National Prescribed Fire Program Review

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FOREWORD

On May 20, 2022, I temporarily paused prescribed burning on National Forest System lands nationwide for 90 days to conduct a national review of our prescribed fire program. Although prescribed fire is one of the most effective ways to reduce wildfire risk, this was a necessary decision in light of recent prescribed fire escapes that had devastating impacts on communities and natural resources. The decision also reflected the growing recognition that extreme conditions resulting from drought, weather, dry fuels, and other climate change effects were influencing fire behavior in ways we had never seen before.

The public expects us to care for the land and meet the needs of people the right way, to the best of our ability. We must expect that of ourselves every day as global leaders in conservation. We must use important management tools such as prescribed fire to do that.

Based on the thorough review, findings, and recommendations provided by the National Review Team, I have decided to resume the Forest Service's prescribed fire program nationwide with the requirement that all seven tactical recommendations identified are followed and implemented immediately by all Forest Service units across the country (see pages 17-21). These actions will ensure prescribed fire plans are up to date with the most recent science, that key factors and conditions are closely evaluated the day of a prescribed burn, and that decisionmakers are engaged in those burns in real time to determine whether a prescribed burn should be implemented.

On average, the Forest Service ignites about 4,500 prescribed fires each year, treating about 1.3 million acres across the National Forest System. Almost all prescribed fires—99.84 percent—go according to plan. However, we cannot underestimate how destructive prescribed fire escapes can be.

We are a global leader in the use of prescribed fire as a key management tool that is necessary to reduce the risk of catastrophic wildfire and improve the resiliency of forests. As leaders, we cannot overly rely on past success—we must continuously learn and adapt to changing conditions so we can be at our best to protect communities and care for the lands and natural resources we manage on behalf of the public. That is exactly why I directed this pause and review.

We can never guarantee that prescribed fires won't escape because there are risks when we use this tool. It's a trade-off we have to take seriously together with communities. The alternative is more large and destructive wildfires like we have seen the past several decades—a result of the combination of overgrown forests, climate change, a growing number of homes in the wildland-urban interface, and more than a century of fire suppression

What we can and will do is learn from them to minimize the risks of escapes and remain committed to doing this work safely and effectively. We must also be upfront with the public about why and where we do prescribed burns and coordinate with Tribes, partners, and communities in planning and implementation to ensure we incorporate

their knowledge and build shared understanding, capacity and support. We must also fully support employees who implement this difficult work by providing them all the tools and resources they need to be successful.

I want to thank the national review team for their comprehensive, thorough, and expeditious work. I am confident that participation from the interagency fire and research community resulted in an objective hard look at our program and bolstered the quality of the review. I ask that you read the attached Final Report to understand this comprehensive review and associated recommendations and considerations.

In addition to the seven immediate actions identified to resume safe and effective prescribed burning operations, I have also decided it is important to undertake additional steps to ensure prescribed fire practitioners have the tools and resources they need to be successful on the ground. This will improve the success of our prescribed fire program and help us implement the 10-year Wildfire Crisis Strategy alongside partners and communities. Therefore, we will begin moving forward on the following actions:

By January 1, 2023, we will establish a Western Prescribed Fire Training curriculum with the interagency fire and research community, and partners, to expand the successes of the National Interagency Prescribed Fire Training Center (NIPFTC) headquartered in Tallahassee, Florida. This curriculum will incorporate the knowledge and experience of Tribes, partners, and communities and include a strategy of training and developing skills together so we can build collective capacity to expand the use of prescribed burning on National Forest System and other lands. We will identify and provide the additional staffing needed to support this action.

By December 15, 2022, our Incident Management Organization will develop a national strategic plan for prescribed fire implementation. The plan will include implementation timing, implementation command structure, and logistics to prioritize and mobilize resources for both suppression and prescribed burning activities. This plan will include necessary staffing, funding, and monitoring to help shape future system improvements.

By December 15, 2022, we will identify a strategy, in collaboration with partners, for having crews that can be dedicated to hazardous fuels work and mobilized across the country to support the highest priority hazardous fuels reduction work.

We will continue investing in potential operational delineations (PODs) and ensure that they are used as a tool for both wildfire response and vegetative/fuels management planning.

For clarity and consistency, we will use a standardized approach for declared wildfire reviews and improve current systems for tracking findings and recommendations for continuous learning.

I want to thank the public and our dedicated employees for their patience and understanding as we conducted this important review. I extend my heartfelt thanks to our review team leaders and every team member for their dedication to this work; for their thorough, forthright, and detailed analysis; and for their outstanding contributions to improving our prescribed fire program. Their work is an example of how we strive to hold ourselves accountable at the Forest Service, learn from our successes and mistakes, and find better ways to serve the American people and steward the lands entrusted to our care, for the benefit of current and future generations.
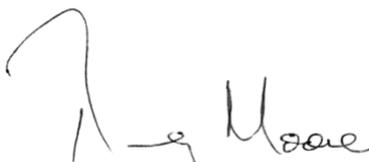
RANDY MOORE, Chief

EXECUTIVE SUMMARY

In the spring of 2022, wildfires caused by escaped prescribed fires compelled Chief Randy Moore of the U.S. Department of Agriculture, Forest Service to call for a 90-day pause in the agency's prescribed fire program pending a program review.

A review team led by Forest Service personnel—with partner representation from municipalities, counties, States, and nongovernmental organizations from across the country—identified themes and findings to form the recommendations in this report. The Agency Co-Team Leaders made final recommendations to the Chief for immediate implementation to lift the program pause. The recommendations are tactical approaches the Forest Service can use to account for multiple factors affecting practitioners' ability to carry out prescribed burns in a safe and effective manner. These tactical recommendations are as follows:

1. Each Forest Service unit will review all prescribed fire plans and associated complexity analyses to ensure they reflect current conditions, prior to implementation. Prescribed fire plans and complexity analyses will be implemented only after receiving an updated approval by a technical reviewer and being certified by the appropriate agency administrator that they accurately reflect current conditions.

2. Ignition authorization briefings will be standardized to ensure consistent communication and collective mutual understanding on key points.

3. Instead of providing a window of authorized time for a planned prescribed fire, agency administrators will authorize ignitions only for the Operational Period (24 hours) for the day of the burn. For prescribed fires requiring multi-day ignitions, agency administrators will authorize ignitions on each day. Agency administrators will document all elements required for ignition authorization.

4. Prior to ignition onsite, the burn boss will document whether all elements within the agency administrator's authorization are still valid based on site conditions. The burn boss will also assess human factors, including the pressures, fatigue, and experience of the prescribed fire implementers.

5. Nationwide, approving agency administrators will be present on the unit for all high-complexity burns; unit line officers (or a line officer from another unit familiar with the burn unit) will be on unit for 30-40% of moderate complexity burns.

6. After the pause has been lifted, units will not resume their prescribed burning programs until forest supervisors go over the findings and recommendations in this review report with all employees involved in prescribed fire activities. Forest supervisors will certify that this has been done.

7. The Chief will designate a specific Forest Service point of contact at the national level to oversee and report on the implementation of these recommendations and on the progress made in carrying out other recommendations and considerations raised in this review report.

The team also identified additional considerations for near-term implementation after the prescribed fire program resumes. Included in the body of this report, the near-term considerations are designed to help the Forest Service better use prescribed fire as part of its Wildfire Crisis Strategy (*Confronting the Wildfire Crisis: A Strategy for Protecting Communities and Improving Resilience in America's Forests*). In carrying out the 10-year strategy, the agency can use additional resources it has received from Congress under the Infrastructure Investment and Jobs Act of 2021 and Inflation Reduction Act of 2022 to scale up fuels and forest health treatments—including prescribed fire—in a way that is safe while also recognizing that risks cannot be fully removed from this land management activity. As a learning organization, the Forest Service can reduce risks by intentionally incorporating learning from past escaped prescribed fires, by expanding available resources and tools for prescribed burning, by enhancing training opportunities, and by clarifying the use of reviews of prescribed burns that have become declared wildfires.

In addition to its immediate recommendations and near-term considerations, the team raised a series of considerations that should be explored in the long term (Appendix A). The considerations for long-term program review are multi-agency in nature, require potential policy changes, or will take a considerable amount of time and effort to implement.

Prescribed burning will be key in treating landscapes to reduce the risk of catastrophic fire to the American people and to the public lands entrusted to Forest Service care. The agency has to do the work—but it has to do it right. One way will be by making investments in changing the agency culture of prescribed burning. Learning will be key, and this report will help lay the foundations for the future of the Forest Service's prescribed fire program.

NATIONAL PRESCRIBED FIRE PROGRAM REVIEW

RISING WILDFIRE RISK

Over the past 20 years, a rising number of large and destructive wildfires has threatened lives, property, and infrastructure. Declining forest health and excessive fuels, exacerbated by climate change and the spread of homes and communities into the wildland/urban interface, have elevated wildfire risks across the Nation, particularly in the West. Although the Forest Service and other land managers have increased fuels and forest health treatments in recent decades, the scale of the treatments has not kept pace with the scale of rising wildfire risks as wildfires have become ever larger and more severe.

In response, the Forest Service has embraced a 10-year Wildfire Crisis Strategy (*Confronting the Wildfire Crisis: A Strategy for Protecting Communities and Improving Resilience in America's Forests*) for rising to the challenge of addressing the threat to our national forests. The strategy articulates the need for a new land management paradigm: stepping up the pace and scale of fuels and forest health treatments to match the scale of rising wildfire risks across western landscapes. The strategy calls for treating up to an additional 20 million acres of National Forest System (NFS) lands; treating up to an additional 30 million acres of other Federal, State, Tribal, and private lands; and developing a plan for long-term maintenance beyond 10 years. Forest thinning and the safe and effective use of prescribed fire, often in conjunction, are essential tools for reducing wildfire risks and creating resilient fire-adapted landscapes.

In fire-adapted landscapes, prescribed fire creates conditions that reduce the intensity of subsequent wildfires, increase suppression success, and reduce firefighter exposure and risk. On average, the Forest Service ignites about 4,500 prescribed fires each year, treating about 1.3 million acres across the National Forest System. Almost all prescribed fires—99.84 percent—go according to plan. However, recent escaped prescribed fires that became wildfires show that even a very small percentage of fire escapes can have severe consequences.

NEED FOR PROGRAM REVIEW

On May 20, 2022, recognizing the need, Forest Service Chief Randy Moore directed the agency to pause all prescribed fire activities pending a 90-day review of its prescribed fire program. Chief Moore established a national team to conduct the review and charged it with examining issues in four thematic areas: (1) the Forest Service's culture of prescribed fire; (2) climate and weather factors related to prescribed fire, including the impacts of climate change; (3) the agency's prescribed fire tactics, policy, and training; and (4) the agency's capacity to conduct prescribed fires.

As part of the review, the team assessed past reviews of escaped prescribed burns that led to wildfires, summarizing the contributing factors. The team also drew on the research community for a synthesis of the best science regarding climate change and other environmental factors to be considered in prescribed fire planning and

implementation (Appendix D). Drawing on everything it learned, the team provided the following (see Appendix A):

1. Recommended changes immediately needed to resume prescribed burning in a safe and effective manner;

2. Considerations for near-term implementation to improve the prescribed fire program (though not necessary to resume prescribed burning in a safe and effective manner); and

3. Considerations for deeper, longer-term study that might be needed and helpful to the prescribed burning program.

TEAM COMPOSITION AND METHODOLOGY

The review team was led by Steve Lohr, Director of Renewable Resources for the Forest Service's Rocky Mountain Region, and Bill Avey, retired Forest Supervisor and former Acting National Fire & Aviation Director for the Forest Service's Washington Office. In addition, the core team included:

- Scott Ray, Forest Supervisor for the Daniel Boone National Forest;

- Jessica Halofsky, Director of the Forest Service's Northwest Climate Hub and Western Wildland Environmental Threat Assessment Center;

- Erin Phelps, Branch Chief for Risk Management in the Forest Service's Washington Office;

- Chad Pickering, Deputy Director for Fire and Aviation Management for the Forest Service's Northern Region;

- Jim Karels, Fire Director and Wildland Fire Committee for the National Association of State Foresters; and

- Sonya Germann, Montana State Forester.

The team established sub-teams in each of the four thematic areas named by Chief Moore: (1) agency culture; (2) climate change and weather; (3) tactics, policies, and training; and (4) agency capacity. Each sub-team was led by a Forest Service member of the core team. The sub-teams included a cross-section of leaders, subject matter experts, and prescribed fire practitioners from across the country. Inputs from Forest Service partners were vital to the integrity of the review, and the sub-teams included representatives from other Federal, State, and local governments as well as from Tribal groups and nongovernmental organizations.

The sub-teams explored a series of questions generated by the Chief and the sub-teams themselves within each of the issues. The sub-teams referenced existing escaped fire reviews and Facilitated Learning Analyses from the past 20 years or more found on the Lessons Learned website: https://www.wildfirelessons.net/irdb?executeSearch=true&LibraryKey=b58e5b48-1c09-4f15-ad0d-c26639dab1a2&SearchMatch=exact&TagsList=%22Escaped+Prescribed+Fire%22. The sub-team members provided their own input from professional experience and perspectives on prescribed fire.

Each sub-team framed their issue and developed a series of recommendations and considerations that was then evaluated by the core team. Information produced by the sub-teams was used in the formulation of this final report.

FACTORS CONTRIBUTING TO ESCAPED PRESCRIBED FIRES

The review team assessed past reviews of escaped prescribed burns that led to wildfires over the past 20 years or more, summarizing the many contributing factors. The factors shown below have all contributed to fire escapes. To reduce risks, the Forest Service needs to better incorporate learning about each factor into its prescribed fire program. Each of these factors have been addressed by the recommendations and long-term considerations in this report (see Appendix A for numeric references below).

Pressure to get work done. The pressure to accomplish a treatment stems from both targets (e.g., acres treated) and the passion of our workforce to implement this important work. This pressure can lead to a failure to systematically ensure that practitioners have enough resources and the right perspectives to make the best risk-informed and strategic decisions. Additionally, implementation of many projects has been curtailed by Government furloughs and the COVID-19 pandemic, heightening the sense of urgency for employees to catch up on completing this critical work. *Recommendations/Considerations that respond: Recommendations (R) 2, 3, 6; Long Term Considerations (LTC) 3, 5, 7, 28 and 34*

Lack of sufficient contingency resources. Contingency resources (additional resources for fire suppression in the event that a prescribed fire begins to burn outside the burn area) in the burn plan can become unavailable on short notice or might be too far away to respond in time.

Recommendations/Considerations that respond: R 2, 3; LTC 8

Inaccurate characterization of fuel types. Such inaccuracies have contributed to many fire escapes. In some cases, fuel types changed from when the burn plan was written to the time of ignition. In other cases, an incorrectly classified fuel type burned more intensely than expected.

Recommendations/Considerations that respond: R 1, 4; LTC 4

Failure to consider adjacent fuel types and values at risk. Fuels on adjacent lands can reduce a practitioner's ability to control a fire that moves beyond control lines. In addition, failure to account for adjacent values at risk increases the likelihood of an undesirable outcome.

Recommendations/Considerations that respond: R 1, 4; LTC 4

Insufficient local weather conditions and forecasts. Several fire escapes have been related to insufficient information on local weather conditions and forecasts. The reason can range from malfunctioning remote automatic weather stations to a failure to request spot forecasts and inaccurate spot forecasts. Failure to consider weather forecasts for the days following ignition has also contributed to escapes.

Recommendations/Considerations that respond: R 2; Near Term Consideration (NTC) 3, 5; LTC 4, 7

Insufficient consideration of the impact of long-term drought on prescribed fire behavior. Drought was cited in several reviews of escaped prescribed fires. The impact of drought on prescribed fire behavior will grow in a warming climate. Various indices and other products summarize drought or excess moisture conditions over periods ranging from a week to months or years before a burn ignition. Drought indices and maps produced by the National Drought Monitor, Western Region Climate Center, the National Interagency Coordination Center's Predictive Services, and other organizations provide this type of information. In prescribed fire decision making, however, drought indices might not be considered—or else metrics are used that do not account for the effects of long-term drought (over months or years).

Recommendations/Considerations that respond: R 1, 2, 3; NTC 4; LTC 4, 7, 29

Not using available forecasting tools or insufficient training in using them. A lack of training and experience with fire behavior models used in prescribed fire planning has led to their improper use and interpretation. All models and tools have inherent output uncertainty, yet users are often unaware of it. For high-complexity burns, spatial fire behavior modeling tools are available but often underused.

Recommendations/Considerations that respond: R 1, 3; NTC 1, 5; LTC 8, 12, 25

Inadequate patrolling and mop-up. Fire escapes during the control and mop-up phase (addressing hot spots on the fire perimeter) often occur when conditions become progressively warmer and drier and burn plans are not modified accordingly. Not viewing residual heat in vegetation within burn unit boundaries as a threat has resulted in escapes.

Recommendations/Considerations that respond: R 3; NTC 1; LTC 4, 16, 26

Underrating the complexity of burns. Underrating complexity has been a common theme in escaped prescribed fires for at least 20 years, by underestimating key factors such as changed environmental conditions (i.e., fuel moisture, drought, weather) and growing local complexities such as air quality and expanding values at risk in the wildland-urban interface—a key contributing factor.

Recommendations/Considerations that respond: R 1; NTC 1, 7; LTC 2, 3, 9, 10

Test burns not representative of the burn unit. Selecting a test burn location not representative of the entire unit can lead to gross underestimation of fire behavior, undermining a practitioner's ability to keep prescribed fires within boundaries.

Recommendations/Considerations that respond: R 2; NTC 1; LTC 2, 4, 10

Burning at the upper end of prescription. Practitioners often underestimate the risks associated with burning at the upper end of the prescription (e.g., burning in drier, hotter, and windier conditions). Some start burning earlier in the day to avoid bumping up against the upper end of the prescription; inevitably, the parameters reach the upper limits earlier than expected.

Recommendations/Considerations that respond: R 1, 2, 3, 4; NTC 1, 3, 4; LTC 2, 3, 4, 8, 9, 13, 23, 26, 28, 34

Fire behavior not what was expected. Most prescribed fire escape reviews have highlighted fire behavior that was significantly more intense than expected, particularly at the upper end of prescriptions. This is likely due to lack of consideration of all climatological factors during the day of the burn.

Recommendations/Considerations that respond: R1, 2, 3, 4; NTC 1, 3, 4, 5, 6; LTC 1, 2, 3, 4, 7, 9, 10, 16, 18, 26, 29

Lack of line officer/agency administrator engagement. Inadequate communication between agency administrators and burn bosses has contributed to fire escapes, particularly when conditions on the ground change before, during, or after the burn. Line officers have ultimate responsibility for the prescribed fire once ignited; however, the lack of consistent engagement suggests a tendency to place responsibility for risk management on the practitioners.

Recommendations/Considerations that respond: R 1, 2, 3, 5, 6; NTC 5, 6; LTC 3, 4, 5, 11, 13

Delaying declaration of a wildfire. In many instances, prescribed fires are not declared wildfires early enough, resulting in slower response times and worse consequences from a fire escape. There appears to be perceived negative consequences by those responsible for declaring wildfires when appropriate that should be addressed at an organizational level.

Recommendations/Considerations that respond: R 1, 2, 3, 4, 5; NTC 1, 2, 4, 5, 6; LTC 5, 6, 9, 11, 13, 26, 27, 29

Communications and briefings fail to convey the information needed by everyone for a successful burn. Lack of coordination and communication among personnel involved in a burn, including the agency administrator, burn boss, and local fire management officer as well as cooperating agencies, has been a recurring theme on fire escapes.

Recommendations/Considerations that respond: R 1, 2, 3, 4, 5, 6; NTC 1, 2, 3, 4, 6, 7; LTC 1, 2, 3, 4, 5, 6, 7, 13, 17, 19, 26, 29, 32

Gaps in communication with partners and adjacent landowners. Failure to communicate includes lack of proper notification and lack of agreements with neighboring landowners.

Recommendations/Considerations that respond: R 1, 2, 3; NTC 9; LTC 7, 13, 17, 19, 34, 36

FINDINGS IN FOUR THEMATIC AREAS

Prescribed fire is a critical tool for confronting the wildfire crisis in the West. Despite the risks inherent in every prescribed burn, practitioners can mitigate factors within human control to reduce the possibility of an adverse outcome when factors beyond their control turn out to be different than expected. The review sub-teams explored related issues in four thematic areas (agency culture; climate change and weather; tactics, policy, and training; and agency capacity), all of which have profound impacts on factors that practitioners try to control in conducting prescribed fires.

AGENCY CULTURE

The Forest Service is full of passionate and resourceful people who strive to overcome barriers to prescribed fire implementation in order to effect change on the landscape. The pressure to perform, combined with difficulties in getting to the implementation phase on a prescribed burn, can keep risk-informed decisions from being made at the right level and within the right context. The pressure to achieve tends to create blind spots, and the agency currently operates with a single point of success or failure: the burn boss.

Both internally and externally, Forest Service practitioners need to be clear about the risk of conducting prescribed burning operations as well as the cost of delaying or avoiding treatments. Instead of creating a culture of risk avoidance, they need to move forward with clarity about what they can control. As they increase the pace and scale of landscape-level treatments, they can increase the odds of success but not reduce the risk to zero.

Additionally, the Forest Service traditionally defines accomplishments in terms of what gets done, like acres of hazardous fuels treated. Tracking acres treated is important because it is easily understood by the public and expected by Congress. However, the pressure to reach these output-focused targets can lead practitioners to focus on conducting treatments that are less complex or more easily attainable, thereby limiting opportunities to hone their experience and expertise. Also, even though the agency does track fuels measures that are more focused on outcomes, like mitigating risk, achieving those targets is not what field practitioners are generally held accountable for.

Forest Service employees are attracted to different aspects of the agency's mission, whether land management responsibilities or the role of protection linked to fire suppression response. The agency treats planned ignitions differently than unplanned ignitions, reinforcing the view that one is optional while the other is not. The difference plays out in numerous ways, including in agency administrator involvement, risk management, funding, staffing, internal and external communication, and analytic support. Investments in both are needed for the agency to be able to effectively suppress fires and have a safe and expanding prescribed fire program.

The prescribed fire implementation environment continues to grow in complexity, whereas the ability of practitioners to practice what they know and hone their expertise in a complex environment has not. Prescribed burning planning and implementation require a different skillset and support network than currently accounted for in the Forest Service's approach. Practitioners need to consistently and frequently recalibrate the baseline across both the wildfire and prescribed fire environments in order to adjust and adapt approaches to avoid undesirable outcomes. Currently, the Forest Service has no good mechanism for gaining expertise in implementing complex prescribed burning projects, such as treatments in areas with a severe departure from historical burning conditions next to high values at risk. Practitioners need to approach such areas differently while also recognizing that becoming proficient means practice. The Forest Service needs to invest in employees while also building a stronger network of support from others, with more depth to the system.

Clear and consistent leader's intent and line officer engagement are key to helping employees overcome conflicting priorities, clarify risk, share ownership in a prescribed burning program, and foster innovation and learning.

The culture of prescribed fire varies across the Forest Service, most notably between the eastern and western regions, but also between individual units based on local leader's intent. Lack of a consistent filter for prioritization or risk management across the organization creates an environment in which prescribed burn implementers need to take on more responsibility in order for work to be accomplished. Although local culture will always have a role in the larger agency culture, the Forest Service needs to remove some of the inconsistencies and move toward a stronger agency-wide stance on prescribed burning. Prescribed burning is often suspended when something unforeseen happens (such as a Government furlough, the COVID-19 pandemic, or catastrophic wildfires); it is typically a lower priority for the Forest Service than other issues and activities, including timber target accomplishments, other resource areas, fire suppression, and social concerns. Although initiatives like the Wildfire Crisis Strategy emphasize the need for fuels treatments, the agency culture is to treat prescribed burning as just one of many priorities, which creates a lack of urgency for almost anything but wildland firefighting (that is, emergency response). Additionally, minor short-term impacts are often strongly weighted above long-term benefits.

The Forest Service's processes for assessing complexity and risk do not take human factors into account, even though human factors directly influence both the risk and complexity involved in carrying out a prescribed fire. For example, cumulative fatigue, implementer experience, pressures to perform, and a common understanding of objectives all figure into a prescribed burning project's risk and complexity.

The current Forest Service approach to sharing information and lessons learned means that learning is applied at the individual or unit level but rarely at a broad, interagency scale. Additionally, the agency offers no incentives for innovation or change; instead, the agency culture instills fear of failure (or a perception of intolerance for it), leading employees to continue past practices out of habit or because it is the current operating environment—and not because it is based on the best available science.

Agency reviews of prescribed fire escapes leading to declared wildfires demonstrate human factors that contribute to the escapes. However, the current system has no mechanism for acknowledging the presence of uncertain variables in the complex environment of planned fire, just as in unplanned fire. The Forest Service needs to improve the communication and documentation of small issues ("weak signals") to prevent the normalization of deviance. Although attention to fire escape reviews can vary, depending on the severity of results, expectations from reviews are not currently scaled to the severity of the wildfire effects resulting from the fire escape, and early communication of issues across a broad spectrum of employees do not occur. Also, more subtly, can-do attitudes in the Forest Service can lead to failure to recognize early warning signs.

For the Forest Service to successfully confront the Wildfire Crisis Strategy, agency culture will need to change to elevate the priority of prescribed fire and adopt an all-hands approach to using this central tool for fuels reduction and forest resiliency.

TACTICS, POLICY, AND TRAINING

Can-do attitudes in the Forest Service can stretch the agency thin by saddling employees with administrative tasks. Staff spend a lot of time and energy on administrative duties, including human resources, contracting, purchasing, and mandatory training. They also face challenges associated with filling positions. Employees could spend much of this time focusing instead on core job duties, in this

case prescribed fire. Such administrative challenges can reduce the ability of employees to focus on working as a high-reliability organization. In addition, key training in technical writing, fire effects monitoring, program management, and basic concepts of ecology might be missing because it is outside the qualifications required for burn boss certification.

Moreover, the interagency community does not have the capacity to update course materials related to prescribed burning because most instructors serve as trainers through a collateral-duty arrangement. More full-time personnel responsible for course content and delivery might be better suited to ensuring the relevance of some courses.

Attrition at the agency administrator and burn boss levels leads to loss of institutional knowledge and experience. The Forest Service needs a system for transferring institutional knowledge and experience to new agency administrators and less experienced burn bosses, especially with respect to complexity analysis and burn plan review processes. Also, local managers and burn bosses might not have the capacity or skills to monitor changing fire danger and drought level indices from the time the burn plan is written to the time planned for ignition.

The guidance for prescribed fire plan preparation is inconsistently applied (an issue that has come up in past fire escapes). Inconsistencies relate to complexity analysis, prescription development, holding, and contingency resources. The technical review process is also inconsistent; it needs more intentionality and fire environment expertise. Implementation details, which can be hard to find in a burn plan, need to be more accessible to all or most members of the burn organization.

Local burn bosses, fire staff, and agency administrators need better decision support in risk and exposure analysis with respect to the latest fire science regarding weather, fuels, drought, smoke, and fire behavior. Weather forecasts can vary between model runs, and the spot forecast might not reflect the most recent information at the time of ignition. A consistent burn day authorization process (sometimes known as a "variance" request) could aid in facilitating conversations about risk through a better decision support system to maximize optimum burning windows after considering weather, drought, staffing, and other factors contributing to risk. Also, monitoring and documentation of the effects of fuels treatments and burn day activities are often incomplete. Such information is critical for evaluating and documenting the outcomes of a burn, and it should be emphasized by burn bosses and agency administrators.

Tools such as drones and infrared devices are not fully used in monitoring and patrolling prescribed fires. Also, drone training and certification for ignitions and monitoring could help but would need a dedicated module and/or dedicated positions to ensure their effectiveness. Risk decision support tools are helpful in determining the appropriate drone platform or other aerial resources to use (such as helicopters). Both infrared devices and drones could be used to improve situational awareness and support strategic and tactical decisions.

Improper sequencing of treatment activities contributes to increased potential for fire escapes. High-level and project-level planning often lead to missed opportunities for strategic fire planning that connects high-level models/planning and project planning on a specific footprint at a local level. Fuels treatments in areas adjacent to the burn unit are sometimes not considered. Project implementation sometimes gets delayed by the need for environmental analysis and surveys, or by weather conditions.

Additionally, processes under the National Environmental Policy Act typically focus on traditional silvicultural treatments at a project level, which severely limits planning attention and resources for fuels treatments.

Test burns are not always representative of the potential fire behavior. Practitioners often face the challenge of finding a location for a test fire that is representative of fuels within the entire burn unit while also ensuring that the test fire does not escape containment. Emerging technology and training using virtual reality will help in building mental models of what "looks right" in a variety of fuel types.

Traditionally, many Forest Service units have used pile burning to reduce fuel loading. Due to a changing climate, piles remain burning over longer periods of time and can rekindle after monitoring has ended. Pile burning typically occurs during the time of year when most seasonal employees are not yet working and when permanent employees are stretched thin. Effective burn plans and appropriate staffing to build, light, and monitor piles are critically important.

Current agreement policies and contracting laws can keep units from finding the resources they need to carry out complex, large-scale, or long-duration prescribed fires. On wildfires, you can order resources you need through a nationalized, interagency ordering system; by contrast, prescribed fires require working with whatever is locally available, which can leave units with limited contingency resources, skillsets, and tools—not necessarily enough to maximize opportunity while minimizing risk. The Forest Service needs to have more tools available for prescribed burning, ranging from a more efficient environmental analysis and regulatory process; to contracting through a process similar to wildfire and oversight with heavy equipment bosses (instead of contract officer representatives); to decision support personnel, aviation resources, and hazard pay for employees. Monetary incentives for prescribed fire can help elevate the profile of the program, just as is being done in the wildfire arena.

CLIMATE CHANGE AND WEATHER

Prescribed fire is a central part of the Forest Service's 10-year strategy for confronting the wildfire crisis in the West. Across many landscapes, the agency has no better tool for reducing fuel levels and increasing the resilience of fire-adapted forests, even in an era of climate change. Nevertheless, as temperatures rise and precipitation patterns shift across the United States, conditions for prescribed fire will change and the potential for fire escapes will grow. Increased temperatures and extreme heat events, along with droughts that are more prolonged and severe, will bring less soil moisture, drier fuels, and more potential for undesirable fire behavior. Higher temperatures and more severe drought will also raise nighttime vapor pressure, possibly resulting in more nighttime fire activity than in the past.

Practitioners have the option of choosing when and where to ignite a prescribed fire based on detailed knowledge of ambient weather conditions (such as temperature, humidity, and wind); fuel conditions; and preceding climate influences. The impacts of climate and climate variability are most significant on fuel availability, and the impacts of weather are most significant on fire behavior as those fuels burn. Climate-driven changes or fluctuations in the availability of desired weather and fuel conditions will affect opportunities to burn, the risk of wildfires, changes in ecosystem structure and scale, and the need for prescribed fire as a means of community and resource protection. Conversations between practitioners and decision makers will be critical to ensure a common operating picture of the fire

environment. Weather parameters and seasonal climate indices can help focus and frame these conversations.

Although changes in weather and fuel conditions (such as temperature, relative humidity, and fuel moisture) will become more frequent with climate change, current tools and models used for prescribed fire planning are generally capable of accounting for the changes. Nevertheless, improved technology and modeling in the longer-term can improve the success of prescribed fire as a tool in fuel treatments.

A fundamental issue in preparing prescribed burn plans—and a factor in the recent prescribed fire escapes—is lack of training and experience with tools and models, leading to their improper use and interpretation. The quality of the input data also limits current models. Increased training on tools and models and improved input data quality will help to ensure the safe and effective use of prescribed fire, even in a changing climate.

However, prescribed fire carries inherent risks, some of which will be exacerbated by climate change. Although eliminating risk is impossible, a sound process anchored in science can greatly reduce the risk and improve outcomes. The Forest Service will continue to carry out prescribed fires while focusing on the risks that managers can control and the uncertainties that can be reduced. Changes in climate and related changes in prescribed fire conditions will vary locally and in different parts of the country. Interpretations of model output might need to be adjusted to account for changing conditions in different regions. Flexibility in using models and tools and thresholds for prescribed fire will be needed to account for regional variability and to ensure that prescribed fire is conducted safely and effectively in different locations and contexts.

AGENCY CAPACITY

As part of its Wildfire Crisis Strategy, the Forest Service has vowed to step up the pace and scale of fuels and forest health treatments to match the scale of wildfire risk across fire-adapted landscapes in the West. Working with partners, the Forest Service will use cutting-edge tools to place the right treatments in the right places at the right scale. In many or even most cases, the right treatments will include the safe and effective use of prescribed fire.

Given the current agency workforce and how it is used, Forest Service units lack the capacity to effectively conduct prescribed burning at the needed scale. In addition to looking at options for maximizing use of the existing workforce, the Forest Service is assessing additional capacity that will be needed for a successful prescribed burn program at scale and how the additional capacity should be defined. Where applicable, an all-hands, all-lands approach to support an interorganizational workforce should be considered.

The Forest Service's national emphasis, especially during severe fire years, is on wildfire suppression response and success. For a fully successful prescribed fire program, the agency needs to elevate prescribed burning and its resource needs to more closely approach the priority level as wildfire response. The need to prioritize prescribed burning in tandem with wildland fire suppression—and not in competition with it—is consistent across all regions. The Wildfire Crisis Strategy and its implementation plan project enormous increases in acres treated to reduce wildfire risk, in large part through the safe and effective use of prescribed fire. To succeed, the Forest Service should begin to

place the same level of emphasis on resource allocation to meet prescribed fire needs as the level of emphasis placed on meeting wildland fire suppression needs, especially to reduce conflicts during long fire years and shoulder season overlap.

The Forest Service's prescribed fire program has institutional limitations on implementation, support, and funding that wildland fire suppression does not. Fire suppression tools, resources, and expertise are not being sufficiently used by prescribed fire practitioners because of perceived and real administrative and procedural barriers.

Building and maintaining public support and acceptance for prescribed fire use will be key to increasing the Forest Service's prescribed fire footprint and adding to its prescribed fire capacity. Communication should be ongoing and tailored to public needs, not given superficial treatment through broad or sporadic information campaigns. As Gifford Pinchot, the first Forest Service Chief, famously noted, "A public official is there to serve the public and not run them." The communication work should engage the public based on how the world is, not on how practitioners would like it to be.

The level of public support for prescribed fire varies across the Nation; overall, however, the acceptance is there. Where public support is limited, it is rarely due to a lack of understanding of the risks associated with prescribed fire. As prescribed fire programs are expanded, and benefits are realized, the social barriers to prescribed fires (such as public understanding and support, air quality regulations, and liability) are less of an issue than widely believed and can be reduced through interactive public engagement.

Forest Service program direction helps to align local decisions regarding the agency's program of work with national priorities and budget management practices. Recent changes in the Forest Service's national budget process have improved planning and execution of the agency's program of work for fuels management, including prescribed fire. However, the Forest Service needs to better channel financial resources to the ground for added prescribed fire capacity.

RECOMMENDATIONS TO SAFELY RESUME OPERATIONS

Based on its review of factors contributing to prescribed fire escapes and findings in thematic areas critical to program success, the review team made the following recommendations for immediate implementation before the Forest Service resumes its prescribed fire program:

1. Prior to implementation—all prescribed fire plans and associated complexity analyses, including plans for pile burning, will be evaluated using the provided checklist (Appendix B). New prescribed fire burn plans and plans that the preparer deems to have changed significantly will use the new burn plan template (Appendix C). Evaluation will focus on the complexity analysis and rating; consideration of fuel conditions in adjacent areas; and current and foreseeable environmental factors, including regionally relevant drought metrics, trends in drought indices, and other information sources that reflect the influence of long-term drought and other climate factors on seasonal fuel changes. The agency administrator will actively participate in the evaluation. Prescribed fire plans may be implemented only after receiving review and updated

approval by a technical reviewer (in the case of a change) and after being certified by the appropriate qualified agency administrator, as described in the Red Book (chapter 5, pages 126-128).

2. To standardize communication, the ignition authorization briefing (element 2A, Agency Administrator Ignition Authorization) will include, at a minimum, a qualified agency administrator; the associated line officer (unless it is the same person); the burn boss; and the fire management officer or duty officer (i.e., the party responsible for wildfire response). The briefing will discuss element 2A, develop a patrol plan, establish responsibilities, and confirm communication points prior to ignition. To ensure close coordination during implementation, with multiple perspectives heard, the agency administrator and burn boss, at a minimum, will communicate at the following points:

   a. confirmation that local/State government and adjacent landowners have been notified**;**

   b. completion of element 2B (Prescribed Fire Go/No go Checklist), including results from the Risk Assessment Tool;

   c. completion of the test fire and results/conclusions—or, for multi-day ignitions, after evaluating the effects of the previous shift and/or current active fire behavior;

   d. completion of ignitions for the shift;

   e. release of resources;

   f. at any point during implementation when contingency actions are needed, including the initiation of contingency resources; and

   g. routine updates on patrol outcomes, including pile burning.

3. Reduce authorized timeframes in element 2A to the Operational Period (24 hours) for the day of the burn and increase the factors discussed. Each day of ignition will receive a new 2A, with required additional coordination at the specific communication points listed above. Element 2A will:

   a. document consideration of regionally relevant drought metrics;

   b. document consideration of fuels and potential fire behavior in areas adjacent to the planned prescribed burn, including values at risk;

   c. validate that the maximum response time for the minimum compliment of contingency resources on moderate or high complexity projects is 30 minutes. Additional contingency resources may have longer response times based on projected needs and timing of foreseeable events that require additional resources to assist;

   d. validate that element 9 is achievable and ensure that a remote automatic weather station that represents the project area is being used (or document coordination with local units of the National Weather Service);

e. ensure consistency with Forest Service Manual requirements (FSM 5142.3) related to weather forecasting for the day(s) of implementation and 7-10 days thereafter to verify that conditions are within the burn plan prescription and to shape the patrol plan; and

f. document that a patrol plan is in place and that the plan is viable until the burn is declared out.

4. **Element 2B will document whether all elements within element 2A are still valid based on site conditions and will also assess human factors,** including pressures on implementers and their fatigue and experience levels. Structure the conversation using the Forest Service Risk Calculator Mobile Application's Risk Assessment Tool or other applicable tool.

5. **Nationally, approving agency administrators and/or line officers will be present on the Forest Service unit for all high-complexity burns;** unit line officers (or line officer from another unit familiar with the burn unit)) will be on unit for 30-40% of moderate complexity burns. In addition, the approving agency administrator and/or unit line officers will visit the fireline on all high complexity burns to observe firing operations and fire behavior. Agency administrators and/or line officers who are new to their roles will greatly benefit from spending additional time on the fireline observing fire behavior together with prescribed fire personnel.

6. **After the pause in prescribed fire activities has been lifted, units will not resume their prescribed burning programs until agency administrators/line officers go over the findings and recommendations in this review report with all employees involved in prescribed fire activities.** Forest supervisors will certify that the briefing has occurred and provide documentation to their Regional Foresters, who will forward it to the Deputy Chief for State and Private Forestry.

7. **The Chief will designate a specific Forest Service point of contact to oversee and report on the implementation of these recommendations** and on the progress made in carrying out other recommendations made and considerations raised in this review report.

The review team also made another set of considerations for near-term implementation to help the Forest Service better use prescribed fire as part of its 10-year Wildfire Crisis Strategy. The team does not consider implementation of the additional recommendations necessary before lifting the pause on prescribed fire activities. However, the following considerations should be reviewed for possible incorporation into the prescribed fire program in the near future:

1. **Establish the Western Interagency Prescribed Fire Training Center under development by the Forest Service's Fire and Aviation Management, Washington Office.**

2. **For clarity and consistency, a declared wildfire review will be the standard approach whenever a prescribed fire has been declared a wildfire.** The review will be delegated by the Regional Forester or the Chief. The review will provide a shared understanding of what happened as a basis for learning from the event while meeting the Forest Service's obligation for a thorough review.

a. The review will be scalable to the severity of the impact resulting from an escaped prescribed fire. A database for tracking results of reviews will be developed. Review requirements will be clearly articulated for each scale and a standard process will be used.

b. The review will not preclude initiation of a rapid lesson sharing (RLS) or facilitated learning analysis (FLA) for the declared wildfire after the review is completed.

c. An escaped prescribed fire that is not declared a wildfire will have an RLS or FLA completed under delegation from the approving agency administrator's supervisor.

d. Lessons learned from declared wildfire reviews, RLSs, and FLAs will be shared during the yearly RT-300 refresher course that burn bosses and agency administrators attend.

3. **Ensure that remote automatic weather stations are functional and maintained to standard (with a clear system for tracking and reporting) to provide localized weather data that is integrated into prescribed burning decision making.** Follow the nationally standardized maintenance and accountability direction from the Remote Automatic Weather Station Depot.

4. **Create a national prescribed fire website** or similar vehicle that is regularly updated (weekly or biweekly) with drought information from multiple sources, including indices that reflect the rapid onset of drought (such as the Evaporative Demand Drought Index).

5. **Deliver standard content across all Prescribed Fire Burn Boss courses (RT-300).** Work with the National Wildfire Coordinating Group (NWCG) to require the Prescribed Fire Burn Boss Refresher course annually for burn bosses and agency administrators, include interagency partners; and update its content to include climate change effects on fire and fuels, drought, and modeling tools.

6. **Increase national and geographic-level situational awareness and alignment** through the incorporation of prescribed fire activity into the National Situation Report and into ongoing roundtable discussions (such as the Incident Management Response Roundtables). Encourage the use of the NWCG Safenet and Wildland Fire Lessons Learned Center systems to communicate "weak signals" and successes.

7. **Continue investing in potential operational delineations (PODs)** and ensure they are used as a tool for both fire response and vegetative/fuels management planning. Use investments under the Infrastructure Investment and Jobs Act and Inflation Reduction Act on treatments that improve the network of PODs and/or help finalize and connect treatments across the landscape. Use established PODs to improve decision making on prescribed fire implementation (including phasing treatments) as well as on managing fire for resource benefits.

8. **Use the Forest Service's focus on 10 Priority Landscapes in its Wildfire Crisis Strategy as centers for innovation to make longer term improvements to systems, including standing up a more robust implementation support system for mobilizing suppression and non-suppression resources for phased implementation of prescribed fire projects.**

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a. Use one National Incident Management Organization to help develop a national strategic plan for prescribed fire implementation across the Priority Landscapes, including a plan for implementation timing as well as a proposed implementation command structure and logistical support for the Priority Landscapes across regional boundaries, analogous to an Area Command effort to prioritize suppression resources across incidents within their area.

b. Mobilize national Forest Service suppression resources, qualified militia, and contractors to support implementation of prescribed-burning-related shelfstock within the 10 Priority Landscapes.

- This will not be solely for ignitions; all preignition work and contingency planning that widens the window for burning and raises the likelihood of success will be included (such as containment lines, shaded fuel breaks, blacklining, and so on).

c. Treat this effort as a pilot project to evaluate the effectiveness of mobilization, assess different approaches to the sequencing of treatments, and act as center of innovation to improve the broader prescribed fire system. This would include tracking successes and undesired outcomes as well as any missed opportunities and what led to those situations (such as lack of sufficient resources, smoke constraints, and so on) to help shape future system improvements.

9. **Establish an interagency, multi-level representation group to evaluate the effectiveness of the short-term recommendations and lessons learned from them for making more permanent changes.** Continue to encourage and foster innovation by adopting effective changes and evaluating them through a longer temporal lens. The group should report to the Director of Fire and Aviation Management through the Deputy Director for Landscapes.

IMPROVING THE FOREST SERVICE'S PRESCRIBED FIRE PROGRAM

The Nation faces a wildfire crisis, especially in the West, where fuel buildups, climate change, and a burgeoning wildland/urban interface have placed homes, communities, infrastructure, and natural resources at rising wildfire risk. In response, the Forest Service has launched a Wildfire Crisis Strategy to dramatically increase the scale of fuels and forest health treatments across the landscapes most at risk. The desperately needed treatments include returning fire to fire-adapted landscapes through the safe and effective use of prescribed fire.

Almost all of the Forest Service's prescribed fire treatments go according to plan, with only a very small percentage of fire escapes each year. In the spring of 2022, however, wildfires resulted from escaped prescribed fires in some States, showing that even a few fire escapes can have devastating results.

As an organization dedicated to learning, the Forest Service paused its prescribed fire program pending a thorough program review. The review team is confident that agency-wide implementation of the immediate recommendations in this report will reposition the Forest Service for the safe and effective use of prescribed fire across the Nation. Moreover, implementation of the near-term considerations in this report, coupled with a subsequent review of the long-term considerations raised, will strengthen the agency's prescribed fire program, underpinning successful implementation of the Wildfire Crisis Strategy over the next 10 years and beyond.

Shown below are all immediate, near term, and potential actions and/or considerations for longer term prescribed fire program review based on findings from this initial review. Future teams might identify other considerations or modify shown here to better meet the needs of the time.

#	Recommendations (1-7) and Considerations (NT-1 through -9 and LT-1 through -36)	Associated Finding(s)	Action	Estimated Timeline
1.	Prior to implementation, review all active prescribed fire plans to ensure accurate complexity ratings, consideration of adjacent fuel conditions, current and foreseeable environmental factors, including drought and other climate factors on seasonal fuel changes. Ensure active agency administrator participation in this review.	Inaccurate characterization of fuel types. Failure to consider adjacent fuel types and values at risk. Insufficient consideration of the impact of long-term drought on prescribed fire behavior. Not using available forecasting tools or insufficient training in using them. Underrating the complexity of burns. Lack of line officer/agency administrator engagement. Gaps in communication with partners and adjacent landowners.	All prescribed fire plans and associated complexity analyses, including plans for pile burning, will be evaluated prior to implementation using the provided checklist. New prescribed fire burn plans and plans that the preparer deems to have changed significantly will use the new burn plan template. Prescribed fire plans may be implemented only after addressing all items from the checklist, undergoing a technical review (in the case of a change to the plan) and after being approved by the appropriate qualified agency administrator.	Immediate
2.	Increase communication between the agency administrator, line officer, burn boss, and party responsible for wildfire response to	Pressure to get work done. Lack of sufficient contingency resources.	To standardize communication, the ignition authorization briefing (element 2A, Agency Administrator Ignition Authorization)	Immediate

#	Recommendations (1-7) and Considerations (NT-1 through -9 and LT-1 through -36)	Associated Finding(s)	Action	Estimated Timeline
	ensure multiple perspectives are incorporated and clear understanding is achieved prior to proceeding with ignition authorization. Standardize communication points throughout the implementation process to share risk and ownership.	Insufficient local weather conditions and forecasts. Insufficient consideration of the impact of long-term drought on prescribed fire behavior. Inadequate patrolling and mop-up. Test burns not representative of the burn unit. Burning at the upper end of prescription. Fire behavior not what was expected. Lack of line officer/agency administrator engagement. Delaying declaration of a wildfire. Communications and briefings fail to convey the information needed by everyone for a successful burn. Gaps in communication with partners and adjacent landowners.	will include, at a minimum, a qualified agency administrator; the associated line officer (unless it is the same person); the burn boss; and the fire management officer or duty officer (i.e., the party responsible for wildfire response).	
3.	Improve critical thinking and incorporation of multiple perspectives in the ignition authorization discussion.	Pressure to get work done. Lack of sufficient contingency resources.	Reduce authorized timeframes in element 2A to the Operational Period (24 hours) for the day of the burn and	Immediate

#	Recommendations (1-7) and Considerations (NT-1 through -9 and LT-1 through -36)	Associated Finding(s)	Action	Estimated Timeline
		Insufficient local weather conditions and forecasts. Insufficient consideration of the impact of long-term drought on prescribed fire behavior. Inadequate patrolling and mop-up. Burning at the upper end of prescription. Lack of line officer/agency administrator engagement. Communications and briefings fail to convey the information needed by everyone for a successful burn. Gaps in communication with partners and adjacent landowners.	increase the factors discussed.	
4.	Increase critical thinking and incorporate human factors into the go/no go check prior to the test fire.	Pressure to get work done. Inaccurate characterization of fuel types. Failure to consider adjacent fuel types and values at risk. Lack of line officer/agency administrator engagement. Communications and briefings fail to convey the information needed by	Element 2B will document whether all elements within element 2A are still valid based on site conditions and will also assess human factors, including pressures on implementers and their fatigue and experience levels.	Immediate

#	Recommendations (1-7) and Considerations (NT-1 through -9 and LT-1 through -36)	Associated Finding(s)	Action	Estimated Timeline
		everyone for a successful burn.		
5.	Increase agency administrator and line officer involvement in and ownership and support of the prescribed fire program.	Lack of line officer/agency administrator engagement.	Nationally, approving agency administrators and/or line officers will be present on the Forest Service unit for all high-complexity burns; unit line officers (or line officer from another unit familiar with the burn unit)) will be on unit for 30-40% of moderate complexity burns. In addition, the approving agency administrator and/or unit line officers will visit the fireline on all high complexity burns to observe firing operations and fire behavior. Agency administrators and/or line officers who are new to their roles will greatly benefit from spending additional time on the fireline observing fire behavior together with prescribed fire personnel.	Immediate
6.	Increase emphasis on learning and shared ownership in the prescribed fire program.	Pressure to get work done. Lack of line officer/agency administrator engagement.	After the pause in prescribed fire activities has been lifted, units will not stand up their prescribed burning	Immediate

#	Recommendations (1-7) and Considerations (NT-1 through -9 and LT-1 through -36)	Associated Finding(s)	Action	Estimated Timeline
			programs until agency administrators/line officers go over the findings and recommendations in this review report with all employees involved in prescribed fire activities. Forest supervisors will certify that the briefing has occurred and provide documentation to their Regional Foresters, who will forward it to the Deputy Chief for State and Private Forestry.	
7.	Ensure agency ownership and accountability for innovation and shifting systems and culture.	The current Forest Service approach to sharing information and lessons learned means that learning is applied at the individual or unit level but rarely at a broad, interagency scale. The agency offers no incentives for innovation or change.	The Chief will designate a specific Forest Service point of contact to oversee and report on the implementation of these recommendations and on the progress made in carrying out other recommendations made and considerations raised in this review report.	Immediate
NT 1.	Increase learning and expertise of prescribed fire practitioners.	The prescribed fire implementation environment continues to grow in complexity, whereas the ability of practitioners to practice what they know and hone their expertise in a complex environment has	Establish the Western Interagency Prescribed Fire Training Center under development by the Forest Service's Fire and Aviation	Currently in progress, 6 months to full implementation

#	Recommendations (1-7) and Considerations (NT-1 through -9 and LT-1 through -36)	Associated Finding(s)	Action	Estimated Timeline
		not. There is a need to expand the existing work of the Prescribed Fire Training Center in Tallahassee to increase agency and partner capacity for prescribed fire in the West.	Management, Washington Office.	
NT 2.	Provide clear direction on the expected processes for escaped prescribed fires to ensure consistent approach across the agency.	Although attention to fire escape reviews can vary, depending on the severity of results, expectations from reviews are not currently scaled to the severity of the wildfire effects resulting from the fire escape, and early communication of issues across a broad spectrum of employees do not occur.	A declared wildfire review will be the standard approach whenever a prescribed fire has been declared a wildfire. The review will be assigned to a Regional Forester for completion.	Move this direction immediately; complete implementation involves policy change and approximately 12 months.
NT 3.	Increase reliability of local and national weather data sources.	Insufficient local weather conditions and forecasts from malfunctioning (or absent) automatic weather stations.	Ensure that remote automatic weather stations are functional and maintained to standard (with a clear system for tracking and reporting) to provide localized weather data that is integrated into prescribed burning decision making.	4-6 months
NT 4.	Increase availability of regionally applicable drought information for burn bosses and agency administrators.	Insufficient consideration of the impact of long-term drought on prescribed fire behavior.	Create a national prescribed fire website or similar vehicle that is regularly updated (weekly or biweekly) with drought	6-8 months

#	Recommendations (1-7) and Considerations (NT-1 through -9 and LT-1 through -36)	Associated Finding(s)	Action	Estimated Timeline
			information from multiple sources, including indices that reflect the rapid onset of drought (such as the Evaporative Demand Drought Index).	
NT 5.	Utilize existing training delivery courses to increase coordination and updated information sharing between interagency partners, burn bosses and agency administrators.	Lack of line officer/agency administrator engagement. Not using available forecasting tools or insufficient training in using them. The current Forest Service approach to sharing information and lessons learned means that learning is applied at the individual or unit level but rarely at a broad, interagency scale. Attrition at the agency administrator and burn boss levels leads to loss of institutional knowledge and experience.	Deliver standard content across all RT-300 courses. Standardize the Prescribed Fire Burn Boss Refresher course (RT-300). Work with the National Wildfire Coordinating Group (NWCG) to require the Prescribed Fire Burn Boss Refresher course annually for burn bosses and agency administrators, include interagency partners; and update its content to include climate change effects on fire and fuels, drought, and modeling tools.	Present Proposal to NWCG in 6-8 months

#	Recommendations (1-7) and Considerations (NT-1 through -9 and LT-1 through -36)	Associated Finding(s)	Action	Estimated Timeline
NT 6.	Increase use of existing communication methods to improve national and geographic-level situational awareness.	The agency treats planned ignitions different than unplanned ignitions, reinforcing the view that one is optional while the other is not. The current Forest Service approach to sharing information and lessons learned means that learning is applied at the individual or unit level but rarely at a broad, interagency scale. The Forest Service needs to improve the communication and documentation of small issues ("weak signals") to prevent the normalization of deviance.	Increase national and geographic-level situational awareness and alignment through the incorporation of prescribed fire activity into the National Situation Report and into ongoing roundtable discussions (such as the Incident Management Response Roundtables). Encourage the use of the NWCG Safenet and Wildland Fire Lessons Learned Center systems to communicate "weak signals" and successes.	Present Proposal to NWCG in 6-8 months
NT 7.	Leverage existing strategic planning efforts to improve decision making on prescribed fire implementation and to help finalize and connect treatments across the landscape.	Lack of a consistent filter for prioritization or risk management across the organization. Improper sequencing of treatment activities contributes to increased potential for fire escapes. High-level and project-level planning often lead to missed opportunities for strategic fire planning that connects high-level models/planning and project planning on a specific footprint at a local level.	Continue investing in potential operational delineations (PODs) and ensure they are used as a tool for both fire response and vegetative/fuels management planning.	Ongoing

#	Recommendations (1-7) and Considerations (NT-1 through -9 and LT-1 through -36)	Associated Finding(s)	Action	Estimated Timeline
NT 8.	Stand up a pilot effort to inform how to change systems related to prioritization, mobilization, and treatment sequencing and to promote innovation.	The agency treats planned ignitions different than unplanned ignitions, reinforcing the view that one is optional while the other is not. Current agreement policies and contracting laws can keep units from finding the resources they need to carry out complex, large-scale, or long-duration prescribed fires. The Forest Service's prescribed fire program has institutional limitations on implementation, support, and funding that wildland fire suppression does not. Improper sequencing of treatment activities contributes to increased potential for fire escapes. High-level and project-level planning often lead to missed opportunities for strategic fire planning that connects high-level models/planning and project planning on a specific footprint at a local level. For a fully successful prescribed fire program, the agency needs to elevate prescribed burning and its resource needs to the same priority level as wildfire	Use the Forest Service's focus on 10 Priority Landscapes in its Wildfire Crisis Strategy as centers for innovation to make longer term improvements to systems, including standing up a more robust implementation support system for mobilizing resources for phased implementation of prescribed fire projects.	Begin immediately with complete implementation in 1 year.

#	Recommendations (1-7) and Considerations (NT-1 through -9 and LT-1 through -36)	Associated Finding(s)	Action	Estimated Timeline
		response. The need to prioritize prescribed burning in tandem with wildland fire suppression—and not in competition with it—is consistent across all regions. The current Forest Service approach to sharing information and lessons learned means that learning is applied at the individual or unit level but rarely at a broad, interagency scale. The agency offers no incentives for innovation or change.		
NT 9.	Utilize momentum from interagency, multilevel short-term review to increase interagency learning and to promote innovation.	The current Forest Service approach to sharing information and lessons learned means that learning is applied at the individual or unit level but rarely at a broad, interagency scale.	Establish an interagency, multilevel representation group to evaluate the effectiveness of the short-term recommendations and lessons learned from them for making more permanent changes.	1 to 4 months
LT 1.	Revise the current prescribed fire plan to more accurately account for pile burning actions and considerations.	Pile burning is widely considered "low" complexity and doesn't garner the same focus attention in planning and implementation and patrol.	Develop a separate prescribed fire plan for pile burning to better capture and evaluate the complexity and the different approaches in the elements. Create an interdisciplinary committee to evaluate the role of pile burning within the broader land	Present Proposal to NWCG in 6-8 months

#	Recommendations (1-7) and Considerations (NT-1 through -9 and LT-1 through -36)	Associated Finding(s)	Action	Estimated Timeline
			management process and review current pile burning guidance, policy, and practice.	
LT 2.	Improve the prescribed fire plan to more accurately capture both the complexity of a prescribed burn as well as the risk, and to spur critical thinking between the agency administrator and the burn boss.	The current system has no mechanism for acknowledging the presence of uncertain variables in the complex environment of planned fire, just as in unplanned fire. Forest Service practitioners need to be clear about the risk of conducting prescribed burning operations as well as the cost of delaying or avoiding treatments. The Forest Service's processes for assessing complexity and risk don't take human factors into account, even though human factors directly influence both the risk and complexity involved in carrying out a prescribed fire. The pressure to perform, combined with difficulties in getting to the implementation phase on a prescribed burn, can keep risk-informed decisions from being made at the right level and within the right context. The pressure to achieve tends to create blind spots, and the agency currently	Redesign element 3 of the burn plan: separate risk and complexity assessments to produce two separate ratings to spur critical thinking and ensure alignment between the agency administrator and burn boss.	12 months

#	Recommendations (1-7) and Considerations (NT-1 through -9 and LT-1 through -36)	Associated Finding(s)	Action	Estimated Timeline
		operates with a single point of success or failure: the burn boss.		
LT 3.	Improve the prescribed fire plan to more accurately capture risk and human factors to spur critical thinking between the agency administrator and the burn boss.	The Forest Service's processes for assessing complexity and risk don't take human factors into account, even though human factors directly influence both the risk and complexity involved in carrying out a prescribed fire. The pressure to perform, combined with difficulties in getting to the implementation phase on a prescribed burn, can keep risk-informed decisions from being made at the right level and within the right context. The pressure to achieve tends to create blind spots, and the agency currently operates with a single point of success or failure: the burn boss.	Revise elements 2A and 2B to better capture risk and human factors, using lessons learned from the short-term recommendations. Evaluate the potential to use biofeedback as an objective measure of personnel fatigue.	6 to 9 months
LT 4.	Increase agency administrator involvement and oversight in the prescribed burn plan preparation process. Consider incorporation of a checklist or guide for agency administrators to help them understand	Inaccurate characterization of fuel types. Failure to consider adjacent fuel types and values at risk. Insufficient consideration of the impact of long-term drought on prescribed fire behavior.	Evaluate the incorporation of the draft High Reliability Checklist produced during the 90-day Prescribed Fire Review into future prescribe fire plans and/or processes.	12 months

#	Recommendations (1-7) and Considerations (NT-1 through -9 and LT-1 through -36)	Associated Finding(s)	Action	Estimated Timeline
	the critical components and how to engage.	Not using available forecasting tools or insufficient training in using them. Underrating the complexity of burns. Lack of line officer/agency administrator engagement. Gaps in communication with partners and adjacent landowners The guidance for prescribed fire plan preparation is inconsistently applied. The technical review process is also inconsistent; it needs more intentionality and fire environment expertise. A fundamental issue in preparing prescribed burn plans—and a factor in the recent prescribed fire escapes—is lack of training and experience with tools and models, leading to their improper use and interpretation.		
LT 5.	Increase ownership understanding of risk across levels as well as prioritization.	Lack of a consistent filter for prioritization or risk management across the organization creates an environment in which prescribed burn implementers need to take on more responsibility in	Implement a burn day authorization process for the Forest Service, whereby forest and regional leaders will further evaluate a planned prescribed fire if	12 months

#	Recommendations (1-7) and Considerations (NT-1 through -9 and LT-1 through -36)	Associated Finding(s)	Action	Estimated Timeline
		order for work to be accomplished. The pressure to perform, combined with difficulties in getting to the implementation phase on a prescribed burn, can keep risk-informed decisions from being made at the right level and within the right context. The pressure to achieve tends to create blind spots, and the agency currently operates with a single point of success or failure: the burn boss.	one or more risk factors is high	
LT 6.	Ensure policies are updated to reflect changes from recommendations.	The current Forest Service approach to sharing information and lessons learned means that learning is applied at the individual or unit level but rarely at a broad, interagency scale.	Assign a working group to evaluate and revise Forest Service and/or National Wildfire Coordinating Group policies to capture changes more formally from recommendations and to identify and update other related items.	2 months to establish working group; work would be ongoing
LT 7.	Create an easy-to-remember method to check assumptions and ensure shared understanding prior to implementation.	The pressure to perform, combined with difficulties in getting to the implementation phase on a prescribed burn, can keep risk-informed decisions from being made at the right level and within the right context. The pressure to achieve	Develop an acronym such as LCES (lookouts, communications, escape routes, and safety zones) that applies to the key elements of prescribed fire implementation and captures prior, current,	6-12 months

#	Recommendations (1-7) and Considerations (NT-1 through -9 and LT-1 through -36)	Associated Finding(s)	Action	Estimated Timeline
		tends to create blind spots, and the agency currently operates with a single point of success or failure: the burn boss. Insufficient local weather conditions and forecasts. Insufficient consideration of the impact of long-term drought on prescribed fire behavior. Not using available forecasting tools or insufficient training in using them. Inadequate patrolling and mop-up.	forecasted future, and possible conditions.	
LT 8.	Improve the contingency planning process to more holistically capture the variability in factors.	Lack of sufficient contingency resources. The guidance for prescribed fire plan preparation is inconsistently applied	Revise the contingency planning process to incorporate spatial contingency plans (that is, potential operational delineations); modeling based on defined scenarios that considers local variables (for example, modeling based on maximum burn parameters such as wind, rate of spread, and so on); and a PACE (primary, alternate, contingency, emergency) model for moderate- to high-complexity burns to establish likely control	8-12 months

#	Recommendations (1-7) and Considerations (NT-1 through -9 and LT-1 through -36)	Associated Finding(s)	Action	Estimated Timeline
			features in case of fire escape.	
LT 9.	Increase expertise and support network for burn bosses.	The guidance for prescribed fire plan preparation is inconsistently applied. The technical review process is also inconsistent; it needs more intentionality and fire environment expertise.	Create interagency technical review boards to establish interdisciplinary prescribed fire plan writing workshops with agency administrator involvement; assist with writing complex prescribed fire plans and complexity assessments/risk assessments; perform declared wildfire reviews as needed; and act as review boards for prescribed fire plan reviews.	6-12 months
LT 10.	Increase support network and prescribed fire plan quality assurance.	The guidance for prescribed fire plan preparation is inconsistently applied. The technical review process is also inconsistent; it needs more intentionality and fire environment expertise.	Require the use of interagency technical review in 10 percent of high-complexity prescribed fire plans, 10 percent of moderate-complexity prescribed fire plans, 10 percent of low-complexity prescribed fire plans, and at least one of all Forest Service complexity type burns annually at the regional level.	3-6 months

#	Recommendations (1-7) and Considerations (NT-1 through -9 and LT-1 through -36)	Associated Finding(s)	Action	Estimated Timeline
LT 11.	Develop tools to support agency administrators in prescribed fire as in wildfire.	The agency treats planned ignitions different than unplanned ignitions, reinforcing the view that one is optional while the other is not. Attrition at the agency administrator and burn boss levels leads to loss of institutional knowledge and experience.	Increase resources to support agency administrators.	Ongoing
LT 12.	Increase capacity for prescribed fire planning and implementation through hiring focused positions.	The agency treats planned ignitions different than unplanned ignitions, reinforcing the view that one is optional while the other is not. Prescribed burning planning and implementation require a different skillset and support network than currently accounted for in the Forest Service's approach. A fundamental issue in preparing prescribed burn plans—and a factor in the recent prescribed fire escapes—is lack of training and experience with tools and models, leading to their improper use and interpretation. Staff spend a lot of time and energy on administrative	Develop prescribed-burning-focused positions and support positions and evaluate the creation of a standardized Hazardous Fuels stand-alone workforce.	6-12 months

#	Recommendations (1-7) and Considerations (NT-1 through -9 and LT-1 through -36)	Associated Finding(s)	Action	Estimated Timeline
		duties, including human resources, contracting, purchasing, and mandatory training.		
LT13.	Increase the depth of qualified agency administrators. Align agency administrator expertise with the needs of the national prescribed burning program.	Lack of line officer/agency administrator engagement. The prescribed fire implementation environment continues to grow in complexity, whereas the ability of practitioners to practice what they know and hone their expertise in a complex environment has not. Prescribed burning planning and implementation require a different skillset and support network than currently accounted for in the Forest Service's approach. Attrition at the agency administrator and burn boss levels leads to loss of institutional knowledge and experience.	Increase required expertise of line officers to more accurately reflect expectations of the position. Evaluate requiring all line officers to become qualified agency administrators and moving forward with matching the required certification level of the agency administrator-level with the complexity of the unit (i.e., a high complexity ranger district/national forest would need a line officer certified at the Advanced/High Complexity level of agency administrator).	12-18 months
LT 14.	Create a process for continuing prescribed burning operations under Preparedness Levels IV and V.	The agency treats planned ignitions different than unplanned ignitions, reinforcing the view that one is optional while the other is not.	Develop a consistent process for strategic management of planned ignitions (including the use of analytics), to be applied under higher preparedness levels regionally and nationally.	8-10 months

#	Recommendations (1-7) and Considerations (NT-1 through -9 and LT-1 through -36)	Associated Finding(s)	Action	Estimated Timeline
		Lack of a consistent filter for prioritization or risk management across the organization.		
LT 15.	Increase investment in employees.	The prescribed fire implementation environment continues to grow in complexity, whereas the ability of practitioners to practice what they know and hone their expertise in a complex environment has not. Prescribed burning planning and implementation require a different skillset and support network than currently accounted for in the Forest Service's approach.	Develop a higher education curriculum for fuels and continuing education opportunities to increase the expertise of practitioners.	12-14 months
LT 16.	Increase investment in new technology.	Tools such as drones and infrared devices are not fully used in monitoring and patrolling prescribed fires.	Increase the use of new technology, including infrared for prescribed fire monitoring, unmanned aircraft systems for ignitions and monitoring, virtual reality for training, and updated models to provide practitioners with the best possible tools for decision making.	Ongoing
LT 17.	Increase cross boundary coordination and expertise across wildfire	Prescribed burning planning and implementation require a different skillset and support network than	Conduct a workforce/ organizational policy assessment to explore the integration of	6-30 months

#	Recommendations (1-7) and Considerations (NT-1 through -9 and LT-1 through -36)	Associated Finding(s)	Action	Estimated Timeline
	suppression, fuels, and vegetation management.	currently accounted for in the Forest Service's approach. Processes under the National Environmental Policy Act typically focus on traditional silvicultural treatments at a project level, which severely limits planning attention and resources for fuels treatments.	suppression, fuels, and vegetation management	
LT 18.	Update procedures and agreements for prescribed burning projects to be able to access more resources for support.	Current agreement policies and contracting laws can keep units from finding the resources they need to carry out complex, large-scale, or long-duration prescribed fires. The agency treats planned ignitions different than unplanned ignitions, reinforcing the view that one is optional while the other is not. The Forest Service's prescribed fire program has institutional limitations on implementation, support, and funding that wildland fire suppression does not.	Evaluate changes in resource ordering procedures and partner/contractor agreements for prescribed burning projects to mimic those for wildland fire suppression.	18-24 months
LT 19.	Increase public education and awareness.	Building and maintaining public support and acceptance for prescribed fire use will be key to increasing the Forest	Implement a large-scale messaging and education campaign highlighting the importance of	4-6 months

#	Recommendations (1-7) and Considerations (NT-1 through -9 and LT-1 through -36)	Associated Finding(s)	Action	Estimated Timeline
		Service's prescribed fire footprint and adding to its prescribed fire capacity.	prescribed fire, including transparent communication related to risk, uncertainty, and complexity.	
LT 20.	Streamline agreements and improve liability coverage to increase ability of partners and public to treat on NFS lands.	Current agreement policies and contracting laws can keep units from finding the resources they need to carry out complex, large-scale, or long-duration prescribed fires.	Revise legislative language for agreements and participation liability.	18-24 months
LT 21.	Reduce existing barriers to prescribed burning implementation tied to smoke constraints.	The Forest Service needs to have more tools available for prescribed burning, including a more efficient environmental analysis and regulatory process.	Coordinate with Environmental Protection Agency to look at opportunities for exemptions to Clean Air Act requirements in some airsheds to implement prescribed burns.	Consideration for longer review
LT 22.	Streamline required environmental analyses for high priority landscapes.	The Forest Service needs to have more tools available for prescribed burning, including a more efficient environmental analysis and regulatory process.	Consider pursuing an alternative arrangement request to the Council on Environmental Quality to exempt prescribed fire planning requirements under the National Environmental Policy Act in high-priority landscapes.	Consideration for longer review
LT 23.	Streamline required environmental analyses and consultations to	The Forest Service needs to have more tools available for prescribed burning, including	Coordinate with the U.S. Department of the Interior and the U.S. Fish	Ongoing

#	Recommendations (1-7) and Considerations (NT-1 through -9 and LT-1 through -36)	Associated Finding(s)	Action	Estimated Timeline
	increase implementation opportunities.	a more efficient environmental analysis and regulatory process.	and Wildlife Service to ensure streamlined and consistent consultations under the Endangered Species Act to increase prescribed burn windows while protecting habitat for listed species.	
LT 24.	Increase ability to hire and train entry-level positions to increase expertise and depth within the prescribed burning program.	Prescribed burning planning and implementation require a different skillset and support network than currently accounted for in the Forest Service's approach.	Step up hiring for positions in fuels management and provide focused entry-level training.	12-18 months
LT 25.	Increase investment in employees while also building a stronger network of support.	A fundamental issue in preparing prescribed burn plans is lack of training and experience with tools and models, leading to their improper use and interpretation.	Continue support and funding for improving data quality and accessibility, as required by current models and decision support systems.	Consideration for longer review
LT 26.	Increase analytics and support to help inform prescribed fire decision making.	Local burn bosses, fire staff, and agency administrators need better decision support with respect to the latest fire science regarding weather, fuels, drought, smoke, and fire behavior (that is, risk analysis).	Support continued development of a burn window application that helps to identify when optimal conditions for prescribed fire are likely to occur based on historical weather and climate data.	16-18 months
LT 27.	Evaluate successful outcomes as well as	The current Forest Service approach to sharing	Increase data collection and syntheses about	6-9 months

#	Recommendations (1-7) and Considerations (NT-1 through -9 and LT-1 through -36)	Associated Finding(s)	Action	Estimated Timeline
	escapes to better understand threshold and risk.	information and lessons learned means that learning is applied at the individual or unit level but rarely at a broad, interagency scale.	conditions that lead to successful and escaped prescribed fires to enable better analysis of risks and thresholds past which prescribed fire is not advisable.	
LT 28.	Reduce the focus on cost per acre to ensure implementers can focus on the right variables for successful outcomes.	Pressure to get work done. The pressure to accomplish a treatment stems from both targets and personal passion.	Explore avenues for increasing financial risk tolerance.	Consideration for longer review
LT 29.	Include drought and climate change in more detail and specificity during environmental planning.	Insufficient consideration of the impact of long-term drought on prescribed fire behavior.	Require inclusion of drought and climate considerations in long-term planning and National Environmental Policy Act assessments for prescribed fire.	8-12 months
LT 30.	Increase flexibilities within the planning phase to reduce constraints during implementation.	Processes under the National Environmental Policy Act typically focus on traditional silvicultural treatments at a project level, which severely limits planning attention and resources for fuels treatments.	Allow for flexibility in planning in response to varying conditions (such as wildfires, seasonal/annual climate variability, and so on) that create opportunities (changed burn windows and locations) for low risk prescribed fire implementation.	12-18 months
LT 31.	Increase incentives to retain and recruit a workforce for prescribed fire.	To safely conduct prescribed burning at the needed scale, Forest Service units lack capacity, given the current	Invest and prioritize funding for new facilities, deferred maintenance, and	Consideration for longer review

#	Recommendations (1-7) and Considerations (NT-1 through -9 and LT-1 through -36)	Associated Finding(s)	Action	Estimated Timeline
		agency workforce and how it is used.	remodeling for housing units for Forest Service personnel.	
LT 32.	Increase ownership in the prescribed burning program as well as different perspectives for a more holistic and robust planning process.	Processes under the National Environmental Policy Act typically focus on traditional silvicultural treatments at a project level, which severely limits planning attention and resources for fuels treatments.	Emphasize the prioritization of interdisciplinary discussion and external stakeholder involvement during project development to ensure that burn plans integrate all disciplines and concerns/actions.	Consideration for longer review
LT 33.	Increase avenues for partners to implement across boundaries.	Current agreement policies and contracting laws can keep units from finding the resources they need to carry out complex, large-scale, or long-duration prescribed fires.	Reduce barriers to collaborative prescribed burning with State agencies and partners.	Consideration for longer review
LT 34.	Increase expertise in landscape-scale prescribed fire planning.	Processes under the National Environmental Policy Act typically focus on traditional silvicultural treatments at a project level, which severely limits planning attention and resources for fuels treatments.	Create full time National Environmental Policy Act (NEPA) strike teams to help prepare conditions-based NEPA environmental analyses that promote more prescribed burning at the landscape level.	Consideration for longer review
LT 35.	Utilize targets to more strategically inform implementation of prescribed burning projects and reduce	The pressure to perform, combined with difficulties in getting to the implementation phase on a prescribed burn, can keep	Revise approaches to assigning targets.	Consideration for longer review

#	Recommendations (1-7) and Considerations (NT-1 through -9 and LT-1 through -36)	Associated Finding(s)	Action	Estimated Timeline
	pressures at the unit level.	risk-informed decisions from being made at the right level and within the right context.		
LT. 36	Promote information exchange with Tribes to increase options for prescribed fire management in a shared management setting.	Tribes have knowledge of traditional burning practices that benefit landscapes. In general, we have not incorporated indigenous traditional knowledge (ITEK) into our practices. Resource and information sharing with Tribal nations will increase opportunities to expand the use of prescribed fire on Forest Service and Tribal lands.	Work with indigenous communities to incorporate ITEK based cultural burning practices, specifically those that provide a perspective of what vegetative assemblages are best burned at different times throughout the year to engage more in patchwork burning even within the burn unit scale.	Consideration for longer review

APPENDIX B—POST-PAUSE FOREST SERVICE PRESCRIBED FIRE PLAN QUALITY ASSURANCE CHECKLIST

As a condition of resuming prescribed fire activities at the end of the Forest Service's 90-day program review period, all prescribed fire plans must be reviewed, updated, and reapproved before proceeding with implementation. This includes previously approved plans, regardless of how recently they were approved, and plans seeking initial approval. This standard holds for all manner of prescribed burning where a prescribed fire plan is required, including all low-, moderate-, and high-complexity projects. The following procedures will be used and will continue to be followed as interim guidance for up to 1 year, after which some version will be incorporated into Forest Service Manual.

Follow established policies and procedures for prescribed fire planning and implementation as described in:

FSM 5140 Hazardous Fuels and Prescribed Fire

NWCG PMS-484 Standards for Prescribed Fire Planning and Implementation

NWCG PMS 484-1 Prescribed Fire Plan Template

NWCG PMS 424 Prescribed Fire Complexity Rating System Guide

NWCG PMS 424-1 Prescribed Fire Complexity Worksheet

Use the following checklist to ensure the recommended procedures and emphasis areas from the 90-Day Review are followed when reviewing previously approved but not fully implemented prescribed fire plans:

☐ **- ELEMENT 2A: Agency Administrator Ignition Authorization**

> All Element 2A documents will add the following line just above the **Key Discussion Items** to remind AA's of requirement to consider drought metrics:

"Current drought condition according to _____ is _____ and the trend over the last several months is _select one:_   Worsening   Improving   Stable"

> All Element 2A documents will remove the following sentence:

"I am authorizing ignition of this prescribed fire between the dates of _____and _____"

> and replace with:

"I am authorizing initial or continued ignition of this prescribed fire for the Operational Period (24 hours) starting _____, and a new 2A Authorization will be required for any subsequent or continued ignitions."

All Element 2A Documents will add a "Recommended by" signature line for the fire management officer (FMO) or duty officer to ensure participation in the briefing by person(s) responsible for mobilization of contingency resources and wildfire response.

All Element 2A Documents will add a "Concurrence by Local Line Officer (if not the approving agency administrator)" signature line to ensure the 2A briefing includes all required personnel per recommendation and conforms with Red Book Chapter 5 which States "The authorization to ignite a prescribed fire must be approved by an appropriately certified AA; however, the line officer with authority over their assigned unit will also retain authority to prohibit the ignition based on their judgement regardless of their certification level."

☐ - **ELEMENT 2B: Prescribed Fire Go/No-Go Checklist**

1. All Element 2B documents will add the following to the list of Preliminary Questions:

   A. Has the experience, qualifications, internal/external pressures, and fatigue levels of the implementation team has been evaluated, and identified concerns have been satisfactorily mitigated? (note: use USFS Risk Calculator Mobile Application, IRPG Risk Management Process, Tailgate Safety Sheet, or similar tool to structure the assessment); If **YES**, proceed with checklist below. If **NO**, STOP: Confer with AA and do not proceed with implementation until concerns are addressed.

2. All Element 2B documents will modify Go/No-Go Checklist item 4 as follows to ensure we are aware of the post-ignition weather conditions and have allowed ourselves time to complete and control the project before adverse weather arrives.

   "Have ALL required current and projected fire weather forecast been obtained and are they favorable through ignition, holding, and mop-up/control phases of the project?"

3. All Element 2B documents for Moderate or High Complexity projects will modify Go/NO-GO Checklist item 8 as follows to ensure compliance with the requirements for the minimum compliment of contingency resources to respond to moderate or high complexity projects within 30 minutes:

"Has the availability of contingency resources applicable to today's implementation been checked and are they available? If Moderate or High complexity, are those contingency resources required for an initial suppression response, beyond the resources implementing the prescribed fire, (the minimum compliment of contingency resources) able to respond within 30 minutes?"

☐ - **ELEMENT 3: Complexity Analysis.** Validate the preliminary risk rating and final complexity rating, focusing on whether adjacent area fuel conditions and impacts of drought are recognized and rated appropriately.

1. The approving and local unit agency administrator(s) if different, must have been briefed by the plan preparer on the preliminary rating and this must be documented on the Preliminary Risk Rating worksheet; NWCG PMS 424 indicates this is an optional step, but the **Forest Service will require that the AA involvement in this step be documented using this worksheet.**

☐ - **ELEMENT 4:** **Description of Prescribed Fire Area**

1. Under B. Vegetation/Fuels Description:

    1. Ensure the fuel models used to depict fuel conditions within the target area and in the surrounding non-target area are appropriate for fire behavior modeling purposes

2. Use appropriate reference: [Standard fire behavior fuel models: a comprehensive set for use with Rothermel's surface fire spread model](#)

3. If prior experience has demonstrated a particular fire behavior fuel model is preferred, describe this as part of the rational for selecting fuel models

4. If uncertain, enlist the expertise of LTAN/FBAN, WFDSS fire behavior analysts, or Prescribed Fire/Fuels Specialists with training in selection of fuel models and document their involvement (i.e., In consultation with a qualified LTAN familiar with the area, Fuel Models GR1, SH3, and TL5 were determined to be the most representative of fuels outside the burn unit.)

☐ - **ELEMENT 7: Prescription.**

Validate prescription paying particular attention to verification of inputs and outputs from fire behavior modeling, and calculations used to determine minimum number and type of resources needed

1. FIRE CONTROL/CONTAINMENT MODELING: Verify that calculations made to determine the minimum number and type of resources required to maintain control of the fire should spotting occur outside the burn unit have been calculated using the best available tools in addition to knowledge and experience from previous projects

    CONTAIN Module Reference: https://www.firelab.org/project/behaveplus

    Fireline Production Rates Reference:
    [https://www.frames.gov/documents/behaveplus/publications/NWCG_2021_FireLineProduction Rates.pdf](https://www.frames.gov/documents/behaveplus/publications/NWCG_2021_FireLineProductionRates.pdf)

2. WIND ADJUSTMENT FACTOR: Verify that assumptions used for determining Wind Adjustment Factor(s) used in fire behavior modeling are valid

   Reference: https://www.nwcg.gov/publications/pms437/weather/estimating-winds-for-fire-behavior#TOC-Adjusting-Surface-20ft-Wind-to-Midflame-Windspeed

☐ - **ELEMENT 9: Pre-burn Considerations and Weather**

1. WEATHER OBSERVATION: Ensure that Element 9B describes the methods and frequency for obtaining weather measurements as well as the process for providing accurate information to NWS to improve the accuracy of their resulting forecasts

   Select one servicing NWS office – projects on the border of forecasting zones have caused confusion during implementation with varied and sometimes conflicting forecasts from multiple NWS offices

2. For moderate or high complexity projects, consult with the servicing NWS office to determine if existing permanent weather stations are sufficient, if portable weather stations are recommended by NWS, and if so, where they should they be placed.

3. Ensure this section includes a description of the timing, location, and frequency for on-site weather observations if appropriate; consult with NWS office on whether on-site observations should be identified in the plan as critical (required) or optional (nice but not required) based on availability of other weather data sources.

   This element should clearly restate FSM 5142.3 direction that a project-specific spot weather forecast must be obtained prior to ignition; for each day that ignition continues; on any day the fire is actively spreading; or when conditions adversely affecting the prescribed fire are predicted in the general forecast.

   Reference https://www.fs.fed.us/im/directives/fsm/5100/wo_5140_Amend-2020-1.docx

☐ - **ELEMENT 11: Organization and Equipment**

1. FIRE CONTROL/CONTAINMENT: Verify minimum number and type of resources required to maintain control of the fire at each phase or stage is based on calculations made using the best available tools, and any additions or modifications made based on knowledge and experience from previous projects that augment those calculated minimums are also described.

   1. For example; identify equipment that will augment handcrew, dozer, or engine production rates such as contingency lines or access routes being brushed out in advance, water-handling equipment put in place, use of UTV sprayers, etc.

   2. CONTAIN Module Reference: https://www.firelab.org/project/behaveplus

Fireline Production Rates Reference:
https://www.frames.gov/documents/behaveplus/publications/NWCG_2021_FireLineProductionRates.pdf

☐ - ELEMENT 12: Communications

1. ESTABLISH EXPECTATIONS FOR BURN BOSS COMMUNICATIONS

    1. Include the following in the communications plan to remind burn boss of key communication points for providing timely updates to unit fire managers and AA on project status:

        At a minimum, the burn boss will relay the following information either directly or through dispatch to inform unit fire management and agency administrators on project status:

        1. Element 2B Go/No-Go is complete and intent to proceed with test fire or take other actions

        2. Results of the test fire and intent to proceed with ignitions or take other course of action

        3. **Any time Contingency Resources are mobilized or engaged in contingency actions**

        4. **Any time Element 18: Wildfire Declaration procedures are proposed or being taken as described in the plan**

        5. Ignition operations completed for the project or shift

        6. Release or extension of assigned resources, project status at the end of shift (Uncontained, Contained, Controlled, Out), and outlook for next operational period

        7. Update on mop-up or patrol activities including project status (Contained, Controlled, Out) and name of the assigned burn boss, incident commander, or duty officer responsible for the day's actions

☐ - ELEMENT 16: Holding Plan

1. ENSURE HOLDING PLAN IS COMPLETE: All holding plans must describe minimum capabilities and procedures for all phases of implementation including mop-up and patrol.

    All Element 16: Holding Plans will include the following four (4) topic headers to remind plan preparers to address all phases of the project until it is declared "out"

    1. Ignition/Holding

Actions and procedures for holding the fire during the ignition and burn-out phases of the project

2. Mop-up/Control

Specify criteria or standards for determining the level of mop-up needed as a condition of reaching "controlled" status—use measurable or observable criteria that can be verified as having been achieved

Minimum staffing levels should reflect minimum line production needed to control spot fires outside the unit assuming the threat of spot-fire initiation remains elevated until the project is "controlled."

3. Patrol/Out

If residual burning is expected after "control" status is achieved, specify minimum personnel, actions, interval, and duration for patrol

Include procedures for maintaining a chain of custody/responsibility to ensure the fire is continually monitored until declared "out" (e.g., when is burn boss vs FMO vs. duty officer responsible?)

4. Critical Weather Step-Up Plan

See below

2. ENSURE HOLDING PLAN INCLUDES A CRITICAL WEATHER STEP-UP PLAN:

In the event of a forecasted critical weather event during post-ignition mop-up or patrol – it is imperative we recognize and react to forecasted weather conditions that can negatively impact a potential ignition source such as a prescribed fire that is not declared out; this plan should specify the type of indicators that will trigger the step-up plan (e.g., Red Flag Warnings, Haines index, Pocket Card Large Fire indicators, locally recognized critical fire weather conditions), and associated actions for elevating the level of response to reduce the potential for wildfire ignition from these know potential ignition sources.

☐ - **ELEMENT 17: Contingency Plan**

1. CONTINGENCY PLANNING: Verify that identified contingency resources in Element 17 can respond as required by the recommendations from the 90-day Review Team

Ensure 30 minutes is set as the Maximum Response Time for the minimum compliment of contingency resources for all Moderate/High complexity projects.

In some cases, this may mean commitment of fully dedicated contingency resources to a single project and may require cooperators or out-of-area resources be paid by the project in order to be dedicated as opposed to available from station.

☐ - **Appendix B: Technical Reviewer Checklist**

1. Ensure each plan is reviewed by a technical reviewer qualified, at least, at the same level as the plan preparer according to the Preliminary Risk rating in the Complexity Analysis.

2. Ensure the technical reviewer uses the Technical Reviewer Checklist from NWCG PMS 484-1 and that it is completed, signed, and included as a required part of the approved prescribed fire plan.

☐ - **Appendix E: Fire Behavior Modeling Documentation or Empirical Documentation**

1. Ensure that the documentation of fire behavior modeling used in preparing Element 7: Prescription is accurately reflected in this appendix

Forest Service Prescribed Fire Plan Template

After several consequential escaped prescribed fires in the spring of 2022, the Forest Service suspended prescribed fire operations for a 90-day period to ensure that as an agency, our prescribed burn program remained anchored in the most contemporary science. policies, practices. and decision-making processes. An interagency team was formed to review our prescribed fire program and on <date> released their findings and recommendations. Among the recommendations was a requirement to review our prescribed fire plans to address several emphasis items where the team felt improvements to the planning process could be made.

This Forest Service Prescribed Fire Plan Template meets or exceeds the minimum requirements found in the *NWCG Standards for Prescribed Fire Planning and Implementation (PMS 484),* as well as the *Prescribed Fire Plan Template (PMS 484-1).* Its primary purpose is to add context and importance for those elements where the 90-Day Review Team's recommendations asked for additional emphasis to be placed. This template is provided as a supplement to the recommendations from the 90-Day review team as a tool to help forests complete the required review and update of their prescribed fire plans according to the teams' recommendations. The NWCG Prescribed Fire Plan Template (PMS 484-1) is the established minimum standard by Forest Service policy, however, this template meets or exceeds that standard with the added benefit of helping prescribed fire planners meet the required emphasis areas in the planning process as highlighted by the 90-Day review team's recommendations.

Prescribed Fire Name:

Ignition Unit Name:

Element 1: Signature Page

PRESCRIBED FIRE PLAN

ADMINISTRATIVE UNIT NAME(S):

PRESCRIBED FIRE NAME:

Prescribed Fire Unit (Ignition Unit):

PREPARED BY:

Name (print): Qualification/Currency:

Signature: Date:

TECHNICAL REVIEW BY:

Name (print): Qualification/Currency:

Signature: Date:

FINAL COMPLEXITY RATING:

MINIMUM BURN BOSS QUALIFICATION:

APPROVED BY:

Agency Administrator Name, Qualification (print):

Signature – Agency Administrator: Date:

Prescribed Fire Name:_____

Ignition Unit Name:_____

Element 2A: Agency Administrator Ignition Authorization

Instructions: The Agency Administrator Ignition Authorization must be completed before a prescribed fire can be implemented. If ignition of the prescribed fire is not initiated prior to expiration date determined by the agency administrator, a new authorization will be required.

Prior to signature the agency administrator should discuss the following key items with the fire management officer (FMO), duty officer responsible for coordinating contingency and wildfire response, and the burn boss. Attach any additional instructions or discussion documentation (optional) to this document.

DROUGHT AWARENESS: Current drought conditions according to _____ is _____ and the trend over the last several months is *select one*:   Worsening   Improving   Stable

Key Discussion Items

A.	Has anything changed since the Prescribed Fire Plan was approved or revalidated? If yes, what changes to the Prescribed Fire Plan have been made to address the changes? *Such as drought or other climate indicators of increased risk, insect activity, new subdivisions/structures, smoke requirements, Complexity Analysis Rating.*
B.	Have compliance requirements and pre-burn considerations been completed? *Such as preparation work; NEPA mitigation requirements; cultural, threatened and endangered species; smoke permits; State burn permits/authorizations.*
C.	Can all the elements and conditions specified in Prescribed Fire Plan be met? *Such as weather, scheduling, smoke management conditions, suitable prescription window, correct season, staffing and organization, safety considerations, etc.*
D.	Are processes in place to ensure all internal and external notifications and media releases will be completed?
E.	Have key agency staffs been fully briefed about the implementation of this prescribed fire?
F.	Are there circumstances that could affect the successful implementation of the plan? *Such as preparedness level restrictions, resource availability, other prescribed fire or wildfire activity*
G.	Have you communicated your expectations to the burn boss and FMO regarding if and when you are to be notified that contingency actions are being taken?
H.	Have you communicated your expectations to the burn boss and FMO regarding decisions to declare the prescribed fire a wildfire?

Prescribed Fire Name: _____

Ignition Unit Name: _____

Implementation Recommended by:

FMO or Prescribed Fire Burn Boss Signature: _____ Date: _____

Implementation Recommended by:

FMO or Unit Duty Officer: Signature: _____ Date: _____

I am authorizing initial or continued ignition of this prescribed fire for the Operational Period (24 hours) starting _____, and a new 2A Authorization will be required for any subsequent or continued ignitions. It is my expectation that the project will be implemented within this time frame and as discussed and documented and attached to this plan. If the conditions we discussed change during this time frame, it is my expectation you will brief me on the circumstances and an updated authorization will be negotiated if necessary.

Additional Instructions or Discussion Documentation attached (Optional): Yes ☐ No☐

Ignition Authorized by:

Agency Administrator Signature and Title: _____

_____ Date: _____

Local Unit Line Officer Concurrence (if not the qualified approver above):

Line Officer Signature and Title

: _____ Date: _____

Prescribed Fire Name: _____

Ignition Unit Name: _____

Element 2B: Prescribed Fire Go/No-Go Checklist

Preliminary Questions	Circle YES or NO	
A. Have conditions in or adjacent to the ignition unit changed, (for example: drought conditions or fuel loadings), which were not considered in the prescription development? If **NO** proceed with the Go/NO-GO Checklist below, if **YES** go to item B.	YES	NO
B. Has the prescribed fire plan been reviewed and an amendment been approved; or has it been determined that no amendment is necessary? If **YES**, proceed with checklist below. If **NO, STOP: Implementation is not allowed. An amendment is needed.**	YES	NO
C. The experience, qualifications, internal/external pressures, and fatigue levels of the implementation team has been evaluated, and identified concerns have been satisfactorily mitigated? (Note: use USFS Risk Calculator Mobile Application, IRPG Risk Management Process, Tailgate Safety Sheet, or similar tool to structure the assessment)	YES	NO
GO/NO-GO Checklist	**Circle YES or NO**	
Have ALL permits and clearances been obtained?	YES	NO
Have ALL the required notifications been made?	YES	NO
Have ALL the pre-burn considerations and preparation work identified in the	YES	NO
Have ALL required current and projected fire weather forecast been obtained and are	YES	NO
Are ALL prescription parameters met?	YES	NO
Are ALL smoke management specifications met?	YES	NO
Are ALL planned operations personnel and equipment on-site, available and operational?	YES	NO
Has the availability of contingency resources applicable to today's implementation been checked and are they available? If Moderate or High complexity, are those contingency resources required to respond within 30 minutes available and in position to meet that timeframe?	YES	NO
Have ALL personnel been briefed on the project objectives, their assignment, safety hazards, escape routes, and safety zones?	YES	NO

Prescribed Fire Name:_____

Ignition Unit Name:_____

Element 2B: Prescribed Fire Go/No-Go Checklist - Continued

If all the questions were answered "**YES**" proceed with a test fire. Document the current conditions, location and results. If any questions were answered "**NO**", DO NOT proceed with the test fire: Implementation is not allowed.
After evaluating the test fire, in your judgment can the prescribed fire be carried out according to the prescribed fire plan and will it meet the planned objective?   **Circle: YES or NO**

Burn Boss Signature:_____ Date:_____

Prescribed Fire Name:_____

Ignition Unit Name:_____

Element 3: Complexity Analysis Summary and Final Complexity

Replace this page with the signed:

Summary and Final Complexity Worksheet
PMS 424-1

This PMS 424-1 worksheet is supplemental to the *Prescribed Fire Complexity Rating System Guide*, PMS 424. It is designed to enable effective risk management. *The Standards for Prescribed Fire Planning and Implementation*, PMS 484, provides further explanation.

The Summary and Final Complexity tab is inserted here as Element 3 in the Prescribed Fire Plan.

The Values, Preliminary Risk, Post-Plan Risk, and Post-Plan Technical Difficulty tabs become Appendix C of the Prescribed Fire Plan.

Various options for printing or inserting the worksheet into the Prescribed Fire Plan are provide on the first tab of the worksheet titled "PMS 424-1 General Instructions"

NOTE: The approving and local unit agency administrator(s) if different, must have been briefed by the plan preparer on the preliminary complexity rating and this must be documented on the Preliminary Risk Rating worksheet that is part of Appendix C; NWCG PMS 424 indicates this is an optional step, but **Forest Service will require that the AA involvement in this step be documented using the Preliminary Risk worksheet.**

Prescribed Fire Name:_____

Ignition Unit Name:_____

Fill out Elements 4 through 21 based on the guidance provided in the *Standards for Prescribed Fire Planning and Implementation*, PMS 484.

Element 4: Description of Prescribed Fire Area

A. Physical Description

1. Location**:**

2. Size:

3. Topography:

4. Project area:

5. Ignition units:

B. Vegetation/Fuels Description:

1. On-site fuels data:

2. Adjacent fuels data:

3. Percent of vegetative type and fuels model(s):

C. Description of Unique Features, Natural Resources, Values:

D. Maps–Attach in Appendix A

1. Vicinity (Required)

2. Project/Ignition Unit(s) (Required)

3. Values (Optional): ☐ Included ☐ Not Included

4. Significant or Sensitive Features (Optional): ☐ Included ☐ Not Included

5. Fuels or Fuel Model(s)(Optional): ☐ Included ☐ Not Included

6. Smoke Impact Area (Optional): ☐ Included ☐ Not Included

Prescribed Fire Name:_____

Ignition Unit Name:_____

Element 5: Objectives

A. Resource Objectives:

B. Prescribed Fire Objectives:

Element 6: Funding

A. Cost:

B. Funding Source:

Element 7: Prescription

A. Prescription Narrative:

1.   Describe how fire behavior will meet objectives

B. Prescription Parameters:

1.   Environmental or fire behavior (or both)

2.   Fire Modeling or empirical documentation (or both)

Element 8: Scheduling

A. Implementation Schedule:

1.   Ignition Time Frames or Season(s) (or both)

B. Projected Duration:

C. Constraints:

Element 9: Pre-burn Considerations and Weather

A. Considerations:

1.   On-site

2.   Off-site

Prescribed Fire Name:_____

Ignition Unit Name:_____

B. Method and Frequency for Obtaining Weather and Smoke Management Forecast(s):

Servicing NWS Office: _____ Phone: _____

NOTE: A project-specific spot weather forecast must be obtained prior to ignition; for each day that ignition continues; on any day the fire is actively spreading; or when conditions adversely affecting the prescribed fire are predicted in the general forecast. Exemption criteria and procedures for the spot weather forecast requirement may be found in FSM 5142.3.

C. Notifications:

Element 10: Briefing

A. Briefing Checklist; including, but not limited to: (additional items may be added)

- ☐ Burn organization and assignments
- ☐ Prescribed Fire objectives and prescription
- ☐ Description of prescribed fire project area
- ☐ Expected weather and fire behavior
- ☐ Communications
- ☐ Ignition plan
- ☐ Holding plan
- ☐ Contingency plan and assignments
- ☐ Wildfire declaration
- ☐ Safety and medical plan
- ☐ Aerial ignition briefing (if aerial ignition devices will be used)

Element 11: Organization and Equipment

A. Positions:

B. Equipment:

C. Supplies:

Prescribed Fire Name:_____

Ignition Unit Name:_____

Element 12: Communication

A. Radio Frequencies:

    1.   Command frequency(ies):

    2.   Tactical frequency(ies):

    3.   Air operations frequency(ies):

B. Telephone Numbers:

C. Key Communication Points:

At a minimum, the burn boss will relay the following information either directly or through dispatch to inform unit fire management and agency administrators on project status:

    1. Element 2B Go/No-Go is complete and intent to proceed with test fire or take other actions

    2. Results of the test fire and intent to proceed with ignitions or take other course of action

    3. Any time Contingency Resources are mobilized or engaged in contingency actions

    4. Any time Element 18: Wildfire Declaration procedures are proposed or being taken as described in the plan

    5. Ignition operations completed for the project or shift

    6. Release or extension of assigned resources, project status at the end of shift (Uncontained, Contained, Controlled, Out), and outlook for next operational period

    7. Update on mop-up or patrol activities including project status (Contained, Controlled, Out) and name of the assigned burn boss, IC, or duty officer responsible for the day's actions

Element 13: Public and Personnel Safety, Medical

A. Safety Hazards:

B. Mitigation: Measures Taken to Reduce the Hazards:

C. Emergency Medical Procedures:

D. Emergency Evacuation Methods:

E. Emergency Facilities:

Element 14: Test Fire

A. Planned Location:

B. Test Fire Documentation:

1. Weather conditions on-site

2. Test fire results

Prescribed Fire Name:_____

Ignition Unit Name:_____

Element 15: Ignition Plan

A. Firing Methods:

1. Techniques, sequences and patterns

B. Devices:

C. Minimum Ignition Staffing:

Element 16: Holding Plan

A. Ignition/Holding

1. General Procedures for Holding:
2. Critical Holding Points and Actions:
3. Minimum Organization or Capabilities Needed:

B. Mop-up/Control

1. General Procedures and Observable Standard(s) to be Achieved:
2. Minimum Organization or Capabilities Needed:

C. Patrol/Out

1. General Procedures and Interval for Patrol:
2. Procedures for transferring Custody/Responsibility for Patrol:
3. General Procedures and Person(s) identified as responsible for declaring the project "out":

D. Critical Weather Step-Up Plan

1. Indicator(s) that will trigger Action:
2. Critical Holding Points and Actions:

Element 17: Contingency Plan

Management Action Points or Limits:

(Optional MAP Table Format)

Management Action Point–Documentation Element	Management Action Point Narrative
Designator and Description:	
Condition:	

Prescribed Fire Name:_____

Ignition Unit Name:_____

Management Action Point– Documentation Element	Management Action Point Narrative
Management Intent:	
Recommended Action(s) to Consider:	
Recommended Resources:	
Time Frame:	
Describe the consequences of not taking the recommended action(s) (Optional):	
Responsibility:	
Date Each Action is Initiated (Optional):	

(if you need to include more MAPs, copy and paste the above template)

B. Actions Needed:

C. Minimum Contingency Resources and Maximum Response Time(s):

NOTE: Maximum Response Time for the minimum compliment of Contingency Resources on Moderate or High complexity projects is 30 Minutes. Additional contingency resource may have longer response times based on projected needs and timing of foreseeable events that require additional resources to assist.

Element 18: Wildfire Declaration

A. Wildfire Declared By:

B. IC Assignment:

C. Notifications:

D. Extended Attack Actions and Opportunities to Aid in Fire Suppression (Optional):

Element 19: Smoke Management and Air Quality

A. Compliance:

B. Permits to be Obtained:

C. Smoke-Sensitive Receptors:

D. Potential Impacted Areas:

E.   Mitigation Strategies and Techniques to Reduce Smoke Impacts:

Element 20: Monitoring

A. Fuels Information Required and Procedures:

B. Weather Monitoring (Forecasted and Observed) Required and Procedures:

C. Fire Behavior Monitoring Required and Procedures:

D. Monitoring Required to Ensure that Prescribed Fire Plan Objectives are Met:

E. Smoke Dispersal Monitoring Required and Procedures:

Element 21: Post-burn Activities

A. Post-Burn Activities that must be Completed:

Prescribed Fire Name:

Ignition Unit Name:

Prescribed Fire Plan Appendices

The following appendices are REQUIRED components of the plan unless designated as "Optional".

Appendix A: Maps: Vicinity, Project or Ignition Units (or both), Optional: Significant or Sensitive Features, Fuels or Fuel Model, Smoke Impact Areas

Appendix B: Technical Reviewer Checklist

Appendix C: Complexity Analysis

Appendix D: Agency-Specific Job Hazard Analysis or Risk Assessment

Appendix E: Fire Behavior Modeling Documentation or Empirical Documentation

Appendix F: Smoke Management Plan and Smoke Modeling Documentation (Optional)

Prescribed Fire Name:_____

Ignition Unit Name:_____

Appendix A: Vicinity Map

Insert your vicinity maps here. Refer to Element 4D in the *Interagency Prescribed Fire Planning and Implementation Procedures Guide*, PMS 484, to fill out this appendix.

Prescribed Fire Name:_____

Ignition Unit Name:_____

Appendix A: Project (Ignition Units) Maps

Insert your project (ignition unit) map(s) here. Refer to Element 4D in the *Interagency Prescribed Fire Planning and Implementation Procedures Guide*, PMS 484, to fill out this appendix.

Prescribed Fire Name:

Ignition Unit Name:

Appendix A: Optional Maps (Fuels, Significant or Sensitive Features/Values, Smoke Receptors, etc.)

Insert your significant or sensitive values and or feature map(s) here. Refer to Element 4D in the *Interagency Prescribed Fire Planning and Implementation Procedures Guide*, PMS 484, to fill out this appendix.

Prescribed Fire Name:_____

Ignition Unit Name:_____

Appendix A: Fuels or Fuel Model: (Optional) Maps

Insert your fuel or fuel model map(s) here. Refer to Element 4D in *the Interagency Prescribed Fire Planning and Implementation Procedures Guide*, PMS 484, to fill out this appendix.

Prescribed Fire Name:

Ignition Unit Name:

Appendix A: Smoke Impact Areas: (Optional) Maps

Insert your significant or sensitive feature map(s) here. Refer to Element 4D in *the Interagency Prescribed Fire Planning and Implementation Procedures Guide*, PMS 484, to fill out this appendix.

Prescribed Fire Name:_____

Ignition Unit Name:_____

Appendix B: Technical Reviewer Checklist

Fill out this checklist based on the guidance provided in the Technical Review section in the *Interagency Prescribed Fire Planning and Implementation Procedures Guide*, PMS 484. Rate each element in the following table with an "S" for Satisfactory or "U" for Unsatisfactory. Use Comment field as needed to support the element rating.

PRESCRIBED FIRE PLAN ELEMENTS	RATING	COMMENTS
1. Signature Page		
2. A. Agency Administrator Ignition Authorization		
2. B. Prescribed Fire GO/NO-GO Checklist		
3. Complexity Analysis Summary		
4. Description of Prescribed Fire Area		
5. Objectives		
6. Funding		
7. Prescription: Prescription Narrative and Prescription Parameters		
8. Scheduling		
9. Pre-Burn Considerations and Weather		
10. Briefing		
11. Organization and Equipment		
12. Communication		
13. Public and Personnel Safety, Medical		
14. Test Fire		
15. Ignition Plan		
16. Holding Plan		
17. Contingency Plan		
18. Wildfire Declaration		
19. Smoke Management and Air Quality		
20. Monitoring		
21. Post-Burn Activities		
Appendix A: Maps		
Appendix C: Complexity Analysis		
Appendix D: Agency-Specific Job Hazard Analysis or Risk Assessment		
Appendix E: Fire Behavior Modeling Documentation or Empirical		
Appendix F: Smoke Management Plan and Smoke Modeling		
Other		

Prescribed Fire Name:

Ignition Unit Name:

☐ **Approval is recommended** subject to the completion of all requirements listed in the comments section, or on the Prescribed
   Fire Plan.

☐ **Recommendation for approval is not granted**. Prescribed Fire Plan should be re-submitted for technical review subject to
   the completion of all requirements listed in the comments section, or on the Prescribed Fire Plan.

Technical Reviewer Signature:

Qualification and Currency:

Date Signed:

Prescribed Fire Name:

Ignition Unit Name:

Appendix C: Complexity Analysis

Please refer to Element 3: Complexity Analysis Summary in the *Standards for Prescribed Fire Planning and Implementation*, PMS 484, and the procedures in *the Prescribed Fire Complexity Analysis Rating System Guide*, PMS 424 for information on completing the Complexity Analysis process, and use the *Summary and Final Complexity Worksheet,* PMS 424-1, to fill out this appendix.

The Values, Preliminary Risk, Post-Plan Risk, and Post-Plan Technical Difficulty tabs from the PMS 424-1 Worksheet become Appendix C of the Prescribed Fire Plan. Delete this text and insert those worksheet elements here.

Various options for printing or inserting the worksheet into the Prescribed Fire Plan are provide on the first tab of the worksheet titled "PMS 424-1 General Instructions"

NOTE: **The approving and local unit agency administrator(s) if different, must have been briefed by the plan preparer on the preliminary complexity rating and this must be documented on the Preliminary Risk Rating worksheet; NWCG PMS 424 indicates this is an optional step, but Forest Service will require that the AA involvement in this step be documented using this worksheet.**

Prescribed Fire Name:

Ignition Unit Name:

Appendix D: Agency-Specific Job Hazard Analysis or Risk Assessment

Please refer to your specific agency guidance to fill out this appendix.

Prescribed Fire Name:

Ignition Unit Name:

Appendix E: Fire Behavior Modeling Documentation or Empirical Documentation

Refer to Element 7: Prescription, in the *Interagency Prescribed Fire Planning and Implementation Procedures Guide*, PMS 484, to fill out this appendix.

Prescribed Fire Name:

Ignition Unit Name:

Appendix F: Smoke Management Plan and Smoke Modeling Documentation

(OPTIONAL)

Refer to the *NWCG Smoke Management Guide for Prescribed Fire*, PMS 420-2, and Appendix A. Basic Smoke Management Practices in the *Interagency Prescribed Fire Planning and Implementation Procedures Guide*, PMS 484, to fill out this appendix.

See *quick-access tables* for existing scientific research, tools, and needs to support prescribed fire planning and implementation.

Framing Questions:

- What is the key existing research on biophysical, social, and operational science to support prescribed fire planning and implementation?

- What are relevant tools and datasets to support prescribed fire planning and implementation?

- What are key science needs to improve prescribed fire planning and implementation?

Research Topics:

- Synthetic/Big Picture

- Fuels

- Fire Effects/Ecology

- Fire Behavior

- Meteorology/Fire Weather

- Smoke

- Organizational/Operational

- Social

Emergent themes from the Madison Prescribed Fire Science Support Workshop

- We conceptualize prescribed fire as inclusive of *both broadcast (spreading) prescribed fire and pile burning,* but science considerations and needs for the two types of burning will vary.

- Prescribed fire is *highly objective-dependent—as such, it is challenging to generalize* on consensus science-based best practices for prescribed fire. Decisions around timing and pattern of ignitions and holding strategies are fundamentally rooted in objectives, which can include widely varying degrees of fuel consumption, fire intensity, and vegetation and ecosystem effects.

- There is *widespread agreement on the critical role of prescribed fire in achieving desirable ecosystem and habitat-level effects*, especially when prescribed fire can approximate the adaptive fire regime of an ecosystem, whether frequent or infrequent,

low-intensity or high-intensity. Specifically, in forests adapted to frequent fire, the application of broadcast fire is the most effective method at reducing surface fuels at a landscape scale, creating fire-resilient forest structure, and ameliorating subsequent wildfire severity.

- *Landscape context around prescribed fire projects is important*; building off prior wildfires and prior treatments, including past prescribed burns, can reduce risks associated with fire spreading outside of designated units.

Fire Danger, Fire Weather, and Smoke

- The **National Fire Danger Rating System (NFDRS)** is based on weather and offers a measure of current and near-term fire potential compared to the historical range of variability. Its core components, the Energy Release Component (representing underlying fuel dryness) and the Burning Index (integrating daily weather), are based on daily data obtained from the Weather Information Management System (WIMS), eventually to be replaced by the Fire Environment Mapping System. These values can be used in prescribed fire planning in some instances, per guidance in FSM 5120. Fuel moisture values underpinning NFDRS depend on the appropriate fuel model selection.

- **The Hot Dry Windy (HDW) Index** is another measure of worst-case conditions and can be used to generate ensemble projections of fire danger.

- *Climate and climate change both impact prescribed burn parameters and windows, principally via influence on weather patterns*. This includes both weather conditions (and trends) at the time of ignition, and weather conditions (and trends) leading up to ignition, which influence fuelbed moisture. For longer-term climatic influences on vegetation productivity and mortality, it is difficult to parse the effects of relative to proximate weather-mediated influences on burning conditions.

- There was broad consensus that conditions at the time of ignition should be placed into context *by evaluating trends (in weather and in fuel moisture) leading up to ignition*. The Las Dispensas/Hermit's Peak Report makes this clear. Trends in Energy Release Component (ERC), Burning Index (BI), HDW, and other parameters can be evaluated against historical averages. Trends can, and should, be characterized at multiple timescales depending on available information.

- In addition to trends, it is also important to look at *variability* in forecast information, and to use an ensemble model approach when possible.

- Our ability to *accurately assess smoke impacts* depends on accurate emissions characterizations from appropriate fuelbeds; accurate estimation of plume rise, transport, and smoke dispersion; and a high enough resolution from particulate matter sensors to validate and improve models.

Fuels, Fire Behavior, and Fire Effects

- Fuels are complex, and while fuel classifications are useful to simplify models of consumption and fire behavior, *fuels can also be characterized in 3D space* to provide more mechanistic characterizations of energy release. This is one of the critical drivers of fire behavior and fire effects. Work in this arena is ongoing, with a core concept to represent fire energy as "doses" which influences combustion and vegetation response.

- A long-term goal of fuel science is a more mechanistic way to *predict fuel moisture from first principles* of fuel size, structure, and weather information. Fuel moisture recovery from wetting events does not occur at the same rate as fuel moisture drying.

- Improvements to our understanding of processes underpinning fire behavior can proceed concurrently with improvements to the tuning and calibration of existing models (e.g., 2D models), and awareness of their limitations.

- General *"watch out" conditions* for extreme fire behavior include burning when conditions are "ramping up" (during the day or the season), burning at the high end of the prescription parameters, limited containment opportunities outside a unit, and long-duration burns.

Operational, Organizational, and Social Science

- In considering whether our actions around prescribed fire meet wildfire risk reduction objectives, there is a need for more *counterfactual research that assesses likely outcomes if the treatments were not in place* or did not include prescribed fire.

- The danger with focusing exclusively on the immediate crisis (i.e., wildfires) is that it can de-value the urgency around mitigation efforts, including prescribed fire.

- Defining the benefits and value of prescribed fire (relative to wildfire costs) would be helpful in defining a tolerance level or threshold to their risk.

- There is a need to *document and share our prescribed fire success stories*.

- Social science research has consistently demonstrated that *organizational capacity* is a primary barrier to increased effective prescribed fire implementation, and *burn window limitations* are also a factor. Air quality is less often cited as a barrier, though it can be a significant issue locally.

- Public acceptance of prescribed fire is often not a key barrier, and research shows that *acceptance increases with more public knowledge* of fire's benefits, more trust in the practitioner community, and more interactive exchange of information.

- Giving more complex information (rather than rosy pictures) leads to more *moderate but stable opinions among the public*.

Regional Nuances Around Prescribed Fire are Important

- In the West, there is variation in the degree to which smoke is a barrier to burning (e.g., tends to be more restrictive in OR and WA, but laws around smoke regulation are changing quickly). Variation in winter precipitation, and its effect on fuel moistures, is seen as a key factor in western prescribed burning, especially as it relates to pile burning, which is widely practiced there.

- Prescribed fire is generally most widespread in the Southeast but is still not implemented enough to meet the need. The Southeast also has a higher concentration of potential control features (especially roads) compared to the West; however, burning in the Southeast is not without risk. In general, the East is looking for more information on growing season burns and reconciling fire programs with timber programs (timber considerations are also significant in the West).

Quick-Access Tables

Table 1: Key existing science

Topic	Source	Key message/findings	Scope
Big picture	(Hiers et al. 2020)	***Prescribed fire research is distinct from wildfire research*** (e.g., longer planning, shorter burn period, interacting firelines). Lists research needs in prescribed science based on fuels, fire effects, behavior, meteorology, and smoke.	National
	(Holden et al. 2018)	Declines in summer precipitation and wetting rain days have likely been a primary ***driver of increases in wildfire area burned***.	West
Fuels	(Ottmar et al. 2007)	This paper presents an ***overview of the Fuel Characteristic Classification System (FCCS)***. The system classifies each fuelbed by calculating fire potentials that provide an index of the intrinsic capacity of each fuelbed to support surface fire behavior and crown fire, and provide fuels for flaming, smoldering, and residual consumption.	National
	(Prichard et al. 2013)	This paper presents the ***technical documentation on the Fuel Characteristic Classification System (FCCS).***	National
	(Prichard et al. In Press)	This chapter of the <u>National Smoke Assessment</u> presents a review of fuel and fuel consumption research.	National
	(Parsons et al. 2018)	This is a paper about STANDFIRE, a system for ***modeling fuels in 3D*** that was developed to help managers analyze fuel treatment effectiveness. STANDFIRE was the predecessor to FastFuels, which provides 3D fuel and fire modeling capabilities in support of prescribed fire planning and analysis.	National

Topic	Source	Key message/findings	Scope
	(Ziegler et al. 2017)	This study used stem mapped stands and 3D fire modeling to explore *fire behavior following restoration treatments*. It is an excellent example of how advanced models can expand our understanding of fuel-fire interactions, and how our management practices can improve wildfire outcomes going forward.	West
Fire Effects & Ecology	(O'Brien et al. 2018)	The conceptual linkage of *fire energy release to mechanistic fire effects* has value beyond simply understanding post-fire tree injury, function, and mortality. It can guide investigations that identify and isolate mechanisms driving other fire effects such as soil heating, organismal population dynamics, and biogeochemistry.	Global
	(Greenberg and Collins 2021)	This book provides a *broad overview and comparison of ecosystem/ecoregion-specific fire regimes* (frequency, severity, scale, spatial patterns) across United States forest types, and provides perspective on how climate change may alter fire regimes and forests in the future.	National
	(Rust et al. 2019)	Identifies and evaluates factors that influence *post-fire streamwater quality,* primarily factors are associated with burn severity and vegetation recovery.	West
	(Rhoades et al. 2019)	Highlights that there is currently limited research available to help land managers compare the small, but potentially chronic *water quality changes* from repeated prescribed burning and fuel reduction activities to the dramatic effects of severe wildfire.	National
Fire behavior	(Werth et al. 2016)	A comprehensive review of what is known and not known about extreme fire behavior.	Global

Topic	Source	Key message/findings	Scope
	(Finney et al. 2021)	A comprehensive review of principles of wildland fire behavior, including ignition, combustion, and spread, and ignition techniques for experimental burning.	Global
	(Thomas et al. 2021)	Higher fire intensities result in the deposition of more, larger firebrands at a given distance from the fire front. For the range of conditions studied, firebrand deposition can be expected up to 200 m ahead of the fire line.	Northeast
Fire behavior-fuel-atmosphere interactions	(Loudermilk et al. 2022)	A conceptual framework for **how vegetation structure embodies the legacy of past fires and creates the physical environment that drives fire behavior** beyond its combustion as a fuel source.	Global
	Heilman et al. (2015), (2017)	Investigated **connections between forest vegetation structure and local atmospheric conditions** (winds, turbulence, heat flux) that can, in turn, affect wildland fire behavior and smoke dispersion.	Northeast
Fire weather	(Chiodi et al. 2019)	Investigated which weather variables are most constraining to burn windows in the Southeast. Relaxing (increasing) the upper mixing height threshold offered the most efficient way of increasing the number of days available for prescribed burning in April through September.	Southeast
Smoke	(Vargo 2020)	[Data paper] that combined NOAA Hazard Mapping System smoke product with census tract data to estimate potential smoke exposure (2010-2019). NOAA HMS data began in 2003. Good example for inferring smoke impacts.	National
	(Urbanski et al. In Press)	This chapter of the [National Smoke Assessment] presents a review of current knowledge on wildfire smoke emissions.	National

Topic	Source	Key message/findings	Scope
	(Liu et al. In Press)	This chapter of the [National Smoke Assessment](#) presents a review of research on the dynamics of smoke plume behavior during wildland fire events.	National
	(Urbanski 2014)	Review of the state of knowledge regarding the chemical composition of emissions and emission factors for fires in United States vegetation types. One in a series of important *Special Issue* papers reviewing the state of science related to wildland fire emissions, carbon, and climate (see Sommers et al. 2014).	National
Operational science	(Cochrane et al. 2012)	Applied counterfactual simulations to examine impacts of fuels treatments on 14 large fires. Fuels treatments altered the probability of fire occurrence both positively and negatively across landscapes, effectively redistributing fire risk by increasing surface fire spread rates and reducing the likelihood of crowning behavior.	West
	(Barnett et al. 2016)	Encounter rate of fuels treatments to wildfire between 1999 and 2012 was <7% on Forest Service fuel treatments.	National
	(Collins et al. 2013)	Physical and political dynamics can lead to an underinvestment in mitigation strategies. The "firefighting trap" describes organizations where employees are rewarded for successfully reacting to emergencies over mitigating potential future emergencies.	Portugal
	(Russell et al. 2021)	Example of a success story where a prescribed burn in New Mexico (implemented with support from the Reserve Treaty Rights Program on ancestral Pueblo territory) was instrumental in the containment of a wildfire that broke out the following year.	Southwest

Topic	Source	Key message/findings	Scope
Social science	(McCaffrey et al. In Press)	Summary of social considerations for wildland fire smoke. Part of the National Science Assessment of wildfire smoke emissions.	National
	(McCaffrey and Olsen 2012, Toman et al. 2013)	Syntheses of social science findings on fire for 2000-2010, including public acceptance of and concerns around fuels treatments (including prescribed fire). Key findings include that use of prescribed fire is acceptable at some level for ~80% of population. Concern about escape and smoke are the main issues associated with lower acceptance, but this decreases with increased knowledge (particularly the ecological benefits) about the practice and greater confidence (trust) in the treatment implementer.	National

Table 2: Available Tools and Datasets

Theme/ Topic	Tool/Dataset (click to access URL)	Description/Inputs/Outputs	Stage
Big picture	Interagency Fuel Treatment Decision Support System (IFTDSS)	A web-based application designed to make fuels treatment planning and analysis more efficient and effective. IFTDSS provides access to data and models through one simple user interface. Includes a "Compare Weather" feature to develop and compare parameters for prescribed burn planning and contingency planning, including spot fire and escape scenarios under varying prescription parameters. IFTDSS allows both the burn plan preparer and the implementer to access maps and summaries of the fuel distribution, spatial fire behavior outputs, and fuel and fire behavior summary reports.	Operational
	Wildland Fire Decision Support System (WFDSS)	Wildfire statistics, GIS, model runs, and decision process. This system assists fire managers and analysts in making strategic and tactical decisions for fire incidents, with a single process that is intuitive, linear, scalable, and progressively responsive to changing fire complexity.	Operational
	Potential Operational Delineations (PODs); accessible through Risk Management Assistance (RMA) Dashboard	Identification of strategic wildland fire management units or polygons based on values at risk, potential control locations, and suppression difficulty index. Fuels management can be leveraged to enforce POD boundaries and develop new opportunities. Linkage to suppression actions is a key advantage.	Operational
	Enterprise Geospatial Portal (EGP)	Many GIS layers that will at least provide a first entry relative to wildfire perimeters, FACTS data, operations information, etc.	Operational

Theme/ Topic	Tool/Dataset (click to access URL)	Description/Inputs/Outputs	Stage
	Forest Service Activity Tracking System (FACTS) database	Repository of record for prescribed fire activities. Information includes location, forest, unit, treatment polygon (unit), funding source (can be tied to objectives), completion date, treatment type, treatment history in the unit, and equipment. Doesn't necessarily specify ignition date; that information would be contained at the Forest or Region level.	Operational
Fuels	Fuel and Fire Tools (FFT)	FFT is a software application that integrates several fire management tools, including the Fuel Characteristic Classification System (FCCS – version 4.0), Consume (version 5.0), Fire Emission Production Simulator (FEPS – version 2.0), Pile Calculator, and Digital Photo Series (DPS) into a single user interface. These tools can produce carbon flux estimates and fire behavior attributes. The fuelbeds are designed to represent the diversity of fuels found throughout the United States.	Operational
	FastFuels	FastFuels is a 3D fuel and fire modeling platform intended to expand the toolbox for fuel treatment and prescribed fire applications. It provides 3D fuels data for the conterminous United States and enables detailed 3D fire simulations with multiple 3D fire models, such as QUIC-FIRE and the Fire Dynamic Simulator (FDS). This tool suite is in active development and is currently being used in select landscapes with early testing partners.	Beta
	BurnPro3D – 3D viewer for FastFuels	BurnPro3D is a platform for next-generation fire analysis, with a growing suite of tools, in development under the NSF WiFIRE Commons project. With the FastFuels data theme turned on, clicking on the map interface in forested areas brings up an interactive 3D viewer with FastFuels 3D fuels data.	Beta
	LANDFIRE	Produces consistent, comprehensive, geospatial data and databases that describe vegetation, wildland fuel, and fire regimes across the United States and insular areas.	Operational

Theme/ Topic	Tool/Dataset (click to access URL)	Description/Inputs/Outputs	Stage
	[ArcFuels](url)	ArcFuels is a toolbar implemented in ArcMap which creates a trans-scale (stand to large landscape) interface to apply pre-existing forest growth (e.g., Forest Vegetation Simulator) and fire behavior models (e.g., FlamMap) to aid in vegetation management, fuel treatment planning, wildfire behavior modeling, and wildfire risk assessments	Operational
	[FuelCalc](url) – canopy fuel calculator and model	Desktop software application to determine changes in surface and crown fuel loading after thinning, pruning, piling, and/or prescribed fire.	Operational
Fire effects & ecology	[Fire Effects Information System](url) (FEIS)	Collection of reviews of the scientific literature about fire effects on plants and animals and about fire regimes of plant communities in the United States.	Operational
	[First Order Fire Effects Model](url) (FOFEM)	FOFEM is a computer program for predicting tree mortality, fuel consumption, smoke production, and soil heating caused by prescribed fire or wildfire.	Operational
Fire behavior	[QUIC-Fire](url) (Linn et al. 2020)	QUIC-Fire is a fast-running 3D physics-based fire model designed for fuel treatment and prescribed fire applications.	Development/ Beta
	[BehavePlus](url) fire modeling system	Point-source system modeling fire behavior (spread, intensity, spotting), probability of containment, and probability of vegetation mortality. For more information, see full list of models [here](url).	Operational, continued development

Theme/ Topic	Tool/Dataset (click to access URL)	Description/Inputs/Outputs	Stage
	[FlamMap](#)	Spatial modeling system of fire growth and spread and conditional burn probabilities under constant weather and fuel moisture, as well as wildfire growth and behavior for longer time periods under heterogeneous terrain, fuels, fuel moistures, and weather. Current version contains FarSite, which provides individual fire spread.	Operational, continued development
Fire danger	National Fire Danger Rating System (NFDRS)	Includes both the [Weather Information Management System](#) (WIMS) (operational, daily), and [FireFamilyPlus](#) (historical analysis, can generate weather inputs for fire behavior modeling simulations).	Operational, continued development
	[Wildland Fire Assessment System](#) (WFAS)	The Wildland Fire Assessment System ([WFAS](#)) collects and displays spatial fire danger information for the United States, including: ▪ NFDRS-based products: NFDRS fire weather; ▪ NFDRS dead fuel moisture, fire danger, adjective rating; ▪ Satellite NDVI-derived products: visual greenness, relative greenness, departure from average.	Operational
	Severe Fire Danger Index within [WildfireSAFE](#)	While designed for wildfires, it may be helpful for prescribed fires as well. WildfireSAFE is designed to increase firefighter and fire manager situational awareness and assist with risk mitigation planning in wildland fire operations. It supports the greater interagency fire community in the planning, response, and recovery phases of wildfire management. By integrating with Federal incident management systems, Wildfire SAFE applications provide an intuitive way of viewing WFAS data (see above) for specific incidents across the nation on mobile devices.	Operational; continued development

Theme/ Topic	Tool/Dataset (click to access URL)	Description/Inputs/Outputs	Stage
Fire weather	WindNinja	Simulates wind in complex terrain at high spatial resolution. Some National Weather Service spot weather forecasts use WindNinja; it depends on the office and the analyst.	Operational; continued development
	NWS 7-day activity planner	This will query the forecast grids to find when specified weather requirements will be met at the nearest grid point over the next 7 days. It requires the user to specify an office as part of the query. Seven-day point forecasts are also available here from the National Digital Forecast Database.	Operational
	WRF-SFIRE forecasts	WRF (Weather Research and Forecasting) is a National Center for Atmospheric Research (NCAR) model. WRF-SFIRE is a coupled fire-atmosphere model with the SFIRE fire spread model. WRF is run nationally for the next seven days and used to provide meteorological products. Local models are also available. Bret Anderson's group does a WRF-SFIRE 7-day forecast every day.	Operational; continued development
Smoke	NOAA HMS	Smoke analysis product: polygons of qualitative column smoke, 2003-present.	
	EPA AQS	Pre-generated hourly data files of pollutants from regulatory monitoring sites.	Regulatory quality
	Emission Factors	Wildland fire emission factors in North America: synthesis of existing data.	Operational
	BlueSky Playground	User-friendly smoke dispersion simulation tool.	Operational

Theme/ Topic	Tool/Dataset (click to access URL)	Description/Inputs/Outputs	Stage
Operational science	[Risk Management Assistance (RMA) Dashboard](url)	RMA Dashboard integrates many data layers that are relevant to operational planning and response, including road density and population density, fire activity, fire danger rating, and more. Linked in "Big picture" section of Table 2 as well.	Operational
Social science	[Trust: A Planning Guide for Wildfire Agencies and Practitioners](url) (Shindler et al. 2014)	This planning guide is the outcome of an international collaboration of researchers and practitioners/field managers working in communities at risk of wildfire in three countries. Initially, the team of social scientists from Australia, Canada, and the United States utilized the collective research literature to examine factors that influence stakeholder trust. A working draft of this document was shared with experienced agency personnel and community leaders prior to interactive workshops and field visits in each country. This allowed for deliberations of the essential features of building trust among parties.	

Table 3: Science Needs

Theme/Topic	Needs	Region
Fuels	Spatially resolved, dynamic estimates of *fuel moisture.*	National
	Improve the characterization of *fuels in 3D*, along with development of tools to put the new research into practice by managers.	National
	Indicators of *ground-fire risk* to help predict incidence of persistent surface/sub-surface burning (e.g., pile burns lingering for months).	National
Fire Behavior	<u>Model evaluation</u>	National
	▪ *Model testing* using inter-model comparison and relevant observational data.	
	▪ Model systems allowing for *ensemble runs* for exploration of varying environmental variables, fuels, and ignition patterns and resulting in *model confidence intervals* and an understanding of the variability of potential fire behavior outcomes.	
	▪ *Sensitivity analysis and validation* of physics-based fire spread models, including over a wide range of fuel conditions.	

Theme/Topic	Needs	Region
	<u>Process understanding</u> ▪ Prediction of transitions (spread-no spread; smoldering-to-flaming) ▪ Physics-based prediction of *combustion* (energy release, mass loss) *in complex fuelbeds*. ▪ Understanding and prediction of *live fuel combustion*.	National
Fire effects & ecology	Rx fire effects on water quality, soils, and carbon sequestration capacity.	National
	Rx fire *C and CO_2 emissions* compared to those from wildfire.	National
	Rx fire use for fuel reduction in *riparian areas.*	National
	Advance coupled fire-atmosphere fire modeling and its application to *process-based first order effects prediction*. Develop so that it can be used to plan Rx fires to meet management objectives.	National
	Growing season fire effects on variable tree species specific to the Lake States.	Great Lakes/ Northeast

Theme/Topic	Needs	Region
Fire effects & ecology	Bark char effects on tree species (including timber value) during variable conditions and seasons (dormant, growing).	National/ especially in the East
Fire weather	How are changing burn windows affecting our ability to conduct Rx fire?	National
Smoke	Low-cost, real-time, particulate matter sensors for monitoring smoke dispersion and impacts (e.g., Purple Air sensors).	National
	Improved emissions estimation • ***Emission factors for pile burns and air curtains*** (review). • ***Emission factors for smoldering*** of coarse woody debris and duff/peat. • ***Emission rates/burning rate*** for coarse woody debris and duff/peat.	National
	Easy use ***high-resolution (100 m) smoke dispersion model*** (e.g., WindNinja + smoke)	National
Operational science	Impact of the decision not to burn as opposed to the risk of burning.	National
	Develop a more complete prescribed fire inventory system. Currently, record-keeping is decent at the federal level, but incomplete at the private/NGO/State level. This system would be based on remote sensing; geostationary satellite observation of active-fire variables and follow-up with burn area mapping. A pre-requisite for comprehensive analysis of why escape fires occur.	National
	Clarify the role of mechanical treatments and what credit towards targets mechanical should receive if not followed by Rx fire.	National

Theme/Topic	Needs	Region
Operational science	<u>Organizational Science & Learning</u>	National

- What skill sets are necessary to produce **high-quality burn plans**? Are there ways to emphasize these skills within the new firefighter job series? What realistic skills for review are expected from line officers, how will they acquire those skills, and how will they be rewarded/required?

- How can we **avoid increasing levels of risk aversion** given the impacts of Hermits Peak?

- What are the implications of increased costs likely to follow from expected recommendations?

- **What are feasible Rx accomplishments** given different realistic workforce capabilities/capacity (current, further degraded, increased integrated, separate fuels workforce) and suppression demands?

- Examine incentive structure of Rx fire relative to fire suppression and address primary issues.

Theme/Topic	Needs	Region
Operational Science	<u>Rx Fire Planning & Implementation</u>	National (NTDC)

- A robust, repeatable and **data driven complexity rating** process to replace or enhance the subjective process currently in use.

- Research to facilitate the update of fireline production charts for engine, dozer, and tractor plow (hand crews were done in 2011).

- Tools/techniques to identify areas **where fire control actions are unsafe or particularly difficult** to allow for prescription parameters that might reduce potential for fire in those areas (e.g., steep/rocky terrain, snag patches, or similar areas).

- **Counter factual simulations** – FTEM database documents Rx fires that were shown to be useful in control/management of subsequent wildfires. What would have been lost if those Rx treatments had not been there to support wildfire response actions?

- Explore **application of PODs to prescribed fire planning**. Potential Control Location (PCL) and Suppression Difficulty Index (SDI) application to explore difficulty and complexity of escape control.

Theme/Topic	Needs	Region
Social science	Timber industry perspective on Rx fire.	National
	Develop social science protocol to assess post-escape public views of Rx fire and fire management. What factors or dynamics lead to increasing or decreasing public concern when there is an escape?	National
	Rx Fire Planning & Implementation Decision Making ▪ How do the ***primary barriers*** to the use of Rx fire identified in existing studies (e.g., limited burn windows and resource constraints) interact and influence Rx fire planning and implementation (particularly go/no go) decisions? ▪ How do ***other institutional dynamics*** (targets, travel caps, risk aversion, etc.) influence Rx fire planning and implementation (particularly go/no go) decisions? ▪ What is the relative (actual rather than perceived or assumed) contribution of ***external influences*** on Rx fire planning and implementation decisions?	National

Key References

Barnett, K., S. Parks, C. Miller, and H. Naughton. 2016. Beyond fuel treatment effectiveness: characterizing interactions between fire and treatments in the US. Forests **7**:237.

Chiodi, A. M., N. K. Larkin, J. M. Varner, and J. K. Hiers. 2019. Sensitivity of prescribed burn weather windows to atmospheric dispersion parameters over southeastern USA. International Journal of Wildland Fire **28**:589-600.

Cochrane, M. A., C. J. Moran, M. C. Wimberly, A. D. Baer, M. A. Finney, K. L. Beckendorf, J. Eidenshink, and Z. Zhu. 2012. Estimation of wildfire size and risk changes due to fuels treatments. International Journal of Wildland Fire **21**:357-367.

Collins, R. D., R. de Neufville, J. Claro, T. Oliveira, and A. P. Pacheco. 2013. Forest fire management to avoid unintended consequences: A case study of Portugal using system dynamics. Journal of Environmental Management **130**:1-9.

Finney, M. A., S. S. McAllister, J. M. Forthofer, and T. P. Grumstrup. 2021. Wildland Fire Behaviour: Dynamics, Principles and Processes. CSIRO PUBLISHING.

Greenberg, C. H., and B. Collins. 2021. Fire Ecology and Management: Past, Present, and Future of US Forested Ecosystems. Springer.

Heilman, W. E., X. Bian, K. L. Clark, N. S. Skowronski, J. L. Hom, and M. R. Gallagher. 2017. Atmospheric turbulence observations in the vicinity of surface fires in forested environments. Journal of Applied Meteorology and Climatology **56**:3133-3150.

Heilman, W. E., C. B. Clements, D. Seto, X. Bian, K. L. Clark, N. S. Skowronski, and J. L. Hom. 2015. Observations of fire-induced turbulence regimes during low-intensity wildland fires in forested environments: implications for smoke dispersion. Atmospheric Science Letters **16**:453-460.

Hiers, J. K., J. J. O'Brien, J. M. Varner, B. W. Butler, M. Dickinson, J. Furman, M. Gallagher, D. Godwin, S. L. Goodrick, S. M. Hood, A. Hudak, L. N. Kobziar, R. Linn, E. L. Loudermilk, S. McCaffrey, K. Robertson, E. M. Rowell, N. Skowronski, A. C. Watts, and K. M. Yedinak. 2020. Prescribed fire science: the case for a refined research agenda. Fire Ecology **16**:11.

Holden, Z. A., A. Swanson, C. H. Luce, W. M. Jolly, M. Maneta, J. W. Oyler, D. A. Warren, R. Parsons, and D. Affleck. 2018. Decreasing fire season precipitation increased recent western US forest wildfire activity. Proceedings of the National Academy of Sciences **115**:E8349-E8357.

Linn, R. R., S. L. Goodrick, S. Brambilla, M. J. Brown, R. S. Middleton, J. J. O'Brien, and J. K. Hiers. 2020. QUIC-fire: A fast-running simulation tool for prescribed fire planning. Environmental Modelling & Software **125**:104616.

Liu, Y., W. E. Heilman, B. E. Potter, C. B. Clements, W. A. Jackson, N. H. F. French, S. L. Goodrick, A. K. Kochanski, N. K. Larkin, P. Lahm, T. J. Brown, J. P. Schwarz, S. M. Strachan, and F. Zhao. In Press. Smoke Plume Dynamics. *in* D. L. Peterson, S. M. McCaffrey, and T. Patel-Weynand, editors. USDA Forest Service National Smoke Assessment. Springer.

Loudermilk, E. L., J. J. O'Brien, S. L. Goodrick, R. R. Linn, N. S. Skowronski, and J. K. Hiers. 2022. Vegetation's influence on fire behavior goes beyond just being fuel. Fire Ecology **18**:9.

McCaffrey, S. M., and C. S. Olsen. 2012. Research perspectives on the public and fire management: a synthesis of current social science on eight essential questions. Gen. Tech. Rep. NRS-104. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 40 p.

McCaffrey, S. M., A. G. Rappold, M. C. Hano, K. M. Navarro, T. F. Phillips, J. P. Prestemon, A. Vaidyanathan, K. L. Abt, C. E. Reid, and J. D. Sacks. In Press. Social, Economic, and Health Effects of Smoke.*in* D. L. Peterson, S. M. McCaffrey, and T. Patel-Weynand, editors. U.S. Department of Agriculture,Forest Service National Smoke Assessment. Springer.

O'Brien, J. J., J. K. Hiers, J. M. Varner, C. M. Hoffman, M. B. Dickinson, S. T. Michaletz, E. L. Loudermilk, and B. W. Butler. 2018. Advances in mechanistic approaches to quantifying biophysical fire effects. Current Forestry Reports **4**:161-177.

Ottmar, R. D., D. V. Sandberg, C. L. Riccardi, and S. J. Prichard. 2007. An overview of the Fuel Characteristic Classification System — Quantifying, classifying, and creating fuelbeds for resource planning. Canadian Journal of Forest Research **37**:2383-2393.

Parsons, R. A., F. Pimont, L. Wells, G. Cohn, W. M. Jolly, F. de Coligny, E. Rigolot, J.-L. Dupuy, W. Mell, and R. R. Linn. 2018. Modeling thinning effects on fire behavior with STANDFIRE. Annals of Forest Science **75**:1-10.

Prichard, S. J., E. M. Rowell, A. T. Hudak, R. E. Keane, E. L. Loudermilk, D. C. Lutes, R. D. Ottmar, L. Chappell, J. Hall, and B. S. Hornsby. In Press. Fuels and Consumption.*in* D. L. Peterson, S. M. McCaffrey, and T. Patel-Weynand, editors. US Forest Service National Smoke Assessment. Springer.

Prichard, S. J., D. V. Sandberg, R. D. Ottmar, E. Eberhardt, A. Andreu, P. Eagle, and K. Swedin. 2013. Fuel characteristic classification system version 3.0: Technical documentation.

Rhoades, C. C., J. P. Nunes, U. Silins, and S. H. Doerr. 2019. The influence of wildfire on water quality and watershed processes: new insights and remaining challenges. International Journal of Wildland Fire **28**:721-725.

Russell, G., J. G. Champ, D. Flores, M. Martinez, A. M. Hatch, E. Morgan, and P. Clarke. 2021. Doing work on the land of our ancestors: Reserved treaty rights lands collaborations in the American Southwest. Fire **4**:7.

Rust, A. J., S. Saxe, J. McCray, C. C. Rhoades, and T. S. Hogue. 2019. Evaluating the factors responsible for post-fire water quality response in forests of the western USA. International Journal of Wildland Fire **28**:769-784.

Shindler, B., C. Olsen, S. M. McCaffrey, B. McFarlane, A. Christianson, T. McGee, A. Curtis, and E. Sharp. 2014. Trust: a planning guide for wildfire agencies and practitioners—an international collaboration drawing on research and management experience in Australia, Canada, and the United States. A Joint Fire Science Program Research Publication. Oregon State University, Corvallis, OR.

Sommers, W. T., R. A. Loehman, and C. C. Hardy. 2014. Wildland fire emissions, carbon, and climate: Science overview and knowledge needs. Forest Ecology and Management **317**:1-8.

Thomas, J. C., E. V. Mueller, M. R. Gallagher, K. L. Clark, N. Skowronski, A. Simeoni, and R. M. Hadden. 2021. Coupled assessment of fire behavior and firebrand dynamics. Frontiers in Mechanical Engineering **7**.

Toman, E., M. Stidham, S. McCaffrey, and B. Shindler. 2013. Social science at the wildland-urban interface: A compendium of research results to create fire-adapted communities. Gen. Tech. Rep. NRS-111. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 75 p. **111**:1-75.

Urbanski, S. 2014. Wildland fire emissions, carbon, and climate: Emission factors. Forest Ecology and Management **317**:51-60.

Urbanski, S. P., S. M. O'Neill, A. L. Holder, S. A. Green, and R. L. Graw. In Press. Emissions in wildland fire smoke in the United States: a scientific assessment.*in* D. L. Peterson, S. M. McCaffrey, and T. Patel-Weynand, editors. U.S. Department of Agriculture, Forest Service National Smoke Assessment. Springer.

Vargo, J. A. 2020. Time series of potential US wildland fire smoke exposures. Frontiers in Public Health **8**.

Werth, P. A., B. E. Potter, M. E. Alexander, C. B. Clements, M. G. Cruz, M. A. Finney, J. M. Forthofer, S. L. Goodrick, C. Hoffman, and W. M. Jolly. 2016. Synthesis of knowledge of extreme fire behavior: volume 2 for fire behavior specialists, researchers, and meteorologists.

Ziegler, J. P., C. Hoffman, M. Battaglia, and W. Mell. 2017. Spatially explicit measurements of forest structure and fire behavior following restoration treatments in dry forests. Forest Ecology and Management **386**:1-12.