units)	Existing Condition	Desired Condition	Need For Change	Potential Management Strategies
Potential Plant Community (PPC): PASM/BOGR2/STCO4 ; PASM/BOGR2/JUDE2/PIED ; PIED/JUNIP/ERNAN5/FAPA/BOGR2 **Most on A-S.**	locations. Gullying is present, but is much less common and disconnected. - Soil hydrologic function is variable on CNF, but usually impaired and shows evidence of compaction on many soils with surface soils blocky or platy and poor porosity to effectively infiltrate water. On A-S, soil hydrologic function is impaired and compacted evidenced by platy surface soil structure and contiguous extents of water-compacted soil crusting from accelerated sheet erosion. Sufficient tubular pore distribution is lacking to effectively infiltrate water. - Soil nutrient cycling is generally satisfactory on CNF with VGC, vegetation composition and diversity near PPC. On A-S, changes in veg. composition indicates a shift towards a drier, less productive plant community. Distribution of litter across the soil surface is below potential on most sites. - On CNF, some areas have encroached pinyon-juniper trees. On A-S, many potential grasslands have been encroached to varying degrees by pinyon / juniper trees.	- Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling. - Desired stand structure is Grassland with tree canopy covers below PPC or below 10%.	tubular porosity to improve site stability and hydrology. - Reduction in tree stand density to improve vegetation productivity and VGC where canopy cover exceeds PPC or 10%.	- Deferral of livestock grazing and/or conservative allowable use (25 – 35%). - Site-specific determinations for potential native grass seeding if thinning and prescribed fire is not successful in rejuvenating herbaceous productivity.
8 - CNF TES Map Units 453, 454, 492, A-S TES Map Units, 58, 502, 580, TNF TES Map Unit 490, 470, 478, 485. Total acres = 17,509.6 **Very Fine-textured (Vertic) Soils.**	- Overall soil condition is impaired and some unsatisfactory. - Current soil loss is below tolerance and soil stability (ability of soil to resist erosion) is satisfactory. - Soil hydrologic function is satisfactory with surface soils well aggregated and sufficient porosity to effectively infiltrate water. - Soil nutrient cycling is satisfactory with VGC and vegetation composition /	- Overall soil is satisfactory. - Soil loss below tolerance and no visible signs of excessive erosion. - Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is	- Reduction in tree stand density to improve veg productivity and VGC where canopy cover exceeds PPC or 10%. - Reduce risk of moderate or high burn severity to watershed from fire.	- Grassland restoration including thinning, lop and scatter, and other identified silvicultural treatments where tree canopy cover exceeds PPC. These are grasslands or PJ savanna type on TNF with low tree canopy cover (<10%) in PPC. - Allow maintenance prescribed fires under proper soil, fuel, and weather conditions where needed.

Strata (Aggregated Terrestrial Ecological Units)	Existing Condition	Desired Condition	Need For Change	Potential Management Strategies
Potential Plant Community (PPC): Grasslands some PJ mixed. Agsm/Bogr2, Pasm/Bogr2/Jude2/Pied	diversity near PPC. Many/common roots are present in the soil surface. - Overall, site is not suitable for timber harvest since it is Grassland. - Risk of moderate or high burn severity to watershed from wildfire where canopy cover is higher than PPC. CNF units are converted PJ to grasslands and will be maintained as grasslands.	present in the surface soil to promote satisfactory nutrient cycling. - Desired stand structure is tree canopy covers below PPC or below 10%.		
9 - CNF TES Map Unit 493, TNF TES Map Units 441, 462, 468, 473, 477, 481, 484, 486, 488, 491, 499, 510, 4161, 4175, 4241, 4457, 4468, 5471. Total acres = 21,424.9 **High Productivity – Pinyon/Juniper Transition Woodland (15- 40-60% slopes) on fine textured soils.** **Dominant Potential Plant Community (PPC): Pimo/Jude2/Qugr3/Qutu2/Arpu5,** ***Over 95% on TNF. Interpretation TBD with ongoing TEUI.**	- Overall soil condition is satisfactory and some impaired. - Current soil loss is below tolerance and soil stability (ability of soil to resist erosion) is satisfactory. - Soil hydrologic function is satisfactory with surface soils well aggregated and sufficient porosity to effectively infiltrate water. - Soil nutrient cycling is satisfactory and impaired with VGC and veg. composition near PPC except where tree stand density and canopy cover exceeds PPC. VGC is adequate enough to protect against accelerated erosion. Many/common roots are present in the soil surface. - Soil erosion hazard is rated as moderate – severe - Risk of moderate or high severity fire where tree stand density and canopy cover exceed PPC. TNF map unit 484 has transitional Pipos on north aspects and PJ on south. TNF map unit 488 is sandy textured.	- Overall soil condition is satisfactory. - Soil loss below tolerance and no visible signs of excessive erosion. - Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling. - Reduced tree stand density approaching a more open stand structure with large, herbaceous interspaces.	- Reduce tree stand density for improved understory herbaceous regeneration & VGC where canopy cover exceeds PPC or as determined by IDT. - Reduce risk of moderate or high burn severity to watershed from fire.	-PJ restoration - thinning (lop and scatter) and other identified silvicultural treatments where needed. - Allow maintenance or operational prescribed fires under proper soil, fuel, and weather conditions.
10 - CNF TES Map Unit 515. Total acres = 12,132.4*	- Overall soil condition is impaired.	- Overall soil condition is satisfactory. - Soil loss below tolerance and no visible signs of excessive erosion.	- Improve understory VGC, including	- Grassland restoration including thinning, lop and scatter, and other identified silvicultural treatments

Strata (Aggregated Terrestrial Ecological Units)	Existing Condition	Desired Condition	Need For Change	Potential Management Strategies
Great Basin Grasslands (< 15% slopes) on Very-fine (Vertic) Textured Soils with CHNA2 Component **Potential Plant Community (PPC): AGSM/CHNA2** ***All on CNF.**	- Current soil loss is below tolerance and soil stability (ability of soil to resist erosion) is satisfactory. - Soil hydrologic function is impaired and shows evidence of compaction on many soils with surface soil blocky or platy structure and poor surface porosity for adequately infiltrating water. - Soil nutrient cycling ranges from satisfactory to slightly impaired with VGC, vegetation composition and diversity slightly below PPC. Root distribution is relatively low and turnover is lacking. - Overall, site is not suitable for timber harvest since it is a Grassland. - Some areas have encroaching ponderosa pine, pinyon, and juniper trees.	- Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling. - Desired stand structure is Grassland with tree canopy covers below PPC or below 10%.	herbaceous plant basal area. - Improve surface soil structure and surface porosity to increase infiltration. - Reduction in tree stand density to improve veg. productivity where canopy cover exceeds PPC or 10%.	where tree canopy cover exceeds PPC or 10%. - Allow maintenance prescribed fires under proper soil, fuel, and weather conditions where needed. - Coordination of elk hunting permits with G&F. - Deferral of livestock grazing and/or conservative allowable use (25 – 35%). - Consider site specific determinations for native grass seeding if thinning and prescribed fire is not successful in rejuvenating herbaceous vegetation.
11 - CNF TES Map Units 500, 523, A-S TES Map Units 178, 186, 187, 523. **Total acres = 72,184.1** **Ponderosa Pine – Pinyon/Juniper Transition Woodland (< 40% slopes) on Soils Derived from Basalt and Cinders** **Potential Plant Community (PPC): PIPOS/PIED/JUMO/ QUGA ; PIPOS/PIED/JUDE2/ JUMO**	- Overall soil condition is satisfactory. - Current soil loss is below tolerance and soil stability (ability of soil to resist erosion) is satisfactory. - Soil hydrologic function is satisfactory with surface soils well aggregated and sufficient porosity to effectively infiltrate water. - Soil nutrient cycling is satisfactory with VGC and veg. composition near PPC except where tree stand density and canopy cover exceeds PPC. VGC is adequate enough to protect against accelerated erosion. Many/common roots are present in the soil surface. - Sites have low natural regeneration potential due to dry site conditions. and - Soil erosion hazards are rated as slight except for A-S unit 187 which is moderate.	- Overall soil condition is satisfactory. - Soil loss below tolerance and no visible signs of excessive erosion. - Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling. - Reduced tree stand density approaching a more open stand structure.	- Reduce tree stand density for improved understory herbaceous regeneration & VGC where canopy cover exceeds PPC or as determined by IDT. - Reduce risk of moderate or high burn severity to watershed from fire.	- Forest restoration including thinning and other identified silvicultural treatments where needed. Mollic integrade soils indicate (on CNF) low canopy covers of pine with herbaceous interspaces so can be thinned accordingly. CNF TEUI map units 500 and 523 and parts of A-S map unit 187 and 523 are Mollic integrade or Mollisols and can be thinned towards low Pipos canopy covers or savanna like but careful to avoid too much opening where Jude2 and Quga could takeover regeneration. - Allow maintenance prescribed fires under proper soil, fuel, and weather conditions.

Strata (Aggregated Terrestrial Ecological Units)	Existing Condition	Desired Condition	Need For Change	Potential Management Strategies
About half occurs on A-S and half on CNF.** * General site index classes are as follows:** **- Class I (high) – 75 or greater** **- Class II (moderate) –** **56 - 74** **- Class III (low) – 55 or less**	- Timber harvest limitations are severe due to low soil strength. - Timber production potential is dominated by site class III** (low – site index of 55 or less). - Risk of moderate or high severity fire where tree stand density and canopy cover exceed PPC.			
12 - CNF TES Map Units 527, A_S TES Map Units 505, 592, 624. Total acres = 10,108.0* **Ponderosa Pine – Alligator Juniper – Pinyon, Juniper (15-40% slopes)** **Potential Plant Community (PPC): PIPOS/Pied/JUDE2/Jumo** ***Most on CNF** **** General site index classes are as follows:** **- Class I (high) – 75 or greater** **- Class II (moderate) –** **56 - 74** **- Class III (low) – 55 or less**	- Overall soil condition in CNF is satisfactory and impaired on A-S. - Soil hydrologic function is satisfactory with surface soils well aggregated and sufficient porosity to effectively infiltrate water. - Soil nutrient cycling is satisfactory with VGC and veg. composition near PPC except where tree stand density and canopy cover exceeds PPC then is impaired. VGC is adequate enough to protect against accelerated erosion.. - Sites have low natural regeneration potential (too dry). - Soil erosion hazard is rated as moderate to severe. - Timber harvest limitations are moderate to severe due to low soil strength and high erosion. - Timber production potential is dominated by site class III** (low – site index of 55 or less). - Risk of moderate or high severity fire where tree stand density and canopy cover exceed PPC.	- Overall soil condition is satisfactory. - Soil loss below tolerance and no visible signs of excessive erosion. - Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling. - Reduced tree stand density approaching a more open stand structure.	- Reduce tree stand density for improved understory herbaceous regeneration & VGC where canopy cover exceeds PPC or as determined by IDT. - Improve surface soil structure and porosity by increasing herbaceous understory regeneration and overall VGC. - Reduce risk of moderate or high burn severity to watershed from fire.	- Forest restoration including thinning and other identified silvicultural treatments where needed with site-specific determinations to assess suitability of treatments since this unit has low natural regeneration potential. Mollisol soils dominate this strata indicating very open stands with large herbaceous understories. Candidate for intensive thinning perhaps 10-20% canopy cover of Pipos. - Allow maintenance prescribed fires under proper soil, fuel, and weather conditions. Follow soil and water BMPs to mitigate moderate and severe erosion hazard from mechanical harvesting.

Strata (Aggregated Terrestrial Ecological Units)	Existing Condition	Desired Condition	Need For Change	Potential Management Strategies
13 - CNF TES Map Unit 520, TNF TES Map Units 500, 5350, . Total acres = 9,407.3 **Ponderosa Pine – Pinyon-Alligator Juniper and Evergreen Oak Forest (< 15% slopes) on Soils Derived from Basalt and cinders.** **Potential Plant Community (PPC): PIPOS/Pifa/Jude2/Qutus/Quar/Quem** ***About 60 percent occurs on the CNF.** **** General site index classes are as follows:** **- Class I (high) – 75 or greater** **- Class II (moderate) – 56 - 74** **- Class III (low) – 55 or less**	- Overall soil condition is satisfactory. - Current soil loss is below tolerance and soil stability (ability of soil to resist erosion) is satisfactory. - Soil hydrologic function is satisfactory with surface soils well aggregated and sufficient porosity to effectively infiltrate water. - Soil nutrient cycling is satisfactory with VGC and veg. composition near PPC except where tree stand density and canopy cover exceeds PPC. VGC is adequate enough to protect against accelerated erosion. Many/common roots are present in the soil surface. - Sites have low natural regeneration potential (too dry). - Soil erosion hazard is rated as slight with map unit 5350 as moderate. - Timber harvest limitations are severe, low strength. - Timber production potential is dominated by site class III** (high – 45-55 site index). - Risk of moderate or high severity fire where tree stand density and canopy cover exceed PPC.	- Overall soil condition is satisfactory. - Soil loss below tolerance and no visible signs of excessive erosion. - Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling. - Reduced tree stand density.	- Reduce tree stand density for improved understory herbaceous regeneration & VGC where canopy cover exceeds PPC or as determined by IDT. - Reduce risk of moderate or high burn severity to watershed from fire.	- Forest restoration including thinning and other identified silvicultural treatments where needed. - Allow maintenance prescribed fires under proper soil, fuel, and weather conditions.
14 - TNF TES Map Units Map Units 505, 504, 5075, 5351. Total acres = 15,517.7 **Moderately Steep (16 - 40% slopes)** **Ponderosa Pine – Pinyon-Alligator**	- Overall soil condition is satisfactory. - Current soil loss is below tolerance and soil stability (ability of soil to resist erosion) is satisfactory. - Soil hydrologic function is satisfactory with surface soils well aggregated and sufficient porosity to effectively infiltrate water. - Soil nutrient cycling is satisfactory with VGC and veg. composition near PPC	- Overall soil condition is satisfactory. - Soil loss below tolerance and no visible signs of excessive erosion. - Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling in satisfactory condition with VGC approaching	- Reduce tree stand density for improved understory herbaceous regeneration & VGC where canopy cover exceeds PPC or as determined by IDT. - Reduce risk of moderate or high burn	- Forest restoration on forest soils including thinning and other identified silvicultural treatments where needed. - Allow maintenance prescribed fires under proper soil, fuel, and weather conditions.

Strata (Aggregated Terrestrial Ecological Units)	Existing Condition	Desired Condition	Need For Change	Potential Management Strategies
Juniper and Evergreen Oak Forest on Soils Derived from Basalt and cinders. **Potential Plant Community (PPC): PIPOS/Pifa/Jude2/Qutus/Quar/Quem** **All on TNF.** **** General site index classes are as follows:** **- Class I (high) – 75 or greater** **- Class II (moderate) – 56 - 74** **- Class III (low) – 55 or less**	except where tree stand density and canopy cover exceeds PPC. VGC is adequate enough to protect against accelerated erosion. Many/common roots are present in the soil surface. - Sites have low to moderate natural regeneration potential (too dry). - Soil erosion hazard is rated as severe. - Timber harvest limitations are moderate to severe due to low soil strength. - Timber production potential is dominated by site class III. Low at 55. - Risk of moderate or high severity fire where tree stand density and canopy cover exceed PPC.	natural conditions in PPC. Sufficient root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling. - Reduced tree stand density.	severity to watershed from fire.	
15 - CNF TES Map Units 572. TNF TES Map Units 530, 535, 5165, 5250, 5550, 5650. Total acres = 39,462.4* **< 15% slopes Ponderosa Pine – Alligator Juniper Evergreen Oak Forest on Soils Derived from sandstone or sedimentary rocks.** **Potential Plant Community (PPC): PIPOS/JUDE/Qugr/Quem/Arpr**	- Overall soil condition is satisfactory. - Current soil loss is below tolerance and soil stability (ability of soil to resist erosion) is satisfactory. - Soil hydrologic function is satisfactory with surface soils well aggregated and sufficient porosity to effectively infiltrate water. - Soil nutrient cycling is satisfactory with VGC and veg. composition near PPC except where tree stand density and canopy cover exceeds PPC. VGC is adequate enough to protect against accelerated erosion. Many/common roots are present in the soil surface. - Sites have moderate to high natural regeneration potential. - Soil erosion hazard is rated as slight.	- Overall soil condition is satisfactory. - Soil loss below tolerance and no visible signs of excessive erosion. - Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling. - Reduced tree stand density approaching a more open stand structure with large, herbaceous interspaces.	- Reduce tree stand density for improved understory herbaceous regeneration & VGC where canopy cover exceeds PPC or as determined by IDT. - Reduce risk of moderate or high burn severity to watershed from fire.	- Forest restoration on forest soils including thinning and other identified silvicultural treatments where needed. - Allow maintenance prescribed fires under proper soil, fuel, and weather conditions.

Strata (Aggregated Terrestrial Ecological Units)	Existing Condition	Desired Condition	Need For Change	Potential Management Strategies
About 75 percent occurs on the TNF.** * General site index classes are as follows:** **- Class I (high) – 75 or greater** **- Class II (moderate) – 56 - 74** **- Class III (low) – 55 or less**	- Timber harvest limitations are severe due to low soil strength. - Timber production potential is dominated by site class II (moderate) and I (high)** (moderate –70-75 site index). - Risk of moderate or high severity fire where tree stand density and canopy cover exceed PPC.			
16 - CNF TES Map Unit 530, TNF TES Map Units 524, 536, 550, 5074, 5251, 5551, 5651. Total acres = 70,230.9 **Ponderosa Pine – Alligator Juniper-Evergreen Oak Forest (15-40% slopes) on fine textured soils Derived from Basalt and Cinders** **Potential Plant Community (PPC): PIPOS/JUDE2/QUEM/QUGR3/QUTU2** ***About 85 percent occurs on the TNF.** **** General site index classes are as follows:** **- Class I (high) – 75 or greater**	- Overall soil condition is satisfactory except unsatisfactory on CNF map unit 530 due to accelerated erosion. - Current soil loss is below tolerance and soil stability (ability of soil to resist erosion) is satisfactory except on CNF - Soil hydrologic function is satisfactory with surface soils well aggregated and sufficient porosity to effectively infiltrate water. - Soil nutrient cycling is satisfactory with VGC and veg. composition near PPC except where tree stand density and canopy cover exceeds PPC. VGC is adequate enough to protect against accelerated erosion. Many/common roots are present in the soil surface. - Sites have moderate and low on CNF (plant competition) natural regeneration potential. - Dominant soil erosion hazard is rated as severe. - Timber harvest limitations are moderate severe due to low soil strength, high erosion. - Timber production potential is dominated by site class II to class I (70-75) with class III (low on CNF)*.	- Overall soil condition is satisfactory. - Soil loss below tolerance and no visible signs of excessive erosion. - Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling. - Reduced tree stand density.	- Reduce tree stand density for improved understory herbaceous regeneration & VGC where canopy cover exceeds PPC or as determined by IDT. - Reduce risk of moderate or high burn severity to watershed from fire.	- Forest restoration including thinning and other identified silvicultural treatments where needed. - Implement soil and water BMPs on moderate to severe erosion hazard soils. - Allow maintenance prescribed fires under proper soil, fuel, and weather conditions.

Strata (Aggregated Terrestrial Ecological Units)	Existing Condition	Desired Condition	Need For Change	Potential Management Strategies
- Class II (moderate) – 56 - 74 - Class III (low) – 55 or less	- Risk of moderate or high severity fire where tree stand density and canopy cover exceed PPC. TNF unit 510 has south aspects (about 30% of unit) PJ transition.			
17 - TNF TES Map Units 5252, 5352, 5368, 5452. Total acres = 15,100.4* Steep (40-80 % slopes) Ponderosa Pine and Alligator Juniper with Evergreen Oak Forest. Potential Plant Community (PPC): PIPOS/JUDE2/Qutu2 /QUGR3/ARPR *All on TNF.	- Overall soil condition is satisfactory or satisfactory inherently unstable or unsuited sue to steep slopes. - Current soil loss is above tolerance on most of strata and soil stability (ability of soil to resist erosion) is inherently unstable due to natural conditions (excessive slopes > 40%). - Soil hydrologic function is unrated, but likely satisfactory with surface soils well aggregated with sufficient porosity to effectively infiltrate water. - Soil nutrient cycling is unrated. VGC inadequate to protect against accelerated erosion on inherently unstable conditions. - Natural regeneration potential is low to moderate due to steep slope grades, plant competition, and naturally low effective VGC. Soil erosion hazard is severe. -Ultimately, sites cannot achieve sufficient cover due to severe erosion and soil loss inherent to the very steep slopes. - Sites are not suitable for timber harvest because of steep slopes and severe erosion hazards without proper BMPs. - Risk of moderate or high severity fire where tree stand density and canopy cover exceed PPC.	- Soil loss close to natural conditions. - Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling. - Limit unacceptable risk of excessive moderate / high burn severity within large portions of watershed.	- Reduce risk of moderate or high burn severity to watershed from wildfire.	- Consider allowing maintenance prescribed fires under proper soil, fuel and weather conditions where tree density and fuels are greatly departed from desired condition. - Use of specialized harvesting equipment may allow operations on steeper slopes with identified BMPS implemented. Viability and authorization of specialized equipment use above these slope gradients will be determined during the layout phase of a sale by the pre-sale forester AND a watershed specialist.
18 - CNF TES Map Unit 546, A-S TES Map Units 191, 193,	. - Overall soil condition is satisfactory.	- Overall soil condition is satisfactory. - Soil loss below tolerance and no visible signs of excessive erosion.	Reduce tree stand density for improved understory herbaceous	. - Forest restoration including thinning and other identified

Strata (Aggregated Terrestrial Ecological Units)	Existing Condition	Desired Condition	Need For Change	Potential Management Strategies
196, 197, and TNF TES Map Unit 5078. Total acres =180,525.5 * Ponderosa Pine – Gambel Oak Forest (< 15% slopes) on Soils Derived from Limestone, Sandstone, and/or Chert **Potential Plant Community (PPC): PIPOS/QUGA/MUVI ; PIPOS/QUGA** ***About 60 percent occurs on the A-S.** **** General site index classes are as follows:** **- Class I (high) – 75 or greater** **- Class II (moderate) – 56 - 74** **- Class III (low) – 55 or less**	- Current soil loss is below tolerance and soil stability (ability of soil to resist erosion) is satisfactory. - Soil hydrologic function is satisfactory with surface soils well aggregated and sufficient porosity to effectively infiltrate water. - Soil nutrient cycling is satisfactory with VGC and veg. composition near PPC except where tree stand density and canopy cover exceeds PPC. VGC is adequate enough to protect against accelerated erosion. Many/common roots are present in the soil surface. - Sites have high natural regeneration potential. - Soil erosion hazard is rated as slight - moderate - Timber harvest limitations are mostly severe and some slight due to low soil strength. - Timber production potential is site class I (high) and II (moderate)** (65 – 80 site index). - Risk of moderate or high severity fire where tree stand density and canopy cover exceed PPC.	- Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling. - Reduced tree stand density approaching a more open stand structure with large, herbaceous interspaces	regeneration & VGC where canopy cover exceeds PPC or as determined by IDT. - Reduce risk of moderate or high burn severity to watershed from fire.	silvicultural treatments where needed. - Allow maintenance prescribed fires under proper soil, fuel, and weather conditions.
19 - CNF TES Map Units 549, 550, 565, 584, A-S TES Map Units 182, 192, 199, 534, 538, 591, TNF TES Map Units 5079, 5080, 5161, 5162. Total acres = 206,360.3*	- Overall dominant soil condition is satisfactory. - Current soil loss is below tolerance and soil stability (ability of soil to resist erosion) is satisfactory except on TNF unit 5080 (Inherently Unstable). - Soil hydrologic function is satisfactory with surface soils well aggregated and	- Overall soil condition is satisfactory. - Soil loss below tolerance and no visible signs of excessive erosion. - Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water.	- Reduce tree stand density for improved understory herbaceous regeneration & VGC where canopy cover exceeds PPC or as determined by IDT. - Reduce risk of moderate or high burn	- Forest restoration including thinning and other identified silvicultural treatments where needed. Many soils (units 550, 584, 565, 591), are Mollic integrade and some Mollisols which indicate open canopy (<30%) and herbaceous understories.

Strata (Aggregated Terrestrial Ecological Units)	Existing Condition	Desired Condition	Need For Change	Potential Management Strategies
Moderately Steep to steep (15 - 40% slopes, some 15-80%) Ponderosa Pine – Gambel Oak Forest on Soils Derived from Limestone, Sandstone, and/or Chert **Potential Plant Community (PPC): PIPOS/QUGA and PIPOS/QUGA/MUVI 2.** **All 3 Forests have this.** **** General site index classes are as follows: - Class I (high) – 75 or greater - Class II (moderate) – 56 - 74 - Class III (low) – 55 or less**	sufficient porosity to effectively infiltrate water. - Soil nutrient cycling is satisfactory with VGC and veg. composition near PPC except where tree stand density and canopy cover exceeds PPC. VGC is adequate enough to protect against accelerated erosion. Many/common roots are present in the soil surface. - Sites have moderate to high natural regeneration potential. - Soil erosion hazard is rated as moderate some minor areas severe. - Timber harvest limitations are moderate to severe due to low soil strength. - Timber production potential is dominated by site class II to class I** (moderate to high – 65 – 75 site index). - Risk of moderate or high severity fire where tree stand density and canopy cover exceed PPC.	- Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling. - Reduced tree stand density approaching a more open stand structure with large, herbaceous interspaces.	severity to watershed from fire.	- Allow maintenance prescribed fires under proper soil, fuel, and weather conditions.
20 – A-S TES Map Unit 536. Total acres = 5,484.7* **Moderately Steep (16 - 40% slopes) Ponderosa Pine – Gambel Oak Forest on Erosive, Cinder Cone Soils**	- Overall soil condition is impaired. - Current soil loss is above tolerance and soil stability (ability of soil to resist erosion) is impaired as evidenced by grass and forb pedestaling, contiguous bare soil exposure, and some minor, discontinuous rilling in some locations. - Soil hydrologic function is slightly impaired from sheet erosion evidenced by block and platy surface soil structure and/or water-compacted surface soil	- Overall soil condition is satisfactory. - Soil loss below tolerance and no visible signs of excessive erosion. - Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient	- Reduce tree stand density for improved understory herbaceous regeneration & VGC where canopy cover exceeds PPC or as determined by IDT. - Improve soil surface structure and tubular porosity to more	- Tree stand density reduction and lop and scatter via hand-thinning methods in locations where tree canopy cover exceeds PPC. - Use BMP{s for cinder cone harvesting since these soils have severe erosion hazard. - Allow maintenance prescribed fires under proper soil, fuel, and weather conditions where needed.

Strata (Aggregated Terrestrial Ecological Units)	Existing Condition	Desired Condition	Need For Change	Potential Management Strategies
Potential Plant Community (PPC): PIPOS/QUGA ***All on A-S.** **** General site index classes are as follows:** **- Class I (high) – 75 or greater** **- Class II (moderate) –** **56 - 74** **- Class III (low) – 55 or less**	crusting. A lack of adequate tubular pore distribution is present at the soil surface in some locations as well. - Soil nutrient cycling is impaired with reduced VGC, vegetation composition, and production. Adequate root distribution and turnover is reduced as well. - Natural regeneration potential is rated as low to moderate due to low-moderate water holding capacity. - Soil erosion hazard is rated as severe. - Timber harvest limitations are rated as severe due to severe erosion hazards and low soil strength. - Timber production potential is rated as a site class II** (moderate – 60 – 65 side index). - Risk of moderate or high severity fire where tree stand density and canopy cover exceed PPC. - Overall, sites are not suitable for mechanical timber harvest as they have severe erosion hazards due to slope, an inherently erosive parent material, and current soil conditions that are in an impaired state.	root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling. - Reduced tree stand density approaching a more open stand structure with large, herbaceous interspaces.	effectively infiltrate water. - Reduce risk of moderate or high burn severity to watershed from fire.	
21 - CNF TES Map Units 582, 586, A-S TES Map Units 532, 537. Total acres =90,360.2 **Ponderosa Pine – Gambel Oak Forest (<15% slopes) on Mollisol Soils Derived from Basalt and Cinders**	- Overall soil condition is satisfactory. - Current soil loss is below tolerance and soil stability (ability of soil to resist erosion) is satisfactory. - Soil hydrologic function is satisfactory with surface soils well aggregated and sufficient porosity to effectively infiltrate water. - Soil nutrient cycling is satisfactory with VGC and veg. composition near PPC except where tree stand density and canopy cover exceeds PPC. VGC is adequate enough to protect against	- Overall soil condition is satisfactory. - Soil loss below tolerance and no visible signs of excessive erosion. - Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is	- Reduce tree stand density for improved understory herbaceous regeneration & VGC where canopy cover exceeds PPC or as determined by IDT. - Reduce risk of moderate or high burn severity to watershed from fire.	- Forest restoration on Mollisols or Mollic integrade soils including thinning and other identified silvicultural treatments where needed. Major portions of these soils (map units 582, 586 and some portions of A-S units 532 and 537) are Mollisols or Mollic integrade soils indicating open canopy (generally 10-30% canopy cover in late seral stage) with appreciable interspaces of herbaceous understory These are excellent

Strata (Aggregated Terrestrial Ecological Units)	Existing Condition	Desired Condition	Need For Change	Potential Management Strategies
Potential Plant Community (PPC): PIPOS/QUGA ***About 50 percent occurs on the CNF.** **** General site index classes are as follows:** **- Class I (high) – 75 or greater** **- Class II (moderate) –** **56 - 74** **- Class III (low) – 55 or less**	accelerated erosion. Many/common roots are present in the soil surface. - Sites have high natural regeneration potential. - Soil erosion hazard is rated as slight. - Timber harvest limitations are severe due to low soil strength. - Timber production potential is dominated by site class II to class I** (moderate to high – 65 – 75 site index). - Risk of moderate or high severity fire where tree stand density and canopy cover exceed PPC.	present in the surface soil to promote satisfactory nutrient cycling. - Reduced tree stand density approaching a more open stand structure with large, herbaceous interspaces.		candidates for intensive thinning to near savanna types (10-20% canopy cover) but consult silviculturalist based on evidence on-site. - Allow maintenance prescribed fires under proper soil, fuel, and weather conditions.
22.-CNF TES Map Units 567, 578, A-S TES Map Units 179, 181, 183. Total acres = 155,412.3* **Ponderosa Pine – Alligator Juniper - Gambel Oak Forest (<15% slopes) on Soils Derived from Sedimentary or Volcanic (Basalt) Parent Materials** **Potential Plant Community (PPC): PIPOS/JUDE2/QUGA** ***About 58% occurs on the A-S.**	- Overall soil condition is satisfactory except for A-S unit 181 which is impaired (18% of Stratum area). - Current soil loss is below tolerance and soil stability (ability of soil to resist erosion) is satisfactory except for A-S unit 181 in which soil stability is rated as impaired. Extent of high/moderate burn severity from the Rodeo-Chediski fire within unit 181has exacerbated sheet erosion to the point where grass/forb pedestaling is contiguous and bare soil exposure is relatively high in some locations. - Soil hydrologic function is satisfactory with surface soils well aggregated and sufficient porosity to effectively infiltrate water except for A-S map unit 181. Unit 181 soil hydrologic function is impaired as evidenced by platy surface soil structure and/or water-compacted surface crusting as well as poor distribution of tubular pores.	- Overall soil condition is satisfactory. - Soil loss below tolerance and no visible signs of excessive erosion. - Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling. - Reduced tree stand density approaching a more open stand structure with large, herbaceous interspaces.	- Reduce tree stand density for improved understory herbaceous regeneration & VGC where canopy cover exceeds PPC or as determined by IDT. - Reduce risk of moderate or high burn severity to watershed from fire. - Reduce juvenile juniper / oak encroachment in Rodeo-Chediski high/moderate burned areas within A-S map unit 181.	- Forest restoration on forest soils including thinning and other identified silvicultural treatments where needed. - Allow maintenance prescribed fires under proper soil, fuel, and weather conditions. For A-S map unit 181: - Consider site-specific determinations for the viability and suitability of potential maintenance prescribed fire treatment to reduce juniper / oak encroachment and help rejuvenate herbeacous vegetation growth / overall VGC. - If prescribed fire is not successful in achieving the aforementioned benefits, then consider the potential of native grass seeding in locations where treatment is suitable and has the greatest chance of success.

Strata (Aggregated Terrestrial Ecological Units)	Existing Condition	Desired Condition	Need For Change	Potential Management Strategies
**** General site index classes are as follows: - Class I (high) – 75 or greater - Class II (moderate) – 56 - 74 - Class III (low) – 55 or less**	- Soil nutrient cycling is satisfactory for all map units (except A-S unit 181) with VGC and veg. composition near PPC except where tree stand density and canopy cover exceeds PPC. VGC is adequate enough to protect against accelerated erosion. In A-S map unit 181, soil nutrient cycling is impaired due to VGC well below potential and a lack of root distribution / turnover in the soil surface in locations that were exposed to moderate to high burn severities. - Sites have moderate natural regeneration potential due to plant competition (JUDE2/ QUGA). Unit 181 has many locations that are encroached by juvenile JUDE2 and QUGA. - Soil erosion hazard is slight for all units except unit 181 where it is moderate due to current site conditions. - Timber harvest limitations are severe due to low soil strength. - A-S TES map unit 181 is not suitable for timber harvest due to fire effects from Rodeo-Chediski Fire. - Timber production potential is dominated by site class II** (moderate – 65 – 70 site index) in all units except 181. - Risk of moderate or high severity fire where tree stand density and canopy cover exceed PPC.			
23. - CNF TES Map Units 579, 585, TNF TES Map Units 6250, 6251. Total acres = 29,468.3* Ponderosa Pine – Alligator Juniper -	- Overall soil condition is satisfactory. - Current soil loss is below tolerance and soil stability (ability of soil to resist erosion) is satisfactory. - Soil hydrologic function is satisfactory with surface soils well aggregated and sufficient porosity to effectively infiltrate water.	- Overall soil condition is satisfactory. - Soil loss below tolerance and no visible signs of excessive erosion. - Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water.	- Reduce tree stand density for improved understory herbaceous regeneration & VGC where canopy cover exceeds PPC or as determined by IDT.	- Forest restoration on forest soils including thinning and other identified silvicultural treatments where needed. - Allow maintenance prescribed fires under proper soil, fuel, and weather conditions.

Strata (Aggregated Terrestrial Ecological Units)	Existing Condition	Desired Condition	Need For Change	Potential Management Strategies
Gambel Oak and Ponderosa Pine – Gambel Oak Forest (<15% slopes) on Shallow, Rocky Soils Derived from Basalt and Cinders **Potential Plant Community (PPC): PIPOS/JUDE2/QUGA ; PIPOS/QUGA** ***All on CNF.** **** General site index classes are as follows:** **- Class I (high) – 75 or greater** **- Class II (moderate) – 56 - 74** **- Class III (low) – 55 or less**	- Soil nutrient cycling is satisfactory with VGC and veg. composition near PPC except where tree stand density and canopy cover exceeds PPC. VGC is adequate enough to protect against accelerated erosion. Many/common roots are present in the soil surface. - Sites have low natural regeneration potential due to shallow, rocky soils. - Soil erosion hazard is rated as slight. - Timber harvest limitations are moderate to severe due to low soil strength and shallow/rocky soils. - Timber production potential is dominated by site class II** (moderate – 60 site index). - Risk of moderate or high severity fire where tree stand density and canopy cover exceed PPC.	- Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling. - Reduced tree stand density approaching a more open stand structure with large, herbaceous interspaces.	- Reduce risk of moderate or high burn severity to watershed from fire.	
24. TNF TES Map Units 6250, 6251. Total Acres 16,402 0-40% slopes. **Dry Mixed Conifer-Ponderosa Pine transitional forest. PPC is PSMEG/PIPOS/JUDE2/Evergreen Oak.**	Soil Condition and Interpretations are unknown with TEUI mapping and assessment in progress.	Overall soil condition is satisfactory. - Soil loss below tolerance and no visible signs of excessive erosion. - Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling.	Unknown.	- Dry mixed conifer restoration including thinning and other identified silvicultural treatments where needed. There is small areas of wet mixed conifer forests on steep sloped north aspects. Care to be taken since plant competition from evergreen oak shrubs is probable. - Allow maintenance prescribed fires under proper soil, fuel, and weather conditions.

Strata (Aggregated Terrestrial Ecological Units)	Existing Condition	Desired Condition	Need For Change	Potential Management Strategies
25 - CNF TES Map Unit 611, A-S TES Map Unit 561. Total acres = 2,457* **Dry Mixed Conifer Forest (<15% slopes) on Soils Derived from Volcanic Parent Material (Andesite, Basalt, and/or Cinders)** **Potential Plant Community (PPC): PSMEG/PIPOS/QUGA ; POTR5/PSMEG/PIPOS**** ***About 53% occurs on A-S and 47% on CNF.** ****Unit is mapped as a fire disclimax.** ***** General site index classes are as follows:** **- Class I (high) – 75 or greater** **- Class II (moderate) – 56 - 74** **- Class III (low) – 55 or less**	- Overall soil condition is satisfactory. - Current soil loss is below tolerance and soil stability (ability of soil to resist erosion) is satisfactory. - Soil hydrologic function is satisfactory with surface soils well aggregated and sufficient porosity to effectively infiltrate water. - Soil nutrient cycling is satisfactory with VGC and veg. composition near PPC except where tree stand density and canopy cover exceeds PPC. VGC is adequate enough to protect against accelerated erosion. Many/common roots are present in the soil surface. - Sites have high natural regeneration potential. - Soil erosion hazard is rated as slight to moderate. - Timber harvest limitations are moderate due to high erosion (unit 611) or low soil strength (unit 561). - Timber production potential is dominated by site class II*** (moderate – 60 – 70 site index). - CNF unit 611 is a fire-disclimax and the dominant overstory vegetation is POTR5, which is generally not a desirable timber product. - Risk of moderate or high severity fire where tree stand density and canopy cover exceed PPC.	- Overall soil condition is satisfactory. - Soil loss below tolerance and no visible signs of excessive erosion. - Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling. - Reduced tree stand density approaching a more open stand structure with large, herbaceous interspaces.	- Reduce tree stand density for improved understory herbaceous regeneration & VGC where canopy cover exceeds PPC or as determined by IDT. - Reduce risk of moderate or high burn severity to watershed from fire.	For A-S unit 561: - Forest restoration including thinning and other identified silvicultural treatments where needed. - Allow maintenance prescribed fires under proper soil, fuel, and weather conditions. For CNF unit 611: - Consider site-specific determinations to assess the viability and suitability for standard forest restoration thinning and other identified silvicultural treatments since this unit is dominated by aspen. - Allow maintenance prescribed fires under proper soil, fuel, and weather conditions.
26 – A-S TES Map Unit 567. Total acres = 3,030.8*	- Overall soil condition is satisfactory. - Current soil loss is below tolerance and soil stability (ability of soil to resist erosion) is satisfactory.	- Overall soil condition is satisfactory. - Soil loss below tolerance and no visible signs of excessive erosion.	- Reduce tree stand density for improved understory herbaceous regeneration & VGC	On slopes less than 25%: - Wet mixed conifer forest restoration including thinning and

Strata (Aggregated Terrestrial Ecological Units)	Existing Condition	Desired Condition	Need For Change	Potential Management Strategies
Moderately Steep (16 - 40% slopes) **Wet Mixed Conifer Forest on Erosive, Cinder Cone Soils** **Potential Plant Community (PPC): PSMEG/PIPOS/QUGA** ***All on A-S.** **** General site index classes are as follows:** **- Class I (high) – 75 or greater** **- Class II (moderate) – 56 - 74** **- Class III (low) – 55 or less**	- Soil hydrologic function is satisfactory with surface soils well aggregated and sufficient porosity to effectively infiltrate water. - Soil nutrient cycling is satisfactory with VGC and veg. composition near PPC except where tree stand density canopy cover exceeds PPC. VGC is adequate enough to protect against accelerated erosion. Many/common roots are present in the soil surface. - Sites have a moderate natural regeneration potential due to low to moderate water holding capacity. - Soil erosion hazard is rated as severe due to slope and inherently erodible cinder cone parent material. - Timber harvest limitations are severe due to severe erosion and low soil strength. - Timber production potential is dominated by site class II** (moderate – 65 site index). - Risk of moderate or high severity fire where tree stand density and canopy cover exceed PPC. - Overall, sites are typically suited for mechanical timber harvest up to 25 percent slope as long as erosion mitigation measures are implemented properly. Over 25 percent slope, only hand-thinning methods for tree removal are recommended due to very high erosion potential on these soils.	- Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling. - Reduced tree stand density approaching a more open stand structure with large, herbaceous interspaces.	where canopy cover exceeds PPC or as determined by IDT. - Reduce risk of moderate or high burn severity to watershed from fire.	other identified silvicultural treatments where needed in wet mixed conifer forest. - Allow maintenance prescribed fires under proper soil, fuel, and weather conditions. On slopes greater than 25%: - Tree stand density reduction via hand-thinning methods in locations where tree canopy cover exceeds PPC. - Allow maintenance prescribed fires under proper soil, fuel, and weather conditions where needed.
27 - CNF TES Map Units 650, 652, 653, A-S TES Map Units 201, 207, TNF TES Map Unit 612. Total acres = 27,473.5*	- Overall soil condition is satisfactory. - Current soil loss is below tolerance and soil stability (ability of soil to resist erosion) is satisfactory. - Soil hydrologic function is satisfactory with surface soils well aggregated and	- Overall soil condition is satisfactory. - Soil loss below tolerance and no visible signs of excessive erosion. - Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate	- Reduce tree stand density for improved understory herbaceous regeneration & VGC where canopy cover	- Dry mixed conifer forest restoration including thinning and other identified silvicultural treatments where needed on dry mixed conifer forests.

Strata (Aggregated Terrestrial Ecological Units)	Existing Condition	Desired Condition	Need For Change	Potential Management Strategies
Dry Mixed Conifer Forest (<15% slopes) on Soils Derived from Predominantly Sedimentary Parent Material **Potential Plant Community (PPC): ABCO/PSMEG/PIPOS/QUGA** ***About 68 percent occurs on CNF.** **** General site index classes are as follows:** **- Class I (high) – 75 or greater** **- Class II (moderate) – 56 - 74** **- Class III (low) – 55 or less**	sufficient porosity to effectively infiltrate water. - Soil nutrient cycling is satisfactory with VGC and veg. composition near PPC except where tree stand density and canopy cover exceeds PPC. VGC is adequate enough to protect against accelerated erosion. Many/common roots are present in the soil surface. - Sites have high natural regeneration potential. - Soil erosion hazard is rated as slight to moderate. - Timber harvest limitations are moderate to severe due to low soil strength or high erosion. - Timber production potential is dominated by site class I high and some II and III (low-moderate). TNF 612 is deep Mollisol and may have appreciable herbaceous understory. - Risk of moderate or high severity fire where tree stand density and canopy cover exceed PPC.	tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling. - Reduced tree stand density approaching a more open stand structure with large, herbaceous interspaces.	exceeds PPC or as determined by IDT. - Reduce risk of moderate or high burn severity to watershed from fire.	- Allow maintenance prescribed fires under proper soil, fuel, and weather conditions.
28. CNF TES Map Units 651, 654. A-S TES Map Units 202, 203, TNF TES Map Unit 652. Total acres = 36,683.8* **Moderately Steep (16 - 40% slopes) Wet Mixed Conifer Forest on Soils Derived from Sedimentary and Volcanic Parent Materials**	- Overall soil condition is satisfactory. - Current soil loss is below tolerance and soil stability (ability of soil to resist erosion) is satisfactory. - Soil hydrologic function is satisfactory with surface soils well aggregated and sufficient porosity to effectively infiltrate water. - Soil nutrient cycling is satisfactory with VGC and veg. composition near PPC except where tree stand density and canopy cover exceeds PPC. VGC is adequate enough to protect against accelerated erosion. Many/common roots are present in the soil surface.	- Overall soil condition is satisfactory. - Soil loss below tolerance and no visible signs of excessive erosion. - Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling.	- Reduce tree stand density for improved understory herbaceous regeneration & VGC where canopy cover exceeds PPC or as determined by IDT. - Reduce risk of moderate or high burn severity to watershed from fire.	- Wet mixed conifer forest restoration including thinning and other identified silvicultural treatments where needed appropriate for wet mixed confier forests. - Allow maintenance prescribed fires under proper soil, fuel, and weather conditions.

Strata (Aggregated Terrestrial Ecological Units)	Existing Condition	Desired Condition	Need For Change	Potential Management Strategies
Potential Plant Community (PPC): ABCO/PSMEG/PIPOS/QUGA ***About 54 percent occurs on A-S.** **** General site index classes are as follows:** **- Class I (high) – 75 or greater** **- Class II (moderate) –** **56 - 74** **- Class III (low) – 55 or less**	- Sites have high natural regeneration potential. - Soil erosion hazard is rated as moderate to severe. - Timber harvest limitations are moderate to severe due to low soil strength or high erosion. - Timber production potential is dominated by site class I** (high – 75 site index or greater). - Risk of moderate or high severity fire where tree stand density and canopy cover exceed PPC.	- Reduced tree stand density approaching a more open stand structure with large, herbaceous interspaces.		
29 - CNF TES Map Units 555, 575, 613, A-S TES Map Units 189, 206, TNF TES Map Units 613, 6252, 6368, 6652. Total acres = 87,807.6* **Steep (> 40% slopes) Ponderosa Pine and Wet Mixed Conifer Forest on Soils Derived from Sedimentary or Volcanic (Basalt) Parent Materials** **Potential Plant Community (PPC): PIPOS/QUGA ; PSMEG/PIPOS ; ABCO/PSMEG/PIPOS/QUGA**	- Overall soil condition is inherently unstable or unsuited. - Current soil loss is above tolerance and soil stability (ability of soil to resist erosion) is inherently unstable due to natural conditions (excessive slopes > 40%). - Soil hydrologic function is unrated, but likely satisfactory with surface soils well aggregated with sufficient porosity to effectively infiltrate water. - Soil nutrient cycling is unrated. VGC inadequate to protect against accelerated erosion on inherently unstable conditions. - Natural regeneration potential is low due to steep slope grades, plant competition, and naturally low effective VGC. Soil erosion hazard is severe. -Ultimately, sites cannot achieve sufficient cover due to severe erosion	- Soil loss close to natural conditions. - Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling. - Limit unacceptable risk of excessive moderate / high burn severity within large portions of watershed.	- Reduce risk of moderate or high burn severity to watershed from wildfire.	- Consider allowing maintenance prescribed fires under proper soil, fuel and weather conditions where tree density and fuels are greatly departed from desired condition. - Use of specialized harvesting equipment may allow operations on steeper slopes. Viability and authorization of specialized equipment use. Many south aspects are dominated by ponderosa poine and north by wet mixed conifer. above these slope gradients will be determined during the layout phase of a sale by the pre-sale forester AND a watershed specialist.

Strata (Aggregated Terrestrial Ecological Units)	Existing Condition	Desired Condition	Need For Change	Potential Management Strategies
***Most occurs on the A-S.**	and soil loss inherent to the very steep slopes. - Sites are not suitable for timber harvest because of steep slopes and severe erosion hazards. - Risk of moderate or high severity fire where tree stand density and canopy cover exceed PPC.			
30 - TNF TES Map Unit 470, 478, 485, and 490. Total acres = 861.5 **Very Fine-textured (Vertic) Soils.** **Potential Plant Community (PPC): Grasslands some PJ mixed. Agsm/Bogr2, Pasm/Bogr2/Jude2/Pied**	- Overall soil condition is satisfactory. - Current soil loss is below tolerance and soil stability (ability of soil to resist erosion) is satisfactory. - Soil hydrologic function is satisfactory with surface soils well aggregated and sufficient porosity to effectively infiltrate water. - Soil nutrient cycling is satisfactory with VGC and vegetation composition / diversity near PPC. Many/common roots are present in the soil surface. - Overall, site is not suitable for timber harvest since it is Grassland. - Risk of moderate or high burn severity to watershed from wildfire where canopy cover is higher than PPC. CNF units are converted PJ to grasslands and will be maintained as grasslands.	- Overall soil is satisfactory. - Soil loss below tolerance and no visible signs of excessive erosion. - Surface soil hydrologic soil function in satisfactory condition with granular surface soil structure and adequate tubular pore distribution to effectively infiltrate water. - Soil nutrient cycling in satisfactory condition with VGC approaching natural conditions in PPC. Sufficient root distribution and turnover is present in the surface soil to promote satisfactory nutrient cycling. - Desired stand structure is tree canopy covers below PPC or below 10%.	- Reduction in tree stand density to improve veg productivity and VGC where canopy cover exceeds PPC or 10%. - Reduce risk of moderate or high burn severity to watershed from fire.	- Grassland restoration including thinning, lop and scatter, and other identified silvicultural treatments where tree canopy cover exceeds PPC. These are grasslands or PJ savanna type on TNF with low tree canopy cover (<10%) in PPC. - Allow maintenance prescribed fires under proper soil, fuel, and weather conditions where needed.

Appendix C – Soil Erosion Modeling Results

Climate Station is located through CLIGEN PRISM Between Heber and Payson with 23.75 inches of annual precipitation at 7,050 feet. Outputs are in 100 year mean annual averages for a 20% probability of the output sediment yield.

The WEPP FuME interface is designed to predict sediment delivery from a variety of conditions, including undisturbed forest, wildfire, prescribed fire, thinning, and forest access roads.

Stratum 1

WEPP FuME **

Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	loam
Hillslope length	200 ft
Hillslope gradient	3 5 3 %
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	83.2	25	3.3
3	Prescribed fire	6.4	15	0.4
4	Thinning	0	25	0.0
5	Low access roads	0.0 to 2.8	1	0.0 to 2.8
6	High access roads	0.0 to 5.4	1	0.0 to 5.4

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 3.3 = 3.3 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 3.3 + (0.0 to 2.8) = 3.3 to 6.1 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 0 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.0 ton mi^{-2} y^{-1}. This is an increase of about 0 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 3.3 + 0.0 + (0.0 to 5.4) = 3.3 to 8.7 ton mi^{-2} y^{-1}. This is an increase of 0 to 164 percent above the background rate, if roads are not considered in the background, or 43 to 0 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 6.4 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 0.4 ton mi^{-2} y^{-1}. This is an increase of 12 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 3.3 + 0.4 + (0.0 to 2.8) = 3.7 to 6.5 tons mi^{-2} y^{-1}, or an increase of 12 to 97 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 3.3 + 0.0 + 0.4 + (0.0 to 5.4) = 3.7 to 9.1 ton mi^{-2} y^{-1}, an increase of 12 to 176 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 25.6 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 1.02 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 1.02 + 0 + 0.4 + (0.0 to 5.4) = 1.42 to 6.82 ton mi^{-2} y^{-1}, a decrease of -12 to 57 percent compared to background with roads or -107 to 57 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 2

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	loam
Hillslope length	200 ft
Hillslope gradient	3 5 3 %
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	83.2	25	3.3
3	Prescribed fire	6.4	15	0.4
4	Thinning	0	25	0.0
5	Low access roads	0.0 to 2.8	1	0.0 to 2.8
6	High access roads	0.0 to 5.4	1	0.0 to 5.4

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 3.3 = 3.3 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 3.3 + (0.0 to 2.8) = 3.3 to 6.1 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 0 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.0 ton mi^{-2} y^{-1}. This is an increase of about 0 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 3.3 + 0.0 + (0.0 to 5.4) = 3.3 to 8.7 ton mi^{-2} y^{-1}. This is an increase of 0 to 164 percent above the background rate, if roads are not considered in the background, or 43 to 0 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 6.4 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 0.4 ton mi^{-2} y^{-1}. This is an increase of 12 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 3.3 + 0.4 + (0.0 to 2.8) = 3.7 to 6.5 tons mi^{-2} y^{-1}, or an increase of 12 to 97 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 3.3 + 0.0 + 0.4 + (0.0 to 5.4) = 3.7 to 9.1 ton mi^{-2} y^{-1}, an increase of 12 to 176 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 25.6 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 1.02 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 1.02 + 0 + 0.4 + (0.0 to 5.4) = 1.42 to 6.82 ton mi^{-2} y^{-1}, a decrease of -12 to 57 percent compared to background with roads or -107 to 57 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 3

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	loam
Hillslope length	200 ft
Hillslope gradient	3 5 3 %
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	83.2	25	3.3
3	Prescribed fire	6.4	15	0.4
4	Thinning	0	25	0.0
5	Low access roads	0.0 to 2.8	1	0.0 to 2.8
6	High access roads	0.0 to 5.4	1	0.0 to 5.4

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 3.3 = 3.3 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 3.3 + (0.0 to 2.8) = 3.3 to 6.1 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 0 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.0 ton mi^{-2} y^{-1}. This is an increase of about 0 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 3.3 + 0.0 + (0.0 to 5.4) = 3.3 to 8.7 ton mi^{-2} y^{-1}. This is an increase of 0 to 164 percent above the background rate, if roads are not considered in the background, or 43 to 0 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 6.4 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 0.4 ton mi^{-2} y^{-1}. This is an increase of 12 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 3.3 + 0.4 + (0.0 to 2.8) = 3.7 to 6.5 tons mi^{-2} y^{-1}, or an increase of 12 to 97 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.
Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 3.3 + 0.0 + 0.4 + (0.0 to 5.4) = 3.7 to 9.1 ton mi^{-2} y^{-1}, an increase of 12 to 176 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 25.6 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 1.02 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 1.02 + 0 + 0.4 + (0.0 to 5.4) = 1.42 to 6.82 ton mi^{-2} y^{-1}, a decrease of -12 to 57 percent compared to background with roads or -107 to 57 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 4

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	sandy loam
Hillslope length	500 ft
Hillslope gradient	40 80 40 % *
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

* Hillslopes with greater than 50% gradient may be prone to mass failure.

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	1689.6	25	67.6
3	Prescribed fire	275.2	15	18.3
4	Thinning	0	25	0.0
5	Low access roads	0.0 to 11.6	1	0.0 to 11.6
6	High access roads	0.0 to 25.1	1	0.0 to 25.1

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 67.6 = 67.6 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 67.6 + (0.0 to 11.6) = 67.6 to 79.2 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 0 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.0 ton mi^{-2} y^{-1}. This is an increase of about 0 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 67.6 + 0.0 + (0.0 to 25.1) = 67.6 to 92.7 ton mi^{-2} y^{-1}. This is an increase of 0 to 37 percent above the background rate, if roads are not considered in the background, or 17 to 0 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 275.2 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 18.3 ton mi^{-2} y^{-1}. This is an increase of 27 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 67.6 + 18.3 + (0.0 to 11.6) = 85.9 to 97.5 tons mi^{-2} y^{-1}, or an increase of 27 to 44 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 67.6 + 0.0 + 18.3 + (0.0 to 25.1) = 85.9 to 111 ton mi^{-2} y^{-1}, an increase of 27 to 64 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 723.2 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 28.93 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 28.93 + 0 + 18.3 + (0.0 to 25.1) = 47.23 to 72.33 ton mi^{-2} y^{-1}, a decrease of 9 to 30 percent compared to background with roads or -7 to 30 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 5

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	sandy loam
Hillslope length	500 ft
Hillslope gradient	8 15 10 %
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	416	25	16.6
3	Prescribed fire	32	15	2.1
4	Thinning	0	25	0.0
5	Low access roads	0.0 to 2.4	1	0.0 to 2.4
6	High access roads	0.0 to 3.1	1	0.0 to 3.1

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 16.6 = 16.6 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 16.6 + (0.0 to 2.4) = 16.6 to 19 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 0 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.0 ton mi^{-2} y^{-1}. This is an increase of about 0 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 16.6 + 0.0 + (0.0 to 3.1) = 16.6 to 19.7 ton mi^{-2} y^{-1}. This is an increase of 0 to 19 percent above the background rate, if roads are not considered in the background, or 4 to 0 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 32 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 2.1 ton mi^{-2} y^{-1}. This is an increase of 13 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 16.6 + 2.1 + (0.0 to 2.4) = 18.7 to 21.1 tons mi^{-2} y^{-1}, or an increase of 13 to 27 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 16.6 + 0.0 + 2.1 + (0.0 to 3.1) = 18.7 to 21.8 ton mi^{-2} y^{-1}, an increase of 13 to 31 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 153.6 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 6.14 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 6.14 + 0 + 2.1 + (0.0 to 3.1) = 8.24 to 11.34 ton mi^{-2} y^{-1}, a decrease of 40 to 50 percent compared to background with roads or 32 to 50 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 6

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	sandy loam
Hillslope length	300 ft
Hillslope gradient	4 8 5 %
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	134.4	25	5.4
3	Prescribed fire	6.4	15	0.4
4	Thinning	0	25	0.0
5	Low access roads	0.0 to 2.4	1	0.0 to 2.4
6	High access roads	0.0 to 3.1	1	0.0 to 3.1

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 5.4 = 5.4 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 5.4 + (0.0 to 2.4) = 5.4 to 7.8 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 0 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.0 ton mi^{-2} y^{-1}. This is an increase of about 0 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 5.4 + 0.0 + (0.0 to 3.1) = 5.4 to 8.5 ton mi^{-2} y^{-1}. This is an increase of 0 to 57 percent above the background rate, if roads are not considered in the background, or 9 to 0 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 6.4 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 0.4 ton mi^{-2} y^{-1}. This is an increase of 7 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 5.4 + 0.4 + (0.0 to 2.4) = 5.8 to 8.2 tons mi^{-2} y^{-1}, or an increase of 7 to 52 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 5.4 + 0.0 + 0.4 + (0.0 to 3.1) = 5.8 to 8.9 ton mi^{-2} y^{-1}, an increase of 7 to 65 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 51.2 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 2.05 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 2.05 + 0 + 0.4 + (0.0 to 3.1) = 2.45 to 5.55 ton mi^{-2} y^{-1}, a decrease of 29 to 55 percent compared to background with roads or -3 to 55 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 7

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	loam
Hillslope length	300 ft
Hillslope gradient	15 30 20 %
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	550.4	25	22.0
3	Prescribed fire	51.2	15	3.4
4	Thinning	0	25	0.0
5	Low access roads	0.0 to 6.2	1	0.0 to 6.2
6	High access roads	0.0 to 11.7	1	0.0 to 11.7

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 22.0 = 22 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 22 + (0.0 to 6.2) = 22 to 28.2 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 0 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.0 ton mi^{-2} y^{-1}. This is an increase of about 0 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 22 + 0.0 + (0.0 to 11.7) = 22 to 33.7 ton mi^{-2} y^{-1}. This is an increase of 0 to 53 percent above the background rate, if roads are not considered in the background, or 20 to 0 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 51.2 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 3.4 ton mi^{-2} y^{-1}. This is an increase of 15 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 22 + 3.4 + (0.0 to 6.2) = 25.4 to 31.6 tons mi^{-2} y^{-1}, or an increase of 15 to 44 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 22 + 0.0 + 3.4 + (0.0 to 11.7) = 25.4 to 37.1 ton mi^{-2} y^{-1}, an increase of 15 to 69 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 204.8 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 8.19 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 8.19 + 0 + 3.4 + (0.0 to 11.7) = 11.59 to 23.29 ton mi^{-2} y^{-1}, a decrease of 17 to 47 percent compared to background with roads or -6 to 47 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 8

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	loam
Hillslope length	300 ft
Hillslope gradient	4 8 6 %
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	160	25	6.4
3	Prescribed fire	12.8	15	0.9
4	Thinning	0	25	0.0
5	Low access roads	0.0 to 2.8	1	0.0 to 2.8
6	High access roads	0.0 to 5.5	1	0.0 to 5.5

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 6.4 = 6.4 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 6.4 + (0.0 to 2.8) = 6.4 to 9.2 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 0 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.0 ton mi^{-2} y^{-1}. This is an increase of about 0 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 6.4 + 0.0 + (0.0 to 5.5) = 6.4 to 11.9 ton mi^{-2} y^{-1}. This is an increase of 0 to 86 percent above the background rate, if roads are not considered in the background, or 29 to 0 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 12.8 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 0.9 ton mi^{-2} y^{-1}. This is an increase of 14 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 6.4 + 0.9 + (0.0 to 2.8) = 7.3 to 10.1 tons mi^{-2} y^{-1}, or an increase of 14 to 58 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 6.4 + 0.0 + 0.9 + (0.0 to 5.5) = 7.3 to 12.8 ton mi^{-2} y^{-1}, an increase of 14 to 100 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 51.2 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 2.05 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 2.05 + 0 + 0.9 + (0.0 to 5.5) = 2.95 to 8.45 ton mi^{-2} y^{-1}, a decrease of 8 to 54 percent compared to background with roads or -32 to 54 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 9

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	sandy loam
Hillslope length	300 ft
Hillslope gradient	15 30 15 %
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	576	25	23.0
3	Prescribed fire	76.8	15	5.1
4	Thinning	0	25	0.0
5	Low access roads	0.0 to 3.0	1	0.0 to 3.0
6	High access roads	0.0 to 8.1	1	0.0 to 8.1

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 23.0 = 23 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 23 + (0.0 to 3.0) = 23 to 26 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 0 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.0 ton mi^{-2} y^{-1}. This is an increase of about 0 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 23 + 0.0 + (0.0 to 8.1) = 23 to 31.1 ton mi^{-2} y^{-1}. This is an increase of 0 to 35 percent above the background rate, if roads are not considered in the background, or 20 to 0 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 76.8 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 5.1 ton mi^{-2} y^{-1}. This is an increase of 22 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 23 + 5.1 + (0.0 to 3.0) = 28.1 to 31.1 tons mi^{-2} y^{-1}, or an increase of 22 to 35 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 23 + 0.0 + 5.1 + (0.0 to 8.1) = 28.1 to 36.2 ton mi^{-2} y^{-1}, an increase of 22 to 57 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 236.8 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 9.47 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 9.47 + 0 + 5.1 + (0.0 to 8.1) = 14.57 to 22.67 ton mi^{-2} y^{-1}, a decrease of 13 to 37 percent compared to background with roads or 1 to 37 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 10

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	loam
Hillslope length	300 ft
Hillslope gradient	4 10 6 %
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	198.4	25	7.9
3	Prescribed fire	12.8	15	0.9
4	Thinning	0	25	0.0
5	Low access roads	0.0 to 2.8	1	0.0 to 2.8
6	High access roads	0.0 to 5.5	1	0.0 to 5.5

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 7.9 = 7.9 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 7.9 + (0.0 to 2.8) = 7.9 to 10.7 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 0 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.0 ton mi^{-2} y^{-1}. This is an increase of about 0 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 7.9 + 0.0 + (0.0 to 5.5) = 7.9 to 13.4 ton mi^{-2} y^{-1}. This is an increase of 0 to 70 percent above the background rate, if roads are not considered in the background, or 25 to 0 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 12.8 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 0.9 ton mi^{-2} y^{-1}. This is an increase of 11 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 7.9 + 0.9 + (0.0 to 2.8) = 8.8 to 11.6 tons mi^{-2} y^{-1}, or an increase of 11 to 47 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 7.9 + 0.0 + 0.9 + (0.0 to 5.5) = 8.8 to 14.3 ton mi^{-2} y^{-1}, an increase of 11 to 81 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 70.4 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 2.82 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 2.82 + 0 + 0.9 + (0.0 to 5.5) = 3.72 to 9.22 ton mi^{-2} y^{-1}, a decrease of 14 to 53 percent compared to background with roads or -17 to 53 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 11

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	loam
Hillslope length	300 ft
Hillslope gradient	6 12 8 %
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	243.2	25	9.7
3	Prescribed fire	19.2	15	1.3
4	Thinning	0	25	0.0
5	Low access roads	0.0 to 2.8	1	0.0 to 2.8
6	High access roads	0.0 to 5.5	1	0.0 to 5.5

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 9.7 = 9.7 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 9.7 + (0.0 to 2.8) = 9.7 to 12.5 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 0 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.0 ton mi^{-2} y^{-1}. This is an increase of about 0 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 9.7 + 0.0 + (0.0 to 5.5) = 9.7 to 15.2 ton mi^{-2} y^{-1}. This is an increase of 0 to 57 percent above the background rate, if roads are not considered in the background, or 22 to 0 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 19.2 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 1.3 ton mi^{-2} y^{-1}. This is an increase of 13 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 9.7 + 1.3 + (0.0 to 2.8) = 11 to 13.8 tons mi^{-2} y^{-1}, or an increase of 13 to 42 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 9.7 + 0.0 + 1.3 + (0.0 to 5.5) = 11 to 16.5 ton mi^{-2} y^{-1}, an increase of 13 to 70 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 89.6 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 3.58 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 3.58 + 0 + 1.3 + (0.0 to 5.5) = 4.88 to 10.38 ton mi^{-2} y^{-1}, a decrease of 17 to 50 percent compared to background with roads or -7 to 50 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 12

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	loam
Hillslope length	200 ft
Hillslope gradient	10 20 15 %
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	313.6	25	12.5
3	Prescribed fire	25.6	15	1.7
4	Thinning	0	25	0.0
5	Low access roads	0.0 to 4.0	1	0.0 to 4.0
6	High access roads	0.0 to 8.1	1	0.0 to 8.1

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 12.5 = 12.5 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 12.5 + (0.0 to 4.0) = 12.5 to 16.5 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 0 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.0 ton mi^{-2} y^{-1}. This is an increase of about 0 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 12.5 + 0.0 + (0.0 to 8.1) = 12.5 to 20.6 ton mi^{-2} y^{-1}. This is an increase of 0 to 65 percent above the background rate, if roads are not considered in the background, or 25 to 0 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 25.6 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 1.7 ton mi^{-2} y^{-1}. This is an increase of 14 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 12.5 + 1.7 + (0.0 to 4.0) = 14.2 to 18.2 tons mi^{-2} y^{-1}, or an increase of 14 to 46 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 12.5 + 0.0 + 1.7 + (0.0 to 8.1) = 14.2 to 22.3 ton mi^{-2} y^{-1}, an increase of 14 to 78 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 121.6 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 4.86 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 4.86 + 0 + 1.7 + (0.0 to 8.1) = 6.56 to 14.66 ton mi^{-2} y^{-1}, a decrease of 11 to 48 percent compared to background with roads or -17 to 48 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 13

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	loam
Hillslope length	300 ft
Hillslope gradient	7 12 8 %
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	249.6	25	10.0
3	Prescribed fire	19.2	15	1.3
4	Thinning	0	25	0.0
5	Low access roads	0.0 to 2.8	1	0.0 to 2.8
6	High access roads	0.0 to 5.5	1	0.0 to 5.5

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 10.0 = 10 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 10 + (0.0 to 2.8) = 10 to 12.8 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 0 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.0 ton mi^{-2} y^{-1}. This is an increase of about 0 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 10 + 0.0 + (0.0 to 5.5) = 10 to 15.5 ton mi^{-2} y^{-1}. This is an increase of 0 to 55 percent above the background rate, if roads are not considered in the background, or 21 to 0 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 19.2 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 1.3 ton mi^{-2} y^{-1}. This is an increase of 13 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 10 + 1.3 + (0.0 to 2.8) = 11.3 to 14.1 tons mi^{-2} y^{-1}, or an increase of 13 to 41 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 10 + 0.0 + 1.3 + (0.0 to 5.5) = 11.3 to 16.8 ton mi^{-2} y^{-1}, an increase of 13 to 68 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 89.6 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 3.58 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 3.58 + 0 + 1.3 + (0.0 to 5.5) = 4.88 to 10.38 ton mi^{-2} y^{-1}, a decrease of 19 to 51 percent compared to background with roads or -4 to 51 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 14

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	sandy loam
Hillslope length	300 ft
Hillslope gradient	25 60 30 % *
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

* Hillslopes with greater than 50% gradient may be prone to mass failure.

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	992	25	39.7
3	Prescribed fire	134.4	15	9.0
4	Thinning	0	25	0.0
5	Low access roads	0.0 to 8.8	1	0.0 to 8.8
6	High access roads	0.0 to 17.9	1	0.0 to 17.9

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 39.7 = 39.7 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 39.7 + (0.0 to 8.8) = 39.7 to 48.5 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 0 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.0 ton mi^{-2} y^{-1}. This is an increase of about 0 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 39.7 + 0.0 + (0.0 to 17.9) = 39.7 to 57.6 ton mi^{-2} y^{-1}. This is an increase of 0 to 45 percent above the background rate, if roads are not considered in the background, or 19 to 0 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 134.4 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 9.0 ton mi^{-2} y^{-1}. This is an increase of 23 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 39.7 + 9.0 + (0.0 to 8.8) = 48.7 to 57.5 tons mi^{-2} y^{-1}, or an increase of 23 to 45 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 39.7 + 0.0 + 9.0 + (0.0 to 17.9) = 48.7 to 66.6 ton mi^{-2} y^{-1}, an increase of 23 to 68 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 428.8 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 17.15 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 17.15 + 0 + 9.0 + (0.0 to 17.9) = 26.15 to 44.05 ton mi^{-2} y^{-1}, a decrease of 9 to 34 percent compared to background with roads or -11 to 34 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 15

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	loam
Hillslope length	300 ft
Hillslope gradient	7 14 8 %
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	281.6	25	11.3
3	Prescribed fire	19.2	15	1.3
4	Thinning	0	25	0.0
5	Low access roads	0.0 to 2.8	1	0.0 to 2.8
6	High access roads	0.0 to 5.5	1	0.0 to 5.5

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 11.3 = 11.3 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 11.3 + (0.0 to 2.8) = 11.3 to 14.1 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 0 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.0 ton mi^{-2} y^{-1}. This is an increase of about 0 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 11.3 + 0.0 + (0.0 to 5.5) = 11.3 to 16.8 ton mi^{-2} y^{-1}. This is an increase of 0 to 49 percent above the background rate, if roads are not considered in the background, or 19 to 0 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 19.2 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 1.3 ton mi^{-2} y^{-1}. This is an increase of 12 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 11.3 + 1.3 + (0.0 to 2.8) = 12.6 to 15.4 tons mi^{-2} y^{-1}, or an increase of 12 to 36 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 11.3 + 0.0 + 1.3 + (0.0 to 5.5) = 12.6 to 18.1 ton mi^{-2} y^{-1}, an increase of 12 to 60 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 102.4 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 4.10 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 4.10 + 0 + 1.3 + (0.0 to 5.5) = 5.4 to 10.9 ton mi^{-2} y^{-1}, a decrease of 23 to 52 percent compared to background with roads or 4 to 52 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 16

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	loam
Hillslope length	300 ft
Hillslope gradient	30 40 25 %
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	684.8	25	27.4
3	Prescribed fire	70.4	15	4.7
4	Thinning	0	25	0.0
5	Low access roads	0.0 to 8.8	1	0.0 to 8.8
6	High access roads	0.0 to 17.3	1	0.0 to 17.3

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 27.4 = 27.4 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 27.4 + (0.0 to 8.8) = 27.4 to 36.2 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 0 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.0 ton mi^{-2} y^{-1}. This is an increase of about 0 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 27.4 + 0.0 + (0.0 to 17.3) = 27.4 to 44.7 ton mi^{-2} y^{-1}. This is an increase of 0 to 63 percent above the background rate, if roads are not considered in the background, or 23 to 0 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 70.4 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 4.7 ton mi^{-2} y^{-1}. This is an increase of 17 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 27.4 + 4.7 + (0.0 to 8.8) = 32.1 to 40.9 tons mi^{-2} y^{-1}, or an increase of 17 to 49 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 27.4 + 0.0 + 4.7 + (0.0 to 17.3) = 32.1 to 49.4 ton mi^{-2} y^{-1}, an increase of 17 to 80 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 262.4 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 10.50 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 10.50 + 0 + 4.7 + (0.0 to 17.3) = 15.2 to 32.5 ton mi^{-2} y^{-1}, a decrease of 10 to 45 percent compared to background with roads or -19 to 45 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 17

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	loam
Hillslope length	300 ft
Hillslope gradient	40 60 45 % *
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

* Hillslopes with greater than 50% gradient may be prone to mass failure.

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	889.6	25	35.6
3	Prescribed fire	102.4	15	6.8
4	Thinning	6.4	25	0.3
5	Low access roads	0.0 to 14.6	1	0.0 to 14.6
6	High access roads	0.0 to 26.7	1	0.0 to 26.7

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 35.6 = 35.6 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 35.6 + (0.0 to 14.6) = 35.6 to 50.2 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 6.4 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.3 ton mi^{-2} y^{-1}. This is an increase of about 1 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 35.6 + 0.3 + (0.0 to 26.7) = 35.9 to 62.6 ton mi^{-2} y^{-1}. This is an increase of 1 to 76 percent above the background rate, if roads are not considered in the background, or 25 to 1 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 102.4 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 6.8 ton mi^{-2} y^{-1}. This is an increase of 19 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 35.6 + 6.8 + (0.0 to 14.6) = 42.4 to 57 tons mi^{-2} y^{-1}, or an increase of 19 to 60 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 35.6 + 0.3 + 6.8 + (0.0 to 26.7) = 42.7 to 69.4 ton mi^{-2} y^{-1}, an increase of 20 to 95 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 345.6 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 13.82 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 13.82 + 0.3 + 6.8 + (0.0 to 26.7) = 20.92 to 47.62 ton mi^{-2} y^{-1}, a decrease of 5 to 41 percent compared to background with roads or -34 to 41 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 18

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	sandy loam
Hillslope length	200 ft
Hillslope gradient	8 14 10 %
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	198.4	25	7.9
3	Prescribed fire	19.2	15	1.3
4	Thinning	0	25	0.0
5	Low access roads	0.0 to 2.4	1	0.0 to 2.4
6	High access roads	0.0 to 3.1	1	0.0 to 3.1

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 7.9 = 7.9 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 7.9 + (0.0 to 2.4) = 7.9 to 10.3 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 0 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.0 ton mi^{-2} y^{-1}. This is an increase of about 0 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 7.9 + 0.0 + (0.0 to 3.1) = 7.9 to 11 ton mi^{-2} y^{-1}. This is an increase of 0 to 39 percent above the background rate, if roads are not considered in the background, or 7 to 0 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 19.2 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 1.3 ton mi^{-2} y^{-1}. This is an increase of 16 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 7.9 + 1.3 + (0.0 to 2.4) = 9.2 to 11.6 tons mi^{-2} y^{-1}, or an increase of 16 to 47 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 7.9 + 0.0 + 1.3 + (0.0 to 3.1) = 9.2 to 12.3 ton mi^{-2} y^{-1}, an increase of 16 to 56 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 76.8 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 3.07 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 3.07 + 0 + 1.3 + (0.0 to 3.1) = 4.37 to 7.47 ton mi^{-2} y^{-1}, a decrease of 27 to 45 percent compared to background with roads or 5 to 45 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 19

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	loam
Hillslope length	300 ft
Hillslope gradient	30 45 25 %
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	736	25	29.4
3	Prescribed fire	76.8	15	5.1
4	Thinning	0	25	0.0
5	Low access roads	0.0 to 9.5	1	0.0 to 9.5
6	High access roads	0.0 to 17.6	1	0.0 to 17.6

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 29.4 = 29.4 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 29.4 + (0.0 to 9.5) = 29.4 to 38.9 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 0 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.0 ton mi^{-2} y^{-1}. This is an increase of about 0 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 29.4 + 0.0 + (0.0 to 17.6) = 29.4 to 47 ton mi^{-2} y^{-1}. This is an increase of 0 to 60 percent above the background rate, if roads are not considered in the background, or 21 to 0 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 76.8 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 5.1 ton mi^{-2} y^{-1}. This is an increase of 17 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 29.4 + 5.1 + (0.0 to 9.5) = 34.5 to 44 tons mi^{-2} y^{-1}, or an increase of 17 to 50 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 29.4 + 0.0 + 5.1 + (0.0 to 17.6) = 34.5 to 52.1 ton mi^{-2} y^{-1}, an increase of 17 to 77 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 288 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 11.52 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 11.52 + 0 + 5.1 + (0.0 to 17.6) = 16.62 to 34.22 ton mi^{-2} y^{-1}, a decrease of 12 to 43 percent compared to background with roads or -16 to 43 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 20

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	clay loam
Hillslope length	300 ft
Hillslope gradient	20 35 25 %
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	12.8
2	Wildfire	729.6	25	29.2
3	Prescribed fire	96	15	6.4
4	Thinning	19.2	25	0.8
5	Low access roads	0.0 to 6.3	1	0.0 to 6.3
6	High access roads	0.0 to 13.0	1	0.0 to 13.0

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 12.8 + 29.2 = 42 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 42 + (0.0 to 6.3) = 42 to 48.3 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 19.2 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.8 ton mi^{-2} y^{-1}. This is an increase of about 2 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 42 + 0.8 + (0.0 to 13.0) = 42.8 to 55.8 ton mi^{-2} y^{-1}. This is an increase of 2 to 33 percent above the background rate, if roads are not considered in the background, or 16 to 2 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 96 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 6.4 ton mi^{-2} y^{-1}. This is an increase of 15 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 42 + 6.4 + (0.0 to 6.3) = 48.4 to 54.7 tons mi^{-2} y^{-1}, or an increase of 15 to 30 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 12.8 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 42 + 0.8 + 6.4 + (0.0 to 13.0) = 49.2 to 62.2 ton mi^{-2} y^{-1}, an increase of 17 to 48 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 320 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 12.80 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 12.80 + 13.6 + 6.4 + (0.0 to 13.0) = 32.8 to 45.8 ton mi^{-2} y^{-1}, a decrease of 5 to 22 percent compared to background with roads or -9 to 22 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 21

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	loam
Hillslope length	200 ft
Hillslope gradient	10 12 9 %
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	204.8	25	8.2
3	Prescribed fire	12.8	15	0.9
4	Thinning	0	25	0.0
5	Low access roads	0.0 to 2.8	1	0.0 to 2.8
6	High access roads	0.0 to 5.5	1	0.0 to 5.5

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 8.2 = 8.2 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 8.2 + (0.0 to 2.8) = 8.2 to 11 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 0 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.0 ton mi^{-2} y^{-1}. This is an increase of about 0 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 8.2 + 0.0 + (0.0 to 5.5) = 8.2 to 13.7 ton mi^{-2} y^{-1}. This is an increase of 0 to 67 percent above the background rate, if roads are not considered in the background, or 25 to 0 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 12.8 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 0.9 ton mi^{-2} y^{-1}. This is an increase of 11 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 8.2 + 0.9 + (0.0 to 2.8) = 9.1 to 11.9 tons mi^{-2} y^{-1}, or an increase of 11 to 45 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 8.2 + 0.0 + 0.9 + (0.0 to 5.5) = 9.1 to 14.6 ton mi^{-2} y^{-1}, an increase of 11 to 78 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 76.8 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 3.07 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 3.07 + 0 + 0.9 + (0.0 to 5.5) = 3.97 to 9.47 ton mi^{-2} y^{-1}, a decrease of 14 to 52 percent compared to background with roads or -15 to 52 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 22

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	sandy loam
Hillslope length	240 ft
Hillslope gradient	9 13 7 %
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	211.2	25	8.4
3	Prescribed fire	19.2	15	1.3
4	Thinning	0	25	0.0
5	Low access roads	0.0 to 2.4	1	0.0 to 2.4
6	High access roads	0.0 to 3.1	1	0.0 to 3.1

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 8.4 = 8.4 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 8.4 + (0.0 to 2.4) = 8.4 to 10.8 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 0 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.0 ton mi^{-2} y^{-1}. This is an increase of about 0 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 8.4 + 0.0 + (0.0 to 3.1) = 8.4 to 11.5 ton mi^{-2} y^{-1}. This is an increase of 0 to 37 percent above the background rate, if roads are not considered in the background, or 6 to 0 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 19.2 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 1.3 ton mi^{-2} y^{-1}. This is an increase of 15 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 8.4 + 1.3 + (0.0 to 2.4) = 9.7 to 12.1 tons mi^{-2} y^{-1}, or an increase of 15 to 44 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 8.4 + 0.0 + 1.3 + (0.0 to 3.1) = 9.7 to 12.8 ton mi^{-2} y^{-1}, an increase of 15 to 52 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 83.2 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 3.33 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 3.33 + 0 + 1.3 + (0.0 to 3.1) = 4.63 to 7.73 ton mi^{-2} y^{-1}, a decrease of 28 to 45 percent compared to background with roads or 8 to 45 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 23

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	loam
Hillslope length	230 ft
Hillslope gradient	5 14 11 %
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	243.2	25	9.7
3	Prescribed fire	19.2	15	1.3
4	Thinning	0	25	0.0
5	Low access roads	0.0 to 2.8	1	0.0 to 2.8
6	High access roads	0.0 to 5.5	1	0.0 to 5.5

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 9.7 = 9.7 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 9.7 + (0.0 to 2.8) = 9.7 to 12.5 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 0 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.0 ton mi^{-2} y^{-1}. This is an increase of about 0 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 9.7 + 0.0 + (0.0 to 5.5) = 9.7 to 15.2 ton mi^{-2} y^{-1}. This is an increase of 0 to 57 percent above the background rate, if roads are not considered in the background, or 22 to 0 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 19.2 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 1.3 ton mi^{-2} y^{-1}. This is an increase of 13 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 9.7 + 1.3 + (0.0 to 2.8) = 11 to 13.8 tons mi^{-2} y^{-1}, or an increase of 13 to 42 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 9.7 + 0.0 + 1.3 + (0.0 to 5.5) = 11 to 16.5 ton mi^{-2} y^{-1}, an increase of 13 to 70 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 89.6 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 3.58 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 3.58 + 0 + 1.3 + (0.0 to 5.5) = 4.88 to 10.38 ton mi^{-2} y^{-1}, a decrease of 17 to 50 percent compared to background with roads or -7 to 50 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 24

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	loam
Hillslope length	270 ft
Hillslope gradient	10 30 15 %
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	505.6	25	20.2
3	Prescribed fire	51.2	15	3.4
4	Thinning	0	25	0.0
5	Low access roads	0.0 to 6.2	1	0.0 to 6.2
6	High access roads	0.0 to 11.5	1	0.0 to 11.5

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 20.2 = 20.2 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 20.2 + (0.0 to 6.2) = 20.2 to 26.4 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 0 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.0 ton mi^{-2} y^{-1}. This is an increase of about 0 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 20.2 + 0.0 + (0.0 to 11.5) = 20.2 to 31.7 ton mi^{-2} y^{-1}. This is an increase of 0 to 57 percent above the background rate, if roads are not considered in the background, or 20 to 0 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 51.2 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 3.4 ton mi^{-2} y^{-1}. This is an increase of 17 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 20.2 + 3.4 + (0.0 to 6.2) = 23.6 to 29.8 tons mi^{-2} y^{-1}, or an increase of 17 to 48 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 20.2 + 0.0 + 3.4 + (0.0 to 11.5) = 23.6 to 35.1 ton mi^{-2} y^{-1}, an increase of 17 to 74 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 192 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 7.68 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 7.68 + 0 + 3.4 + (0.0 to 11.5) = 11.08 to 22.58 ton mi^{-2} y^{-1}, a decrease of 14 to 45 percent compared to background with roads or -12 to 45 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 25

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	loam
Hillslope length	220 ft
Hillslope gradient	10 14 8 %
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	243.2	25	9.7
3	Prescribed fire	19.2	15	1.3
4	Thinning	0	25	0.0
5	Low access roads	0.0 to 2.8	1	0.0 to 2.8
6	High access roads	0.0 to 5.5	1	0.0 to 5.5

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 9.7 = 9.7 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 9.7 + (0.0 to 2.8) = 9.7 to 12.5 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 0 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.0 ton mi^{-2} y^{-1}. This is an increase of about 0 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 9.7 + 0.0 + (0.0 to 5.5) = 9.7 to 15.2 ton mi^{-2} y^{-1}. This is an increase of 0 to 57 percent above the background rate, if roads are not considered in the background, or 22 to 0 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 19.2 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 1.3 ton mi^{-2} y^{-1}. This is an increase of 13 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 9.7 + 1.3 + (0.0 to 2.8) = 11 to 13.8 tons mi^{-2} y^{-1}, or an increase of 13 to 42 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 9.7 + 0.0 + 1.3 + (0.0 to 5.5) = 11 to 16.5 ton mi^{-2} y^{-1}, an increase of 13 to 70 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 89.6 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 3.58 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 3.58 + 0 + 1.3 + (0.0 to 5.5) = 4.88 to 10.38 ton mi^{-2} y^{-1}, a decrease of 17 to 50 percent compared to background with roads or -7 to 50 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 26

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	sandy loam
Hillslope length	280 ft
Hillslope gradient	30 35 28 %
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	646.4	25	25.9
3	Prescribed fire	83.2	15	5.5
4	Thinning	0	25	0.0
5	Low access roads	0.0 to 5.5	1	0.0 to 5.5
6	High access roads	0.0 to 11.2	1	0.0 to 11.2

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 25.9 = 25.9 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 25.9 + (0.0 to 5.5) = 25.9 to 31.4 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 0 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.0 ton mi^{-2} y^{-1}. This is an increase of about 0 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 25.9 + 0.0 + (0.0 to 11.2) = 25.9 to 37.1 ton mi^{-2} y^{-1}. This is an increase of 0 to 43 percent above the background rate, if roads are not considered in the background, or 18 to 0 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 83.2 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 5.5 ton mi^{-2} y^{-1}. This is an increase of 21 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 25.9 + 5.5 + (0.0 to 5.5) = 31.4 to 36.9 tons mi^{-2} y^{-1}, or an increase of 21 to 42 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 25.9 + 0.0 + 5.5 + (0.0 to 11.2) = 31.4 to 42.6 ton mi^{-2} y^{-1}, an increase of 21 to 64 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 275.2 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 11.01 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 11.01 + 0 + 5.5 + (0.0 to 11.2) = 16.51 to 27.71 ton mi^{-2} y^{-1}, a decrease of 12 to 36 percent compared to background with roads or -7 to 36 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 27

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	sandy loam
Hillslope length	275 ft
Hillslope gradient	9 14 11 %
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	256	25	10.2
3	Prescribed fire	25.6	15	1.7
4	Thinning	0	25	0.0
5	Low access roads	0.0 to 2.4	1	0.0 to 2.4
6	High access roads	0.0 to 3.1	1	0.0 to 3.1

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 10.2 = 10.2 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 10.2 + (0.0 to 2.4) = 10.2 to 12.6 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 0 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.0 ton mi^{-2} y^{-1}. This is an increase of about 0 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 10.2 + 0.0 + (0.0 to 3.1) = 10.2 to 13.3 ton mi^{-2} y^{-1}. This is an increase of 0 to 30 percent above the background rate, if roads are not considered in the background, or 6 to 0 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 25.6 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 1.7 ton mi^{-2} y^{-1}. This is an increase of 17 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 10.2 + 1.7 + (0.0 to 2.4) = 11.9 to 14.3 tons mi^{-2} y^{-1}, or an increase of 17 to 40 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 10.2 + 0.0 + 1.7 + (0.0 to 3.1) = 11.9 to 15 ton mi^{-2} y^{-1}, an increase of 17 to 47 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 102.4 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 4.10 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 4.10 + 0 + 1.7 + (0.0 to 3.1) = 5.8 to 8.9 ton mi^{-2} y^{-1}, a decrease of 29 to 43 percent compared to background with roads or 13 to 43 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 28

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	sandy loam
Hillslope length	300 ft
Hillslope gradient	10 27 18 %
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	524.8	25	21.0
3	Prescribed fire	64	15	4.3
4	Thinning	0	25	0.0
5	Low access roads	0.0 to 3.0	1	0.0 to 3.0
6	High access roads	0.0 to 8.1	1	0.0 to 8.1

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 21.0 = 21 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 21 + (0.0 to 3.0) = 21 to 24 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 0 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.0 ton mi^{-2} y^{-1}. This is an increase of about 0 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 21 + 0.0 + (0.0 to 8.1) = 21 to 29.1 ton mi^{-2} y^{-1}. This is an increase of 0 to 39 percent above the background rate, if roads are not considered in the background, or 21 to 0 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 64 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 4.3 ton mi^{-2} y^{-1}. This is an increase of 20 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 21 + 4.3 + (0.0 to 3.0) = 25.3 to 28.3 tons mi^{-2} y^{-1}, or an increase of 20 to 35 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 21 + 0.0 + 4.3 + (0.0 to 8.1) = 25.3 to 33.4 ton mi^{-2} y^{-1}, an increase of 20 to 59 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 217.6 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 8.70 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 8.70 + 0 + 4.3 + (0.0 to 8.1) = 13 to 21.1 ton mi^{-2} y^{-1}, a decrease of 12 to 38 percent compared to background with roads or -0 to 38 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 29

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	sandy loam
Hillslope length	300 ft
Hillslope gradient	65 90 55 % *
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

* Hillslopes with greater than 50% gradient may be prone to mass failure.

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	1216	25	48.6
3	Prescribed fire	166.4	15	11.1
4	Thinning	0	25	0.0
5	Low access roads	0.0 to 12.7	1	0.0 to 12.7
6	High access roads	0.0 to 28.9	1	0.0 to 28.9

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 0 + 48.6 = 48.6 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 48.6 + (0.0 to 12.7) = 48.6 to 61.3 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 0 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.0 ton mi^{-2} y^{-1}. This is an increase of about 0 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 48.6 + 0.0 + (0.0 to 28.9) = 48.6 to 77.5 ton mi^{-2} y^{-1}. This is an increase of 0 to 59 percent above the background rate, if roads are not considered in the background, or 26 to 0 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 166.4 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 11.1 ton mi^{-2} y^{-1}. This is an increase of 23 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 48.6 + 11.1 + (0.0 to 12.7) = 59.7 to 72.4 tons mi^{-2} y^{-1}, or an increase of 23 to 49 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 0 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 48.6 + 0.0 + 11.1 + (0.0 to 28.9) = 59.7 to 88.6 ton mi^{-2} y^{-1}, an increase of 23 to 82 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 537.6 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 21.50 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 21.50 + 0 + 11.1 + (0.0 to 28.9) = 32.6 to 61.5 ton mi^{-2} y^{-1}, a decrease of -0 to 33 percent compared to background with roads or -27 to 33 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

Stratum 30

WEPP FuME **
Fuel Management Erosion Analysis Results

Climate	**FLAGSTAFF WB AP AZ**
Soil texture	clay loam
Hillslope length	250 ft
Hillslope gradient	6 12 8 %
Buffer length	50 ft
Wildfire cycle	25 y
Prescribed fire cycle	15 y
Thinning cycle	25 y
Road density	4 mi mi^{-2}

Running **Disturbed WEPP** for Undisturbed forest ... Thinned forest ... Prescribed burn ... Wildfire ... Lower thinning ... Higher Rx fire ... Lower Rx fire ... Moderate wildfire ... Low wildfire ...
Running **WEPP:Road** for No traffic ... Low traffic ... High traffic ...

Output summary based on 50 years of possible weather

Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	6.4
2	Wildfire	307.2	25	12.3
3	Prescribed fire	32	15	2.1
4	Thinning	6.4	25	0.3
5	Low access roads	0.0 to 1.9	1	0.0 to 1.9
6	High access roads	0.0 to 5.3	1	0.0 to 5.3

Summary of Analysis

The output summary table presents the predicted sediment yield rates from seven runs with the WEPP model. The outputs from those runs were converted to common units of ton mi^{-2} y^{-1}. From these runs, several key watershed sedimentation values can be estimated.

Background sedimentation. The background sedimentation rate -- the rate that will occur with no action -- can be estimated either with or without roads. In the absence of roads, the background sedimentation rate is erosion from undisturbed forest plus erosion from wildfire. This value is the sum of lines 1 and 2, or 6.4 + 12.3 = 18.7 ton mi^{-2} y^{-1}. If the existing low access road network is included in the background sediment rate, then the background rate will be the sum of lines 1, 2, and 5, or 18.7 + (0.0 to 1.9) = 18.7 to 20.6 ton mi^{-2} y^{-1}, depending on what percent of the road network crosses live water during major runoff events.

Thinning effects. From the summary table, line 4, thinning will generate 6.4 tons of sediment the year following thinning, and when averaged over the thinning period of once in 25 years, will average about 0.3 ton mi^{-2} y^{-1}. This is an increase of about 2 percent above background without roads.

In order to carry out the thinning operation, however, traffic on the roads will have to be increased to the high access level to support the traffic associated with an ongoing thinning operation in the watershed. The total sediment yield from the watershed will then be the background value plus that from thinning and from high access roads for a total of 18.7 + 0.3 + (0.0 to 5.3) = 19 to 24.3 ton mi^{-2} y^{-1}. This is an increase of 2 to 30 percent above the background rate, if roads are not considered in the background, or 18 to 2 percent if the road network is considered in the background rate.

Further comparisons can be made by assuming that thinning will eliminate wildfire from the watershed, thus reducing the wildfire sedimentation value, or that thinning will lead to a less severe wildfire, and the moderate or low severity fire sedimentation rate from the table below can be substituted for the wildfire erosion rate in line 2.

Prescribed fire effects. From the summary table, line 3, prescribed fire will generate 32 ton mi^{-2} the year of the prescribed fire, or when averaged over the prescribed fire return period of 15 y, it will generate 2.1 ton mi^{-2} y^{-1}. This is an increase of 11 percent above background. As there will be no need for heavy traffic to carry out the prescribed burn, there is no increase in sedimentation from the road network. For a watershed with an active prescribed fire program, the total erosion will then be the background rate plus the low access road rate and the average erosion from prescribed fire, or 18.7 + 2.1 + (0.0 to 1.9) = 20.8 to 22.7 tons mi^{-2} y^{-1}, or an increase of 11 to 21 percent above background, if roads are not included in the background value.

If the prescribed fire eliminates the risk of wildfire, the background erosion rate will need to be set to 6.4 (line 1 of the outputs summary) for the analysis. Alternatively, the impact of the prescribed fire program may be to reduce the intensity of the wildfire, in which case, the sedimentation associated with a moderate or low severity fire from the following table can be substituted for the wildfire prediction for the analysis.

Combined thinning and prescribed fire effects. The combined effects of thinning and prescribed fire can be determined by summing up the background rate, the thinning rate, the prescribed fire rate, and the high access road rate. In this case, this leads to a total predicted erosion rate of 18.7 + 0.3 + 2.1 + (0.0 to 5.3) = 21.1 to 26.4 ton mi^{-2} y^{-1}, an increase of 13 to 41 percent above the background erosion rate without roads.

If this intensive fuel management scenario can reduce the severity of wildfire in the watershed, then the moderate severity fire sedimentation value of 121.6 ton mi^{-2} can be substituted for the wildfire erosion rate once every 25 years to give an average value of 4.86 ton mi^{-2} y^{-1}. Using this value to determine the total impact of fuel management gives 4.86 + 6.7 + 2.1 + (0.0 to 5.3) = 13.66 to 18.96 ton mi^{-2} y^{-1}, a decrease of 8 to 27 percent compared to background with roads or -1 to 27 percent compared to background without roads.

Road Impacts. The range of values given for road sedimentation represent the amount of sediment delivered across the buffer, and the amount delivered to a stream crossing. Roads with buffers greater than 50 ft will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies -- including minimizing rutting, minimizing stream crossings, and maximizing the use of buffers between the road and the stream -- are well established to minimize sedimentation. The WEPP:Road interface can be used to evaluate the impacts of some of these improved practices. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed with modern timber operations. Watershed managers may wish to offset the increase in sediment associated with fuel management with a decrease in sediment from improved road management or a reduction in road density.

The WEPP Erosion Risk Management Tool (ERMiT) interface (USDA, 2014) was used to model soil erosion and sediment delivery to connected streamcourses under low, moderate and high soil burn severity conditions.

Stratum 1

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **5%** rock fragment
3% top, 5% average, 3% toe hillslope gradient
500 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.063	**in**	annual runoff from rainfall from	17	events
0.044	**in**	annual runoff from snowmelt or winter rainstorm from	10	events

15 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms						
Storm Rank based on runoff (return interval)	**Storm Runoff (in)**	**Storm Precipitation (in)**	**Storm Duration (h)**	**10-min Peak Rainfall Intensity (in h^{-1})**	**30-min Peak Rainfall Intensity (in h^{-1})**	**Storm Date**
1	2.70	3.91	4.28	3.63	3.11	September 4 year 68
5 (20-year)	**0.52**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
10 (10-year)	**0.05**	**0.00**	**0.00**	**N/A**	**N/A**	**January 21 year 79**

Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	**Event sediment delivery (ton ac^{-1})**				
	Year following fire				
	1st year	**2nd year**	**3rd year**	**4th year**	**5th year**
Unburned	**0**	**0**	**0**	**0**	**0**

Return to input screen

Low Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **5%** rock fragment
3% top, 5% average, 3% toe hillslope gradient
500 ft hillslope horizontal length
low soil burn severity on forest

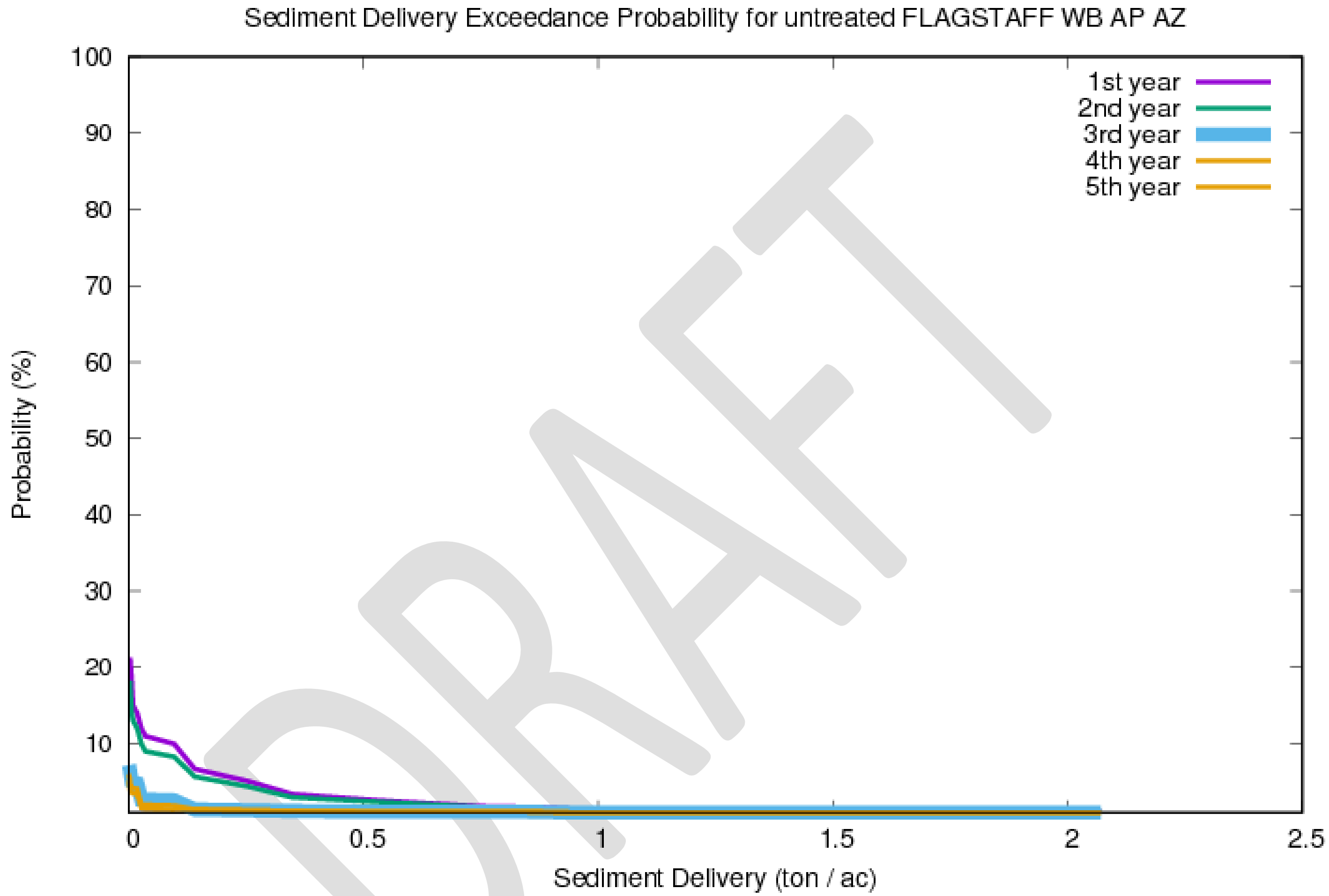
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.1	**in**	annual runoff from rainfall from	496	events
0.33	**in**	annual runoff from snowmelt or winter rainstorm from	120	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.94	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.83**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**

10 (10-year)	**1.56**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
20 (5-year)	**1.10**	**1.96**	**2.22**	**0.62**	**0.62**	**January 18 year 72**
50 (2-year)	**0.66**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**
75 (1 $^{1}/_{3}$-year)	**0.32**	**1.30**	**5.31**	**1.32**	**1.11**	**August 31 year 90**



10-26-2018 -- loam; 5% rock; 3%, 5%, 3% slope; 500 ft; low soil burn severity [wepp-51892]

Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	0	0	0	0	0
Seeding	0	0	0	0	0
Mulch (0.5 ton ac^{-1})	0	0	0	0	0
Mulch (1 ton ac^{-1})	0	0	0	0	0
Mulch (1.5 ton ac^{-1})	0	0	0	0	0
Mulch (2 ton ac^{-1})	0	0	0	0	0
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Moderate Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **5%** rock fragment
3% top, 5% average, 3% toe hillslope gradient
500 ft hillslope horizontal length
moderate soil burn severity on forest

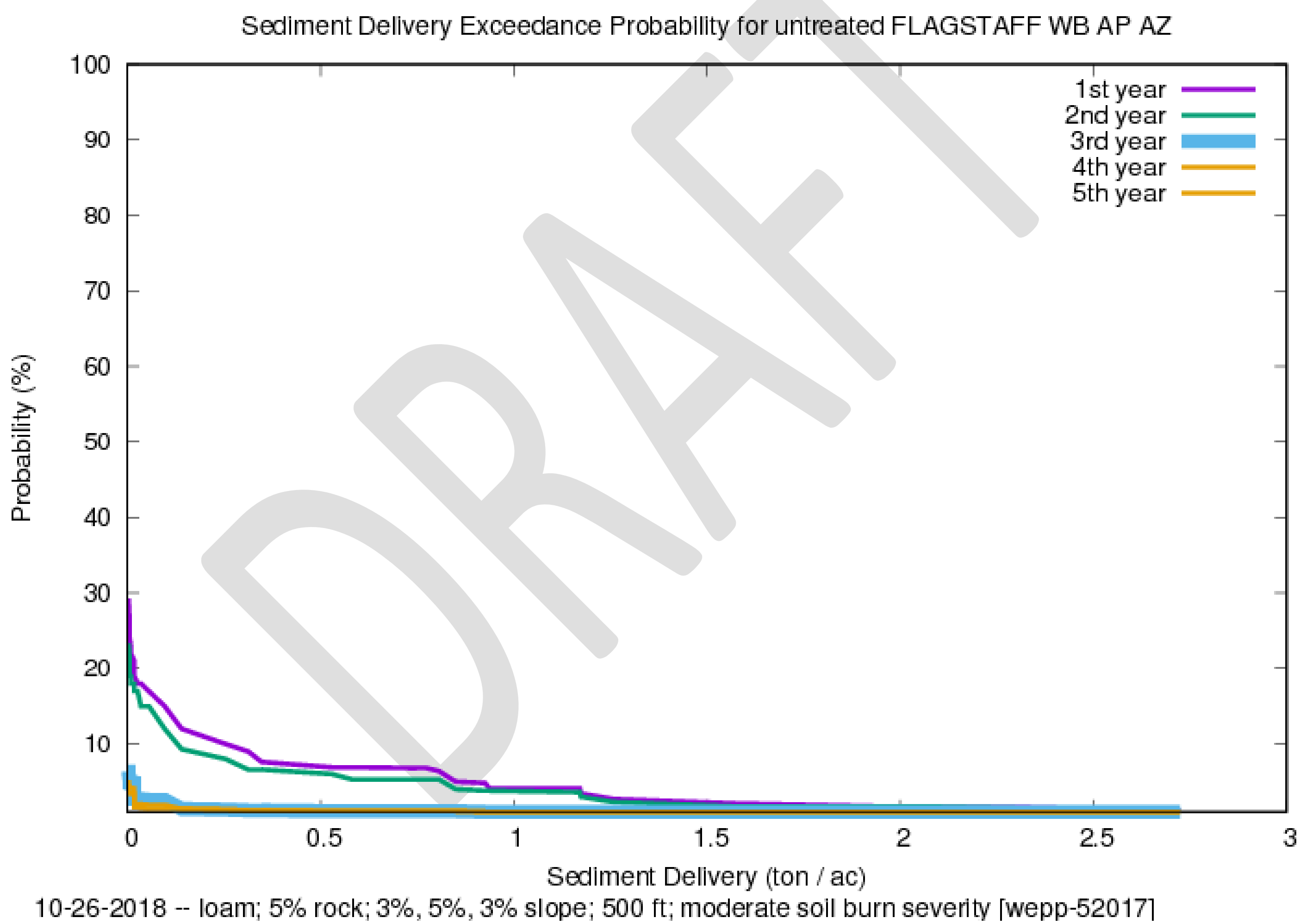
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.1	**in**	annual runoff from rainfall from	496	events
0.33	**in**	annual runoff from snowmelt or winter rainstorm from	120	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.94	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.83**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**
10 (10-year)	**1.56**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
20 (5-year)	**1.10**	**1.96**	**2.22**	**0.62**	**0.62**	**January 18 year 72**

50 (2-year)	**0.66**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**
75 (1$^{1}/_{3}$-year)	**0.32**	**1.30**	**5.31**	**1.32**	**1.11**	**August 31 year 90**



Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	0.02	0.01	0	0	0
Seeding	0.02	0	0	0	0
Mulch (0.5 ton ac^{-1})	0	0	0	0	0
Mulch (1 ton ac^{-1})	0	0	0	0	0
Mulch (1.5 ton ac^{-1})	0	0	0	0	0
Mulch (2 ton ac^{-1})	0	0	0	0	0
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

High Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **5%** rock fragment
3% top, 5% average, 3% toe hillslope gradient
500 ft hillslope horizontal length
high soil burn severity on forest

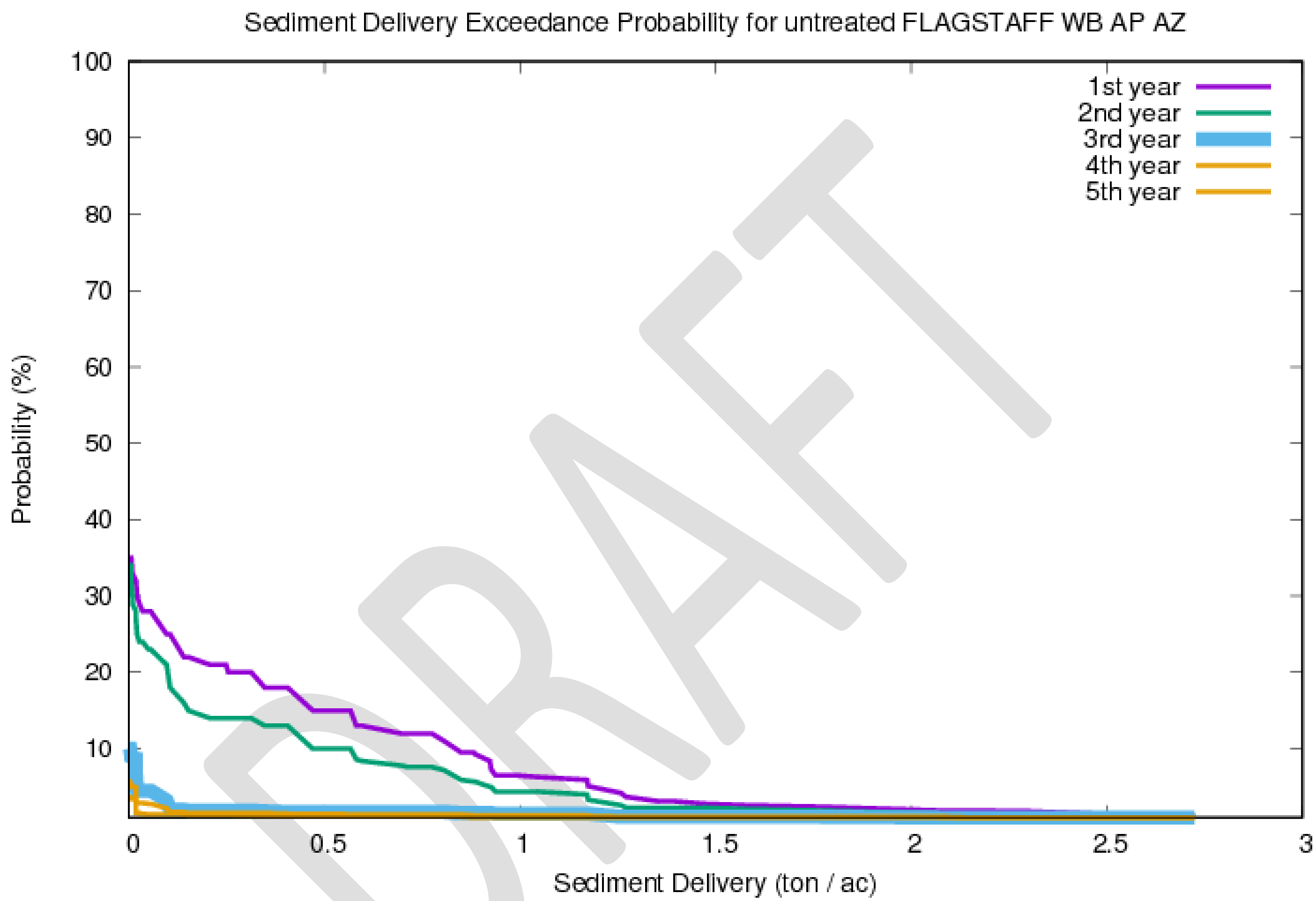
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.1	**in**	annual runoff from rainfall from	496	events
0.33	**in**	annual runoff from snowmelt or winter rainstorm from	120	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.94	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.83**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**
10 (10-year)	**1.56**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**

20 (5-year)	**1.10**	**1.96**	**2.22**	**0.62**	**0.62**	**January 18 year 72**
50 (2-year)	**0.66**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**
75 ($1^1/_3$-year)	**0.32**	**1.30**	**5.31**	**1.32**	**1.11**	**August 31 year 90**



10-29-2018 -- loam; 5% rock; 3%, 5%, 3% slope; 500 ft; high soil burn severity [wepp-146392]

Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	0.32	0.1	0	0	0
Seeding	0.32	0	0	0	0
Mulch (0.5 ton ac^{-1})	0	0	0	0	0
Mulch (1 ton ac^{-1})	0	0	0	0	0
Mulch (1.5 ton ac^{-1})	0	0	0	0	0
Mulch (2 ton ac^{-1})	0	0	0	0	0
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Citation:

Robichaud, Peter R.; Elliot, William J.; Pierson, Fredrick B.; Hall, David E.; Moffet, Corey A. 2014. **Erosion Risk Management Tool (ERMiT).** [Online at <https://forest.moscowfsl.wsu.edu/fswepp/>.] Moscow, ID: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

WEPP VERSION 2010.100
ERMiT run ID wepp-146392
Observed annual precip 554.1 mm; July, August, September precip 186.7 mm (33.69 percent): MONSOONAL climate

Stratum 2

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **5%** rock fragment
3% top, 5% average, 3% toe hillslope gradient
500 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.063	**in**	annual runoff from rainfall from	17	events
0.044	**in**	annual runoff from snowmelt or winter rainstorm from	10	events

15 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date

1	2.70	3.91	4.28	3.63	3.11	September 4 year 68
5 (20-year)	**0.52**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
10 (10-year)	**0.05**	**0.00**	**0.00**	**N/A**	**N/A**	**January 21 year 79**

Sediment Delivery					
Probability that sediment yield will be exceeded	Event sediment delivery (ton ac^{-1})				
	Year following fire				
20 % go	1st year	2nd year	3rd year	4th year	5th year
Unburned	0	0	0	0	0

Return to input screen

ERMiT Version 2015.05.03

Low Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **5%** rock fragment
3% top, 5% average, 3% toe hillslope gradient
500 ft hillslope horizontal length
low soil burn severity on forest

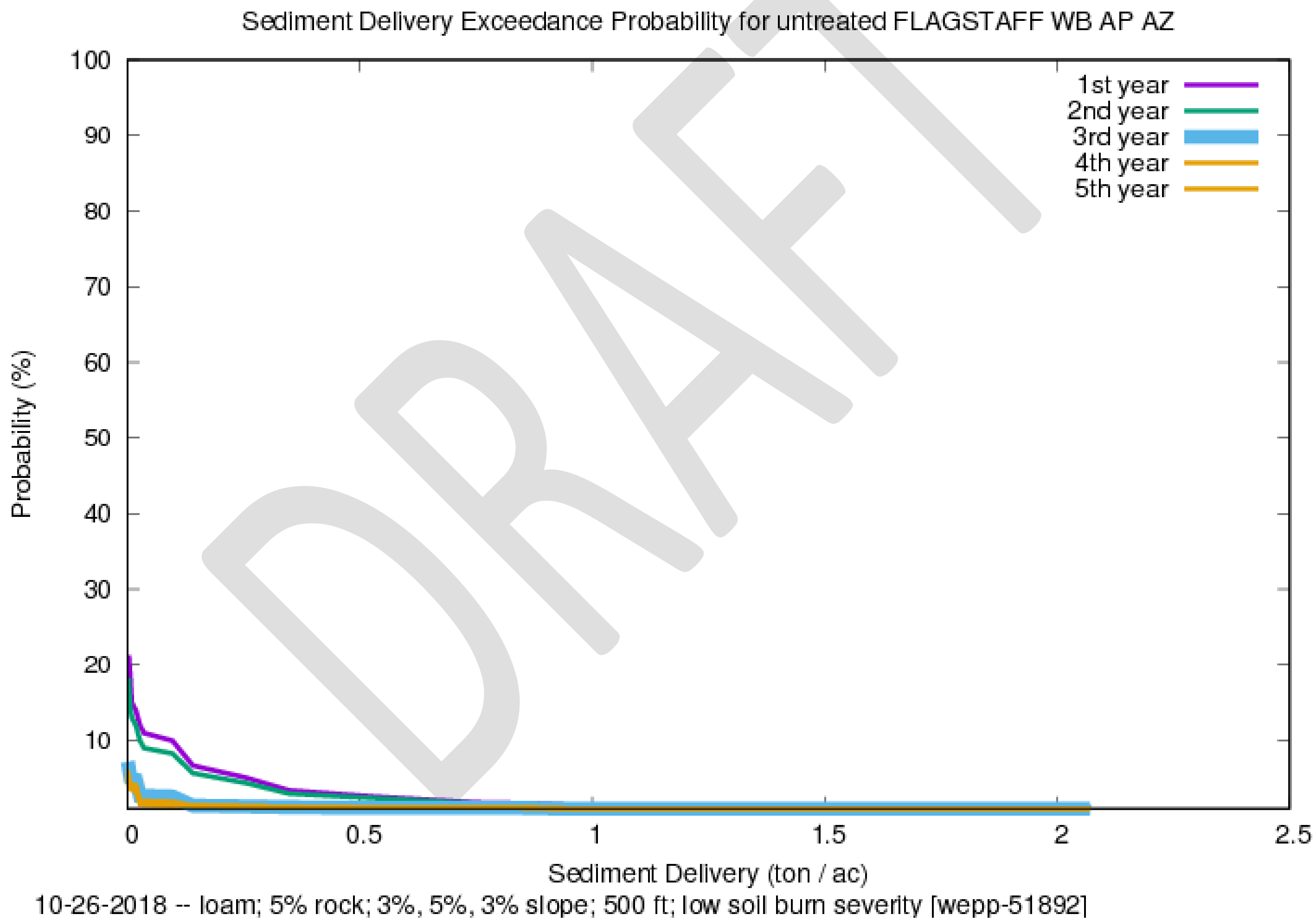
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.1	**in**	annual runoff from rainfall from	496	events
0.33	**in**	annual runoff from snowmelt or winter rainstorm from	120	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.94	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	1.83	4.34	5.92	N/A	N/A	December 2 year 32
10 (10-year)	1.56	4.44	6.01	N/A	N/A	December 7 year 97
20 (5-year)	1.10	1.96	2.22	0.62	0.62	January 18 year 72

50 (2-year)	**0.66**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**
75 (1 1/3-year)	**0.32**	**1.30**	**5.31**	**1.32**	**1.11**	**August 31 year 90**



Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	0	0	0	0	0
Seeding	0	0	0	0	0
Mulch (0.5 ton ac^{-1})	0	0	0	0	0
Mulch (1 ton ac^{-1})	0	0	0	0	0
Mulch (1.5 ton ac^{-1})	0	0	0	0	0
Mulch (2 ton ac^{-1})	0	0	0	0	0
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Moderate Burn Severity

Erosion Risk Management Tool

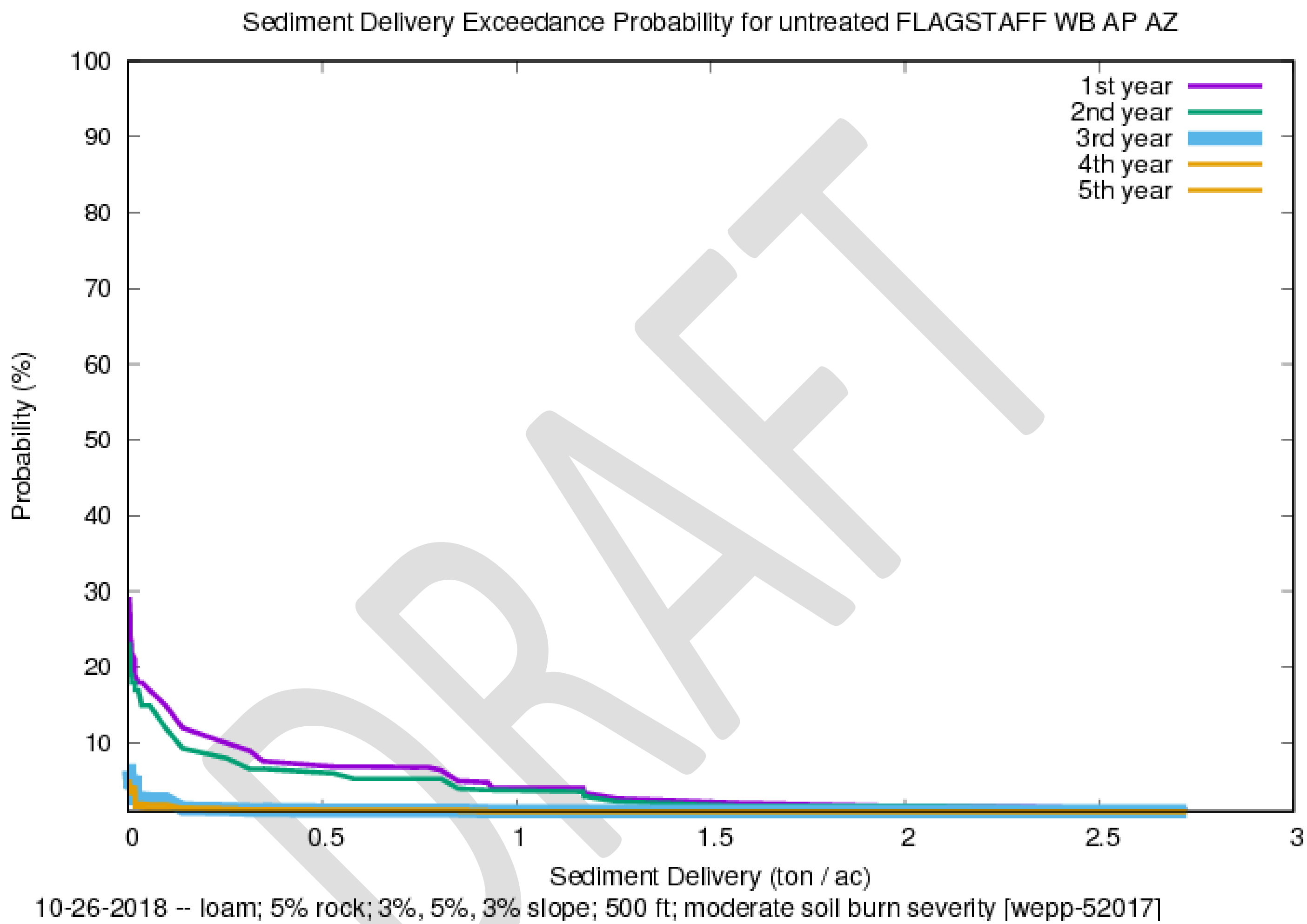
FLAGSTAFF WB AP AZ
loam soil texture, **5%** rock fragment
3% top, 5% average, 3% toe hillslope gradient
500 ft hillslope horizontal length
moderate soil burn severity on forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.1	**in**	annual runoff from rainfall from	496	events
0.33	**in**	annual runoff from snowmelt or winter rainstorm from	120	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.94	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.83**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**

10 (10-year)	**1.56**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
20 (5-year)	**1.10**	**1.96**	**2.22**	**0.62**	**0.62**	**January 18 year 72**
50 (2-year)	**0.66**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**
75 ($1\frac{1}{3}$-year)	**0.32**	**1.30**	**5.31**	**1.32**	**1.11**	**August 31 year 90**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	0.02	0.01	0	0	0
Seeding	0.02	0	0	0	0
Mulch (0.5 ton ac^{-1})	0	0	0	0	0
Mulch (1 ton ac^{-1})	0	0	0	0	0
Mulch (1.5 ton ac^{-1})	0	0	0	0	0
Mulch (2 ton ac^{-1})	0	0	0	0	0
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

High Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **5%** rock fragment

0% top, 50% average, 30% toe hillslope gradient
500 ft hillslope horizontal length
high soil burn severity on forest

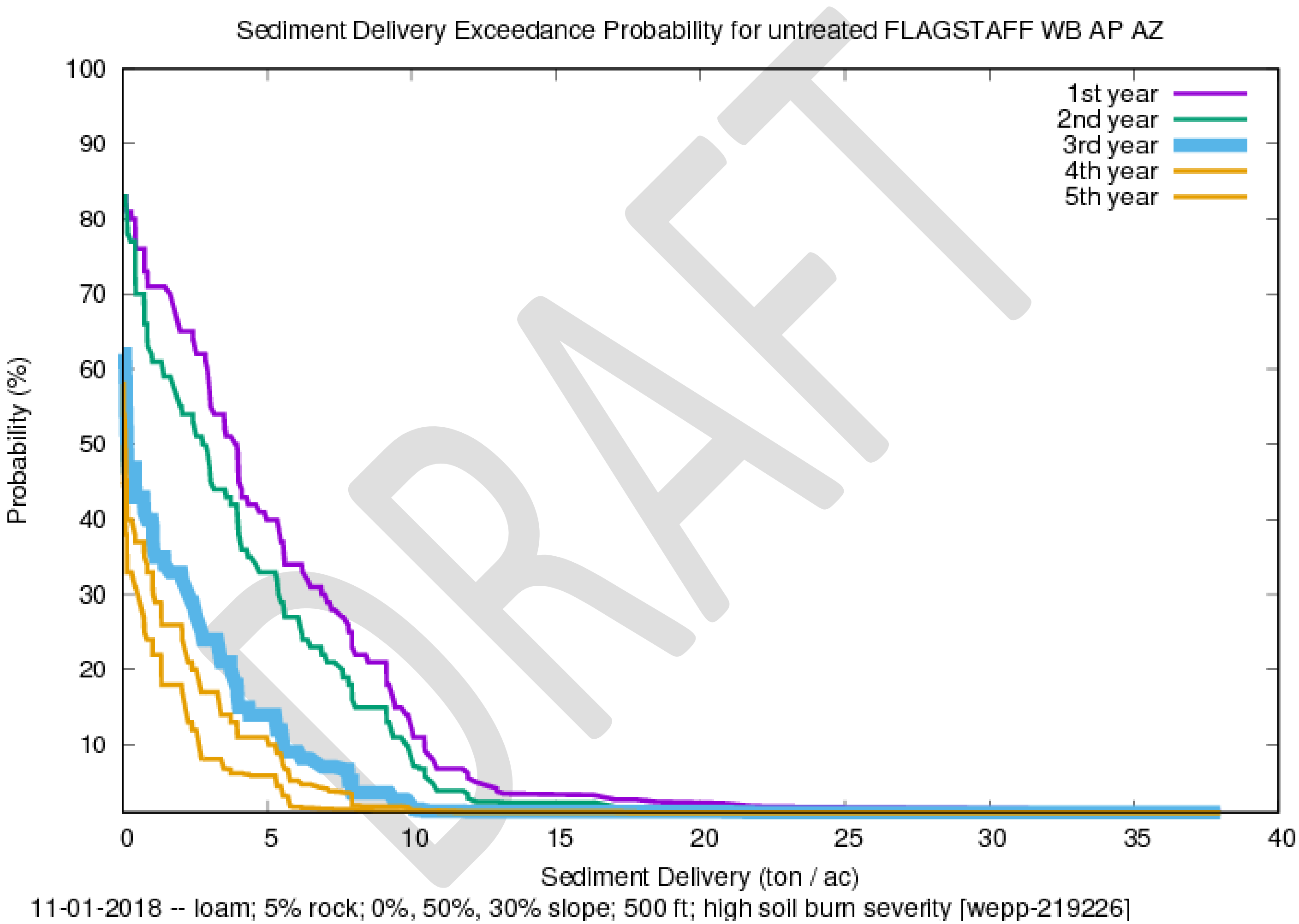
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.5	**in**	annual runoff from rainfall from	576	events
0.37	**in**	annual runoff from snowmelt or winter rainstorm from	140	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.96	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	1.83	4.34	5.92	N/A	N/A	December 2 year 32
10 (10-year)	1.55	4.44	6.01	N/A	N/A	December 7 year 97
20 (5-year)	1.17	1.91	1.81	4.71	3.04	July 19 year 20
50 (2-year)	0.69	1.57	3.40	3.54	2.38	September 5 year 31

75 (1 1/3-year)	0.42	1.18	1.22	1.88	1.49	July 6 year 92



Sediment Delivery

Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	9.12	7.61	3.78	2.57	1.33
Seeding	9.12	3.96	3.31	2.2	1.33
Mulch (0.5 ton ac^{-1})	3.9	3.83	3.78	2.57	1.33
Mulch (1 ton ac^{-1})	3.42	3.46	3.78	2.57	1.33
Mulch (1.5 ton ac^{-1})	3.4	3.35	3.78	2.57	1.33
Mulch (2 ton ac^{-1})	3.38	3.32	3.78	2.57	1.33
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Stratum 3

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **30%** rock fragment
3% top, 5% average, 3% toe hillslope gradient
500 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.042	**in**	annual runoff from rainfall from	20	events
0.015	**in**	annual runoff from snowmelt or winter rainstorm from	5	events

16 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.29	3.91	4.28	3.63	3.11	September 4 year 68

5 (20-year)	0.12	3.42	5.02	5.90	4.37	September 19 year 48
10 (10-year)	0.03	1.91	1.81	4.71	3.04	July 19 year 20

Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Unburned	0	0	0	0	0

Return to input screen

Low Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **30%** rock fragment
3% top, 5% average, 3% toe hillslope gradient
500 ft hillslope horizontal length

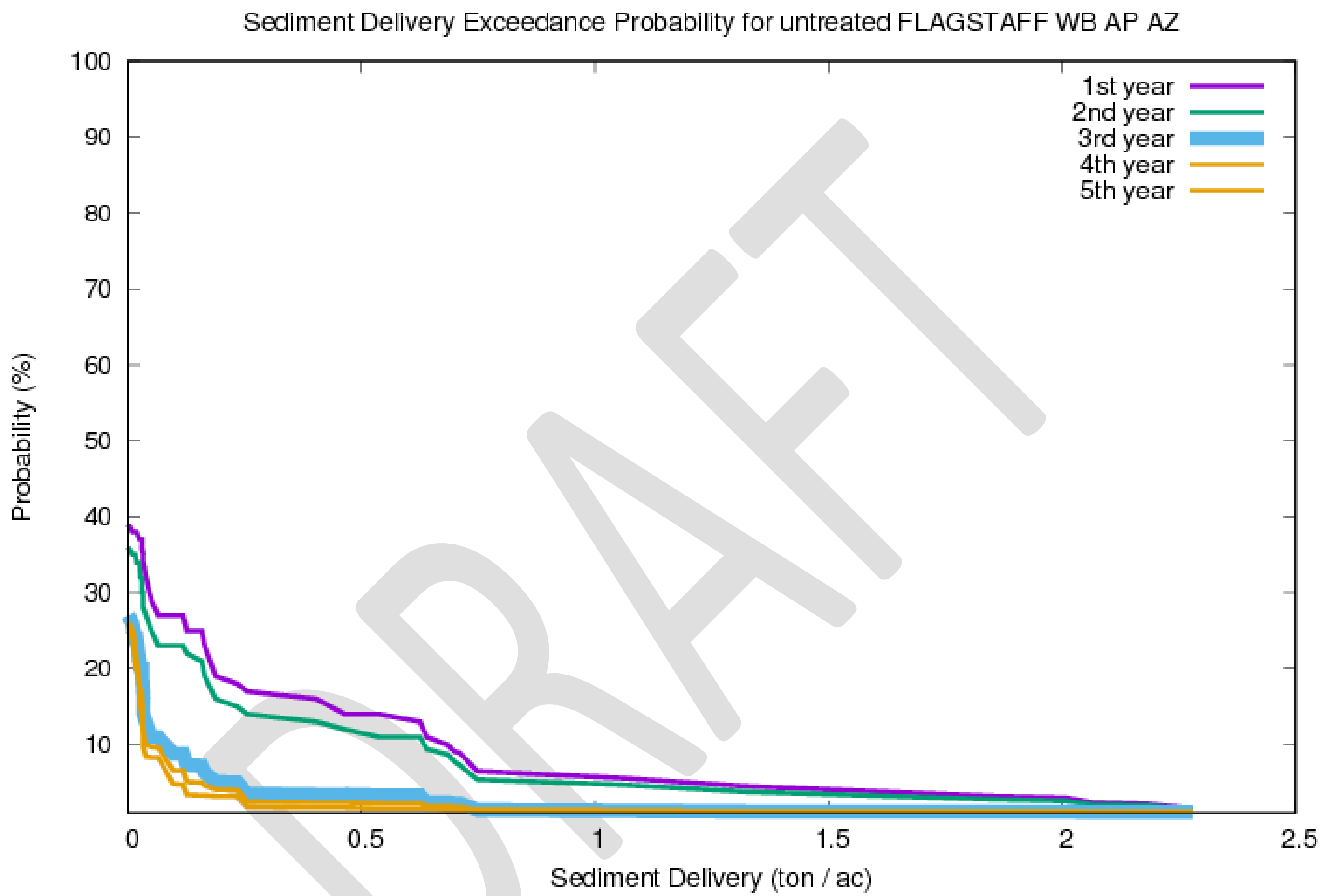
low soil burn severity on forest

100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.3	**in**	annual runoff from rainfall from	535	events
0.38	**in**	annual runoff from snowmelt or winter rainstorm from	128	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.00	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	1.93	4.34	5.92	N/A	N/A	December 2 year 32
10 (10-year)	1.66	4.44	6.01	N/A	N/A	December 7 year 97
20 (5-year)	1.12	2.06	2.13	4.70	3.14	August 8 year 79
50 (2-year)	0.70	1.47	3.72	2.66	1.94	September 15 year 76
75 ($1^1/_3$-year)	0.37	1.37	1.92	4.23	2.42	December 10 year 13



10-26-2018 -- loam; 30% rock; 3%, 5%, 3% slope; 500 ft; low soil burn severity [wepp-53250]

Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	0.18	0.16	0.03	0.02	0.02
Seeding	0.18	0.03	0.02	0.02	0.02
Mulch (0.5 ton ac^{-1})	0.02	0.02	0.03	0.02	0.02
Mulch (1 ton ac^{-1})	0.02	0.02	0.03	0.02	0.02
Mulch (1.5 ton ac^{-1})	0.02	0.01	0.03	0.02	0.02
Mulch (2 ton ac^{-1})	0.01	0.01	0.03	0.02	0.02
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Moderate Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **30%** rock fragment
3% top, 5% average, 3% toe hillslope gradient
500 ft hillslope horizontal length
moderate soil burn severity on forest

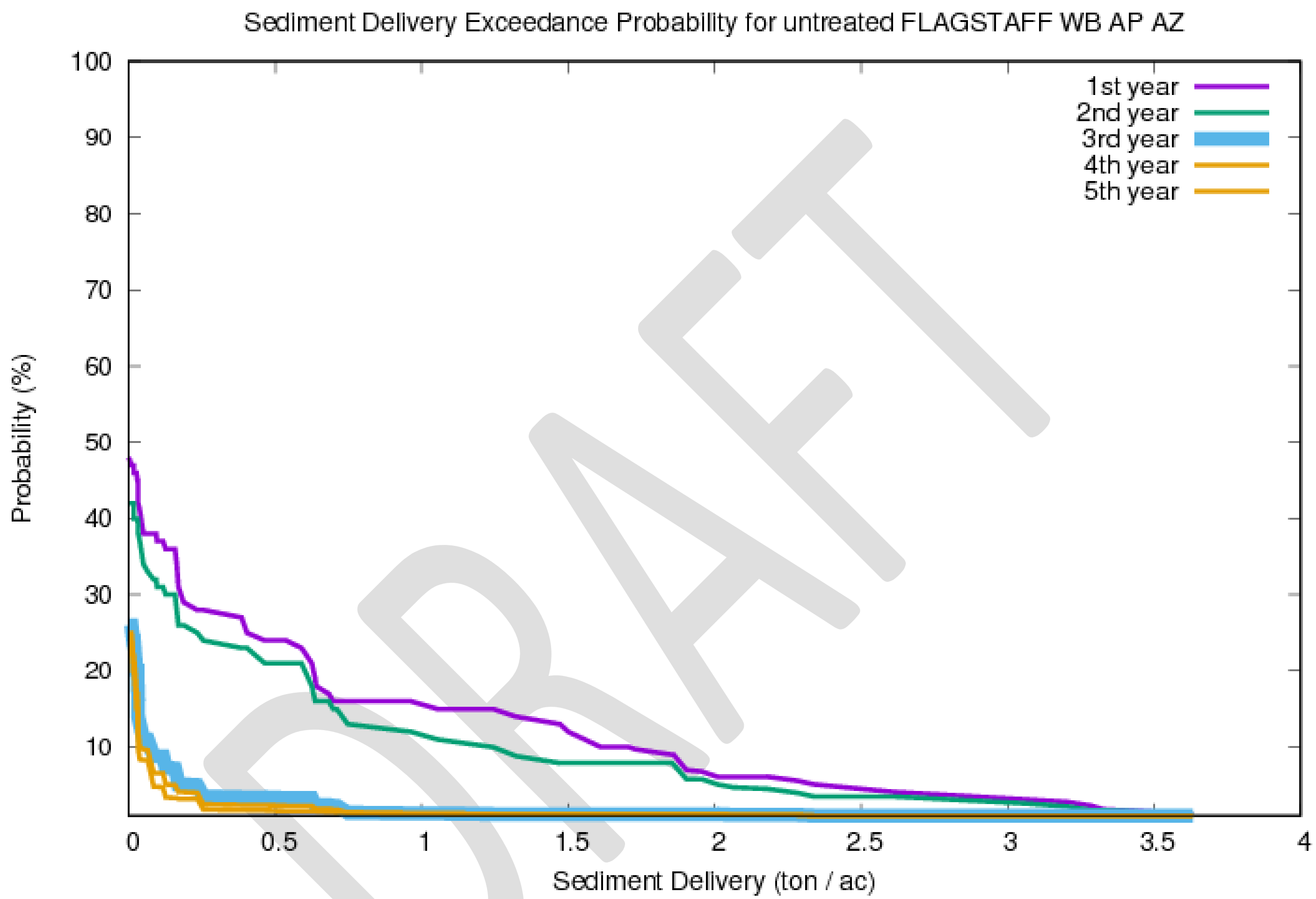
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.3	**in**	annual runoff from rainfall from	535	events
0.38	**in**	annual runoff from snowmelt or winter rainstorm from	128	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.00	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.93**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**
10 (10-year)	**1.66**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**

20 (5-year)	**1.12**	**2.06**	**2.13**	**4.70**	**3.14**	**August 8 year 79**
50 (2-year)	**0.70**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**
75 ($1^1/_3$-year)	**0.37**	**1.37**	**1.92**	**4.23**	**2.42**	**December 10 year 13**



10-26-2018 -- loam; 30% rock; 3%, 5%, 3% slope; 500 ft; moderate soil burn severity [wepp-53425]

Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	0.63	0.6	0.03	0.02	0.02
Seeding	0.63	0.03	0.02	0.02	0.02
Mulch (0.5 ton ac^{-1})	0.03	0.03	0.03	0.02	0.02
Mulch (1 ton ac^{-1})	0.02	0.03	0.03	0.02	0.02
Mulch (1.5 ton ac^{-1})	0.02	0.03	0.03	0.02	0.02
Mulch (2 ton ac^{-1})	0.02	0.03	0.03	0.02	0.02
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Citation:

High Burn Severity

Erosion Risk Management Tool

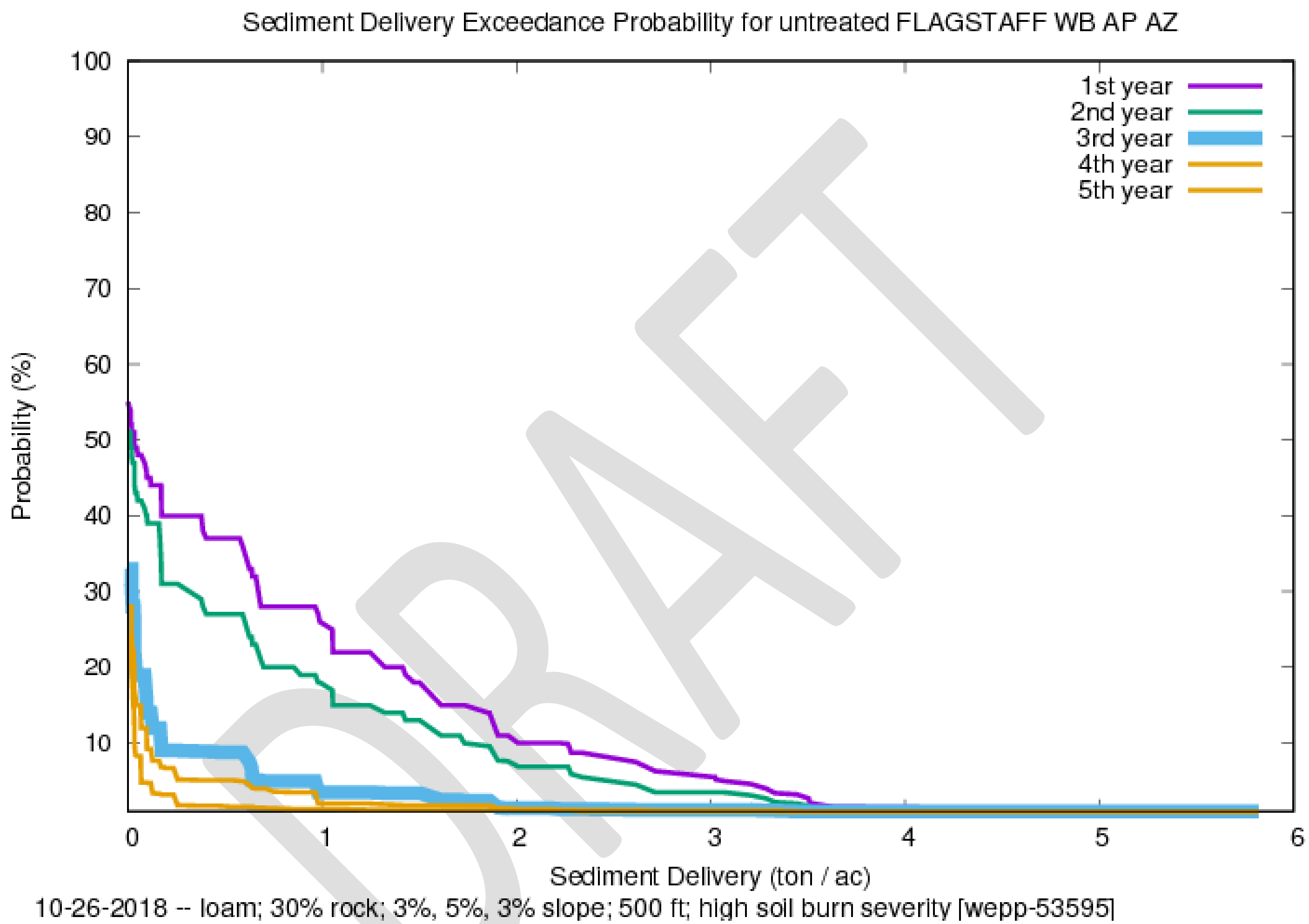
FLAGSTAFF WB AP AZ
loam soil texture, **30%** rock fragment
3% top, 5% average, 3% toe hillslope gradient
500 ft hillslope horizontal length
high soil burn severity on forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.3	**in**	annual runoff from rainfall from	535	events
0.38	**in**	annual runoff from snowmelt or winter rainstorm from	128	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.00	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.93**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**

10 (10-year)	**1.66**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
20 (5-year)	**1.12**	**2.06**	**2.13**	**4.70**	**3.14**	**August 8 year 79**
50 (2-year)	**0.70**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**
75 ($1^{1}/_{3}$-year)	**0.37**	**1.37**	**1.92**	**4.23**	**2.42**	**December 10 year 13**



<table>
<tr><th colspan="6">Sediment Delivery</th></tr>
<tr><th rowspan="3">Probability that sediment yield</th><th colspan="5">Event sediment delivery (ton ac^{-1})</th></tr>
<tr><th colspan="5">Year following fire</th></tr>
<tr><th>1st year</th><th>2nd year</th><th>3rd year</th><th>4th year</th><th>5th year</th></tr>
</table>

will be exceeded 20 % go					
Untreated	1.42	0.78	0.05	0.03	0.02
Seeding	1.42	0.09	0.03	0.03	0.02
Mulch (0.5 ton ac^{-1})	0.09	0.07	0.05	0.03	0.02
Mulch (1 ton ac^{-1})	0.06	0.05	0.05	0.03	0.02
Mulch (1.5 ton ac^{-1})	0.06	0.04	0.05	0.03	0.02
Mulch (2 ton ac^{-1})	0.05	0.03	0.05	0.03	0.02
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Stratum 4

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **50%** rock fragment
40% top, 80% average, 40% toe hillslope gradient
500 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.022	**in**	annual runoff from rainfall from	14	events
0.0043	**in**	annual runoff from snowmelt or winter rainstorm from	2	events

12 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	1.59	3.91	4.28	3.63	3.11	September 4 year 68
5 (20-year)	**0.06**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**

10 (10-year)	0.00	2.36	7.49	3.43	2.67	August 31 year 22

Sediment Delivery					
Probability that sediment yield will be exceeded	Event sediment delivery (ton ac^{-1})				
	Year following fire				
20 % go	1st year	2nd year	3rd year	4th year	5th year
Unburned	0.03	0.03	0.03	0.03	0.03

Return to input screen

Low Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **50%** rock fragment

40% top, 80% average, 40% toe hillslope gradient
500 ft hillslope horizontal length
low soil burn severity on forest

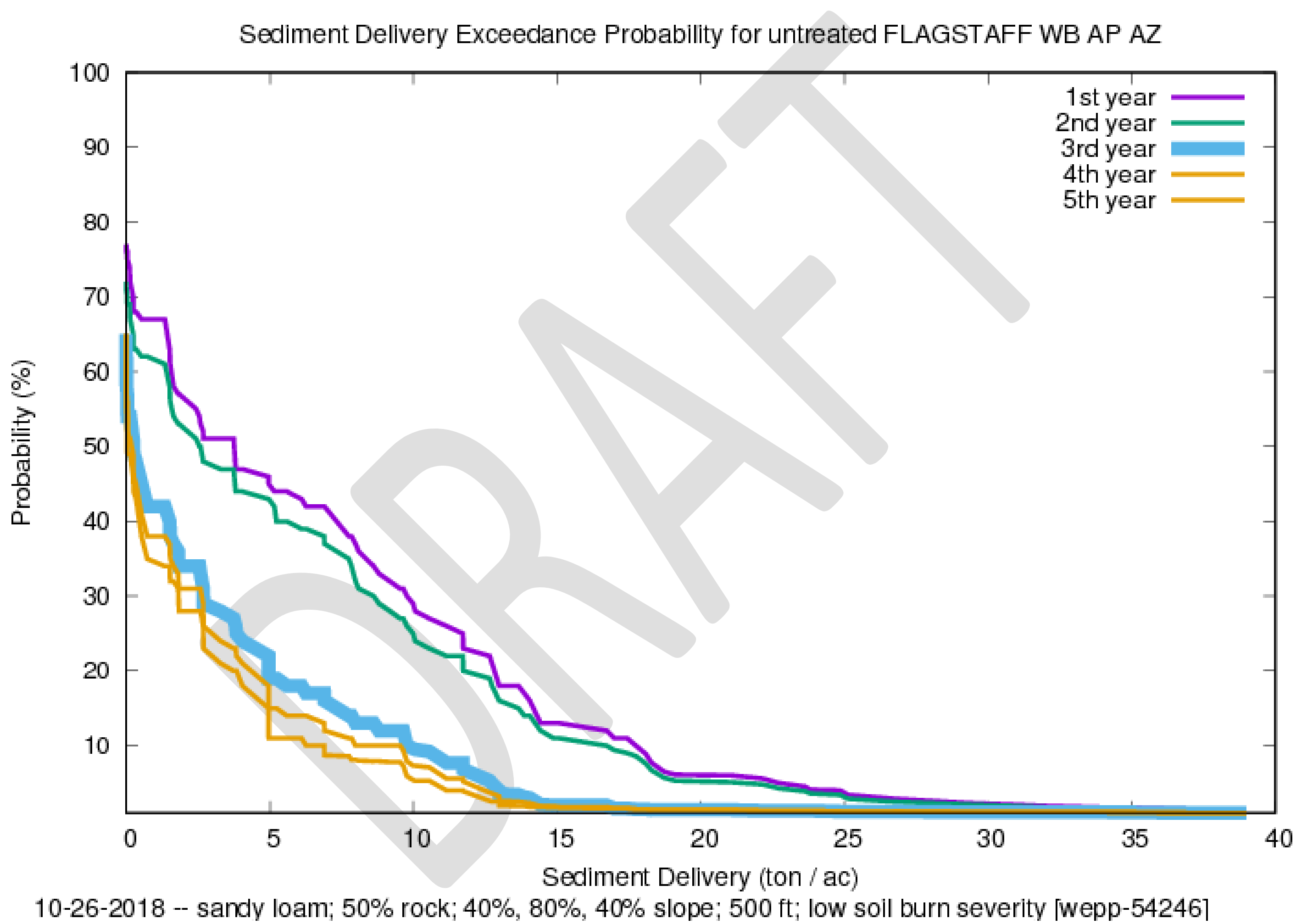
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.7	**in**	annual runoff from rainfall from	629	events
0.35	**in**	annual runoff from snowmelt or winter rainstorm from	127	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.00	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	1.85	2.91	4.51	4.42	3.40	September 13 year 27
10 (10-year)	1.53	2.50	5.67	3.27	2.61	September 29 year 26
20 (5-year)	1.17	1.91	1.81	4.71	3.04	July 19 year 20
50 (2-year)	0.72	1.57	3.40	3.54	2.38	September 5 year 31

75 (1 1/3-year)	**0.42**	**1.26**	**3.29**	**1.55**	**1.26**	**August 29 year 43**



Sediment Delivery

Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	12.82	11.84	4.95	4.35	3.81
Seeding	12.82	4.95	4.35	3.81	3.81
Mulch (0.5 ton ac^{-1})	4.19	4.48	4.95	4.35	3.81
Mulch (1 ton ac^{-1})	3.34	3.86	4.95	4.35	3.81
Mulch (1.5 ton ac^{-1})	3.2	3.54	4.95	4.35	3.81
Mulch (2 ton ac^{-1})	3.05	3.39	4.95	4.35	3.81
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

Moderate Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **50%** rock fragment
40% top, 80% average, 40% toe hillslope gradient
500 ft hillslope horizontal length
moderate soil burn severity on forest

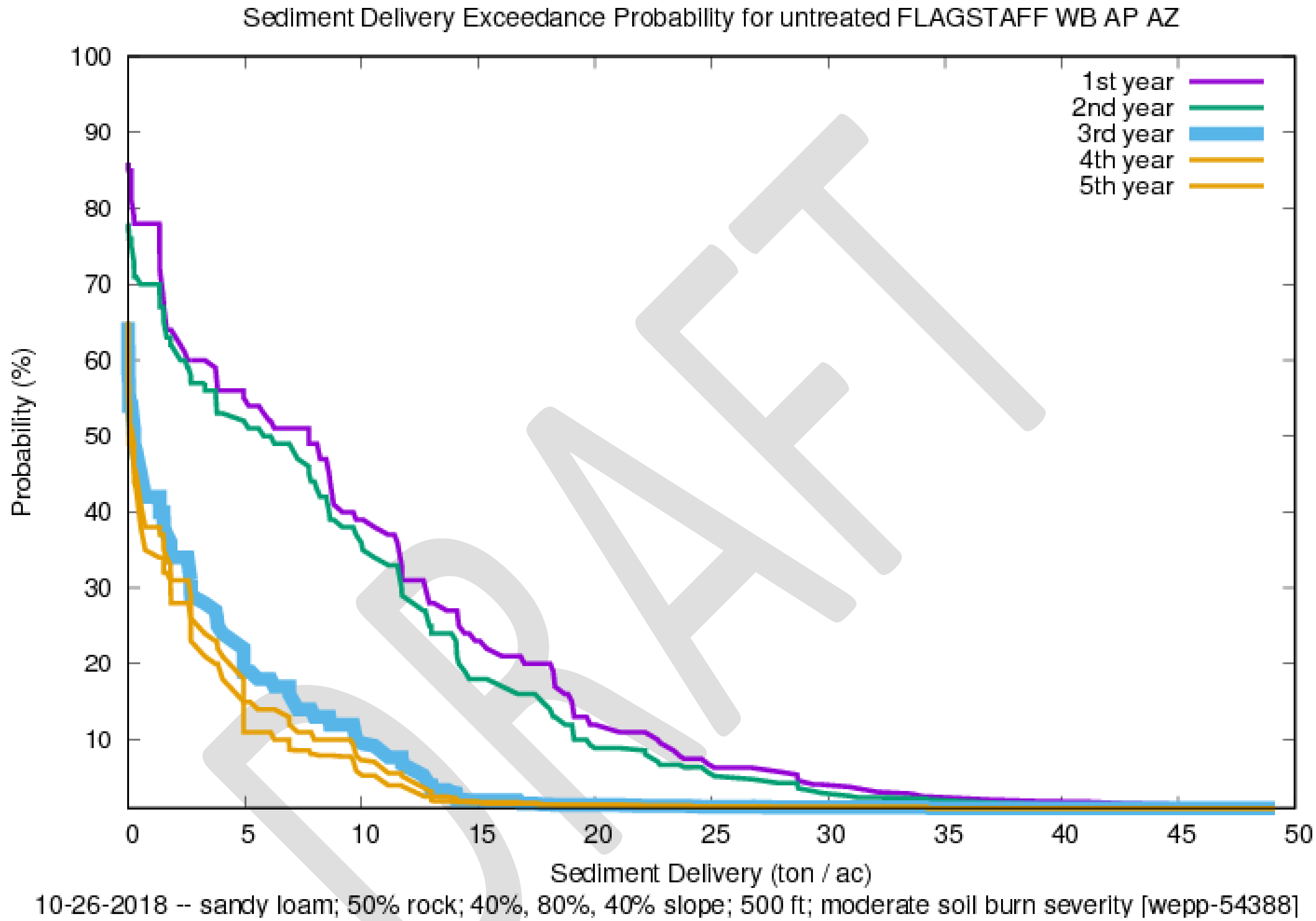
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.7	**in**	annual runoff from rainfall from	629	events
0.35	**in**	annual runoff from snowmelt or winter rainstorm from	127	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.00	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.85**	**2.91**	**4.51**	**4.42**	**3.40**	**September 13 year 27**

10 (10-year)	**1.53**	**2.50**	**5.67**	**3.27**	**2.61**	**September 29 year 26**
20 (5-year)	**1.17**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.72**	**1.57**	**3.40**	**3.54**	**2.38**	**September 5 year 31**
75 ($1^{1}/_{3}$-year)	**0.42**	**1.26**	**3.29**	**1.55**	**1.26**	**August 29 year 43**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	17.87	14.16	4.95	4.35	3.81
Seeding	17.87	7.77	4.35	3.81	3.81
Mulch (0.5 ton ac^{-1})	7.75	7.49	4.95	4.35	3.81
Mulch (1 ton ac^{-1})	5.98	6.06	4.95	4.35	3.81
Mulch (1.5 ton ac^{-1})	5.58	4.95	4.95	4.35	3.81
Mulch (2 ton ac^{-1})	5.56	4.95	4.95	4.35	3.81
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

High Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **50%** rock fragment
40% top, 80% average, 40% toe hillslope gradient
500 ft hillslope horizontal length
high soil burn severity on forest

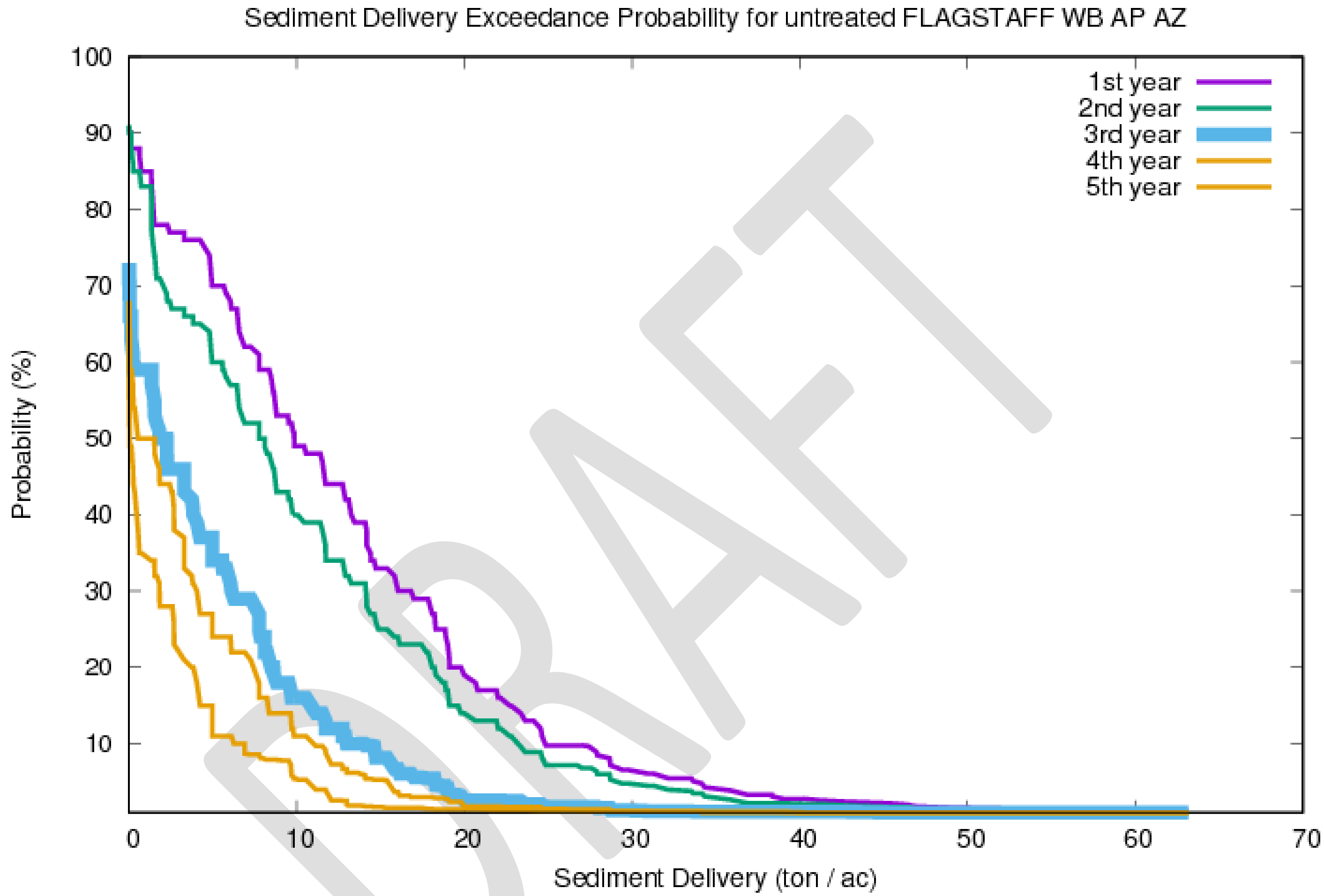
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.7	**in**	annual runoff from rainfall from	629	events
0.35	**in**	annual runoff from snowmelt or winter rainstorm from	127	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.00	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.85**	**2.91**	**4.51**	**4.42**	**3.40**	**September 13 year 27**
10 (10-year)	**1.53**	**2.50**	**5.67**	**3.27**	**2.61**	**September 29 year 26**

20 (5-year)	**1.17**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.72**	**1.57**	**3.40**	**3.54**	**2.38**	**September 5 year 31**
75 ($1^{1}/_{3}$-year)	**0.42**	**1.26**	**3.29**	**1.55**	**1.26**	**August 29 year 43**



10-26-2018 -- sandy loam; 50% rock; 40%, 80%, 40% slope; 500 ft; high soil burn severity [wepp-54556]

Sediment Delivery					
Probability that sediment yield	**Event sediment delivery (ton ac^{-1})**				
	Year following fire				
	1st year	**2nd year**	**3rd year**	**4th year**	**5th year**

will be exceeded 20 % go					
Untreated	19.71	18.24	8.44	7.47	3.81
Seeding	19.71	9.7	8.08	5.21	3.81
Mulch (0.5 ton ac^{-1})	9.72	8.93	8.44	7.47	3.81
Mulch (1 ton ac^{-1})	8.27	8.22	8.44	7.47	3.81
Mulch (1.5 ton ac^{-1})	8.23	8.08	8.44	7.47	3.81
Mulch (2 ton ac^{-1})	8.21	8.08	8.44	7.47	3.81
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Stratum 5

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **35%** rock fragment
8% top, 15% average, 10% toe hillslope gradient
500 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.023	**in**	annual runoff from rainfall from	13	events
0.002	**in**	annual runoff from snowmelt or winter rainstorm from	1	events

10 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	1.87	3.91	4.28	3.63	3.11	September 4 year 68
5 (20-year)	**0.02**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**

10 (10-year)	0.00	1.65	6.13	4.16	2.66	August 7 year 97

Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Unburned	0.01	0.01	0.01	0.01	0.01

Return to input screen

Low Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **35%** rock fragment

8% top, 15% average, 10% toe hillslope gradient
500 ft hillslope horizontal length
low soil burn severity on forest

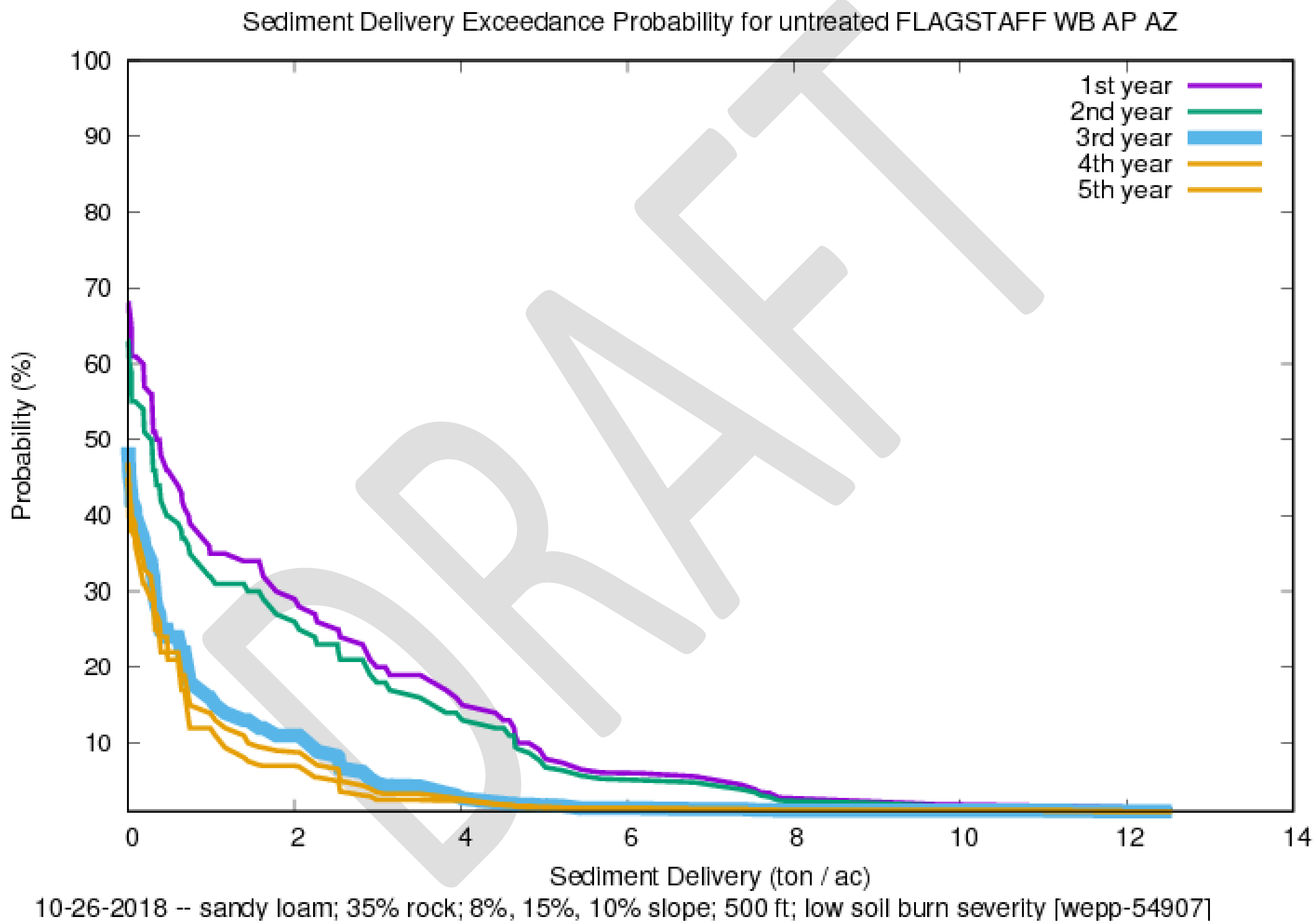
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.4	**in**	annual runoff from rainfall from	579	events
0.29	**in**	annual runoff from snowmelt or winter rainstorm from	116	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.95	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.81**	**2.91**	**4.51**	**4.42**	**3.40**	**September 13 year 27**
10 (10-year)	**1.48**	**2.50**	**5.67**	**3.27**	**2.61**	**September 29 year 26**
20 (5-year)	**1.11**	**2.06**	**2.13**	**4.70**	**3.14**	**August 8 year 79**
50 (2-year)	**0.69**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**

75 (1 1/3-year)	**0.37**	**1.26**	**3.29**	**1.55**	**1.26**	**August 29 year 43**



Sediment Delivery

Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	3.04	2.85	0.71	0.63	0.61
Seeding	3.04	0.71	0.63	0.61	0.61
Mulch (0.5 ton ac^{-1})	0.68	0.64	0.71	0.63	0.61
Mulch (1 ton ac^{-1})	0.61	0.61	0.71	0.63	0.61
Mulch (1.5 ton ac^{-1})	0.61	0.6	0.71	0.63	0.61
Mulch (2 ton ac^{-1})	0.61	0.6	0.71	0.63	0.61
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

Moderate Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **35%** rock fragment
8% top, 15% average, 10% toe hillslope gradient
500 ft hillslope horizontal length
moderate soil burn severity on forest

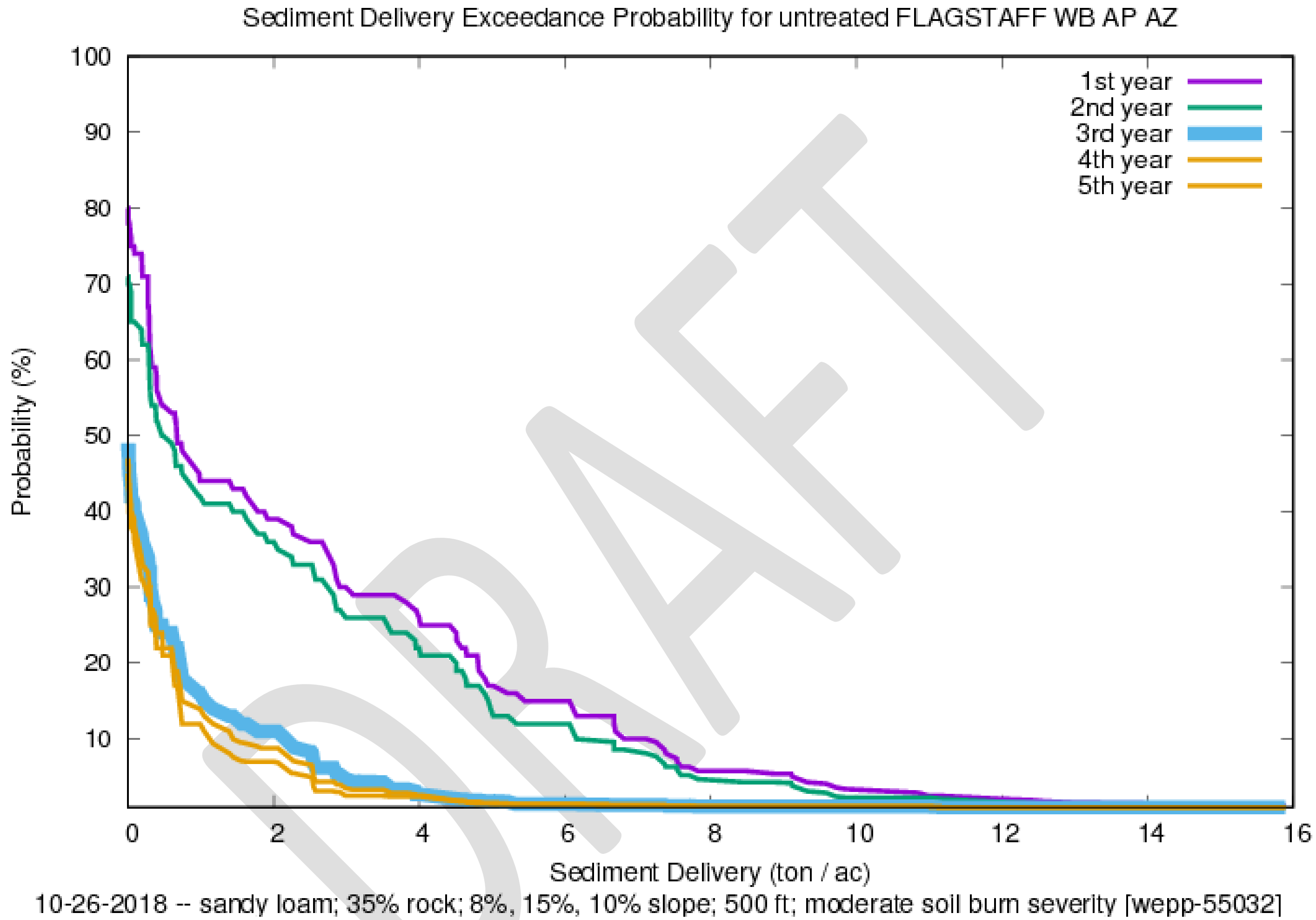
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.4	**in**	annual runoff from rainfall from	579	events
0.29	**in**	annual runoff from snowmelt or winter rainstorm from	116	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.95	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.81**	**2.91**	**4.51**	**4.42**	**3.40**	**September 13 year 27**

10 (10-year)	**1.48**	**2.50**	**5.67**	**3.27**	**2.61**	**September 29 year 26**
20 (5-year)	**1.11**	**2.06**	**2.13**	**4.70**	**3.14**	**August 8 year 79**
50 (2-year)	**0.69**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**
75 (1 1/3-year)	**0.37**	**1.26**	**3.29**	**1.55**	**1.26**	**August 29 year 43**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	4.81	4.51	0.71	0.63	0.61
Seeding	4.81	1.86	0.63	0.61	0.61
Mulch (0.5 ton ac^{-1})	1.87	1.34	0.71	0.63	0.61
Mulch (1 ton ac^{-1})	1.56	1.04	0.71	0.63	0.61
Mulch (1.5 ton ac^{-1})	1.56	0.98	0.71	0.63	0.61
Mulch (2 ton ac^{-1})	1.37	0.74	0.71	0.63	0.61
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

High Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **35%** rock fragment
8% top, 15% average, 10% toe hillslope gradient
500 ft hillslope horizontal length
high soil burn severity on forest

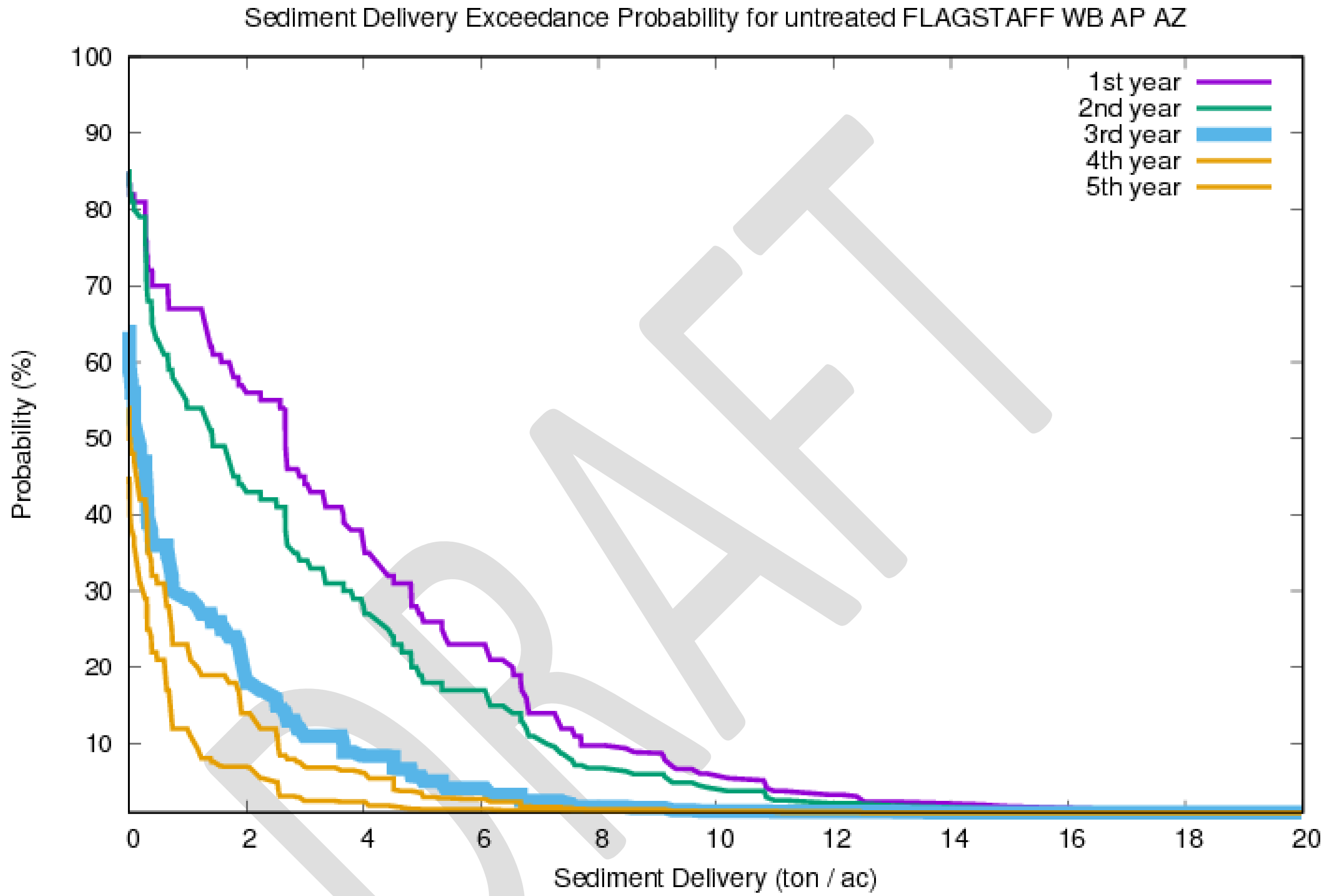
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.4	**in**	annual runoff from rainfall from	579	events
0.29	**in**	annual runoff from snowmelt or winter rainstorm from	116	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.95	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.81**	**2.91**	**4.51**	**4.42**	**3.40**	**September 13 year 27**
10 (10-year)	**1.48**	**2.50**	**5.67**	**3.27**	**2.61**	**September 29 year 26**

20 (5-year)	**1.11**	**2.06**	**2.13**	**4.70**	**3.14**	**August 8 year 79**
50 (2-year)	**0.69**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**
75 (1 1/3-year)	**0.37**	**1.26**	**3.29**	**1.55**	**1.26**	**August 29 year 43**



10-26-2018 -- sandy loam; 35% rock; 8%, 15%, 10% slope; 500 ft; high soil burn severity [wepp-55207]

Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	6.47	4.9	1.96	1.22	0.61
Seeding	6.47	2.55	1.89	1	0.61
Mulch (0.5 ton ac^{-1})	2.57	2.06	1.96	1.22	0.61
Mulch (1 ton ac^{-1})	1.95	1.9	1.96	1.22	0.61
Mulch (1.5 ton ac^{-1})	1.91	1.88	1.96	1.22	0.61
Mulch (2 ton ac^{-1})	1.91	1.88	1.96	1.22	0.61
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Stratum 6

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **30%** rock fragment
4% top, 8% average, 5% toe hillslope gradient
300 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.024	**in**	annual runoff from rainfall from	9	events
0.0035	**in**	annual runoff from snowmelt or winter rainstorm from	1	events

6 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	1.92	3.91	4.28	3.63	3.11	September 4 year 68
5 (20-year)	**0.02**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**

Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Unburned	0.01	0.01	0.01	0.01	0.01

Return to input screen

ERMiT Version 2015.05.03

Low Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **30%** rock fragment
4% top, 8% average, 5% toe hillslope gradient

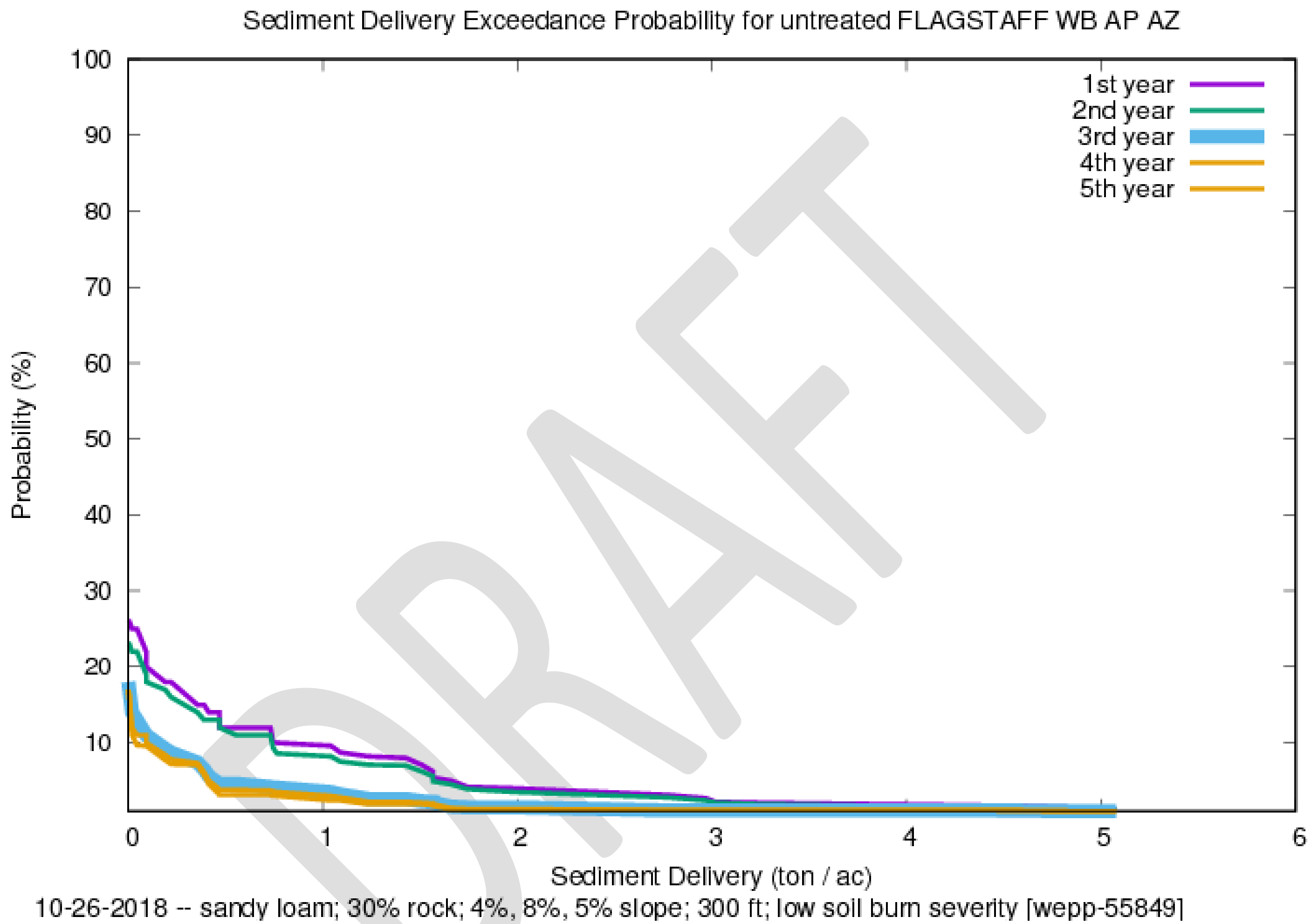
300 ft hillslope horizontal length
low soil burn severity on forest

100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.3	**in**	annual runoff from rainfall from	521	events
0.27	**in**	annual runoff from snowmelt or winter rainstorm from	94	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.93	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	1.79	2.91	4.51	4.42	3.40	September 13 year 27
10 (10-year)	1.47	4.44	6.01	N/A	N/A	December 7 year 97
20 (5-year)	1.13	1.96	2.22	0.62	0.62	January 18 year 72
50 (2-year)	0.67	1.47	3.72	2.66	1.94	September 15 year 76
75 ($1^1/_3$-year)	0.35	1.42	2.01	3.18	2.14	December 11 year 45



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	0.09	0.08	0	0	0
Seeding	0.09	0	0	0	0
Mulch (0.5 ton ac^{-1})	0	0	0	0	0
Mulch (1 ton ac^{-1})	0	0	0	0	0
Mulch (1.5 ton ac^{-1})	0	0	0	0	0
Mulch (2 ton ac^{-1})	0	0	0	0	0
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Moderate Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **30%** rock fragment
4% top, 8% average, 5% toe hillslope gradient
300 ft hillslope horizontal length
moderate soil burn severity on forest

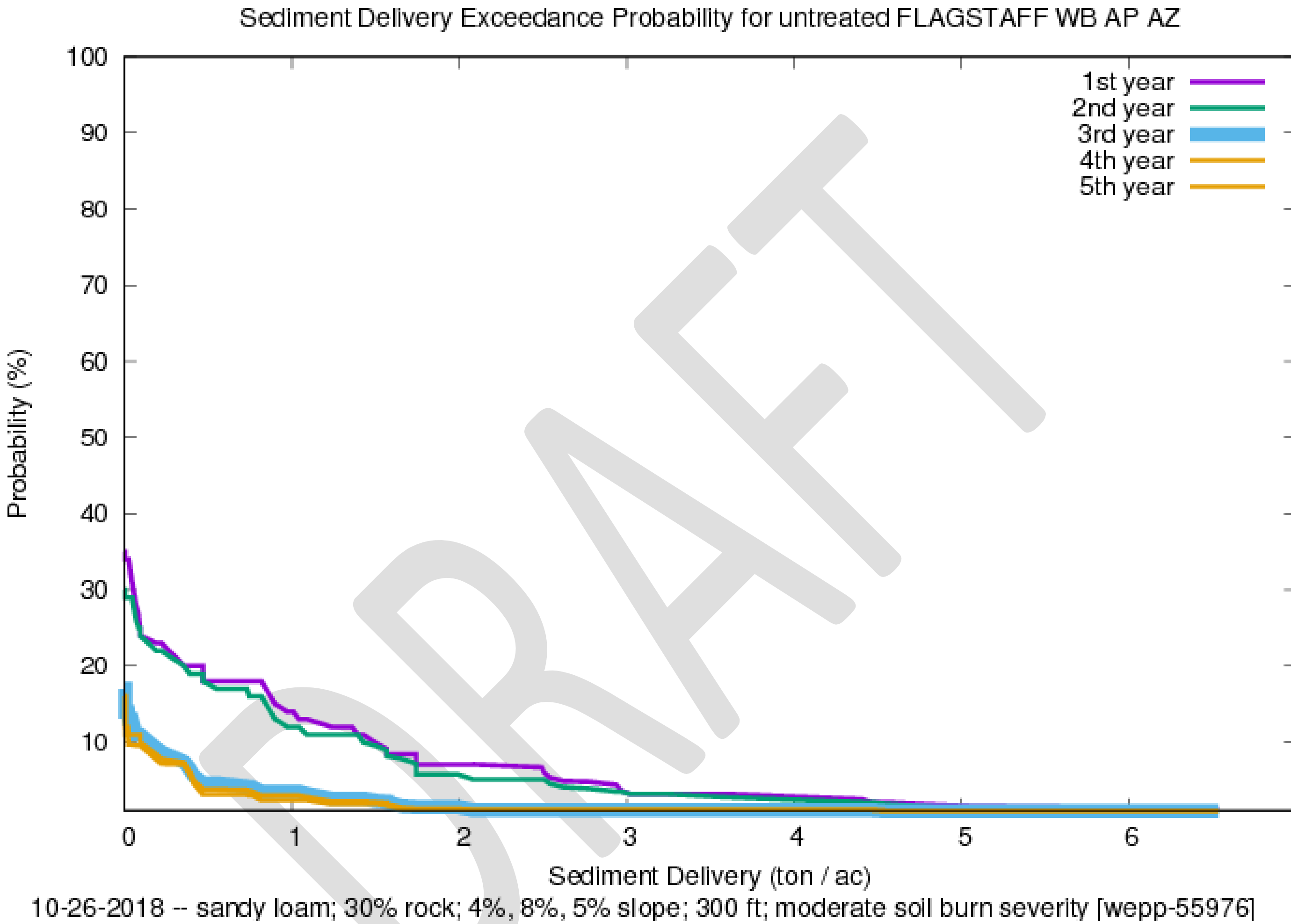
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.3	**in**	annual runoff from rainfall from	521	events
0.27	**in**	annual runoff from snowmelt or winter rainstorm from	94	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.93	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.79**	**2.91**	**4.51**	**4.42**	**3.40**	**September 13 year 27**
10 (10-year)	**1.47**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**

20 (5-year)	**1.13**	**1.96**	**2.22**	**0.62**	**0.62**	**January 18 year 72**
50 (2-year)	**0.67**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**
75 ($1^1/_3$-year)	**0.35**	**1.42**	**2.01**	**3.18**	**2.14**	**December 11 year 45**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	0.36	0.33	0	0	0
Seeding	0.36	0.01	0	0	0
Mulch (0.5 ton ac^{-1})	0.01	0	0	0	0
Mulch (1 ton ac^{-1})	0	0	0	0	0
Mulch (1.5 ton ac^{-1})	0	0	0	0	0
Mulch (2 ton ac^{-1})	0	0	0	0	0
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

High Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **30%** rock fragment
4% top, 8% average, 5% toe hillslope gradient
300 ft hillslope horizontal length
high soil burn severity on forest

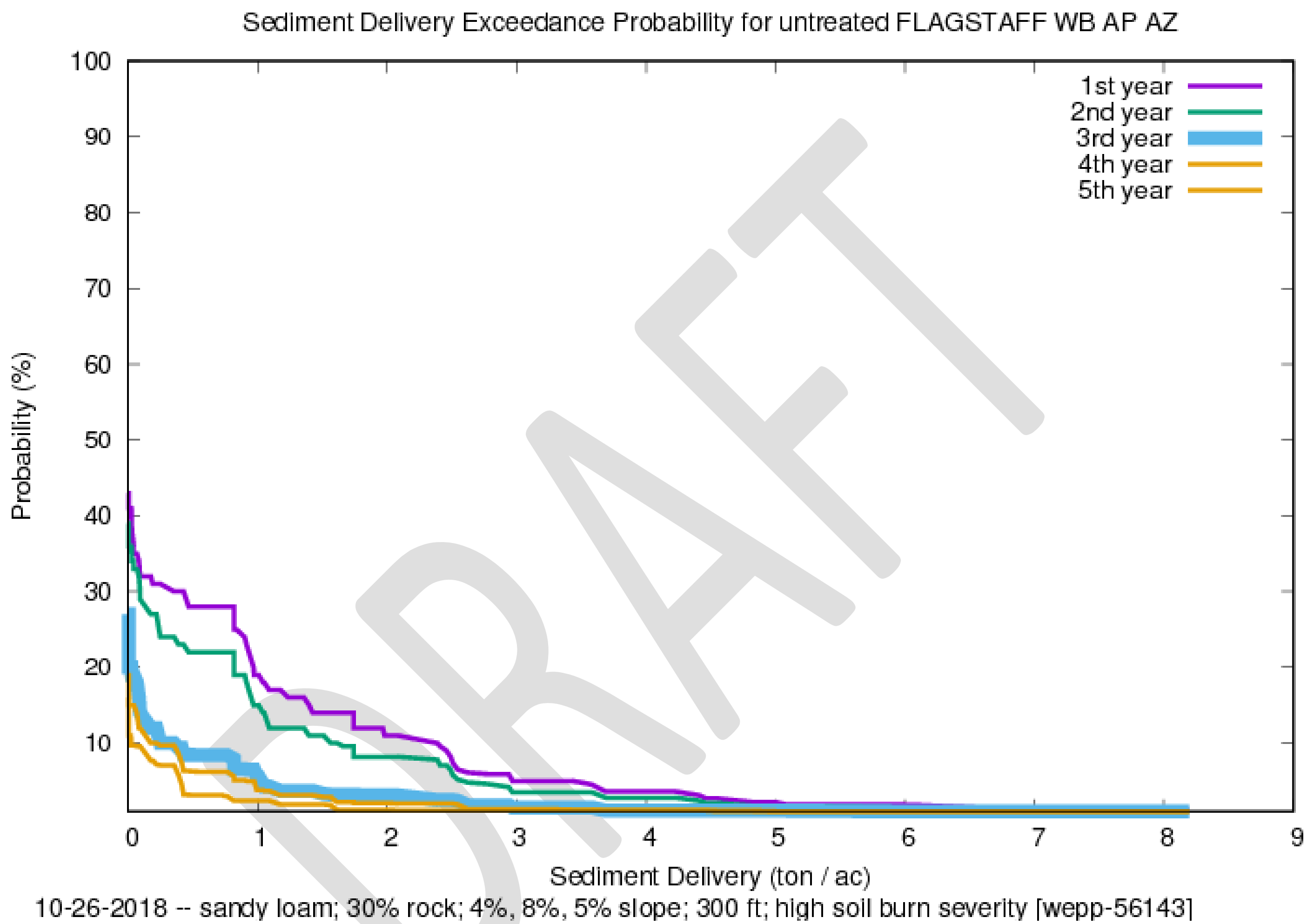
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.3	**in**	annual runoff from rainfall from	521	events
0.27	**in**	annual runoff from snowmelt or winter rainstorm from	94	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.93	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.79**	**2.91**	**4.51**	**4.42**	**3.40**	**September 13 year 27**
10 (10-year)	**1.47**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**

20 (5-year)	**1.13**	**1.96**	**2.22**	**0.62**	**0.62**	**January 18 year 72**
50 (2-year)	**0.67**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**
75 (1¹/₃-year)	**0.35**	**1.42**	**2.01**	**3.18**	**2.14**	**December 11 year 45**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	0.97	0.82	0.03	0	0
Seeding	0.97	0.08	0.01	0	0
Mulch (0.5 ton ac^{-1})	0	0.02	0.03	0	0
Mulch (1 ton ac^{-1})	0	0.01	0.03	0	0
Mulch (1.5 ton ac^{-1})	0	0.01	0.03	0	0
Mulch (2 ton ac^{-1})	0	0.01	0.03	0	0
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Stratum 7

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ	
loam soil texture, **40%** rock fragment	
15% top, 30% average, 20% toe hillslope gradient	
300 ft hillslope horizontal length	
unburned forest	

100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.054	**in**	annual runoff from rainfall from	34	events
0.0051	**in**	annual runoff from snowmelt or winter rainstorm from	1	events

26 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.14	3.91	4.28	3.63	3.11	September 4 year 68
5 (20-year)	**0.28**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**

10 (10-year)	0.03	2.18	2.24	5.05	3.35	November 16 year 5
20 (5-year)	0.00	1.85	2.25	4.22	2.82	June 16 year 41

Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Unburned	0.02	0.02	0.02	0.02	0.02

Return to input screen

ERMiT Version 2015.05.03

Low Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **40%** rock fragment

15% top, 30% average, 20% toe hillslope gradient
300 ft hillslope horizontal length
low soil burn severity on forest

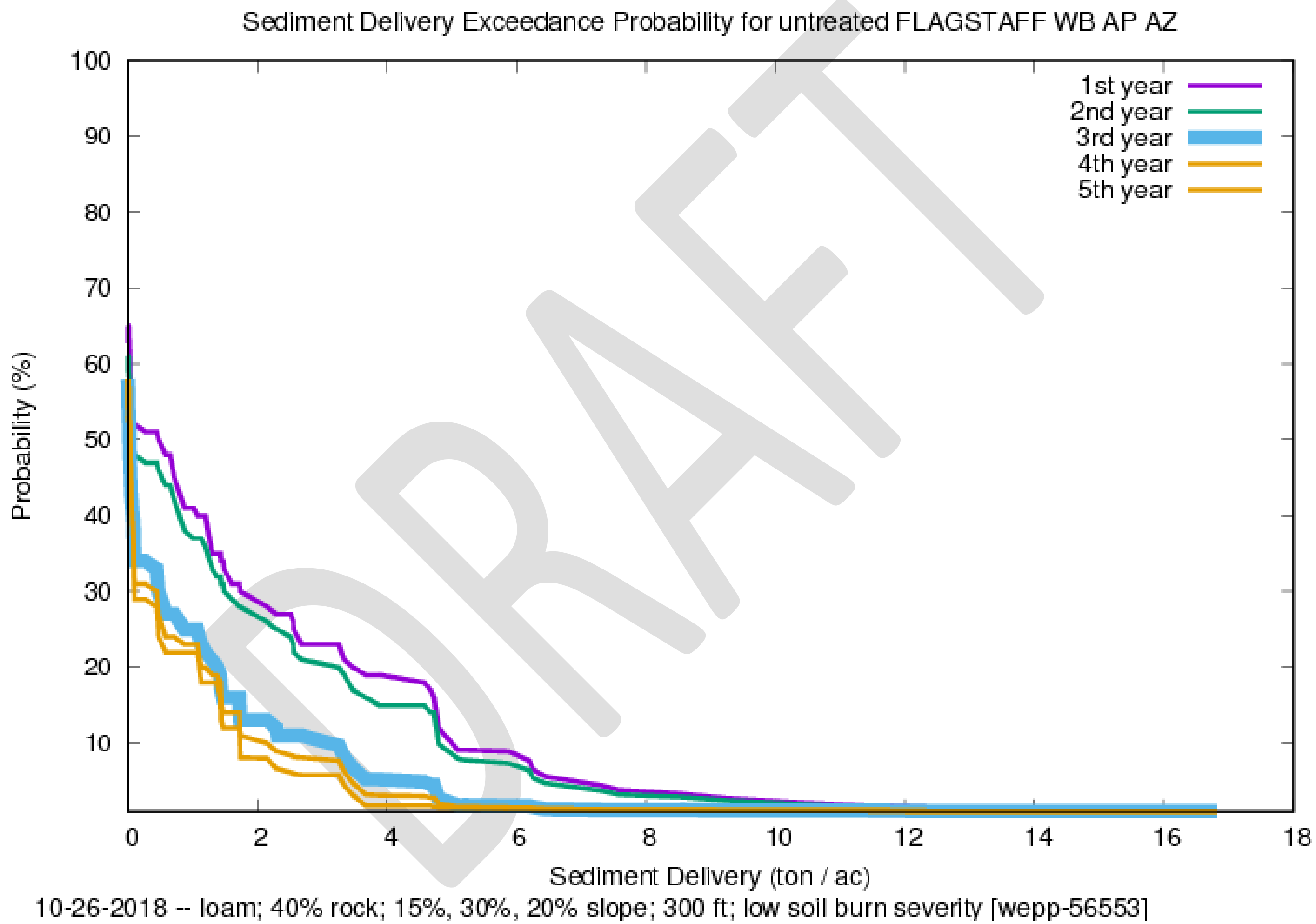
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.7	**in**	annual runoff from rainfall from	660	events
0.46	**in**	annual runoff from snowmelt or winter rainstorm from	173	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.03	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.95**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**
10 (10-year)	**1.69**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
20 (5-year)	**1.19**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.76**	**2.95**	**8.97**	**N/A**	**N/A**	**December 29 year 25**

75 (1 1/3-year)	0.49	1.28	2.47	3.38	2.11	August 5 year 100



Sediment Delivery

Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	3.51	3.13	1.39	1.17	1.1
Seeding	3.51	1.39	1.17	1.1	1.1
Mulch (0.5 ton ac^{-1})	1.26	1.22	1.39	1.17	1.1
Mulch (1 ton ac^{-1})	1.1	1.11	1.39	1.17	1.1
Mulch (1.5 ton ac^{-1})	1.1	1.09	1.39	1.17	1.1
Mulch (2 ton ac^{-1})	1.09	1.09	1.39	1.17	1.1
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Moderate Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **40%** rock fragment
15% top, 30% average, 20% toe hillslope gradient
300 ft hillslope horizontal length
moderate soil burn severity on forest

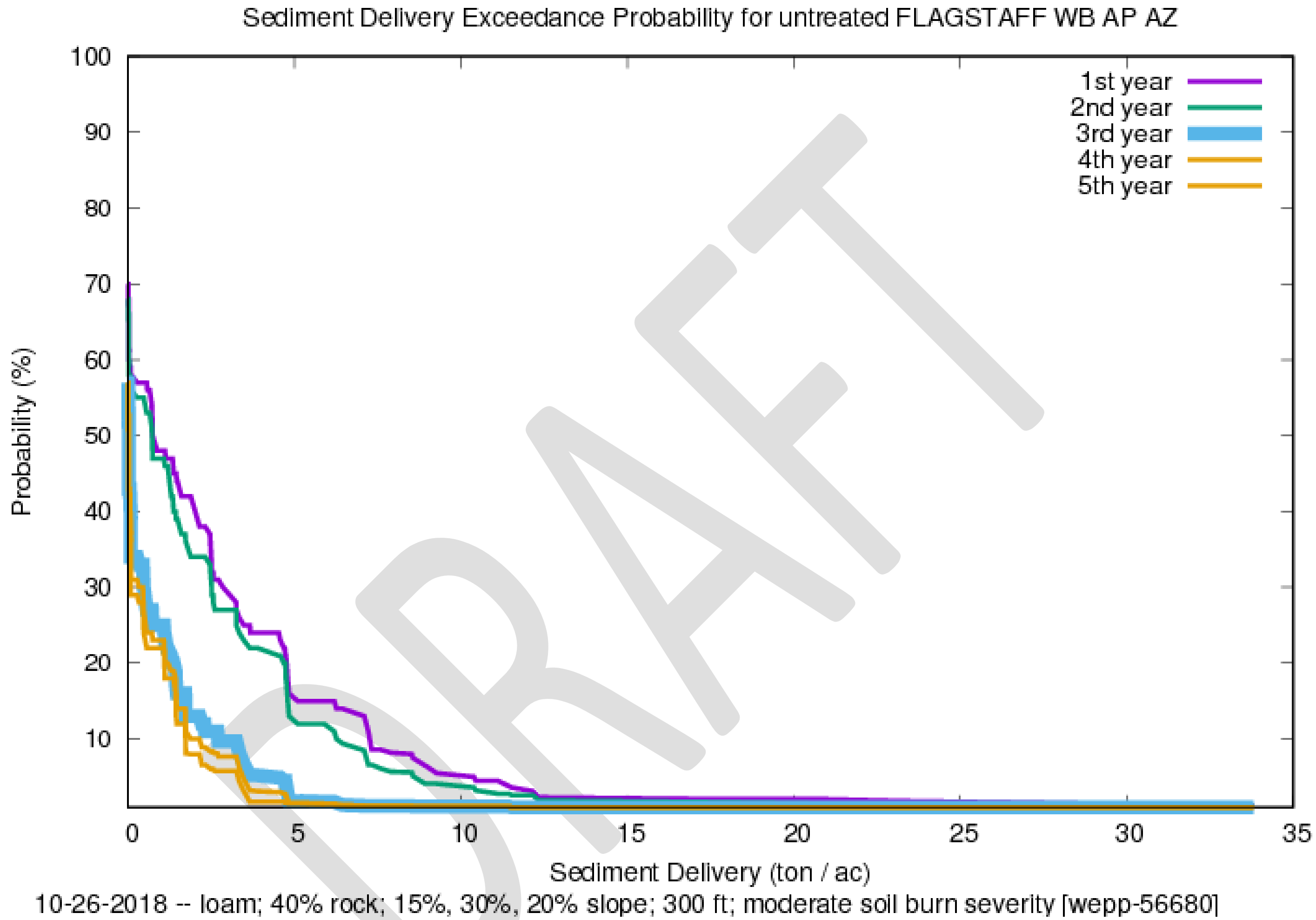
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.7	**in**	annual runoff from rainfall from	660	events
0.46	**in**	annual runoff from snowmelt or winter rainstorm from	173	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.03	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.95**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**

10 (10-year)	**1.69**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
20 (5-year)	**1.19**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.76**	**2.95**	**8.97**	**N/A**	**N/A**	**December 29 year 25**
75 ($1^1/_3$-year)	**0.49**	**1.28**	**2.47**	**3.38**	**2.11**	**August 5 year 100**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	4.75	4.69	1.39	1.17	1.1
Seeding	4.75	1.72	1.17	1.1	1.1
Mulch (0.5 ton ac^{-1})	1.79	1.44	1.39	1.17	1.1
Mulch (1 ton ac^{-1})	1.43	1.43	1.39	1.17	1.1
Mulch (1.5 ton ac^{-1})	1.43	1.43	1.39	1.17	1.1
Mulch (2 ton ac^{-1})	1.43	1.42	1.39	1.17	1.1
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

High Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **40%** rock fragment
15% top, 30% average, 20% toe hillslope gradient
300 ft hillslope horizontal length
high soil burn severity on forest

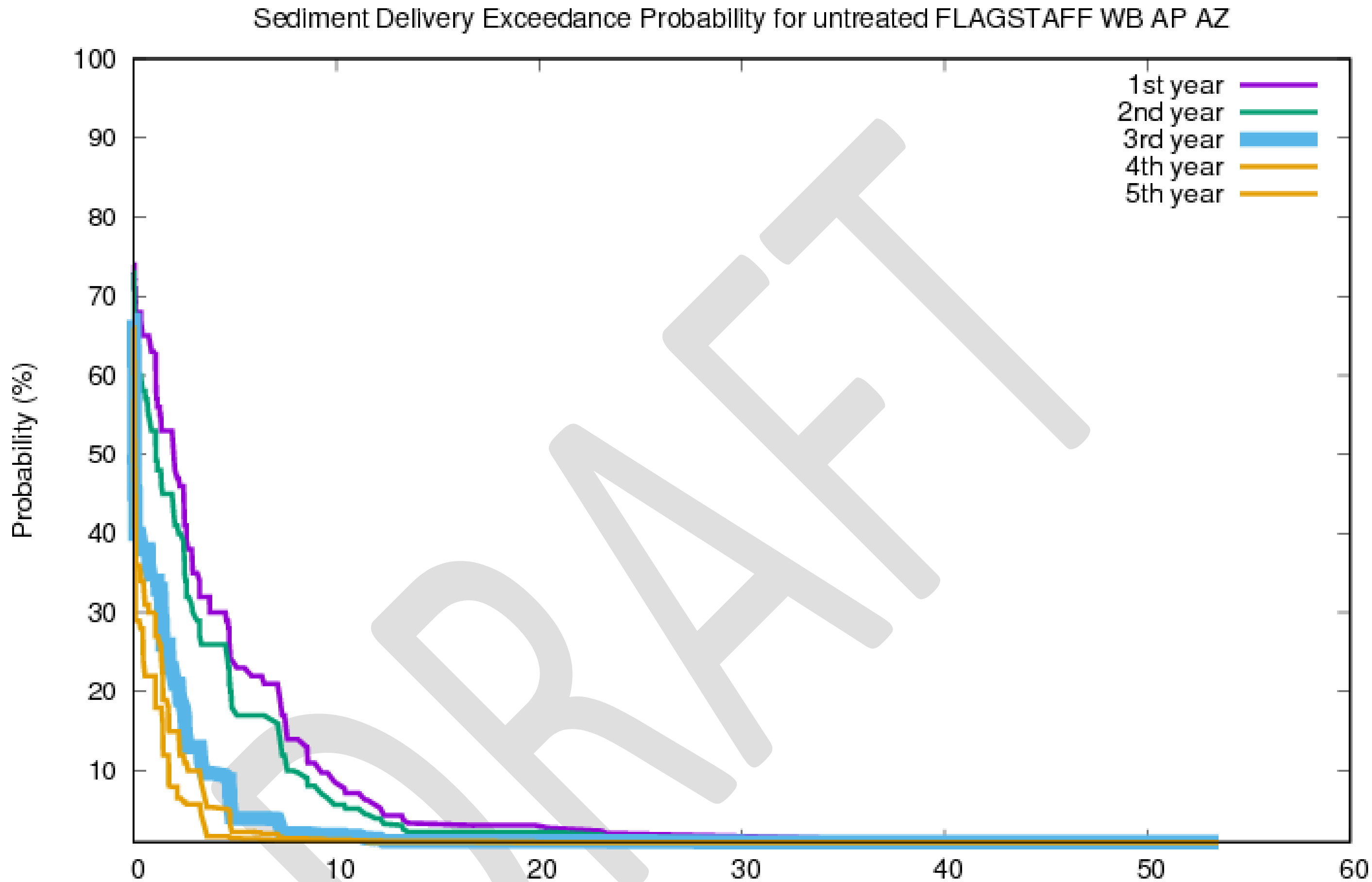
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.7	**in**	annual runoff from rainfall from	660	events
0.46	**in**	annual runoff from snowmelt or winter rainstorm from	173	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.03	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.95**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**
10 (10-year)	**1.69**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**

20 (5-year)	**1.19**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.76**	**2.95**	**8.97**	**N/A**	**N/A**	**December 29 year 25**
75 ($1^{1}/_{3}$-year)	**0.49**	**1.28**	**2.47**	**3.38**	**2.11**	**August 5 year 100**



10-26-2018 -- loam; 40% rock; 15%, 30%, 20% slope; 300 ft; high soil burn severity [wepp-56850]

Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	7.16	4.8	2.26	1.44	1.1
Seeding	7.16	2.49	1.86	1.43	1.1
Mulch (0.5 ton ac^{-1})	2.5	2.29	2.26	1.44	1.1
Mulch (1 ton ac^{-1})	2.24	2.24	2.26	1.44	1.1
Mulch (1.5 ton ac^{-1})	2.24	2.19	2.26	1.44	1.1
Mulch (2 ton ac^{-1})	2.24	2	2.26	1.44	1.1
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Stratum 8

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **35%** rock fragment
4% top, 8% average, 6% toe hillslope gradient
300 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.049	**in**	annual runoff from rainfall from	23	events
0.0087	**in**	annual runoff from snowmelt or winter rainstorm from	2	events

17 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.22	3.91	4.28	3.63	3.11	September 4 year 68

5 (20-year)	0.17	2.95	8.97	N/A	N/A	December 29 year 25
10 (10-year)	0.02	2.07	2.13	4.63	3.12	July 1 year 58

Sediment Delivery					
Probability that sediment yield will be exceeded	Event sediment delivery (ton ac^{-1})				
	Year following fire				
20 % go	1st year	2nd year	3rd year	4th year	5th year
Unburned	0.01	0.01	0.01	0.01	0.01

Return to input screen

ERMiT Version 2015.05.03

Low Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **35%** rock fragment

4% top, 8% average, 6% toe hillslope gradient
300 ft hillslope horizontal length
low soil burn severity on forest

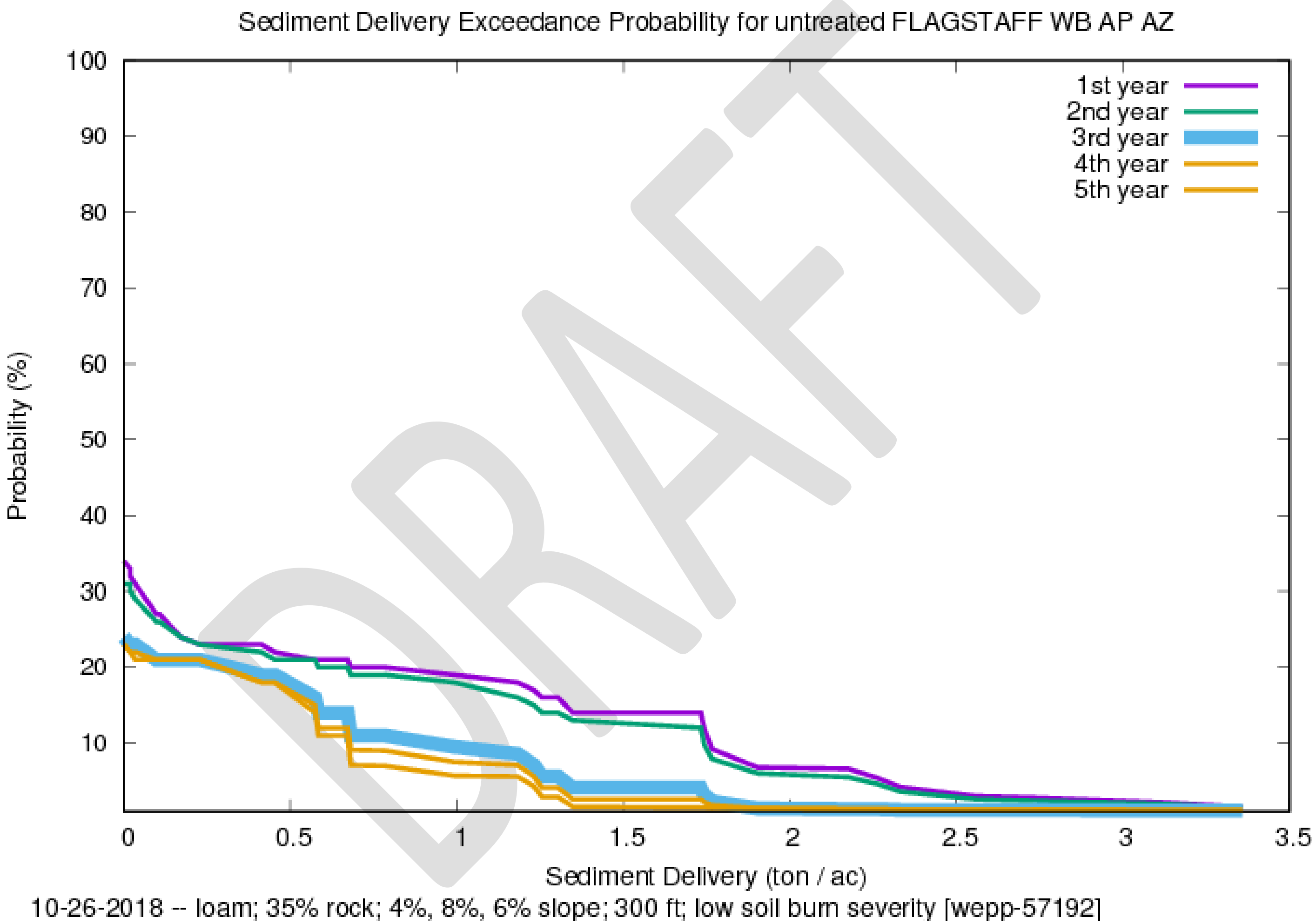
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.5	**in**	annual runoff from rainfall from	574	events
0.41	**in**	annual runoff from snowmelt or winter rainstorm from	134	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.02	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	1.99	4.34	5.92	N/A	N/A	December 2 year 32
10 (10-year)	1.75	4.44	6.01	N/A	N/A	December 7 year 97
20 (5-year)	1.17	1.91	1.81	4.71	3.04	July 19 year 20
50 (2-year)	0.73	1.89	2.74	2.35	1.91	December 29 year 42

75 (1[1]/3-year)	0.45	1.18	1.22	1.88	1.49	July 6 year 92



Sediment Delivery

Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	0.68	0.63	0.32	0.3	0.29
Seeding	0.68	0.32	0.3	0.29	0.29
Mulch (0.5 ton ac^{-1})	0.39	0.3	0.32	0.3	0.29
Mulch (1 ton ac^{-1})	0.35	0.29	0.32	0.3	0.29
Mulch (1.5 ton ac^{-1})	0.35	0.28	0.32	0.3	0.29
Mulch (2 ton ac^{-1})	0.34	0.28	0.32	0.3	0.29
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Moderate Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **35%** rock fragment
4% top, 8% average, 6% toe hillslope gradient
300 ft hillslope horizontal length
moderate soil burn severity on forest

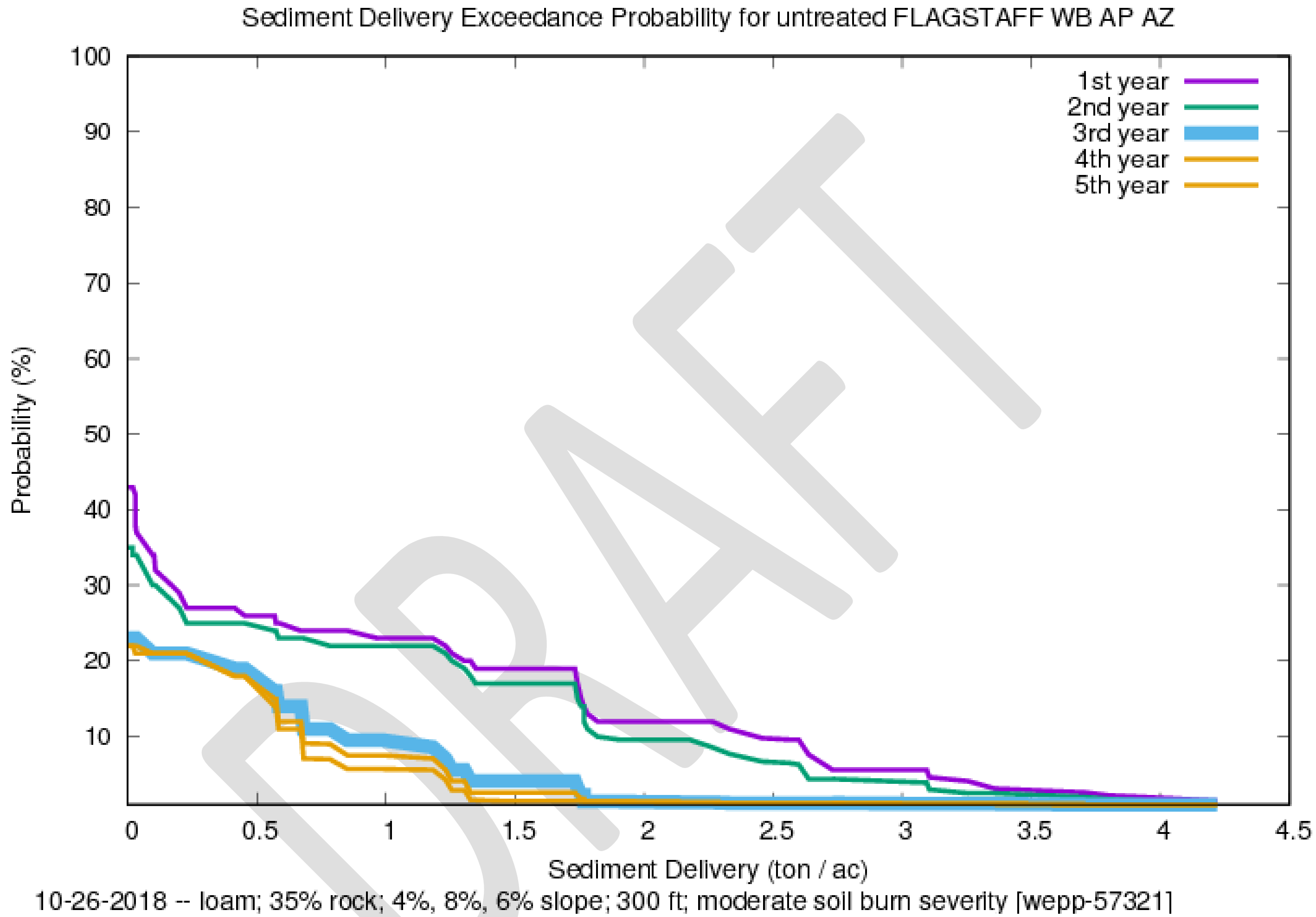
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.5	**in**	annual runoff from rainfall from	574	events
0.41	**in**	annual runoff from snowmelt or winter rainstorm from	134	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.02	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.99**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**

10 (10-year)	**1.75**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
20 (5-year)	**1.17**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.73**	**1.89**	**2.74**	**2.35**	**1.91**	**December 29 year 42**
75 ($1^1/_3$-year)	**0.45**	**1.18**	**1.22**	**1.88**	**1.49**	**July 6 year 92**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	1.37	1.25	0.32	0.3	0.29
Seeding	1.37	0.52	0.3	0.29	0.29
Mulch (0.5 ton ac^{-1})	0.58	0.51	0.32	0.3	0.29
Mulch (1 ton ac^{-1})	0.58	0.5	0.32	0.3	0.29
Mulch (1.5 ton ac^{-1})	0.58	0.49	0.32	0.3	0.29
Mulch (2 ton ac^{-1})	0.58	0.49	0.32	0.3	0.29
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

High Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **35%** rock fragment
4% top, 8% average, 6% toe hillslope gradient
300 ft hillslope horizontal length
high soil burn severity on forest

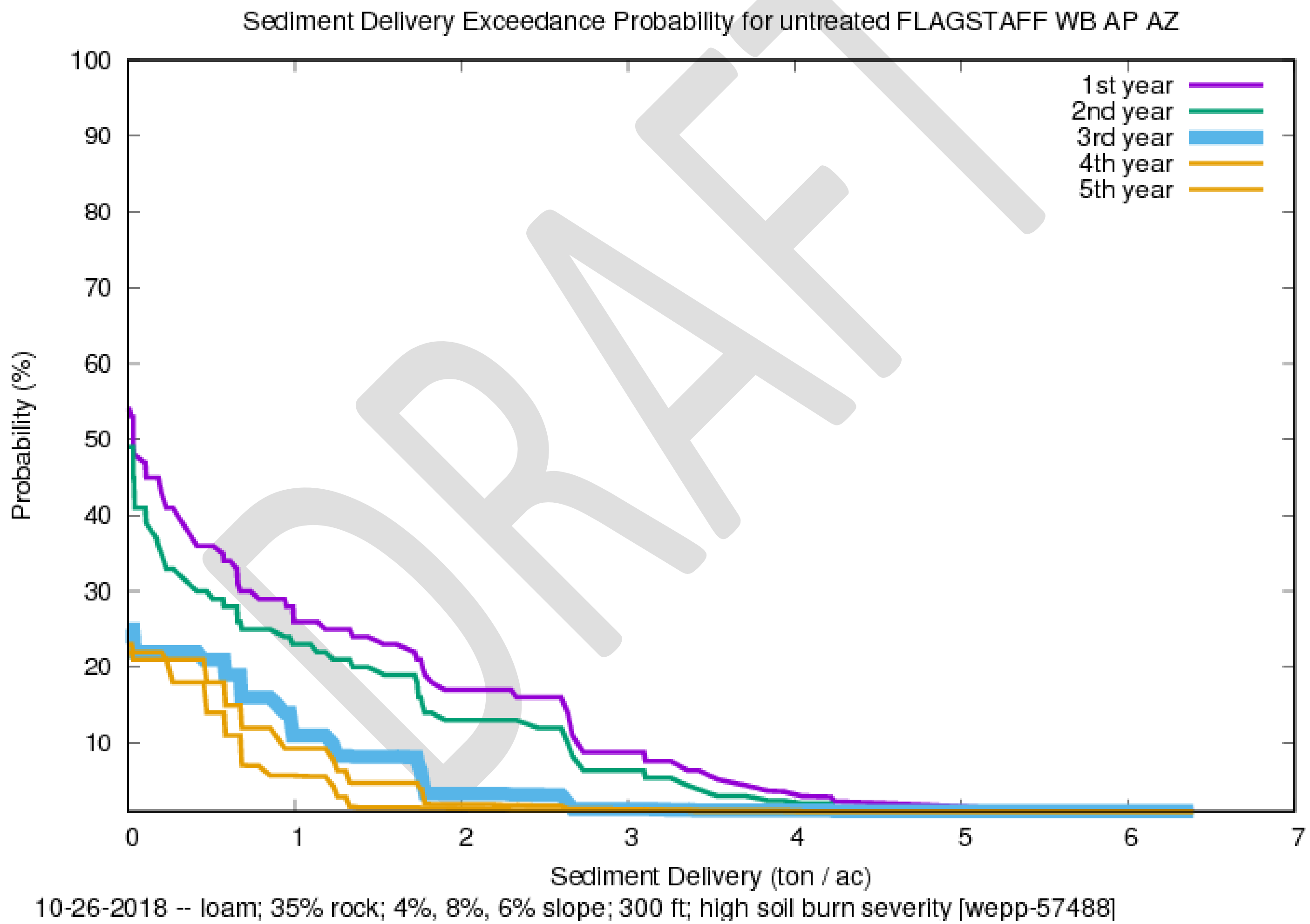
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.5	**in**	annual runoff from rainfall from	574	events
0.41	**in**	annual runoff from snowmelt or winter rainstorm from	134	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.02	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	1.99	4.34	5.92	N/A	N/A	December 2 year 32
10 (10-year)	1.75	4.44	6.01	N/A	N/A	December 7 year 97
20 (5-year)	1.17	1.91	1.81	4.71	3.04	July 19 year 20

50 (2-year)	0.73	1.89	2.74	2.35	1.91	December 29 year 42
75 (1$\frac{1}{3}$-year)	0.45	1.18	1.22	1.88	1.49	July 6 year 92



Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	1.77	1.43	0.58	0.51	0.29
Seeding	1.77	0.71	0.58	0.5	0.29
Mulch (0.5 ton ac^{-1})	0.89	0.7	0.58	0.51	0.29
Mulch (1 ton ac^{-1})	0.88	0.7	0.58	0.51	0.29
Mulch (1.5 ton ac^{-1})	0.88	0.7	0.58	0.51	0.29
Mulch (2 ton ac^{-1})	0.88	0.69	0.58	0.51	0.29
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Stratum 9

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **25%** rock fragment
15% top, 30% average, 15% toe hillslope gradient
300 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.027	**in**	annual runoff from rainfall from	12	events
0.0035	**in**	annual runoff from snowmelt or winter rainstorm from	1	events

9 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms						
Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	1.91	3.91	4.28	3.63	3.11	September 4 year 68
5 (20-year)	**0.04**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**

Sediment Delivery					
Probability that sediment yield will be exceeded	Event sediment delivery (ton ac^{-1})				
	Year following fire				
20 % go	1st year	2nd year	3rd year	4th year	5th year
Unburned	0.02	0.02	0.02	0.02	0.02

Return to input screen

ERMiT Version 2015.05.03

Low Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **25%** rock fragment
15% top, 30% average, 15% toe hillslope gradient
300 ft hillslope horizontal length
low soil burn severity on forest

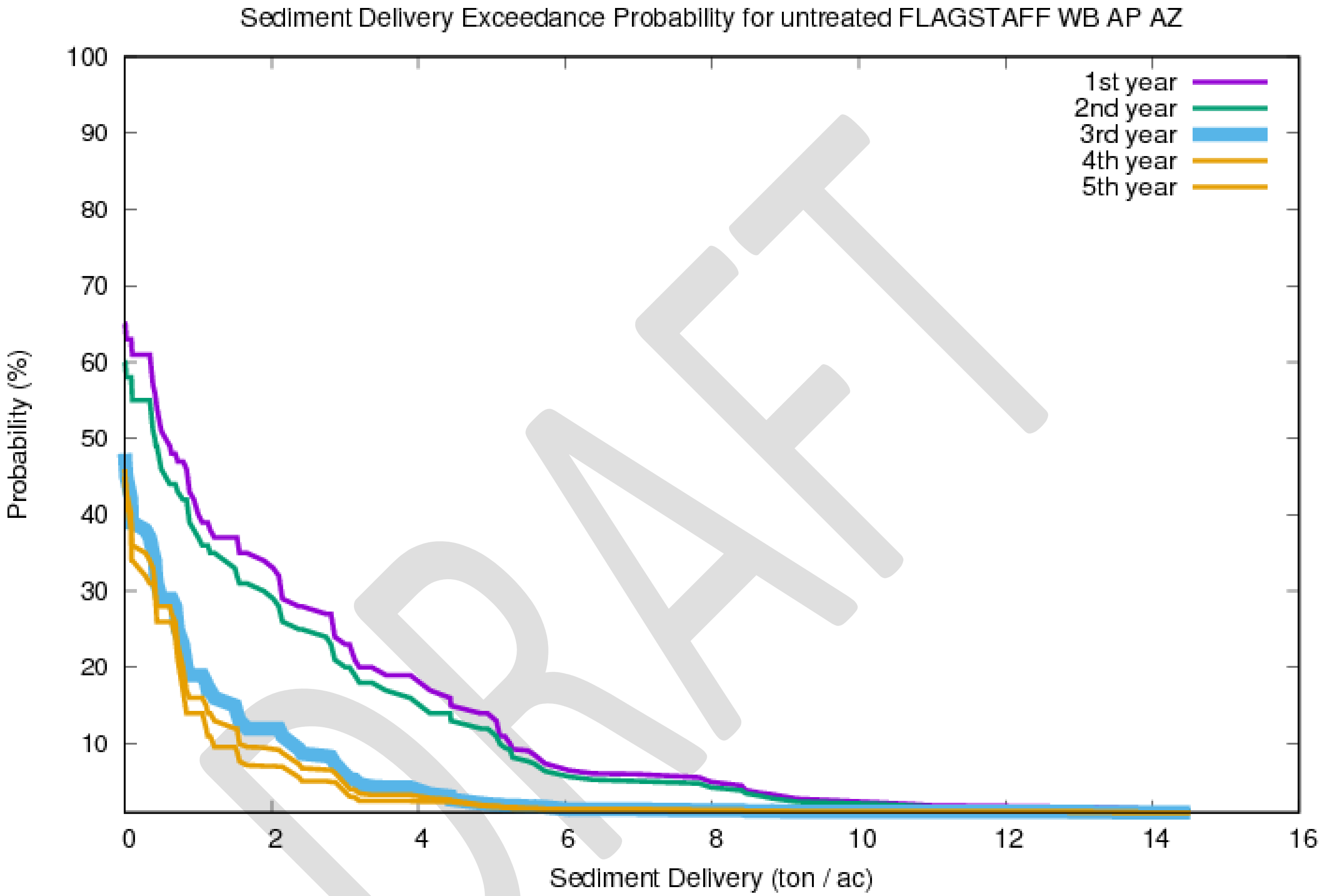
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.5	**in**	annual runoff from rainfall from	554	events
0.28	**in**	annual runoff from snowmelt or winter rainstorm from	109	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.92	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.79**	**2.91**	**4.51**	**4.42**	**3.40**	**September 13 year 27**
10 (10-year)	**1.45**	**2.50**	**5.67**	**3.27**	**2.61**	**September 29 year 26**

20 (5-year)	**1.09**	**2.06**	**2.13**	**4.70**	**3.14**	**August 8 year 79**
50 (2-year)	**0.66**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**
75 (1$^{1}/_{3}$-year)	**0.35**	**1.26**	**3.29**	**1.55**	**1.26**	**August 29 year 43**



10-26-2018 -- sandy loam; 25% rock; 15%, 30%, 15% slope; 300 ft; low soil burn severity [wepp-57790]

Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	3.28	3.06	0.85	0.79	0.74
Seeding	3.28	0.85	0.79	0.74	0.74
Mulch (0.5 ton ac^{-1})	0.8	0.8	0.85	0.79	0.74
Mulch (1 ton ac^{-1})	0.75	0.76	0.85	0.79	0.74
Mulch (1.5 ton ac^{-1})	0.74	0.74	0.85	0.79	0.74
Mulch (2 ton ac^{-1})	0.74	0.73	0.85	0.79	0.74
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Moderate Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **25%** rock fragment
15% top, 30% average, 15% toe hillslope gradient
300 ft hillslope horizontal length
moderate soil burn severity on forest

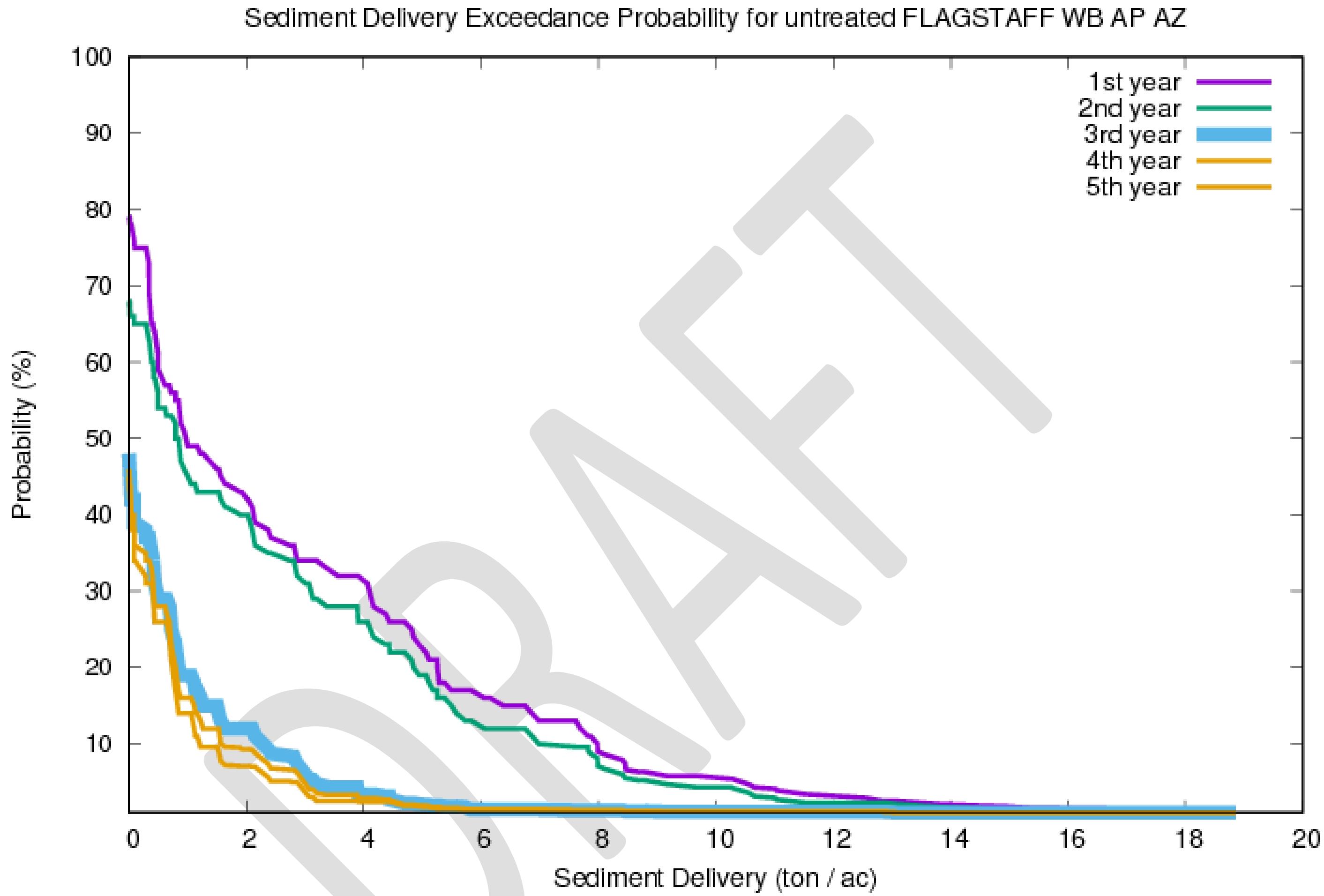
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.5	**in**	annual runoff from rainfall from	554	events
0.28	**in**	annual runoff from snowmelt or winter rainstorm from	109	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.92	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.79**	**2.91**	**4.51**	**4.42**	**3.40**	**September 13 year 27**
10 (10-year)	**1.45**	**2.50**	**5.67**	**3.27**	**2.61**	**September 29 year 26**

20 (5-year)	**1.09**	**2.06**	**2.13**	**4.70**	**3.14**	**August 8 year 79**
50 (2-year)	**0.66**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**
75 (1 1/3-year)	**0.35**	**1.26**	**3.29**	**1.55**	**1.26**	**August 29 year 43**



10-26-2018 -- sandy loam; 25% rock; 15%, 30%, 15% slope; 300 ft; moderate soil burn severity [wepp-57915]

Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	5.28	4.84	0.85	0.79	0.74
Seeding	5.28	1.99	0.79	0.74	0.74
Mulch (0.5 ton ac^{-1})	1.91	1.56	0.85	0.79	0.74
Mulch (1 ton ac^{-1})	1.65	1.12	0.85	0.79	0.74
Mulch (1.5 ton ac^{-1})	1.64	1.09	0.85	0.79	0.74
Mulch (2 ton ac^{-1})	1.5	1.08	0.85	0.79	0.74
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

High Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **25%** rock fragment
15% top, 30% average, 15% toe hillslope gradient
300 ft hillslope horizontal length
high soil burn severity on forest

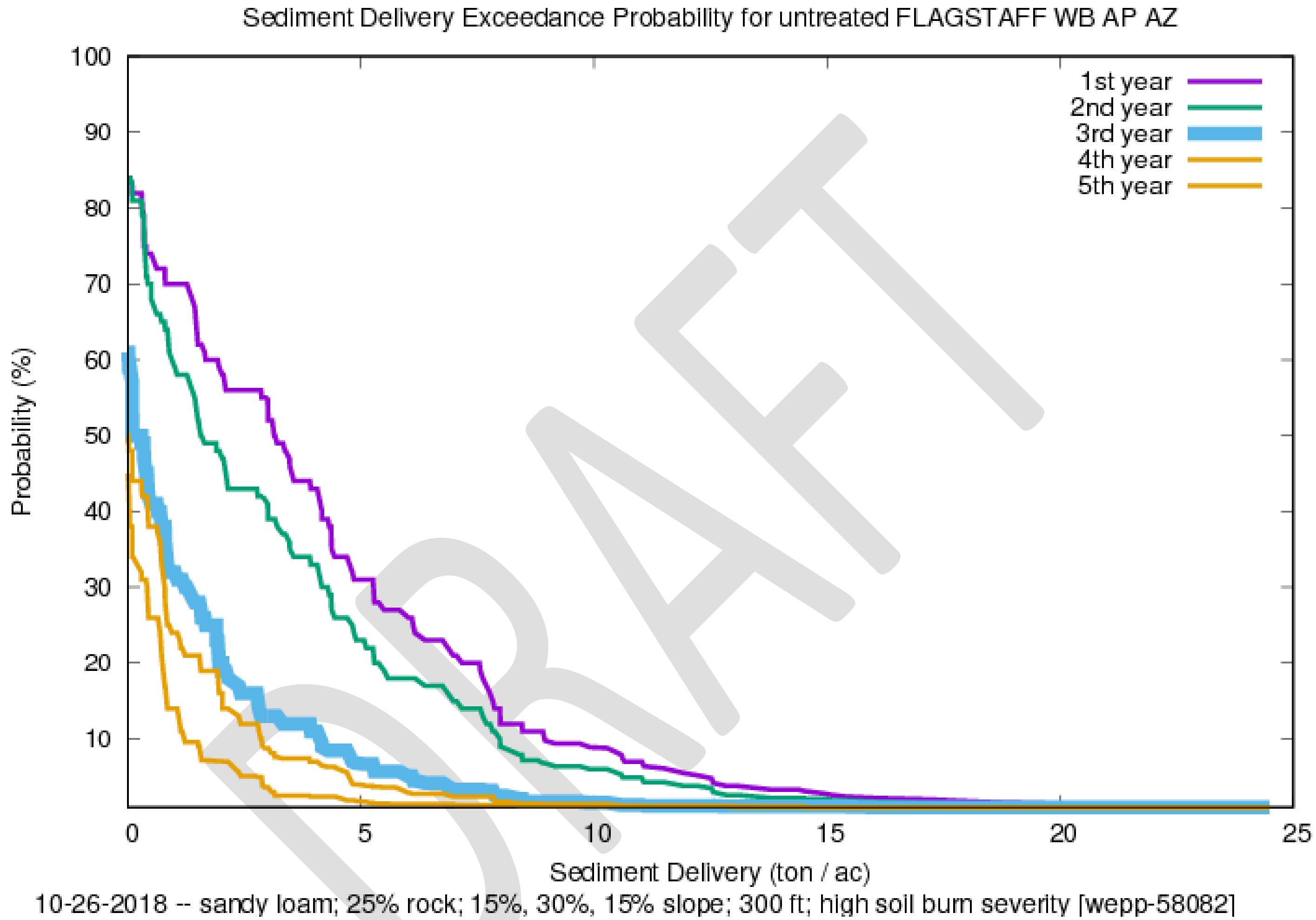
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.5	**in**	annual runoff from rainfall from	554	events
0.28	**in**	annual runoff from snowmelt or winter rainstorm from	109	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.92	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.79**	**2.91**	**4.51**	**4.42**	**3.40**	**September 13 year 27**
10 (10-year)	**1.45**	**2.50**	**5.67**	**3.27**	**2.61**	**September 29 year 26**

20 (5-year)	**1.09**	**2.06**	**2.13**	**4.70**	**3.14**	**August 8 year 79**
50 (2-year)	**0.66**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**
75 ($1^1/_3$-year)	**0.35**	**1.26**	**3.29**	**1.55**	**1.26**	**August 29 year 43**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	7.18	5.38	2.02	1.55	0.74
Seeding	7.18	2.78	1.92	1.12	0.74
Mulch (0.5 ton ac^{-1})	2.8	2.02	2.02	1.55	0.74
Mulch (1 ton ac^{-1})	1.98	1.96	2.02	1.55	0.74
Mulch (1.5 ton ac^{-1})	1.98	1.95	2.02	1.55	0.74
Mulch (2 ton ac^{-1})	1.97	1.94	2.02	1.55	0.74
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Citation:
Robichaud, Peter R.; Elliot, William J.; Pierson, Fredrick B.; Hall, David E.; Moffet, Corey A. 2014. **Erosion Risk Management Tool (ERMiT).** [Online at <https://forest.moscowfsl.wsu.edu/fswepp/>.] Moscow, ID: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

WEPP VERSION 2010.100
ERMiT run ID wepp-58082
Observed annual precip 554.1 mm; July, August, September precip 186.7 mm (33.69 percent): MONSOONAL climat

Stratum 10

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **25%** rock fragment
4% top, 10% average, 6% toe hillslope gradient
300 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.053	**in**	annual runoff from rainfall from	23	events
0.017	**in**	annual runoff from snowmelt or winter rainstorm from	6	events

18 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.33	3.91	4.28	3.63	3.11	September 4 year 68

5 (20-year)	0.38	3.42	5.02	5.90	4.37	September 19 year 48
10 (10-year)	0.05	4.34	5.92	N/A	N/A	December 2 year 32

Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Unburned	0	0	0	0	0

Return to input screen

ERMiT Version 2015.05.03

Low Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ

loam soil texture, **25%** rock fragment
4% top, 10% average, 6% toe hillslope gradient
300 ft hillslope horizontal length
low soil burn severity on forest

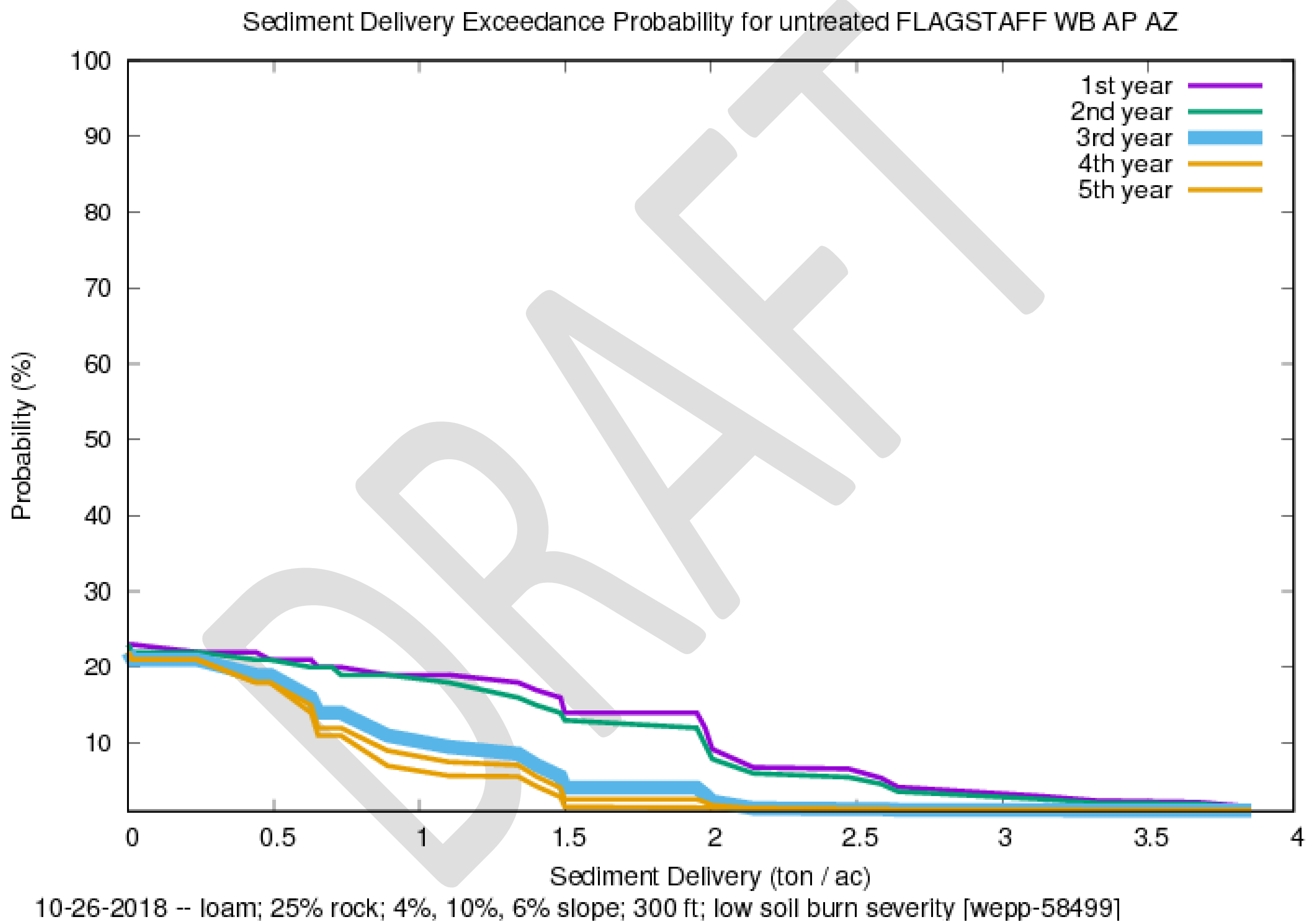
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.5	**in**	annual runoff from rainfall from	582	events
0.4	**in**	annual runoff from snowmelt or winter rainstorm from	133	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.99	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	1.92	4.34	5.92	N/A	N/A	December 2 year 32
10 (10-year)	1.70	4.44	6.01	N/A	N/A	December 7 year 97
20 (5-year)	1.17	1.91	1.81	4.71	3.04	July 19 year 20
50 (2-year)	0.71	1.89	2.74	2.35	1.91	December 29 year 42

75 (1 1/3-year)	**0.42**	**0.80**	**0.89**	**1.80**	**1.27**	**February 17 year 57**



Sediment Delivery

Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	0.71	0.64	0.32	0.31	0.3
Seeding	0.71	0.32	0.31	0.3	0.3
Mulch (0.5 ton ac^{-1})	0.39	0.31	0.32	0.31	0.3
Mulch (1 ton ac^{-1})	0.36	0.3	0.32	0.31	0.3
Mulch (1.5 ton ac^{-1})	0.36	0.29	0.32	0.31	0.3
Mulch (2 ton ac^{-1})	0.35	0.29	0.32	0.31	0.3
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Citation:

Moderate Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **25%** rock fragment
4% top, 10% average, 6% toe hillslope gradient
300 ft hillslope horizontal length
moderate soil burn severity on forest

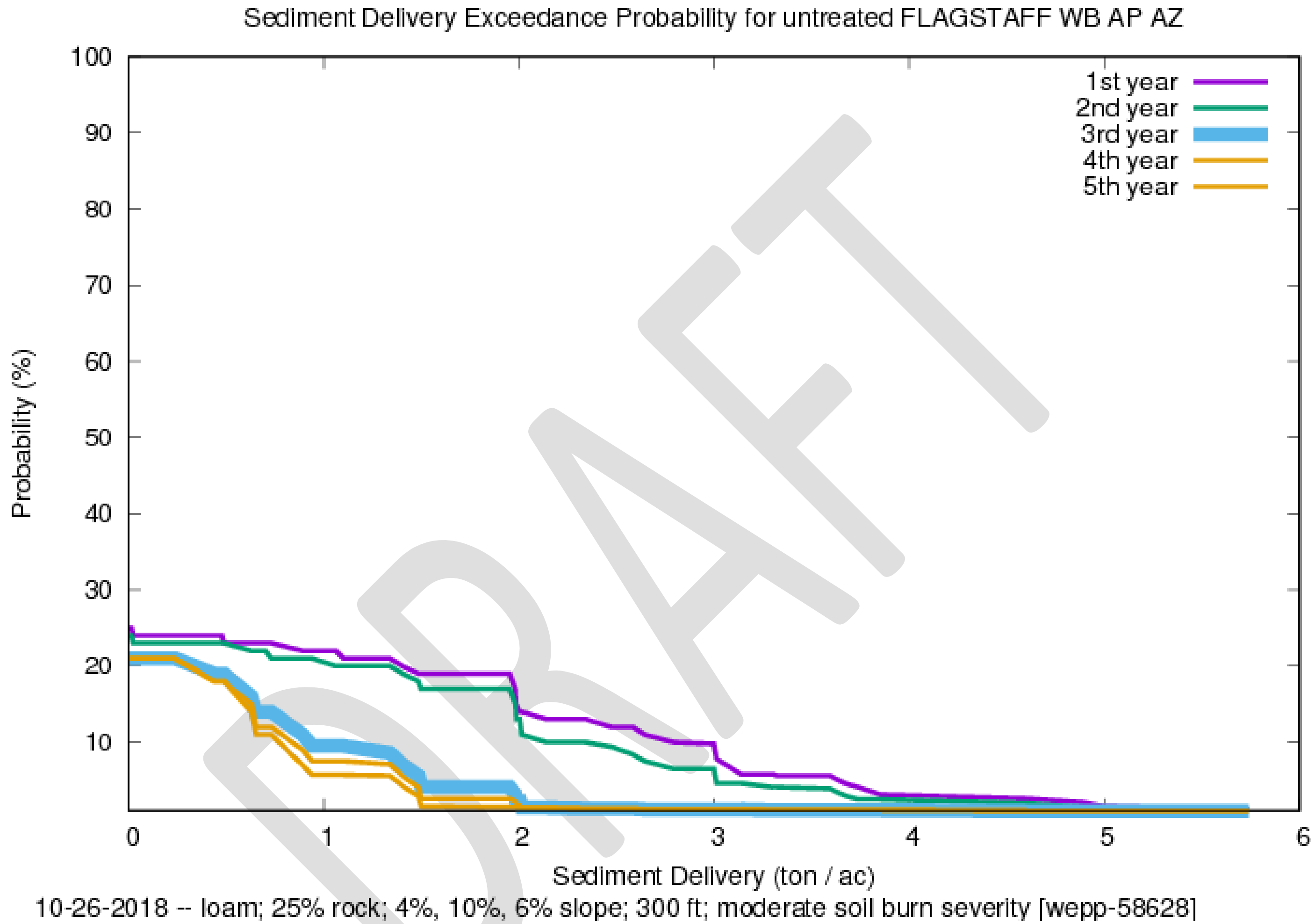
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.5	**in**	annual runoff from rainfall from	582	events
0.4	**in**	annual runoff from snowmelt or winter rainstorm from	133	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.99	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.92**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**
10 (10-year)	**1.70**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**

20 (5-year)	**1.17**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.71**	**1.89**	**2.74**	**2.35**	**1.91**	**December 29 year 42**
75 ($1^1/_3$-year)	**0.42**	**0.80**	**0.89**	**1.80**	**1.27**	**February 17 year 57**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	1.4	1.35	0.32	0.31	0.3
Seeding	1.4	0.55	0.31	0.3	0.3
Mulch (0.5 ton ac^{-1})	0.64	0.54	0.32	0.31	0.3
Mulch (1 ton ac^{-1})	0.63	0.53	0.32	0.31	0.3
Mulch (1.5 ton ac^{-1})	0.63	0.53	0.32	0.31	0.3
Mulch (2 ton ac^{-1})	0.63	0.53	0.32	0.31	0.3
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

High Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **25%** rock fragment
4% top, 10% average, 6% toe hillslope gradient
300 ft hillslope horizontal length
high soil burn severity on forest

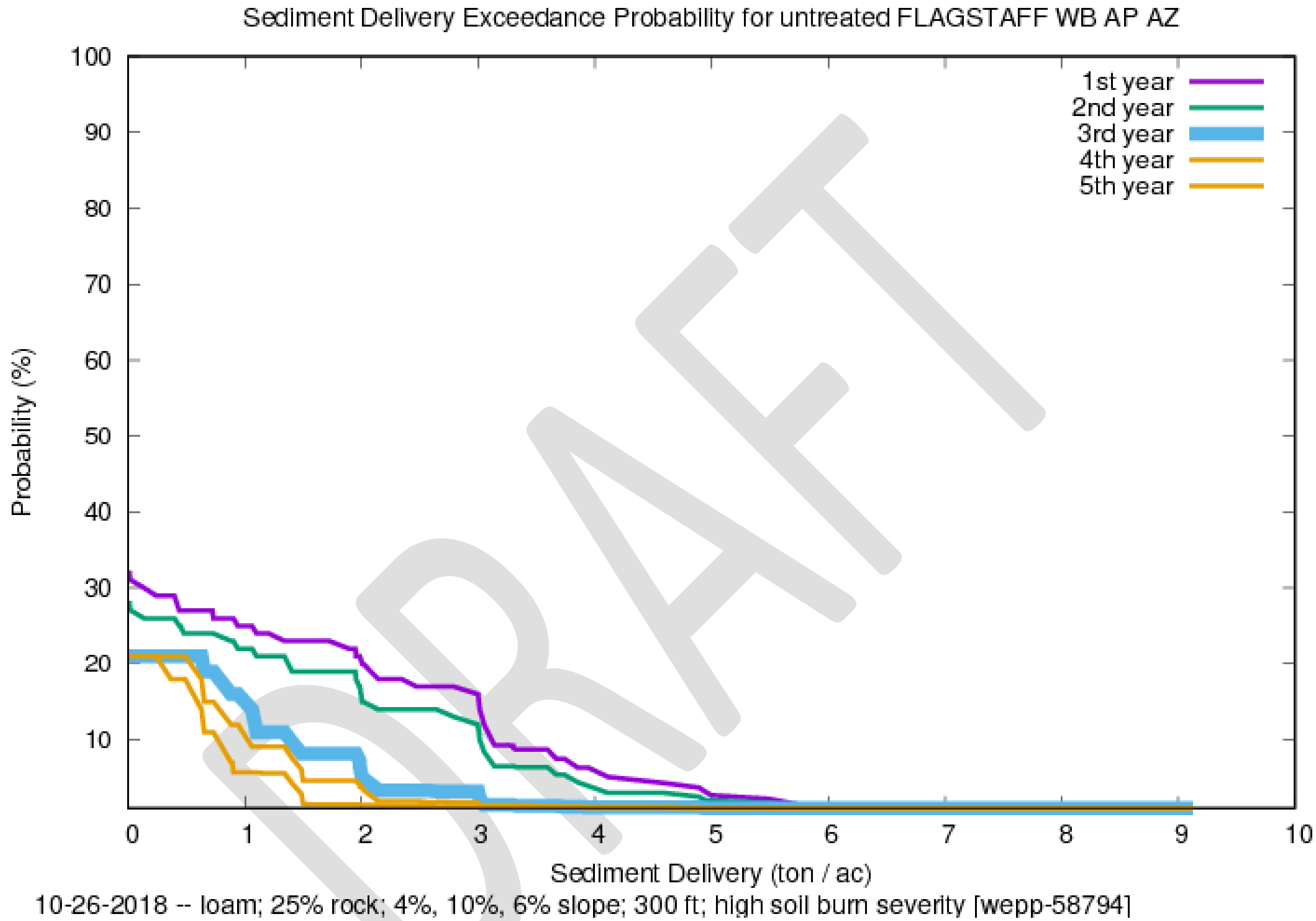
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.5	**in**	annual runoff from rainfall from	582	events
0.4	**in**	annual runoff from snowmelt or winter rainstorm from	133	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.99	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.92**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**
10 (10-year)	**1.70**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**

20 (5-year)	**1.17**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.71**	**1.89**	**2.74**	**2.35**	**1.91**	**December 29 year 42**
75 (1 1/3-year)	**0.42**	**0.80**	**0.89**	**1.80**	**1.27**	**February 17 year 57**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	2	1.64	0.64	0.54	0.3
Seeding	2	0.81	0.64	0.53	0.3
Mulch (0.5 ton ac^{-1})	0.98	0.79	0.64	0.54	0.3
Mulch (1 ton ac^{-1})	0.97	0.78	0.64	0.54	0.3
Mulch (1.5 ton ac^{-1})	0.97	0.78	0.64	0.54	0.3
Mulch (2 ton ac^{-1})	0.97	0.78	0.64	0.54	0.3
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Stratum 11

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **20%** rock fragment
6% top, 12% average, 8% toe hillslope gradient
300 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.057	**in**	annual runoff from rainfall from	23	events
0.02	**in**	annual runoff from snowmelt or winter rainstorm from	6	events

18 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date

1	2.37	3.91	4.28	3.63	3.11	September 4 year 68
5 (20-year)	**0.36**	**2.95**	**8.97**	**N/A**	**N/A**	**December 29 year 25**
10 (10-year)	**0.06**	**3.00**	**3.46**	**5.09**	**3.78**	**June 17 year 56**

Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Unburned	0	0	0	0	0

Return to input screen

ERMiT Version 2015.05.03

Low Burn Severity

Erosion Risk Management Tool

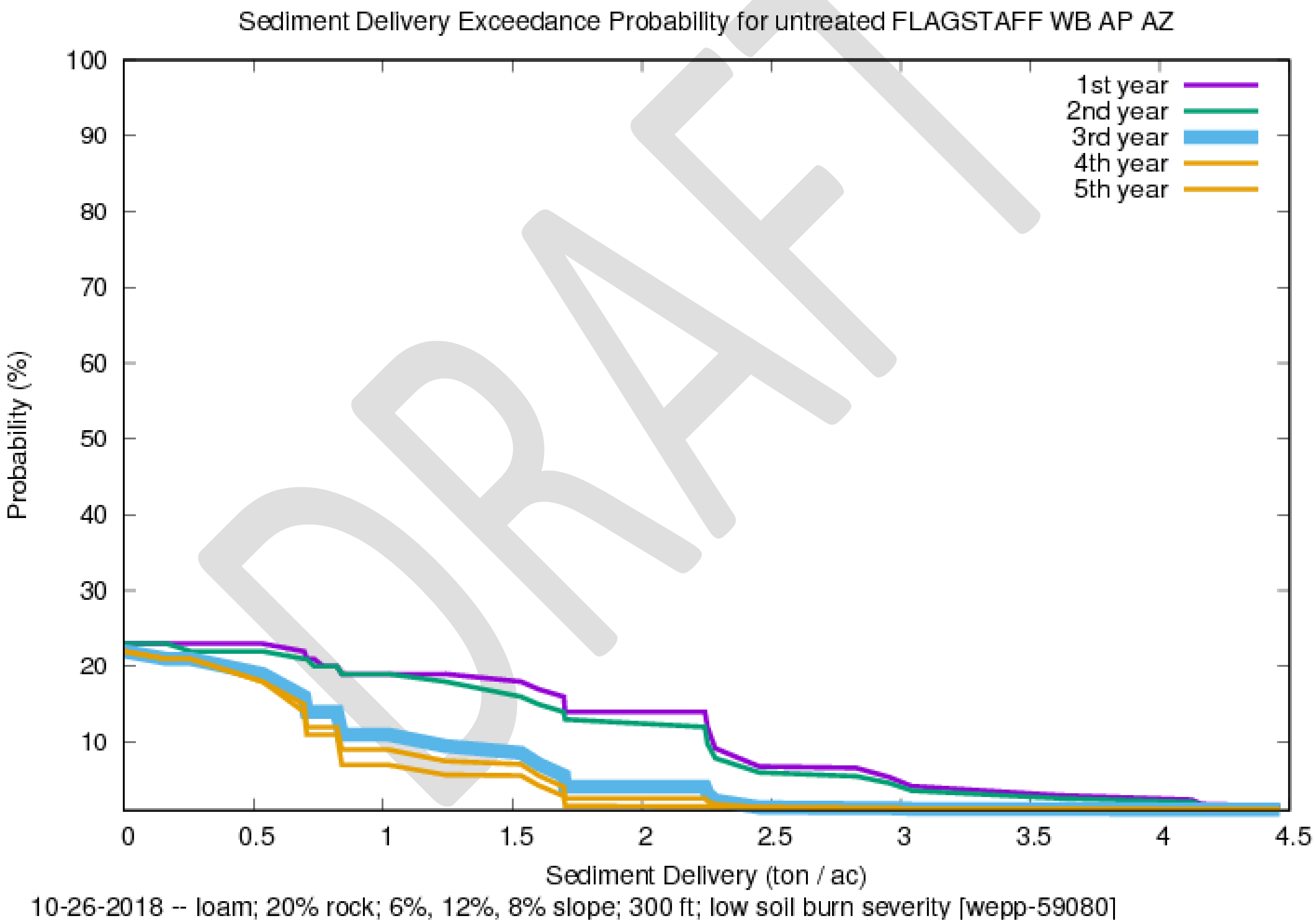
FLAGSTAFF WB AP AZ
loam soil texture, **20%** rock fragment
6% top, 12% average, 8% toe hillslope gradient
300 ft hillslope horizontal length
low soil burn severity on forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.5	**in**	annual runoff from rainfall from	603	events
0.4	**in**	annual runoff from snowmelt or winter rainstorm from	157	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.98	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.89**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**
10 (10-year)	**1.69**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
20 (5-year)	**1.17**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**

50 (2-year)	**0.73**	**1.89**	**2.74**	**2.35**	**1.91**	**December 29 year 42**
75 (1 1/3-year)	**0.42**	**0.80**	**0.89**	**1.80**	**1.27**	**February 17 year 57**



Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	0.82	0.76	0.38	0.36	0.35
Seeding	0.82	0.38	0.36	0.35	0.35
Mulch (0.5 ton ac^{-1})	0.49	0.36	0.38	0.36	0.35
Mulch (1 ton ac^{-1})	0.44	0.35	0.38	0.36	0.35
Mulch (1.5 ton ac^{-1})	0.43	0.34	0.38	0.36	0.35
Mulch (2 ton ac^{-1})	0.43	0.34	0.38	0.36	0.35
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Moderate Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **20%** rock fragment
6% top, 12% average, 8% toe hillslope gradient
300 ft hillslope horizontal length
moderate soil burn severity on forest

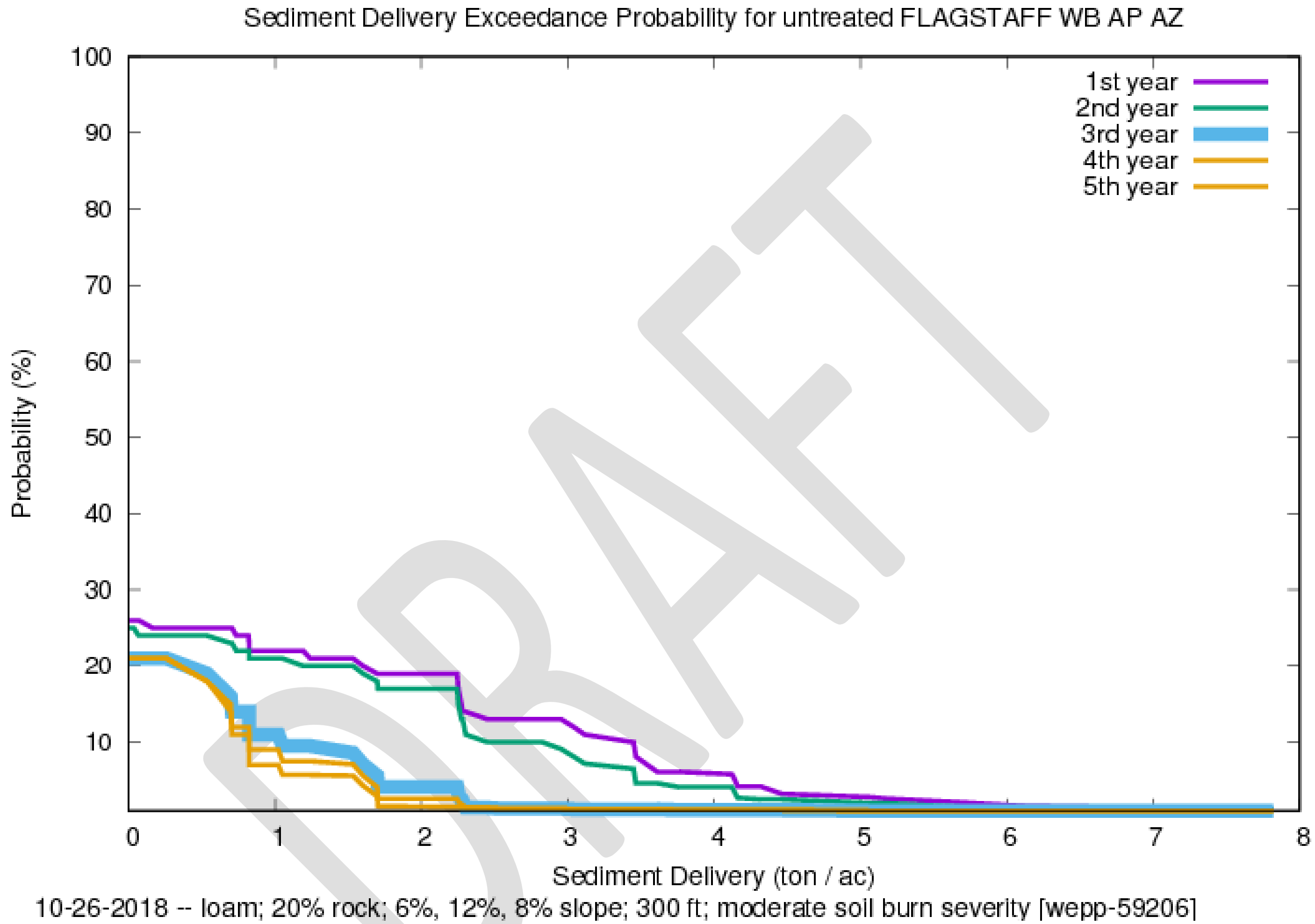
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.5	**in**	annual runoff from rainfall from	603	events
0.4	**in**	annual runoff from snowmelt or winter rainstorm from	157	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.98	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.89**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**

10 (10-year)	**1.69**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
20 (5-year)	**1.17**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.73**	**1.89**	**2.74**	**2.35**	**1.91**	**December 29 year 42**
75 (1 1/3-year)	**0.42**	**0.80**	**0.89**	**1.80**	**1.27**	**February 17 year 57**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	1.6	1.54	0.38	0.36	0.35
Seeding	1.6	0.62	0.36	0.35	0.35
Mulch (0.5 ton ac^{-1})	0.7	0.6	0.38	0.36	0.35
Mulch (1 ton ac^{-1})	0.7	0.59	0.38	0.36	0.35
Mulch (1.5 ton ac^{-1})	0.7	0.59	0.38	0.36	0.35
Mulch (2 ton ac^{-1})	0.7	0.59	0.38	0.36	0.35
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

High Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **20%** rock fragment
6% top, 12% average, 8% toe hillslope gradient
300 ft hillslope horizontal length
high soil burn severity on forest

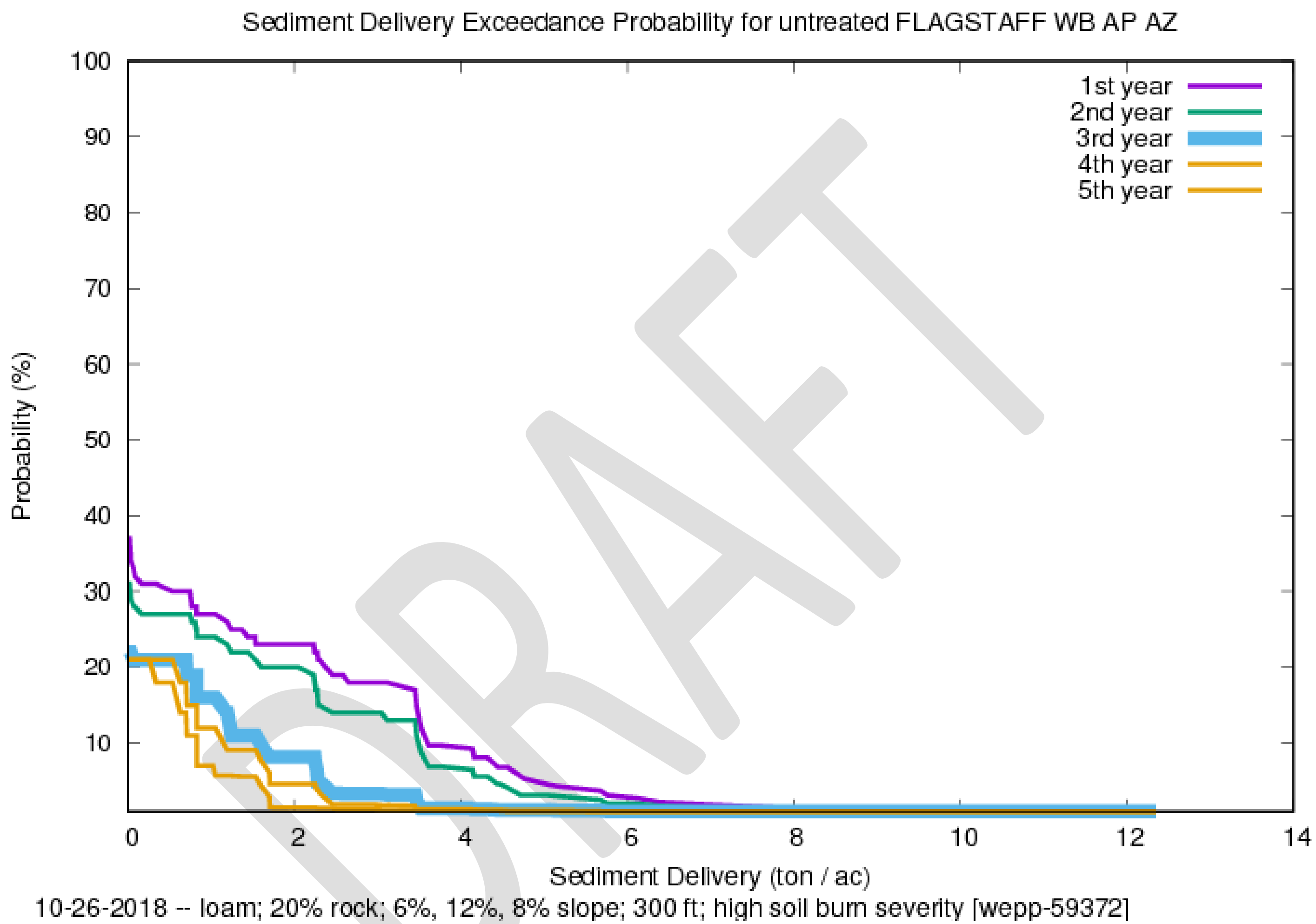
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.5	**in**	annual runoff from rainfall from	603	events
0.4	**in**	annual runoff from snowmelt or winter rainstorm from	157	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.98	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	1.89	4.34	5.92	N/A	N/A	December 2 year 32
10 (10-year)	1.69	4.44	6.01	N/A	N/A	December 7 year 97

20 (5-year)	**1.17**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.73**	**1.89**	**2.74**	**2.35**	**1.91**	**December 29 year 42**
75 ($1^{1}/_{3}$-year)	**0.42**	**0.80**	**0.89**	**1.80**	**1.27**	**February 17 year 57**



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<tr><th colspan="6">Sediment Delivery</th></tr>
<tr><th rowspan="3">Probability that sediment yield</th><th colspan="5">Event sediment delivery (ton ac^{-1})</th></tr>
<tr><th colspan="5">Year following fire</th></tr>
<tr><th>1st year</th><th>2nd year</th><th>3rd year</th><th>4th year</th><th>5th year</th></tr>
</table>

will be exceeded 20 % go					
Untreated	2.41	1.87	0.7	0.6	0.35
Seeding	2.41	0.82	0.7	0.59	0.35
Mulch (0.5 ton ac^{-1})	1.1	0.82	0.7	0.6	0.35
Mulch (1 ton ac^{-1})	1.09	0.82	0.7	0.6	0.35
Mulch (1.5 ton ac^{-1})	1.09	0.82	0.7	0.6	0.35
Mulch (2 ton ac^{-1})	1.09	0.82	0.7	0.6	0.35
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Stratum 12

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **50%** rock fragment
10% top, 30% average, 15% toe hillslope gradient
300 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.054	**in**	annual runoff from rainfall from	36	events
0.002	**in**	annual runoff from snowmelt or winter rainstorm from	1	events

27 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.02	3.91	4.28	3.63	3.11	September 4 year 68

5 (20-year)	0.30	1.91	1.81	4.71	3.04	July 19 year 20
10 (10-year)	0.06	2.07	2.13	4.63	3.12	July 1 year 58
20 (5-year)	0.00	2.41	2.78	3.77	2.88	September 10 year 17

Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Unburned	0.02	0.02	0.02	0.02	0.02

Return to input screen

Low Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ

loam soil texture, **50%** rock fragment
10% top, 30% average, 15% toe hillslope gradient
300 ft hillslope horizontal length
low soil burn severity on forest

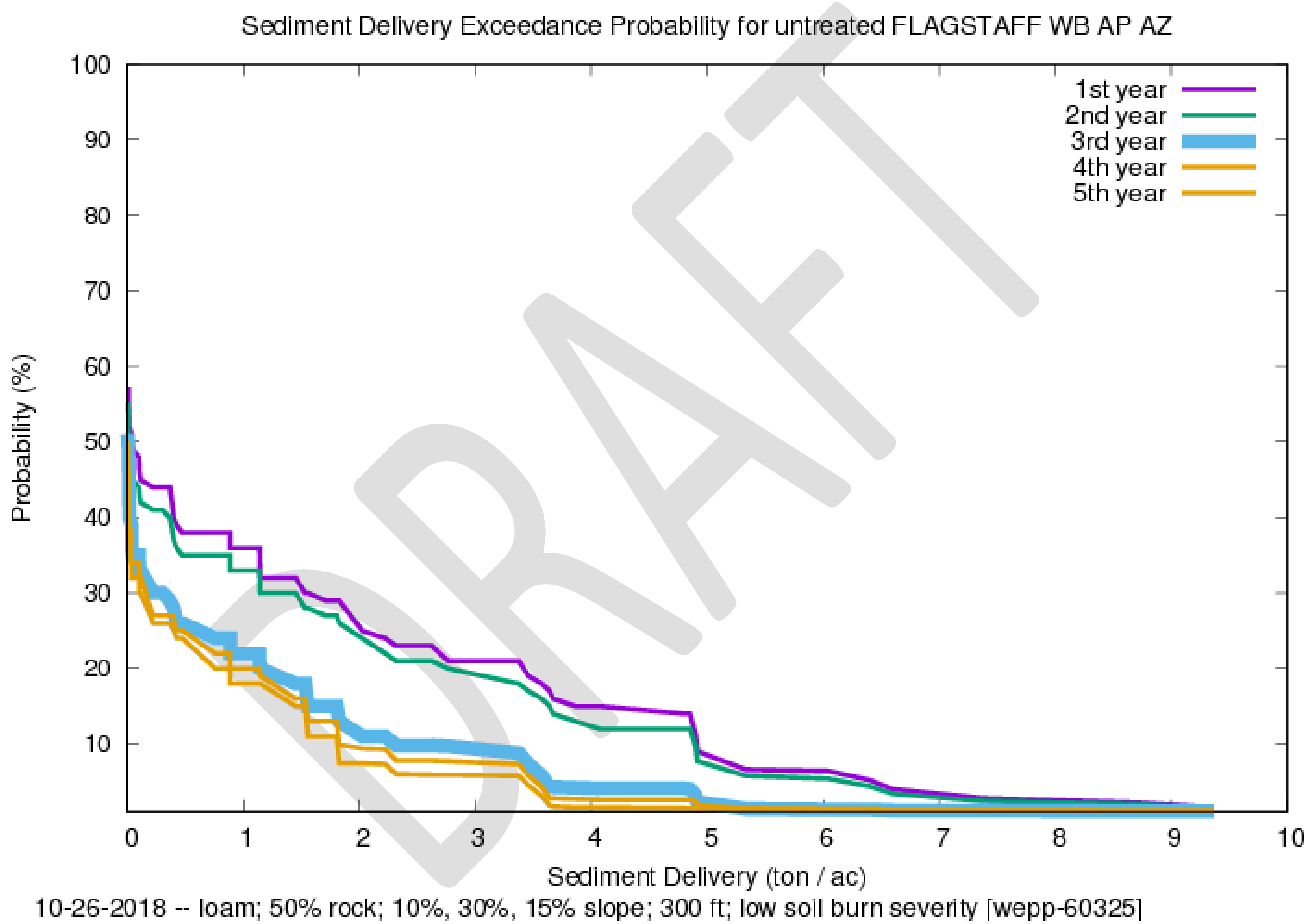
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.9	**in**	annual runoff from rainfall from	699	events
0.5	**in**	annual runoff from snowmelt or winter rainstorm from	200	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.06	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	1.99	4.34	5.92	N/A	N/A	December 2 year 32
10 (10-year)	1.75	4.44	6.01	N/A	N/A	December 7 year 97
20 (5-year)	1.20	1.91	1.81	4.71	3.04	July 19 year 20
50 (2-year)	0.82	1.48	2.38	2.84	2.03	August 29 year 23

75 (1 1/3-year)	**0.51**	**0.80**	**0.89**	**1.80**	**1.27**	**February 17 year 57**



Sediment Delivery

Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	3.41	2.73	1.18	0.89	0.89
Seeding	3.41	1.18	0.89	0.89	0.89
Mulch (0.5 ton ac^{-1})	1.21	1.14	1.18	0.89	0.89
Mulch (1 ton ac^{-1})	0.89	0.89	1.18	0.89	0.89
Mulch (1.5 ton ac^{-1})	0.89	0.73	1.18	0.89	0.89
Mulch (2 ton ac^{-1})	0.75	0.71	1.18	0.89	0.89
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Moderate Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **50%** rock fragment
10% top, 30% average, 15% toe hillslope gradient
300 ft hillslope horizontal length
moderate soil burn severity on forest

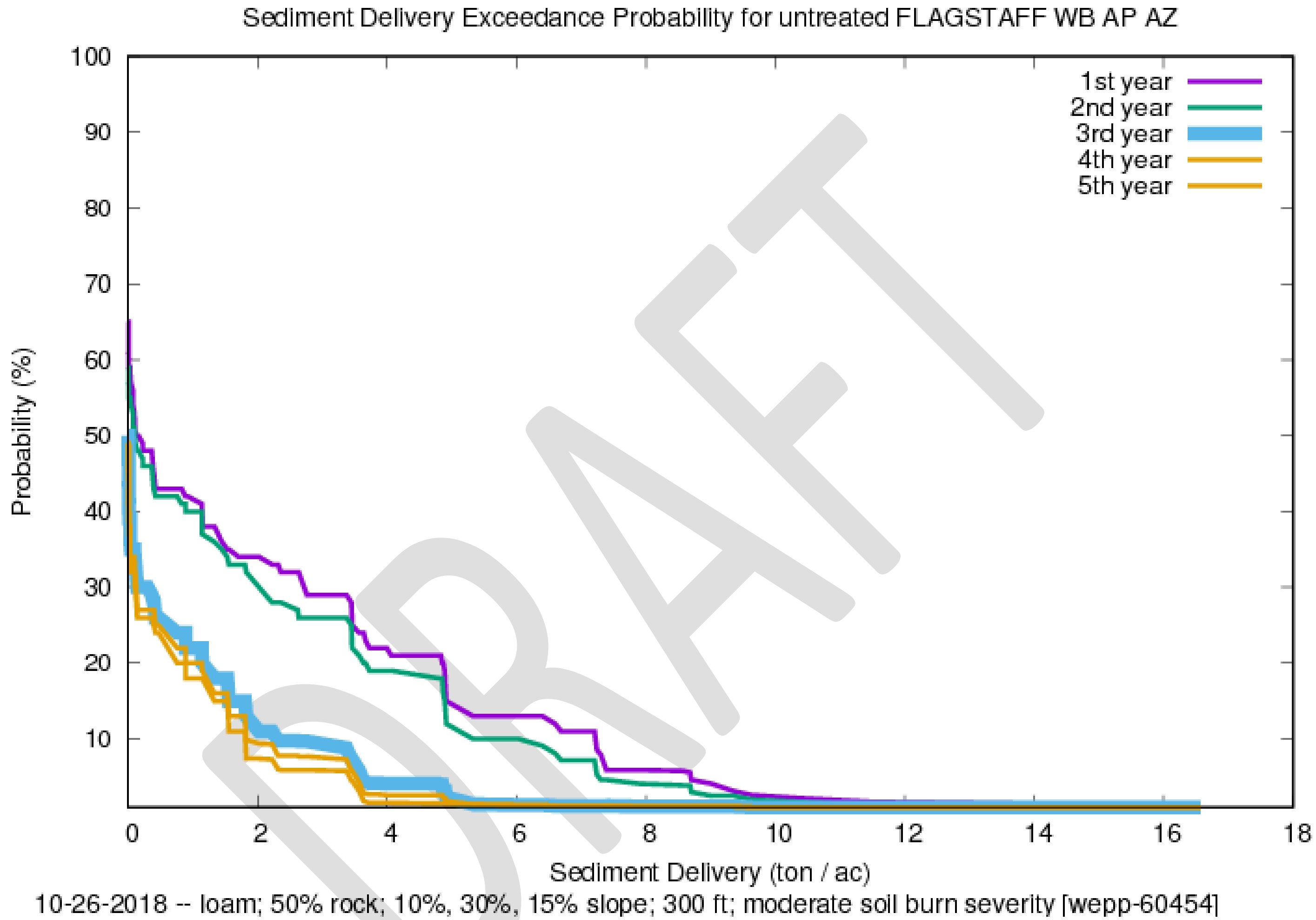
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.9	**in**	annual runoff from rainfall from	699	events
0.5	**in**	annual runoff from snowmelt or winter rainstorm from	200	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.06	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.99**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**

10 (10-year)	**1.75**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
20 (5-year)	**1.20**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.82**	**1.48**	**2.38**	**2.84**	**2.03**	**August 29 year 23**
75 (1 1/3-year)	**0.51**	**0.80**	**0.89**	**1.80**	**1.27**	**February 17 year 57**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	4.86	3.65	1.18	0.89	0.89
Seeding	4.86	1.55	0.89	0.89	0.89
Mulch (0.5 ton ac^{-1})	1.55	1.54	1.18	0.89	0.89
Mulch (1 ton ac^{-1})	1.54	1.39	1.18	0.89	0.89
Mulch (1.5 ton ac^{-1})	1.54	1.32	1.18	0.89	0.89
Mulch (2 ton ac^{-1})	1.54	1.3	1.18	0.89	0.89
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

High Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **50%** rock fragment
10% top, 30% average, 15% toe hillslope gradient
300 ft hillslope horizontal length
high soil burn severity on forest

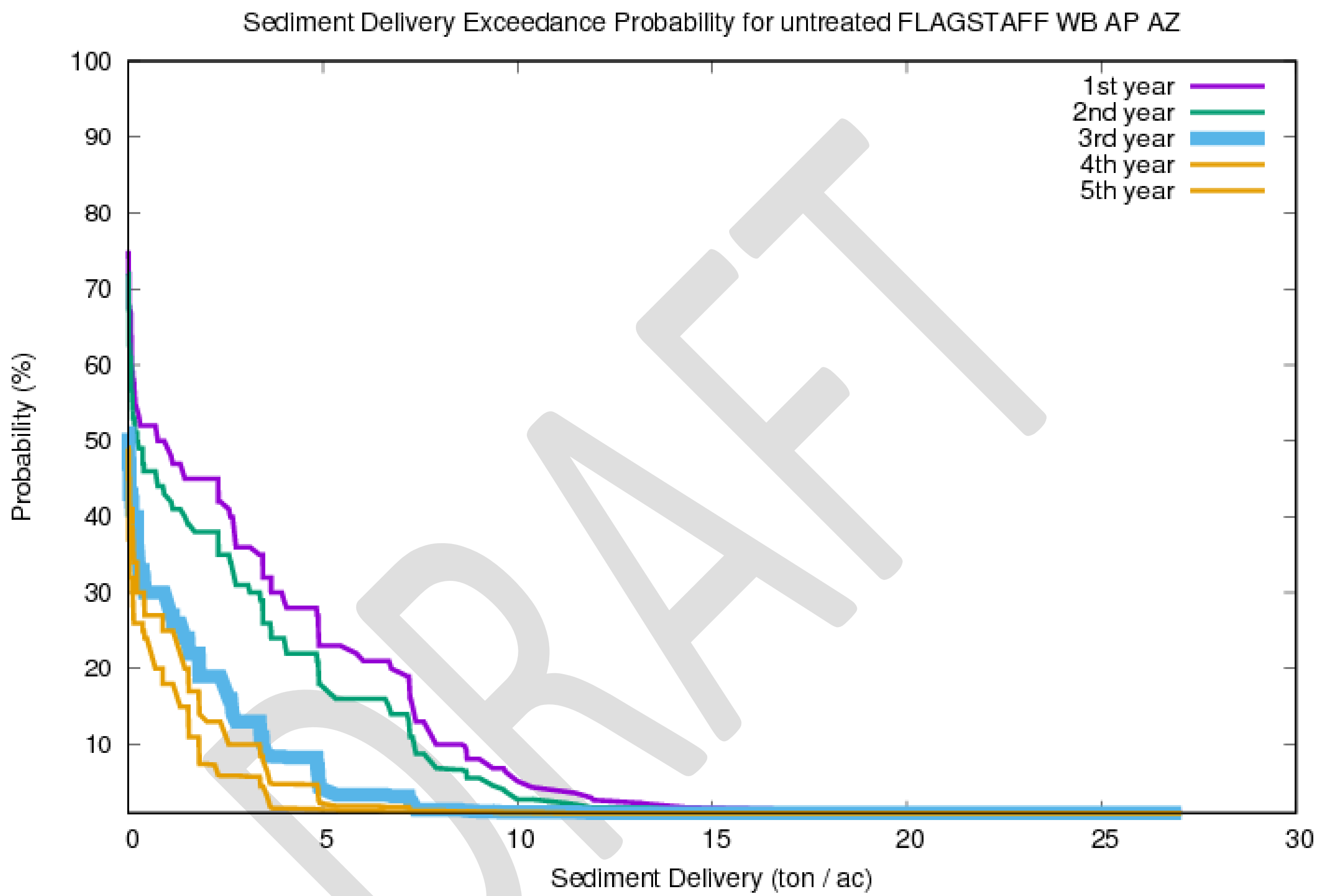
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.9	**in**	annual runoff from rainfall from	699	events
0.5	**in**	annual runoff from snowmelt or winter rainstorm from	200	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.06	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.99**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**
10 (10-year)	**1.75**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**

20 (5-year)	**1.20**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.82**	**1.48**	**2.38**	**2.84**	**2.03**	**August 29 year 23**
75 ($1^1/_3$-year)	**0.51**	**0.80**	**0.89**	**1.80**	**1.27**	**February 17 year 57**



10-26-2018 -- loam; 50% rock; 10%, 30%, 15% slope; 300 ft; high soil burn severity [wepp-60619]

Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	6.77	4.88	1.94	1.44	0.89
Seeding	6.77	2.54	1.56	1.34	0.89
Mulch (0.5 ton ac^{-1})	2.55	2.41	1.94	1.44	0.89
Mulch (1 ton ac^{-1})	2.44	2.3	1.94	1.44	0.89
Mulch (1.5 ton ac^{-1})	2.44	2.2	1.94	1.44	0.89
Mulch (2 ton ac^{-1})	2.44	2.13	1.94	1.44	0.89
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Citation:

Stratum 13

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **35%** rock fragment
7% top, 12% average, 8% toe hillslope gradient
300 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.052	**in**	annual runoff from rainfall from	31	events
0.0075	**in**	annual runoff from snowmelt or winter rainstorm from	3	events

24 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date

1	2.21	3.91	4.28	3.63	3.11	September 4 year 68
5 (20-year)	**0.21**	**3.00**	**3.46**	**5.09**	**3.78**	**June 17 year 56**
10 (10-year)	**0.02**	**2.18**	**2.24**	**5.05**	**3.35**	**November 16 year 5**
20 (5-year)	**0.00**	**1.81**	**3.26**	**3.87**	**2.66**	**October 25 year 12**

Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Unburned	0.01	0.01	0.01	0.01	0.01

Return to input screen

ERMiT Version 2015.05.03

Low Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **35%** rock fragment
7% top, 12% average, 8% toe hillslope gradient
300 ft hillslope horizontal length
low soil burn severity on forest

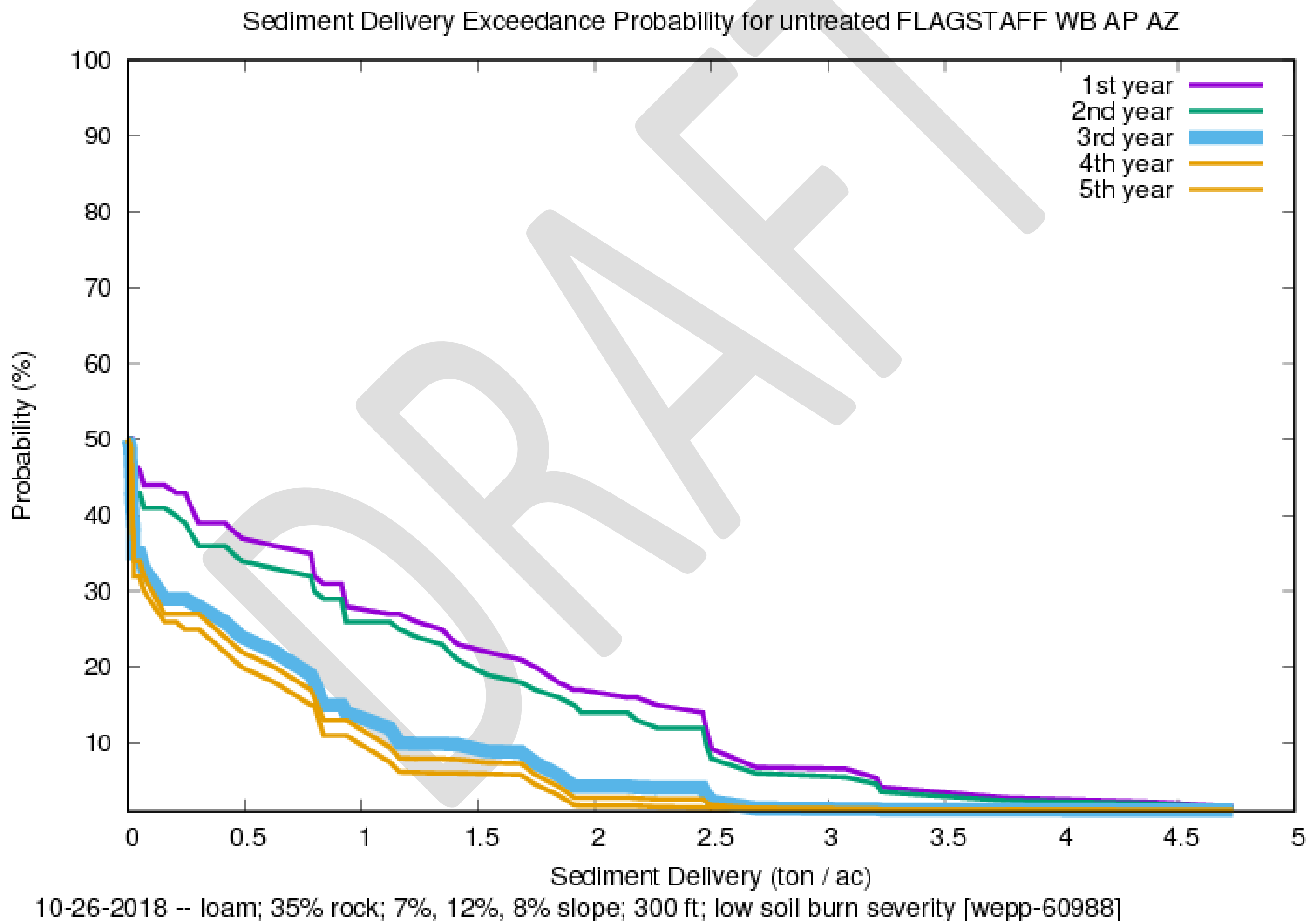
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.6	**in**	annual runoff from rainfall from	641	events
0.44	**in**	annual runoff from snowmelt or winter rainstorm from	172	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.02	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	1.94	4.34	5.92	N/A	N/A	December 2 year 32
10 (10-year)	1.74	4.44	6.01	N/A	N/A	December 7 year 97
20 (5-year)	1.19	1.91	1.81	4.71	3.04	July 19 year 20

50 (2-year)	**0.75**	**1.56**	**6.97**	**4.73**	**2.74**	**July 22 year 8**
75 ($1^1/_3$-year)	**0.46**	**0.80**	**0.89**	**1.80**	**1.27**	**February 17 year 57**



Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	1.72	1.49	0.72	0.6	0.49
Seeding	1.72	0.72	0.6	0.49	0.49
Mulch (0.5 ton ac^{-1})	0.68	0.64	0.72	0.6	0.49
Mulch (1 ton ac^{-1})	0.62	0.54	0.72	0.6	0.49
Mulch (1.5 ton ac^{-1})	0.58	0.45	0.72	0.6	0.49
Mulch (2 ton ac^{-1})	0.41	0.44	0.72	0.6	0.49
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Moderate Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **35%** rock fragment
7% top, 12% average, 8% toe hillslope gradient
300 ft hillslope horizontal length
moderate soil burn severity on forest

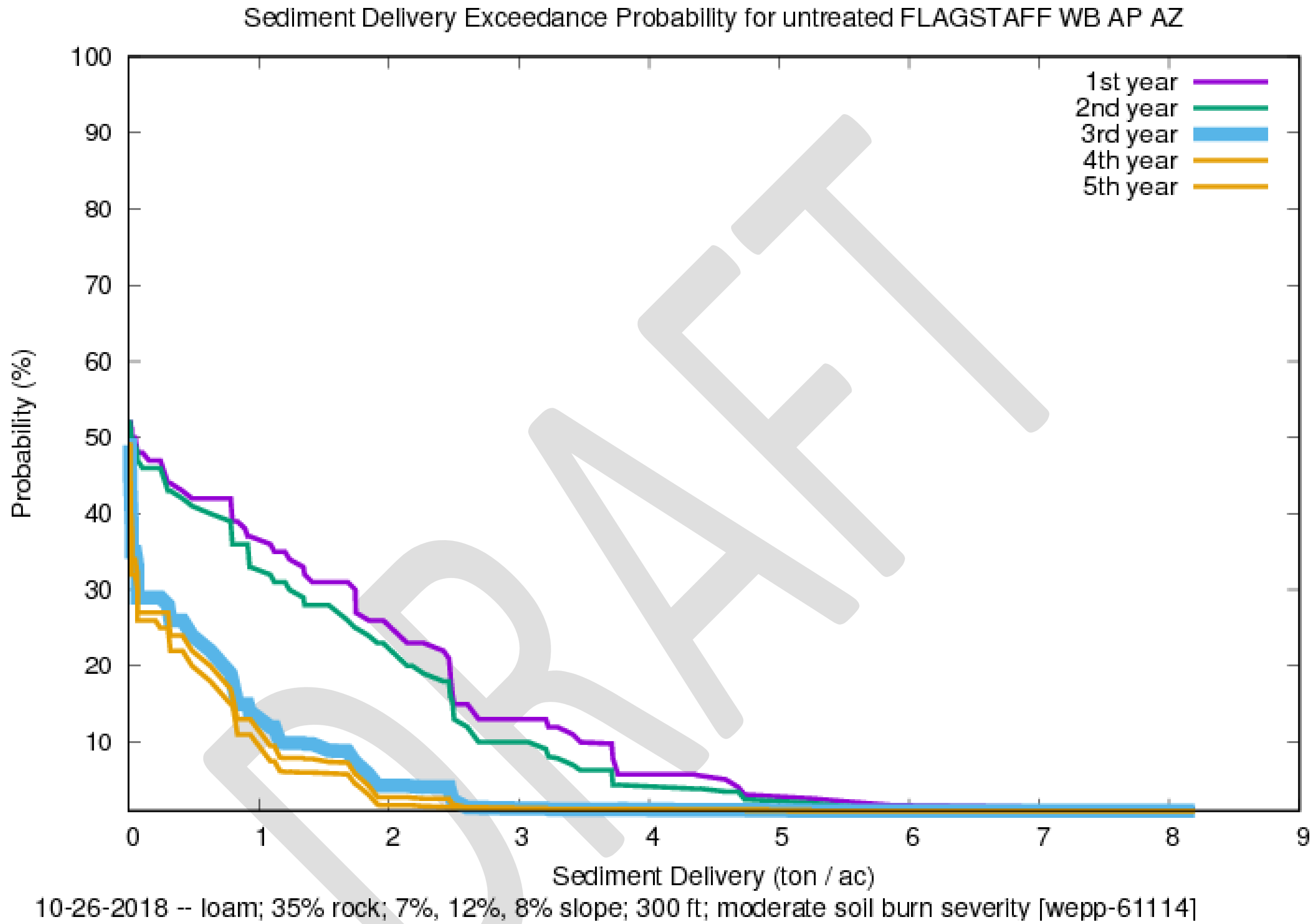
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.6	**in**	annual runoff from rainfall from	641	events
0.44	**in**	annual runoff from snowmelt or winter rainstorm from	172	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.02	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.94**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**

10 (10-year)	**1.74**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
20 (5-year)	**1.19**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.75**	**1.56**	**6.97**	**4.73**	**2.74**	**July 22 year 8**
75 ($1^1/_3$-year)	**0.46**	**0.80**	**0.89**	**1.80**	**1.27**	**February 17 year 57**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	2.47	2.16	0.72	0.6	0.49
Seeding	2.47	0.93	0.6	0.49	0.49
Mulch (0.5 ton ac^{-1})	0.96	0.83	0.72	0.6	0.49
Mulch (1 ton ac^{-1})	0.82	0.81	0.72	0.6	0.49
Mulch (1.5 ton ac^{-1})	0.82	0.79	0.72	0.6	0.49
Mulch (2 ton ac^{-1})	0.81	0.77	0.72	0.6	0.49
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

High Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **35%** rock fragment
7% top, 12% average, 8% toe hillslope gradient
300 ft hillslope horizontal length
high soil burn severity on forest

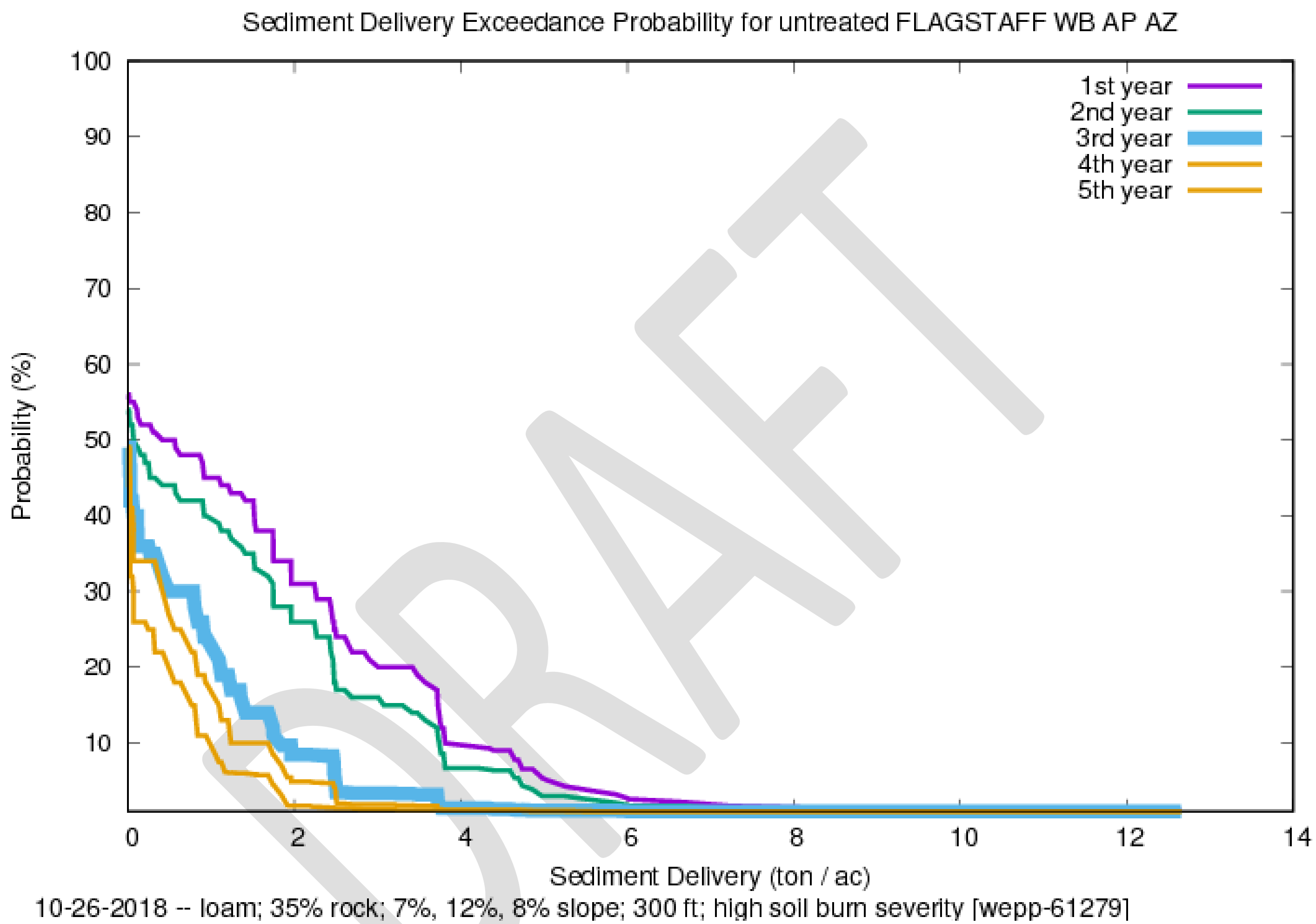
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.6	**in**	annual runoff from rainfall from	641	events
0.44	**in**	annual runoff from snowmelt or winter rainstorm from	172	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.02	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.94**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**
10 (10-year)	**1.74**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**

20 (5-year)	**1.19**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.75**	**1.56**	**6.97**	**4.73**	**2.74**	**July 22 year 8**
75 (1 1/3-year)	**0.46**	**0.80**	**0.89**	**1.80**	**1.27**	**February 17 year 57**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	3.25	2.47	1.15	0.82	0.49
Seeding	3.25	1.37	1.03	0.8	0.49
Mulch (0.5 ton ac^{-1})	1.36	1.22	1.15	0.82	0.49
Mulch (1 ton ac^{-1})	1.26	1.19	1.15	0.82	0.49
Mulch (1.5 ton ac^{-1})	1.26	1.1	1.15	0.82	0.49
Mulch (2 ton ac^{-1})	1.26	1.08	1.15	0.82	0.49
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Stratum 14

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **40%** rock fragment
25% top, 60% average, 30% toe hillslope gradient
300 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.024	**in**	annual runoff from rainfall from	12	events
0.0075	**in**	annual runoff from snowmelt or winter rainstorm from	2	events

10 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	1.75	3.91	4.28	3.63	3.11	September 4 year 68
5 (20-year)	**0.07**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**

10 (10-year)	0.00	1.65	6.13	4.16	2.66	August 7 year 97

Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Unburned	0.02	0.02	0.02	0.02	0.02

Return to input screen

ERMiT Version 2015.05.03

Low Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **40%** rock fragment

25% top, 60% average, 30% toe hillslope gradient
300 ft hillslope horizontal length
low soil burn severity on forest

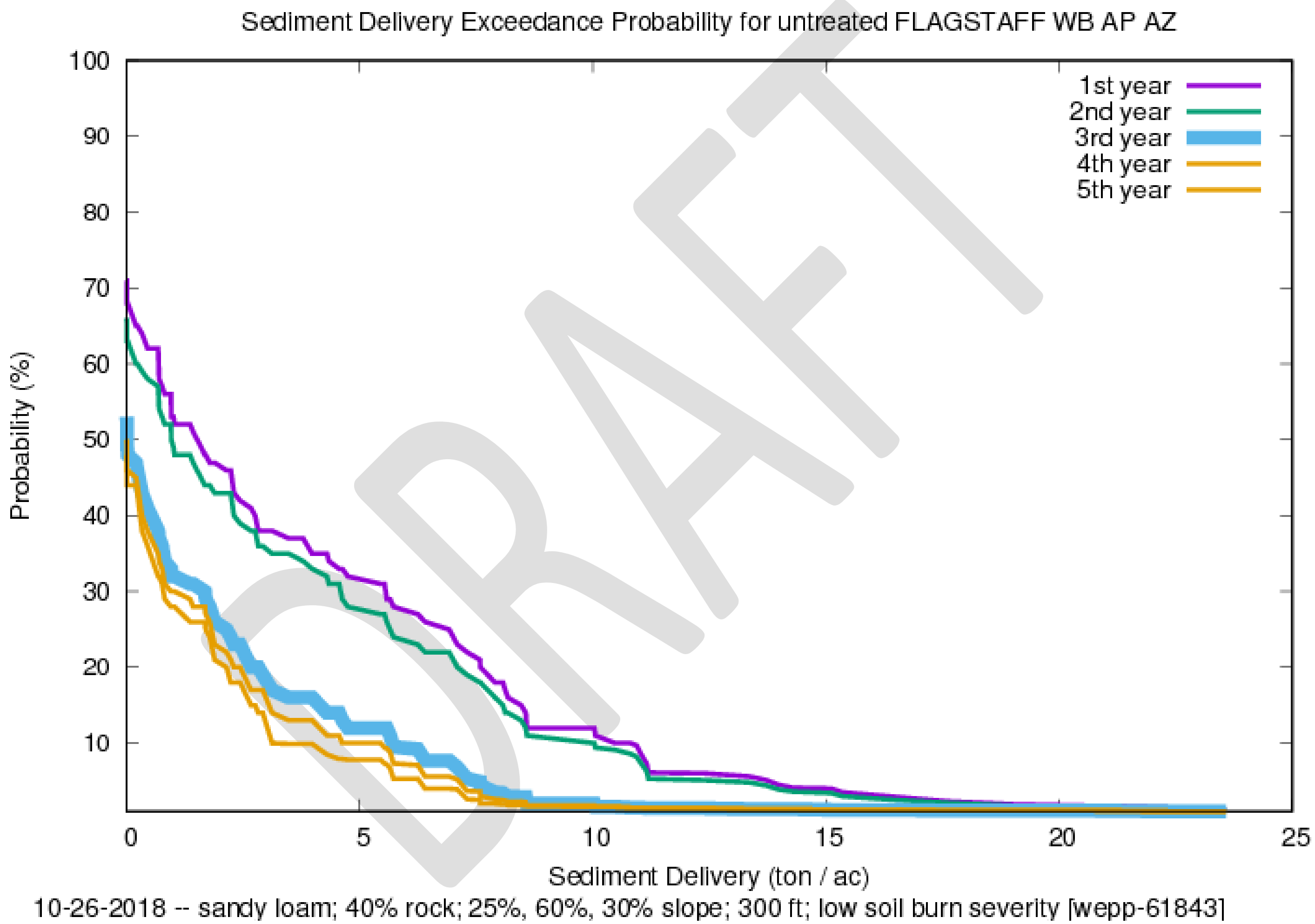
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.6	**in**	annual runoff from rainfall from	596	events
0.32	**in**	annual runoff from snowmelt or winter rainstorm from	117	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.96	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	1.82	2.91	4.51	4.42	3.40	September 13 year 27
10 (10-year)	1.49	2.50	5.67	3.27	2.61	September 29 year 26
20 (5-year)	1.17	1.91	1.81	4.71	3.04	July 19 year 20
50 (2-year)	0.69	1.47	3.72	2.66	1.94	September 15 year 76

75 (1 1/3-year)	**0.39**	**1.26**	**3.29**	**1.55**	**1.26**	**August 29 year 43**



Sediment Delivery

Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	7.64	7.12	2.7	2.46	2.05
Seeding	7.64	2.7	2.46	2.05	2.05
Mulch (0.5 ton ac^{-1})	2.3	2.46	2.7	2.46	2.05
Mulch (1 ton ac^{-1})	1.88	2.15	2.7	2.46	2.05
Mulch (1.5 ton ac^{-1})	1.87	1.89	2.7	2.46	2.05
Mulch (2 ton ac^{-1})	1.87	1.88	2.7	2.46	2.05
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Moderate Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **40%** rock fragment
25% top, 60% average, 30% toe hillslope gradient
300 ft hillslope horizontal length
moderate soil burn severity on forest

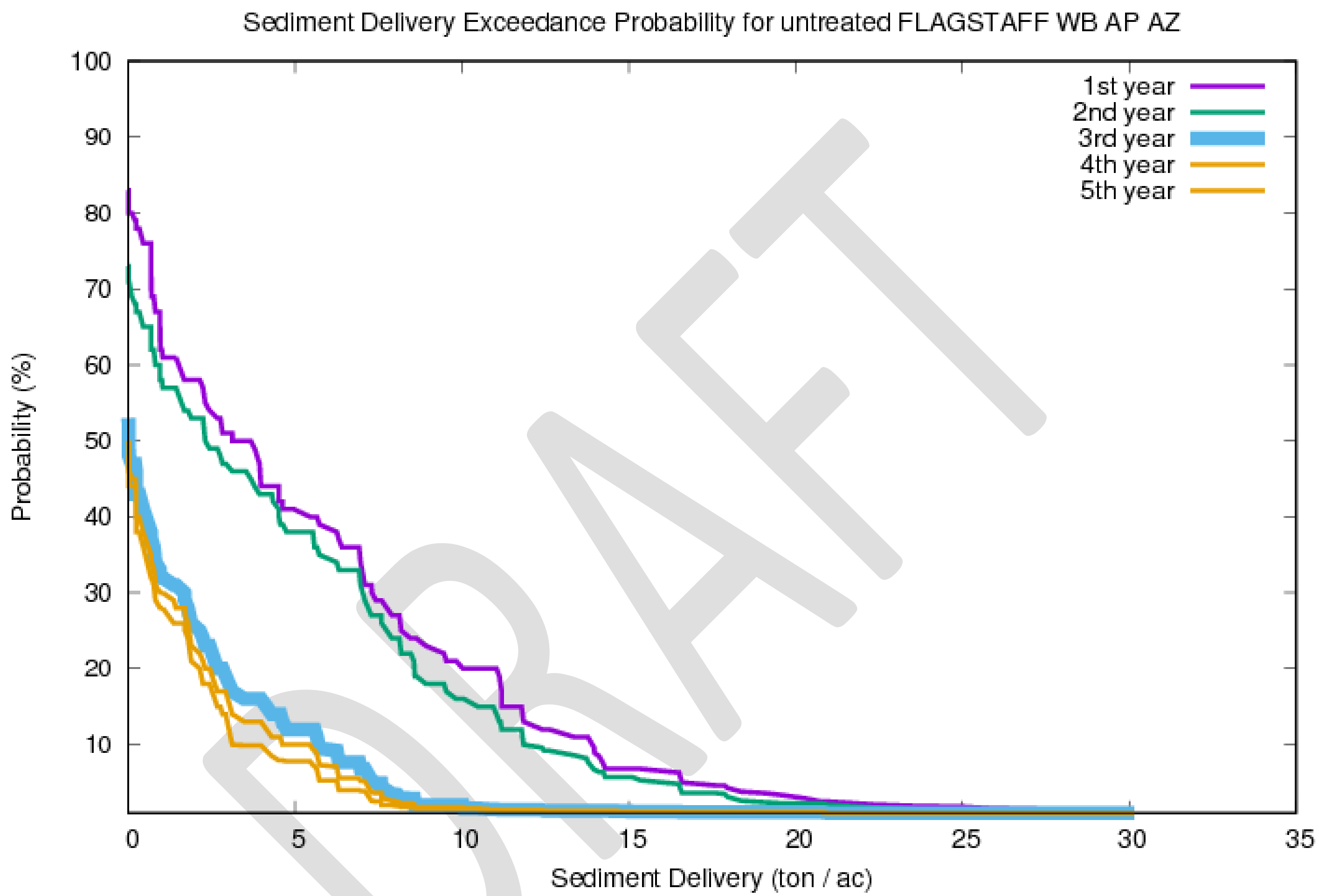
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.6	**in**	annual runoff from rainfall from	596	events
0.32	**in**	annual runoff from snowmelt or winter rainstorm from	117	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.96	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.82**	**2.91**	**4.51**	**4.42**	**3.40**	**September 13 year 27**

10 (10-year)	**1.49**	**2.50**	**5.67**	**3.27**	**2.61**	**September 29 year 26**
20 (5-year)	**1.17**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.69**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**
75 (1 1/3-year)	**0.39**	**1.26**	**3.29**	**1.55**	**1.26**	**August 29 year 43**



10-26-2018 -- sandy loam; 40% rock; 25%, 60%, 30% slope; 300 ft; moderate soil burn severity [wepp-62023]

Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	10.55	8.6	2.7	2.46	2.05
Seeding	10.55	4.58	2.46	2.05	2.05
Mulch (0.5 ton ac^{-1})	4.54	3.76	2.7	2.46	2.05
Mulch (1 ton ac^{-1})	3.12	3.11	2.7	2.46	2.05
Mulch (1.5 ton ac^{-1})	3.12	3	2.7	2.46	2.05
Mulch (2 ton ac^{-1})	3.11	2.98	2.7	2.46	2.05
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

High Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **40%** rock fragment
25% top, 60% average, 30% toe hillslope gradient
300 ft hillslope horizontal length
high soil burn severity on forest

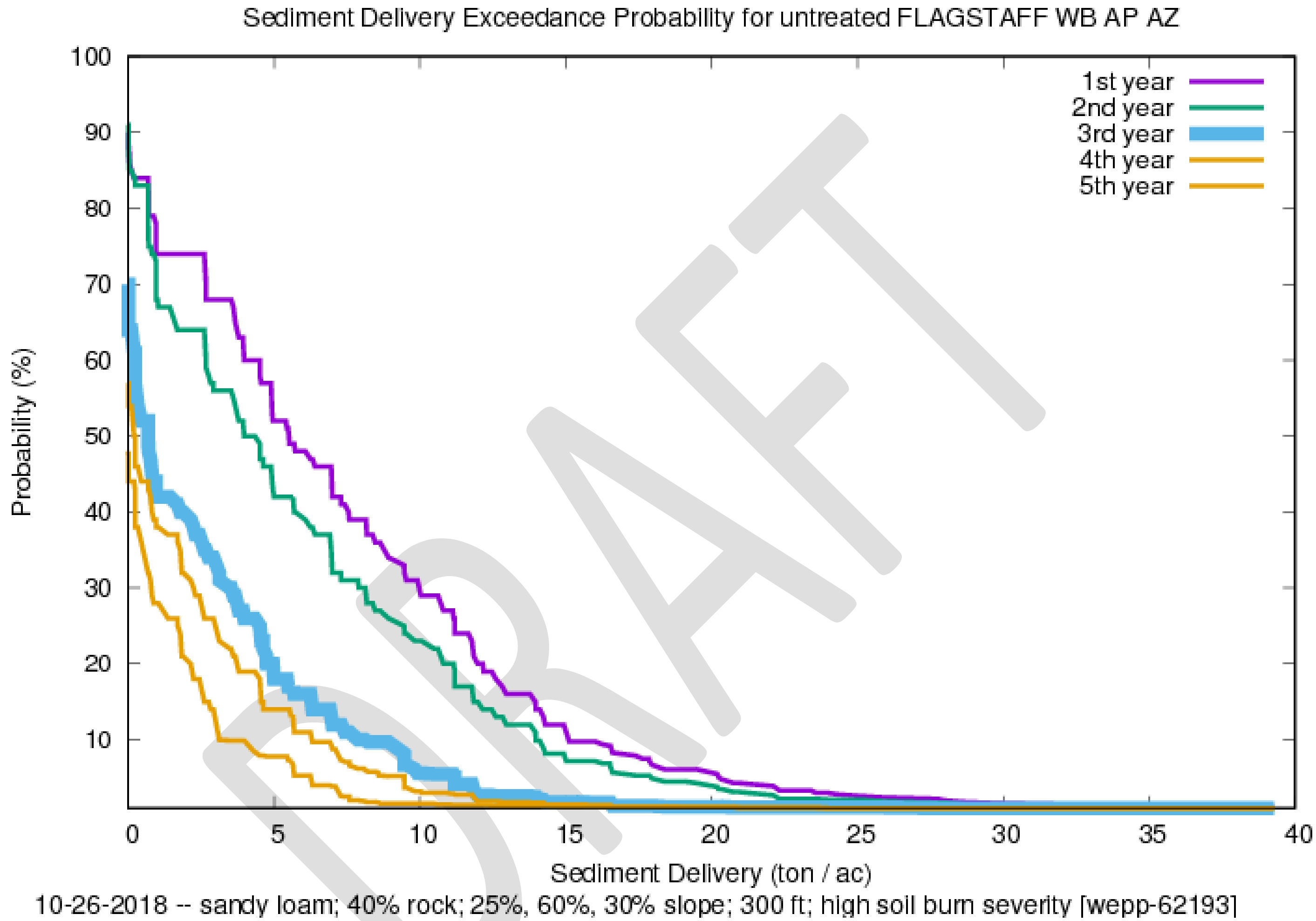
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.6	**in**	annual runoff from rainfall from	596	events
0.32	**in**	annual runoff from snowmelt or winter rainstorm from	117	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.96	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.82**	**2.91**	**4.51**	**4.42**	**3.40**	**September 13 year 27**
10 (10-year)	**1.49**	**2.50**	**5.67**	**3.27**	**2.61**	**September 29 year 26**

20 (5-year)	**1.17**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.69**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**
75 ($1^{1}/_{3}$-year)	**0.39**	**1.26**	**3.29**	**1.55**	**1.26**	**August 29 year 43**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	12.07	11.14	5.05	3.74	2.05
Seeding	12.07	5.67	4.6	3.11	2.05
Mulch (0.5 ton ac^{-1})	5.5	4.99	5.05	3.74	2.05
Mulch (1 ton ac^{-1})	4.97	4.96	5.05	3.74	2.05
Mulch (1.5 ton ac^{-1})	4.97	4.8	5.05	3.74	2.05
Mulch (2 ton ac^{-1})	4.96	4.75	5.05	3.74	2.05
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Stratum 15

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **20%** rock fragment
7% top, 14% average, 8% toe hillslope gradient
300 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.059	**in**	annual runoff from rainfall from	24	events
0.019	**in**	annual runoff from snowmelt or winter rainstorm from	6	events

19 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.37	3.91	4.28	3.63	3.11	September 4 year 68

5 (20-year)	0.25	2.95	8.97	N/A	N/A	December 29 year 25
10 (10-year)	0.06	3.00	3.46	5.09	3.78	June 17 year 56

Sediment Delivery					
Probability that sediment yield will be exceeded	Event sediment delivery (ton ac^{-1})				
	Year following fire				
20 % go	1st year	2nd year	3rd year	4th year	5th year
Unburned	0	0	0	0	0

Return to input screen

ERMiT Version 2015.05.03

Low Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ

loam soil texture, **20%** rock fragment
7% top, 14% average, 8% toe hillslope gradient
300 ft hillslope horizontal length
low soil burn severity on forest

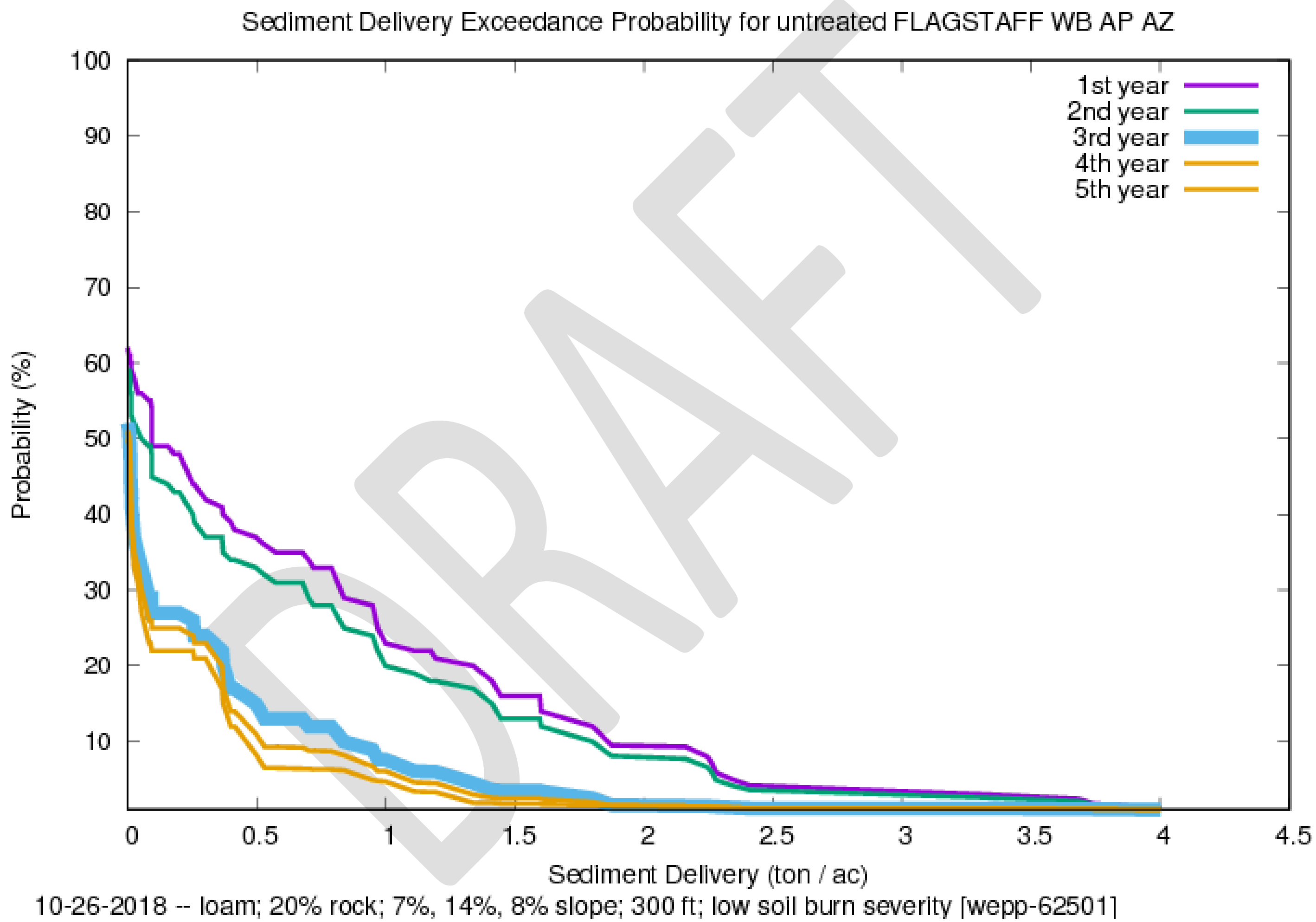
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.6	**in**	annual runoff from rainfall from	606	events
0.39	**in**	annual runoff from snowmelt or winter rainstorm from	157	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.98	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	1.88	4.34	5.92	N/A	N/A	December 2 year 32
10 (10-year)	1.69	4.44	6.01	N/A	N/A	December 7 year 97
20 (5-year)	1.12	2.06	2.13	4.70	3.14	August 8 year 79
50 (2-year)	0.73	1.56	6.97	4.73	2.74	July 22 year 8

75 (1 1/3-year)	0.44	1.18	1.22	1.88	1.49	July 6 year 92



Sediment Delivery

Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	1.35	1.04	0.37	0.35	0.32
Seeding	1.35	0.37	0.35	0.32	0.32
Mulch (0.5 ton ac^{-1})	0.37	0.36	0.37	0.35	0.32
Mulch (1 ton ac^{-1})	0.32	0.32	0.37	0.35	0.32
Mulch (1.5 ton ac^{-1})	0.31	0.3	0.37	0.35	0.32
Mulch (2 ton ac^{-1})	0.3	0.26	0.37	0.35	0.32
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Moderate Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **20%** rock fragment
7% top, 14% average, 8% toe hillslope gradient
300 ft hillslope horizontal length
moderate soil burn severity on forest

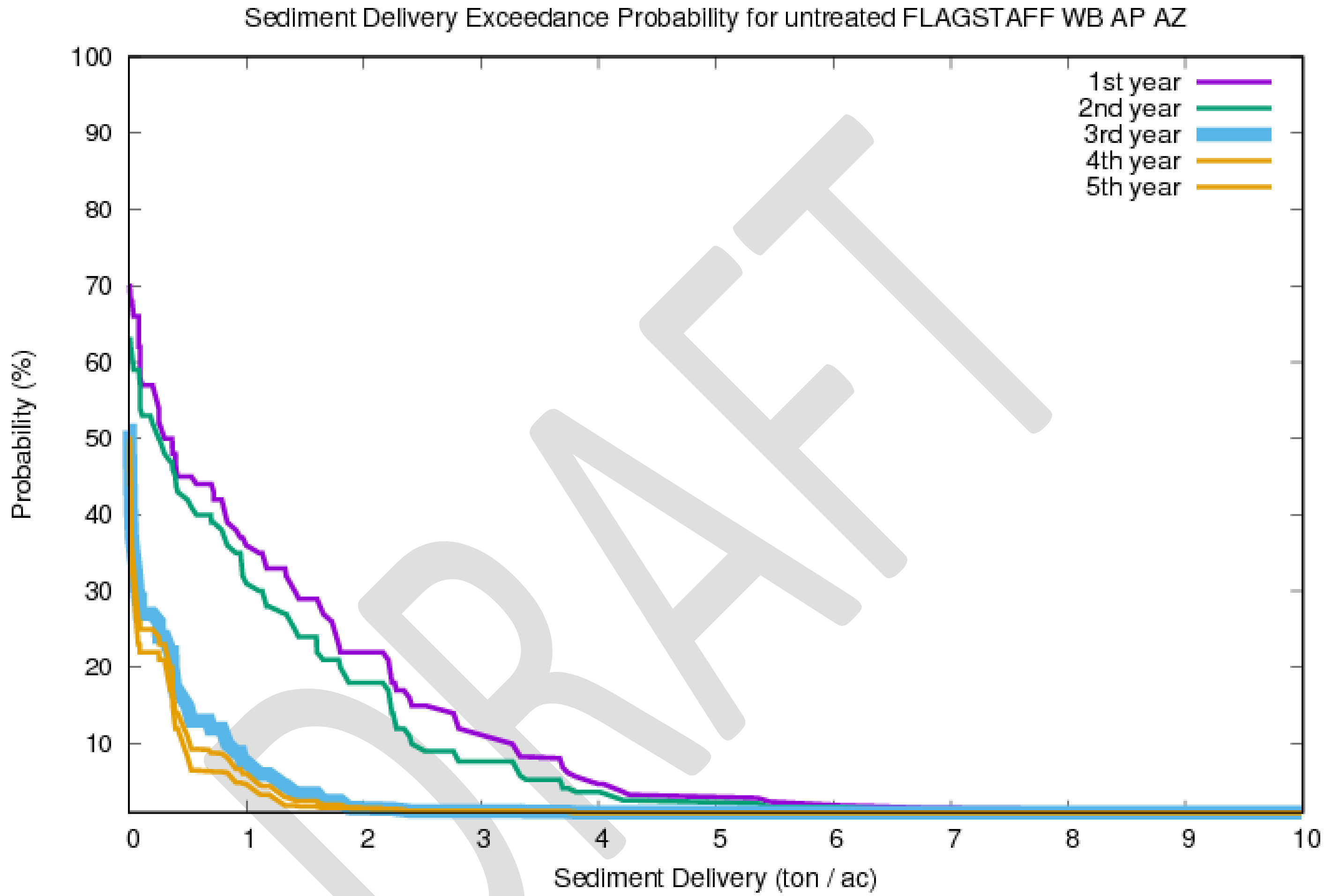
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.6	**in**	annual runoff from rainfall from	606	events
0.39	**in**	annual runoff from snowmelt or winter rainstorm from	157	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.98	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.88**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**

10 (10-year)	**1.69**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
20 (5-year)	**1.12**	**2.06**	**2.13**	**4.70**	**3.14**	**August 8 year 79**
50 (2-year)	**0.73**	**1.56**	**6.97**	**4.73**	**2.74**	**July 22 year 8**
75 ($1^1/_3$-year)	**0.44**	**1.18**	**1.22**	**1.88**	**1.49**	**July 6 year 92**



10-26-2018 -- loam; 20% rock; 7%, 14%, 8% slope; 300 ft; moderate soil burn severity [wepp-62637]

Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	2.23	1.79	0.37	0.35	0.32
Seeding	2.23	0.7	0.35	0.32	0.32
Mulch (0.5 ton ac^{-1})	0.51	0.47	0.37	0.35	0.32
Mulch (1 ton ac^{-1})	0.39	0.39	0.37	0.35	0.32
Mulch (1.5 ton ac^{-1})	0.39	0.38	0.37	0.35	0.32
Mulch (2 ton ac^{-1})	0.38	0.38	0.37	0.35	0.32
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

High Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **20%** rock fragment
7% top, 14% average, 8% toe hillslope gradient
300 ft hillslope horizontal length
high soil burn severity on forest

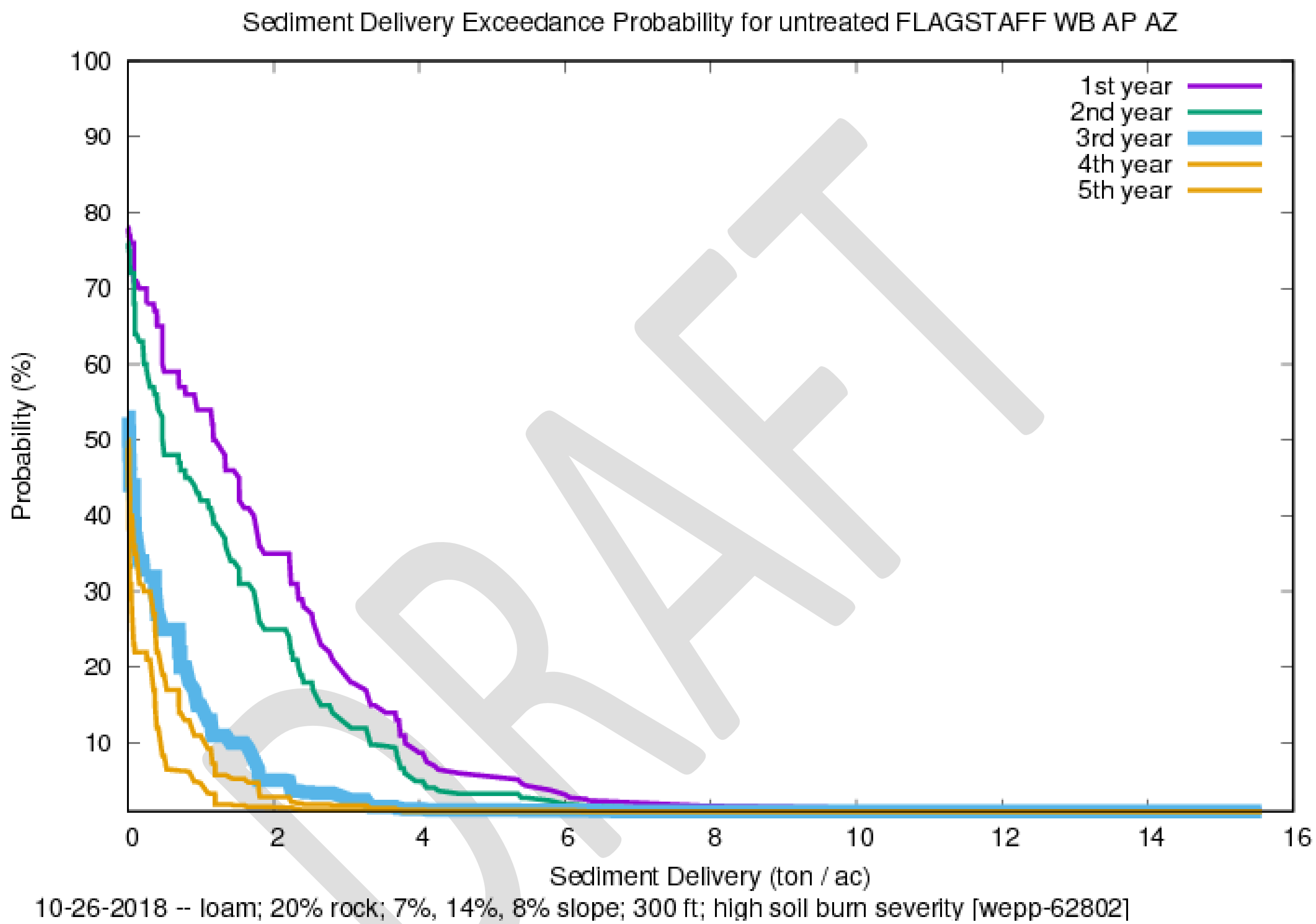
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.6	**in**	annual runoff from rainfall from	606	events
0.39	**in**	annual runoff from snowmelt or winter rainstorm from	157	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.98	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.88**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**
10 (10-year)	**1.69**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**

20 (5-year)	**1.12**	**2.06**	**2.13**	**4.70**	**3.14**	**August 8 year 79**
50 (2-year)	**0.73**	**1.56**	**6.97**	**4.73**	**2.74**	**July 22 year 8**
75 ($1^{1}/_{3}$-year)	**0.44**	**1.18**	**1.22**	**1.88**	**1.49**	**July 6 year 92**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	2.9	2.34	0.72	0.46	0.32
Seeding	2.9	0.85	0.7	0.39	0.32
Mulch (0.5 ton ac^{-1})	0.8	0.77	0.72	0.46	0.32
Mulch (1 ton ac^{-1})	0.71	0.72	0.72	0.46	0.32
Mulch (1.5 ton ac^{-1})	0.71	0.71	0.72	0.46	0.32
Mulch (2 ton ac^{-1})	0.71	0.7	0.72	0.46	0.32
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Stratum 16

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **15%** rock fragment
30% top, 40% average, 25% toe hillslope gradient
300 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.064	**in**	annual runoff from rainfall from	23	events
0.017	**in**	annual runoff from snowmelt or winter rainstorm from	7	events

19 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.43	3.91	4.28	3.63	3.11	September 4 year 68

5 (20-year)	0.24	1.91	1.81	4.71	3.04	July 19 year 20
10 (10-year)	0.09	2.95	8.97	N/A	N/A	December 29 year 25

Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Unburned	0	0	0	0	0

Return to input screen

Low Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ

loam soil texture, **15%** rock fragment
30% top, 40% average, 25% toe hillslope gradient
300 ft hillslope horizontal length
low soil burn severity on forest

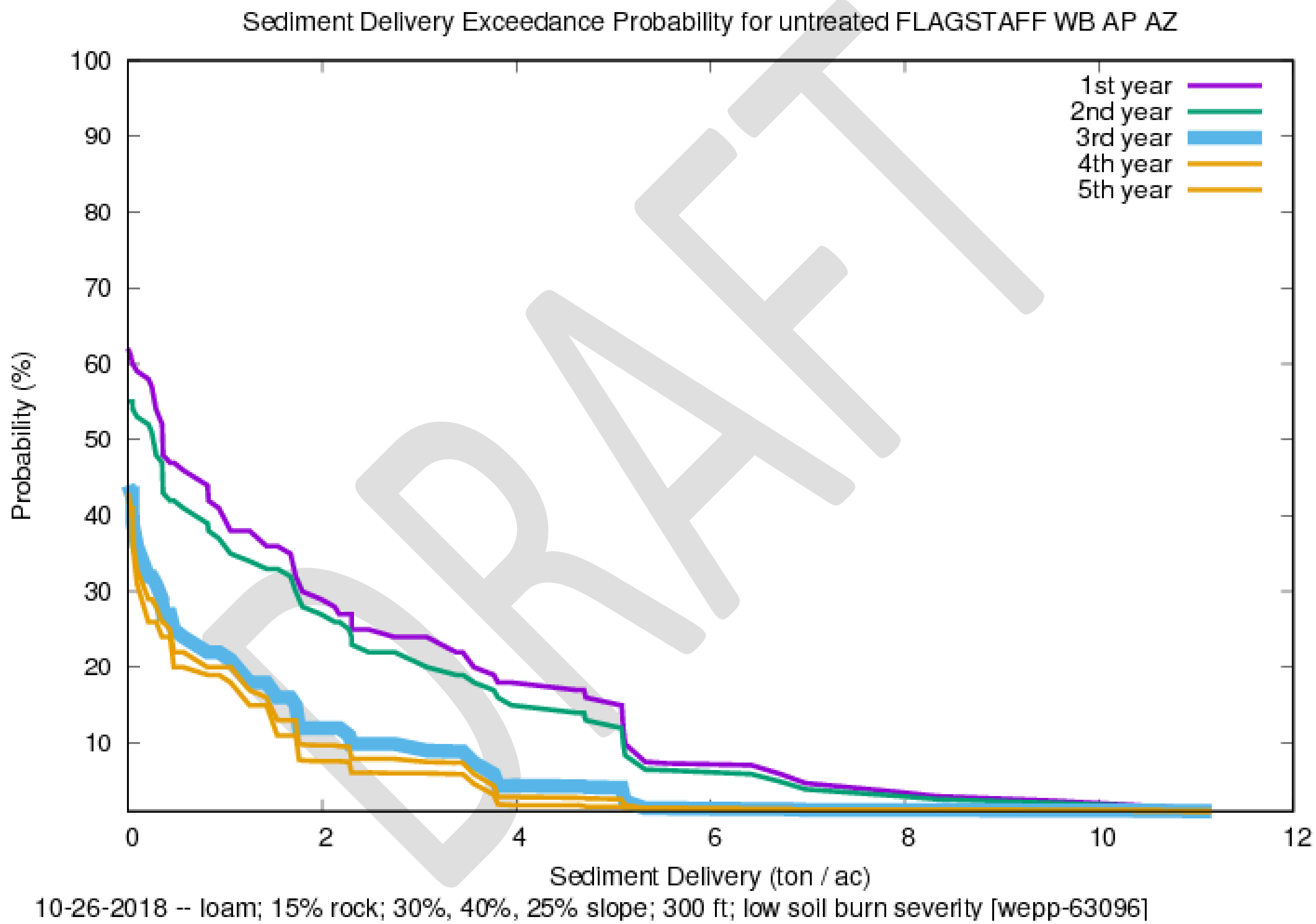
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.6	**in**	annual runoff from rainfall from	595	events
0.39	**in**	annual runoff from snowmelt or winter rainstorm from	149	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.97	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	1.86	4.34	5.92	N/A	N/A	December 2 year 32
10 (10-year)	1.59	4.44	6.01	N/A	N/A	December 7 year 97
20 (5-year)	1.17	1.91	1.81	4.71	3.04	July 19 year 20
50 (2-year)	0.70	1.57	3.40	3.54	2.38	September 5 year 31

75 (1 1/3-year)	**0.43**	**1.18**	**1.22**	**1.88**	**1.49**	**July 6 year 92**



Sediment Delivery

Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	3.63	3.13	1.13	0.96	0.63
Seeding	3.63	1.13	0.96	0.63	0.63
Mulch (0.5 ton ac^{-1})	1.12	1.06	1.13	0.96	0.63
Mulch (1 ton ac^{-1})	1.07	0.77	1.13	0.96	0.63
Mulch (1.5 ton ac^{-1})	1.06	0.59	1.13	0.96	0.63
Mulch (2 ton ac^{-1})	1.06	0.47	1.13	0.96	0.63
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Moderate Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **15%** rock fragment
30% top, 40% average, 25% toe hillslope gradient
300 ft hillslope horizontal length
moderate soil burn severity on forest

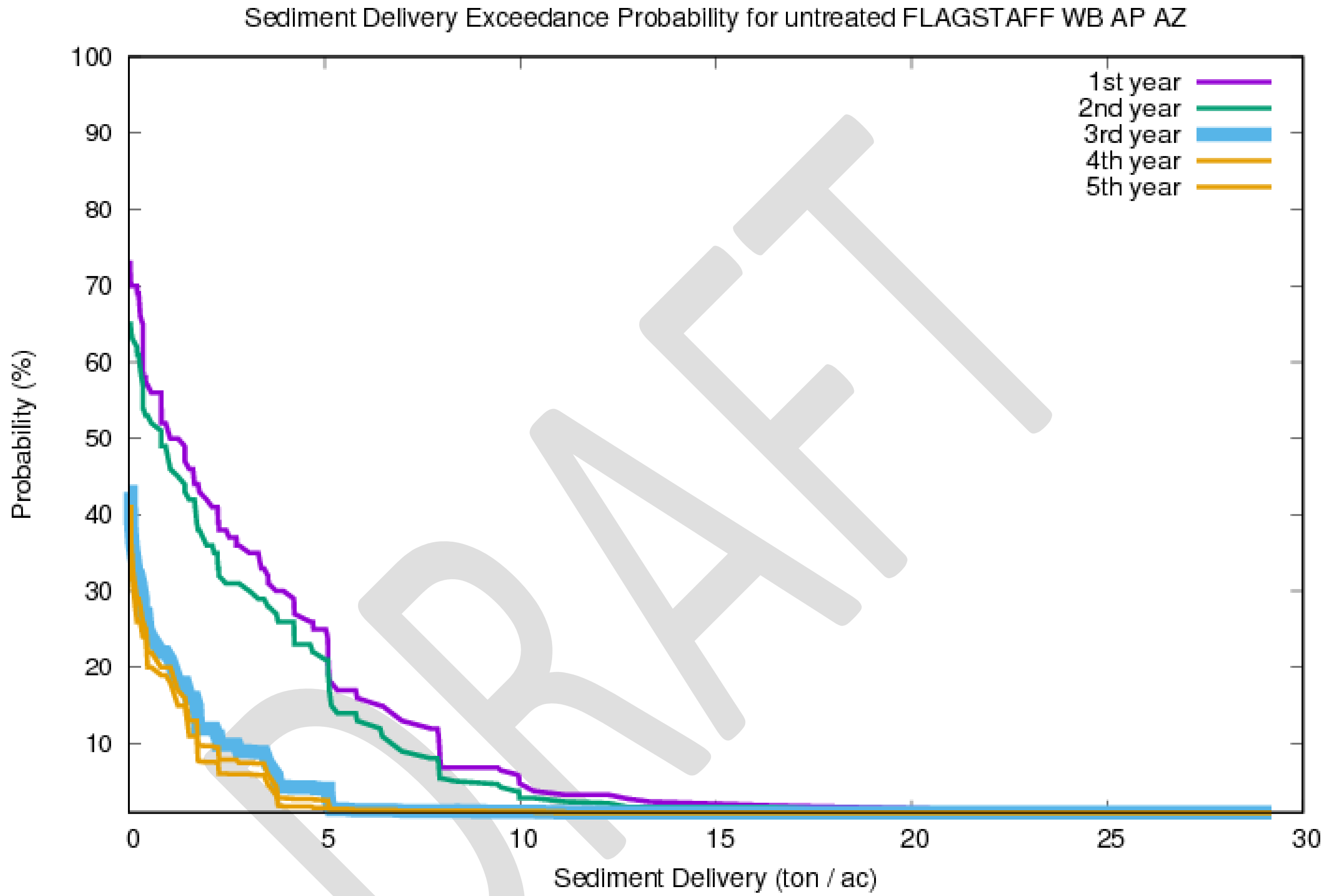
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.6	**in**	annual runoff from rainfall from	595	events
0.39	**in**	annual runoff from snowmelt or winter rainstorm from	149	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.97	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.86**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**

10 (10-year)	**1.59**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
20 (5-year)	**1.17**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.70**	**1.57**	**3.40**	**3.54**	**2.38**	**September 5 year 31**
75 ($1^1/_3$-year)	**0.43**	**1.18**	**1.22**	**1.88**	**1.49**	**July 6 year 92**



10-26-2018 -- loam; 15% rock; 30%, 40%, 25% slope; 300 ft; moderate soil burn severity [wepp-63225]

Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	5.11	5.09	1.13	0.96	0.63
Seeding	5.11	1.75	0.96	0.63	0.63
Mulch (0.5 ton ac^{-1})	1.74	1.69	1.13	0.96	0.63
Mulch (1 ton ac^{-1})	1.51	1.47	1.13	0.96	0.63
Mulch (1.5 ton ac^{-1})	1.49	1.44	1.13	0.96	0.63
Mulch (2 ton ac^{-1})	1.48	1.42	1.13	0.96	0.63
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

High Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **15%** rock fragment
30% top, 40% average, 25% toe hillslope gradient
300 ft hillslope horizontal length
high soil burn severity on forest

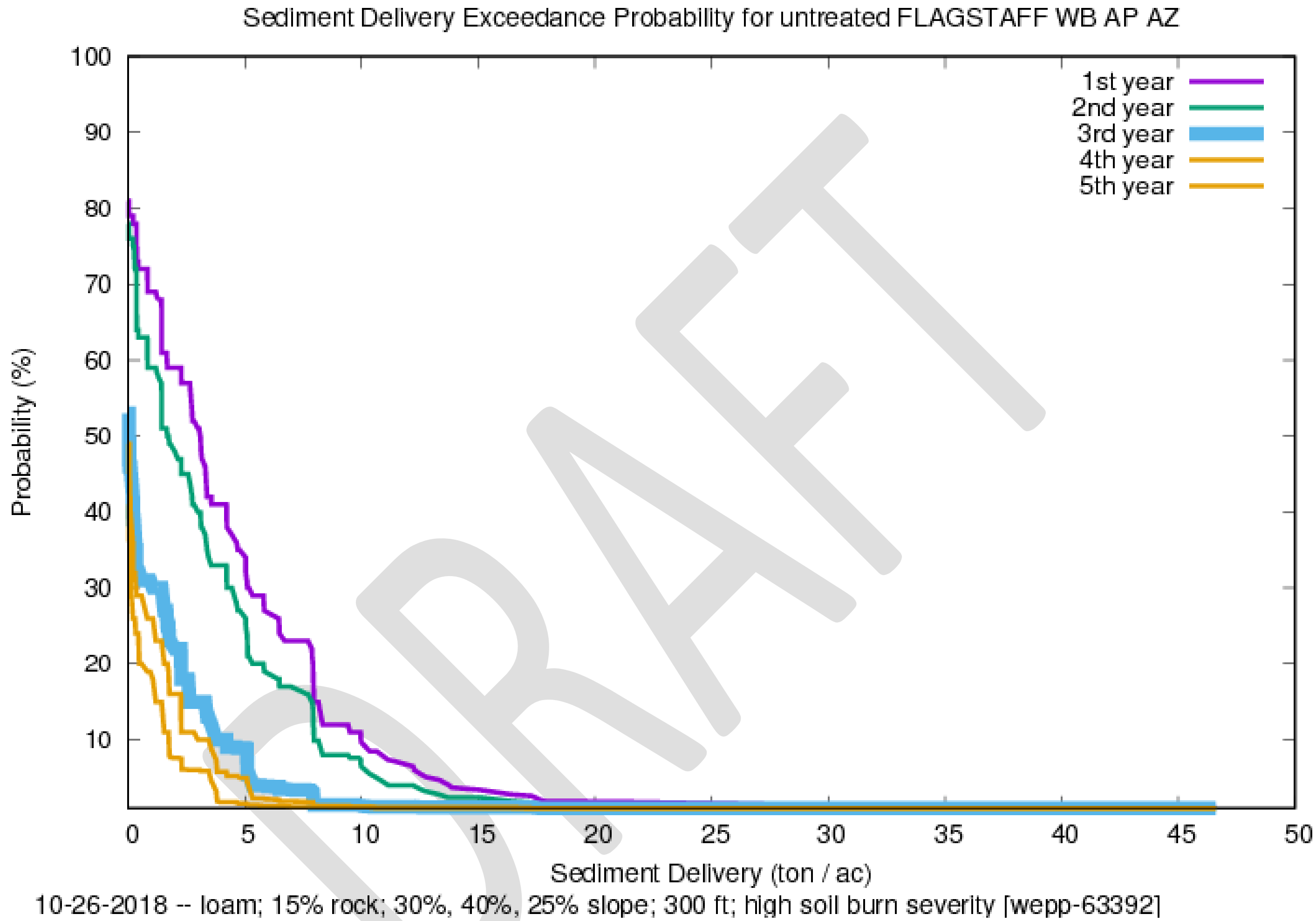
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.6	**in**	annual runoff from rainfall from	595	events
0.39	**in**	annual runoff from snowmelt or winter rainstorm from	149	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.97	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	1.86	4.34	5.92	N/A	N/A	December 2 year 32
10 (10-year)	1.59	4.44	6.01	N/A	N/A	December 7 year 97

20 (5-year)	**1.17**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.70**	**1.57**	**3.40**	**3.54**	**2.38**	**September 5 year 31**
75 (1 $^{1}/_{3}$-year)	**0.43**	**1.18**	**1.22**	**1.88**	**1.49**	**July 6 year 92**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	7.92	5.75	2.26	1.52	0.63
Seeding	7.92	2.63	1.76	1.44	0.63
Mulch (0.5 ton ac^{-1})	2.6	2.45	2.26	1.52	0.63
Mulch (1 ton ac^{-1})	2.26	2.26	2.26	1.52	0.63
Mulch (1.5 ton ac^{-1})	2.26	2.26	2.26	1.52	0.63
Mulch (2 ton ac^{-1})	2.26	2.25	2.26	1.52	0.63
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Stratum 17

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **30%** rock fragment
40% top, 60% average, 45% toe hillslope gradient
300 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.058	**in**	annual runoff from rainfall from	27	events
0.021	**in**	annual runoff from snowmelt or winter rainstorm from	2	events

20 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms						
Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date

1	2.24	3.91	4.28	3.63	3.11	September 4 year 68
5 (20-year)	**0.26**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
10 (10-year)	**0.03**	**2.18**	**2.24**	**5.05**	**3.35**	**November 16 year 5**
20 (5-year)	**0.00**	**2.41**	**2.78**	**3.77**	**2.88**	**September 10 year 17**

Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Unburned	0.02	0.02	0.02	0.02	0.02

Return to input screen

Low Burn Severity

Erosion Risk Management Tool

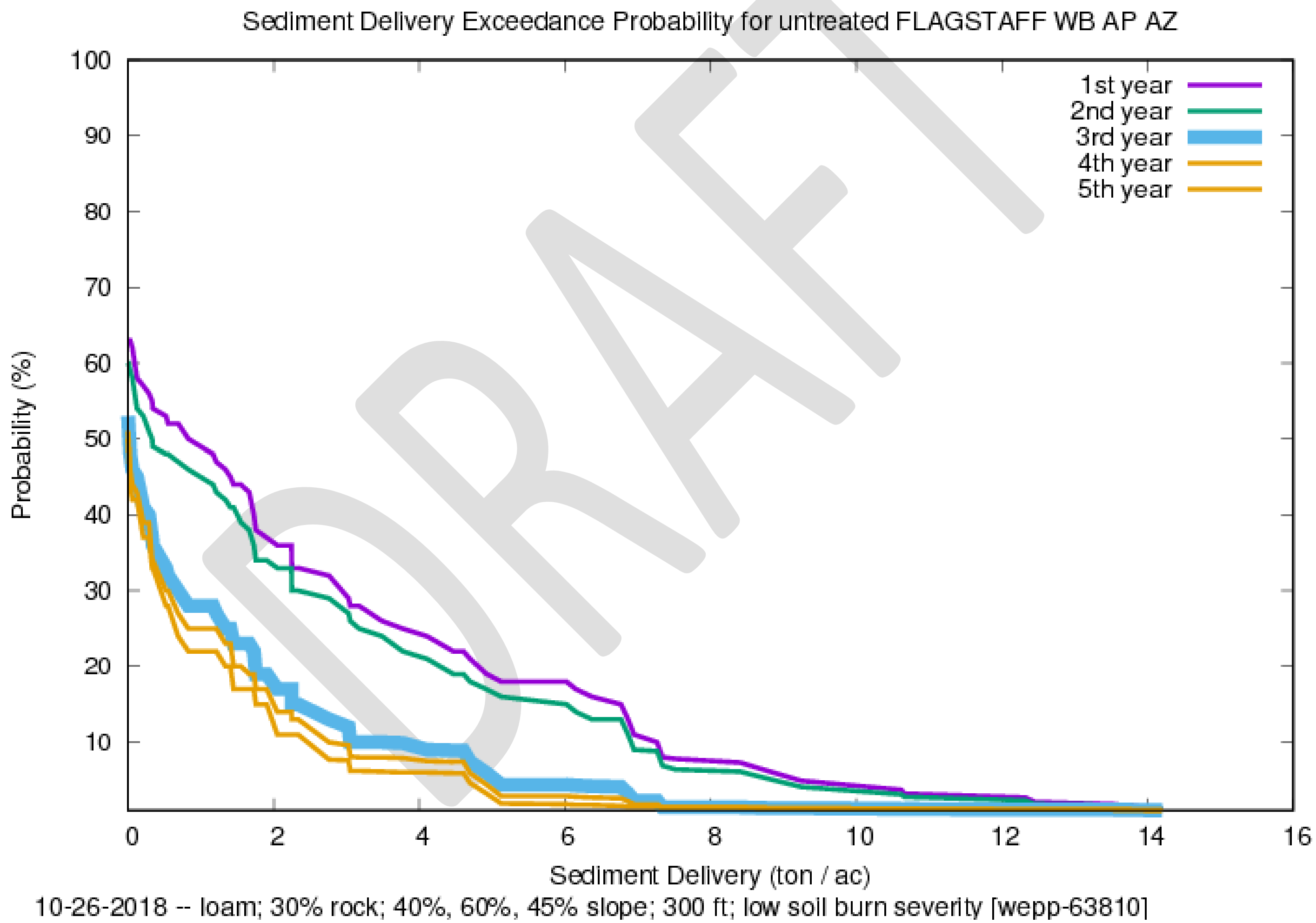
FLAGSTAFF WB AP AZ
loam soil texture, **30%** rock fragment
40% top, 60% average, 45% toe hillslope gradient
300 ft hillslope horizontal length
low soil burn severity on forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.7	**in**	annual runoff from rainfall from	629	events
0.44	**in**	annual runoff from snowmelt or winter rainstorm from	162	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.00	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	1.91	4.34	5.92	N/A	N/A	December 2 year 32
10 (10-year)	1.59	4.44	6.01	N/A	N/A	December 7 year 97
20 (5-year)	1.18	1.91	1.81	4.71	3.04	July 19 year 20

50 (2-year)	**0.76**	**1.59**	**1.55**	**4.12**	**2.60**	**August 30 year 2**
75 ($1^1/_3$-year)	**0.46**	**1.42**	**2.01**	**3.18**	**2.14**	**December 11 year 45**



Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	4.82	4.26	1.75	1.45	1.41
Seeding	4.82	1.75	1.45	1.41	1.41
Mulch (0.5 ton ac^{-1})	1.58	1.68	1.75	1.45	1.41
Mulch (1 ton ac^{-1})	1.41	1.42	1.75	1.45	1.41
Mulch (1.5 ton ac^{-1})	1.41	1.41	1.75	1.45	1.41
Mulch (2 ton ac^{-1})	1.41	1.33	1.75	1.45	1.41
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Moderate Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **30%** rock fragment
40% top, 60% average, 45% toe hillslope gradient
300 ft hillslope horizontal length
moderate soil burn severity on forest

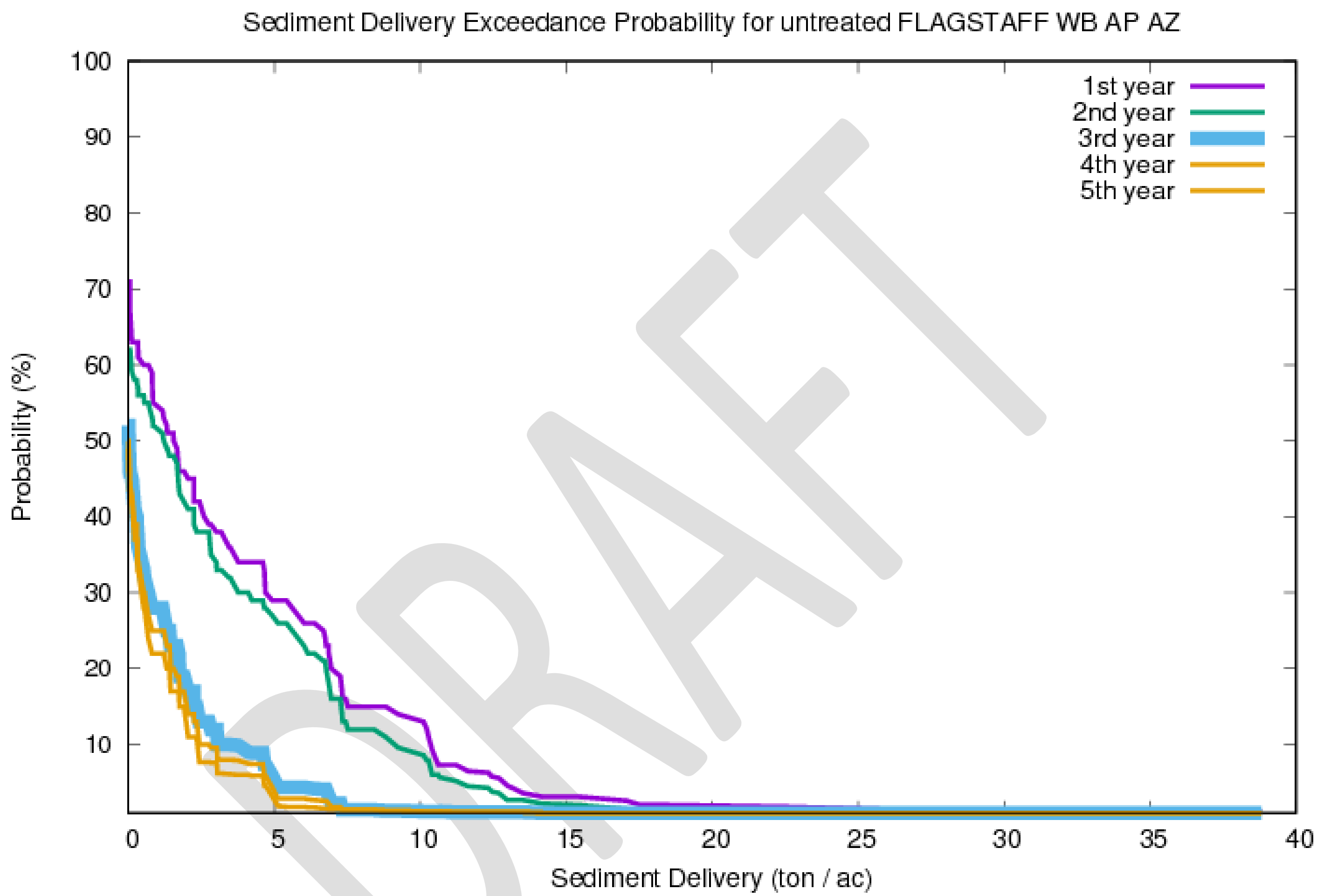
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.7	**in**	annual runoff from rainfall from	629	events
0.44	**in**	annual runoff from snowmelt or winter rainstorm from	162	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.00	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.91**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**

10 (10-year)	**1.59**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
20 (5-year)	**1.18**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.76**	**1.59**	**1.55**	**4.12**	**2.60**	**August 30 year 2**
75 ($1^{1}/_{3}$-year)	**0.46**	**1.42**	**2.01**	**3.18**	**2.14**	**December 11 year 45**



10-26-2018 -- loam; 30% rock; 40%, 60%, 45% slope; 300 ft; moderate soil burn severity [wepp-63999]

Sediment Delivery					
Probability that sediment yield	**Event sediment delivery (ton ac^{-1})**				
	Year following fire				
	1st year	**2nd year**	**3rd year**	**4th year**	**5th year**

will be exceeded 20 % go					
Untreated	6.93	6.77	1.75	1.45	1.41
Seeding	6.93	2.62	1.45	1.41	1.41
Mulch (0.5 ton ac^{-1})	2.4	2.25	1.75	1.45	1.41
Mulch (1 ton ac^{-1})	2	1.97	1.75	1.45	1.41
Mulch (1.5 ton ac^{-1})	1.99	1.92	1.75	1.45	1.41
Mulch (2 ton ac^{-1})	1.97	1.81	1.75	1.45	1.41
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

High Burn Severity

Erosion Risk Management Tool

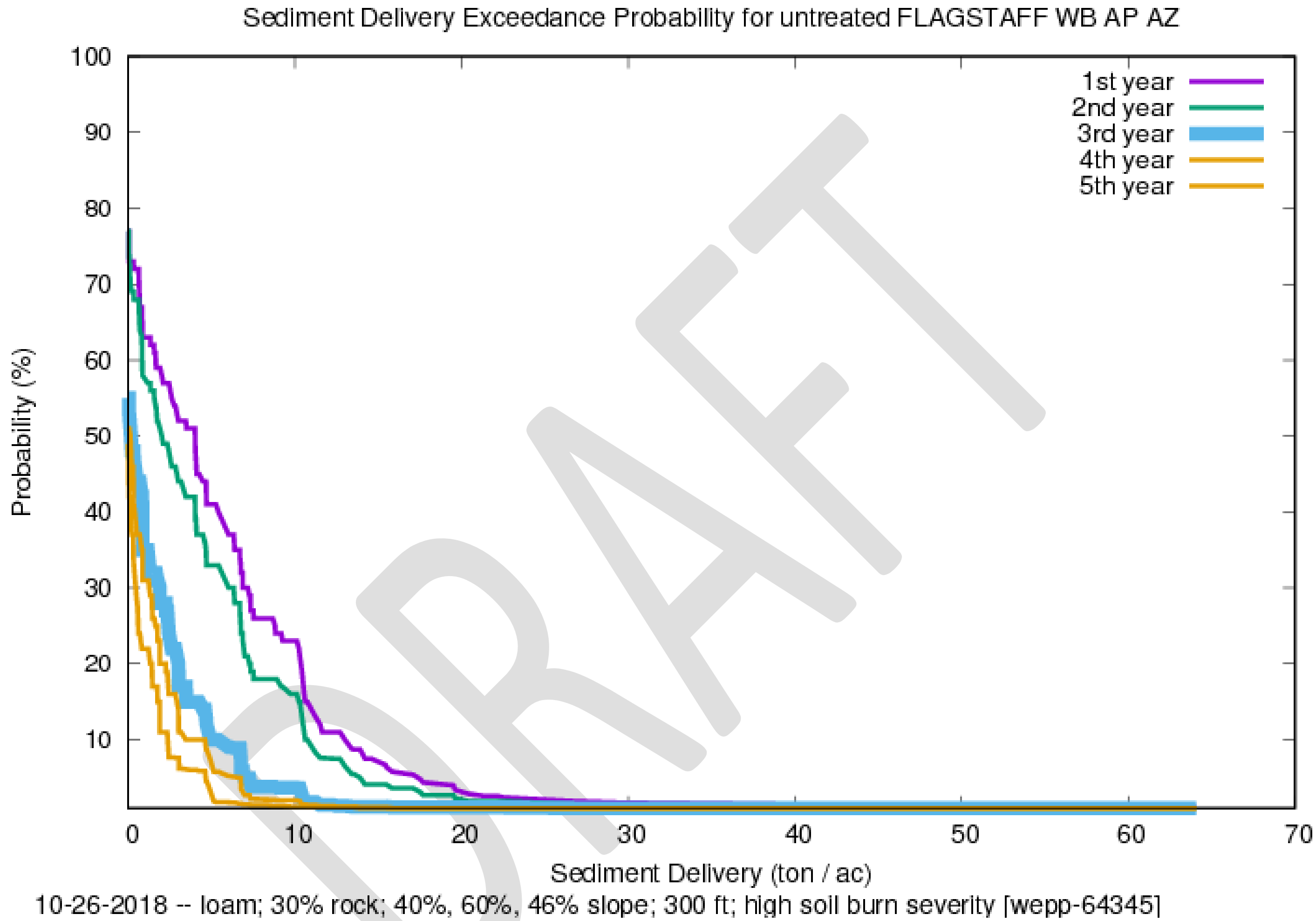
FLAGSTAFF WB AP AZ
loam soil texture, **30%** rock fragment
40% top, 60% average, 46% toe hillslope gradient
300 ft hillslope horizontal length
high soil burn severity on forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.7	**in**	annual runoff from rainfall from	630	events
0.44	**in**	annual runoff from snowmelt or winter rainstorm from	162	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.00	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.91**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**
10 (10-year)	**1.59**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**

20 (5-year)	**1.18**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.76**	**1.59**	**1.55**	**4.12**	**2.60**	**August 30 year 2**
75 ($1^1/_3$-year)	**0.46**	**1.42**	**2.01**	**3.18**	**2.14**	**December 11 year 45**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	10.34	7.34	2.98	2.07	1.41
Seeding	10.34	3.76	2.55	1.93	1.41
Mulch (0.5 ton ac^{-1})	3.62	3.14	2.98	2.07	1.41
Mulch (1 ton ac^{-1})	3.24	3.04	2.98	2.07	1.41
Mulch (1.5 ton ac^{-1})	3.22	2.95	2.98	2.07	1.41
Mulch (2 ton ac^{-1})	3.21	2.87	2.98	2.07	1.41
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Stratum 18

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **18%** rock fragment
8% top, 14% average, 10% toe hillslope gradient
200 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.029	**in**	annual runoff from rainfall from	10	events
0.0051	**in**	annual runoff from snowmelt or winter rainstorm from	1	events

7 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms						
Storm Rank based on runoff (return interval)	**Storm Runoff (in)**	**Storm Precipitation (in)**	**Storm Duration (h)**	**10-min Peak Rainfall Intensity (in h^{-1})**	**30-min Peak Rainfall Intensity (in h^{-1})**	**Storm Date**

1	1.98	3.91	4.28	3.63	3.11	September 4 year 68
5 (20-year)	**0.04**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**

Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Unburned	0.03	0.03	0.03	0.03	0.03

Return to input screen

ERMiT Version 2015.05.03

Low Burn Severity

Erosion Risk Management Tool

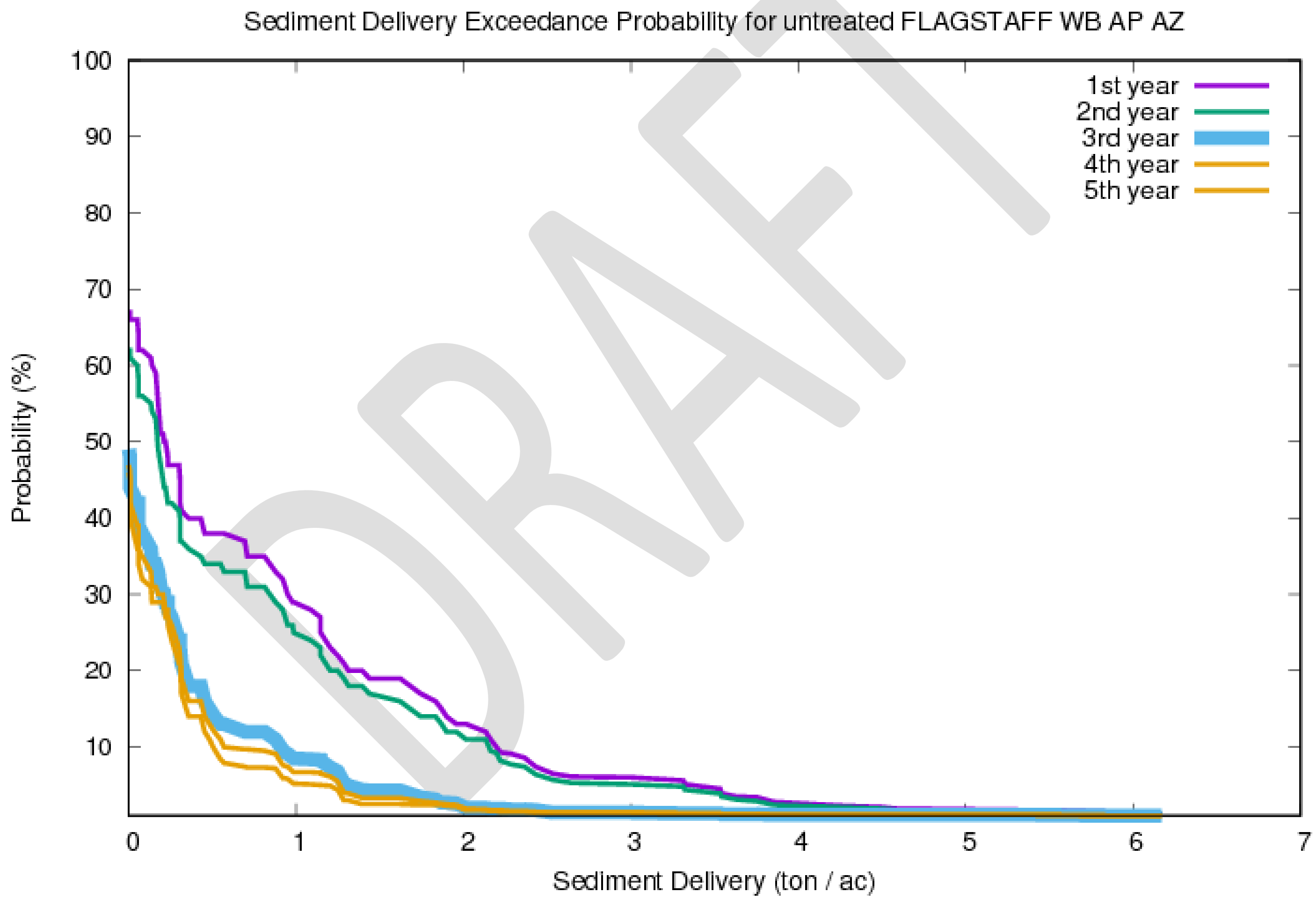
FLAGSTAFF WB AP AZ
sandy loam soil texture, **18%** rock fragment
8% top, 14% average, 10% toe hillslope gradient
200 ft hillslope horizontal length
low soil burn severity on forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.4	**in**	annual runoff from rainfall from	546	events
0.26	**in**	annual runoff from snowmelt or winter rainstorm from	112	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.91	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	1.78	2.91	4.51	4.42	3.40	September 13 year 27
10 (10-year)	1.43	2.50	5.67	3.27	2.61	September 29 year 26
20 (5-year)	1.08	2.06	2.13	4.70	3.14	August 8 year 79

50 (2-year)	**0.65**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**
75 ($1^{1}/_{3}$-year)	**0.35**	**1.00**	**2.45**	**2.92**	**1.73**	**September 28 year 63**



10-26-2018 -- sandy loam; 18% rock; 8%, 14%, 10% slope; 200 ft; low soil burn severity [wepp-64630]

Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	1.31	1.21	0.33	0.31	0.31
Seeding	1.31	0.33	0.31	0.31	0.31
Mulch (0.5 ton ac^{-1})	0.31	0.31	0.33	0.31	0.31
Mulch (1 ton ac^{-1})	0.31	0.31	0.33	0.31	0.31
Mulch (1.5 ton ac^{-1})	0.31	0.31	0.33	0.31	0.31
Mulch (2 ton ac^{-1})	0.31	0.31	0.33	0.31	0.31
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Moderate Burn Severity

Erosion Risk Management Tool

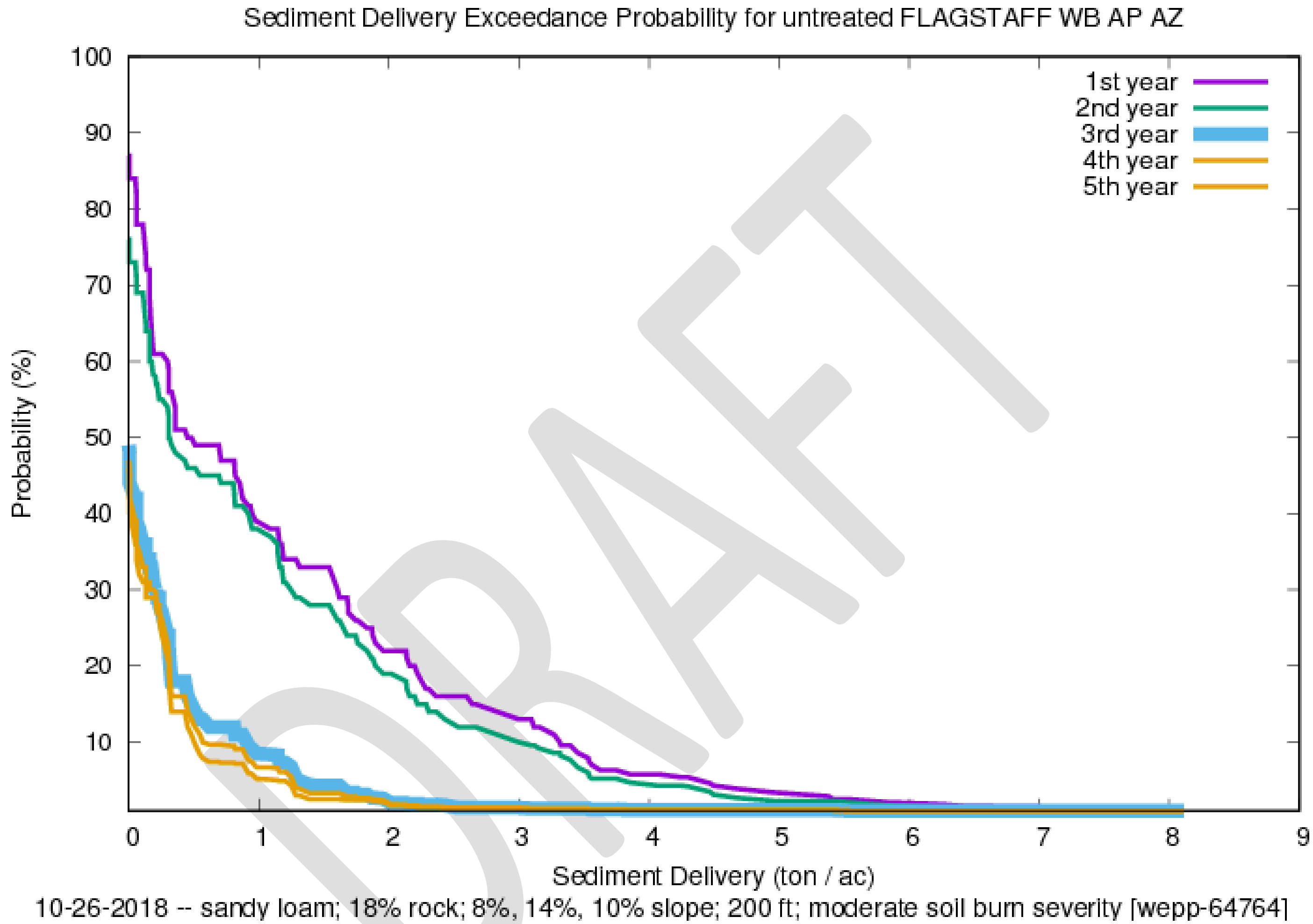
FLAGSTAFF WB AP AZ
sandy loam soil texture, **18%** rock fragment
8% top, 14% average, 10% toe hillslope gradient
200 ft hillslope horizontal length
moderate soil burn severity on forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.4	**in**	annual runoff from rainfall from	546	events
0.26	**in**	annual runoff from snowmelt or winter rainstorm from	112	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.91	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.78**	**2.91**	**4.51**	**4.42**	**3.40**	**September 13 year 27**

10 (10-year)	**1.43**	**2.50**	**5.67**	**3.27**	**2.61**	**September 29 year 26**
20 (5-year)	**1.08**	**2.06**	**2.13**	**4.70**	**3.14**	**August 8 year 79**
50 (2-year)	**0.65**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**
75 (1 1/3-year)	**0.35**	**1.00**	**2.45**	**2.92**	**1.73**	**September 28 year 63**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	2.2	1.89	0.33	0.31	0.31
Seeding	2.2	0.82	0.31	0.31	0.31
Mulch (0.5 ton ac^{-1})	0.8	0.6	0.33	0.31	0.31
Mulch (1 ton ac^{-1})	0.65	0.49	0.33	0.31	0.31
Mulch (1.5 ton ac^{-1})	0.64	0.46	0.33	0.31	0.31
Mulch (2 ton ac^{-1})	0.63	0.45	0.33	0.31	0.31
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

High Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **18%** rock fragment
8% top, 14% average, 10% toe hillslope gradient
200 ft hillslope horizontal length
high soil burn severity on forest

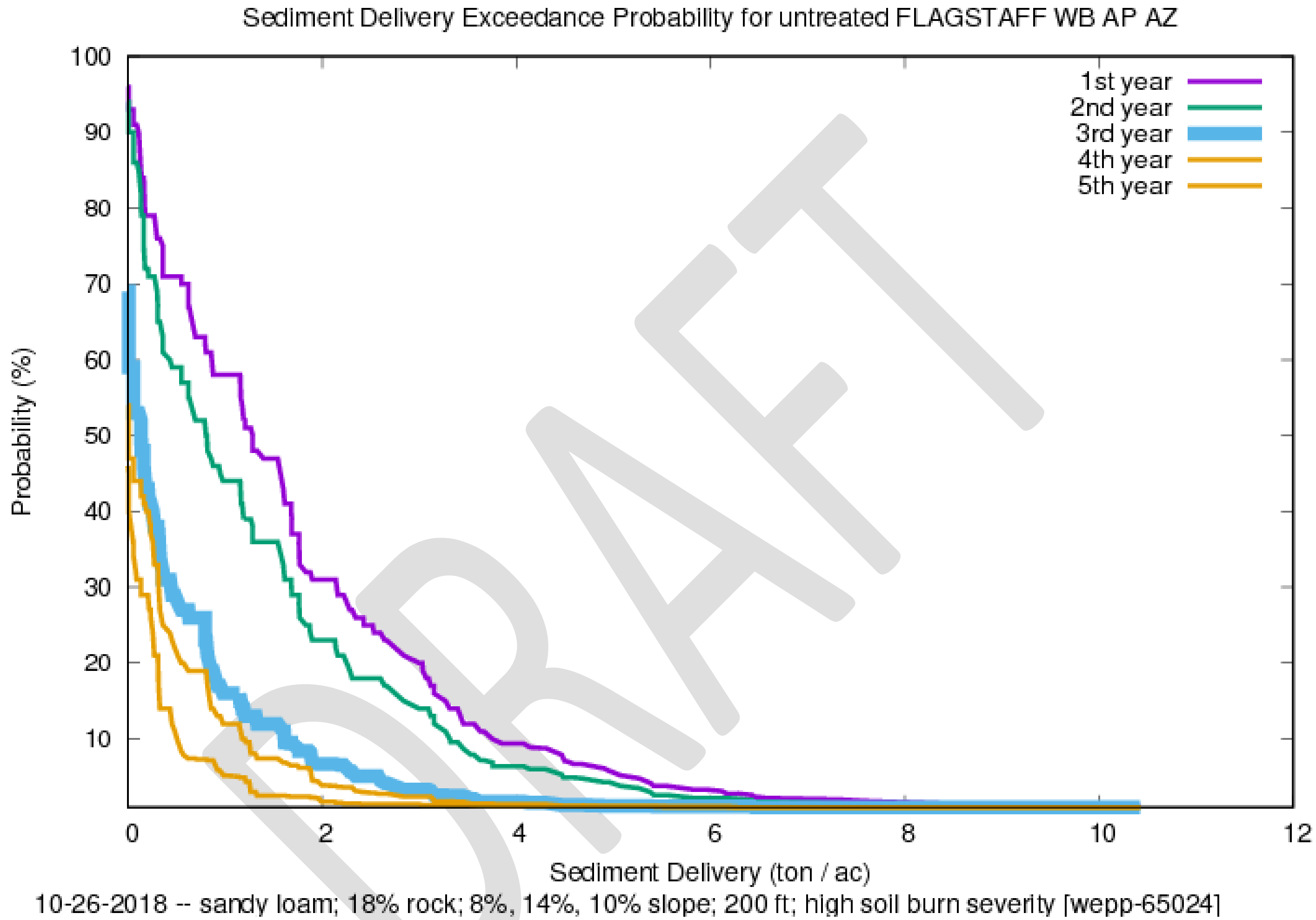
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.4	**in**	annual runoff from rainfall from	546	events
0.26	**in**	annual runoff from snowmelt or winter rainstorm from	112	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.91	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.78**	**2.91**	**4.51**	**4.42**	**3.40**	**September 13 year 27**
10 (10-year)	**1.43**	**2.50**	**5.67**	**3.27**	**2.61**	**September 29 year 26**

20 (5-year)	**1.08**	**2.06**	**2.13**	**4.70**	**3.14**	**August 8 year 79**
50 (2-year)	**0.65**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**
75 ($1^{1}/_{3}$-year)	**0.35**	**1.00**	**2.45**	**2.92**	**1.73**	**September 28 year 63**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	2.96	2.24	0.84	0.55	0.31
Seeding	2.96	1.16	0.8	0.47	0.31
Mulch (0.5 ton ac^{-1})	1.17	0.84	0.84	0.55	0.31
Mulch (1 ton ac^{-1})	0.82	0.81	0.84	0.55	0.31
Mulch (1.5 ton ac^{-1})	0.82	0.8	0.84	0.55	0.31
Mulch (2 ton ac^{-1})	0.81	0.8	0.84	0.55	0.31
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Stratum 19

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **25%** rock fragment
30% top, 45% average, 25% toe hillslope gradient
300 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.058	**in**	annual runoff from rainfall from	26	events
0.0094	**in**	annual runoff from snowmelt or winter rainstorm from	3	events

19 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.30	3.91	4.28	3.63	3.11	September 4 year 68

5 (20-year)	0.25	1.91	1.81	4.71	3.04	July 19 year 20
10 (10-year)	0.02	2.18	2.24	5.05	3.35	November 16 year 5

Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Unburned	0.02	0.02	0.02	0.02	0.02

Return to input screen

ERMiT Version 2015.05.03

Low Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ

loam soil texture, **25%** rock fragment
30% top, 45% average, 25% toe hillslope gradient
300 ft hillslope horizontal length
low soil burn severity on forest

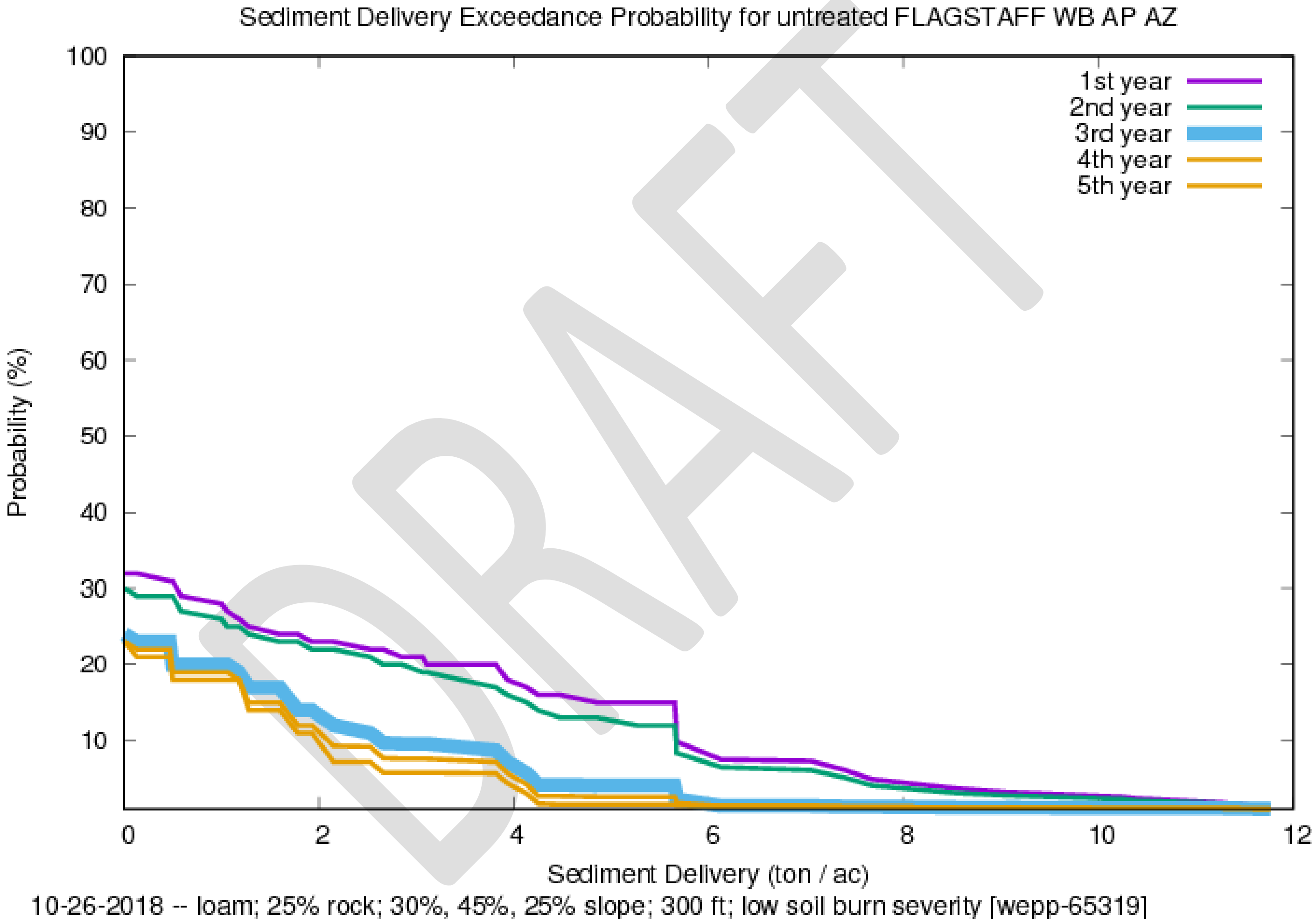
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.7	**in**	annual runoff from rainfall from	615	events
0.41	**in**	annual runoff from snowmelt or winter rainstorm from	161	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.99	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.89**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**
10 (10-year)	**1.60**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
20 (5-year)	**1.18**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.73**	**1.35**	**2.10**	**N/A**	**N/A**	**January 17 year 39**

75 (1 1/3-year)	**0.45**	**1.42**	**2.01**	**3.18**	**2.14**	**December 11 year 45**



Sediment Delivery

Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	3.46	2.65	0.74	0.49	0.48
Seeding	3.46	0.74	0.49	0.48	0.48
Mulch (0.5 ton ac^{-1})	1.18	0.49	0.74	0.49	0.48
Mulch (1 ton ac^{-1})	0.49	0.48	0.74	0.49	0.48
Mulch (1.5 ton ac^{-1})	0.49	0.48	0.74	0.49	0.48
Mulch (2 ton ac^{-1})	0.49	0.48	0.74	0.49	0.48
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Moderate Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **25%** rock fragment
30% top, 45% average, 25% toe hillslope gradient
300 ft hillslope horizontal length
moderate soil burn severity on forest

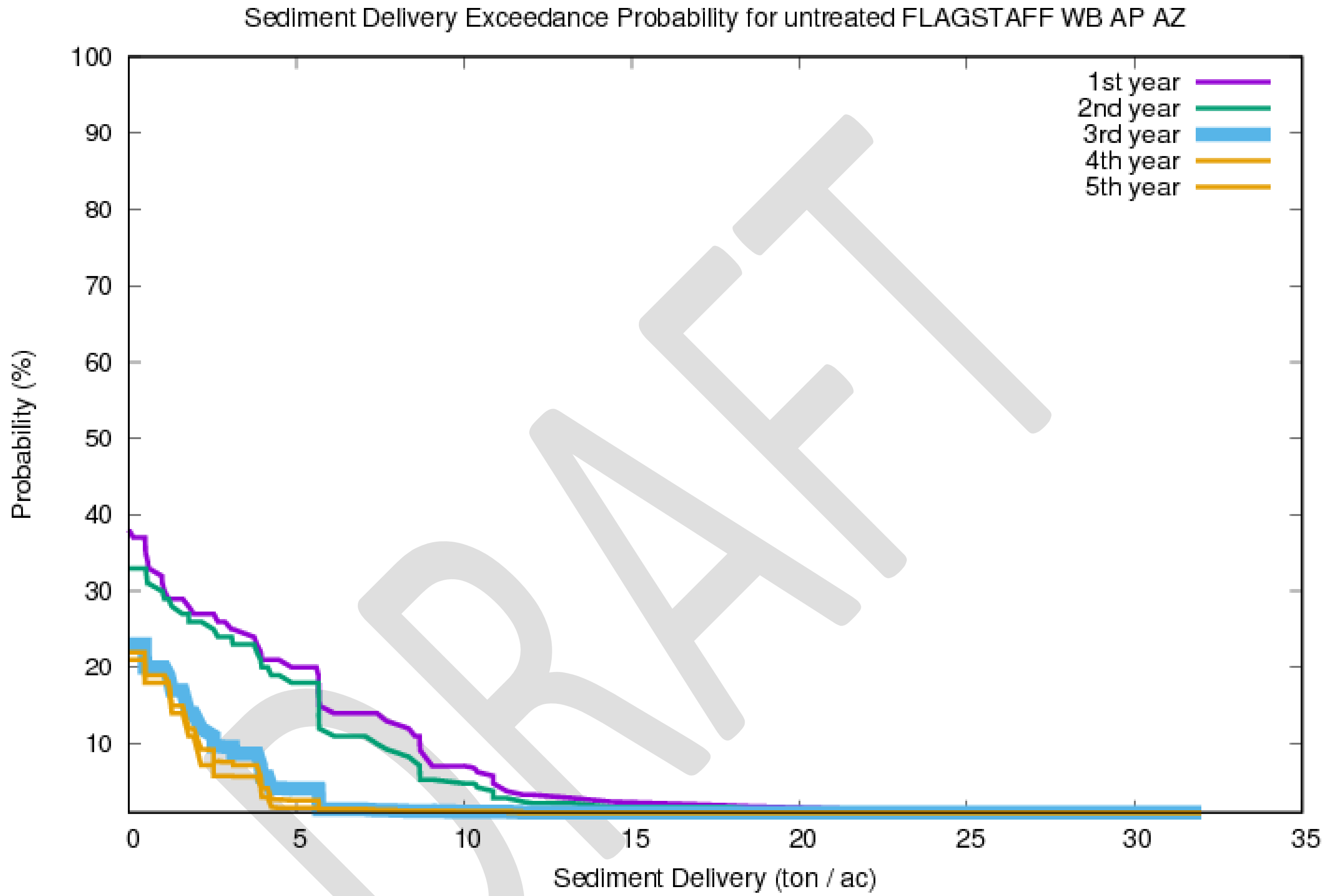
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.7	**in**	annual runoff from rainfall from	615	events
0.41	**in**	annual runoff from snowmelt or winter rainstorm from	161	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.99	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.89**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**

10 (10-year)	**1.60**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
20 (5-year)	**1.18**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.73**	**1.35**	**2.10**	**N/A**	**N/A**	**January 17 year 39**
75 ($1^1/_3$-year)	**0.45**	**1.42**	**2.01**	**3.18**	**2.14**	**December 11 year 45**



10-26-2018 -- loam; 25% rock; 30%, 45%, 25% slope; 300 ft; moderate soil burn severity [wepp-65451]

Sediment Delivery					
Probability that sediment yield	**Event sediment delivery (ton ac^{-1})**				
	Year following fire				
	1st year	**2nd year**	**3rd year**	**4th year**	**5th year**

will be exceeded 20 % go					
Untreated	5.26	4.09	0.74	0.49	0.48
Seeding	5.26	1.47	0.49	0.48	0.48
Mulch (0.5 ton ac^{-1})	1.69	1.26	0.74	0.49	0.48
Mulch (1 ton ac^{-1})	1.66	1.23	0.74	0.49	0.48
Mulch (1.5 ton ac^{-1})	1.65	1.23	0.74	0.49	0.48
Mulch (2 ton ac^{-1})	1.65	1.22	0.74	0.49	0.48
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

High Burn Severity

Erosion Risk Management Tool

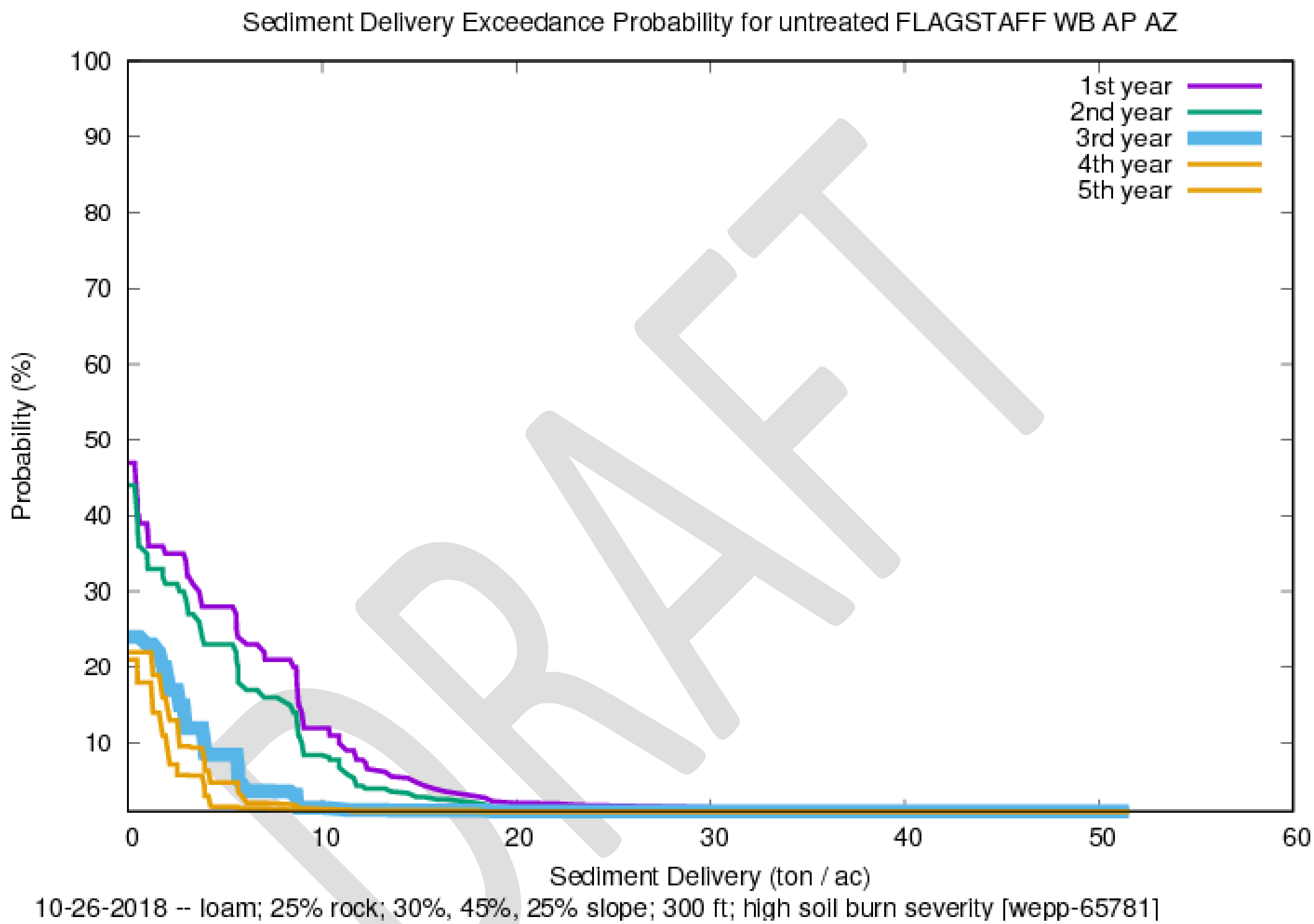
FLAGSTAFF WB AP AZ
loam soil texture, **25%** rock fragment
30% top, 45% average, 25% toe hillslope gradient
300 ft hillslope horizontal length
high soil burn severity on forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.7	**in**	annual runoff from rainfall from	615	events
0.41	**in**	annual runoff from snowmelt or winter rainstorm from	161	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.99	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.89**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**
10 (10-year)	**1.60**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**

20 (5-year)	**1.18**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.73**	**1.35**	**2.10**	**N/A**	**N/A**	**January 17 year 39**
75 ($1^1/_3$-year)	**0.45**	**1.42**	**2.01**	**3.18**	**2.14**	**December 11 year 45**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	8.67	5.65	1.77	1.24	0.48
Seeding	8.67	2.58	1.71	1.22	0.48
Mulch (0.5 ton ac^{-1})	2.73	2.43	1.77	1.24	0.48
Mulch (1 ton ac^{-1})	2.64	2.3	1.77	1.24	0.48
Mulch (1.5 ton ac^{-1})	2.63	2.24	1.77	1.24	0.48
Mulch (2 ton ac^{-1})	2.63	2.21	1.77	1.24	0.48
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Stratum 20

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
clay loam soil texture, **50%** rock fragment
20% top, 35% average, 25% toe hillslope gradient
300 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.08	**in**	annual runoff from rainfall from	28	events
0.015	**in**	annual runoff from snowmelt or winter rainstorm from	3	events

20 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date

1	2.74	3.91	4.28	3.63	3.11	September 4 year 68
5 (20-year)	**0.29**	**1.65**	**6.13**	**4.16**	**2.66**	**August 7 year 97**
10 (10-year)	**0.13**	**2.73**	**2.85**	**4.75**	**3.51**	**September 23 year 27**
20 (5-year)	**0.00**	**2.94**	**4.77**	**3.37**	**2.77**	**August 5 year 36**

Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Unburned	0.02	0.02	0.02	0.02	0.02

Return to input screen

ERMiT Version 2015.05.03

Low Burn Severity

Erosion Risk Management Tool

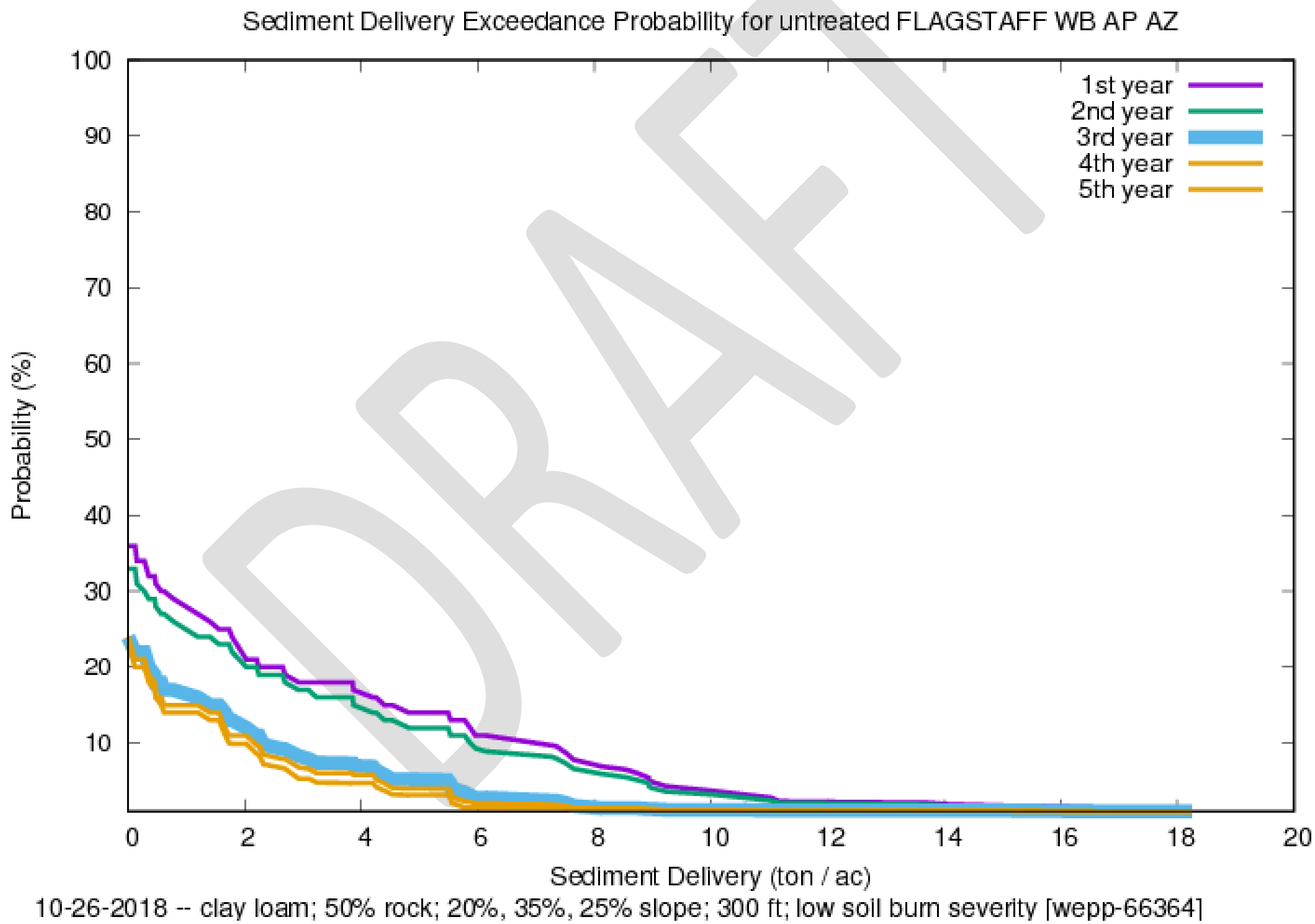
FLAGSTAFF WB AP AZ
clay loam soil texture, **50%** rock fragment
20% top, 35% average, 25% toe hillslope gradient
300 ft hillslope horizontal length
low soil burn severity on forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
2.3	**in**	annual runoff from rainfall from	850	events
1.1	**in**	annual runoff from snowmelt or winter rainstorm from	478	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.19	4.74	6.90	N/A	N/A	February 14 year 30
5 (20-year)	2.31	3.42	5.02	5.90	4.37	September 19 year 48
10 (10-year)	1.97	3.00	3.46	5.09	3.78	June 17 year 56
20 (5-year)	1.37	1.96	2.22	0.62	0.62	January 18 year 72

50 (2-year)	**1.02**	**2.17**	**3.80**	**1.84**	**1.60**	**February 16 year 31**
75 (1 1/3-year)	**0.61**	**1.07**	**3.09**	**1.57**	**1.22**	**December 9 year 63**



Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	2.3	2.05	0.36	0.31	0.11
Seeding	2.3	0.36	0.31	0.11	0.11
Mulch (0.5 ton ac^{-1})	0.29	0.31	0.36	0.31	0.11
Mulch (1 ton ac^{-1})	0.07	0.11	0.36	0.31	0.11
Mulch (1.5 ton ac^{-1})	0.07	0.09	0.36	0.31	0.11
Mulch (2 ton ac^{-1})	0.06	0.08	0.36	0.31	0.11
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Moderate Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
clay loam soil texture, **50%** rock fragment
20% top, 35% average, 25% toe hillslope gradient
300 ft hillslope horizontal length
moderate soil burn severity on forest

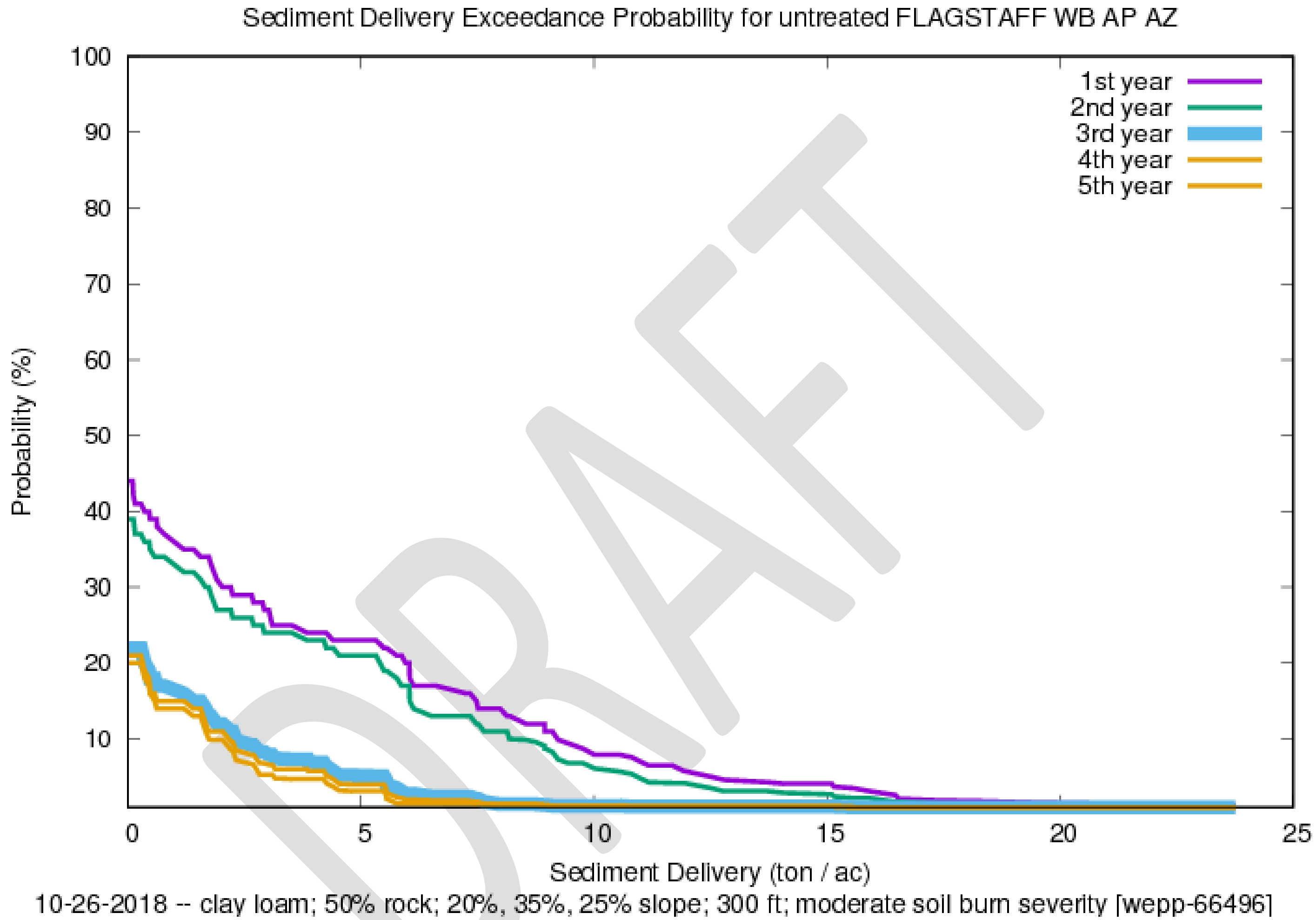
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
2.3	**in**	annual runoff from rainfall from	850	events
1.1	**in**	annual runoff from snowmelt or winter rainstorm from	478	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.19	4.74	6.90	N/A	N/A	February 14 year 30
5 (20-year)	**2.31**	**3.42**	**5.02**	**5.90**	**4.37**	**September 19 year 48**

10 (10-year)	**1.97**	**3.00**	**3.46**	**5.09**	**3.78**	**June 17 year 56**
20 (5-year)	**1.37**	**1.96**	**2.22**	**0.62**	**0.62**	**January 18 year 72**
50 (2-year)	**1.02**	**2.17**	**3.80**	**1.84**	**1.60**	**February 16 year 31**
75 (1 1/3-year)	**0.61**	**1.07**	**3.09**	**1.57**	**1.22**	**December 9 year 63**



Sediment Delivery					
Probability that sediment yield	**Event sediment delivery (ton ac^{-1})**				
	Year following fire				
	1st year	**2nd year**	**3rd year**	**4th year**	**5th year**

will be exceeded 20 % go					
Untreated	5.99	5.41	0.36	0.31	0.11
Seeding	5.99	1.23	0.31	0.11	0.11
Mulch (0.5 ton ac^{-1})	0.62	0.82	0.36	0.31	0.11
Mulch (1 ton ac^{-1})	0.07	0.46	0.36	0.31	0.11
Mulch (1.5 ton ac^{-1})	0.06	0.32	0.36	0.31	0.11
Mulch (2 ton ac^{-1})	0.05	0.28	0.36	0.31	0.11
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

High Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
clay loam soil texture, **50%** rock fragment
20% top, 35% average, 25% toe hillslope gradient
300 ft hillslope horizontal length
high soil burn severity on forest

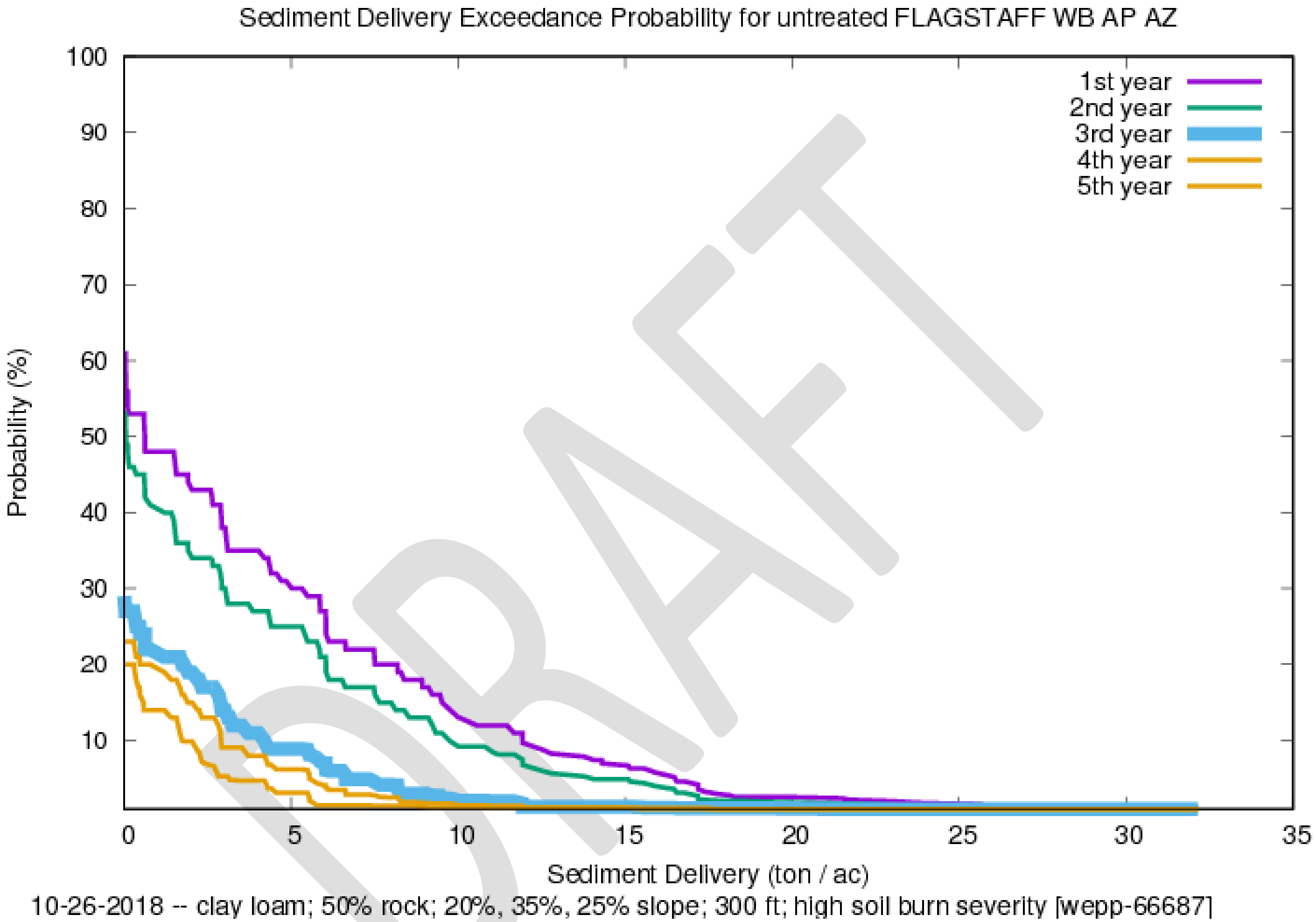
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
2.3	**in**	annual runoff from rainfall from	850	events
1.1	**in**	annual runoff from snowmelt or winter rainstorm from	478	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.19	4.74	6.90	N/A	N/A	February 14 year 30
5 (20-year)	**2.31**	**3.42**	**5.02**	**5.90**	**4.37**	**September 19 year 48**
10 (10-year)	**1.97**	**3.00**	**3.46**	**5.09**	**3.78**	**June 17 year 56**

20 (5-year)	**1.37**	**1.96**	**2.22**	**0.62**	**0.62**	**January 18 year 72**
50 (2-year)	**1.02**	**2.17**	**3.80**	**1.84**	**1.60**	**February 16 year 31**
75 ($1^1/_3$-year)	**0.61**	**1.07**	**3.09**	**1.57**	**1.22**	**December 9 year 63**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	8.08	6.04	1.79	0.47	0.11
Seeding	8.08	2.7	0.87	0.44	0.11
Mulch (0.5 ton ac^{-1})	2.84	2.07	1.79	0.47	0.11
Mulch (1 ton ac^{-1})	0.51	1.92	1.79	0.47	0.11
Mulch (1.5 ton ac^{-1})	0.45	1.07	1.79	0.47	0.11
Mulch (2 ton ac^{-1})	0.41	0.62	1.79	0.47	0.11
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Stratum 21

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **27%** rock fragment
10% top, 12% average, 9% toe hillslope gradient
200 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.057	**in**	annual runoff from rainfall from	26	events
0.012	**in**	annual runoff from snowmelt or winter rainstorm from	5	events

20 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.30	3.91	4.28	3.63	3.11	September 4 year 68

5 (20-year)	0.25	1.91	1.81	4.71	3.04	July 19 year 20
10 (10-year)	0.06	3.64	8.96	N/A	N/A	December 12 year 5
20 (5-year)	0.00	2.15	5.47	4.32	3.04	September 13 year 18

Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Unburned	0.01	0.01	0.01	0.01	0.01

Return to input screen

Low Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ

loam soil texture, **27%** rock fragment
10% top, 12% average, 9% toe hillslope gradient
200 ft hillslope horizontal length
low soil burn severity on forest

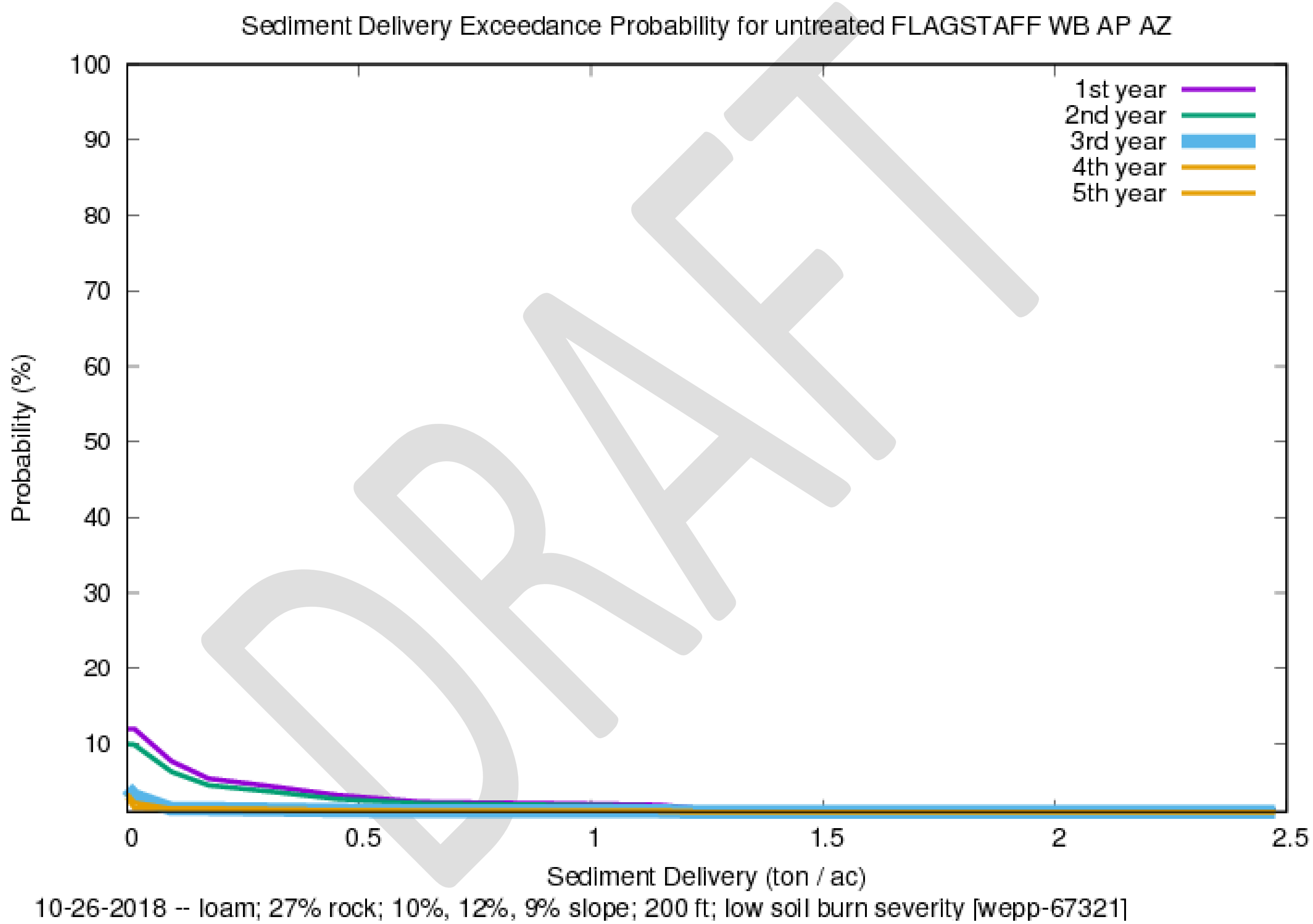
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.6	**in**	annual runoff from rainfall from	617	events
0.42	**in**	annual runoff from snowmelt or winter rainstorm from	164	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.00	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	1.91	4.34	5.92	N/A	N/A	December 2 year 32
10 (10-year)	1.71	4.44	6.01	N/A	N/A	December 7 year 97
20 (5-year)	1.16	1.96	2.22	0.62	0.62	January 18 year 72
50 (2-year)	0.74	1.89	2.74	2.35	1.91	December 29 year 42

75 ($1^{1}/_{3}$-year)	**0.42**	**1.26**	**3.29**	**1.55**	**1.26**	**August 29 year 43**



Sediment Delivery

Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	0	0	0	0	0
Seeding	0	0	0	0	0
Mulch (0.5 ton ac^{-1})	0	0	0	0	0
Mulch (1 ton ac^{-1})	0	0	0	0	0
Mulch (1.5 ton ac^{-1})	0	0	0	0	0
Mulch (2 ton ac^{-1})	0	0	0	0	0
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Moderate Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **27%** rock fragment
10% top, 12% average, 9% toe hillslope gradient
200 ft hillslope horizontal length
moderate soil burn severity on forest

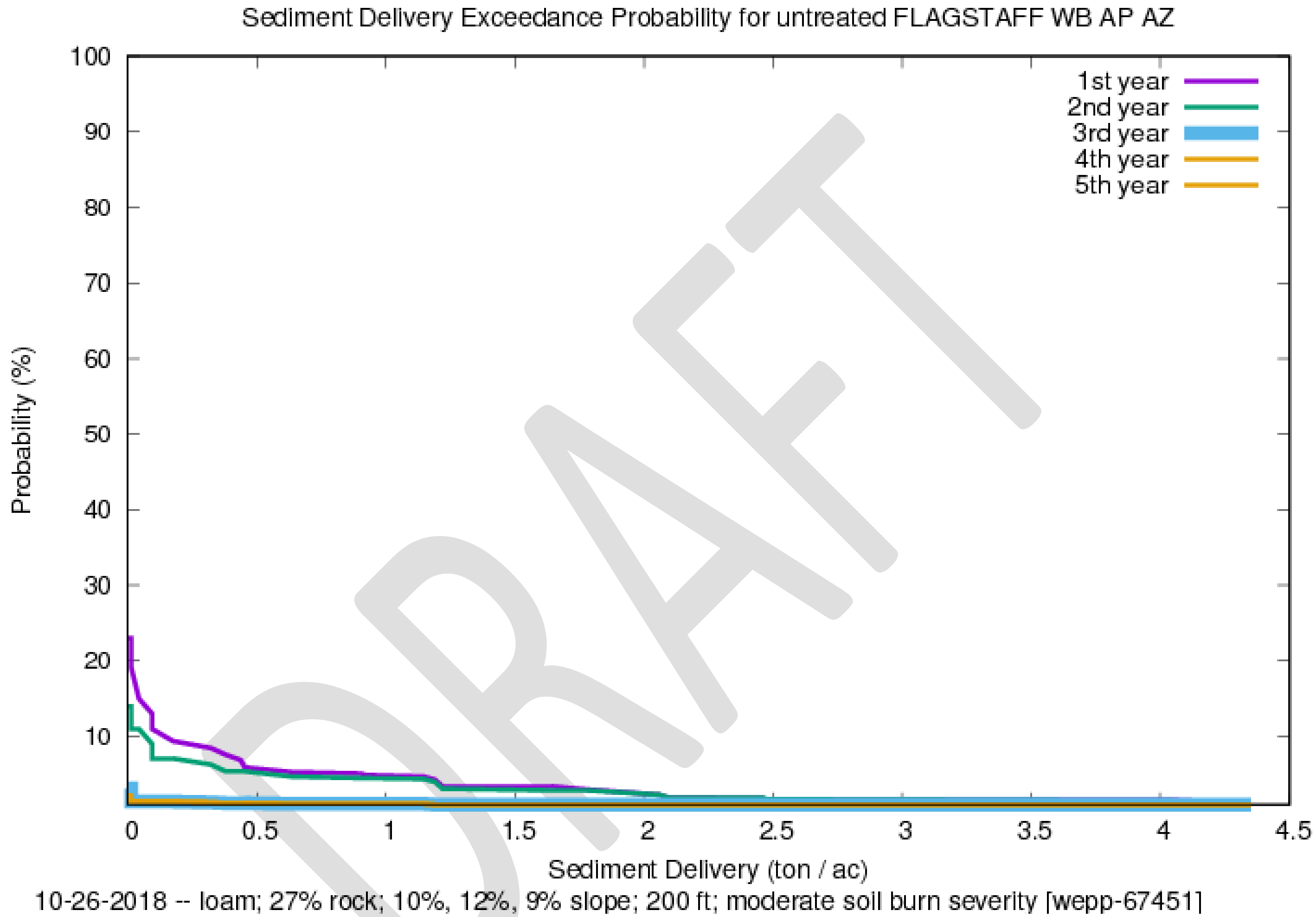
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.6	**in**	annual runoff from rainfall from	617	events
0.42	**in**	annual runoff from snowmelt or winter rainstorm from	164	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.00	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.91**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**

10 (10-year)	**1.71**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
20 (5-year)	**1.16**	**1.96**	**2.22**	**0.62**	**0.62**	**January 18 year 72**
50 (2-year)	**0.74**	**1.89**	**2.74**	**2.35**	**1.91**	**December 29 year 42**
75 (1 1/3-year)	**0.42**	**1.26**	**3.29**	**1.55**	**1.26**	**August 29 year 43**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	0.01	0	0	0	0
Seeding	0.01	0	0	0	0
Mulch (0.5 ton ac^{-1})	0	0	0	0	0
Mulch (1 ton ac^{-1})	0	0	0	0	0
Mulch (1.5 ton ac^{-1})	0	0	0	0	0
Mulch (2 ton ac^{-1})	0	0	0	0	0
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

High Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **27%** rock fragment
10% top, 12% average, 9% toe hillslope gradient
200 ft hillslope horizontal length
high soil burn severity on forest

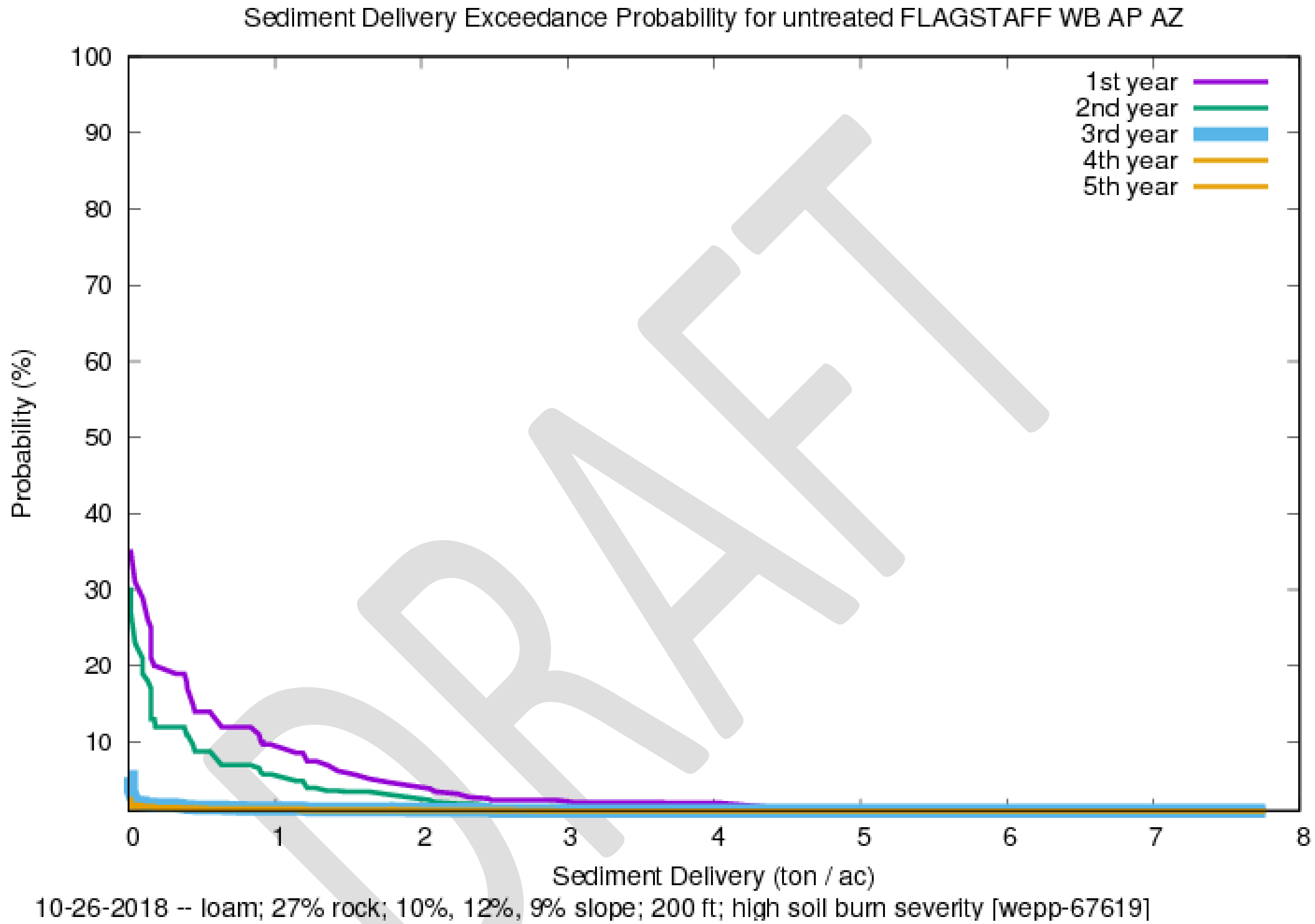
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.6	**in**	annual runoff from rainfall from	617	events
0.42	**in**	annual runoff from snowmelt or winter rainstorm from	164	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.00	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.91**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**
10 (10-year)	**1.71**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**

20 (5-year)	**1.16**	**1.96**	**2.22**	**0.62**	**0.62**	**January 18 year 72**
50 (2-year)	**0.74**	**1.89**	**2.74**	**2.35**	**1.91**	**December 29 year 42**
75 (1 1/3-year)	**0.42**	**1.26**	**3.29**	**1.55**	**1.26**	**August 29 year 43**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	0.18	0.09	0	0	0
Seeding	0.18	0	0	0	0
Mulch (0.5 ton ac^{-1})	0	0	0	0	0
Mulch (1 ton ac^{-1})	0	0	0	0	0
Mulch (1.5 ton ac^{-1})	0	0	0	0	0
Mulch (2 ton ac^{-1})	0	0	0	0	0
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Stratum 22

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **20%** rock fragment
9% top, 13% average, 7% toe hillslope gradient
240 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.028	**in**	annual runoff from rainfall from	10	events
0.0051	**in**	annual runoff from snowmelt or winter rainstorm from	1	events

7 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms						
Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date

1	1.96	3.91	4.28	3.63	3.11	September 4 year 68
5 (20-year)	**0.03**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**

Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Unburned	0.02	0.02	0.02	0.02	0.02

Return to input screen

ERMiT Version 2015.05.03

Low Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **20%** rock fragment
9% top, 13% average, 7% toe hillslope gradient
240 ft hillslope horizontal length
low soil burn severity on forest

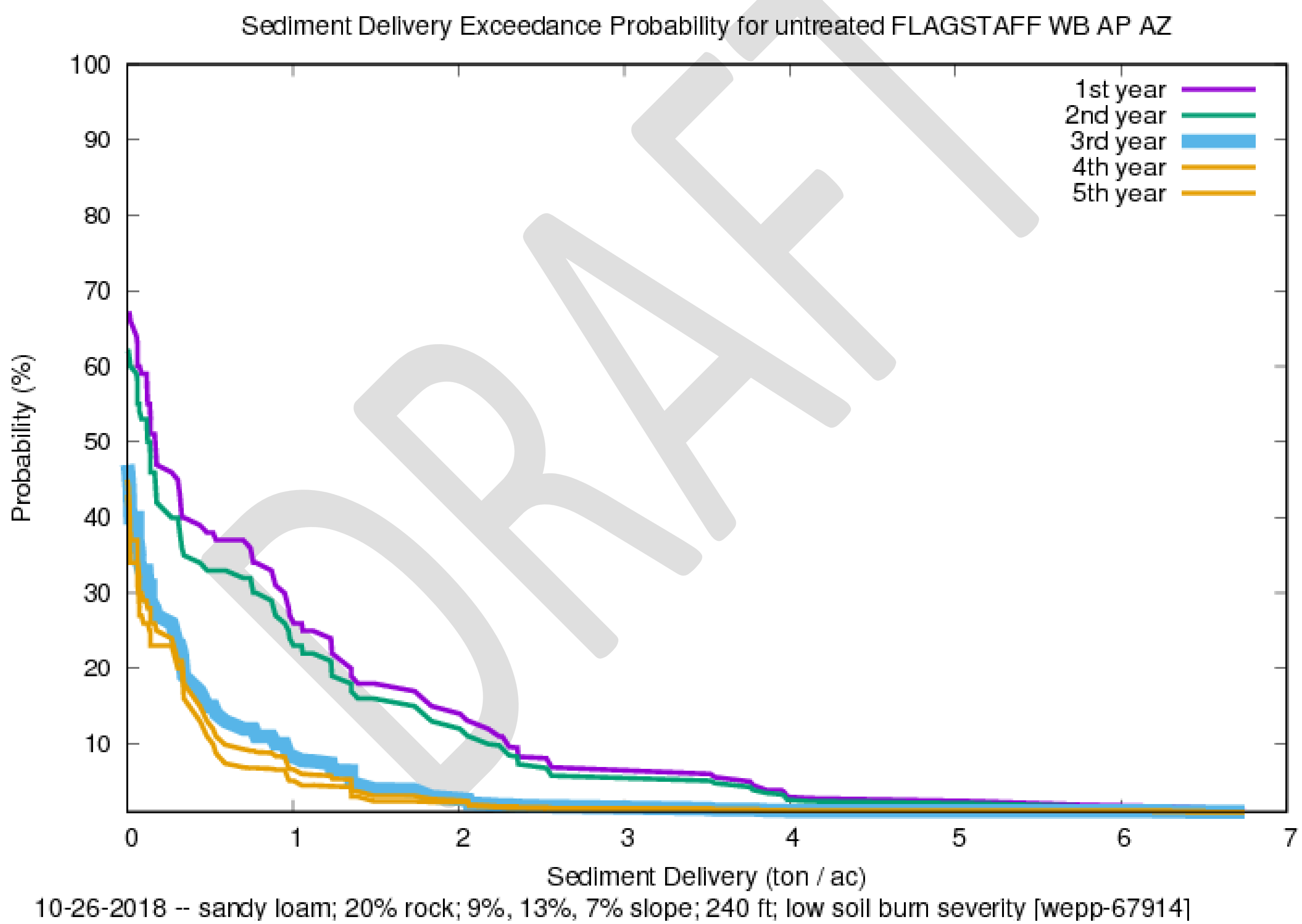
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.4	**in**	annual runoff from rainfall from	546	events
0.27	**in**	annual runoff from snowmelt or winter rainstorm from	113	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.91	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.78**	**2.91**	**4.51**	**4.42**	**3.40**	**September 13 year 27**
10 (10-year)	**1.45**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
20 (5-year)	**1.08**	**2.06**	**2.13**	**4.70**	**3.14**	**August 8 year 79**

50 (2-year)	0.65	1.47	3.72	2.66	1.94	September 15 year 76
75 ($1^{1}/_{3}$-year)	0.35	1.00	2.45	2.92	1.73	September 28 year 63



Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	1.35	1.23	0.34	0.33	0.3
Seeding	1.35	0.34	0.33	0.3	0.3
Mulch (0.5 ton ac^{-1})	0.34	0.33	0.34	0.33	0.3
Mulch (1 ton ac^{-1})	0.33	0.33	0.34	0.33	0.3
Mulch (1.5 ton ac^{-1})	0.33	0.3	0.34	0.33	0.3
Mulch (2 ton ac^{-1})	0.33	0.3	0.34	0.33	0.3
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Moderate Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **20%** rock fragment
9% top, 13% average, 7% toe hillslope gradient
240 ft hillslope horizontal length
moderate soil burn severity on forest

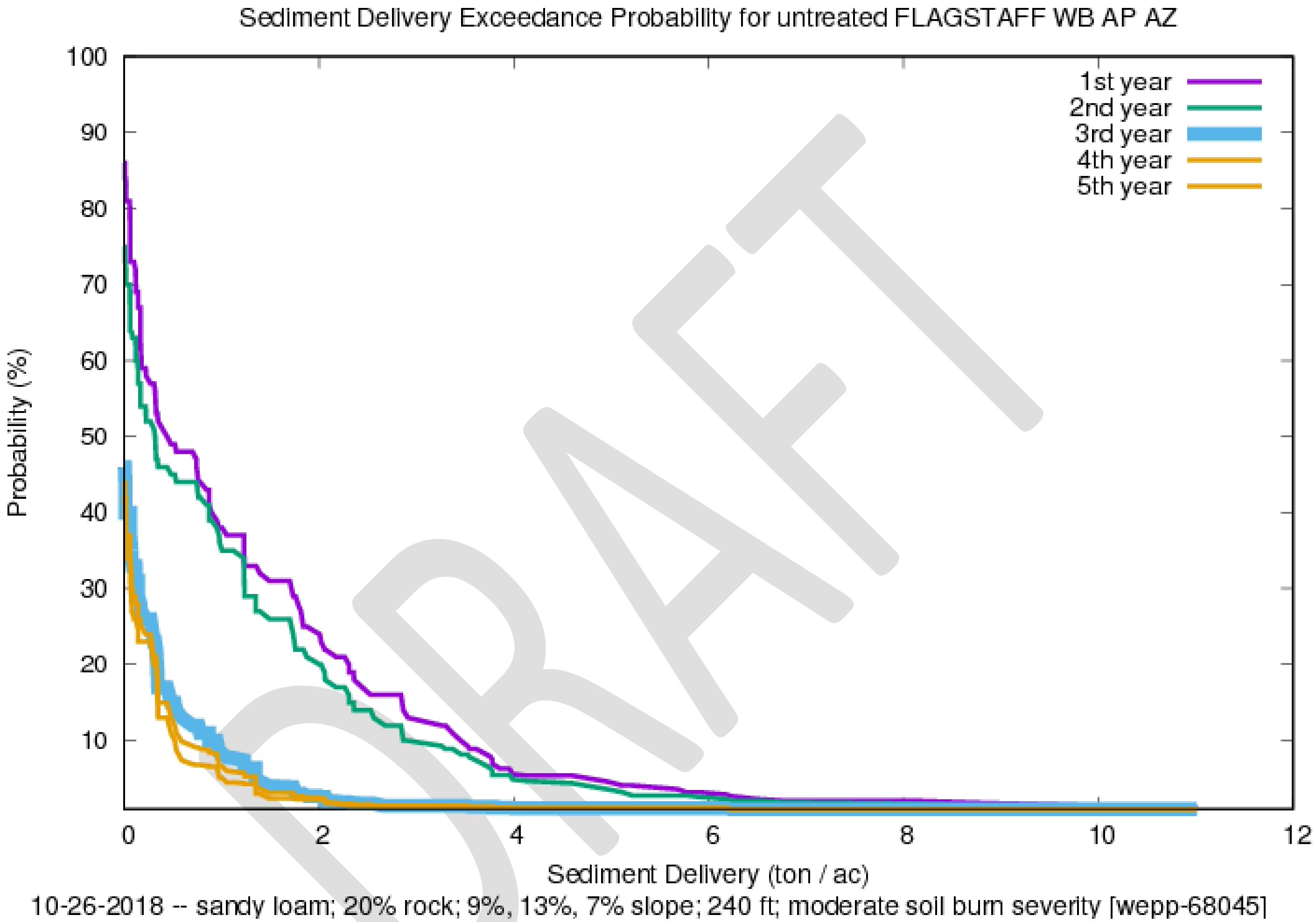
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.4	**in**	annual runoff from rainfall from	546	events
0.27	**in**	annual runoff from snowmelt or winter rainstorm from	113	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.91	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.78**	**2.91**	**4.51**	**4.42**	**3.40**	**September 13 year 27**

10 (10-year)	**1.45**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
20 (5-year)	**1.08**	**2.06**	**2.13**	**4.70**	**3.14**	**August 8 year 79**
50 (2-year)	**0.65**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**
75 ($1^1/_3$-year)	**0.35**	**1.00**	**2.45**	**2.92**	**1.73**	**September 28 year 63**



Sediment Delivery					
Probability that sediment yield	**Event sediment delivery (ton ac^{-1})**				
	Year following fire				
	1st year	**2nd year**	**3rd year**	**4th year**	**5th year**

will be exceeded 20 % go					
Untreated	2.31	2.01	0.34	0.33	0.3
Seeding	2.31	0.75	0.33	0.3	0.3
Mulch (0.5 ton ac^{-1})	0.74	0.52	0.34	0.33	0.3
Mulch (1 ton ac^{-1})	0.52	0.45	0.34	0.33	0.3
Mulch (1.5 ton ac^{-1})	0.52	0.41	0.34	0.33	0.3
Mulch (2 ton ac^{-1})	0.52	0.4	0.34	0.33	0.3
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

High Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **20%** rock fragment
9% top, 13% average, 7% toe hillslope gradient
240 ft hillslope horizontal length
high soil burn severity on forest

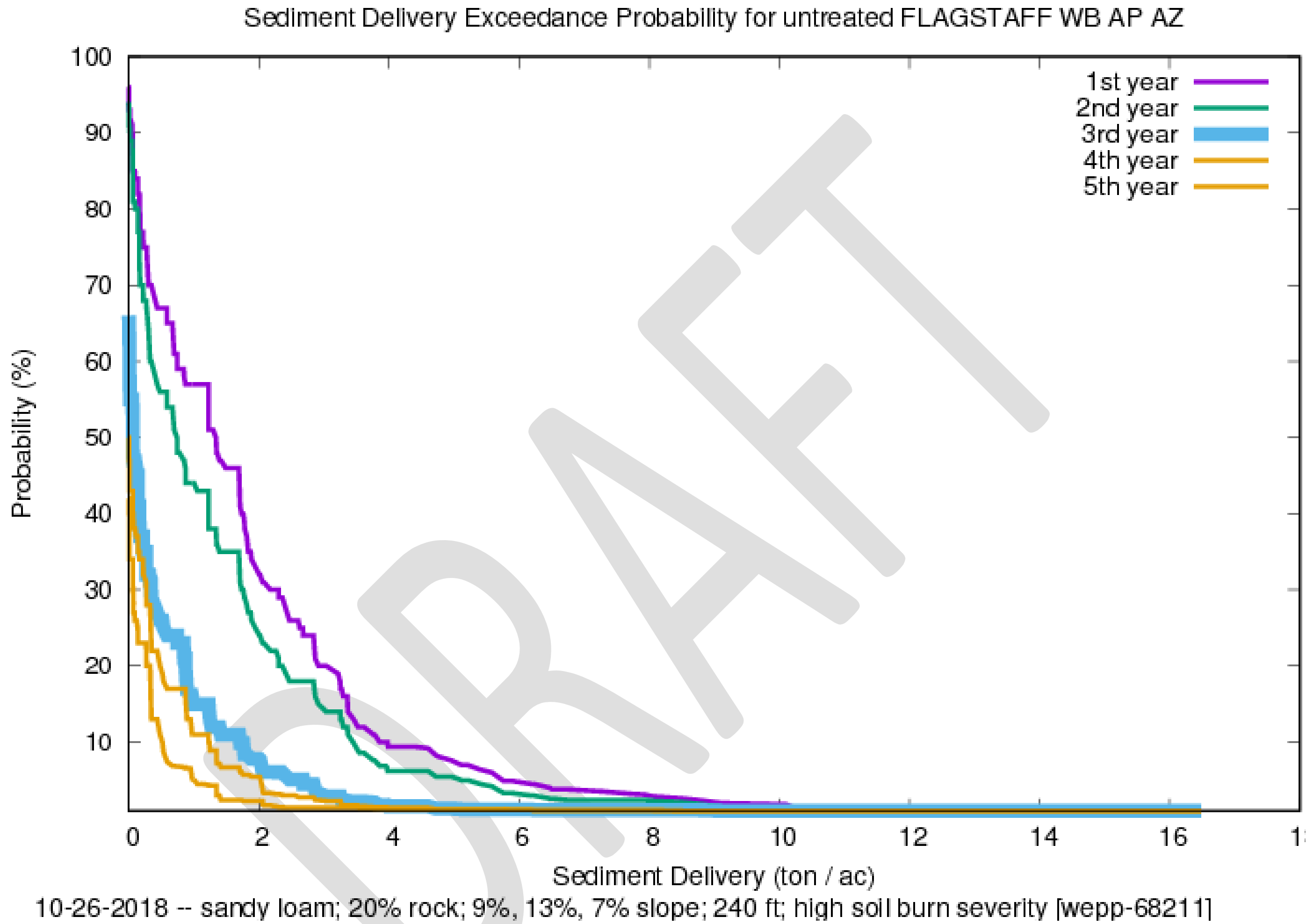
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.4	**in**	annual runoff from rainfall from	546	events
0.27	**in**	annual runoff from snowmelt or winter rainstorm from	113	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.91	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.78**	**2.91**	**4.51**	**4.42**	**3.40**	**September 13 year 27**
10 (10-year)	**1.45**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**

20 (5-year)	**1.08**	**2.06**	**2.13**	**4.70**	**3.14**	**August 8 year 79**
50 (2-year)	**0.65**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**
75 (1 1/3-year)	**0.35**	**1.00**	**2.45**	**2.92**	**1.73**	**September 28 year 63**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	2.97	2.36	0.87	0.49	0.3
Seeding	2.97	0.99	0.85	0.42	0.3
Mulch (0.5 ton ac^{-1})	1.23	0.87	0.87	0.49	0.3
Mulch (1 ton ac^{-1})	0.87	0.86	0.87	0.49	0.3
Mulch (1.5 ton ac^{-1})	0.87	0.86	0.87	0.49	0.3
Mulch (2 ton ac^{-1})	0.87	0.85	0.87	0.49	0.3
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Stratum 23

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **50%** rock fragment
5% top, 14% average, 11% toe hillslope gradient
230 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.054	**in**	annual runoff from rainfall from	36	events
0.0024	**in**	annual runoff from snowmelt or winter rainstorm from	1	events

27 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms						
Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date

1	2.03	3.91	4.28	3.63	3.11	September 4 year 68
5 (20-year)	**0.30**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
10 (10-year)	**0.06**	**2.07**	**2.13**	**4.63**	**3.12**	**July 1 year 58**
20 (5-year)	**0.00**	**2.41**	**2.78**	**3.77**	**2.88**	**September 10 year 17**

Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	**Event sediment delivery (ton ac^{-1})**				
	Year following fire				
	1st year	**2nd year**	**3rd year**	**4th year**	**5th year**
Unburned	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**

Return to input screen

Low Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **50%** rock fragment
5% top, 14% average, 11% toe hillslope gradient
230 ft hillslope horizontal length
low soil burn severity on forest

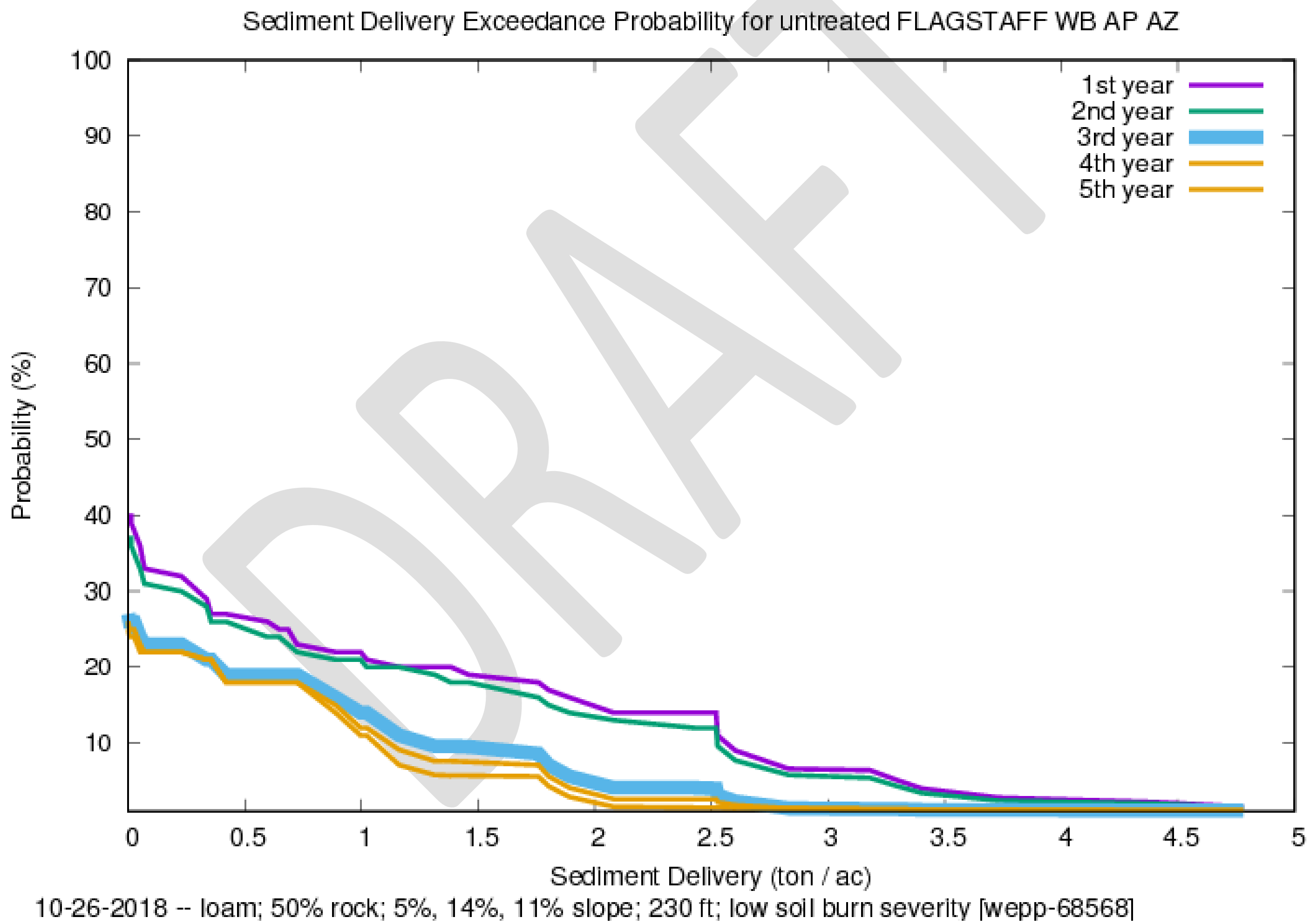
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.8	**in**	annual runoff from rainfall from	700	events
0.5	**in**	annual runoff from snowmelt or winter rainstorm from	197	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.06	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	1.99	4.34	5.92	N/A	N/A	December 2 year 32
10 (10-year)	1.82	4.44	6.01	N/A	N/A	December 7 year 97
20 (5-year)	1.20	1.91	1.81	4.71	3.04	July 19 year 20

50 (2-year)	**0.78**	**1.63**	**5.28**	**2.03**	**1.64**	**August 9 year 15**
75 (1 1/3-year)	**0.50**	**0.80**	**0.89**	**1.80**	**1.27**	**February 17 year 57**



Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	1.27	1.07	0.39	0.39	0.38
Seeding	1.27	0.39	0.39	0.38	0.38
Mulch (0.5 ton ac^{-1})	0.59	0.39	0.39	0.39	0.38
Mulch (1 ton ac^{-1})	0.41	0.38	0.39	0.39	0.38
Mulch (1.5 ton ac^{-1})	0.41	0.38	0.39	0.39	0.38
Mulch (2 ton ac^{-1})	0.4	0.38	0.39	0.39	0.38
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Moderate Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **50%** rock fragment
5% top, 14% average, 11% toe hillslope gradient
230 ft hillslope horizontal length
moderate soil burn severity on forest

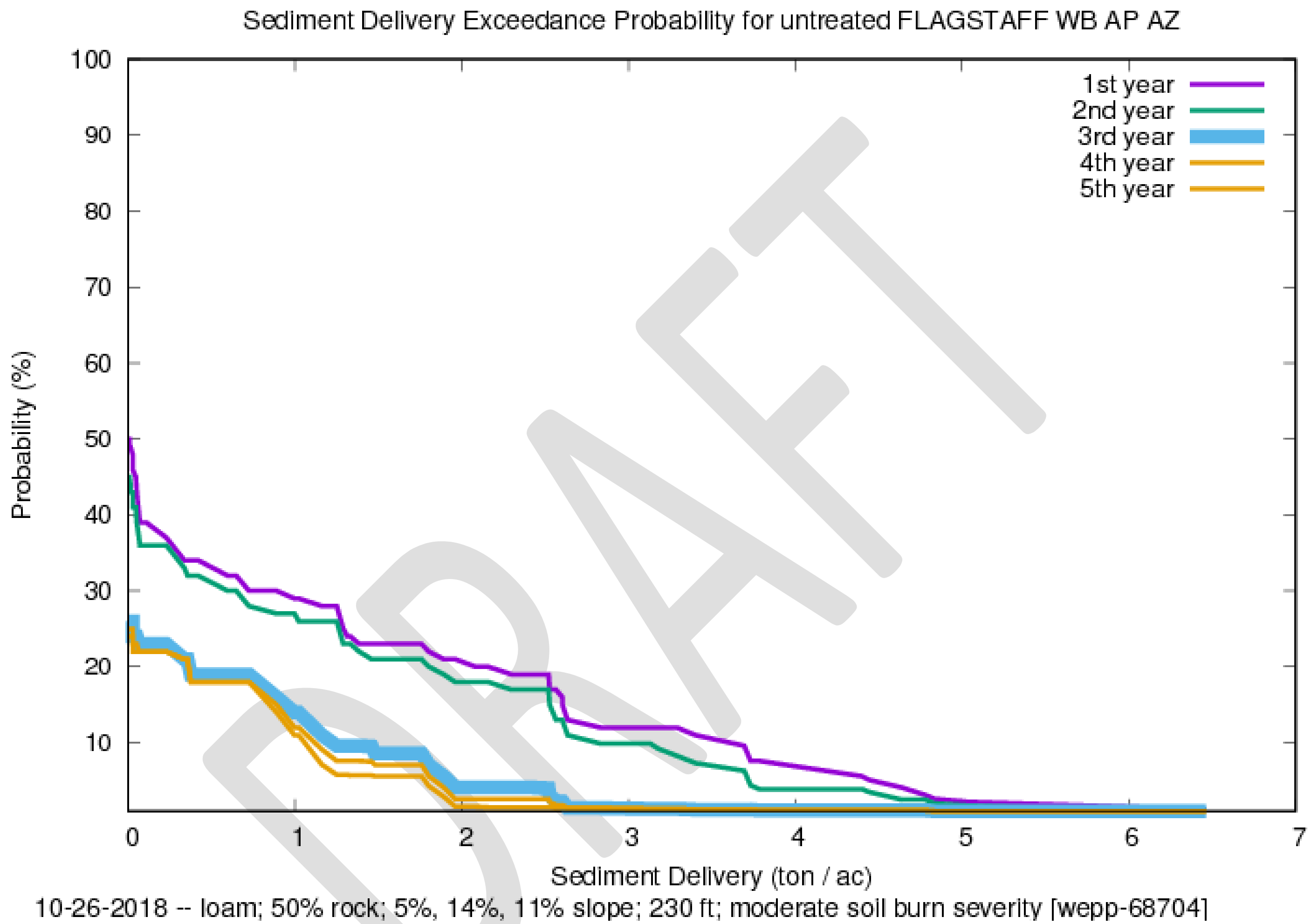
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.8	**in**	annual runoff from rainfall from	700	events
0.5	**in**	annual runoff from snowmelt or winter rainstorm from	197	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.06	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.99**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**

10 (10-year)	**1.82**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
20 (5-year)	**1.20**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.78**	**1.63**	**5.28**	**2.03**	**1.64**	**August 9 year 15**
75 (1 1/3-year)	**0.50**	**0.80**	**0.89**	**1.80**	**1.27**	**February 17 year 57**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	2.21	1.84	0.39	0.39	0.38
Seeding	2.21	0.89	0.39	0.38	0.38
Mulch (0.5 ton ac^{-1})	0.95	0.85	0.39	0.39	0.38
Mulch (1 ton ac^{-1})	0.92	0.81	0.39	0.39	0.38
Mulch (1.5 ton ac^{-1})	0.92	0.8	0.39	0.39	0.38
Mulch (2 ton ac^{-1})	0.92	0.79	0.39	0.39	0.38
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

High Burn Severity

Erosion Risk Management Tool

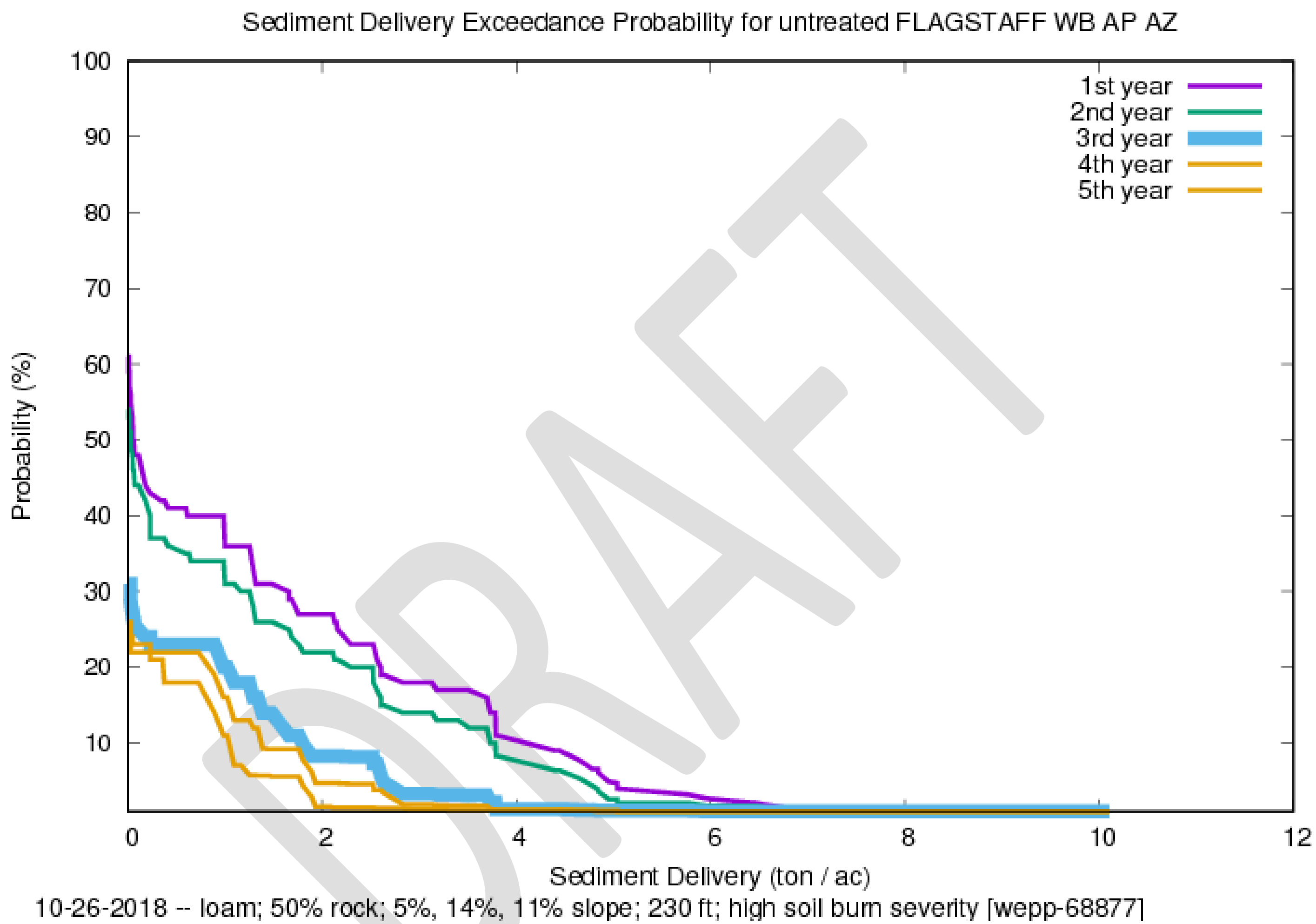
FLAGSTAFF WB AP AZ
loam soil texture, **50%** rock fragment
5% top, 14% average, 11% toe hillslope gradient
230 ft hillslope horizontal length
high soil burn severity on forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.8	**in**	annual runoff from rainfall from	700	events
0.5	**in**	annual runoff from snowmelt or winter rainstorm from	197	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.06	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	1.99	4.34	5.92	N/A	N/A	December 2 year 32
10 (10-year)	1.82	4.44	6.01	N/A	N/A	December 7 year 97

20 (5-year)	**1.20**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.78**	**1.63**	**5.28**	**2.03**	**1.64**	**August 9 year 15**
75 ($1^1/_3$-year)	**0.50**	**0.80**	**0.89**	**1.80**	**1.27**	**February 17 year 57**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 %					
Untreated	2.61	2.27	1.03	0.83	0.38
Seeding	2.61	1.26	0.96	0.79	0.38
Mulch (0.5 ton ac^{-1})	1.4	1.08	1.03	0.83	0.38
Mulch (1 ton ac^{-1})	1.38	1.06	1.03	0.83	0.38
Mulch (1.5 ton ac^{-1})	1.38	1.06	1.03	0.83	0.38
Mulch (2 ton ac^{-1})	1.38	1.05	1.03	0.83	0.38
Erosion Barriers: Diameter ft Spacing ft					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Stratum 24

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **12%** rock fragment
10% top, 30% average, 15% toe hillslope gradient
270 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.066	**in**	annual runoff from rainfall from	23	events
0.022	**in**	annual runoff from snowmelt or winter rainstorm from	8	events

19 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date

1	2.50	3.91	4.28	3.63	3.11	September 4 year 68
5 (20-year)	**0.29**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
10 (10-year)	**0.13**	**2.73**	**2.85**	**4.75**	**3.51**	**September 23 year 27**

Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Unburned	0	0	0	0	0

Return to input screen

Low Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **12%** rock fragment
10% top, 30% average, 15% toe hillslope gradient
270 ft hillslope horizontal length
low soil burn severity on forest

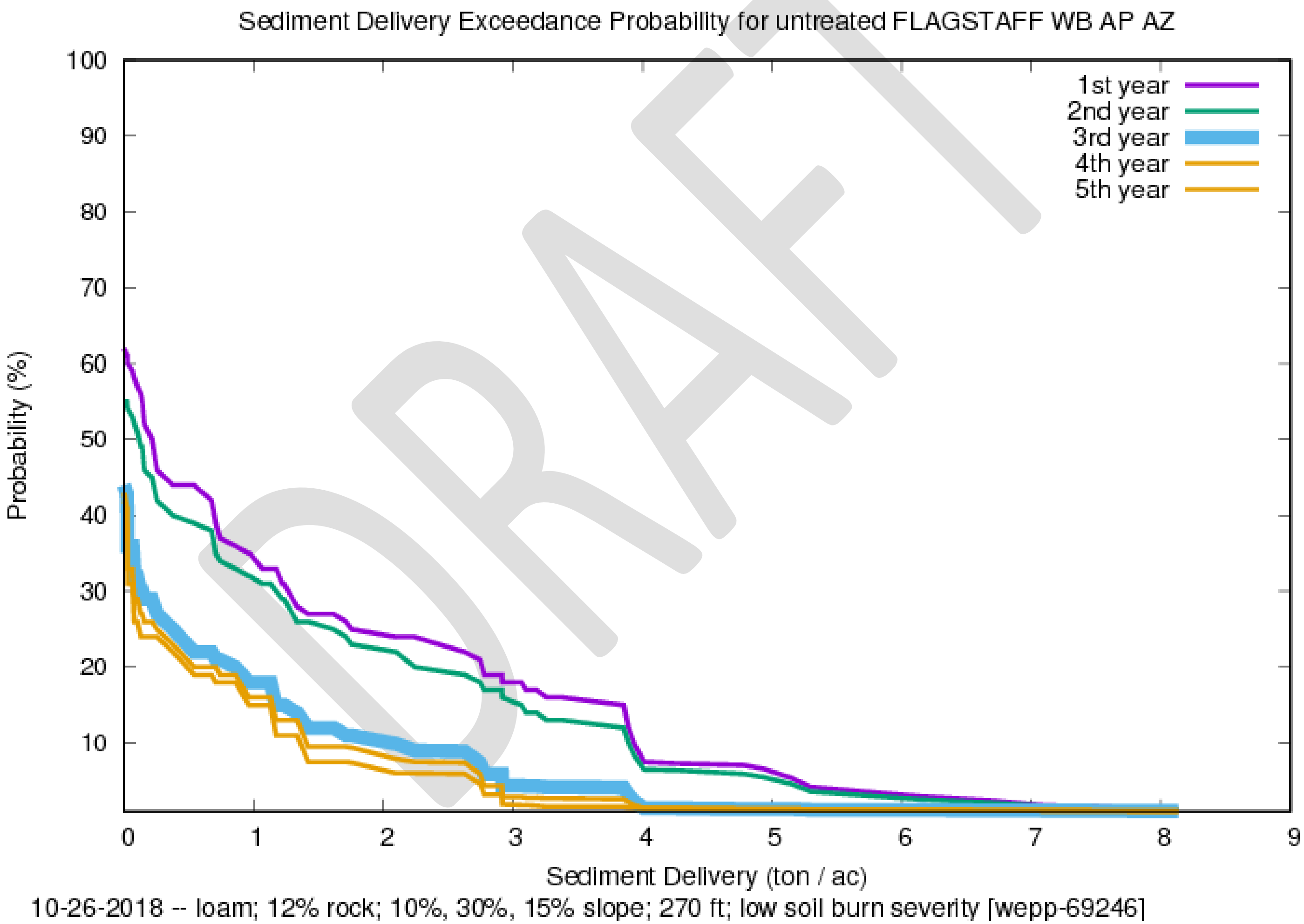
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.6	**in**	annual runoff from rainfall from	593	events
0.38	**in**	annual runoff from snowmelt or winter rainstorm from	144	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.97	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	1.85	4.34	5.92	N/A	N/A	December 2 year 32
10 (10-year)	1.60	4.44	6.01	N/A	N/A	December 7 year 97
20 (5-year)	1.17	1.91	1.81	4.71	3.04	July 19 year 20

50 (2-year)	**0.70**	**1.57**	**3.40**	**3.54**	**2.38**	**September 5 year 31**
75 (1$^1/_3$-year)	**0.43**	**1.18**	**1.22**	**1.88**	**1.49**	**July 6 year 92**



Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	2.76	2.3	0.88	0.68	0.48
Seeding	2.76	0.88	0.68	0.48	0.48
Mulch (0.5 ton ac^{-1})	0.89	0.71	0.88	0.68	0.48
Mulch (1 ton ac^{-1})	0.86	0.53	0.88	0.68	0.48
Mulch (1.5 ton ac^{-1})	0.86	0.5	0.88	0.68	0.48
Mulch (2 ton ac^{-1})	0.86	0.49	0.88	0.68	0.48
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Moderate Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **12%** rock fragment
10% top, 30% average, 15% toe hillslope gradient
270 ft hillslope horizontal length
moderate soil burn severity on forest

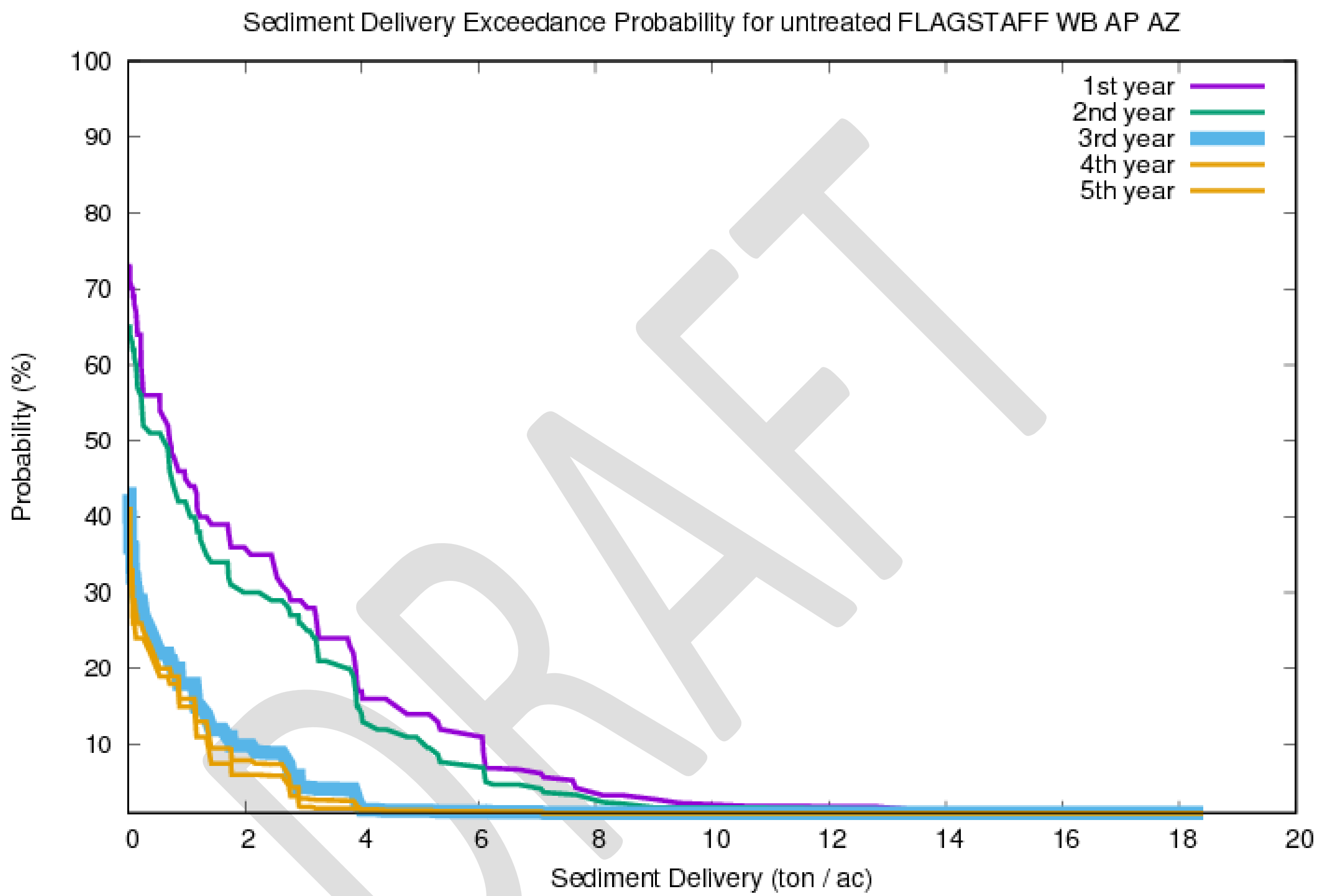
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.6	**in**	annual runoff from rainfall from	593	events
0.38	**in**	annual runoff from snowmelt or winter rainstorm from	144	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.97	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.85**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**

10 (10-year)	**1.60**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
20 (5-year)	**1.17**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.70**	**1.57**	**3.40**	**3.54**	**2.38**	**September 5 year 31**
75 ($1^1/_3$-year)	**0.43**	**1.18**	**1.22**	**1.88**	**1.49**	**July 6 year 92**



10-26-2018 -- loam; 12% rock; 10%, 30%, 15% slope; 270 ft; moderate soil burn severity [wepp-69381]

Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	3.89	3.8	0.88	0.68	0.48
Seeding	3.89	1.35	0.68	0.48	0.48
Mulch (0.5 ton ac^{-1})	1.44	1.17	0.88	0.68	0.48
Mulch (1 ton ac^{-1})	1.16	1.14	0.88	0.68	0.48
Mulch (1.5 ton ac^{-1})	1.15	1.13	0.88	0.68	0.48
Mulch (2 ton ac^{-1})	1.15	0.96	0.88	0.68	0.48
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

High Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **12%** rock fragment
10% top, 30% average, 15% toe hillslope gradient
270 ft hillslope horizontal length
high soil burn severity on forest

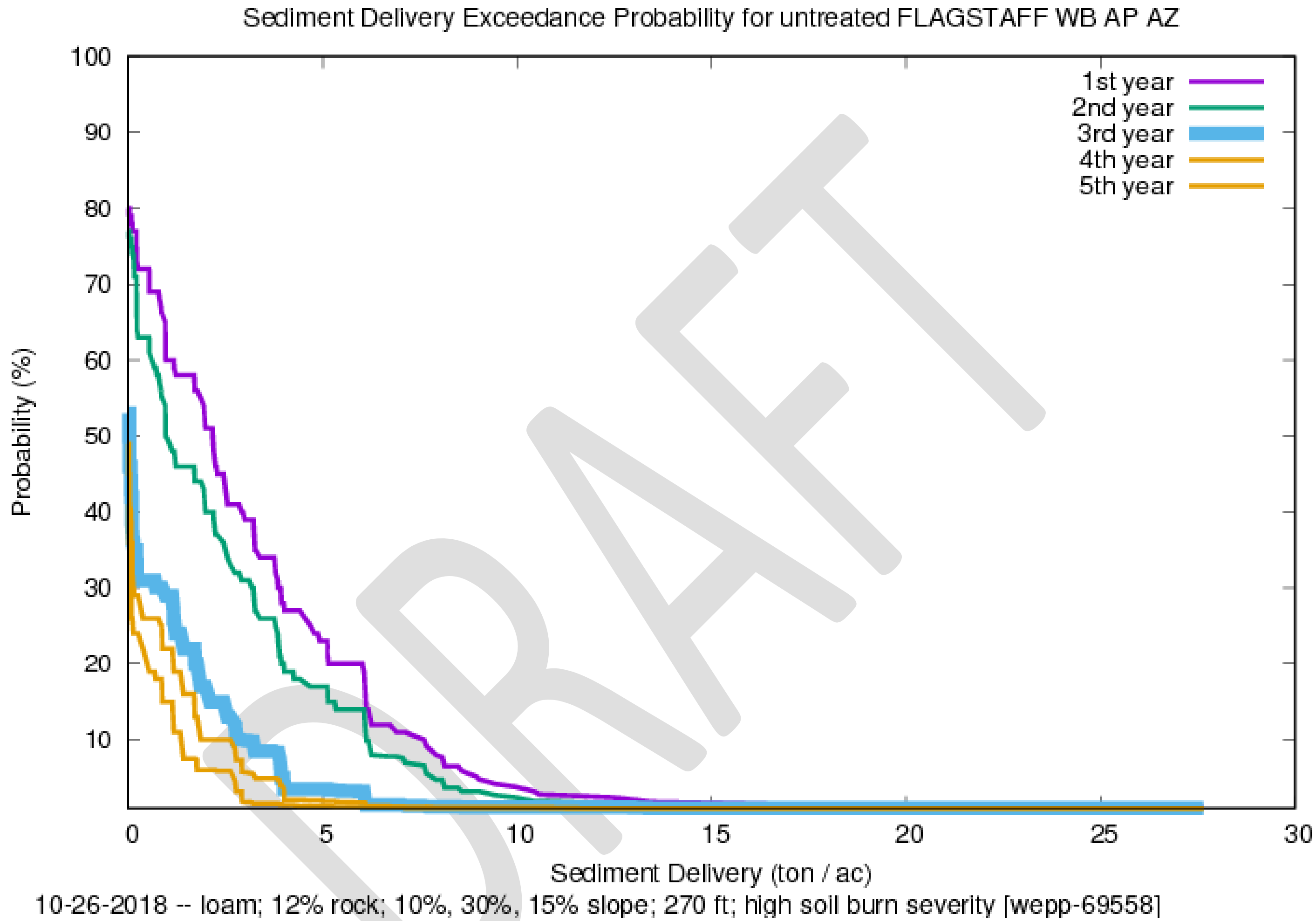
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.6	**in**	annual runoff from rainfall from	593	events
0.38	**in**	annual runoff from snowmelt or winter rainstorm from	144	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.97	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.85**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**
10 (10-year)	**1.60**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**

20 (5-year)	**1.17**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.70**	**1.57**	**3.40**	**3.54**	**2.38**	**September 5 year 31**
75 (1$^{1}/_{3}$-year)	**0.43**	**1.18**	**1.22**	**1.88**	**1.49**	**July 6 year 92**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	5.73	3.98	1.71	1.16	0.48
Seeding	5.73	1.98	1.6	1.13	0.48
Mulch (0.5 ton ac^{-1})	2.02	1.84	1.71	1.16	0.48
Mulch (1 ton ac^{-1})	1.82	1.78	1.71	1.16	0.48
Mulch (1.5 ton ac^{-1})	1.82	1.75	1.71	1.16	0.48
Mulch (2 ton ac^{-1})	1.82	1.72	1.71	1.16	0.48
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Stratum 25

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **25%** rock fragment
10% top, 14% average, 8% toe hillslope gradient
220 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.058	**in**	annual runoff from rainfall from	27	events
0.013	**in**	annual runoff from snowmelt or winter rainstorm from	5	events

21 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date

1	2.31	3.91	4.28	3.63	3.11	September 4 year 68
5 (20-year)	**0.25**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
10 (10-year)	**0.11**	**3.64**	**8.96**	**N/A**	**N/A**	**December 12 year 5**
20 (5-year)	**0.00**	**1.75**	**4.38**	**4.74**	**2.92**	**July 22 year 91**

Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Unburned	0.02	0.02	0.02	0.02	0.02

Return to input screen

Low Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **25%** rock fragment
10% top, 14% average, 8% toe hillslope gradient
220 ft hillslope horizontal length
low soil burn severity on forest

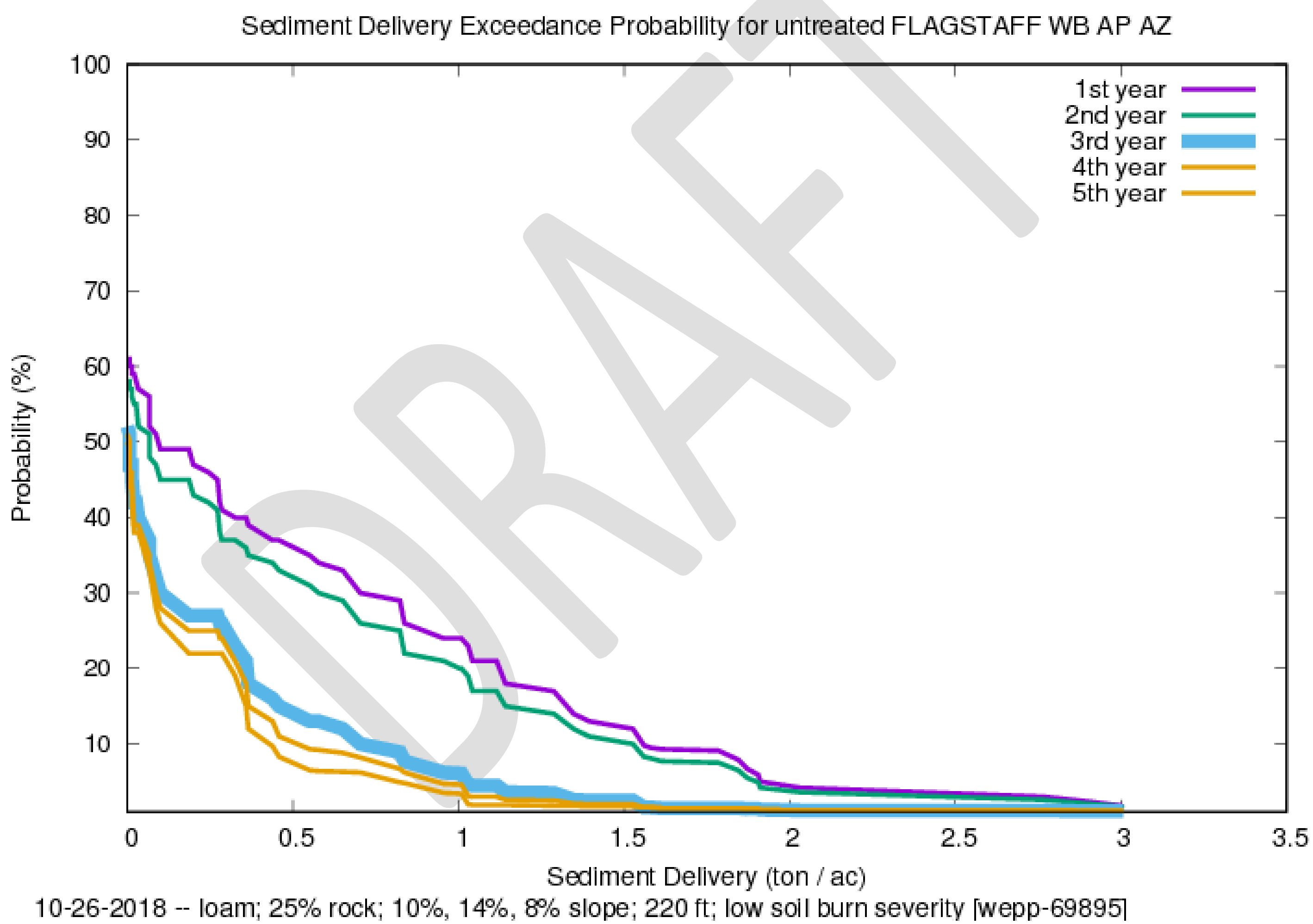
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.6	**in**	annual runoff from rainfall from	614	events
0.41	**in**	annual runoff from snowmelt or winter rainstorm from	160	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.00	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.89**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**
10 (10-year)	**1.70**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
20 (5-year)	**1.13**	**2.06**	**2.13**	**4.70**	**3.14**	**August 8 year 79**

50 (2-year)	**0.74**	**1.56**	**6.97**	**4.73**	**2.74**	**July 22 year 8**
75 ($1^1/_3$-year)	**0.44**	**1.18**	**1.22**	**1.88**	**1.49**	**July 6 year 92**



Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	1.12	1	0.36	0.34	0.31
Seeding	1.12	0.36	0.34	0.31	0.31
Mulch (0.5 ton ac^{-1})	0.33	0.34	0.36	0.34	0.31
Mulch (1 ton ac^{-1})	0.29	0.31	0.36	0.34	0.31
Mulch (1.5 ton ac^{-1})	0.29	0.29	0.36	0.34	0.31
Mulch (2 ton ac^{-1})	0.29	0.29	0.36	0.34	0.31
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Moderate Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **25%** rock fragment
10% top, 14% average, 8% toe hillslope gradient
220 ft hillslope horizontal length
moderate soil burn severity on forest

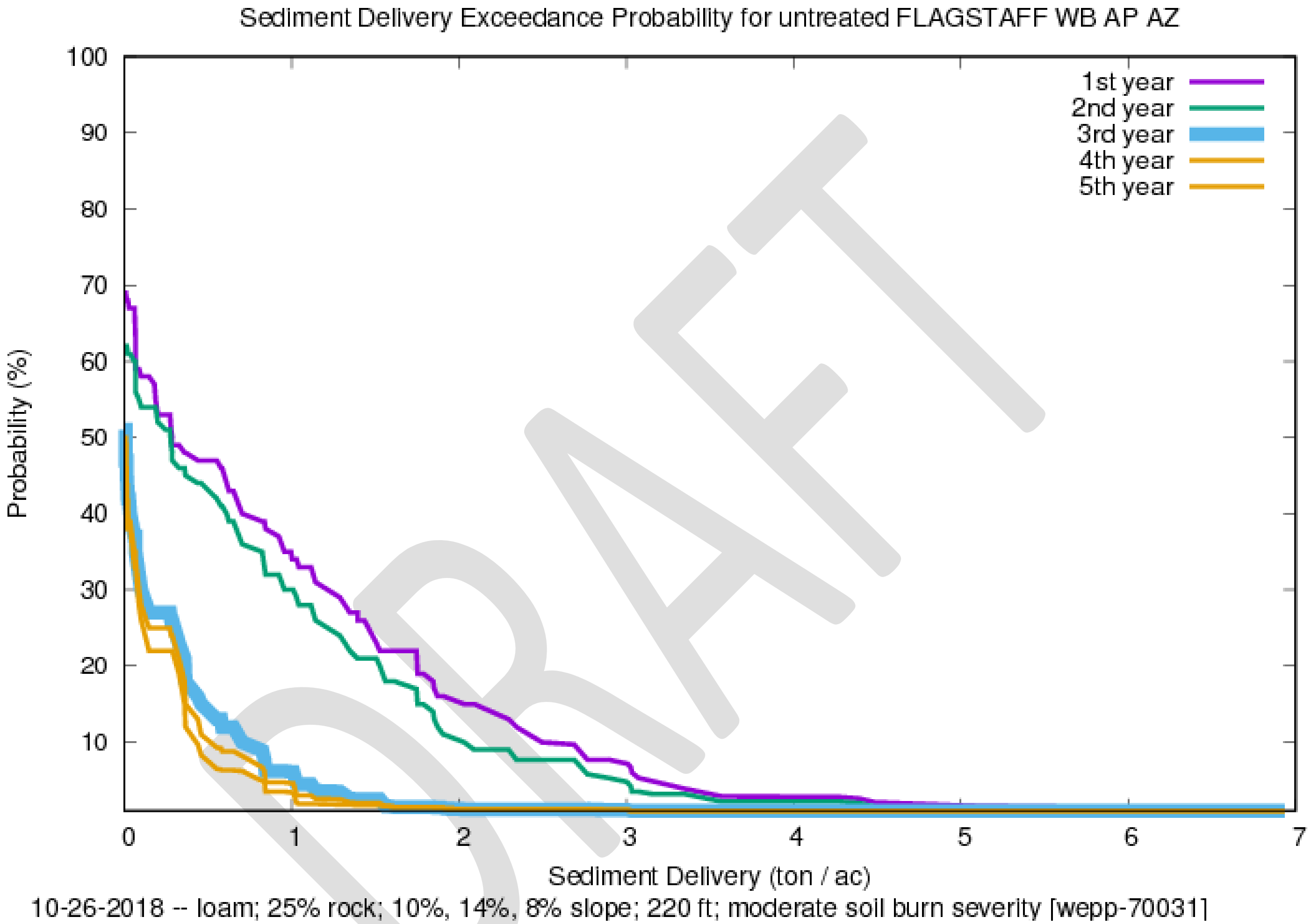
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.6	**in**	annual runoff from rainfall from	614	events
0.41	**in**	annual runoff from snowmelt or winter rainstorm from	160	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.00	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.89**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**

10 (10-year)	**1.70**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
20 (5-year)	**1.13**	**2.06**	**2.13**	**4.70**	**3.14**	**August 8 year 79**
50 (2-year)	**0.74**	**1.56**	**6.97**	**4.73**	**2.74**	**July 22 year 8**
75 (1 1/3-year)	**0.44**	**1.18**	**1.22**	**1.88**	**1.49**	**July 6 year 92**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	1.75	1.52	0.36	0.34	0.31
Seeding	1.75	0.61	0.34	0.31	0.31
Mulch (0.5 ton ac^{-1})	0.48	0.41	0.36	0.34	0.31
Mulch (1 ton ac^{-1})	0.35	0.36	0.36	0.34	0.31
Mulch (1.5 ton ac^{-1})	0.35	0.35	0.36	0.34	0.31
Mulch (2 ton ac^{-1})	0.34	0.34	0.36	0.34	0.31
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

High Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **25%** rock fragment
10% top, 14% average, 8% toe hillslope gradient
220 ft hillslope horizontal length
high soil burn severity on forest

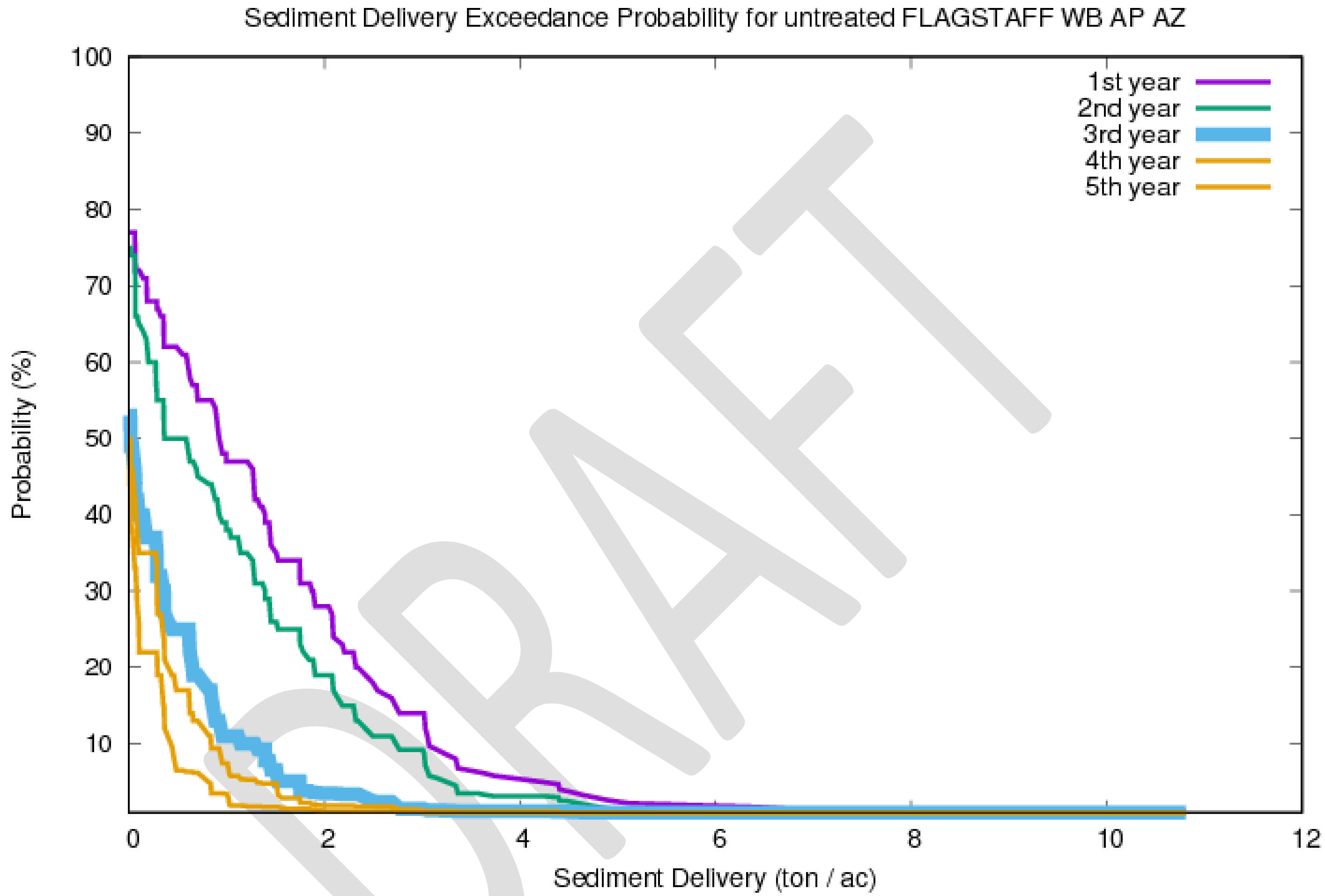
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.6	**in**	annual runoff from rainfall from	614	events
0.41	**in**	annual runoff from snowmelt or winter rainstorm from	160	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.00	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.89**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**
10 (10-year)	**1.70**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**

20 (5-year)	**1.13**	**2.06**	**2.13**	**4.70**	**3.14**	**August 8 year 79**
50 (2-year)	**0.74**	**1.56**	**6.97**	**4.73**	**2.74**	**July 22 year 8**
75 ($1^1/_3$-year)	**0.44**	**1.18**	**1.22**	**1.88**	**1.49**	**July 6 year 92**



10-26-2018 -- loam; 25% rock; 10%, 14%, 8% slope; 220 ft; high soil burn severity [wepp-70205]

Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	2.35	1.89	0.65	0.4	0.31
Seeding	2.35	0.7	0.62	0.36	0.31
Mulch (0.5 ton ac^{-1})	0.67	0.67	0.65	0.4	0.31
Mulch (1 ton ac^{-1})	0.62	0.63	0.65	0.4	0.31
Mulch (1.5 ton ac^{-1})	0.62	0.62	0.65	0.4	0.31
Mulch (2 ton ac^{-1})	0.62	0.62	0.65	0.4	0.31
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Stratum 25

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **25%** rock fragment
10% top, 14% average, 8% toe hillslope gradient
220 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.058	**in**	annual runoff from rainfall from	27	events
0.013	**in**	annual runoff from snowmelt or winter rainstorm from	5	events

21 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.31	3.91	4.28	3.63	3.11	September 4 year 68

5 (20-year)	0.25	1.91	1.81	4.71	3.04	July 19 year 20
10 (10-year)	0.11	3.64	8.96	N/A	N/A	December 12 year 5
20 (5-year)	0.00	1.75	4.38	4.74	2.92	July 22 year 91

Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Unburned	0.02	0.02	0.02	0.02	0.02

Return to input screen

Low Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ

loam soil texture, **25%** rock fragment
10% top, 14% average, 8% toe hillslope gradient
220 ft hillslope horizontal length
low soil burn severity on forest

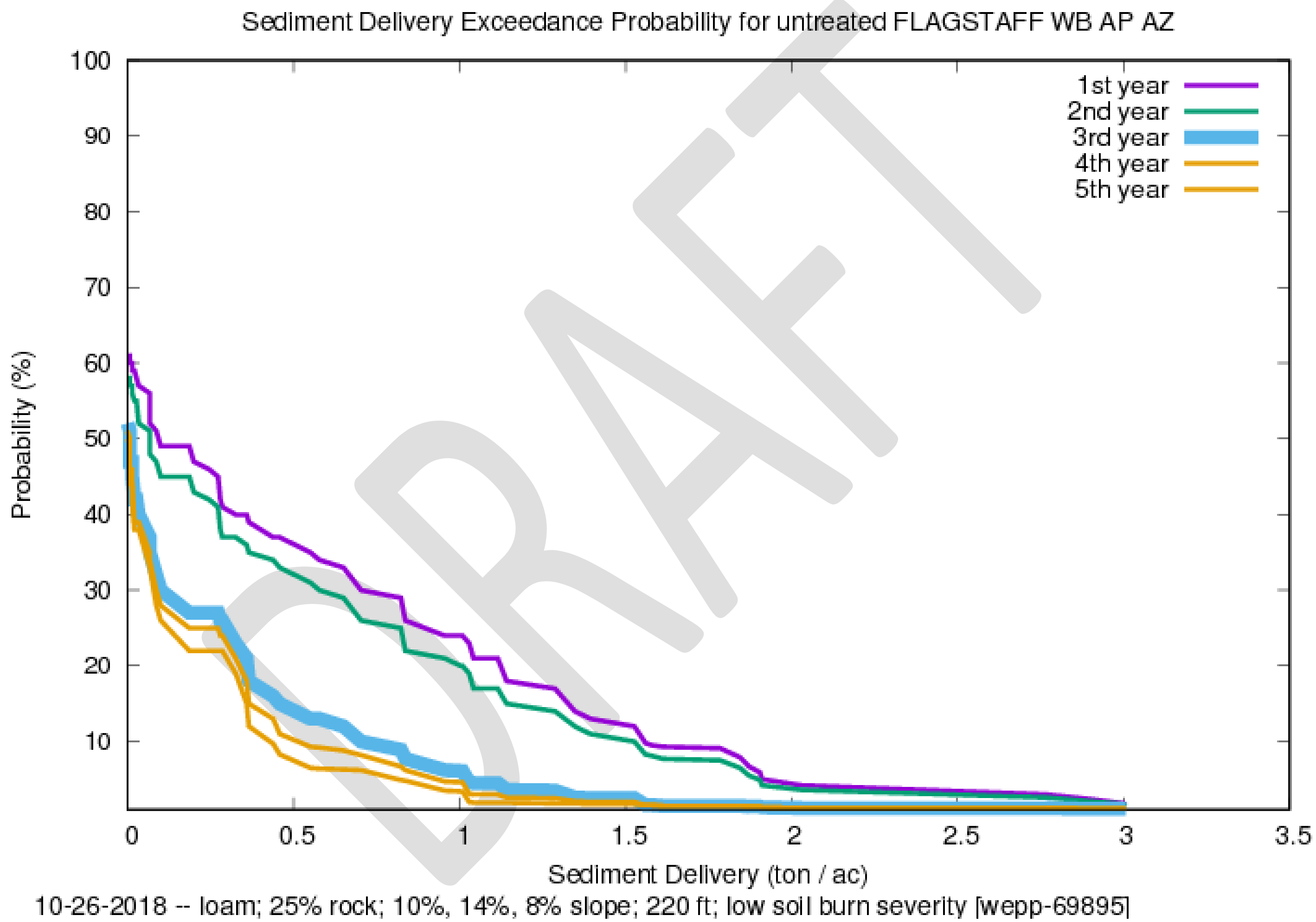
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.6	**in**	annual runoff from rainfall from	614	events
0.41	**in**	annual runoff from snowmelt or winter rainstorm from	160	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.00	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	1.89	4.34	5.92	N/A	N/A	December 2 year 32
10 (10-year)	1.70	4.44	6.01	N/A	N/A	December 7 year 97
20 (5-year)	1.13	2.06	2.13	4.70	3.14	August 8 year 79
50 (2-year)	0.74	1.56	6.97	4.73	2.74	July 22 year 8

75 (1 1/3-year)	0.44	1.18	1.22	1.88	1.49	July 6 year 92



Sediment Delivery

Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	1.12	1	0.36	0.34	0.31
Seeding	1.12	0.36	0.34	0.31	0.31
Mulch (0.5 ton ac^{-1})	0.33	0.34	0.36	0.34	0.31
Mulch (1 ton ac^{-1})	0.29	0.31	0.36	0.34	0.31
Mulch (1.5 ton ac^{-1})	0.29	0.29	0.36	0.34	0.31
Mulch (2 ton ac^{-1})	0.29	0.29	0.36	0.34	0.31
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Moderate Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **25%** rock fragment
10% top, 14% average, 8% toe hillslope gradient
220 ft hillslope horizontal length
moderate soil burn severity on forest

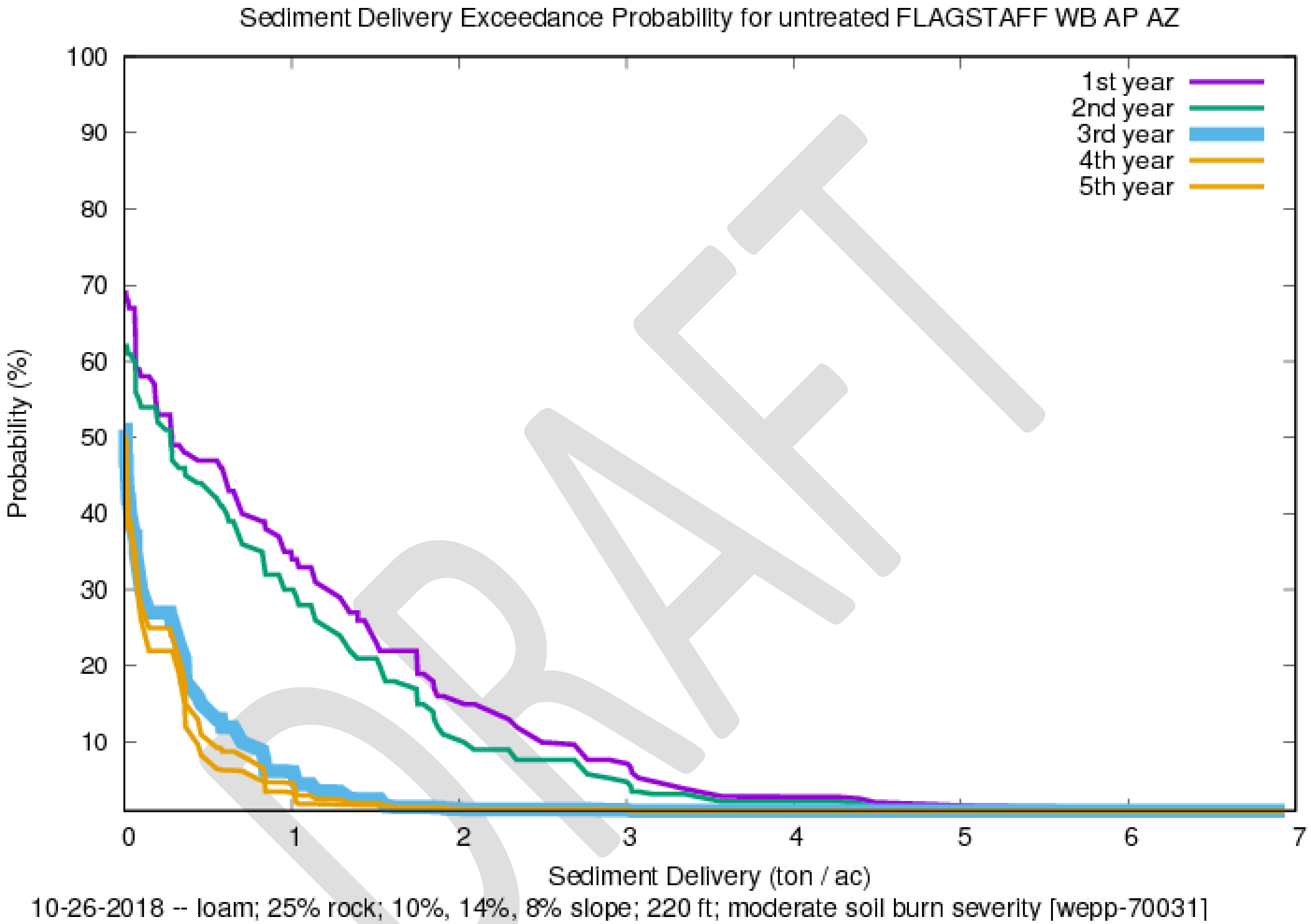
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.6	**in**	annual runoff from rainfall from	614	events
0.41	**in**	annual runoff from snowmelt or winter rainstorm from	160	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.00	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.89**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**

10 (10-year)	**1.70**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
20 (5-year)	**1.13**	**2.06**	**2.13**	**4.70**	**3.14**	**August 8 year 79**
50 (2-year)	**0.74**	**1.56**	**6.97**	**4.73**	**2.74**	**July 22 year 8**
75 ($1^{1}/_{3}$-year)	**0.44**	**1.18**	**1.22**	**1.88**	**1.49**	**July 6 year 92**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	1.75	1.52	0.36	0.34	0.31
Seeding	1.75	0.61	0.34	0.31	0.31
Mulch (0.5 ton ac^{-1})	0.48	0.41	0.36	0.34	0.31
Mulch (1 ton ac^{-1})	0.35	0.36	0.36	0.34	0.31
Mulch (1.5 ton ac^{-1})	0.35	0.35	0.36	0.34	0.31
Mulch (2 ton ac^{-1})	0.34	0.34	0.36	0.34	0.31
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

High Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
loam soil texture, **25%** rock fragment
10% top, 14% average, 8% toe hillslope gradient
220 ft hillslope horizontal length
high soil burn severity on forest

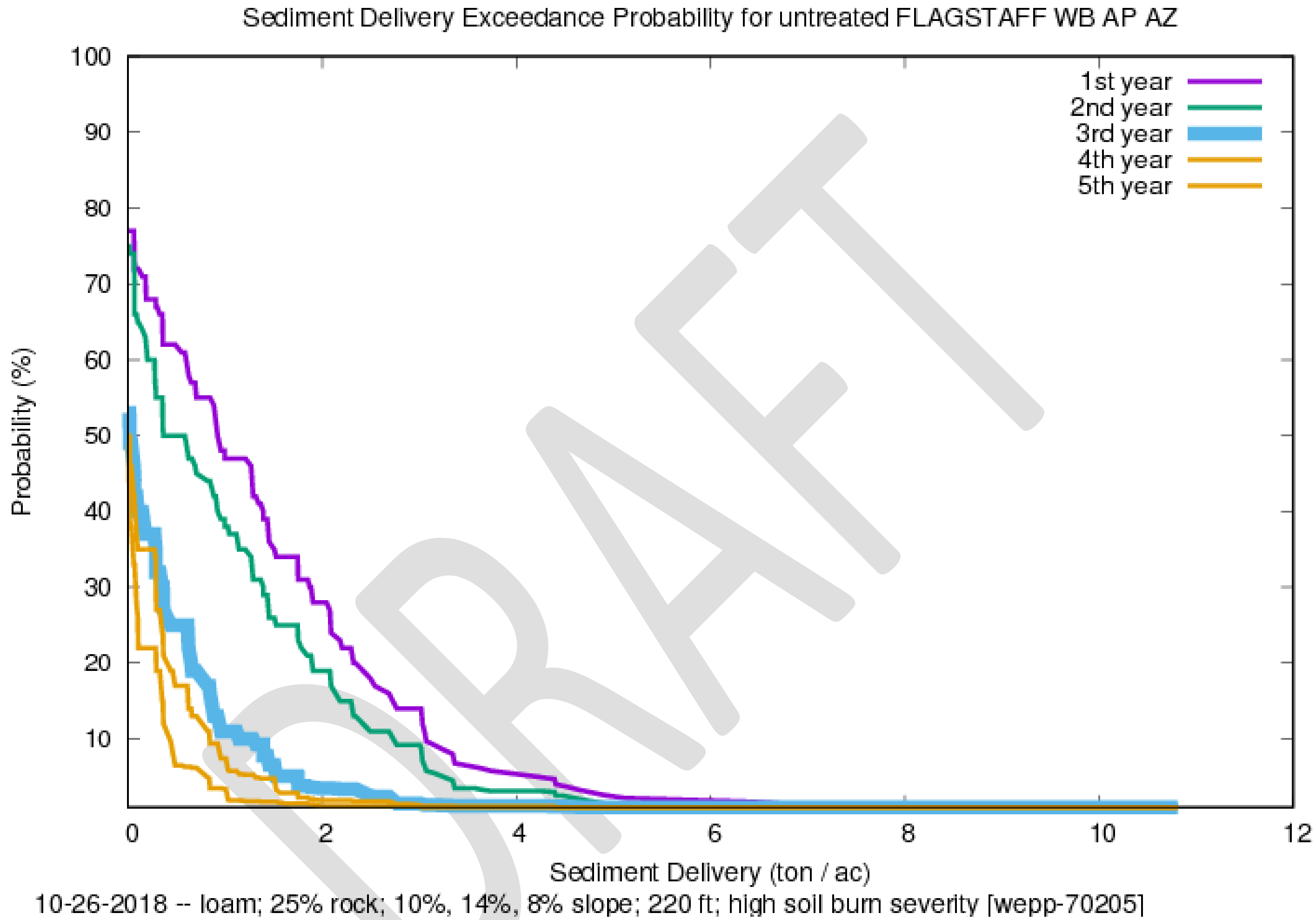
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.6	**in**	annual runoff from rainfall from	614	events
0.41	**in**	annual runoff from snowmelt or winter rainstorm from	160	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.00	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.89**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**
10 (10-year)	**1.70**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**

20 (5-year)	**1.13**	**2.06**	**2.13**	**4.70**	**3.14**	**August 8 year 79**
50 (2-year)	**0.74**	**1.56**	**6.97**	**4.73**	**2.74**	**July 22 year 8**
75 ($1^{1}/_{3}$-year)	**0.44**	**1.18**	**1.22**	**1.88**	**1.49**	**July 6 year 92**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	2.35	1.89	0.65	0.4	0.31
Seeding	2.35	0.7	0.62	0.36	0.31
Mulch (0.5 ton ac^{-1})	0.67	0.67	0.65	0.4	0.31
Mulch (1 ton ac^{-1})	0.62	0.63	0.65	0.4	0.31
Mulch (1.5 ton ac^{-1})	0.62	0.62	0.65	0.4	0.31
Mulch (2 ton ac^{-1})	0.62	0.62	0.65	0.4	0.31
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Stratum 27

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **26%** rock fragment
9% top, 14% average, 11% toe hillslope gradient
275 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.028	**in**	annual runoff from rainfall from	12	events
0.0039	**in**	annual runoff from snowmelt or winter rainstorm from	1	events

9 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date

1	1.91	3.91	4.28	3.63	3.11	September 4 year 68
5 (20-year)	**0.03**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**

Sediment Delivery					
Probability that sediment yield will be exceeded	Event sediment delivery (ton ac^{-1})				
	Year following fire				
20 % go	1st year	2nd year	3rd year	4th year	5th year
Unburned	0.01	0.01	0.01	0.01	0.01

Return to input screen

ERMiT Version 2015.05.03

Low Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **26%** rock fragment
9% top, 14% average, 11% toe hillslope gradient
275 ft hillslope horizontal length
low soil burn severity on forest

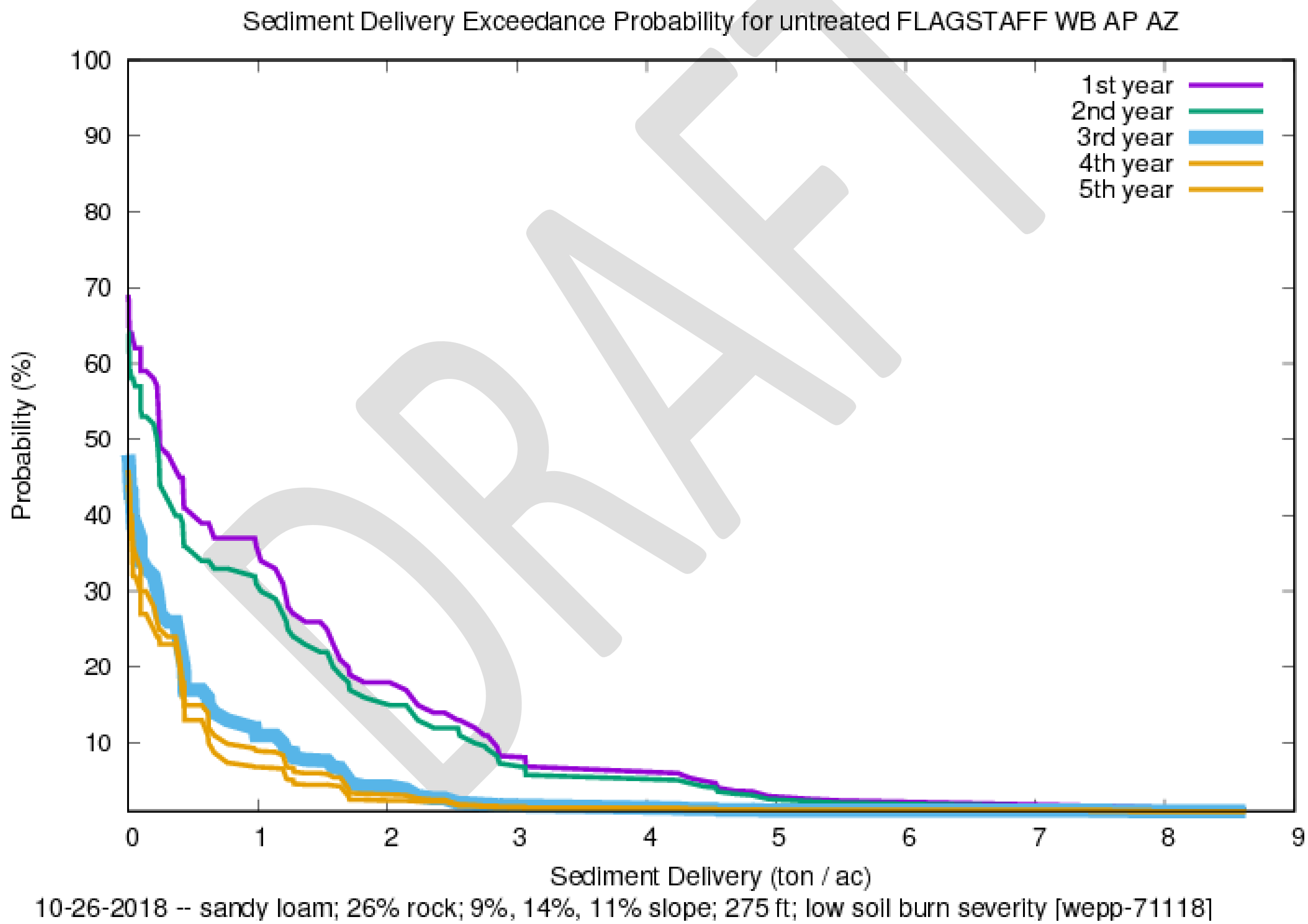
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.4	**in**	annual runoff from rainfall from	554	events
0.27	**in**	annual runoff from snowmelt or winter rainstorm from	112	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.93	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	1.79	2.91	4.51	4.42	3.40	September 13 year 27
10 (10-year)	1.46	4.44	6.01	N/A	N/A	December 7 year 97
20 (5-year)	1.09	2.06	2.13	4.70	3.14	August 8 year 79

50 (2-year)	**0.66**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**
75 ($1^{1}/_{3}$-year)	**0.35**	**1.00**	**2.45**	**2.92**	**1.73**	**September 28 year 63**



Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	1.69	1.58	0.43	0.41	0.4
Seeding	1.69	0.43	0.41	0.4	0.4
Mulch (0.5 ton ac^{-1})	0.42	0.41	0.43	0.41	0.4
Mulch (1 ton ac^{-1})	0.4	0.4	0.43	0.41	0.4
Mulch (1.5 ton ac^{-1})	0.4	0.4	0.43	0.41	0.4
Mulch (2 ton ac^{-1})	0.4	0.4	0.43	0.41	0.4
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Moderate Burn Severity

Erosion Risk Management Tool

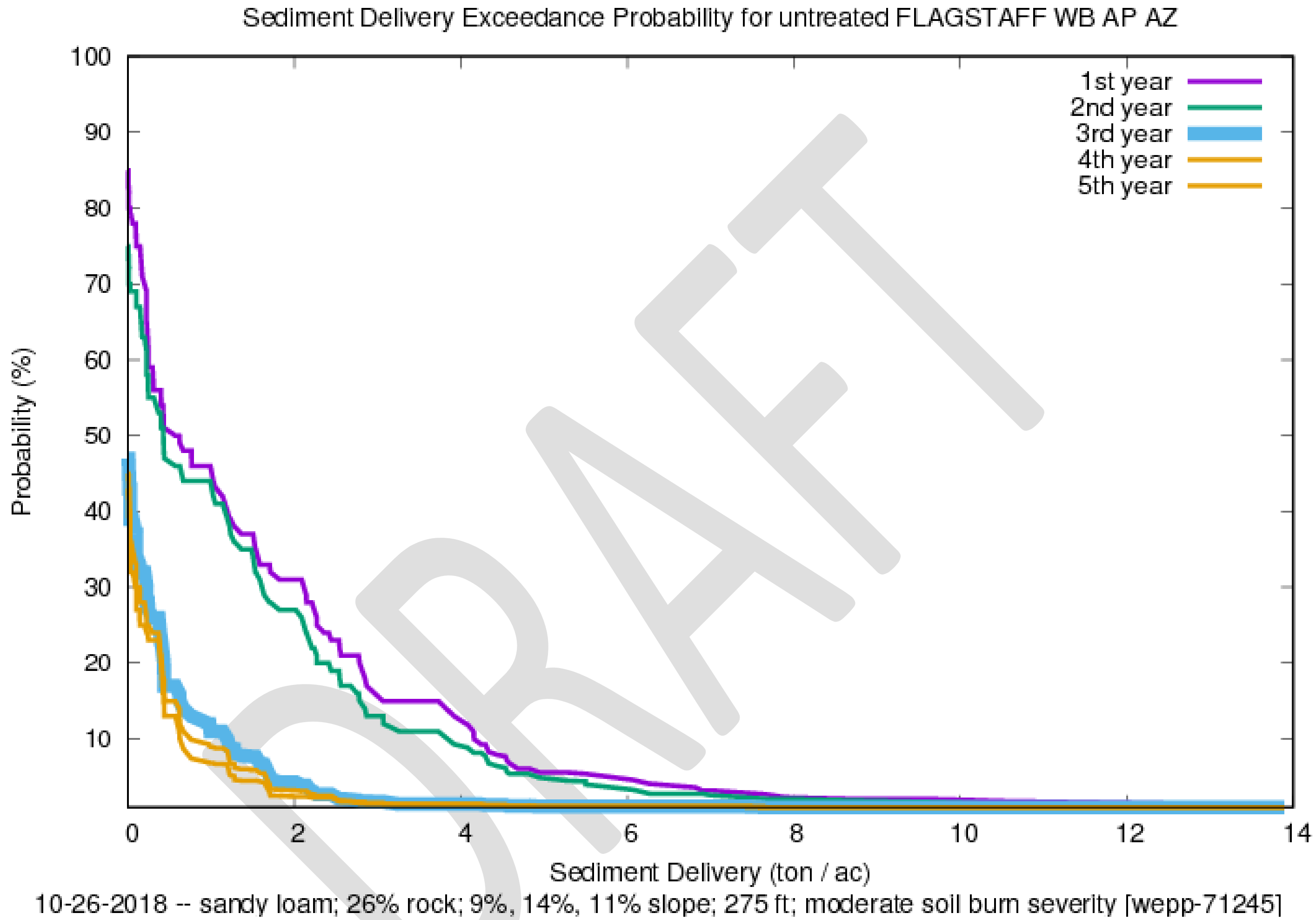
FLAGSTAFF WB AP AZ
sandy loam soil texture, **26%** rock fragment
9% top, 14% average, 11% toe hillslope gradient
275 ft hillslope horizontal length
moderate soil burn severity on forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.4	**in**	annual runoff from rainfall from	554	events
0.27	**in**	annual runoff from snowmelt or winter rainstorm from	112	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.93	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.79**	**2.91**	**4.51**	**4.42**	**3.40**	**September 13 year 27**

10 (10-year)	**1.46**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**
20 (5-year)	**1.09**	**2.06**	**2.13**	**4.70**	**3.14**	**August 8 year 79**
50 (2-year)	**0.66**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**
75 ($1^{1}/_{3}$-year)	**0.35**	**1.00**	**2.45**	**2.92**	**1.73**	**September 28 year 63**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	2.78	2.42	0.43	0.41	0.4
Seeding	2.78	1	0.41	0.4	0.4
Mulch (0.5 ton ac^{-1})	0.98	0.63	0.43	0.41	0.4
Mulch (1 ton ac^{-1})	0.62	0.58	0.43	0.41	0.4
Mulch (1.5 ton ac^{-1})	0.62	0.43	0.43	0.41	0.4
Mulch (2 ton ac^{-1})	0.62	0.43	0.43	0.41	0.4
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

High Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **26%** rock fragment
9% top, 14% average, 11% toe hillslope gradient
275 ft hillslope horizontal length
high soil burn severity on forest

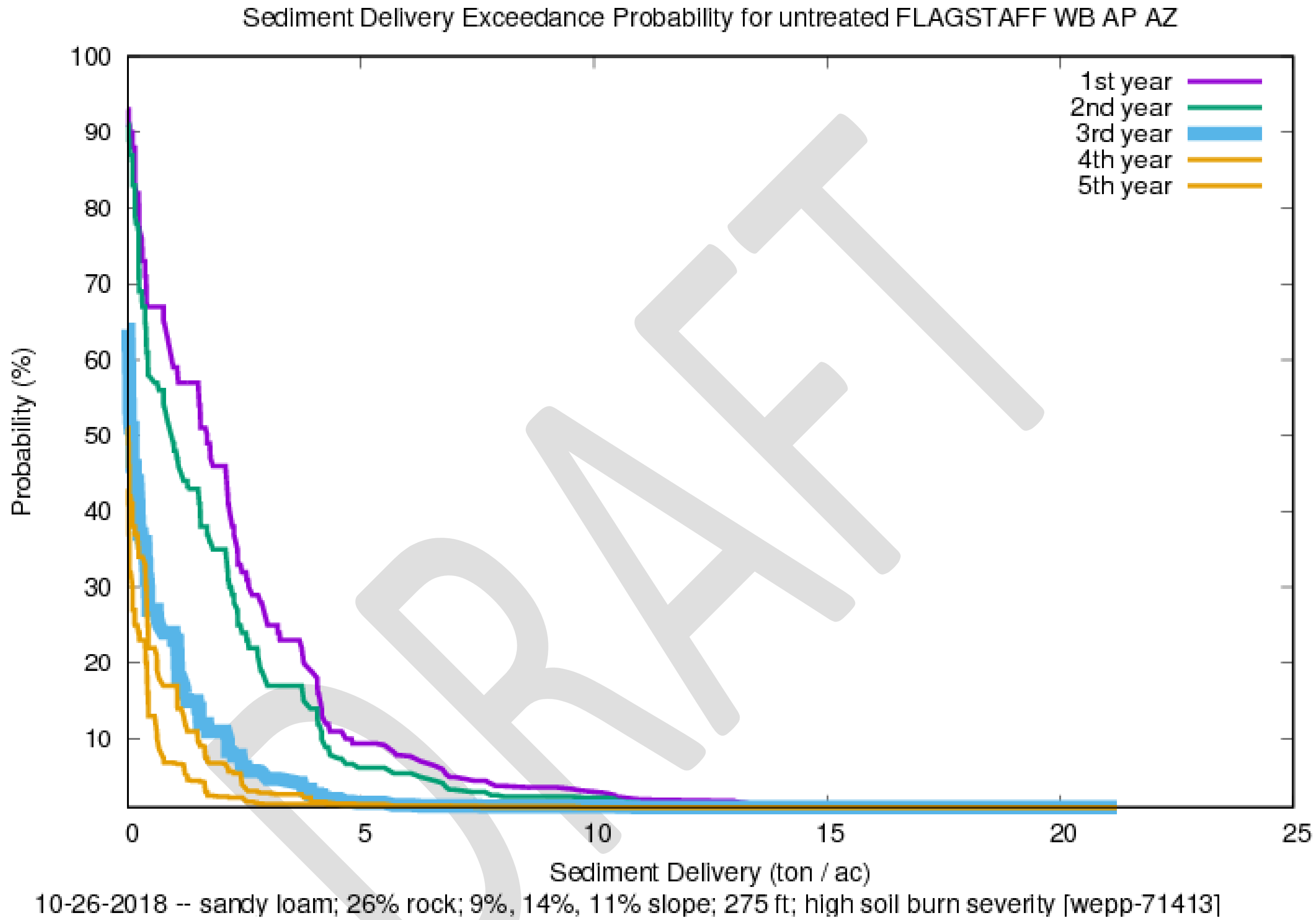
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.4	**in**	annual runoff from rainfall from	554	events
0.27	**in**	annual runoff from snowmelt or winter rainstorm from	112	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.93	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.79**	**2.91**	**4.51**	**4.42**	**3.40**	**September 13 year 27**
10 (10-year)	**1.46**	**4.44**	**6.01**	**N/A**	**N/A**	**December 7 year 97**

20 (5-year)	**1.09**	**2.06**	**2.13**	**4.70**	**3.14**	**August 8 year 79**
50 (2-year)	**0.66**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**
75 (1 1/3-year)	**0.35**	**1.00**	**2.45**	**2.92**	**1.73**	**September 28 year 63**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	3.77	2.82	1.09	0.62	0.4
Seeding	3.77	1.22	1.05	0.43	0.4
Mulch (0.5 ton ac^{-1})	1.48	1.09	1.09	0.62	0.4
Mulch (1 ton ac^{-1})	1.08	1.07	1.09	0.62	0.4
Mulch (1.5 ton ac^{-1})	1.07	1.07	1.09	0.62	0.4
Mulch (2 ton ac^{-1})	1.07	1.06	1.09	0.62	0.4
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Stratum 28

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **20%** rock fragment
10% top, 27% average, 18% toe hillslope gradient
300 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.028	**in**	annual runoff from rainfall from	10	events
0.0043	**in**	annual runoff from snowmelt or winter rainstorm from	1	events

7 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	1.96	3.91	4.28	3.63	3.11	September 4 year 68

5 (20-year)	0.04	1.91	1.81	4.71	3.04	July 19 year 20

Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Unburned	0.03	0.03	0.03	0.03	0.03

Return to input screen

ERMiT Version 2015.05.03

Low Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ

sandy loam soil texture, **20%** rock fragment
10% top, 27% average, 18% toe hillslope gradient
300 ft hillslope horizontal length
low soil burn severity on forest

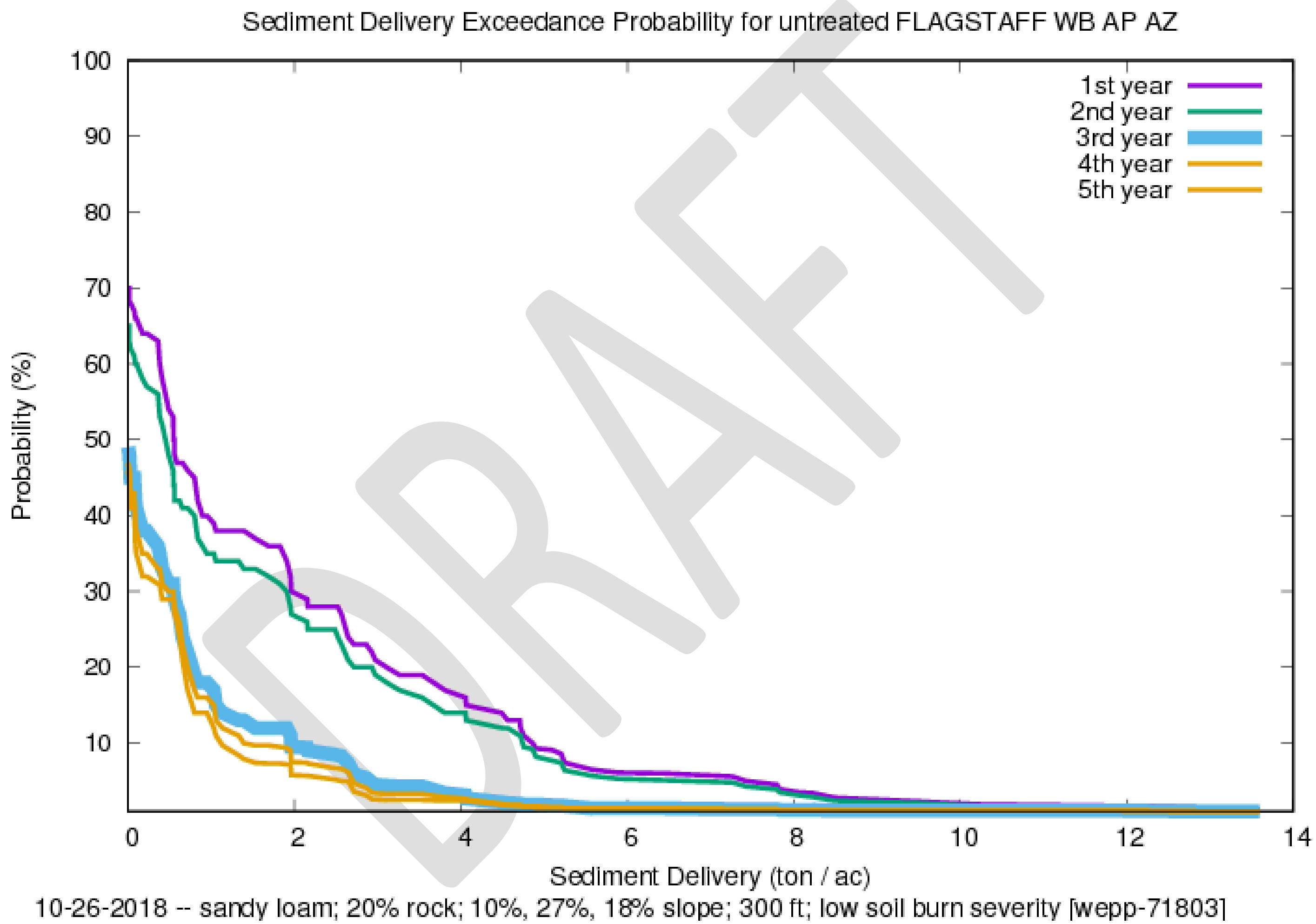
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.4	**in**	annual runoff from rainfall from	548	events
0.28	**in**	annual runoff from snowmelt or winter rainstorm from	110	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.91	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.78**	**2.91**	**4.51**	**4.42**	**3.40**	**September 13 year 27**
10 (10-year)	**1.44**	**2.50**	**5.67**	**3.27**	**2.61**	**September 29 year 26**
20 (5-year)	**1.08**	**2.06**	**2.13**	**4.70**	**3.14**	**August 8 year 79**
50 (2-year)	**0.65**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**

75 (1 1/3-year)	0.35	1.12	1.54	2.01	1.49	July 4 year 40



Sediment Delivery

Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	3.07	2.86	0.78	0.71	0.67
Seeding	3.07	0.78	0.71	0.67	0.67
Mulch (0.5 ton ac^{-1})	0.73	0.71	0.78	0.71	0.67
Mulch (1 ton ac^{-1})	0.67	0.68	0.78	0.71	0.67
Mulch (1.5 ton ac^{-1})	0.67	0.66	0.78	0.71	0.67
Mulch (2 ton ac^{-1})	0.67	0.66	0.78	0.71	0.67
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Citation:

Moderate Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **20%** rock fragment
10% top, 27% average, 18% toe hillslope gradient
300 ft hillslope horizontal length
moderate soil burn severity on forest

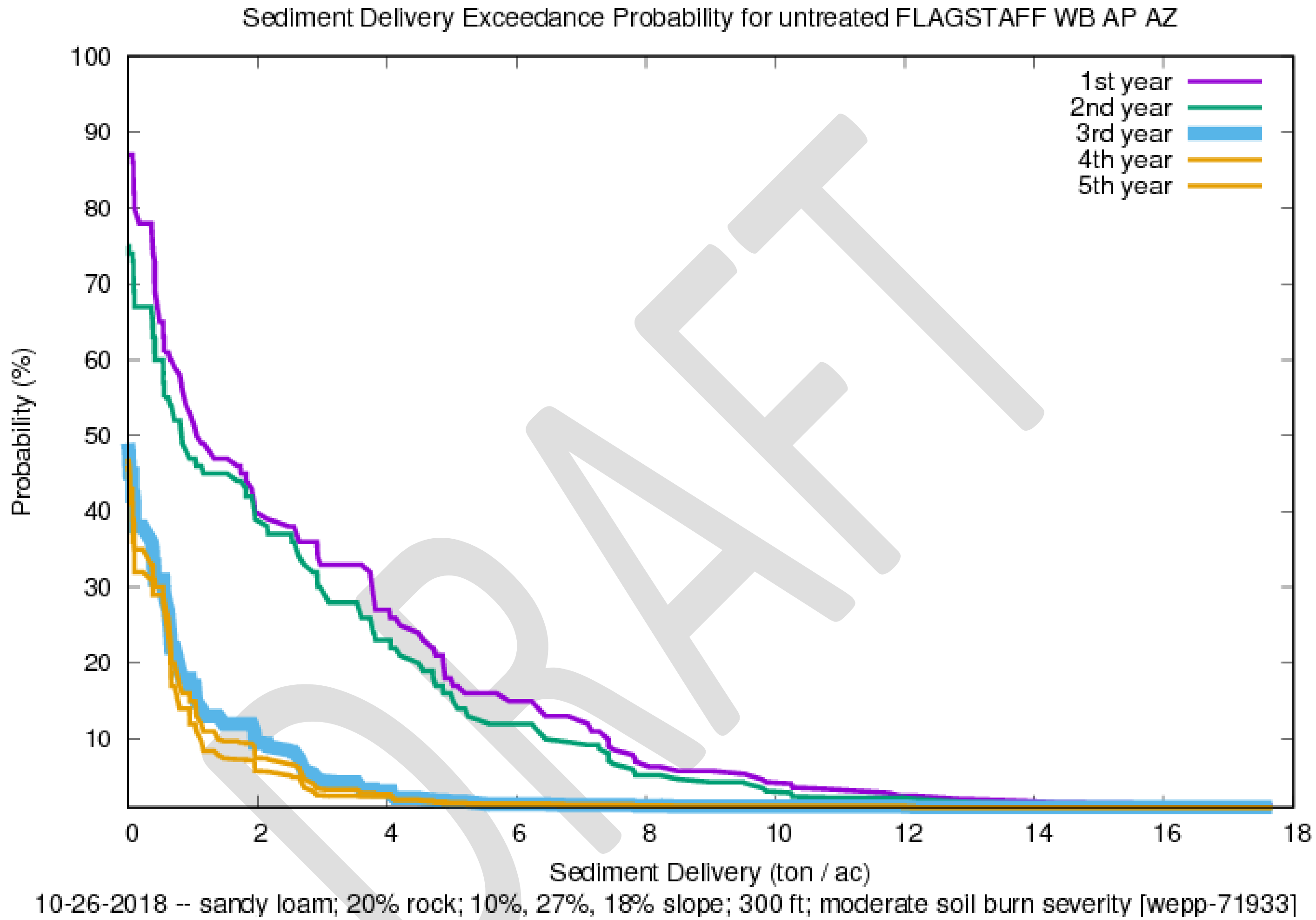
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.4	**in**	annual runoff from rainfall from	548	events
0.28	**in**	annual runoff from snowmelt or winter rainstorm from	110	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.91	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.78**	**2.91**	**4.51**	**4.42**	**3.40**	**September 13 year 27**
10 (10-year)	**1.44**	**2.50**	**5.67**	**3.27**	**2.61**	**September 29 year 26**

20 (5-year)	**1.08**	**2.06**	**2.13**	**4.70**	**3.14**	**August 8 year 79**
50 (2-year)	**0.65**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**
75 ($1^1/_3$-year)	**0.35**	**1.12**	**1.54**	**2.01**	**1.49**	**July 4 year 40**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	4.89	4.46	0.78	0.71	0.67
Seeding	4.89	1.81	0.71	0.67	0.67
Mulch (0.5 ton ac^{-1})	1.74	1.43	0.78	0.71	0.67
Mulch (1 ton ac^{-1})	1.5	1.07	0.78	0.71	0.67
Mulch (1.5 ton ac^{-1})	1.49	1.01	0.78	0.71	0.67
Mulch (2 ton ac^{-1})	1.48	0.99	0.78	0.71	0.67
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

High Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **20%** rock fragment
10% top, 27% average, 18% toe hillslope gradient
300 ft hillslope horizontal length
high soil burn severity on forest

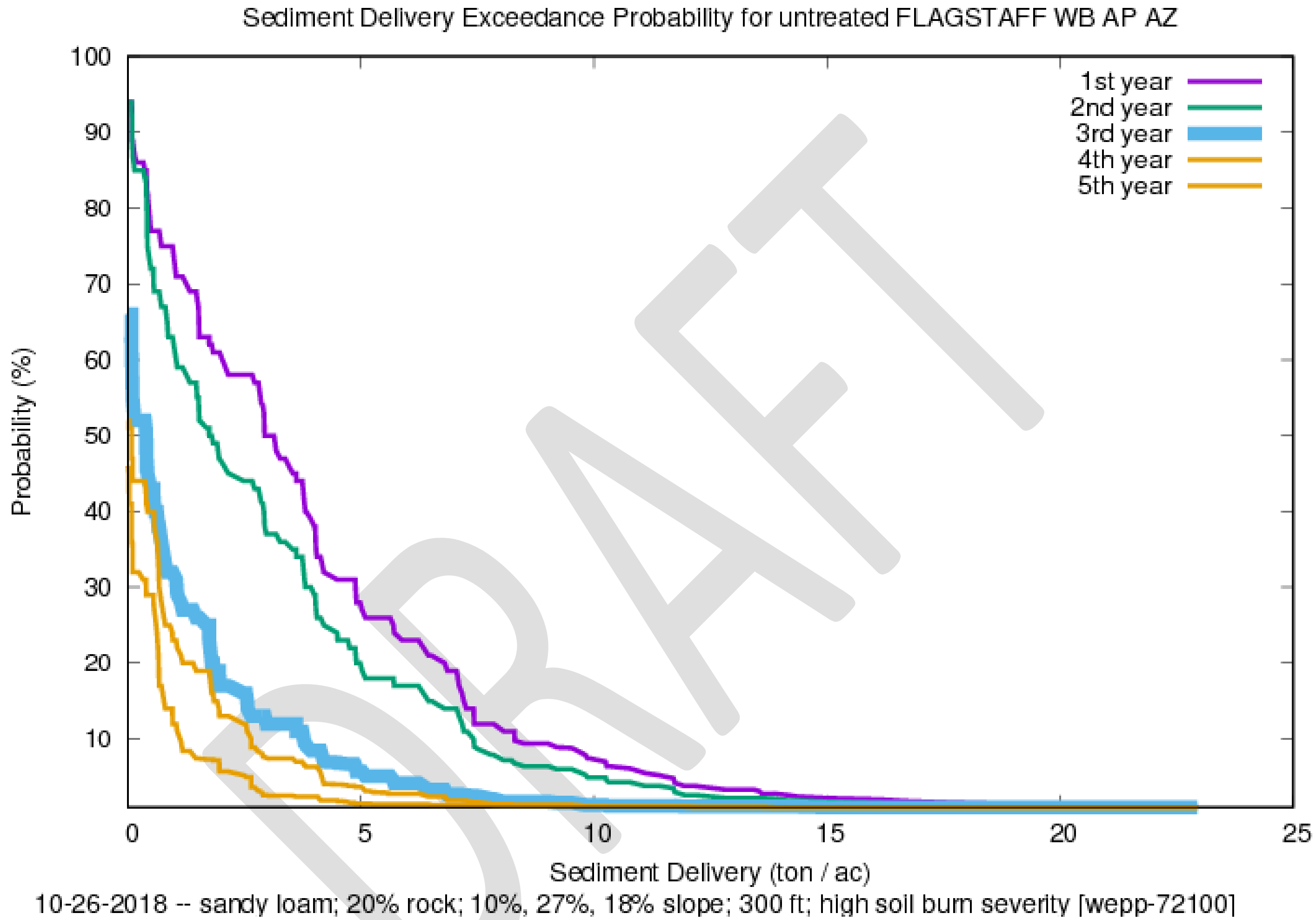
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.4	**in**	annual runoff from rainfall from	548	events
0.28	**in**	annual runoff from snowmelt or winter rainstorm from	110	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.91	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.78**	**2.91**	**4.51**	**4.42**	**3.40**	**September 13 year 27**
10 (10-year)	**1.44**	**2.50**	**5.67**	**3.27**	**2.61**	**September 29 year 26**

20 (5-year)	**1.08**	**2.06**	**2.13**	**4.70**	**3.14**	**August 8 year 79**
50 (2-year)	**0.65**	**1.47**	**3.72**	**2.66**	**1.94**	**September 15 year 76**
75 ($1^1/_3$-year)	**0.35**	**1.12**	**1.54**	**2.01**	**1.49**	**July 4 year 40**



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<tr><th rowspan="3">Probability that sediment yield</th><th colspan="5">Event sediment delivery (ton ac^{-1})</th></tr>
<tr><th colspan="5">Year following fire</th></tr>
<tr><th>1st year</th><th>2nd year</th><th>3rd year</th><th>4th year</th><th>5th year</th></tr>
</table>

will be exceeded 20 % go					
Untreated	6.68	4.98	1.86	1.29	0.67
Seeding	6.68	2.55	1.74	1.05	0.67
Mulch (0.5 ton ac^{-1})	2.59	1.86	1.86	1.29	0.67
Mulch (1 ton ac^{-1})	1.82	1.81	1.86	1.29	0.67
Mulch (1.5 ton ac^{-1})	1.82	1.8	1.86	1.29	0.67
Mulch (2 ton ac^{-1})	1.81	1.79	1.86	1.29	0.67
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Stratum 29

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **47%** rock fragment
65% top, 90% average, 55% toe hillslope gradient
300 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.024	**in**	annual runoff from rainfall from	12	events
0.0043	**in**	annual runoff from snowmelt or winter rainstorm from	2	events

10 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	1.63	3.91	4.28	3.63	3.11	September 4 year 68

5 (20-year)	0.17	1.91	1.81	4.71	3.04	July 19 year 20
10 (10-year)	0.00	1.65	6.13	4.16	2.66	August 7 year 97

Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Unburned	0.02	0.02	0.02	0.02	0.02

Return to input screen

ERMiT Version 2015.05.03

Low Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **47%** rock fragment

65% top, 90% average, 55% toe hillslope gradient
300 ft hillslope horizontal length
low soil burn severity on forest

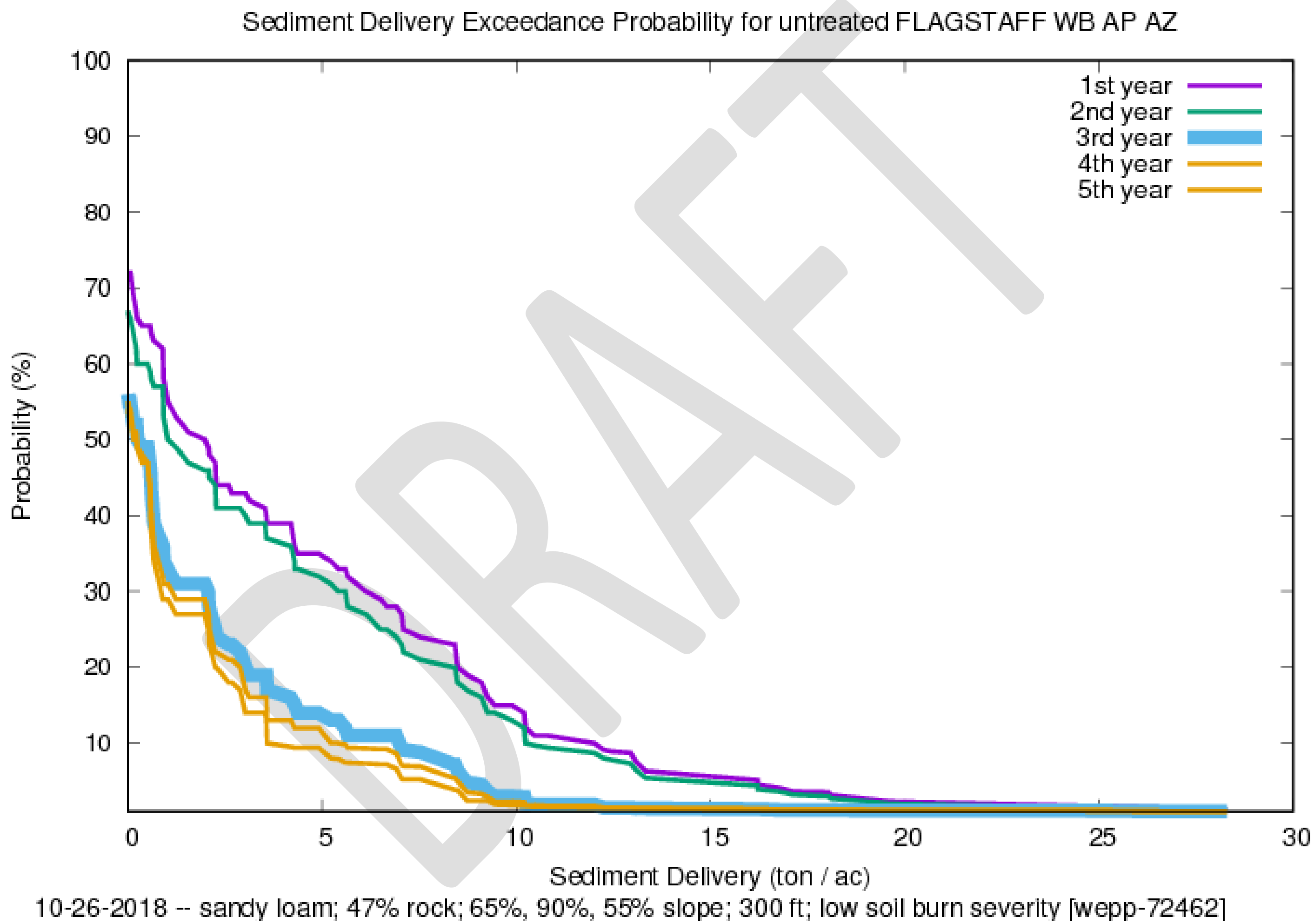
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.7	**in**	annual runoff from rainfall from	614	events
0.34	**in**	annual runoff from snowmelt or winter rainstorm from	124	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.98	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.84**	**2.91**	**4.51**	**4.42**	**3.40**	**September 13 year 27**
10 (10-year)	**1.55**	**2.78**	**2.87**	**4.81**	**3.56**	**December 7 year 84**
20 (5-year)	**1.17**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.71**	**1.57**	**3.40**	**3.54**	**2.38**	**September 5 year 31**

75 (1 1/3-year)	0.41	1.26	3.29	1.55	1.26	August 29 year 43



Sediment Delivery

Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	8.57	8.39	3	2.8	2.24
Seeding	8.57	3	2.8	2.24	2.24
Mulch (0.5 ton ac^{-1})	2.8	2.88	3	2.8	2.24
Mulch (1 ton ac^{-1})	2.24	2.38	3	2.8	2.24
Mulch (1.5 ton ac^{-1})	2.23	2.24	3	2.8	2.24
Mulch (2 ton ac^{-1})	2.22	2.22	3	2.8	2.24
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

ERMiT Version 2015.05.03

Moderate Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **47%** rock fragment
65% top, 90% average, 55% toe hillslope gradient
300 ft hillslope horizontal length
moderate soil burn severity on forest

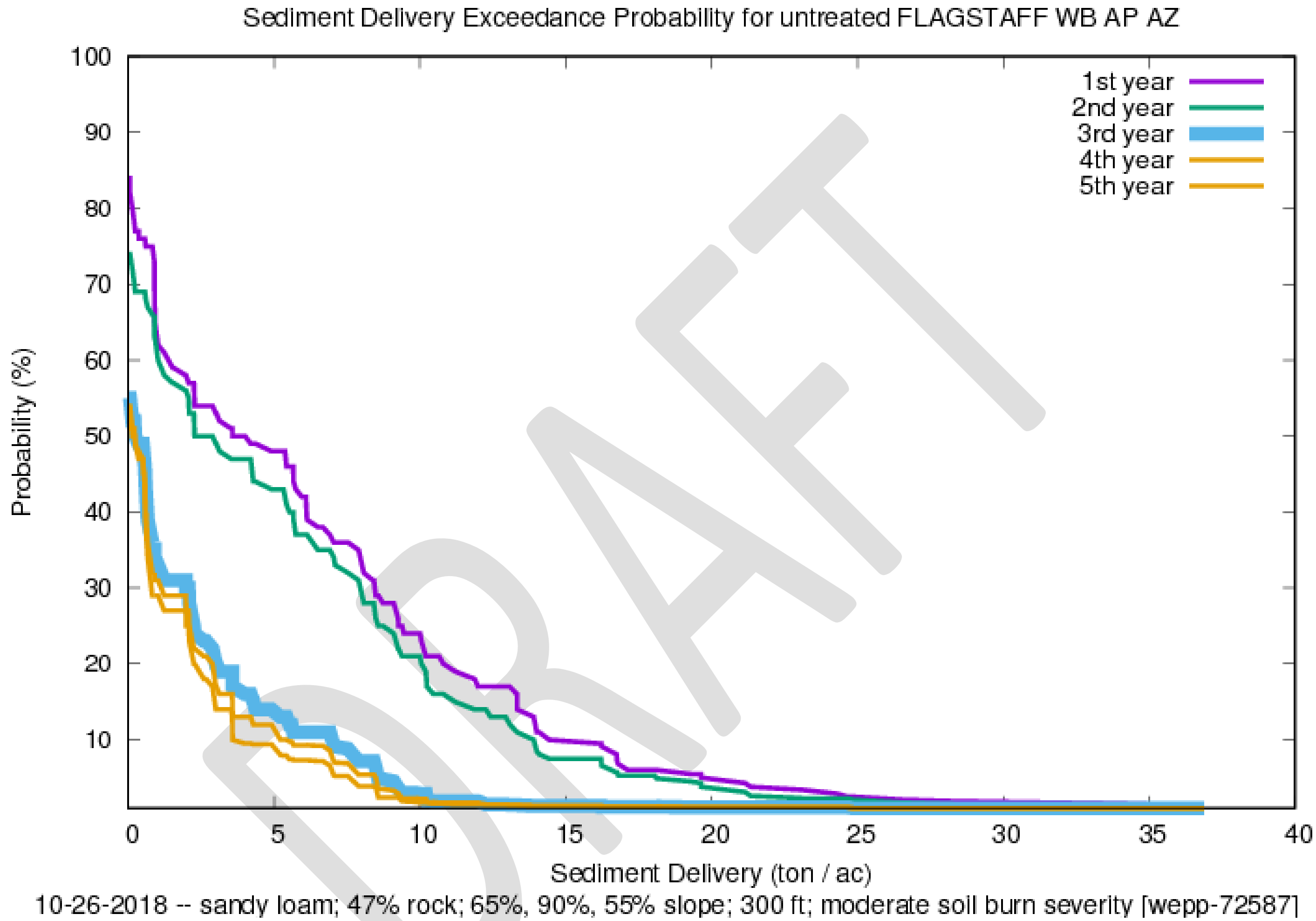
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.7	**in**	annual runoff from rainfall from	614	events
0.34	**in**	annual runoff from snowmelt or winter rainstorm from	124	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.98	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.84**	**2.91**	**4.51**	**4.42**	**3.40**	**September 13 year 27**

10 (10-year)	**1.55**	**2.78**	**2.87**	**4.81**	**3.56**	**December 7 year 84**
20 (5-year)	**1.17**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.71**	**1.57**	**3.40**	**3.54**	**2.38**	**September 5 year 31**
75 (1 1/3-year)	**0.41**	**1.26**	**3.29**	**1.55**	**1.26**	**August 29 year 43**



Sediment Delivery					
Probability that sediment yield	**Event sediment delivery (ton ac^{-1})**				
	Year following fire				
	1st year	**2nd year**	**3rd year**	**4th year**	**5th year**

will be exceeded 20 % go					
Untreated	10.73	10.04	3	2.8	2.24
Seeding	10.73	5.38	2.8	2.24	2.24
Mulch (0.5 ton ac^{-1})	5.36	4.28	3	2.8	2.24
Mulch (1 ton ac^{-1})	3.83	3.77	3	2.8	2.24
Mulch (1.5 ton ac^{-1})	3.76	3.01	3	2.8	2.24
Mulch (2 ton ac^{-1})	3.69	2.99	3	2.8	2.24
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

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High Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
sandy loam soil texture, **47%** rock fragment

65% top, 90% average, 55% toe hillslope gradient
300 ft hillslope horizontal length
high soil burn severity on forest

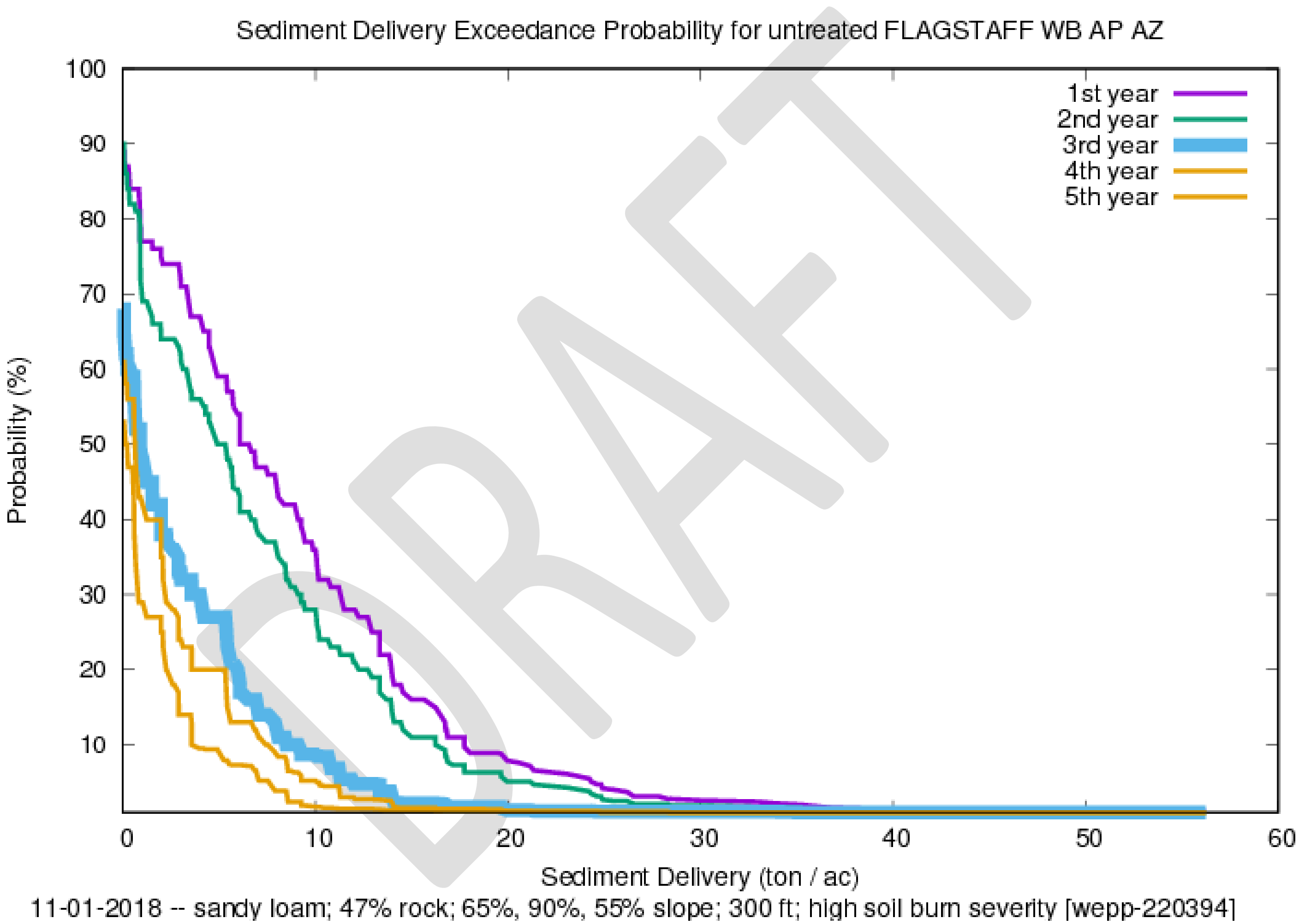
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
1.7	**in**	annual runoff from rainfall from	614	events
0.34	**in**	annual runoff from snowmelt or winter rainstorm from	124	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	2.98	4.32	5.07	5.00	4.10	August 17 year 55
5 (20-year)	**1.84**	**2.91**	**4.51**	**4.42**	**3.40**	**September 13 year 27**
10 (10-year)	**1.55**	**2.78**	**2.87**	**4.81**	**3.56**	**December 7 year 84**
20 (5-year)	**1.17**	**1.91**	**1.81**	**4.71**	**3.04**	**July 19 year 20**
50 (2-year)	**0.71**	**1.57**	**3.40**	**3.54**	**2.38**	**September 5 year 31**

75 (1 1/3-year)	0.41	1.26	3.29	1.55	1.26	August 29 year 43



Sediment Delivery

Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	13.96	12.86	5.97	4.26	2.24
Seeding	13.96	6.3	5.41	3.66	2.24
Mulch (0.5 ton ac^{-1})	6.15	6.04	5.97	4.26	2.24
Mulch (1 ton ac^{-1})	5.97	5.87	5.97	4.26	2.24
Mulch (1.5 ton ac^{-1})	5.96	5.63	5.97	4.26	2.24
Mulch (2 ton ac^{-1})	5.94	5.59	5.97	4.26	2.24
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

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Stratum 30

Unburned

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
clay loam soil texture, **45%** rock fragment
6% top, 12% average, 8% toe hillslope gradient
250 ft hillslope horizontal length
unburned forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
0.089	**in**	annual runoff from rainfall from	30	events
0.033	**in**	annual runoff from snowmelt or winter rainstorm from	6	events

22 years out of 100 had runoff events.

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date

1	2.84	3.91	4.28	3.63	3.11	September 4 year 68
5 (20-year)	**0.42**	**3.42**	**5.02**	**5.90**	**4.37**	**September 19 year 48**
10 (10-year)	**0.22**	**2.73**	**2.85**	**4.75**	**3.51**	**September 23 year 27**
20 (5-year)	**0.00**	**1.87**	**7.72**	**4.98**	**3.10**	**September 9 year 52**

Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	**Event sediment delivery (ton ac^{-1})**				
	Year following fire				
	1st year	**2nd year**	**3rd year**	**4th year**	**5th year**
Unburned	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**

Return to input screen

Low Burn Severity

Erosion Risk Management Tool

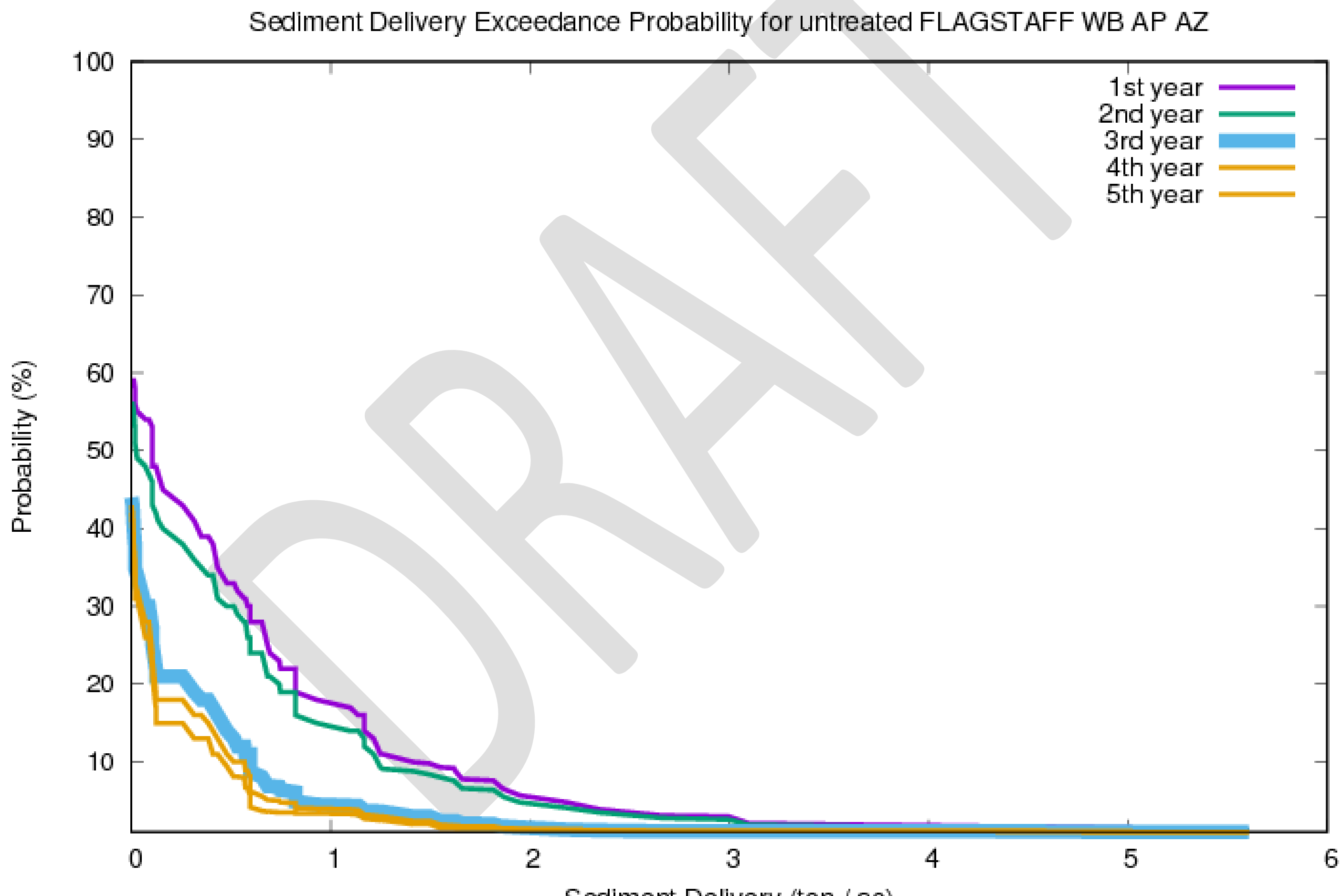
FLAGSTAFF WB AP AZ
clay loam soil texture, **45%** rock fragment
6% top, 12% average, 8% toe hillslope gradient
250 ft hillslope horizontal length
low soil burn severity on forest

100 - YEAR MEAN ANNUAL AVERAGES				
			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
2.1	**in**	annual runoff from rainfall from	809	events
1.1	**in**	annual runoff from snowmelt or winter rainstorm from	439	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.17	4.74	6.90	N/A	N/A	February 14 year 30
5 (20-year)	2.44	4.34	5.92	N/A	N/A	December 2 year 32
10 (10-year)	1.95	3.00	5.00	3.87	3.10	September 27 year 4
20 (5-year)	1.35	1.96	2.22	0.62	0.62	January 18 year 72

50 (2-year)	**0.96**	**1.59**	**1.55**	**4.12**	**2.60**	**August 30 year 2**
75 ($1^1/_3$-year)	**0.57**	**1.18**	**1.22**	**1.88**	**1.49**	**July 6 year 92**



10-26-2018 -- clay loam; 45% rock; 6%, 12%, 8% slope; 250 ft; low soil burn severity [wepp-73027]

Sediment Delivery					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	0.82	0.74	0.28	0.12	0.11
Seeding	0.82	0.28	0.12	0.11	0.11
Mulch (0.5 ton ac^{-1})	0.12	0.12	0.28	0.12	0.11
Mulch (1 ton ac^{-1})	0.1	0.11	0.28	0.12	0.11
Mulch (1.5 ton ac^{-1})	0.1	0.11	0.28	0.12	0.11
Mulch (2 ton ac^{-1})	0.1	0.11	0.28	0.12	0.11
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

Moderate Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
clay loam soil texture, **45%** rock fragment
6% top, 12% average, 8% toe hillslope gradient
250 ft hillslope horizontal length
moderate soil burn severity on forest

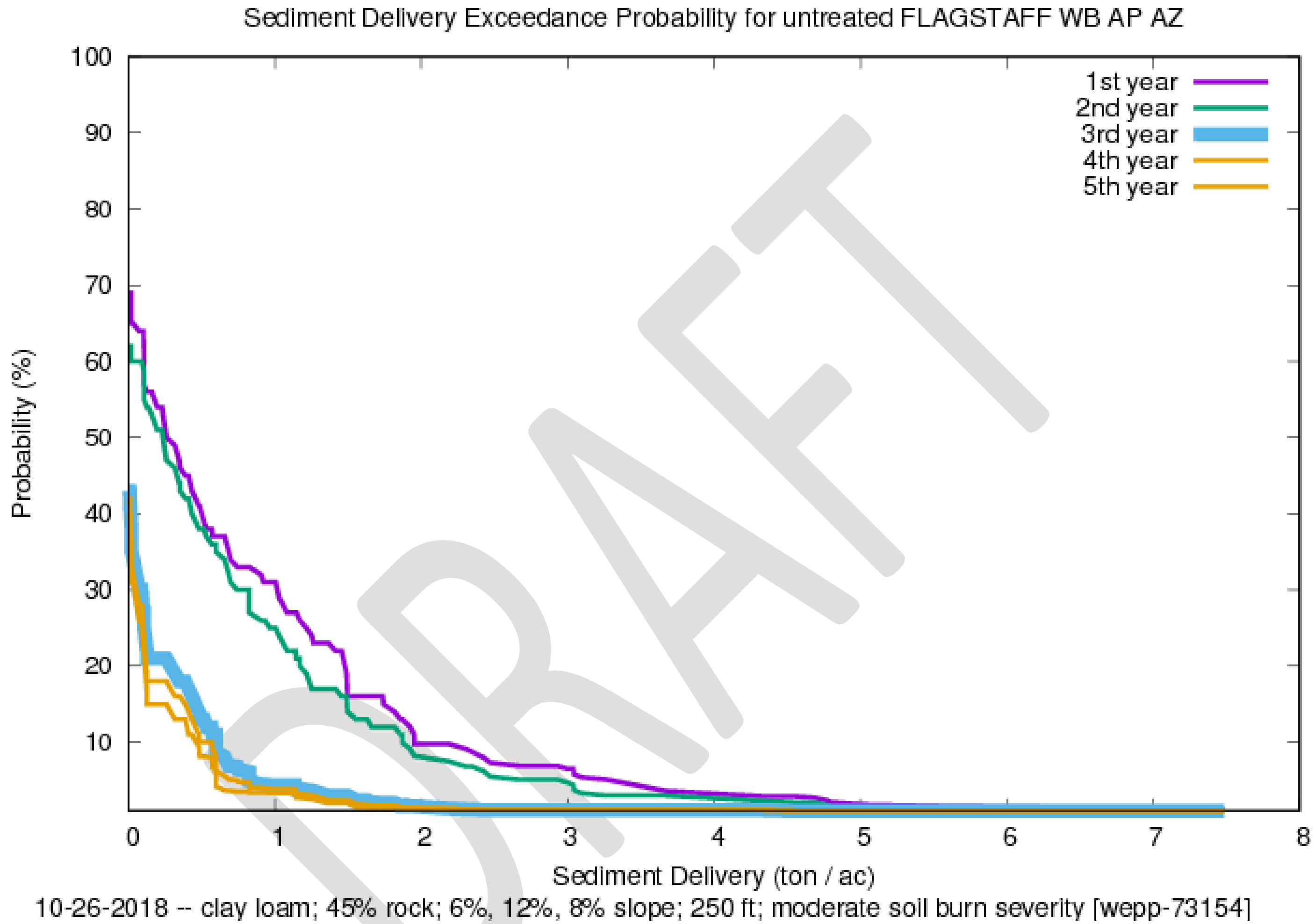
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
2.1	**in**	annual runoff from rainfall from	809	events
1.1	**in**	annual runoff from snowmelt or winter rainstorm from	439	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.17	4.74	6.90	N/A	N/A	February 14 year 30
5 (20-year)	**2.44**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**

10 (10-year)	**1.95**	**3.00**	**5.00**	**3.87**	**3.10**	**September 27 year 4**
20 (5-year)	**1.35**	**1.96**	**2.22**	**0.62**	**0.62**	**January 18 year 72**
50 (2-year)	**0.96**	**1.59**	**1.55**	**4.12**	**2.60**	**August 30 year 2**
75 ($1\frac{1}{3}$-year)	**0.57**	**1.18**	**1.22**	**1.88**	**1.49**	**July 6 year 92**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	1.48	1.17	0.28	0.12	0.11
Seeding	1.48	0.46	0.12	0.11	0.11
Mulch (0.5 ton ac^{-1})	0.35	0.39	0.28	0.12	0.11
Mulch (1 ton ac^{-1})	0.35	0.35	0.28	0.12	0.11
Mulch (1.5 ton ac^{-1})	0.35	0.35	0.28	0.12	0.11
Mulch (2 ton ac^{-1})	0.35	0.35	0.28	0.12	0.11
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

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High Burn Severity

Erosion Risk Management Tool

FLAGSTAFF WB AP AZ
clay loam soil texture, **45%** rock fragment
6% top, 12% average, 8% toe hillslope gradient
250 ft hillslope horizontal length
high soil burn severity on forest

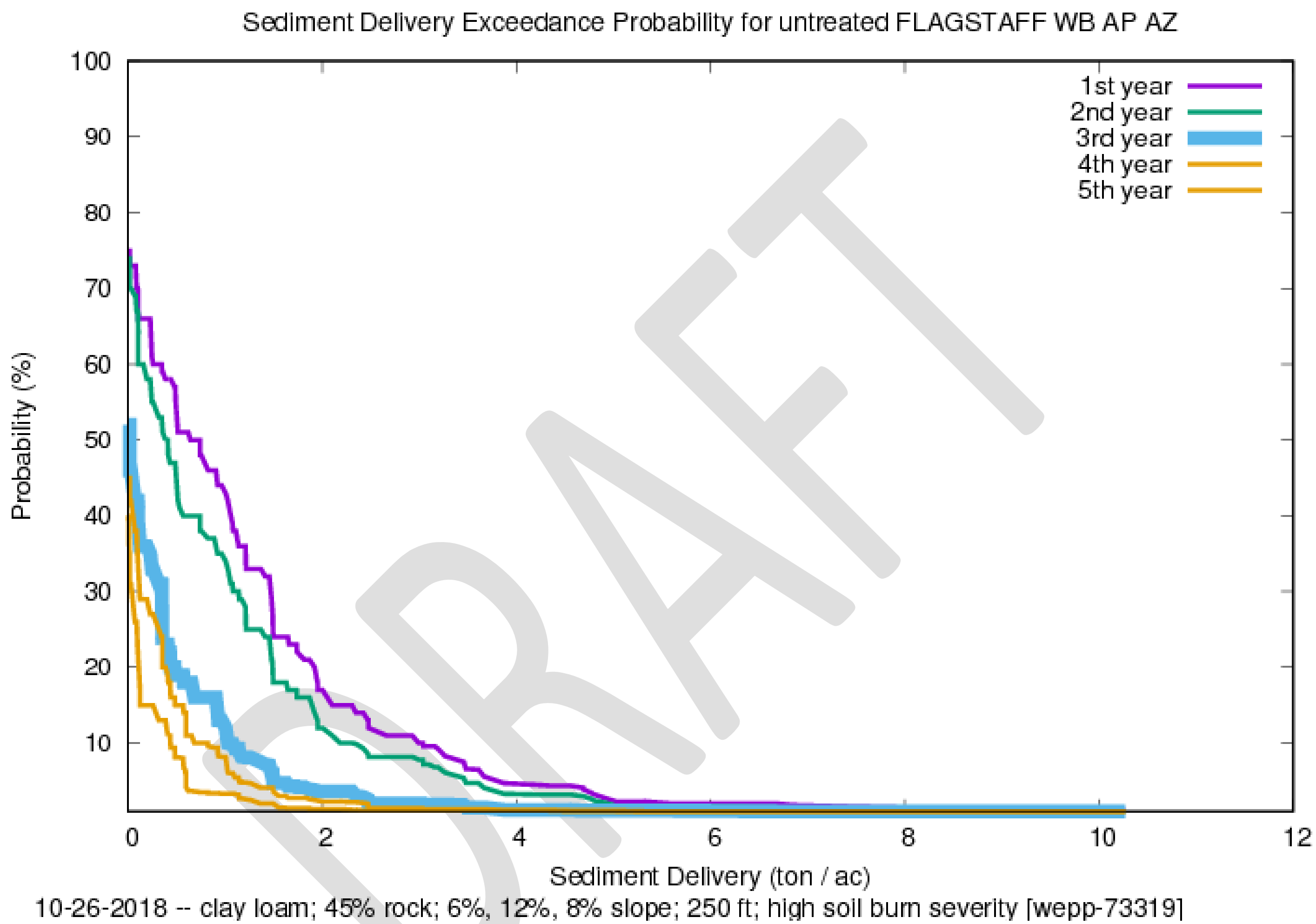
100 - YEAR MEAN ANNUAL AVERAGES

			Total in 100 years	
23	**in**	annual precipitation from	8198	storms
2.1	**in**	annual runoff from rainfall from	809	events
1.1	**in**	annual runoff from snowmelt or winter rainstorm from	439	events

Rainfall Event Rankings and Characteristics from the Selected Storms

Storm Rank based on runoff (return interval)	Storm Runoff (in)	Storm Precipitation (in)	Storm Duration (h)	10-min Peak Rainfall Intensity (in h^{-1})	30-min Peak Rainfall Intensity (in h^{-1})	Storm Date
1	3.17	4.74	6.90	N/A	N/A	February 14 year 30
5 (20-year)	**2.44**	**4.34**	**5.92**	**N/A**	**N/A**	**December 2 year 32**
10 (10-year)	**1.95**	**3.00**	**5.00**	**3.87**	**3.10**	**September 27 year 4**

20 (5-year)	**1.35**	**1.96**	**2.22**	**0.62**	**0.62**	**January 18 year 72**
50 (2-year)	**0.96**	**1.59**	**1.55**	**4.12**	**2.60**	**August 30 year 2**
75 (1 1/3-year)	**0.57**	**1.18**	**1.22**	**1.88**	**1.49**	**July 6 year 92**



Sediment Delivery					
Probability that sediment yield	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year

will be exceeded 20 % go					
Untreated	1.91	1.5	0.48	0.37	0.11
Seeding	1.91	0.8	0.4	0.35	0.11
Mulch (0.5 ton ac^{-1})	0.64	0.51	0.48	0.37	0.11
Mulch (1 ton ac^{-1})	0.4	0.41	0.48	0.37	0.11
Mulch (1.5 ton ac^{-1})	0.39	0.39	0.48	0.37	0.11
Mulch (2 ton ac^{-1})	0.39	0.38	0.48	0.37	0.11
Erosion Barriers: Diameter ft Spacing ft go ?					
Logs & Wattles					

Return to input screen

Appendix D. Subwatershed condition information for subwatersheds having land in the Rim Country project boundary.

Table 1. Subwatershed acres, ownership percentages and process category classes and scores for subwatersheds of the Apache-Sitgreaves National Forest in the Rim Country Project analysis area.

ASSESSMENT YEAR	HUC12 CODE	HUC12 NAME	WATERSHED CLASS FS LAND	WATERSHED SCORE FS LAND	TOTAL WATERSHED ACRES	FS LAND ACRES	NONFS LAND ACRES	FS LAND PERCENT	NONFS LAND PERCENT	PROCESS CAT AQ PHYS CLASS	PROCESS CAT AQ PHYS SCORE	PROCESS CAT AQ BIO CLASS	PROCESS CAT AQ BIO SCORE	PROCESS CAT TERR PHYS CLASS	PROCESS CAT TERR PHYS SCORE	PROCESS CAT TERR BIO CLASS	PROCESS CAT TERR BIO SCORE
2010	150200020401	Pulcifer Creek	1	1.6	15424	14382	1042	93	7	1	1.2	2	2.0	1	1.5	1	1.5
2010	150200020403	Sepulveda Creek	1	1.6	11418	5552	5866	49	51	1	1.3	2	2.0	1	1.5	1	1.5
2010	150200020406	Windsor Valley	1	1.5	40562	3798	36765	9	91	1	1.3	1	1.5	2	1.7	1	1.5
2010	150200050101	Billy Creek	2	2.0	17835	9468	8367	53	47	2	2.1	3	2.4	1	1.5	1	1.5
2010	150200050102	Porter Creek	2	1.9	25108	22459	2650	89	11	2	2.0	2	2.2	2	1.7	1	1.5
2010	150200050103	Fools Hollow	2	2.0	7185	3982	3203	55	45	2	2.0	3	2.5	2	1.7	1	1.3
2010	150200050104	Show Low Lake-Show Low Creek	2	1.9	19228	8207	11021	43	57	2	2.0	3	2.5	1	1.5	1	1.3
2010	150200050105	Long Lake	2	2.0	13714	10625	3089	78	23	3	2.3	2	2.0	2	1.9	1	1.3
2010	150200050106	Linden Draw	2	1.7	12256	7123	5133	58	42	1	1.2	2	2.0	2	1.7	2	1.8
2010	150200050107	Bagnal Draw-Show Low Creek	2	2.1	17726	13970	3756	79	21	3	2.3	3	2.5	1	1.5	2	1.8
2010	150200050108	Bull Hollow	2	2.0	8552	8138	414	95	5	2	1.8	3	2.5	2	2.0	1	1.5
2010	150200050109	Thistle Hollow-Show Low Creek	2	2.1	13808	12481	1326	90	10	2	2.0	3	2.5	2	2.0	1	1.5
2010	150200050201	Ortega Draw	1	1.5	10495	6574	3921	63	37	1	1.3	1	1.5	2	1.7	2	1.8
2010	150200050202	Upper Brown Creek	2	2.1	11090	10280	810	93	7	2	2.1	3	2.7	2	1.7	1	1.5
2010	150200050204	Lower Brown Creek	2	2.0	22102	7797	14305	35	65	2	2.0	3	2.7	1	1.5	1	1.5
2010	150200050205	Upper Rocky Arroyo	2	1.8	16241	15381	859	95	5	1	1.0	3	2.9	1	1.4	2	1.8
2010	150200050206	Lower Rocky Arroyo	2	2.1	15128	9862	5266	65	35	2	2.0	3	2.4	2	1.9	2	1.8
2010	150200050301	Stinson Wash	2	1.8	8023	7060	963	88	12	1	1.5	2	2.0	2	1.9	2	2.0
2010	150200050302	West Fork Cottonwood Wash-Cottonwood Wash	2	1.9	18803	18083	720	96	4	1	1.5	2	2.0	2	2.2	2	2.0
2010	150200050303	Upper Day Wash	2	1.9	12183	11220	963	92	8	1	1.5	2	2.0	2	2.0	2	2.0
2010	150200050304	Lower Day Wash	2	1.9	16662	16201	460	97	3	2	1.7	2	2.0	2	2.0	1	1.5
2010	150200050305	Dalton Tank-Cottonwood Wash	2	2.0	11703	11033	670	94	6	2	1.8	3	2.5	2	1.9	1	1.5
2010	150200050306	Town Draw	2	1.8	16504	12933	3571	78	22	1	1.5	2	2.0	2	1.9	1	1.5
2010	150200050308	Mortensen Wash	2	1.8	19430	17645	1784	91	9	2	1.7	2	2.0	2	1.7	2	2.0
2010	150200050309	Dodson Wash	2	2.0	21428	16793	4635	78	22	2	1.8	2	2.0	2	2.2	1	1.5
2010	150200080101	Decker Wash	2	1.8	20118	18971	1147	94	6	1	1.5	2	2.0	2	1.9	1	1.5
2010	150200080102	Upper Phoenix Park Wash	2	1.9	19280	19171	109	99	1	2	1.7	2	2.0	2	1.9	2	2.0
2010	150200080305	Gentry Canyon	1	1.6	15042	14945	96	99	1	1	1.6	1	1.5	2	1.9	1	1.3

ASSESSMENT YEAR	HUC12 CODE	HUC12 NAME	WATERSHED CLASS FS LAND	WATERSHED SCORE FS LAND	TOTAL WATERSHED ACRES	FS LAND ACRES	NONFS LAND ACRES	FS LAND PERCENT	NONFS LAND PERCENT	PROCESS CAT AQ PHYS CLASS	PROCESS CAT AQ PHYS SCORE	PROCESS CAT AQ BIO CLASS	PROCESS CAT AQ BIO SCORE	PROCESS CAT TERR PHYS CLASS	PROCESS CAT TERR PHYS SCORE	PROCESS CAT TERR BIO CLASS	PROCESS CAT TERR BIO SCORE
2010	150200080306	Upper Willow Creek	2	2.1	18603	18131	473	98	3	3	2.6	2	2.2	2	1.8	1	1.5
2010	150200080308	Cabin Draw	2	1.7	14272	14227	45	100	0	1	1.2	2	2.2	2	1.7	1	1.5
2010	150200080309	Wilkins Canyon	1	1.6	13422	13333	89	99	1	1	1.4	2	2.0	1	1.5	1	1.4
2010	150200080310	Lower Willow Creek	1	1.6	12387	11917	470	96	4	1	1.4	2	2.2	1	1.4	1	1.3
2010	150200080401	Tillman Draw	2	1.8	12370	10196	2174	82	18	1	1.5	2	2.0	2	2.0	1	1.5
2010	150200080402	Sand Draw	2	1.7	14828	9834	4994	66	34	2	1.8	1	1.5	2	2.0	1	1.5
2010	150200100101	Woods Canyon and Willow Springs Canyon	2	2.0	16705	16705	0	100	0	2	2.2	3	2.5	1	1.4	1	1.5
2013	150200100102	Long Tom Canyon-Chevelon Canyon	1	1.5	21249	20908	340	98	2	1	1.0	2	1.9	2	1.7	1	1.5
2013	150200100103	Upper Wildcat Canyon	1	1.4	25488	25046	442	98	2	1	1.3	1	1.5	1	1.5	1	1.5
2010	150200100104	Upper Chevelon Canyon-Chevelon Canyon Lake	2	1.9	17082	17029	52	100	0	3	2.3	2	1.9	2	1.7	1	1.5
2010	150200100105	Middle Wildcat Canyon	2	1.7	10362	10362	0	100	0	1	1.5	2	2.0	2	1.7	1	1.5
2010	150200100106	Alder Canyon	1	1.6	15614	15545	69	100	0	1	1.4	1	1.5	2	1.8	1	1.5
2010	150200100107	Upper West Chevelon Canyon	1	1.5	16752	16287	465	97	3	1	1.4	1	1.5	2	1.7	1	1.3
2010	150200100108	Lower West Chevelon Canyon	1	1.4	16865	16795	70	100	0	1	1.2	1	1.0	2	1.9	2	1.8
2010	150200100109	Lower Wildcat Canyon	2	1.8	10923	10923	0	100	0	1	1.5	2	2.0	2	2.0	1	1.5
2010	150200100110	Durfee Draw-Chevelon Canyon	1	1.6	22790	22057	733	97	3	1	1.2	2	1.9	2	1.7	1	1.5
2010	150200100201	West Fork Black Canyon	2	2.0	8670	8670	0	100	0	2	2.1	2	1.7	2	2.2	2	2.0
2010	150200100202	Buckskin Wash	2	1.9	18626	17141	1485	92	8	2	1.8	2	2.0	2	1.7	2	2.0
2010	150200100203	Bear Canyon-Black Canyon	2	2.0	16916	15947	969	94	6	1	1.3	3	2.5	2	2.2	2	2.0
2010	150200100204	Upper Pierce Wash	2	1.8	16415	13164	3252	80	20	1	1.5	2	2.0	2	1.9	2	2.0
2010	150200100205	Upper Brookbank Canyon	2	1.8	16593	16313	280	98	2	1	1.4	2	2.0	2	2.0	1	1.5
2010	150200100206	Long Draw	2	1.9	15538	12853	2685	83	17	2	1.8	2	2.0	2	2.0	1	1.5
2010	150200100208	Long Hollow Tank-Black Canyon	2	1.9	24188	19471	4717	81	20	1	1.5	3	2.5	2	1.7	2	1.8
2010	150200100209	Lower Brookbank Canyon	2	2.0	20977	19724	1253	94	6	2	1.8	3	2.5	2	1.7	1	1.5
2010	150200100301	Upper Potato Wash	2	1.7	12971	12968	3	100	0	1	1.5	2	2.0	1	1.5	1	1.5
2010	150200100302	Lower Potato Wash	2	1.8	24199	10519	13680	44	57	1	1.5	2	2.0	2	2.0	1	1.5
2010	150601030301	Bull Flat Canyon	2	1.8	14374	4993	9382	35	65	2	1.7	2	2.0	2	1.7	2	2.0

ASSESSMENT YEAR	HUC12 CODE	HUC12 NAME	WATERSHED CLASS FS LAND	WATERSHED SCORE FS LAND	TOTAL WATERSHED ACRES	FS LAND ACRES	NONFS LAND ACRES	FS LAND PERCENT	NONFS LAND PERCENT	PROCESS CAT AQ PHYS CLASS	PROCESS CAT AQ PHYS SCORE	PROCESS CAT AQ BIO CLASS	PROCESS CAT AQ BIO SCORE	PROCESS CAT TERR PHYS CLASS	PROCESS CAT TERR PHYS SCORE	PROCESS CAT TERR BIO CLASS	PROCESS CAT TERR BIO SCORE
2010	150601030302	Canyon Creek Headwaters	2	1.8	25820	20503	5317	79	21	1	1.4	2	2.2	2	1.7	2	2.0
2010	150601040302	Buckskin Canyon-Carrizo Creek	2	1.9	23934	3843	20091	16	84	2	1.8	2	2.0	2	1.7	2	2.0

Table 2. Subwatershed acres, ownership percentages and process category classes and scores for subwatersheds of the Coconino National Forest in the Rim Country Project analysis area.

ASSESSMENT YEAR	HUC12 CODE	HUC12 NAME	WATERSHED CLASS FS LAND	WATERSHED SCORE FS LAND	TOTAL WATERSHED ACRES	FS LAND ACRES	NONFS LAND ACRES	FS LAND PERCENT	NONFS LAND PERCENT	PROCESS CAT AQ PHYS CLASS	PROCESS CAT AQ PHYS SCORE	PROCESS CAT AQ BIO CLASS	PROCESS CAT AQ BIO SCORE	PROCESS CAT TERR PHYS CLASS	PROCESS CAT TERR PHYS SCORE	PROCESS CAT TERR BIO CLASS	PROCESS CAT TERR BIO SCORE
2010	150200080301	Miller Canyon	2.0	1.8	10676	10676	0	100	0	1	1.4	3	2.5	1	1.6	1	1.5
2010	150200080302	Bear Canyon	2.0	2.1	14586	14525	61	100	0	2	2.0	3	2.9	1	1.5	1	1.5
2015	150200080303	East Clear Creek-Blue Ridge Reservoir	2.0	2.1	20232	20002	230	99	1	2	1.9	3	2.9	1	1.5	2	1.7
2010	150200080304	Barbershop Canyon	2.0	1.9	13447	13406	41	100	0	1	1.2	3	2.9	2	1.7	2	1.8
2010	150200080307	Leonard Canyon	2.0	1.9	29553	28761	792	97	3	1	1.5	3	2.7	1	1.5	1	1.5
2010	150200080311	East Clear Creek-Clear Creek	2.0	2.0	39180	36676	2504	94	6	2	1.9	3	2.4	2	1.8	2	1.8
2010	150200080403	Echinique Draw-Clear Creek	1.0	1.4	33561	20313	13248	61	40	1	1.0	2	1.9	1	1.3	1	1.3
2010	150200080501	Windmill Draw-Jacks Canyon	2.0	2.0	27335	26967	368	99	1	2	2.0	2	2.0	2	2.0	2	2.2
2010	150200080502	Tremaine Lake	2.0	2.0	30828	30524	304	99	1	2	1.9	2	1.7	3	2.5	2	1.7
2010	150200080503	Dogie Tank-Jacks Canyon	2.0	2.0	22108	20321	1787	92	8	2	2.0	2	2.0	2	2.0	2	2.1
2010	150200080504	Chavez Draw	3.0	2.3	10238	10238	0	100	0	2	2.0	2	2.0	3	2.7	3	2.8
2010	150200080505	Hart Tank	2.0	1.9	21661	18315	3345	85	15	1	1.6	2	2.0	2	2.0	2	1.9
2010	150200150201	Mormon Lake	1.0	1.6	26018	24419	1599	94	6	2	1.8	1	1.4	1	1.5	2	1.9
2010	150200150401	Sawmill Wash	2.0	2.2	12396	12396	0	100	0	2	2.1	3	2.5	2	2.2	2	1.7
2010	150200150402	Long Lake-Chavel Pass Ditch	2.0	2.0	14607	14495	112	99	1	3	2.5	2	1.7	2	1.9	2	1.7
2010	150602020601	Bar M Canyon	1.0	1.4	17532	17404	127	99	1	1	1.3	1	1.0	2	1.7	2	2.0
2010	150602020602	Upper Woods Canyon	2.0	1.9	12680	12680	0	100	0	2	1.7	2	2.0	2	1.9	2	2.1
2010	150602020603	Double Cabin Park-Jacks Canyon	2.0	1.8	21686	20977	709	97	3	2	2.1	2	1.7	2	1.7	2	1.8
2010	150602020604	Brady Canyon	2.0	2.1	17933	17815	118	99	1	2	2.0	3	2.5	2	1.8	2	1.7
2010	150602020605	Rattlesnake Canyon	2.0	1.9	17043	16964	79	100	1	2	1.9	1	1.5	2	2.2	2	2.2
2010	150602020609	Upper Wet Beaver Creek	1.0	1.6	23112	22830	282	99	1	1	1.1	1	1.5	2	2.1	1	1.4
2010	150602020610	Red Tank Draw	2.0	2.2	36149	35592	557	99	2	3	2.3	3	2.4	2	2.1	2	1.8
2010	150602030101	Upper Willow Valley	2.0	2.0	22842	22598	244	99	1	2	2.0	3	2.4	1	1.6	2	1.7
2010	150602030102	Long Valley Draw	2.0	1.8	18316	17466	851	95	5	2	2.0	1	1.5	1	1.6	2	2.2
2010	150602030103	Toms Creek	2.0	2.0	8530	8530	0	100	0	2	2.1	3	2.5	1	1.4	2	2.0
2010	150602030104	Clover Creek	2.0	1.8	9936	9936	0	100	0	1	1.3	3	2.5	2	1.7	2	1.9

ASSESSMENT YEAR	HUC12 CODE	HUC12 NAME	WATERSHED CLASS FS LAND	WATERSHED SCORE FS LAND	TOTAL WATERSHED ACRES	FS LAND ACRES	NONFS LAND ACRES	FS LAND PERCENT	NONFS LAND PERCENT	PROCESS CAT AQ PHYS CLASS	PROCESS CAT AQ PHYS SCORE	PROCESS CAT AQ BIO CLASS	PROCESS CAT AQ BIO SCORE	PROCESS CAT TERR PHYS CLASS	PROCESS CAT TERR PHYS SCORE	PROCESS CAT TERR BIO CLASS	PROCESS CAT TERR BIO SCORE
2010	150602030105	Lower Willow Valley	2.0	1.8	30903	30634	269	99	1	2	2.0	2	2.0	1	1.4	1	1.6
2010	150602030106	Home Tank Draw	2.0	1.8	22908	22908	0	100	0	1	1.3	2	2.0	2	1.9	2	1.9
2010	150602030107	Upper West Clear Creek	1.0	1.4	14461	14461	0	100	0	1	1.3	1	1.4	1	1.6	1	1.5
2010	150602030108	Middle West Clear Creek	2.0	1.7	35733	35733	0	100	0	1	1.3	2	1.7	2	2.0	1	1.6
2010	150602030305	Upper Fossil Creek	2.0	1.8	25859	25859	0	100	0	2	1.8	1	1.5	2	2.1	2	1.8
2010	150602030307	Lower Fossil Creek	2.0	1.9	29826	29813	14	100	0	1	1.6	2	1.9	2	2.1	2	1.7

Table 3. Subwatershed acres, ownership percentages and process category classes and scores for subwatersheds of the Tonto National Forest in the Rim Country Project analysis area.

ASSESSMENT YEAR	HUC12 CODE	HUC12 NAME	WATERSHED CLASS FS LAND	WATERSHED SCORE FS LAND	TOTAL WATERSHED ACRES	FS LAND ACRES	NONFS LAND ACRES	FS LAND PERCENT	NONFS LAND PERCENT	PROCESS CAT AQ PHYS CLASS	PROCESS CAT AQ PHYS SCORE	PROCESS CAT AQ BIO CLASS	PROCESS CAT AQ BIO SCORE	PROCESS CAT TERR PHYS CLASS	PROCESS CAT TERR PHYS SCORE	PROCESS CAT TERR BIO CLASS	PROCESS CAT TERR BIO SCORE
2010	150601030304	Upper Canyon Creek	2	1.8	14386	1475	12911	10	90	1	1.5	2	2.0	2	2.0	1	1.4
2010	150601030305	Gentry Canyon	2	1.9	7829	5769	2060	74	26	1	1.6	2	2.0	3	2.4	1	1.2
2010	150601030306	Ellison Creek	2	2.2	11993	6028	5965	50	50	2	2.0	3	2.5	3	2.5	1	1.4
2010	150601030401	Parallel Canyon-Cherry Creek	2	2.0	14658	13848	810	95	6	1	1.6	3	2.7	2	2.0	1	1.4
2010	150601030402	Pleasant Valley	3	2.3	8279	4565	3714	55	45	2	2.2	3	2.4	3	2.7	1	1.3
2010	150601030403	Crouch Creek	2	1.9	10756	10357	399	96	4	2	1.9	2	1.9	2	2.0	1	1.3
2010	150601030404	Gruwell Canyon-Cherry Creek	2	2.1	24021	21838	2183	91	9	2	1.8	3	2.5	2	2.2	1	1.6
2010	150601030406	Walnut Creek-Cherry Creek	2	2.0	17054	16876	178	99	1	1	1.6	3	2.5	2	2.0	1	1.3
2010	150601030407	P B Creek-Cherry Creek	2	1.9	34802	34802	0	100	0	1	1.6	3	2.4	2	1.9	1	1.3
2010	150601030408	Cooper Forks-Cherry Creek	2	2.1	25050	24859	191	99	1	2	2.1	3	2.5	2	1.9	1	1.3
2010	150601030409	Bladder Canyon-Cherry Creek	2	2.2	35621	27980	7641	79	22	3	2.4	3	2.4	2	2.2	1	1.0
2016	150601030801	Reynolds Creek	2	1.7	10049	9871	179	98	2	1	1.1	2	2.0	2	2.2	1	1.4
2016	150601030802	Workman Creek	2	1.7	12902	12725	177	99	1	1	1.1	2	2.0	2	2.0	1	1.4
2010	150601030803	Upper Salome Creek	2	1.7	19057	18996	61	100	0	1	1.4	2	1.9	2	2.0	1	1.2
2010	150601030804	Middle Salome Creek	1	1.6	17534	17534	0	100	0	1	1.2	2	1.9	2	1.7	1	1.3
2010	150601030907	Cottonwood Wash	2	2.1	15263	15263	0	100	0	2	2.1	2	2.0	3	2.3	2	1.8
2010	150601030908	Armer Gulch	2	2.0	10251	10232	19	100	0	2	2.0	2	2.0	2	2.2	1	1.5
2010	150601050101	Buzzard Roost Canyon	2	1.8	14061	14006	55	100	0	1	1.4	2	2.0	2	2.0	1	1.4
2010	150601050102	Rock Creek	2	1.9	16331	16131	200	99	1	1	1.6	2	2.0	2	2.0	2	1.8
2010	150601050103	Upper Spring Creek	2	1.7	21290	21155	135	99	1	1	1.2	2	2.0	2	2.0	1	1.3
2010	150601050105	Middle Spring Creek	2	1.9	16637	16581	56	100	0	2	1.7	2	2.0	3	2.3	1	1.3
2010	150601050201	Marsh Creek	2	1.9	21747	21543	204	99	1	2	1.7	2	1.9	3	2.3	1	1.6
2010	150601050202	Gordon Canyon	2	1.9	17995	17594	401	98	2	1	1.6	3	2.4	2	2.0	1	1.4
2010	150601050203	Christopher Creek	3	2.3	18828	18217	610	97	3	3	2.3	3	2.9	2	1.9	1	1.4

ASSESSMENT YEAR	HUC12 CODE	HUC12 NAME	WATERSHED CLASS FS LAND	WATERSHED SCORE FS LAND	TOTAL WATERSHED ACRES	FS LAND ACRES	NONFS LAND ACRES	FS LAND PERCENT	NONFS LAND PERCENT	PROCESS CAT AQ PHYS CLASS	PROCESS CAT AQ PHYS SCORE	PROCESS CAT AQ BIO CLASS	PROCESS CAT AQ BIO SCORE	PROCESS CAT TERR PHYS CLASS	PROCESS CAT TERR PHYS SCORE	PROCESS CAT TERR BIO CLASS	PROCESS CAT TERR BIO SCORE
2010	150601050204	Horton Creek-Tonto Creek	2	2.1	17274	16977	297	98	2	2	1.9	3	2.4	2	2.0	1	1.6
2010	150601050205	Haigler Creek	2	1.7	33196	32526	670	98	2	1	1.3	2	2.0	2	2.0	1	1.2
2010	150601050206	Bull Tank Canyon-Tonto Creek	2	2.2	22122	21687	435	98	2	3	2.4	3	2.5	2	1.9	1	1.4
2010	150601050301	Green Valley Creek	2	2.2	18164	18036	128	99	1	2	2.1	2	2.0	3	2.7	1	1.5
2010	150601050304	Houston Creek	3	2.4	26331	21651	4680	82	18	3	2.3	3	2.7	3	2.5	2	1.8
2010	150601050401	Gun Creek	1	1.6	36725	36706	19	100	0	1	1.2	2	2.0	2	1.7	1	1.5
2010	150601050404	Cottonwood Creek	2	2.1	10664	10505	159	99	2	2	2.0	2	2.0	3	2.3	2	2.0
2010	150601050405	Oak Creek	2	2.1	10605	10421	184	98	2	2	2.0	2	2.0	3	2.3	3	2.3
2016	150601050406	Lambing Creek-Tonto Creek	3	2.4	33424	30968	2456	93	7	3	2.4	3	2.7	3	2.3	2	1.8
2010	150601050408	Greenback Creek	2	2.1	21888	21146	741	97	3	2	1.9	2	2.2	3	2.3	1	1.5
2016	150602030201	Ellison Creek	2	1.9	27120	26342	779	97	3	1	1.6	2	2.0	2	2.2	2	1.8
2010	150602030202	East Verde River Headwaters	2	2.2	18836	18267	570	97	3	2	2.2	3	2.5	2	2.2	1	1.4
2010	150602030203	Webber Creek	2	2.0	22500	22067	433	98	2	2	1.9	2	2.0	2	2.2	1	1.6
2010	150602030205	Upper East Verde River	2	2.2	34234	33400	834	98	2	2	2.2	2	2.0	3	2.5	2	1.8
2016	150602030206	Pine Creek	2	2.2	30725	27885	2840	91	9	2	2.2	3	2.5	2	2.0	1	1.6
2010	150602030208	Rock Creek	2	2.0	12796	12796	0	100	0	2	2.0	2	2.0	2	2.0	1	1.5
2010	*150602030306*	Hardscrabble Creek	*2*	*2.0*	*25252*	*23476*	*1776*	*93*	*7*	*2*	*2.0*	*2*	*2.0*	*2*	*2.2*	*1*	*1.4*

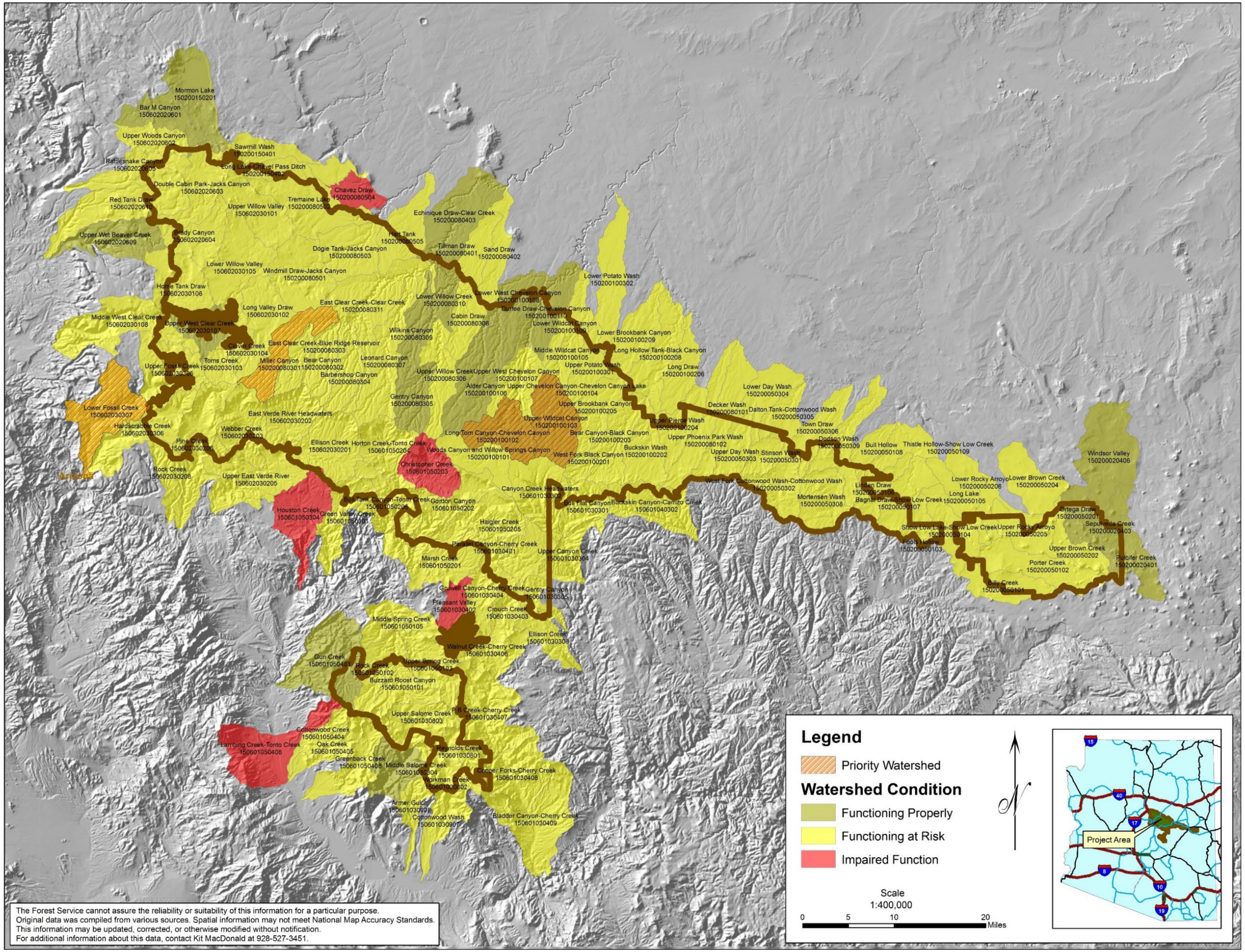


Figure 2. Map depicting watershed condition and locations of priority watersheds in the Rim Country Restoration Project analysis area.

Appendix E. Perennial stream reaches in the Rim Country Restoration Project analysis area.

GNIS ID	GNIS NAME	REACHCODE	FTYPE	FCODE	Miles	Kilometers
00032925	Pine Creek	15060203000460	460	46006	0.51	0.83
00032925	Pine Creek	15060203000460	460	46006	0.52	0.84
00035932	Webber Creek	15060203000501	460	46006	0.29	0.47
00035932	Webber Creek	15060203000503	460	46006	1.07	1.71
00028796	East Verde River	15060203000208	460	46006	0.40	0.64
		15060203000991	460	46006	0.37	0.59
00028796	East Verde River	15060203000216	460	46006	0.01	0.02
00026594	Bonita Creek	15060203005996	460	46006	2.19	3.52
00028658	Dude Creek	15060203005995	460	46006	0.58	0.93
00028882	Ellison Creek	15060203000948	460	46006	0.32	0.51
00028743	East Clear Creek	15020008000085	460	46006	0.04	0.07
00028743	East Clear Creek	15020008000083	460	46006	0.94	1.52
00035375	Tonto Creek	15060105000128	460	46006	0.18	0.28
00035375	Tonto Creek	15060105000134	460	46006	0.47	0.75
00035375	Tonto Creek	15060105000140	460	46006	0.30	0.49
00028743	East Clear Creek	15020008000079	460	46006	0.05	0.08
		15060105000645	460	46006	0.50	0.80
00028743	East Clear Creek	15020008000079	460	46006	0.38	0.60
		15060105000581	460	46006	0.43	0.69
		15020008000621	460	46006	0.97	1.56
		15060105003367	460	46006	0.49	0.79
00028743	East Clear Creek	15020008000076	460	46006	0.48	0.78
00027620	Christopher Creek	15060105000622	460	46006	0.12	0.19

GNIS ID	GNIS NAME	REACHCODE	FTYPE	FCODE	Miles	Kilometers
		15020008000621	460	46006	0.34	0.55
		15020008000619	460	46006	0.35	0.56
		15020008000625	460	46006	0.25	0.41
00036230	Willow Creek	15020008000105	460	46006	0.07	0.12
		15020008000611	460	46006	0.06	0.10
00036399	Workman Creek	15060103000548	460	46006	0.36	0.57
00033592	Reynolds Creek	15060103000560	460	46006	0.40	0.65
00029681	Haigler Creek	15060105000116	460	46006	1.17	1.88
00036399	Workman Creek	15060103000550	460	46006	0.70	1.13
00033592	Reynolds Creek	15060103000560	460	46006	0.01	0.02
00033592	Reynolds Creek	15060103000561	460	46006	0.08	0.13
00033592	Reynolds Creek	15060103000562	460	46006	0.17	0.27
00027571	Chevelon Creek	15020010000047	460	46006	0.02	0.03
00027571	Chevelon Creek	15020010000046	460	46006	0.06	0.10
00027571	Chevelon Creek	15020010000046	460	46006	0.13	0.21
00027571	Chevelon Creek	15020010001608	460	46006	0.08	0.12
00027571	Chevelon Creek	15020010001608	460	46006	0.08	0.12
00027571	Chevelon Creek	15020010001608	460	46006	0.14	0.22
00027571	Chevelon Creek	15020010001608	460	46006	0.40	0.64
00027571	Chevelon Creek	15020010000044	460	46006	0.50	0.80
00027571	Chevelon Creek	15020010000043	460	46006	0.08	0.13
00027571	Chevelon Creek	15020010001607	460	46006	0.12	0.19
00027269	Canyon Creek	15060103000185	460	46006	0.56	0.90
00027571	Chevelon Creek	15020010000039	460	46006	0.58	0.93
00034392	Show Low Creek	15020005000146	460	46006	2.11	3.40
00034392	Show Low Creek	15020005000572	460	46006	0.87	1.41

GNIS ID	GNIS NAME	REACHCODE	FTYPE	FCODE	Miles	Kilometers
		15020005000579	460	46006	0.18	0.30
		15020005001467	460	46006	0.01	0.01
		15020005001467	460	46006	0.12	0.19
00026783	Brown Creek	15020005000138	460	46006	2.48	4.00
00032925	Pine Creek	15060203000460	460	46006	0.40	0.64
00032925	Pine Creek	15060203000460	460	46006	0.31	0.50
00036027	West Webber Creek	15060203001017	460	46006	1.97	3.17
00035932	Webber Creek	15060203000501	460	46006	0.09	0.15
00035932	Webber Creek	15060203000503	460	46006	0.40	0.64
		15060203000991	460	46006	0.69	1.11
00028743	East Clear Creek	15020008000084	460	46006	0.77	1.24
00028743	East Clear Creek	15020008000081	460	46006	0.77	1.24
00028743	East Clear Creek	15020008000080	460	46006	0.78	1.26
00035375	Tonto Creek	15060105000139	460	46006	0.58	0.93
00035375	Tonto Creek	15060105000140	460	46006	0.11	0.17
		15020008000582	460	46006	0.12	0.20
00035375	Tonto Creek	15060105000133	460	46006	0.43	0.69
00027620	Christopher Creek	15060105000616	460	46006	0.27	0.43
00027620	Christopher Creek	15060105000618	460	46006	0.78	1.25
00028757	East Fork Horton Creek	15060105001886	460	46006	0.28	0.46
		15020008000617	460	46006	0.46	0.75
00033979	Salome Creek	15060103000570	460	46006	0.33	0.52
00033979	Salome Creek	15060103000572	460	46006	0.40	0.65

GNIS ID	GNIS NAME	REACHCODE	FTYPE	FCODE	Miles	Kilometers
00027620	Christopher Creek	15060105000619	460	46006	0.22	0.35
		15020008000620	460	46006	0.13	0.21
		15020008000616	460	46006	0.46	0.73
		15020008000615	460	46006	0.56	0.90
		15060105000587	460	46006	0.18	0.30
00027620	Christopher Creek	15060105000621	460	46006	0.59	0.95
00027620	Christopher Creek	15060105000622	460	46006	0.13	0.20
00036399	Workman Creek	15060103000547	460	46006	0.63	1.01
00029681	Haigler Creek	15060105000116	460	46006	0.78	1.26
00033592	Reynolds Creek	15060103000562	460	46006	0.11	0.19
		15060103009892	460	46006	0.00	0.00
		15060103001428	460	46006	0.14	0.22
00027571	Chevelon Creek	15020010000046	460	46006	0.04	0.07
00027571	Chevelon Creek	15020010000047	460	46006	0.39	0.63
00027571	Chevelon Creek	15020010000047	460	46006	0.05	0.09
		15020010001603	460	46006	0.12	0.19
00027571	Chevelon Creek	15020010001608	460	46006	0.10	0.16
00027571	Chevelon Creek	15020010000043	460	46006	0.25	0.40
00027571	Chevelon Creek	15020010001610	460	46006	0.10	0.16
00027571	Chevelon Creek	15020010001604	460	46006	0.07	0.12
00027571	Chevelon Creek	15020010000040	460	46006	0.15	0.24
00027269	Canyon Creek	15060103000182	460	46006	0.19	0.31
00027269	Canyon Creek	15060103000183	460	46006	0.16	0.25
		15020005001462	460	46006	0.14	0.23

GNIS ID	GNIS NAME	REACHCODE	FTYPE	FCODE	Miles	Kilometers
00026783	Brown Creek	15020005001566	460	46006	0.19	0.30
00032925	Pine Creek	15060203000460	460	46006	0.19	0.30
00035932	Webber Creek	15060203000502	460	46006	0.28	0.46
00035932	Webber Creek	15060203000500	460	46006	0.06	0.09
00028796	East Verde River	15060203003348	460	46006	0.57	0.92
00028796	East Verde River	15060203000213	460	46006	0.14	0.22
00027523	Chase Creek	15060203000988	460	46006	0.89	1.43
00028882	Ellison Creek	15060203000940	460	46006	0.46	0.75
00028882	Ellison Creek	15060203000941	460	46006	0.75	1.20
00032804	Perley Creek	15060203000974	460	46006	2.18	3.51
00028882	Ellison Creek	15060203000947	460	46006	0.10	0.16
00028882	Ellison Creek	15060203000946	460	46006	0.11	0.18
00028882	Ellison Creek	15060203000947	460	46006	0.34	0.54
00028882	Ellison Creek	15060203000948	460	46006	0.20	0.33
00028743	East Clear Creek	15020008000082	460	46006	1.47	2.36
00028743	East Clear Creek	15020008000080	460	46006	0.72	1.16
00030215	Horton Creek	15060105000641	460	46006	0.87	1.40
		15020008002921	460	46006	0.22	0.35
		15020008000582	460	46006	0.04	0.06
00035375	Tonto Creek	15060105001789	460	46006	0.59	0.96
00027620	Christopher Creek	15060105000617	460	46006	0.84	1.36
00030215	Horton Creek	15060105000641	460	46006	1.12	1.80
		15020008000616	460	46006	1.73	2.79
		15020008000619	460	46006	1.70	2.74
00029681	Haigler Creek	15060105000115	460	46006	0.37	0.60
		15020008000615	460	46006	0.54	0.87

GNIS ID	GNIS NAME	REACHCODE	FTYPE	FCODE	Miles	Kilometers
		15020008000611	460	46006	0.66	1.06
00033592	Reynolds Creek	15060103000561	460	46006	0.79	1.28
00033592	Reynolds Creek	15060103000562	460	46006	0.29	0.47
00027542	Cherry Creek	15060103000233	460	46006	0.16	0.26
00027542	Cherry Creek	15060103000232	460	46006	0.46	0.73
		15060103009891	460	46006	0.02	0.04
00027571	Chevelon Creek	15020010000049	460	46006	0.45	0.73
00027571	Chevelon Creek	15020010000049	460	46006	0.18	0.28
00027571	Chevelon Creek	15020010000046	460	46006	0.06	0.09
00027571	Chevelon Creek	15020010000047	460	46006	0.20	0.33
		15020010001151	460	46006	0.02	0.03
00027571	Chevelon Creek	15020010001607	460	46006	0.02	0.03
00027571	Chevelon Creek	15020010000040	460	46006	0.01	0.01
00027269	Canyon Creek	15060103000180	460	46006	0.70	1.13
		15020005001626	460	46006	1.83	2.95
		15020005001459	460	46006	0.16	0.26
00026783	Brown Creek	15020005000137	460	46006	0.12	0.20
		15020005001520	460	46006	0.23	0.38
00026783	Brown Creek	15020005000139	460	46006	0.32	0.51
		15020005000437	460	46006	0.11	0.18
00032925	Pine Creek	15060203000460	460	46006	0.02	0.03
00032925	Pine Creek	15060203000460	460	46006	0.71	1.14
		15060203002949	460	46006	0.68	1.10
00035932	Webber Creek	15060203000504	460	46006	0.47	0.75
00035932	Webber Creek	15060203000504	460	46006	0.20	0.32
00026726	Bray Creek	15060203001009	460	46006	1.40	2.26

GNIS ID	GNIS NAME	REACHCODE	FTYPE	FCODE	Miles	Kilometers
00028796	East Verde River	15060203000208	460	46006	0.46	0.74
00028882	Ellison Creek	15060203003423	460	46006	0.08	0.13
		15060203000991	460	46006	0.37	0.59
00028796	East Verde River	15060203000214	460	46006	1.23	1.98
00035932	Webber Creek	15060203000500	460	46006	0.55	0.88
00028658	Dude Creek	15060203005983	460	46006	0.56	0.90
00028743	East Clear Creek	15020008000080	460	46006	0.98	1.57
00035375	Tonto Creek	15060105000136	460	46006	0.46	0.75
00035375	Tonto Creek	15060105000134	460	46006	0.10	0.16
		15020008002899	460	46006	0.25	0.40
		15020008000617	460	46006	1.22	1.96
00033979	Salome Creek	15060103000335	460	46006	0.93	1.50
00033979	Salome Creek	15060103000572	460	46006	0.17	0.28
00027620	Christopher Creek	15060105000622	460	46006	0.64	1.04
00027620	Christopher Creek	15060105000622	460	46006	0.73	1.17
		15020008000620	460	46006	0.14	0.22
		15020008000619	460	46006	0.39	0.63
00035539	Turkey Creek	15020008000612	460	46006	0.67	1.08
00035539	Turkey Creek	15020008000612	460	46006	1.30	2.10
		15020008000625	460	46006	0.23	0.37
00035539	Turkey Creek	15020008000612	460	46006	0.97	1.56
00033592	Reynolds Creek	15060103000562	460	46006	0.54	0.87
00033592	Reynolds Creek	15060103000562	460	46006	0.27	0.43
		15060103001435	460	46006	0.30	0.48
00029681	Haigler Creek	15060105000116	460	46006	0.89	1.43

GNIS ID	GNIS NAME	REACHCODE	FTYPE	FCODE	Miles	Kilometers
00027571	Chevelon Creek	15020010000048	460	46006	1.07	1.72
		15020010000835	460	46006	0.04	0.06
		15020010000870	460	46006	0.35	0.57
00027571	Chevelon Creek	15020010000044	460	46006	0.04	0.06
00027571	Chevelon Creek	15020010000040	460	46006	0.97	1.56
00027571	Chevelon Creek	15020010000040	460	46006	1.15	1.85
00027269	Canyon Creek	15060103000180	460	46006	0.53	0.85
00027571	Chevelon Creek	15020010000037	460	46006	1.41	2.28
		15020005001467	460	46006	0.02	0.04
00032925	Pine Creek	15060203000460	460	46006	0.23	0.37
00027734	Clover Creek	15060203005960	460	46006	0.49	0.79
00028796	East Verde River	15060203000212	460	46006	0.11	0.17
00028796	East Verde River	15060203000216	460	46006	1.13	1.82
00028658	Dude Creek	15060203005993	460	46006	0.48	0.78
00028743	East Clear Creek	15020008000085	460	46006	0.15	0.24
00035375	Tonto Creek	15060105000135	460	46006	0.38	0.61
00035375	Tonto Creek	15060105000138	460	46006	0.84	1.35
00035375	Tonto Creek	15060105000138	460	46006	0.17	0.28
00035375	Tonto Creek	15060105000140	460	46006	1.22	1.96
00028469	Dick Williams Creek	15060105000646	460	46006	2.11	3.40
		15020008002905	460	46006	0.29	0.47
		15020008000578	460	46006	0.06	0.10
00028743	East Clear Creek	15020008000079	460	46006	0.15	0.24
		15060105000581	460	46006	1.00	1.60
		15020008000621	460	46006	0.12	0.19
		15020008000617	460	46006	1.34	2.16

GNIS ID	GNIS NAME	REACHCODE	FTYPE	FCODE	Miles	Kilometers
		15060105001959	460	46006	0.44	0.71
		15020008000620	460	46006	0.44	0.70
		15060105000585	460	46006	0.35	0.57
00027620	Christopher Creek	15060105000621	460	46006	0.03	0.04
00036399	Workman Creek	15060103000548	460	46006	0.26	0.41
00036399	Workman Creek	15060103000550	460	46006	0.78	1.25
00036399	Workman Creek	15060103000547	460	46006	0.21	0.34
00036399	Workman Creek	15060103000550	460	46006	0.21	0.33
00036399	Workman Creek	15060103000550	460	46006	0.17	0.27
00033592	Reynolds Creek	15060103000561	460	46006	0.19	0.31
00033592	Reynolds Creek	15060103000561	460	46006	0.14	0.23
		15060105002710	460	46006	0.01	0.02
00028189	Crouch Creek	15060103000394	460	46006	0.58	0.94
00027571	Chevelon Creek	15020010000047	460	46006	0.00	0.01
00027571	Chevelon Creek	15020010000047	460	46006	0.00	0.00
		15020010000868	460	46006	0.01	0.02
00027620	Christopher Creek	15060105000620	460	46006	0.42	0.67
00036399	Workman Creek	15060103000550	460	46006	0.15	0.24
00028757	East Fork Horton Creek	15060105003368	460	46006	0.75	1.21
00027542	Cherry Creek	15060103000231	460	46006	0.04	0.06
00027571	Chevelon Creek	15020010000040	460	46006	0.16	0.26
00027269	Canyon Creek	15060103000182	460	46006	0.30	0.48
00027269	Canyon Creek	15060103000184	460	46006	0.12	0.20
00027571	Chevelon Creek	15020010000039	460	46006	0.16	0.26

GNIS ID	GNIS NAME	REACHCODE	FTYPE	FCODE	Miles	Kilometers
00033112	Porter Creek	15020005001452	460	46006	0.31	0.50
		15020005000380	460	46006	0.07	0.12
		15020005001498	460	46006	0.37	0.60
00032925	Pine Creek	15060203000460	460	46006	0.84	1.35
00035932	Webber Creek	15060203000504	460	46006	0.41	0.66
00028796	East Verde River	15060203000208	460	46006	0.15	0.25
00028796	East Verde River	15060203000211	460	46006	0.48	0.77
00028796	East Verde River	15060203000214	460	46006	1.11	1.79
00028743	East Clear Creek	15020008000084	460	46006	0.72	1.15
00028743	East Clear Creek	15020008000080	460	46006	2.31	3.72
00030215	Horton Creek	15060105000640	460	46006	0.69	1.12
00028743	East Clear Creek	15020008000079	460	46006	1.08	1.74
00028757	East Fork Horton Creek	15060105003369	460	46006	0.40	0.65
00028743	East Clear Creek	15020008000078	460	46006	0.29	0.47
00028743	East Clear Creek	15020008000077	460	46006	0.57	0.92
00028743	East Clear Creek	15020008000077	460	46006	1.40	2.25
00033979	Salome Creek	15060103000570	460	46006	0.44	0.71
00027620	Christopher Creek	15060105000617	460	46006	0.21	0.34
00027620	Christopher Creek	15060105000617	460	46006	0.06	0.09
		15060105000582	460	46006	0.46	0.74
00027620	Christopher Creek	15060105000619	460	46006	0.40	0.64
		15020008000615	460	46006	0.31	0.50
00036399	Workman Creek	15060103000547	460	46006	0.06	0.10
00029681	Haigler Creek	15060105000115	460	46006	1.08	1.73

GNIS ID	GNIS NAME	REACHCODE	FTYPE	FCODE	Miles	Kilometers
		15060105000586	460	46006	0.53	0.86
00027620	Christopher Creek	15060105000621	460	46006	0.50	0.80
00027620	Christopher Creek	15060105000621	460	46006	0.09	0.14
00027620	Christopher Creek	15060105000621	460	46006	0.47	0.75
00027620	Christopher Creek	15060105000622	460	46006	0.23	0.37
00036399	Workman Creek	15060103000548	460	46006	0.18	0.28
00033592	Reynolds Creek	15060103000561	460	46006	0.09	0.14
00033592	Reynolds Creek	15060103000561	460	46006	0.17	0.27
00033592	Reynolds Creek	15060103000561	460	46006	0.04	0.07
00033592	Reynolds Creek	15060103007476	460	46006	0.44	0.70
00033592	Reynolds Creek	15060103000563	460	46006	0.40	0.64
		15060103001426	460	46006	0.25	0.40
		15060103001427	460	46006	0.73	1.17
		15020010000832	460	46006	0.09	0.14
00027571	Chevelon Creek	15020010000047	460	46006	0.09	0.15
00027571	Chevelon Creek	15020010000047	460	46006	0.32	0.52
00027571	Chevelon Creek	15020010000046	460	46006	0.21	0.34
00027571	Chevelon Creek	15020010000047	460	46006	0.27	0.43
00027571	Chevelon Creek	15020010000046	460	46006	0.25	0.40
00027571	Chevelon Creek	15020010000044	460	46006	0.04	0.07
00027269	Canyon Creek	15060103000185	460	46006	0.33	0.52
00027571	Chevelon Creek	15020010000040	460	46006	0.05	0.08
00027571	Chevelon Creek	15020010000040	460	46006	0.48	0.77
00027571	Chevelon Creek	15020010000039	460	46006	0.97	1.56

GNIS ID	GNIS NAME	REACHCODE	FTYPE	FCODE	Miles	Kilometers
00035854	Walnut Creek	15020005000367	460	46006	0.20	0.33
00026342	Billy Creek	15020005000148	460	46006	0.47	0.76
00033112	Porter Creek	15020005000585	460	46006	0.45	0.72
00036027	West Webber Creek	15060203001016	460	46006	0.40	0.64
00032398	North Sycamore Creek	15060203000993	460	46006	1.70	2.73
00028796	East Verde River	15060203000213	460	46006	0.49	0.79
00031455	Mail Creek	15060203003262	460	46006	1.77	2.84
00028882	Ellison Creek	15060203000939	460	46006	0.32	0.52
		15060203000972	460	46006	1.36	2.19
		15060203003612	460	46006	0.01	0.02
00028743	East Clear Creek	15020008000082	460	46006	0.59	0.94
00028743	East Clear Creek	15020008000081	460	46006	1.27	2.05
00028743	East Clear Creek	15020008000080	460	46006	0.94	1.52
00035375	Tonto Creek	15060105000137	460	46006	0.12	0.19
00030215	Horton Creek	15060105000639	460	46006	0.09	0.14
00035375	Tonto Creek	15060105000136	460	46006	0.89	1.43
		15020008002926	460	46006	0.26	0.42
		15020008002927	460	46006	0.29	0.46
00035375	Tonto Creek	15060105000131	460	46006	0.10	0.16
00027620	Christopher Creek	15060105000616	460	46006	0.34	0.55
		15060103000336	460	46006	0.13	0.20
		15020008000621	460	46006	0.73	1.17
00028743	East Clear Creek	15020008000075	460	46006	0.92	1.47
		15060105000581	460	46006	0.34	0.55

GNIS ID	GNIS NAME	REACHCODE	FTYPE	FCODE	Miles	Kilometers
		15060105000585	460	46006	1.04	1.68
		15020008000619	460	46006	0.22	0.35
00027620	Christopher Creek	15060105000620	460	46006	0.09	0.14
00035375	Tonto Creek	15060105000132	460	46006	1.09	1.75
00035375	Tonto Creek	15060105000134	460	46006	0.14	0.22
00033592	Reynolds Creek	15060103000561	460	46006	0.17	0.28
00033592	Reynolds Creek	15060103000562	460	46006	0.35	0.56
00029681	Haigler Creek	15060105000118	460	46006	0.58	0.94
00029681	Haigler Creek	15060105000119	460	46006	0.66	1.06
00029681	Haigler Creek	15060105000119	460	46006	0.63	1.01
00027571	Chevelon Creek	15020010000047	460	46006	0.04	0.07
00027571	Chevelon Creek	15020010000046	460	46006	0.09	0.14
00027571	Chevelon Creek	15020010000046	460	46006	0.22	0.36
00027571	Chevelon Creek	15020010000047	460	46006	0.12	0.20
00027571	Chevelon Creek	15020010000046	460	46006	0.17	0.28
00027571	Chevelon Creek	15020010000046	460	46006	0.10	0.15
00027571	Chevelon Creek	15020010000044	460	46006	0.35	0.57
		15020010000731	460	46006	0.07	0.12
00027571	Chevelon Creek	15020010000040	460	46006	0.70	1.13
00027571	Chevelon Creek	15020010000040	460	46006	0.17	0.28
		15020010000572	460	46006	0.23	0.37
00027571	Chevelon Creek	15020010000040	460	46006	0.77	1.23
00027269	Canyon Creek	15060103000182	460	46006	0.72	1.15
00027269	Canyon Creek	15060103000182	460	46006	0.94	1.51
00032165	Mule Creek	15060103001276	460	46006	1.30	2.10
00026342	Billy Creek	15020005000147	460	46006	0.34	0.55

GNIS ID	GNIS NAME	REACHCODE	FTYPE	FCODE	Miles	Kilometers
00026342	Billy Creek	15020005000148	460	46006	1.13	1.81
		15020005001467	460	46006	0.19	0.30
00032925	Pine Creek	15060203000460	460	46006	0.27	0.43
00035932	Webber Creek	15060203000502	460	46006	0.26	0.41
00028796	East Verde River	15060203000214	460	46006	0.26	0.42
00028796	East Verde River	15060203000215	460	46006	0.05	0.08
		15060203005998	460	46006	0.28	0.45
00028882	Ellison Creek	15060203000948	460	46006	0.28	0.45
00028743	East Clear Creek	15020008000085	460	46006	0.71	1.15
00028743	East Clear Creek	15020008000084	460	46006	0.28	0.44
00028743	East Clear Creek	15020008000083	460	46006	1.00	1.62
00035375	Tonto Creek	15060105000140	460	46006	0.28	0.44
00028743	East Clear Creek	15020008000080	460	46006	0.08	0.12
00028743	East Clear Creek	15020008000079	460	46006	0.29	0.46
00035375	Tonto Creek	15060105000132	460	46006	0.73	1.17
00035375	Tonto Creek	15060105000132	460	46006	0.42	0.67
		15060103000337	460	46006	0.18	0.29
		15020008000616	460	46006	0.63	1.02
00027620	Christopher Creek	15060105000618	460	46006	0.44	0.70
		15020008000620	460	46006	0.48	0.77
00027699	Clear Creek	15020008000072	460	46006	0.06	0.09
		15020008002917	460	46006	0.36	0.57
		15020008000615	460	46006	1.42	2.28
00027620	Christopher Creek	15060105000620	460	46006	0.59	0.94
		15020008001223	460	46006	2.28	3.67

GNIS ID	GNIS NAME	REACHCODE	FTYPE	FCODE	Miles	Kilometers
00029681	Haigler Creek	15060105000116	460	46006	2.26	3.64
00029681	Haigler Creek	15060105000117	460	46006	0.42	0.68
00033592	Reynolds Creek	15060103000562	460	46006	0.23	0.37
00027542	Cherry Creek	15060103000229	460	46006	0.00	0.00
		15060103001428	460	46006	0.27	0.43
00027571	Chevelon Creek	15020010000046	460	46006	0.07	0.12
		15020010000857	460	46006	0.06	0.10
		15020010000855	460	46006	0.07	0.11
00027571	Chevelon Creek	15020010000047	460	46006	0.04	0.07
		15020010000834	460	46006	0.03	0.05
00027571	Chevelon Creek	15020010001607	460	46006	0.05	0.08
		15020010000561	460	46006	0.06	0.10
00027269	Canyon Creek	15060103000181	460	46006	0.25	0.40
00027269	Canyon Creek	15060103000184	460	46006	0.61	0.98
00032165	Mule Creek	15060103001275	460	46006	0.80	1.29
00027571	Chevelon Creek	15020010000038	460	46006	0.04	0.07
00034392	Show Low Creek	15020005000110	460	46006	0.53	0.85
00026342	Billy Creek	15020005000148	460	46006	0.36	0.58

Appendix F. Resource Protection Measures.

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation	Primary Resource	Category (BMP, CM, DF)
AQ001	Any equipment or personnel for activities in and around streams, natural or constructed waters, springs, or wetlands of any kind will use decontamination procedures to prevent the spread of disease (e.g., Chytrid fungus) and aquatic invasive species. Personnel entering water bodies for any reason will also follow these procedures. This applies to entry into every aquatic restoration site and in between sites."	To minimize potential for spreading aquatic diseases or invasive species.	X		Aquatics	CM
AQ002	**Porous boulder structures and vane restoration treatments:** •Full channel spanning boulder structures are to be installed only in highly uniform, incised, bedrock-dominated channels to enhance or provide fish habitat in stream reaches where log placements are not practicable due to channel conditions (not feasible to place logs of sufficient length, bedrock dominated channels, deeply incised channels, artificially constrained reached, etc.), where damage to infrastructure on public or private lands is of concern. •Install boulder structures low in relation to channel dimensions so that they are completely overtopped during channel-forming flow events (approximately a 1.5 flow event). • Boulder step structures are to be placed diagonally across the channel or in more traditional upstream pointing "V" or "U" configurations with the apex oriented upstream. • Boulder step structures are to be constructed to allow upstream and downstream passage of all native fish species and life stages that occur in the stream. Plunges shall be kept to less than 6 inches in height. • The use of gabions, cable, or other means to prevent the movement of individual boulder in a boulder step structure is not allowed. • Rock for boulder step structures shall be durable and of suitable quality to assure long-term stability in the climate in which it is to be used. Rock sizing depends on the size of the stream, maximum depth of low, planform, entrenchment, and ice and debris loading.	To guide porous boulder structures and vane restoration treatments for aquatic and watershed restoration.		X	Aquatics	DF

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	• The project designer or an inspector experienced in these structures should be present during installation. • Full spanning boulder step structure placement should be coupled with measures to improve habitat complexity and protection of riparian areas to provide long-term inputs of large wood.					
AQ003	When using pressure treated lumber for fence posts, complete all cutting/drilling offsite (to the extent possible) so that treated wood chips and debris do not enter water or flood prone areas.	To prevent detrimental effects of chemicals from entering aquatic habitats.		X	Aquatics	DF
AQ004	**Set-back or removal of existing berms:** • Design actions to restore floodplain characteristics-elevation, width, gradient, length, and roughness—in a manner that closely mimics, to the extent possible, those that would naturally occur at that stream and valley type. • Remove drain pipes, fences, and other capital projects to the extent possible. • To the extent possible, remove nonnative fill material from the floodplain to an upland site. • Where it is not possible to remove or set-back all portions of berms, or in areas where existing berms support abundant riparian vegetation, openings will be created with breaches. Breaches shall be equal to or greater than the active channel width to reduce the potential for channel avulsion during flood events. In addition to other breaches, the berm, dike, or levee shall always be breached at the downstream end of the project or at the lowest elevation of the floodplain to ensure the flows will natural recede back into the main channel thus minimizing fish entrapment.	To guide set-back or removal of existing berms, dikes, and levees to reconnect stream channels with floodplains as a means to increase habitat diversity and complexity, moderate flow disturbances, and provide refuge for fish during high flows.	X	X	Aquatics	DF

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AQ005	**Channel Reconstruction/Relocation Treatments:** • Construct geomorphically appropriate stream channels and floodplains within a watershed, valley, and reach context. • Design actions to restore floodplain characteristics – elevation, width, gradient, length, and roughness-in a manner that closely mimics, to the extent possible, those that would naturally occur at that stream and valley type. • To the greatest degree possible, remove nonnative fill material from the channel and floodplain to an upland site. • When necessary, loosen compacted soils once overburden material is removed. Overburden or fill comprised of native materials, which originated from the project area, may be used within the floodplain where appropriate to support the project goals and objectives. • Structural elements shall fit within the geomorphic context of the stream system. For bed stabilization and hydraulic control structures, constructed riffles shall be preferentially used in pool-riffle stream types, while roughened channels and boulder step structures shall be preferentially used in step-pool and cascade stream types. • Material selections (large wood, rock, gravel) shall also mimic natural stream system materials. • Construction of the stream bed should be based on Stream Simulation Design principles as described in section 6.2 of Stream Simulation: An Ecological Approach to Providing Passage of Aquatic Organisms at Road-Stream Crossings or other appropriate design guidance documents (USDA-Forest Service 2008).	To guide stream, floodplain, and other stream/watershed restoration treatments to minimize detrimental effects to aquatic habitats.	X	X	Aquatics	DF
AQ006	Minimize the number and length of stream crossings. Such crossings will be at right angles and avoid potential spawning or breeding areas to the greatest extent possible. Stream crossings shall not increase the risk of channel re-routing at low and high water conditions. After project completion, temporary stream crossing will be abandoned and the stream channel and banks restored.	To minimize ground disturbance in aquatic and associated habitats during site preparation and sedimentation to aquatic habitats.	X	X	Aquatics	CM

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AQ007	For recreation relocation projects—such as campgrounds, horse corrals, off-road vehicle trails—move current facilities out of the riparian area or as far away from the stream as possible.	To reduce recreation effects on aquatic habitats.	X		Aquatics	DF
AQ008	To the extent feasible, heavy equipment will work from the top of the bank, unless working from within the stream bed would result in less damage to the aquatic ecosystem, as determined by a biologist.	To minimize ground disturbance in aquatic and associated habitats during site preparation and sedimentation to aquatic habitats.	X	X	Aquatics	DF
AQ009	Any fence placement must allow for lateral movement of a stream and to allow establishment of riparian plant species. To the extent possible, fences will be placed outside the channel migration zone.	To maximize success of riparian planting and reduce maintenance on fencing.		X	Aquatics	DF
AQ010	When building riparian exclosure fences, minimize vegetation removal, especially potential large wood recruitment sources, when constructing fence lines.	To reduce detrimental effects to riparian species (flora and fauna) and floodplains.		X	Aquatics	DF
AQ011	Where appropriate, include hazard tree removal (amount and type) in project design. Fell hazard trees when they pose a safety risk. If possible, fell hazard trees within riparian areas towards a stream. Keep felled trees on site when needed to meet coarse large wood objective or to be used as part of restoration treatments.	Improve aquatic habitat complexity while meeting safety objectives.		X	Aquatics	DF
AQ012	Leave sufficient numbers of cut trees (large woody debris) onsite for needed surface flow grade control. Fisheries, wildlife, or watershed personnel will identify locations for large woody debris before works starts and/or inspect large woody debris placement work done by the timber sale administrator or contracting officer representative prior to unit closeout.	To minimize impacts to streams and soils in meadows from tree thinning operations.	X	X	Aquatics	DF

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AQ013	**Streambank Restoration Treatments:** • Without changing the location of the bank toe, restore damaged streambanks to a natural slope and profile suitable for establishment of riparian vegetation. This may include sloping of unconsolidated bank material to a stable angle of repose or the use of benches in consolidated, cohesive soils. • Complete all soil reinforcement earthwork and excavation when soils are sufficiently dry to prevent excessive rutting. When necessary, use soil layers or lifts that are strengthened with biodegradable fabrics and penetrable by plant roots. • Include large wood to the extent it would naturally occur for streambank restoration. If possible, large wood should have untrimmed root wads to provide functional refugia habitat for fish. Wood that is already within the stream or suspended over the stream may be repositioned to allow for greater interaction with the stream. • Rock will not be used for streambank restoration, except as ballast to stabilize large wood. • Use a diverse assemblage of vegetation species native to the action area or region, including trees, shrubs, and herbaceous. Vegetation, such as willow, sedge and rush mats, may be gathered from abandoned floodplains, stream channels, etc. • Install fencing as necessary to prevent access to revegetated sites by livestock or unauthorized persons. • Conduct post-construction monitoring and treatment or removal of invasive plants until native plant species are well established.	To guide streambank and channel restoration/resilience treatments.	X	X	Aquatics	DF
AQ014	Minimize removal of desirable vegetation around springs and wetlands.	To reduce detrimental effects to sensitive habitats.	X	X	Aquatics	CM
AQ015	Minimize disturbance of existing vegetation in ditches and at stream crossings.	To provide vegetative filters that reduce sedimentation to aquatic habitats.		X	Aquatics	DF

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AQ016	When removing a culvert from a first or second order, non-fish bearing stream roads managers, biologists, and watershed personnel shall determine if culvert removal should include stream isolation and rerouting in project design. Culvert removal on fish bearing streams shall adhere to the measures described in Fish Passage Restoration.	To reduce impacts to fish passage.		X	Aquatics	DF
AQ017	For culvert removal projects, restore natural drainage patterns and channel morphology. Evaluate channel incision risk and construct in-channel grade control structures when necessary.	To reduce detrimental effects to floodplains, riparian areas, stream channels and aquatic habitat.	X	X	Aquatics	DF
AQ018	Structural erosion control measures will not include materials that can trap reptiles or amphibians. This requirement will be described in a standard contract provision BT6.6 (erosion prevention and control), BT6.67 (erosion control structure maintenance) and within the road package, or specified in any agreements as a provision. Structural erosion control measures not made of biodegradable material (e.g., silt fences) will be removed and material contoured in or removed within one year to prevent them from causing resource issues and decomposing on site.	To minimize detrimental effects to federally listed, sensitive, or other reptiles and amphibians.	X	X	Aquatics	CM
AQ019	• Given the potential for multiple aquatic species to occur in a given location, FS, FWS, and AGFD biologists will cooperatively prioritize aquatic species of concern on a site specific basis regarding timing restrictions for instream and riparian restoration activities. • Work will occur during base-flow conditions, and on dry or frozen riparian soil conditions where possible.	To minimize direct effects to critical habitat (e.g. spawning and breeding) for federally listed and forest sensitive species.	X	X	Aquatics	CM
AQ020	Biologists will be consulted during pre-planning for all treatments that will occur in springs, streams, and riparian areas, as well as fens or bogs where histic soils are present, to determine presence of federally listed or sensitives species (plants or animals), as well as mitigations needed for rare or sensitive species in/near the work areas.	To minimize effects to rare/sensitive aquatic species during project implementation.	X	X	Aquatics	DF

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AQ021	**Garter snakes:** • Aquatic Management Zones in Narrow-headed and Northern Mexican Garter snake proposed critical habitat will be 600 ft. on either side of the stream. • No mechanical or hand piling will occur within the Garter snake AMZs to minimize effects during controlled burns or pile burning. • Any Narrow-headed and Northern Mexican garter snakes found will be relocated for the project types listed above following the Instream Construction Zone Isolation for Aquatic Species design features. Per the protocol, biologists will pre-identify areas where snakes would be moved in coordination with Arizona Game and Fish Department and U.S. Fish and Wildlife Service. • Disturbance of rock/boulder piles and large woody debris in narrow-headed or northern Mexican garter snake habitat or proposed critical habitat will be avoided to the greatest extent practical during their hibernation period. • Do not build temporary roads in narrow-headed or northern Mexican garter snake habitat or proposed critical habitat during their hibernation period.	To minimize detrimental effects to federally listed garter snakes.	X	X	Aquatics	CM
AQ022	A qualified, permitted biologist will be on site during heavy equipment construction activities to attempt to protect narrow-headed or northern Mexican garter snakes and/or key habitat features during construction. This will occur within proposed critical habitat for construction zones in the following project types: • Fish Passage Restoration • Large Wood, Boulder, and Gravel Placement • Legacy structure removal or maintenance • Channel Reconstruction/Relocation • Off- and Side-Channel Habitat Restoration • Streambank Restoration • Set-back or Removal of existing berms for aquatic restoration • Beaver Habitat Restoration	To minimize direct effects to spawning and breeding grounds for federally listed and forest sensitive species.		X	Aquatics	CM

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AQ023	**Garter snakes:** Any Narrow-headed and Northern Mexican garter snakes found will be relocated for the project types listed above following the Instream Construction Zone Isolation for Aquatic Species design features. Per the protocol, biologists will pre-identify areas where snakes would be moved in coordination with Arizona Game and Fish Department and U.S. Fish and Wildlife Service.	To minimize direct effects to spawning and breeding grounds for federally-listed and forest sensitive species.		X	Aquatics	CM
AQ024	**Instream Construction Zone Isolation from Aquatic Species: Isolate Capture Area within the construction zone** • Install block nets at up and downstream locations outside of the construction zone to exclude fish from entering the project area. Leave nets secured to the stream channel bed and banks until construction activities within the stream channel are complete. If block nets or traps remain in place for more than one day, monitor the nets or traps at least on a daily basis to ensure they are secured to the banks and free of organic accumulation and to minimize fish predation or inadvertent capture of other aquatic species in the trap. **Capture and release of species within the construction zone** • Species trapped within the isolate work area will be captured and released as prudent to minimize risk of injury, then released at a safe release site, preferably upstream of the isolated reach, for fish in a pool or other area that provided cover and flow refuge. Collect fish in the best manner to minimize potential stranding and stress by seine or dip nets as the area is slowly dewatered, baited minnow traps placed overnight, or electrofishing (if other options are ineffective). Fish must be handled with extreme care and kept in water the maximum extent possible during transfer procedures. A healthy environment for the stressed fish shall be provided – large buckets (five-gallon minimum to prevent overcrowding) and minimal handling of fish. Place large fish in buckets separate from smaller prey-sized fish. Monitor water temperature in buckets and well-being of captured fish. If buckets are not being immediately transported, use aerators to maintain water quality. As rapidly as possible, but after fish	To minimize sedimentation and detrimental effects to aquatic species and habitat during aquatic and watershed restoration projects.		X	Aquatics	CM

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	have recovered, release fish. In cases where the stream is intermittent upstream, release fish in downstream areas and away from the influence of construction. Capture and release will be supervised by a fishery biologist experienced with work area isolation and safe handling of all fish. **Dewatering construction site** • When dewatering is necessary, ensure diversion passes flows and aquatic species to minimize detrimental effects. Return flow to downstream channel so they are not dewatered. Coffer dams should be built with non-erosive materials or covered in a manner that minimizes erosion and sedimentation as well as decreases in water quality. Diversion sandbags can be filled with material mined from the floodplain as long as such material is replaced at the end of project. Small amounts of instream material can be moved to help seal and secure diversion structures. Dissipate flow energy at the bypass outflow to prevent damage to riparian vegetation or stream channel. If diversion allows for downstream fish passage, place diversion outlet in a location to promote safe reentry of fish into the stream channel, preferably into pool habitat with cover. Pump seepage water from the de-watered work area to a temporary storage and treatment site or into upland areas and allow water to filter through vegetation prior to reentering the stream channel. **Surface Water Withdrawals** • Surface water may be diverted to meet construction needs, but only if developed sources are unavailable or inadequate. If aquatic species are or may be present (e.g. fish, tadpoles, mollusks), diversions may not exceed 10% of the available flow and fish screen(s) will be installed, operated, and maintained. **Stream re-watering** • Upon project completing, slowly re-water the construction site to prevent loss of surface water downstream as the construction site streambed absorbs water and to prevent a sudden release of suspended sediment. Monitor downstream during re-watering to prevent stranding of aquatic organisms below the construction site.					

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AQ025	Avoid water withdrawals from streams bearing aquatic species whenever possible. Water drafting must take no more than 10% of the stream flow and must not dewater the channel to the point of isolating species. Pump intakes shall have fish screens of 3/32 inch mesh or less and will have an intake flow of less than 1 foot/second to prevent entraining fish. Biologists must be consulted in all situations when pumping water from streams or other natural waterbodies.	To avoid, or minimize detrimental effects to native or desirable aquatic species and habitats.	X		Aquatics	CM
AQ026	Avoiding discharging water from one source into a different body of water, such as dumping unused water from a water tender in or near a water body other than the water body from which it was acquired.	To avoid spread of invasives, disease, and contaminants.	X		Aquatics	DF
AQ027	**Restoring fish passage during headcut and grade stabilization treatments**: • In streams with current or historic fish presence, provide fish passage over stabilized headcut through constructed riffles for pool/riffle streams or series of log or rock structures for step/pool channels. If large wood and boulder placement will be used for headcut and grade stabilization, refer to Large Wood, Boulder, and Gravel Placement. • Armor headcut with sufficiently sized and amounts of material to prevent continued up-stream migration of the headcut. Materials can include both rock and organic materials which are native to the area. Material shall not contain gabion baskets, sheet pile, concrete, articulated concrete block, and cable anchors. • Focus stabilization efforts in the plunge pool, the headcut, as well as a short distance of stream above the headcut. • Minimize lateral migration of channel around headcut (“flanking”) by placing rocks and organic material at a lower elevation in the center of the channel cross section to direct flows to the middle of the channel. • Short-term headcut stabilization may occur without associated fish passage measures. However, fish passage must be incorporated into the final headcut stabilization action and be completed during the first subsequent in-water work period. • In streams without current or historic fish presence, it is recommended to	To minimize loss of fish passage during headcut and channel grade stabilization treatments.		X	Aquatics	DF

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	construct a series of downstream log or rock structures to expedite channel aggradation. • Construct structures in a 'V' or 'U' shape, oriented with the apex upstream, and lower in the center to direct flows to the middle of the channel. • Key structures into the stream bed to minimize structure undermining due to scour, preferably at least 2.5x their exposure height. The structures should also be keyed into both banks – if feasible greater than 8 ft. • If several structures will be used in a series, space them at the appropriate distances to promote fish passage of all life stages of native fish. Incorporate jump height, pool depth, etc. in the design of step structures. Recommended spacing should be no closer than the net drop divided by the channel slope (for example, a one-foot high step structure in a stream with a two-percent gradient will have a minimum spacing of 50-feet. • Include gradated (cobble to fine) material in the rock structure material mix to help seal the structure/channel bed, thereby preventing subsurface flow and ensuring fish passage immediately following construction if natural flows are sufficient. • If a project involves the removal of multiple barriers on one stream or in one watershed over the course of a work session, remove the most upstream barrier first if possible.					
AQ028	**Large Wood, Boulder, and Gravel Placement Treatments:** • Place large wood and boulders in areas where they would naturally occur and in a manner that closely mimic natural accumulations for that particular stream type. For example, boulder placement may not be appropriate in low gradient meadow streams. • Structure types shall simulate disturbance events to the greatest degree possible and if appropriate, could include, but are not limited to, log jams, debris flows, windthrow, and tree breakage. • No limits are to be placed on the size and shape of structures as long as such structures are within the range of natural variability of a given location and do not block fish passage.	To guide successful large wood and boulder stream restoration treatments.	X	X	Aquatics	DF

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation	Primary Resource	Category (BMP, CM, DF)
	• Projects can include grade control and bank stabilization structures, while size and configuration of such structures will be commensurate with scale of project site and hydraulic forces. • The partial burial of large wood and boulders is permitted. This applies to all stream systems but more so for larger stream systems where use of adjacent riparian trees or channel features is not feasible or does not provide the full stability desired. • Large wood includes whole conifer and hardwood trees, lobs, and root wads. Large wood size (diameter and length) should account for bankfull width and stream discharge rates. When available, trees with root wads should be a minimum of 1.5x bankfull channel width, while logs without root wads should be a minimum of 2.0x bankfull width. • Structures may partially or completely span stream channels or be positioned along stream banks. • Stabilizing or key pieces of large wood must be intact, hard, with little decay, and if possible have root wads (untrimmed) to provide functional refugia habitat for fish. Consider orienting key pieces such that the hydraulic forces upon the large wood increases stability. • Anchoring large wood – Anchoring alternatives may be used in preferential order: 1) Use of adequate sized wood sufficient for stability. 2) Orient and place wood in such a way that movement is limited. 3) Ballast (gravel or rock) to increase the mass of the structure to resist movement. 4) Use of large boulders as anchor points for large wood. 5) Pin large wood with rebar to large rock to increase its weight. For stream that are entrenched (Rosgen F, G, A, and potentially B) or for other streams with very low width to depth ratios (<12) and additional 60% ballast weight may be necessary due to greater flow depths and higher velocities.					
AQ029	Engineered Logjams: • Engineered log jams will be patterned, to the greatest degree possible, after stable natural log jams.	To guide engineered log jam stream treatments.	X	X	Aquatics	DF

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	• Grade control engineered log jams are design to arrest channel down-cutting or incision by providing a grade control that retains sediment, lowers stream energy, and increases water elevations to reconnect floodplain habitat and diffuse downstream flood peaks. • Stabilizing or key pieces of large wood that will be relied on to provide streambank stability or redirect flows must be intact, solid (little decay). If possible, acquire large wood with untrimmed root wads to provide functional refugia habitat for fish. • When available, trees with root wads should be a minimum of 1.5x bankfull channel width, while logs without root wads should be a minimum of 2.0x bankfull width. • The partial burial of large wood and boulders may constitute the dominant means of placement, and key boulders (footings) or large wood can be buried into the stream bank or channel. • Angle and Offset – The large wood portions of engineered log jam structures should be oriented such that the force of water upon the large wood increases stability. If a root wad is left exposed to the flow, the bole placed into the stream bank should be oriented downstream parallel to the flow direction so the pressure on the root wad pushes the bole into the streambank and bed. Wood members that are oriented parallel to flow are more stable than members oriented at 45 or 90 degrees to the flow. • If large wood anchoring is required, a variety of methods may be used. These include buttressing the wood between riparian trees, the use of manila, sisal or other biodegradable ropes for lashing connections. If hydraulic conditions warrant use of structural connections, such as rebar pinning or bolted connections, may be used. Rock may be used for ballast but it limited to that needed to anchor the large wood. • There is no DBH (diameter at breast height) restriction for large wood, but consider the following before removing and placing trees. Diameter This key to establishing a logjam is utilizing larger diameter wood that					

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	resists decay. These pieces of wood are often called "key pieces," and serve as the anchors for the logjam structure. Wood can improve fish habitat only if the wood is large enough to stay, influence flow patterns, and sediment sorting. Larger diameter wood retains its size longer as abrasion and decay occurs over the years. Larger diameter wood is more effective in creating pools and complex channels that improve fish populations. The minimum diameter required for a key piece of wood depends on bankfull width of the stream is found in the following table. Bankfull widths and minimum diameter of logs to be considered key pieces. Bankfull Width* - Feet Minimum Diameter* - Inches 0 to 10 10 10 to 20 16 20 to 30 18 Over 30 22 * This table was taken from '1995 Guide to Placement of Large Wood in Streams'. Length • The length of the wood is also important to stability. To be considered a key piece a log with a rootwad still attached should be at least one and one-half times (1.5X) the bankfull or a log without a rootwad should be twice (2X) the length of the stream's bankfull width. As the best fish habitat is formed around jams composed of 3 to 7 logs, at least 2 key pieces should be used at each structure. • Mimic natural accumulations of large woody debris based on stream type, valley setting, and community type and ensure future large woody debris recruitment. • Tailholds as part of tree tipping operations are permitted across perennial, intermittent, and ephemeral streams but the use of protective straps will be required to prevent tree damage.					

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AQ030	**Gravel Augmentation Stream Restoration Treatments:** • Gravel can be placed directly into the stream channel, at tributary junctions, or other areas in a manner that mimics natural debris flows and erosion. • Augmentation will only occur in areas where the natural supply has been eliminated, significantly reduced through anthropogenic disruptions, or used to initiate gravel accumulations in conjunction with other projects, such as simulated log jams and debris flows. • Gravel to be placed in streams shall be a properly sized gradation for that stream, clean, and non-angular. When possible use gravel of the same lithology as found in the watershed. Reference the Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings (USDA-Forest Service 2008) to determine gravel sizes appropriate for the stream. • Gravel can be mined from the floodplain at elevations above bankfull, but not in a manner that would cause stranding during future flood events. Crushed rock is not permitted. • After gravel placement in areas accessible to higher stream flow, allow the stream to naturally sort and distribute the material. • Do not place gravel directly on bars and riffles that are known spawning areas, which may cause fish to spawn on the unsorted and unstable gravel, thus potentially resulting in red destruction.	To guide gravel augmentation treatments for aquatic and watershed restoration.	X	X	Aquatics	DF
AQ031	Imported gravel for use in or around aquatic systems must be free of invasive species, non-native seeds, and aquatic diseases. If necessary, wash gravel prior to placement and allow it to completely dry for a minimum of 2 days to prevent spread of chytrid fungus. More time for drying may be needed depending on the amount of gravel.	To prevent spread or introduction of invasive species and aquatic diseases in stream habitat.	X	X	Aquatics	CM

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AQ032	**Off and Side Channel Stream Habitat Restoration**: • When a proposed side channel will contain >20% of the bankfull flow, the Action Agencies will ensure that the action is reviewed by the Forest or Regional Fisheries Biologist and the Forest or Regional Engineer. • Data requirements and analysis for off- and side-channel habitat restoration include evidence of historical channel location, such as land use surveys, historical photographs, topographic maps, remote sensing information, or personal observation. • Allowable excavation – • Off- and side channel improvements can include minor excavation (<10% of volume) of naturally accumulated sediment within historic channels. There is no limit as to the amount of excavation of anthropogenic fill within historic side channels as long as such channels can be clearly identified through field or aerial photographs. Excavation depth will not exceed the maximum thalweg depth in the main channel. Excavated material removed from off- or side-channels shall be hauled to an upland site or spread across the adjacent floodplain in a manner that does not restrict floodplain capacity.	To reconnect historic side-channels with floodplains by removing off-channel fill and plugs. Furthermore, new side-channels and alcoves can be constructed in geomorphic settings that will accommodate such features.	X	X	Aquatics	DF
AQ033	Ensure that an experienced engineer, fisheries biologist, wildlife biologist, hydrologist and geomorphologist are involved in the design of all aquatic restoration projects. The experience should be commensurate with technical requirements of a project and needs to involve all.	To ensure technical skill and planning requirements for all aquatic and watershed restoration treatments.		X	Aquatics	DF
AQ034	Replant each area requiring revegetation prior to or at the beginning of the first growing season following instream or riparian restoration activities. Achieve reestablishment of vegetation in disturbed areas to at least 70% of pre-project levels within three years. Barriers will be installed as necessary to prevent access to revegetated sites by ungulates or unauthorized persons.	To rehabilitate all disturbed areas from aquatic and watershed restoration treatments, minimize erosion and sedimentation to aquatic habitats and potential effects to species.	X		Aquatics	BMP

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AQ035	During all implementation, maintain shade, bank stability, and large woody material recruitment potential.	Minimize detrimental disturbance of desirable riparian/aquatic conditions to the greatest extent practical.	X		Aquatics	DF
AQ036	Inspect daily for fluid leaks before leaving the vehicle staging area for operation.	To prevent petroleum contamination into aquatic systems and habitats.		X	Aquatics	BMP
AQ037	For stream restoration, live conifers and other trees can be felled or pulled/pushed over for in-channel large wood placement in streams or floodplains only when conifers and trees are fully stocked. Tree felling shall not create excessive stream bank erosion or increase the likelihood of channel avulsion during high flows.	To maintain forest structure and facilitate riparian restoration activities		X	Silviculture	
AQ038	Within the primary shade zone retain 100% of the over-story canopy closure, unless other exceptions listed below are met. Source trees being extracted (either by tipping and/or felling) for stream restoration will not be cut from within the primary shade zone. Hill Slope — Primary Shade Zone Width (slope distance) <30% — 50 ft. 30-60% — 55 ft. >60% — 60 ft. The distances listed above may be reduced (but not less than 25 ft.) if any of the following conditions apply: • The trees are located on a south facing slope and therefore do not provide stream shade; • An appropriate level of analysis is completed and documents, such as shade modeling with LiDAR, using site-specific characteristics to determine the primary shade tree width; and/or • Field monitoring or measurements are completed to determine the width where Optimum Angular Canopy Density (65% or greater) is achieved. • If trees are being felled for safety reasons they can be felled towards the stream.	To maintain or improve the primary shade zone surrounding aquatic habitats.		X	Silviculture	

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BT001	During layout, protect Southwestern Region sensitive or analysis plant groups where practical by including the plants within tree groups and using areas not occupied by the plants as interspaces.	Provide protection and shade needed by the sensitive plants while allowing for the least effect on clump/group/interspace design and layout during implementation and help mitigate effects on Southwestern Region sensitive plants and forest plan analysis species.		X	Botany	DF
BT002	Survey springs and channels for Bebb's willow before implementation and identify locations. Inform the forest botanist or district wildlife biologist if new locations are found and mitigate effects to plants and populations. Mitigations include avoiding plants, altering designs, or including plants in enclosures. Identify opportunities to enhance Bebb's willow where plants are decadent or dying. Manual grubbing of grasses may be used to increase the likelihood of planting success.	Protects populations and habitat of Bebb's willow. Bebb's willow stands would be enhanced by using cuttings, planting locally cultivated plants, and fencing existing or newly planted willows.	X		Botany	DF
BT003	Prescribed fires are conducted under conditions that promote native plant communities, hinder weed species germination, aid with controlling existing weed infestations, and prevent the spread of existing weeds.	Promote healthy native plant communities and reduces the risk of noxious or invasive weed invasions.	X		Botany	DF

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation	Primary Resource	Category (BMP, CM, DF)
BT004	Review various sites such as spring restoration for opportunities to introduce and restore Bebb's willow to supplement existing locations on the forest and introduce young plants into areas where plants are decadent and dying. Bebb's willow stands would be enhanced by using cuttings, planting locally cultivated plants, and using barriers as needed to protect existing or newly planted willows from browsing. Manual grubbing of grasses may be used to increase the likelihood of planting success. Where needed, fire lines would be placed around Bebb's willows and/or fuels would be removed from the vicinity of willow clumps to ensure there is only low to very low burn severity (fire effects to soil) and low to very low severity (fire effects to vegetation) in and around willow clumps.	Aids in restoring Bebb's willow which is a Southwestern Region sensitive species for the A-S and Coconino NF and a rare species on the landscape for both forests.		X	Botany	CM
BT005	When planning for implementation, identify species of concern (such as Southwestern Region sensitive plants), and determine potential habitat based on past occurrences and the known ranges of the species. If there are no documented surveys, the appropriate specialist (e.g., forest botanist, wildlife biologist) should be consulted to determine the need for, and extent of, new surveys. If the appropriate specialist is unavailable, the area to be treated should be surveyed prior to implementation and implementation plans should be adjusted if/as needed, based on survey results. Surveys should focus on areas most likely to contain plants or potential habitat for the targeted species, based on conditions such as soil or vegetation type, rather than covering the entire area. Habitat modeling, or the use of habitat descriptions of species from past documentation, etc. will be used to help define survey areas. Narrow endemics should receive more attention than more widespread species because the loss of individuals would have greater impact on the overall population of the species than in more widely distributed species.	Complies with FSM direction 2670. Manual direction (FSM 2670.5(19)) emphasizes that management actions should avoid or minimize effects on sensitive species.	X		Botany	DF
BT006	Monitor the effects of treatment on Southwestern Region sensitive plants after treatments are completed.	Provides opportunities to obtain knowledge on local species that are often poorly understood. Allows for adaptive	X		Botany	

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation	Primary Resource	Category (BMP, CM, DF)
		management in future treatments.				
BT007	Mitigate loss of individuals and groups of Southwestern Region sensitive plants during management activities by avoiding plants as much as possible while achieving management objectives. Preserve plants and habitat during implementation of management activities, while realizing there may be some short-term losses of individuals or groups and short-term effects to habitat while moving toward desired conditions.	Complies with FSM direction, minimizes effects on Southwestern Region sensitive plants.	X		Botany	CM
BT008	Landings, machine slash piles and other ground disturbing activities (e.g., firelines, parking areas, etc.) and other ground-disturbing activities should not occur directly on Southwestern Region sensitive plant populations.	Mitigates effects of disturbance, loss of plants, and severe burning effects on soils. Reduces loss of native seed bank and limits extent of severe disturbances.	X	X	Botany	CM
BT009	Prohibit temporary road construction and reconstruction, tracked vehicles, and pits within populations of Southwestern Region sensitive plants.	Eliminates direct loss of plants.		X	Botany	DF
BT010	Sensitive plant populations would be avoided when constructing temporary roads.	Prevents direct impacts to sensitive plant species.		X	Botany	DF
CK001	A buffer with a radius of 300 feet should be used to restrict activities that can negatively alter the resources, functions, and associated features of caves or karst features unless site-specific adjustments are made in coordination with the appropriate specialist(s), based on the characteristics and importance of the cave or karst features and the expected impact of the proposed activity. If felled trees must be removed from within the buffer, avoid yarding over or through karst features.	Minimize alteration of the chemical, physical, and biological conditions of karst features, to protect human health and safety, and to reduce potential disturbance to roosting bats	X	X	Caves and Karst	

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation	Primary Resource	Category (BMP, CM, DF)
CK002	Thinning or other vegetation treatments with chainsaws or other light equipment, as needed to implement mechanical treatments or prescribed fire, may be used up to cave openings or edges of the sinkholes/pits if specialists determine that there is some risk to the cave/karst environment if nothing is done. Directional felling should be used to fell trees away from karst features. Slash piles should be located at least 50 feet from any karst features.	To protect cave ecosystems from negative fire effects and to minimize alteration of the chemical, physical, and biological conditions of karst features.	X	X	Caves and Karst	
CK003	Take measures to ensure that petroleum products, herbicides, and other pollutants do not contaminate karst buffers by following proper storage and transport procedures.	To avoid contamination/pollution of caves/karst features.	X	X	Caves and Karst	DF
FE001	Prescribed fire will be implemented in such a way that, whenever possible, damage to fencing and other infrastructure used for managing livestock will be minimized. Any damage incurred to fences or other infrastructure associated with grazing management resulting from prescribed fire will be the responsibility of fire to fix as soon as possible following the burn, or on a timeline agreed on with range managers that would not affect planned grazing management.	To minimize damage to grazing infrastructure. Fire can easily damage grazing infrastructure, particularly fences, gates, and their supporting structure. Fencing can be costly, and is critical to the effective implementation of grazing management strategies.		X	Fire	

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation	Primary Resource	Category (BMP, CM, DF)
FE002	Burn unit size, as well as strategic placement, would be a consideration in designing units and implementation prioritization.	Fire effects & behavior: Large treatment areas arranged across a landscape are generally more effective at reducing fire behavior than arrangements of small treatment areas are. The arrangement of treatment units, regardless of size, can also make a significant difference in the effectiveness of treatments. Air Quality: Larger burn blocks, can mitigate some air quality impacts by increasing the number of acres that could be burned in a single burn window.		X	Fire	DF
FE003	As burn plans and burn units are developed, ensure consideration is given to the spatial and temporal effects of broadcast burning in the upper levels of a watershed.	To mitigate the cumulative effects to aquatic habitats and riparian areas of broadcast burning multiple adjacent levels within a watershed. Such effects include, but are not limited to, sedimentation and ash delivery to aquatic habitat.	X	X	Fire	DF

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation	Primary Resource	Category (BMP, CM, DF)
FE004	When practicable, damage or mortality to old trees and large trees would be mitigated by implementing prescription parameters, ignition techniques, raking, wetting, thinning, compressing slash, or otherwise mitigating fire effects to the degree necessary to meet burn objectives and minimize fire effects and behavior that could threaten old trees. Trees identified as being of particular concern (e.g., trees with known nests or roosts for herons, eagles, osprey, or other raptors, occupied nest cores, or critical areas in Mexican spotted owl protected activity centers (PACs) would be managed in accordance with wildlife design features (see Wildlife). Prepare old trees 1 year or more before a burn if possible.	Old trees are rare components and are under-represented across much of the project area. Implementing mitigation measures when possible is a critical component of restoration on a landscape scale. Large trees that are not old are not as susceptible to damage from fire as old trees. Mitigation measures that can be implemented a year or more before a burn, such as thinning or raking, may improve the response of the effectiveness of the mitigation measures.		X	Fire	DF
FE005	Fire personnel should confer with the appropriate district or forest personnel to identify noxious or invasive weeds within the perimeter of the prescribed burn unit, and areas that will be utilized as part of the implementation (such as staging areas), before burning is implemented. Jointly they shall identify the necessary mitigations as identified in the applicable forest weed management document. Mitigations may include, but are not limited to, avoiding noxious weeds while implementing and/or pretreatment of weeds before implementation. Follow-up monitoring should be conducted, especially in areas of severe disturbance. Large slash pile sites should be monitored after burning, and noxious or invasive weeds should be controlled according to the applicable forest weed management document.	Detect new weed infestations before they spread. Controls weeds, reduces risk of invasion and reduces risk to native species by reducing weed competition.		X	Fire	DF

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FE006	Burning within narrow-headed garter snake occupied habitat or proposed critical habitat will not occur during the hibernation period (December - February) when garter snakes are more likely to be hibernating in wood piles, debris jams, etc., unless cleared by the district biologist.	To avoid, improve, or minimize effects on the narrow-headed garter snake.	X	X	Fire	CM
FE007	Ignitions will not occur within any AMZ, unless approved by a watershed specialist and/or a biologist.	To prevent the introduction of chemicals, such as drip torch fuel, into soils and water.	X	X	Fire	
FE008	Firelines would be used to facilitate prescribed fire operations as needed to balance fire management and other resource protection objectives: (1) Firelines may consist of natural barriers, roads and trails, or may be constructed, if necessary, in coordination with other resource specialists. (See SW015 (#498)) (2) Fireline width would be determined as adjacent fuels and expected fire behavior dictate, assuming compliance with the requirements of cultural, wildlife, and other resource areas. (3) Constructed firelines would be rehabilitated when they are no longer needed, using methods appropriate to the site.	To provide for activities needed to implement prescribed fire while minimizing disturbance to all resources.		X	Fire	
FE009	Burn plans will incorporate Emission Reduction Techniques (ERTs) when they can effectively minimize air quality impacts, and when feasible (subject to economic and technical constraints, safety criteria, and land management objectives). Decision documents will identify smoke-sensitive receptors (or specify that there are none), and include objectives and courses of action to minimize and mitigate effects on those receptors as feasible.	Emission reduction techniques are recommended by the ADEQ as techniques that can be effective for minimizing air quality impacts.		X	Fire	

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation	Primary Resource	Category (BMP, CM, DF)
FE010	Mitigation and design features for smoke effects include: 1) Reducing emissions produced for a given area treated 2) Redistributing/diluting emissions through meteorological scheduling and by coordinating with other burners in the airshed. Dilution involves controlling the rate of emissions (from multiple fires) or scheduling for dispersion to assure tolerable concentrations of smoke in designated areas 3) Avoidance uses meteorological conditions when scheduling burning in order to avoid incursions of wildland fire smoke into smoke sensitive areas.	Minimize air quality impacts	X	X	Fire	
FE011	Concerned/interested public will be given as much warning as possible in advance of prescribed burns via notices, press releases, email lists, public announcements, phone lists, or other notification methods as appropriate.	To provide advanced notice for publics concerned about potential effects from emissions resulting from prescribed fires.	X	X	Fire	DF
FE012	Prescribed fires may be conducted before or after mechanical treatments. The sequencing of prescribed fires and mechanical treatments would be decided on a site-specific basis, depending on the site, burn windows, available resources, thinning schedules, etc.	Increase the flexibility for implementing both prescribed fire and mechanical treatments.		X	Fire	
FE013	Mechanical treatments following broadcast burns would occur after surface vegetation has recovered sufficiently to minimize soil disturbance from the mechanical treatments. Prescribed fire treatments following mechanical treatments would occur after there has been adequate surface vegetation recovery that fuel loads are sufficient to meet the objectives of a prescribed burn.	Minimize effects from the combined effects from mechanical treatments and prescribed fire on vegetation and soil. To maintain soil condition and productivity, and to ensure that prescribed fire objectives can be met.		X	Fire	

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NW001	Survey for noxious or invasive weeds in treatment areas prior to treatment and follow appropriate guidance based on location: Apache-Sitgreaves NFs: Follow the guidance in Appendix A of the Environmental Assessment for the ASNFs Integrated Forest-Wide Noxious Or Invasive Weed Management Program Coconino NF: Follow the guidance in appendix B of the "Final Environmental Impact Statement for Integrated Treatment of Noxious or Invasive Weeds, Coconino, Kaibab, and Prescott NFs within Coconino, Gila, Mojave, and Yavapai Counties, Arizona" Tonto NF: Follow the guidance in Appendix C of the Tonto NF Weed Treatment EA when operating on the Tonto NF.	Provides guidance and mitigation for noxious or invasive weeds.	X		Noxious Weeds	DF
NW002	Prevent spread of potential and existing noxious or invasive weeds by vehicles and equipment used in management activities by washing vehicles and equipment to remove seeds, soil, vegetative matter, and other debris that could contain or hold seeds prior to entering the project area and when moving from one treatment unit to another. For example, see timber sale contract provision WO-C/CT 6.36.	Reduces the potential for introduction of noxious weeds into NFS lands and mitigates effects of management actions on existing and potential noxious or invasive weed infestations; Forest Plan direction is complementary to Timber Sale Contract Clause CT WO-C/CT 6. 36 and watershed best management practices.	X	X	Noxious Weeds	BMP
NW003	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 or timber sale administrator as to the location for such cleaning and measures, if any, for controlling impacts.	This measure is designed to prevent the spread of noxious weeds from one treatment unit to another.	X	X	Noxious Weeds	BMP

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation	Primary Resource	Category (BMP, CM, DF)
NW004	If noxious or invasive weeds are identified during or post-implementation, treat the weeds and monitor for a minimum of three growing seasons.	This measure is designed to eliminate noxious or invasive weeds identified within a treatment area and provide assurance that the treatments were successful.	X	X	Noxious Weeds	DF
NW005	Timing of prescribed fire and herbicide application in areas with leafy spurge will be determined on a site-specific basis by the District Fuels Specialist and District Weeds Coordinator at the time of implementation. Herbicide treatments in the fall are most effective, though spring herbicide treatments following fall burns may be necessary to facilitate control.	Allows prescribed fire to occur in our near existing populations of leafy spurge while providing for control of it. Allows on the ground, site-specific assessment and coordination of the prescribed fire and control of leafy spurge on a site-specific basis.		X	Noxious Weeds	BMP
NW006	Before ground disturbing activities begin, inspect material sources on site annually (or before disturbance for new sites) to ensure they are weed- free before use and transport. Treat weed-infested sources for eradication, and strip, stockpile, and treat contaminated materials before using pit materials.	Prevent establishment and spread of invasive weed populations	X	X	Noxious Weeds	BMP
NW007	If weed treatments are not successful or not possible, operators would be informed of locations of noxious or invasive weed populations and ground disturbance associated with rock pit sites would be located away from noxious or invasive weed populations.	Prevent establishment and spread of invasive weed populations		X	Noxious Weeds	DF
NW008	Equipment (other than for hauling, unless coming from sites with known invasive weed populations) would be inspected and cleaned before entering rock pit areas to prevent introduction of invasive weeds.	Prevent establishment and spread of invasive weed populations		X	Noxious Weeds	DF

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NW009	Monitor and treat noxious or invasive weed populations following project implementation annually for at least three years to ensure that any weeds transported to the site are detected and controlled.	Prevent establishment and spread of invasive weed populations		X	Noxious Weeds	DF
NW010	Prevent any new noxious or invasive weed species from becoming established, contain or control the spread of known weed species, and eradicate species that are the most invasive and pose the greatest threat to the biological diversity and watershed condition. Maintain stockpiled, uninfested material in a weed-free condition.	Prevent establishment and spread of invasive weed populations	X		Noxious Weeds	BMP
RM001	Historic range monitoring sites including witness trees/posts, 1inch angle iron stakes, and any other site location markers would be protected. These sites would not be excluded from treatment but care needs to be taken to avoid loss of these site markers and damage to the areas. These sites would not be used as locations for temporary access roads, skid trails, landing areas, or large slash piles. District range and timber personnel will coordinate on these locations during presale packaging and prior to implementation.	Avoid monitoring site damage.		X	Rangeland Management	DF
RM002	The sale administrator would work closely with the district range staff to determine pasture use during thinning activities.	Avoid infrastructure damage, and retain allotment and pasture fences within a thinning treatment area. Provides for coordination of different activities within the same areas		X	Rangeland Management	

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RM003	All fences in the cutting area would be protected from thinning activities. Skid trail layout would attempt to keep equipment on one side of the fence to avoid having to cut fences. If fences need to be cut, a gate or temporary cattleguard may need to be constructed/installed with appropriate bracing; these areas shall be coordinated with district range personnel prior to cutting. If the fence is cut or damaged it shall be repaired to conditions equal to or better than existed (to Forest Service Standards). Temporary cattle guards would be installed on all haul roads where gates exist within active grazed pastures. All cattle guards on haul roads would be maintained throughout hauling activities and cleaned, if necessary upon completion of a sale. Damage to other range improvements, such as tanks, drainage into tanks, spillways, drinkers, pipelines, corrals, etc., shall be repaired or cleaned to a condition that was as good or better than existed. Skid trails, roads, landings, etc. should not be placed next to these range improvements.	Protect infrastructure.		X	Rangeland Management	
RM004	Rest or deferment of a pasture by livestock may occur after the completion of ground disturbing activities, such as burning and mechanical thinning. Range management personnel will evaluate conditions to determine when adjustment to livestock management, such as rest of deferment of a pasture is needed. Several factors may be used to assist in these determinations, such as plant recovery, plant vigor, and size of the disturbed area in relation to the pasture size. Plants that are well rooted, have multiple leaves or branches, and/or are producing seed head or flowers provide evidence of plant recovery, vigor, and reproductive ability.	Post ground-disturbing treatment assessment.		X	Rangeland Management	
RM005	The removal or exclusion of livestock water would be mitigated with alternative water sources, providing lanes to the water, or piping water to a livestock drinker.	Provide alternate water sources.		X	Rangeland Management	DF

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RM006	Prior to the construction of any exclosure fences or barriers, which exclude forage and/or water, or the removal of a water source, such as earthen tanks or trough, there needs to be a review by the District Ranger, Range Management personnel and other specialist to evaluate the extent and amounts that may be excluded on an allotment/pasture.	If a pasture/allotment has a considerable amount or extent of fencing or water exclusion, which could change livestock management such as numbers, season of use, distribution, etc., then these proposals should be analyzed during the Allotment Management Planning process. During this process, livestock management on the allotment can be evaluated along with the resource concern that would have initiated the fence and other possible solutions may arise. This will also allow a review of water rights, if applicable.		X	Rangeland Management	DF
RM007	Range and fire managers will coordinate burning and grazing schedules to minimize disruption of grazing while maximizing the implementation of prescribed fires. Each allotment will have specific management needs to be considered as management actions are planned and implemented. Past and future burns, projected rest/deferment are examples of things that should be considered when burn plans are being written and prior to implementation of prescribed fire. Grazing options, such as swing pastures, may be utilized to increase flexibility for range and fire managers.	The process of planning and implementing prescribed fire is long and complex. The effects are beneficial to most resources, though there are a myriad of restrictions on where and when prescribed fire can be implemented. The USFS issues Term Grazing Permits, Allotment Management Plans, and/or Annual Operating Instructions describing numbers, season of		X	Rangeland Management	

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		use, pasture rotations, etc. that permittees follow. Coordination will help maintain good working relationships and will minimize hardships to the permittees, while managing for ecosystem health. Coordinating the management of these programs for minimal disruption to both is desirable.				
RM008	Range readiness monitoring will be included in the appendix D implementation plan checklist. Annual monitoring typically includes measures for forage production, precipitation, forage utilization, livestock numbers, and livestock season of use. Condition and trend monitoring every 5 to 10 years measures plant canopy cover, plant frequency, and ground cover. By requiring inclusion of all design features and mitigation, appendix E, the biophysical and social monitoring and adaptive management plan, includes grazing-related monitoring.	To ensure range readiness is part of the annual compliance process.		X	Rangeland Management	DF
RS001	Coordination with the District Recreation Planner, District Trails Specialist, and local trail stewards will occur during prescription or burn plan development, layout, marking, thinning, and burning where any treatment will occur on, adjacent or near National and system trails. This is to ensure that trails and trail infrastructure are considered and protected and effects to scenic qualities are minimized to the extent practicable.	Resource protection	X	X	Recreation and Scenery	DF

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation	Primary Resource	Category (BMP, CM, DF)
RS002	Historic trails, roads and trail markers in the project area will be protected during project implementation in accordance with timber sale contract provision BT6.221, and BT6.22 (protection of improvements not owned by the forest service and those owned by the forest service respectively). Additionally, the General Crook Trail, the Arizona Trail, the Highline Trail, and other historic trails, roads and National Recreation Trails will maintain historic and scenic integrity during project implementation.	Regulatory requirement. Compliance with NHPA and Southwestern Region PA with AZ SHPO, National Recreational Trails compliance, National Historic Trails compliance.	X	X	Recreation and Scenery	DF
RS003	Efforts would be taken to limit forest treatment activities and hauling from rock pits within the project area during high-use weekends and holidays (e.g., Memorial Day, 4th of July, Labor Day, etc.); especially in locations where recreation-based activities (e.g., trails, trailheads, etc.) occur.	Protect public safety, decrease noise, reduce dust and minimize visibility issues on roads during high-use periods	X	X	Recreation and Scenery	DF
RS004	**Fire Control Lines:** (a) Generally restore control lines to a near undisturbed condition in the foregrounds (within 300 feet) of sensitive roads, trails, and developed recreation sites; (b) Rehabilitate containment lines by rolling back the soil berm formed during line construction and constructing drainage features as necessary to prevent concentration of runoff. Disguise containment lines to line of sight or first 300 feet, whichever is greater; (c) To hasten recovery and help eliminate unauthorized motorized and nonmotorized use of control lines in these areas, use measures such as recontouring, pulling slash and rocks across the line, and disguising entrances, and (d) Do not use motorized equipment on national scenic, historic and recreation trails, or other forest system trails if these are used for control lines. Coordinate with the district recreation staff regarding use of national trails as control lines.	Resource protection	X	X	Recreation and Scenery	
RS005	Where new temporary roads intersect existing roads or trails, native materials such as logs, slash, and/or boulders would be placed along temporary road to line-of-sight or first 300', whichever is greater.	Reduce unauthorized use	X	X	Recreation and Scenery	DF

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RS006	Unit Marking: (a) Avoid using trails as boundaries. (b) Avoid abrupt changes between treatment units. (c) Where feasible strive to have the minimal marking of trees within the Arizona Trail, General Crook Trail, and Highline Trail corridors. (d) Utilize species designation where appropriate to minimize the amount of necessary marking. (e) Unit boundaries will be marked with water based paint. (f) Use the below techniques suggested for edges of treatment units. Edges of Individual Units: (a) Ensure that forest stand composition changes are textural, with small, natural openings and not symmetrical in shape. Avoid straight lines and right angles. Ensure that openings resemble the form, line, and texture of those found in the surrounding natural landscape with edges feathered to avoid a shadowing effect. (b) where treatment unit is adjacent to denser forest (treated or untreated), the percent of thinning within the transition zone (150–250 feet) would be progressively reduced toward denser edges of the unit; (c) where treatment unit interfaces with an opening (including savanna and grassland treatments, and natural openings) the transition zone would progressively increase toward open edges of the unit; (d) soften edges by thinning adjacent to the existing unit boundaries. Treat up to edges; do not leave a screen of trees. Favor groups of trees complying with prescribed treatments that visually connect with the unit's edge to avoid an abrupt and noticeable change; (e) treatment boundaries should extend up and over ridgelines to avoid "mohawk" look; and (f) the ridgeline silhouette should have a textural effect of small, natural-appearing openings rather than large, thinned areas and unnatural-appearing breaks	Scenic integrity	X	X	Recreation and Scenery	DF

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RS007	Skidding activities would avoid National and forest system trails, if possible, except where motorized use is already authorized (trails located on open system and administrative roads). If it is determined necessary that a trail must be used as a skid trail crossing, make perpendicular trail crossings. Trail crossing locations, including those on the Arizona National Scenic Trail and the General Crook and Highline National Recreation Trails would be designated and flagged with input from the District Trails Specialist, Recreation Planner or Archaeologist. The trail would be restored to USFS standards (pre-project condition) following treatment.	Avoid degrading recreation setting and resource protection	X	X	Recreation and Scenery	DF
RS008	Mechanical thinning operations shall not damage cairns or markers.	Resource protection	X	X	Recreation and Scenery	DF
RS009	If trails are temporarily closed due to thinning, trails shall be returned to pre-treatment conditions.	Resource protection	X	X	Recreation and Scenery	DF
RS010	**Temporary Road, Skid Trail, Landing, and In-Woods Processing Site Construction:** (a) Utilize dust abatement methods for hauling during the season when dust is likely and funding is available. Coordinate with the appropriate county on the application and timing of application of dust abatement on road segments that have county maintenance responsibilities. (b) Blend temporary roads and skid trails into the characteristic landscape of the surrounding area. Create cut and fill banks to be sloped to accommodate natural revegetation and to reduce sharp contrasts viewed from any distance. Where new temporary roads and skid trails meet a primary travel route, they should intersect at a right angle and, where practicable, curve after the junction, to minimize the length of route seem from the primary travel route. (c) Shape and/or feather the edges of log landings and in-woods processing sites to avoid abrupt changes between treated and untreated areas. Standing trees and shrubs around in-woods processing sites and landings shall be left in strategic locations to serve as screening in sensitive viewsheds.	Resource protection and scenic integrity	X	X	Recreation and Scenery	DF

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	(d) When possible, in-woods processing sites, landings, temporary roads, and skid trails should be located out of view of CL1 and CL2 travel routes and wild and scenic rivers, to avoid observation of management activities. When avoiding these locations is not possible, the evidence of management activities should be restored in a timely manner per (f). (e) In woods processing sites, landings, temporary roads, and skid trails should be minimized within sensitive viewsheds, such as those within eligible or suitable wild and scenic river corridors or next to developed recreation sites, private homes, or communities, and along paved and passenger car level roads and trails; Stump heights shall be cut low with a 8" height above ground (uphill side) within wild and scenic river corridors; in the immediate foreground (300 feet) of CL1 and CL2 travel ways; and in the foreground of recreation sites, private lands, and trails. (f) Highest emphasis for slash treatment, temporary road closures and road decommissioning will be placed on eligible or suitable wild and scenic river corridors; foreground (up to 300 feet) of developed recreation sites, private homes or communities; and Concern Level 1 roads (paved roads and passenger car roads) and trails, especially those designated as national scenic, historic, or recreation trails. (g) All constructed features including but not limited to fencing, office trailers, sanitation facilities, fuel storage containers, or temporary structures shall be designed to blend with the surrounding environment. Color of proposed above-ground features shall be non-reflective and treated to be Forest Service brown or for a rusty appearance, or as approved by a FS landscape architect or other FS official. (h) In-woods processing sites, landings, skid trails, and temporary roads will be rehabilitated, including restoring proper drainage and reseeding as needed with native species. (i) To hasten recovery and help eliminate unauthorized motorized and non-motorized use of skid trails and temporary roads, use physical measures such as re-contouring, pulling slash and rocks across the line, placing cull logs perpendicular to the route, and disguising entrances;.					

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	(j) Avoid using FS designated trails as skid trails or for temporary roads. (k) National Scenic, Historic, and Recreation Trails as well as forest system trails (motorized and non-motorized) will not be used for temporary roads or skid trails. It is acceptable to make perpendicular trail crossings. The locations of crossings will be designated. Trail crossings will be restored to pre-project condition after use. (l) Crossing of the Arizona Trail will be done sparingly and only if no other alternative exists. These crossing locations will be coordinated with District Recreation Staff					
RS011	**Cull Logs, Stump Heights, and Slash Treatments:** (a) Cull logs would not be abandoned on landings. Use cull logs for closing temporary roads and decommissioning roads. Cull logs may also be suitable to use as down woody material, but must be scattered away from the landings. (b) Stump heights should be cut as low as possible. Within corridors of wild and scenic rivers; in the foreground of CL1 and CL2 travel routes, all trails, recreation sites, and private homes/ communities, flush cut stumps, if possible, or cut less than 8 inches above ground (uphill side), where topography and operational safety allows, with 12-inch heights as the exception and rarely occurring. (c) Slash must be treated or removed in the immediate foreground of sensitive places (e.g., in corridors of eligible or suitable wild and scenic rivers; within 300 feet of the centerline of Concern Level 1 roads, or national trails and sensitive trails; or 300 feet from the boundary of a recreation site or private land/communities). Where whole tree thinning occurs, machine piling may occur toward the back of landings. Prioritize slash burning in these locations within one year or as soon as possible after treatment. If conventional thinning practices are used and trees are delimbed and topped in the forest, machine-piled slash should be placed outside of eligible or suitable wild and scenic river corridors and at least 300 feet away from the centerline of roads, national trails, and sensitive trails;	Maintain scenic integrity.	X	X	Recreation and Scenery	DF

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	developed recreation sites; or private land/communities. In these instances, piles should be burned as soon as possible or within 1 - 3 years. Root wads and other debris in sensitive foreground areas and in wild and scenic river corridors would be removed, burned, or chipped. Outside of these areas, it is acceptable to scatter root wads and debris or use them to help close temporary roads or skid trails. If slash is not removed in grassland treatment areas, it is acceptable to create machine piles 300 feet away from the centerline of sensitive roads and trails, developed recreation sites, and private land/communities. Within eligible or suitable wild and scenic river corridors, slash should be removed, burned, or otherwise treated to return the area to its pre-implementation condition.					
RS012	Coordinate with designated Forest Service representative prior to implementing jackstraw, spring, and road restoration treatments. Do not implement jackstraw treatments within 1,000 feet of National Trails.	Maintain scenic integrity.	X	X	Recreation and Scenery	DF
RS013	In semi-primitive non-motorized recreation opportunity spectrum classes specifically (occurring on about 13 percent of the project area), in eligible or suitable wild and scenic river corridors, and in inventoried roadless areas (IRAs): (a) Temporary roads should not generally be built (also see RS023). If they are used, they would be restored to pre-treatment conditions when projects are completed; (b) Strive to make stump heights 8 inches above ground (uphill side) or lower, with 12-inch heights the exception and rarely occurring; (c) Slash must be treated or removed in these areas; and (d) Use existing barriers (roads) and natural barriers as control lines whenever possible.	Protection of visitor experience	X	X	Recreation and Scenery	DF

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RS014	**Recreation Sites:** (a) Proposed mechanical treatments and prescribed fire adjacent to developed recreation sites must be reviewed and approved by the district ranger. Work with the district recreation staff to determine boundaries or no treatment zones around constructed features that need to be protected in campgrounds. Treatments around the perimeter of campgrounds are encouraged. The timing of treatments must be worked out with districts. Treatments would generally avoid summer. Activity slash must be piled in agreed upon locations, and treated as soon as possible. If campgrounds remain open into fall and winter, provide information about upcoming closures and management activities onsite, at FS offices, and on FS Web sites.	Protection of visitor experience	X	X	Recreation and Scenery	DF
RS015	Implement road closures, one-way traffic, and area closure restrictions as deemed necessary by forest officials for health and safety concerns during any operation. Signs would be placed at major intersections on hauling routes during periods of active hauling. If it is necessary to close forest roads or areas of the forest, notices and signs would be posted at key locations adjacent to and within the project area, such as along major FS roads accessing the area or on kiosks at trailheads, bulletin boards, electronic sign boards, etc. Closures due to operations would also be posted online and on social media as well as being publicized via news releases. Coordinate with the District Recreation Planner or trails specialist to ensure well marked and publicized detour routes for the Arizona Trail, General Crook Trail, and Highline Trail, and system trails during operational closures within the project.	Public safety	X	X	Recreation and Scenery	DF
RS016	When mechanical treatment and/or burning are occurring along open trails that are not National Recreation Trails, slash will be pulled back immediately within 100 feet of the centerline of the trail corridor within specified timeframes (coordinate with recreation specialist).	Maintain scenic integrity.	X	X	Recreation and Scenery	DF

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RS017	Character trees that have unique shape or form along all trails should be retained where feasible within the applicable prescription. Avoid lines of trees; strive to achieve a grouped appearance to avoid abrupt changes in the landscape character along the trail corridor.	Protect visitor experience	X	X	Recreation and Scenery	DF
RS018	(a) Prior to blasting activities, nearby landowners or other permitted Forest users near the blasting location would be notified. (b) Standing trees and shrubs would be left in strategic locations along the perimeter of active rock pits to serve as screening to sensitive viewsheds.	To improve public safety by increasing awareness of blasting activities and to minimize impacts to scenic resources and wildlife.	X	X	Recreation and Scenery	DF
RS019	Trucks hauling materials would be limited to no more than 25 miles per hour on all forest roads, and 10 miles per hour within 0.25 miles of all signed campgrounds and trailheads.	Reduces noise and dust during hauling.	X	X	Recreation and Scenery	DF
RS020	Entrances to active rock pit sites would be gated to prevent inappropriate motor vehicle use, dumping, or other activities.	Decrease noise, protect public safety and minimize impacts to forest resource in and around rock pit sites	X	X	Recreation and Scenery	DF
RS021	Material extraction activities should not be permitted in designated or recommended special areas or Chevelon Canyon.	To protect the unique character of these areas.	X		Soils and Watershed	DF
RS022	All restoration activities within eligible or suitable wild and scenic river corridors will be designed to protect or enhance the free-flowing character and outstandingly remarkable values (ORVs) of rivers, and to maintain the rivers' current inventoried classifications (wild, scenic, or recreational), unless a suitability study is completed that recommends management for a less restrictive classification. This includes the management of fire, which should be carried out using minimum impact suppression tactics, or other tactics appropriate for the protection of identified ORVs.	To protect eligible and suitable wild and scenic rivers	X		Recreation and Scenery	DF

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RS023	Restoration activities within the corridors of eligible or suitable wild river segments on the Apache-Sitgreaves National Forests will not include any tree cutting.	To protect the primitive character of eligible or suitable rivers classified as wild	X		Recreation and Scenery	DF
RS024	Temporary roads will not be constructed within inventoried roadless areas (IRAs) or within the corridors of eligible or suitable river segments classified as wild. Within corridors of eligible or suitable river segments classified as scenic, avoid constructing long stretches of conspicuous temporary roads paralleling the riverbank.	To ensure that wild river segments and IRAs maintain their primitive characteristics and to protect the largely undeveloped character of scenic river segments	X		Recreation and Scenery	DF
SU001	Notify the affected landowners, permit holders, and Forest Service permit administrators whenever project activities are planned in areas having special use authorizations or non-NFS inholdings.	To ensure that land owners and permit holders are aware of planned activities well in advance, and to provide them opportunity to discuss concerns and potential mitigations to protect their sites.		X	Lands/Minerals and Special Uses	DF
SU002	Ensure non-federal land boundaries are known and marked in advance of any activities or treatments near those lands.	To ensure that project activities occur only on NFS lands.		X	Lands/Minerals and Special Uses	DF
SU003	Evaluate potential haul routes that may be needed through non-federal land and ensure easements are in place or obtained prior to use.	To prevent illegal trespass across lands with other ownership.		X	Lands/Minerals and Special Uses	DF

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SU004	Coordinate management activities with permit holders for any utility corridors (powerlines, pipelines, etc.) to determine how to protect facilities and improvements. Provide notification of activities during planning/layout and prior to implementation. Include pre-work safety meetings between utility holders and contractors.	To protect permit holders' facilities and improvements and ensure that management activities do not interfere with the operation of utility corridors.		X	Lands/Minerals and Special Uses	DF
SU005	Place project-generated slash outside of permitted utility line and pipeline rights-of-way; do not interfere with utility corridor management.	Ensure that activities do not interfere with the operation of utility corridors		X	Lands/Minerals and Special Uses	DF
SU006	Vegetation treatments adjacent to power line corridors will be designed to reduce linear edges and create a more irregular natural appearance outside of the right-of-ways.	Maintain natural appearance of landscape	X	X	Lands/Minerals and Special Uses	DF
SU007	Implement a 100 foot buffer zone around weather stations and other meteorological facilities. No road construction or thinning is to occur within the buffer. Routine management activities (such as hazard tree removal) may still occur within the buffer zone.	To ensure that project activities do not interfere with meteorological data gathering.		X	Lands/Minerals and Special Uses	DF
SU008	Protect highway ROW infrastructure from damage by management activities	To ensure ROW infrastructure remains functional for its intended purposes		X	Lands/Minerals and Special Uses	DF
SU009	Coordinate planned activities with ADOT and/or the appropriate county to ensure safe operation of roads and highways during project implementation.	To protect public safety on the affected roadways during operations.		X	Lands/Minerals and Special Uses	DF
SU010	Remove thinning slash from highway ROWs. If approved by the FS, chipped slash may be left onsite at a maximum depth of two inches, otherwise it must be removed completely. The maximum duration that logs and biomass can be left in the ROW is 30 days.	To ensure slash does not interfere with ROW access as potentially needed by ADOT or county		X	Lands/Minerals and Special Uses	DF

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SU011	Processing sites would be authorized under the terms of the timber contract or through a special use authorization depending on who would be the operator. Fees may be associated with special use authorizations.	Ensure proper authorization and permitting of in-woods processing sites	X		Lands/Minerals and Special Uses	DF
SU012	Through the Arizona Department of Environmental Quality (ADEQ), the operator of a processing site would obtain coverage under a Multi-Sector General Permit (MSGP) for storm water discharges associated with non-mining industrial facilities such as timber products http://www.azdeq.gov/node/525 and http://www.azdeq.gov/permits-needed-timber-products-sector. Coverage under this permit would entail preparation and implementation of a storm water pollution prevention plan (SWPPP) as well as periodic inspections of the facility consistent with requirements of the permit.	Ensure proper authorization and permitting of in-woods processing sites	X		Lands/Minerals and Special Uses	DF
SU013	Petroleum storage in aboveground storage containers with a total aggregate capacity of 1,320 gallons or more, would be subject to the Spill Prevention, Countermeasures, and Contingency (SPCC) Rule and a SPCC plan is required. A permit for installation of an aboveground storage tank is also required through the AZ State Fire Marshall's Office: https://www.dfbls.az.gov/ofm/AGST.aspx	Ensure proper authorization and permitting of in-woods processing sites	X		Lands/Minerals and Special Uses	BMP
SU014	Support operations and facilities on processing sites that would be allowed include: office trailers, sanitation facilities and fuel products storage containers or temporary structures. Fencing would be allowed to provide security for equipment and products. Camping or living trailers would not be allowed in the processing sites. Operators would provide their own water and water storage facilities and trash pickup. Connections to nearby powerlines and phones lines would be permitted. Operations on site would comply with fire restrictions and forest closures as applicable. Processing sites located in the interior of the project area would operate when the roads are open and passable and would be closed during the winter months, typically mid-December to April. Sites located near state highways or other paved roads may operate year-round.	Ensure proper design and construction of in-woods processing sites	X	X	Lands/Minerals and Special Uses	DF

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SU015	The design, construction and operation of processing sites shall utilize practicable procedures for control of surface water runoff from facilities.	Ensure proper design and construction of in-woods processing sites	X		Lands/Minerals and Special Uses	BMP
SU016	Aggregate surfacing of the processing site location would be required to minimize soil rutting, control surface water runoff and allow for operations during wet weather periods	Ensure proper design and construction of in-woods processing sites	X		Lands/Minerals and Special Uses	BMP
SU017	Processing site equipment and vehicles shall be operated and maintained to minimize petroleum and lubricating products from entering soil or surface/ground waters.	Ensure proper design and construction of in-woods processing sites	X		Lands/Minerals and Special Uses	BMP
SU018	The contractor or permittee operating the processing site shall maintain the authorized facility and site in good condition and in accordance with approved contract or operating plans and specifications. When the contractor or permittee completes the authorized activity, they must rehabilitate by removing all facilities and structures, removing all wastes with disposal at an approved facility, restoring the pre-disturbance site gradient, preparing the site for reseeding by scarifying the site, and application of a native seed mix as specified and approved by the Forest Service.	Ensure proper reclamation and rehabilitation of in-woods processing sites.	X		Lands/Minerals and Special Uses	DF
SW001	All stream channels will be protected with Aquatic Management Zones (AMZs), measured as the slope distance from the edge of each side the stream. Where AMZ widths are not customized to site conditions and don't occur in Narrow-headed or Northern Mexican Garter Snake proposed critical habitat (see AQ021), the default minimum width for ground-based mechanical and prescribed burning treatments for perennial, intermittent, and ephemeral streams are 150, 75, and 50 feet, respectively. Lakes and reservoirs should follow the same default AMZ widths (150 feet) as those for perennial waters.	To insure adequate protection of surface water quality during ground-based mechanical vegetation treatments and to provide consistency in how AMZ widths are measured and identified on the ground.	X	X	Soils and Watershed	BMP

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SW002	AMZs can be customized by an ID team of qualified specialists prior to project implementation based on desired conditions along the stream reach and the nature of resource values at risk (such as the presence of aquatic ESA species or its potential introduction), special concerns for water quality degradation, erosion hazard, existing vegetative ground cover conditions, stream bank and riparian conditions, natural geologic features, and flow regime. The IDT will determine appropriate AMZ widths and treatment limitations within these zones. These changes should be reflected in the plan-in-hand documents and included in the task order or contract maps.	To allow the greatest flexibility in designing AMZ prescription to meet resource benefits while protecting the values at risk.	X	X	Soils and Watershed	BMP
SW003	Stream channels to be protected with a prescribed aquatic management zone (AMZ) will be shown on the project task order, contract maps, or burn plan maps. AMZ widths will be clearly labeled or described.	Reduce ground disturbance by limiting the turning of equipment in or near the stream channels, and retain as much of the filtering effect of undisturbed ground cover as possible.		X	Soils and Watershed	BMP
SW004	Accepted activities within AMZs include mechanical and conventional tree felling, yarding, skidding, backing fire. Landings, decking areas, machine or hand piles, and skidding across streams or wetlands are to occur outside of AMZs unless otherwise specified. Skidding across ephemeral or intermittent streams may occur at designated crossing under no-flow conditions.	To avoid, improve, or minimize effects on aquatic species and habitat.	X	X	Soils and Watershed	BMP
SW005	If completing mechanical vegetation treatments within an AMZ, the preferred method of using feller-buncher or grapple skidder equipment is to approach the material to be extracted on the contour as much as possible to the stream, then back equipment out. Turning machines and skidding within AMZs should be minimized to the greatest extent possible.	Allows for a reduction in ground disturbance by limiting the number of passes required to extract material and turning of equipment. Maintaining this type of travel pattern aims to reduce potential concentrated run-off and sediment delivery downslope compared to travel		X	Soils and Watershed	BMP

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		courses that follow the slope direction. BMP ultimately aims to reduce the amount of disturbed area affected during operation and to retain as much as possible the filtering effect of the undisturbed ground.				
SW006	Landings, log decks, and piles (burn, slash, or biomass) should be placed in upland locations and will not be allowed in areas such as: meadows, riparian areas, springs, seeps, AMZs, stream channels, or at the heads of stream channels. Landings, log decks and burn piles will be located outside at least 100 feet from these features, far enough away that direct (unfiltered) entry of sediment, bark, ash and burning products will not enter. The authorized FS officer AND a watershed specialist may authorize landings in these areas if absolutely required.	Limit the overall amount and extent of heavy ground disturbance that implicates soil stability/ productivity as well as the filtering capacity of upland areas.	X	X	Soils and Watershed	BMP
SW007	Mechanical vegetation treatments within AMZs will minimize the amount of thinning debris deposited in stream channels and remove excess debris by hand or end-lining with one end suspension except where coarse woody debris is needed for stream health as identified by fisheries or watershed specialists. Remove thinning debris less than six inches in diameter and less than six feet long and place it above the ordinary high water mark.	To minimize the potential for stream or culvert blockage.		X	Soils and Watershed	BMP
SW008	Mechanical vegetation treatments within AMZs will fell trees outside the stream channel unless otherwise specified as a stream treatment.	To minimize disturbance to stream morphology as much as possible and reduce the amount of fine woody debris entering the stream system.		X	Soils and Watershed	BMP
SW009	If completing mechanical vegetation treatments within an AMZ, do not cut trees where the root system is important in maintaining channel morphology.	To provide for bank stability and minimize erosion and bank instability to streams or other aquatic habitats.	X	X	Soils and Watershed	BMP

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SW010	New temporary road construction is not allowed in AMZs.	To minimize adverse environmental effects within aquatic management zones.		X	Soils and Watershed	BMP
SW011	Establish staging areas 150 feet outside of AMZs or from natural water bodies and wetlands for storage of vehicles, equipment and fuels, and fueling/servicing areas to minimize erosion into or contamination of streams, wetlands, and floodplains.	To prevent the spread of invasive and noxious weeds, aquatic diseases, and invasive species, and to prevent petroleum contamination and minimize ground disturbance and sedimentation in aquatic and associated habitats	X		Soils and Watershed	BMP
SW012	Site-specific criteria whereby either fire is allowed to burn in AMZs or is actively ignited will be solely driven by the need to maintain or improve riparian and stream habitat. A site-specific evaluation will be conducted by a specialist as a part of the burn plan for each unit where fire is proposed.	Proper maintenance of prescribed burning activities adjacent to and/or within AMZs should help maintain the sediment filtering capacity of drainage way and reduce potential erosion in these locations.		X	Soils and Watershed	BMP
SW013	Fire control lines shall only be constructed within AMZs if mutually agreed upon by the authorized FS officer, fuels specialist, watershed specialist, and biologist. Only the following are allowed in AMZs: Raking, brushing (less than 3 feet wide), leaf-blower, or other techniques that do not disturb soils or cause erosion.	To minimize the disturbance of riparian vegetation.		X	Soils and Watershed	BMP
SW014	The following direction should be incorporated in developing the burn plan: High soil burn severity should not occur on greater than 5 percent areal extent of the uplands or an AMZ in each burn unit. High severity should be patchy rather than concentrated. No more than 5 percent mortality is allowed in the mature forest canopy along a streamside in each	Maintaining low / moderate burn intensities and limiting the areal extent of high intensity burning will reduce the potential for severe soil burning which ultimately	X	X	Soils and Watershed	BMP

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	burn unit, with this mortality occurring as discontinuous patches. Variance in these parameters would need to be approved by appropriate specialist(s).	helps retain long-term soil stability/productivity and minimizes detrimental effects to soil, aquatic species, aquatic habitat, and desirable riparian species (flora and fauna) in AMZs.				
SW015	Apply the following direction if AMZ is within ½ mile of private land boundary or designated WUI: Treatment measures necessary to reduce the risk of wildfire encroachment on adjacent private lands may take priority over other considerations in these AMZs. Entry and treatments in these reaches will be considered on a case-by-case basis by ID teams.	To ensure that the fire management objectives and water quality objectives for these reaches are appropriately balanced.		X	Soils and Watershed	BMP
SW016	Do not apply surface fertilizer within an AMZ.	To protect water quality	X	X	Soils and Watershed	BMP
SW017	Domestic livestock grazing within an AMZ affected by prescribed fire will be deferred until ground cover is adequately re-established.	Promote recovery and establishment of riparian species, protect floodplain function, and provide for resilient stream systems.		X	Soils and Watershed	BMP
SW018	During project implementation use existing system travel courses and stream crossings whenever possible, unless new construction would result in less resource disturbance. Minimize the number of temporary access roads and travel paths to lessen soil disturbance, compaction, and impacts to vegetation. Temporary roads will not be built on slopes where grade, soil, or other features suggest a likelihood of excessive erosion or failure. Temporary roads areas will be restored to natural, preconstruction conditions as much as possible.	To minimize soil disturbance and reduce sedimentation and erosion in aquatic habitats.	X	X	Soils and Watershed	BMP
SW019	When altering spring developments or splitting flow, place troughs far enough away from groundwater-dependent ecosystems (GDEs), wetlands, and other sensitive or unique habitats to prevent erosion, compaction, or degradation to sensitive soils and vegetation due to livestock or wildlife congregations.	To maintain or improve the integrity of springs and other groundwater-dependent ecosystems (GDE) and		X	Soils and Watershed	BMP

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		minimize effects on these sensitive systems.				
SW020	Spill prevention, containment, and counter measure plans are required if the fuel exceeds 660 gallons in a single container or if the total fuel storage at a site exceeds 1,360 gallons.	To protect soil/water resources and aquatic species from petroleum contamination.	X	X	Soils and Watershed	BMP
SW021	Any leaks originating from contractor equipment shall be repaired or the equipment replaced in a timely manner.	To protect soil/water resources and aquatic species from petroleum contamination.	X	X	Soils and Watershed	BMP
SW022	During servicing and refueling of equipment, pollutants shall not be allowed to enter any waterway, riparian area or stream course. Construct berms where necessary to contain potential spills. An authorized FS Official shall also be aware of actions to be taken in case of a hazardous substance spill.	To protect water resources and aquatic species from petroleum contamination.	X	X	Soils and Watershed	BMP
SW023	Equipment operators shall maximize that recovery and proper disposal of all fuels, fluids, lubricants, empty containers, and replacement parts.	To protect soil/water resources and aquatic species from petroleum contamination.	X	X	Soils and Watershed	BMP
SW024	Refuse resulting from the contractor's use, servicing, repair or abandonment of equipment shall be removed from National Forest System lands by the contractor to the appropriate disposal facilities.	To protect soil/water resources and aquatic species from petroleum contamination.	X	X	Soils and Watershed	BMP
SW025	All dry meadow locations identified during the layout phase of a project sale will be clearly labeled on sale contract maps.	To improve implementation.		X	Soils and Watershed	BMP
SW026	Heavy equipment, vehicle operation, road construction, staging areas, stockpile areas, piling of slash, fence construction, fire lines, and other operational activities shall not be allowed in springs, seeps, or any other Groundwater-dependent Ecosystem (GDE), unless it is for the benefit or protection of the GDE or development of the springs.	To maintain or improve the integrity of springs and other GDEs and minimize effects on these sensitive systems.	X	X	Soils and Watershed	BMP
SW027	At spring development restoration sites, place watering troughs far enough from a steam or surround with a protective surface to prevent sediment delivery to the stream. Avoid steep slopes and areas where compaction or damage could occur to sensitive soils, slopes or vegetation due to congregating livestock or wildlife.	To reduce sediment delivery to aquatic habitats.		X	Soils and Watershed	BMP

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SW028	At spring restoration sites, ensure that each livestock or wildlife water development has a float valve or similar device, a return flow system, a fenced overflow area, or similar means to minimize water withdrawal and potential runoff and erosion.	To reduce water withdrawal, protect stream/spring flows, and channel functionality.		X	Soils and Watershed	BMP
SW029	Spring developments should not disturb the spring orifice (point where water emerges). Spring head boxes should be places in a location that will cause the least amount of disturbance to the soils and vegetation of the GDE. Preferable locations for spring head boxes should be in an established channel downstream from the orifice or a locations where flowing water becomes subsurface.	To maintain or improve the integrity of springs and other groundwater-dependent ecosystems (GDE) and minimize effects on these sensitive systems.		X	Soils and Watershed	BMP
SW030	When necessary, construct barriers around spring developments to prevent damage from wild or domestic ungulates, OHVs, or other recreational impacts.	To maintain or improve the integrity of springs and other groundwater-dependent ecosystems (GDE) and minimize effects on these sensitive systems.		X	Soils and Watershed	BMP
SW031	Spring developments shall have a return flow system to minimize the diversion of surface and subsurface water from the catchment area. Consider using a float valve or similar device to reduce the amount of water withdrawn from the groundwater-dependent ecosystems (GDE).	To maintain or improve the integrity of springs and other groundwater-dependent ecosystems (GDE) and minimize effects on these sensitive systems.		X	Soils and Watershed	BMP
SW032	Formerly used skid trails should be utilized where properly located. The designation of new skid trails should be oriented to the contour of the slope as much as operationally feasible. Skid trail design should minimize concentrated runoff and sediment delivery by avoiding long, straight skid trails and providing breaks in grade.	Utilization of existing skid trails, designation of new skid trails, and proper skidding design should reduce the overall heavy disturbance footprint across the treatment unit. Skid trail placement that follows the contour of the slope as much as operationally feasible will help lessen the		X	Soils and Watershed	BMP

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		potential for accelerated erosion downslope.				
SW033	Closed skid trails and roads must have adequate runoff and erosion control features. Slash is the preferred method for diverting water if of sufficient quantity and size is available to maintain complete contact with the ground. Otherwise construct water bars and lead out ditches. Waterbars should not be more than 2 feet deep and need at least a 10-foot lead-out. Waterbars are only to be implemented with equipment with an articulating blade (no skidders), or by hand to remove berms, seeded, mulched, and cross-ripped. Waterbar spacing should be approximately 130 feet for slopes 0-5%, and 100 feet for slopes 6-10%. All berms and depressions (i.e., ruts) created along the skid trail or road will be filled in to restore the natural grade of the slope as much as possible.	Minimize the concentration of run-off and sediment delivery into stream channels.	X	X	Soils and Watershed	BMP
SW034	Erosion control structures and measures must be in place prior to the first erosive event. Contracts and agreements should outline the timing and application of erosion control methods to minimize soil loss and sedimentation of stream courses.	Minimize the concentration of run-off and sediment delivery into stream channels.	X	X	Soils and Watershed	BMP
SW035	Scarification or ripping of landings should be conducted in a manner as not to mix the surface soil and subsoils to the point where subsoil becomes inverted and exposed at the surface.	Mixing of surface soil and subsoil is generally not conducive to obtaining desirable herbaceous revegetation.		X	Soils and Watershed	BMP
SW036	During machine piling of slash, rough piling is encouraged. This involves piling only large concentrations of slash, leaving areas of low concentration undisturbed. Also, where feasible, rack and pile.	Rough piling minimizes disturbance to existing ground cover and the surface soil.		X	Soils and Watershed	BMP
SW037	Slash can be placed on skid trail and travel corridors to drive on to reduce rutting and soil disturbance from mechanized equipment.	To reduce potential for rutting and compaction along mechanical equipment travel courses.	X	X	Soils and Watershed	BMP

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation	Primary Resource	Category (BMP, CM, DF)
SW038	Seed mixes for post-thinning erosion control can include any of the following certified weed-free native species at a minimum of 5 pounds per acre pure live seed. Potential vegetation for individual sites should utilize the Apache-Sitgreaves, Coconino, and Tonto NFs' Terrestrial Ecosystem Surveys (TES) to identify species to be utilized.	Minimize soil loss and sedimentation of stream courses from skidding operations. Minimize noxious weed spread and reestablish native vegetation. Minimize effects on severe erosion soils.	X		Soils and Watershed	BMP
SW039	Mechanical crushing of lopped slash can only occur on 0–25 percent slopes.	Incorporate slash into the soil to promote long term soil productivity.	X		Soils and Watershed	BMP
SW040	Slash and/or chips can be scattered on landings to help minimize the formation of rills and gullies.	Minimize the concentration of run-off and sediment delivery into stream channels.		X	Soils and Watershed	BMP
SW041	Skid trail stream crossings will not be allowed unless pre-approved by the authorized FS officer AND a watershed specialist for perennial and intermittent streams. Ephemeral streams crossings will be authorized by the FS officer. Crossings will be at right angles to channel and drainage banks. The number of designated crossings should be minimized.	A qualified person should designate stream crossings in order to protect stream banks and stream morphology.		X	Soils and Watershed	BMP
SW042	Felling to the lead would be required within the integrated resource service contract to minimize ground disturbance from skidding operations.	Felling of timber should be done to minimize ground disturbance from skidding operations and to minimize effects on severe erosion soils.	X		Soils and Watershed	BMP
SW043	Culverts, temporary bridges, low-water crossings, or log-fords will be required on all temporary roads and skid crossings on all streams that will have flowing water during the life of the temporary crossing. Temporary road and skid trail crossings will be removed when no longer needed. Any fill material will be removed and the channel and stream banks restored to a pre-project condition.	Protect stream morphology from damage from crossings while avoid damming or impounding free-flowing waters to provide streamflows needed for aquatic and riparian-dependent species.	X	X	Soils and Watershed	BMP

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation	Primary Resource	Category (BMP, CM, DF)
SW044	During thinning, operators shall avoid excavating skid trails whenever practical.	To prevent soil displacement		X	Soils and Watershed	BMP
SW045	During thinning, operators shall locate skid trails where the need for sidecasting is minimized	To prevent soil displacement		X	Soils and Watershed	BMP
SW046	During thinning, avoid adverse skidding to the greatest extent possible unless specialized equipment capable of adverse skidding without creating adverse soil impacts is utilized	To prevent excess rutting and compaction of soil surfaces and minimize downhill movement of slash and soils.		X	Soils and Watershed	BMP
SW047	Slash should be distributed throughout skid trails, forwarder trails and cable corridors wherever mineral soils are exposed.	To provide surface roughness and prevent concentrated runoff that could cause accelerated erosion.		X	Soils and Watershed	BMP
SW048	Operators shall limit cable thinning to uphill yarding whenever practical. When downhill cable yarding is necessary, operators shall layout the cutting system in a manner which minimizes soil displacement.	To prevent soil displacement from cable yarding operations.		X	Soils and Watershed	BMP
SW049	Operators shall minimize the yarding of logs across streams or wetlands	To prevent adverse effects to water quality		X	Soils and Watershed	BMP
SW050	Cable yarding across ephemeral streams shall be performed in ways that minimize soil and bank disturbances.	To prevent erosion and sedimentation by reducing potential for damage to stream banks and beds		X	Soils and Watershed	BMP
SW051	Operators shall minimize the numbers and widths of yarding corridors.	To minimize soil disturbance and prevent erosion and sediment delivery to streams		X	Soils and Watershed	BMP
SW052	Where it is necessary to yard across intermittent or perennial streams or wetlands, it shall be done by swinging the yarded material free of the ground to the greatest extent practicable (i.e., full suspension).	To prevent adverse effects to stream banks, beds and wetlands.		X	Soils and Watershed	BMP
SW053	During cable thinning, operators shall install effective cross ditches that drain onto undisturbed forest floor on all skid trails and cable corridors located on steep or erosion-prone slopes.	To prevent erosion and sediment delivery to stream courses and other waterbodies.		X	Soils and Watershed	BMP

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation	Primary Resource	Category (BMP, CM, DF)
SW054	Location of new skid trails and overall skid trail placement should be designed to minimize the overall disturbance footprint across the treatment unit while still meeting the objectives of the stand treatment.	Limit the overall amount and extent of heavy ground disturbance that implicates soil stability/ productivity as well as the filtering capacity of upland areas.		X	Soils and Watershed	BMP
SW055	Landings and decks should be clearly designated on the project area task order or contract maps.	To aid in implementation of project.		X	Soils and Watershed	BMP
SW056	Sizing, spacing, and placement of landings should be designed to minimize the overall ground disturbance footprint across the treatment unit while still meeting the objectives of the stand treatment.	Limit the overall amount and extent of heavy ground disturbance that implicates soil stability/ productivity as well as the filtering capacity of upland areas.	X	X	Soils and Watershed	BMP
SW057	Heavy ground disturbance activity areas (landings, major skid trails, unsurfaced haul roads, etc.) and excessive ground disturbance in any location (i.e., exceeding the rutting guidelines) should aim to not exceed 15 percent -areal extent of a treatment unit within a timber sale area.	To meet soil condition thresholds for management concern and to reduce the overall heavy ground disturbance footprint across a treatment unit.	X	X	Soils and Watershed	BMP
SW058	Skid trails, landings, and temporary roads are to be closed post-treatment and landings are to be scarified and seeded with a certified weed-free mix of primarily native, perennial grasses. The Coconino NF does not require scarification unless compaction is present.	Scarification and seeding of heavily disturbed areas will help break up soil compaction and reintroduction of native, perennial grass species will aid in mitigating the over-establishment of exotic or noxious weeds. Water-barring, restoring the natural grade or the slope, and utilizing slash for additional erosion control mitigation will dissipate the	X	X	Soils and Watershed	BMP

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation	Primary Resource	Category (BMP, CM, DF)
		run-off energy, reducing sediment delivery, as well as aiding in long-term site stability/productivity.				
SW059	In meadow restoration sites where trees are being removed, designate skid trails in order to limit disturbance from skidding. Where material is not being removed, lop and scatter or manually remove slash from meadow; these are the preferred methods of treating slash.	To minimize impacts to streams and soils in meadows from tree thinning operations.	X		Soils and Watershed	BMP
SW060	When thinning trees, no skidding is allowed across wetlands or springs and their outflows.	To minimize impacts to streams and soils in meadows from tree thinning operations.	X		Soils and Watershed	BMP
SW061	The authorized FS officer AND a watershed specialist will verify that the contractor has properly implemented the project watershed BMPs and erosion control measures prior to the closure of the project contract. In evaluating acceptance the following definition will be used by the FS: "Acceptable" erosion control means only minor deviation from the established standards and guidelines, providing no major or lasting impact is caused to soil and water resources. Include Biology staff where units are adjacent to federally listed and sensitive aquatic species habitat. Certified Timber Sales Administrators or CORs will not accept erosion control measures that fail to meet these criteria.	It is necessary to have a watershed specialist present during closeout to ensure that project watershed BMPs were implemented correctly as they were the original designer of the conservation practice. To minimize sediment delivery to T&E and sensitive species aquatic habitat		X	Soils and Watershed	BMP
SW062	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 nonriparian stream course, designate any crossing prior to skidding.	Minimize effects on streams and soils in meadows from tree thinning operations.	X		Soils and Watershed	BMP

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation	Primary Resource	Category (BMP, CM, DF)
SW063	Wet Meadows, springs, seeps or other wet features where mechanized equipment is to be excluded will be designated as "protected areas" be clearly labeled on task order or contract maps and marked on the ground. Any features discovered during the layout phase of a project will also be included on task order or contract maps and boundaries shall be delineated on the ground during layout.	Soils and vegetation in wet meadows, dry meadows, springs, seeps or other sources where the presence of water is indicated will be protected from disturbance which could cause adverse effects on water quality, quantity, wildlife and aquatic habitat.		X	Soils and Watershed	DF
SW064	Only hand-felling methods will be permitted when removing trees from designated protected areas and other sensitive areas such wet meadows, or around springs, seeps, and other wet features unless approved by a watershed specialist or a biologist. The use of end-lining for removal of encroachment trees in these areas will be determined on a case-by-case basis by the authorized FS officer AND a watershed specialist.	Wet meadows, springs, seeps, and other wet areas have soil types with low soil weight-bearing strength due to permanently or seasonally high moisture contents and inherent soil characteristics which make them highly prone to detrimental soil compaction and topsoil displacement.		X	Soils and Watershed	BMP
SW065	Dry meadows will be treated in a site-specific manner to be determined by a watershed specialist in consultation with the project ID team.	Dry meadow soil types have low soil weight-bearing strength due to seasonally high moisture contents and inherent soil characteristics which make them highly prone to detrimental soil compaction and topsoil displacement.		X	Soils and Watershed	BMP
SW066	Mechanized equipment usage for thinning timber or biomass will be restricted to slope gradients of 25 percent or less on fragile or sensitive soil types (e.g., cinder cones).	Severe erosion hazards are present on soil types above these slope gradients.		X	Soils and Watershed	DF

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation	Primary Resource	Category (BMP, CM, DF)
SW067	Whether identified pre-implementation and on a task order/contract area map OR during the implementation phase, locations above 25 percent slope gradient on sensitive soil types will include a "protected area" designation that is clearly marked to exclude the use of mechanized thinning equipment. Hand-felling methods only will be permitted in these locations.	To protect highly erodible/sensitive soils on steep slopes by preventing traffic by heavy machinery on soils that are susceptible to destabilization and erosion.		X	Soils and Watershed	BMP
SW068	Use of specialized thinning equipment may allow operations on steeper slopes. Viability and authorization of specialized equipment use above these slope gradients will be determined during the layout phase of a sale by the pre-sale forester AND a watershed specialist. This equipment must be specified in the contract.	To insure that highly erodible/sensitive soils on steep slopes are protected during the layout of mechanical vegetation treatments.	X	X	Soils and Watershed	BMP
SW069	All ground disturbing activities using heavy equipment must be done under conditions which maintain soil condition (i.e. avoiding excess rutting, compaction, displacement).	Insure that mechanical operations do not take place when ground conditions are such that detrimental soil compaction and topsoil displacement can occur.		X	Soils and Watershed	BMP
SW070	Skid Trails: Allow up 6 inches of rutting over no more than 15 percent areal extent along a skid trail (two or more drags being considered a skid trail). Depth of rut is a measurement from the bottom to the top of a berm. Slope gradients of 20 percent or more will be considered on a case-by-case basis.	Excessive ground disturbance and rutting causes detrimental soil compaction and topsoil displacement. Compaction effects to the surface soil and inverted, exposed subsoil is not conducive to obtaining desirable long-term herbaceous revegetation. Excessive ground disturbance hinders long-term soil stability and productivity through increased erosion and establishment of exotic or	X	X	Soils and Watershed	BMP

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation	Primary Resource	Category (BMP, CM, DF)
		invasive species that out-compete native, perennial grasses and forbs.				
SW071	At landings and within 75 feet of landings, rutting depths greater than 10 inches will not be allowed. Equipment shall not be turned on roads. Landings on slopes will be minimized to the greatest extent practicable and soil and watershed mitigation measures will be applied on a case by case basis to ensure that unacceptable soil loss does not occur.	Prevents detrimental soil disturbance to depths that are difficult to adequately ameliorate and that could lead to broken tree roots resulting in drought stress of remaining trees.	X	X	Soils and Watershed	BMP
SW072	Rutting will not exceed 8 inches depth for more than 75 linear feet or 10% of road length, whichever is shorter. Rutting in excess of 3 inches depth will not be permitted on surfaced collector or arterial roads. If unsurfaced, guideline will be the same as for terminal and service roads.	Prevents rutting of the road traveled way that could lead to concentrated runoff, erosion and adverse effects to surface water quality.	X	X	Soils and Watershed	BMP
SW073	For any other locations (e.g., interior locations) within a sale area, if wheel tracks or depressions consistently exceed 2 inches then conditions are too wet to operate in these areas.	To prevent detrimental soil disturbance and compaction that would make it difficult for vegetation to become reestablished.	X	X	Soils and Watershed	BMP
SW074	No fire control lines should be constructed using mechanized equipment on slopes greater than 40 percent or greater than 25 percent on identified fragile or sensitive soil types.	Restriction of fire control line construction and burning activities to these slope breaks will help mitigate accelerated overland flow and erosion typically associated with these settings.		X	Soils and Watershed	BMP

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation	Primary Resource	Category (BMP, CM, DF)
SW075	If fire control lines are constructed, rehabilitate lines after use by either rolling berm back over the entire fire line, spreading slash across the fire line, or water barring the fire line. If water barring only, vary spacing dependent on slope and disguise the first 400 feet of line to discourage use as a trail.	To prevent erosion and sediment delivery from firelines to stream courses. Also prevents firelines from being used as trails, thereby hastening recovery.		X	Soils and Watershed	BMP
SW076	Surface fuel loading will be managed to achieve forest plan direction and specialist recommendations. These recommended levels may be lower in WUI areas. Ponderosa Pine Forest: 3 to 10 tons/acre (For Tonto NF: Refer to Forest Plan) Dry Mixed Conifer: 5 to 15 tons/acre (For Tonto NF: Refer to Forest Plan) For facilitative operations or other activities that may occur in non-target vegetation types (E.g., Pinyon-Juniper, Wet Mixed Conifer), refer to the applicable forest plan to find appropriate fuel loading levels.	Maintain long term soil productivity. To provide levels of surface fuels (fine and coarse woody debris) to address the need for habitat (cover), soils (organic material and limited areas of high burn severity), and fire (to limit areas of high burn severity and a high resistance to control).	X	X	Soils and Watershed	BMP
SW077	High soil burn severity fire should occur on no more than 5 percent of the entire treatment area for all prescribed fire in the project area.	Maintain long term soil productivity by minimizing erosion from containment lines and minimizing high soil burn severity to the degree possible.	X	X	Soils and Watershed	BMP
SW078	Burn plans will be designed to minimize fire intensity in riparian areas that have a PFC rating of Nonfunctional or Functional-at-Risk with a downward trend.	These systems may lack the vegetation to adequately dissipate energy and protect stream banks, therefore retaining the vegetative cover is necessary.		X	Soils and Watershed	BMP

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation	Primary Resource	Category (BMP, CM, DF)
SW079	Avoid treatment intensities (mechanical thinning and prescribed burning) which may cumulatively produce undesirable effects in subwatersheds. A watershed specialist will evaluate the potential for adverse cumulative subwatershed effects prior to implementation. Methodologies may include but are not limited to an Equivalent Disturbed Area analysis or watershed modeling software. If it is determined that potential cumulative effects may be adverse to watershed function and condition, treatments can be spread out spatially and/or temporally.	Reduce potential cumulative effects which may adversely affect subwatershed scale (HUC12) condition or function.		X	Soils and Watershed	DF
SW080	If a watershed analysis is not completed, the default limit of areal extent of mechanical vegetative treatments which may occur in a subwatershed (HUC12) is 25% in a given year and 40% over 5 years of that subwatershed. For prescribed burning the percentages of subwatershed treated can be doubled over the same time periods.	Reduce potential cumulative effects which may adversely affect subwatershed scale (HUC12) condition or function.		X	Soils and Watershed	DF
SW081	When restoring floodplains, mimic to the extent possible, the elevation, width, gradient, length, and roughness that would occur naturally for that stream reach and associated valley type.	To improve hydrologic function and connectivity and reduce detrimental effects to channel morphology and aquatic habitat. Reconnecting floodplains to their historic stream channels will improve soil hydrologic function, increase wetted area, and provide for improved stream morphology.		X	Soils and Watershed	BMP
SW082	Without changing the location of the bank toe, restore damaged streambanks to a natural slope and profile suitable for establishment of riparian vegetation. This may include sloping of unconsolidated bank material to a stable angle of repose or the use of benches in consolidated, cohesive soils.	To guide streambank restoration treatments.		X	Soils and Watershed	BMP

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation	Primary Resource	Category (BMP, CM, DF)
SW083	Road erosion control, such as lead-out ditches or water bars, shall be constructed to hydrologically disconnect road surface runoff from stream channels.	Minimize the concentration of run-off and sediment delivery into stream channels.		X	Soils and Watershed	BMP
SW084	Road drainage is controlled by a variety of methods including rolling the grade, insloping, outsloping, crowning, water spreading ditches, and 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.	Minimize soil movement, maintain water quality, and minimize effects on severe erosion soils.	X	X	Soils and Watershed	BMP
SW085	Road maintenance through the integrated resource service contract should require pre-haul and post-haul maintenance on all roads to be used for haul.	To minimize soil movement, maintain water quality, and to minimize effects on severe erosion soils.	X	X	Soils and Watershed	BMP
SW086	Relocated trails or roads will be constructed in a manner that does not hydrologically connect them to stream courses to the extent practical. Relocated roads and trails will have sufficient drainage features to maintain the integrity of the traveled way. New cross drains shall discharge to stable areas where the outflow will quickly infiltrate the soil and not develop a channel to a stream.	To provide for stable and serviceable roads and trails that do not adversely affect soils, surface water quality or aquatic habitats.		X	Soils and Watershed	BMP
SW087	Site rehabilitation on riparian sites for stream channel and road reconstruction projects where ground disturbance occurs: seed at 5 pounds per acre or other appropriate rate with certified weed-free native seed mix to rehabilitate the site and minimize effects of noxious weeds.	To comply with State and Federal water quality standards by minimizing soil erosion through the stabilizing influence of vegetation ground cover.	X	X	Soils and Watershed	BMP

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation	Primary Resource	Category (BMP, CM, DF)
SW088	**Site rehabilitation on disturbed sites and stream channel shaping on previously decommissioned roads**: Site rehabilitation consists of several revegetation methods, such as, but not limited to: (1) Storing sod removed from the initial ground disturbance and replace the sod from the top of the bank on the disturbed site; (2) Use appropriate mix of species that will achieve vegetation establishment and erosion control objectives at the site. (3) Protect site with slash spread across the disturbed area to create microclimates and protect from grazing ungulates. Slash placement should be limited to the upper two-thirds of the bank to limit transport downstream of woody material;(4) Consider the use of mycorrhizal inoculum on severely disturbed sites where no topsoil is left; and (5) install erosion mat.(6) Protect site with herptile-friendly barriers until the site has reestablished (see AQ018). Temporary erosion control should be installed before land or channel disturbing activities commence and will be inspected for adequacy/effectiveness at sufficient intervals to minimize adverse effects to soils or surface water quality.	Comply with State and Federal water quality standards by minimizing soil erosion through the stabilizing influence of vegetation ground cover. Minimize noxious weed spread.		X	Soils and Watershed	BMP
SW089	All potential seeding areas as part of restoration treatment to re-establish native, perennial grass abundance and vigor will be evaluated on a site-specific, case-by-case basis by the project interdisciplinary team (IDT). Seeding product for potential treatment areas will contain a mixture of certified weed-free native grasses which will contain a composition and ratio to be determined by the IDT.	For locations that do not have a viable enough seed bank to be propagated by prescribed fire activities alone, seeding may be necessary to help sites rejuvenate a more abundant and diverse herbaceous cover component that is aligned with the natural vegetative potential of the site.		X	Soils and Watershed	BMP

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation	Primary Resource	Category (BMP, CM, DF)
SW090	De-compact soil by scarifying the soil surface of roads and paths, stream crossings, staging, and stockpile areas so that seeds and plantings can root.	To rehabilitate all disturbed areas from aquatic and watershed restoration treatments, minimize erosion and sedimentation to aquatic habitats and potential effects on species.	X		Soils and Watershed	BMP
SW091	Potential revegetation seeding for individual sites should utilize the Apache-Sitgreaves, Coconino, and Tonto NFs (Terrestrial Ecosystem Surveys (TES) to identify species to be utilized. Where feasible, protect site with a variety of methods (e.g., ungulate proof fence, spreading slash, etc.).	Minimize noxious weed spread.	X		Soils and Watershed	BMP
SW092	Upon project completion, rehabilitate all disturbed areas in a manner that results in similar or better than pre-work conditions through removal of project related waste, spreading of stockpiled materials (soil, large wood, trees, etc.), seeding, or planting with local native seed mixes or plants.	To rehabilitate all disturbed areas from aquatic and watershed restoration treatments, minimize erosion and sedimentation to aquatic habitats and potential effects to species.	X		Soils and Watershed	BMP
SW093	For road, trail, aquatic, and watershed treatments: dispose of slide and waste material in stable sites out of the flood-prone area. Use native materials to restore natural or near-natural contours.	To protect water quality and aquatic habitat		X	Soils and Watershed	BMP
SW094	If soil compaction occurs during implementation, mitigate through ripping, seeding with native weed-free seed, and covering compacted areas with slash.	Minimize soil compaction, soil detachment, and sediment transport. To maintain long term soil productivity.	X		Soils and Watershed	BMP

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SW095	The project fisheries biologist/hydrologist will ensure that project design features are incorporated into implementation contracts. If a biologist or hydrologist is not the Contracting Officer Representative, then the project Contracting Officer Representative must regularly coordinate with the biologist or hydrologist to ensure project design features and conservation measures are being followed.	To ensure technical skill and planning requirements for all aquatic and watershed restoration treatments.		X	Soils and Watershed	DF
SW096	Prior to construction / site preparation, critical riparian vegetation areas, wetlands, and other sensitive sites will be clearly delineated to minimize ground disturbance, erosion, and sedimentation to aquatic habitats.	To minimize ground disturbance in aquatic and associated habitats during site preparation and sedimentation to aquatic habitats.		X	Soils and Watershed	BMP
SW097	Minimize clearing and grubbing activities when preparing staging, project, and or stockpile areas. Any large wood, topsoil, and native channel material displaced by construction will be stockpiled for use during restoration. Materials used for implementation of aquatic and watershed restoration categories (e.g., large wood, boulders, fencing material) should be staged out of the 100-year floodplain.	To minimize ground disturbance in aquatic and associated habitats during site preparation and sedimentation to aquatic habitats.		X	Soils and Watershed	BMP
SW098	Minimize time in which heavy equipment is in stream channels, riparian areas, and wetlands. Complete earthwork as quickly as possible and prior monsoon season. During excavation, stockpile native streambed materials above the bankfull elevation, where it cannot reenter the stream, for later use.	To minimize ground disturbance in aquatic and associated habitats during site preparation and sedimentation to aquatic habitats.	X	X	Soils and Watershed	BMP
SW099	Streambank vegetation will be protected except where its disturbance or removal is absolutely necessary for completion of the work.	To protect riparian vegetation and stream channel stability.		X	Soils and Watershed	BMP
SW100	Do not borrow road fill or embankment materials from the stream channel or meadow surface on road maintenance projects. End-load all material hauled onsite and compact fill.	Minimize disturbance in drainage systems and minimize sediment production within channel.		X	Soils and Watershed	BMP
SW101	Heavy equipment will be commensurate with the project and operated in a manner that minimizes adverse effects to the environment (e.g., minimally-	To minimize impacts to streams and wetlands as well	X	X	Soils and Watershed	BMP

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	sized, low pressure tires, minimal hard turn paths for tracked vehicle, temporary mats or plates within wet areas or sensitive soils.)	as aquatic habitats from heavy equipment use to implement restoration treatments.				
SW102	Placement of lop / scatter material or piling for burning will occur outside of fragile or sensitive soil types.	Minimize disturbance of sensitive soil.		X	Soils and Watershed	BMP
SW103	Soil and vegetation disturbance would be avoided to the extent practicable. Clear only the area needed for expansion of the pit.	Prevents impacts to soil, vegetation, and wildlife.		X	Soils and Watershed	BMP
SW104	All operators at a proposed rock pit site must obtain coverage under an Arizona Pollutant Discharge Elimination System Permit (AZPDES) and establish and implement a stormwater pollution prevention plan (SWPPP), if required to comply with State water requirements based on the magnitude of the specific rock pit operation.	To avoid and minimize impacts to water quality and watershed integrity.	X		Soils and Watershed	BMP
SW105	Erosion control work would be kept current immediately preceding expected seasonal periods of precipitation or runoff.	To avoid and minimize impacts to water quality and watershed integrity.	X	X	Soils and Watershed	BMP
SW106	One 50-gallon spill kit (or two 30-gallon spill kits) must be located on-site during use of all heavy equipment.	To avoid impacts to water quality and wildlife.		X	Soils and Watershed	BMP
SW107	No permanent structures would be constructed as part of any rock pit; although at least one self-contained portable toilet is required to be on-site during all operations.	To protect water quality and prevent unnecessary impacts to vegetation and wildlife.		X	Soils and Watershed	BMP
SW108	Mine pit areas would be designed to be internally draining during mining activity.	To avoid and minimize impacts to water quality.		X	Soils and Watershed	BMP

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SW109	Where there is topsoil that is first removed to access the aggregate material source, this soil shall be stockpiled for reclamation. Soil would be stockpiled instratum and replaced so that the "A" horizon is back on the surface.	To facilitate reclamation efforts.		X	Soils and Watershed	BMP
SW110	Stockpiled material should be placed and shaped to prevent water from ponding and to direct water to a drainage system.	To protect water quality.		X	Soils and Watershed	BMP
SW111	Keep sediment on-site of rock pits using settling ponds, check dams, or sediment barriers; and monitor and inspect the site frequently and correct problems promptly. Ponds should be cleaned out before they are more than 1/3 full of sediment.	To avoid and minimize impacts to water quality.		X	Soils and Watershed	BMP
SW112	Removal of pit material will not involve disturbance of riparian areas or alteration of streambeds and/or floodplain.	To protect riparian and stream habitat.	X		Soils and Watershed	BMP
SW113	Replace topsoil, revegetate, and reclaim mined areas pit as soon as possible once pit use is discontinued.	To protect soil and water resources.		X	Soils and Watershed	BMP
TR001	Avoid locating temporary roads on soils with severe erosion hazard.	The completion of a total maximum daily load assessment may result in developing additional water quality improvement strategies and mitigation of effects within associated watersheds		X	Transportation and Roads	BMP
TR002	On areas to be prescribed burned, if decommissioned roads are used as fire lines, return decommissioned roads to their pre-burn condition. Rehabilitation of the surface should refer to the soil and water BMPs for rehabilitation of fire lines and disturbed areas.	Discourage use on previously decommissioned roads and maintain a safe and economic road system.		X	Transportation and Roads	BMP

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TR003	Where temporary road construction is unavoidable, provide soil protection through implementation of any of the following methods to control sediment and protect water quality. Methods may include, but are not limited to: wattling, hydro-mulching, straw or wood-shred mulching, spread slash, erosion mats, terraces, blankets, mats, silt fences, riprapping, tackifiers, soil seals, seeding and side drains, and appropriately spaced water bars or water spreading drainage features.	To protect long-term soil productivity and water quality.		X	Transportation and Roads	BMP
TR004	Utilize road safety signage with any project road activities that are related to project implementation.	Provide for user safety.		X	Transportation and Roads	DF
TR005	Utilize the closest material source that has the specified material type for all road maintenance/reconstruction/relocation projects.	Minimize energy use for road maintenance/reconstruction/relocation activities.		X	Transportation and Roads	DF
TR006	Existing and newly constructed roads are maintained throughout the life of the project. Drainage control structures will receive maintenance prior to monsoon season and winter shutdown of project operations. Drainage should be maintained and improved as needed. Consider wildlife in the design, installation, and maintenance of these structures.	Proper maintenance of roads throughout the life of the project will ensure that drainage structures are functioning correctly and that concentrated surface run-off does not occur.		X	Transportation and Roads	BMP
TR007	Road maintenance through the timber sale contract or stewardship contract should require pre-haul and post-haul maintenance on all roads to be used for haul.	Provide for a safe travel surface and provide for access to the project area.		X	Transportation and Roads	DF

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation	Primary Resource	Category (BMP, CM, DF)
TR008	Decommissioned roads should have the roadbed removed and natural contours and gradients restored as much as possible. Slash or other suitable erosion material (mats, wattles, jute, silt fence, etc.) should be used where necessary and disturbed areas should be seeded with a suitable erosion control see mix consisting primarily of native grass species. Roads that are in closed status should be either lightly scarified and seeded or stabilized with erosion control features (e.g., rolling the grade, waterbars, etc.). Road entrances should be blocked to prevent access and signed as closed. Camouflaging of road entrances with large rocks and woody debris may prevent unauthorized access and improve stability. Road drainage features such as lead-out ditches or waterbars should not be hydrologically connected to stream channels on active or closed roads.	To protect long-term soil stability/productivity and water quality by reducing overland flow and sediment delivery originating from these locations.		X	Transportation and Roads	BMP
TR009	As a condition of approval for use of a temporary road under any contract involving mechanical thinning, temporary roads will be decommissioned, using any one or combination of appropriate methods, by the purchaser/contractor when mechanical treatments are finished.	To protect long-term soil productivity and water quality and ensure that temp roads do not become de facto new roads.		X	Transportation and Roads	BMP
TR010	If trees need to be removed for temporary road construction, avoid old trees unless necessary to prevent additional habitat degradation. Avoid removal of large trees, as well as oaks and aspens where feasible.	To minimize adverse effects on forest structure and habitat, and to minimize road disturbance from temporary roads and need for fills in stump holes.		X	Transportation and Roads	BMP
TR011	Roads causing damage to hydrological resources, cultural resources or threatened endangered, and sensitive species habitat are a priority for decommissioning.	To reduce effects to aquatic habitats from roads.		X	Transportation and Roads	BMP

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation	Primary Resource	Category (BMP, CM, DF)
TR012	Do not borrow road fill or embankment materials from the stream channel or meadow surface on road maintenance or stream crossing projects. Compact (compress) the fill dirt.	To minimize disturbance in drainage systems, sediment production within channels, and changes to channel morphology that will alter aquatic habitats.		X	Transportation and Roads	BMP
TR013	Where feasible, relocate roads out of drainage bottoms to an upland location. If this is not feasible, rock armor outfall of drainage features as an energy dissipater.	To minimize sediment delivery into and disturbance to drainage systems, and minimize sediment production within channels.		X	Transportation and Roads	BMP
TR014	Avoid road rehabilitation and maintenance during periods of sustained or heavy rainfall.	To minimize erosion and negative effects from sediment and other contaminants on water bodies and aquatic and associated habitats and cave/karst systems.		X	Transportation and Roads	BMP
TR015	When deemed necessary in order to prevent potential damage to water pipelines, the Forest Service shall coordinate any hauling activity which will cross water pipelines with the owner of the line. Care shall be taken to prevent damage to pipelines which may include mitigation measures such as gravel padding or other suitable measures.	Prevent damage to water pipelines		X	Transportation and Roads	DF
TR016	While in operation, appropriate dust abatement measures will be taken on roads and pit areas where trucks are operating if necessary.	Reduce dust and minimize visibility issues on roads.		X	Transportation and Roads	DF

Appendix G. Past, Present, and Reasonably Foreseeable Future Actions

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[6]	Forest	Past	Current	Reasonably Foreseeable
Vegetation Management Projects (Mechanical Thinning and Prescribed Fire)								
Mullen Saw timber and Whitcom Multiproduct Offerings	1990	Group selection, intermediate thin, pre-commercial thin, shelterwood seed cut	Mullen: 1,798/0/0 Whitcom: 1,440/0/0	0 /130/685 wildlife habitat improvement	Apache-Sitgreaves	X		
Jersey Horse Timber Sale	1991	Species habitat improvements, timber sales, forest vegetation improvements, fuel treatments		1,452/351/0	Apache-Sitgreaves	X		
Amended Elk Timber Sale	1993	Commercial and pre-commercial mechanical thinning	2,589/0/0	834/466/0	Apache-Sitgreaves	X		
Brookbank Multi-Product Timber Sale	1994	Mechanical thinning and prescribed fire	6,177/6,465/0	5,624/4,981/0	Apache-Sitgreaves	X		
Cottonwood Wash Ecosystem Management Area	1995	Mechanical thinning, fuelwood sales, prescribed fire	3,493/10,896/0	516/2,447/0	Apache-Sitgreaves	X		
Blue Ridge-Morgan	1997	Commercial mechanical thinning, fuelwood sales, broadcast burning	8,280/7,618/0	14,471/14,552/0	Apache-Sitgreaves	X		

[6] Acres of implementation may be counted more than once for multiple activities on the same acres.

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[6]	Forest	Past	Current	Reasonably Foreseeable
Gentry	1997	Thinning, fire	7,718	451/191/ 0	Apache-Sitgreaves	X		
Sundown Ecosystem Management Area	1997	Salvage cut intermediate treatment, regen, fire	7,607	2,075/24/170 range vegetation control, 1,830 range veg manipulation and type conversion, 3,463 tree encroachment control, 1,560 tree release and weed	Apache-Sitgreaves	X		
Wiggins Analysis Area	1998	Group selection, intermediate thinning, pre-commercial thinning, broadcast burning	5,935/3,385	0/4,224/0	Apache-Sitgreaves	X		
Show Low South (#22297)	1999	Prescribed fire, construction/ maintenance of defensible space		0/2,696/0	Apache-Sitgreaves	X		
Larson Rx Burn	2001	Prescribed fire	0/2,500/0	0/3,015/0	Apache-Sitgreaves	X		
Treatment of Dead Trees in the Rodeo-Chediski Fire (#20740)	2002	Treat dead trees for trail management, facility and road maintenance, utility line safety		5,730/1,880/15 fuels compaction	Apache-Sitgreaves	X		

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[6]	Forest	Past	Current	Reasonably Foreseeable
Heber-Overgaard WUI	2003	Mechanical thinning, prescribed fire	3,593/489/0	5,089/686/571 fuels chipping, 541 range forage improvement, 96 special products removal	Apache-Sitgreaves	X		
Hidden Lake Rx Burn	2003	Prescribed fire	0/2,000/0	0/2,828/0	Apache-Sitgreaves	X		
Camp Tatiyee / Camp Grace Fuel Reduction	2004	Pile Burning	340/340/0	0/172/0	Apache-Sitgreaves	X		
Country Club Escape Route	2004	Commercial thinning, fire	0/975/0	524/1,848 burning/915 range cover manipulation	Apache-Sitgreaves	X		
High Value Ponderosa Pine Tree Protection	2004	Mechanical thinning, insecticide treatment	698/0/698	985/826/203 insect control and prevention	Apache-Sitgreaves	X		
Rodeo-Chediski Fire Salvage	2004	Mechanical thinning, fuel treatments	47,467/0/0	25,913/ 626/1,256 fuel breaks, 411 planting/ regeneration site prep	Apache-Sitgreaves	X		
Forest Lakes WUI Treatment	2005	Mechanical thinning, hand thinning, piling, pile burning		1,691/1,645/0	Apache-Sitgreaves	X		

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[6]	Forest	Past	Current	Reasonably Foreseeable
Rim Top Rx Burn (formerly Woods Canyon Fuel Treatment)	2005	Prescribed fire	0/665/0	0/665/0	Apache-Sitgreaves	X		
Show Low South (#4456)	2005	Thinning, fuels treatments		10/585/0	Apache-Sitgreaves	X		
Dye Thinning	2006	Mechanical thinning	250/250/0	247/0/0	Apache-Sitgreaves	X		
Hilltop WUI	2006	Mechanical thinning, mastication, prescribed fire	1,544/1,544/0	1,534/45/616 range forage improvement	Apache-Sitgreaves	X		
Bruno Thinning and Slash	2009	Hand thinning, piling, pile burning	0/86/0	0/70/0	Apache-Sitgreaves	X		
Whitcom WUI	2009	Commercial thinning, fire	0	925/0/0	Apache-Sitgreaves	X		
Hilltop II Fuels Reduction	2011	Mechanical thinning, prescribed fire	190/1,544/0	0/799/616 cultural site protection	Apache-Sitgreaves	X		
Rodeo-Chediski Site Prep for Reforestation (#48660)	2016	Mastication, prep for planting	200/0/0		Apache-Sitgreaves	X		
Little Springs WUI	2003	Group selection, improvement cut, commercial thin	7,991/0/0	4,376/4,227/ 2,500 range cover manipulation	Apache-Sitgreaves		X	

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[6]	Forest	Past	Current	Reasonably Foreseeable
Nagel	2005	Commercial thin, salvage cut, fire	116,618	19,611/18,231/ 889 range cover manipulation, 1,592 range forage improvement, 321 scarify and seed landings	Apache-Sitgreaves		X	
Los Burros	2006	WUI thinning, hazardous fuels treatments, woodland stand thinning, thin from below, aspen regeneration treatments	22,224/3,560/0	30,237/13,059/ 29 range cover manipulation	Apache-Sitgreaves		X	
Nutrioso WUI	2006	Commercial thin, salvage cut, fire	28,576/39,356/0	19,476/9,870/ 827 tree planting, 394 control range vegetation, 33 control tree encroachment	Apache-Sitgreaves		X	
Show Low South (#29987)	2011	Commercial thin, group selection, fire	3,739/4,637/0	3,372/0/0	Apache-Sitgreaves		X	
Rodeo-Chediski Fire Rx Burn	2012	Fire, pruning, limbing	0/148,222/0	0/9,506/9,670 range cover manipulation, 5,162 weed & tree release	Apache-Sitgreaves		X	

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[6]	Forest	Past	Current	Reasonably Foreseeable
Timber Mesa/Vernon WUI	2012	Single tree and group selection, commercial thinning, fire	27,000/as needed/0	18,781/39,760/ 9,911 range cover manipulation, 3,979 control tree encroachment, 6,551 weed & tree release	Apache-Sitgreaves		X	
Rim Lakes Forest Restoration	2013	Selection cut, broadcast burn	23,671/32,954/0	12,483/1,335/ 116 pruning, 6,251 range cover manipulation, 80 weed & tree release	Apache-Sitgreaves		X	
Larson Forest Restoration	2015	Group selection, intermediate thinning, pre-commercial thin, shelterwood seed cut, broadcast burn	25,726/4,906/0	1,867/0/2,513 range cover manipulation, 3 weed & tree release	Apache-Sitgreaves		X	
Upper Rocky Arroyo Restoration	2016	Mechanical thinning,hand thinning, fire	30,400/as needed/0	696/5,411/ 3,960 wildlife habitat improvement	Apache-Sitgreaves		X	
Section 31 Fuels Reduction	2017	Mechanical thinning	230/0/0	44/0/0	Apache-Sitgreaves		X	

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[6]	Forest	Past	Current	Reasonably Foreseeable
Rodeo-Chediski Mastication (Heber-Overgaard and Ricochet/ Williams Ranch Fuels Reduction)	2018	Mastication and removal of small trees, hand thinning, and piling and burning	301/301/0	0/0/0	Apache-Sitgreaves		X	
Heber-Overgaard Insect and Disease Farm Bill CE					Apache-Sitgreaves			X
Pocket Baker	2000	Mechanical treatment, prescribed fire	5,200/17,000/0	0/5,450/0	Coconino	X		
Blue Ridge Urban Interface	2001	Pre-commercial thinning, prescribed fire	8,158/10,549/0	416/6,225/ 2325 control range vegetation	Coconino	X		
IMAX	2002			0/6,008/0	Coconino	X		
Pack Rat Salvage	2004	Salvage, thinning, pile burning	550/550/0		Coconino	X		
Bald Mesa Fuels Reduction	2005	Mechanical treatment, prescribed fire, fuels reduction		2,485/5,150/0	Coconino	X		
APS Blue Ridge 69kV Transmission Line	2005	Mechanical treatment, prescribed fire		0/1,600/0	Coconino	X		
Good/Tule	2006	Thinning, prescribed fire	4,337/8,361/0	1,389/2,025/0	Coconino	X		
Post-Tornado	2011	Removing	14,776/3,990/0	765/0/0	Coconino	X		

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[6]	Forest	Past	Current	Reasonably Foreseeable
Resource Protection and Recovery		downed wood, thinning						
Lake Mary Road ROW Clearing (ADOT)	2016			788/0/0	Coconino	X		
Lake Mary Meadows Two Fuel Reduction	2005			117/10,223/ 803 control range vegetation	Coconino		X	
East Clear Creek Watershed Health Improvement	2006	Mechanical treatment, prescribed fire	10,407/10,497/0	40,020/38,470/ 30,000 weed & tree release, 10,000 control tree encroachment	Coconino		X	
Victorine 10K Area Analysis	2006	Mechanical thinning, prescribed fire	1,293/8,407/0	9,015/29,585/0	Coconino		X	
Upper Beaver Creek Watershed Fuel Reduction	2010	Mechanical thinning, prescribed fire	15,807/75,068/0	20,608/64,000/0	Coconino		X	
Blue Ridge Community Fire Risk Reduction	2012	Mechanical, pile burning	50-75/5/0	0/45,000/0	Coconino		X	
Clints Well Forest Restoration	2013	Mechanical thinning, prescribed fire	12,899/16,444/ 25 rock pit expansion	11/6,639/0	Coconino		X	
Hutch Mountain Communication Site	2017	Clearing for communication site and solar array, thinning	2.5/0/0	0.5/0/0	Coconino		X	

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[6]	Forest	Past	Current	Reasonably Foreseeable
Cragin WPP	2018	Mechanical thinning, prescribed fire	41,046/63,656/0	0/0/0	Coconino			X
Ridge Analysis Area	1994	Commercial thinning, salvage, vegetation improvements, hazardous fuels reduction		33,311/0/1,094 control range vegetation	Tonto	X		
Lion Analysis Area	2001	Intermediate thinning, prep cutting, uneven-aged management, wildlife forage areas, prescribed burning	2,455/9,000-10,000/0	5,664/6,900/ 664 weed & tree release	Tonto	X		
Verde WUI	2004	Thinning, PJ savanna restoration, fuel break construction, prescribed burning	15,471/28,438/1,401 PJ savanna restoration	10,648/48,500/ 5,000 range cover manipulation	Tonto	X		
Parallel Prescribed Burn	2014	Prescribed fire	0/24,089/0	0/4,759/0	Tonto	X		
Pine-Strawberry WUI	2006	Thinning, grassland restoration, fuel break construction, prescribed fire	9,709/40,928/ 7,525 grassland restoration	41,086/19,868/ 200 range cover manipulation	Tonto		X	

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[6]	Forest	Past	Current	Reasonably Foreseeable
Chamberlain Analysis Area	2008	Mechanical thinning, prescribed burning, shaded fuel breaks	8,072/20,050/0	9,044/19,000/ 1,675 control range vegetation	Tonto		X	
Christopher/Hunter WUI	2009	Thinning, fuel break construction, prescribed burning	32,358/20,550/0	10,763/19,000/ 450 weed & tree release, 489 control range vegetation	Tonto		X	
Cherry Prescribed Burn	2012	Prescribed burning	0/14,700 – 21,000/0	0/6,582/0	Tonto		X	
Myrtle WUI	2012	Fuel breaks, thinning, prescribed fire	16,702/27,131/0	103,891/75,800/ 1,091 weed & tree release, 744 control range vegetation	Tonto		X	
Flying V&H Prescribed Fire	Decision expected 2018	Prescribed burning, shaded fuel breaks	1,798/59,124/0	0/0/0	Tonto			X
Haigler Fuels Analysis		Prescribed burning, shaded fuel breaks	43,435/43,435/0	0/0/0	Tonto			X
Right-of-Way (ROW) Projects with Herbicide Use								
Management of Noxious Weeds and Hazardous Vegetation on State Highway ROWs	2004	Herbicide treatment of noxious weeds and hazardous vegetation		25/0/ 11,005 pesticide control of invasives	Tonto	X		

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[6]	Forest	Past	Current	Reasonably Foreseeable
APS-Herbicide Use within Authorized Power Line ROWs on NFS Lands in AZ	Decision expected 2019	Herbicide treatment	0/0/ 2,136 herbicide application	0/0/0	Apache-Sitgreaves Coconino Tonto			X
WAPA Glen Canyon-Rogers 230/345kV Integrated Vegetation Management	Decision expected 2019	Hazard tree removal, herbicide treatment, road repair	13,338/0/0	0/0/0	Coconino Tonto			X
SRP-Herbicide Use within Authorized Power Line ROWs on NFS Lands in AZ	Decision expected 2018 or 2019	Herbidicide treatment	0/0/ 7,469 herbicide application	0/0/0	Apache-Sitgreaves Tonto			X
Wildlife Habitat Improvement, Grassland Restoration Projects/Allotment Projects								
Park Day Allotment	1994	Mechanical and hand thinning, fuelwood sales, broadcast burning	14,665/250/0	2,193/0/ 701 control range vegetation	Apache-Sitgreaves	X		
Clear Creek Allotment	2000	Species habitat improvement, rangeland vegetation improvement	108	2,397/0/ 949 control tree encroachment, 2,288 range cover manipulation	Apache-Sitgreaves	X		
Wallace Allotment	Unknown			0/0/ 1,586 control tree	Apache-Sitgreaves	X		

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[6]	Forest	Past	Current	Reasonably Foreseeable
				encroachment, 161 control understory vegetation				
Railroad Allotment (Formerly Carlisle Complex Vegetation Treatments)	2007	Mechanical juniper removal	10,000/0/0	2,873/0/ 561 control tree encroachment	Apache-Sitgreaves		X	
Heber Allotment		Mechanical thinning, prescribed fire	0/0/ 39,000 grassland restoration	0/0/0	Apache-Sitgreaves			X
Pierce Wash Allotment-Section 18 Analysis of Vegetation Treatments		Grassland restoration			Apache-Sitgreaves			X
Apache Maid Grassland Restoration	2004			54,528/6,770/0	Coconino	X		
Bar T Bar/Anderson Springs Allotment	2005	Meadow, grassland, wildlife corridor restoration treatment; prescribed fire	32,677/32,677/0	1,304/132,938/ 1,519 control range vegetation, 39,180 control tree encroachment, 652 wildlife habitat improvement	Coconino		X	
Flying V and		Juniper removal,	10,875/0/	0/0/0	Tonto			X

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[6]	Forest	Past	Current	Reasonably Foreseeable
Flying H Allotment		seeding native grass, fence construction	112 fence construction					
Hardscrabble Allotment Juniper Clearing		Cut juniper trees	100/0/0	0/0/0	Tonto			X
New Delph Tank & Bear Tank Maintenance		Construct earthen stock tank, maintain existing tank	0/0/ 0.15 acres dredging and berm construction	0/0/0	Tonto			X
Pleasant Valley Northwest Grazing Allotments		Fence construction, juniper removal		0/0/0	Tonto			X
Red Lake Tanks		Tank construction, shrub removal	0/0/0.8 acres dredging, berm construction, ditch excavation	0/0/0	Tonto			X
Reforestation/Planting Projects								
Bison Reforestation	2003	Site prep, planting	0/0/500	356/312/ 308 tree planting, 275 animal damage control	Apache-Sitgreaves	X		
Clay Springs Reforestation	2004	Site prep, planting	0/0/710	0/0/ 169 tree planting, 169 animal damage control	Apache-Sitgreaves	X		
Jacques Marsh Elk Proof Fence & Riparian Planting	2006	Exclosure, planting	0/0/10	0/73/0	Apache-Sitgreaves	X		

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[6]	Forest	Past	Current	Reasonably Foreseeable
Pierce Reforestation	2009	Site prep, planting	0/0/1,375	0/0/ 203 tree planting, 203 animal damage control	Apache-Sitgreaves	X		
Rodeo-Chediski Riparian Planting	2010	Planting	0/0/ 1 tree planting	0/0/ 0.6 tree planting	Apache-Sitgreaves	X		
Rodeo-Chediski Reforestation (#18675)	2007	Planting, shade installation, fencing	0/0/3,071	0/150/ 551 tree planting, 303 animal damage control, 202 weed & tree release	Apache-Sitgreaves		X	
Rodeo-Chediski Reforestation (#53470)	2018	Mechanical and hand prep and possible fire to remove juniper before planting ponderosa pine seedlings	0/0/3,500 site prep and planting	0/0/0	Apache-Sitgreaves		X	
AGFD Fairchild Draw Elk Exclosure	2018	Maintain fence	0/0/ 16 fence maintenance	0/0/0	Apache-Sitgreaves			X
Conifer Weeding for Aspen Enclosure	Unknown			65/0/0	Coconino	X		
Emory Oak Restoration		Construction of exclosures, thinning, transplanting, and other actions		0 / 0 / 0	Tonto			X
Spring and Meadow Restoration Projects								

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[6]	Forest	Past	Current	Reasonably Foreseeable
Bill Dick, Foster, and Jones Springs Enhancement	2013	Pond and trough installation, fence installation and maintenance, willow pole planting	0/0/9.3	Unknown	Coconino	X		
Long Valley Work Center Meadow Restoration	2018	Channel reconstruction, tree removal, pond removal, install erosion control matting		0/0/ 16 tree encroachment control	Coconino		X	
Mogollon Rim Spring Restoration Project	2018	Invasive weed removal, planting, install fencing, tree thinning	Unk/Unk/ 5 spring restoration		Coconino			X

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[6]	Forest	Past	Current	Reasonably Foreseeable
Other Projects								
ASNF - No NEPA docs found - various activities reported in FACTS but not tied to other named projects	Unknown			42,763/74,202/ 2,158 tree planting, 350 replant trees, 1,720 site prep, 59 animal damage control, 82 invasives control, 497 control range vegetation; 4,297 range cover manipulation, 438 seeding and planting, 5,563 control tree encroachment, 27 weed & tree release, 1,465 habitat improvement	Apache-Sitgreaves		X	
Four Springs Trail Realignment	Decision expected 2018	Trail reroute and rehabilitation	0/0/4.5 miles	0/0/0	Apache-Sitgreaves			X
Heber-Overgaard Non-motorized Trail System		Creation of trail system		0/0/0	Apache-Sitgreaves			X
Navopache Electric Cooperative		Add new trunk line		0/0/0	Apache-Sitgreaves			X

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[6]	Forest	Past	Current	Reasonably Foreseeable
Trunk Line Addition								
Grapevine Interconnect (Grapevine Canyon Wind Project)	2012	Installation of powerline and switchyard	24/0/0		Coconino	X		
APS Line Maintenance	Unknown			87/0/0	Coconino	X		
COF - No NEPA docs found - various activities reported in FACTS but not tied to other named projects	Unknown	N/A	N/A	16,049/15,175/ 15 biocontrol of invasives, 20 pesticide control of invasives, 3,921 control range vegetation, 739 weed & tree release	Coconino	X		
Sixteen Rock Pits and Additional Reclamation	2017	Expansion and reclamation of rock pits	66/0/ 66 excavation, 5 re-contouring, 5 planting	0/0/0	Coconino		X	
Glen Canyon-Pinnacle Peak 345kV Transmission Line Vegetation Management (WAPA)	2014	Mechanical vegetation removal	4,580/0/0		Coconino		X	

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[6]	Forest	Past	Current	Reasonably Foreseeable
TNF - No NEPA docs found - various activities reported in FACTS but not tied to other named projects	Unknown	N/A	N/A	15,565/26,386/ 260 tree planting, 198 tree re-planting, 4,018 pesticide control of invasives, 21,000 biocontrol of invasives, 6,890 range cover manipulation, 11,345 weed and tree release	Tonto	X		
Noxious Weed Treatment Projects	2005	Noxious weed treatment		61,015/1,008/ 2,021 pesticide control of invasives, 11 biocontrol of invasives	Tonto		X	
Cragin-Payson Water Pipeline and Treatment Plant	2012	Construct, operate, and maintain water transmission pipeline right-of-way	≤ 352/0/ ≤ 352 excavation, construction, and pipeline burial	0/0/0	Tonto			X