COMMUNITY PLANNING ASSISTANCE FOR WILDFIRE

2018

Final Recommendations for Township of Ocean, NJ

Prepared by:

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About the Community Planning Assistance for Wildfire Program

The Community Planning Assistance for Wildfire (CPAW) program works with communities to reduce wildfire risks through improved land use planning. It is supported through grants from the U.S. Forest Service, the LOR Foundation, and other private foundations. It is a program of Headwaters Economics and Wildfire Planning International.

Author Contact Information

CPAW engages professionals with training and expertise in land use planning, forestry, risk modeling, and fire behavior. This report was written by the following CPAW team members:

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Acknowledgments

CPAW relies on collaboration with local stakeholders to provide meaningful feedback throughout the process. Our team would like to thank everyone who contributed their time to our CPAW activities in the Township of Ocean, including: Township of Ocean staff, Waretown Volunteer Fire Company, New Jersey Forest Fire Service. Any omissions are solely the responsibility of the authors and are not intended to reflect the value of other participants.

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Cover photos provided by CPAW.

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Introduction

Each year, wildfires affect communities across the United States. These wildfires—both human- and lightning-caused—can have a variety of impacts on communities' built and natural environments. Some of these impacts bring positive ecological outcomes, such as improved forest health and habitats. Other wildfires, however, can have devastating social, economic, and environmental consequences to communities' public and first responder safety, homes and businesses, parks, roads, watersheds, forests, hospitals, and more.

Communities have many options to address and reduce their wildfire risk. The Community Planning Assistance for Wildfire (CPAW) program offers a unique approach to help community stakeholders identify what's at risk in the "wildland-urban interface" (WUI, pronounced "WOO-EE") and determine ways to address this risk through improved land use planning strategies.

❖ Community Planning Assistance for Wildfire

CPAW was established by Headwaters Economics and Wildfire Planning International in 2015 and is funded by the U.S. Forest Service and other private foundations. Since its inception, CPAW has worked with communities of varying sizes, capacities, and geographical locations across the United States

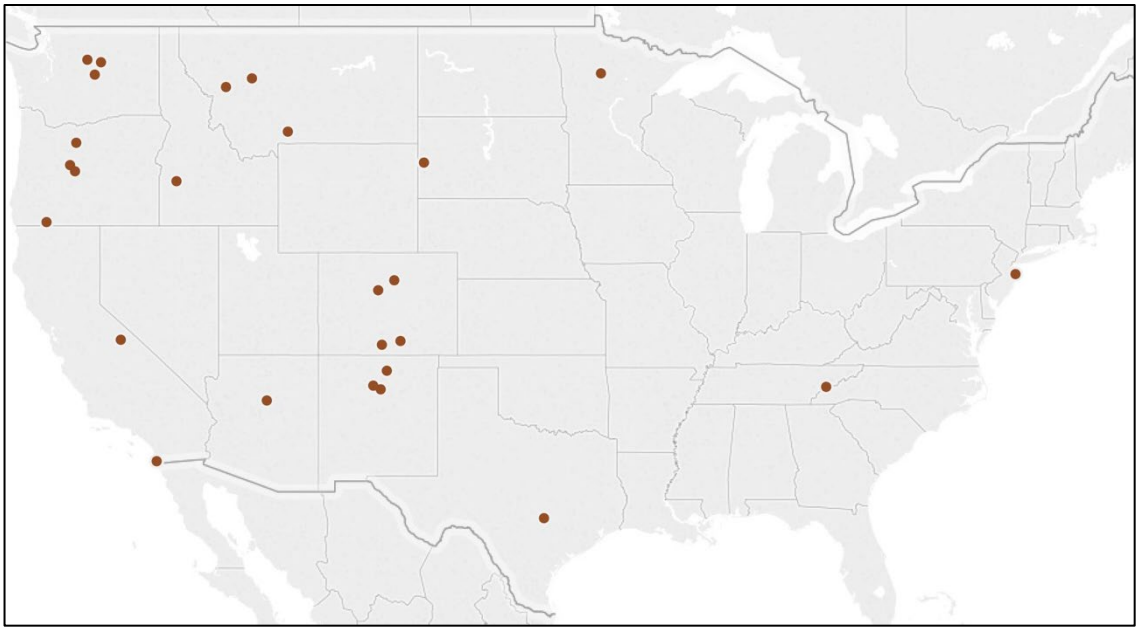

Figure 1. Map of communities that have been engaged in the Community Planning Assistance for Wildfire program.

Community Selection and Services

Each year, communities voluntarily apply and are competitively selected to participate in the program. Communities must show commitment and engagement from both local planning and fire departments to reflect the collaborative nature required for CPAW success. If selected, communities receive customized technical consulting services from CPAW's team of professional land use planners, foresters, risk modelers, and researchers. Specific services vary based on community needs and may include capacity-building trainings on WUI planning topics, risk modeling and spatial analysis, guidance on wildfire mitigation plans and policies, and other strategies to address local wildfire risk.

Stakeholder Engagement

Community members engaged in the CPAW process play a critical role to project success. While services are provided at no charge to the community, each community signs a Memorandum of Understanding with CPAW to outline its mutual understanding of roles and responsibilities and project commitments. CPAW teams engage with a variety of local stakeholders who may serve as steering group members, local experts, or interested parties. These stakeholders provide valuable input and feedback, represent diverse wildfire and community development interests, and act as communication channels to other local groups.

CPAW Process

The CPAW community planning process typically occurs over the course of one year. During that time, CPAW team members meet with stakeholders to discuss local issues, conduct several field tours (Figure 2) to learn about unique WUI and wildfire mitigation challenges, and provide presentations to help the community understand CPAW's program goals. Team members also thoroughly review community planning documents to analyze gaps and opportunities for strengthening wildfire policies and regulations. At the end of the process, team members provide the community with a set of voluntary recommendations to more effectively address the WUI through appropriate land use planning strategies. Follow-up implementation assistance may also be available to communities depending on their unique needs and CPAW's program funding.

Figure 2. The CPAW process engages with local experts and stakeholders through meetings and field tours to learn about local conditions within the planning area. Image credits: CPAW.

CPAW Recommendations

There are many planning tools available to communities to help address challenges associated with the WUI. These tools include plans and policies (e.g., growth management plans, neighborhood plans, open space management plans), and codes and regulations (e.g., subdivision regulations, landscaping ordinances, steep-slope ordinances, zoning codes, building codes, and WUI codes). See Figure 3 for more examples.

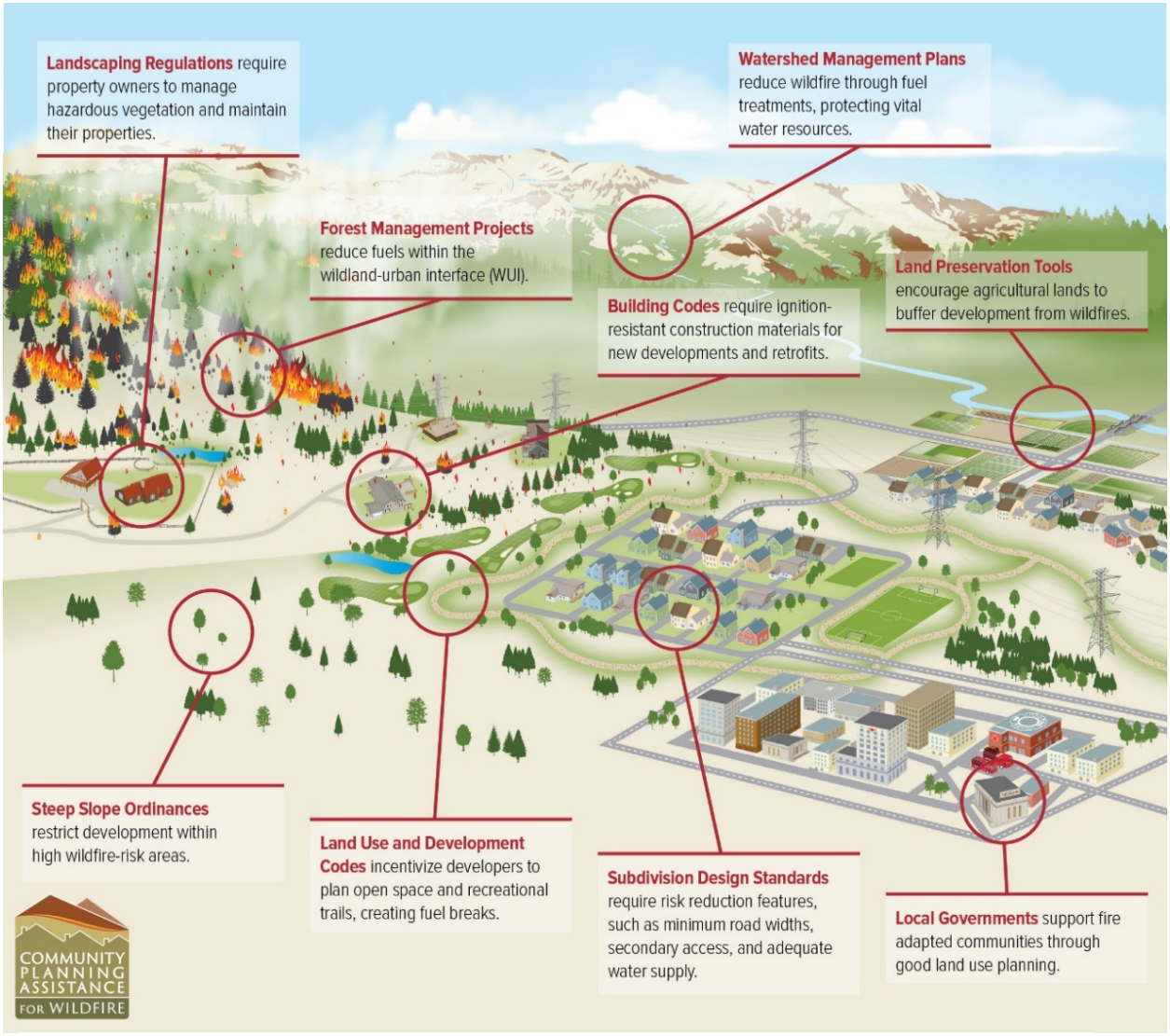

Figure 3. Community planning tools for wildfire.

CPAW expertise builds on research, science, and national best practices to customize recommendations for each local community. Additional inputs include community observations and stakeholder feedback. Recommendations focus on the nexus between land use planning, forestry, hazard mitigation, and wildfire risk-reduction strategies. Implementation of CPAW recommendations is voluntary; local governments retain sole authority for the decision to move any recommendations forward.

❖ Community Planning Context

Geographic Location and Significant Features

The Township of Ocean is one of 565 municipalities within New Jersey. Waretown is the only census-designated place and unincorporated community located within the township. The township is bordered by Barnegat Township (south), Lacey Township (north), Barnegat Bay (east), and the Pinelands Management Area (west). The township is bifurcated by the Garden State Parkway, and stakeholders commonly refer to areas within the township as either "west or east of the Parkway." The eastern portion of the township is largely flat and coastal with tidally influenced streams in the developed portions of the township.[1] Generally, stakeholders are more concerned with wildfire activity west of the Parkway (which is within the Pinelands).

Land Area and Ownership

The Township of Ocean's total area is approximately 32 square miles (20,242 acres). Thirteen square miles are under the jurisdiction of the Pinelands Commission, and nine square miles are under the jurisdiction of the Coastal Area Facility Review Act (CAFRA).[2] The Department of the Interior/ U.S. Fish and Wildlife Service manages approximately one square mile.[3] Remaining lands are publicly or privately owned, and include residential, commercial, and industrial uses, vacant land, schools, churches, and cemeteries. Land managers in Ocean County include Pinelands Commission, CAFRA, Department of Interior, and Department of Defense.

Key Demographics

The median age of township residents in 2016 was 56.1 years, which was an increase from 48.5 years in 2010.[4] Stakeholders attribute this demographic shift to an influx of retirees seeking to live in age-restricted communities across the region.

Table 1: Overview of Demographics in Township

Topic	Key Statistic	Notes
Current population	8,746[a]	Ocean County population is 576,567[a]
Population density	405 ppl/sq. mile[b]	Compared to 917 ppl/sq. mile in Ocean County[b]
Median age	56.1[a]	Compared to 42.8 in Ocean County[a]
Total number of housing units	4,505[a]	27% of housing units were built 2000-2009[a]
Housing units for seasonal, recreational or occasional use	575[b]	In 2016, homeowner vacancy rate was 1.3% and rental vacancy rate was close to 0%[a]

[1] Township of Ocean, Ocean County, New Jersey. 2015 "Floodplain Management Plan." T&M Associates. Pg. 3
[2] New Jersey Department of Environmental Protection. https://www.state.nj.us/dep/gis/stateshp.html
[3] BLM Surface Management Agency. https://catalog.data.gov/dataset/blm-national-surface-management-agency-area-polygons-national-geospatial-data-asset-ngda
[4] U.S. Census Bureau, 2012-2016 American Community Survey 5-Year Estimates

Median home price	$303,900[a]	Compared to $264,200 in Ocean County[a]
Median household income	$65,258[a]	Compared to $63,108 in Ocean County[a]
Workforce employment	3,543[a]	Largest sector of the workforce is sales and office work[a]
Poverty rate	6.3%[a]	Compared to 11.2% in Ocean County[a]

Data Sources:
a. U.S. Census Bureau, 2012-2016 American Community Survey 5-Year Estimates.
b. U.S. Census Bureau. 2010.

Fire Environment and Wildfire History

Based on records dating back to 1924, most of the large fires (more than 100 acres) within or affecting the Township of Ocean typically occur from April through May and have been concentrated in the northeastern and western portions of the township.[5] The largest and most devastating fire to affect the county was the 1963 Pine Barrens fire which grew to 193,000 acres (4% of the entire state land mass), burning the entire forest north of County Route 532 and the Garden State Parkway, with 196 structure losses, $8.5 million in property damages, and seven people killed. The same area burned again in 1995.

The New Jersey Pine Barrens have been influenced by humans and fire for thousands of years. Historically, the Lenape and Delaware tribes regularly employed fire to improve plant production and support their hunting efforts. Historical records show numerous early European settler references to frequent fires and the open nature of the forest as a result. Since European settlement and during the heavy industrial and logging activities, the high frequency of fire continued, resulting in ongoing historical records of repeated "destructive" fires.[6]

In an 1898 report to the New Jersey State Geologist, U.S. Forester Gifford Pinchot recommended the establishment of a Forest Fire Service, "not only to disseminate information about forestry and forest fire prevention, but also to rapidly and accurately locate forest fires and to provide the speedy response of a trained force of fire fighters."[7] On July 4, 1906, the New Jersey Forest Fire Service was brought into existence. In 1939, the Waretown Volunteer Fire Company was formed.

Land owners, land managers, and researchers also soon recognized the value of using prescribed fire to protect properties and manage the pine-oak forests of the Pine Barrens.[8] An active and robust prescribed fire program is a key component of the New Jersey Forest Fire Service today.

[5] Ocean Township (Ocean County) Community Wildfire Protection Plan, December 2014-2019.
[6] Pyne, Steven. 2014. "Bog and Burn: The Paradoxes of the New Jersey Pine Barrens", in A fire History of America 1960-2011.
[7] Wright, Kevin. 2006. A Century of Forest Stewardship in New Jersey 1905-2005.
[8] Little, Sylas and Somes, Horace. 1953. "Choosing Suitable Times For Prescribed Burning in New Jersey." Fire Control Notes January 1953, U.S. Forest Service.

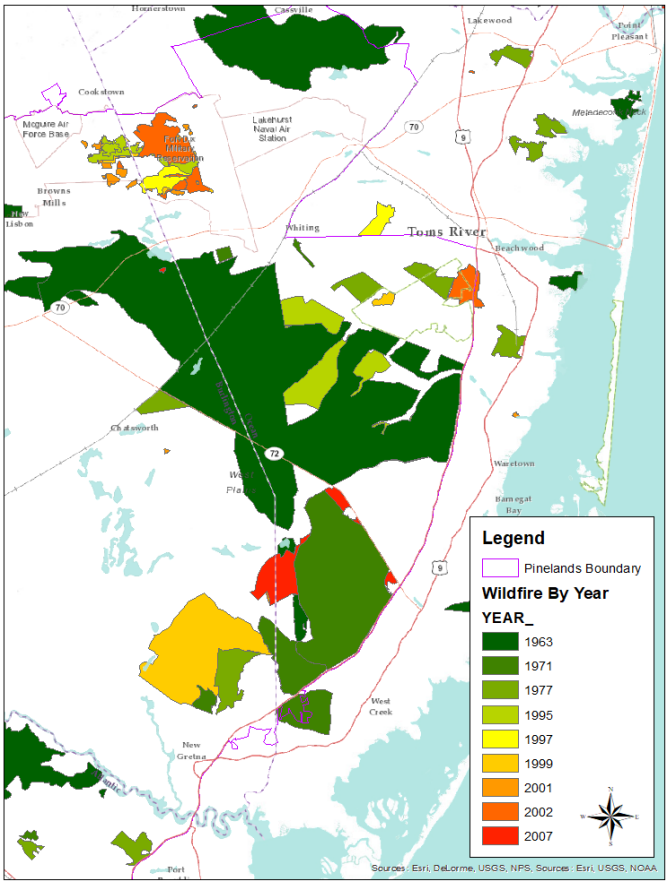

Figure 4. Recent wildfire occurrences resulting in evacuations or other significant effects on the Township of Ocean and/or area 1963-2007. Data source: Inga La Puma, 2018.

Table 2: Overview of Community Fire History (1963 to 2012)

Fire Name	Year	Size (acres)	Location	Evacuations	Significant effects
Pine Barrens	1963	193,000	Multiple counties	Yes	Benchmark for WUI fires in the U.S. 197 buildings lost (186 homes), 7 killed, $8.5 million in property damage
Manahawkin	1971	21,000	Ocean County	Yes	Burned 21,000 acres in 7 hours and 31 minutes
Bass River Fire	1977	2,300	Ocean County	Yes	4 firefighters killed
Greenwood	1995	19,225	Manchester, Lacey, & Ocean townships	Yes	
Wranglebrook	1997	702	Berkley Township	Yes	300 homes threatened; 20 damaged

Table 2: Overview of Community Fire History (1963 to 2012)					
Fire Name	**Year**	**Size (acres)**	**Location**	**Evacuations**	**Significant effects**
Barnegat	1997	17,000	Berkeley & Manchester townships	Yes	4 homes destroyed; 50 damaged
Chamberlain	1999	70	Lacey Township		
Warren Grove	2001	1,600	Stafford Township	Yes	Started on Warren Grove Range
Jake's Branch	2002	1,277	Berkeley Township & Beachwood Borough	Yes	3 homes and 15 outbuildings destroyed; 50 additional homes seriously damaged; Garden State Parkway closed for 11 hours
Warren Grove	2007	15,550	Stafford and Barnegat townships	Yes	Started on Warren Grove Range. Wide spread evacuations. Structures destroyed. 7 miles of the GSP closed along with other major state and county roads.
Data Sources: New Jersey State Hazard Mitigation Plan; 2014 Multi-Jurisdictional All Hazard Mitigation Plan, Ocean County					

❖ Township of Ocean Community Analysis

In addition to understanding the local planning context, CPAW team members gather information through facilitated conversations and meetings with stakeholders, field tours, and internal research. CPAW team members also review and analyze community plans, policies, and regulations to determine their level of effectiveness for community wildfire mitigation. This information is compiled into an internal audit and reviewed with the local steering group. This section highlights planning challenges and opportunities that emerged during that process.

Local Planning Challenges

- **Two separate and independent fire hazard/risk assessments.** Currently, there are two separate wildfire risk/hazard assessments that can potentially influence planning decisions within the Township of Ocean: a dated (1995) Pinelands Comprehensive Management Plan fire hazard assessment and the 2009 New Jersey Forest Fire Service municipal hazard and risk assessment for the Township of Ocean. This presents two separate standards, both of which require updating. Additionally, a recent independent research project undertaken by NASA and the University of Alabama produced a wildfire risk assessment that was made available to the Pinelands Commission staff for review

and possible adoption. Finally, the New Jersey Forest Fire Service has engaged with a contractor to develop an updated statewide wildfire risk assessment that uses the same methodology as the proposed hazard mapping that has been developed as part of the CPAW assistance.

- **Local coordination is required on wildfire planning activities.** In the past decade, the neighboring Township of Barnegat approved the development of new residential subdivisions which abut the Township of Ocean's southern border. Land managers are concerned with potential fires starting in the township's forested areas (including the Pinelands) and threatening the subdivisions in Barnegat due to typical wind directions and previous fire history.
- **State and federal agencies have authority on local regulatory changes.** State and federal agencies have a significant influence over land use, building, and forestry programs in the Township of Ocean through the Pinelands Management and Coastal Zone Management areas. Many planning activities need to be coordinated as a multi-agency approach.
- **Human ignitions are the primary cause of local wildfires**. Most wildfires are a result of human ignition sources, which typically occur close to development, resulting in most fires immediately involving the WUI.

Local Planning Opportunities

- **Population growth is expected to continue for residential and non-residential uses to service local market needs.** New development will be required for future residents. Although there is limited development anticipated in the Pinelands, other areas of the township that have an identified wildfire hazard are likely to see growth. This presents an opportunity to proactively address new development before it increases wildfire risk within the township.
- **Local and state partnerships.** The Township of Ocean has a coordinated relationship with the New Jersey Forest Fire Service. Communication is frequent and New Jersey Forest Fire Service staff are integrated into wildfire planning activities at the local level. This lends itself to productive and successful mitigation outcomes.

- **Interest and leadership in wildfire planning.** During the CPAW process, local and state stakeholders expressed interest in incorporating innovative planning strategies and tools to support WUI planning activities. Showcasing these best practices within the township could garner interest from across the state. This level of support makes the township an ideal candidate to explore and implement best practices in land use planning and fire modeling.

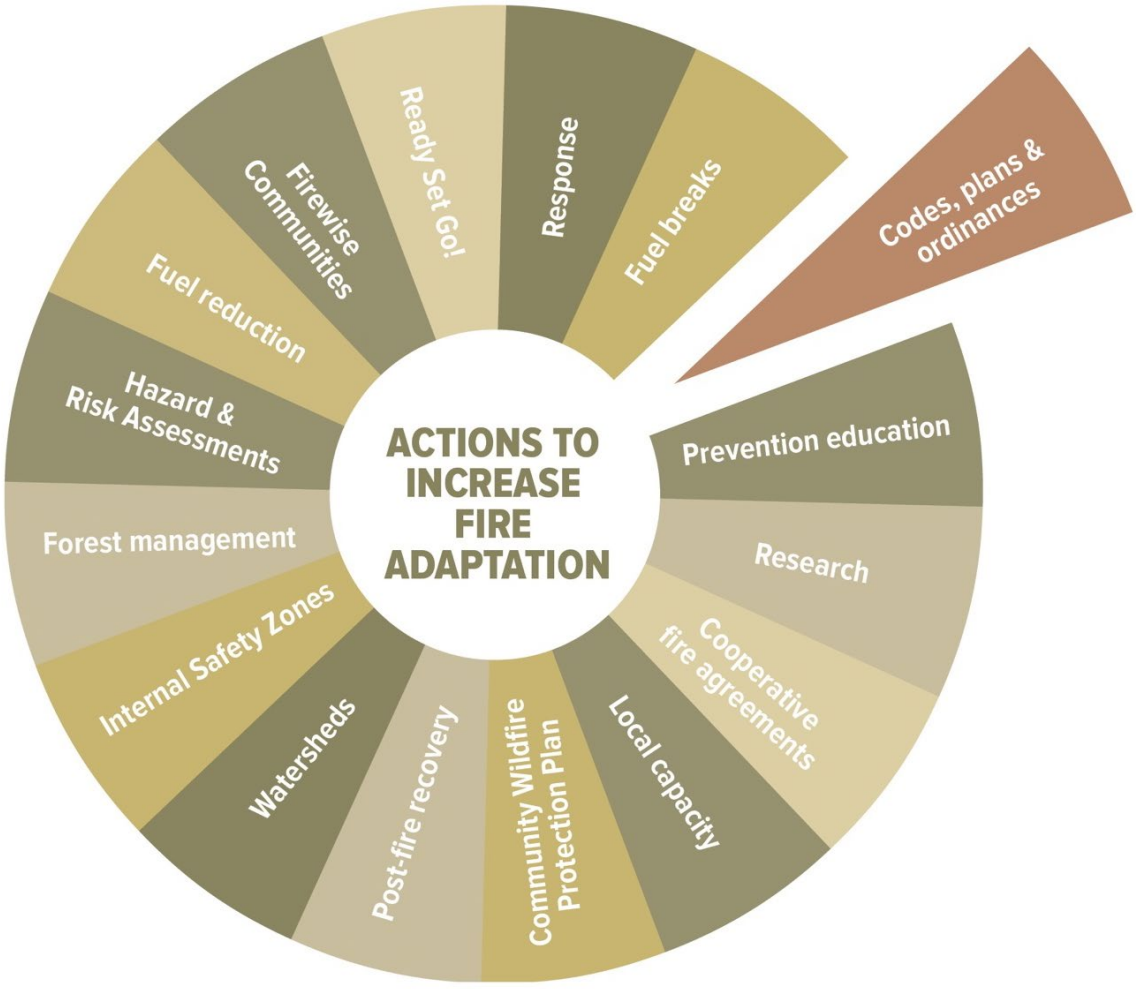

Figure 5: Community fire adaptation requires a coordinated approach. CPAW (codes, plans, and ordinances) is one piece of the fire adaptation "wheel"; other efforts include Community Wildfire Protection Plans, fuel reduction activities, hazard and risk assessments, and education.

Summary of Recommendations

Table 3. Overview of Recommendations		
Recommendation	**Summary**	**Key Points**
Recommendation 1: Define the Wildland-Urban Interface (WUI) and Implement a Consolidated WUI Risk Assessment Program	A consolidated wildfire risk assessment should be developed, including a map of spatially delineated WUI risk classes across the county. This map should be provided at an appropriate resolution and scale to support land use and regulatory decisions.	This assessment should: • provide updated and consolidated information across the land base to use in replacement of the two separate and outdated assessments currently being used; • provide spatial definition of the WUI; • provide spatially delineated risk or hazard classes in a format that can be used to support land use planning decisions; • provide a measure of built environment susceptibility to wildfire.
Recommendation 2: Update and Apply the Fire Protection Standards Across the Township Based on WUI Delineation and Hazard Classes	Updated Fire Protection Standards that are based on the most up-to-date best practices and apply consistently across the entire township will be both easy to follow by the public and defendable.	Updated Fire Protection Standards should: • be based on the most up-to-date science and best practices; • use an up-to-date hazard assessment; • provide consistent application across the entire jurisdiction.
Recommendation 3: Amend Master Plan to Align Resiliency and Wildfire Planning Activities	Currently there are no specific references to wildfire resiliency in the master plan. To address the gaps, future amendments to the current Master Plan should incorporate new wildfire planning topics and align community-based wildfire initiatives with other planning documents.	An amended Master Plan should: • include resilience goals that address wildfire; • align with the hazard mitigation plan and Community Wildfire Protection Plan; • not conflict with other plans.

Table 3. Overview of Recommendations		
Recommendation	**Summary**	**Key Points**
Recommendation 4: Update Community Wildfire Protection Plan to Reflect National Best Practices	The National Cohesive Fire Management Strategy framework can be used to effectively communicate and best align the community wildfire protection plan with national best practices.	The Cohesive Strategy approach that can guide the next CWPP update would: • focus on creating resilient landscapes, promoting fire-adapted communities, improving response and suppression capabilities; • involve a collaborative approach using a fire council model; • incorporate land use planning; • align with other plans.

RECOMMENDATION 1: Define the Wildland-Urban Interface (WUI) and Implement a Consolidated WUI Risk Assessment Program

❖ Why This Recommendation Matters

Overview Township of Ocean Wildfire Risk Assessment History

Currently, there are two separate wildfire risk/hazard assessments that can potentially influence planning decisions within the Township of Ocean. The first assessment is a hazard classification developed in 1995 for use in the Pinelands Comprehensive Management Plan Part XII Fire Management. This provides guidance for development and implementation of the fire hazard mitigation standards and guidelines for construction. The second assessment is a municipal hazard and risk assessment undertaken by the New Jersey Forest Fire Service in 2009 and used in the 2014 Township of Ocean Community Wildfire Protection Plan with no specific application linked to land use planning.

The Need for an Updated, Cohesive and Consolidated Risk Assessment

Current research and best practices typically describe the WUI as a "set of conditions" in which both vegetation (wildland fuels) and the built environment (built fuels) are influenced by weather and topography to create an environment where fire can ignite and spread through this combined fuel complex (the combination of wildland and built fuels). One cohesive and comprehensive township-wide risk assessment and spatial definition of the WUI is necessary to provide consistent decision support for developing and implementing land use policies and regulations. This assessment should include a map of spatially delineated risk classes across the county and be provided at an appropriate resolution and scale to support land use and regulatory decisions.

What is Wildfire Risk?

Wildfire risk can be visualized as a triangle, consisting of three components:

1. Likelihood of a wildfire occurring based on topography, weather, and ignition patterns; this can also include ignition sources from hazardous land uses (e.g., sawmills or propane storage facilities);

2. Predicted intensity of a wildfire (usually measured in flame length) based on vegetation type and weather conditions;

3. Susceptibility of values (for land use planning purposes, values consist of communities, structures, and infrastructure).

Together, these components complete the wildfire risk triangle (Figure 6).

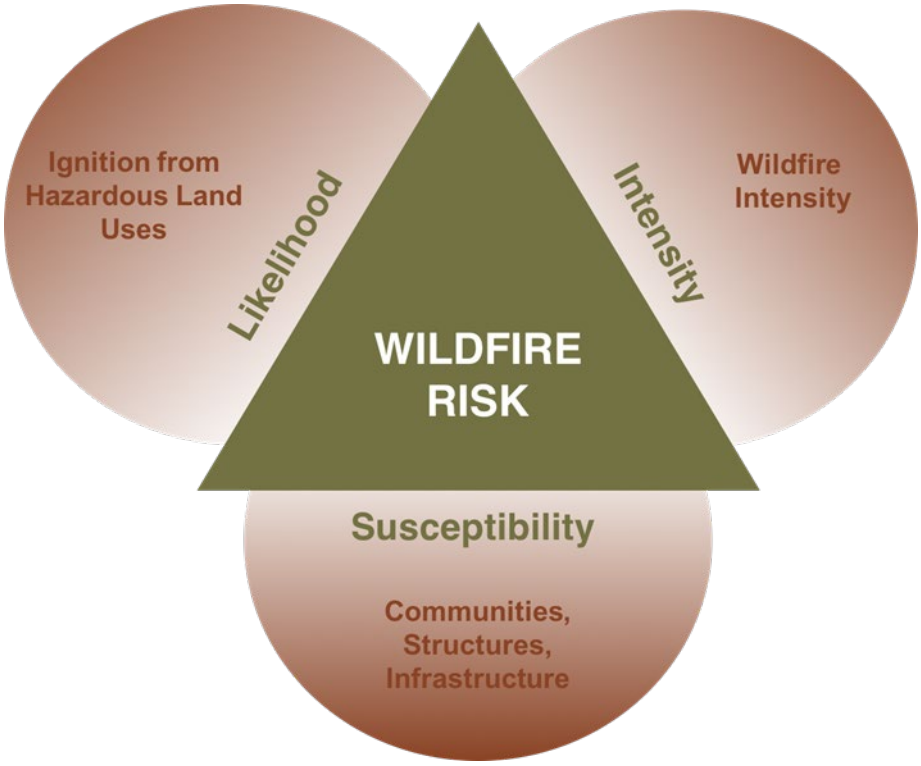

Figure 6. Components of the wildfire risk triangle

Land use planning largely focuses on mitigating the susceptibility portion of the wildfire risk triangle. Two important susceptibility inputs should be evaluated to appropriately determine wildfire risk in the context of land use planning:

- The location and density of structures and infrastructure;
- The ignition potential of individual structures and infrastructure.

Implementing this recommendation will provide clear definition of the Township of Ocean's WUI and integrate a hazard assessment map as a component of the decision support tool for land use policies and regulations. The further incorporation of a property-specific assessment system to complement the hazard assessment with a built environment susceptibility component will provide a comprehensive risk assessment.

Pinelands Hazard Classification

The Pinelands Comprehensive Management Plan currently uses a very simple model developed in 1995 that uses specific vegetation classifications to determine the fire hazard as follows:

Hazard	Vegetation Type
Low	Atlantic white cedar Hardwood swamps
Moderate	Non-Pine Barrens forest and prescribed burned areas
High	Pine Barrens forest including mature forms of pine, pine-oak, and oak-pine
Extreme	Immature or dwarf forms of pine-oak or oak-pine, all classes of pine-scrub oak and pine-lowland

Through recent communications with Pinelands Commission staff, the CPAW team learned that staff are currently working on integrating a new wildfire risk assessment process in partnership with the National Aeronautics and Space Administration (NASA) and the University of Alabama.[9] The project utilizes vegetation indices derived from Landsat 8 Operational Land Imager (OLI) and Sentinel-2 Multi-Spectral Instrument (MSI), land-use classification derived from LandFire data, and elevation into a fuzzy logic model to generate a 30 x 30 m Fire Risk Assessment Map. The map delineates risk into five classes:

- Extremely Low
- Low
- Moderate
- High
- Extremely High

The outputs from this assessment indicate that 53% of the total area within the Pinelands WUI is classified as having a moderate fire risk, while high and extremely-high fire risk accounted for 13%. The New Jersey Pinelands Commission is planning on using the results and maps produced to guide urban development planning and decision making.

New Jersey Forest Fire Service Hazard/Risk Assessment

The current municipal hazard and risk assessment for the Township of Ocean was undertaken by the New Jersey Forest Fire Service in 2009 and integrated into the Township of Ocean Community Wildfire Protection Plan in 2014.

[9] New Jersey Urban Development. 2018. Project Summary: Identifying Optimal Regions within New Jersey's Pine Barrens Forest for Urban Development Based on Wildfire Risk and the Wildland-Urban Interface Theory.

As part of the hazard and risk assessment, the New Jersey Forest Fire Service evaluated and ranked the fuel hazard, risk of wildfire occurrence, structural ignitibility and fire-fighting limitations. These criteria are defined as:

1. Fuel Hazard: the rank of the wildland fuels that burn in and around the community, structure, or area.
2. Risk of Wildfire Occurrence: the measure of what causes a wildfire and the impact that it has.
3. Structure Ignitability: the rank of a structure's ability to resist the threat from a wildfire as determined by an assessment that meets or exceeds NFPA.
4. Firefighting Limitations: an assessment of the equipment, organization, training, communication, mutual-aid agreements, and water supply available and in place.

USDA Forest Service Risk and Hazard Assessment

As part of the CPAW program, the U.S. Forest Service Rocky Mountain Research Station (RMRS) provides wildfire risk and hazard assessment support. After assessing the current need (and prior to learning about the newest Pinelands Commission/ NASA partnership project), the CPAW team engaged RMRS to undertake a township-wide order to develop an updated, cohesive, and consistent hazard assessment approach (likelihood and susceptibility) to support this project. As a component of the hazard assessment, RMRS is also undertaking the SILVIS lab's approach to spatially defining the WUI in the Township of Ocean.

Parcel-Level Susceptibility Assessments

Individual Parcel-Level Assessments complete the risk triangle by providing the susceptibility component. This focuses on assessing each structure and the immediate surroundings, or Structure Ignition Zone (SIZ). The township should also consider undertaking parcel-level assessments to complete the susceptibility component of the risk triangle by providing ignition potential data for individual structures and infrastructure.

❖ Implementation Guidance

As part of the CPAW process, RMRS staff engaged with local wildfire risk subject matter experts to achieve three main objectives:

1. Validate the RMRS spatial fuels layers through local subject matter expert input.
2. Explore RMRS tools that can be used to develop a countywide hazard map to complement the Region 6 Risk Assessment process and better support land use planning and other wildfire risk reduction efforts.
3. Spatially define the WUI.

This collaborative engagement was undertaken in the form of a workshop in which local subject matter experts worked with RMRS staff and CPAW team members to determine the appropriate parameters and tools that would be useful in supporting local risk-reduction efforts.

As a result of this collaborative work, RMRS has calibrated the spatial fuel layer and developed a methodology to provide spatial hazard assessment to support to the development and implementation of land use planning policy and regulations.

Wildfire Hazard Assessments and Mapping

To provide an effective decision support tool for the county and its partners, RMRS staff developed wildfire hazard mapping outputs, described below. Two maps are provided at two scales: the Landscape-Level Wildfire Hazard (270 m pixels) and Local Wildfire Hazard (90 m pixels which includes ember zones). A summary of the methodology used to develop these outputs can be found in Appendix A.

Landscape Wildfire Hazard

This scale (270 m pixel resolution) represents the likelihood (probability) of a fire occurring and intensity of the fire at the landscape level based on the inherent landscape characteristics, including broad existing vegetation, biophysical settings, fire regimes, and fire histories. To provide the assessment in a format that is easily interpreted by the expected users (public, developers, land use planners), the pixelated display was summarized to polygon boundaries based on the U.S. Geological Survey Hydrological Unit Code (HUC) 12 (sub watershed) boundaries. The landscape-level hazard assessment is delineated into the following rankings:

- **MODERATE**
- **HIGH**
- **VERY HIGH**

The factors influencing these rankings can be used to determine the potential landscape-level exposure that a development will be subject to. The ranking at this scale is difficult to change at the local/parcel level. Mitigation affecting change at this scale is typically done by large-scale disturbances such as insect mortality, fires, or landscape-level mitigation.

Land Use Planning Application: This informs land use planners on the general areas where fires are most likely to occur and where collaborative, multi-agency, large-scale fire management planning and mitigation is necessary.

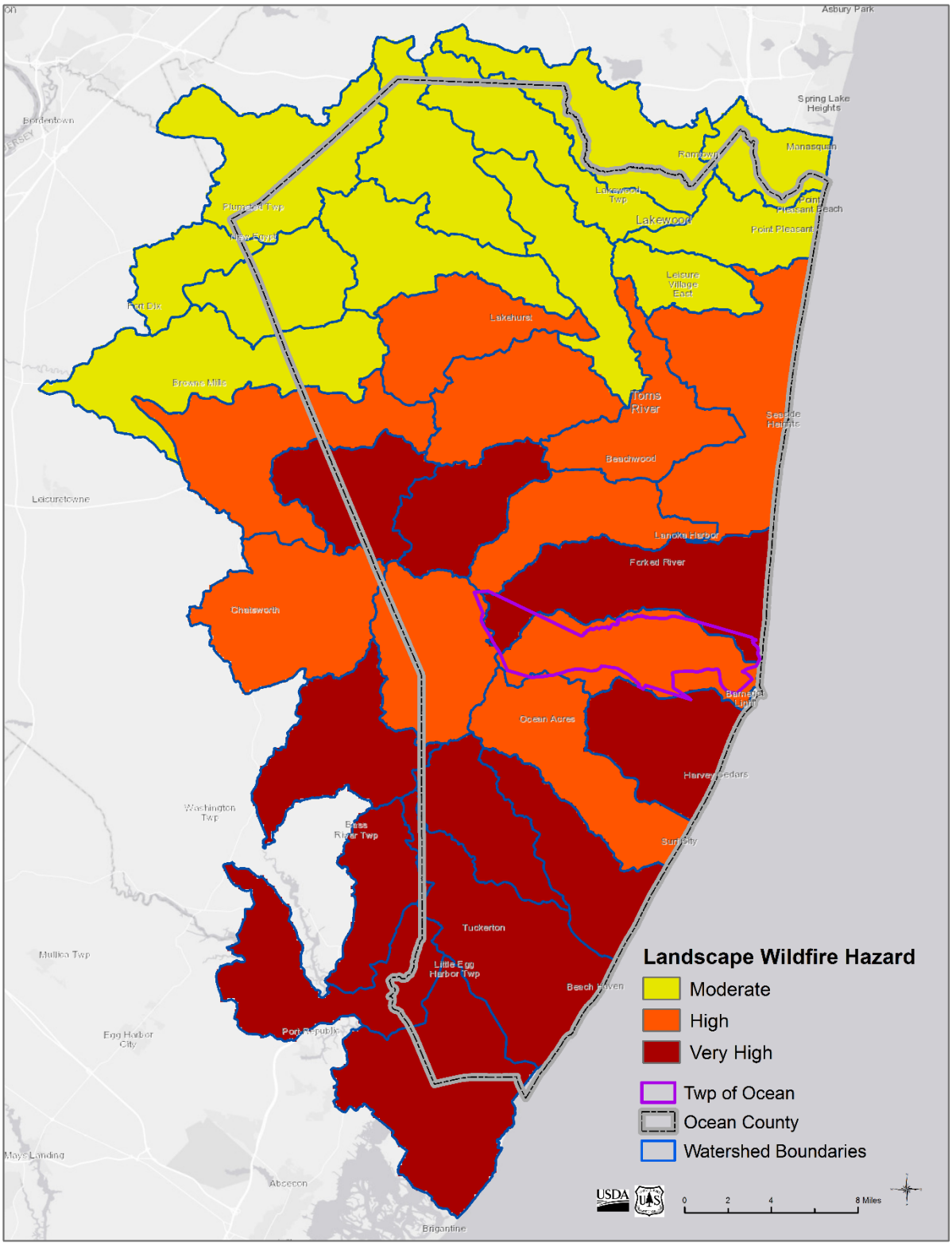

Figure 7. The Township of Ocean Landscape Wildfire Hazard Map

Local Wildfire Hazard

This scale (90 m pixel resolution) is based on an extreme event (worst fire days). To provide the assessment in a format that is easily interpreted by the expected users (public, developers, land use planners), the pixelated display was summarized to polygon boundaries based on the catchment boundaries within the HUC 12 boundaries. This does not show the likelihood of a fire occurring but does shows where fires are likely to burn at high intensity. For example, a fire that starts in an area where the local hazard is high can spread fast and burn at high intensity creating significant wildfire exposure to any structures in the area. The same rankings used at the landscape scale are used at this local scale:

- **MODERATE**
- **HIGH**
- **VERY HIGH**

As part of the wildfire hazard analysis, the potential ember transport was assessed using several approaches and all outcomes indicated that the entire township is susceptible to ember impingement.

Land Use Planning Application: This informs land use planners on the relative worst-case (hottest, driest, windiest days during a fire season) wildfire exposure (radiant, convective, and ember) that can be expected in any given polygon where development exists or is planned.

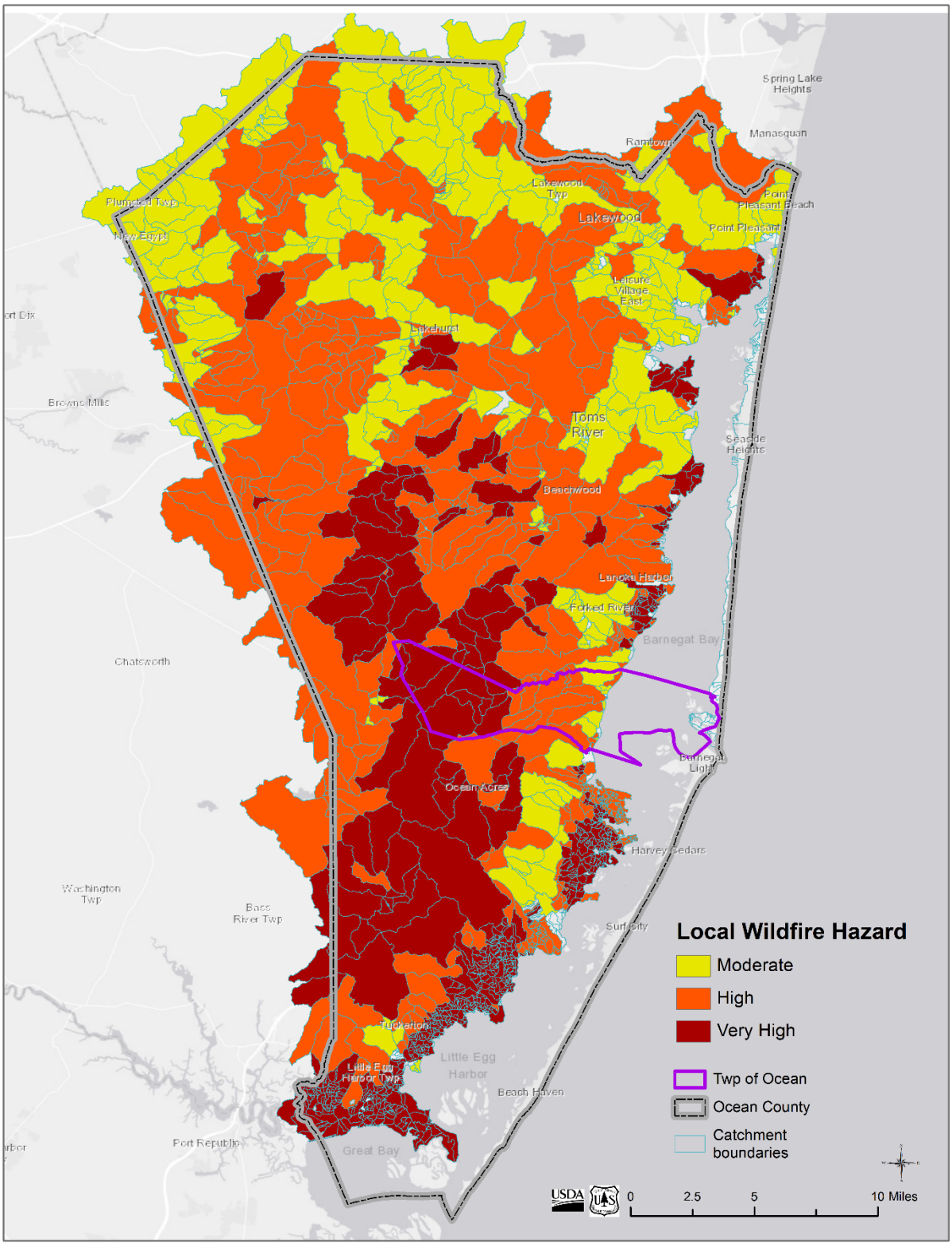

Figure 8. The Township of Ocean Local Wildfire Hazard Map

Parcel-Level Assessment

Parcel-level wildfire assessment requires a "boots on the ground" approach.

CPAW recommends the township engage with the fire districts to gain a better understanding of the current data available and the gaps where a collaborative approach can facilitate the coordinated collection of township-wide parcel-level assessment information.

Defining the WUI

A general WUI definition used across all policies, plans and regulations should account for the "set of conditions" where vegetation (wildland fuels) and structures or infrastructure (built fuels) are influenced by weather and topography to allow fire to ignite and spread through the WUI environment. To provide the basis for a true understanding of the risk that the Township of Ocean faces, the WUI should be more accurately defined as:

Any developed area where conditions affecting the combustibility of both wildland and built fuels allow for the ignition and spread of fire through the combined fuel complex.

In order to provide a spatial reference in defining the WUI, the SILVIS lab's approach should be used. The SILVIS lab approach originated in the Federal Register report[10] on WUI communities at risk from fire, and Tie and Weatherford's 2000 report to the Council of Western State Foresters on WUI fire risk. This approach focuses on the following inputs:

1. Housing density
2. Landcover[11]
    a) **WUI Intermix**: Areas with ≥16 houses per square mile and ≥50 percent cover of wildland vegetation
    b) **WUI Interface:** Areas with ≥16 houses per square mile and <50 percent cover of vegetation located <1.5 miles of an area ≥2 square miles in size that is ≥75 percent vegetated
    c) **Non- WUI Vegetated (no housing):** Areas with ≥50 percent cover of wildland vegetation and no houses (e.g., protected areas, steep slopes, mountain tops)
    d) **Non-WUI (very low housing density):** Areas with ≥50 percent cover of wildland vegetation and <16 houses per square mile (e.g., dispersed rural housing outside neighborhoods)
    e) **Non-Vegetated or Agriculture (low and very low housing density):** Areas with <50 percent cover of wildland vegetation and <128 houses per square mile (e.g., agricultural lands and pasturelands)
    f) **Non-Vegetated or Agriculture (medium and high housing density):** Areas with <50 percent cover of wildland vegetation and ≥128 houses density per square

[10] USDA and USDI. 2001. Urban wildland interface communities within vicinity of Federal lands that are at high risk from wildfire. Federal Register 66:751–777.
[11] Schlosser, W.E. 2012. Defining the Wildland-Urban Interface: A Logic-Graphical Interpretation of Population Density. Kamiak Ridge, LLC

mile (e.g., urban and suburban areas, which may have vegetation, but not dense vegetation**)**

CPAW and RMRS have modified the above approach by removing the < 1.5 mile reference in b) and considering the entire township as an "ember zone." Due to this outcome and for simplicity, the categories have also been modified into the following categories:

g) **WUI Intermix**: Areas with houses present and ≥50 percent cover of wildland vegetation

h) **WUI Interface:** Areas with ≥16 houses per square mile and <50 percent cover of vegetation

i) **Non-WUI Vegetated:** Areas with ≥50 percent cover of wildland vegetation and no houses (e.g., protected areas, steep slopes, mountain tops)

j) **Non-Vegetated:** Areas with <50 percent cover of wildland vegetation

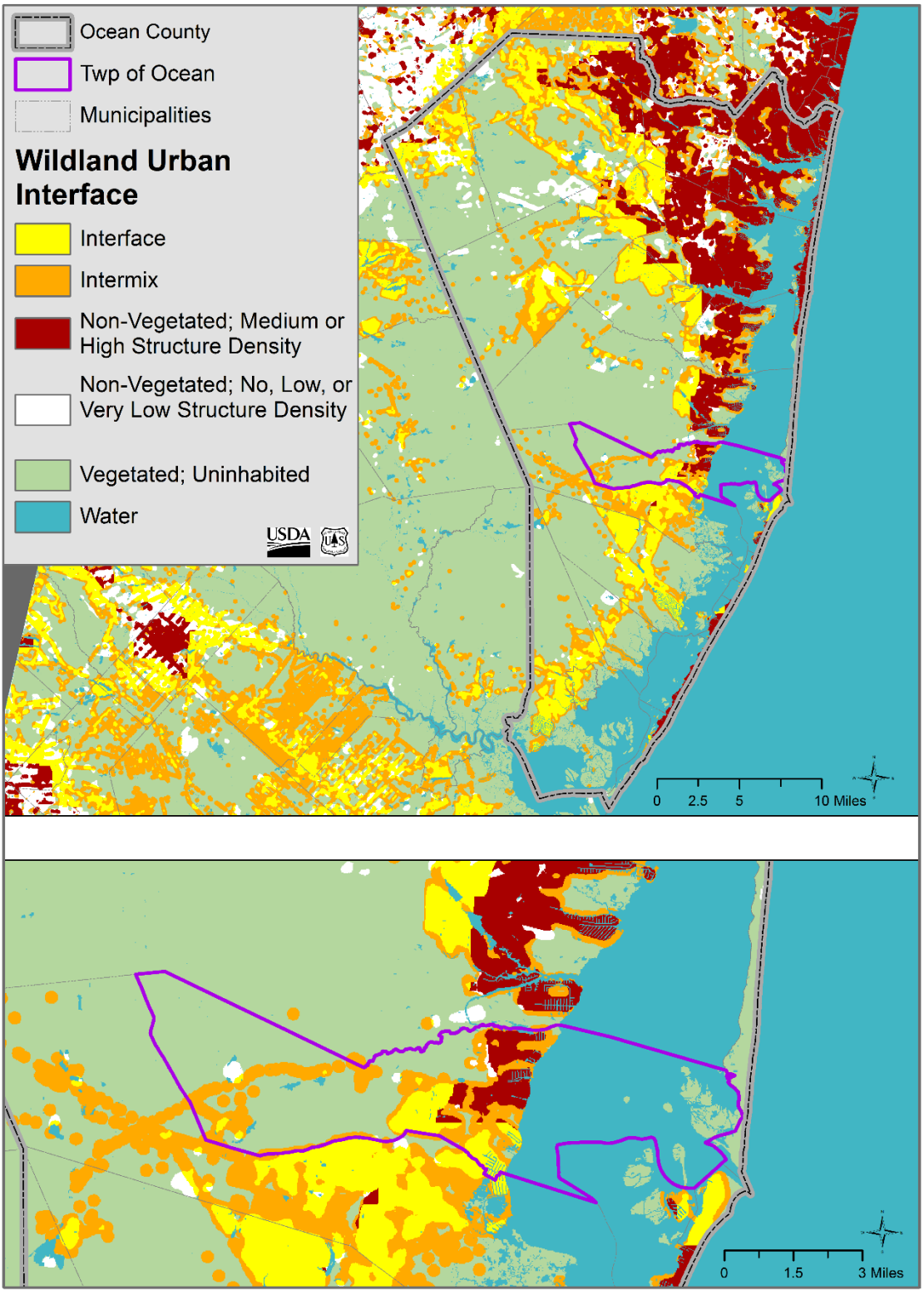

Figure 10. The Township of Ocean Map of the Wildland Urban Interface and Wildland Urban Intermix

Using the Risk Assessment to Support Land Use Policy and Regulation

The landscape and local-scale maps will be supplied as a geodatabase to the township. This will allow the user to explore a hierarchy of hazard/exposure metrics including all of the elements described above. For example, if a user clicks on a watershed polygon, they will see the elements that contribute to the calculation of the final hazard rating. The display of pixel-level model outputs at finer display scales will also provide the ability for end-users to examine the spatial variability of factors contributing to hazard and exposure with any watershed. The local-scale map will provide the opportunity for planners to appropriately assess a future or existing development area for wildfire exposure and require the appropriate mitigation. It will also provide a ranked scale to guide implementation of Fire Protection Standards with regards to the degree of standards that must apply based on exposure.

❖ Tips and Additional Resources

The resulting hazard assessment tool will be provided in the form of a geodatabase for addition to the township's geomatics servers for use as an ESRI ARC GIS layer.

For the data to be made available to land use planners and the development community, the expertise of a GIS specialist will be required to ensure it is in the appropriate format for access and consumption by these groups.

The hazard assessment tools must be kept up to date to be relevant. A minimum default 5-year update schedule is recommended, with recommended updates to occur based on the following:

- Significant wildland fire activity;
- Significant fuel management activity;
- Significant forest health impacts, or other disturbances that alter large-scale vegetation structure;
- Significant urban growth.

RMRS has provided a best practices document (Appendix A) that will provide guidance to the township on the methodology for updating the assessment. The risk assessment outputs should be strongly linked as a decision support tool for implementing the proposed WUI requirements and planning policies.

RECOMMENDATION 2: Update and Apply the Fire Protection Standards Across the Township Based on WUI Delineation and Hazard Classes

❖ Why This Recommendation Matters

Overview of Current Wildfire Regulations

The Township of Ocean regulates its WUI within the Pinelands per Chapter 410. Zoning (§410-86) Fire Protection. These standards are adopted verbatim from the Pinelands Comprehensive Management Plan (CMP). Standards address specific defensible space and structure mitigation requirements.

Current requirements under §410-86 Fire Protection apply to any new development which occurs in areas as having moderate, high, or extreme risk hazard according to the Pinelands Comprehensive Management Plan Hazard Classification (see Recommendation 1). The township does not have WUI fire protection requirements for areas outside of the Pinelands; however, there are property maintenance standards where an opportunity to include wildfire exists.

The township's Fire Protection Standards have the following requirements:

1. Two fire suppression equipment access ways for developments with 25 dwellings or more;
2. Dead-end roads to terminate in areas that provide fire equipment access and egress;
3. Rights-of-way of all roads maintained to provide effective fuel breaks;
4. Fire hazard fuel break standards and distances around all structures proposed for human use based on the fire hazard classifications;
5. Residential developments of 100 dwelling units or more in high or extreme hazard to have 200-foot-perimeter fuel break meeting specific standards between structures and the forest, with a maintenance program;
6. Roofing material and exteriors to be constructed of fire-resistant materials, with "fire retardant treated wood shingles or shake-type" roofs prohibited in high or extreme areas;
7. All projections to be fire resistant or treated with fire retardant chemicals;
8. Any openings in the roof, attic, and the floor shall be screened;
9. Chimneys and stovepipes (designed to burn solid or liquid fuel) to have outlets screened;
10. Prohibition on flat roofs in areas where vegetation is higher than the roof;

11. Ongoing maintenance plan for a proposed development with 100 dwellings or more.

Regulations for Wildfire Mitigation on Existing Private Parcels

Currently, there are no regulations that directly address existing developed parcels to engage in wildfire mitigation, unless the parcel is in the Pinelands and is being re-developed. However, there is an opportunity to update the existing Chapter 280 Property Maintenance to include requirements for maintaining defensible space appropriate to the assessed wildfire risk.

Potential Conflicting Codes and Regulations

Township of Ocean Code Conflicts

Upon review of standards in both the Pinelands CMP and standards in the Township of Ocean Zoning Code, a few specific possible conflicts with wildfire mitigation efforts regarding residential structures, commercial structures, or infrastructure were identified:

1. Screening of motor vehicles and utility structures using vegetation (Chapter 410, Zoning §410-45. Design standards, pg. 71)
2. Wireless Telecommunications Towers and Facilities (Zoning Article VIII, pg. 79)
3. Construction, alteration, remodeling of a historic resource (Zoning §410-96 (B) (1), pg. 119)
4. Minimum buffer strip (Zoning, §410.123 (D) Motels (11), pg. 129)
5. Fees for tree removal permit (fire protection) (Trees §373-10. Fees, pg. 3)

State of New Jersey Code Conflicts

Currently, neither the State of New Jersey Uniform Construction Code (NJAC 5:23) and sub-codes, nor the Residential Site Improvement Standard provide direction on wildfire mitigation requirements. Furthermore, these codes and standards specifically exclude municipalities from developing their own local codes to increase stringency in areas that are governed by these regulations.

Opportunities for Improvement

Develop Updated and Consistent Fire Protection Standards

The current Fire Protection Standards apply only to areas within Pinelands, all other areas of the township do not have WUI standards in place. The risk and hazard assessments undertaken by both the New Jersey Forest Fire Service and RMRS (see Recommendation 1) indicate that significant portions of the township's jurisdiction outside of the Pinelands are at risk of wildfire. Fire Protection Standards that are based on scientifically driven best practices and applied consistently across the jurisdiction informed by a robust, scientifically based risk assessment (Recommendation 1) are easy to follow by the public and defendable. Since the development of the existing Fire Protection Standards, wildfire mitigation best practices have evolved and

improved based on new research and findings. The CMP authorizes municipalities to either adopt the Pinelands Fire Protection Standards or develop their own Fire Protection Standards that meet or exceed the standards. This provides an opportunity for the Township of Ocean to update current standards and apply them throughout the jurisdiction. This will allow the township to:

- **Appropriately mitigate the wildfire structure vulnerabilities.** Based on the most up-to-date and defendable science and subsequent best practices.
- **Increase public and first responder safety.** Requiring construction and access standards both within and outside the Pinelands reduces likelihood of ignitions across the entire Township of Ocean jurisdiction, increases ability for the public to safely evacuate, and improves response capabilities.
- **Ensure consistency of standards.** Requiring future development or infill be built to a consistent mitigation standard provides a measurable way to address one of the township's most significant hazards, both within and outside the Pinelands.

Resolve Conflicts Between Regulations

There are several existing local and state regulations that potentially conflict with wildfire mitigation efforts. This either prevents the township from legally pursuing some standards or may impede or discourage developers and residents from taking action. To minimize barriers to wildfire risk reduction, staff should:

- Apply for change of rule to the State of New Jersey Department of Community Affairs to allow for the implementation of appropriate wildfire mitigation standards in identified WUI areas;
- Consider reviewing and updating the identified existing regulations to resolve these potential conflicts.

❖ Implementation Guidance

To adequately plan for and address wildfire in the built environment, the CPAW team recommends that the Township of Ocean update the existing Fire Protection Standards to reflect current best practices, as provided below.

1. Define the Wildland-Urban Interface

The existing fire protection requirements do not reference a spatial delineation of the WUI, nor do they extend beyond the Pinelands. **Based on the results of the RMRS wildfire hazard assessment, the CPAW recommends that the township use designate the entire Township of Ocean as the WUI and use the Local Wildfire Hazard map to define where specific Fire Protection Standards will apply.** This information will provide for a more accurate reflection of the local WUI.

2. Update the Existing Fire Protection Standards to Align with Current Science and Best Practices

The existing fire protection standards do not accurately reflect the most current science and best practices in WUI wildfire mitigation. **CPAW recommends that the township update the existing Fire Protection Standards with the changes and additions outlined in Table 4 (below) for which the township has legal authority. CPAW further recommends that the township engage in the process for rule change with the referenced New Jersey State Department of Community Affairs authority identified in Table 4 for changes to state rule that will provide for appropriate Fire Protection Standards.**

TABLE 4: Recommended Changes to Fire Protection Standards

Reference	Existing Requirement	Proposed Change
B (1)	**CHANGE FROM:** All proposed developments, or units or sections thereof, of 25 dwelling units or more will have two accessways of a width and surface composition sufficient to accommodate and support fire-fighting equipment.	**APPLY FOR RULE CHANGE TO: The New Jersey State Department of Community Affairs Site Improvement Advisory Board to change the New Jersey Administrative Code, TITLE 5. COMMUNITY AFFAIRS, CHAPTER 21. RESIDENTIAL SITE IMPROVEMENT STANDARDS, SUBCHAPTER 1. GENERAL GUIDELINES** to require two ingress and egress roads for subdivisions within identified wildland-urban interface areas.
B (2)	**CHANGE FROM:** All dead-end roads will terminate in an area adequate to provide ingress and egress for fire-fighting equipment.	**CHANGE TO:** All proposed developments must provide fire apparatus access in accordance with the requirements of the 2015 New Jersey State International Fire Code, Section 503 Fire Apparatus Access.

(3), B (4) and B (5)	**CHANGE FROM:** B (3) The rights-of-way of all roads will be maintained so that they provide an effective firebreak. B (4) A fire hazard fuel break is provided around structures proposed for human use by the selective removal or thinning of trees, bushes, shrubs and ground cover as follows: a) In moderate fire hazard areas, a fuel break of 30 feet measured outward from the structure in which: 1. Shrubs, understory trees and bushes and ground cover are to be selectively removed, mowed or pruned on an annual basis. 2. All dead plant material is removed. b) In high fire hazard areas, a fuel break of 75 feet measured outward from the structures in which: 1. Shrubs, understory trees and bushes and ground cover are to be selectively removed, mowed, or pruned and maintained on an annual basis. 2. All dead plant material is removed. c) In extreme high hazard areas, a fuel break of 100 feet measured outward from the structure in which: 1. Shrubs, understory trees and bushes and ground cover are to	**CHANGE TO:** B (3) The proponent will submit a fire protection plan for approval that details appropriate vegetation mitigation to ensure that: (a) The rights-of-way of all roads will be maintained so that they provide an effective firebreak as required by the approving authority. (b) A fire hazard fuel break is provided around primary structures (to mitigate the structure ignition zone) proposed for human use as follows: i. In all fire hazard areas within interface or intermix zones, a 5-foot non-combustible fuel break (structure ignition zone) measured outward from the structure; including under extensions, is created and maintained. ii. In all fire hazard areas within interface or intermix zones, a fuel break (to mitigate the structure ignition zone) of 30 feet (slope adjusted) measured outward from the structure in which radiant and convective heat impingement on the primary structure is to be prevented by: a) All vegetation is to be selectively removed, mowed, arranged or pruned and maintained on an annual basis b) All dead plant material is removed. iii. In high or very high fire hazard areas, an additional fuel break (structure ignition zone) extending to 100 feet (slope adjusted) measured outward from the structure in which crown fire activity is prevented by: a) All vegetation is to be selectively removed, mowed, arranged or pruned and maintained on an annual basis to prevent crown fire activity b) All dead plant material is removed.

	be selectively removed, mowed or pruned and maintained on an annual basis. 2. No pine tree (Pinus spp.) is closer than 25 feet to another pine tree. 3. All dead plant material is removed. B (5) All residential development of 100 dwelling units or more in high or extreme high hazard areas will have a two-hundred-foot perimeter fuel break between all structures and the forest in which: a) Shrubs, understory trees and bushes and ground cover are selectively removed, mowed or pruned and maintained on an annual basis. b) All dead plant material is removed. c) Roads, rights-of-way, wetlands and waste disposal sites shall be used as fire breaks to the maximum extent practical. d) There is a specific program for maintenance.	c) Roads, rights-of-way, wetlands and waste disposal sites shall be used as fire breaks to the maximum extent practical.

		PROPOSE A RULE CHANGE TO: The New Jersey State Department of Community Affairs for changes to the New Jersey Administrative Code, TITLE 5. COMMUNITY AFFAIRS, CHAPTER 23. UNIFORM CONSTRUCTION CODE, SUBCHAPTER 2. ADMINISTRATION AND ENFORCEMENT; PROCESS § 5:23-2.2 Matter covered and, either: • **the 2015 New Jersey International Building Code;** • **the 2015 New Jersey International Fire Code, OR;** • **adopt an appropriate New Jersey State Wildland-Urban Interface Code,** that will provide for the following standards within identified wildland-urban interface areas: a) appropriate wildfire mitigation of accessory structures within the Structure Ignition Zone. b) Appropriate mitigation of fences, decks, and other extensions within the Structure Ignition Zone.
B (6)	**CHANGE FROM:** All structures will meet the following specifications: a) Roofs and exteriors will be constructed of fire-resistant materials, such as asphalt rag felt roofing, tile, slate, asbestos cement shingles, sheet iron, aluminum or brick. Fire-retardant-treated wood shingles or shake-type roofs are prohibited in high or extreme fire hazard areas. b) All projections such as balconies, decks and roof gables shall be constructed of fire-resistant materials or materials treated with fire-retardant chemicals. c) Any openings in the roof, attic, and the floor shall be screened.	**PROPOSE A RULE CHANGE TO: The New Jersey State Department of Community Affairs Division of Codes and Standards** for changes to **the New Jersey Administrative Code, TITLE 5. COMMUNITY AFFAIRS, CHAPTER 23. UNIFORM CONSTRUCTION CODE, SUBCHAPTER 2. ADMINISTRATION AND ENFORCEMENT; PROCESS § 5:23-2.2 Matter covered and, either:** • **the 2015 New Jersey International Building Code;** • **the 2015 New Jersey International Fire Code, OR;** • **adopt an appropriate New Jersey State Wildland-Urban Interface Code,** that will provide for the following standards within identified wildland-urban interface areas: a) Roofs to have a roof assembly that complies with a Class A fire rating when tested in accordance with ASTM E108 or UL 790. For roof coverings where the profile allows a space between the roof covering and roof decking, the space at the eave ends to be fire stopped to preclude entry of flames. b) Attic ventilation openings, foundation or underfloor vents, or other ventilation

	d) Chimneys and stovepipes which are designed to burn solid or liquid fuels shall be equipped with screens over the outlets. e) Flat roofs are prohibited in areas where vegetation is higher than the roof.	openings in vertical exterior walls and vents through roofs to be covered with noncombustible corrosion-resistant mesh with openings not to exceed 1/8 inch or be designed and approved to prevent flame or ember penetration into the structure. c) All gutters and downspouts to be constructed of non-combustible material. d) All wall exterior coverings within moderate, high or very high fire hazard areas to be of ignition resistant, or non-combustible material. e) All exterior windows, window walls and glazed doors, windows within exterior doors, and sky- lights within moderate, high or very high fire hazard areas to be tempered glass, multilayered glazed panels, glass block or have a fire protection rating of not less than 20 minutes. f) All underfloor areas to be enclosed to the ground with exterior walls ignition resistant or non-combustible walls OR the underside of exposed floors and exposed structural columns, beams and supporting walls to be protected as required for exterior 1-hour fire-resistance-rated construction or heavy timber construction or fire-retardant- treated wood. g) require a minimum of 6 inches of vertical non-combustible surface between any grade, patio, deck, or roof deck and any combustible wall covering or exterior combustible wall components. h) Require that unenclosed accessory structures attached to buildings for human use, have non-combustible, non-corrosive metal flashing or tape applied to the top of joists and, to be not less than 1-hour fire-resistance-rated construction, constructed of heavy timber construction or constructed of one of the following: i. Approved noncombustible materials. ii. Fire-retardant-treated wood identified for exterior use. iii. Ignition-resistant building materials. i) Chimneys and stovepipes which are designed to burn solid or liquid fuels shall be equipped with screens over the outlets.

3. Apply the Fire Protection Standards Based on the Wildfire Hazard Assessment

The existing Fire Protection Standards reference a hazard classification that was last updated in 1995 for the Pinelands CMP. This hazard classification is outdated; however, the township will have a new wildfire hazard assessment (see Recommendation #1). **CPAW recommends that the township amend the existing Fire Protection Standards to instead reference the newly developed wildfire hazard assessment to determine the appropriate application of the standard:**

A. Determine the Local Wildfire Hazard summarized ranking in which the proposed development is located to understand the likelihood of the building's exposure to high intensity fire.
B. Apply the appropriate requirements (including the requirement for a fire protection plan)
C. Review and approve submitted fire protection plan.

4. Align Existing Regulations with the Fire Standards

Once the Fire Protection Standards are updated, the township should review other existing regulations to reconcile any potential conflicts with the updated fire standards and/or add appropriate references.

To avoid unforeseen conflicts and inconsistencies between the Fire Protection Standards and other regulations, CPAW also recommends that the township include conflict resolution language to clearly state the relationship between regulations.

5. Coordinate with Local Communities, Industry Professionals, and the State Department of Municipal Affairs

Current township zoning regulations apply to the Pinelands under the Township of Ocean's zoning code. The township can apply vegetation standards that are more stringent than the current guidelines within the Pinelands CMP. The standards pertaining to access and ingress, fire apparatus access, and building standards, are all under the jurisdiction of the State of New Jersey Department of Community Affairs. Based on the approach the CPAW team has proposed, a collaborative discussion and working sessions with Pinelands Commission staff to align WUI regulatory objectives and implementation would facilitate the greatest success in moving forward. To the extent feasible, coordination should establish uniformity across landscape and proposed building and construction requirements to minimize the burden on developers and residents and maximize the success with the rule change proposal application.

RECOMMENDATION 3: Amend Master Plan to Align Resiliency and Wildfire Planning Activities

❖ Why This Recommendation Matters

The Township of Ocean adopted its first Master Plan in 1982. Reexaminations of the Master Plan occurred in 1999, 2001, 2005, and 2015. The primary catalyst for the 2015 Reexamination Report and Master Plan Amendments was promotion of long-term recovery from Hurricane Sandy. As a result, a significant focus of the 2015 Master Plan is on increasing resiliency to future coastal hazards by minimizing potential flooding and addressing storm water management. New resiliency policies support sustainable development regulations, green building and infrastructure techniques, open space acquisition, and trail improvement projects.

In relation to resiliency goals and objectives, there are several references to "other potential natural hazards" in the 2015 Master Plan. However, there are no specified actions to support wildfire planning implementation as part of the township's resiliency activities. Although wildfire mitigation, fire hazard identification, prescribed burning, and other fire management activities are addressed in other plans (e.g., the Township of Ocean Community Wildfire Protection Plan, Pinelands Comprehensive Management Plan, Ocean County's Multi-Jurisdictional All Hazards Mitigation Plan), there are limited connections between these plans and the township's Master Plan.

To address these gaps, future amendments to the current Master Plan should achieve two primary objectives:

1. Incorporate new wildfire goals, objectives, and actions to ensure wildfire hazard is part of the township's resiliency planning; and
2. Align community-based wildfire goals, objectives, and actions with local, county, and state planning documents to coordinate wildfire activities across agencies and planning scales.

❖ Implementation Guidance

To help achieve these primary objectives, the following implementation guidance is provided.

1. Align Master Plan Wildfire Activities with Local and County Plans

Overview of Plans

Five primary plans locally influence the Township of Ocean's wildfire hazard mitigation and planning activities: Pinelands Comprehensive Management Plan, New Jersey State Hazard Mitigation Plan, Ocean County's Multi-Jurisdictional All Hazards Plan, Township of Ocean Master Plan, and Township of Ocean Community Wildfire Protection Plan. These plans have a relationship with one another in terms of which plans direct other activities. In some cases, plans will mutually influence one another (see Figure 11).

Figure 11: Primary plans that locally influence wildfire hazard planning activities.

Following an internal document review and discussions with stakeholders, it's unclear what the relationship is between several of these plans, particularly related to wildfire planning activities and updates. For example:

Master Plan and All Hazards Mitigation Plan

The 2015 Master Plan Reexamination Report and Master Plan Amendments provides a discussion on local-, county-, and state-level changes that occurred since the 2005 Master Plan Reexamination Report. This discussion includes the adoption of relevant local, county, and state plans. The two plans most directly tied to wildfire hazard are the 2014 Ocean County Multi-Jurisdictional All Hazards Mitigation Plan (pp. 23-25) and the Pinelands Comprehensive

Management Plan (pp. 28-29). Many mitigation actions from the All Hazards Mitigation Plan are listed in the Master Plan, but there is no linkage to the resiliency actions listed in the Master Plan. Some actions are duplicative, such as the implementation of flood control-related projects, while others are complementary. Recent updates of the All Hazards Mitigation Plan (2015, 2016, 2017) also do not provide any information on wildfire-related activities that are listed in the 2014 version.

Master Plan and CWPP

The CWPP contains detailed information on wildfire hazard and specifies a range of mitigation actions for the local community. Several CWPP actions, such as creating Firewise Communities or enforcement of local zoning rules, reinforce actions listed in the All Hazards Mitigation Plan or Master Plan, but there is no clear connection between the CWPP and the Master Plan.

Creating Linkages

CPAW recommends that stakeholders create a shared understanding of how each plan's wildfire hazard goals and actions relate to one another. Specific actions should include:

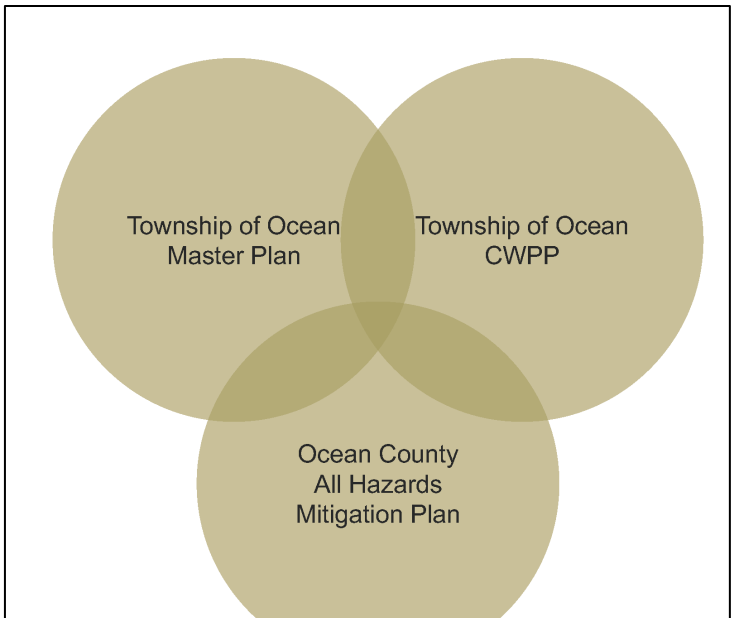

Figure 12: Ideal relationship between Master Plan and local hazard plans will have linkages but minimize content overlap and duplication.

- Add general information and a reference to the CWPP in the Master Plan;
- Add an objective tied to the general resiliency goal that supports the ongoing implementation of the CWPP;
- Coordinate with Ocean County on the next update of the All Hazards Mitigation Plan to follow up on the status of wildfire activities;
- During future Master Plan, CWPP, or Hazards Mitigation Plan updates, perform a crosswalk to determine where actions are duplicative.

While some overlap among key plans is helpful, recognizing where each set of actions is most beneficial will avoid unnecessary repetition. Ideally, township-specific actions on wildfire mitigation activities should be centrally located in the CWPP as one easy reference. Some actions may require implementation through land use changes in the Master Plan and appropriate ordinances, such as the adoption of new defensible space regulations. See Recommendation 4 for more information on CWPPs.

2. Expand Master Plan Resiliency Goals to Include Wildfire

In addition to creating linkages with other plans, the Master Plan should include goals to support long-term wildfire risk reduction. Many of the recently updated Master Plan goals promote resilient outcomes for floods and storm water management. Minor revisions to these goals, along with the strategic addition of several new goals, would magnify the plan's resilience scope to include wildfire—bringing a more holistic approach to resilience planning across the township.

The following table suggests new goals and/or revisions to existing goals in the 2015 Master Plan Reexamination Report and Master Plan Amendments to include wildfire hazard (see Master Plan Goals and Objectives, pp. 41-44, for a complete list of goals).

Table 5. Recommended Revisions for Master Plan Goals

Element	Recommended Revision	Significance
General Development Goals	Revise existing goal: "Focus public agencies on community vulnerabilities to hazards such as flooding and wildfire."	Expands resilience focus to include wildfire.
General Development Goals	Revise existing goal: "Ensure that future capital projects are designed and constructed to incorporate features that are resilient to hazard impacts, including those related to storms, floods, and wildfires."	Expands resilience focus to include wildfire.
Residential Development and Housing	Add new goal: "Encourage housing stock that is resilient to natural hazards, including floods and wildfires."	Creates an additional goal to encourage resilient housing.
Transportation and Public Facilities	Revise existing goal: "Develop a system of secondary streets in built-up and urbanizing areas, which improve access to individual areas, reduce use of Route 9 for internal trips, and may provide additional evacuation routes during emergencies."	Expands goal to include emergency evacuation routes.
Conservation and Environmental Protection	Revise existing goal: "Limit the type and scale of development west of the Parkway in accordance with Pinelands regulations to meet ecological and fire risk reduction objectives."	Connects the goal with resilience outcomes.
Conservation and Environmental Protection	Add new goal: "Collaborate with local, state, and federal partners to adopt a wildfire hazard assessment to guide future land management and planning decisions."	Provides a foundational hazard assessment tool to support future land use decisions.

Table 5. Recommended Revisions for Master Plan Goals		
Infrastructure and Utilities	Revise existing goal: "Encourage green infrastructure projects that align with resiliency outcomes for flooding, storms, and wildfires."	Reduces potential conflicts between different hazard mitigation objectives.

3. Minimize Multi-Hazard Planning Conflicts Through Expert Consultation

Several resiliency-based goals and actions contained in the Master Plan and All Hazards Mitigation Plan are focused specifically on flood mitigation. These mitigation actions may inadvertently conflict with wildfire mitigation or fire management objectives. For example, encouraging green infrastructure projects that increase vegetation, such as tree cover, green roofs, bioswales, and rain gardens, are a positive solution for addressing storm water management. However, increased vegetation can also affect an area's wildfire risk, depending on factors such as location and type of vegetation in proximity to structures. Implementation of green infrastructure goals that increase vegetation should be done in consultation with fire management experts to ensure that mitigating flood hazard is not unintentionally increasing local fire hazard.

RECOMMENDATION 4: Update Community Wildfire Protection Plan to Reflect National Best Practices

❖ Why This Recommendation Matters

The Township of Ocean worked with the New Jersey Forest Fire Service to adopt its first Community Wildfire Protection Plan (CWPP) in 2014. The next anticipated CWPP update will occur in 2019. The timing of the update aligns well with the township's participation in CPAW by providing an opportunity to include information on the wildfire hazard assessment and new planning-based actions for the community's WUI.

❖ Implementation Guidance

1. Update CWPP to Reflect National Best Practices

The following CWPP recommendations are based on discussions with stakeholders and national best practices derived from research and project experience. Notably, CPAW suggests that future updates re-organize the existing CWPP content to align with the three goals of the National Cohesive Wildland Fire Management Strategy ("Cohesive Strategy"): Creating Resilient Landscapes, Promoting Fire Adapted Communities, Improving Response and Suppression Capabilities.

Table 6. Suggested Recommendations for the Township of Ocean's CWPP

Front Matter/ Introduction	
Executive Summary	Update the executive summary to provide a more robust plan overview to readers who may not read the entire document. Specifically, the Executive Summary should contain: • An overview of the CWPP's approach that align with national planning priorities and "living with fire" themes; • Confirmation of CWPP requirements that meet the Healthy Forest Restoration Act; • A summary of key topics and takeaways (e.g., priority actions, highest risk areas; notable achievements from past mitigation projects).
Community Background and Existing Conditions	
Background	Reference other local planning documents, such as the Township of Ocean Master Plan, to direct readers to other sources of information if they are interested in more detail.

Table 6. Suggested Recommendations for the Township of Ocean's CWPP	
Area Description of City (NEW)	Provide additional information in this section to help readers understand broad influences on the planning area, including: • Narrative description of geographic location (e.g., size of community); • Topographical features; • Climate conditions (e.g., seasonal weather patterns, average temperatures and precipitation patterns); • Environment (e.g., vegetation types, local habitat); • Key demographics that may need to be considered when planning for local/vulnerable populations (e.g., population change, median age, rental/homeownership rates, seasonal changes, primary economic drivers).
Fire History/ Acres Burned/ Ignition Frequency/ Wildfire Occurrences	• Expand this section to include inputs to the CPAW hazard assessment to illustrate the fire environment and explain these with interpretations and general implications for the township. This should include the definition/delineation of the Wildland-Urban Interface areas. • Reference other planning documents, such as the county and state hazard mitigation plans, which provide additional information on local fire history.
Community Base Maps	Embed maps and visuals within the relevant sections throughout the plan for ease of reference by the reader. Consider providing spatial files of the maps as an online resource so readers can review the maps in detail.
Goals and Objectives	
Goals and Objectives	Link goals and objectives to relevant sections to ensure mitigation actions meet the intended CWPP outcomes.
Municipal Hazard & Risk Assessment	Use the CPAW hazard assessment outputs to illustrate the wildfire risk and explain these with interpretations and general implications for the township.
Mitigation Recommendations	
Cohesive Strategy Approach (NEW)	Create new section title to: "Mitigation Recommendations for a Cohesive Strategy Approach" (or similar).
Fuel Hazard Mitigation Recommendations	As part of aligning projects with a cohesive strategy approach, change the subsection to "Creating Resilient Landscapes" by including: • Overview of resilient landscapes, local fire ecology and ecosystems, habitat types, watersheds; synthesizes risk assessment outputs for landscapes; • Overview of *primary* stakeholder roles: federal, state, and local land management agencies, large landowners; • Fire management and mitigation topics which synthesize risk assessment outputs, discuss opportunities and challenges, and identify prioritized recommendations for mitigation: ○ Ecology/Ecosystem-based fire management

Table 6. Suggested Recommendations for the Township of Ocean's CWPP	
	○ Fuel treatments for landscapes (public and private) ○ Role of prescribed fire and smoke management ○ Post-fire effects and recovery ○ Land management planning (state, national forest) • Relationship to other plans.
Recommendations to Reduce Structural Ignitability	As part of aligning projects with a cohesive strategy approach, change this subsection to "Promoting Fire Adapted Communities" by including: • Introduction/overview of topic, including recent development trends and anticipated future growth in the WUI; • Overview of primary stakeholder roles: residents, community development and planning staff, industry professionals, elected officials; • Fire Adaptation and Mitigation topics which synthesize risk assessment outputs, discuss opportunities and challenges, and identify prioritized recommendations for mitigation: ○ WUI communities; Structure Ignition Zone—structural ignitability, property management and maintenance ○ Additional community values at risk (critical infrastructure, water supplies, cultural/tribal/historical sites, open space/recreation) ○ Public education/outreach programs (Firewise, Ready, Set, Go!) ○ Local government land use planning tools (policies, regulations, codes) • Relationship to other plans.
Outreach Recommendations	Combine this section with above (new title suggestion: "Promoting Fire Adapted Communities")
Improving Response and Suppression Capabilities (NEW)	Add a new subsection "Improving Response & and Suppression Capabilities" and include the following information: • Introduction/overview of topic; • Overview of primary stakeholder roles: Fire Departments and response areas; additional responding agencies (New Jersey Forest Fire Service, U.S. Forest Service); • Fire Response topics: • Each topic below synthesizes risk assessment outputs, discusses opportunities, challenges and makes applicable recommendations: ○ Current response and suppression capabilities ○ Current limitations in the township (fire flow, ingress/egress) ○ Emergency management/evacuation planning ○ Interagency cooperation ○ Addressing coverage gaps • Relationship to other plans.
Implementation Strategy and Action Plan	
Implementation Strategy and Action Plan	• Update action table to reflect changes/updates/implementation of activities. • Identify lead agencies/ departments that are responsible for implementation of individual actions.

Table 6. Suggested Recommendations for the Township of Ocean's CWPP	
	• Add actions that support wildfire risk reduction in the community, such as: o Defensible ordinance for new development o Incentive programs for home retrofits
Implementation and Plan Monitoring	• Identify council and meetings (see #2 below). • Crosswalk future updates with Master Plan, All Hazards Mitigation Plan.
Additional Resources and Materials	
Resource Materials	See CPAW's Tips and Additional Resources (below).
Appendix A: Updated Project List 2014	Update as necessary to maintain an ongoing project list that is regularly updated for easy reference.
Definitions	Keep for easy reference.
Additional Materials	Consider creating a dedicated webpage for the Township of Ocean CWPP to house this content online (rather than in CWPP) or refer readers to New Jersey Fire Safety Council webpage.

2. Create CWPP Wildfire Council

Convening a multi-stakeholder wildfire council on a regular basis is essential to tracking CWPP progress. The council should be comprised of stakeholders who are engaged in the development and/or implementation of the CWPP. Council meetings can occur quarterly, semi-annually, or annually, but should not be less frequent than annual. The council can be formalized through an ordinance that establishes purposes, members, powers and duties, and any other applicable information. This concept replicates the success of other local communities that have established councils, including Barnegat, Manchester, Waterford, and Washington.

3. Link the CWPP to Other Local Plans

As discussed in Recommendation 3, development of CWPP goals, objectives, and mitigation actions should reference other local plans and regulations, where applicable. For example, communities often develop land use planning goals to address natural hazards when undergoing their comprehensive (or master) planning process. This is an opportunity to reinforce mutually compatible goals across the community.

4. Work with New Jersey Forest Fire Service to Update State CWPP Template

Following the update of its local CWPP, the Township of Ocean may wish to work with the New Jersey Forest Fire Service to support the development of a revised CWPP statewide template. Sharing local feedback would be beneficial to other communities in New Jersey seeking to

develop a comprehensive CWPP framework while minimizing required resources. For example, the New Jersey Forest Fire Service is already helping communities with GIS data, technical assistance at meetings, and pursuing grant funding. Insights that the township could provide to state partners to help the CWPP process in other communities would be a natural complement.

❖ Tips and Additional Resources

Guides and Handbooks

Several guides and handbooks provide additional information and advice to support the development of CWPPs, including tips on forming a steering committee, collaborating with stakeholders, engaging the public, meeting CWPP minimum requirements, and evaluating future progress:

- New Jersey Forest Fire Service provides state information on the creation of CWPPs and related resources.
- New Jersey Fire Safety Council contains information on grant opportunities and resources to support CWPP development and implementation.
- Community Guide to Preparing and Implementing a Community Wildfire Protection Plan (2008)
- Best Management Practices for Creating a Community Wildfire Protection Plan (2012)
- Community Wildfire Protection Plan – A Fire Service Leader's Guide (prepared by the International Association of Fire Chiefs)

Municipal Wildfire Safety Councils

Model ordinance available on New Jersey Fire Safety Council website: www.njfiresafetycouncil.org/Grant-Opportunities

Example ordinance from Barnegat Township: www.barnegat.net/wp-content/uploads/2016/07/Ordinance-2016-01.pdf

Sharing Project Outcomes

Many communities are creating public-facing webpages or story maps to make CWPPs easily accessible to a wide local audience. This eliminates the need for readers to download or print large documents and quickly conveys key points about the plan. For example, CPAW recently worked with Missoula County, MT to create a Missoula County CWPP Story Map that shared the primary takeaways of the plan, including benefits for updating the CWPP, local values at risk

to wildfire, components of wildfire risk, and an overview of the county's WUI. The project website can be accessed here.[12]

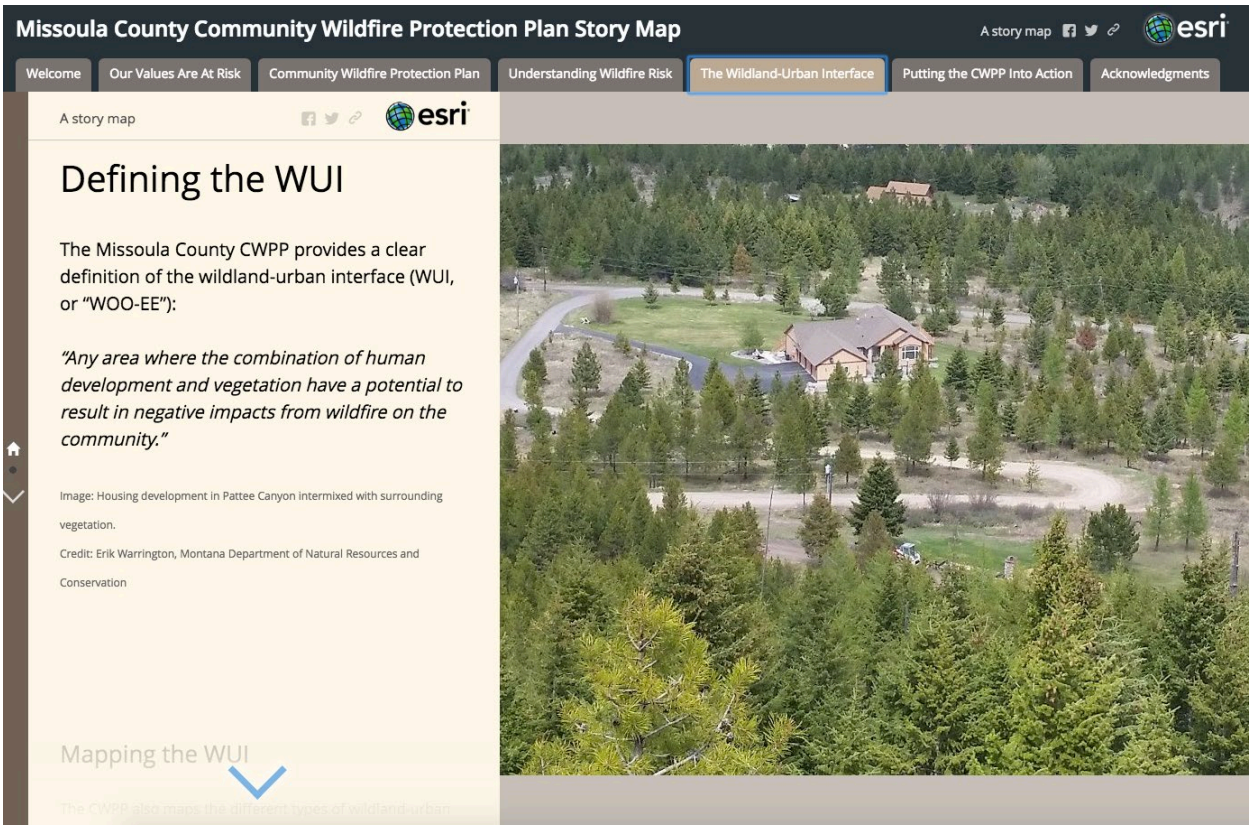

Figure 13: The Missoula County CWPP Story Map provides an accessible online resource for the public to learn more about the recently updated plan.

[12] Address: http://mcgis.maps.arcgis.com/apps/MapSeries/index.html?appid=29b21eb849db408c8b36960fff3cb3e6

Conclusion

This report reflects a year-long process of stakeholder engagement, coupled with local and national expertise and best practices, to culminate in a final set of recommendations. CPAW recommendations for the township focus on planning and regulatory mechanisms to reduce wildfire risk – the core of the CPAW program:

- Define the Wildland-Urban Interface (WUI) and Implement a Consolidated WUI Risk Assessment Program
- Update and Apply the Fire Protection Standards Across the Township Based on WUI Delineation and Hazard Classes
- Amend Master Plan to Align Resiliency and Wildfire Planning Activities
- Update Community Wildfire Protection Plan to Reflect National Best Practices

Opportunities for the township to take action on these recommendations are timely. For example, the New Jersey Forest Fire Service is implementing a statewide assessment, and the U.S. Forest Service is undertaking a northeastern wildfire risk assessment. The local assessment provided by CPAW uses the same science as the state and regional assessments. Each assessment will complement one another at different scales. As a result, the township has the opportunity to become a local leader in terms of showcasing how local assessments can be used to strengthen planning-based approaches to wildfire.

CPAW also recognizes that addressing the WUI and wildfire risk is a complex and nuanced process. Addressing wildfire challenges typically requires long-term commitment. In addition, many other activities, such as fuel mitigation projects, are complementary to a comprehensive risk management program. Educational, outreach, and public engagement activities will be required to successfully implement new wildfire mitigation practices. However, the township has many successful relationships in place with state partners who can offer both expertise and resources, including the New Jersey Forest Fire Service and New Jersey Fire Safety Council. In some cases, CPAW can also offer limited supplemental

Figure 14. The Township of Ocean is well suited for success given its close relationship with other key stakeholders, including the New Jersey Forest Fire Service. (Image credit: CPAW)

support in the form of additional advisory services to help the township in its implementation efforts.

Finally, CPAW recommendations are voluntary and may be modified to best meet the needs of the local community. Where applicable, this report has provided detailed guidance to offer as much assistance as possible.

CPAW Definitions

The following list of definitions is intended to aid understanding of terms associated with CPAW recommendations.

Built Fuels - Man-made structures (buildings and infrastructure).

Burn Probability - The probability or effect of a wildland fire event or incident, usually evaluated with respect to objectives.

Burn Severity - A qualitative assessment of the heat pulse directed toward the ground during a fire. Burn severity relates to soil heating, large fuel and duff consumption, consumption of the litter and organic layer beneath trees and isolated shrubs, and mortality of buried plant parts.

Community Based Ecosystem Management - With an emphasis on local stakeholder participation, allowing the local community to manage their ecosystem based on the unique characteristics of an area.

Community Wildfire Protection Plan (CWPP) - Established by the 2002 Healthy Forest and Restoration Act, A CWPP is a plan that identifies and prioritizes areas for hazardous fuel reduction treatments on Federal and non-Federal land that will protect one or more at-risk communities and essential infrastructure and recommends measures to reduce structural ignitability throughout the at-risk community. A CWPP may address issues such as wildfire response, hazard mitigation, community preparedness, and structure protection.

Convection Heat - The movement caused through the rising of a heated gas or liquid.

Conduction Heat - Transfer of heat through direct contact of material.

Critical Facilities - FEMA defines critical facilities as “facilities/infrastructure that are critical to the health and welfare of the population and that are especially important following hazard events. Critical facilities include, but are not limited to, shelters, police, fire stations, and hospitals”. In addition, CPAW recognizes emergency water pumping stations, egress routes, communication facilities, and backup power supplies as critical facilities.

Ecosystem Based Fire Management - The incorporation of the natural or desired ecological role of fire into the management and regulation of community’s natural areas.

Effects - The anticipated benefits and losses associated with exposure to a hazard or event, in this case fire.

Embers - A small piece of burning material that can be thrown into the air due to the convective heating forces of a wildfire. Larger embers and flammable materials have the ability to sustain ignition through transport.

Exposure - The contact of an entity, asset, resource, system, or geographic area with a potential hazard. Note: In incident response, fire responder exposure can be characterized by the type of activity.

Fire Adapted Communities - A group of partners committed to helping people and communities in the wildland urban interface adapt to living with wildfire and reduce their risk for damage, without compromising firefighter or civilian safety.

Fire Effects - The physical, biological, and ecological impacts of fire on the environment.

Fire Intensity - Commonly referred to as fire line intensity, this is the amount of heat energy that is generated by burning materials.

Firewise - Program administered by the National Fire Protection Association which teaches people how to adapt to living with wildfire and encourages neighbors to work together and take action to prevent losses. The program encourages local solutions for wildfire safety by involving homeowners and others in reducing wildfire risks by fostering defensible space and resilient structures for homes and communities.

Frequency - The number of occurrences of an event per a specified period of time.

Hazard - Any real or potential condition that can cause damage, loss, or harm to people, infrastructure, equipment, natural resources, or property.

Hazard Reduction - Coordinated activities and methods directed to reduce or eliminate conditions that can cause damage, loss, or harm from real or potential hazards.

Home Ignition Zone - The characteristics of a home and immediate surrounding area when referring to ignition potential during a fire event.

Infrastructure - The basic physical structures and facilities (e.g., buildings, roads, and power supplies) needed for the operation of a community.

Prescribed Fire - A planned controlled wildland fire that is used to meet a variety of objectives for land managers.

Radiation Heat - Transmission of heat through waves or particles.

Residual Risk - Risk that remains after risk control measures have been implemented.

Resilience - The ability to recover from undesirable outcomes, both individually and organizationally.

Risk - A measure of the probability and consequence of uncertain future events.

Risk Acceptance - A strategy that involves an explicit or implicit decision not to take an action that would affect all or part of a particular risk.

Risk Assessment - A product or process that collects information and assigns values (relative, qualitative, quantitative) to risks for the purpose of informing priorities, developing or comparing courses of action, and informing decision making.

Risk Avoidance - A strategy that uses actions or measures to effectively remove exposure to a risk.

Risk Based Decision Making - A decision making process that relies on the identification, analysis, assessment, and communication of wildland fire risk as the principal factors in determining a course of action to improve the likelihood of achieving objectives.

Risk Communication - An exchange of information with the goal of improving the understanding of risk, affecting risk perception, or equipping people or groups to act appropriately in response to an identified risk.

Risk Management - A comprehensive set of coordinated processes and activities that identify, monitor, assess, prioritize, and control risks that an organization faces.

Risk Mitigation - The application of measure to alter the likelihood of an event or its consequences.

Risk Perception - Subjective judgment about the characteristics and magnitude of consequences associated with a risk.

Risk Reduction - A decrease in risk through risk avoidance, risk control, or risk transfer.

Risk Transfer - A strategy that uses actions to manage risk by shifting some or all of the risk to another entity, asset, resources, system, or geographic area.

Values-At- Risk - Those ecological, social, and economic assets and resources that could be impacted by fire or fire management actions.

Vulnerability - The physical feature or attribute that renders values susceptible to a given hazard.

Wildfires - Unplanned wildland fires resulting in a negative impact.

Wildland Fire - Any non-structure fire that occurs in vegetation or natural fuels. Wildland fire includes prescribed fire and wildfire.

Wildland Fuels - All vegetation (natural and cultivated).

Wildland Urban Interface (WUI) - Any developed area where conditions affecting the combustibility of both wildland and built fuels allow for the ignition and spread of fire through the combined fuel complex.

Wildland Urban Interface Hazard - Combustibility of the wildland or built fuels, fuel type or fuel complex.

Wildland Urban Interface Risk - The WUI hazard accounting for factors that contribute to the probability and consequences of a WUI fire.

Appendix A: RMRS WILDFIRE HAZARD MAPPING - TOWNSHIP OF OCEAN, NJ

Eva Karau, USDA Forest Service, Rocky Mountain Research Station, Fire Modeling Institute

❖ 1. Overview

The U.S. Forest Service's Rocky Mountain Research Station (RMRS) collaborates with the group of planners and analysts leading the Community Planning Assistance for Wildfire (CPAW) effort for the Township of Ocean, NJ to perform assessments of spatial wildfire hazard to support CPAW's recommendations for wildfire planning codes and regulations. In this analysis and report we accomplish two objectives: 1) provide a realistic, localized representation of wildfire behavior in the township, including finely-tuned model parameters and landscape modifications that reflect stakeholder input; 2) use methods that are transparent, based on the best available science, and appropriate for use with federal and state partners when planning for wildland fires. In this document we provide a brief background outlining wildfire hazard and risk terminology, a detailed explanation of our modeling and mapping methods, and descriptions of final Township of Ocean wildfire hazard maps.

Background – Wildfire Hazard and Risk

How likely is it that a place will burn? How hot is it likely to burn? And, at different fire intensity levels, what would the effects be on something we care about? These questions describe the three fundamental components needed to assess wildfire risk: likelihood, intensity, and effects (sometimes termed "susceptibility"). Scott et al. (2013) conceptualize this as the wildfire risk triangle (Figure A1). If we can gather quantitative information on all three legs of this triangle, then we can quantify the risk to the thing we care about.

Figure A1. The wildfire risk triangle

For the purposes of this analysis, we focus on two sides of the wildfire risk triangle: *likelihood* and *intensity*. Together, those two pieces of information represent wildfire *hazard*. To map likelihood and intensity across a landscape, we use outputs from two different, but related, fire behavior models. The fire modeling application most often used for large-scale landscapes is called the Large Fire Simulator, or FSim (Finney et al. 2011). FSim draws upon weather and fire occurrence data from recent decades to generate statistically possible weather for 10,000 or more simulated fire seasons. Within each of these simulated years, ignitions are placed on the landscape informed by observed fire occurrence patterns, fires are spread using spatial data for fuels, topography, and simulated weather, and a set of many thousand possible fire perimeters are generated.

Whereas FSim provides a synoptic, "landscape scale" assessment of fire behavior and estimates annualized probabilities of the occurrence and intensity of large fires, another model, FlamMap (Finney 2006), computes a localized, and specialized view of potential fire behavior under a specific set of environmental conditions. If a user parameterizes FlamMap for environmental conditions representative of when problem wildfires have occurred, fire behavior outputs represent a "problem fire" scenario at a "local scale." Including characterizations of wildfire hazard at both landscape and local scales affords a two-pronged assessment of potential fire behavior; we see what kind of fire behavior we could experience under a range of conditions that have occurred in recent history, and we also get a picture of fire behavior that could occur under extreme conditions.

While we don't specifically address the susceptibility side of the triangle in this analysis, we combine fire behavior probability and intensity estimates to assess and map wildfire hazard at multiple spatial scales in the Township of Ocean.

❖ 2. Wildfire Hazard Characterization for the Township of Ocean

Wildfire hazard is a measure of the likelihood that an area will burn and the likely intensity of the burn, given that a fire occurs. For the Township of Ocean, we present two evaluations of wildfire hazard: landscape level and local level.

Landscape-Level Wildfire Hazard - Modeling, Maps, and Figures

We used national-scale 2012 FSim modeling outputs (Finney et al. 2011) for the purpose of evaluating wildfire likelihood and intensity for landscape-level analysis. We acquired the 270-m-resolution raster geospatial outputs along with the spatial point and polygon datasets for the simulated ignition points and fire perimeters.

Landscape-Level Summary Zone

To summarize the spatial metrics of likelihood, intensity, and hazard for the landscape-level analysis, we chose sub-watersheds from the national USGS Watershed Boundary Dataset (https://nhd.usgs.gov/wbd.html) as the polygon summary unit. Sub-watersheds are designated by 12-digit hydrologic unit codes and are often referred to as "HUC12" watersheds. The HUC12 summary unit is commonly used to summarize landscape attributes, is devoid of administrative boundaries, and is based on the areal extent of surface water draining to a point (Bureau of Land Management, Watershed Boundaries Washington, available at (https://nhd.usgs.gov/wbd.html, accessed 10-30-2017.) Using a summary unit is important, because an individual spot on the landscape will have an individual value, but that one spot is inevitably impacted by the values of its neighbors; summarizing the raster FSim outputs and the derived hazard index to these polygons allows for broad-scale patterns to emerge that may not be immediately visible in the raw pixel datasets.

Landscape Fire Likelihood

Landscape Fire Likelihood, or burn probability (BP), is the FSim-modeled annual likelihood that a wildfire will burn a given point or area. It is calculated as the number of times a pixel burns during a simulation, divided by the total number of iterations.

The landscape-level burn probability map represents the average of all 270-m pixel values within each sub-watershed, classified into three classes of moderate, high, and very high (Figure A2a). The classes are relative to the distribution of watershed averages only within the analysis area and are based on quantile thresholds. "Moderate" represents values below the 33rd percentile, "high" represents values between the 33rd and 66th percentile, and "very high" represents values above the 66th percentile.

Landscape Fire Intensity

FSim can apportion burn probability into wildfire intensity levels and produce estimates of the probability of a certain flame length, given a fire burns a pixel. Conditional flame length (CFL) is the average of all flame length probabilities that FSim simulated for each 270-m pixel.

The landscape-level CFL map represents the average of all 270-m pixel values within each sub-watershed, classified into three classes of moderate, high, and very high, based on quantiles as described for the burn probability map (Figure A2b).

Landscape Wildfire Hazard

Wildfire hazard is an integration of likelihood and intensity, quantified here as the product of burn probability (BP) and conditional flame length (CFL). We calculated hazard at the pixel scale and then summarized values to the HUC12 sub-watershed by calculating the mean hazard in each watershed polygon. We then classified the values into three classes (moderate, high, and very high) based on quantiles in the distribution of values in the analysis area (Figure A2c). The actual numeric values of hazard are less directly interpretable than BP or CFL. Instead, they provide a relative depiction of hazard across a landscape.

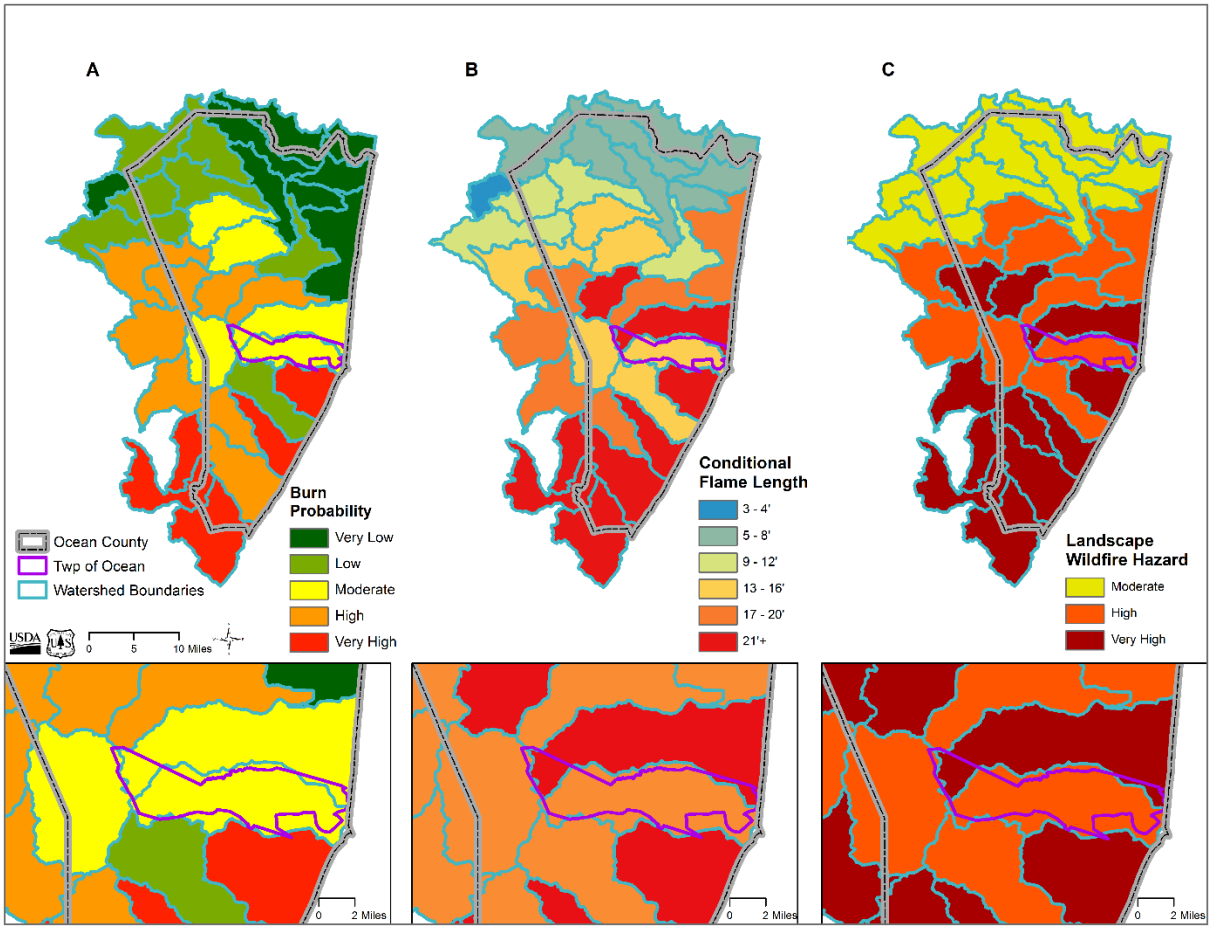

Figure A2. Summarized landscape wildfire burn probability (A), conditional flame length (B), and hazard (C).

Local-Level Wildfire Hazard - Modeling, Maps, and Figures

For the local-level hazard assessment, we used FlamMap 6.0 to model wildfire behavior. We initialized the Minimum Travel Time (MTT) module within FlamMap with 46,000 fire ignitions whose locations were random but informed by locations where wildfires have occurred during the period of 1992 through 2015 (Short 2017). We used a maximum simulation time of 480 minutes per ignition (equating to an 8-hr burn period), a calculation resolution of 90 meters, an interval for Minimum Travel Paths of 500 meters, and a spot probability of 0.02. We chose to output burn probabilities, fire perimeters, flame length probabilities classed into 6 bins, and a fire size list.

Wind, Weather, and Fuel Moisture Parameters

FlamMap needs information regarding fuel moisture, wind, and weather to parameterize a simulation. Based on information from subject matter experts (SMEs) gleaned during our site visits, as well as our own evaluation of records from weather stations in the vicinity of the township, we chose to base our weather and wind-related modeling inputs on records from two stations: the Coyle Field Remote Automated Weather Station, and the Cedar Bridge Ameriflux site.

Choosing a single wind direction to parameterize the FlamMap simulation for the township proved challenging. Local SMEs reported SW winds on active fire days, but they reported it is also common to experience NW winds during a frontal passage. These trends did emerge in wind roses from Coyle Field and Cedar Bridge, however the signal from S and N winds were slightly stronger than the SW and NW winds (Figure A3), as detailed below:

- Average winds recorded at Cedar Bridge for the hours of 1600 – 1900 (assumed to be the period of highest potential fire growth), were generally S and SSW for the dates of March 1 through November 1 (assumed to encompass the "fire season") (Figure A3a).
- Average winds recorded at Coyle Field for the hours of 1600 – 1900, were mostly N for the dates of March 1 through November 1 (Figure A3b).
- Gusts recorded at Coyle Field for the hours of 1600 – 1900, were predominantly from the S for the dates of March 1 through November 1 (Figure A3c).

Considering the local input, combined with the wind rose information, we decided to do two FlamMap simulations, each with a different wind direction (N and S), while holding all other parameters constant. We then combined the outputs of the modeling by choosing the maximum fire behavior values for burn probability, conditional flame length, and hazard (defined in a later section) to derive our final metrics. We chose to initialize both simulations, with a wind speed of 27 mph, as the Coyle Field RAWS recorded gusts in the range of 25-32 mph (Figure A3c), and our modeling objective is to represent a "problem fire" scenario.

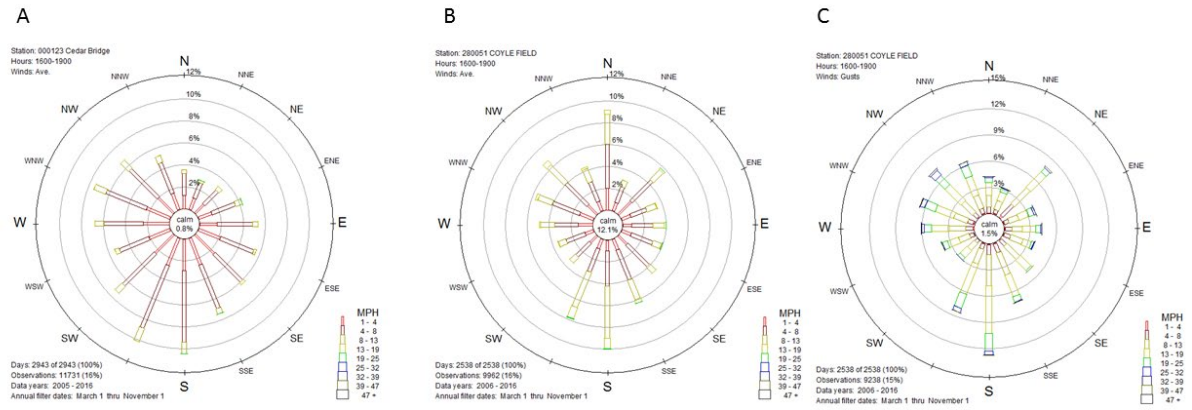

Figure A3. Coyle Field and Cedar Bridge Remote Automated Weather Station wind directions

We selected May 11-15, 2007 as parameterization dates for fuel moisture estimates and the weather records used for fuel moisture conditioning, as that time period corresponds to the period leading up to the 15,000-acre Warren Grove wildfire. Climatology analysis, along with personal communication with Kenneth Clark, indicates that this period set records for seasonal dryness indices. For example, on May 13, 2007, the Energy Release Component (a fire danger metric with higher values indicating seasonal dryness trends in large fuels, especially in timbered areas; ERC) achieved a maximum value for the period of 2005-2016 at the Cedar Bridge weather station (Figure A4). Fuel moistures for the selected dates were estimated as 3, 6, and 14% for the 1-hr, 10-hr, and 100-hr dead fuel moistures, and 44% and 88% for herbaceous and woody live fuel moistures.

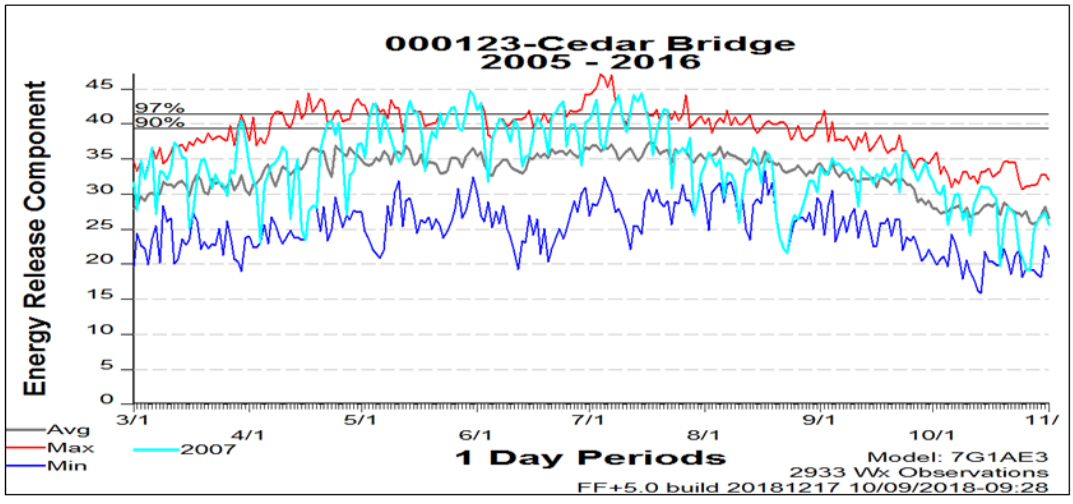

Figure A4: Cedar Bridge RAWS Energy Release Component.

Landscape File Layers

Most fire modeling systems (including FSim and FlamMap) require a set of raster geospatial layers that characterize landscape topography (elevation, slope, and aspect) and fuels attributes (fuel model, canopy cover, canopy height, crown base height, and crown bulk density). A local-level analysis allows for fine-scale modifications to the surface and canopy fuel attributes to reflect the current landscape as well as possible, given the modeling assumptions of FlamMap. Initially, we obtained 30-meter resolution geospatial layers from LANDFIRE (LF 1.4.0) to use as a starting point for modifications that we ultimately made to create the final topography and fuels layers needed to run FlamMap 6.0 for the Township of Ocean.

During our July 2018 site visit in the township, SMEs indicated that our initial modeling (based on default LF 1.4.0 layers) under-predicted burn probabilities and flame lengths in the areas mapped to the Northern Atlantic Coastal Pitch Pine Barrens Existing Vegetation Type (EVT). The fuel models mapped within this EVT were primarily shrub models that produce relatively high rates of spread and intensity that experts in the original LANDFIRE workshops felt reflected the fire behavior in this Pine Barrens ecosystem. Canopy fuel information was excluded within this ecosystem in the default LF 1.4.0, which resulted in no modeled crown fire. Township SMEs felt that crown fires were indeed an important component of the fire behavior that they observe in the area, so we consulted with local experts (Inga LaPuma, Jeremy Webber, and Nicholas Skowronski) to ultimately arrive at the decision to retain the default-mapped shrub fuel models, but to modify canopy fuel mapping rules to include canopy characteristics, depending on specific combinations of vegetation height and disturbance.

Since the LF 1.4.0 layers represent the landscape as it existed in 2014, we made changes to the layers to render them current (to 2018) as accurately as possible given available local disturbance data. We used the LANDFIRE Total Fuel Change Tool (LFTFC 0.153) to implement the fuel modifications. To use the LFTFC tool, we needed to create a raster file that spatially delineates the disturbances using the framework used by LANDFIRE whereby each disturbance must be classified by type (fire, mechanical add, mechanical remove, windthrow, insects-disease, exotics), severity (low, moderate, or high), and time since disturbance (1 year, 2-5 years, or 6-10 years). We delineated the following disturbances, as follows:

- Wildfires – We obtained a fire atlas from Inga La Puma that includes wildfires from 1924 through 2017. Because we did not have specific information about fire severity for each fire, we assumed that all fires were moderate severity (defined as having a moderate effect on the landscape). We selected fires that occurred after 2013 and represented them in the disturbance file with a 2- to 5-year time since disturbance.
- Prescribed fires – We obtained shapefiles from Jeremy Webber delineating prescribed fires conducted by the New Jersey Forest Fire Service. Because we did not have specific information about fire severity for each prescribed fire, we assumed that all fires were moderate severity. We selected fires that occurred between 2014 and 2017 and represented them in the disturbance file with a 2- to 5-year time since disturbance.
- Mechanical Treatments – We obtained a shapefile from Marie Cook that delineates mechanical treatments conducted by the New Jersey Forest Fire Service. All the treatments fit under the category of "mechanical remove" as they were documented in the original dataset as either "thinning", "shelterwood," or "fuel break,", but as we did not have specific information about the severity (or intensity) of the treatments, we assumed

them to be moderate severity. We selected treatments that occurred between 2014 and 2017 and represented them in the disturbance file with a 2- to 5-year time since disturbance.

With the new ruleset that incorporated canopy fuels into the Pine Barrens EVT and the file that delineated recent local landscape disturbances, we were able to implement the LFTFC and generate the modified landscape fuel layers to use as input to FlamMap 6.0.

Local-Level Summary Zone

To summarize the spatial metrics of likelihood, intensity, and hazard for the "local level" analysis, we chose to use catchments from the USEPA and USGS National Hydrography Dataset Plus V2 (https://www.epa.gov/waterdata/nhdplus-national-hydrography-dataset-plus). Catchments are local-level drainage areas and typically subdivide HUC12 watersheds into smaller polygon units. Using a summary unit is important, because an individual spot on the landscape will have an individual value, but that one spot is inevitably impacted by the values of its neighbors; summarizing the raster FlamMap outputs and the derived hazard index to these polygons allows for broad-scale patterns to emerge that may not be immediately visible in the raw pixel datasets.

Local Fire Likelihood

Local Fire Likelihood, or burn probability (BP), is the FlamMap-modeled likelihood that a wildfire will burn a given point or area. It is calculated as the number of times a pixel burns during a simulation, divided by the total number of iterations. Because we parameterized FlamMap with a "problem fire" scenario as describe above, BP from our FlamMap run represents those specific conditions.

The local-level burn probability map represents the average of all 90-m pixel values within each catchment, classified into three categories: moderate, high, and very high (Figure A5a). The classes are relative to the distribution of catchment averages only within the analysis area and are based on quantile thresholds. "Moderate" represents values below the 33rd percentile, "high" represents values between the 33rd and 66th percentile, and "very high" represents values above the 66th percentile.

Local Fire Intensity

Like FSim, FlamMap can apportion burn probability into wildfire intensity levels and produce estimates of the probability of a certain flame length level, given a fire burns a pixel. Local Conditional Flame Length (CFL) is the average of all flame length probabilities that FlamMap simulated for each 90-m pixel.

FlamMap generates a raster layer for burn probability, but for the individual flame length probabilities, the model generates a text file with the probabilities at each intensity level. We converted the text file to a geospatial point layer, calculated CFL within the point layer, and then exported CFL as a raster.

The local-level CFL map represents the average of all 90-m pixel values within each catchment, classified into three classes of moderate, high, and very high, based on quantiles as described for the burn probability map (Figure A5b).

Local Wildfire Hazard

Wildfire hazard is an integration of likelihood and intensity, and we calculated it as the product of BP and CFL. We calculated local hazard at the pixel scale and then summarized values to the catchment scale by calculating the mean CFL within each catchment polygon. We then classified the values into three categories (moderate, high, and very high) based on quantiles in the distribution of values in the analysis area (Figure A5c). The actual numeric values of hazard are less directly interpretable than BP or CFL. Instead, they provide a relative depiction of hazard across a landscape.

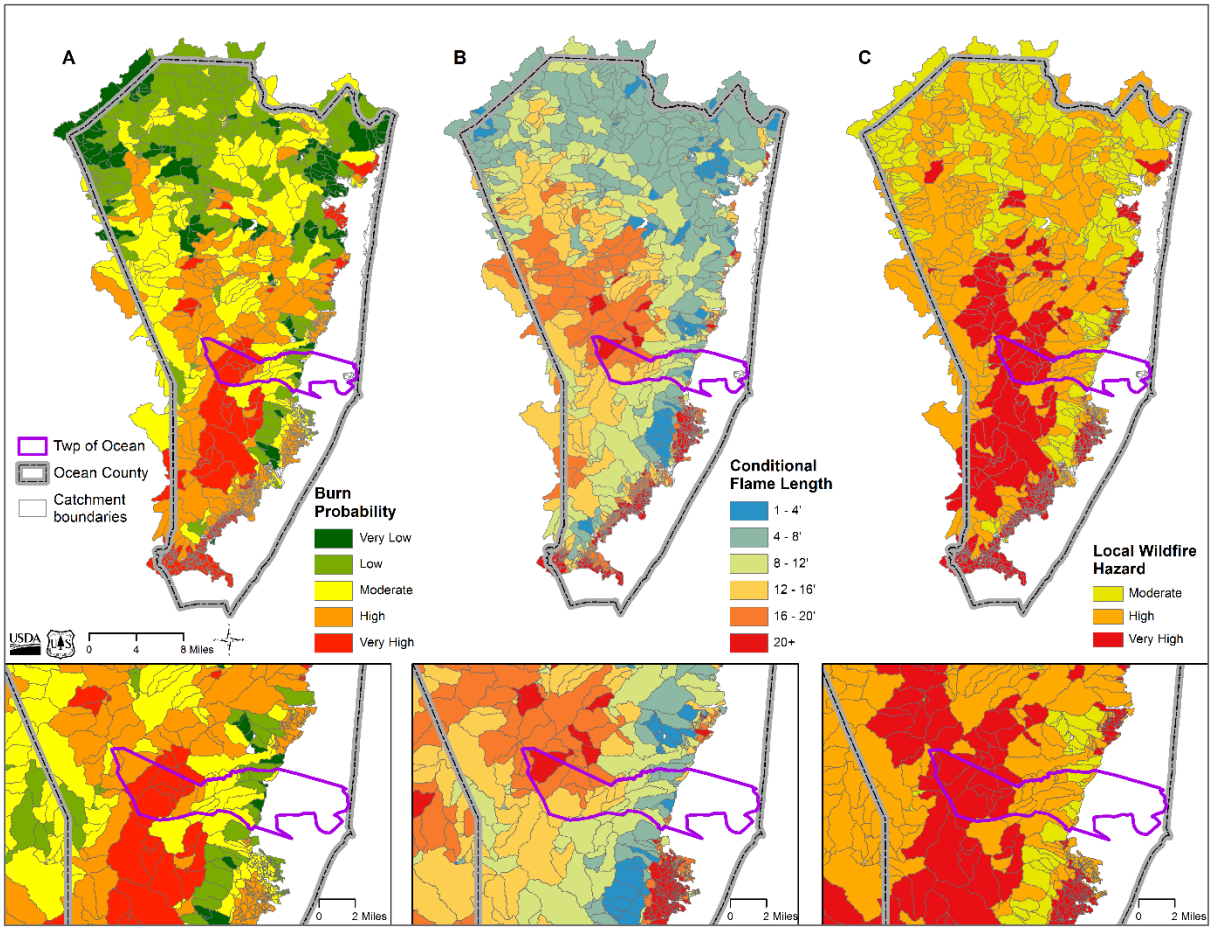

Figure A5. Summarized local wildfire burn probability (A), conditional flame length (B), and hazard (C)

❖ 3. Wildland-Urban Interface Zones

We mapped categories of structure density integrated with wildland vegetation to characterize where structures are in or near burnable vegetation in the Township of Ocean.

Though we generally followed methods that mimic Federal Register Wildland Urban Interface (WUI) definitions as adapted by Martinuzzi et al. 2015, we customized our WUI mapping to appropriately represent rural developed areas in the township. Since New Jersey has accurate and up-to-date address point data for all structures in the county, we used these points (accessed from New Jersey Geographic Information Network, June 2018), instead of Census data, to represent

structures for our mapping efforts. We used the point data as input into the Point Density tool (ESRI 2015) to create a raster surface of structure density, which we then sliced into the ranges of values needed to combine with vegetation categories to create WUI classes (Table A1).

For the WUI mapping process, we define wildland vegetation as any land cover type that does not burn. Typically, in this process, we delineate non-burnable areas using the same LANDFIRE-based fuel model raster data that we use in our local-level fire behavior modeling. However, during our July 2018 site visit in the Township of Ocean, local SMEs perceived that some areas in the draft WUI map either under- or over-represented burnable vegetation. As an alternative to the fuel model layer, we used the 2012 update of the Land Use/Land Cover map published by the NJ Department of Environmental Protection (http://www.nj.gov/dep/gis/listall.html), as suggested during our site visit. We categorized the urban, barren, agriculture and water land use/land cover categories as non-burnable and the forest and wetlands categories as burnable. To quantify the percentage of vegetation within an area, we used the Focal Statistics tool (ESRI 2015) to calculate the percentage of burnable fuel within a 40-ac moving window around each pixel and assign that value to the center pixel.

Structure density and vegetation raster layers were combined to map the WUI, with the map categories described in Table A1. One modification that we made to rules outlined in Martinuzzi 2015 was to include the "Vegetated Very Low Density" category with the WUI Intermix category. This decision reflects the Federal Register statement that "intermix exists where structures are scattered throughout a wildland area" (USDA and USDOI 2001) and our intent to include isolated structures in rural areas as WUI.

Table A1. Description of mapping ruleset for Wildland Urban Interface zones.

WUI Category	Structure Density Description	Structure Density (structures/ac)	Vegetation Description
Interface	Very Low to High Density	>= 1	Wildland vegetation <= 50% and within 1.5-mi of area with >= 75% wildland vegetation
Intermix	Very Low to High Density	>= 1	Wildland vegetation > 50%
Non-Vegetated	Medium or High Density	> 8	Wildland vegetation <= 50%
	No, Very Low, or Low Density	0 - 8	
Vegetated	Uninhabited	0	Wildland vegetation > 50%

Though the scientific community has not yet developed a way to quantify the *probability* of wildfire ember impact to structures, what we found within the Township of Ocean is that virtually every address point is within a distance from wildland fuels that *could* produce embers. Since the entire community could possibly be impacted by embers, we chose not to include an "ember zone" which would add no informational value to the final WUI map.

❖ 4. Final Considerations

In this report, we presented two complementary representations of wildfire hazard for the Township of Ocean, NJ. The landscape-level assessment addresses the question of "what is the annual chance of a fire occurring?" anywhere on a landscape. As such, this part of the assessment sets the context for a broad picture of wildfire hazard. The local-level assessment

used a more focused approach to model fire behavior under a "problem fire" scenario. It brings the benefit of integrating local stakeholder input that customizes the modeling landscape and represents local fire behavior at a finer spatial resolution. The local hazard map indicates where wildfire could cause a problem in a community, given a specific set of weather conditions.

We intend that this hazard assessment be considered as "living data." Now that we have established the methodology for mapping the local wildfire hazard, there is opportunity for local analysts to implement the methods on updated or modified datasets, either to refine the current picture of hazard or to compare current vs. past assessments to assess progress toward landscape changes that decrease hazard in the township.

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Jeremy Webber, Assistant Division Forest Fire Warden, New Jersey Forest Fire Service

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