Community Wildfire Protection Plan for the Towns of Arlington, Glastenbury, Sandgate, Shaftsbury and Sunderland

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I. Introduction

A. Purpose of Plan

Community Wildfire Protection Plans or CWPPs are intended to guide communities in reducing or eliminating potential wildfire hazard. This plan is intended to address that risk for the towns of Arlington, Sandgate and Sunderland, covered by the Arlington Fire Department and the towns of Shaftsbury and Glastenbury covered by the Shaftsbury Fire Department. The towns of Arlington, Glastenbury, Sandgate, and Sunderland have substantial areas within Green Mountain National Forest, where U.S. Forest Service is responsible for wildland fire suppression resources as well. This plan describes the conditions affecting wildland fire and recommends actions for education and outreach, reduction of structural ignitability, provision of adequate access, enhancement of rural water supplies for fire suppression and fuel management. The U.S. Forest Service, Region 9 provided funding with the Northern Vermont RC and D serving as a conduit and grant manager.

B. Vision and Goals

Early in the process, the planning team identified the following goals for community wildfire protection:

1. Establish cooperative relationships between agencies tasked with planning for and responding to both structural and wildland fires
2. Establish means to promote good communications between the planning team and members of the public
3. Integrate the Community Wildfire Protection Plan into other town plans and ordinances
4. Create an ongoing wildfire planning coordinating group that would meet beyond the completion of the plan
5. Prioritize fuel treatments
6. Identify and prioritize methods to protect structures
7. Provide maps of travel pathways including bridges for use by first responders
8. Develop and regularly update mutual aid agreements between fire departments and with the state and the U.S. Forest Service.

II. Planning Process

A. Cooperating Agencies

Community wildfire protection planning is a cooperative process as multiple agencies and organizations are involved in planning, resource management and emergency management. Table 1 below shows the members of the planning team. In addition, each of the planning commissions of the respective towns was provided with a presentation on the planning process to solicit their input.

Table 1. Cooperating agencies and their representatives

Name	Organization	Phone	Email
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Dan Zimmer	Bennington County Mutual Aid/Arlington Fire Department	802-375-1201 (H) 802-839-6493 (W)	Daniel.Zimmer@state.vt.us
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Kyle Mason	Bennington County Forester	802-371-7349	Kyle.mason@state.vt.us
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Heidi Wagner, Firewise Advisor with the National Fire Protection Association, was asked to review the draft plan given her experience with Firewise Communities. She was not part of the planning team, but provided valuable comments on the Firewise program. Collette Galusha of BCRC edited the final draft.

B. Process

This study was first conceived in 2010, and a grant application was submitted to the Northern Vermont Resource Conservation and Development, Inc. for funds to develop the plan. This grant was approved in February of 2012, and the process began. Initially, meetings were held in the summer of 2012 to identify rural water sources within the Arlington Fire District. The full committee met in November and December of 2012 to identify goals and key issues to address in the plan. A draft of the plan was sent out for review in April of 2013 and a final draft prepared on July 8, 2013.

III. Study Area Description

A. Town and Fire Department Areas

The study area consists of approximately 217.5 square miles and includes the towns of Arlington, Glastenbury, Sandgate, Shaftsbury and Sunderland (Map 1). The Arlington Fire Department covers the towns of Arlington, Sandgate and Sunderland and the Shaftsbury Fire Department covers Shaftsbury and Glastenbury. Table 2 below shows the area of each town and the town population.

Table 3 shows the number of structures by type in each of the towns. Single family residences are the dominant structure type with other residential types and commercial development making up much smaller proportions.

Table 2. Area and 2010 population of study area towns. Source: Vermont Center for Geographic Information (www.vcgi.org) and Broziecevic and Nyland-Funke 2012

Town	Land Area (sq. miles)	Population
Arlington	42.2	2,317
Sandgate	42.3	405
Sunderland	45.5	956
Subtotal Covered by the Arlington Fire Department	**130.0**	**3,678**
Shaftsbury	43.1	3,590
Glastenbury	44.4	8
Subtotal Covered by the Shaftsbury Fire Department	**87.5**	**3,598**
Grand Total	**217.5**	**7,276**

B. Land Cover Types

1. Land Cover

As shown in Table 3, most of the study area is forested (Map 2). Shaftsbury and Arlington have significant acreage in agricultural lands which could include grass and herbaceous dominated fields. Most developed areas are low density.

Table 3. Number of acres by cover type for each town. Source: Vermont Center for Geographic Information (vcgi.org) and NOAA C-CAP Land Cover Atlas (www.csc.noaa.gov/digitalcoast/tools/lca

Cover Type	Sunderland	Glastenbury	Shaftsbury	Arlington	Sandgate
High intensity developed	0	0	6	10	0
Medium intensity developed	35	6	97	89	0
Low intensity developed	183	34	455	267	12
Developed open space	69	3	339	168	48
Cultivated	41	0	587	264	145

Table 3. Number of acres by cover type for each town. Source: Vermont Center for Geographic Information (vcgi.org) and NOAA C-CAP Land Cover Atlas (www.csc.noaa.gov/digitalcoast/tools/lca

Cover Type	Sunderland	Glastenbury	Shaftsbury	Arlington	Sandgate
Pasture	710	16	5760	1857	909
Grassland	50	35	91	20	4
Deciduous forest	14,925	21,092	13,383	20,004	23,388
Coniferous forest	6,227	2,733	2,514	2,181	843
Mixed forest	5,009	3,758	2,526	985	1,430
Shrubland	365	128	367	252	178
Emergent wetland	841	479	673	517	27
Forested wetland	413	68	532	305	48
Shrub wetland	160	48	163	35	16
Bare land	3	3	11	8	1

2. Types of Structures

As shown in Table 4, the majority of structures are residential based on E911 data (VCGIS 2012). The following types were identified as critical facilities: schools, government buildings, fire stations, rescue squads, the Vermont State Police barracks, public gathering places including places of worship, and utilities (Map 2).

Table 4. Number of structures by type by town. Source: Vermont Center for Geographic Information 2012, www. VCGI.org. Critical facilities are indicated with a *.

Type	Arlington	Glastenbury	Sandgate	Shaftsbury	Sunderland
Accessory Building	3		4	3	
Camp	31	1	63	31	29
Commercial/Industrial	85		7	71	27
Commercial Farm	2		2	7	
Commercial with Residence	2				
Development Site	6				4
Educational*	5		1	3	1
Fire, Rescue, Law Enforcement*	3			3	
Government*	1		1	4	2
House Of Worship*	5		2	3	2
Lodging	17		1	5	5
Mobile Home	45		7	79	33
Multi-Family Dwelling	15		1	5	1
Other	37		5	32	7
Other Residential	3		3	5	
Public Gathering*	7			5	
Single Family Dwelling	1,052	3	227	1461	441
Utility*	1			4	

Table 4. Number of structures by type by town. Source: Vermont Center for Geographic Information 2012, www. VCGI.org. Critical facilities are indicated with a *.					
Type	Arlington	Glastenbury	Sandgate	Shaftsbury	Sunderland
Total	1,320	4	324	1721	552

C. Fire Environment

1. Fuels and Potential Fire Behavior

In the northeastern United States, forests tend to be dominated by northern hardwood species such as sugar maple (*Acer saccharum*), birch (*Betula* spp.), white pine (*Pinus strobus*) and hemlock (*Tsuga canadensis*). These species tend to create relatively low flammability litter, so that surface fires have low intensity and rates of spread, thereby limiting fire hazard (Anderson 1982). There are areas of oak (*Quercus* spp.) that create more flammable litter and understory, especially where huckleberry (*Gaylussacia baccata*) or blueberry (*Vaccinium* spp.) grow underneath. Old fields can be highly variable depending on how they are managed. In areas of short grass maintained by haying or grazing, fire behavior will likely be of low intensity and fuels may be patchy. In fields that have been allowed to grow, or in wetlands with tall grasses and cattails, fire behavior could be more extreme during the dormant season.

For the study area, fuel types were determined from two sources: the Landfire program (Landfire 2013), a national program to provide spatial and other data on fuels, topography and potential fire behavior, and the National Oceanographic and Atmospheric Administration (NOAA undated). Raster grids (30 m) of each coverage were combined so that each pixel contained attributes of both datasets. Where they matched, the Landfire fuel data was used. Otherwise, fuel types, using the newer fuel models (Scott and Burgan 2005) were determined based on the characteristics of both the NOAA and Landfire datasets, limited analyses of the 2011 and 2012 National Aerial Imagery Program orthophotographs for Bennington County (USDA undated) and limited field work. Most of the land area is covered by broadleaf litter fuels that exhibit fires of low intensity and slow rates of spread. Map 3 shows broad fuel types, and fuel models are shown under these categories in Table 5. Table 5 also describes the fuels and likely fire behavior during the spring prior to green-up. The intensity of a fire, in terms of rates of spread and flame length are important to gauging resources for fire suppression. Table 6 lists categories of potential fire behavior from Scott and Burgan (2005) used in Table 5. Appendix II contains more detailed descriptions of these types. Table 7 shows the total area of each type in the study area (Map 3).

Table 5. Fuel types and expected fire behavior. Source: Scott and Burgan 2005. Flame lengths in ***bold italics*** exceed those safe for direct attack[1] (Table 6). Spotting distances were calculated using BEHAVE (see Appendix I). More detailed fuel descriptions are in Appendix II.

Fuel Type	Description	Expected Fire Behavior	Spotting Distance (miles)
Grass Fuels (grass with herbaceous vegetation)			
GR1 – Short, Sparse Dry Climate Grass	Sparse, patchy grass and herbaceous vegetation.	Rate of spread moderate Flame length low	0.0 to 0.1
GR2 – Low Load, Dry Climate Grass	Moderately coarse, continuous grass and herbaceous vegetation with an average fuel bed depth of one foot.	Rate of spread high ***Flame length moderate***	0.1 to 0.3
GR3 – Low Load, Very Coarse, Humid Climate Grass	Continuous, coarse grasses and herbaceous vegetation with a fuel bed depth of approximately two feet	Rate of spread high ***Flame length moderate***	0.1 to 0.4
GR5 – Low Load, Humid Climate Grass	Dense, coarse grass and herbaceous vegetation with an average fuel bed depth of one to two feet.	Rate of spread very high ***Flame length high***	0.1 to 0.6
Grass-Shrub Fuels (grass and shrubs)			
GS1 – Low Load, Dry Climate Grass-Shrub	Sparse grass and shrubs one foot high	Rate of spread moderate Flame length low	0.1 to 0.3
GS2 – Moderate Load, Dry Climate Grass-Shrub	Moderate grass with shrubs 1-3 feet high	Rate of spread high ***Flame length moderate***	0.1 to 0.4
GS3 – Moderate Load, Humid Climate Grass Shrub	Moderate grass and shrub fuels with depth of less than two feet	Rate of spread high ***Flame length moderate***	0.1 to 0.5
Shrub Fuels (shrubs)			
SH1 – Low Load, Dry Climate Shrub	Low shrub fuel load with fuel bed depth of one foot	Rate of spread very low Flame length very low	0.1 to 0.2
SH2 – Moderate Load, Dry Climate Shrub	Moderate fuel load with fuel bed depth of one foot and no grass present	Rate of spread low Flame length low	0.1 to 0.3
SH3 – Moderate Load, Humid Climate Shrub	Moderate shrub fuels with fuel bed depth of 2-3 feet	Rate of spread low Flame length low	0.1 to 0.5
Timber Litter Fuels (broadleaf and/or conifer litter with grass and herbaceous vegetation)			
TL1 – Low Load Compact Conifer Litter	Light to moderate litter with fuel bed depth of 1-2 inches	Rate of spread very low Flame length very low	0.0
TL2 – Low Load Broadleaf Litter	Low load, compact litter	Rate of spread very low Flame length very low	0.0
TL3 – Moderate Load Conifer Litter	Moderate load of conifer litter	Rate of spread very low Flame length low	0.0
TL5 – High Load Conifer Litter	High load conifer litter with light slash or downed woody debris	Rate of spread low Flame length low	0.0 to 0.1
TL6-Moderate Load Broadleaf Litter	Moderate load of uncompacted leaf litter	Rate of spread moderate Flame length low	0.0 to 0.1

[1] Any treatment applied directly to burning fuel such as wetting, smothering, or chemically quenching the fire or by physically separating the burning from unburned fuel (NWCG 2012)

Table 5. Fuel types and expected fire behavior. Source: Scott and Burgan 2005. Flame lengths in ***bold italics*** exceed those safe for direct attack[2] (Table 6). Spotting distances were calculated using BEHAVE (see Appendix I). More detailed fuel descriptions are in Appendix II.

Timber Understory (broadleaf and/or conifer litter with grass and herbaceous vegetation, shrubs and slash)			
Fuel Type	Description	Expected Fire Behavior	Spotting Distance (miles)
TU1 – Low Load Dry Climate Timber-Grass-Shrub	Low load grass or shrub with litter	Rate of spread low Flame length low	0.0 to 0.1
TU2 – Moderate Load, Humid Climate Timber-Shrub	Moderate litter load with shrub component	Rate of spread moderate Flame length low	0.0 to 0.2
TU3 – Moderate Load, Humid Climate Timber-Grass-Shrub	Moderate litter load with grass and shrubs	Rate of spread high ***Flame length high***	0.1 to 0.4
TU5 – Very High Load, Dry Climate Timber-Shrub	High conifer litter load with shrub understory	Rate of spread moderate ***Flame length moderate***	0.1 to 0.4

Table 6. Categories of fire behavior characteristics. Source: Scott and Burgan 2005. Shaded cells are where fire behavior exceeds limits for direct attack. Pace of walking at two miles/hour = 176 ft./min.

Intensity Class	Rate of Spread (feet/minute)	Flame Length (ft.)
Very Low	0-2	0-1
Low	2-5	1-4
Moderate	5-20	4-8
High	20-50	8-12
Very High	50-150	12-25
Extreme	>150	>25

[2] Any treatment applied directly to burning fuel such as wetting, smothering, or chemically quenching the fire or by physically separating the burning from unburned fuel (NWCG 2012)

Table 7. Area and proportion of fuel types. Fuel types in ***bold italics*** exceed those safe for direct attack.		
Fuel Type	Area in Acres	Proportion of Study Area (%)
Grass Fuels		
GR1	1,604.6	1.2
GR2	***6,670.5***	***4.8***
GR3	***11.6***	***0.0***
GR5	***3.8***	***0.0***
Grass-Shrub Fuels		
GS1	754.6	0.5
GS2	***21.8***	***0.0***
GS3	50.3	0.0
Shrub Fuels		
SH1	6.9	0.0
SH2	1.1	0.0
SH3	163.9	0.1
Timber Litter Fuels		
TL1	1.1	0.0
TL2	109,343.1	78.5
TL3	274.2	0.2
TL5	0.2	0.0
TL6	3935.3	2.8
Timber Understory Fuels		
TU1	3915.9	2.8
TU2	1396.0	1.0
TU3	***2882.9***	***2.1***
TU5	***3718.9***	***2.7***
Sparse and No Fuels		
Sparse fuels	3346.6	2.4
No fuel	1116.6	0.8
Total	*139,219.8*	*100.0*

Photograph 1. Typical northern hardwood forest with litter fuels typical of TL2.

Photograph 2. Old field with short grass typical of GR1.

Photograph 3. Old field with mixed grasses and herbaceous vegetation typical of GR2 or GR3

2. Topographic Conditions

Most of the study area has slopes in the 5-25% range. Fire behavior can become much more intense with slopes greater than 25%. Aspect classes are fairly evenly distributed (Map 4).

Table 8. Proportion of study area in each slope and aspect category

Slope Range	Proportion	Aspect Range	Proportion
0-5	11.7	North	8.4
5-15	31.6	Northeast	8.3
15-25	23.9	East	12.7
25-35	16.6	Southeast	14.3
>35	16.2	South	10.0
		Southwest	11.8
		West	18.2
		Northwest	16.3

3. Fire Weather

Both Vermont and New York have the highest number of fires in April and May, with 75% of all recorded fires in Vermont occurring in those two months. This is reflected in Table 10 below for the study area. In the spring, high pressure systems build from Canada bringing dry air with low relative humidity values that result in drying of fine fuels (leaves, grass). These systems may also have strong winds with a northwesterly or westerly component that can cause rapid fire spread (National Weather Service 2011).

Fire behavior is most extreme during periods when the relative humidity is low, generally less than 35-45%. These conditions are most prevalent in the spring, following snow melt, between March and late May or early June. Summer is usually more humid with more rain (Table 9) and vegetation is green so fire spread is extremely limited. Drought may allow for some summer fire, but relative humidity levels and large scale die back of vegetation would be needed for any significant fires to occur. Fall again brings drying fuels and weather conditions increasing fire hazard. However, relative humidity levels increase after dark, and shorter days limit the amount of time for fuels to dry. Therefore, there is a lower potential in the fall for intense and fast moving fires to occur (USDA 2005).

Table 9. Bennington normal temperatures and precipitation for 1981 to 2010. Source: National Weather Service, http://www.weather.gov/aly/climate

Month	High Temperature (^{0}F)	Low Temperature (^{0}F)	Mean Temperature (^{0}F)	Precipitation (in)
January	30.7	11.6	21.1	2.75
February	34.7	15.3	25.0	2.24
March	43.8	22.7	33.3	3.15
April	56.7	34.3	45.5	3.27
May	67.0	43.3	55.1	3.66
June	75.0	52.4	63.7	4.13

Table 9. Bennington normal temperatures and precipitation for 1981 to 2010. Source: National Weather Service, http://www.weather.gov/aly/climate				
Month	High Temperature (^{0}F)	Low Temperature (^{0}F)	Mean Temperature (^{0}F)	Precipitation (in)
July	79.4	57.0	68.2	4.34
August	77.7	55.2	63.7	4.13
September	70.4	47.4	58.9	3.57
October	58.7	36.4	47.5	3.57
November	47.5	29.7	39.8	3.11
December	35.7	19.5	27.6	2.79
Annual	56.5	35.5	46.0	40.70

4. Fire History

The northeastern United States, including Vermont, has a low frequency of fire. However, the northeast has a more dense population than much of the rest of the county, so the potential for damage from wildfires, even if they are small, can be significant. Table 10 below lists wildfires within the study area and their causes since 1990. Map 5 shows locations of many, but not all, of these from locations provided by the Arlington and Shaftsbury Fire Departments.

Table 10. Historic wildfires in the study area				
Date of Fire	Day of Week	Town	Cause	Size (acres)
4/8/1992	Wednesday	Arlington	Burning barrel	0.05
4/14/1992	Tuesday	Arlington	Burning barrel	0.10
4/14/1992	Tuesday	Arlington	Cigarette	0.11
4/7/1993	Wednesday	Arlington	Leaf & grass burning	0.25
4/25/1993	Sunday	Arlington	Burn barrel	0.08
5/2/1993	Sunday	Arlington	Power wires/tree	0.08
4/5/1994	Tuesday	Arlington	Burning papers	0.25
4/19/2005	Tuesday	Arlington	Railroad	0.33
4/19/2005	Tuesday	Arlington	Railroad	0.10
4/19/2005	Tuesday	Arlington	Railroad	0.50
4/19/2005	Tuesday	Arlington	Railroad	2.50
4/19/2005	Tuesday	Arlington	Railroad	6.00
4/25/2009	Saturday	Arlington	Forest fire	39.00
4/23/1994	Saturday	Sandgate	Unknown	110.00
4/22/1996	Monday	Sandgate	Camping	10.00
2/28/1999	Sunday	Sandgate	Burning field - grass	0.75
4/6/1999	Tuesday	Sandgate	Careless burning in a barrel	10.00
4/11/1999	Sunday	Sandgate	Structure fire - spread to woods	2.00

Table 10. Historic wildfires in the study area

Date of Fire	Day of Week	Town	Cause	Size (acres)
4/12/1999	Monday	Sandgate	Trash pile in open field next to woods	4.00
6/21/1999	Monday	Sandgate	Lightning - fire not located til 6/22 - reported to this office by NY forestry	2.00
7/9/2002	Tuesday	Sandgate	Carelessness	0.13
4/21/2008	Monday	Sandgate	Brush fire	14.0
4/9/1994	Saturday	Shaftsbury	Burning debris/fire escaped	0.25
4/24/1994	Sunday	Shaftsbury	Debris burning	3.00
3/29/1995	Wednesday	Shaftsbury	Debris burning	0.10
3/29/1995	Wednesday	Shaftsbury	Debris burning	0.10
5/6/2001	Sunday	Shaftsbury	Trash burning	0.10
5/5/2002	Sunday	Shaftsbury	Debris burning	0.50
3/24/2004	Wednesday	Shaftsbury	Possibly discarded cigarette	1.50
4/20/2008	Sunday	Shaftsbury	Burning brush pile	0.50
4/22/2008	Tuesday	Shaftsbury	Debris burning	0.10
4/22/2008	Tuesday	Shaftsbury	Debris burning	0.10
4/23/2008	Wednesday	Shaftsbury	Burning brush with no permit	0.25
4/25/2009	Saturday	Shaftsbury	Debris burning	1.25
4/15/2010	Thursday	Shaftsbury	Campfire	2.00
3/11/2012	Sunday	Shaftsbury	Grass fire from NY spread across into VT	0.50
3/11/2012	Sunday	Shaftsbury	Burning brush	0.13
4/28/1993	Wednesday	Sunderland	Kids with matches	0.25
4/19/2005	Tuesday	Sunderland	Train	0.25
4/26/2005	Tuesday	Sunderland	Unknown	0.25

Of the total of 212.4 acres burned in the above fires, the majority of 182.4 acres were forest lands while the remaining 28.9 were grass and brush.

IV. Areas at Risk

A. Fire Hazard

The potential for fire is governed by the kinds of wildland fuels (Map 3), which are based on vegetation, topographic conditions (Map 4), and factors affecting drying of fuels such as solar radiation and moisture, which are based on topography. Fine fuels consisting of leaves and grass are the primary fuels which can ignite larger woody debris and shrubs. Crown or canopy fires are limited to conifers such as spruce and red pine as white pine and hemlock are comparatively fire resistant. Crown fires require very specific conditions to occur, and their extent is limited by the extent of conifer vegetation.

To estimate fire hazard, we developed raster data sets of fuels and several topographic parameters and scored those to arrive at a hazard score. Methods and scoring are described in Appendix III. Map 5 shows the results. In general, areas of shallow slope have lower hazard scores than steep slope. Most development is in valley areas where slopes are relatively gentle.

B. Wildland-Urban Interface

The Wildland-Urban Interface or WUI is a major focus for wildland fire management planning, especially due to the increasing amount of development located in fire prone areas. The Federal Register definition (2001) defines the WUI as the area "…where humans and their development meet or intermix with wildland fuel." The Federal Register divides the WUI into three types: <u>interface</u>, where development of three or more structures per square mile or 250 people per square mile abuts wildlands; the <u>intermix</u>, where there is no clear boundary and development is located in patchy distributions within wildland areas with a density of more than one house per 40 acres or 28-250 people per square mile; and <u>occluded</u>, where patches of wildland of less than 1,000 acres in area are found within developed areas. For this study, all three are considered wildland urban interface. Communities adjacent to federal land and considered at risk are listed in the Federal Register. In Bennington County, these include the towns of Dorset and Sunderland.

Platt (2009) and Stewart et al. (2007) interpret the three types of WUI as having the characteristics of human presence, wildland vegetation and a distance beyond the boundaries of human settlement representing areas where potential fire effects could affect those settlements. There are no good definitions of this "buffer" area nor are there standard methods to define it. The Healthy Forests Initiative recommends 0.5 miles while California uses 1.5 miles based on the distance a firebrand could be carried (Radeloff et al. 2005).

Table 5 shows that spotting distances in the various fuel types range from 0.0 to 0.5 miles. The predominant forest fuels have very limited spotting distances (0.0 to 0.1 miles) while grass and grass shrub fuels range from 0.1 to 0.5 miles. Using the E911 sites from the Vermont Center for Geographic Information, we create three distances from E911 sites: 0.1, 0.2 and 0.5 miles (Map 6) to represent the wildland-urban interface for this plan. These will be discussed under fuel treatments below.

V. Resources

A. Fire Departments

1. Arlington Fire Department

The Arlington Fire Department has the following major resources:

- 2000 gallon tanker/engine replacing their current 1000 gallon vehicle

- 1000 gallon structure engine
- Rescue vehicle with 500 gallons
- Brush truck with 200 gallons
- ATV that can be driven wheeled or tracked when converted with 50 gallons
- 1000 gallon tanker/engine in West Arlington

They also have a variety of portable pumps and crewmembers have Nomex™ personal protective equipment for fighting wildland fires.

2. Shaftsbury Fire Department

- Two 1250 gallon engines/tankers (1500 gpm)
- 1000 gallon tanker/engine (1500 gpm)
- Brush truck with 100 gallons
- Six ATVs
- 15 trained crew

Shaftsbury also has portable pumps.

3. Vermont Department of Forests, Parks and Recreation

For Bennington and Rutland Counties, the Vermont Department of Forests, Parks and Recreation has:

- Fire Response Truck (3/4 ton) with pump, 1,500 feet of hose, mop-up kit, handtools and GPS
- Fire trailer with additional pumps, hose, hand tools, mop-up kit and drip torches

4. U.S. Forest Service

During the fire season, Green Mountain National Forest has a Type 3 Engine and two Type 6 Engines along with crew to operate them. They can get additional resources if conditions during the season become extreme.

B. Water Sources and Helicopter Landing Zones

Map 7 shows the locations and types of water sources. Hydrants are hooked to a public water supply while dry hydrants are connected to ponds or, in some cases, underground storage tanks. Fire ponds mapped were of sufficient size, in the opinion of the Arlington Fire Chief, Jamie Paustian, to provide sufficient water for a fully involved house fire. Drafting sites include streams accessible by road or ponds that have not been evaluated.

Table 11. Number of water sources by type						
Town	Hydrants	Dry Hydrants	Dry Hydrant Tank	Fire Ponds	Drafting Sites	Total
Arlington	29	3	1	7	11	51
Glastenbury	0	0	0	0	9	9
Sandgate	0	9	1	5	2	17
Shaftsbury	59	4	0	0	19	83
Sunderland	0	2	1	8	4	16
Totals	89	20	3	20	46	178

Four of the dry hydrants use streams for their sources. Following Tropical Storm Irene, some of these became blocked and could not be cleared using the standard procedures. It may be necessary to work within the streams to either remove blockage or rebuild the intakes.

C. Sources Fire Planning Information

There are several readily available sources of information that could be useful during a wildfire or for planning prescribed burns.

1. NWS Fire Weather Forecasts Including Spot Forecasts

The National Weather Service in Albany, NY provides forecasts on their web site (www.erh.noaa.gov/aly/indes.php) including fire weather. During the fire season, there is a fire weather forecaster who can provide spot fire weather forecasts through http://www.weather.gov/aly/EMfire. Basically, one gives latitude and longitude information and the time frame and the forecast is developed specific for that area and time. That site is especially useful for planning for prescribed fires to ascertain local conditions.

2. Local Weather Station (Base of Red Mountain)

There are two weather stations that can provide current weather conditions through the Weather Underground:

Base of Red Mountain in Arlington -
http://www.wunderground.com/weatherstation/WXDailyHistory.asp?ID=KVTARLIN2

South Shaftsbury:
http://www.wunderground.com/weather-forecast/US/VT/South_Shaftsbury.html

Monitoring data from that site could be useful during a wildfire or prescribed burn and would be available from any device that can access the Internet.

3. Other References

Section VII and the appendices provide sources of information on fuels, potential fire behavior and other information needed for wildland fire planning.

VI. Actions and Resources Needed

A. Education and Outreach

A wealth of educational materials can be obtained from Firewise (National Fire Protection Association 2013) and can be made available to property owners by BCRC, fire departments and towns. The Firewise Communities /USA Recognition Program allows homeowners to work with their neighbors to reduce their risk. Neighborhoods can become recognized by following certain steps as a community to reduce their risk. There are presently over 900 recognized Firewise communities in the US. The program helps to engage communities to continue to reduce their risk for wildfire on into the future. Appendix V lists the steps to becoming a Firewise Community, and more detailed information can be found at http://www.firewise.org/information/brochures-and-booklets.aspx.

Table 12. Education and outreach actions

Action	Responsible Agent	Time Frame
Acquire materials from Firewise for homeowners	BCRC	2013
Provide Firewise materials on the BCRC and town websites	BCRC; town website managers	2013
Encourage neighborhoods to participate in the Firewise/Communities USA® Recognition Program	BCRC; residents	Ongoing
Provide information on outdoor burning safety prior to the spring and fall fire seasons	Fire wardens	Ongoing

B. Reducing Structural Ignitability

A good deal can be done as new structures are built or existing ones renovated to reduce structural ignitability. While the study area towns do not have codes for residential development, the Zoning Administrators and Planning Commissions can encourage the use of appropriate construction techniques. The National Fire Protection Association has several documents that can be used to assess wildland fire risk (National Fire Protection Association 2008 and 2002). Community members can be trained through the NFPA Firewise program to complete assessments (National Fire Protection Association 2013).

Table 13. Actions to reduce structural ignitability		
Action	Responsible Agent	Time Frame
Provide a review for homeowners requesting an assessment of their properties	BCRC, Shaftsbury FD, Arlington FD	Ongoing
Offer NFPA's "Assessing Wildfire Hazards in the Home Ignition Zone" workshop to fire officials to provide the training to conduct home assessments	BCRC	2013-2015
Maintain a database of properties assessed for wildfire hazard	BCRC	2013-2015
Encourage fire resistant construction in new buildings or when older buildings are being renovated (see Appendix IV A)	Town Zoning Administrators	Ongoing
Encourage defensible space around structures (see Appendix IV B)	Town Zoning Administrators and Planning Commissions	Ongoing
Encourage homeowners to post their E911 address prominently	Town Select Boards	Ongoing
Use Green Up Day to reduce brush and other fuels rather than have owners burn them on site[3]	Green Up Day Volunteers	Annually

C. Adequate Access

Unpaved and/or narrow roads and roads with grades greater than five percent can limit access by emergency vehicles. Roads and driveways should have sufficient grade and width to allow emergency vehicles to access sites as well as to turn around as necessary. The Town of Sandgate has recently adopted driveway standards, and these standards might be useful to other towns in developing their own standards for driveways (Town of Sandgate 2013).

Table 14. Actions to assure adequate access		
Action	Responsible Agent	Time Frame
Assess roads for width, surface and grade to identify potential hazard areas	Arlington and Shaftsbury Fire Departments BCRC	2014

[3] This could be billed as a "Firewise Day" project which is one of the steps for recognition.

Table 14. Actions to assure adequate access		
Action	Responsible Agent	Time Frame
Adopt standards for driveway width, grade and surface to assure adequate access by emergency vehicles during all conditions	Town Planning Commissions	2013 to 2015
Town roads should be maintained to the standards	Town Highway Departments	Ongoing

D. Equipment and Training

Both the Arlington and Shaftsbury Fire Departments are skilled in firefighting. Along with Green Mountain National Forest and the Vermont Department of Forests, Parks and Recreation, there are significant resources for wildland fire suppression, especially given the types of fuels in the area. Water supply enhancements are needed to support structure fire protection in sparsely populated areas away from existing sources.

Table 15. Actions to enhance water supplies		
Action	Responsible Agent	Time Frame
Continue to apply for grants for dry hydrants	Shaftsbury and Arlington Fire Departments	2013 to 2018
Maintain existing hydrants as necessary	Shaftsbury and Arlington Fire Departments	Ongoing
Assure that adequate water supplies are available during site and subdivision plan review	Arlington, Sandgate,, Shaftsbury and Sunderland Planning Commissions Glastenbury	Ongoing
Develop new water sources in areas shown on Map 7.	Arlington and Shaftsbury Fire Departments	2014-2016
Hold a tabletop exercise annually to evaluate wildland suppression communication and coordination	Arlington Fire Department Shaftsbury Fire Department Green Mountain National Forest Vermont Department of Forests, Parks and Recreation	2014-2016

The Arlington and Shaftsbury Fire Departments and the planning commissions of the study area towns have actively worked to assure that ponds, dry hydrants and subsurface tanks are established in areas of new development and elsewhere as needed. As individual houses or small developments occur, a funding mechanism should be developed to create water sources where needed.

The National Fire Protection Association (1992) recommends that a water source be within six minutes of any structure, given a 35 mph speed of fire truck carrying water. We split this in half to allow for necessary refilling of engines to determine areas within the study area that were more than 1.5 miles from a hydrant or fire pond. Using that standard, the following are areas in need of water resources (Map 7):

Arlington the area of Rt. 313, River Rd. and Hawley Mountain Rd.
Arlington along Route 313, River Rd. and Benedict Hollow Rd.
Shaftsbury along 7A and Hidden Valley Rd.
Shaftsbury along Hollow Rd.
Sunderland in the North Rd., Cobbs Rd. and Sunderland Heights Rd. area
Sunderland to serve two areas along Kelly Stand Rd.

The above areas could be served by drafting sites, but those may not have sufficient water during dry periods or more difficult access. Map 7 also shows helicopter landing zones which may be critical for medical evacuation, reconnaissance, water drops or other purposes.

E. Fuels Treatment

1. Forested Areas

Timber litter and timber understory are the dominant fuel types and tend to burn with low intensity. As discussed above, we established three wildland-urban interface zones beyond the sites of individual structures. The inner 0.1 and 0.2 mile buffers would be the priority areas for fuel treatment. Depending on topography and fuel conditions, fuel reduction should also be pursued in the 0.5 mile buffer (Map 8). Fuel treatments could involve mechanical treatment in areas of slash or areas with extensive downed woody debris and dense shrubs, or prescribed burns in areas where suppression may be difficult due to terrain. Litter dries the fastest following lower humidity levels followed by small woody debris. These can be reduced by prescribed fires to reduce fuel loads and break up the continuity of fuels. Branches and limbs can also be crushed with a vehicle so they are against the soil surface and so dry out more slowly.

Thinning of the canopy can also be used to alter fuel types and loads and break up the continuity of fuels. Thinning operations have been shown to reduce litter levels, and equipment may redistribute surface fuels creating more patchy conditions. However, thinning will likely increase overall fuel loads with the addition of branches and limbs from downed trees (Joint Fire Science Program 2008). Therefore, prescribed burns are necessary to reduce this residual material. Prescribed burns may also be more effective on steep slopes where equipment may not be able to operate.

However, prescribed burns should be carefully planned and executed. Burns may also be appropriate for areas where logging has been completed to help prepare the seedbed or reduce undesirable species, such as raspberry and to reduce both fine and coarse fuels that may be left from logging operations. Along with fuel reduction, during periods when the potential for wildfire is high, property owners could be encouraged to use leaf blowers to clear fuel breaks in forested areas near their properties to reduce the potential for escapes from their properties or to protect their properties in the event of a wildfire. If homeowners are educated in Firewise principals this will become part of their ongoing Firewise maintenance in their Home Ignition Zone, which can be done well ***before*** a wildfire occurs.

Beyond those, the following are priority areas for fuel treatments:

a. Black Hole Hollow is an area with several camps which are permanent structures generally used seasonally or on weekends and located on unpaved roads in forested areas. The area is characterized by steep terrain and areas of grass and other potentially flashy fuels. A fire in a 39 acre fire on April 25, 2009 threatened camps in that area. Much of the eastern portion of the study area falls within Green Mountain National Forest. Fuel treatments there could reduce the potential for wildfire originating from developed areas or from Green Mountain National Forest lands that are used for recreational purposes.

b. The Kelly Stand in Sunderland is an area where reliable water sources are beyond the 1.5 mile distance used in this plan. Fuel treatments would protect homes along that road from potential wildfires originating in Green Mountain National Forest, or forest lands from fires originating along roads or adjacent to those homes.

c. Glastenbury Road has several houses within the wildland-urban interface and adjacent to Green Mountain National Forest. Again, fuel treatments, both to provide defensible space around structures and within the forested areas, would protect public and private lands from potential wildfire. Illegal trash burning is a chronic problem in Fayville, and prescribed burns or other treatments in the meadow and orchard in that area could reduce the potential for escapes if such fires are set during periods when wildfires could occur.

2. Old Fields

Table 10 shows that approximately 9,000 acres or 6.5% of the study area are in grass or mixed grass-shrub fuels. Most of these can be found in old fields or areas near development in the valley area. These fields are open, subject to wind and rapid drying so that they may become flammable on a spring afternoon after being wet in the morning. They are often near sources of ignition such as roads or residences. There have been two major sets of fires due to the railroad in which trains set multiple fires on fields along the line.

The following are priorities, but all fields should be considered for treatment to prevent ignitions from roads, railroads and open burning (Map 8):

a. Route 313 West in Arlington has a series of fields and is in an area outside of the 1.5 mile distance from a reliable water supply.

b. West Sandgate Road in Sandgate has a concentration interspersed with residences.

c. Tate Hill and Pantaleon Roads were identified as priority sites.

Fields can be mowed in the fall to reduce the height of grasses and herbaceous vegetation or in the spring to do the same and to break up continuous fuels. Prescribed burns can also be done in the spring or fall if weather conditions are favorable, to reduce fuel loads. It is particularly important to reduce fuels near structures as fires in grass can move rapidly with great intensity.

3. Invasive Species

The draft State of Vermont Hazard Mitigation Plan (DEMHS 2013) lists invasive species, defined as non-native species that could cause economic or environmental harm or harm human health, in the state. Among the most common that could be addressed through fuels management are the following:

Berberis thunbergii (Japanese barberry) found in forested areas
Lonicera spp (exotic bush honeysuckle) found in forest and woodland edges
Rosa multiflora (multiflora rose) found in old fields and field edges
Phragmites australis (common reed) found in wetlands
Phalaris arundinacea (reed canary grass) found in wetlands and wet fields

Barberry, honeysuckle and multiflora rose can form dense stands and could represent hazard to wildland firefighters. In some conditions, they may burn with great intensity. Both common reed and reed canary grass can create high intensity, fast moving fires. Some studies have indicated that invaded forests have higher fuel loads than similar forests that were free of invasive species (Dibble et al. 2008). Fire alone is likely to have limited effectiveness in reducing the abundance of invasive species in forests as many have the capability of resprouting, and fuels in most northern forests result in relatively low intensity fires that would limit the top-killing of woody invasive plants. However, mechanical and chemical treatments, possibly used with fire, could reduce invasive species abundance and therefore both fuel loads and hazards to wildland fire fighters. For species such as reed canary grass and common reed, fire may be useful when managing wetlands or old fields. However, fire alone may not be effective.

Generally for reducing the abundance of invasive species, growing season burns have been shown to be most effective (Richburg et al. 2004). However, it is often more difficult to burn during the growing season due to the higher humidity of the summer and higher live fuel moisture of plants. Fuel treatments for invasive species should be undertaken as part of an overall invasive management program.

At this point, Vermont is relatively free of insects such as the Emerald Ash Borer that could radically change forest composition and leave many dead trees in the forests of Vermont. The effects of such infestations on fuels and fire behavior can only be speculated on at this point, but they could be significant.

Table 16. Fuel management actions		
Action	Responsible Agent	Time Frame
Prioritize and implement prescribed burning on old fields at owners request and given available resources	Arlington and Shaftsbury Fire Departments	Ongoing
Limit or prohibit open burning between March 1 (or earlier depending on snow cover) and May 31st	Fire Wardens	Ongoing
Plan and implement prescribed fire and mechanical treatments for Black Hole Hollow, Glastenbury and the Kelly Stand	Arlington and Shaftsbury Fire Departments U.S. Forest Service	2014-2016
Encourage owners to mow edges of field at least 30 feet from roads and around structures	Arlington and Shaftsbury Fire Departments Fire Wardens	Ongoing
Map areas of invasive species concentrations where fuel treatments could be applied	U.S. Forest Service	2014-2016
Investigate planning for invasive species and potential impacts in the forests of Bennington County	VT Department of Parks, Forests and Recreation BCRC	2014-2016

F. Mutual Aid Agreements and Memoranda of Agreement

The Arlington and Shaftsbury Fire Departments are part of the Bennington County Mutual Aid and have agreements with fire departments in New York as well. This is important as some areas, such as Black Hole Hollow, can only be accessed via New York. The U.S. Forest Service also has agreements with all of the town fire departments for sharing services for wildland fire suppression.

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B. Additional Resources

The National Fire Protection Association has a catalog of materials, most of which are free or can be downloaded from: http://www.firewise.org/catalog.aspx, including:

1. Be Firewise Around Your Home
2. Communities Compatible with Nature
3. Firewise Guide to Landscape and Construction
4. Sample Home Ignition Zone Assessment and Mitigation Guide
5. Wildland/Urban Interface Fire Hazards: A New Look at Understanding Hazard Assessment Methodologies

Appendices

Appendix I. BEHAVE Calculation Assumptions

For spotting distances, 20-foot wind speeds ranged from 5 to 20 mph, the temperature was 75^0 F, slope was 10%, ridge to valley difference was 50 feet, ridge to valley horizontal distance 0.5 miles and spotting source was a ridgetop. Sheltering was 0.5 for grass fuels and 0.4 for timber fuels assuming leaf off. Assuming dormant conditions, 1 hour fuel moisture was set at 6%, 10 hour at 12%, 100 hour at 25%, and live fuel moisture at 30%.

Multiple runs indicated that ridge to valley distances and differences in height did not alter estimated spotting distances, but windspeed did.

Appendix II. Fuel Descriptions

The following are from Scott and Burgan 2005. Dry climate fuels have a moisture of extinction (the moisture content above which fire will not spread) of 15% while humid climate fuels have a moisture of extinction of 40%.

<u>GR1 – Short, Sparse Dry Climate Grass</u>: Fire is carried through sparse fuels. The fine fuel load is approximately 0.40 tons/acre

<u>GR2 – Low Load, Dry Climate Grass:</u> Fire is carried through grass and herbs. The fuel load is approximately 1.10 tons/acre

GR3 – Low Load, Very Coarse, Humid Climate Grass: Fire is carried by continuous, coarse grasses and herbs with a fuel bed depth of approximately two feet. The fine fuel load is 1.6 tons/acre. This would result in higher flame lengths and rates of spread.

GR5-Low Load, Humid Climate Grass: Fire is carried through grass and herbaceous vegetation. The fuel load is approximately 2.9 tons/acre, the fuel bed depth 1-2 feet.

GS1-Low Load, Dry Climate Grass-Shrub: Grass and shrubs carry the fire with shrubs approximately 1 foot high. The grass load is low and overall load is approximately 1.35 tons/acre.

GS2-Moderate Load, Dry Climate Grass-Shrub: Fire is carried through grasses and shrubs with shrubs 1-3 feet high. The fuel load is 2.1 tons/acre, the spread rate high and flame lengths moderate.

SH1-Low Load, Dry Climate Shrub: Fire is carried through low shrubs with a fuel bed depth of 1 foot. There may be some grass and herbaceous vegetation present. Spread rates and flame lengths are low and the fuel load is 1.7 tons/acre.

SH2-Moderate Load, Dry Climate Shrub: Woody shrubs and shrub litter are primary carriers with a fuel bed depth of 1 foot and fine fuel load of 5.2 tons/acre. Grass fuels are absent. Spread rates and flame lengths are low.

SH3-Moderate Load, Humid Climate Shrub: Woody shrubs and litter with some herbaceous fuels carry the fire. Spread rates and flame lengths are low. The fuel bed depth is 2-3 feet and the load 6.65 tons/acre.

TL1-Low Load, Compact Conifer Litter: Compacted litter carries the fire with fuels 1-2 inches deep. The fuel load is 1.0 tons/acre and spread rates and flame lengths are very low.

TL2 – Low Load Broadleaf Litter: Fire is carried by hardwood leaf litter, primarily from species such as red maple (*Acer rubrum*), cherry (*Prunus* spp.) and ash (*Fraxinus americana*). These species tend to create litter that has a low flammability, so rates of spread and flame lengths are low. Fuel loads are approximately 1.4 tons/acre.

TL3-Moderate Load Conifer Litter: Conifer litter with a fuel load of 0.5 tons/acre carries fires of very low flame lengths and rates of spread.

TL5-High Load Conifer Litter: fire is carried by conifer litter with a fuel load of 1.15 tons/acre producing low flame lengths and rates of spread.

TL6-Moderate Load Broadleaf Litter: Fire is carried through litter from species such as oaks (*Quercus* spp.), American Beech (*Fagus grandifolia*) and hickory (*Carya* spp.). Litter from these species results in higher flame lengths and rates of spread than TL 2. Fuel loads are approximately 2.4 tons/acre. The fine fuel load is 2.4 tons/acre; the fuel bed depth is less than 0.5 feet and the moisture of extinction if 25%. This is comparable to standard fuel model 9, but presents lower rates of spread than that model, but comparable flame lengths.

<u>TU1-Low Load, Dry Climate Timber-Grass-Shrub:</u> Spread rates and flame lengths are low.

<u>TU2-Moderate Load, Humid Climate Timber-Shrub</u>: There may be areas where shrubs and litter carry fire. The fuel load is approximately 1.15 tons/acre.

<u>TU3-Moderate Load, Humid Climate Timber-Grass-Shrub</u>: Fire is carried by litter with grass, herbaceous and litter components. The fuel load is approximately 2.85 tons/acre. The spread rate is high and flame lengths moderate.

<u>TU5-Very High Load, Dry Climate Timber-Shrub</u>: Fire is carried through heavy forest litter and shrub understory. The fuel load is approximately 7.0 tons/acre. Spread rates and flame lengths are moderate.

In Vermont, shrubs, which may include invasive species such as bush honeysuckle (*Lonicera* spp.), multiflora rose (*Rosa multiflora*) and Japanese barberry (*Berberis thunbergii*), as well as native shrub dogwood (*Cornus* spp.) and viburnum (*Viburnum* spp.), along with dense vines such as wild grape (*Vitis* spp.) and the invasive Oriental bittersweet (*Celastrus orbiculatus*), may create patches of intense fire.

Appendix III. Assessment of Fire Hazard

1. Fuels

As discussed above, fuels in the study area produce fires of relatively low intensity except for some of the grass fuels. Some areas of mixed development and vegetation have sparse fuels and were given a low score primarily as they are limited in area. Based on the above characteristics, fuels were scored as shown in table A III-1 below:

Table A III-1. Hazard scoring for fuels. USFS risk assessment from USDA 2010

Score	Fuel Types	U.S. Forest Service Risk Assessment
0	No fuel	0
1	Sparse fuels of all types	NA
2	GR1, GS1, SH1, SH2, SH3 TL1, TL2, TL3, TL5	GR2, GS1, and SH2=2 SH3=1; TL1 through5=1 SH1 NA
3	TL6, TU1, TU2,	TU1=1, TU2=2, TL6=2
4	GR2, GR3, GS2, GS3,TU3, TU5	GR2=2, GR3=3, GS2=3, GS3=4, TU3=3, TU5=3
5	GR5	4

Cells with “No Fuel” were given a score of zero and sparse fuels a 1 regardless of the other scoring criteria described below. This scoring system is similar a risk assessment score for fuels developed by the U.S. Forest Service for an area ranging from Maine to West Virginia to Minnesota and Missouri.

2. Slope

Slope affects fire behavior by increasing rates of spread and flame length as the steepness of slope increases. In a sense, slope acts as wind. In addition, increasing slope can make attacking a wildfire increasingly difficult. In general, slopes greater than 30% result in a significant increase in the spread rate of wildland fire (Butler et al. 2007), but slopes greater than 15% present difficulties for suppression. To combine these two factors, we used the following slope categories:

Table A III-2. Hazard scoring for slope (Map 3)		
Score	Slope Percent	Notes
1	0-5	Flat terrain
2	5-15	Flat to moderate
3	15-25	Moderate to steep
4	25-35	Steep slope
5	>35	Fire behavior increases dramatically with slopes increasing beyond 45%. 35% slope was used to be conservative

3. Aspect

In general, winds with a westerly component prevail when high pressure systems dominate and wildfires are most likely to occur. Dry easterly winds may occur, but winds with an easterly component are more likely to occur during rainy periods. Table A III-3 below shows scoring for aspect.

Table A 111-3. Hazard scoring for aspect (Map 3)		
Score	Aspect range	Class
2	337.5 to 22.5	North
1	22.5 to 67.5	Northeast
1	67.5 to 112.5	East
1	112.5 to 157.5	Southeast
2	157.5 to 202.5	South
3	202.5 to 247.5	Southwest
3	247.5 to 292.5	West
3	292.5 to 337.5	Northwest

4. Solar Radiation

The ArcGIS solar radiation tool in Spatial Analyst was used to calculate the amount of direct solar radiation in watts/m2 across the study area. Generally aspect is used to calculate fine, dead fuel moisture, but a flat northerly aspect can have as much solar input as a flat southerly aspect. Limited statistical analyses indicated that solar radiation could be broken into the four classes shown in Table A III-4 below. Solar radiation is a better measure of fuel drying than aspect alone.

Table A III-4. Hazard scoring for solar radiation	
Score	Solar Radiation Range (watts/m^2)
1	<=500,000
2	<=700,000
3	>700,000 to <900,000
4	+>900,000

5. Moisture

Soil moisture can affect the ability of fine fuels to dry, regardless of solar radiation and relative humidity. Fine fuels in areas that collect moisture will take longer to dry than those in drier conditions. One way of estimating soil moisture is to use a compound topographic index or CTI. In a nutshell, this calculates the amount of water that would enter a given cell given how many other cells would drain into that cell.

Table A III-5. Hazard scoring for moisture (compound topographic index)	
Score	Moisture Class
1	Wetlands
2	Mesic Uplands
3	Dry Uplands
4	Very Dry Uplands

The classes were developed by the U.S. Geological Survey using the CTI, slope, aspect and mapped National Wetland Inventory boundaries (USGS 2011). Statistical analyses allowed for creation of wetlands, mesic uplands, dry uplands and very dry uplands, with the latter two based on both steep slopes and aspect. The 30 meter resolution is the same as other data used (Landfire, NOAA land cover), and while we could have developed study area specific index, that would have required resources to validate it beyond the scope of this project.

Appendix IV. Measures to Reduce Structural Ignitability (source: National Fire Protection Association 2008)

A. Structure Construction

Reducing the hazards from wildfire within the wildland-urban interface (WUI) involves the following kinds of actions:

- Appropriately locating buildings so they are not within or near wildfire hazard areas, such as within dense forest or surrounded by tall grasses. In addition, the location and siting should allow for access by emergency vehicles.
- Roofing material that has a Class A, B or C rating is fire resistant and includes composition shingle, metal, or tiles.

- Exterior walls that are fire resistant are also preferred. Double tempered glass reduces the potential for fracture or collapse.
- Eaves, fascias, soffits and vents should be enclosed with metal screens.
- Any fences, porches, decks or other attachments to a building should be considered part of the house and made fire resistant.

B. Defensible Space

For existing buildings, vegetation management is critical. The National Fire Protection Association and Firewise recommend (NFPA 2008):

- Maintaining buildings and surrounds to eliminate accumulation of combustible leaves, branches and vegetation

- Reduce fuels in the Home Ignition Zone, which extends up to 200 feet around the buildings and homes and all attachments.

  The following three zones can be thought of as ranging from high to low priority in terms of managing potential fuels near structures:

  Zone 1: an area within 30 feet of a building within which flammable vegetation could allow a wildfire to directly contact the building. Within this area, vegetation should be managed so that no type of wildfire could be supported. The best option for these areas would be low, maintained lawn. Plants should be free of resins, oils and waxes that burn easily. Leaves or other dead vegetation should be removed from under any decks or other overhangs and away from the building. Firewood stacks and propane tanks should not be located within this zone. Patio materials should be fire-resistant.

  Zone 2: an area within 30 to 100 feet of a building where flames, radiant heat, and embers could ignite a structure. Topography is important, as this area would extend further down slope than upslope, as fire intensity is dramatically greater when moving upslope than down slope. Vegetation should be managed to limit fire to low intensity and rates of spread. Where feasible, fuel breaks including walking paths and driveways can break up fuels.

  Zone 3: An area 100 to 200 feet of a building within which structures are threatened by embers from crown fires. Vegetation should be managed to prevent high intensity and rapidly moving surface fires that could also generate embers. Heavy accumulations of fuels as well as fine fuels such as tall grasses should be removed or broken up so they are not continuous.

- Provide defensible space around homes and buildings, water supplies and utilities through vegetation management by:

- Locating combustibles such as fuel, wood piles, and storage buildings at least 30 feet away from the home, especially during fire season.
- Keeping trees and shrubs pruned six to ten feet from the ground to avoid ladder fuels.

- Removing overhanging branches from roof.
- Removing debris, such as leaves, pine needles and downed branches from gutters, roof and along foundation.
- Replacing flammable plants, such as holly and pine, with fire-resistant vegetation.
- Keeping landscaping and lawn well watered.

- Providing adequate water supplies for structure protection

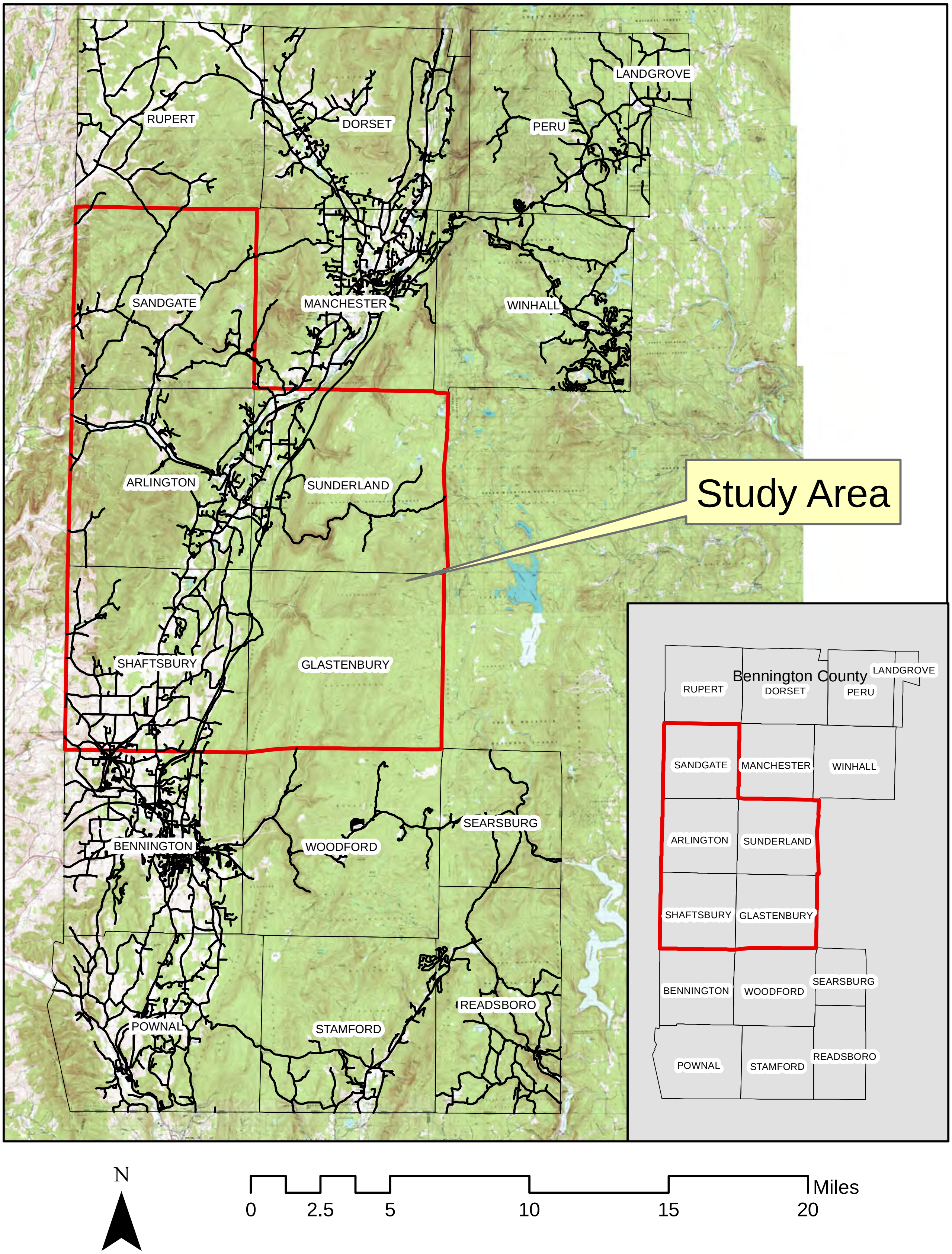
Appendix V. Steps to Becoming a Firewise Community (see Becoming a Recognized Firewise Community/USA available via: http://www.firewise.org/information/brochures-and-booklets.aspx

- Complete a Community Assessment which paints a picture of the structures in relation to the surrounding vegetation and topography and identifies wildfire risk.
- Form a local Firewise Board which maintains the Firewise Community program.
- Create a Community Action Plan that provides its residents with actions they can take to reduce their wildfire risk.
- Observe an annual Firewise Day Event that carries out a portion of the community action plan. Examples: Chipping Day, Fairs/Education Days.
- Invest a minimum of $2.00 per capita per year in local Firewise efforts. Work by municipal employees or volunteers, state/federal grants can be included.

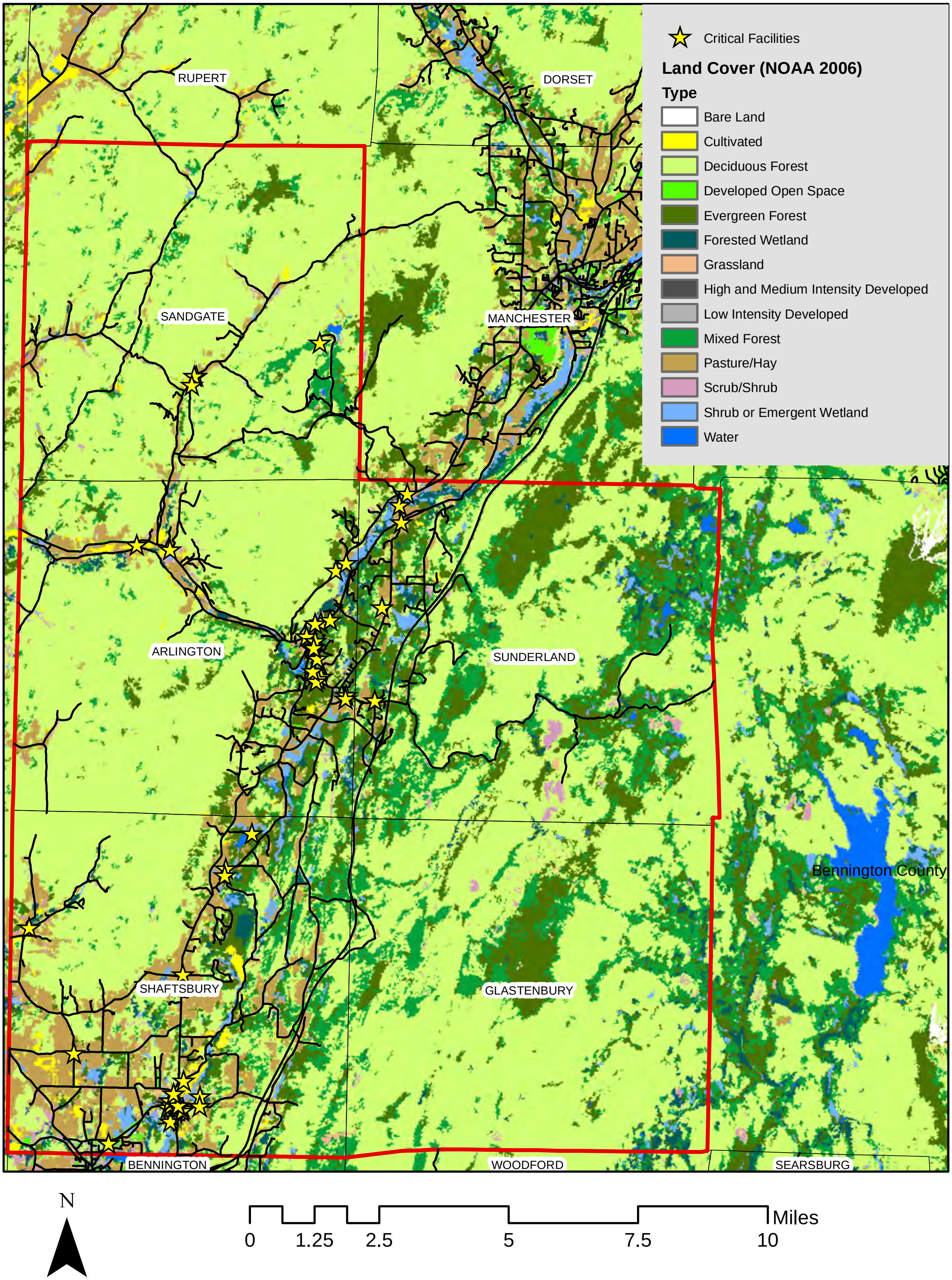
Appendix VI. Occupancy hazard classification number and construction classification numbers for water supply calculations. Source: NFPA 1992.

Structure Type	Occupancy Hazard Classification Number	Construction Type	Classification Number
Accessory Building	4	Type I Fire Resistant (concrete, stone, etc. and resistant to collapse)	0.5
Camp	7	Type II Noncombustible (all parts noncombustible)	0.75
Commercial/Industrial	6	Type III Ordinary Construction (outer walls noncombustible with rest combustible)	1.0
Commercial Farm	4	Type IV Heavy Timber (heavy timber and masonry)	0.75
Commercial with Residence	6	Type V Wood Frame (wood or other combustible materials0	1.5
Development Site		For mixed materials, the higher classification number should be used.	
Educational	7		
Fire, Rescue, Law Enforcement	7	No occupancy hazard number is assigned for buildings with appropriately designed and installed sprinklers	
Government	6		
House Of Worship	6		
Lodging	7		
Mobile Home	7		
Multi-Family Dwelling	7		
Structure Type	Occupancy Hazard Classification Number		
Other	NA		
Other Residential	7		
Public Gathering	6		
Single Family Dwelling	7		

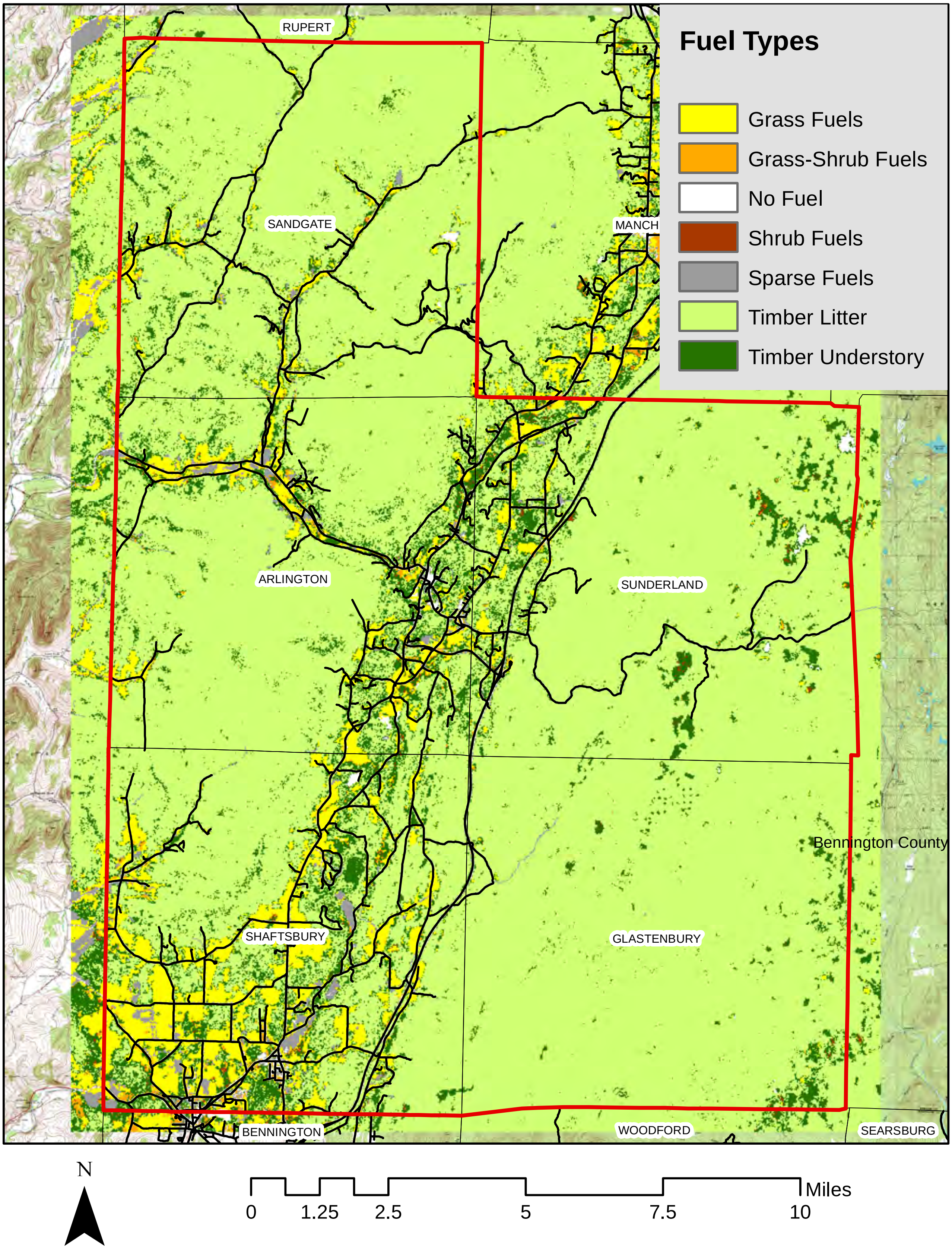
Map 1. Arlington, Glastenbury, Sandgate, Shaftsbury and Sunderland Community Wildfire Protection Planning Area



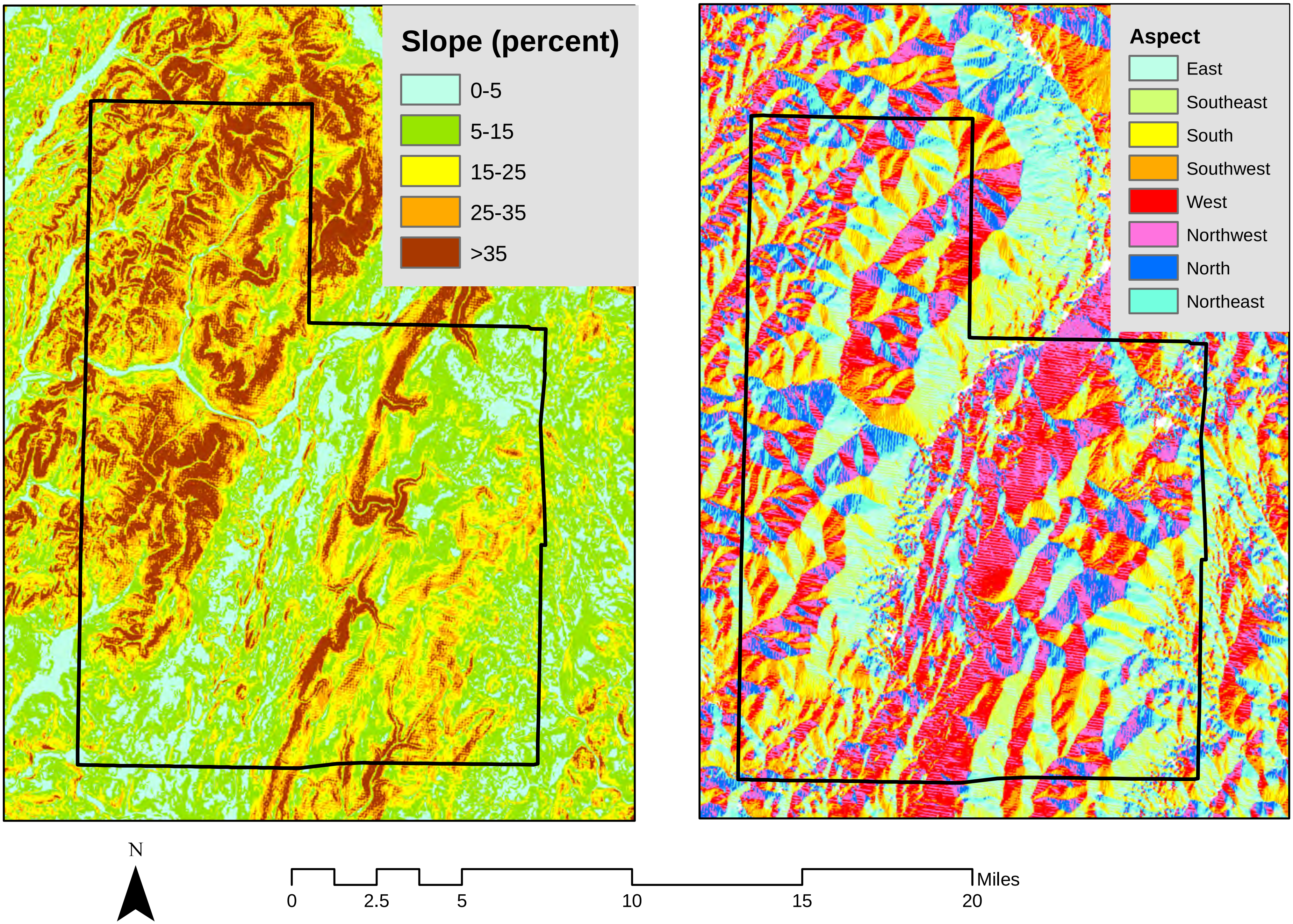
Map 2. Land Cover



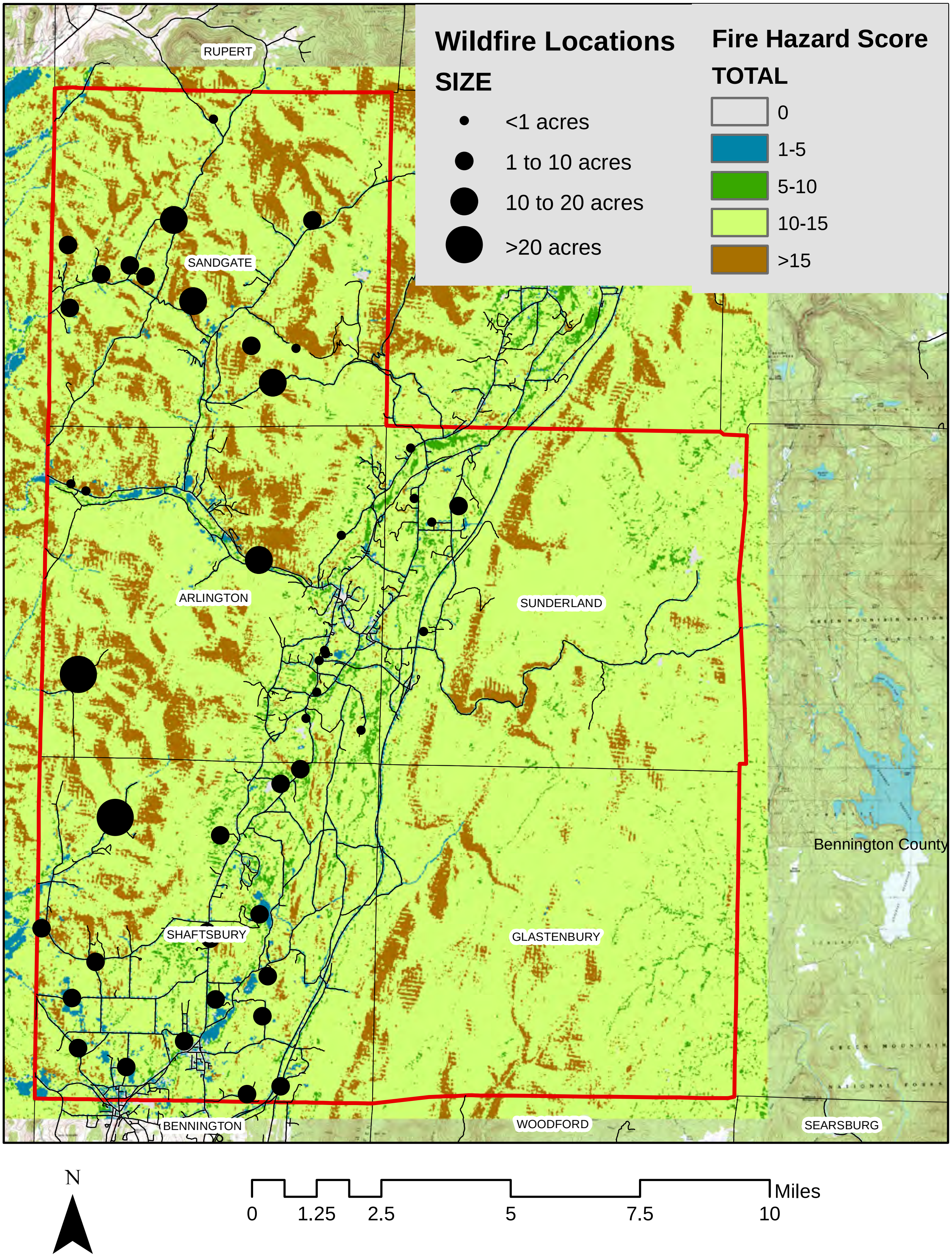
Map 3. Fuel Types



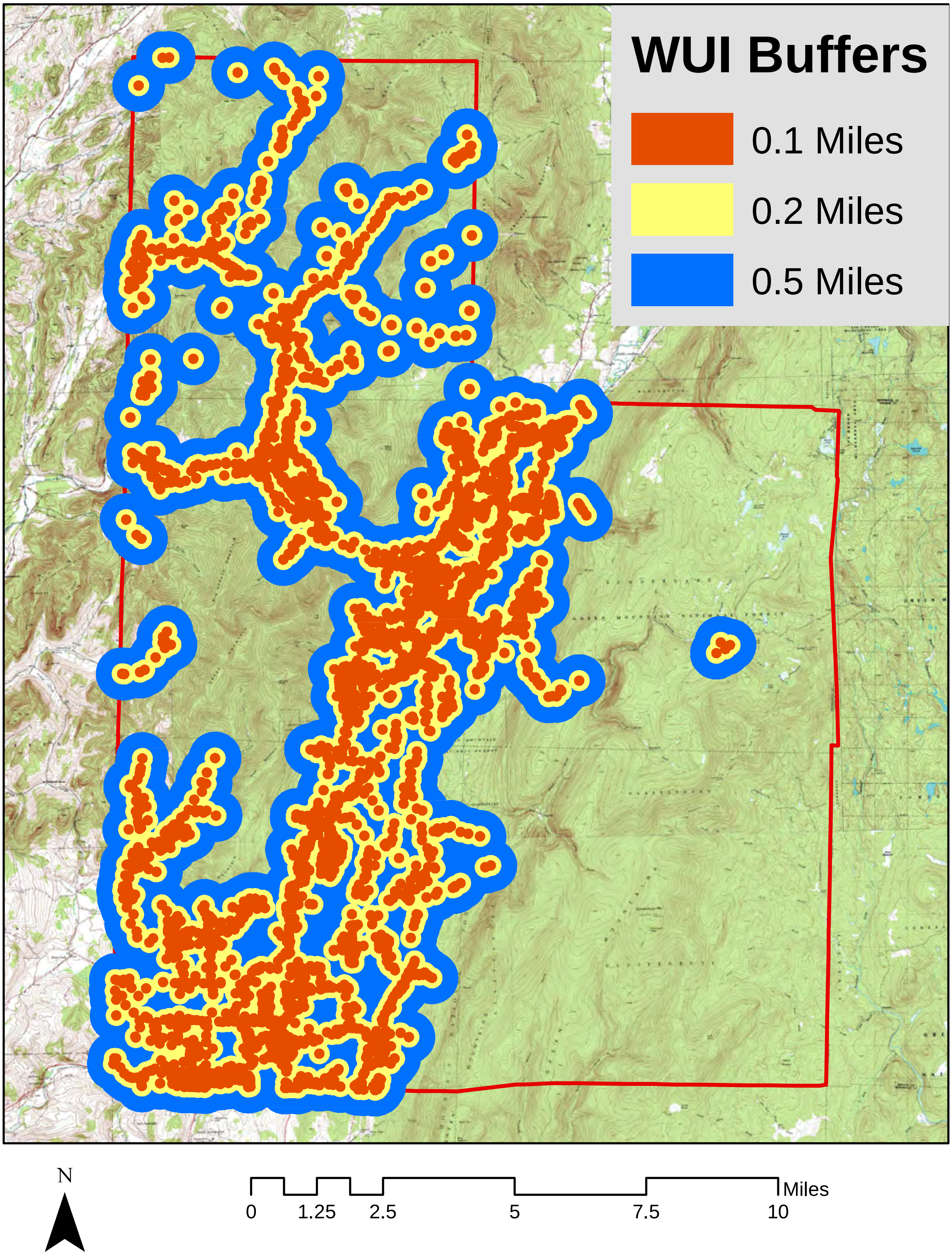
Map 4. Slope and Aspect Categories



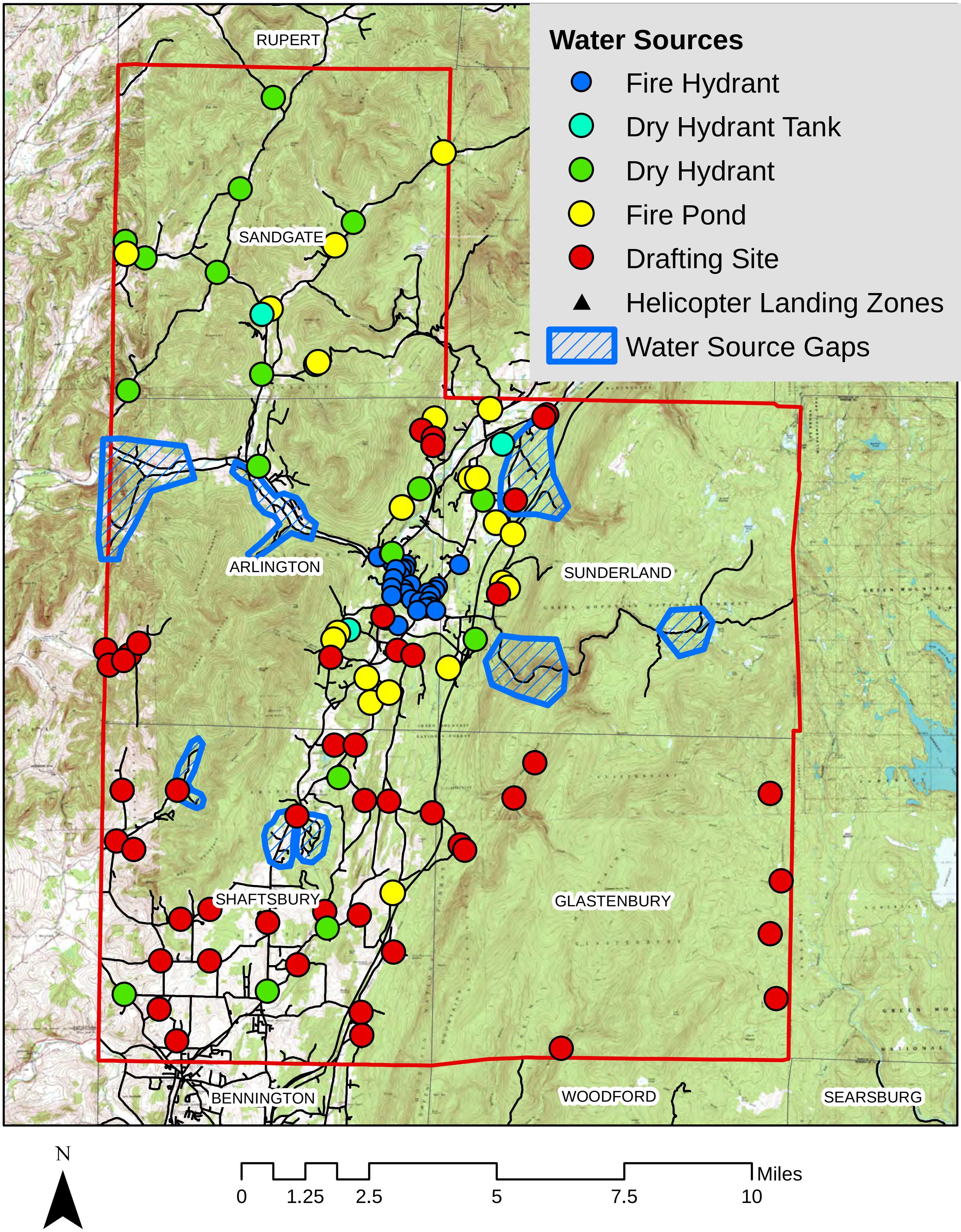
Map 5. Fire Hazard and Fire History



Map 6. Wildland-Urban Interface



Map 7. Water Sources and Landing Zones



Map 8. Fuel Treatment Areas