United States
Department of
Agriculture

Forest
Service

**Southwestern
Region**

Fire Specialist Report

Forest Plan Revision DEIS

Submitted by: __/s/ ___________________________

JUDITH PALMER
Forest Fuels Specialist
Apache-Sitgreaves National Forests
August 29, 2012

Contents

Introduction

This report evaluates and discloses the potential environmental consequences related to the disturbance process of fire that may result with the adoption of a revised land management plan. It examines, in detail, four different alternatives for revising the 1987 Apache-Sitgreaves NFs land management plan (1987 forest plan).

Relevant Laws, Regulations, and Policy that Apply

Clean Air Act (USC 7401) of 1970, as amended: Forms a basis for the US air pollution control effort.

Clean Air Act, Sec. 118; Arizona Revised Statutes (ARS 49:5011): Mandates the Arizona Department of Environmental Quality to protect Arizona citizens from air pollution.

Arizona Administrative Code, Title 18. Environmental Quality, Chapter 2. Department of Environmental Quality Air Pollution Control, Article 15, **Forest and Range Management Burns**:.State regulations for prescribed burning and smoke.

Healthy Forest Restoration Act of 2003: Aimed at expediting the preparation and implementation of hazardous fuels reduction projects on federal land; encouraging collaboration between federal agencies and local communities; requiring courts to balance effects of action versus no-action prior to halting implementation; and requires federal agencies to retain large trees under certain conditions.

"Urban Wildland Interface Communities within the Vicinity of Federal Lands That Are at High Risk From Wildfire" Federal Register Vol. 66, No. 3, 2001: List of communities in the vicinity of federal lands that are at high risk from wildfire.

Forest Service Manual 5142: Provides direction on using fire to accomplish land and natural resource objectives.

Forest Service Handbook 5109: Provides direction for fire managers**.**

National Fire Plan, August 2000: Outlines a plan of action for federal agencies in order to protect wildland-urban interface and be prepared for extreme fire conditions.

Federal Wildland Fire Management Policy of 1995 (updated January 2001): Guides the philosophy, direction, and implementation of fire management on federal lands.

2002 President's Healthy Forest Initiative: Emphasizes administrative and legislative reforms to expedite fuels treatments and post-fire rehabilitation actions.

Interagency Prescribed Fire Planning and Implementation Procedures Guide, July 2008: Provides standardized procedures, specifically associated with the planning and implementation of prescribed fire.

Guidance for Implementation of Federal Wildland Fire Management Policy, February 13, 2009: Guidance for consistent implementation of the 1995/2001 Federal Fire Policy. This guidance includes the following.

- Planned ignitions – the intentional initiation of a wildland fire by hand-held, mechanical or aerial device where the distance and timing between ignition lines or points and the sequence of igniting them is determined by environmental conditions (weather, fuel, topography), firing technique, and other factors which influence fire behavior and fire effects (also known as prescribed fire).

- Unplanned ignitions - the initiation of a wildland fire by lightning, volcanoes, unauthorized and accidental human-caused fires (also known as wildfire).

- A wildland fire may be concurrently managed for one or more objectives and objectives can change as the fire spreads across the landscape. Objectives are affected by changes in fuels, weather, topography; varying social understanding and tolerance; and involvement of other governmental jurisdictions having different missions and objectives.
- Managers will use a decision support process to guide and document wildfire management decisions. The process will provide situational assessment, analyze hazards and risk, define implementation actions, and document decisions and rationale for those decisions.

Interagency Standards for Fire and Fire Aviation Operations (Red Book): **USDA Forest Service Wildland Fire and Aviation Program Organization and Responsibilities**: A reference guide that documents the standards for operational procedures and practices for the Forest Service fire and aviation management program.

Apache-Sitgreaves National Forests Fire Management Plan, 2010: Provides information concerning the fire process for the Apache and Sitgreaves National Forests and compiles guidance from existing sources such as but not limited to, the Apache and Sitgreaves National Forests Land and Resource Management Plan (LMP), national policy, and national and regional directives.

Smoke Management Guide for Prescribed and Wildland Fire, 2001: Provides guidance on understanding and application of smoke management.

Methodology and Analysis Process

This report examines how the plan alternatives address the risk of uncharacteristic wildfire and how they contribute to returning wildfire to a more natural role. This is done by comparing the existing Fire Regime Condition Class (FRCC) with the alternatives to determine the percent of the forests that would move towards desired conditions. It also compares how each alternative may contribute smoke, by comparing the amount of burning that is planned in each alternative. The report also compares how each alternative varies in its emphasis of treatments near the wildland-urban interface.

All alternatives use mechanical and fire treatments to reduce fuel loads and tree densities, thus reducing the risk of uncharacteristic wildfires which pose threats to ecosystems and communities. These treatments assist in moving fire to a more natural role. FRCC is a tool used to determine if a landscape is moving towards desired conditions. It measures how close or far a system has departed from its natural fire regime.

FVS-FFE (Forest Vegetation Simulator-Fire and Fuels Extension) and VDDT (Vegetation Dynamics Development Tool) models were used in this analysis. The output of the models resulted in the projected FRCC by alternative. Information, including assumptions and input, variables about these models and the results are displayed in the Vegetation Specialist Report. Additional notes on FVS-FFE input variables are located in Appendix B and C.

All of the alternatives contain objectives for treating (mechanical and burning) vegetation to improve structure and composition, including reducing ladder fuels and canopy density. For each alternative there is an objective for a range of acres to be treated (e.g. treat 1,500 to 3,000 acres). For this analysis the average of the range (e.g. 2,250 acres) was used to determine FRCC. This FRCC outcome was compared by alternative at 15 years of implementation, the expected length of the plan, and the trends were assessed through the 50 year timeframe.

The effect of smoke, from planned and unplanned ignitions, was compared by alternative as it relates to air quality. The comparison was based on the average number of acres treated by alternative. Alternative A was estimated based on the average number of acres burned from 1985-2006 Forest Service Activity Tracking System (FACTS).

Historic fire regimes, condition classes, and fire return intervals are documented in the Ecological Sustainability Report (Forest Service 2008a). Existing vegetation condition (mid-scale) was reassessed following the Wallow Fire of 2011.

Assumptions

In the analysis for this resource, the following assumptions have been made:

- To meet the plan's treatment objective for acres of burning, a combination of planned (prescribed burning) and unplanned (wildfire) ignitions would occur. Burning could occur across all National Forest System (NFS) lands.
- This analysis assumes a set acreage would be burned each year. This number varies by alternative. The actual acres burned, when the plan is implemented, may fluctuate yearly due to natural ignitions, weather, and burning conditions.
- For this analysis planned ignitions are represented by the amount of broadcast burning.
- The effects of pile burning were not analyzed in this report because treatments may involve removing biomass (leaving no piles). If needed the effects would be considered at the project level.
- The agency has the capacity (e.g. funding, personnel, other resources) to accomplish the minimum planned objectives.
- Unplanned ignitions are analyzed at the time of the ignition and documented in the Wildland Fire Decision Support System (WFDSS). Management response to a wildfire would be based on direction in the land management plan. All wildfires would receive a management response appropriate to conditions of the fire, fuels, weather, and topography to accomplish specific objectives for the area where burning may occur.
- The response to wildfires is not discretionary and is considered an emergency action. Suppression responses would vary markedly in scale and duration, depending on the particular fire and conditions.
- Particulate emissions from planned ignitions would be modeled at the project level.
- For this analysis, each PNVT was given an overall FRCC classification. For example, there are some areas in the ponderosa pine forest have recently been treated and those stands may now be in FRCC 1 or 2; however, the majority of the ponderosa pine across the forests is highly departed and thus the entire PNVT is classified as FRCC 3.
- Boundaries of Community Wildfire Protection Plans (CWPPs) may change as local entities update/revise their plans.

Revision Topics Addressed in this Analysis

Wildland-Urban Interface

- Qualitative discussion explaining how treatments are emphasized by alternative (priority for treating different areas of land)

The risk of uncharacteristic wildfire and the ability for wildfire to play its natural role.

- FRCC measured by vegetation type by alternative.
- Acres burned by alternative.

Effect of smoke on air quality

- Qualitative discussion

Summary of Alternatives

A summary of alternatives, including the key differences among alternatives, is outlined in the Draft Environmental Impact Statement.

Description of Affected Environment (Existing Condition)

National Fire Policy and Wildland Urban Interface

Fire managers have been faced with increasing costs, urban development, and unprecedented fire behavior. Decades of government policy directed at extinguishing every fire on public lands have contributed to the disruption of the natural fire processes. In response to these issues, there have been several changes in national fire policy over the past two decades.

The current Federal Wildland Fire Management Policy was signed in 1995 and updated in 2001. The Federal Wildland Fire Management Policy guides the philosophy, direction, and implementation of fire management planning, activities, and projects on federal lands. The policy helps ensure consistency, coordination, and integration of wildland fire management programs and related activities throughout the federal government.

On August 8, 2000, the President directed the Secretaries of the Department of Agriculture and the Department of the Interior to prepare a report recommending how best to respond to that year's severe fires, reduce the impacts of those fires on rural communities, and ensure sufficient fire management resources in the future. On September 8, 2000, the President accepted their report, "Managing the Impacts of Wildfires on Communities and the Environment," which provided an overall framework for fire management and forest health programs (66 FR 751-777).

These recommendations initiated a number of policies including the National Fire Plan, the Healthy Forests Initiative (HFI), long-term stewardship contracting authority, and the Healthy Forests Restoration Act (HFRA). These policies led to the preparation of Community Wildfire Protection Plans (CWPPs) to define the wildland-urban interface (WUI) and to establish priorities for wildfire preparedness and hazardous fuels reduction work in these areas.

The wildland-urban interface, commonly referred to as WUI, exists where humans and infrastructure intermix with wildland fuels. There continues to be a significant growth in the communities surrounded by the Apache-Sitgreaves NFs both in population and construction of summer homes. For example, it was estimated in 2004 that there were approximately 25,000 full-time residents and about 80,000 seasonal residents (primarily summer) within communities of: Forest Lakes, Heber/Overgaard, Aripine, Clay Springs, Pinedale, Linden, Show Low, Wagon Wheel, Pinetop-Lakeside, Hondah, McNary, Vernon, Hideaways area, Greer, South Fork, Eagar, Springerville, Nutrioso, and Alpine (Forest Service 2008b), see figure 1. Growth in all the communities has been steady. For example, a local electrical cooperative reported an average of

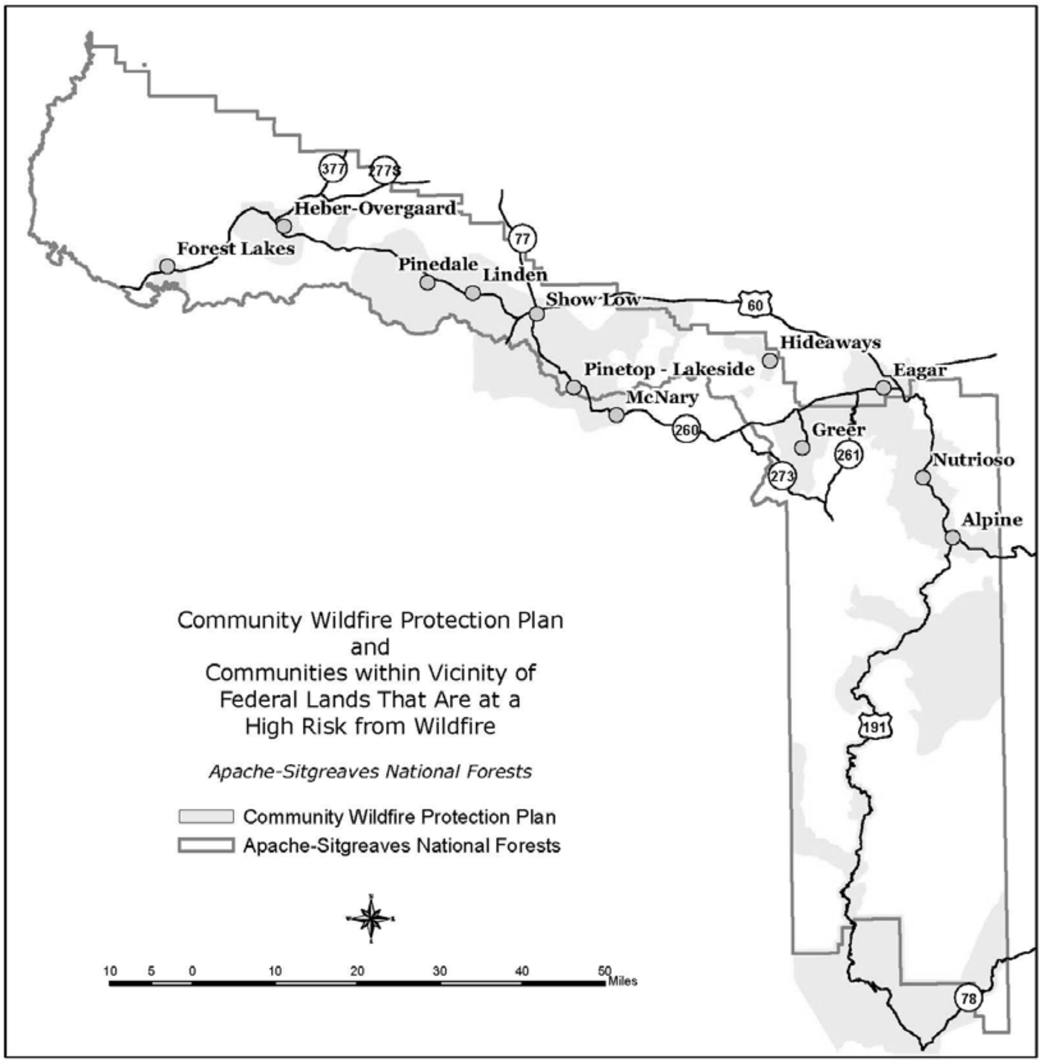


Figure 1. Communities within Vicinity of Federal Lands That Are at a High Risk from Wildfire and Areas currently covered by Community Wildfire Protection Plan

1,300 to 1,500 new customers per year (Navajo County et al. 2004).

There are 12 communities within or adjacent to the forests which have been identified as "Urban Wildland Interface Communities within the Vicinity of Federal Lands That Are at High Risk from Wildlife" (66 FR 751-777). They include: Alpine, Eagar, Forest Lakes, Greer, Heber-Overgaard, Hideaways, Linden, McNary, Nutrioso, Pinedale, Pinetop-Lakeside, and Show Low (see figure above). Hazardous fuel reduction treatments on adjacent Federal lands around these communities are ongoing.

The forests have three CWPPs that cover over 895,000 acres of WUI on Federal, State, county, and private lands and include 36 communities within the boundaries. Approximately 612,000 acres on National Forests System (NFS) lands are covered by the CWPPs. The CWPPs include “CWPP for At-Risk-Communities in Apache County”, “CWPP for At-Risk-Communities in Greenlee County”, and the “Sitgreaves CWPP (includes Apache, Coconino, and Navajo Counties)”(Logan-Simpson Design Inc. 2004, 2004a, and 2005)). These plans identify and prioritize areas for treatment based upon input from the communities. There are additional areas on the forest that meet the definition of WUI as defined in Forest Service Manual. Because the CWPPs did not cover all development that might be threatened by wildfire, the following WUI definition is also used when considering values at risk:

> Wildland Urban Interface (WUI) – includes those areas of resident populations at imminent risk from wildfire, and human developments having special significance. These areas may include critical communications sites, municipal watersheds, high voltage transmission lines, church camps, scout camps, research facilities, and other structures that if destroyed by fire, would result in hardship to communities. These areas encompass not only the sites themselves, but also the continuous slopes and fuels that lead directly to the sites, regardless of the distance involved. (R3 Supplement Forest Service Manual 5140.5)

Alternative A (1987 plan) does not address the hazards associated with the WUI. However, since 2001, there has been a management emphasis to treat areas identified in the CWPPs and WUI.

Fire History and Behavior

At the time of Euro-American settlement, the Apache-Sitgreaves NFs, as well as other forests in northern Arizona, generally consisted of open stands of uneven-aged ponderosa pine with an extensive grass-forb understory. Frequent (every 5 to 10 years) low intensity fires burning through small pine regeneration and other ground fuels, prevented forests from becoming the dense stands so frequently found in northern Arizona today.

Fire scar samples taken in ponderosa pine vegetation within the White Mountains show an average return interval of 3 years with widespread fires occurring every 10 years (Forest Service 2002). Grasslands on southern aspects had the greatest frequency, fires were fast moving and killed conifer seedlings encroaching from adjacent forested areas.

Fire frequency and severity has been altered from historic condition in most vegetation types. See table 1 for comparison of historic fire return intervals to current intervals (Forest Service 2008a). Historically, fires could burn until they were extinguished by precipitation, ran out of fuel, or reached a previously burned area. Fires could burn for months and cover thousands of acres (Swetnam 1990, Swetnam and Baisan 1996).

Table 1. Fire frequency (fire interval) by major vegetation type (Forest Service 2008a)

Vegetation Type (PNVT)	Historic Fire Return Interval (years)	Current Fire Return Interval (years)
Ponderosa Pine Forest	2 to 17	155
Dry Mixed Conifer Forest	10 to 22	325
Wet Mixed Conifer Forest	35 to 50	3,335
Spruce-Fir Forest	150 to 400	3,335
Madrean Pine-Oak Woodland	3 to 8	715
Piñon-Juniper Woodland	6 to 400	885
Interior Chaparral	20 to 100	130
Great Basin Grassland	10 to 30	5,000
Semi-desert Grassland	3 to 10	3,335
Montane/Subalpine Grasslands	2 to 400	3,335
Wetland/Cienega Riparian Areas and Mixed Broadleaf Deciduous, Montane Willow and Cottonwood-Willow Riparian Forests' historic and current fire return intervals are similar to the adjacent vegetation type.		

Fire severity is an actual physical change in the vegetation, litter, or soils caused by fire. Post-fire effects are typically classified as low to high severity (http://www.northernrockiesfire.org/history/fireis.htm).

Table 2. Fire frequency and severity by PNVT (ESR, Forest Service, 2008) compared to the 2011 Wallow Fire burn severities

			Wallow Fire Burn Severity within Perimeter Acres (Percent)				
Vegetation Type (PNVT)	Historic Fire Return Interval (years)	Historic Fire Severity	High	Moderate	Low	Unburned	Wallow Fire Severity
Ponderosa Pine Forest	2 to 17	Low	11,809 (9.2)	22,734 (17.6)	79,821 (61.9)	14,488 (11.2)	Low-Mixed
Dry Mixed Conifer Forest	10 to 22	Low	19,412 (24.9)	12,253 (15.7)	31,462 (40.4)	14,813 (19)	Low-High
Wet Mixed Conifer Forest	35 to 50	Mixed	47,409 (35.3)	19,835 (14.8)	43,494 (32.4)	23,702 (17.6)	Low-High

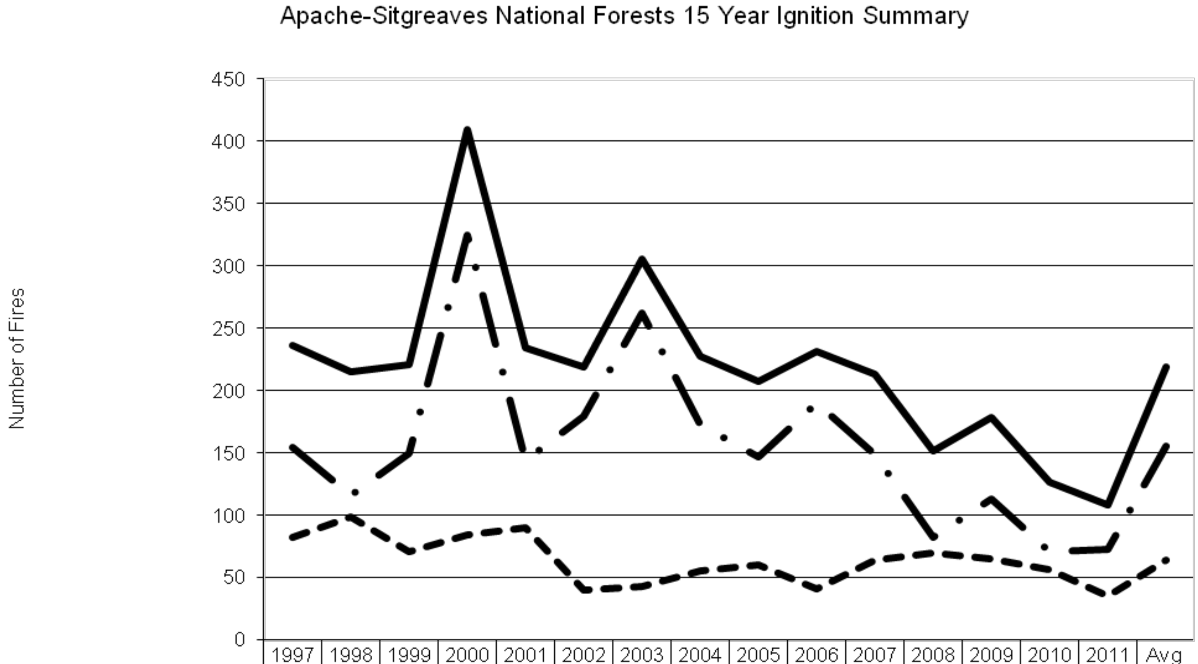
			Wallow Fire Burn Severity within Perimeter Acres (Percent)				
Vegetation Type (PNVT)	**Historic Fire Return Interval (years)**	**Historic Fire Severity**	**High**	**Moderate**	**Low**	**Unburned**	**Wallow Fire Severity**
Spruce-Fir Forest	150 to 400	High	3,874 (30.6)	2,462 (19.5)	3,897 (30.8)	2,423 (19.1)	Low-High
Madrean Pine-Oak Woodland	3 to 8	Low	1,246 (2.3)	4,767 (9.0)	20,396 (38.4)	26,679 (50.3)	Low
Piñon-Juniper Woodland	6 to 400	Low, Mixed, and High	583 (3.3)	2,225 (12.5)	5,587 (31.4)	9,389 (52.8)	Low
Interior Chaparral	20 to 100	High	357 (3.6)	2,426 (24.4)	3,266 (32.8)	3,900 (39.2)	Low-Mixed
Great Basin Grassland	10 to 30	Low	88 (1.3)	325 (4.9)	3,311 (50.3)	2,854 (43.4)	Low
Semi-desert Grassland	3 to 10	Low	35 (2.3)	251 (16.5)	606 (40.0)	624 (41.2)	Low
Montane/Subalpine Grasslands	2 to 400	Low	176 (0.5)	1,679 (4.6)	27,422 (75.3)	7,159 (19.6)	Low
Wetland/Cienega Riparian Areas	0 to 35	Low	441 (3.7)	759 (6.4)	7,406 (62.7)	3,212 (27.2)	Low
Cottonwood-Willow Riparian Forest	0 to 35	Low	72 (4.2)	176 (10.1)	731 (42.0)	759 (43.7)	Low-Mixed
Mixed Broadleaf Deciuous Riparian Forest	0 to 35	Low	0 (0.1)	27 (5.6)	212 (43.2)	251 (51.1)	Low
Montane Willow Riparian Forest	0 to 35	Low	196 (5.9)	424 (12.7)	1,674 (50.2)	1,041 (31.2)	Low-Mixed

Table 2 displays historical frequency and severity of fires within PNVTs. The 2011 Wallow Fire is used as an example of how these vegetation types burned based on mapped burn soil severity classes, It also summarizes the observed effects from the Wallow Fire in the last column. For example the Dry Mixed Conifer type, which would have historically burned at a frequency of 10-22 years with low severity fires, experienced a wide range of severities in the Wallow Fire. While the Dry Mixed Conifer type within the Wallow Fire experienced predominately low severity effect, almost 41% of the acres burned at moderate to high severity. In addition the Wet Mixed Conifer type had approximately 50% of the acres burned in moderate to high severity. Historically Wet Mixed Conifer burned with a mixed fire severity with discontinuous patches of high severity

Years of land management practices in the early 1900s (e.g. fire suppression, livestock grazing) have impacted the ability of fire to play its natural role in maintaining ecosystem health (Covington and Moore 1994). Consequently there are higher levels of woody vegetation (fuel loads) and less herbaceous cover than existed historically (Forest Service 2008a). Altered fire regimes are now the norm in fire-adapted ecosystems in the Southwest and have resulted in uncharacteristic wildfire, which are increasingly larger and more severe. This has resulted in increased attention to the way land is managed in the Southwest (Swetnam and Betancourt, 1998).

On the Apache-Sitgreaves NFs, fire season is generally April 1 through October 15. Strong southwest winds and low humidity are prevalent from mid-April to mid-June, resulting in mainly wind driven fire behavior. Hot, dry and unstable conditions usually occur from mid-June to early July. The potential for dry lightning is most likely during this time period. The monsoon season, accompanied by higher humidity and rainfall potential, decreased wind, and reduced fire behavior, generally begins during the first or second week in July and it typically ends in the second or third week in September when dry and mild conditions return leading to a period of increased fire behavior potential before the onset of winter conditions.

From 1997 to 2011, the majority of fires on the Apache-Sitgreaves NFs were caused by lightning, with an average of 155 fire starts per year. The remaining fires were human-caused, averaging 64 fire starts per year, see figure 2. Both human and lightning fires contribute to the total number of acres burned on the forests and are displayed in figure 3. Fires occurred every month of the year with the greatest amount occurring from May to August, usually lasting less than 2 days.



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Avg
Total All Ignitions	236	215	221	409	234	219	305	228	207	231	213	152	178	127	108	219
Lightning	154	116	150	325	144	179	262	173	147	190	149	82	113	71	73	155
Human Ignition	82	99	71	84	90	40	43	55	60	41	64	70	65	56	35	64

Figure 2. Number and Source of unplanned ignitions on the Apache-Sitgreaves NFs from 1997 to 2011.

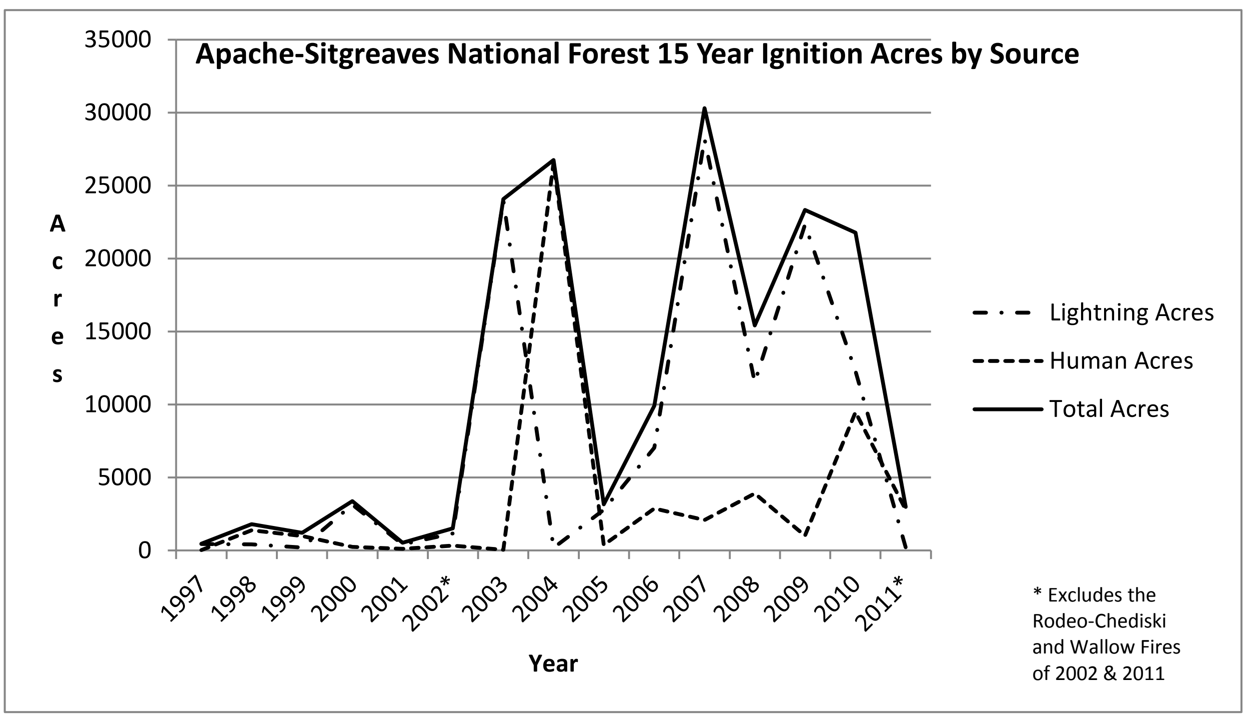


Figure 3. Unplanned ignitions per year by ignition source.

Over a million acres have burned on the Apache-Sitgreaves NFs between 1997 and 2011. About 80 percent were unplanned ignitions, while approximately 20 percent were planned ignitions. Approximately 40 percent of the acreage burned occurred in the ponderosa pine vegetation type , see table 3. Fire sizes have been generally small with over 65 percent of the fires less than one quarter of an acre and 94 percent of them being less than 10 acres (Fire Family Plus). The 2002 Rodeo-Chediski Fire burned 173,000 acres on the forests, and the 2011 Wallow Fire burned 538,000 acres. Both of these fires were human-caused.

Table 3. Acres burned between 1997 and 2011 by vegetation and ignition source from Apache-Sitgreaves NF's GIS data.

Vegetation Type (PNVT)	Unplanned Ignition (Wildfires) Acres*	Planned Ignition (Prescribed Fire) Acres*	Total Acres Burned
Ponderosa Pine Forest	306,933	109,500	416,433
Dry Mixed Conifer Forest	108,529	15,741	124,270
Wet Mixed Conifer Forest	149,364	8,758	158,122
Spruce-Fir Forest	16,891	53	16,944
Madrean Pine-Oak Woodland	83,292	44,358	127,650
Piñon-Juniper Woodland	38,750	6,728	45,478
Interior Chaparral	28,733	8,325	37,058
Great Basin Grassland	13,000	542	13,542
Semi-desert Grassland	3,394	10,777	14,171
Montane/Subalpine Grasslands	36,937	2,312	39,249
Cottonwood-Willow Riparian Forest	5,482	419	5,901
Mixed Broadleaf Deciduous Riparian Forest	685	198	883
Montane Willow Riparian Forest	3,608	413	4,021
Wetland/Cienega Riparian Areas	12,092	1,374	13,466
Urban or Agricultural	26	0	26
TOTAL	**807,716**	**209,498**	**1,017,214**

* Unplanned ignitions include both fires used for multiple resource objectives and those with the objective of full suppression. Planned ignitions include both broadcast and pile burning.

Fire Regime Condition Class

A natural fire regime is a general classification of the role fire would play across a landscape in the absence of modern human mechanical intervention, but it includes the influence of aboriginal burning (Agee 1993, Brown 1995). Coarse-scale definitions for natural fire regimes have been developed by Hardy et al. (2001) and Schmidt et al. (2002) and interpreted for fire and fuels management by Hann and Bunnell (2001). The five natural fire regimes are classified based on average number of years between fires (fire frequency) combined with the severity of the fire on the dominant overstory vegetation. These five regimes are:

Fire Regime I – 0-35 year frequency and low (surface fires most common) to mixed severity (less than 75 percent of the dominant overstory vegetation replaced);

Fire Regime II – 0-35 year frequency and high (stand replacement) severity (greater than 75 percent of the dominant overstory vegetation replaced);

Fire Regime III – 35-100+ year frequency and mixed severity (less than 75 percent of the dominant overstory vegetation replaced);

Fire Regime IV – 35-100+ year frequency and high (stand replacement) severity (greater than 75 percent of the dominant overstory vegetation replaced);

Fire Regime V – 200+ year frequency and high (stand replacement) severity.

All fire regimes are represented across the forests (LANDFIRE) as noted in table 3.

Table 4. Fire regimes by PNVTs on the Apache-Sitgreaves NFs

Potential Natural Vegetation Type (PNVT)	Fire Regime	Potential Natural Vegetation Type (PNVT)	Fire Regime
Ponderosa Pine Forest	I	Great Basin Grassland	I
Dry Mixed Conifer Forest	I	Semi-desert Grassland	I
Wet Mixed Conifer Forest[1]	III	Montane/Subalpine Grassland	I
Spruce-Fir Forest	III, IV	Cottonwood-Willow Riparian Forest[3]	I, III
Madrean Pine-Oak Woodland	I	Mixed Broadleaf Deciduous Riparian Forest[3]	I, III
Piñon-Juniper Woodland[2]	I, III, IV, V	Montane Willow Riparian Forest[3]	I, III
Interior Chaparral	IV	Wetland/Cienega Riparian Areas[3]	I, III

[1]Within wet mixed conifer , fire regime IV and V may occur; however, it is rare.
[2]Within pinon-juniper, fire regime I is found in pinon-juniper savanna; while III, IV, and V are found in pinon-juniper persistant woodland.
[3]Wetland/cienega riparian areas and mixed broadleaf deciduous, montane willow, and cottonwood-willow riparian forests' historic and current fire return intervals are strongly influenced by surrounding PNVTs and their fire regime.

Fire Regime Condition Class (FRCC) is a metric that quantifies how departed a system is from historical conditions in relation to fire, the role fire historically played in that system, and the vegetative structure (Hann and Bunnell 2001, Hardy et al. 2001, Hann et al. 2004). The classification is based on a relative measure describing the degree of departure from the historical fire regime. FRCC is developed as a measure of the difference in structure between current and reference condition. This disparity has strong inferences about fire regime and changes to one (or more) of the following ecological components: vegetation characteristics (e.g. species composition, structural stages, stand age, canopy closure, mosaic pattern); fuel composition; fire frequency, severity, and pattern; and other associated disturbances (e.g. insect and disease mortality, grazing, drought).

There are three condition classes for each fire regime based on low (FRCC 1), moderate (FRCC 2), and high (FRCC 3) departure from the central tendency of the natural fire regime (Hann and Bunnell 2001, Hardy et al. 2001, Schmidt et al. 2002). Low departure is considered to be within the natural (historical) range of variability, while moderate and high departures are outside. The desired condition is to move towards or maintain vegetation conditions in FRCC 1.

Vegetation in FRCC 1 is more resilient and resistant and less likely to lose key ecosystem components (e.g. native species, large trees, soil) after a disturbance. Fire behavior and other associated disturbances are similar to those that occurred prior to fire exclusion. For example, ponderosa pine in FRCC 1 would have a fire regime and vegetative structure similar to historic conditions where fires were low intensity and high frequency and vegetation consisted of open stands and clumps of trees.

Vegetation in FRCC 2 and 3 is moderately to highly altered and there is a risk of losing key ecosystem components. Fire behavior and other associated disturbances are moderately to highly departed from historic conditions.

For this analysis FRCC 1 is represented by vegetation departure index 0 to 33, FRCC 2 is 34 to 66, and FRCC 3 is 67 to 100. For more information about vegetation condition and departure from desired conditions, see Vegetation section.

Approximately 86 percent of the forests are departed from historic conditions and are in FRCC 2 and 3, see table 4 and figure 4. Existing overall FRCC by vegetation type is displayed in table 5. Only 14 percent of the vegetation types are in FRCC 1.

Table 5. Existing forestwide FRCC on the Apache-Sitgreaves NFs.

	FRCC 1	FRCC 2	FRCC 3	Total
Acres	287,804	280,996	1,442,302	2,011,102*
Percent	14%	14%	72%	100%

*total excludes water, quarries, urban/agriculture lands.

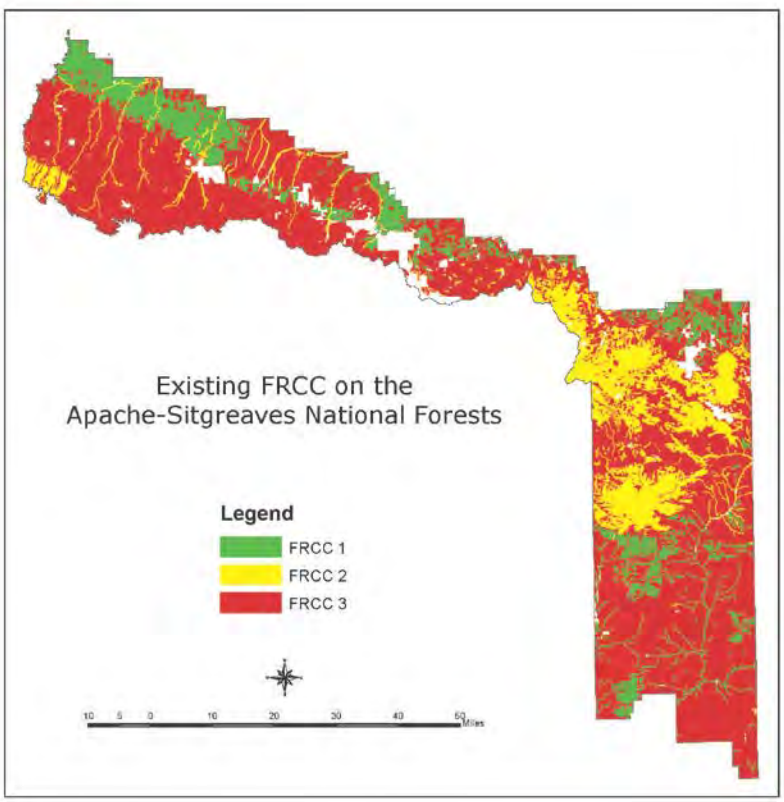


Figure 4. Map of current forestwide FRCC for the Apache-Sitgreaves NFs.

Table 6. Current FRCC by PNVT

Potential Natural Vegetation Type (PNVT)	FRCC	Potential Natural Vegetation Type (PNVT)	FRCC
Ponderosa Pine Forest	3	Great Basin Grassland	3
Dry Mixed Conifer Forest	3	Semi-desert Grassland	3
Wet Mixed Conifer Forest	2	Montane/Subalpine Grassland	2
Spruce-Fir Forest	2	Cottonwood-Willow Riparian Forest	2
Madrean Pine-Oak Woodland	3	Mixed Broadleaf Deciduous Riparian Forest	1
Piñon-Juniper Woodland	1	Montane Willow Riparian Forest	3
Interior Chaparral	1	Wetland/Cienega Riparian Areas	2

Air Quality Related to Smoke

Periodic planned ignitions (prescribed burns) and unplanned ignitions (wildfires) are tools used to decrease fuel accumulation and to restore ecosystem processes. Wildfires and prescribed burns within the planning area may produce temporary, but large, amounts of smoke, particulates, carbon monoxide, and other ozone precursors.

Limits to smoke emissions from planned ignitions are imposed by the Arizona Department of Environmental Quality (ADEQ). Smoke from unplanned ignitions is considered a natural event and not regulated by law. However, fire managers work to influence smoke production by suppressing fires, checking or redirecting the growth of the fire, or through smoke reduction techniques, such as performing burns when climatic conditions are optimal.

Prescribed fires and wildfires have the potential to produce smoke that may impact air quality depending on the amount, extent, and duration. Wildfire events and associated poor air quality can last for weeks. For example, during June and July of 2002 when the Rodeo-Chediski Fire took place, over 460,000 acres burned across multiple jurisdictions and affected air quality in the communities along the Mogollon Rim for weeks.

Particulate matter (PM) is of the greatest concern because particulate emissions in smoke can affect both visibility and human health. Particulate matter is described as very fine solid particles suspended in smoke and are measured as a 24 hour average. PM10 particles are 10 microns or less in size; PM2.5 particles are 2.5 microns or less in size. The amount of particles present in these size classes, especially PM2.5, is important when considering the health effects of smoke. PM2.5 particles can become lodged in the deepest part of the respiratory system and are difficult for the body to expel.

The Clean Air Act of 1970 mandates that every state have a Statewide Implementation Plan to regulate pollutants. Smoke is regulated with oversight and compliance by the State of Arizona. The Arizona State Implementation Plan, administered by Arizona Department of Environmental Quality (ADEQ), requires that federal and state land management agencies submit annual registrations, prescribed fire burn plans, and prescribed burn requests in order to obtain authorization to burn (see Appendix A).

Arizona is divided into 11 smoke management units (SMUs), see figure 5. The Apache-Sitgreaves NFs occurs within 3 units: Little Colorado River Airshed (SMU 3), Lower Salt River Airshed (SMU 6), and Upper Gila River Airshed (SMU 7). Special considerations to address smoke are required when a fire is in a nonattainment area for national ambient air quality standards[1] including ensuring compliance and conformity with state and tribal implementation plans. There are no nonattainment areas within SMUs 3 and 7. However, there is a nonattainment area in SMU 6 southwest of the forests around Payson, Arizona.

There is one Class I airshed on the forests, Mount Baldy Wilderness. Petrified Forest National Park is another Class I airshed and is directly north of the forests. Class I is an airshed classification which requires the highest level of protection under the Clean Air Act of 1963. Projects which may potentially impact Class I airsheds must include efforts to minimize smoke impacts on visibility. See Air Specialist Report for more information on Class I airsheds and overall air quality.

[1] The Clean Air Act requires the Environmental Protection Agency to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment .

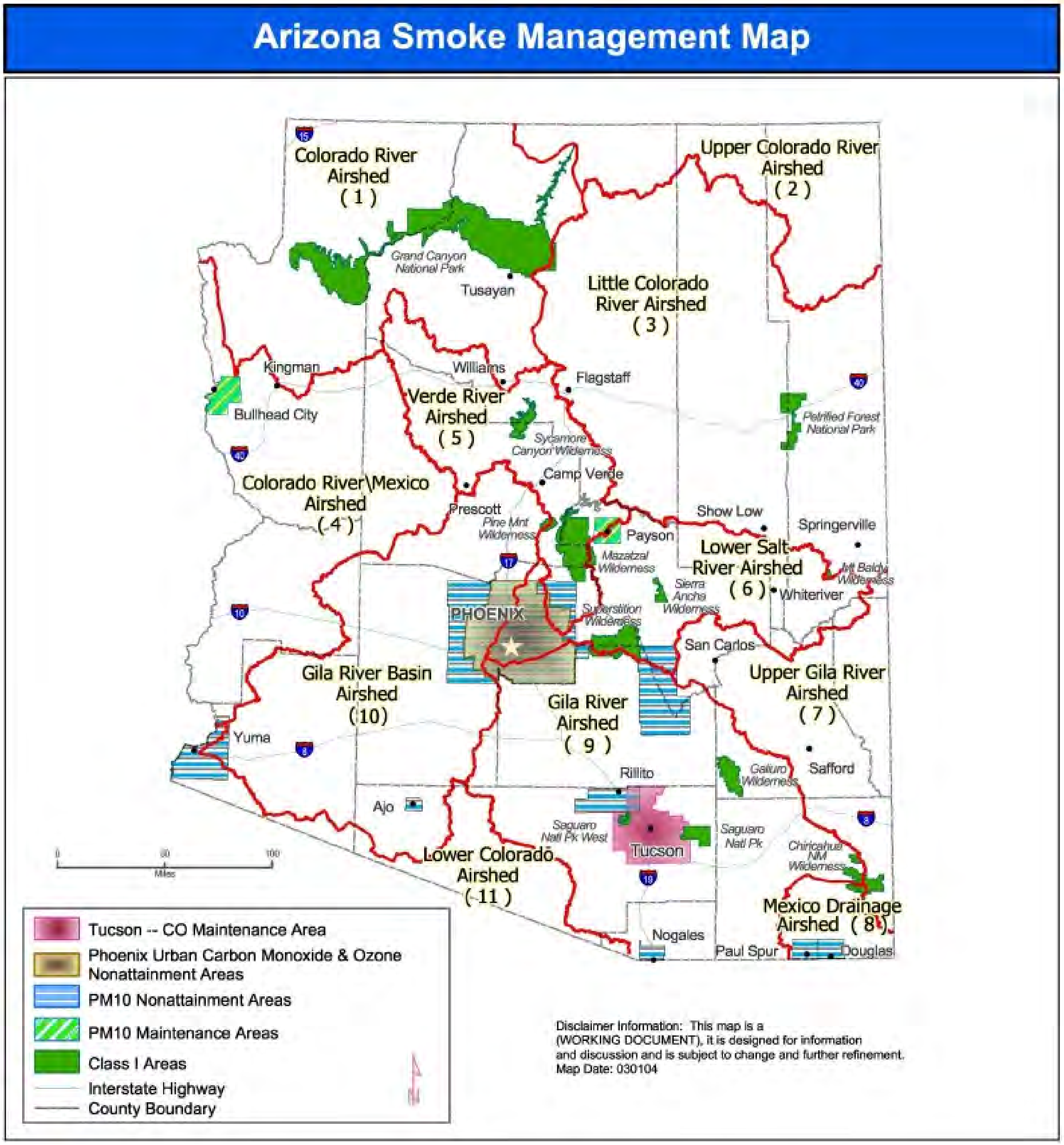


Figure 5. Arizona smoke management units. The Apache-Sitgreaves NFs falls in units 3, 6, and 7.

Environmental Consequences of Alternatives

The land management plan provides a programmatic framework that guides site-specific actions but does not authorize, fund, or carryout any project or activity. Because the land management plan does not authorize or mandate any site-specific projects or activities (including ground-disturbing actions) there can be no direct effects. However, there may be implications, or longer term environmental consequences, of managing the forests under this programmatic framework.

Wildland-Urban Interface

Alternative A (1987 plan) would not specifically address the hazards associated with the WUI or prioritize treatments to address those hazards. Since 2001, however, there has been a management emphasis to treat areas identified in CWPPs and WUI.

Due to the threat of fire moving into or from developed areas, higher levels of management may be needed to restore fire-adapted ecosystems, including regular maintenance treatments. A management area was created for the **action alternatives** to address this threat. The Community-Forest Intermix Management Area consists of NFS lands within ½ mile of communities-at-risk. The Community-Forest Intermix Management Area accounts for approximately 10 percent of the NFS lands identified in the CWPPs. See appendix G for maps of the management areas.

All of the **action alternatives** would have land allocated to the Community-Forest Intermix Management Area where fuels reduction treatments and maintenance are emphasized. However, these alternatives would differ in where overall forest treatments are prioritized for placement.

Alternative B would most emphasize treating lands identified in the CWPPs including the Community-Forest Intermix Management Area. **Alternative C** would prioritize treatments just in the Community-Forest Intermix Management Area (versus the entire CWPP). **Alternative D** would least emphasize treating areas identified in the CWPPs because treatment emphasis is spread over all PNVTs across the forests, see table 7.

Table 7. Comparison of alternatives and how much emphasis is placed on treating the hazards associated with the WUI.

Least Emphasis	<--------------	------------>	Most Emphasis
Alternative A	Alternative D	Alternative C	Alternative B

As treatments occur within the wildland-urban interface, the risk of uncharacteristic wildfire and the resulting threat to communities and ecosystems would be reduced and potential losses from such fires would be mitigated. Treatments within the wildland-urban interface would not only help protect communities but would also help protect the forests from fire that starts on private lands. These treatments would also benefit firefighter and public safety. Treatments aimed to protect natural resources from uncharacteristic wildfire could outweigh the short-term impacts to the landscapes during treatment. **Alternative B** would provide the greatest benefit followed by **alternatives C, D, and A** based on the alternatives' emphasis.

Fire Regime Condition Class

Both mechanical and fire treatments would be used to move vegetation towards desired conditions in all alternatives. These treatments are used to change the character of the vegetation (e.g. a dense forest with too many evenly spaced trees to an open forest with groups and clumps of trees) that would result in lower risk of uncharacteristic fire and a return of wildfire to a more natural role. The desired condition is to move towards or maintain vegetation conditions in FRCC 1.

The amounts of treatment types vary by alternative as shown in table 8 and 9.

Table 8. The average annual acreage by treatment type, planned by alternative across all vegetation types.

Treatment Type	Alternative A Treatment Acres	Alternative B Treatment Acres	Alternative C Treatment Acres	Alternative D Treatment Acres
Mechanical	12,182	19,591	23,997	15,954
Fire	6,844	28,930	12,857	48,927
Total	19,026	48,521	36,854	64,881

Table 9. Average acres treated and percent of vegetation (PNVT) treated per year.

<table>
<tr><th>Vegetation Type (PNVT)</th><th>PNVT Total Acres of NFS</th><th>Alternative A Acres (Percent PNVT)</th><th>Alternative B Acres (Percent PNVT)</th><th>Alternative C Acres (Percent PNVT)</th><th>Alternative D Acres (Percent PNVT)</th></tr>
<tr><td>Ponderosa Pine Forest</td><td>602,206</td><td>10,269
(1.7%)</td><td>12,589
(2.1%)</td><td>18,955
(3.q1%)</td><td>18,113
(3.0%)</td></tr>
<tr><td>Dry Mixed Conifer Forest</td><td>147,885</td><td>2,608
(1.8%)</td><td>3,247
(2.2%)</td><td>4,913
(3.3%)</td><td>4,761
(3.2%)</td></tr>
<tr><td>Wet Mixed Conifer Forest</td><td>177,995</td><td>3,097
(1.7%)</td><td>3,800
(2.1%)</td><td>5,748
(3.2%)</td><td>5,464
(3.1%)</td></tr>
<tr><td>Spruce Fir Forest</td><td>17,667</td><td>208
(1.2%)</td><td>402
(2.3%)</td><td>605
(3.4%)</td><td>576
(3.3%)</td></tr>
<tr><td>Madrean Pine-Oak Woodland</td><td>394,927</td><td>1,063
(0.3%)</td><td>7,429
(1.9%)</td><td>3,125
(0.8%)</td><td>13,029
(3.3%)</td></tr>
<tr><td>Piñon-Juniper Woodland</td><td>222,166</td><td>1,213
(0.5%)</td><td>2,502
(1.1%)</td><td>3,008
(1.4%)</td><td>4,367
(2.0%)</td></tr>
<tr><td>Interior Chaparral</td><td>55,981</td><td>*</td><td>*</td><td>*</td><td>*</td></tr>
<tr><td>Great Basin Grassland</td><td>185,523</td><td>541
(0.0%)</td><td>15,202
(8.2%)</td><td>0
(0.0%)</td><td>15,121
(8.2%)</td></tr>
<tr><td>Semi-desert Grassland</td><td>106,952</td><td>27
(0.0%)</td><td>2,500
(2.3%)</td><td>0
(0.0%)</td><td>2,500
(2.3%)</td></tr>
<tr><td>Montane/Subalpine Grassland</td><td>51,559</td><td>*</td><td>500
(1.0%)</td><td>500
(1.0%)</td><td>500
(1.0%)</td></tr>
<tr><td>Cottonwood-Willow Riparian</td><td>15,876</td><td rowspan="4">*</td><td rowspan="4">350
(0.7%)</td><td rowspan="4">*</td><td rowspan="4">450
(0.9%)</td></tr>
<tr><td>Mixed Broadleaf Deciduous Riparian</td><td>9,657</td></tr>
<tr><td>Montane Willow Riparian</td><td>4,808</td></tr>
<tr><td>Wetland/Cienega Riparian</td><td>17,900</td></tr>
<tr><td>Total</td><td>2,011,102</td><td>19,026
(0.9%)</td><td>48,521
(2.4%)</td><td>36,854
(1.8%)</td><td>64,881
(3.2%)</td></tr>
</table>

* No treatments planned however, as opportunities arise wildfire may be used to allow fire to play a natural role..

Table 10 displays the forestwide FRCC outcome by alternative after 15 years of vegetative treatments at the average treatment objective levels. Alternatives B and D would result in the most acreage in FRCC 1 (24 percent) followed by Alternatives A and C (14 percent).

Table 10. Forestwide FRCC outcome by alternative in acres and percent of the forests after 15 years of treatment.

Alternative	FRCC 1	FRCC 2	FRCC 3	Total
A	287,804 (14%)	614,405 (31%)	1,108,893 (55%)	2,011,102 (100%)
B	473,327 (24%)	823,809 (41%)	713,966 (35%)	2,011,102 (100%)
C	287,804 (14%)	1,009,332 (51%)	713,966 (35%)	2,011,102 (100%)
D	473,327 (24%)	823,809 (41%)	713,966 (35%)	2,011,102 (100%)

Table 11 displays the FRCC trend from 15 to 50 years as noted by the downward, upward, or neutral arrows. A more detailed comparison can be found in Appendix D. In all alternatives, fire and mechanical treatments (table 7) would be used to move vegetation conditions towards desired condition. The desired condition is to move towards a lower FRCC or maintain vegetation in FRCC 1. A downward trend (downward arrow) shows movement towards a lower FRCC.

Table 11. Comparison of alternatives showing FRCC outcomes by vegetation type after 15 years and the trend from 15 to 50 years – as represented by the arrows.

Vegetation Type	Current FRCC	Alternative A FRCC	Alternative B FRCC	Alternative C FRCC	Alternative D FRCC
Ponderosa Pine Forest	3	3↓	3↓	3↓	3↓
Dry Mixed Conifer Forest	3	2↓	2↓	2↓	2↓
Wet Mixed Conifer Forest	2	2↓	2↓	2↓	2↓
Spruce Fir Forest	2	2↓	2↓	2↓	2↓
Madrean Pine-Oak Woodland	3	3↓	2↓	2↓	2↓
Piñon-Juniper Woodland	1	1↑	1↑	1↑	1↔
Interior Chaparral	1	1↔	1↔	1↔	1↔
Great Basin Grassland	3	2↑	1↑	2↑	1↓
Semi-desert Grassland	3	3↑	3↓	3↑	3↓
Montane/Subalpine Grassland	2	2↑	2↑	2↑	2↑
Cottonwood-Willow Riparian	2	2↑	2↓	2↑	2↓
Mixed Broadleaf Deciduous Riparian	1	1↑	1↓	1↑	1↓

Vegetation Type	Current FRCC	Alternative A FRCC	Alternative B FRCC	Alternative C FRCC	Alternative D FRCC
Montane Willow Riparian	3	3↑	3↓	3↑	3↓
Wetland/Cienega Riparian	2	2↑	2↔	2↔	2↔
↑ indicates trend toward a higher FRCC from 15-50 years. ↓ indicates trend towards a lower FRCC from 15-50 years. ↔ indicates a static trend in FRCC from 15-50 years.					

Over the planning period of 15 years, the action alternatives would have the most (6) vegetation types at desired condition. Alternative A would have the least number (5) of vegetation types that meet desired conditions.

Between 15 to 50 years, alternatives D and B trends show that FRCC continues to move toward a lower FRCC or remain within FRCC 1 in the most vegetation types (12). Alternative C and A show the least improvement at 50 years (8).

Under all alternatives there would be some improvement in FRCC by vegetation types (table 11). Changes in FRCC are directly related to the number of acres treated within a vegetation type. For example, Great Basin grassland would be treated in alternatives B and D and would move from FRCC 3 to 1. In alternatives A and C, there would be less emphasis on treating Great Basin grassland, and it would move to FRCC 2 but trend back towards a higher FRCC.

As the FRCC is improved over the planning period, there should be movement towards a natural fire regime and a reduced risk of uncharacteristic wildfire. Vegetation would become more resistant and resilient and less likely to lose key ecosystem components after a disturbance. This would benefit firefighter and public safety. Additionally, treatments aimed to protect natural resources from uncharacteristic wildfire would outweigh the short-term impacts upon the landscapes during treatment.

As FRCC is improved over the planning period, fire would behave more similar to reference conditions. For example, ponderosa pine in FRCC 1 would have a fire regime and vegetative structure similar to reference conditions where fires were low intensity and high frequency and vegetation consisted of open stands and clumps of trees promoting surface fire versus crown fire behavior.

Although this analysis examined overall FRCC by total vegetation type, it is anticipated that as site specific projects are conducted there would be an improvement in FRCC for those treated acres. For example, the overall FRCC for ponderosa pine is 3, but would include areas which have had treatment and are now rated at FRCC 1 and 2.

Fire disturbances may have adverse environmental consequences on some resources (e.g., smoke affecting communities, vegetation structure) in the short-term. Over the long-term, however, these resources would benefit from fire disturbances that result in more sustainable and productive ecosystems and reduced risk of uncharacteristic wildfire.

Fire is a management tool for altering vegetation however there could be some risk such as: (1) prescribed fires could escape and become wildfires; (2) some fires may not get accomplished due to narrow burning windows and/or smoke management constraints; and (3) use of high and/or moderate severity burns may result in more acres needing reforestation efforts (e.g. Wilkins, Durfee, and Wagon Draw resource benefit fires, per Forest Products Specialist Report).

Air Quality Related to Smoke

All alternatives include an average number of acres that will be treated by fire each year with the expectation that desired conditions for air quality, including Class I airsheds, are met. Treatments with fire includes both planned and unplanned ignitions. Table 12 displays the amount of acres treated by alternative.

Table 12. Average acres of burning per year by alternative.

Alternative A	Alternative B	Alternative C	Alternative D
6,844	28,929	12,855	48,926

Smoke production is an unavoidable part of planned ignitions (prescribed burns). However, strategies to limit smoke impacts are required in every burn plan. Because climatic and environmental conditions vary (e.g., ventilation, wind direction, mixing height), the number of acres burned on any given day would also vary. Climatic and environmental conditions each year may also affect the annual total number of acres treated. Projects are designed in a way to lessen the impacts produced by smoke emissions. The prescribed fire burn plan may include such strategies as burning with wind directions and other atmospheric conditions that allow smoke to adequately ventilate or be transported away from communities. The burn plan may also stipulate management practices which would mitigate smoke production. For example, managers can choose ignition sequences and patterns, avoid lighting heavy fuels, community notification, and use other management practices that would limit smoke production. ADEQ reviews daily burn requests and may limit the amount of acres burned daily to reduce smoke impacts.

Impacts on air quality from unplanned ignitions (wildfires) may be highly variable. Smoke management for unplanned ignitions includes notifying ADEQ based on fire size and location, and assessing potential fire behavior and smoke. If smoke impacts occur, overall fire management strategies may be adjusted in order to mitigate smoke to sensitive individuals, communities, and visibility.

Problem or nuisance smoke is defined by the Environmental Protection Agency as the amount of smoke in the ambient air that interferes with a right or privilege common to members of the public, including the use or enjoyment of public or private resources. While no laws or regulations govern nuisance smoke, it effectively limits opportunities of land managers to use fire. Public outcry regarding nuisance smoke often occurs long before smoke exposures reach levels that violate NAAQS (Achtemeir et al., 2001). Public tolerance of smoke, however, sets the social limit of the number of acres burned and smoke produced from planned and unplanned ignitions. The level of acceptance varies from year to year and by community. Smoke may impact nursing homes, hospitals, and other populations sensitive to temporary air pollution. Smoke can also impact other areas such as local communities, transportation corridors, and highly valued scenic vistas.

With its number of acres being treated with fire, there is a higher probability that **alternative D** would have more short-term impacts to forest visitors and local residents. These impacts could include smoke, areas of blackened or charred vegetation, and possible delay or denial of forest access due to fire activity. **Alternative A** would have less acres proposed for fire treatments, and therefore, would have less short-term impacts followed by **alternative C and B**, respectively.

The potential for nuisance smoke impacts to communities varies by alternative due to the number of acres burned and proximity of treatments. **Alternative D** treats the most acres with fire, distributing the treatments among the Community-Forest Intermix Management Area (1/2 mile buffer around communities-at-risk) and priority watersheds. **Alternative B** emphasizes treatments within areas identified in the CWPPs. Potential smoke impacts to communities would be lessened because treatments are spread across the entire CWPP and not concentrated within the ½ mile buffer of the Community-Forest Intermix Management Area. **Alternative C** emphasizes treatments within the Community-Forest Intermix Management Area. However, fewer acres are treated than in **alternatives B and D**, reducing the potential impacts to communities. The emphasis in **alternative A** is to treat around communities. However, this alternative treats the least number of acres by fire so potential smoke impacts are reduced.

There is also a potential to have smoke impacts due to the mechanical treatments and subsequent burning of slash created by those treatments. Residual slash would be treated by piling and burning or broadcast burning. **Alternative C** mechanically treats the greatest number of acres within the Community-Forest Intermix Management Area which results in the highest potential for burning activity fuels in close proximity to communities. Even though **alternative B** mechanically treats the next highest number of acres, **alternative D** has more potential to impact communities due to the placement of treatments within the Community-Forest Intermix Management Area. **Alternative A** treats the least number of acres around communities.

Under **all alternatives**, the risk of uncharacteristic wildfire and subsequent smoke emissions is expected to increase in proportion to the acres left untreated (based on the average planned fire and mechanical treatment objectives over the 15 year planning period). Untreated acres would have a greater overall fuel load and increased presence of ladder fuels over the long-term. **Alternative D**, while creating the most short-term impacts to communities, would in the long-term reduce potential smoke impacts by reducing the risk of uncharacteristic wildfires. **Alternative B** treats the next highest amount of acres followed by **alternatives C and A**, respectively. Treated acres would reduce fuel loads and ladder fuels resulting in a lower likelihood of crown fire and associated smoke impacts over the long-term. .

See the Air Specialist Report for more information on Class I airsheds and overall air quality.

Climate Change

There may be environmental consequences associated with climate change. Temperature changes may alter fire regimes (Sprigg and Hinkley2000). For instance, higher temperatures increase evaporation rates and higher temperatures combined with a drier landscape increase wildfire hazard and put extra stress on ecosystems (Lenart 2007). Fire frequency and severity may be exacerbated if temperatures increase, precipitation decreases, and overall drought conditions become more common. Seasonal timing of burning may be affected by climate change (e.g, if there are hotter drier seasons, burning may occur during times when areas would have usually been covered in snow). During the planning period, alternatives B and D followed by alternatives C and A would provide the most resiliency to climate change since they have the greatest amount of vegetation at desired condition (vegetation within or moving towards FRCC 1).

<u>Relationship of Short-Term Uses and Long-Term Productivity</u>

Fire disturbance may have adverse environmental consequences on some resources (e.g. smoke affecting communities, vegetation structure) in the short term. Over the long term, however, these resources would benefit from fire disturbances that result in more sustainable and productive ecosystems and reduced risk of uncharacteristic wildfire.

Cumulative Environmental Consequences

The area considered for this level of analysis includes adjacent land ownerships, national forests in Arizona, and the SMUs that cover the forests (Little Colorado River Airshed, Lower Salt River Airshed, and Upper Gila Airshed). Through CWPPs there has been an emphasis to treat not only NFS lands but also private and state lands within the WUI. Communities are working to reduce the risk of fire to and from private lands by emphasizing on community fire and fuels reduction programs. These efforts identified in all alternatives, in combination with treatments on adjacent Federal land, help to further reduce the risk of uncharacteristic wildfires to communities and the national forests.

Numerous national forests within Arizona are revising their forest plans. These plans would emphasis vegetation treatments that would improve FRCC. Neighboring tribal, state, and BLM lands are also conducting vegetation treatments. These efforts, in combination with Apache-Sitgreaves NF's vegetation treatments in all alternatives, would contribute to landscape restoration, overall improvement in FRCC, the return of wildfire to a more natural role, and a reduction in uncharacteristic wildfire across the broader landscape

Neighboring land managers (e.g. Tribes, Bureau of Land Management, Coconino and Tonto NFs) are also implementing projects that produce emissions (i.e., smoke). Considering these projects, burning on the forests identified in all alternatives, and climatologic conditions, there may be additional impacts to air quality, visibility, and human health. Effects from multiple sources can affect the 3 SMUs that encompass the forests. Agencies within Arizona fall under the purview of ADEQ air quality division and the State Implementation Plan, however, tribes cooperate with ADEQ on a voluntary basis. ADEQ coordinates its issuance of burn permits among all the resource agencies to minimize the potential effects, including impacts to air quality and public safety, of numerous agencies burning concurrently.

Adaptive Management

Wildfires are evaluated to determine if resource objectives can be achieved. If resource objectives can be achieved, appropriate strategies are determined at the time of the fire. When managing unplanned ignitions to achieve resource objectives, forest managers consider the needs and values of all resources (e.g. firefighter and public safety, cultural resources, vegetation, recreation).

A protection objective or a combination of protection and resource objectives will be assigned to all wildfires. The protection objective(s) may include the protection of firefighters and the public, private property, manmade infrastructure, or natural resources. Uncharacteristic or undesirable fire behavior due to unnatural fuel buildup, unusual environmental conditions, or proximity to infrastructure or sensitive natural resources may dictate a need for a protection objective(s) for wildfires. Objectives and management of a wildfire may change as the wildfire changes in direction, size, or under certain weather conditions. Adaptive management will be in place when managing all wildfires.

Prescribed fire managers can choose the climatic conditions under which to ignite prescribed fires, resulting in reduced fire severity. Climatic conditions are monitored to ensure conditions are favorable for adequate dispersion and resulting in reduced smoke. When smoke issues arise, strategies are applied to mitigate impacts to sensitive individuals, communities, and to visibility.

Other Planning Efforts

Arizona Forest Resource Strategy (Arizona State Forestry)

Statewide Strategy for Restoring Arizona's Forests (Governor's Forest Health Councils)

Community Wildfire Protection Plans

References

Agee, J. K. 1993. Fire ecology of the Pacific Northwest forests. Washington, D.C.: Island Press. 493p.

Brown, J.K. 1995. Fire regimes and their relevance to ecosystem management. Pages 171-178 In Proceedings of Society of American Foresters National Convention, Sept. 18-22, 1994, Anchorage, AK. Society of American Foresters, Wash. DC.

Covington, V. V., and M. M. Moore. 1994. Southwestern ponderosa pine forest structure: changes since Euro-American settlement. Journal of Forestry 92:39-47.

Federal Register. 2001. "Managing the Impacts of Wildfires on Communities and the Environment" Federal Register 66:3 (January 4, 2001). P. 751.

Federal Register. 2001. "Urban Wildland Interface Communities within the Vicinity of Federal Lands That Are at High Risk from Wildlife" Federal Register 66:3 (January 4, 2001). P. 751.

Fire Family Plus Software (Version 3.0.1.2). Computer program for weather and fire information and analysis. Available from http://firemodels.org

Forest Service. 2002. Little Colorado Landscape Assessment. USDA Forest Service CEEM. Apache-Sitgreaves National Forests. Springervile, Arizona.

Forest Service. 2008a. Ecological Sustainability Report. Apache-Sitgreaves National Forests. USDA Forest Service Southwestern Region. Springerville, Arizona.

Forest Service. 2008b. Apache-Sitgreaves National Forests Resource Evaluations. USDA Forest Service Southwestern Region. Springerville, Arizona.

Hardy, C.C., Schmidt, K.M., Menakis, J.M., Samson, N.R. 2001. Spatial Data for National Fire Planning and Fuel Management. International Journal of Wildland Fire 10:353-372

Hann, W.J. D.L. Bunnell. 2001 Fire and land management planning and implementation across multiple scales. Int. J. Wildland Fire. 10:389-403.

Hann, W.J., A. Shlisky, D. Havlina, K. Schon, S. Barrett, T. DeMeo, K. Pohl, J. Menakis, D. Hamilton, J. Jones, M. Levesque, and C. Frame. 2004. Interagency Fire Regime Condition Class Guidebook. Last update June 2008: Version 1.3. www.frc.gov

Johnson, Douglas G. 2002. Biogeography of Quaking Aspen (Populus tremuloides). San Francisco State University Department of Geography. San Francisco, California.

Joyce, L.A., G.M. Blate, J.S. Littell, S.G. McNulty, C.I. Millar, S.C. Moser, R.P. Neilson, K. A. O'Halloran, and D.L. Peterson. 2008. National Forests. Chapter 3, Pp. 1-127 In: Preliminary review of adaptation options for climate-sensitive ecosystems and resources. Julius, S.H., and J.M. West (eds.). A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. U.S. Environmental Protection Agency, Washington, DC.

LANDFIRE. 2011. LANDFIRE Project, U.S.Department of Agriculture, Forest Service; U.S. Department of Interior,. Available: http://www.landfire.gov/index.php.

Lenart, M. 2007. Global warming in the Southwest: Projections, observations, and impacts. Climate Assessment for the Southwest. University of Arizona, Institute for the Study of Planet Earth, Tucson, AZ.

Logan Simpson Design, Inc. 2004. Community Wildfire Protection Plan for At-Risk Communities of the Apache National Forest in Apache County. Tempe, Arizona.

Logan Simpson Design, Inc. 2004. Community Wildfire Protection Plan for At-Risk Communities of the Sitgreaves National Forest in Apache, Coconino, and Navajo Counties. Tempe, Arizona.

Logan Simpson Design, Inc. 2005. Greenlee County Community Wildfire Protection Plan for At-Risk Communities of the Apache National Forest in Greenlee County. Tempe, Arizona.

Reinhardt, E. D. and N. L. Crookston, (Technical Editors). 2003. The Fire and Fuels Extension to the Forest Vegetation Simulator. Gen. Tech. Rep. RMRS-GTR-116. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 209 p.

Schmidt, K. M., J. P.Menakis, C. C.Hardy, W. J. Hann, D. L. Bunnell, 2002. Development of coarse-scale spatial data for wildland fire and fuel management. Gen. Tech. Rep. RMRS-GTR-87. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 41 p.

Sprigg, W. A., T. Hinkley, et al. (2000). Preparing for a Changing Climate: The Potential Consequences of Climate Variability and Change: Southwest. A Report of the Southwest Regional Assessment Group. University of Arizona. The Institute for the Study of Planet Earth. Tucson, AZ, US Global Change Research Program: 66.

Swetnam, T.W., and Betancourt, J.L. 1990. Fire-southern oscillation relations in the southwestern United States. Science 249:1017–1020.

Swetnam, T. W., and J. L. Betancourt. 1998. Mesoscale disturbance and ecological response to decadal climatic variability in the American Southwest. Journal of Climate 11:3128-3147

Swetnam, T.W., and Baisan, C.H. 1996. Fire effects in southwestern forests. Proceedings of the Second La Mesa Fire Symposium, March 29–31, 1994, Los Alamos, NM. USDA Forest Service Gen. Tech. Rep. RM-GTR-286.

APPENDIX A

Arizona Administrative Code: Forest and Range Management Rules

http://www.azdeq.gov/environ/air/smoke/download/prules.pdf

Effective March 15, 2004

The actual Notice of Final Rulemaking is published in the Feb. 6, 2004, Arizona Administrative Register

TITLE 18. ENVIRONMENTAL QUALITY

CHAPTER 2. DEPARTMENT OF ENVIRONMENTAL QUALITY - AIR POLLUTION CONTROL

ARTICLE 15. FOREST AND RANGE MANAGEMENT BURNS

R18-2-1501. Definitions

In addition to the definitions contained in A.R.S. ' 49-501 and R18-2-101, in this Article:

1. Activity fuels means those fuels created by human activities such as thinning or logging.

2. "ADEQ" means the Department of Environmental Quality.

3. Annual emissions goal means the annual establishment in cooperation with the F/SLM=s, under R18-2-1503(G), of a planned quantifiable value of emissions reduction from prescribed fires and fuels management activities.

4. Burn plan means the ADEQ form that includes information on the conditions under which a burn will occur with details of the burn and smoke management prescriptions.

5. "Burn prescription" means, with regard to a burn project, the pre-determined area, fuel, and weather conditions required to attain planned resource management objectives.

6. "Burn project" means an active or planned prescribed burn, including a wildland fire use incident.

7. "Duff" means forest floor material consisting of decomposing needles and other natural materials.

8. An Emission reduction techniques (ERT) means methods for controlling emissions from prescribed fires to minimize the amount of emission output per unit of area burned.

9. A Federal land manager (FLM) means any department, agency, or agent of the federal government, including the following:

   a. United States Forest Service,

   b. United States Fish and Wildlife Service,

c. National Park Service,

d. Bureau of Land Management,

e. Bureau of Reclamation,

f. Department of Defense,

g. Bureau of Indian Affairs, and

h. Natural Resources Conservation Service.

10. "F/SLM" means a federal land manager or a state land manager.

11. "Local fire management officer" means a person designated by a F/SLM as responsible for fire management in a local district or area.

12. "Mop-up" means the act of extinguishing or removing burning material from a prescribed fire to reduce smoke

13. "National Wildfire Coordinating Group" means the national inter-agency group of federal and state land managers that shares similar wildfire suppression programs and has established standardized inter-agency training courses and qualifications for fire management positions.

14. A Non-burning alternatives to fire@ means techniques that replace fire for at least five years as a means to treat activity fuels created to achieve a particular land management objective (e.g. reduction of fuel-loading, manipulation of fuels, enhancement of wildlife habitat, and ecosystem restoration). These alternatives are not used in conjunction with fire. Techniques used in conjunction with fire are referred to as emission reduction techniques (ERTs).

15. "Planned resource management objectives" means public interest goals in support of land management agency objectives including silviculture, wildlife habitat management, grazing enhancement, fire hazard reduction, wilderness management, cultural scene maintenance, weed abatement, watershed rehabilitation, vegetative manipulation, and disease and pest prevention.

16. "Prescribed burning" means the controlled application of fire to wildland fuels that are in either a natural or modified state, under certain burn and smoke management prescription conditions that have been specified by the land manager in charge of or assisting the burn, to attain planned resource management objectives. Prescribed burning does not include a fire set or permitted by a public officer to provide instruction in fire fighting methods, or construction or residential burning under R18-2-602.

17. "Prescribed fire manager" means a person designated by a F/SLM as responsible for prescribed burning for that land manager.

18. "Smoke management prescription" means the predetermined meteorological conditions that affect smoke transport and dispersion under which a burn could occur without adversely affecting public health and welfare.

19. A Smoke management techniques (SMT) means management and dispersion practices used during a prescribed burn or wildland fire use incident which affect the direction, duration, height, or density of smoke.

20. "Smoke management unit" means any of the geographic areas defined by ADEQ whose area is based on primary watershed boundaries and whose outline is determined by diurnal wind flow patterns that allow smoke to follow predictable drainage patterns. A map of the state divided into 11 the smoke management units is on file with ADEQ.

21. "State land manager (SLM)" means any department, agency, or political subdivision of the state government including the following:

a. State Land Department,

b. Department of Transportation,

c. Department of Game and Fish, and

d. Parks Department.

22. "Wildfire" means an unplanned wildland fire subject to appropriate control measures. Wildfires include those incidents where suppression may be limited for safety, economic, or resource concerns.

23. A Wildland fire use means a wildland fire that is ignited by natural causes, such as lightning, and is managed using the same controls and for the same planned resource management objectives as prescribed burning.

R18-2-1502. Applicability

A. A F/SLM that is conducting or assisting a prescribed burn shall follow the requirements of this Article.

B. A private or municipal burner with whom ADEQ has entered into a memorandum of agreement shall follow the requirements of this Article.

C. The provisions of this Article apply to all areas of the state except Indian Trust lands. All federally-managed lands and all state lands, parks, and forests are under the jurisdiction of ADEQ in matters relating to air pollution from prescribed burning.

D. Notwithstanding subsection (C), ADEQ and any Indian tribe may enter into a memorandum of agreement to implement this Article.

E. ADEQ and any private or municipal prescribed burner may enter into a memorandum of agreement to implement this Article.

R18-2-1503. Annual Registration, Program Evaluation and Planning

A. Each F/SLM shall register annually with ADEQ, on a form prescribed by ADEQ, all planned burn projects, including areas planned for wildland fire use.

B. Each planned year extends from January 1 of the registration year to December 31 of the same year. Each F/SLM shall use best efforts to register before December 31 and no later than January 31 of each year.

C. A F/SLM shall include the following information on the registration form:

1. The F/SLM's name, address, and business telephone number;

2. The name, address, and business telephone number of an air quality representative who will provide technical support to ADEQ for decisions regarding prescribed burning. The same air quality representative may be selected by more than one F/SLM;

3. All prescribed burn projects and potential wildland fire use areas planned for the next year;

4. Maximum project and annual acres to be burned, maximum daily acres to be burned, fuel types within project area, and planned use of emission reduction techniques to support the annual emissions goal for each prescribed burn project;

5. Planned use of any smoke management techniques for each prescribed burn project;

6. Maximum project and annual acres projected to be burned, maximum daily acres projected to be burned, and a map of the anticipated project area, fuel types and loading within the planned area for an area the F/SLM anticipates for wildland fire use;

7. A list of all burn projects that were completed during the previous year;

8. Project area for treatment, treatment type, fuel types to be treated, and activity fuel loading to support the annual emissions goal for areas to be treated using non-burning alternatives to fire; and

9. The area treated using non-burning alternatives to fire during the previous year including the number of acres, the specific types of alternatives utilized, and the location of these areas.

D. After consultation with the F/SLM, ADEQ may request additional information for registration of prescribed burns and wildland fire use to support regional coordination of smoke management, annual emission goal setting using ERTs, and non-burning alternatives to fire.

E. A F/SLM may amend a registration at any time with a written submission to ADEQ.

F. ADEQ accepts a facsimile or other electronic method as a means of complying with the deadline for registration. If an electronic means is used, the F/SLM shall deliver the original paper registration form to ADEQ for its records. ADEQ shall acknowledge in writing the receipt of each registration.

G. ADEQ shall hold a meeting after January 31 and before April 1 of each year between ADEQ and F/SLMs to evaluate the program and cooperatively establish the annual emission goal. The annual emission goal shall be developed to minimize prescribed fire emissions to the maximum extent feasible using emission reduction techniques and alternatives to burning subject to economic, technical, and safety feasibility criteria, and consistent with land management objectives.

H. At least once every five years, ADEQ shall request long-term projections of future prescribed fire and wildland fire use activity from the F/SLMs to support planning for visibility impairment and assessment of other air quality concerns by ADEQ.

R18-2-1504. Prescribed Burn Plan

Each F/SLM planning a prescribed burn shall complete and submit to ADEQ the "Burn Plan" form supplied by ADEQ no later than 14 days before the date on which the F/SLM requests permission to burn. ADEQ shall consider the information supplied on the Burn Plan Form as binding conditions under which the burn shall be conducted. A Burn Plan shall be maintained by ADEQ until notification from the F/SLM of the completion of the burn project. Revisions to the Burn Plan for a burn project shall be submitted in writing no later than 14 days before the date on which the F/SLM requests permission to burn. To facilitate the Daily Burn authorization process under R18-2-1505, the F/SLM shall include on the Burn Plan form:

1. An emergency telephone number that is answered 24 hours a day, seven days a week;

2. Burn prescription;

3. Smoke management prescription;

4. The number of acres to be burned, the quantity and type of fuel, type of burn, and the ignition technique to be used;

5. The land management objective or purpose for the burn such as restoration or maintenance of ecological function and indicators of fire resiliency;

6. A map depicting the potential impact of the smoke unless waived either orally or in writing by ADEQ. The potential impact shall be determined by mapping both the daytime and nighttime smoke path and down-drainage flow for 15 miles from the burn site, with smoke-sensitive areas delineated. The map shall use the appropriate scale to show the impacts of the smoke adequately;

7. Modeling of smoke impacts unless waived either orally or in writing by ADEQ, for burns greater than 250 acres per day, or greater than 50 acres per day if the burn is within 15 miles of a Class I Area, an area that is non-attainment for particulates, a carbon monoxide non-attainment area, or other smoke-sensitive area. In consultation with the F/SLM, ADEQ shall provide guidelines on modeling;

8. The name of the official submitting the Burn Plan on behalf of the F/SLM; and

9. After consultation with the F/SLM, any other information to support the Burn Plan needed by ADEQ to assist in the Daily Burn authorization process for smoke management purposes or assessment of contribution to visibility impairment of Class I areas.

R18-2-1505. Prescribed Burn Requests and Authorization

A. Each F/SLM planning a prescribed burn, shall complete and submit to ADEQ the "Daily Burn Request" form supplied by ADEQ. The Daily Burn Request form shall include:

1. The contact information of the F/SLM conducting the burn;

2. Each day of the burn;

3. The area to be burned on the day for which the Burn Request is submitted, with reference to the Burn Plan, including size, legal location to the section, and latitude and longitude to the minute;

4. Projected smoke impacts; and

5. Any local conditions or circumstances known to the F/SLM that, if conveyed to ADEQ, could impact the Daily Burn authorization process.

B. After consultation with the F/SLM, ADEQ may request additional information related to the burn, meteorological, smoke dispersion, or air quality conditions to supplement the Daily Burn Request form and to aid in the Daily Burn

C. The F/SLM shall submit the Daily Burn Request form to ADEQ as expeditiously as practicable, but no later than 2 p.m. of the business day preceding the burn. An original form, a facsimile, or an electronic information transfer are acceptable submittals.

D. An F/SLM shall not ignite a prescribed burn without receiving the approval of ADEQ, as follows:

1. ADEQ shall approve, approve with conditions, or disapprove a burn on the same business day as the Burn Request submittal.

2. If ADEQ fails to address a Burn Request by 10 p.m. of the business day on which the request is submitted, the Burn Request is approved by default after the burner makes a good faith effort to contact ADEQ to confirm that the Burn Request was received.

3. ADEQ may communicate its decision by verbal, written, or electronic means. ADEQ shall provide a written or electronic reply if requested by the F/SLM.

E. If weather conditions cease to conform to those in the smoke management prescription of either the Burn Plan or an Approval with Conditions, the F/SLM shall take appropriate action to reduce further smoke impacts, ensure safe and appropriate fire control, and notify the public when necessary. After consultation with ADEQ, the smoke management prescription or burn plan may be modified.

F. The F/SLM shall ensure that there is appropriate signage and notification to protect public safety on transportation corridors including roadways and airports during a prescribed fire.

R18-2-1506. Smoke Dispersion Evaluation

ADEQ shall approve, approve with conditions, or disapprove a Daily Burn Request submitted under R18-2-1505, by using the following factors for each smoke management unit:

1. Analysis of the emissions from burns in progress and residual emissions from previous burns on a day-today basis;

2. Analysis of emissions from active wildland fire use incidents, and active multiple-day burns, and consideration of potential long-term emissions estimates;

3. Analysis of the emissions from wildfires greater than 100 acres and consideration of their potential longterm growth;

4. Local burn conditions;

5. Burn prescription and smoke management prescription from the applicable Burn Plan;

6. Existing and predicted local air quality;

7. Local and synoptic meteorological conditions;

8. Type and location of areas to be burned;

9. Protection of the national visibility goal for Class I Areas under ' 169A(a)(1) of the Act and 40 CFR

51.309;

10. Assessment of duration and intensity of smoke emissions to minimize cumulative impacts;

11. Minimization of smoke impacts in Class I Areas, areas that are non-attainment for particulate matter, carbon monoxide non-attainment areas, or other smoke-sensitive areas; and

12. Protection of the National Ambient Air Quality Standards.

R18-2-1507. Prescribed Burn Accomplishment; Wildfire Reporting

A. Each F/SLM conducting a prescribed burn shall complete and submit to ADEQ the "Burn Accomplishment" form supplied by ADEQ. For each burn approval, the F/SLM shall submit a Burn Accomplishment form to ADEQ by 2 p.m. of the business day following the approved burn. The F/SLM shall include the following information on the Burn Accomplishment form:

1. Any known conditions or circumstances that could impact the Daily Burn decision process;

2. The date, location, fuel type, fuel loading, and acreage accomplishments;

3. The ERTs and SMTs described in R18-2-1509 and R18-2-1510, respectively, and may include any further ERTs and SMTs that become available, that the F/SLM used to reduce emissions or manage the smoke from the burn.

B. The F/SLM shall submit the Burn Accomplishment form as an original form, a facsimile, or an electronic information transfer.

C. ADEQ shall maintain a record of Burn Requests, Burn Approvals/Conditional Approvals/Denials and Burn Accomplishments for five years.

D. The F/SLM in whose jurisdiction a wildfire occurs shall make available to ADEQ no later than the day after the activity all required information for wildfire incidents that burned more than 100 acres per day in timber or slash fuels or 300 acres per day in brush or grass fuels. For each day of a wildfire incident that exceeds the daily activity threshold, the F/SLM shall provide the location, an estimate of predominant fuel type and quantity consumed, and an estimate of the area blackened that day.

R18-2-1508. Wildland Fire Use: Plan, Authorization;, Monitoring; Inter-agency Consultation; Status Reporting

A. In order for ADEQ to participate in the wildland fire use decision-making process, the F/SLM shall notify ADEQ as soon as practicable of any wildland fire use incident projected to attain or attaining a size of 50 acres of timber fuel or 250 acres of brush or grass fuel.

B. For each wildland fire use incident that has been declared as such by the F/SLM, the F/SLM shall complete and submit to ADEQ a Wildland Fire Use Burn Plan in a format approved by ADEQ in cooperation with the F/SLM. The F/SLM shall submit the Wildland Fire Use Burn Plan to ADEQ as soon as practicable but no later than 72 hours after the wildland fire use incident is declared or under consideration for such designation. The F/SLM shall include the following information in the Wildland Fire Use Burn Plan:

1. An emergency telephone number that is answered 24 hours a day, seven days a week;

2. Anticipated burn prescription;

3. Anticipated smoke management prescription;

4. The estimated daily number of acres, quantity, and type of fuel to be burned;

5. The anticipated maximum allowable perimeter or size with map;

6. Information on the condition of the area to be burned, such as whether it is in maintenance or restoration, its ecological function, and other indicators of fire resiliency;

7. The anticipated duration of the wildland fire use incident;

8. The anticipated long-range weather trends for the site;

9. A map depicting the potential impact of the smoke. The potential impact shall be determined by mapping both the daytime and nighttime smoke path and down-drainage flow for 15 miles from the wildland fire use incident, with smoke-sensitive areas delineated. Mapping is mandatory unless waived either orally or in writing by ADEQ. The map shall use the appropriate scale to show the impacts of the smoke adequately; and

10. Modeling or monitoring of smoke impacts, if requested by ADEQ after consultation with the F/SLM.

C. ADEQ shall approve or disapprove a Wildland Fire Use Burn Plan within three hours of receipt. ADEQ shall consult directly with the requesting F/SLM before disapproving a Wildland Fire Use Burn Plan. If ADEQ fails to address the Wildland Fire Use Burn Plan within the time allotted, the Plan is approved by default under the condition that the F/SLM makes a good faith effort to contact ADEQ to confirm that the Plan was received.

Approval by ADEQ of a Wildland Fire Use Burn Plan is binding upon ADEQ for the duration of the wildland fire use incident unless smoke from the incident creates a threat to public health or welfare. If a threat to public health or welfare is created, ADEQ shall consult with the F/SLM regarding the situation and develop a joint action plan for reducing further smoke impacts.

D. The F/SLM shall submit a Daily Status Report for each wildland fire use incident to ADEQ for each day of the burn that the fire burns more than 100 acres in timber or slash fuels or 300 acres in brush or grass fuels. The F/SLM shall include a synopsis of smoke behavior, future daily anticipated growth, and location of the activity of the wildland fire use incident in the Daily Status Report.

E. The F/SLM shall consult with ADEQ prior to initiating human-made ignition on the wildland fire use incident when greater than 250 acres is anticipated to be burned by the ignition. Emergency human-made ignition on the incident for protection of public or fire-fighter safety does not require consultation with ADEQ regardless of the size of the area to be burned.

F. The F/SLM shall ensure that there is appropriate signage and notification to protect public safety on transportation corridors including roadways and airports during a wildland fire use incident.

R18-2-1509. Emission Reduction Techniques

A. Each F/SLM conducting a prescribed burn shall implement as many Emission Reduction Techniques as are feasible subject to economic, technical, and safety feasibility criteria, and land management objectives.

B. Emission Reduction Techniques include:

1. Reducing biomass to be burned by use of techniques such as yarding or consolidation of

unmerchandisable material, multi-product timber sales, or public firewood access, when economically feasible.

2. Reducing biomass to be burned by fuel exclusion practices such as preventing the fire from consuming dead snags or dead and downed woody material through lining, application of fire-retardant foam, or water;

3. Using mass ignition techniques such as aerial ignition by helicopter to produce high intensity fires of high fuel density areas such as logging slash decks

4. Burning only fuels essential to meet resource management objectives;

5. Minimizing consumption and smoldering by burning under conditions of high fuel moisture of duff and litter;

6. Minimizing fuel consumption and smoldering by burning under conditions of high fuel moisture of large woody fuels;

7. Minimizing soil content when slash piles are constructed by using brush blades on material-moving equipment and by constructing piles under dry soil conditions or by using hand piling methods;

8. Burning fuels in piles;

9. Using a backing fire in grass fuels;

10. Burning fuels with an air curtain destructor, as defined in R18-2-101, operated according to manufacturer specifications and meeting applicable state or local opacity requirements;

11. Extinguishing or mopping-up of smoldering fuels;

12. Chunking of piles and other consolidations of burning material to enhance flaming and fuel consumption, and to minimize smoke production;

13. Burning before litter fall;

14. Burning before green-up of fuels;

15. Burning before recently cut large fuels cure in areas with activity; and

16. Burning just before precipitation to reduce fuel smoldering and consumption.

R18-2-1510. Smoke Management Techniques

A. Each F/SLM conducting a prescribed burn shall implement as many Smoke Management Techniques as are feasible subject to economic, technical, and safety feasibility criteria, and land management objectives.

B. Smoke management techniques include:

1. Burning from March 15 through September 15, when meteorological conditions allow for good smoke dispersion;

2. Igniting burns under good-to-excellent ventilation conditions;

3. Suspending operations under poor smoke dispersion conditions;

4. Considering smoke impacts on local community activities and land users;

5. Burning piles when other burns are not feasible, such as when snow or rain is present;

6. Using mass ignition techniques such as aerial ignition by helicopter to produce high intensity fires with short duration impacts;

7. Using all opportunities that meet the burn prescription and all burn locations to spread smoke impacts over a broader time period and geographic area;

8. Burning during optimum mid-day dispersion hours, with all ignitions in a burn unit completed by 3 p.m. to prevent trapping smoke in inversions or diurnal windflow patterns;

9. Providing information on the adverse impacts of using green or wet wood as fuel when public firewood access is allowed;

10. Implementing maintenance burning in a periodic rotation to shorten prescribed fire duration and to reduce excessive fuel accumulations that could result in excessive smoke production in a wildfire; and

11. Using wildland fire-use strategies to shift smoke into more favorable smoke dispersion seasons.

R18-2-1511. Monitoring

A. ADEQ may require a F/SLM to monitor air quality before or during a prescribed burn or a wildland fire use incident if necessary to assess smoke impacts. Air quality monitoring may be conducted using both federal and non-federal reference method as well as other techniques.

B. ADEQ may require a F/SLM to monitor weather before or during a prescribed burn or a wildland fire use incident, if necessary to predict or assess smoke impacts. After consultation with the F/SLM, ADEQ may also require the F/SLM to establish burn site or area-representative remote automated weather stations or their equivalent, having telemetry that allows retrieval on a real-time basis by ADEQ. An F/SLM shall give ADEQ notice and an opportunity to comment before making any change to a long-term established remote automated weather station.

C. A F/SLM shall employ the following types of monitoring, unless waived by ADEQ, for burns greater than 250 acres per day, or greater than 50 acres per day if the burn is within 15 miles of a Class I Area, an area that is nonattainment for particulate matter, a carbon monoxide, or ozone, or other smoke-sensitive area:

1. Smoke plume measurements, using a format supplied by ADEQ; and

2. The release of pilot balloons (PIBALs) at the burn site to verify needed wind speed, direction, and stability. Instead of pilot balloons, a test burn at the burn site may be used for specific prescribed burns on a case-by-case basis as approved by ADEQ, to verify needed wind speed, direction, and stability.

D. An F/SLM shall make monitoring information required under subsection (C) available to ADEQ on the business day following the burn ignition.

E. The F/SLM shall keep on file for one year following the burn date any monitoring information required under this Section.

R18-2-1512. Burner Qualifications

A. All burn projects shall be conducted by personnel trained in prescribed fire and smoke management techniques as required by the F/SLM in charge of the burn and established by National Wildfire Coordinating Group training qualifications.

B. A Prescribed Fire Boss or other local Fire Management Officer of the F/SLM having jurisdiction over prescribed burns shall have smoke management training obtained through one of the following:

1. Successful completion of a National Wildfire Coordinating Group or F/SLM-equivalent course addressing smoke management; or

2. Attendance at an ADEQ-approved smoke management workshop.

R18-2-1513. Public Notification and Awareness Program; Regional Coordination

A. The Director shall conduct a public education and awareness program in cooperation with F/SLMs and other interested parties to inform the general public of the smoke management program described by this Article. The program shall include smoke impacts from prescribed fires and the role of prescribed fire in natural ecosystems.

B. ADEQ shall make annual registration, prescribed burn approval, and wildfire and wildland fire use activity information readily available to the public and to facilitate regional coordination efforts and public notification.

R18-2-1514. Surveillance and Enforcement

A. An F/SLM conducting a prescribed burn shall permit ADEQ to enter and inspect burn sites unannounced to verify the accuracy of the Daily Burn Request, Burn Plan, or Accomplishment data as well as matching burn approval with actual conditions, smoke dispersion, and air quality impacts. On-ground site inspection procedures and aerial surveillance shall be coordinated by ADEQ and the F/SLM for safety purposes.

B. ADEQ may use remote automated weather station data if necessary to verify current and previous meteorological conditions at or near the burn site.

C. ADEQ may audit burn accomplishment data, smoke dispersion measurements, or weather measurements from previously conducted burns, if necessary to verify conformity with, or deviation from, procedures and authorizations approved by ADEQ.

D. Deviation from procedures and authorizations approved by ADEQ constitute a violation of this Article. Violations may require containment or mop-up of any active burns and may also require, in the Director's discretion, a five-day moratorium on ignitions by the responsible F/SLM. Violations of this Article are also subject to a civil penalty of not more than $10,000 per day per violation under A.R.S. ' 49-463.

R18-2-1515. Forms; Electronic Copies; Information Transfers

A. ADEQ shall make available on paper and in electronically-readable format any form required to be developed by ADEQ and completed by a F/SLM.

B. After consultation with an F/SLM, ADEQ may require the F/SLM to provide data in a manner that facilitates electronic transfers of information.

APPENDIX B

Forest Plan Revision Fire Modeling Rationale

Documented by Dan Mindar, Forest Fuels Specialist.

The Forest Vegetation Simulator (FVS) (v2.02) along with the Fire and Fuels Extension (FFE) were used to simulate the effects of using fire as a restoration tool on various stand conditions. Only one fire cycled per stand was modeled, but each fire was modeled at low, moderate and high intensities. The comparative stand conditions from pre-modeled fire to post-modeled fire were then used as input to the Vegetation Dynamics Development Tool (VDDT. VDDT was used to model vegetation succession over the life of the forest plan and into the future, under the various proposed management alternatives.

Environmental conditions used to simulate the low, moderate, and high fire conditions are based on historic weather data from the Alpine Remote Automated Weather Station (RAWS). The Alpine RAWS has the most complete and accurate data of all the weather stations on the forest. The data was sorted using Fire Family Plus (v4.1) to produce a Percentile Weather Report. This percentile report was used to determine the 15th, 75th and 90th percentile weather for the past twenty years (1990-2009). Weather data were used for a period from April 1- October 15 each year, representing a typical fire season period. The 15th percentile represents natural fire season conditions for a low intensity fire and the 75th percentile represents moderate and the 90th percentile the high intensity fire conditions (see table 13).

These percentile environmental conditions were used to represent both natural fire conditions such as wildfires that may be managed to move vegetative conditions toward desired conditions, as well as burning prescriptions that may be used for management ignited prescribed fires. These environmental conditions approximate natural conditions under which a natural fire may burn and would be a good starting point for development of a management burning prescription. Winds generated by the report were unusually low, therefore 10, 15 and 20 mph winds were substituted for low, moderate, and high 20’ winds. The percentile weather report does not produce an air temperature, so based on analysis of the weather data and professional judgment 60, 75, and 90 degrees were used respectively. Duff moisture is also not produced by the percentile weather report. These were derived using FVS, FFE defaults for duff moisture under moist 125%, dry 50%, and very dry 15% conditions (Forest Service 2008 p. 43). Varying duff moisture in the model had little effect in the model on fire effects on stand conditions. These conditions were used across all vegetation types to provide consistency. A cooler and moister condition at higher elevation vegetation types compared to hotter and dryer lower elevation vegetation types was not significant in model outcome.

SIMFIRE key word was used to simulate a fire event in 2009. Percent area burned were set at 60% for low, 70% moderate, and 80% for high based on experience and personal observations on fires indicating that cooler fire conditions produce more of a mosaic of burned and unburned area. (Forest Service 2008 p. 93)

MOISTURE key word was employed to set fuel moisture parameters to those indicated by the Percentile Weather Report. (Forest Service 2008 p. 90)

FIRECALC key word was used to set the model to use the new fuel model selection logic and the 40 new Scott and Burgan fuel models. This uses the latest science and model logic for selecting fuel models based on various stand conditions and selects from the 40 fuel models giving the model greater latitude to select the most appropriate fuel model. (Forest Service 2008 p. 72)

Table 13. Weather Report

Fire Family Plus Percentile Weather Report for RERAP				
Station: 020401: ALPINE Variable ERC				
Model: 7G2PE2 Data Years: 1990 – 2009 Date Range: April 1 – October 15 Wind Directions: S, SW, W				
Percentiles, Probabilities, and Mid-Points				
3772 Weather Records Used, 2200 Days with Wind (58.32%)				
Percent Area Burned: 60 70 80				
Variable/Component Range	**Low**	**Mod**	**High**	**Ext**
Percentile Range	0-15	16-89	90-97	98-100
Climatol Probability	15	75	7	3
Mid-Point ERC	15-15	48-48	90-90	102-102
Num Observations	61	82	61	18
Calculated Spread Comp	4	10	16	16
Calculated ERC	16	49	91	103
Fuel Moistures	**Low**	**Mod**	**High**	**Ext**
1 Hour Fuel Moisture	11.17	4.46	2.42	1.55
10 Hour Fuel Moisture	15.39	6.15	2.81	1.91
100 Hour Fuel Moisture	19.11	10.39	4.36	3.37
Herbaceous Fuel Moisture	108.83	60.23	39.72	33.73
Woody Fuel Moisture	166.06	105.34	60.00	60.00
20’ Wind Speed	10	15	20	30
1000 Hour Fuel Moisture	21.81	13.95	6.06	4.33
Duff Moisture	125	50	15	8
Temperature	60	75	90	100

Reference

Forest Service. 2010. The Fire and Fuels Extension to the Forest Vegetation Simulator: Updated Model Documentation. USDA Forest Service Forest Management Service Center, Fort Collins, Colorado

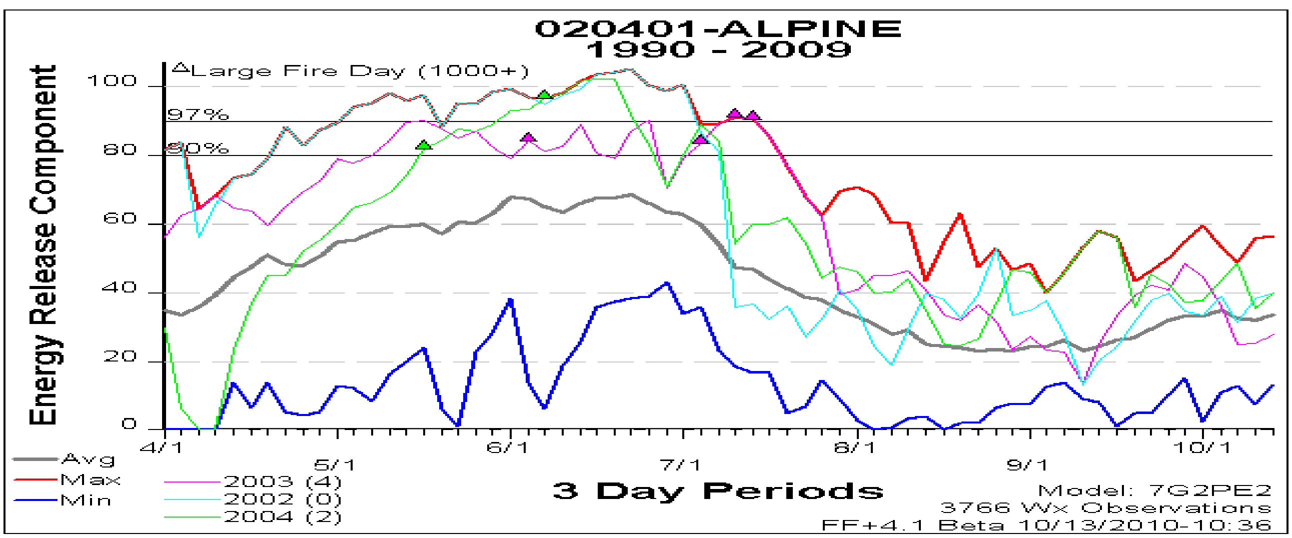
APPENDIX C

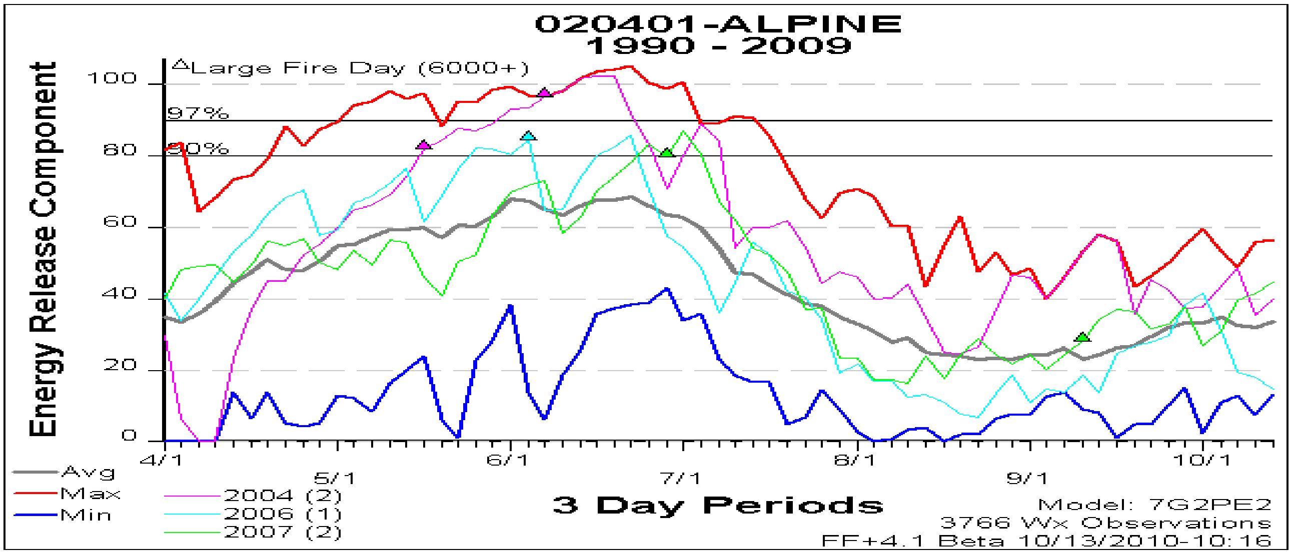
Rationale for Using Low, Moderate, and High Weather and Fuel Moisture Conditions to Represent Wildfire Effects

Documented by Linda Wadleigh, Regional Fuels Specialist.

Former Apache-Sitgreaves Forest Fuels Specialist Dan Mindar developed low, moderate, and high fire conditions to be used in the Forest Vegetation Simulator for selected potential natural vegetation types (see Appendix B). These conditions included fuel moistures and the weather variables of windspeed and temperature based on historical weather data for the Alpine weather station from 1990 to 2009. Mindar calculated the energy release component for the 15th, 75th and 90th percentile, a value related to the available energy (BTU) per unit area (square foot) within the flaming front at the head of a fire, that is commonly used as a representative of long-term drying in large fuels as the fire season progresses. The fuel and weather conditions derived from the historical weather data were then categorized into the low, moderate, and high conditions by percentile.

These low, moderate and high ranges of conditions can be used to represent prescribed fire prescriptions as well as conditions that might be experienced during an unplanned ignition or wildfire. The high conditions, namely low fuel moistures and higher windspeeds and temperatures, that occur during May and June on the Apache-Sitgreaves National Forests, also coincide with the occurrence of large (1000 acre plus and 6000 acre plus) fires. The two fire sizes of 1000 and 6000 acres were found to be reasonable breakpoints in the fire database and thought to be large enough to allow for a variety of burn intensities and severities to occur. Most of the fires larger than 1000 and 6000 acres burned during the hottest, driest part of the fire season, when potential effects would be the most severe. In the attached graphs, ERC is used as a surrogate for fuel moistures, and the years overlain on the graphs are years that experienced multiple occurrences of large wildfires. The colored triangles display actual wildfires that started on those calendar days and eventually exceeded either 1000 or 6000 acres in size.





The area below the 90th percentile line on both charts displays those large fires that occurred under moderate and low conditions, suggesting conditions were not right for large fire growth, not that fires did not occur. The area above the 90th percentile line displays fires that went over 1000 and 6000 acres and coincides with the high fire conditions.

While the fact that a fire started during higher or more extreme conditions does not mean high or extreme fire effects occurred, the resulting size of these fires and the weather and fuel conditions under which they burned provides the opportunity for a range of fire intensity and fire severity to happen.

APPENDIX D

FRCC- Detailed Comparison of Alternatives

Within each alternative a range of acres treated was analyzed, using VDDT, from low to high based on how much is estimated to be achieved within a given year. The average of the high and low range was also analyzed and is used in the comparison of alternatives.

The vegetation departure index is used to compare alternatives and how they move towards desired conditions. The departure index is a data product that uses a range from 0 to 100 to depict the amount that current vegetation structure and composition as well as fire severity and intensity has departed from historic or desired conditions. The departure index is then further classified into the 3 Fire Regime Condition Classes, 1 = 0-33, 2 = 34-66, and 3 = 67-100. (http://www.landfire.gov/NationalProductDescriptions11.php).

The following are the VDDT results by vegetation type. For each vegetation type, a description of how the FRCC changes by alternative is provided. Table 12 provides the departure index for each vegetation type as modeled after 15 years and the trend from 15 to 50 years. The trends are based on the actual numeric value of the departure found in the PNVT VDDT output spreadsheets, with a comparison of the value at 15 and 50 years. More detailed information on the model outcomes and the analytical methodology can be found in the Vegetation Specialist Report.

Ponderosa Pine

Alternative A (no action alternative, which represents the 1987 forest plan) – The VDDT modeled trend for the FRCC demonstrates that the departure remains within Condition Class 3 through 50 years.

Alternatives B, C, and D remain in FRCC 3 at 15 years.

Alternative D reaches the lowest the FRCC 2 in 50 years, while alternatives **B** & **C** remain at FRCC 3.

Dry Mixed Conifer

Alternatives A, B, C, and D move from FRCC 3 to a FRCC 2 within 15 years. All three alternatives remain in FRCC 2 over 50 years.

Spruce Fir and Wet Mixed Conifer

Alternative A – The VDDT modeled trend for the FRCC demonstrates that the departure is moderate in FRCC 2.

Alternative B, C, D remain in FRCC 2 at 15 years, and at 50 years.

Madrean Pine-Oak

Alternative A – The VDDT modeled trend for the FRCC demonstrates that the departure the departure from historic conditions increase to a FRCC 3.

Alternative B, C, D move from FRCC 3 to a FRCC 2 within 15 years. All three alternatives remain in FRCC 2 over 50 years.

Piñon-Juniper Woodland

Alternative A – The VDDT modeled trend for the FRCC demonstrates that the departure is low, FRCC 1, and moves to FRCC 2 at 50 years.

Alternative B, C, D remain in FRCC 1 at 15 years, and at 50 years.

Great Basin Grassland

Alternative A – This vegetation type is currently in FRCC 3 and with current management would move to FRCC 2 at 15 years and moves back to FRCC 3 at 40 years.

Alternative B and D move into FRCC 1 within 15 years, and at 50 years.

Alternative C would move to FRCC 2 at 15 years and moves back to FRCC 3 at 40 years.

Semi-desert Grassland

Alternative A – The VDDT modeled trend for the FRCC demonstrates that the departure remains high within Condition Class 3.

Alternative B and D remains in FRCC 2 at 15 years however, they both move into FRCC 2 within 20 years.

Alternative C did not include any additional treatment and would remain in FRCC 3.

Other PNVTs

For the remaining PNVTs treatment emphasis within the alternatives will not significantly change the FRCC, however there may be changes in the trend based on whether treatments are planned in those PNVT (by treating there would be a trend to lower the departure over time).

Table 12. Comparison of alternatives showing overall FRCC outcomes by vegetation type after 15 years and the trend from 15 to 50 years.

Vegetation Type	Current FRCC	Alternative A FRCC	Alternative B FRCC	Alternative C FRCC	Alternative D FRCC
Ponderosa Pine Forest	3	3↓	3↓	3↓	3↓
Dry Mixed Conifer Forest	3	2↓	2↓	2↓	2↓
Wet Mixed Conifer Forest	2	2↓	2↓	2↓	2↓
Spruce Fir Forest	2	2↓	2↓	2↓	2↓
Madrean Pine-Oak Woodland	3	3↓	2↓	2↓	2↓
Piñon-Juniper Woodland	1	1↑	1↑	1↑	1↔
Interior Chaparral	1	1↔	1↔	1↔	1↔
Great Basin Grassland	3	2↑	1↑	2↑	1↓
Semi-desert Grassland	3	3↑	3↓	3↑	3↓
Montane/Subalpine Grassland	2	2↑	2↑	2↑	2↑

Vegetation Type	Current FRCC	Alternative A FRCC	Alternative B FRCC	Alternative C FRCC	Alternative D FRCC
Cottonwood-Willow Riparian	2	2↑	2↓	2↑	2↓
Mixed Broadleaf Deciduous Riparian	1	1↑	1↓	1↑	1↓
Montane Willow Riparian	3	3↑	3↓	3↑	3↓
Wetland/Cienega Riparian	2	2↑	2↔	2↔	2↔
↑ indicates trend toward a higher FRCC from 15-50 years. ↓ indicates trend towards a lower FRCC from 15-50 years. ↔ indicates a static trend in FRCC from 15-50 years.					

Reference

Forest Service. 2008. Assessment of Vegetation Diversity and Risks to Ecological Sustainability: Vegetation Specialist's Report Apache-Sitgreaves National Forests. USDA Forest Service Southwestern Region. Springerville, Arizona.

APPENDIX E

Fire types and entry into VDDT

For the PNVTs which were modeled in VDDT the number of acres burned by fire type (J, K, L) was entered into the model which effected the outputs. J, K, and L fires are prescribed fires as defined below (An Example of How VDDT Fire Effects were computed using FVS/FFE Simulations), these fires also represent potential effects on unplanned ignitions. The acres were based on FVS-FEE outputs and how each fire would move towards a desired state within that PNVT.

The inputs are displayed in the VDDT output tables created by the Forest Ecologist. The FVS-FEE outputs are displayed in tables created by the Forest Silviculturalist.

Forest Plan Revision Fire Modeling Rationale

The Forest Vegetation Simulator (FVS) (v2.02) and Fire and Fuels Extension (FFE) were used to simulate the effects of using planned and unplanned fires as a restoration tool on various Potential Natural Vegetation Type (PNVT) states. The vegetation species, cover and structure within each state were compared from pre-modeled fire to post-modeled fire. The resulting conditions were then used to determine the transitional pathways to be used in the Vegetation Dynamics Development Tool (VDDT). The VDDT model simulates vegetation succession over the life of the Forest Plan and into the future, under the various proposed management alternatives.

Fire behavior is a combination of fuels, weather and topography. The FVS/FFE model accepts fuel and weather parameters that mimic environmental conditions at the time of an ignition. The resulting fire behavior, such as type of fire (surface, passive or crown fire) and the flame length and torching and crowning index are then estimated by FVS/FFE. These fire behavior parameters are applied to the vegetation stands or states in this case, and FVS/FFE then predicts mortality and survival of the vegetation by species and size. One fire disturbance was applied at the beginning of the growth cycle, with each fire modeled at low, moderate and high conditions of weather and fuel moisture.

Environmental conditions used to simulate the low, moderate and high fire conditions are based on historic weather date from the Alpine Remote Automated Weather Stations (RAWS). The Alpine RAWS has the most complete and accurate data of all the weather stations on the Apache-Sitgreaves National Forests, and was used for the ponderosa pine/bunchgrass, pinyon-juniper grassland, mixed conifer dry, and the mixed conifer wet PNVTs.

Weather data were sorted using FireFamilyPlus (v4.1) to produce a Percentile Weather Report. This percentile report was used to determine the 15th, 75th, and 90th percentile weather for the past twenty years (1990-2009). Weather data used were from the period of April 1-October 15 each year, representing a typical fire season. The 15th percentile represents natural fire season conditions for a low intensity fire, 75th is moderate conditions, and the 90th is high intensity fire conditions (see Percentile Weather Report page 2).

These percentile environmental conditions were used to represent both natural fire conditions such as wildfires that may be managed to move vegetative conditions toward desired conditions, as well as burning prescriptions that may be used for management ignited prescribed fires. These environmental conditions approximate natural conditions under which a natural fire may burn and would be a good starting point for development of a management burning prescription.

Winds are recorded at the RAWS each day at 1:00 p.m. and while they capture wind speed and direction at the average hottest time of the day, this does not represent wind gusts adequately. Consequently, the wind speeds generated from analysis of the historical weather were considered too low to reflect wind gusts effecting fire behavior, so 10, 15 and 20 mph winds were substituted for low, moderate and high 20' winds (the wind speed reported at the RAWS is considered to be the wind speed 20' above the main vegetation canopy). Based on analysis of the weather data and professional judgment, 60, 75 and 90 degrees were used respectively for air temperature. Duff moisture is also not produced by the percentile weather report. These were derived using FVS/FFE defaults for duff moisture under moist 125%, dry 50% and very dry 15% conditions (Rebain, 2011). These conditions were used across all vegetation types to provide consistency.

FVS/FFE Keywords

SIMFIRE keyword was used to simulate a fire event in 2009. Percent area burned was set at 60% for low conditions, 70% for moderate and 80% for high based on experience and person observations on fires indicating that cooler fire conditions produce more of a mosaic of burned and unburned area (FFE Documentation p. 93).

MOISTURE keyword was employed to set fuel moisture parameters to those indicated by the Percentile Weather Report (FFE Documentation p. 90).

FIRECALC keyword was used to set the model to use the new fuel model selection logic and the 40 new Scott and Burgan fuel models. This uses the latest science and model logic for selecting fuel models based on various stand conditions and selects from the 40 fuel models giving the model greater latitude to select the most appropriate fuel model (FFE Documentation p. 72).

Station: 020401: ALPINE Variable: ERC Model: 7G2PE2
Data Years: 1990 - 2009 Date Range: April 1 - October 15 Wind Directions: S, SW, W

Percentile, Probabilities and Mid-Points

Variable/Component Range	Low	Moderate	High
Percentile Range	0-15	16-89	90-97
Climatological Probability	15	75	7
Mid-Point ERC	15-15	48-48	90-90
Number Observations	61	82	61
Calculated Spread Component	4	10	16
Calculated ERC	16	49	91

Percent Area Burned	60	70	80

Fuel Moistures/Weather

Variable	**Low**	**Moderate**	**High**
1 Hour Fuel Moisture	11.17	4.46	2.42
10 Hour Fuel Moisture	15.39	6.15	2.81
100 Hour Fuel Moisture	19.11	10.39	4.36
1000 Hour Fuel Moisture	21.81	13.95	6.06
Herbaceous Fuel Moisture	108.83	60.23	39.72
Woody Fuel Moisture	166.06	105.34	60.00
Duff Moisture	125	50	15
Temperature	60	75	90
20' Windspeed	10	15	20

3772 Weather Records Used, 2200 Days With Wind (58.32%)

An Example of How VDDT Fire Effects were computed using FVS/FFE Simulations

This provides an example of how fire effects were computed by using FVS/FFE simulation runs on FIA plots within each VDDT model state for a PNVT. The PNVT that we are using in this example is the Ponderosa Pine/Bunchgrass PNVT. We evaluated three types of prescribed fire defined as follows:

- RX J: Prescription J is a prescribed fire that burns under low intensity fire conditions
- RX K: Prescription K is a prescribed fire that burns under moderate intensity fire conditions
- RX L: Prescription L is a prescribed fire that burns under high intensity fire conditions

Table 1 on the following page defines each of the 14 model states in the Ponderosa Pine/Bunchgrass PNVT. Within each state in the VDDT model, we gathered up all of the FIA plots in the Southwestern Region which had the characteristics of each model state.

As the right hand side of Table 2 indicates, there were 5 plots in State B, the Seedling and Sapling Open (SSO) State; as Table 2 indicates, when we applied RX K (a prescribed fire burning under moderate intensity conditions) to the five FIA plots in State B using FVS/FFE, four of the plots moved to State A immediately after the fire, and one plot remained in State B. So the VDDT model indicates that whenever the RX K prescribed fire occurs in State B, .80 or 80% of the acres burned will transition to State A (the grass.forb.brush state) and 20% of the acres will remain in State B; see Table 3. The output files produced by the FFE/FVS simulation runs on the FIA plots in each model state were tabulated using the Statistical Analysis System (SAS) software http://www.sas.com/?gclid=CPum-JmmvacCFQsFbAodNRbxBA to provide the types of statistics that are shown in Tables 2 and 3. Then the results of these tabulations were entered into the VDDT model.

Table 1: Model States for the Ponderosa Pine/Bunchgrass Potential Natural Vegetation Type (PNVT)

Name	Code	Description	Dominance Unit Types	Tree Size Class Break in Inches	Story	Tree-shrub Canopy Cover %
A	GFB/SHR	Grass, Forb, Brush/Shrub	Non-Tree	N/A	N/A	0 - 10
B	SSO	Seedling, Sapling, Open	Tree	0 – 5	Single	10 - 30
C	SMO	Small, Open	Tree	5 – 10	Single	10 - 30
D	MOS	Medium, Open, Single story	Tree	10 – 20	Single	10 - 30
E	VOS	Very-large, Open, Single story	Tree	20 plus	Single	10 - 30
F	SSC	Seedling, Sapling, Closed	Tree	0 – 5	Single	30 plus
G	SMC	Small, Closed	Tree	5 – 10	Single	30 plus
H	MCS	Medium, Closed, Single story	Tree	10 – 20	Single	30 plus
I	VCS	Very-large, Closed, Single story	Tree	20 plus	Single	30 plus
J	MOM	Medium, Open, Multiple story and Uneven Aged	Tree	10 – 20	Multiple story and uneven aged	10 - 30

K	VOM	Very-large, Open, Multiple story and uneven aged	Tree	20 plus	Multiple story and uneven aged	10 - 30
L	MCM	Medium, Closed Multiple story	Tree	10 – 20	Multiple story and uneven aged	30 plus
M	VCM	Very-large, Closed, Multiple story	Tree	20 plus	Multiple story and uneven aged	30 plus
N	GFB/SHR	Grass, Forb, Brush/Shrub	Non-Tree	N/A	N/A	0 - 10

Table 2. Number of FIA plots moving from one state to another as a result of RX K, a prescribed fire burning under moderate intensity con

		To_State													
Rx	From_State	A_GFB	B_SSO	C_SMO	D_MOS	E_VOS	F_SSC	G_SMC	H_MCS	I_VCS	J_MOM	K_VOM	L_MCM	M_VCM	Total
K	B_SSO	4	1												5
K	C_SMO	4		4	2	1					3				14
K	D_MOS	4			40	1									45
K	E_VOS					11						2			13
K	F_SSC		3	2	1	1	1				3	1			12
K	G_SMC			7	2	1	1	16	10		1	1	4	1	44
K	H_MCS				13				23		1		3		40
K	I_VCS					3				1					4
K	J_MOM	3			5						8	1			17
K	K_VOM					3						7			10
K	L_MCM				5				1		10		31		47
K	M_VCM					3				1		2		5	11

	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Table 3. Probability of transitioning from one state to another as the result of RX K, a prescribed fire burning under moderate intensity cor															
2	Rx	From_State	A_GFB	B_SSO	C_SMO	D_MOS	E_VOS	F_SSC	G_SMC	H_MCS	I_VCS	J_MOM	K_VOM	L_MCM	M_VCM	Total
63	K	B_SSO	0.80	0.20												1.00
64	K	C_SMO	0.29		0.29	0.14	0.07					0.21				1.00
65	K	D_MOS	0.09			0.89	0.02									1.00
66	K	E_VOS					0.85						0.15			1.00
67	K	F_SSC		0.25	0.17	0.08	0.08	0.08				0.25	0.08			1.00
68	K	G_SMC			0.16	0.05	0.02	0.02	0.36	0.23		0.02	0.02	0.09	0.02	1.00
69	K	H_MCS				0.33				0.58		0.03		0.08		1.00
70	K	I_VCS					0.75				0.25					1.00
71	K	J_MOM	0.18			0.29						0.47	0.06			1.00
72	K	K_VOM					0.30						0.70			1.00
73	K	L_MCM				0.11				0.02		0.21		0.66		1.00
74	K	M_VCM					0.27				0.09		0.18		0.45	1.00

Literature Cited

Rebain, Stephanie A. comp. 2010 (revised January 20, 2011). **The Fire and Fuels Extension to the Forest Vegetation Simulator: Updated Model Documentation.** Internal Rep. Fort Collins, CO: U. S. Department of Agriculture, Forest Service, Forest Management Service Center. 379p.