Forest Service
U.S. DEPARTMENT OF AGRICULTURE

Office of the Chief | June 2022

Gallinas-Las Dispensas Prescribed Fire Declared Wildfire Review

Santa Fe National Forest, Southwestern Region

Cover image: The Las Dispensas Prescribed Fire on the Pecos/Las Vegas Ranger District of the Santa Fe National Forest as seen from an elevation of 8,000 feet on the Chuparosa Ridge. USDA Forest Service photo.

Contents

Foreword from Chief Randy Moore

On May 10, 2022, I established a Chief's Review of the Hermit's Peak Fire (Santa Fe National Forest, NM), which was a result of an escaped prescribed fire (Las Dispensas). The devastating impact of this fire to the communities and livelihoods of those affected in New Mexico demanded this level of review to ensure we understand how this tragic event unfolded. I cannot overstate how heartbreaking these impacts are on communities and individuals. In the most tragic events, people have lost their lives and it grieves us as agency employees who live and work in these communities.

Climate change is leading to conditions on the ground we have never encountered. We know these conditions are leading to more frequent and intense wildfires. Drought, extreme weather, wind conditions and unpredictable weather changes are challenging our ability to use prescribed fire as a tool to combat destructive fires. This spring in New Mexico, a pile burn of hazardous logs that started in January, smoldered underground for months, persisting through multiple snowstorms and freezing temperatures, before resurfacing as a wildfire. That type of event was nearly unheard of until recently in the century-plus of experience the Forest Service has in working on these landscapes. Fires are outpacing our models and, as the final report notes, we need to better understand how megadrought and climate change are affecting our actions on the ground. We must learn from this event and ensure our decision-making processes, tools, and procedures reflect these changed conditions.

The Forest Service takes its role to respond to and prevent wildfires seriously. The safety of the communities and firefighters involved is our primary goal. Wildfire mitigation, wildland firefighting, and many other land management activities we perform are inherently dangerous. When that work does not go as planned, it is imperative that we learn from those experiences. And we do. This review, which will be made available on the Wildland Fire Lessons Learned Center website*, includes an analysis of the conditions on the ground, the planning process and design, an assessment of the decisions leading up to the prescribed fire implementation, a summary of contributing factors, and key findings, lessons learned and recommendations.*

On May 20th I temporarily ceased all Forest Service prescribed burning nationwide as an immediate safety precaution due to continued extreme conditions. We are conducting a 90-day learning review of the agency's national prescribed fire program. Representatives from across the wildland fire and research community are evaluating the prescribed fire program, from the best available science to on-the-ground implementation. Wildfires are threatening more communities than they ever have. Prescribed fire must remain a tool in our toolbox to combat them. Unfortunately, the effects of climate change are narrowing the windows where this tool can be used safely. This Chief's Review of the Hermit's Peak Fire, and the results of the 90-day prescribed burn program review, will help us learn what needs to change to be able to continue to safely use this tool in today's fire environment.

I hope you will read the entire report to truly understand how this fire went from a prescribed fire, in which the employees involved followed all procedures and policies, to a fire that escaped its containment lines and became the largest wildfire in New Mexico's history. I want to thank our review team for their dedication to this work and their thorough, forthright, and detailed

analysis. This Chief's Review is an example of how the Forest Service, as a learning organization, must account for its actions and move forward to continue to deliver our critical mission of protecting forests and communities from wildfires.

Executive Summary

The Gallinas Watershed Prescribed Fire, Las Dispensas Unit, is located on the Santa Fe National Forest Pecos-Las Vegas Ranger District in New Mexico. Test fire ignitions began the morning of April 6, 2022. The test fire was determined successful at 1234, and ignitions continued. The prescribed fire was declared a wildfire (Hermit's Peak Fire) about four hours later. On May 10, 2022, USDA Forest Service Chief Randy Moore launched a review team to conduct a Declared Wildfire Review of the incident.

In addition to examining the parameters set forth in the Interagency Prescribed Fire Planning and Implementation Procedures Guide (PMS 484) for Declared Wildfire Review, the team was asked to provide (Appendix A):

- A description of the overall fuels and wildfire situation on the Santa Fe National Forest and the overall context within which these events took place;
- An assessment of the planning and analysis related to the Gallinas Prescribed Fire Wildland Urban Interface (WUI) project, including the purpose and need for treatment as well as factors that contributed to the overall design and sequencing of planned treatments;
- An assessment of the prescribed fire planning specific to the Las Dispensas Prescribed Fire;
- An assessment of the information related to fuel conditions, weather and other key factors that informed decisions leading up to the implementation of the Las Dispensas Prescribed Fire up until the declaration of the Hermit's Peak fire on April 6, 2022; and
- A summary of factors that contributed to the declaration, along with proposed recommendations to improve policies, protocols or performance.

In order to maintain and restore existing fire-dependent ecosystems, prescribed fires are often conducted in areas absent of recent fire history. These areas typically have higher densities of vegetation and concentrations of downed woody debris, creating a situation where the ecosystem is heavily departed from the natural range of variability within the fire regime.

The review team found that the personnel assigned to the Las Dispensas Prescribed Fire followed their approved prescribed fire plan. There was confidence they were within the approved prescription limits, and they had a plan to suppress the fire and cease ignitions if the prescription parameters were exceeded. However, a post-prescribed fire analysis of fuel and weather revealed that the implementation was occurring under much drier conditions than were recognized. Persistent drought, limited overwinter precipitation, less than average snowpack, fine fuel accumulation—post mechanical treatment, and increased heavy fuel loading after fireline preparation all contributed to increasing the risk of fire escape.

Competing obligations limit the ability of the workforce to prioritize and focus on prescribed fire projects. Increasing agency goals for prescribed fire treatments and, in this case, expectations from the forest, district and the Burn Boss to begin catching-up after 2 years of delays due to government shutdowns, a global pandemic, and Mexican Spotted Owl regulations have led to unrealistic expectations. These expectations, coupled with the opportunity to implement during a narrow window when the crew was available, smoke dispersion was good and the prescribed fire area was forecasted to be in prescription, led to acceptance of unforeseen risk.

The prescribed fire plan appeared to be complete and in compliance with current policy. However, the fire environment is in constant flux. The environmental conditions in which the plan was executed generated unforeseen challenges. Training of prescribed fire personnel is highly weighted toward developing and implementing the plan to ensure adherence to policy.

While innovative tools associated with robust analysis of the fire environment have been developed and are readily available, they are not routinely internalized into the planning and implementation process of

prescribed fire. Training and education efforts are often outdated and do not incorporate the latest tools or the latest fire science available to consider the fire environment (fuels, topography, climate, and weather) when developing and implementing prescribed fire plans. There are very few subject matter experts (SMEs) with the skillsets associated with robust analysis and interpretation of potential fire behavior and weather patterns. In addition, the number of specialists is diminishing due to some of the requirements needed to attain qualifications. Furthermore, these SMEs are not always readily available due to conflicting needs within their fire management positions. Although essential, these skills are not currently required as elements in prescribed fire qualifications or position descriptions for fire management employees.

This report begins with the setting in which the incident took place, followed by a narrative chronology of events. The team analyzed both planning and implementation elements of the operation. There are findings and lessons learned in the areas of: weather, fire behavior and fuels, communications, prescribed fire planning and design, and other socio-political influences. The team makes recommendations in these areas as well as in the prescribed fire plan implementation process, (fire) qualifications, capacity building and organizational learning.

Setting

National

In recent years the Forest Service has treated up to 3 million acres per year for hazardous fuels and forest health across the nation. The historic Infrastructure Investment and Jobs Act (IIJA) signed in November 2021 directed $3 billion toward restoring ecosystems and reducing wildfire risk over the next five years. The related USFS Wildfire Crisis Strategy is driving the agency toward treating 20 million acres over the next 10 years. The expectations are for the Forest Service to increase treatments to 4 million acres per year on National Forest System lands and support our partners in treating an additional 30 million acres per year on other federal, state, tribal and private lands. Depending upon our role with partners, this means that the Forest Service will be expected to treat between 5 and 8 million acres of hazardous fuels using all the tools available.

Over the past dozen years, prescribed fire has accounted for an average of 51% of the acreage of hazardous fuels reduction accomplished, or an average of 1.4 million acres per year. Meeting the objectives of the IIJA is likely to require the Forest Service to conduct prescribed fires on between 2.5 and 4 million acres annually, nationally. However, because the majority of the additional fuels reduction effort will be focused in the West, some regions may actually be expected to quadruple their hazardous fuel reduction efforts. Prescribed fire is the most ecologically appropriate, and often the most economical, way to maintain healthy forest ecosystems and to reduce or maintain fuel loads. Prescribed fire at a national scale becomes even more critical as a tool to maintain fuels after the initial reduction efforts.

To accomplish this level and frequency of prescribed fire on the landscape, we must ensure that practitioners have access to the best science and the best tools, and that they are confident and practiced in using both. In the past, fire suppression has had a higher utilization of science and technology, while prescribed fire has typically been more or less a collateral effort. If we are truly expected to meet these landscape restoration needs across the nation, the agency's commitment to prescribed fire will need to be commensurate with the effort that is invested in wildland fire suppression.

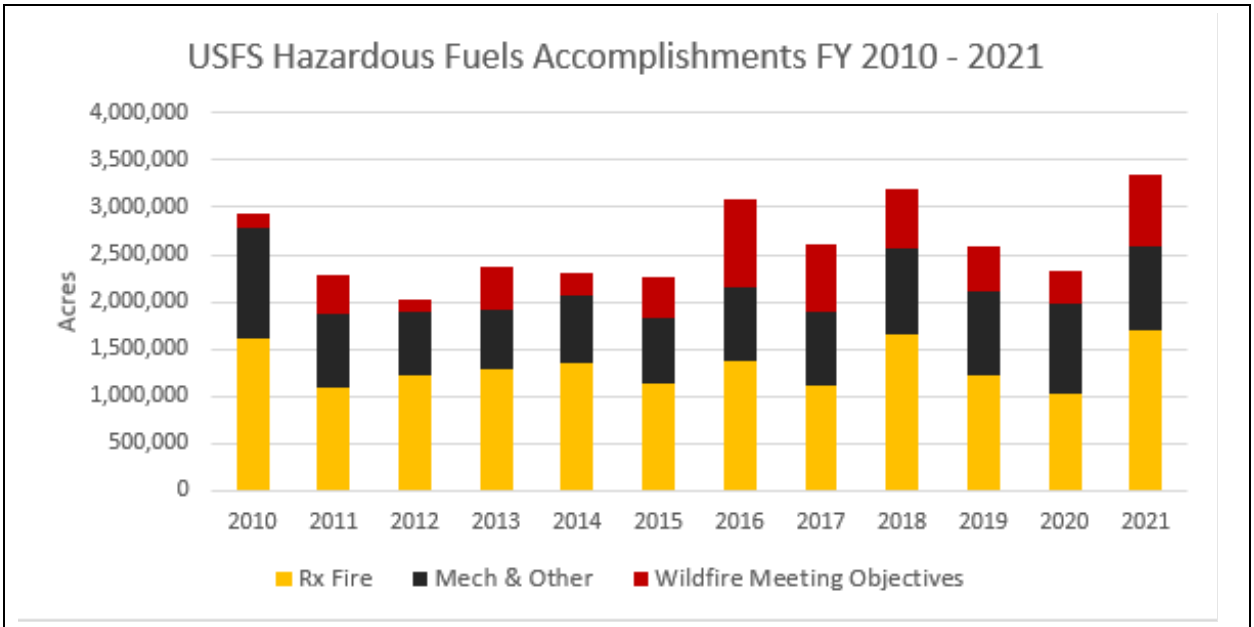


Figure 1: USFS Hazardous Fuels Accomplishments 2010 to 2021 from USFS Hazardous Fuels Program FY21 Accomplishments, Gromatzky.

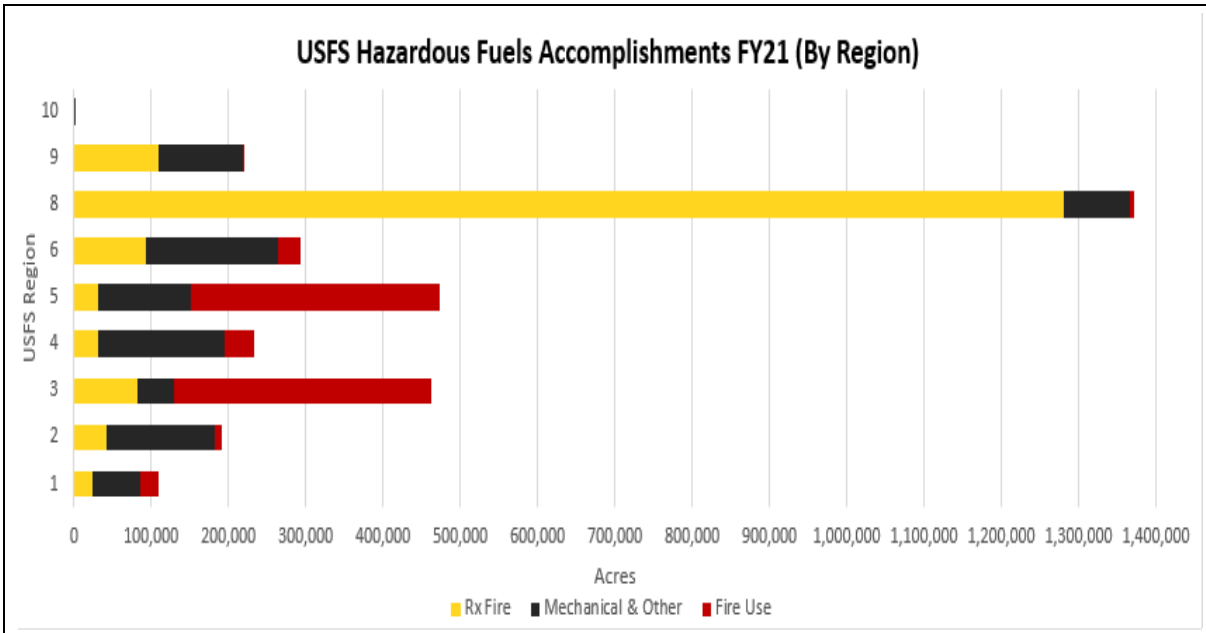


Figure 2: USFS Hazardous Fuels accomplishments by region from USFS Hazardous Fuels Program FY21 Accomplishments, Gromatzky.

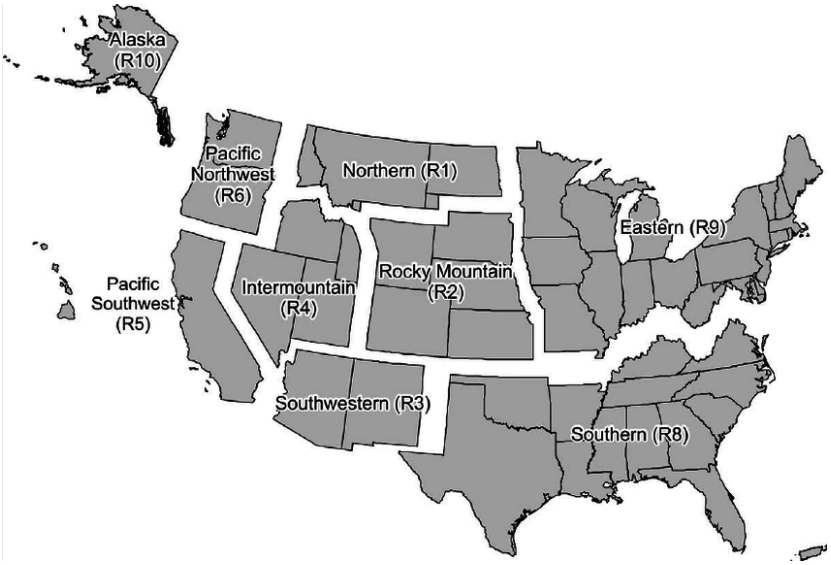


Figure 3: Forest Service Regions.

Regional

The Southwestern Region, encompassing Arizona and New Mexico, boasts a very diverse mix of ecosystems that range from Sonoran Desert to high-elevation tundra types. Over 70% of the southwestern ecosystems have adapted to frequent fire regimes. These frequent fires have not been able to influence undergrowth and forest structure in as much of these ecosystems as they would have historically in over 100 years. As with much of the western United States, ponderosa pine and mixed conifer forests in the Gallinas Watershed have changed greatly due to a lack of wildland fires over the last 100 years. Approximately one century of fire suppression in the watershed has resulted in a highly modified ponderosa pine forest structure that is more prone to high-intensity and high-severity wildfires (GTR 191, DeBuys and Allen 2005). Refer to map in Appendix B. In order to address the risk of high-severity wildfires and the risk to values, property and lives, the Southwestern Region has encouraged land managers to carefully plan to increase the use of fuels treatments, including the use of fire as a management tool.

Project Area

In May of 2000, the Viveash Fire burned in the Cow Creek drainage just west of the Gallinas Watershed. This high-intensity, high-severity fire produced dramatic effects to the Las Vegas, New Mexico city water quality. Although the fire occurred on only a small part of the Gallinas Watershed, sediment and ash showed up in the Las Vegas municipal water treatment works about 22 miles downstream. Concern grew around the potential effects to water quality of a larger fire within that same watershed.

Additionally, the area was identified in the 2001 National Fire Plan as a community at risk, highlighting the need for hazardous fuel management. In order to meet the need for treatment, the Gallinas Municipal Watershed Wildland Urban Interface Project Environmental Assessment (Gallinas EA) process was initiated. The Gallinas Watershed Council, made up of specialists from the state of New Mexico; Forest Service; U.S. Fish and Wildlife Service; City of Las Vegas, New Mexico; and other constituents, served as a stakeholder group to help inform and develop alternatives to address the situation.

About 17,000 people in the City of Las Vegas, New Mexico and surrounding communities depend on Gallinas Creek for their drinking water. Gallinas Creek feeds the Peterson, Bradner and Storrie Lake reservoirs, providing the primary source of water to residents (EA, p. 3). The Watershed is an 84-square-mile mosaic of

privately-owned land, national forest and other public lands. National Forest System lands comprise about two thirds of the Watershed (51 square miles or 33,000 acres). The project area is about 20,600 acres in size and consists of ponderosa pine forest (about 2,400 acres), mixed conifer forest (about 10,800 acres), spruce-fir forest (about 5,700 acres), and other/aspen (about 1,700 acres).

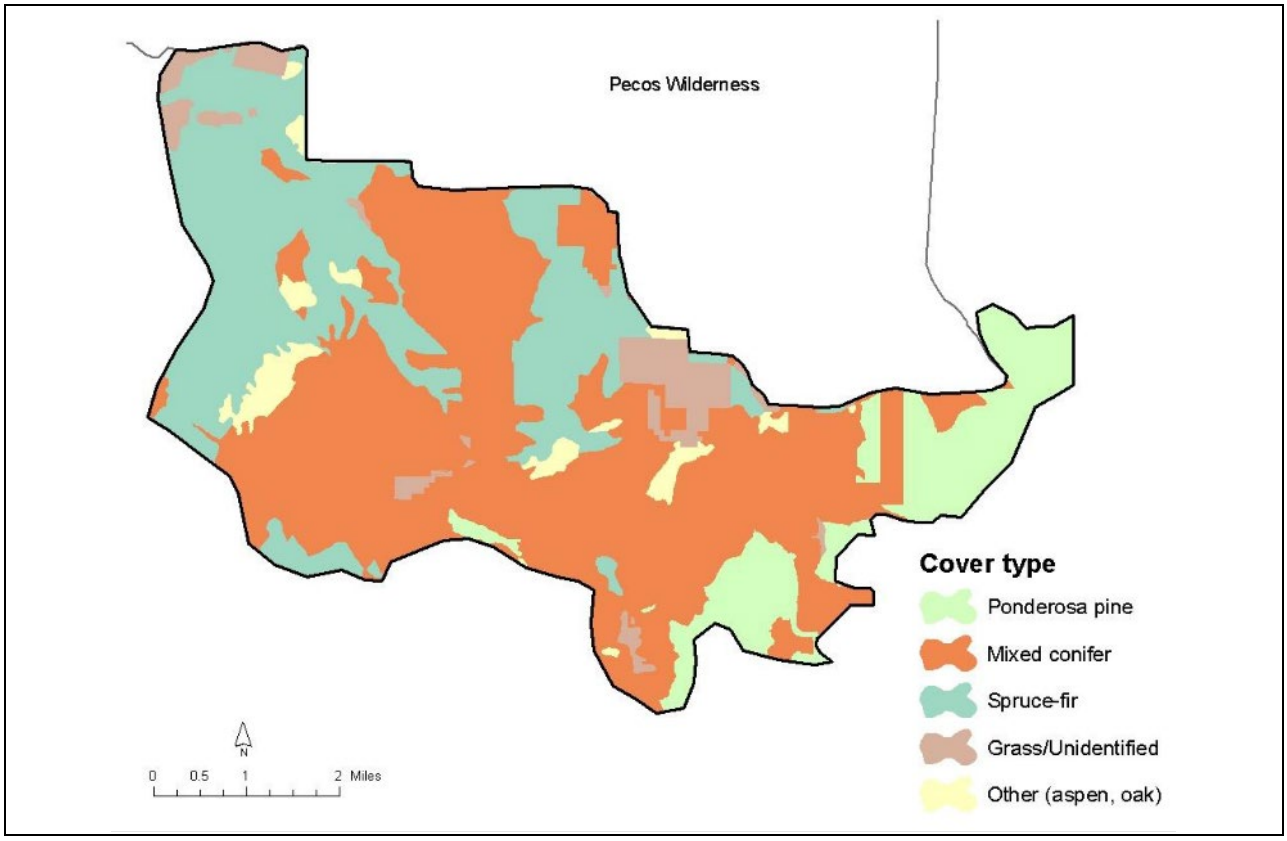


Figure 4: Forest types in the Gallinas EA project area, from the 2006 Gallinas EA.

Several Major Setbacks Prompt Sense of Urgency to Accomplish Projects

Implementation of the Gallinas EA and other projects across the Santa Fe National Forest and other New Mexico forests has been hampered by several consecutive restraints. In December 2018 most Forest Service employees were furloughed because of a government shutdown that lasted until February 2019. In addition to the furlough time, work time was lost to orderly shutdown and return-to-work processes. In March 2020, the COVID 19 pandemic sent most employees home again for more than two years. Then the Mexican Spotted Owl Injunction from September 2019 through October 2020 restricted mechanical and prescribed fire treatments throughout the Region. These consecutive and overlapping events not only affected overall employee morale, but also built a sense of urgency to accomplish projects to "catch up."

Prescribed Fire Plan, Objectives, Prescription and Desired Outcomes

The Gallinas Watershed Prescribed Fire Plan outlines mechanical treatments ranging from hand thinning to machine thinning with log decking followed by prescribed fire. The Gallinas Prescribed Fire project area is divided into 12 prescribed fire units to help mitigate smoke impacts (see Las Dispensas Vicinity Map on next page). One of these prescribed fire units, Las Dispensas, encompasses approximately 1,273 acres of the overall 8,300 acres that are treatable within the project area. Las Dispensas was further divided into 10 prescribed fire sub-units to provide greater implementation flexibility.

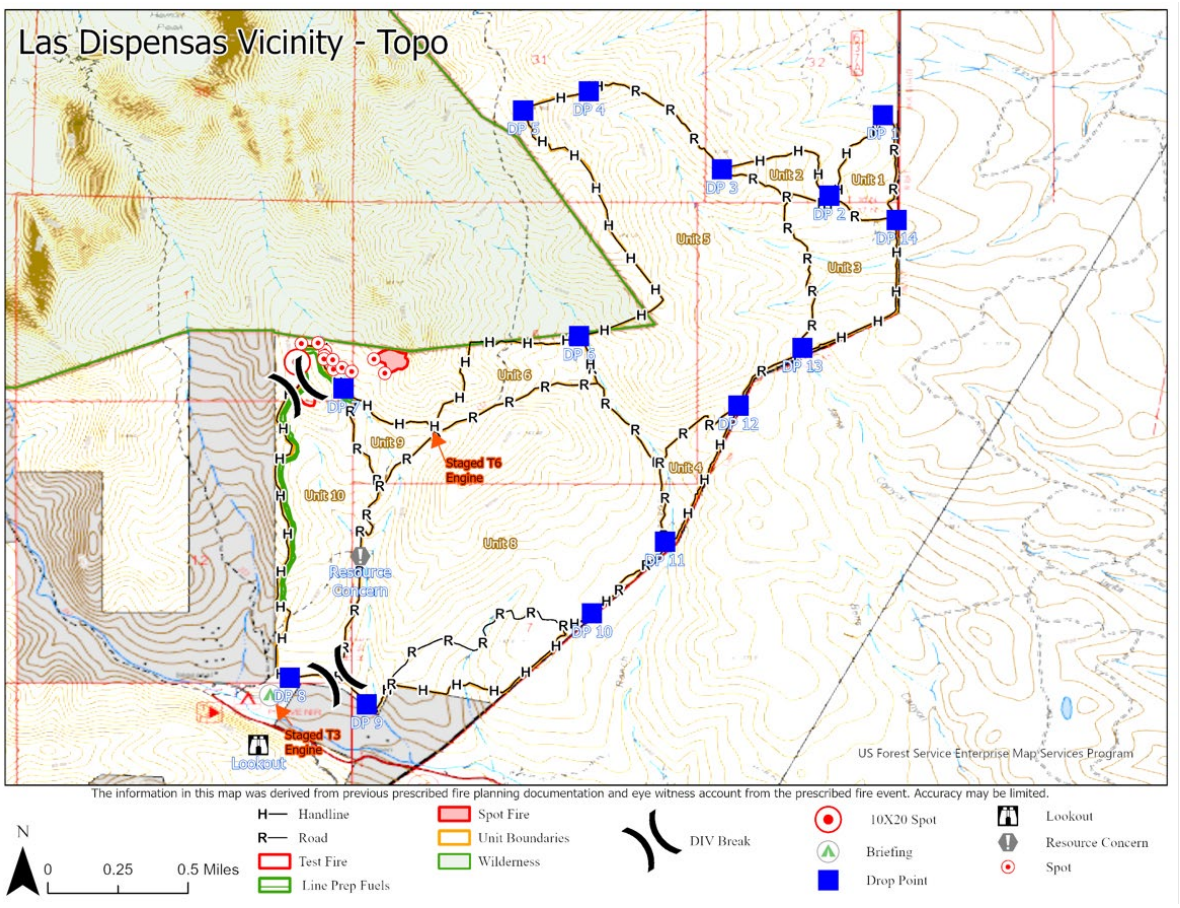


Figure 5: Las Dispensas Aerial Vicinity Map.

The Las Dispensas prescribed fire unit sits on the eastern edge of the project area against private land to the east. The unit is mostly characterized by ponderosa pine with some mixed conifer. Pretreatment conditions include 700 to 1,000 trees per acre of ponderosa pine, Douglas fir and white fir. To prevent potential adverse impacts from high-severity wildfire in the watershed in the future, the Santa Fe National Forest, Pecos/Las Vegas Ranger District developed a plan to restore the forest and protect the watershed by reducing the risk of high-intensity wildfire. According to the approved prescribed fire plan, the project specifically intended to:

1. Reduce potential for large-scale, high-intensity crown fires
2. Restore soil and hydrological condition
3. Reduce risk to life, property and natural resources
4. Restore fire-adapted ecosystem
5. Reduce mortality in mature trees (>12 inch diameter breast height [dbh]) to ≤ 20%

The forest in the project area had been precommercial thinned in 2008. This resulted in fuel loading as high as 20 to 25 tons per acre. Piled material had been burned in preparation for broadcast burning. Firelines had been improved through additional thinning and limbing. The task order for fireline construction required the debris to be dragged at least 66 feet (one chain) away from the fireline to the interior of the prescribed fire unit and placed parallel to the fireline exterior to the prescribed fire unit. The intent of this implementation was to increase the probability of holding the fire line, reduce fire intensity, and limit mortality to the remaining overstory trees. Local timber market conditions made this the only viable option.

The desired conditions post-project included fewer trees per acre, reduced ladder fuels, less brush and downed woody debris, a more open forest canopy, and improved groundcover conditions. Under these

conditions, future fires would more likely remain surface fires and be less likely to result in torching or crown fire.

Seasonal Severity, Weather, and On-site Conditions

Traditional monsoon precipitation was significantly below the historic average in 2019 and 2020 during the planning and preparation phase of the Gallinas Watershed Project leading up to the Las Dispensas Prescribed Fire. In the summer of 2021, a monsoon did bring some short-term benefits. However, overall precipitation for the season was near to below average for the northern New Mexico mountains. Nevertheless, there was an increase in late season fine fuels growth that cured in the fall and early winter coincident with seasonal dormancy. Overall, these fine fuels remained upright and available to burn because the few light snow events that occurred failed to compact them.

According to the Drought Mitigation Center's Drought Monitor product, which represents long-term impacts, both the magnitude and spatial extent of drought improved beginning in July and August 2021 due to the monsoon precipitation. They slightly improved from the highest drought category "Exceptional, D4" to "Extreme, D3". This trend continued through fall, winter and spring during the time leading up to the prescribed fire.

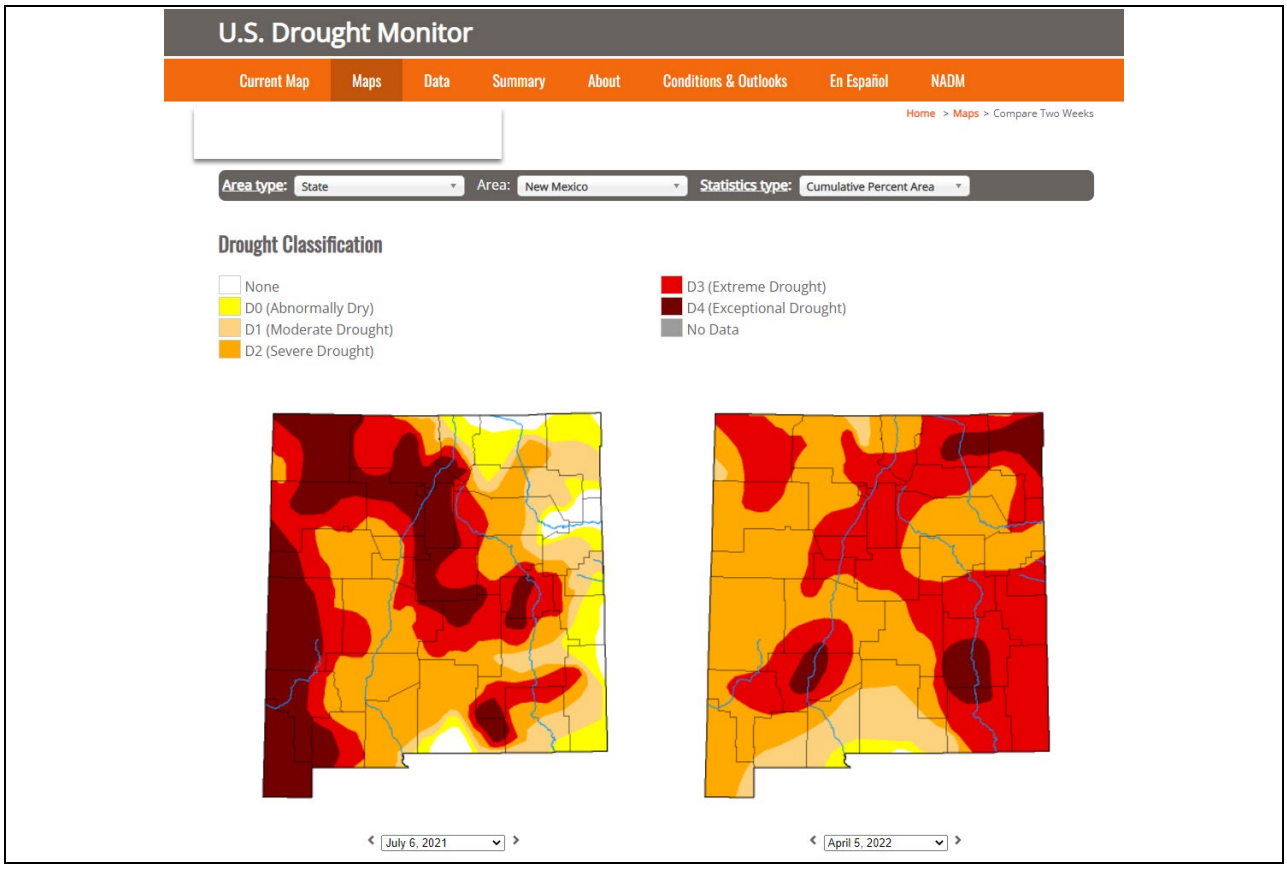


Figure 6: Comparison of Drought Classification from July 6 2021 to April 5 2022 from the U.S. Drought Monitor shows that the Las Dispensas Prescribed Fire area improved from D4 to D3 following beneficial monsoonal moisture, but still showed below average precipitation in the fall and winter months leading up to the day of the prescribed fire.

Despite the limited improvement to the drought conditions, anomalous dryness continued in the fall and then transitioned to a second consecutive winter (Double Dip) La Niña cycle that strengthened in the spring.

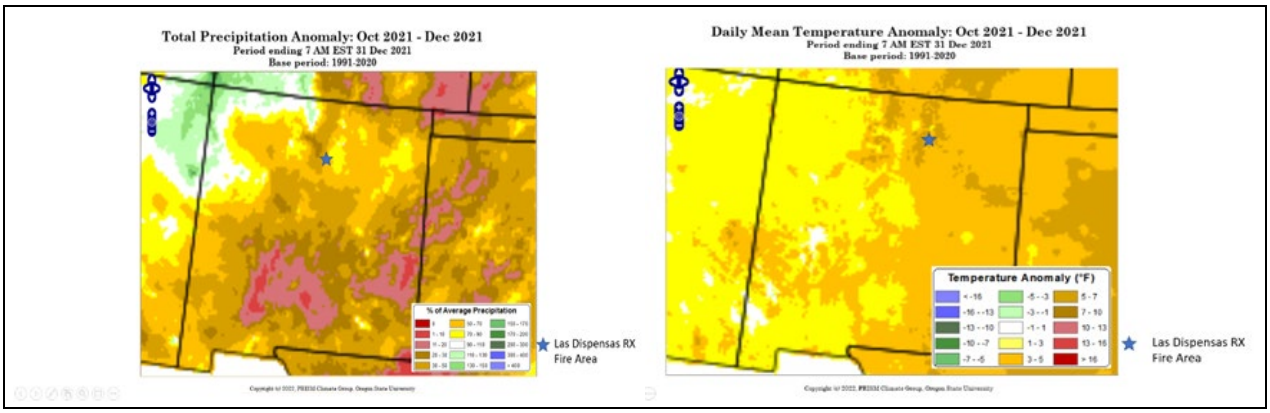


Figure 7: Fall-Winter Precipitation (left) and Temperature (right) anomalies suggest drier and warmer than average conditions for the Las Dispensas Prescribed Fire area for the period.

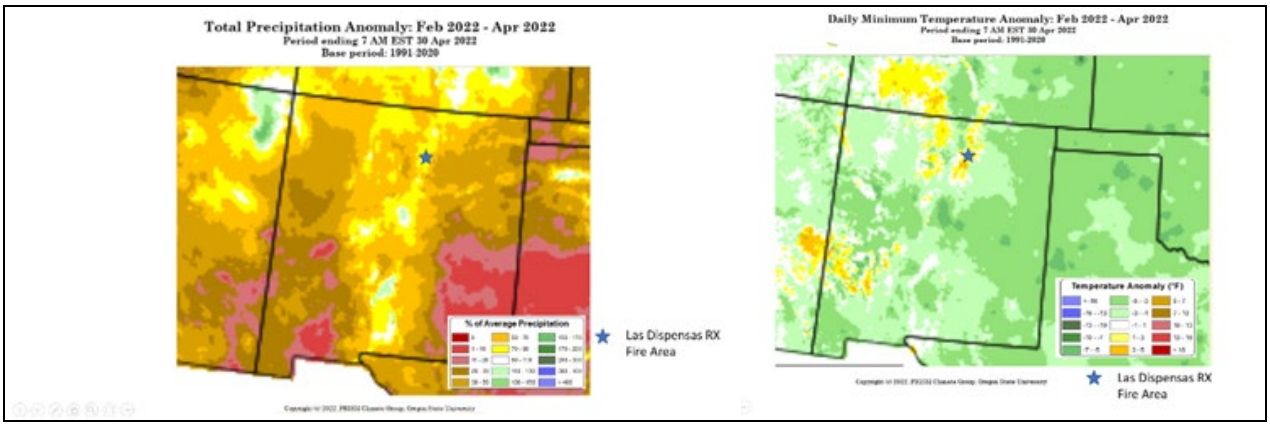


Figure 8: Winter-Spring Precipitation (left) and Temperature (right) anomalies continue to suggest drier and warmer than average conditions for the Las Dispensas Prescribed Fire area for the period, but cooler than average conditions surrounding the area and throughout the region.

Along with below normal precipitation, the seasonal snowpack was significantly compressed, as it did not start until January then abruptly melted off much earlier than average.

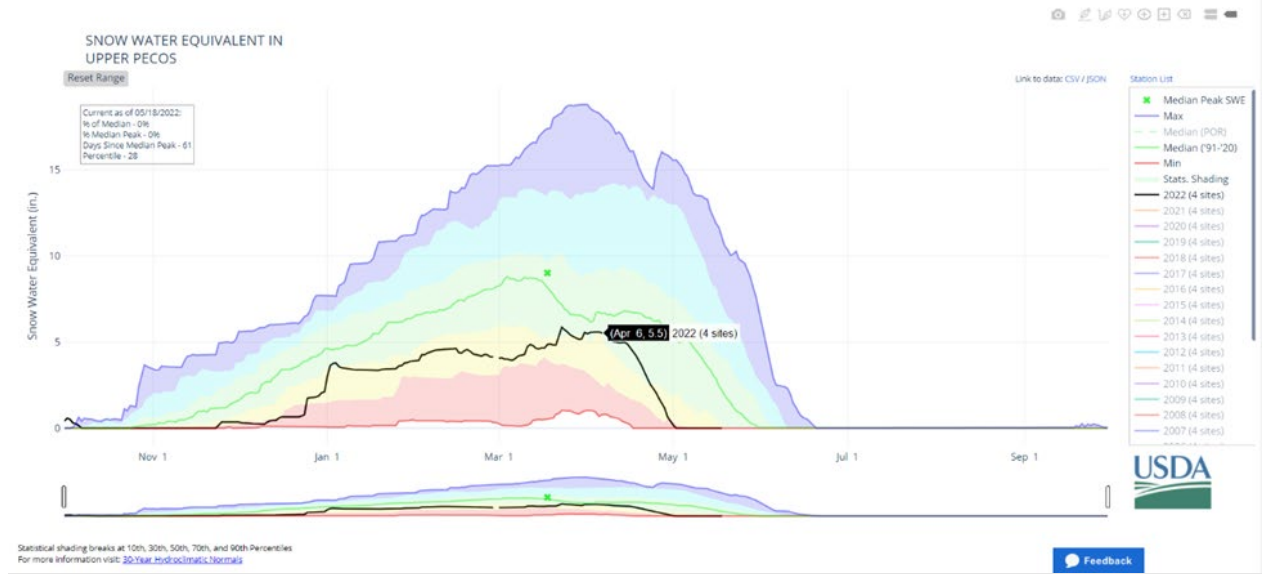


Figure 9: Snow Water Equivalent Data for the Water Year 2021-2022 in the Upper Pecos Basin. Courtesy USDA NRCS.

This setup was declared and monitored by the National Integrated Drought Information System (NIDIS) as a "snow drought."

More specifically, snowpack accrual in the Upper Rio Grande Hydrologic Basin, where the prescribed fire area is located, began the last week in December and into the New Year, which is much later than the median late October date. Then, the snow water equivalent (SWE) was maintained in the snowpack with adequately cool temperatures but very little additional accrual until a storm cycle in March and early April brought snowpack and the water contained within it back up to normal.

Weather Leading up to the Wildfire Declaration

Warm temperature and dry precipitation anomalies were reflected in the nighttime minimum temperatures for both the long- and short-term periods leading up to the April 6 prescribed fire ignition. This resulted in drier overnight conditions with lower humidity recoveries and led to drier fuels and longer daily burning periods.

The days preceding the Las Dispensas Prescribed Fire were described as a weather roller coaster with a light snow event just the weekend beforehand, the benefits of which quickly diminished as shown below from the Hot, Dry, and Windy Index (HDWI) that reached a peak value on April 5. The HDWI helps users determine which days are more likely to have adverse atmospheric conditions that could make it more difficult to manage a fire. It combines the maximum wind speed and evaporative potential in the lowest levels of the atmosphere.

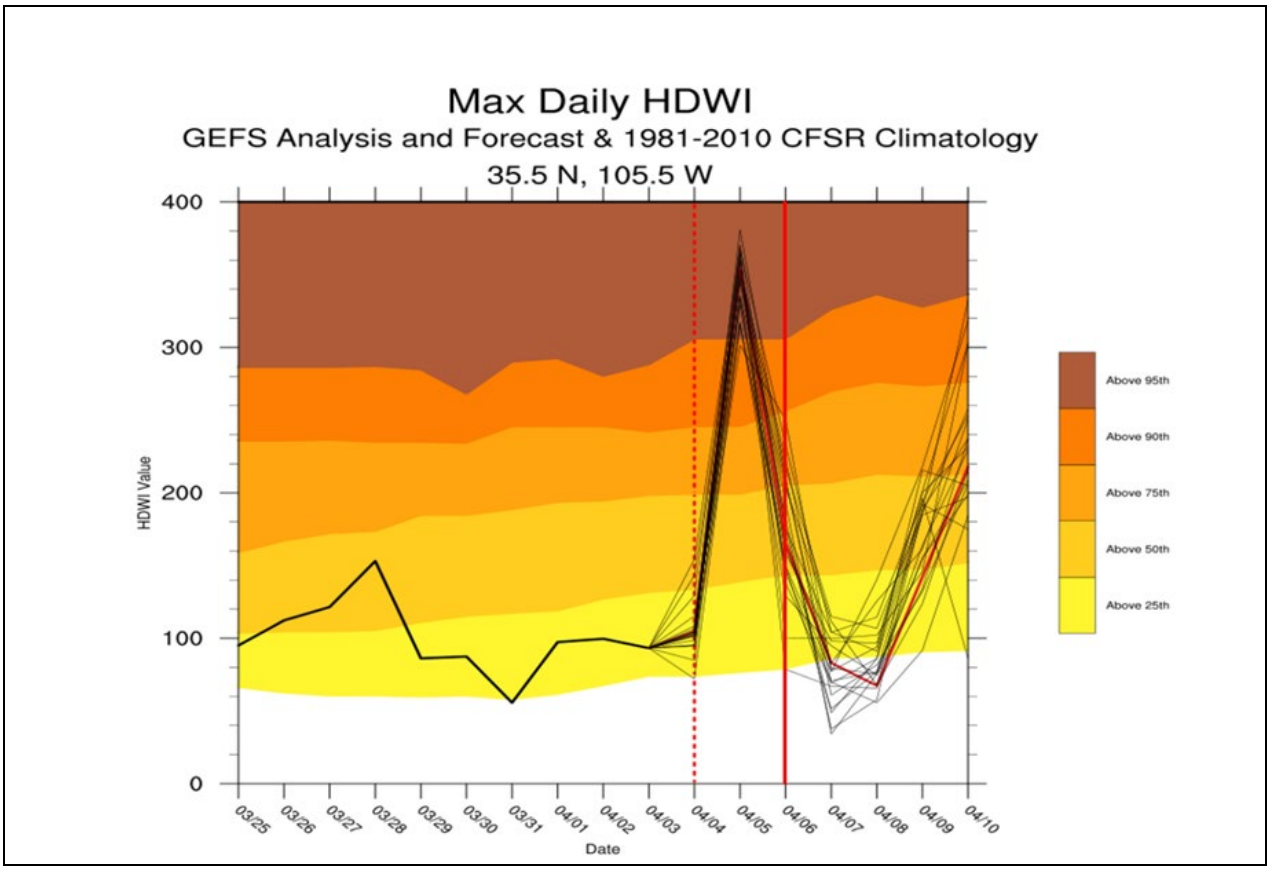


Figure 10: Forecast Hot, Dry, Windy Index provided courtesy Joseph Charney, Ph D. Research Meteorologist, USFS Northern Research Station.

This was quickly followed by a back-door cold front, with cooler and less windy but drier conditions on April 6. The cold front brought a shift in low-level winds from an easterly direction, along with cooler temperatures in the 50s. These post-cold frontal weather conditions on the day of the prescribed fire were considerably cooler than previous days, with somewhat lower wind speeds due to less instability and less wind mixing down from aloft than previously seen. Each of the forecasts from the National Weather Service (NWS) in Albuquerque leading up to the day of the prescribed fire (Fire Weather Zone 103 Forecast, Tabular, and Spot forecasts) predicted a complete airmass replacement of considerably drier air to move in from the northwest that would subsequently create much lower relative humidity in the afternoon compared to recent days, despite the cooler temperatures. Although the cooler weather on the day of the prescribed fire presented conditions that were more favorable than had been presented for much of the fall and spring, they were still predicted to be near the high end of the prescription parameters in Element 7 of the prescribed fire plan.

A National Weather Service Red Flag Warning was not headlined for Forecast Zone 103 in the Fire Weather Forecast (FWF) or the Spot Weather Forecast (FWS). However, Red Flag Warnings were in effect for other fire weather zones on the day of the prescribed fire due to the combination of relative humidity and wind, as defined in the criteria of the SW Fire Weather Annual Operating Plan, pg. 32.

Narrative Description of the Event

For a table chronology of the event please refer to Appendix C.

2000

In 2000 the Viveash Fire burned in the Cow Creek drainage just west of the Gallinas Watershed, with dramatic effects to the City of Las Vegas, New Mexico's water quality. Though occurring on only a small part of the Gallinas Watershed, sediment and ash from this fire disrupted the Las Vegas municipal water treatment works about 22 miles downstream.

2004 to 2006

The first version of the Gallinas EA was published in February 2004. The decision dated June 24, 2004 (Project Record 122) was appealed and the decision was reversed by Forest Service Region 3 on September 27, 2004. The Pecos/Las Vegas Ranger District revised the EA by modifying the selected alternative, adding an alternative, and bolstering the effects analysis. Alternative 1 was chosen, and the Decision Notice (DN) was signed on June 19, 2006.

2017

The first (recorded) prescribed fire entry in the Gallinas Prescribed Fire Project Area occurred in early October of 2017. This entry consisted of pile burning in several units located within the municipal watershed of the City of Las Vegas, New Mexico. Due to persistently dry weather, prescribed fire implementation actions continued throughout the fall in multiple units. Moisture/snow was predicted on several occasions across the prescribed fire area, but snowfall accumulation was well below normal and snow across the project area melted rapidly. This resulted in the prescribed fire spreading away from the piles but remaining well within the project area. The district had a presence throughout the fall and responded appropriately to areas of concern. This strategy resulted in a long-duration event. In late fall, a portion of the prescribed fire crossed into an area where fire was not desired within the unit. On December 29, the decision was made to suppress that portion of the prescribed fire.

2018

On January 18, the same portion of the prescribed fire that was designated for suppression was converted to a wildfire due to unwanted fire effects. This decision was made due to the potential for ash to enter the municipal watershed, which could have degraded water quality and compromised community relations.

In March, the Forest Supervisor requested a Facilitated Learning Analysis (FLA) of this event to explore opportunities to improve communications, safety, coordination and the prescribed fire program. After hearing from individuals involved in the planning and implementation of the prescribed fire, the FLA Team identified "communication" and "prescribed fire preparation and risk" as two common themes.

2019

In 2019, the Santa Fe National Forest drafted an addendum to the Gallinas EA to: include the acres left out in the Gallinas EA for broadcast prescribed fire between thinning treatment units; tie in previous treatment units for a larger, more consistent hazardous fuel treatment area; and place proposed containment lines on the roads and ridgelines where firefighters could safely and successfully conduct broadcast prescribed fire. These units would incorporate existing areas but also add areas that had not been included initially to better meet the need for fuels and risk reduction within the watershed*. As of June 2022, this draft has not been finalized.*

2021

In May, a task order was solicited for hand-constructed fuel breaks and fireline, along with manual thinning and piling, on the Espanola and Pecos/Las Vegas ranger districts of the Santa Fe National Forest. Work began on June 22 and was completed on July 21. This preparation work included the units in the Gallinas Prescribed

Fire Project Area, and specifically Las Dispensas Unit 10. Work was completed within specifications of the contract. Slash from fireline prep was lopped and scattered no higher than two feet in height and pulled interior from the control lines a minimum of 66 feet (1 chain).

Key Decisions/Authorizations

Authorization/Decision	Signor	Date signed
Gallinas Municipal Watershed WUI Decision Notice	District Ranger	2006
Burn Plan	Burn Boss Review Burn Boss Agency Administrator	12/18/19 12/18/19 10/22/21
Ignition Authorization	Agency Administrator	3/24/22
Go/No Go	Burn Boss	4/6/22

March 2022
In March, wind speeds were determined to be too high and dead woody fuel moistures too wet to achieve prescribed fire plan objectives. Several other planned prescribed fire implementation actions in the area were also canceled due to similar factors.

March 8
A news release announced the planned Las Dispensas Prescribed Fire implementation actions.

March 18
Citing information from the prescription narrative, a second news release announced that the prescribed fire would be canceled due to unfavorable weather conditions resulting from recent snowstorms and wet roads.

March 24
The Burn Boss and District Ranger (Agency Administrator) signed the Agency Administrator Ignition Authorization (Form 2A) authorizing ignitions on the Las Dispensas Unit between April 1-30, 2022. They believed that these future burn windows would better fit prescription parameters.

April 1
Additional news releases were issued to ensure the public was informed of the potential for prescribed fire implementation if optimal windows became available.

April 2-3
The weekend before the prescribed fire was implemented, the project area received snow. This was cited in the prescribed fire plan 2A (Ignition Authorization) as a mitigation for long-term drought because there was a perception that fuels were moist.

April 3
Personnel sampled live and dead fuel moistures onsite in Unit 2. An observation was made that fuel moisture values fell compared to previous samples. An electronic Kestrel instrument was hung out to record weather observations. A spot weather forecast was requested.

April 4
The Burn Boss was notified that the New Mexico State Inmate Crew preidentified in the prescribed fire organization was unavailable for assignment. The Burn Boss requested a spot weather forecast. An additional email was sent to the Regional Smoke Coordinator and Predictive Services Meteorologist referencing potential concerns regarding forecasted winds. The response email indicated that there was a solid burn window that would not be limited by the expected winds. Because it was the closet Remote Automated

Weather Station (RAWS), the Pecos RAWS was used in lieu of the Bartley RAWS.

April 5
The Division Bravo Firing Boss met with four members of the Hotshot Crew in prescribed fire Unit 10. Anecdotal observations were made in reference to the availability and amount of fuel. The Firing Boss asked the crew to scout units 1 and 2 as secondary options.

Onsite weather observations were taken at 1100 and 1500 local time in Unit 10. These were the same times as the ignitions planned for the following day.

1500 Weather Observations for spot weather forecast: Elevation 7,512 feet; dry bulb temperature 70; wet bulb temperature 45; relative humidity 15%; winds N/NW gusts to 11 mph; clear sky.

At 1501 a spot weather forecast was requested from the National Weather Service through Dispatch. At 1539 Dispatch relayed the spot weather forecast.

April 6
On the morning of April 6, resources were shown enroute to the prescribed fire unit at 0806. At 0807 the Burn Boss arrived on scene. At 0823 a spot weather forecast was requested through Dispatch. At 0829 the name of the Burn Boss (RXB2) was relayed to Dispatch, along with the information that there would be no Burn Boss Trainee.

At 0900 crew and equipment shuttles began, and at 0930 onsite resources were briefed at El Porvenir Campground. At 0938 the spot weather forecast (Appendix D) was relayed by Dispatch. Personnel on scene reviewed and signed the Job Hazard Analysis (JHA) at 1015. At 1023 the Burn Boss called Dispatch on the radio to relay that the briefing had been completed and resources were getting in place to conduct the test fire. The Go/No-Go Checklist (2b) was documented by the Burn Boss. The Burn Boss stated that he had obtained and reviewed the tabular and zone weather forecasts from the National Weather Service online.

The Organization was broken into two Firing Groups and two holding groups. Alpha Firing and Holding were assigned to work the southern end of the unit. Bravo Firing and Holding were assigned to work from the test fire site north and east. Each firing group had a trainee Firing Boss and fully qualified Firing Boss assigned. Bravo firing would lead the prescribed firing operation to create a buffer to the north side (first entry) of the slope due to heavier concentrations of dead and down fireline-prepared fuels inside of the unit about 30 feet inside the fireline.

After briefing, one engine was parked at El Porvenir Campground due to narrow road conditions and inaccessibility to Drop Point 7. There was also a tanked Utility Terrain Vehicle (UTV) staffed by one of the engine crewmembers. A second engine was moved up to the saddle near Unit 6, north of Drop Point 7. At 1100 resources were getting in place to initiate the test fire at the saddle in Unit 10. A Kestrel reading of light 2.4 mph wind speeds was observed below the Test Fire site.

1100 Weather Observations: Dry bulb temperature 50; wet bulb temperature 37; relative humidity 30%; winds 3-8 mph from SW.

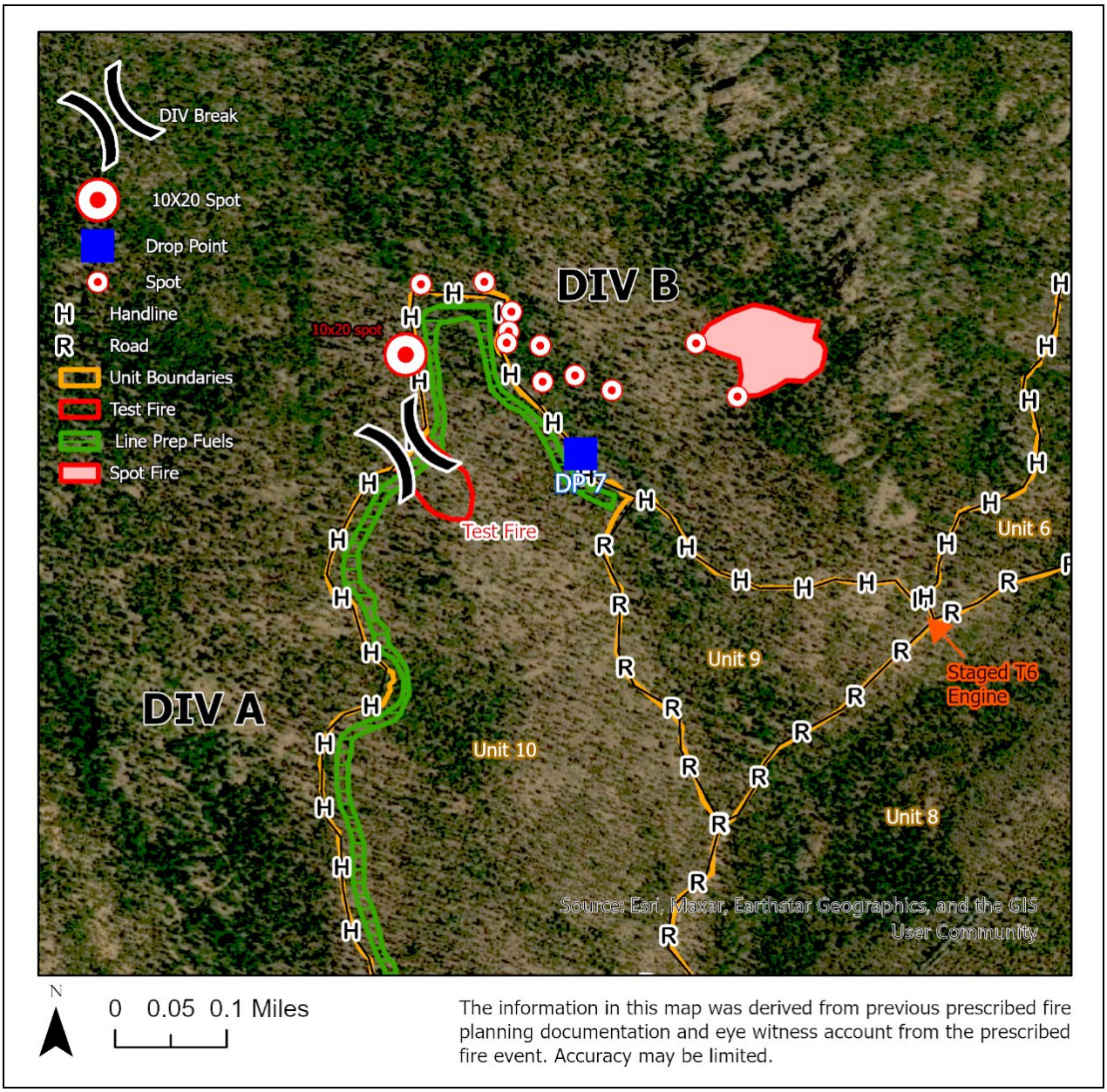


Figure 11: Area Map of Unit 10 of the Las Dispensas Prescribed Fire area.

Las Dispensas Unit 10 test fire site post burn May 19, 2022.

Las Dispensas Unit 10 test fire from above on April 6, 2022.

At 1134 the Test Fire was initiated in 2-inch-deep needle cast in Unit 10 of the Las Dispensas Prescribed Fire area. The location was on the top of the knob on the northwest end of the unit. The decision was made to start the test fire there because there was minimum heavy fuel within the test fire area. It was believed to be a place that could be easily extinguished if fire behavior and effects were not desirable. Single-tree torching occurred during the test fire.

Line preparation consisted of lop and scatter fuels arrangement, with some areas of higher concentrations of fuels. Heavy concentrations of dead and downed fireline-prepared fuels were located 66 feet (one chain) inside the fireline throughout all the units on the downhill side. In some cases, these heavy concentrations of fuels were underneath trees with ladder fuels. With this type of line preparation, the only available fuel near the line was light fuels (1 and 10 hour fuels, pine needles, twigs and patchy grasses). From the test fire site moving north within the unit, there was an area that was a first entry for fire—meaning that no fire activity, prescribed or otherwise, had ever been recorded there. Fuels inside this area of the unit were heavy dead and down ponderosa pine and mixed conifer with ladder fuels; tree height estimation ranged from 20 to 80 feet.

Wind Observation: Upslope, upcanyon with speeds around 2 to 4 mph with occasional gusts to 6 mph.

Smoke observation: Several hundred feet NW white/light.

Weather Observations: Dry bulb temperature 55; wet bulb temperature 39; relative humidity 25%; winds 3-6 mph; gusts 6-10 mph from a S/SW direction. Probability of Ignition 50% shaded-50% unshaded.

Fire Behavior Observations: Fire consuming jackpot heavies well; single-tree torching when jackpot heavies are underneath them; fire spreading in needle cast (when present). Backing and flanking behavior.

The firing plan on the Bravo side was to take fire about 500 feet to the southeast from the test fire (knob) along a rocky ridge, keeping fire to the northeast side of a rock outcrop. Next, to take fire down to an area where it would have to back into the wind downslope to flat ground where rocks would keep it from backing down into the other side (Alpha). This technique was used to promote a backing fire to the north. Once Bravo firing had made three passes from the test fire to the toe of the slope and back, Alpha was given the OK to start their blackline and to widen out from the edge of the rock outcrop (test fire to the south) and help fire back down the slope to the south. Alpha blackline would stay even with the backing fire on their end. At 1220, Bravo Firing continued to bring fire along the knob to the north. (Refer to map on page 14.)

1230 Smoke Observation: Drifting NE, light smoke with some gray.

The test fire results were determined successful by the Burn Boss. At 1234, “Test Fire successful” was called into Dispatch.

Wind Observations: Winds upslope, upcanyon 2 to 3 mph with occasional gusts to 6 mph, terrain-dominated, predominantly SW.

Fire Behavior Observation: Fire consuming heavies well and spreading where fine fuels are present, backing and flanking behavior, winds SW.

1235 Dispatch emailed Pecos/Las Vegas District Group informing that test fire was successful and ignitions would continue.

1242 Smoke Observation: Smoke drifting 1600 feet NE.

1300 Division Alpha began firing on the West Flank.

Weather Observations: Dry bulb temperature 57; wet bulb temperature 37; relative humidity 22%; winds 2-6 mph E/SE; probability of ignition 60% shaded-60% unshaded.

1310 District Fire Management Officer was shown to be enroute to the prescribed fire.

1322 Smoke Observation: Smoke drifting 2,000 feet NE/E, gray.

Fire Observation: Backing off knob, consuming jackpot heavies.

1335 A small spot fire was reported on Division Bravo; there were no reported control issues.

As Alpha Firing started their operation, Bravo Firing Boss, radioed Bravo Trainee and informed that they were going to walk down to the east (toe of slope) to check the fire spread.

Fire Behavior Observations: Low intensity backing fire with flame lengths of 3-6 inches at the toe of the slope with the wind still upslope. Interior fire slowly backing through dead and down fuels towards the north.

Bravo Firing Boss proceeded to the south and west to look at the topography and fuels Alpha was going to be working through. When Bravo Firing Boss arrived back up to the handline via a drainage on the Alpha side, they met with Alpha Firing Boss and the Bravo Holding Boss. They discussed being patient and not rushing the ignitions. They didn't expect to finish the entire unit in one day. They agreed to find a good spot to cut it off in the evening.

Bravo Firing Boss then walked north up the fireline past the test fire site to meet Bravo Trainee. They discussed taking it slow; Bravo Trainee would use a dotting firing technique and work available jackpots.

1351 Burn Boss called Deputy Fire Staff Officer to check on additional resources. Fire Management Officer was going to follow-up with Deputy to confirm availability of resources for the next day.

As fire was backing into the heavier concentration of dead and down fireline-prepared fuels in Division Bravo, the winds were observed to occasionally shift from up slope to down slope. Bravo Firing Boss Trainee asked to take one more pass to the east with one igniter (to bring fire around the corner to the base of the knob and hang it up for the evening), while the other two igniters began to bring blackline down slope 10 to 20 feet at a time.

The igniter that took fire to the toe returned unannounced with a second pass back up to the fireline, bringing fire with them. As they waited for fire to come together, intensities picked up due to the heavy concentration of dead and downed fuels and interior single and group tree torching began. This interior tree torching created the first large spot fire. The 10 x 20-foot spot fire occurred at approximately 1426 on the northeast corner of Division Bravo.
During the spot fire, Bravo Firing Boss tried to radio Bravo Holding Boss several times to get a status on the spot but received no response. Holders and two igniters from Alpha were pulled to Bravo to assist with the spot.

Fire Behavior Observations: Intense slash burning, fireline-prepared fuels involved, torching.

1400 Lookout Weather Observation: Dry bulb temperature 51; wet bulb temperature 36; relative humidity 23%; winds 2-7 mph from the E/SE. Probability of ignition 60% shaded-60% unshaded.

1403 Smoke Observation: Smoke drifting 2,000 feet NE.

Fire Behavior Observation: Heavies and terrain-dominated winds influence, winds east and up-canyon.

Bravo Firing Boss walked back down to the toe of the slope to monitor any spread into Division Alpha. Division Alpha had picked up a couple additional spots.

Between 1430 and 1445, Bravo Firing Boss observed low fire intensity at the toe of the slope. Bravo Firing Boss established radio contact with Holding Boss. The holding resources had discovered a 10 X 20-foot spot fire and eventually contained it at 0.25 acre. The holding resources then gridded the green for other spots.

1439 The Burn Boss updated Dispatch: “Everything is going good on the Alpha side, no concerns. On the Bravo side, we’ve picked up a few small spots and caught them, currently working a quarter acre spot, should be able to hold it with engines, will call back later with another update.”

The Bravo Firing Boss requested a meeting via radio with the Bravo Holding Boss. The outcome of this meeting was that the Bravo Holding Boss would scout a ridge to the south to verify it as a viable location for a check line.

1455 The Burn Boss updated Dispatch that they were able to get around the 0.25-acre spot with the engine crews.

1458 Dispatch relayed they would be sending Santa Fe Hotshots to the prescribed fire implementation site in the morning and their Crew Manifest would be sent to Burn Boss.

1500 Weather Observations: Dry bulb temperature 56; wet bulb temperature 37; relative humidity 18%; winds 3-7 mph, gusts to 15 mph from the E/SE; probability of ignition 70% shaded-70% unshaded.

While hiking along the northern fire edge, Bravo Firing Boss realized that the tanked UTV pumping the hose lay to the 10 x 20-foot spot was almost out of water. He walked down to the to ask one of the Hotshot UTV operators to give him a ride to the road to reposition the engine.

Halfway to Drop Point 7, the tanked UTV was topped off with water, and the engine was moved up to where

the line started on Unit 9, just below Drop Point 7. The Hotshots assigned to Alpha were moved to Bravo to chase spots.

1530 The Holding Boss-B radioed Bravo Firing Boss and stated that the earlier-discussed check line location would be viable. They had found the ridge he was talking about. Although it would take some work to ensure it could be held, it (a checkline) could be done.

Due to variable and shifting winds, Bravo Firing Boss decided to hold off on firing until holding was in good shape to start again. He made several attempts to contact Bravo Holding on the radio with no success. He then radioed Alpha Firing to ask what they were seeing. Alpha Firing Boss mentioned they had a couple of small spot fires they were able to pick up and that they were planning to take another ("small bite") strip below the ridge line and blackline at the same time.

Bravo Firing Boss asked a Hotshot Squad Leader face-to-face if he could contact Bravo Holding. The Squad Leader established contact with Bravo Holding on a crew net channel. Bravo Holding responded on the designated tactical frequency saying everything was good and there were no new spots. At this time, ignitions were still on hold and Bravo Firing Boss decided to walk back down to the toe of the slope.

1545 At the toe of the slope, the fire still had not progressed any farther to the east or to the south, as it was tied into some rocks and creeping in the open flat ground. The dead and down fuel in this area (Open Flat Ground) had been removed by wood haulers and fuels were sparse. Bravo Firing Trainee radioed Bravo Firing Boss to advise they would continue ignitions. Bravo Firing radioed Alpha Firing to let them know they were starting up again with one more pass to the east. Three igniters took fire east down to the toe. Bravo Firing radioed Bravo Firing Trainee, asked their location, and asked them to hold the igniters. Bravo Firing Trainee relayed that the igniters were already at the toe. Bravo Firing Boss directed Bravo Firing Trainee not to bring any more fire up the line and to bring more blackline down.

1555 The Burn Boss reported multiple spots to Dispatch. Alpha had a few small spots; Burn Boss reported no holding concerns, several spots on Bravo, and that all ignition operations had stopped.

1600 Weather Observations: Dry bulb temperature 56; wet bulb temperature 35; relative humidity 10%; winds 4-8 mph, gusts to 15 mph W/SW.

Fire Behavior Observations: Increased fire activity and prolonged group tree torching observed.

At this time the Bravo Firing Boss radioed Bravo Holding Boss with no response. Fire was spotting within the unit. The tanked UTV and operator was instructed to move down to the corner where the road and the line met.

A wind shift was noted at this time to upcanyon S/SE.

1606 The Burn Boss updated Dispatch that there were multiple spots on the NW corner of Unit 10. He stated that there were a dozen or so spots, and that it would take a bit of time to get around them. He placed a request for contingency resources and asked the Forest Fire Staff to give him a call.

At 1610 crews were working multiple spots on the north side in Division Bravo. Multiple spots across the creek-bed at eye level were observed. One spot was 300 feet above the rest and growing.

1615 The Bravo Firing Boss (FIRB) reported frequent spots across the line and not enough resources to catch them. Holders disengaged from spots along the eastern fireline on the Bravo side and moved downslope toward Drop Point 7. Bravo Firing Boss asked holders to engage four new spots just above Drop Point 7. Several resources returned to the spot fires that had now grown together; the tanked UTV was out of water; there was a lot of dead and downed fuel outside the line. Heat off the spot was intense and fire was starting to spot up-canyon. At this time, the Lookout came over the radio stating she has spotted “a couple of spot fires 0.25 miles north of the drainage and are starting to grow.” Firing Boss Bravo contacted the Burn Boss on the radio to let him know they were unable to catch the larger spot and that they would disengage.

Resources were instructed to disengage and regroup at the vehicles at Drop Point 7 due to increased fire behavior. All assigned resources met back at the vehicles.

Fire Behavior Observations: Group tree torching, fireline prep fuels fully involved, spotting.

1620 Spots were growing and pulling together with south/southwest wind. The wind had shifted in multiple directions above Drop Point 7, causing multiple spot fires to the west, north and east sides of the fireline of Unit 10. The resources on scene were unable to handle everything across the fireline. The Burn Boss had instructed everyone to disengage and head down the road to regroup. As the resources making their way down passed Drop Point 7, the Burn Boss asked Bravo Firing Boss to "go get an evaluation of how much fire was across the lines and to develop strategies and tactics to re-engage if safe to do so."

Bravo Firing Boss was unable to reach the west end, where most of the spot fires had already come together, to scout safely. Because the fire activity was relatively moderate on the east flank, he was able to find the heel of the larger spot fire mid-slope, which he followed upslope to a rock ridge. As he reached the rocks, he noticed top smoke from another spot fire west of the spot fire he was located.

1621 The Burn Boss instructed Dispatch to contact the Forest Fire Management Officer and advise of the multiple spots and need to order contingency resources, also to contact the Agency Administrator and advise. There was one spot on the north end; crews were anchoring the west side and assessing the east side.

1625 Dispatch acknowledged the request for mobilization of contingency resources. Resources were physically located in Taos, New Mexico at the Fire Summit (an annual training exercise). At 1628 Dispatch advised the District Ranger of the situation at the prescribed fire. At 1630 there was an uphill crown run to the top of the ridge due to wind and slope alignment.

1634 The Burn Boss requested Dispatch to contact the Agency Administrator via phone. The Burn Boss had spoken with the District Fire Management Officer, and they had determined that it would be proper to declare the prescribed fire a wildfire.

The fire was heading north toward Hermit's Peak and west toward the Pecos Wilderness. At 1638 Dispatch advised the Agency Administrator that the Burn Boss and the Fire Management Officer were recommending wildfire declaration. The Agency Administrator made the wildfire declaration. At 1645 a FireCode was requested. At 1650 the Incident was named the Hermit's Peak wildfire.

Planning Analysis

Analysis of the Environmental Assessment

Planning for the overall Gallinas Municipal Watershed Wildland Urban Interface (WUI) project began in 2001 after the Las Vegas municipal water quality was negatively impacted by the 2000 Viveash Fire. An Environmental Assessment (Gallinas EA) was prepared and a Decision Notice was signed in 2004. The Forest Service Region 3 Regional Office reversed this decision to include an alternative proposed by the Gallinas Watershed Council. The Gallinas EA was modified and the second Decision Notice was signed in June of 2006. Alternative 1, Mechanical in Place, was the selected alternative over the proposed action because more pretreatment, thinning, piling and burning before broadcast burning were identified as more fully meeting the purpose and need.

One of three key issues brought forth in the Gallinas EA was the risk of escaped prescribed fire. Areas that were only identified for broadcast burn treatment were judged to have a higher risk of prescribed fire burning beyond unit boundaries versus areas that received a mechanical pretreatment first.

This treatment sequence reduced the probability of escaped fire as compared to the proposed action, which proposed more broadcast burning of natural fuels without any mechanical pretreatment. Alternative 1 would mechanically pretreat 1,600 more acres than the proposed action before broadcast burning, in this case hand

thinning with piles or lop and scatter followed by burning of piled material and broadcast burning. As of May 2022, 5,221 acres of mechanical treatment and 2,442 acres of prescribed burning had been completed on the overall 8,300 acres.

While 45% of the overall area falls within an Inventoried Roadless Area (IRA), and a majority of the watershed to the west is within Mexican Spotted Owl Habitat, the Las Dispensas Prescribed Fire unit does not fall within those designations and therefore was not as limited in mechanical and burn options.

The Gallinas EA has not been revisited within the 16 years since the Decision Notice was signed, although changes in fuels conditions likely occurred in that time. However, there was an effort to draft an addendum to the EA to address the need to implement prescribed fire treatments more safely and effectively. The purpose of the proposed addendum was to: include the acres left out in the Gallinas EA for broadcast prescribed fire between thinning treatment units; tie-in previous treatment units for a larger, more consistent hazardous fuel treatment area; and place proposed containment lines on the roads and ridgelines where firefighters could safely and successfully conduct broadcast prescribed fire. However, the addendum has not been finalized or signed.

Las Dispensas consisted of two prescribed fire units totaling 1,204 acres of broadcast burning. There are 46,926 feet of fireline and 14 acres of broadcast prescribed fire that fall outside of the current EA planning acres, and 5 acres of thinning and fireline prep that falls outside of the current EA planning area.

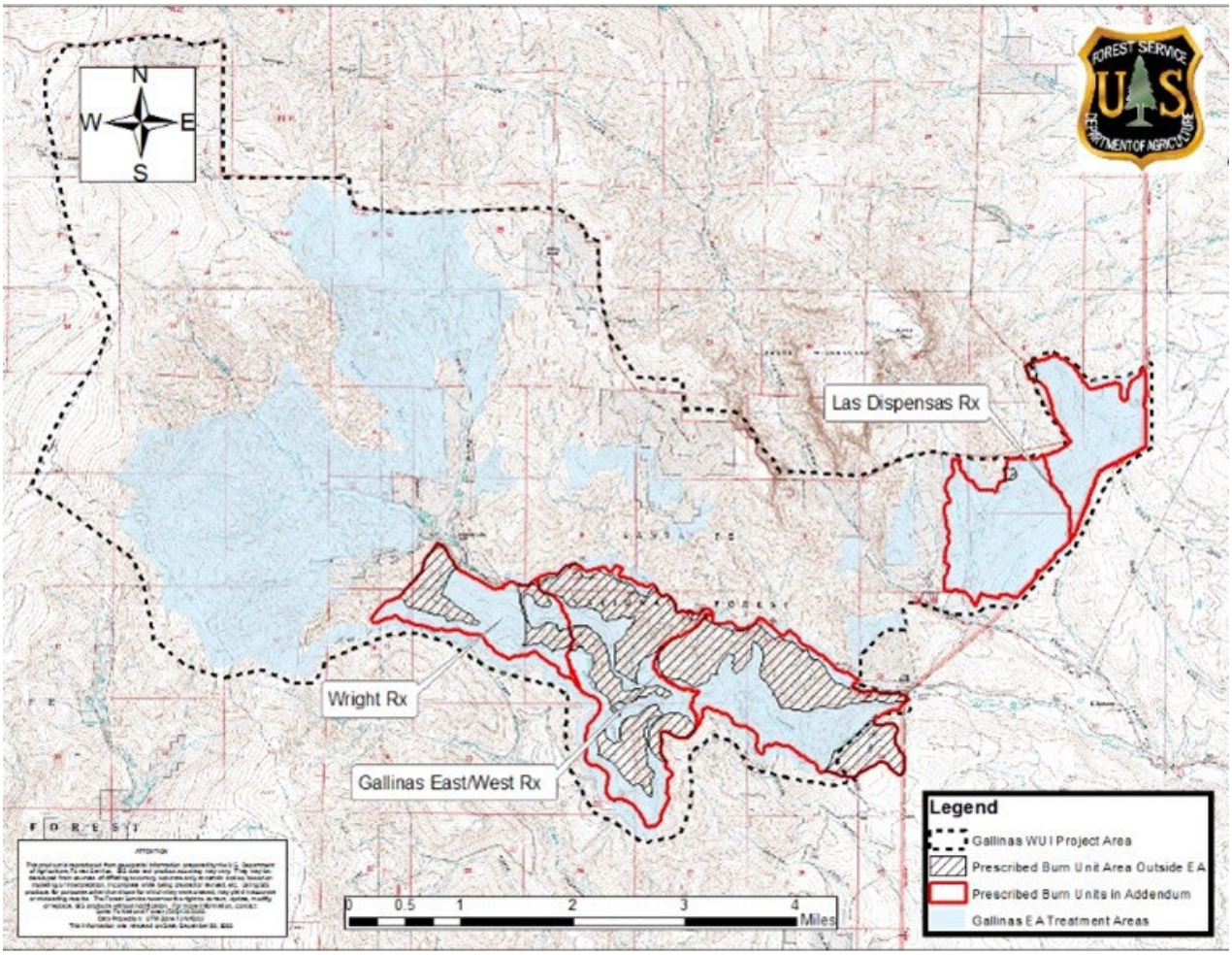


Figure 12: Prescribed Fire Units Included in EA Addendum.

Analysis of the Prescribed Fire Plan

The Gallinas Watershed Prescribed Fire Plan was prepared in 2019. The prescribed fire plan and complexity analysis was approved on January 10, 2020 by the Agency Administrator. The prescribed fire plan and complexity analysis was reviewed and approved again on October 22, 2021. This plan encompasses many prescribed fire units tied to the 2006 Gallinas EA.

Table 1: Analysis of Las Dispensas Prescribed Fire Plan Elements, Compliance and Potential Contributions

PRESCRIBED FIRE PLAN ELEMENTS	POLICY CONSISTENT	COMMENTS	CONTRIBUTING FACTOR?
Element 1: Signature Page	YES	The signature page of the prescribed fire plan was signed by the preparer on December 12, 2019, the technical reviewer on December 18, 2019, and the Agency Administrator on October 22, 2021.	NO
Element 2A: Agency Administrator Ignition Authorization	YES	The authorization was signed by the Prescribed Fire Burn Boss and Agency Administrator on March 24, 2022 with an authorization period of April 1 through April 30, 2022.	NO
Element 2B: Prescribed Fire GO/NO-GO Checklist	YES	The checklist was completed by the Burn Boss on April 6, 2022.	NO
Element 3: Complexity Analysis Summary and Final Complexity	YES	The most current Prescribed Fire Complexity Rating System Guide (PMS 424, July 2017) was signed by the Prescribed Fire Plan preparer and the Technical Reviewer on December 18, 2019 and Agency Administrator on January 10, 2020 and resigned digitally on October 22, 2021.	YES
Element 4: Description of Prescribed Fire Area	YES	Fuel model (FM) estimates did not accurately depict previous thinning in the area that is better represented by FM 2 (Appendices E and F). Line prep also resulted in concentrations of fuels 66 feet inside and parallel to the fireline; these fuels were likely to be more representative of fuel model 12.	YES
Element 5: Objectives	YES	Criteria met as per PMS-484.	NO
Element 6: Funding	YES	Criteria met as per PMS-484.	NO
Element 7: Prescription	YES	Criteria met the PMS-484 requirements. Refer to the findings (Table 2)	YES

Element 8: Scheduling	YES	Criteria met as per PMS-484	NO
Element 9: Pre-burn Considerations and Weather	YES	Criteria met as per PMS-484	NO
Element 10: Briefing	YES	Criteria met as per PMS-484.	NO
Element 11: Organization and Equipment	YES	CONTAIN module was not used in the development of the prescribed fire plan (see narrative).	YES
Element 12: Communication	YES	Criteria met as per PMS-484.	NO
Element 13: Public and Personnel Safety and Medical	YES	Criteria met as per PMS-484.	NO
Element 14: Test Fire	YES	Criteria met as per PMS-484.	NO
Element 15: Ignition Plan	YES	Criteria met as per PMS-484.	NO
Element 16: Holding Plan	YES	The "Minimum Organization or Capabilities" were determined on misguided understanding of the resources necessary to effectively stop fire outside the line. See Element 11 and above narrative.	YES
Element 17: Contingency Plan	YES	Contingency resources identified were not adequate when evaluating the need to include fuel models 2 and 12 in analysis of potential fire behavior.	YES
Element 18: Wildfire Declaration	YES	Criteria met as per PMS-484.	NO
Element 19: Smoke Management and Air Quality	YES	Criteria met as per PMS-484.	NO
Element 21: Post Burn Activities	YES	Criteria met as per PMS-484.	NO
Prescribed Fire Plan Appendices: Appendix A: Maps: Vicinity, Project (Ignition Units)	YES	Criteria met as per PMS-484.	NO

Appendix B: Technical Review Checklist	YES	Criteria met as per PMS-484. Technical Reviewer did not recognize the lack of CONTAIN modeling outputs. The technical reviewer commended a few elements in the prescribed fire plan, did not request any changes to it, and recommended the plan for approval on December 18, 2019.	NO
Appendix C: Complexity Analysis	YES	Criteria met as per PMS-484	YES
Appendix D: JHA Risk Assessment	YES	Criteria met as per PMS-484	NO
Appendix E: Medical Plan	YES	Criteria met as per PMS-484	NO
Appendix F: Fire Behavior Modeling Documentation	YES	CONTAIN module was not used in the development of the prescribed fire plan. Fuels models 2 and 12 were not included in the SURFACE, SPOT, SCORCH, IGNITE BehavePlus 5.05 modules. CROWN module was not used.	YES
Appendix G: Smoke Management Plan and Smoke Modeling Documentation (Optional)	N/A	Criteria met as per PMS-484	NO

Fuel Model Assignment

Elements 7, 11 and 18 of the prescribed fire plan were developed using BehavePlus 5.0.5 (GTR 249). Modeling output results were generated for fuel models 8, 9, 10 and 11 (Anderson 1982) to produce the high- and low-intensity fire thresholds of the prescription utilizing the SURFACE, SPOT, SCORCH and IGNITE modules. Both the complexity analysis and the prescribed fire plan indicated that the CONTAIN module should have been used to determine the required suppression resources. Results from the CONTAIN module in BehavePlus were not included in Appendix F of the prescribed fire plan, nor were they used in the development of the prescribed fire plan. Further analysis suggests that fuel model 10 was used in the planning analysis to account for the highest rate of spread (ROS) and to determine resource needs based on the production rates outlined in the Wildland Fire Incident Management Field Guide. The ROS for fuel model 10 was calculated to be 22.8 chains per hour (ch/hr). The prescribed fire plan makes reference to suppression resources needing to exceed 22.8 ch/hr of line production. The CONTAIN module requires suppression resources to be at or above 48 ch/hr of line construction to successfully catch an escape under the most optimistic parameters. A key difference in results is that CONTAIN requires suppression of both flanks. This creates a situation in which the required suppression resources were underestimated. The use of the CONTAIN module in BehavePlus 5.0.5 is not required when estimating the numbers and types of resources necessary to hold a prescribed fire within unit boundaries, nor identifying the minimum number and type of contingency resources needed to keep the prescribed fire within the scope of the prescribed fire plan. Such fire behavior modeling though can inform holding/contingency plans, especially when combined with empirical observations and experience.

Spatial Fire Behavior Modeling

Spatial fire behavior is a better modeling method that can be used to capture a potential fuel model, as well as other components of the landscape/vegetation, including elevation, slope, aspect, canopy cover, stand height, canopy base height and canopy bulk density. The variability and juxtaposition of these variables varies spatially across landscapes. Thus, only through spatial fire behavior analysis can those complexities and their associated interactions with fire behavior be captured. In addition, these programs can utilize satellite-derived landscape information from LANDFIRE, updated at a regular interval, that captures fuel model changes associated with treatment or disturbance (see Appendices G and H). In the figure below (Figure 13), the Las Dispensas burn area is composed of primarily 8 fuels models. Fuel models 1 and 2 are grass models, fuel models 4, 5 and 6 are shrub models, fuel models 8, 9 and 10 are timber litter models (GTR 122).

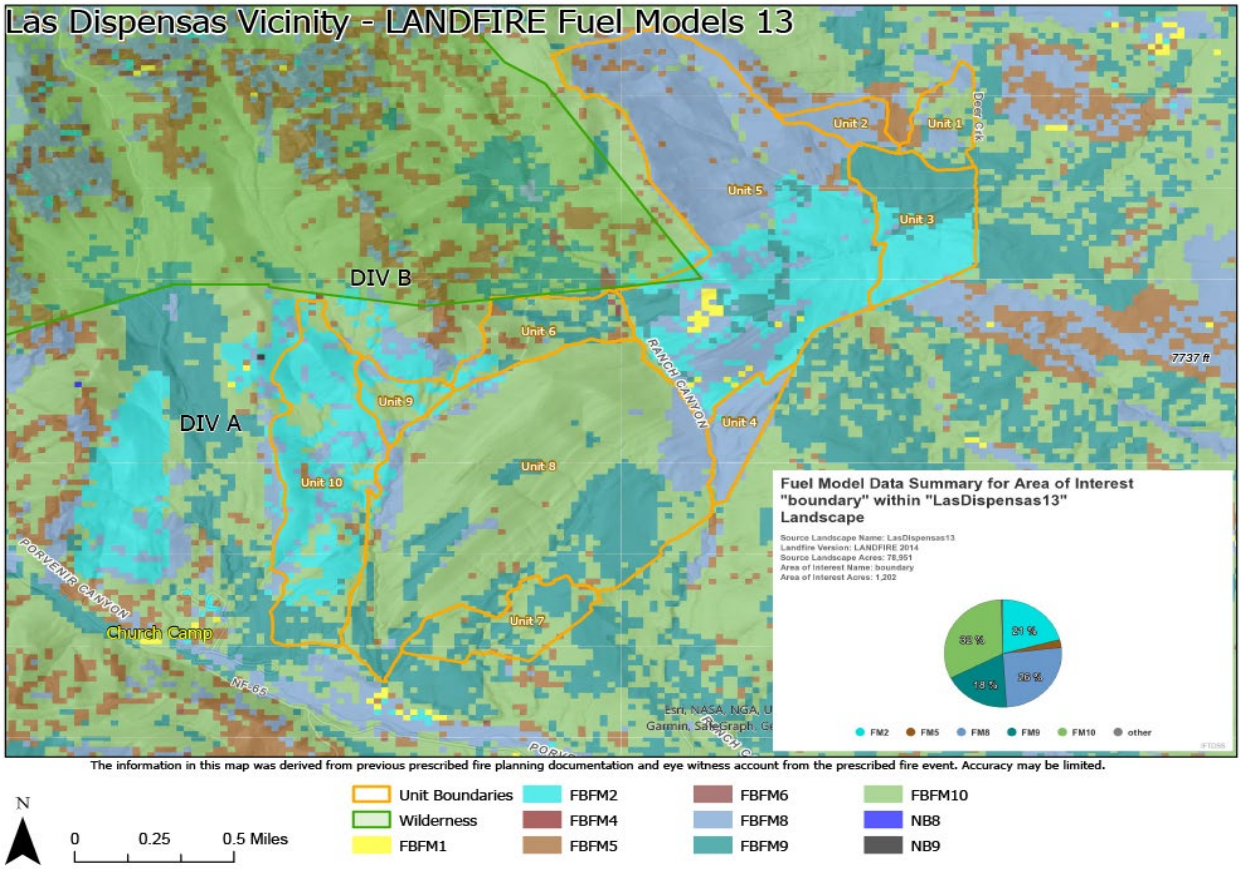


Figure 13: Spatial representation of fuels models (GTR 122) within the Las Dispensas Prescribed Fire area as represented from LANDFIRE 2014 version 1.4.0.

Complexity Analysis

A review of the Complexity Analysis (CA) process offers the following observations.

> The term "complexity" is generally used to characterize something with many parts where those parts interact with each other in multiple ways. In the context of the prescribed fire complexity analysis, complexity refers to the interconnectedness and dependence of the individual elements as they relate to the planning and implementation of the prescribed fire. July 2017, PMS-424

See Appendix I

Value Identification
The rating of Moderate Significance of the On-Site and Political and Public Values in the CA is likely an underestimate. The identified values in the CA represent some of the highest values that can exist, including numerous summer homes, watershed-supplying drinking water, historic and prehistoric heritage sites, Mexican Spotted Owl and Northern Goshawk habitat, range allotments, the adjacent Pecos Wilderness and small rural communities. Additionally, smoke impacts to nearby residences and rural communities were identified.

Pre-Plan Risk Assessment and Ratings, Agency Administrator Review
The fire behavior element did not consider the fuels outside the burn unit. Additionally, this section identifies "Fire behavior may present challenges that are easily mitigated" but does not describe the challenges or the mitigations to be taken. It also indicates "Probability of ignition outside the unit is low and any spotting is expected to be short-range" without any indication as to why. In fact, on the date the burn was conducted, the probability of ignition was 70 percent.

In the resistance to control element, the pre-plan assessment reports "...probability of ignition in fuels outside the unit is moderate to high," and it recognizes local drought and/or fire indices are expected to be high or extreme. These statements are in direct conflict with the fire behavior element.

In the management organization element, the pre-plan assessment significantly underestimates the suppression capacity that is necessary. Later, the modeling used to calculate suppression capacity amplifies the error.

In the constraints element, the pre-plan assessment correctly reports that: "Water resources will need to be brought in (port/fold-a-tanks) when necessary." In the project logistics element, the pre-plan assessment correctly identifies that "Extensive dedicated logistical support through most phases of the prescribed fire is required to safely meet project objectives." It appears that neither identified water resources nor extensive logistical support was addressed in the prescribed fire plan.

Prescribed Fire Plan Developed Addressing Mitigations Associated with Complexity Analysis Elements
The plan did not adequately address fuels outside planned burn area and CONTAIN was not used in calculating resource requirements. The Burn Plan did not limit the prescription to the low end, ensuring low or moderated fire behavior as called for in the pre-plan assessment. The plan did not include, nor did it mitigate for, the identified need for water as suggested by the constraints element. The plan also did not address the "extensive logistical support" identified.

Post-Plan Risk Management Assessment and Ratings
In the safety element of post-plan risk assessment, the risk was reduced from high to moderate in part due to inaccurate modeling. The model outcomes utilized in the approved prescribed fire plan required significantly less personnel than would have been required if the modeling was accurate.

The fire behavior element indicates that risk will be mitigated because: "The prescribed fire prescription dictates ignitions will be conducted under conditions in which low to moderate fire behavior can be expected. Use of slow ignition operations during black lining will decrease fire behavior." However, the plan includes weather parameters that include high-end fire behaviors.

Within the resistance to control element, mitigations that contribute to reducing the risk from high to moderate include "Control lines will be thoroughly prepped prior to the day of the burn to remove fuel concentrations and ladder fuels near critical holding points." While this did occur, this prep work concentrated fuels into jackpots that contributed to torching and spotting. Additionally, the mitigation reported as "Based on high-end fire behavior predicted using Behave, resources on-site can handle spot fires and slops from line production rates in the Wildland Fire Incident Management Field Guide" was

underestimated because CONTAIN was not used.

The constraints section in the pre-plan risk assessment suggests the need for water resources in the form of porta/fold-a tanks, but the plan and post-plan assessment has no mention of those resources.

The pre-plan assessment identified risks from project logistics to be high and the post-plan risk is rated as moderate, and yet there are no additional mitigation strategies listed that adjusted the risk ranking.

Post-Plan Technical Difficulty Assessment
Inadequate mitigation of risk identified in the initial assessment (high range), particularly in elements safety, resistance to control, constraints and project logistics. In the case of constraints, the valid concern in the pre-plan risk assessment that "Water resources will need to be brought in (port/fold-a-tanks) when necessary" was ignored during plan development and removed from the post-plan risk assessment.

Summary Post-plan Assessment of Risk and Planned Technical Difficulty Resulting in the Calculated Prescribed Fire Complexity Rating
Based on the information provided, this subjective assessment draws an acceptable conclusion. The problem is that several underestimations made in individual elements underestimate the actual risk.

Final Complexity Determination
The final rating for the complexity analysis under-represented the actual complexity. Errors in the preliminary rating and overestimating the effects of mitigating actions resulted in an inaccurate final rating. The complexity analysis provided the Agency Administrator with a picture that indicated risks had been reduced, when in fact that was not the case.

Key Implementation Analysis Observations and Learning Elements

Analysis of the Prescribed Fire Implementation for Consistency with the Prescription, Actions and Procedures in the Prescribed Fire Plan

The prescribed fire organization followed the prescribed fire plan. They believed they were within the approved prescription limits, and they had a plan to construct a check line and cease ignitions if the prescription parameters were exceeded. However, analysis of fuel and weather information shows that the prescribed fire was burning under much drier conditions than they understood. Persistent drought, limited snow and rain, fine fuel accumulation, and fuel loading from burn unit preparation all contributed to increasing the risk of escape. A mix of spot weather forecasts and on-site observations were the only methods of weather collection used. The Pecos RAWS, although available at the time of the prescribed fire, was not representative of the area. The calculated fuel moistures presented in the table below for the Pecos RAWS are considered irrelevant. Therefore, on-site sampled fuel moistures were used rather than the Pecos RAWS calculated fuel moistures.

Table 2: Weather and fuel moisture parameters and limited observations that display whether the prescribed fire was within prescription parameters.

Broadcast and Jackpot RX FM: 8,9,10,11	Jackpot/ Pile Low Fire Intensity	Jackpot/ Pile High Fire Intensity	Broad-cast Low Fire Intensity	Broad-cast High Fire Intensity	Spot Wx 4/6	Sampled On-site Obs (4/3)	During Burn On-site Obs	Pecos RAWS WIMS ID: 291202 (FM-G)
Temperature (F)	NA	65	30	80	54-58		56	58

Relative humidity (%)	NA	12	60	12	9-13*		10*	6*
Mid-flame wind speed (mph)	0	8	0	8			8	
20 ft wind speed (mph)	0	25	0	25	10-15 g25			12
1-hr fuel moisture (%)	NA	10	12	5		8	4*	2*
10-hr fuel moisture (%)	NA	12	13	6		11		3*
100-hr fuel moisture (%)	NA	15	14	7		16		8
1000-hr fuel moisture (%)	NA	10	NA	15		16		12.5*
Live herbaceous moisture (%)	NA	150	300	50				2*
Live woody moisture (%)	NA	100	150	75				60*
Slope	0	50	0	50				
Any	Any	Any	Any	Any				

** Exceeds Element 7 of the Prescribed Fire Plan.*

Analysis of Information Related to Fuel Conditions, Weather and Other Key Factors

Test Fire Location

The test fire is intended to be conducted in a location that is representative of the prescribed fire area (PMS 484). According to prescribed fire organization descriptions of the Las Dispensas Prescribed Fire implementation, the test fire was initiated in the northern portion of the unit on top of the ridge in a small saddle (Figure 11). This area was expressed to have relatively light fuels and was "scabby." It was referenced that it took time for the fire to "react" in the fuels when the test fire was lit. It was also noted that when heavy fuels were present under tree canopies, individual tree torching occurred. After the test fire was deemed successful, the ignition continued downslope and into heavier fuels that were associated with debris resulting from previously completed line preparation in 2021. Element 14 of the prescribed fire plan references that the test fire should be conducted in a location that is representative of the rest of the unit. Since the test fire was initiated in a location on the unit with lighter fuels, it was not representative. The test fire was ignited within the prescription parameters identified in the prescribed fire plan and the forecasted weather values predicted in the spot weather forecast.

Fuel Loadings

Although spatial interpolation of fuel models is not a requirement, the PMS 484 does list the following as a previous lesson learned: "Long-duration prescribed fire plans that did not take into consideration the potential changes in fuels and weather typically shifted from proactive to reactive management when fire activity increased." Fuel conditions are dynamic and can change as a result of many natural and land

management factors on an annual or even an interannual basis. In 2008, mechanical thinning was implemented in Unit 10 and other units within the Las Dispensas Prescribed Fire area that resulted in a transition to a higher percentage of fuel model 2 within a 6-year period as represented from LANDFIRE 2014 1.4.0 data derived in IFTDSS (Figure 14). This fuel model component was not represented or modeled in the prescribed fire plan (Element 7) that was authored in 2019. Fuel model 2 is considered a grass fuel model within GTR 122 (Aids to determining fuel models for estimating fire behavior). Fuel model 2 will result in substantially higher flame lengths and faster rates of spread than the original fuel models included in the analysis phase of the prescribed fire plan preparation. (See Appendices E and F.) Furthermore, the spatial arrangement of fuel models can help in the development of holding and contingency plans if adequately modeled/considered.

Foliar Fuel Moisture

Foliar, live herbaceous, live woody fuel moisture plays a key role in fire behavior. Foliar moisture plays a unique role in the ignition of crown fire (Van Wagner 1977, Scott and Reinhardt 2001). Although the potential impacts in changes to foliar moisture can be modeled by both spatial and nonspatial fire behavior models, accurate and consistent sampling, measuring and monitoring continues to be difficult (PMS 437, Haase et al 2016, FS 2011, Pollet and Brown 2007). In addition, it is equally difficult to model crown fire initiation effectively (Alexander and Cruz 2013). Fuels and foliar moisture samples that were taken onsite at the Las Dispensas Prescribed Fire area showed a substantial downward trend from the March 16 to April 3 samples. Among the 4 species with foliar moistures sampled (Douglas fir, ponderosa pine, white fir, white pine), there was an average of 19% moisture reduction to 94%. The average generally accepted value to model crown fire initiation is 100% if no other data exists (Scott and Reinhardt 2001). Monitoring dead and live fuel moistures was acknowledged and conducted per Elements 9 and 20 of the prescribed fire plan, but the significance of monitoring the live fuel moistures, especially the conifer foliar fuel moistures could have led to greater situational awareness.

Table 3: Samples taken by Pecos District personnel on-site at the Las Dispensas Prescribed Fire area.

Fuel	16-Mar	3-Apr	Trend
10 HR	12	11	-1
100 HR	12	16	4
1000 HR	17	16	-1
Oak	54	55	1
Douglas fir	116	91	-25*
Ponderosa pine	104	88	-16*
White fir	118	101	-17*
White pine	115	97	-18*

**Exceeds Element 7 of the Prescribed Fire Plan.*

This data provides a better understanding of the events that occurred during the Las Dispensas Prescribed Fire escape when associating the potential for longer flame lengths that resulted from Unit 10 having a high proportion of fuel model 2 (resulting from open forest canopy post mechanical treatment), potentially fuel model 12 (resulting from contracted fireline prep thinning and fireline creation), and low foliar moisture percentages in the overstory tree canopies (resulting from prolonged drought and less than average over winter precipitation). Higher flame lengths would have introduced more radiant and convective heat, leading

to high fire intensity than what was modeled/expected. Low fuel/foliar moisture creates less of a heat sink, or resistance in the combustion process. This can increase the potential fire initiation to the crowns. Descriptions provided by individuals involved during the firing operation reported higher fire intensity in areas of heavy fuel concentrations. Tree canopies above these heavy fuel concentrations torched readily and sustained single to group tree torching longer than anticipated. Shortly after this event, multiple spot fires occurred over the line and presented a high resistance to control as holding resources engaged.

Fire Danger

Monitoring trends in Fire Danger indices is an effective component toward assessing and predicting fire potential and fire season trends (see Figure 14), especially when compared with historical trends and extremes (PMS 932). For example, the Energy Release Component (ERC) directly relates to the amount of potential energy in flaming front from the head fire.

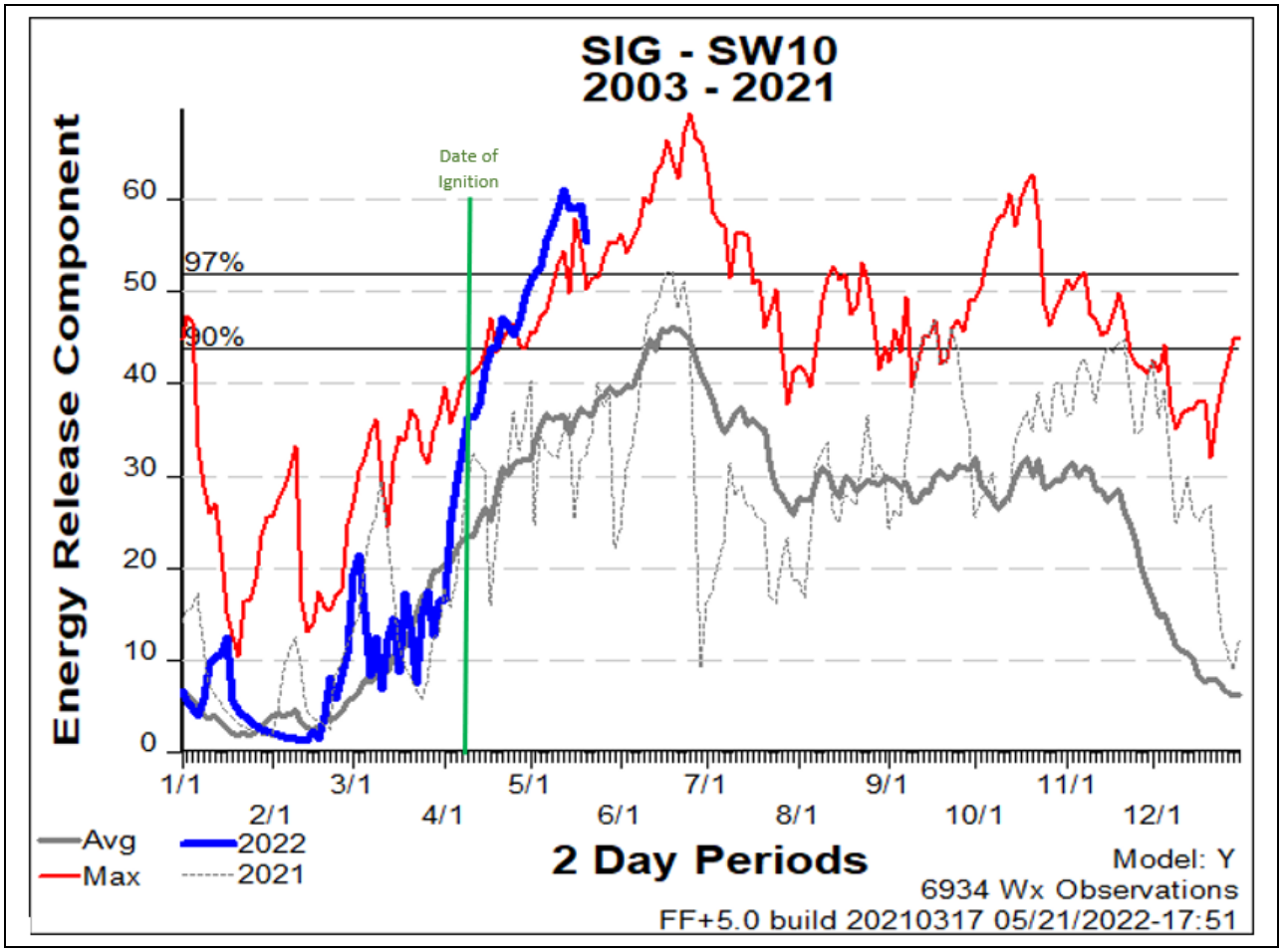


Figure 14: Energy Release Component.

Although the National Fire Danger Rating System (NFDRS) is undergoing a transition to a new version (NWCG Memo 19-002), the Santa Fe National Forest does have an older signed National Fire Danger Rating System (NFDRS) plan from 2015 and associated pocket cards to provide reference (FSM 5120) from 2019.

ERC is listed in Element 9 of the prescribed fire plan, but no reference frame is provided to indicate if values are considered to be a concern or out of prescription. In addition, while ERC provides a strong correlation to fire season trends, it does not capture the impact of wind in the fire environment. Burning Index (BI) is often used to capture the influence of wind to Fire Danger and fire potential (Appendix E). More importantly, the

combination of ERC and BI values creates the Severe Fire Danger Index (SFDI) (Appendix E). The SFDI incorporates (National Gridded Forecast Database forecasts from the National Weather Service for a seven-day period and predicts a statistically significant forecast of days with high Fire Danger (Jolly 2019). Each of these indices can be presented in a text product using individual RAWS or as a gridded product (WFAS). Issues with the RAWS stations have been referenced (see weather analysis section below), however, the gridded products could have provided information to better inform fire potential on the day of the prescribed fire.

Weather

Numerous details regarding situational awareness of weather in the fire environment were overlooked or misrepresented, including remote automated weather station (RAWS) availability and representativeness, handheld electronic weather observations, and documentation.

Neither Bartley RAWS nor Pecos RAWS were used to help prepare for nor observe weather conditions for the Las Dispensas Prescribed Fire (FSM 5140). Bartley RAWS, which was more representative of the fuels, aspect and climatology of the prescribed fire area, did not meet NWCG Standards because it had not been maintained. Furthermore, it was unavailable prior to and during the prescribed fire and therefore could not be used to determine seasonal trends for fire potential. The Pecos RAWS was not considered representative of the prescribed fire area because it is separated by a major terrain feature locally referred to as "The Skyline" that creates different microclimate and fuels conditions. It was also offline with missing data for several weeks from January through mid-February 2022 and therefore could not be used to determine seasonal trends for fire potential. Pecos RAWS does not currently have a fuels stick. While this is not a requirement for the RAWS to meet NFDRS standards, it does provide more accurate readings of fuel moistures. The best source for weather and Fire Danger trends was determined to be a combination of Truchas (WIMS 290210) and Pecos (WIMS 291202) RAWS, which collectively make up SW10 Special Interest Group (SIG) in the Weather Interactive Management System (WIMS).

Spot weather forecasts from the National Weather Service Albuquerque office were obtained prior to ignition day beginning on April 3, consistent with requirements listed in the prescribed fire plan elements 9, 14 and 20—except for some typographical errors in the requests that were made to the National Weather Service. For example, the dates of the observations were in error, as was the size of the prescribed fire. Instead of approximately 150 acres for Unit 10 intended for the prescribed fire, 1,204 acres—which represents the entire project—was listed. These spot weather forecasts predicted minimum relative humidity dipping as low as the single digits, which is below the minimum value in Element 7. Management Action Point (MAP) 1 in Element 17 (contingency plan) specifies that if RH values fall close to 12% or winds near 8 mph are sustained for 20 minutes, that weather observations will be taken every half hour. There is no documentation that the frequency of weather observations increased after the MAP thresholds were met.

The 20-foot winds predicted by the NWS Spot Weather Forecast were to be from a westerly direction with ridgetop winds from the northwest. The success of meeting the prescribed fire objectives was dependent on this wind direction because the intent was to lead fire away from the wilderness and private property boundaries toward the interior of Unit 10. The general area near the Las Dispensas Prescribed Fire area exhibits highly variable terrain and topographical features as it lies within the headwaters of the Rio Grande River where multiple drainages converge. Collective experience from in-person discussions with personnel in the prescribed fire organization suggest that forecast predictions from the National Weather Service are seldom representative of what is observed at the site because of the terrain influences overriding the numerical weather predictions.

Consistent and accurate relative humidity readings and trends could have led to better situational awareness of the actual warming and drying trends within the context of the prescription and increasing fire behavior that was observed leading up to the wildfire declaration.

Weather observations were initially taken at the test fire location using an electronic Kestrel instrument. After the test fire, the lookout continued to take weather observations with the Kestrel from Chuparosa Ridge, which is directly south of the campground at an elevation of 8,000 feet. (The lookout's location was near the ridgetop just over on the north aspect.) According to the lookout's unit log and WildCAD dispatch log, during most of the prescribed fire, weather parameters appeared to be within prescription with a notable exception at 1600 hours when the relative humidity dipped to 10% and Fine Dead Fuel Moisture (FDFM) also dropped.

Regarding temperature (dry bulb and wet bulb) and relative humidity, the observations recorded by the lookout showed a cooler and more moist bias when compared with other observations of weather and fire behavior on the site. Specifically, relative humidity readings taken from the Kestrel differed from what the relative humidity values should have been if calculated using the NWCG standard tables for that elevation and the dry bulb and wet bulb observations. The relative humidity values recorded from the Kestrel provided values that are nearly 10 percent higher than those calculated. Fire behavior and weather observations from the Alpha Firing Boss were more similar to the relative humidity values calculated from dry and wet bulb temperature observations than those documented on the unit log.

Table 4: Weather Observations from the Lookout along with recalculated values.

Time	Dry Bulb	Wet Bulb	Original RH%	Recalculated RH%	Wind speed (avg)	Wind speed (max)	Wind direc-tion	Cloud Cover	Comments and Probability of Ignition
1100	50	37	30	30	3-8	-	SW	0	PIG 40% Shaded 40% Unshaded
1200	55	39	25	24	3-6	10	S-SW	0	PIG 50% Shaded 50% Unshaded
1300	57	37	22	**11**	2-6	-	E-SE	0	PIG 60% Shaded 60% Unshaded
1400	51	36	23	23	2-7	10	E-SE	0	PIG 60% Shaded 60% Unshaded
1500	56	37	18	13	3-7	15	E-SE	0	PIG 70% Shaded 70% Unshaded
1600	56	35	**10**	**6**	4-8	15	W-SW	0	PIG 70% Shaded

									70% Unshaded
1700	51	34	12	14	3-7	15	N-NW	0	PIG 70% Shaded 70% Unshaded
1800	51	33	12	**10**	3-8	-	SW	-	PIG 50%
1900	47	31	15	12	Light & Variable	-	Erratic	-	

Recalculation was done using Dry and Wet Bulb observations and NWCG charts
Elevation: 8,000 Aspect: North Fuel Type: Timber/Grass
Values in Red indicate they are outside prescribed parameters

In the prescribed fire plan, Element 20 "Monitoring, B" states that observations on site will include dewpoint. Since no dewpoints were included, it is not possible to determine the source of these errors.

Findings/Lessons Learned

Weather

Findings

- Remote Automated Weather Stations (RAWS) were unavailable to support seasonal pre-planning and implementation (FSM 5140/element 9).
    - Both nearby stations were offline for periods in 2022. The Pecos RAWS that was online for the day of the prescribed fire was not representative for the Las Dispensas project area.
- Spot weather forecasts predicted a range of minimum relative humidity values that included values below the prescribed fire minimum of 12% in element 7 of the prescribed fire plan.
- Observed relative humidity values fell below the prescribed minimum of 12% determined in element 7 of the prescribed fire plan for at least an hour. Significantly, the relative humidity dropped well below the forecasted range of 9-13%, reaching 6%. Therefore, the magnitude of the increase in fire behavior in response to the weather was much greater than what would be expected had it remained within the 9-13% range.
- Management Action Point (element 17), requiring weather observations to be increased from hourly to half-hourly frequency when conditions were observed, was not initiated.
    - Weather observations were taken at hourly intervals despite the relative humidity dropping below the 12% threshold that was identified in the management action point (element 17) for taking more frequent half-hourly weather observations.
- Discrepancies in weather observations taken on site could have limited or reduced situational awareness.
    - Observations were disparate regarding temperature (dry bulb and wet bulb) and relative humidity. Observations showed a cooler and more moist bias when compared with other observations of weather and fire behavior on the site. The relative humidity values recorded from the Kestrel provided values that are nearly 10 percent higher than those calculated.
- Variable wind directions that were caused by complex terrain on the prescribed fire unit should have been considered and anticipated based on local expertise. Instead, there was an over-reliance on predicted winds from the National Weather Service (NWS) forecasts.

- There was no Red Flag Warning in effect for the prescribed fire area or the fire weather zone on April 6, 2022.
    - A National Weather Service Red Flag Warning was not headlined for Forecast Zone 103 in the Fire Weather Forecast (FWF) or the Spot Weather Forecast (FWS) products. However, there were Red Flag Warnings in effect for other fire weather zones on the day of the prescribed fire due to the combination of relative humidity and wind. That said, the forecast parameters for wind and relative humidity in the FWF Zone 103 could have met Red Flag criteria for part of Zone 103 according to the Southwest Fire Weather Annual Operating Plan. But the majority of the zone was not expected to experience those conditions.
    - *Refer to NWSI 10-401 to differentiate the intended uses and differences in the various National Weather Service products including Red Flag Warning (RFW), Fire Weather Forecast (FWF) and Spot Weather Forecast (SWS). There is not a recommendation for improvement in this case, just a reminder that the FWF for a large zone may not provide much detail for a prescribed fire and is not expected to. Furthermore, the FWF wind forecast takes a high-end from a range of values and may not represent the prescribed fire area, especially in complex terrain.*

Lessons Learned

- Awareness of wind adjustment factors in complex terrain, a broad training emphasis in the NWCG "S-Series" and "RX-B-Series" as well as annual fire refreshers may help practitioners with data gathering and communication.
- Accurate weather observation is an input into methods that help us understand the fire environment. Ensure weather observation devices follow calibration standards and are performed by trained individuals. Ensure that weather collection is included in annual fire refreshers (RT-130) and includes both observations from the belt weather kit and electronic devices (RAWS, Kestrel).

Fuels and Fire Behavior

Findings

- Assigned personnel did not recognize and mitigate a high potential for escape.
    - Personnel did not cease ignitions or suppress the prescribed fire after clear indications of high fire intensity and receptive fuels.
- Fine and heavy fuel loading increased after the prescribed fire plan was developed, resulting from a combination of canopy opening from thinning (fine fuels) and fireline preparation (heavy fuels). This contributed to high fire intensity, torching, prolific spotting and resistance to control.
    - Fuel models were not adequately represented in the prescribed fire plan (elements 4 and 7) or the spot weather forecast requests.
- The foliar fuel moistures were low and contributed to the transition from surface to crown fire.
    - Fuel moisture samples taken from March 16 to April 3 showed a significant downward trend that contributed to the transition from surface to crown fire and increased spotting potential. Foliar moistures were listed to be sampled in the prescribed fire plan (Element 9), but they were not part of the prescription (Element 7).
- Fuel models may not have been adequately represented in the development of the prescribed fire plan (fuel models 8, 9, 10 and 11).
    - According to spatial fuel models from the LANDFIRE system, the primary fuel models represented in the Las Dispensas prescribed fire area are fuel model 2, 5, 8, 9 and 10. Unit 10 and the surrounding area is comprised of all 8 fuel models present in the larger planning area; however, a larger proportion of Unit 10 was covered by fuel model 2.

    - Fuel model 12 would have been a more representative fuel model for the heavy fuels that resulted from contracted fireline preparation work.
    - Furthermore, there are additional standard fuel models (GTR 153) featuring fuel models that can dynamically adjust fuel loading based on fuel moisture. They also offer a wider range of fuel model selections than the original 13 fuel models used in the preplanning efforts.
- There was an underestimation of fire potential leading up to the prescribed fire.
    - Energy Release Component (ERC) is mentioned in the prescribed fire plan (Element 9) as an element of the National Fire Danger Rating System (NFDRS) that should be monitored, but was not clearly used in preplanning or implementation of the prescribed fire.
- Suppression resources (holding and contingency) were not calculated adequately (element 11 and 16).
    - In preparing the prescription, the CONTAIN module of BehavePlus was referenced in the complexity analysis but not utilized in developing the prescribed fire plan.
    - Recalculations of the original BehavePlus runs, including fuel models 2 and 12, result in longer flame lengths and higher rates of spread than the original fuel models used. This information is key when trying to determine the maximum potential fire behavior and resistance to control under low- and high-fire intensity prescriptions.
- No spatial analysis of fire behavior seems to have been used.
    - EA analysis of effects relied heavily on Forest Vegetation Simulator, Fuels and Fire Extension, and other timber and silvicultural tools.
    - Although not required by policy, utilizing existing spatial modeling tools such as the Interagency Fuel Treatment Decision Support System (IFTDSS), the Wildland Fire Decision Support System (WFDSS) or the Fire Behavior Mapping and Analysis Program (FlamMap) would have helped more accurately capture the spatial complexities of the fire environment (see Appendices G and H).
- There was no indication of Extreme Fire Danger in San Miguel County or adjacent counties consistent with the Prescribed Fire Approval Act of 2016.
    - San Miguel County (Las Dispensas Prescribed Fire area) is bordered by 6 other counties in New Mexico (Mora, Harding, Quay, Guadalupe, Torrance and Santa Fe). When reviewing ERC as an indicator of Fire Danger, all available RAWS stations showed values near or below the 90th percentile. These values are below thresholds for an Extreme Adjective Rating as defined by PMS-932. Quay and Guadalupe counties do not have a RAWS station within the county. Therefore, the Fire Danger Adjective Rating would have to be inferred by adjacent counties with RAWS stations.

Lessons Learned

- A clear recognition and acknowledgment of long-term drought and climate factors versus short-term weather events would have led toward better situational awareness of the fire environment and could have led to more favorable outcomes.
- The test fire was initiated in an area of the unit that was not representative of the rest of the unit (Element 14).
    - On several occasions, both before the burn was ignited and after test fire was considered and accepted, some personnel felt that the dry conditions would result in difficult burning conditions and an increase in risk, but they accepted the assignment.
- Additional anecdotal information shared from prescribed fire organization personnel, as well as the prescribed fire unit prep task order, suggests that fuel model 12 would have better captured the resulting debris from hand line prep (Appendix F) than the original fuel model 11 used.
    - The task order stated that all debris associated with hand line prep will be moved interior a minimum of 66 feet, lopped and scattered no greater than 2 feet in depth.

- To ensure prescription validity, reassess fuel models annually or after environmental changes, such as changes in fuel loadings resulting from prescribed fire unit preparation or changes in fine fuel resulting from seasonal weather events or previous treatments.
- Planning did not properly recognize challenges posed by the tree density, fuel loading and continuity outside the prescribed fire area.
    - There were few natural or human-made barriers outside the project area.
    - The lack of previous fire history (Appendix J) had resulted in continuous fuel concentrations, creating high suppression difficulties and limiting control opportunities in the event of a wildfire declaration (Appendix H and K).

Communications

Finding

- The intra-crew Net (radio frequency) used by the Interagency Hotshot Crew (IHC).
    - Some of the personnel on the prescribed fire were using an intra-crew frequency and were unreachable by radio on several occasions. This may have created additional complexities with communication on the prescribed fire.

Other

Findings

- The pre-burn briefing was not adequately documented.
    - Not all personnel were documented on or signed the pre-burn briefing checklist, making it difficult to determine who was present on the burn. The checklist of items to be covered during the briefing had not been checked off, making it impossible to determine if these items had been addressed.
- Administrative boundaries limited the selection number of potential control lines.
    - Prescribed fire unit designation followed boundary lines from private property and other land designations, such as wilderness, and not necessarily advantageous fuels changes or topography.
- District fire employees perceived pressure to "accomplish the mission," which may have led to taking greater risk.

Lessons Learned

- Although the Las Dispensas Prescribed Fire area was not within Threatened, Endangered, and Sensitive (TES) species management areas, the delineation eliminated other potential prescribed fire areas for specific periods in the year that offer more favorable conditions that are representative of natural fire on the landscape.
    - Mexican Spotted Owl (TES) breeding season (Mar 1-Sept 30) has reduced the opportunities for "in-season" prescribed fire. This has led to further emphasis in utilizing "shoulder" seasons within critical habitat areas. Increased emphasis on prescribed fire implementation has also led to the need to accomplish burning in "shoulder" seasons. However, "shoulder" seasons offer fewer days and potentially less favorable conditions for prescribed fire implementation, as well as less availability of personnel and equipment for implementation.

Wildfire Declaration

Finding

- The Burn Boss did not hesitate to recommend transition to wildfire and followed Element 18 of the prescribed fire plan.

Qualifications

Findings

- The Agency Administrator was qualified to sign and approve Type 2 complexity prescribed fire plans (PFP) and Agency Administrator Ignition Authorization (element 2A) of the PFP.
- The Burn Boss and supporting fireline personnel assigned to the Las Dispensas Prescribed Fire were fully qualified to perform their duties as assigned. In some cases their qualifications exceeded the requirements (refer to Appendix L).

- Dispatch record (WildCAD) shows the Prescribed Fire Burn Boss Type 2 (RXB2) performed as a fully qualified RXB2 at least 12 times since 2015.

Prescribed Fire Plan

Finding

- All elements were consistent with agency policy and guidance outlined in the Interagency Prescribed Fire Planning and Implementation Procedures Guide (PMS 484) and the Prescribed Fire Complexity Rating System (PMS 424).
    - The April 1, 2018 letter of delegation from the Forest Supervisor was reviewed and found to be current. The Agency Administrator was briefed on the prescribed fire plan and complexity analysis before ignitions occurred and allowed the opportunity to provide feedback into the process.
    - A technical review was completed by a qualified Burn Boss Type 2. The technical reviewer commended a few elements of the prescribed fire plan, did not request any changes to it, and recommended the plan for approval on December 18, 2019.

Recommendations

The following recommendations are offered in the spirit of improving our performance in the use of prescribed fire, reducing the exposure to our firefighters and the public, more effectively evaluating the risk to communities and natural resources, and striving to achieve the vision in the National Cohesive Wildland Fire Management Strategy *"*to safely and effectively extinguish fire when needed; use fire where allowable; manage our natural resources; and as a nation, to live with wildland fire."

We need to truly learn from past prescribed fire escapes as seen through the lens of high reliability. We should not be overconfident in the prescribed burn plans we develop. We should test, confirm, and update the assumptions and information in them based on real-time, on-the-ground information. We must be "Preoccupied with Failure" such that we can identify when fuels models are not accurate or have changed in our plans, as well as implementation where test fires are not conducted in representative fuels in the burn unit. We must maintain "Sensitivity to Operations" where subtle signals indicate that prior experience or planning does not match on-the-ground conditions any longer, such as changes in fuel models/arrangements or fuel moistures, and in significant fire behavior parameters due to predicted relative humidity or long-term drought (Dether and Black; Vol. 66; No 4; Fall 2006).

(F) denotes a recommendation that is tied to a finding from this review.

Weather

- Ensure weather observing equipment and data collection is included in annual fire refreshers (RT-130) and includes both observations from the belt weather kit and electronic devices such as Remote Automated Weather Stations (RAWS) and Kestrel hand-held devices. Ensure RAWS stations are maintained in accordance with NWCG standards.
- To help inform planning and implementation considerations, make a portable RAWS station available on every district/unit to measure local weather trends within the proposed prescription implementation area where a fixed RAWS station may not be available or representative of conditions in the prescribed fire area. (F)

Fuels and Fire Behavior

- When including foliar moisture measurements for planning and implementation, include frame of reference and ensure sampling follows standardized protocols. Ensure moisture reading device is calibrated appropriately. (F)
    - Forest Service Sampling Protocols
    - Fire Behavior Field Reference Guide
- To further incorporate understanding of the fire environment, use Fire Danger Indices (NFDRS) for planning and implementation. This provides consistency in fire environment indicators as a function of fire behavior potential that is consistent with the Fire Danger Operating Plan. Include NFDRS in earlier NWCG training opportunities (S-191, S291, S391). (F)
    - Wildland Fire Assessment System
    - Fire Environment Mapping System (under development)
- When utilizing a measured variable of the fire environment (i.e., canopy foliar moisture) in the prescribed fire plan, ensure that variable is included in Element 7 to more accurately identify the prescription window. (F)
- To better account for complexities between the landscape, fuel matrix and associated fire behavior, make spatial fire behavior modeling (i.e., IFTDSS, FLAMMAP, etc.) required for the development of the prescribed fire plan. Include spatial fire behavior training in NWCG courses (RX 301/341). (F)
- To further expand the understanding of the fire environment, firefighter risk, and the potential for escape, consider utilizing other spatial analysis tools in combination with spatial fire behavior analysis in the development of the complexity analysis, prescription, holding plan, ignition plan. contingency plans. etc. Examples of spatial analysis tools include:
    - Spatial values inventories found in WFDSS (Wildland Fire Decision Support System)
    - Estimated ground evacuation time found in WFDSS (Wildland Fire Decision Support System)
    - Suppression Difficulty Index (SDI) found in RMA (Risk Management Assistance Products)
    - Potential Control Locations (PCL) found in RMA (Risk Management Assistance Products (Appendix H)
    - Potential Operational Delineations (PODs) found in RMA (Risk Management Assistance Products)
    - Snag hazard found in RMA (Risk Management Assistance Products)

Fire Culture

- Continue to support a learning culture to ensure open and effective communications between personnel.
    - Strengthen and empower employee feedback avenues.
    - Burn Bosses should continue to use After Action Reviews (AAR) to ensure that employees have input.
    - Burn Bosses, Duty Officers and Line Officers have a face-to-face conversation to understand perspective and risk and to validate strategy.
    - The Burn Boss is responsible for informing employees of the strategy and tactics to implement a prescribed fire and, if necessary, changes to the original plan (Gallinas Prescribed Fire FLA, 2018).

Communications

- When using inter-crew radio frequencies, added attention must be made to ensure that pertinent communications are relayed and received on assigned tactical frequencies. (F)

Project/Plan Design

- Explore Wyden Amendment options with adjacent private landowners when holding features increase the margin of success during prescribed fire implementation. (F)
- Consult the fire planner or equivalent when planning projects to determine logical boundaries, regardless of land ownership status (i.e., wilderness or private). (F)
- Utilize FBANS and/or LTANS in the design phase of prescribed fire projects.
    - Implementation plans need to include strategically locating units to set each consecutive unit up for success. (F)
    - Consider treatment areas that are adjacent to recently burned areas to reduce the risk of escape.
- Amend FSM 5140 to better define what it means to "review" the prescribed fire plan annually, i.e., all components including complexity analysis, fuels (to include a site visit) or just the plan. Ensure that expectations of fire behavior are predicated on conditions existing at the time of ignition and for the duration of the burn, not just at the time the prescribed fire plan was developed (Dether and Black; Vol. 66; No 4; Fall 2006).

Prescribed Fire Implementation Process

- Consider requiring overhead, such as Firing Boss, Holding Boss and other staffed positions, to document support of the agreement with the Test Fire and/or Go/No-Go decision. Ensure that multiple perspectives are obtained during prescribed fire plan development and then followed through, seeking multiple perspectives at implementation (Dether and Black; Vol. 66; No 4; Fall 2006).
- Ensure all personnel are legibly documented in attendance on the prescribed fire plan or Incident Accident Plan (IAP) during the pre-operation safety briefing or as they arrive during implementation. (F)

Programmatic Recommendations

Qualifications and Training

- Invest in education opportunities for continued learning in science and technology specific to fire behavior and fire environment. Consider workshops tailored for prescribed fire practitioners that address today's challenges related to environmental and social conditions. Also consider developing Regional or multi-Regional prescribed fire burn boss workshops that would meet the biannual RT-300 requirements while allowing practitioners to attend sessions that would teach current advancements in available science-based tools. A program like this is already established in Forest Service Region 8 (see Figure 2).
- Develop and encourage a network of interagency and partner mentoring and coaching programs for prescribed fire practitioners.
- Better integrate into prescribed fire training the full scope of prescribed fire planning from Forest Plans and NEPA, such as prescribed fire plans, Incident Action Plans (IAPs), and day-of prescribed fire plan.

Project/Plan Design

- Strengthen connection between predictive services and fire managers and expand risk-sharing where state fire agencies and communities are more involved in planning, operations, monitoring and communications.

Prescribed Fire Implementation Process

- Establish Regional- and Forest-level burn day authorization processes for providing oversight and risk-sharing with field units regarding Go/No-go ignition authorization on burn days that are forecast to meet or exceed predetermined fuels and fire environmental thresholds. These thresholds should be identified through analysis of common denominators of escaped prescribed burns in Region 3. On threshold exceedance days, the field unit would be responsible for requesting ignition authorization from the Regional Forester or Forest Supervisor or designee using a process that provides supporting rationale and documentation on how increased resistance to containment issues will be mitigated. Considerations of potential escaped fire parameters need to include the potential for long-duration smoldering fire.

Capacity Building

- There must be an all-hands, all-lands approach (National Cohesive Wildland Fire Management Strategy) to support an interorganizational workforce specialized to help analyze, assess, plan and implement prescribed fire across all lands.
- Prescribed fire programs and projects should invest in staffing, training, planning and other supporting resources commensurate with the priority and complexity of prescribed fire projects.
    - Consider Incident Management Teams when implementing complex prescribed fire projects.
    - Increase support for existing Burn Bosses by activating Planning Section functions when complexity warrants the additional capacity.
        - Increase access to fire weather and fuels environment monitoring and analysis.
        - Use LTANs, FBANs, SOPLs, IMETs, FEMOs and ICs.
    - Support prescribed fire programs and projects by having contingency resources, such as helicopters and water source contracts, available and in place during periods of prescribed fire activity.
    - Include non-agency community liaisons, partnership coordinators and community engagement specialists.
- Re-envision how we cooperatively conduct prescribed fires with partners, how we make available real and reasonable opportunities to accept different qualification systems and credentials, and how we share resources through more streamlined mechanisms, agreements and funding sources.
- Acknowledge and respect the vast prescribed fire experience and expertise outside the federal firefighting workforce. Integrate tribes, communities, non-governmental organizations and other skilled and appropriate members and organizations within the prescribed fire workforce.
- Establish a cross-organizational workforce development pipeline for Burn Bosses from across jurisdictional boundaries. Establish mechanisms to ensure they have the full support of Agency Administrators and the protection of the federal government should they conduct their duties in accordance with policy. They should come from not just the federal agencies, but from all facets of fire management.
- Develop national, regional, and local partnerships and agreements that can support and supplement the existing prescribed fire workforce.
- Recruit and hire personnel whose sole responsibility will be to plan and conduct prescribed fire. They should not be part of our suppression workforce but will instead ensure that we have the capacity to safely conduct prescribed fires when needed across the country. They should be full-time employees eligible for hazard and overtime pay.

Organizational Learning

- Ensure that recommendations and lessons learned from Facilitated Learning Analysis and other reviews are shared and emphasized with practitioners, Agency Administrators and others involved in the planning and implementation of future prescribed fires.
- Establish an interagency training facility, such as the National Interagency Prescribed Fire Training Center, that would be located in the Western U.S. and focus on the additional complexities involved with western fuel treatments.
- Leverage Predictive Services and the Joint Fire Science exchange network to foster learning through technology transfer from research to operations. This will lead to more informed decision support and fire management on the ground.
- Learn from indigenous communities about cultural land management practices.

Conclusions

The Las Dispensas Prescribed Fire is representative of the complexities of contemporary prescribed fire in the North American Southwest, and more broadly across the United States and the world.

Overall, the planning and analysis for this project were done according to current standards and policy. The implementation of the prescribed fire conformed to the approved prescribed fire plan, but the combination of changes in fuel conditions, underestimated potential fire behavior outside the burn unit, and conducting the prescribed fire on the warmer and drier end of the prescription, led to an increased probability of an escaped prescribed fire, if the burn spread beyond the unit boundary. The following main findings could have led to a different outcome:

- Ensure that Remote Automated Weather Stations (RAWs) are properly maintained and operational, in order to monitor trends in Fire Danger indices.
- More accurate real-time weather observations could have improved situational awareness.
- Recognition of increased fine fuel loadings from canopy-opening thinning (fine fuels) and 2021 monsoons and from fireline preparation (heavy fuels) contributed to higher fire intensities, torching, spotting, and higher resistance-to-control.
- Low foliar fuel moistures facilitated the transition from surface fire to torching and spotting outside the unit boundaries. Needed context to highlight fuel moisture level concerns.
- Underestimated fire potential leading up to the prescribed fire. ERC (Energy Release Component) was mentioned in Element 9 of the prescribed fire plan to be monitored, but needed context to describe how this NFDRS element would be used.
- Underestimation of minimum holding and contingency resources.
- Last year's monsoonal moisture (2021), and late season (winter/spring 2022) snowpack and moisture, did little to ameliorate the magnitude and spatial extent of the ongoing drought.

These findings, in combination, became focused in a small portion of Las Dispensas Unit #10. The "dogleg" in the north portion of the prescribed burn unit concentrated activity fuels from the fireline preparation because of the proximity of the unit boundaries. When overstory trees began to torch later in the afternoon due to heavy surface fuel loadings, low foliar fuel moistures, and low relative humidity, embers from the torching trees did not have far to travel to establish spot fires outside unit boundaries. Recent precipitation and cooler temperatures masked the ongoing and persistent drought impacts which exascerbated fire potential and increased exposure to risk of an escaped prescribed fire. In a matter of five hours, unexpected fire behavior and intensity caused the Las Dispensas Prescribed Fire in Unit #10 to establish outside of the unit boundaries requiring a wildfire declaration.

All personnel involved in this prescribed fire project want to see this review lead to process improvements that will prevent similar events from occurring in the future. There are many lessons we can learn from the series of events that led to this outcome.

To maintain and restore existing fire-dependent ecosystems (Prichard et al. 2021), prescribed fires are conducted in areas that often lack recent fire history and have large concentrations of vegetation, and dead and downed fuel. Prescribed fires are being conducted during a period of climate change, which affects the local weather patterns we are used to and increases the frequency of extreme weather events.

Competing obligations limit the ability of the workforce to prioritize and focus on prescribed fire projects. The increased complexity of prescribed fire projects and programs is created by a collection of constraints, expectations and opportunities (Shultz et al. 2019). These constraints, which come from numerous sources—including policy and procedures, past and current land management practices, community and organizational expectations, and workforce limitations—create an environment in which achieving success is increasingly challenging.

The factors that make the process of planning and implementing prescribed fire more complex are not exclusive to the U.S. Forest Service. Prescribed fire practitioners nationwide are subject to many of the same constraints.

Every day we place our fire teams, including our firefighters, burn teams, burn organizations and other personnel, under difficult circumstances and enormous pressure. We ask them to make up ground on long-needed and far-behind proactive restoration work while barely allowing time to recover from a previously taxing wildland fire response and preparing to respond yet again. We ask them to restore fire process to ecosystems that have evolved to burn, but many of which are now primed for extreme fire behavior due to our own decisions to exclude or suppress fire in these areas.

Restoring fire to these systems is the only path to living better with fire, to persisting on a planet that will only see more fire. U.S. Forest Service Chief Moore stated: "*We must do more prescribed burning to improve the health and resilience of our forests and grasslands. That work is vital to reducing the potential for catastrophic wildfires that are devastating to people, infrastructure and landscape health. Simultaneously, we must minimize impacts to communities and businesses when we do that work, as well as ensure our employees and partners have the best support and tools available to be successful.*"

To accomplish this level and frequency of prescribed fire on the landscape, we must ensure that practitioners have access to the best science, technology and tools, and that they are confident and practiced in their usage. We need an approach to planning and implementing prescribed fire that's as robust as our Incident Management Teams' response to wildfire. We have an added responsibility to assisting, supporting and revising the planning process at the NEPA level. This would include robust fire behavior and weather analysis as part of the planning process, as well as just prior to and during implementation.

In conclusion, it is important for fire management programs to continue to take on prescribed burning implementation actions in complex units, to push in closer to the homes and the infrastructure that we have been tasked with protecting. As we continue to push into these higher risk, more complex areas, intentional management focused on adapting current forest conditions to a rapidly evolving future climate is needed. Adaptations can foster forest resilience to longer, warmer, drier, and windier fire seasons, increasing incidence of episodic, multi-year to decadal droughts, and increasing dominance of severe wildfire and insect disturbances (Prichard, S.J, et al. 2021).

It is the hope of this review team that the findings and recommendations contained in this report will serve as a catalyst for the upcoming national programmatic review.

Appendices

A - Letter of Delegation

Forest Service | **Washington Office** | **1400 Independence Avenue, SW Washington, DC 20250**

File Code: 5140 **Date:** May 10, 2022
Route To:

Subject: Las Dispensas/Hermit Peak Declared Wildfire Review

To: Chuck Mark, Review Team Leader

This letter directs the initiation and expectations of a comprehensive internal Declared Wildfire Review of the Las Dispensas prescribed fire on the Santa Fe National Forest that resulted in the declaration of the Hermit's Peak wildfire on April 6, 2022. This review seeks to examine what occurred, and why, so that employees and the agency can learn together and identify actions we can take to prevent similar subsequent events. As a learning organization, we recognize that conditions on the ground, in particular growing fuel loads, more frequent wind events, and extended drought across the West, have intensified. It is critical we better understand how these changed conditions impact our prescribed fire implementation actions agency-wide, and this review will be a key component of that.

As the Team Leader, I expect you, and the review team, to uphold the core values of the agency and ensure an objective, professional, and transparent process in accordance with agency policy and procedures. If you need further intent or guidance throughout the review, please come directly to me.

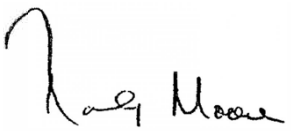
Forest Service Manual 5142.3 requires that all prescribed fires that have been declared a wildfire be reviewed. This review is to include the requirements for a Declared Wildfire Review outlined in the *Interagency Prescribed Fire Planning and Implementation Procedures Guide* (PMS 484, July 2017, pages 38 and 39). The objectives of the Declared Wildfire Review can be found in Forest Service Manual 5137.1. In addition to the requirements described in NWCG PMS-484, the review should also include:

- A description of the overall fuels and wildfire situation on the Santa Fe National Forest and the overall context within which these events took place;
- An assessment of the planning and analysis related to the Gallinas Prescribed Fire WUI project, including the purpose and need for treatment as well as factors that contributed to the overall design and sequencing of planned treatments;
- Assessment of the prescribed fire planning specific to the Las Dispensas prescribed fire;
- Assessment of the information related to fuel conditions, weather and other key factors that informed decisions leading up to the implementation of the Las Dispensas prescribed fire up until the declaration of the Hermit's Peak fire on April 6, 2022; and
- Summary of factors that contributed to the declaration along with proposed recommendations to improve policies, protocols, or performance.

To ensure an objective and insightful review, my expectation is to have a review team that includes a cross-section of leadership and subject matter experts from the Washington Office, other Regions and the Southwest Region. As the Team Leader, please identify a team that meets this intent and is needed to conduct an effective and thorough review and provide a proposed team member roster for my approval.

I expect the draft report for the Declared Wildfire Review to be submitted to me within 14 days. We will finalize the report within 21 days at the latest. If either can be done more expeditiously, without compromising quality or thoroughness, please work towards that goal. Following the completion of the Declared Wildfire Review report, as part of its submission to me, you will also provide a recommendation for the next step in the learning process.

I want to thank you for your leadership and willingness to lead this important review. Please work directly with my Chief of Staff, Tony Scardina, so that we can schedule key team meetings and check-ins. Again, if you need further intent or guidance throughout the review, or have any concerns or questions at any time, please contact me.



RANDY MOORE
Chief

B - Potential Control Locations – Risk Management Assistance (Stratton and Miller 2021)

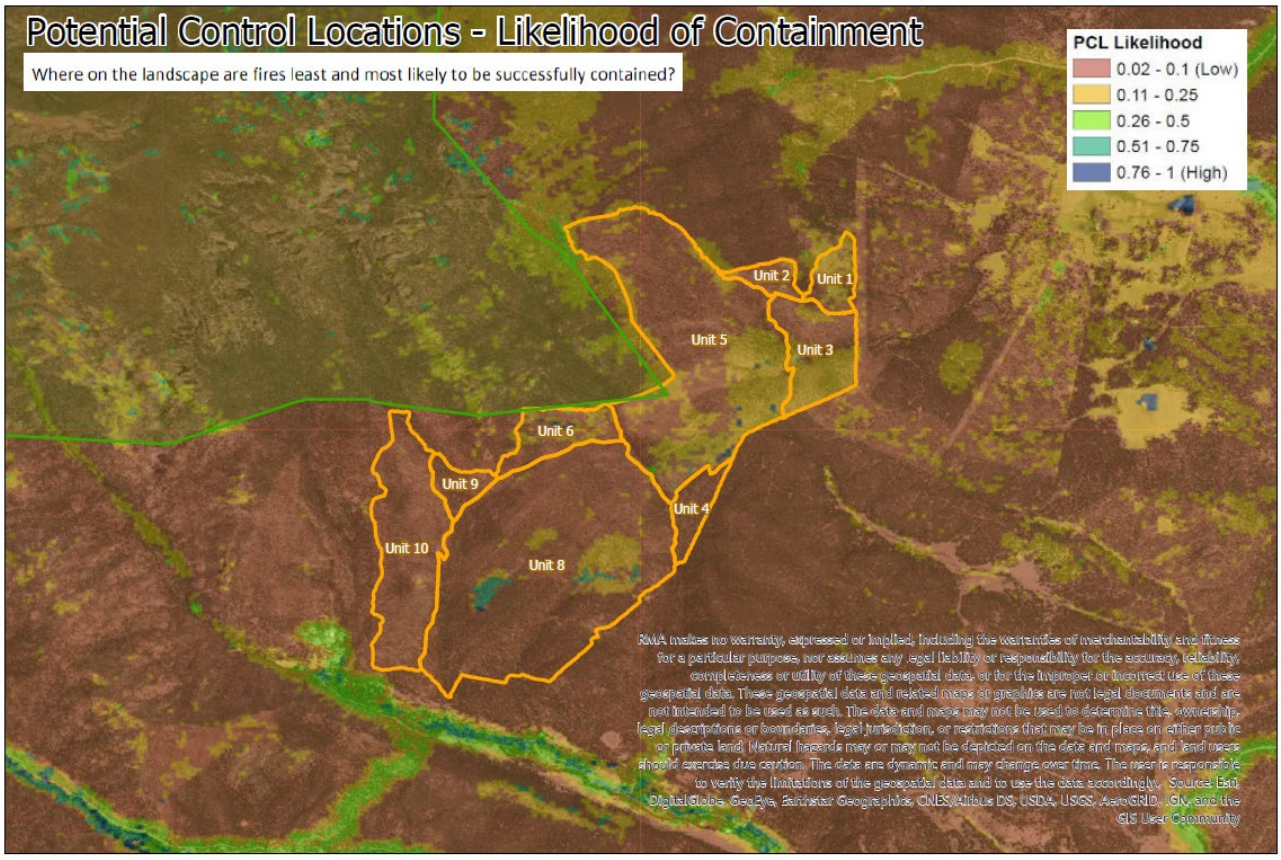
Question(s) Answered: Where on the landscape are wildland fires least and most likely to be successfully contained?

Purpose: The atlas of Potential Control Locations (PCL) (O'Connor et al. 2017) provides a map of wildland fire containment likelihood. The PCL surface is developed through statistical associations between fire containment successes (fire perimeters) and failures (fire interiors) from the 2002-2021 period with physical landscape conditions related to topography, fuels, accessibility, suppression difficulty, and potential fire behavior. In pre-prescribed fire planning, local fire managers can leverage the PCL atlas to assess the quality of potential holding features. PCL is scaled from zero to one, corresponding to conditions with low to high probability of containing a fire. The PCL model is not developed with detailed weather for past incidents, and the prepositioned products on the RMA dashboard are representative of 90th percentile fire weather. Therefore, PCL will not provide a precise probability of containment for a given fire environment. PCL provides a reasonable assessment of where containment is most likely to be successful based on where fires stopped in the past. A key assumption of PCL is that current controls on fire containment success (both physical landscape and fire management factors) are consistent with those during the 2002-2021 period. Model diagnostics can be used to examine the relative importance of predictor variables and how each variable influences containment potential.

PCL is displayed (see map on next page) using five containment likelihood break points ranging from very low in red (PCL<0.1), to orange (0.1-0.25), green (0.25-0.5), light blue (0.5-0.75) and high in dark blue (PCL> 0.75). Red zones represent areas where large fire containment is unlikely—potentially suggesting the need for an indirect suppression strategy based on higher probability of success features. Blue zones (PCL > 0.5) in the PCL atlas are areas where fires tend to stall or stop due to some combination of site conditions and suppression efficacy.

Data Sources: PCL incorporates rate of spread from basic FlamMap runs (Finney 2006; Stratton 2004; McHugh 2019) using 90th percentile fire weather and fuel moisture conditions. The pre-season products use the wind blowing uphill option to represent a consistent worst-case scenario. As with SDI, input fuels data are

updated to the most recent fire year using a standard crosswalk for surface and canopy fuel modifications for fires and fuel treatments that occurred after the most recent LANDFIRE version. The model uses gradient boosting machine learning to quantify statistical relationships between past fire containment successes and failures with landscape conditions. For example, for the 2022 fires season, fires from 2002-2021 were used to train the model, and the model was then projected onto the 2022 fuelscape. As with Suppression Difficulty Index (SDI), Fuelcaster (Reeves 2020) can be used to further adjust surface fire behavior models in non-forested systems to account for seasonal variability in the model projections. Predictor variables including road distance, travel cost distance, distance to barriers, and distance to topographic features (ridges, valleys, and flats) are calculated from HERE 2020 Roads, Forest Service, and Department of Interior road and trails databases, LANDFIRE digital elevation models, and the national hydrography dataset.



N

The information in this map was derived from previous prescribed fire planning documentation and eye witness account from the prescribed fire event. Accuracy may be limited.

0 0.25 0.5 Miles

Unit Boundaries Wilderness

C - Chronology of Events

DATE	EVENTS
2000 May	Sediment and ash from the Viveash Fire impact the Las Vegas, New Mexico city water quality.
2001	The Gallinas Watershed Area is identified in the National Fire Plan as a community at risk, and the Gallinas Municipal Watershed Wildland Urban Interface Project and the Environmental Assessment (EA) Process are initiated.
2004 June	Gallinas Watershed Project EA signed by Pecos/Las Vegas Agency Administrator.
2004 Sep.	Gallinas (EA) Decision reversed by the Regional Office.
2006 June	The Gallinas (EA) signed on the 19th.
2008	Mechanical thinning is conducted in multiple units of the Gallinas Prescribed Fire Project.
2017 Oct.	In early October, the Santa Fe National Forest initiated prescribed fire in multiple units within the municipal watershed for the city of Las Vegas, New Mexico.
2017 Nov.	Snowfall accumulation well below historically normal conditions. In late fall, a portion of the prescribed fire crossed into an area where fire was not desired within the unit.
2017 Dec. 29	Decision made to suppress this portion of the prescribed fire.
2018 Jan. 18	The same portion of the fire was declared a wildfire.
2018 Mar.	Facilitated Learning Analysis conducted on escaped piles.
2018 Dec.-Feb.	Government furlough prohibiting non-essential employees from planning or implementing any projects; additional work time is lost due to orderly shutdown and return to work.
2019 Sep.- 2020 Oct.	Project implementation is halted due to Mexican Spotted Owl injunction.
2020 Mar.	Implementation delayed due to COVID Pandemic.
2021 May	Prescribed fire preparation contract is solicited.
2021 June	On June 22 contractors begin preparation work: constructing fuel breaks and fireline, and manually thinning and piling.
	On July 12 contract preparation work is completed and deemed satisfactory to the specifications of the contract.
2021 Nov.	Due to 35 mph winds, all prescribed burning is canceled.
2021 Dec. 15	High Wind Event with windspeeds of 60 mph and gusts as high as 86 mph at Las Vegas, New Mexico at 0953.
2022 Jan.-Feb.	Private landowner's burn piles escape adjacent to the Las Dispensas Unit of the Gallinas Prescribed Fire Project.
2022 Mar.	Winds and fuel moistures are too high, and several other planned prescribed fires in the area are canceled.
2022 Mar. 16	Fuel moisture samples indicate that fuels are too wet to burn.
2022 Mar. 24	Agency Administrator Ignition Authorization (2A) is signed by the Burn Boss and the Agency Administrator, authorizing ignitions from April 1-30, 2022.
2022 Apr. 1	Project area receives snow the weekend before the prescribed fire (This is cited as a mitigation for long-term drought because fuels are wettened.)
2022 Apr. 3	Fuel moistures sampled onsite in Unit 2: observed values have dropped; Kestrel hung out to record weather observations (Table 3).

DATE	EVENTS
2022 Apr. 4	New Mexico State Inmate Work Crew slated in the organization for the prescribed fire becomes unavailable for the assignment.
2022 Apr. 4	Burn Boss requests spot weather forecasts via email from the Predictive Services Southwest Coordination Center meteorologist, specifically asking about expected winds. Response email indicates there is a solid burn window that should not be impacted by expected winds.
2022 Apr. 5	Division Bravo Firing Boss meets with four members of the Hotshot Crew assigned to holding for area orientation. Discussion around the fireline prep fuels possibly being too dense. Crews were instructed to look at units one and two as well as at the treatment on adjacent private land.
2022 Apr. 5	Onsite Weather observations are taken at 1100 and 1500 local time, the same times as the ignitions planned for the following day.
	1100 Weather Observations for Spot Forecast (note typo in the date on the spot forecast): *Dry Bulb 54, Wet Bulb 36, RH 14%, winds S/SW 8 mph*. 1500 Weather Observations for Spot Forecast: *Elevation 7,512, Dry Bulb 70, Wet Bulb 45, RH 15%, winds N/NW gusts to 11 mph, Td 21, clear sky.*
2022 Apr. 5	1501 A spot weather forecast was requested from the NWS through Dispatch.
2022 Apr. 5	1539. Dispatch relayed the spot weather forecast.
2022 Apr. 6	0806 Resources are shown enroute to the prescribed fire.
2022 Apr. 6	0807 Burn Boss is shown on scene.
2022 Apr. 6	0823 A spot weather forecast is requested from Dispatch.
2022 Apr. 6	0829 Name of the Burn Boss (RXB2) is relayed to Dispatch; there will be no Burn Boss Trainee.
2022 Apr. 6	0900 Crew and equipment shuttles begin.
2022 Apr. 6	0930 Briefing of onsite resources begins at El Porvenir Campground.
2022 Apr. 6	0938 Spot weather forecast is relayed by Dispatch.
2022 Apr. 6	1015 Briefing and Job Hazard Analysis (JHA) completed.
2022 Apr. 6	1023 Call to Dispatch to relay that briefing completed and getting in place to conduct test fire. Confirm with Dispatch that Hotshot Crew is onsite.
2022 Apr. 6	The Burn Boss obtains and reviews the tabular and zone weather forecasts.
2022 Apr. 6	The Go/No-Go Checklist (2b) is documented by the Burn Boss.
2022 Apr. 6	After briefing, one engine is parked at El Porvenir Campground due to narrow road conditions and inaccessibility to Drop Point 7. There is also a UTV mini-pumper staffed by one of the engine crewmembers. A second engine is moved up to the saddle near Unit 6, north of Drop Point 7.

DATE	EVENTS
2022 Apr. 6	1100 Resources getting in place to initiate test fire at the saddle. Kestrel reading of light 2.4 mph average wind speeds taken below Test Fire site. Winds are terrain-dominated up-canyon. Weather Observations: *Dry Bulb 50, Wet Bulb 37, RH 30%, winds 3-8 mph SW.*
2022 Apr. 6	1134 Test Fire initiated in 2-inch needle cast in Division Bravo. Wind Observation: *Upslope, up-canyon with speeds around 2 to 4 mph with occasional gusts to 6 mph.*
2022 Apr. 6	1200 Smoke observation: *several hundred feet NW white/light.* Weather Observations: *Dry Bulb 55, Wet Bulb 39, RH 25%, winds 3-6 mph, gusts 6-10 mph S/SW, PIG (probability of ignition) 50%/50%.*
2022 Apr. 6	1220 Test Fire successful. Firing operations continue. Fire Behavior Observations: *Fire is consuming jackpot heavies well, single tree torching occurred when jackpot heavies are underneath them, fire is spreading in needle cast (when present). Backing and flanking occurring.*
2022 Apr. 6	1220 Bravo Firing continues to bring fire along the knob to the north. Alpha Firing to slowly bring fire on the south. Wind Observations: *Winds are upslope, upcanyon 2 to 3 mph with occasional gusts to 6 mph, winds are terrain dominated, predominant SW winds.*
2022 Apr. 6	1230 Smoke Observation: *Drifting NE, light smoke with some gray.* Fire Behavior Observation: *Fire is consuming heavies well and spreading where fine fuels are present, backing and flanking are occurring, winds are SW.*
2022 Apr. 6	1234 Test burn successful, will continue burn relayed to Dispatch.
2022 Apr. 6	1235 Dispatch sent email to Pecos/Las Vegas District Group informing that Test Fire is successful and ignitions will continue.
2022 Apr. 6	1242 Smoke Observation: *Smoke drifting 1600 feet NE.*
2022 Apr. 6	1300 Division Alpha begins firing on the West Flank. Weather Observations: *Dry Bulb 57, Wet Bulb 37, RH 22%, winds 2-6 mph E/SE, PIG 50%/50%.*
2022 Apr. 6	1310 District Fire Management Officer (Burn Boss) enroute to prescribed firing operation.
2022 Apr. 6	1322 Smoke Observation: *Smoke drifting 2,000 feet NE/E, gray.* Fire Observation: *Backing off knob, consuming jackpot heavies.*
2022 Apr. 6	1335 Small spot fire on Division Bravo, no control issues.
2022 Apr. 6	1351 Burn Boss places call to Deputy Fire Staff Officer to check on contingency resources. Fire Management Officer was going to follow-up with Deputy for Contingency

	Resources for tomorrow.
DATE	**EVENTS**
2022 Apr. 6	1400 Lookout Weather Observation: *Dry Bulb 51, Wet Bulb 36, RH 23%, winds 2-7 mph E/SE, PIG 60%/60%.* Fire Behavior Observations: *Slash burning intensely, windrow (fireline prep fuels) involved, torching.*
2022 Apr. 6	Holders and two igniters pulled to Bravo.
2022 Apr. 6	1403 Smoke Observation: *Smoke drifting 2,000 feet NE.*
2022 Apr. 6	Bravo Firing instructs Hotshots to take one more strip. An igniter takes an extra strip walking back. Fire intensity picks up. Internal torching produces the 10x20 spot fire.
2022 Apr. 6	1426 10 foot x 20 foot spot on the NE corner of Division Bravo. Spot caught at 0.25 acre on the NW corner. Bravo ignitions stopped. Burn Boss discusses with Bravo Firing Boss to bring fire around the corner to the base of the knob and hang it up for the evening. Fire Behavior Observation: *Heavies and terrain dominated winds influence, winds are East and up-canyon PIG 70%/70%.*
2022 Apr. 6	During the spot fire, Bravo Firing Boss tries to radio Bravo Holding several times to get a status on the spot and gets no response.
2022 Apr. 6	Bravo Firing Boss makes radio contact with Holding Boss: they have caught the spot and will grid the green for others.
2022 Apr. 6	Bravo Firing Boss walks back down to the toe of the slope to monitor any spread into division Alpha. Division Alpha has picked up a couple of spots already.
2022 Apr. 6	1439 Burn Boss update to Dispatch: *Everything is going good, picked up a few small spots and caught them, currently working a quarter acre spot, should be able to hold it with engines, will call back later with another update.*
2022 Apr. 6	Between 1430 and 1445 p.m. Bravo Firing Boss observes low fire intensity at the toe of the slope. Bravo Firing Boss radios Hotshot Foreman and requests a meeting at the toe of the slope. After an assessment of the conditions and anticipated fire behavior, Bravo Firing Boss instructs Hotshot Foreman to scout a ridge to the south to verify it as a viable location for a check line.
2022 Apr. 6	1455 Burn Boss update to Dispatch: *We were able to get around the 1/4 acre spot with the engines.*
2022 Apr. 6	1458 Dispatch relays they will be sending Santa Fe Hotshots to the prescribed firing operation in the morning. Crew Manifest will be sent to Burn Boss.
2022 Apr. 6	1500 Weather Observations: *Dry Bulb 56, Wet Bulb 37, RH 18%, winds 3-7 mph, gusts to 15 mph E/SE.*

DATE	EVENTS
2022 Apr. 6	Bravo Firing Boss is hiking along the northern fire edge and realizes that the holders on the hose lay to the 10x20 spot are noticing that the mini-pumper is almost out of water. He walks down to the UTVs. He asks one of the Hotshot UTV operators to give him a ride to the road to bring the engine closer. There is radio traffic that the mini-pumper is almost out of water. Halfway to Drop Point 7, the mini-pumper is topped off with water and the engine is moved up to where the line starts on Unit 9, just below Drop Point 7. Hotshots assigned to Alpha are moved to Bravo to chase spots.
2022 Apr. 6	1530 Hotshot Foreman radios Bravo Firing Boss: they have found the ridge he was talking about; it will take some work, but it (checkline) can be done.
	Due to changing winds, Bravo Firing Boss decides to hold off on firing until holding is in good shape to start again. He makes several attempts to contact Bravo Holding on the radio with no success. He then radios Alpha Firing to ask what they were seeing. Alpha Firing Boss mentions they have a couple of small spot fires they were able to pick up, and they are planning on taking another ("small bite") strip below the ridge line and blackline at the same time. Bravo Firing Boss asks a Hotshot Squad Leader face to face if he can get ahold of Bravo Holding. The Squad Leader makes contact with Bravo Holding on a crew net channel. Bravo Holding responds on the designated radio channel saying everything is good and there are no new spots.
2022 Apr. 6	15:45 Bravo Firing Trainee radios Bravo Firing Boss to advise they will continue ignitions. Bravo Firing radios Alpha Firing to let them know they are starting up again with one more pass to the east. Three igniters take fire east down to the toe. Bravo firing radios Bravo Firing Trainee and asks their location and to hold the igniters. Bravo Firing Trainee relays that the igniters are already at the toe. Bravo Firing Boss directs Bravo Firing Trainee not to bring any more fire up the line and to bring more blackline down.
2022 Apr. 6	1555 multiple spots. Alpha has a few small spots; Burn Boss reports no holding concerns. Several spots on Bravo. All ignition operations are stopped.
2022 Apr. 6	1600 Weather Observations: *Dry Bulb 56, Wet Bulb 35, RH 10%, winds 4-8 mph, gusts to 15 mph W/SW.*
2022 Apr. 6	Fire activity is increasing; prolonged group tree torching is observed. Bravo Firing Boss radios Bravo Holding Boss with no response. Fire is spotting within the unit. Mini-pumper and operator are instructed to move down to the corner where the road and the line meet. Winds shift upcanyon S/SE.

DATE	EVENTS
2022 Apr. 6	1606 Burn Boss update to Dispatch that there are multiple spots on the NW corner of the prescribed fire. There are a dozen or so spots; it's going to take a bit of time to get around them. Request for contingency resources placed. Request for phone call to Dispatch.
2022 Apr. 6	1610 Crews working multiple spots on the north side (Bravo). Multiple spots across the creek bed at eye level. One spot is 300 feet above the rest and growing.
2022 Apr. 6	1615. Frequent spots across the line, not enough resources to catch them. Holders disengage from spot and move downslope. Firing Boss asks holders to engage in four new spots just above Drop Point 7. Several resources go back to the now 20x20 foot spot; the mini-pumper is out of water; there is a lot of dead and down fuel outside the line. Heat off the spot is intense, and fire is starting to spot up-canyon. Firing Boss Bravo contacts Burn Boss on radio to let him know they are unable to catch the larger spot and they will disengage. Resources are instructed to disengage and regroup at the vehicles at Drop Point 7 due to increased fire behavior. All assigned resources meet back at the vehicles. Fire Behavior Observations: *Group tree torching, windrow (fireline prep fuels) fully involved, spotting.*
2022 Apr. 6	1620 Spots growing and pulling together with S/SW wind.
2022 Apr. 6	1621 Burn Boss instructs Dispatch to contact the Forest Fire Management Officer and advise of the multiple spots and need to order contingency resources. Also contact the Agency Administrator and advise. Burn Boss reports to Dispatch: one spot on the north end, anchoring the west side, and assessing the east side.
2022 Apr. 6	1625 Burn Boss requests contingency resources for the prescribed fire from Dispatch. Resources are physically located in Taos, New Mexico at the Fire Summit (an annual spring training exercise).
2022 Apr. 6	1628 Dispatch advises the Agency Administrator of the situation at the prescribed fire.
2022 Apr. 6	1630 there is an uphill crown run to the top of the ridge due to wind and slope alignment. Group tree torching is occurring.
2022 Apr. 6	1634 Burn Boss requests Dispatch to contact Agency Administrator. Burn Boss speaks with the District Fire Management Officer: recommends this be declared a wildfire. The fire is heading north toward Hermit's Peak and west toward the wilderness.
2022 Apr. 6	1638 Dispatch advises Ranger that Burn Boss and 5-1 are recommending Wildfire Declaration.
2022 Apr. 6	Agency Administrator declares the prescribed fire a wildfire.
2022 Apr. 6	1645 FireCode requested.
2022 Apr. 6	1650 Incident named Hermit's Peak.

D - Spot Weather Forecast

Spot Forecast for Las Dispensas...USFS
National Weather Service Albuquerque NM
853 AM MDT Wed Apr 6 2022
DISCUSSION...
Very dry and cool today and Thursday. Breezy today, light winds Thursday. Dry and milder Friday and Saturday. Excellent ventilation each afternoon through Saturday, except good on Friday.

TODAY...
Sky/weather.....Sunny.
Chance of Pcpn.....0 percent.
Max Temperature.....54-58.
Min Humidity.....9-13 percent.
20 Foot Winds.....West winds 10 to 15 mph. Gusts to 25 mph possible.
Mixing Height.....8500 ft AGL.
Transport winds.....Northwest 18 knots.
Max Vent Rate.....Excellent/155456 knot-ft at 1700 local.
Ventilation Trend...Good/62753 knot-ft around mid morning and excellent/155456 knot-ft by mid afternoon.

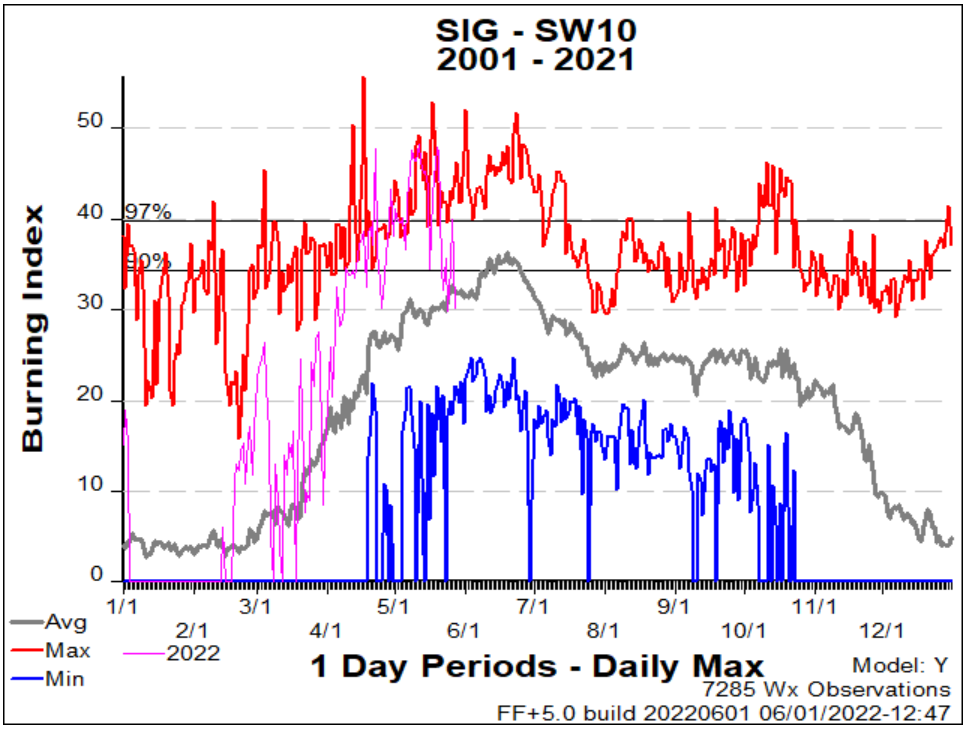
Copy of the spot weather forecast for the day of ignitions of the Gallinas Watershed Prescribed Burn, Las Dispensas Unit.

E - Burning Index and Severe Fire Danger Index

Burning Index

Question(s) Answered: How can I assess fire danger trends as they relate to fire behavior potential and the effects of windspeed?

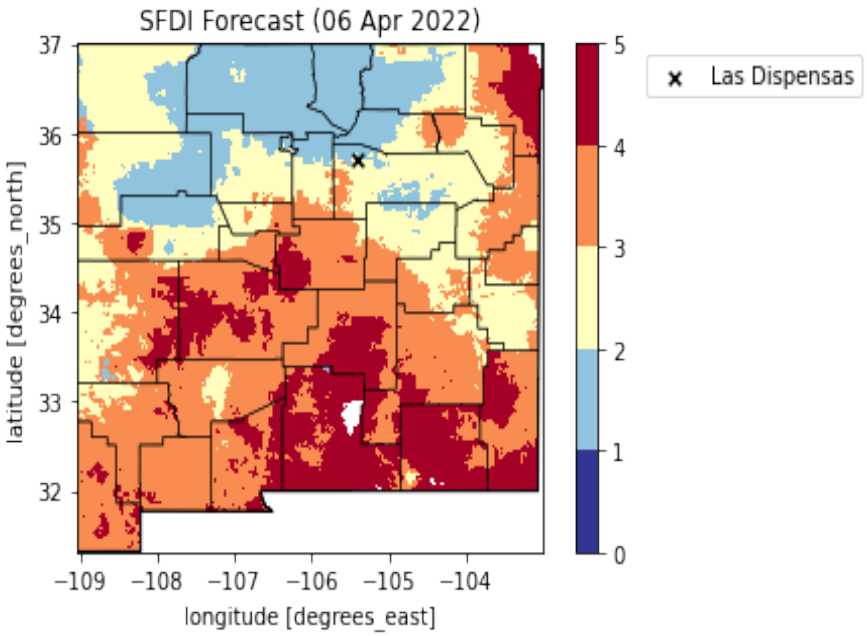
Purpose: Burning Index (BI) is a number related to the contribution of fire behavior to the effort of containing a fire. The BI is derived from a combination of Spread and Energy Release Components. It is expressed as a numeric value closely related to the flame length in feet multiplied by ten. For pre-prescribed fire planning, BI can be used in addition to ERC (see Figure 14) to determine the seasonal fire potential compared to the maximum, minimum and average for the previous ten-year period. These charts can be a good predictor of seasonality and can help identify inter-seasonal anomalies. The chart on the next page illustrates that 2022 has trended above the seasonal average since late March. This is likely due to prolonged seasonal drought, below average seasonal snowpack, and higher frequency of stronger winds, which are discussed in the narrative above.



Severe Fire Danger Index

Question(s) Answered: How can I visually assess fire danger spatially across the landscape to determine locations of heightened fire danger when my local RAWS is offline or unrepresentative of my wildland fire location?

Purpose: The Severe Fire Danger Index (SFDI) assesses historical fire events and forecasts the potential for extreme fire behavior in a manner that can be used by both fire managers and the public (Jolly et al. 2019). SFDI was very recently approved for operational use through the WildfireSAFE application (https://wildfiresafe.technosylva.com). This product can now be used to satisfy requirements under the 2019 Prescribed Fire Approval Act. However, during the time of the Las Dispensas Prescribed Fire, managers had to use RAWS data to determine extreme fire, and some counties do not have RAWS available to validate the level of fire danger that they are observing compared with a weather station. The Index is normalized based on a 39-year climatology from 1992-2017. The Severe Fire Danger Index has five classes: Low, Moderate, High, Very High and Severe (Extreme). For future pre-prescribed fire planning, it is recommended that WildfireSAFE and/or SFDI be used to inform compliance of the 2019 Prescribed Fire Approval Act because the index incorporates National Weather Service National Digital Forecast Database (NDFD) forecasts through a seven-day period.



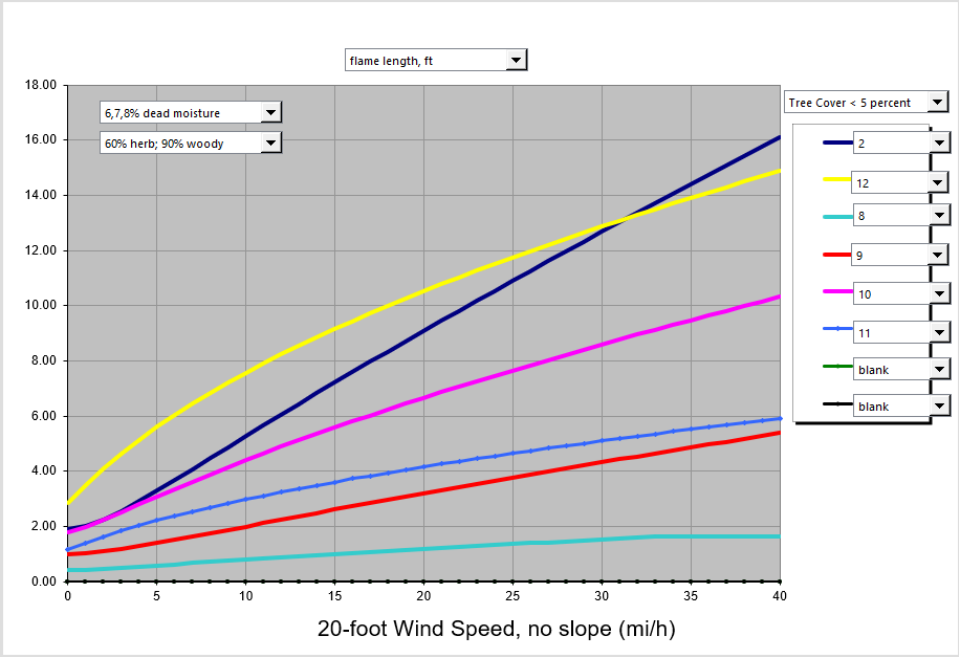
F - Fuel Model – Fire Behavior Comparison

Flame Length

Question(s) Answered: How can I visualize the different potential flame lengths per fuel model?

Purpose: The comparison chart on the next page can be used to visualize potential flame lengths based on fuel models (https://iftdss.firenet.gov/firenetHelp/help/pageHelp/content/00-concepts/fbfm/fbfmcomparexls.htm). Based on this chart, fuel models 8, 9, 10 and 11 show that at a 20-ft wind speed of 25mph, the max potential flame length is slightly under 8 feet (fuel model 10).

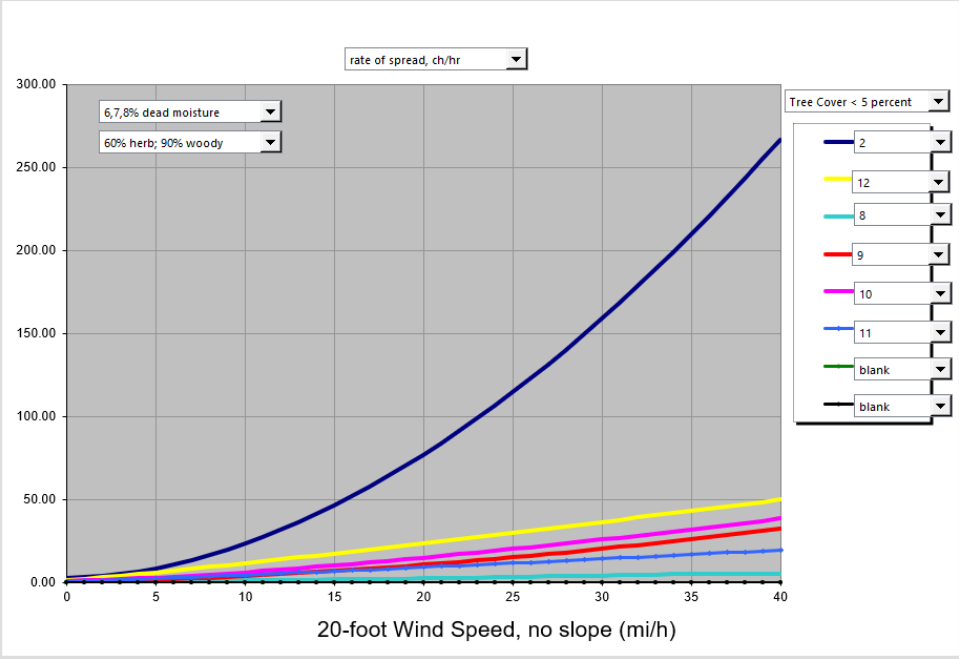
Whereas fuel model 2, represented in Unit 10 of the Las Dispensas Prescribed Fire (Figure 13), has a max potential flame length around 11 feet. These differences can result in significant observed flame lengths when prescribed fire is implemented. In addition, if including additional fuel bed of up to 2 feet of fireline preparation fuels as outlined in the fireline preparation task order, fuel model 12 also results in a potential flame length, around 12 feet.



Rate of Spread

Question(s) Answered: How can I visualize the different potential rates of spread per fuel model?

Purpose: The comparison chart below can be used to visualize potential rates of spread based on fuel models (https://iftdss.firenet.gov/firenetHelp/help/pageHelp/content/00-concepts/fbfm/fbfmcomparexls.htm). Based on the chart below, fuel models 8, 9, 10 and 11 show that at a 20-ft wind speed of 25mph, the max potential rate of spread is around 20 chains/hour (fuel model 10). Whereas fuel model 2, represented in Unit 10 of the Las Dispensas Prescribed Fire (Figure 13), has a max potential flame length around 114 chains/hour. These differences can result in significant observed flame lengths when prescribed fire is implemented. In addition, if including additional fuel bed of up to 2 feet of fireline preparation fuels as outlined in the fireline preparation task order, fuel model 12 also results in a high rate of spread, around 36 chains/hour.



G - Spatial Analysis – Prescription – FlamMap

Question(s) Answered: What method can be used to assess potential fire behavior across the prescribed fire area given different weather/prescription scenarios?

Purpose: Spatial fire behavior modeling is an effective way of assessing and comparing different fire environment scenarios and can be used to better inform the planning and development process of the prescribed fire plan. More specifically, spatial fire behavior modeling can assist in the drafting of the objectives, prescription, holding and contingency portions of the prescribed fire plan (elements 5, 7, 16 and 17) as well as, the complexity analysis.

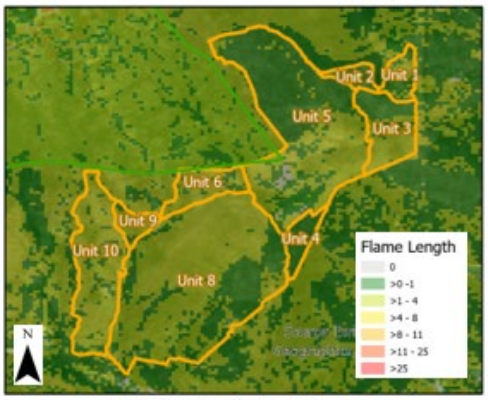
Spatial fire behavior can expand beyond traditional fire behavior modeling in BehavePlus because it can incorporate additional landscape complexity and utilize topography (elevation, slope aspect) and vegetation characteristics (canopy cover, stand height, canopy base height, canopy bulk density) in addition to fuel models.

In the example on the next page, the FlamMap model is being used as it is implemented in the application (Interagency Fuels Treatment Decision Support System (IFTDSS) (https://iftdss.firenet.gov/firenetHelp/help/pageHelp/content/20-models/lfb/about.htm?tocpath=Modeling%7CLandscape%20Fire%20Behavior%7C 1).

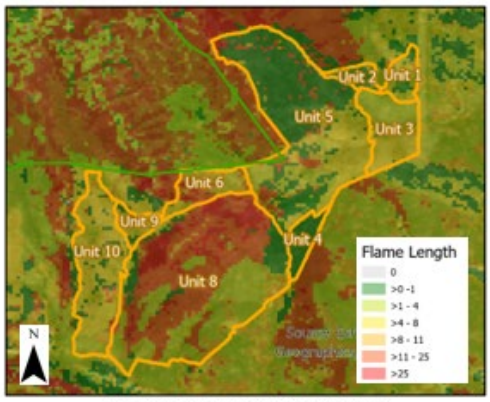
The series of maps on the next page display potential flame lengths, rates of spread, and crown fire activity under both the low end (left) and high end (right) parameters specified in the Las Dispensas Prescribed Fire plan.

Another benefit of spatial modeling is the ability to predict fire behavior potentially outside of the prescribed fire unit. This gives the Burn Boss better awareness of fire behavior potential in the event that the fire exceeds the prescribed fire unit. Furthermore, this information can also be used when laying out the schedule or sequence of burning and suggests locations across the area with higher resistance to control or location of potential holding concerns. IFTDSS offers spatial fire behavior modeling training through the wildland fire learning portal (https://wildlandfirelearningportal.net/login/index.php).

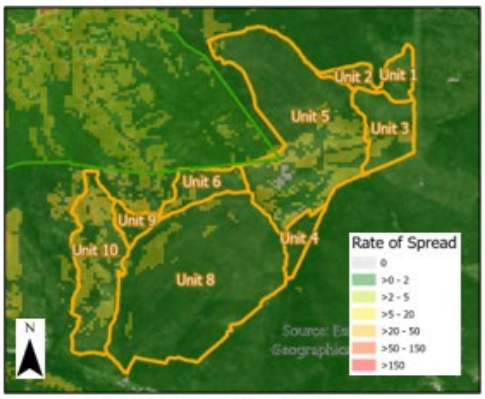
Spatial Fire Behavior Analysis of Las Dispensas Prescribed Fire (High & Low Prescription)



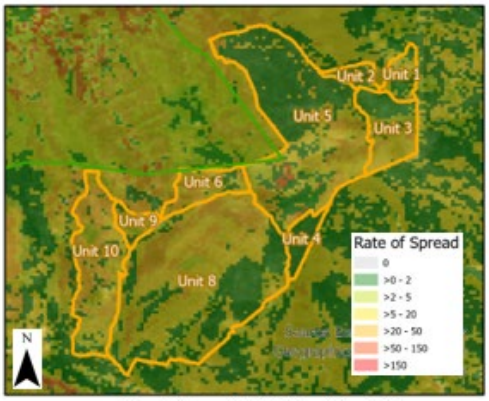
Flame Length (Low Fire Intensity)



Flame Length (High Fire Intensity)



Rate of Spread (Low Fire Intensity)



Rate of Spread (High Fire Intensity)

Crown Fire Activity (Low Fire Intensity)

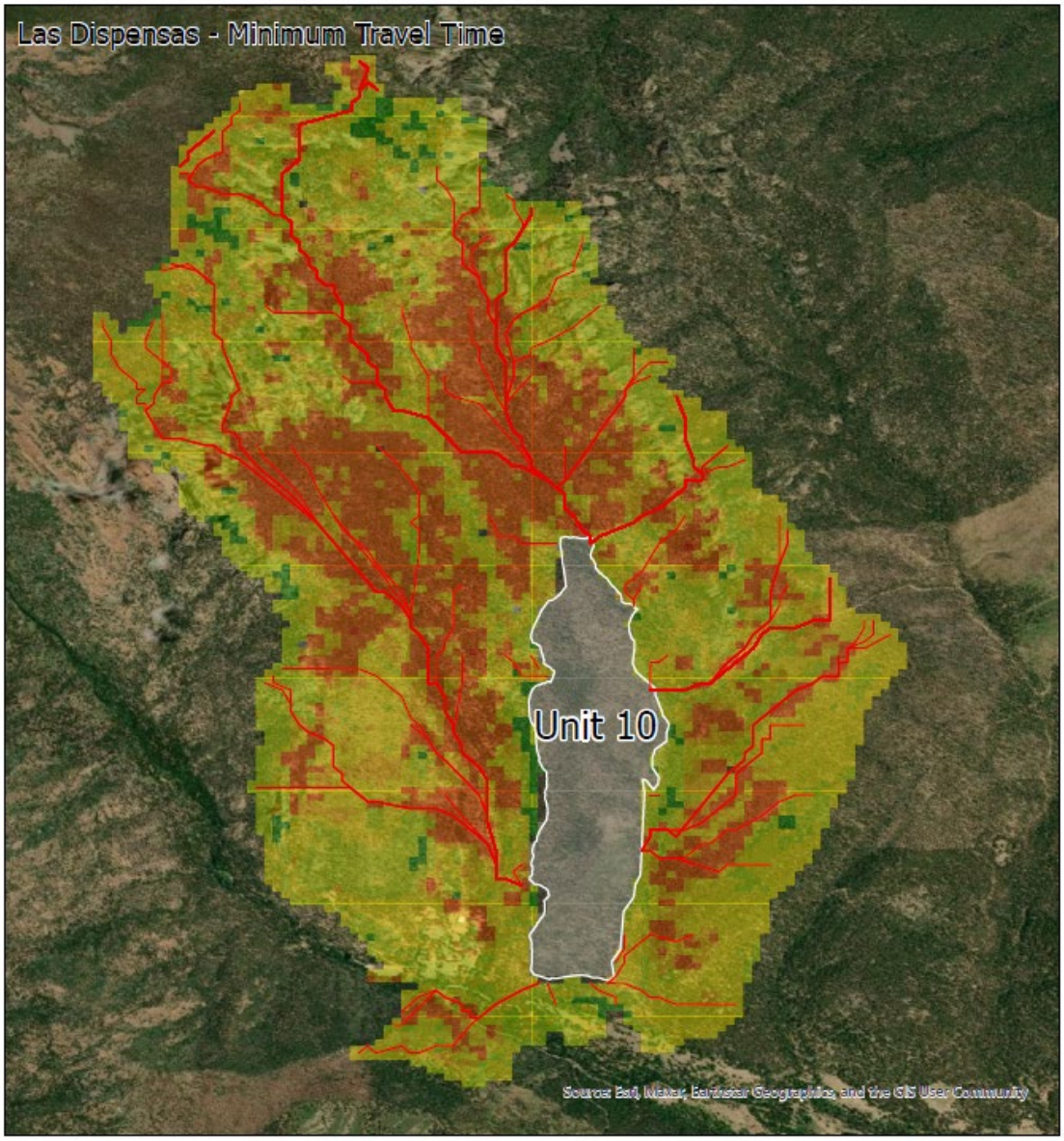
Crown Fire Activity (High Fire Intensity)

H - Spatial Analysis – Holding/Contingency – Minimum Travel Time

Question(s) Answered: Given a scenario where fire was to escape the planned prescribed fire unit and established holding lines, where are the major paths that fire would likely spread, and how successful would suppression actions be in the event fire becomes established outside of the prescribed fire unit?

Purpose: Another use of spatial fire behavior modeling is the actual projection of fire growth on the landscape. The Minimum Travel Time (MTT) model can be used to project the spread of fire across the landscape for a single set of weather inputs. This model is available for use in IFTDSS (https://iftdss.firenet.gov/firenetHelp/help/pageHelp/content/20-models/mtt/about.htm).

In the scenario modeled below, MTT was used to project fire growth out under an 8-hour burn period. Outputs include the major pathways of fire spread (red lines) and modeled fireline intensity, which is a direct interpretation of rate of spread and heat per unit area (derived from flame lengths) similar to the FlamMap model run in Appendix G. When modeled in a manner such as the one below, the Burn Boss can interpret the growth potential and difficulty of suppression in the event that the fire exceeds the prescribed fire holding lines. Both the holding and contingency (elements 16 and 17) of the prescribed fire plan can be informed through the use of fire growth projection models like MTT.



N

0 0.2 0.4 Miles

The is a Minimum Travel Time spatial analysis displaying potential Fire Line Intensity from an 8 hour burn period under the high intensity prescription parameters from the Las Dispensas prescribed fire. The red lines indicate major flow paths of fire spread in the event that fire exceeds the control lines of the unit.

Major Spread Paths

Fire Line Intensity
<VALUE>
Non-burnable
Burnable but not burned
>0 - 5
>5 - 100
>100 - 500
>500 - 1,000
>1,000 - 6,175
>6,175

I - Review of Las Dispensas Complexity Analysis

Complexity Analysis Element	Sub-element	Quantity	Significance	Findings Specific to the Complexity Analysis	Review Team's Post Assessment
Value Identification	On Site	Multiple	Moderate	The values identified may have been underrated in Significance category.	Values such as summer homes, heritage sites, Mexican Spotted Owl and Goshawk habitat, consider high rating in Significance. Review Team believes this should be rated as high.
	Off Site	Multiple	Moderate	The values identified are commensurate with a Moderate Rating.	
	Public/Political Interest	Multiple	Moderate	The values identified may have been underrated in Significance category.	According to the preliminary comment about smoke will impact communities. Consider high rating in Significance. Review Team believes this should be rated as high.
Risk Management Assessment and Ratings	Sub-element	Preliminary	Post-plan	Findings Specific to the Complexity Analysis	Review Team's Post Assessment
	Safety	High		Risks to safety were identified.	Risks not mitigated. Post-Plan Rating departs from conditions on the day of the prescribed burn was implemented.
	Fire Behavior	Moderate		Fire behavior rating did not adequately consider fuels outside the unit and the assessment stated: “Fire behavior may present challenges that are easily mitigated” and “Probability of ignition outside the unit is low and any spotting is expected to be short-range.” Fire Behavior Outputs did not include FM2 or FM 12.	Environmental conditions during the ignitions trended on the high end of the prescription which is not consistent with the complexity analysis. Fuel models 2 and 12 result in higher potential flame lengths and rates of spread than the original fuel models 8,9,10 &11 assessed.

	Resistance to Control	High		This section recognizes potential for multiple escape mechanisms to exist, fuel concentrations challenge holding, and in conflict to the previous element "probability of ignition in fuels outside the unit is moderate to high," and it recognizes local drought and/or fire indices are expected to be high or extreme.	Due to the absence of CONTAIN outputs, resistance to control would be difficult to assess. Risks were identified, however they were not mitigated. Fuel models 2 and 12 result in higher potential flame lengths and rates of spread than the original fuel models 8,9,10 &11 assessed. Review Team believes this should be rated as high.
	Ignition Procedures and Methods	Moderate		Risks were accurately identified.	Ignition procedures and methods would appear to be Moderate complexity as described in the examples provided in the CA (Complexity Analysis).
	Prescribed Fire Duration	Moderate		The descriptor includes the need for at least three days of accurate forecasts.	Spot weather forecasts were submitted to meet this intent.
	Smoke Management	Moderate		Risks were accurately identified.	
	Number and Dependence of Activities	Moderate		Risks were accurately identified.	Risks were not adequately mitigated.
	Management Organization	Moderate		The plan under-represented the size of the organization required to contain an escape.	Risks were identified appropriately for the plan but not for the conditions on the day of the prescribed burn.
	Treatment Resource Objectives	Moderate		Factors such as steep terrain and highly erodible soils in relation to watershed preservation is often more attainable utilizing the low to moderate spectrum of the environmental prescription parameters.	These factors are usually given more weight when developing a plan and could have discouraged implementation on the high end of the prescribed parameters.

	Constraints	Moderate		This element correctly identifies "Water resources will need to be brought in (port/fold-a-tanks) when necessary."	
	Project Logistics	High		This element identified that "Extensive dedicated logistical support through most phases of the prescribed fire is required to safely meet project objectives." Yet no evidence of such support existed.	CA highlights the use of aviation resources but was not applicable to Unit 10. UTVs were utilized to mitigate the lack of access via Engines.
Prescribed Fire Plan Developed Addressing Mitigations Associated with Complexity Analysis Elements				The plan did not address fuels outside planned burn area and CONTAIN was not used in calculating resource requirements. The Prescribed Fire Plan did not mitigate for the identified need for water as suggested by the "Constraints" element.	The PFP (Prescribed Fire Plan) did not limit the prescription to the low end, ensuring low or moderated fire behavior which was identified as a mitigating factor in the CA.
Post-plan Risk	Sub-element	Preliminary	Post-plan	Findings Specific to the Complexity Analysis	Review Team's Post Assessment
	Safety	High	Moderate	This element describes "Only 18 personnel are required, determined from line production rates in the Wildland Fire Incident Management Field Guide, as well as contain runs for fuel models 8, 9, 10, and 11 in Behave Plus."	The modeling errors led to a situation in which the number of suppression resources was significantly underestimated. A CONTAIN run was never calculated, and 18 personnel was based on several of those personnel performing as engine crews. Due to lack of full road access to burn Unit 10, engines were parked, and engine crew members were functioning as hand crews.

	Fire Behavior	Moderate	Moderate	This element reports that "The prescribed fire prescription dictates ignitions will be conducted under conditions in which low to moderate fire behavior can be expected."	Conditions on the day of the prescribed fire trended towards the hot end of the prescription and did not align with the identified parameters of low or moderated fire behavior captured on the CA. Overall, fuel conditions and fire behavior attributes outside of the project area were not distinguished in the CA. According to the spatial fuel model data collected, FM2 and FM12 were both present outside of the burn unit.
	Resistance to Control	High	Moderate	The mitigation for the risk identified that "Control lines will be thoroughly prepped prior to the day of the burn to remove fuel concentrations and ladder fuels near critical holding points." This prep work actually concentrated fuels inside the burn unit that contributed to torching and spotting under the prescribed parameters.	Prescribed fire organization in the PFP was developed in the absence CONTAIN outputs which resulted in an under representation of resource needs to adequately mitigate long-range spotting under the high-intensity prescribed parameters.
	Ignition Procedures and Methods	Moderate	Moderate	Risks were adequately identified.	In most cases, ignition procedures and methods are typically rated at a higher level of difficulty when operating under the high spectrum of prescribed parameters when more than one firing group is required.
	Prescribed Fire Duration	Moderate	Moderate	Risks were adequately identified.	
	Smoke Management	Moderate	Moderate	Risks were adequately identified.	

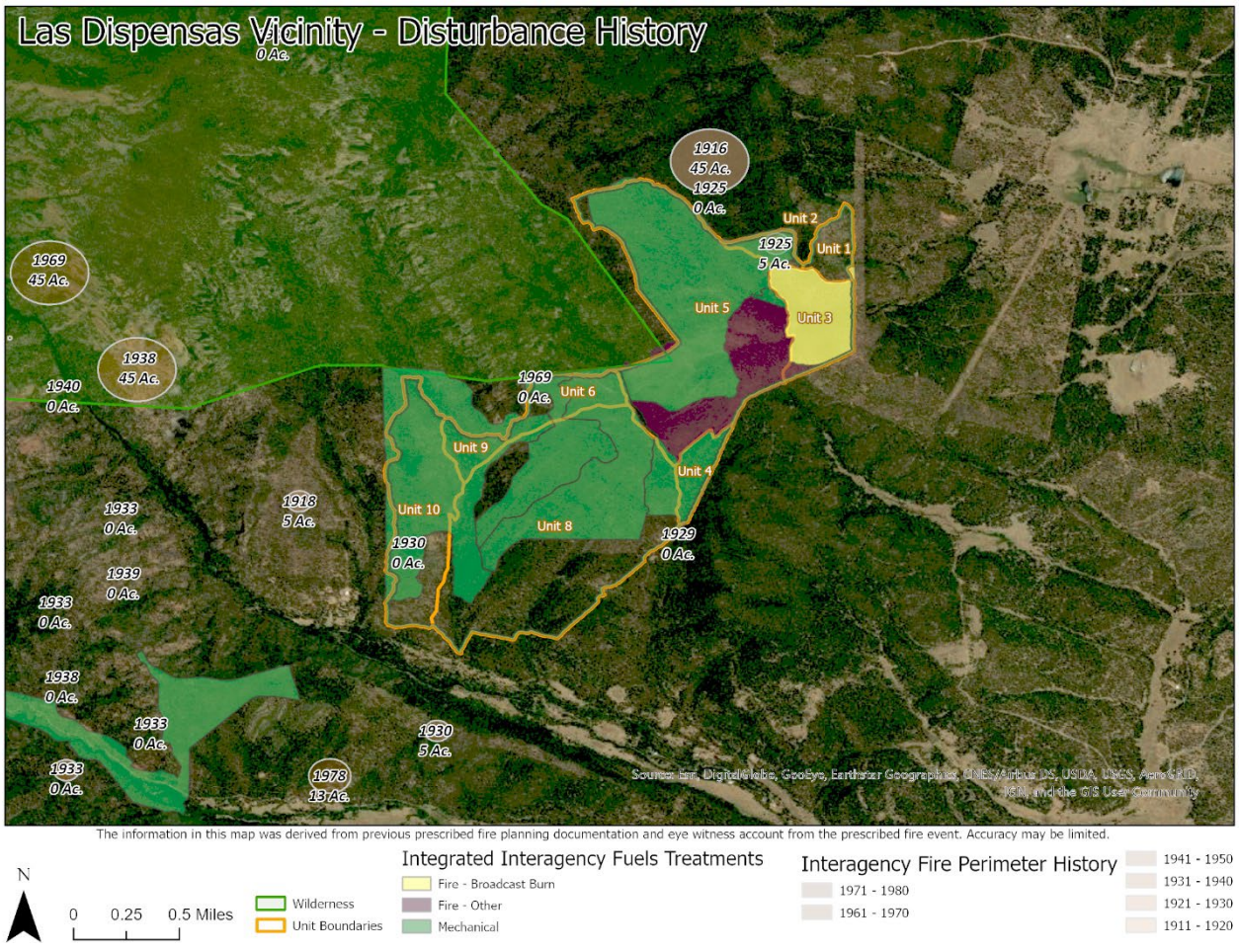
	Number and dependence of Activities	Moderate	Moderate	Risks were adequately identified.	
	Management Organization	Moderate	Moderate	Risks were identified appropriately for the plan but not for the actual situation because the plan underrepresented the size of the organization required to contain an escape.	Consider fire behavior and fuel conditions outside of project when developing a prescribed fire organization.
	Treatment Resource Objectives	Moderate	Moderate	This element reports that "Prescribed fire prescriptions are low enough to meet prescribed fire objectives without causing any short-term adverse impacts" when in fact the range of acceptable parameters within the prescription allowed for fire behavior on the high end.	Although the prescribed fire plan included a range of parameters from the low to high end, consider burning initial entry conditions under a lower end of the prescription to meet resource objectives.
	Constraints	Moderate	Moderate	The pre-plan risks identified the potential need for water resources, but the post-plan has no mention of those resources.	Although Engines were on-site, they had limited access and use. Tanked UTVs were available; the Review Team believes they do not meet the intended need for water resources to adequately mitigate risk.
	Project Logistics	High	Moderate	No mitigations are evident that provided for the reduction from "High" to "Moderate." The use of ATVs or UTVs was identified in the Pre-Plan Risk Assessment, so their inclusion in the Post-Plan Risk Assessment should not alter the rating.	Ensure mitigating factors meet the intent of the proposed action.

Post-Plan Technical Difficulty Assessment		Moderate		Inadequate mitigation of risk identified in the initial assessment (High range), particularly in elements Safety, Resistance to Control, and Constraints.	
Summary Post-plan Assessment of Risk and Planned Technical Difficulty Resulting in the Calculated Prescribed Fire Complexity Rating		Moderate		Based on a number of factors discussed previously, the conclusion drawn complies.	
Final Complexity Determination		Moderate		A series of small underestimations during the development of the complexity analysis, including initial assessment and inadequate mitigation, led to an assessment of reduced complexity that did not accurately represent actual conditions.	

J - Disturbance History

Question(s) Answered: When developing a prescribed fire plan, how can I determine what the previous fire/treatment history was?

Purpose: In the map below, both historical fire perimeters and previous treatments are displayed for the Las Dispensas Prescribed Fire area. Both of these layers are published feature services through ArcGIS Online and can be added to any map. Previous disturbance history can be used to help determine whether previous treatments or wildfire have occurred in the area. This knowledge can aid in assessing prescribed fire complexity along with the scheduling or sequencing of prescribed fire implementation. In locations with little or no previous disturbance on the landscape, complexity is increased and should be considered in prescribed fire plan development.



K - Suppression Difficulty Index – Risk Management Assistance (Stratton and Miller 2021)

Question(s) Answered: Can I see a map of the fire area that shows the ease or difficulty of suppressing the fire given topography, fuels, accessibility and percentile weather?

Purpose: Suppression Difficulty Index (SDI) (Rodriguez y Silva et al. 2020) is a rating of relative difficulty in performing wildland fire control work. It factors in topography, fuels, expected fire behavior under percentile

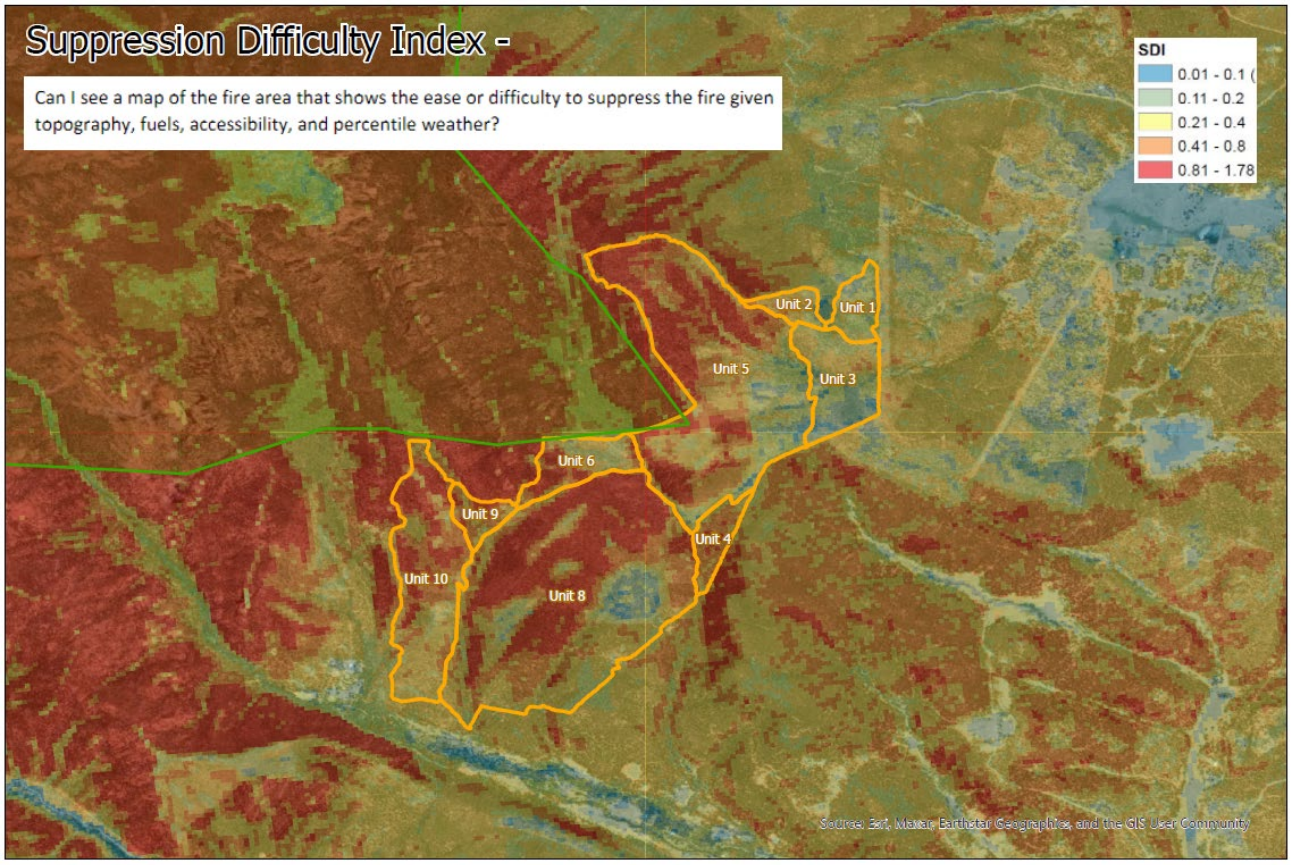
weather conditions, fireline production rates in various fuel types with and without heavy equipment, and access via roads, trails or cross-country travel. During the 2020 fire season, thresholds for difficulty ratings developed for west-wide use (Rodriguez y Silva et al. 2020) were rescaled to better align with field observations on individual incidents.

SDI is currently classified into six categories representing lowest to highest difficulty. Highest difficulty (>1.0) zones represented in red are “watch out” situations where engagement is likely to be very challenging given the combination of potential fire behavior, fuel types, fuels, difficult terrain, and lack of access. Low difficulty zones represented in blue (see map on next page) indicate areas where some combination of reduced potential for dangerous fire behavior, light surface fuels, relative ease of access, and low slope conditions make suppression actions easier.

SDI does not account for standing snags or other overhead hazards to firefighters. Therefore, this is not a firefighter hazard map. It is only showing, in relative terms, where it is harder or easier to perform work. For pre-prescribed fire planning, SDI can be used to assess potential holding features for reinforcement, access and egress.

Data Sources: SDI incorporates flame length and heat per unit area from basic FlamMap runs (Finney 2006; Stratton 2004; McHugh 2019), using a standard set of thresholds (80th, 90th, 97th percentile fire weather and fuel moisture conditions) for pre-positioned fire behavior inputs, or custom inputs for near real-time representation of potential fire behavior from field observations.

The pre-season products use the wind blowing uphill option to represent a consistent worst-case scenario. Input fuels data are updated to the most recent fire year using a crosswalk for surface and canopy fuel modifications for fires and fuel treatments that occurred after the most recent LANDFIRE version. For example, the LANDFIRE 2016 model inputs are modified to incorporate fires (MTBS, GeoMac, and WFIGS) and fuel treatments (USFS FACTS and NFPORS hazardous fuels reduction treatments) from 2017 to the present. Where available, custom runs can incorporate surface fuel models to reflect seasonal fuels changes in non-forested systems using the Fuelcaster product (Reeves 2020). Road and trail inputs are developed from a combination of HERE 2020 Roads, U.S. Forest Service and Department of Interior road and trails databases. Hand crew and dozer fireline production rates are from FPA 2012 (Dillon et al. 2014). Classification of topography and accessibility thresholds are detailed in Rodriguez et al. (2020).



The information in this map was derived from previous prescribed fire planning documentation and eye witness account from the prescribed fire event. Accuracy may be limited.

N

0 0.25 0.5 Miles

Unit Boundaries Wilderness

L - Review of the Qualifications

Experience and Involvement of Key Personnel Involved in the Prescribed Fire

According to the current IQCS records, the qualifications and experience of key personnel at time of ignition is as follows:

- Burn Boss (RXB2) was a fully qualified RXB2
- Firing Boss Division A was fully qualified
- Firing Boss Trainee (Division A) was fully qualified trainee
- Holding Boss Division A was fully qualified
- Firing Boss Division B was fully qualified
- Firing Boss Trainee (Division B) was fully qualified trainee
- Holding Boss Division B was fully qualified

Approving Agency Administrator's Qualifications, Experience, and Involvement

- Agency Administrator (AA) was qualified to sign and approve Type 2 prescribed fire plans. The AA met minimum involvement standards.

Glossary of Terms

The main reference glossary for this guide is the National Wildfire Coordinating Group (NWCG) Glossary, which is updated periodically: http://www.nwcg.gov/.

1,000-hr (thousand-hour) timelag fuel moisture – an index of the NFDRS relating to moisture content of large, dead fuels. It provides an indication of longer-term seasonal drying trends.

AA – Agency Administrator

AIMs (Action, Implementation & Mitigation)- Grant program that funds on-the-ground wildfire risk reduction activities.

Blackline/Blacklining – Preburning of fuels adjacent to and within a control line before igniting a prescribed burn. Blacklining is done prior to main ignitions to reduce heat on holding crews and lessen chances for spotting across control line.

Broadcast Prescribed Burning – Prescribed burning activity where fire is applied generally to most or all of an area within defined boundaries for reduction of fuel hazard, as a resource management treatment, or both.

Burn Boss – Person responsible for supervising a prescribed fire from ignition through mop-up. The Burn Boss is responsible for writing prescribed fire plans, determining when the prescribed fire is in prescription, obtaining smoke clearance and weather forecasts, notifying officials of the upcoming fire, and obtaining all qualified personnel and equipment needed to conduct and patrol the area. The Burn Boss must also ensure all operations are conducted in a safe manner and considers personnel and public safety during and after the prescribed fire.

Burning Season (In Season Burning) – The number of days available each year for prescribed fire implementation is constrained by weather variables such as temperature, wind speed and relative humidity. In many areas, the season for prescribed fire implementation is late winter to early spring. Often, a narrow window of weather parameters is required due to safety issues, policy, and regulation, which will reduce the number of available days.

CRWB (Crew Boss) – A person in supervisory charge of usually 16 to 21 firefighters and responsible for their performance, safety, and welfare.

Chain – Unit of measure equaling 66 feet.

Chains per hour – The rate of fire spread is measured in “chains per hour.” A chain is 66 feet.

Crown Fire – A fire that advances from top to top of trees or shrubs more or less independent of a surface fire. Crown fires are sometimes classed as “running” or “dependent” to distinguish the degree of independence from the surface fire.

Dry Bulb Temperature – The ambient air temperature that is measured by a thermometer.

EA (Environmental Assessment) – A requirement of National Environmental Policy Act (NEPA), an EA evaluates the potential impacts of proposed actions, such as a prescribed fire, on the environment and suggests alternatives, or mitigations, to reduce or eliminate these impacts.

ENGB (Engine Boss) – The Engine Boss (ENGB) leads a single fire engine and attached personnel and is responsible for the crew's safety on wildland and prescribed fire incidents.

ERC (Energy Release Component) – Index of the National Fire Danger Rating System (NFDRS) relating to the available energy (BTU) per unit area (square foot) within the flaming front at the head of a fire. It is a cumulative or "build-up" type of index and is an indicator of potential fire intensity.

Escaped Prescribed Fire – A prescribed fire that has exceeded or is expected to exceed prescription parameters or otherwise meets the criteria for conversion to wildfire. Criteria are specified in "Interagency Prescribed Fire – Planning and Implementation Procedures Reference Guide".

FBAN (Fire Behavior Analyst) – Responsible for collecting weather data, developing strategic and tactical fire behavior information, predicting fire growth, and interpreting fire characteristics for use by incident overhead.

FDFM (Fine Dead Fuel Moisture) – The moisture content of dead organic fuels, expressed as a percentage of the oven dry weight of the sample, that is controlled entirely by exposure to environmental conditions.

FEMO (Fire Effects Monitor) – The Fire Effects Monitor is responsible for collecting the onsite weather, fire behavior, and fire effects information needed to assess whether the fire is achieving established resource management objectives.

FF2 (Firefighter) – Firefighter Type 2.

FFT1 (Firefighter) – A working leader of a small group (usually not more than seven members), who is responsible for their performance, safety, and welfare.

FFPv5 (Fire Family Plus) – Software for summarizing and analyzing daily weather observations and computing Fire Danger indices based on the U.S. National Fire Danger Rating System

Fine Fuels – Fast-drying dead or live fuels, generally characterized by a comparatively high surface area-to-volume ratio, which are less than 1/4-inch in diameter and have a time lag of one hour or less. These fuels (grass, leaves, needles, etc.) ignite readily and are consumed rapidly by fire when dry.

FIRB (Firing Boss) – The Firing Boss reports to the Prescribed Fire Burn Boss and is responsible for supervising and directing ground and/or aerial ignition operations according to established standards in the Prescribed Fire Plan.

Fire Duty Officer (FDO) – Individual working for a jurisdiction or agency responsible for coordinating that agency (Wildland Fire Response) on a given day.

Fireline – The part of a containment or control line that is scraped or dug to mineral soil.

FLA (Facilitated Learning Analysis) – A non-punitive accident review process that seeks to understand the events of an accident through the process of "sensemaking." The FLA process seeks to understand "how" it made sense to those involved, rather than "how" it makes sense in hindsight.

FlamMap (Fire Behavior Mapping and Analysis Program) – A fire behavior mapping and analysis program that computes potential fire behavior characteristics (spread rate, flame length, fireline intensity, etc.).

Flash Fuels – Highly combustible fine fuels such as grass, leaves, draped pine needles, fern, tree moss and some kinds of slash that ignite readily and are consumed rapidly when dry.

Foliar Moisture – The moisture content of the conifer needles in tree crowns. It is used along with surface fire intensity and crown base height as input to the crown fire initiation model FOBS (Field Observer)—this position is responsible for collecting and reporting situation information for an incident.

Fuel Loading – The amount of flammable material that surrounds a fire. Fuel load is measured by the amount of available fuel per unit area, usually tons per acre. A small fuel load will cause a fire to burn and spread slowly, with a low intensity.

FVS (Forest Vegetation Simulator) – The FVS is a forest growth simulation model that simulates forest vegetation change in response to natural succession, disturbances and management.

Group Torching – The burning of the foliage of a group of trees from the bottom up.

Haines Index – Is an index developed by meteorologist Donald Haines in 1988 that measures the potential for large fire growth (Plume-Driven). The index is derived from the stability (temperature difference between different levels of the atmosphere) and moisture content (dew point depression) of the lower atmosphere. The data may be acquired from radiosonde information. The index is calculated over three ranges: low elevation (950–850mb), mid elevation (850–700mb), and high elevation (700–500mb). A Haines Index of 6 means a high potential for large fire growth. 5 means medium potential, 4 low potential, and anything less than 4 (2 and 3) means very low potential.

Heavies (Heavy Fuels) – Large diameter fuels such as snags, logs, large limbwood that ignite and are consumed more slowly than flash fuels. Also called coarse fuels.

Holding Boss – Reporting to the Burn Boss, the Holding Boss manages the holding crew, a larger team of fire professionals working on foot and on fire engines who are responsible for keeping the fire within the pre-designated prescribed fire unit along control lines, such as roads.

IFTDSS (Interagency Fuel Treatment Decision Support System) – A web-based application designed to make fuels treatment planning and analysis more efficient and effective by providing access to data and models all in one place through one user interface. It is available to all interested users, regardless of agency or organizational affiliation.

Incident – An occurrence either human-caused or natural phenomenon, that requires action or support by emergency service personnel to prevent or minimize loss of life or damage to property and/or natural resources.

IMET (Incident Meteorologist) – A National Weather Service meteorologist specially trained to provide onsite weather support at wildfires and other all-hazard incidents.

Inventoried Roadless Area – A group of Forest Service lands that have been identified by government reviews as lands without existing roads that could be suitable for roadless area conservation as wilderness or other non-standard protections. Typically exceed 5,000 acres.

Jackpot Burn – A fire treatment type. A prescribed fire to deliberately burn natural or modified concentrations (jackpots) of wildland fuels under specified environmental conditions, which allows the fire to be confined to a predetermined area and produces the fireline intensity and rate of spread required to attain

planned resource Management Objectives.

Kestrel – The brand name of an electronic, handheld instrument used to measure weather observation elements including temperature, wind and humidity.

LANDFIRE – A data management program that delivers spatial data related to vegetation, fuel, disturbance, and fire regimes. Designed to be used at a landscape-scale to support strategic vegetation, fire and fuels management planning to evaluate management alternatives across boundaries and facilitate national- and regional-level strategic planning and reporting of wildland fire management activities.

Lop and Scatter – To remove the upward extending branches from the tops of felled trees to keep slash low to the ground to lower the fire hazard or as a pretreatment prior to burning.

LTAN (Long Term Fire Analyst) – Responsible for collecting weather data, developing strategic and tactical fire behavior information, predicting fire growth, and interpreting fire characteristics for use by incident overhead.

Maximum Management Area (MMA) – The maximum geographic limits of spread within which a wildland fire use fire is allowed to spread.

Mechanical Treatment – Mechanical fuel treatments involve the use of hand tools, such as chainsaws and rakes, or large machines, like bulldozers and wood chippers, to reduce the amount of vegetation or fuel that has built up to dangerous levels.

National Wildfire Coordinating Group (NWCG) – An operational group designed to coordinate programs of the participating wildfire management agencies.

NFDRS – National Fire Danger Rating System.

NWS – National Weather Service.

Piles (Pile Burning) – Cut material piled either by hand or mechanical—resulting from logging or fuel management activities—burned during the wetter months to reduce damage to residual stand and to confine fire to the size of the pile. Piling allows for the material to cure, producing less smoke and rapid consumption when burned.

Precommercial Thinning (Timber stand improvement) – To reduce timber stock to appropriate levels to allow remaining trees to grow in preparation for a future harvest.

Prescribed Fire Burn Boss – Type 1 (RXB1) – Person responsible for supervising a prescribed fire from ignition through mop-up. See definition for "Type" below.

Prescribed Fire Burn Boss – Type 2 (RXB2) – Person responsible for supervising a prescribed fire from ignition through mop-up. See definition for "Type" below.

Prescribed Fire Plan – A plan required for each fire application ignited by management. It must be prepared by qualified personnel and approved by the appropriate Agency Administrator prior to implementation. Each plan will follow specific direction and must include critical elements and how to mitigate each element.

Prescription Guidelines – Guidelines used to show upper and lower reaches of a prescription.

RAWS (Remote Automatic Weather Station) – A weather station that transmits weather observations via GOES satellite to the Wildland Fire Management Information system.

SFDI (Severe Fire Danger Index) – A Fire Danger index developed by Dr. Matt Jolly that combines two separate Fire Danger indices: Energy Release Component (ERC) and Burning Index (BI).

SOPL (Strategic Operational Planner) – The primary task of this position is to coordinate the development of the course of action for a wildfire (unplanned ignition).

Spot Fire – Fire ignited outside the perimeter of the main fire by a firebrand.

Spot Weather Forecast (NWS) – A site-specific forecast issued by the National Weather Service (NWS) to fit the time, topography, and weather of a specific incident. These forecasts are issued upon request of the user agency and are more detailed, timely and specific than zone forecasts. On-site weather observations or a close, representative observation is required for a forecast to be issued.

Spotting – Behavior of a fire producing sparks or embers that are carried by the wind and start new fires beyond the zone of direct ignition by the main fire.

Standard Operating Procedure (SOP) – Rules for the operation of a fire department, such as how to respond to various types of emergencies, training requirements, use of protective equipment, radio procedures; often including local interpretations of regulations and standards. In general, "procedures" are specific, whereas "guidelines" are less detailed.

Terrain Dominated Winds – Winds in mountain topography are extremely complex. Differences in air heating over mountain slopes, canyon bottoms, valleys, and adjacent plains results in several different but related wind systems. These systems combine in most instances and operate together. Their common denominator is up-valley, upcanyon, upslope flow in the daytime, and downflow at night. They result from horizontal pressure differences, local changes in stability that aid vertical motion, or from a combination of the two.

Torching (Candling) – The burning of the foliage of a single tree or a small group of trees from the bottom up.

Type 1/2/3 – Refers to resource capability. Resource typing provides managers with additional information in selecting the best resource for the task.

Upcanyon Winds – These winds may be quite turbulent because of the unstable air and the roughness of the terrain. Eddies may form at canyon bends and at tributary junctions. Along upper ridges particularly, the flow tends to be quite erratic. Wind speed and direction may change quickly, drastically affecting fire behavior.

Upslope Winds – Upslope winds develop along heated slopes, typically beginning as the sun warms the slope. The strength of upslope winds is influenced by the length and steepness of the slope as well as the exposure. These can begin suddenly, depending on how unstable the atmosphere is.

Wet Bulb Temperature – Dry bulb and wet bulb are used to calculate relative humidity. Wet bulb temperature is measured by sling psychrometers within a belt weather kit using thermometers that are wrapped in wetted wicks. The higher the difference between the dry bulb and wet bulb temperatures (called the depression), the greater the felt effect is on the discharge air temperature.

WFDSS (Wildland Fire Decision Support System) – Map-based application that displays information to agency administrators, line officers, fire managers, and analysts as they move through the risk-informed

decision process for wildland fire. Combines desktop applications for fire modeling into a web-based system

Wildfire – An unwanted wildland fire.

Wildland Fire – Any nonstructural fire, other than prescribed fire, that occurs in the wildland. This term encompasses fires previously called both wildfires and prescribed natural fires.

Wildland Urban Interface (WUI) – The line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetation fuels.

Wyden Amendment – Allows managers of federal lands to spend funds to conduct treatments on adjacent non-federal lands to improve the viability of, and otherwise benefit, fish, wildlife, and other biotic resources.

Review Team

Chuck Mark	Forest Supervisor, Salmon Challis National Forest, USFS R4, Review Team Leader
Danny Bryant	Regional Deputy Director for Safety and Fire, USFS R2, Deputy Team Leader & Fire Management Subject Matter Expert
Roberto Trincado	Director, National Interagency Prescribed Fire Training Center, US Fish and Wildlife Service, Prescribed Fire Subject Matter Expert
Jeremy Bailey	Fire Training and Network Coordinator, The Nature Conservancy, Prescribed Fire Subject Matter Expert
Tessa Nicolet	Regional Fire Ecologist, USFS R3, NEPA and Fuels and Prescribed Fire Project Planning Subject Matter Expert
Wesley Hall	Fire Application Specialist, USFS WO-FAM, Wildland Fire Management Research, Development and Application, Fire Behavior Subject Matter Expert
Coleen Haskell	Wildland Fire Meteorologist, National Park Service, Predictive Services Rocky Mountain Area, Fire Weather Subject Matter Expert
Lori Bell	Deputy Forest Supervisor Ouachita NF, USFS R8, Facilitated Learning Process Subject Matter Expert
Steve Miller	Regional Fire Director, USFS R9, Facilitated Learning Process and Fire Management Subject Matter Expert
Janan Hay Sharp	Emergency Management Specialist, USFS WO, NIMO, Planning Section Chief and NEPA Subject Matter Expert
Jimmy Grimes	Emergency Management Specialist, USFS WO, NIMO, Logistics Section Chief
Joyce El Kouarti	Public Affairs Specialist, USFS WO, Office of Communications, Writer/Editor and Liaison with Office of Communication
Kerry Greene	Emergency Management Specialist, USFS WO, NIMO, Writer/Editor