Critical Infrastructure Security and Resilience Note: Wildland Fires and Critical Infrastructure

August 1, 2014, 1515 EDT

SCOPE

The Department of Homeland Security Office of Cyber and Infrastructure Analysis (DHS/OCIA)[1] produces Critical Infrastructure Security and Resilience Notes in response to changes in the infrastructure protection community's risk environment from terrorist attacks, natural hazards, and other events. This product examines the potential impacts to the United States due to annual wildland fire activity.

This product was developed in coordination with the National Infrastructure Simulation and Analysis Center (NISAC), the DHS Office of Infrastructure Protection (IP) Sector Outreach and Programs Division (SOPD), Federal Emergency Management Agency (FEMA) U.S. Fire Administration (USFA), the Department of the Interior (DOI) Office of Wildland Fire (OWF), and the National Interagency Fire Center (NIFC).

OCIA continues to monitor conditions and will produce additional, incident specific, analysis if significant wildfires occur.

KEY FINDINGS

- **The annual wildland fire threat exists year round to some degree with elevated periods occurring between April and October, primarily in the western and southern regions of the United States.**
- **The National Interagency Fire Center estimates that between 1983 and 2013 an average of 83 percent of wildland fires were caused by human actions and the remaining 17 percent are attributable to various natural causes.**
- **OCIA assesses that the sectors potentially vulnerable to wildland fires are Transportation Systems, Energy (Electric Power), Water and Wastewater Systems, Communications, and Emergency Services.**
- **In the short term, local economic impacts may be high in small towns affected by wildland fires. Government loans or business interruption insurance may mitigate these impacts.**

[1]In February 2014, the DHS National Protection and Programs Directorate (NPPD) created the Office of Cyber and Infrastructure Analysis by integrating analytic resources from across NPPD, including the Homeland Infrastructure Threat and Risk Analysis Center (HITRAC) and the National Infrastructure Simulation and Analysis Center (NISAC).

OVERVIEW

The annual wildland fire threat exists year round to some degree with elevated periods occurring between April and October, primarily in the western and southern regions of the United States. Fire occurrence in the United States is cyclical and is largely driven by climatology over broad regional areas.[2] Figure 1 illustrates which regional areas are most at risk by month.

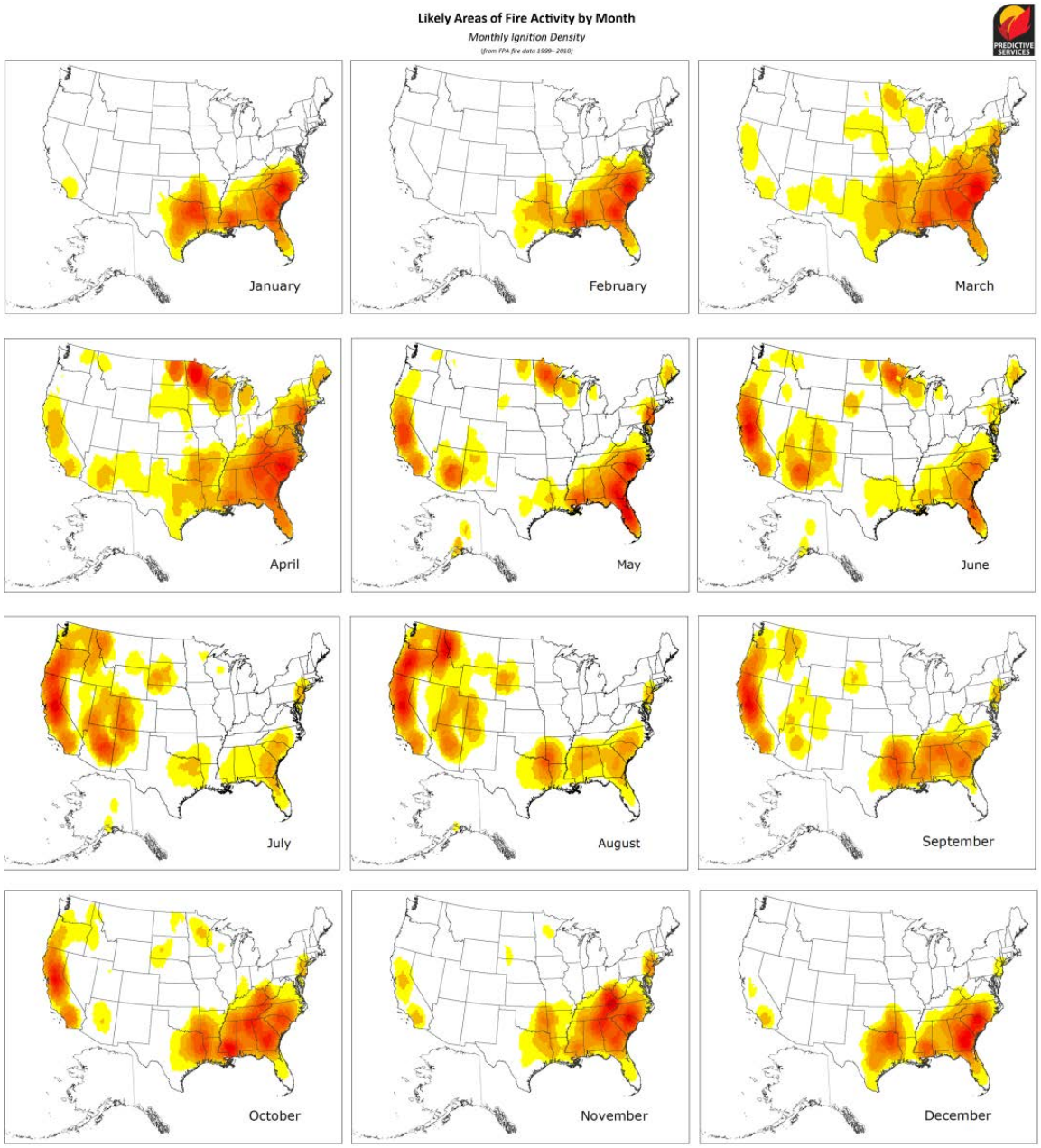

FIGURE 1.—Likely Areas of Fire Activity by Month-Monthly Ignition Density[3]

[2]Email from National Interagency Fire Center Subject Matter Experts, 9 July 2014, 1421 EDT.
[3]*Ibid.*

On average, approximately 75,000 wildland fires occur per year, and burn an average of 7.2 million acres of land.[4,5] Causes of wildland fires include:

- **Human Activity**: The National Interagency Fire Center estimates that from 1983 to 2013 an average of 83 percent of wildfires in the U.S. were caused by human actions such as unattended campfires, discarded cigarettes, burning debris, or intentional acts of arson.[6]
- **Natural Activity:** The National Interagency Fire Center estimates that from 1983 to 2013 17 percent of the wildfires in the U.S. are attributable to various natural causes. Notable sources of natural fires are lightning strikes and drought. Dry vegetation combined with dry, hot weather, strong winds, and a spark are the perfect combination to start wildland fires.[7,8] Additionally, droughts can also make wildland fires burn at higher temperatures, as they foster drier, more flammable fuel loads. Wildland fires also may occur through the spontaneous combustion of dead matter accumulated on a forest floor (e.g., leaves, twigs, trees) creating enough heat to ignite.[9]

TYPES OF WILDLAND FIRES

Figure 2 displays the three basic types of wildland fires: Ground Fires, Surface Fires, and Crown Fires. Furthermore, Figure 2 provides an explanation of the unique characteristics of the three basic types of wildland fires.[10]

[4]U.S. Fire Administration, "Total Wildland Fires and Acres," www.usfa.fema.gov/statistics/estimates/wildfire.shtm, accessed June 19, 2014.
[5]Email from Department of the Interior, Office of Wildland Fire Subject Matter Experts, 9 July 2014, 0741 EDT.
[6]Email from National Interagency Fire Center Subject Matter Experts, 9 July 2014, 1421 EDT; Email from National Interagency Fire Center Subject Matter Experts, 10 July 2014, 0722 EDT.
[7]National Park Service, U.S. Department of the Interior, "Wildfire Causes," www.nps.gov/fire/wildland-fire/learning-center/fire-in-depth/wildfire-causes.cfm, accessed June 13, 2014.
[8]National Integrated Drought Information System, U.S. Drought Portal, "Wildfire," www.drought.gov/drought/content/products-current-drought-and-monitoring/wildfire, accessed June 13, 2014.
[9]Dosomething.org, "11 Facts About Wildfires," www.dosomething.org/actnow/tipsandtools/11-facts-about-wildfire, accessed June 13, 2014.
[10]American Red Cross, *Talking About Disaster: Guide for Standard Messages*, 2007, page 33, www.crh.noaa.gov/images/bis/AmericanRedCross_TalkingAboutDisaster.pdf, accessed June 23, 2014 and U.S. Forest Service, "Fire Effects Information System Glossary," www.fs.fed.us/database/feis/glossary.html, accessed June 23, 2014.

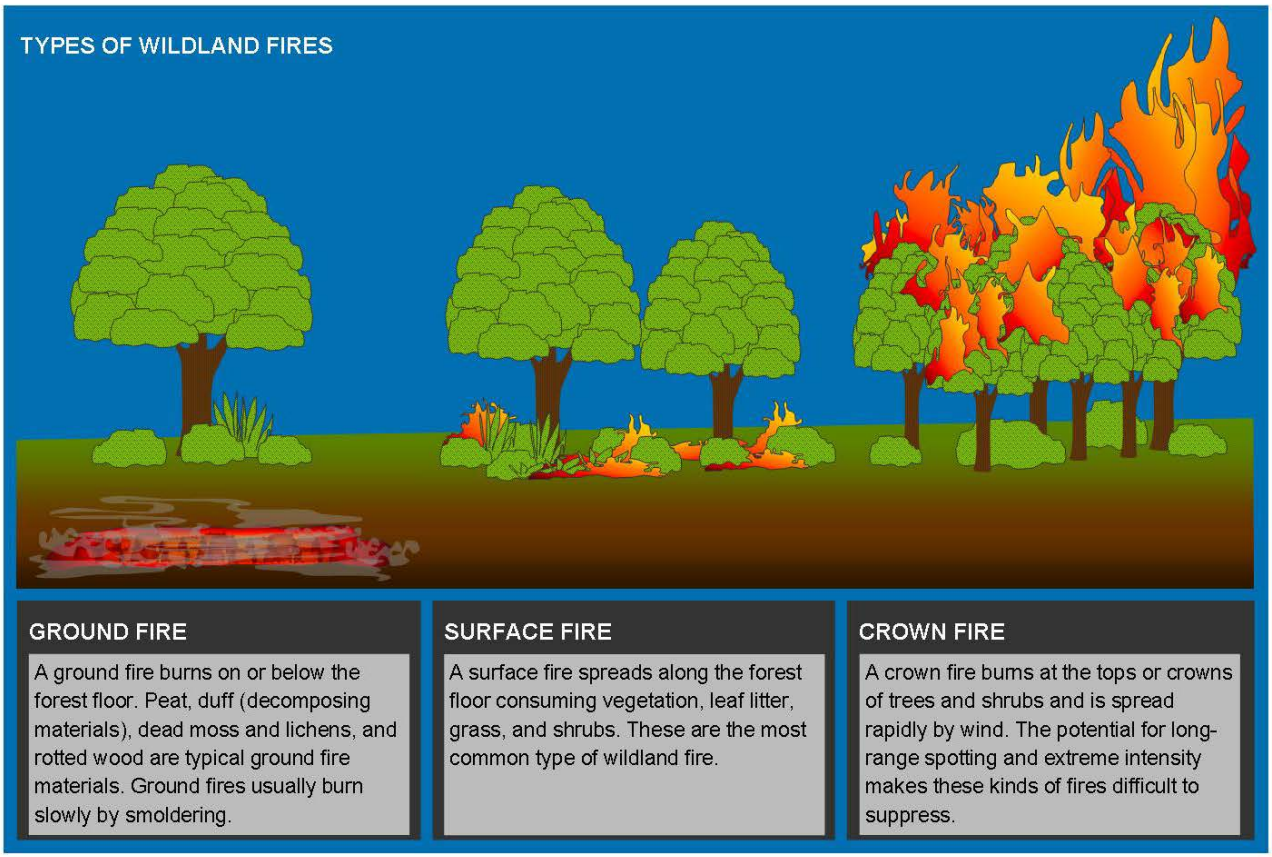

FIGURE 2.—Types of Wildland Fires[11]

WILDLAND-URBAN INTERFACE

The Wildland-Urban Interface is the area where structures are located near or among undeveloped natural areas, and are particularly susceptible to wildland fires. These areas are popular locations for homes because they offer residents the advantages of privacy, recreational opportunities, more affordable housing and the enjoyment of natural beauty.[12] Wildland fires threaten homes through wind-blown embers, contact by flames or radiant heat. Embers of burning material carried by the wind can land on structures or vegetation and ignite them. Contact by flames occurs when a fire is burning close enough to a property, for example, to directly touch an object and set it alight. Radiant heat ignition occurs when a fire burns close enough to a property for a sufficient amount of time to heat up an object to the point where it self-ignites without coming into contact with flames.[13]

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[11]National Wildfire Coordinating Group, "Glossary of Wildland Fire Terminology," www.nwcg.gov/pms/pubs/glossary/s.htm and www.nwcg.gov/pms/pubs/glossary/l.htm, accessed July 10, 2014. Spotting – a fire produces sparks or embers that are carried by the wind that start new fires beyond the zone of direct ignition of the main fire. Long-range spotting can occur when embers are carried a quarter of a mile or more from the main fire; Email from Department of the Interior, Office of Wildland Fire Subject Matter Experts, 9 July 2014, 0741 EDT.
[12]International Association of Fire Chiefs, "What is the Wildland-Urban Interface?," wildlandfirersg.org/Learn/content.cfm?ItemNumber=646&navItemNumber=505, accessed June 24, 2014.
[13]Glen Nader, Ed Smith and Stephen L. Quarles, "How Wildfire Threatens a House," www.extension.org/pages/23737/how-wildfire-threatens-a-house#.U6MLG1NsGy4, accessed June 24, 2014.

Property owners can combat wildland-urban interface fire threats through the creation of defensible space, which is the area around a structure modified to slow or stop the spread of a wildland fire by removal or treatment of potential fuel sources.[14] The U.S. Forest Service created the concept of the home ignition zone to assist property owners in creating defensible space, as seen in Figure 3. The formation of a home ignition zone helps to limit the amount of vegetation and flammable material surrounding a structure through the creation of three zones that encompass a home and an area of 200 feet surrounding it. Up to 30 feet from the home (Zone 1) calls for measures such as mowing the lawn regularly, use of non-flammable landscaping materials, removal of dead vegetation, and using fire-resistant lawn furniture. The area 30 to 100 feet from the home (Zone 2) should consist of low growing plants, adequate spacing between trees, and the use of fuel breaks such as driveways and gravel walkways. One hundred to 200 feet away from the home (Zone 3), the removal of smaller trees and accumulations of woody debris is recommended.[15]

FIGURE 3.—The Home Ignition Zone[16]

WILDLAND FIRE POTENTIAL OUTLOOK

The National Interagency Coordination Center, Predictive Services Unit assesses the significant potential for wildland fires and publishes wildland fire forecast maps on a monthly basis (Figures 4 and 5). For the 2014 wildland fire season, these maps indicate the potential for wildland fires will decrease from above normal to normal in most of the western States beginning in September.

[14]Colorado State Fire Service, "Protecting Your Home from Wildfire: Creating Wildfire-Defensible Zones," csfs.colostate.edu/pdfs/FIRE2012_1_DspaceQuickGuide.pdf , accessed June 24, 2014.
[15]National Fire Protection Association, "The Basics of Defensible Space and the Home Ignition Zone," www.firewise.org/wildfire-preparedness/be-firewise/home-and-landscape/defensible-space.aspx?&sso=0, accessed June 24, 2014.
[16]Wisconsin Department of Natural Resources, "Be Ember Aware," dnr.wi.gov/topic/forestfire/BeEmberAware.html, accessed June 24, 2014.

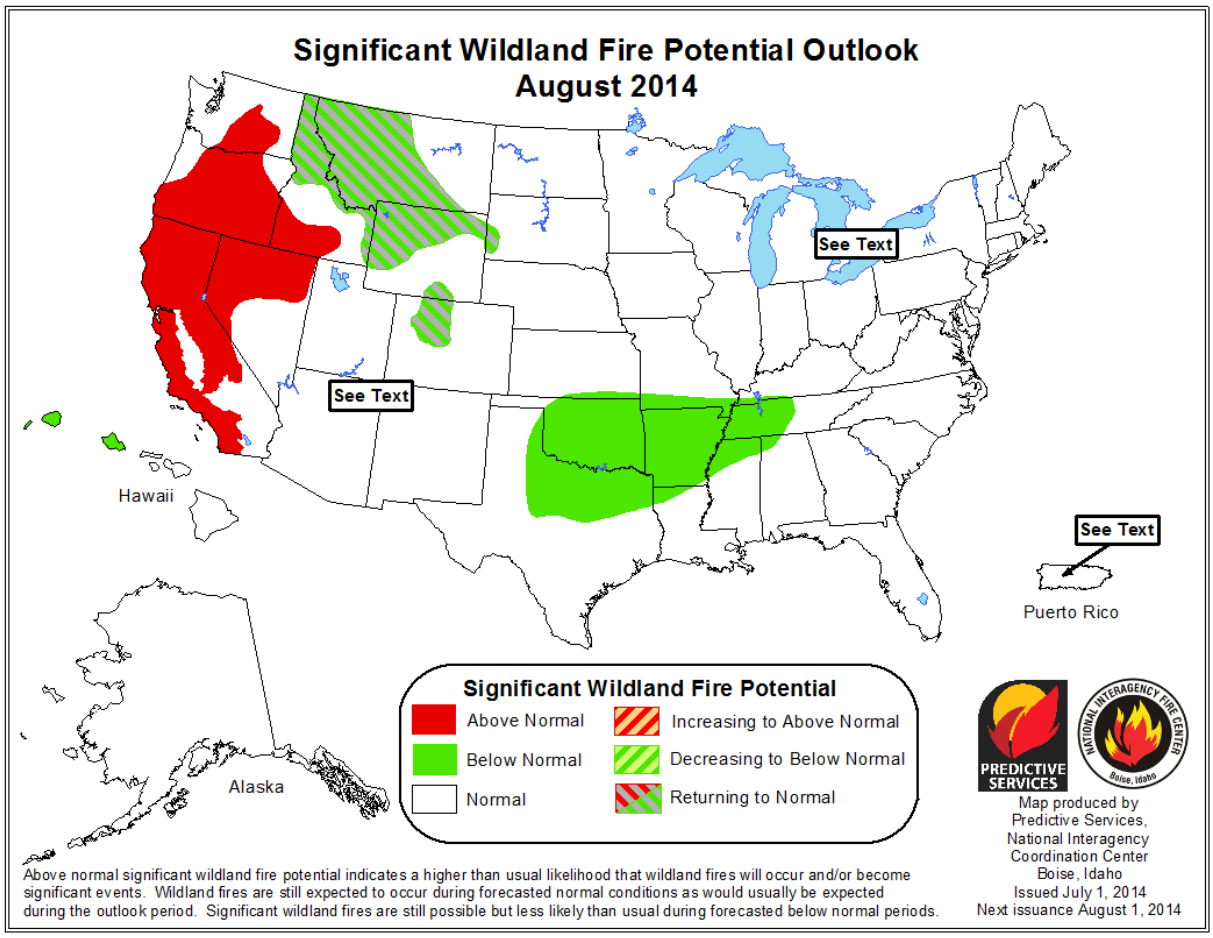

FIGURE 4.—August 2014 Significant Wildland Fire Potential Outlook[17]

[17]National Interagency Coordination Center, National Interagency Fire Center, "Outlooks," www.predictiveservices.nifc.gov/outlooks/outlooks.htm, accessed July 7, 2014. Above normal fire potential will continue over most of California, Nevada, Oregon, Washington and Idaho. Above normal conditions could possibly develop across the New England states and Four Corners area if short-term weather develops that would support fire outbreaks. Below normal fire potential will continue over northern Idaho, Montana and portions of Wyoming, Colorado and South Dakota. Portions of Texas, Oklahoma, Arkansas, Tennessee, Louisiana, and Mississippi will also continue to see below normal fire potential.

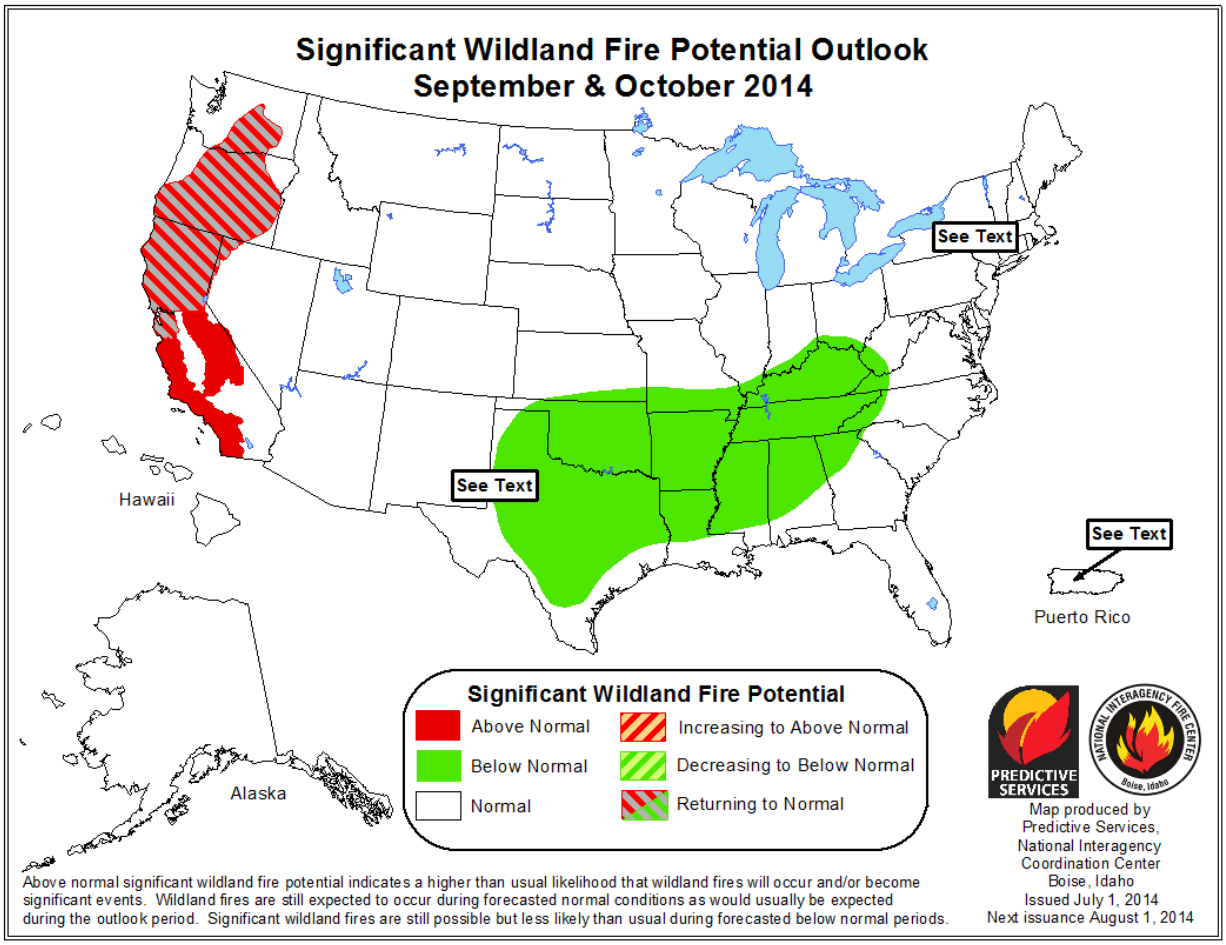

FIGURE 5.—September and October 2014 Significant Wildland Fire Potential Outlook[18]

[18]National Interagency Coordination Center, National Interagency Fire Center, "Outlooks," www.predictiveservices.nifc.gov/outlooks/outlooks.htm, accessed July 7, 2014. Above normal fire potential will remain over Southern and Central California. Northern California, Oregon and Washington will return to normal during September/October. Below normal fire potential will return across much of the Southeastern U.S. except for gulf coastal areas and most of the Coastal Atlantic states.

WILDLAND FIREFIGHTING

U.S. Forest Service, Fire and Aviation Management and the Department of the Interior, Office of Wildland Fire provides fire protection for national forests and supports other Federal, state and local firefighting agencies in wildland fire response.[A]
Various specialty firefighting crews and equipment are used to address the unique challenges of wildland firefighting:[B]

- **Hotshot Crews: Highly trained and experienced firefighters sent to the toughest part of a fire. They use hand tools, chainsaws, and explosives to build firebreaks, create burn outs and backfires (i.e. creating controlled fires to counteract the wildland fire), and conduct mop up operations once the fire is under control.**
- **Smokejumpers: Firefighters who parachute into remote and inaccessible areas to fight fires.**
- **Engine Crews: Operate heavy-duty, off rode fire engines that use both water and foam to extinguish the flames.**
- **Helitack Crews: Firefighters who can be rapidly deployed by helicopter to an affected area to fight fires and deliver equipment and supplies.**
- **Modular Airborne Firefighting Systems: Air National Guard and AIr Force Reserve aircraft equipped as air tankers to support wildland fire suppression.[C]**

Wildland Firefighting Methods:[D]

- **Wildland fires are most often fought by firefighters on the ground, using hand tools and chainsaws, to suppress the fire.**
- **Firefighters are routinely supported by heavy equipment (bulldozers, water tenders, etc.) that can create fuel breaks and aerial assets that have the ability to use water and retardant to slow the progression of the fire.**

SOURCES:

[A] Department of Homeland Security, Emergency Services Sector Specific Plan An Annex to the National Infrastructure Protection Plan, 2010, page 24 and Email from Department of the Interior, Office of Wildland Fire Subject Matter Experts, 9 July 2014, 0741 EDT.
[B] National Interagency Fire Center, "Frequently Asked Questions," www.nifc.gov/aboutNIFC/about_faq.html, accessed on June 23, 2014.
[C] National Interagency Fire Center, "Military Support in Wildland Fire Suppression," www.nifc.gov/fireInfo/fireInfo_military.html, accessed June 20, 2014.
[D] Email from Department of the Interior, Office of Wildland Fire Subject Matter Experts, 9 July 2014, 0741 EDT.

ECONOMIC IMPACTS

Economic impacts are comprised largely of the loss of residential and commercial property (homes, personal belongings, commercial structures, and inventory) and loss of business and personal income. Some of these losses, however, are offset by the increase in construction and other recovery activities after the fire.

Local economic impacts from wildand fires tend to be high in the short term in small towns affected by wildland fires.[19] Businesses suffer direct and indirect economic impacts as a result of

[19]Email from National Infrastructure Simulation and Analysis Center Subject Matter Experts, 12 June 2012, 1740 EDT.

the voluntary and involuntary evacuation of the affected population. Additional indirect economic impacts may stem from a loss of tourism to affected and surrounding areas.[20] Some of these impacts can be offset by small business and personal hardship grants and loans available from the Federal Emergency Management Agency, the Small Business Administration, the Farm Services Agency, and State governments. Business interruption insurance, if purchased in advance, may also offset these impacts. There are additional losses that may not have a defined market value, such as a temporary loss of wilderness and recreational areas.[21]

IMPACTS TO CRITICAL INFRASTRUCTURE

Although a wildland fire event may affect all critical infrastructure sectors, the Transportation, Energy, Water and Wastewater, Communications, and Emergency Services Sectors are most likely to experience the greatest infrastructure impacts. The degradation or disruption of these assets, nodes, and systems can have significant cascading effects on other critical infrastructure sectors.

TRANSPORTATION SYSTEMS

Wildland fires can disrupt transportation systems in various ways. Roadways and rail lines may close due to fire damage, fires blocking access, or poor visibility caused by smoke and ash in the air. Road and railway bridges may be damaged or destroyed. Airports may close and air traffic rerouted due to visibility problems (smoke, haze), unstable air currents caused by the fires or damage to aviation facilities and runways. Disruption or destruction of key transportation nodes may lead to cascading effects on larger regional transportation networks.

Transportation systems are important to response and recovery efforts. Damaged or closed roadways and airports may impede response efforts by complicating the delivery of emergency response personnel, machinery (e.g., bulldozers, fire trucks, water tankers) and supplies.

ENERGY

Most sectors are dependent on the Energy Sector for operations, and the loss or disruption can have cascading impacts across other infrastructure sectors. A reliable energy supply is especially critical to response and recovery due to interdependencies with other sectors, including Emergency Services, Health and Public Health, and Water and Wastewater.

ELECTRICITY

Electric power assets most likely damaged by a fire include above ground distribution systems, poles, substations and transformers. Electrical transmission lines in the area may be directly damaged by fire or indirectly affected by smoke and ash from the fire. Ash may cause arcing across insulators resulting in outages. System performance would start to degrade, resulting in power outages if too many assets are damaged.

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[20]Email from National Infrastructure Simulation and Analysis Center Subject Matter Experts, 12 June 2012, 1740 EDT.
[21]*Ibid.*

Municipalities in the vicinity of wildland fires depend on the resiliency of their local electric-power grid; whether those systems can withstand the loss of transmission lines and substations without negative system effects. Also factored into resilience is the load on the electric system at the time of the fire; summer peak temperatures typically result in the highest demand for electric-power generation, transmission and delivery systems. In the event of sudden energy shortages or blackouts as a result of wildland fire impacts on transmission and delivery systems, some electric-power systems are designed to maintain service to emergency services (e.g., police, firefighters, hospitals, and critical providers).[22]

The effects of firefighting also can affect transmission lines. Aircraft dumping loads of fire retardant can foul lines. Power lines also may be temporarily shut down as a safety measure. These effects may interrupt a line's service for either short or extended periods of time. However, the redundancy built into the power system often can compensate for these outages.[23] These actions are usually coordinated and planned in advance allowing greater flexibility in mitigating the impact.

WATER AND WASTEWATER

A loss of electric power to key facilities is the primary risk to water infrastructure from wildland fires. Most water and wastewater treatment facilities have backup power generation capabilities and should be able to operate temporarily without electric power. The length of time that backup generation is available depends on the facility's onsite fuel storage and the ability to obtain off-site fuel. In general, water facilities have priority contracts with electric power utilities and are among the first customers to have power restored.

Wildland fires burning adjacent to watersheds may have some qualitative impact on sediments and water quality including turbidity and taste and odor concerns, which would increase the operating load of downstream water treatment plants.

After a wildland fire, water-repellant soil created by the fire, as well as the absence of grass, brush, and trees, creates conditions conducive to flash flooding from even minor rainstorms. These flash floods can destroy roads, bridges, and other infrastructure in areas that are not generally flood prone. There is also increased risk of erosion and sediment being introduced into the water system long after the fires are extinguished.

COMMUNICATIONS AND INFORMATION TECHNOLOGY

Wildland fires can knock out landlines and wireless towers. Large numbers of emergency response personnel entering a wildland fire area create spikes in demand on networks. Wildland fires often occur in remote areas where wireless networks are weakest. Before an incident occurs, clearing combustible growth around cell sites and performing preventive maintenance on the backup generators and backup batteries at cell sites can help to ensure minimal disruptions in service in an emergency. When a wildland fire occurs, communications companies can deploy

[22]Tucson Electric Power (TEP), Wallow Fire Update, www.tep.com/Company/News/WallowFire dated 0800MST, 9 June 2011.
[23]Lawrence Berkeley National Laboratory, "Estimating Risk to California Energy Infrastructure from Projected Climate Change," July 2012, page 40, www.energy.ca.gov/2012publications/CEC-500-2012-057/CEC-500-2012-057.pdf, accessed June 16, 2014.

portable cell towers and network repeaters to boost wireless and data transmission coverage and capacity.[24]

EMERGENCY SERVICES

A lack of available water sources may complicate firefighting efforts in urban areas where standard wildland fire firefighting tactics, such as using chemical retardants and controlled burns, are less suitable. The lack of available water sources are less of a concern in remote areas where firefighters can employ these standard tactics and are experienced in combating fires with limited water resources.[25] Any extensive damage to roadways can slow response time. For remote regions, aerial operations may be required to move firefighting personnel and the injured into and out of these locations.

HEALTHCARE AND PUBLIC HEALTH

Wildland fires can spread rapidly, and change direction quickly. Consequently, hospitals, nursing homes, and prisons may be difficult to fully evacuate ahead of a fire reaching the area in which they are located. Emergency management officials should take these types of facilities into consideration when evaluating the impact of wildland fires. Hospitals generally have backup generation capacity, and can continue operations in the event of short-term power outages caused by a wildland fire. However, hospital facilities will likely need to be evacuated if the following impacts occur: understaffing, loss of electric power and generating capacity, or loss of potable water or wastewater treatment services, or if the facilities are unable to resupply. Roads made impassable by wildland fire could complicate evacuation. Damaged roadways can prevent staff members from reaching these facilities.

NUCLEAR

Nuclear reactor buildings are constructed of steel reinforced high strength concrete.[26] Therefore, a wildland fire would probably not affect reactor buildings.[27] Wildland fires could interrupt offsite power used to operate plant equipment compelling facilities to rely on backup generators to power these systems. Wildland fires could hinder access to nuclear plant sites by blocking roads leading to facilities. The U.S. Nuclear Regulatory Commission (NRC) requires all nuclear power plants to incorporate response to natural disasters in their emergency preparedness plans. The NRC examines these plans to ensure they can provide an efficient and effective response. The NRC also requires that all nuclear power plants have staff members who are specially trained and qualified to respond to fires. Some nuclear plants maintain on-site fire departments and others make arrangements with local off-site fire departments to supplement their initial response.[28]

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[24]Verizon, "Staying Connected as Wildfires Rage," www.verizonwireless.com/dam/news/pdf/VZWcasestudy_California_7.14.11R.pdf, accessed June 13, 2014.
[25]Email from National Infrastructure Simulation and Analysis Center Subject Matter Experts, 12 June 2012, 1740 EDT.
[26]Email from DHS Office of Infrastructure Protection, Sector Outreach and Program Division Subject Matter Experts, 14 July 2014, 1251 EDT.
[27]Remy Melina, "Could Wildfires Threaten U.S. Nuclear Reactors?," http://www.livescience.com/8473-wildfires-threaten-nuclear-reactors.html, accessed June 11, 2014.
[28]Victor Dricks, U.S. Nuclear Regulatory Commission, "Southern California Fire Puts Spotlight on NRC Regs," http://public-blog.nrc-gateway.gov/tag/wildfires/, accessed June 11, 2014.

MITIGATION MEASURES

In addition to creating defensible space, there are other mitigation measures that can be taken to reduce the risks of wildland fires.

- Prescribed fires are intentional fires planned by specialists to achieve specific land management objectives. These objectives include reduction of flammable fuels accumulated on forest floors (e.g., brush, logs), minimizing the spread of pest insects, improving habitat for threatened or endangered species, and protecting human communities from threat of wildland fires. Prescribed fires are set within predetermined boundaries and under certain weather conditions to ensure the fire can be kept under control.[29]

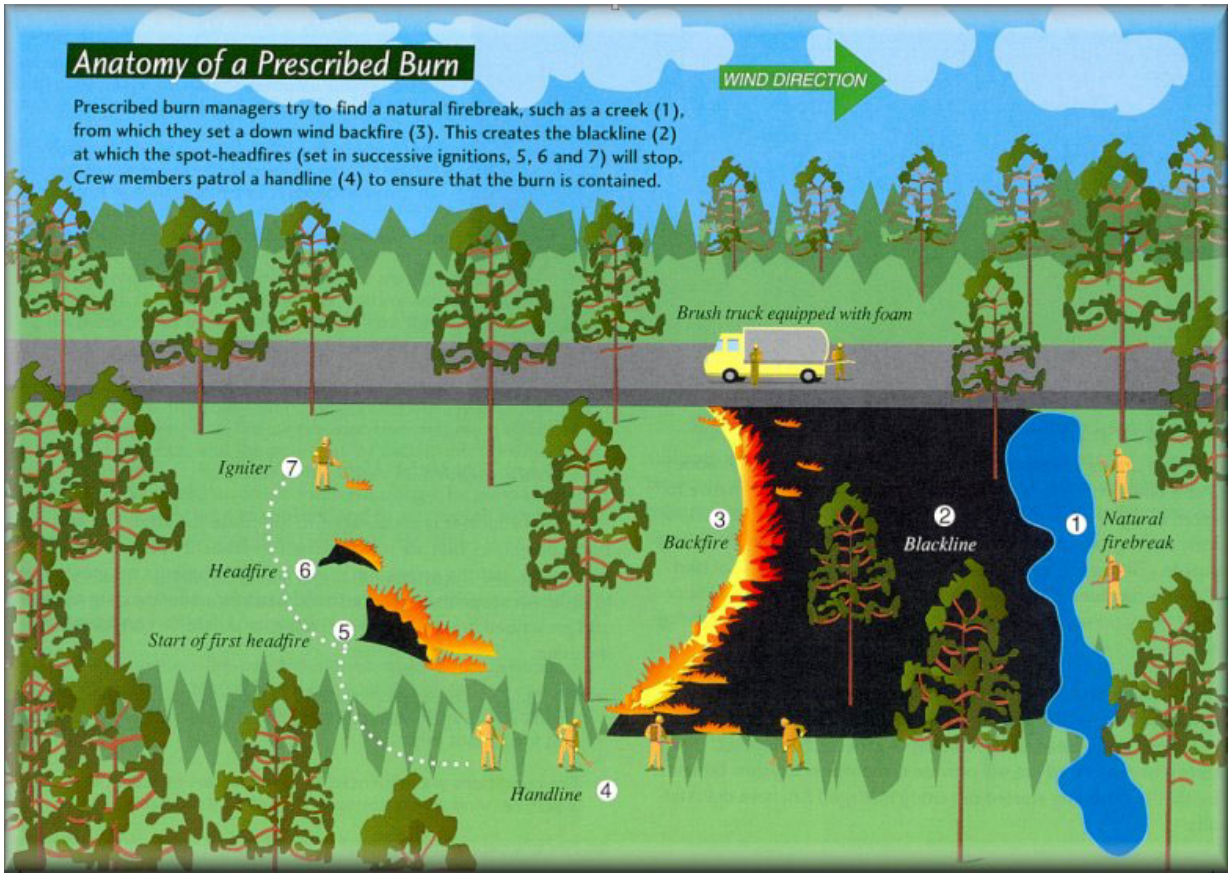

FIGURE 6.—Prescribed Fire Example[30]

- Constructing homes using fire resistant materials and design features can reduce the risk of wildland fire damage. Roofs can be built using fire-retardant-treated wood, metal or tile. Covering vents with metal mesh materials can protect against embers entering. Radiant heat can shatter window glass even before a building ignites. Using dual-paneled tempered glass windows can reduce the chances of breakage. Fencing and decks can be constructed with

[29]U.S. Forest Service, "Prescribed Fire," www.fs.fed.us/fire/management/rx.html , accessed June 25, 2014 and National Interagency Fire Center, "Frequently Asked Questions," www.nifc.gov/aboutNIFC/about_faq.html, accessed June 23, 2014.
[30]Bill Gabbert, "Anatomy of a Prescribed Fire," wildfiretoday.com/2010/04/22/anatomy-of-a-prescribed-fire/, accessed June 24, 2014.

ignition resistant or non-combustible materials.[31] Walls can be built using fire-retardant-treated wood, stucco, brick, adobe, concrete blocks or metal siding. Metal core doors and metal panel garage doors offer added fire protection. Installing automatic sprinkler equipment on roofs, patios and decks provides the ability to extinguish spot fires on the roof and near walls.[32]

- Communities can reduce their risks to wildland fires by creating a Community Wildfire Protection plan. To develop a plan to protect residents from fires, communities collaborate with applicable Federal, state, and local agencies and stakeholders to identify areas for flammable fuel reduction treatments (e.g., selective removal of vegetation and trees) and to recommend construction measures that will reduce the ignitability of homes and other structures. Under the Healthy Forests Restoration Act of 2003, a community that develops a Community Wildfire Protection plan is afforded the opportunity to influence Federal wildland fire management practices. It can provide input on how to implement flammable fuel reduction projects on nearby Federal lands. It also can offer suggestions on how federal funds are distributed for such projects on nearby non-Federal lands.[33]

[31]California Department of Forestry and Fire Protection, "Hardening Your Home," www.readyforwildfire.org/hardening_your_home/, accessed June 25, 2014.
[32]Murray Milne, "Designing Your Home to Survive Wildfires," www.energy-design-tools.aud.ucla.edu/FIRES.pdf, accessed June 25, 2014.
[33]Society of American Foresters et al, *Preparing a Community Wildfire Protection Plan A Handbook for Wildland-Urban Interface Communities*, page 3, www.forestsandrangelands.gov/communities/documents/cwpphandbook.pdf, accessed June 20, 2014.