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STATE OF CONNECTICUT

DEPARTMENT OF ENERGY AND ENVIRONMENTAL PROTECTION

Bureau of Natural Resources
Division of Forestry

FOREST MANAGEMENT PLAN
2013 through 2023

MEANS BROOK WATERSHED BLOCK
CENTENNIAL WATERSHED STATE FOREST

666 Acres
Shelton, Connecticut
Monroe, Connecticut

Approvals:

2/28/13
Christopher Martin, Director — Date
Division of Forestry

3/20/13
William Hyatt, Chief — Date
Bureau of Natural Resources

4/18/13
Susan Whalen, Deputy Commissioner — Date
Outdoor Recreation and Natural Resources

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I would like to acknowledge the following colleagues who have made the completion of this plan possible; DEEP State Lands Forester II, Jerry Milne and Aquarion Water Company Forester, Gary Haines, for contributions made during all phases of the planning process; and DEEP Wildlife Biologist, Peter Picone, for contributing wildlife resource information and recommendations.

A. Executive Summary

1. This management plan covers the Means Brook Watershed Block of Centennial Watershed State Forest. The plan assesses and describes the watershed's forest-related resources, and provides forest management recommendations for the next ten years. More general information on the value of forest management in public water supply watersheds, silvicultural techniques, and Best Management Practices is in the accompanying "Forest Management Guidelines for the Centennial Watershed State Forest" in Appendix A.

- The primary goal for Centennial Watershed State Forest is to create a healthy, diverse, more uneven-aged and resilient forest to provide high quality drinking water for thousands of people in Fairfield County. This can be accomplished by:
  - long-term and sustainable yield forest management for forest products;
  - reducing the deer population to allow ample forest regeneration; and
  - controlling and removing non-native invasive plants to allow forest regeneration and enhance the diversity of native species
- Long-term management history – nearly one century of forest management as a public water supply storage system.
- Land is managed by the Conservation Land Committee, a partnership between DEEP, The Nature Conservancy, and Aquarion Water Company.
- Present forest structure is unbalanced; predominantly over-mature and susceptible to disturbances.
  - Forest lacks a healthy understory of seedling/sapling size classes.
  - High deer population impedes desirable tree regeneration.
  - Exotic invasive plant populations are spreading, competing with native vegetation.
- Provide additional opportunities for public use consistent with primary goals:
  - Open additional areas to the CWSF Archery Deer Hunting Program.
  - Implement DEEP Division of Forestry cordwood program on Class II or III lands.
  - Potential for new hiking trails to connect to adjacent permanent open space.
- Forest Management – 100 year rotation, 20 year cutting cycle.
- 666 acres within Means Brook Watershed; 268 acres will be actively managed.
- 125 acres slated for management during this plan period.
- Before any timber harvest, the sale area will be evaluated for treatment to eradicate non-native invasive plants and treated as necessary.
- Driveway apron construction, and the spreading of gravel, will begin on areas to be managed in the next ten years.
- Forest manager staffing vital to accomplishing plan objectives.

Location: The Means Brook Watershed (MBW) Block of Centennial Watershed State Forest (CWSF) is located in eastern Fairfield County, in the towns of Shelton and Monroe. It is separated into three compartments, compartment 1: south of Route 110 in Shelton, compartment 2: north of Route 110, east of Route 111 in Monroe, and compartment 3: east of Route 111 off of East Village Road in Monroe.

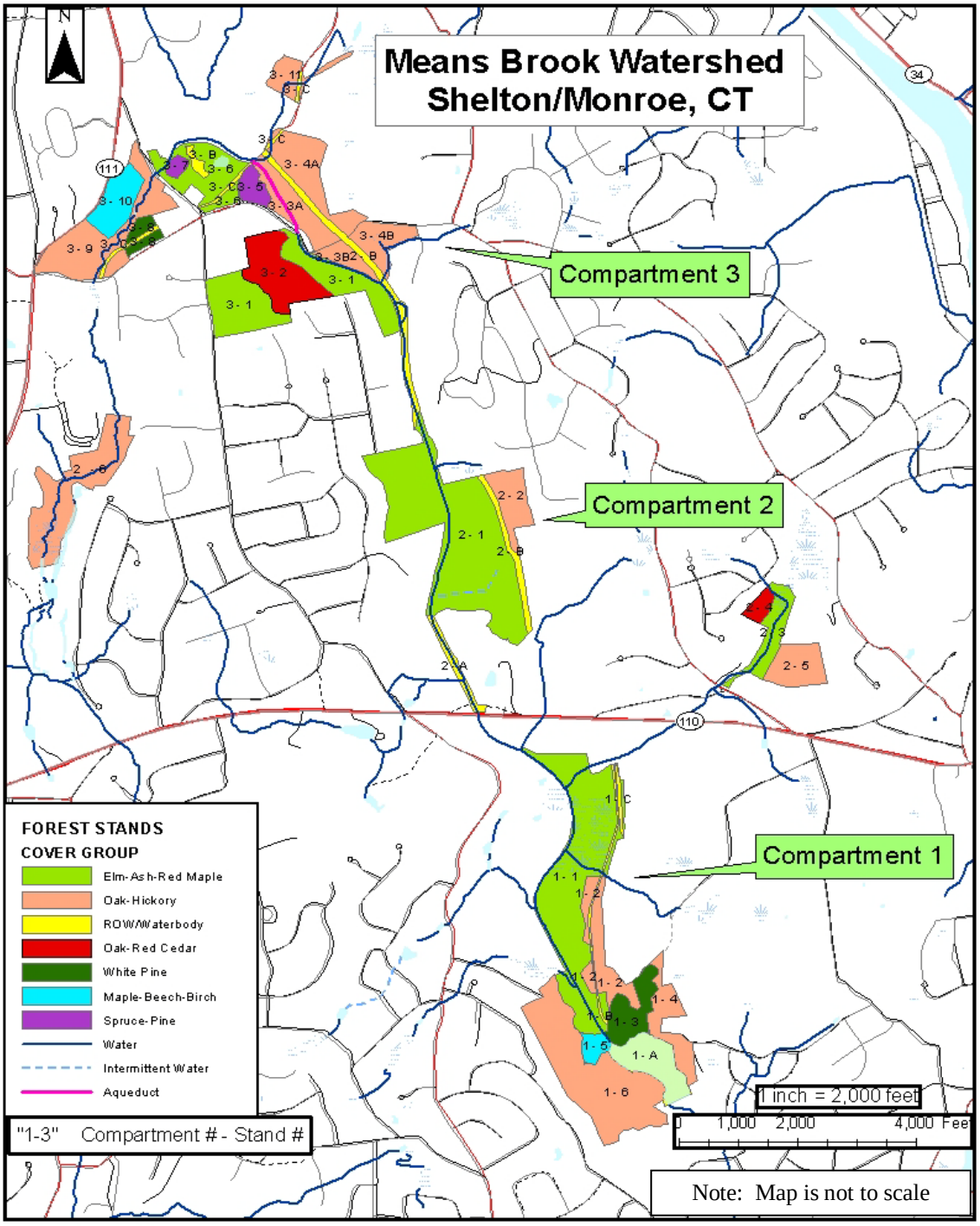


Figure 1: Compartment map for Means Brook Watershed showing forest cover groups.

B. History

1. Reason for acquisition and funding sources: The woodlands within this watershed are second and third growth forests that regenerated after farmlands were abandoned during the Industrial Revolution in the late 1800s. Farms and other lands were bought by the Bridgeport Hydraulic Company (BHC) in the early 1900s to construct public drinking water supply reservoirs and undeveloped, forested buffers surrounding reservoirs and their tributaries.
The Forest is comprised of land surrounding Means Brook Reservoir and its tributaries (i.e. Means Brook, Hurds Brook and a number of smaller, unnamed streams). Means Brook Watershed (MBW) serves as a biological filter for clean drinking water.

In 2002, the State of Connecticut Department of Environmental Protection (now called Department of Energy and Environmental Protection - DEEP) and The Nature Conservancy (TNC) purchased land and conservation easements from the Aquarion Water Company (AWC, formerly BHC). The agreement, funded by $80,000,000 from DEEP and $10,000,000 by TNC, preserved approximately 15,300 acres of primarily forested watershed lands. Management is conducted by the Conservation Land Committee (CLC), a cooperative partnership of foresters and land management professionals representing DEEP, TNC, and AWC.

On September 16, 2004, Governor M. Jodi Rell officially designated the land as "Centennial Watershed State Forest," to recognize its importance in protecting drinking water supplies and to commemorate the 100th anniversary of the State Forest system in Connecticut.

Photo: http://www.ct.gov/dep/cwp/view.asp?a=2716&Q=447970&depNav_GID=1650

The Natural Resources Management Agreement was signed by all three entities. It governs how the land is managed, stating the goals for science-based stewardship of this property as follows:

a. Permanently preserve open space,
b. Protect and provide a safe, reliable, and adequate water supply,
c. Promote a healthy, diverse, and resilient forest capable of providing forest products, clean air, plant and animal habitats, recreational opportunities, and aesthetics,
d. Maintain significant tracts of naturally occurring, mature, diverse, and continuous forest cover,
e. Provide opportunities for public use consistent with the above goals.

Land owned by water companies is regulated by State Statute (CGS25-73c). Land is classified as Class I, II, or III. Class I and II lands are within the watershed of the reservoir while Class III lands are outside of the watershed. In MBW, AWC owns the Class I land and parcels surrounding CWSF property that are occupied by facilities and buildings. DEEP owns the Class II and III land.

Because the Class I and II lands are intermingled on the landscape to such an extent that they cannot be easily delineated in detail on the ground, they are managed as one entity.

2. Development of resource before acquisition: Historical forestry practices and other land-use management activities within MBW, by BHC, include timber harvesting, firewood harvesting, and reforestation.

BHC had plantations of red pine *(Pinus resinosa),* white pine *(Pinus strobus),* and norway spruce *(Picea abies)*. By the early 1940s, the red pine plantations were rapidly declining due to the Red pine scale *(Matsucoccus resinosa)*. BHC salvaged its red pine in MBW in the 1960s and 1970s. Most of these salvaged areas were left to regenerate to hardwoods, while some were replanted with white pine and norway spruce. There were timber harvests on Sawmill City Road in Shelton and East Village Road in Monroe during the late 1980s.

Means Brook Reservoir is a storage reservoir within the Trap Falls Watershed distribution system. The dam that retains the 18-acre water body was built by BHC in 1915-1916 primarily to supply Trumbull, Shelton, and Monroe with clean drinking water. Means Brook is an engineered canal which feeds the reservoir, built around the same time.

The main purpose of managing these woodlands is to provide clean drinking water by maintaining a healthy, productive, diverse, and resilient forest. The last timber harvest was in the late 1980s when MBW was included within the Trap Falls management plan. As a result, there have been no recent steps taken to maintain the crowded conifer plantations, overstocked pole-sized stands, or control the ever-spreading non-native invasive plants taking over the understory.

Properly managed forests can act as an unmatched biological filter to provide high quality drinking water. Healthy, productive forests with identifiable overstory, midstory, understory, and ground cover provide multiple opportunities for mitigating the kinetic energy of rainfall. Multiple layers of vegetation slow down the rate at which raindrops hit the forest floor, causing less erosion of forest soils. The complex canopy structure intercepts rain and snow, delaying storm peak flows, as well as filtering pollutants in the air by leaf surface area. Retaining a healthy, forested buffer on lands surrounding reservoirs and their tributaries is essential to maintaining a quality drinking water supply. Without this protective, natural filter, large amounts of nutrients, sediment, and pollutants can easily wash into the water system during heavy rain and snow melts.

As forests mature their net productivity decreases as senescence begins to balance growth rates. Young, rapidly growing forests are shown to generally retain higher levels of nitrogen than mature, slower growing forests. Aggrading, middle-aged stands that include all age classes will optimize the buffering of further nutrient inputs, such as pollutants from atmospheric deposition. Continuous maintenance creates a lush understory layer of vegetation, allowing rapid recovery of young trees, shrubs, and herbs. This provides uninterrupted protection against a large flux of sediments and nutrients into streams and reservoirs following a disturbance affecting mature trees.

Forests that are low in species diversity are at greater susceptibility of mortality than a mixed-species forest when a species-specific pest arrives (e.g. Gypsy moth in an oak-dominated forest). Similarly, a forest that is primarily composed of mature trees will be more susceptible to wind damage than a forest of mixed heights and ages. In the event of a large-scale

disturbance, such as an ice storm or hurricane, a forest that has a mosaic of stands with different age structures and species, will be more likely to avoid damage than a homogenously structured forest. When large-scale disturbances occur within a forest, there can be a flux of nutrients and sediments that are leached into the water system, negatively impacting water quality. Maintaining a heterogeneous, complex forest structure of varying ages and species will form a protective forest cover, serve as a biological filter, and will be more resilient to various disturbances (e.g. ice storms, hurricanes, tornadoes, fire, wind, and insects/diseases).

Further discussion of managing watershed forests for optimal drinking water quality and the values of public water supply watershed protection can be found in Appendix A: "Forest Management Guidelines for the Centennial Watershed State Forest."

C. Acres and Access

1. Acres: The MBW Block consists of 666 acres separated into three compartments.
Compartment 1 – 221 acres
Compartment 2 – 214 acres
Compartment 3 – 231 acres
92% of the total land cover of the Block is forestland, 5% is utility right of way, and 3% are water bodies.

Land Cover	Acres
Forested stands	611
Utility Right of way	35
Water body	20
Grand Total	**666**

Figure 2: Land cover by acres

2. Present Access: All state, and most local roads are paved. In Shelton, a 2,900 foot portion of Sawmill City Road is unpaved and is maintained by the Town. Pearmain Road is also unpaved, and upon reaching state forest boundaries, is unmaintained, and currently impassable to traffic other than four-wheel drive vehicles. Major state roads that abut the Forest are Connecticut Routes 110 and 111, both of which are busy thoroughfares for regional commuter and truck traffic.

Compartment 1 can be accessed from the south end on Sawmill City and Pearmain Roads. Access to compartment 2 is limited as the boundaries run behind private homes and abut Jones Family Farm fields and orchards. There is frontage on a cul-de-sac at the south-end of Old Castle Drive.
Access to parcels within compartment 3 is by East Village Road, Barn Hill Road and Webb Circle Drive, which are town roads off of Route 111.

3. Right of Ways (ROW): The Iroquois Gas Company has a pipeline that parallels a section of the CWSF boundary in the northern section of compartment 1 stand 1 for roughly 1,225 feet. It also runs through compartment 2 for 2,900 feet and for 5,550 feet in compartment 3. Iroquois will be notified before a timber harvest is conducted. A pad or bridge will be required if crossing the pipeline to displace the weight of machinery. The Company's office is located in Shelton and the phone number is (203) 925-7200.

Connecticut Light and Power (CL&P) has a transmission line right-of-way through a section of compartment 3, for approximately 3,500 feet. CL&P will be notified before a timber harvest.

4. Boundary conditions and total miles of boundary: There are approximately 19.5 miles of boundary lines. About 14.6 miles are interior boundary lines, and 4.9 miles are roadside boundaries. The interior lines are marked both by paint and signs whereas the road-front boundaries are posted with signs only.

The boundaries of compartment 1(approximately 5.5 miles) were marked in 2011 and tagged with the new CLC-designed boundary signs. Roadside tagging has been completed on about another mile in compartment 3, with a total of 6.5 miles being refreshed to date. Boundaries surrounding the other compartments are marked in faded yellow paint and signs from when the land was owned by BHC. Areas that will be involved in the deer management bow hunting program will be posted before others. As new areas are open for permitted public access, the boundaries will be posted with the CLC signs.

5. Known boundary problems: Lost Line – Stand 2-6 is a 39-acre parcel located behind residential homes, Whitney Farms Golf Club, and Masuk High School. During inventory, questionable boundary lines, and potential encroachment by the golf course was discovered. The majority of the boundaries in this stand are severely faded or non-existent. Further investigation at the Monroe Town Hall on exact boundaries will be conducted, along with field evaluation to locate old lines. Stand 3-11 off of Webb Circle Dr. has questionable boundaries, as much of the line has faded and could not be found during inventory.

As with many sections of CWSF, forest boundaries run behind neighborhood houses whose backyards often abut, and occasionally sprawl over into CWSF property. Brush and other yard debris dumping is the most common encroachment. Boundaries will be inspected as they are scheduled to be marked in 2013-2014 and offenders will be contacted.

D. Special Use Areas

1. Lakes and ponds: Means Brook Reservoir is a dammed body of water of approximately 18 acres in compartment 1. It is used as a storage reservoir to the Trap Falls Watershed distribution system. There is also a 2-acre wetland bog located in compartment 3 (stand B).

2. Streams and rivers: Means Brook flows for 3.25 miles through the MBW Block. Hurds Brook flows for 3,450 feet in compartment 2 and for 4,700 feet in compartment 3 before it feeds into Means Brook. The DEEP GIS hydrography layer implies that Hurds Brook flows into Aquarion's aqueduct in stand 3-3A, where it is then called Means Brook.

3. Cultural sites: There are charcoal mounds in some of the stands. An old dam in stand 3-9 was built in the early 1900s to create a drinking water supply reservoir by the Birmingham Water Company. This preceded Means Brook Reservoir, and was later acquired by BHC. BHC diverted water from this area back into Means Brook via the "Boy's Halfway Diversion." Additionally, old cellar holes of abandoned mill buildings, homes and farms, along with ubiquitous stonewalls, are found throughout the Block.

4. Recreation and scenic sites – trails and signs: All recreational uses are regulated by the Connecticut Department of Public Health. Hiking is allowed on the Paugussett Blue Trail in Monroe. The trail crosses through compartment 3, beginning in stand 3-8, enters into 3-9 where it crosses Barn Hill Road and enters stand 3-6 for several hundred feet before leaving

CWSF boundaries. The length of the Paugussett Trail through the MBW Forest is 1,740 feet. There is potential for new trails to connect the Paugussett Trail to Monroe Open Space. Harvesting may take place close to the trail as it crosses through pine and spruce stands that need thinning. Caution signs will be posted during an active timber sale. The Connecticut Forest and Park Association (CFPA) will be notified of upcoming timber sales to temporarily close the trail to hikers. During harvests surrounding the Blue Trail, hazardous trees along it will be marked for removal, and the trail will be cleared of debris before the close of sale.

Since 1958, 81 acres north of Sawmill City Road have been open to shotgun small game and waterfowl hunting. DEEP stocked pheasants until 1999. In the fall of 2012, 189 acres will be open to archery hunting for deer in the vicinity of Sawmill City Road. Please refer to the DEEP Hunting and Trapping Field Guide for additional information (e.g. season dates, bag limits, license and permit requirements, etc.).
Fishing is not allowed in Means Brook or Means Brook Reservoir.

5. Critical habitat: In MBW, there are two known State Species of Special Concern; the Eastern Box Turtle (*Terrapene carolina carolina*) and the Wood Turtle (*Glyptemys insculpta*). The Natural Diversity Data Base (NDDB) indicates the presence of these reptiles in Monroe around stand 2-6 (reference 5/22/12 memo from Dawn McKay to Jeremy Clark). During inventory, an eastern box turtle shell was also found in stand 2-3. Neither of these stands will have active management, protecting the integrity of the surrounding habitat for turtles.

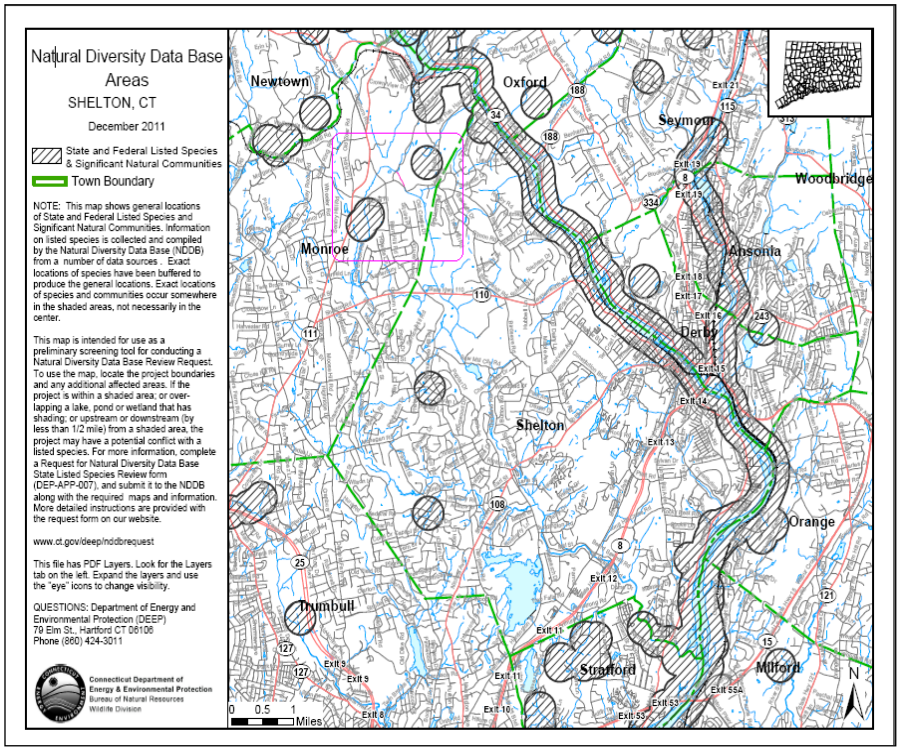


Figure 3: NDDB review map for Shelton and Monroe. Critical habitat area is shown in purple box.

6. Natural Areas: There are no state-designated Natural Areas in MBW.

7. Old Forestland Management Sites: There are no sites designated as old forestland management sites in the MBW.

8. Research Areas: There are no research areas within the MBW Block.

9. Miscellaneous: AWC still holds title to Class I lands. This includes water bodies, streams, wetlands, and also aqueducts and water-main pipelines. In compartment 1, a roughly 100 year old water main crosses through stand 1, approximately 4,650 feet in length. If it were

necessary to cross the water main, pads or bridges would be required to displace the weight of machinery. In compartment 3, there is also a short section where Means Brook was diverted using an underground aqueduct. The aqueduct is approximately 1,280 feet in length and is impassable due to steep terrain.

E. Extensive Areas of Concerns

1. Wetlands: There are approximately 315 acres of wetlands in MBW, constituting about 52% of the total forested area. Wetlands and riparian buffer areas will not be operated in to protect water quality.

2. Unauthorized or illegal activity: In many parts of the forest, illegal deer stands are present either on CWSF property or on the forest boundary line facing into state land. These deer stands have been found on areas that are currently not open to any form of hunting. While deer herd management is greatly needed in this forest, it must be conducted legally and ethically. This information was reported to DEEP Law Enforcement.

F. Wildlife Habitat

1. Investment in habitat improvement: There has been no specific wildlife habitat improvement work such as mowing or prescribed burns.
96% of the forestland is classified as small or large sawtimber size classes. There are very few stands that have desirable tree regeneration occurring in the understory and there are no stands that are classified as completely in the seedling/sapling stage. Silvicultural prescriptions for certain stands will recommend removing some of the large canopy trees to provide growing space and sunlight for younger generations of trees. This early-successional habitat is proven to be exceptionally beneficial to a large variety of wildlife.

There are several stands where areas will be managed on an even-aged basis to provide dense, young, early-successional growth to benefit wildlife, particularly shrubland and ground-nesting bird species of Greatest Conservation Need as determined within the Connecticut Comprehensive Wildlife Conservation Strategy. These areas under even-aged management will also begin to achieve a more balanced distribution of age classes throughout the forest and will be created next to ROWs, to enhance the pre-existing permanent openings for wildlife. These areas were chosen to be managed on an even-aged rotation as they currently have very little to no regeneration and the present stand is predominantly stocked with undesirable growing stock. By removing the mature overstory, and replacing it with young growth, there will be an influx of new bird and animal species that are currently not present in the older forest.
Overall, the amount of stands being treated on an even-aged basis is low compared to the total area of active forestland (approximately 26%). The majority of the active forest will be managed through uneven-aged rotations using selection harvests. In these cuts, single trees will be removed to allow more desirable trees of acceptable growing stock to continue to grow. Group selection patches of ½ to 1 acre will be used near tulip trees and shade-intolerant species to create areas of regeneration. As time progresses, these unevenly managed areas will provide a diverse forest type with different age-classes, increasing vertical stratification and structural diversity within the forest.

2. Existing diversity situation: Currently the forested acreage, 611 acres, is not diverse with Elm-Ash-Maple and Oak-Hickory forests comprising 87% of the forest cover. Approximately 4.5% of the forest is pure conifer stands, with another 5% being a mix of oak with declining eastern red cedar in the understory. While there are a few stands that have some sapling shade-tolerant species growing in the understory, there is an overall lack of sapling size trees. There are no stands classified as sapling stands, a serious dilemma for securing future generations of productive forests and maintaining a diverse forest structure for wildlife habitat. While the roughly 35 acres of ROWs serve as early-successional habitat, they are narrow corridors. They are mowed every couple of years to prevent new growth from taking over. The silvicultural prescriptions in this plan will provide greater diversity of size classes throughout the forest.

Deer populations are very dense, as in most areas of Fairfield County. Regeneration is heavily browsed, often leaving nothing but birch, red maple, and non-native plants. The browsing of native tree seedlings leaves openings for non-native, invasive plants which are becoming a major concern in the understory. The lack of understory affects ground nesting birds because there is little cover available. The DEEP Hunting Review Team opened sections of CWSF to bow-hunting as part of a deer-management program, including MBW, compartment 1. Compartment 2 has no public access and will not be opened to hunting. Compartment 3 will be evaluated to determine if it could safely be opened up to deer bow-hunting. Regenerating desirable species such as oak, hickory, and white pine will be difficult with the present numbers of deer.

G. Vegetative Condition

1. Silviculture: 83% of the forest cover in MBW falls within the Elm-Ash-Maple (42%) and Oak-Hickory (41%) cover groups as defined by the United States Forest Service (USFS) Forest cover type groups in the Northern United States. The pivot chart (Fig. 4) and table (Fig. 5) provide a breakdown of acreage by cover group and size classes in MBW.

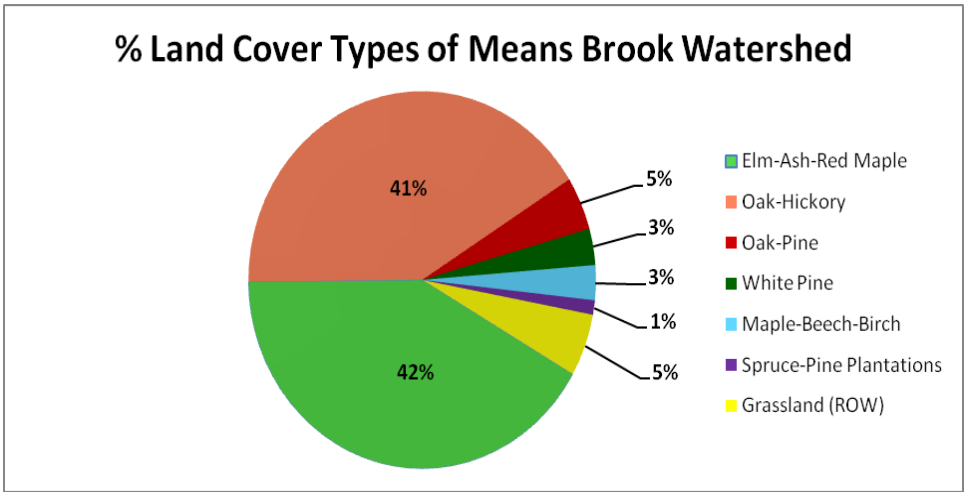


Figure 4: Percent of each land cover type within the Forest (excludes 20 acres of water bodies).

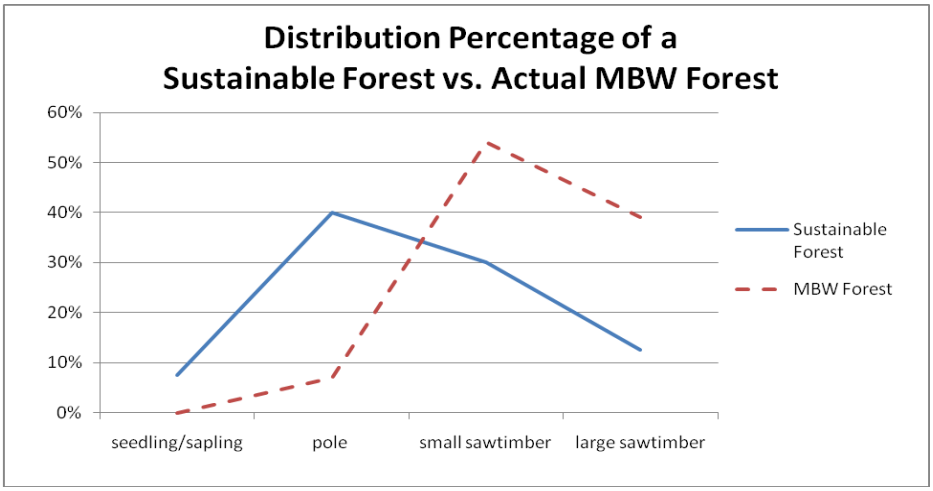
The distribution of size classes through the MBW Forest is not well-balanced (See Figure 5 below). A balanced sustainable forest will have roughly 5-10% of the area in a seedling and sapling stage that will in time become pole timber. The distribution of size classes for actively managed areas of MBW is shown in Figure 7 compared to ranges in a balanced forest ecosystem.

Size Class	Balanced Range	Actual Range	Difference
seedling/sapling	05 to 10	0%	- 5%
pole	35 to 45	7%	-28%
small sawtimber	25 to 35	54%	+19%
large sawtimber	10 to 15	39%	+24%

Figure 5 : Size class distribution percentage of a balanced forest ecosystem and the actual forest of MBW under active management.

Figure 6 on page 12 shows the distribution percentage of each size class in a well-balanced, sustainable forest as well as the unbalanced distribution of MBW Forest. Note that the majority of MBW is sawtimber size forest with no seedling/sapling areas and a handful of acres of pole-sized stands (4%). Regeneration harvests are needed to obtain, and ultimately maintain, a sustainable forest ecosystem, that will support diverse native forest cover types, providing clean water, healthy wildlife populations, and productive soils. As shown in the graph below, a sustainable forest has a much higher percentage of pole timber than is in the Forest now.

Figure 6: Distribution percentage of a balanced, sustainable forest versus MBW forest. This graph represents total age classes throughout the entire MBW Forest (Regeneration/seedling has been combined with sapling size class. Medium sawtimber has been combined with small sawtimber size class).



As discussed previously, 40% of the total acreage of MBW has been classified as active forestland. Figure 7 below shows the forest size classes associated with all active land in the forest.

Size class has been determined by data analysis generated from NED 2 forestry software. Size class has been broken out by the following diameters;

- Seedling <= 1.0”
- Sapling 1.0” <= 4.5”
- Poletimber 4.5” <= 10.5”
- Small Sawtimber 10.5” <= 13.5”
- Medium Sawtimber 13.5” <= 16.5”
- Large Sawtimber 16.5” and larger

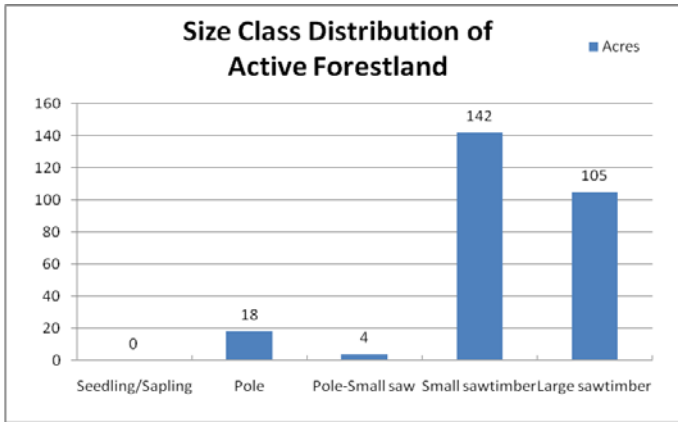


Figure 7: Number of acres in each size class for 268 acres of actively managed forest (Regeneration/seedling has been combined with sapling size class. Medium sawtimber has been combined with small sawtimber size class).

2. Forest size class and condition class on areas to be managed:

Forest size classes by forest type (total forest)

Land Cover Group	Size Class	Acres	%	Total %
Elm-Ash-Red Maple	Pole	5	<1%	
	Sawtimber	263	40%	41%
Oak-Hickory	Sawtimber	266	41%	41%
Oak-Red Cedar	Sawtimber-Pole	4	<1%	
	Sawtimber	25	4%	5%
White Pine	Sawtimber	20	3%	3%
Maple-Beech-Birch	Pole	5	<1%	
	Sawtimber	15	3%	4%
Spruce-Pine Plantations	Pole	8	1%	1%
Grassland (ROW)	Grass	35	5%	5%
Grand Total		646	100%	100%

Figure 8: Land cover group types by size class for the total acreage of MBW excluding 20 acres of water bodies.

3. Forest type size class and condition class on areas to be managed:

Forest Group and Condition Class on Areas to be Actively Managed

Figures are in acres.

Forest Cover Group	Satisfactory Growing	Timber Stand Improvement	Needs Thinning	Convert to Uneven-Aged	Regenerate Even-Aged	Total
Oak-Hickory	9			172	17	199
Elm-Ash-Red Maple		4		18		22
White Pine			20			20
Maple-Beech-Birch	7				13	19
Spruce-Pine		8				8
Total	**16**	**12**	**20**	**190**	**30**	**268**

Figure 9: Forest groups and acres of forest condition on actively managed areas (All areas where management will eventually be done, not just in the next 10 years.)

4. Forest health: Means Brook Watershed consists largely of Elm-Ash-Red Maple lowlands and Oak-Hickory forest types. Other than non-native earthworms and plant species, there are no significant outbreaks of pests or diseases that are a concern at this time. Outbreaks of Sudden Oak Death, or the presence of the Asian Long-horned Beetle or Emerald Ash Borer, would change the characteristics of the forest unlike any disturbance since the loss of the American chestnut. The forest will be continually monitored for the presence of these, and any other destructive forest pests.

a. **Understory concerns:** Most of the forest is experiencing a decline in the amount of organic soil material due to high numbers of earthworms. The *Amynthas hawayanus*, a non-native species from Asia, rapidly consume leaves and organic materials, decreasing the amount of nutrients within the top soil layer available to trees. With fewer slowly decomposing leaves and organic material in the soil, there will be higher levels of erosion and nutrient loss, ultimately reducing forest productivity. Through the processes of forest management and sustainable timber harvesting, tree tops left after a

harvest should increase the amount of organic soil material on the forest floor.

Non-native invasive plants are a significant issue that must be dealt with throughout the MBW, and are rapidly spreading. During inventory, 75% of the watershed acreage was determined to have established populations of a variety of non-native plants. Plants noted include Japanese Barberry, Multiflora Rose, Japanese Stiltgrass, Oriental Bittersweet, Autumn Olive, Garlic Mustard, Honeysuckle, and Winged Euonymus. These exotic, noxious plants threaten the health of the forest because the plants generally start blooming earlier than native plants, produce large seed crops, which stay viable in the seed bank for years, and form monocultures over time. These characteristics give invasive plants a competitive advantage over desirable native shrub and tree species. With non-native plants dominating ground cover and/or forest understory, light is unable to penetrate to the forest floor to successfully regenerate tree species to ensure the next generation of healthy forest. The majority of plant species listed above are considered controllable through various methods. Eradication efforts will occur before harvesting in areas with high levels of exotic plants. If left unmanaged, these invasive plants will spread unchecked.

DEEP policy states *"Protecting native plant species and the habitats in which they occur is an objective of the Connecticut Department of Energy and Environmental Protection (the Department). Many non-native plants have been introduced intentionally or accidentally, with most having no deleterious effects on agricultural lands, waterways, wetlands, or conservation areas. Some non-native plants, however, exhibit an aggressive growth habit and can out-compete and displace native species. These are referred to as invasive. Invasive plants, also called harmful or noxious weeds, are a serious problem in Connecticut and elsewhere, reducing agricultural production, impairing recreation, and causing the loss of biological diversity. Significant funds are invested annually in the control of invasive species, both by the citizens and municipalities in Connecticut, and by State and Federal agencies.*

Non-native invasive species that have a detrimental impact to native plants, wildlife, or their habitats will be controlled, reduced, or removed from lands and waters managed by the Department whenever practical."[1]

Nearly 500 acres representing 75% of the total property have been identified as having established populations of invasive plant species that require action to eradicate prior to implementing a forest practice. Project proposals will be used to identify areas of concern and treatment methods. Funding can be provided by the 11-192 revolving forestry account.

The predominant understory concern is the lack of seedling and sapling age classes within MBW Forest. This is a product of multiple variables; heavy browsing by dense deer populations, ground space being dominated by non-native plants, and a largely over-mature forest that has complete canopy closure, limiting the amount of light reaching the forest floor.

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[1] *DEEP Non-Native Invasive Plant Species Policy*

H. Landscape Context

1. MBW Forest provides 611 acres of protected forestland for communities around Shelton and Monroe. Private farms, such as Jones Family Farms and Beardsley Cider Mill and Orchards surround MBW property. There are protected parcels of forestland abutting MBW; the Shelton Land Trust Property and Town of Monroe open space called Webb Mountain Park. A public golf course, the Whitney Farms Golf Club abuts stand 2-6.

I. Specific Acquisition Desires

1. Any land within the watershed should be evaluated for acquisition if it becomes available. Any land that abuts CWSF and would allow access into currently inaccessible stands should be considered for purchase. Currently no parcels are for sale.

J. Public Involvement

1. A copy of this management plan was sent to the Shelton and Monroe Town Conservation Commissions on August 6, 2012. Email correspondence is included with written comments.

K. Adaptive Management

1. The CLC understands the nature of forest management as it occurs as part of a dynamic landscape. Management actions are often affected by outside variables which influence the outcome of resource decisions. The CLC reserves the right to reasonably change our management approach as environmental change and resource needs warrant. Some of these changes may be associated with biological factors such as insect and disease outbreaks. Increased unauthorized motorized recreation which erodes trails and roads may require action unforeseen during the composition of this plan. Additionally, environmental conditions such as hurricanes or record-breaking precipitation may additionally affect resource condition. The CLC will use an adaptive-management philosophy and additionally reserve the right to address unforeseen circumstances should they arise during the tenure of this forest management plan.

L. 10 Year Goals

1. The forest has been evaluated and categorized into groups affected by current physical conditions, policy, or management principles. The pivot chart below illustrates the forest as it exists today. The category labeled “Active” is forestland that is actively managed for timber resources which directly enhance the wildlife habitat in the forest. “Inoperable” land contains physical features such as steep slopes, excessively rocky terrain, or wetlands that prevent active management for resource protection or operator safety. “Inaccessible” areas are stands that cannot be accessed due to the deterioration of forest roads, no present access, or inoperable conditions (e.g. wetlands). The “Inactive” category refers to land that is not considered forest (e.g. water bodies, aqueducts, and rights of way).

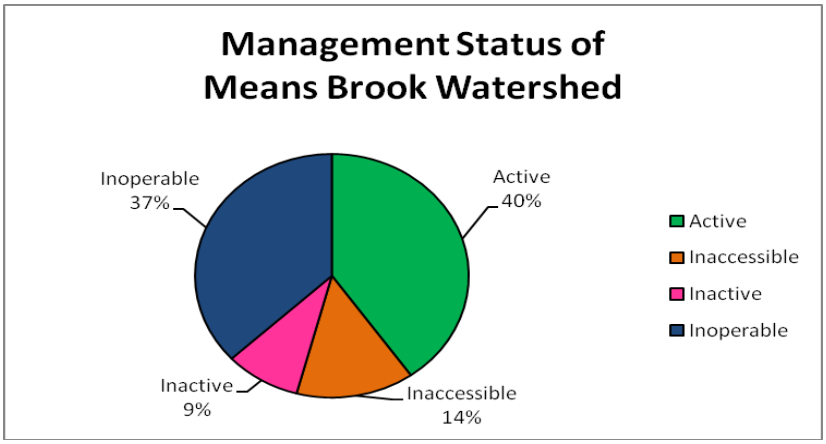

Figure 10: Management status of all 666 acres within MBW; displayed as a percent.

2. Objectives:

- Continued high-quality water protection
- Create and maintain a more uneven, resilient, and diverse forest structure (and wildlife habitats therein) by:
  - Implement a sustainable timber management program
  - Implement a homeowner cordwood cutting program on Class II and III lands
  - Create early-successional habitat for regeneration and wildlife
  - Maintain and expand conifer plantations
  - Create mix of Oak-dominated and Sugar Maple-dominated hardwood stands
  - Protect critical habitat areas designated by NDDB
- Reduce the watershed's excessive deer herd to allow forest regeneration
- Control/remove non-native invasive plants to allow forest regeneration and better protect diversity of native species
- Improve access by re-establishing old, existing forest roads that have deteriorated
- Improve access to forest stands by creating new driveway aprons and forest roads, as well as applying gravel to above-mentioned features

268 acres (44% of the total 611 acres of forested area) will eventually undergo forest management.

343 acres (56% of the total forested area) will not be actively managed because of inoperability due to wetland soils type (roughly 315 acres) or there is no present access to the stand. These areas will be left in a "natural" state.

3. Uneven-aged management:

198 acres will be managed on an uneven-aged basis (76% of the total area to be managed).

In uneven-aged management, timber harvests will use single tree and small group selection techniques, where openings in the canopy will generally be less than 1 acre in size. This should allow enough sunlight to regenerate some shade-intolerant species, such as tulip-poplar, although intermediate and shade tolerant species will eventually become most abundant (such as maple, birch, beech, and hemlock).

Roughly 33% of the basal area (and approximately 33% of the timber volume) in a given stand will be removed with each harvest, to be repeated on a 20-year cutting cycle. Roughly 20% of each area cut will be regenerated with each 20-year harvest.

198 acres/20-year cutting cycle results in about ten acres per year (100 acres over ten years on a sustainable basis). During this management plan, approximately 94 acres will be converted to uneven-aged management through selection harvests.

4. Even-aged management:
70 acres will be managed on an even-aged basis (26% of the total area to be managed).
In even-aged management, a 100-year cutting rotation will be used. This may include pre-commercial thinning, overstory thinning, seed tree, clearcut, and first and second stage shelterwood harvests. At the end of the rotation, the entire overstory is removed to provide full sunlight to the forest floor, stimulating the growth of shade intolerant species such as oak, hickory, and tulip poplar. Because the stands to be managed as even-aged are already 100 years old, some will be close to 200 years at the time of final regeneration.

70 acres/100-year rotation results in about seven-tenths of an acre per year (seven acres every ten years) being regenerated. With such a small area being managed on an even-aged basis, it is not commercially feasible to put a seven acre sale out to bid. As a compromise, roughly thirteen acres will be regenerated during this management plan, and no regeneration harvests will be conducted during the next management plan.

In even aged management, during the course of the rotation, intermediate treatments such as thinning are used to improve the composition and spacing of the trees. Thinning in overstocked stands (relative density over 80%) will provide optimum growing space for the better quality trees.

During this management plan, 18 acres will be thinned.

M. Work Plans

Silvicultural activity for the duration of this management plan:

- **Forest stand regeneration (even-aged management)**

Acres	Stand #	Type of Activity
13	3-10	Clearcut

- **Begin conversion to uneven-aged management**

Acres	Stand #	Type of Activity
60	1-6	Selection Harvest
20	3-9	Selection Harvest
6	3-3B	Selection Harvest
8	3-4B	Selection Harvest
94		

- **Improve species composition, growth rates, and timber quality in even-aged stands**

Acres	Stand #	Type of Activity
5.5	3-5	Spruce Thinning/Release (May be non-commercial)
2.5	3-7	Spruce Thinning/Release (May be non-commercial)
6	3-8	Pine Thinning
4	3-6	Sugar Maple Thinning/Release (Potential sugarbush)
18		

- Implement DEEP homeowner firewood program on Class II and III lands.
- Before any timber harvest, the sale area will be evaluated for treatment to eradicate non-native invasive plants and treated as appropriate.
- DEEP Wildlife Division will be contacted to conduct a Hunting Review on the parcels of MBW within Monroe (compartment 3).
- Boundaries will be painted and tagged in 2013 - 2014.
- Lost line issues will be investigated in 2013.
- Driveway apron construction, and the spreading of gravel, will begin on areas to be managed within this management plan period.

Road Improvements:

- Access to stand 1-6 is a gated forest road on Sawmill City Road. A tracking pad of 2" crushed stone will be needed at the entrance to the road. A landing will have to be cleared upon time of harvest.
- Access to stands 3-3B and 3-4B will be from the south side of East Village Road by an old forest access road that was used for red pine salvage in the late 1970s by BHC. There are two separate entrances to the stands and will require improvements to existing driveway apron and a tracking pad.
- Access to spruce and pine stand 3-5 will be from Webb Circle Drive. An old access road is visible from East Village Road and will be cleared of black birch poles by cordwood cutters.
- Access to the white pine plantation in stand 3-8 will require a driveway apron to allow trucks to enter the stand.

Appendix A: Forest Management Guidelines for the Centennial Watershed State Forest

This document contains management-related guidelines information applicable to all watersheds within the Centennial Watershed State Forest. For watershed-specific information (e.g. Aspetuck-Hemlock, Saugatuck, etc.), please consult that watershed's Management Plan.

A.1 Forests & Water Quality

Forests that border reservoirs, streams, and wetlands are excellent nutrient sinks. Recent studies have shown that both soil and vegetation in riparian areas function to absorb and stabilize nutrients. Plant material incorporates excess nutrients, especially nitrogen and phosphorus, into their tissues through growth. They also convert troublesome nutrients (nitrate, nitrogen) to harmless gaseous forms through denitrification processes[2].

Forest ecosystems are extremely effective at absorbing, retaining, and utilizing nutrients. They have developed complex and effective systems for reorganizing and reestablishing themselves following disturbance, including such disturbances as fire, windstorm, insect or disease outbreaks, or harvesting. Younger forests are most effective in this regard, while mature forests can reach more of a steady-state and lose the ability to retain excess nutrients.

This is important because one possible risk is having a large amount of the forest cover in older stands dominated by trees at risk of massive, simultaneous loss such as frequently occurs in the area during major hurricanes. Therefore, the forest management program recommended for the watershed aims to develop forests with multiple age-classes of trees, which can help prevent nutrients from reaching the reservoirs following major tropical storms. Therefore, the forest ecosystem can also serve as both a short and long-term nutrient filter and sink if "above ground vegetative biomass is periodically harvested to ensure a net uptake of nutrients"[3].

However, forest management can also harm water quality if it is not done properly[4]. The greatest risk is through erosion and sedimentation during road construction and use. Permanent roads contribute the most sediment, while temporary forest roads which are properly designed, constructed, utilized, and stabilized following use, have little impact. The use of best management practices (BMPs) during timber harvesting has been shown to be highly effective in minimizing potential impacts of forestry[5]. The maintenance of permanent watershed roads (used during forestry operations but constructed and used primarily for more general watershed management activities such as maintenance, water testing, and system

[2] Lowrance et al 1984; 1985.
[3] Vellidis Lowrance, Hubbard, 1995. Processing of Pesticide and Nutrient Inputs by a Restored Riparian Forest. In Versatility of Wetlands in the Agricultural Landscape. Kenneth L. Campbell, Ed. American Society of Agricultural Engineers.
[4] Chapter 5, Effects of Forest and Grassland Management on Drinking Water Quality for Public Water Supplies: A Review and Synthesis of the Scientific Literature, George E. Dissmeyer, 2000.
[5] Water, Woods and People: A Primer. Some effects of human actions on water resources of the eastern forest. 1995. James H. Patric. Artistic Printers, Greeneville, TN. 80 pages.

operation) is crucial in this regard. (See Section A.6, "Best Management Practices for Timber Harvesting").

In general, long experience and results of many experiments have shown "overwhelming evidence that neither the productivity of forest soil nor the quality of forest water are substantially lessened during or after responsibly managed harvesting of wood products"[6].

The positive effects of a managed forest far outweigh the potential negative effects. For this reason, the vast majority of drinking water watersheds in the region, including lands owned by Aquarion and within the Centennial Watershed Forest, have active forest management programs, including some nearly 100 years old. Other examples include the South Central Connecticut Regional Water Authority, the Metropolitan District Commission, the Connecticut Water Company, the Manchester Water Department, the Winsted Water Department, the Southington Water Department, the New Britain Water Department, and Groton Utilities.

A.1.1 Water Quality Management

Water draining from forests free of recent disturbances usually represents a baseline for high quality water. The forest vegetation and the associated natural forest litter layer protect watersheds against erosion and sedimentation, leaching of nutrients and excessive heating of stream water and soil by solar radiation.

Human influences and activities can alter these protective capabilities and in turn change the quality of forest streams[7]. Examples include extensive land-clearing and unsustainable agriculture, poorly conducted timber harvests, or the importation of exotic trees, vegetation, or insect and disease organisms. Forests throughout the world are subject to these "management" influences, including the forests on the Aspetuck-Hemlock Watershed. However, modern scientific forest management practices on water supply watersheds are designed to mitigate past and present human influences, work within the capabilities of natural systems and processes, and restore and maintain healthy, diverse, and productive forest ecosystems.

It is known that past forestry operations have had no measurable effect on water color or turbidity. Monitoring of water color and turbidity and how they relate to watershed activities such as forestry and agricultural practices and development is recommended.

A.1.2 Watershed Protection

The best way to protect water quality and reduce the cost of treating water is to own the land in the watershed and to maintain it as a forest. This would provide complete control over man-made impacts on water quality. Land acquisition efforts made by the Bridgeport Hydraulic Company during the 1900s and the creation of the Centennial Watershed Forest through the current partnership between Aquarion Water Company, the State of Connecticut, and the Nature Conservancy has provided long-term protection for a significant percentage of the

[6] Patric, J.H., Harvesting effects on soil and water in the eastern hardwood forest. Southern Journal of Applied Forestry.
[7] The Forestry Handbook, Second Edition. Society of American Foresters, edited by Karl F. Wenger, 1984.

watersheds for the Aspetuck and Hemlock Reservoirs. Additional potential acquisitions are listed in Section 1.9.

A.1.3 Riparian Buffers (Streamside Management Zones)

Riparian buffers (also known as Streamside Management Zones, or SMZs) are an important resource that can be used to efficiently protect riparian areas and the functions they provide. They protect water quality in several ways, the most important of which may be the removal of pollutants. "As storm water passes through a buffer, either as overland flow or as groundwater, nutrients, sediments, metals, organics, pathogens, and other pollutants are removed. In general, buffers have the potential to remove pollutants at the following rates:

- Sediment: 75 percent
- Total Nitrogen: 40 percent
- Total Phosphorous: 50 percent
- Trace Metals: 60 to 70 percent
- Hydrocarbons: 75 percent

There are several factors that contribute to actual pollutant removal for a given buffer area. The most important are "slope length and steepness, soil type, water table elevation, adjacent upland uses, management measures being used in and around the buffer, and vegetative cover."[8]

Identification of SMZs, utilizing the United States Forest Service methodology, is recommended in all stands prior to implementing any forest management activities.

A.2 Water Quantity

Properly planned and supervised logging activities can increase water yield from the watershed. The net effect of tree cutting is that groundwater and stream-flow increase temporarily by decreasing the water lost to transpiration of soil water and interception of precipitation by foliage. As long as at least a 20% reduction in the basal area is attained, increases in stream-flow may approach .2 inches per year for each percent reduction in basal area. Conversely, increases following clear-cutting have been shown to range from 6 to 16 inches, averaging about 11 inches, in the first year after treatment[9]. In all cases the actual water yield increases are a function of the hydrology of the watershed, the amount of basal area removed, and the size and species composition of the buffer areas around reservoirs, streams and wetlands. These stream-flow increases do not last very long however. Stream flow will usually return to original levels in 5 to 10 years on clearcut areas and 1 to 3 years in areas where less than 50% of the basal area was removed. The reason for this is that as growing trees occupy the site interception and transpiration return to pre-treatment levels, leaving less water in the soil to drain back to the streams. Conversely, the replacement of a hardwood forest with a conifer forest will reduce stream-flow below its original base level. For example, the conversion of a

[8] Davis, Patrick and Hitchings, Ben, March 2000.
[9] Patric, James H. 1994. Water , Woods and People: A Primer.

hardwood forest to white pine has been shown to reduce the annual yield about 3 to 8 inches of stream-flow below base level.

The reason for this is that conifers have greater winter interception and a longer season of transpiration than hardwoods do. These facts may cast some doubt as to the recommendations to encourage conifers around the reservoirs. However the area converted to conifers is likely to be small, and the increased leaf screening effect of the conifers and the associated water quality increases are far more important than small decreases in water quantity. Timber management for naturally growing hardwood tree species is not only a source of additional income, but will create the potential for modest increases in water yield. The following, taken from the Second Edition of The Forestry Handbook, provides some general guidelines for increasing water yields through various harvesting and thinning techniques.

1) For small increases (1 to 3 years duration):
    a. Thin pole-size stands by removing 20 to 30% of the basal area.
    b. Cut patches or strip openings in pole-size stands.
    c. In sawtimber stands create openings in the canopy by group selection, removing 10 to 30% of the basal area.

2) For larger increases (3 to 10 years duration):
    a. Convert uneven-aged stands to even-aged stands through clear-cutting in blocks, strips or patches.
    b. Convert conifer stands to hardwood stands.

It is recommended that watershed management include even-aged and unevenaged management techniques (items 2 a and b) so larger increases in stream-flow may occur in some areas, but water quality considerations should preclude evenaged management techniques near reservoirs or major streams entering the reservoirs.

A.3 Natural Disturbance Regimes

The major natural disturbance regimes in this area consist of wind, ice, hurricanes, insects and diseases, and to a much lesser degree, fire. Mild events can create small gaps in the canopy, while more serious events can destroy whole stands. Although mild events are much more typical, infestations of native and nonnative insects, such as the gypsy moth and hemlock woolly adelgid, have had dramatic effects on the forests of southern New England.

In general mild events that create small to moderate openings in the canopy allow the release of advanced regeneration, and, if the openings are large enough, the establishment of less shade tolerant species. Larger scale disturbances, such as the death of large areas or whole stands of hemlock trees, often lead to a dramatic change in the composition of the forest (i.e. conversion from conifer dominated stands to hardwood dominated stands).

Mild events tend to have very little impact on plant animal communities as they are adapted to and often times are dependant on small disturbances to meet their needs. Larger scale disturbances are much more troublesome though. Often times they can lead to extreme

changes in the plant and animal communities (i.e. birch often colonizes sites where hemlock has died, resulting in loss of habitat for species requiring mature conifer forests). However, not all these changes are negative. For example, major events that lead to stand replacement can be very beneficial to many species of wildlife that require early successional habitat.

In general our management involves encouraging the development of diverse, multiple aged forests with a variety of tree sizes, ages, and species over relatively small areas. This can be accomplished by using uneven-aged regeneration techniques, which most closely mimic mild disturbance events, even-aged regeneration techniques, which most closely mimic major disturbance events, and by using shelterwood methods, which mimic "top-down" stand replacement events. These methods can be applied in mixture in various spatial patterns, which are more natural than large, uniform treatments in appearance and in resulting stand structure. The forests derived from such treatments should contain a variety of species and age classes, which are generally less susceptible to insect infestation or disease epidemics, and which may be more capable of recovering (closed forest canopies) following major wind events. Active management can thus minimize the risk and impact of inevitable forest disturbances by developing spatially, structurally and temporally diverse forests.

A.4 Forest Resource Management Concepts

A.4.1 Utilize a range of scientific forest management methods to develop a healthy forest that can withstand disturbances while maintaining high-quality water.

The overall effect of this management approach, where broad areas are inventoried, mapped, and treated using a variety of techniques, will be the development of multiple-aged forests. Over time several age classes will be developed within the stands or management units. Most of the forest will consist of even-aged groups, patches, or small stands of trees, providing a diverse, ecologically resilient, productive, and attractive forest.

A.4.2 Manage the forest to produce healthy, diverse stands of trees.

Management for high quality drinking water and healthy, diverse forests complement the techniques required to grow good quality, valuable timber. All these goals are generally consistent with the protection of the soil, water, and wildlife, fisheries, and the aesthetics of the forest. In those few cases where the techniques would differ, the overriding goal of protecting water quality will be foremost in the management of the forest.

Growing good quality timber is important for several reasons. First, vigorous, healthy trees, which develop into good timber, are the same trees that absorb and retain nutrients. As long as these trees are growing rapidly they are net absorbers of nutrients. Left undisturbed, the system cannot be a net absorber of nutrients forever. When trees mature and begin to decline they release more nutrients than they absorb. At that time, provided the trees contain good quality timber, they can be sold at a profit and removed from the system. This exports a modest quantity of nutrients (studies have shown that this quantity is within the capacity of forest systems to replace nutrients) while also making space for other, younger trees to begin to grow rapidly during their peak nutrient accumulating phases. A second benefit of growing good quality timber is that the buyers of such timber are willing and financially able to meet the stringent requirements for safely harvesting trees from the watershed, including any additional

contractual requirements that may be necessary from time to time. These additional requirements might include crushing undesirable brushy vegetation, removing low value or no value trees, removing slash generated by their activities or other natural disturbances, and many other necessary forest management activities. In fact, prudent forest managers have long recognized timber harvests as the single most cost-effective and extensive method of controlling the growth and character of forests.

A.4.3 Increase the diversity of tree ages and sizes to promote resilience and maintenance of tight nutrient cycles.

The natural pattern of forest disturbances in this region includes periodic, widespread tree loss from tropical storms and hurricanes. Past management, former land uses, and natural disturbances can lead to a somewhat diverse mosaic of forest types. Having such diversity provides a forest with resilience from future unplanned disturbances, such as hurricanes or insect infestations. If a large part of the forest does die over a short period it will release a large nutrient and sediment load into the watershed. Planned timber harvests, and the development of a spatially, structurally, and temporally diverse forest will minimize the risk and the impact of the inevitable forest disturbances here.

It is recommended that forest management on the watershed should be focused on developing multiple aged forests with a variety of tree sizes, ages, and species present over relatively small areas. This can be accomplished by using even-aged and uneven-aged regeneration techniques on most upland areas, individual selection in streamside and reservoir buffers, and a variety of techniques adjacent to visually sensitive areas. In addition, young stands and smaller trees must be tended using firewood markets, pulp markets, precommercial thinning of young trees, or other tools designed to improve stands by releasing the best trees for rapid growth.

A.4.4 Utilize even-aged regeneration techniques in some upland stands away from water resources.

Even-aged methods must be utilized in many stands because of the reproduction requirements of many of the tree species that are well adapted to local conditions and contribute to forest diversity and health (oaks, ash, tulip, white pine, black birch). Even-aged regeneration involves occasional heavy cutting. This heavy cutting can be dispersed over the forest and can be staggered over time, minimizing the aesthetic impact and maximizing the watershed diversification and resilience benefits. If done gradually over time and dispersed carefully over the watershed these cuttings and the stands, which they create, will appear natural to most observers *except for the relatively short period during which the forests are being thinned and during which they respond to such thinnings.*

Large clear-cuts (over one acre) are not required to successfully reproduce the valuable trees. Smaller harvests called patch cuts will succeed provided:

- They are timed correctly.
- They are made at least as large as the trees are tall.
- Undesirable, shade tolerant species have not taken over the lower canopy levels.

The optimum patch size depends on many factors, including slope, aspect, soil moisture levels, species desired, presence of advance growth seedlings, and shrubby competition. Patches smaller than 1/4 acre are unlikely to succeed for oak, ash, or tulip. Patches at least two tree heights wide (based on the height of the surrounding vegetation) are more likely to succeed.

The patch cuts described above constitute the *regeneration phase* of a broader regime of forest treatments called the *shelterwood silvicultural system*, or shelterwood. Patch cuts are more likely to result in new trees of desirable species if the principles of shelterwood systems are incorporated throughout the entire life of the stand, including:

- Leaving some trees with large, healthy crowns to provide seed.
- Designing harvests to create seedbed and light conditions favorable to key species.
- Attempting to establish a reservoir of well-established, advance regeneration seedlings of desirable species.
- Removing undesirable trees and hindering the growth of dense, shrubby layers.
- Removing the older, overtopping trees (the "shelterwood") only after adequate numbers of desirable young trees are sufficiently well established so they are likely to ultimately out-compete the profusion of vegetation that follows heavy patch cutting.

A.4.5 Use individual tree selection to manage forests in sensitive areas.

Individual tree selection, a "light-handed" management option, can be appropriate in many sensitive areas, such as Streamside Management Zones (SMZs). These areas include strips along reservoirs, major streams, margins of suitable wetlands, and other areas where the heavier even-aged management techniques are not suited to ownership objectives or soil conditions. This involves the removal of a low percentage of trees in a given harvest. With this technique, the remaining forest retains enough trees to constitute full stocking at all times. Over time, this method favors trees that tolerate shady conditions, including red maple, sugar maple, and beech. It can also favor the development of a dense shrubby layer that could preclude the growth of young trees, a situation that should be monitored.

Areas managed using individual tree selection will not appear to change much, even during timber harvests. Over time, however, it will be difficult to grow valuable species of timber or a wide variety of species using this method, so it is recommended for use only in these locations:

- In buffer areas/SMZs around wetlands, streams, and reservoirs if soil conditions are suitable for the growth of valuable trees and their harvest.
- Along edges of public roads and other areas visible to the public
- Along the edges of open areas near reservoirs and dams.

A.4.6 Utilize group selection in a variety of locations to determine the suitability and effectiveness of this regeneration method within the watershed.

Group selection is a modification of individual tree selection, which provides many of the benefits of less noticeable harvests while providing more opportunities for growing valuable species. With this method small groups of 2 to 7 trees are harvested in scattered locations within the stand. The openings created by the removal of these groups may provide

opportunities for the regeneration of sun-loving trees including oaks, ash, and white pine. There is a greater risk that shrubs and less desirable, shade tolerant species such as beech and red maple will become established and overgrow desirable young trees with this method versus with shelterwood-based approaches.

Group selection is a technique that has not been used much in this forest type. We do know that it is more likely to work on dry, sandy soils where oak and pine grow well and which have little or no red maple or beech. We also know that it is not likely to favor valuable species on the areas with rich, moist soils where low value trees are likely to compete with the most valuable ones and where growth rates are fastest (and the economic cost of failing to grow valuable trees is highest).

Some of the smaller patches that are being created in the even-aged regeneration approach recommended for upland portions of the property are actually small enough to be described as group selection. Over time, if these smaller openings are successful in meeting the watershed's management objectives, then the entire forest management approach can shift towards group selection. This should be assessed over the next 7 to 9 years by revisiting the past harvests annually. In addition, as watershed managers gain experience with the appearance of the harvests they may wish to allow some of the heavier "group selection" type cutting in the sensitive areas where we initially recommend individual tree selection.

Group selection can thus be viewed as an experimental approach whose utility on this watershed will be determined through experience. The very conservative individual tree selection method will be applied to the sensitive areas of the forest where tree cutting is generally done for tree health and for aesthetic and water-quality reasons. Even-aged regeneration using shelterwood techniques on large groups and small patches is recommended on most of the forestland, providing conditions favorable for the germination, establishment, and growth of vigorous new age-classes of trees.

A.4.7 Thinning young stands is crucial to implementing proper silviculture.
Not all of the forest management needs can be met through sales of forest products such as timber or firewood. Some parts of the forest will require cultural work to cut down smaller trees or cut vines in order to release selected trees for maximum growth. The trees to be released will be selected to meet specific water quality and health objectives detailed elsewhere in the plan. The trees to be killed will generally be small, unhealthy, poorly formed, or growing in locations that do not match their long-term growth requirements. Some of the trees to be killed will be healthy but overcrowded. Also, forest scientists have determined that stands managed using the individual tree selection method (see #5 above) must have some trees from all size classes removed in each stand treatment in order for the system to work effectively.

Several approaches can be taken to accomplish this young stand thinning and improvement work in a cost-effective manner. In sawtimber stands that are scheduled for a commercial timber harvest the following options are available:

- Young, crowded trees and cull trees could be marked and cut down during the timber harvest by the logging subcontractor.
- The undesirable trees could be marked following the timber harvest and sold as firewood or pulpwood. At this time there is a limited market for firewood or pulpwood so it may only be an option on small areas of the watershed.
- The undesirable trees could be selected by the forester and cut down in a single operation.

In young stands that are not ready for a commercial harvest the following options are available.

- The undesirable trees could be marked and sold as firewood or pulpwood.
- Forester selects the undesirable trees and cuts them down in a single operation.

In both commercial and non-commercial stands any combination of these techniques could be combined to help achieve the goal of maintaining water quality, tree/forest health and aesthetics.

A.4.8 Employ adaptive management techniques in the management program.

Foresters, biologists, and scientists must recognize the complex, dynamic nature of the forest ecosystem. This system has been strongly influenced by past human actions and continuing human influences. Its management must be guided by the use of the best available science and techniques, acknowledging that we do not know everything about this system. Using adaptive management involves managing now using current knowledge, tracking research to take advantage of new information developed elsewhere about similar forests, and employing opportunities to conduct applied and scientific research during the management of the watershed. Ongoing operations can be structured and monitored in ways that promote obtaining more knowledge about this specific forest. This will require some effort to identify unique aspects of each treatment, document those aspects, and monitor the results of the treatments long enough to draw reasonable conclusions.

A.5 Forest Resource Management Techniques

A.4.1 Timber Management and Silviculture

We recommend that the timber resources be managed through a long-term silviculture program designed to improve water quality. The forests should continue to be thinned periodically in order to maintain rapid tree growth, promote tree vigor and thus improve the forest's ability to clean and filter water. Wood products associated with forest management are a unique resource in that they can be effectively and profitably managed while improving other resource conditions.

Continuing the long-term timber stumpage sale program is very important. These sales provide a modest financial return, while at the same time contributing to the overall health of the forest. The property contains many different forest stands capable of producing commercially valuable forest products. These stands cover over 1,800 acres and are comprised of a variety of tree species, sizes and ages. It is essential that each stand be managed according to its age,

condition and overall goal of improving water quality. Thus we have prepared an individualized silvicultural prescription for each stand.

We recommend using a combination of the shelterwood silvicultural system and selection system to accomplish the goal of protecting water quality through the scientific management of the forests on their watersheds. A diverse approach is used allowing the forester more flexibility to match specific field conditions with management goals on an acre-by-acre basis.

As management continues in a sustainable system designed to produce a continuously healthy and vigorous forest it becomes necessary to regenerate the forest. This includes a specifically designed set of deliberate treatments used to regenerate desirable species while maintaining the natural diversity of species in the natural forest. As the main canopy of 90 to 100 year and older trees mature and become overmature increases in growth rate stop, and vigor can begin to decline. These trees become susceptible to disease and can slow in growth significantly. Currently, these trees are mature and include the healthiest and best quality trees from the old stand that have been retained through past harvests. These trees are now used as a seed source to regenerate a new stand of the same quality. Waiting too long will result in these trees becoming overmature and succumbing to the aforementioned natural processes of decline.

Securing regeneration may require treatments called site preparation designed to prepare the substrate (forest floor) and to manage competing vegetation in the forest in order to secure regeneration from intolerant and mid tolerant species that require heavier disturbance than often created during the average timber harvest. Thus site preparation could include scarification or disturbance of the forest floor intentionally with logging equipment to create a substrate beneficial to the establishment of oak seedlings and removal of lower and mid canopy trees of low value to increase light levels within treatment areas.

As stands are regenerated, the forest (within stands and throughout the watershed) will contain less overall merchantable volume (sawtimber) as the new young stands are in the process of maturing. Because this has on the management schedule laid out in this plan is that entries into stands for harvest have been delayed in order to allow the forest to grow more merchantable timber. One factor that will bolster timber revenues in the next 20 to 30 years is the maturation of small sawtimber and larger poletimber stands created and released during harvests and other disturbance factors such as storms well in advance of the management regime established by Ferrucci & Walicki, LLC. Some of these stands have received TSI in the past and others have been released during sawtimber harvests.

As stands are regenerated, they go through a period when timber value is nonexistent. These “premerchantable” stands are initially comprised of seedling and sapling sized trees. As these stands reach the poletimber stage they should receive crop tree intensity TSI to release the best quality trees with the best potential for future growth. This will maintain the growth of these trees and move them more quickly to a merchantable size while creating the most effective nutrient screen for water flowing to the reservoirs.

A5.2 Silvicultural Techniques

A.5.2.1 Thinning

Thinning is a cultural treatment to reduce stand density to improve growth and health. The crowns of crop trees are released on at least two sides and preferably three or four sides. A thinning can be implemented in a poletimber stand or in a sawtimber stand typically by removing 10-20% of the stems. Per acre volume removals tend to be higher in softwood stands due to higher stand density.

A.5.2.2 Shelterwood

A Shelterwood system is a cultural treatment designed to remove selected trees over time to create a suitable microenvironment and seed source to develop a new age class of trees. Typically a three-cut Shelterwood system is recommended.

The first entry is the **Preparatory** cut to mostly improve desirable seed production. Approximately 25% of the sawtimber stems are removed.

The second entry is the **Establishment** cut. The goal is to get a new age class of seedlings established by reducing the canopy cover to desired levels of desired species, greatly reducing understory stems and shade, and possible performing soil preparation. Approximately 50% of the sawtimber stems are removed. Poletimber and "low-shade" stems are reduced. A **second** Establishment cut should be considered if the first Establishment cut did not develop the desired regeneration levels, or if understory species dominate the regeneration. (The resulting stand will somewhat resemble a seed tree system.)

The final entry of the cycle is the **overstory removal**. Seed trees are removed to fully release established regeneration. Sometimes reserve trees are left to grow – this would work well with established sugar maple poletimber and saplings.

A.5 Wildlife Resource Management

A.6.1 Overview

Many species of wildlife need various types of habitat in order to survive. Scientists studying the needs of wildlife during their life cycles call these needs *life requisites*. These life requisites are necessary for successful survival and reproduction of a species and are often the limiting factors that determine whether or not a species will survive in a given area. Life requisites include shelter from predators, shelter from weather, places where they can find food, and areas where they can breed. Areas of potential habitat with particular vegetative characteristics satisfy these requisites.

The amount of habitat in each of these areas relative to each other can affect the carrying capacity of the area for a given species. The carrying capacity is the number of individuals of a given species that can live in a given area. Carrying capacity can also be influenced by the overall size of an area, depending on the range of the species considered. For example, a given

acreage with the right types of habitat for a given species can support more individuals of a species with a small home range than a species with a large home range.

A multitude of seral stages (ages) within a forest, provide habitat for the largest variety of species. Less than 20% of 338 species in New England studied by the Forest Service[10] used only one habitat type throughout the whole year. The remaining species use two, three or four habitat combinations during the year. Open water, grassland, marsh, sapling forest, mature forest and wooded wetland are all needed to support the greatest variety of species.

A forest is composed of countless living organisms, each moving through its life cycle and eventually dying. Consequently, the forest is in a constant state of change and development. As the characteristics of the forest change, its usefulness for satisfying the life requisites of a given species changes as well. Furthermore, many species of wildlife require a mosaic of different habitat types in order to be successful. Wild turkeys for example use mature forest with downed woody debris or shrubby areas for nesting habitat or breeding habitat. After the young have hatched they use open fields where soft-bodied insects are abundant for them to feed on. As the young turkeys develop they are able to use the mature forest for feeding on hard mast from oak and beech trees.

Approximately 43% of the species surveyed required a combination of forest/non-forest cover types. Species such as the red tailed hawk, great horned owl, white-tailed deer, wild turkey, ruffed grouse, black rat snake and northern mockingbird all rely on a combination of forested and non-forested areas for breeding, feeding and nesting. The second most important habitat combination is forest/non-forest/water. The wood duck, beaver, mink, northern leopard frog, snapping turtle, great blue heron, and the hoary bat are just a few of the species that require three different habitat types throughout the year. Points where three habitat types converge, referred to as “coverts” by wildlife biologists, are generally considered to be of high habitat value. Species such as the gray squirrel, northern flying squirrel, pileated woodpecker and wood thrush require strictly forested habitat all through the year.

Use of different types of habitats can also be seasonal. For example, during the spring and summer turkeys will often feed on insects and grasses in fields and other open areas, then return to the mature forest in fall and winter to feed on hard mast[11].

Mature forests have another quality that is important to the survival of some species of wildlife. This quality is commonly called stratification. There can be many strata in a forest but generally there is the main or upper canopy, the mid canopy, and the forest floor. These strata develop because trees with different tolerances to shade grow at different rates. As the forest matures, trees that are tolerant of shade begin to fall behind the fast growing shade intolerant species, creating a mid canopy strata. These trees also have the ability to regenerate under a dense canopy creating another vegetation stratum near the ground. This lower stratum may also

[10] USDA Forest Service Northeastern Forest Experiment Station General Technical Report NE-108. New England Wildlife: Habitat, Natural History, and Distribution. 1992.
[11] DeGraff, R. M.;Yamasaki, M. 2001. *New England Wildlife Habitat, Natural History and Distribution*. Hanover, N.H.: University Press of New England. 482 pp.

contain shrubs, vines and herbs that are tolerant of shade. These strata contribute to the life requisites of different species in different ways. The wood thrush, for example, sings from the canopy, nests in the mid-story, and feeds on the ground.

For these reasons, a mosaic of different stands from open fields to mature forests generally provides the best potential habitat for many different species of wildlife.

A.6.2 Historical Impact

Before European settlement portions of southern New England were quite open due to the presence of Native American agricultural clearings, as a result of fuelwood gathering, and the occurrence of periodic hurricanes. Also, throughout the region beaver meadows and periodic fires next to very small Native American settlements provided for a shifting mosaic of open habitats within the forested landscape.[12]

Since then the New England landscape has undergone dramatic changes. Land was cleared for agriculture, slowly until the 1750s, and then at an increased pace. Between 1800 and 1860, 75 percent of the arable land in southern and central New England was in pasture and farm crops. One hundred years later, New England was again mostly forested as the result of a long period of farm abandonment that began soon after the opening of rich farmlands in Ohio and the Midwest.[13]

About 1910 the cutting of the trees that had seeded into the abandoned agricultural and pasture land constituted the last major land clearing in this region. Once cut, these sites tended to regenerate to hardwoods. Today about 65 percent of southern New England remains forested.[14]

The decline of agriculture and the resulting regrowth of the forest have essentially eliminated many species of wildlife, especially grassland birds, from most of the New England landscape. This current trend underscores both the dynamic nature of the landscape and the long-term effects of past human activities. Active forest management has the best potential for maintaining habitat for these early successional species in a forested landscape that is continuing to increase in age and extent[15], if that is a management objective.

A.6.3 Wildlife Habitat & Timber Management

In general, a variety of tree species, sizes, and ages are essential for maintaining productive habitat for a variety of native wildlife. Any habitat management program should encourage different successional stages of a forest and a wide variety of forest cover types in close proximity to each other in order to help support the largest variety of wildlife species.

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[12] IBID
[13] IBID
[14] IBID
[15] IBID

Therefore, the habitat, not the individual species, should be managed for relative diversity so as to meet the varied habitat requirements of wildlife species found in southern New England.

In general the current forest conditions on the property are accommodating for a variety of wildlife species, but are somewhat limited for species that require dense poletimber or sapling stage forests. The forest is constantly growing and changing, so early successional stages of a forest such as dense sapling stands or open areas quickly convert into timber stands. The various forest management recommendations outlined in this plan, such as shelterwood establishment harvests with reserves, group selection harvests, and overstory removal harvests will continually add sections of open, herbaceous, brushy, and then dense young forest to replace existing areas of young forest that will quickly grow into mature stands.

The current forests are predominantly composed of oak, maple, birch and white pine trees that produce large amounts of hard mast and seed that benefits numerous species of wildlife. Thus the current forest conditions are very accommodating for a large variety of wildlife species. The current forest is also constantly growing and changing. The early seral stages of a forest such as dense sapling stands or open areas quickly convert into timber stands.

Individual observations of black bears, bobcats, owls and other raptors on managed watersheds in Connecticut indicate that these species can and do live in managed forests throughout Connecticut.

A.6.4 Natural Diversity Database

The Natural Diversity Database, maintained by the Connecticut DEP, is a compilation of data collected by the Environmental and Geographic Information Center's Geological and Natural History Survey and cooperating units of the DEP, private conservation groups and the scientific community. This database includes species of flora and fauna that have limited or low populations, or have populations that are thought to be in danger of extirpation or extinction. This management plan included a review of the December, 2008 update of NDDB GIS data that yielded results in four areas, indicating that NDDB species may or may not be found on the watershed property. It is recommended that the DEP be notified when planning to operate in any of these areas.

A.6.5 Vernal Pools

Vernal pools are essential habitat for many species of amphibians and invertebrates. Some of these species breed only in these pools, and/or may be rare, threatened or endangered species, such as the wood frog. "The area in the immediate vicinity of these pools also provides these species with important nonbreeding habitat functions, such as feeding, shelter and overwintering sites. Therefore, the protection of vernal pool habitat, and the are immediately surrounding the pool is vital for the continued survival of wildlife species that are dependent upon these unique habitats."[16]

[16] The Commonwealth of Massachusetts Division of Fisheries and Wildlife, Guidelines For Certification of Vernal Pool Habitat, May 1998.

Timber harvesting near these pools must be modified to protect these pools and the species that use them. Within the pool depression there is to be no activity. It is important to maintain the physical integrity of the pool; otherwise its ability to hold water could be altered. No activity means keeping equipment and treetops and slash out of the pool. Also, sedimentation from disturbed areas nearby should be avoided as this can change the breeding habitat.

Shade around the pool is also important so that the soil surface is cool and moist. A 50-foot wide buffer zone around the pool where only light, partial cuts are done is recommended. Also, equipment use in these areas should be severely limited, especially if the ground is not dry or frozen, in order to avoid creating ruts. Winching logs out of this area at all times is recommended.

Potential vernal pool areas should be field-identified prior to any management activities.

A.6.6 Coarse Woody Debris

As a forest develops and trees become stressed by intense competition, drought, disease, or insects, or are damaged by severe weather, many begin to rot, producing live trees with cavities in them that are useful as shelter and feeding habitat for many small mammals and birds. As some of these trees die they remain standing and continue to rot or they fall down. These two types of trees are classified into standing dead woody debris and down woody debris respectively. As a whole they are known as coarse woody debris (CWD). Standing dead trees, often called snags, provide habitat and a source of insects that birds and other small mammals will eat. Down woody debris provides cavities for ground dwelling animals, cover for amphibians (salamanders) and reptiles (snakes), and good conditions for the germination of the seeds of some tree species.

CWD is considered to be any downed or suspended woody material that is 4 inches and larger in diameter. This definition for CWD would include such items as snags, fallen logs, wind blown trees and large branches. It is introduced into the management equation in numerous ways: logging debris, seedbeds, carbon pool, wildlife habitat, fuel, etc. Wildlife biologists, ecologists, mycologists, foresters, and fuels specialists are some of the people interested in CWD because it helps describe the quality and status of wildlife habitats, structural diversity within a forest, fuel loading and fire behavior, carbon sequestration, and the storage and cycling of nutrients and water[17].

Management guidelines for coarse woody debris include the following generalities: (http://www.massforesters.org/coarse.htm - *note: this website no longer in existence 11/06*)

1. A volume of at least 200 cubic feet per acre is recommended.
2. Larger pieces of CWD are more valuable than smaller pieces.
3. CWD scattered across a site is more valuable than if it is concentrated (although it is good to have some piles).
4. It is important to maintain a full range of CWD decay classes (from hard to crumbling).
5. Coniferous CWD is generally more long lasting than deciduous wood.

[17] Mount, J.R., 2002, Water, Wildlife, Recreation, Timber…Coarse Woody Debris, USDA Forest Service GTR, PSW-GTR 181, 2002

6. A long-term approach to CWD management needs to consider the distribution and quantity of future sources.

As a forest matures and the trees become overmature, large trees die and fall to the ground increasing CWD in the forest. Thus, barring human influence such as timber harvesting, CWD tends to increase over time. Periodic harvests, which remove the main stem of trees from the forest, prevent these trees from ending up as large logs on the forest floor after they die. However, since few harvests in Connecticut remove firewood or other top wood, the tops of trees are left and tend to increase CWD. While harvesting generally results in a net increase in CWD, the increase is generally concentrated in small diameter material that has less wildlife value than large diameter material. A strategy of leaving large snags and cavity trees may lessen this effect on wildlife species that prefer large CWD for habitat by replacing large down material with live vertical stems.

A.6.7 Forest Interior Birds

Forest interior birds have received considerable attention recently as evidence accumulates concerning their population declines. However, because they are so mobile, the effects of forest management on most bird species are not as great as was once commonly thought. A more significant issue involves the lack of young forest stands and the implications for the large number of bird and mammal species that are dependent on young forest and dense, brushy cover.

Forest interior birds are an ecologically distinct group of bird species that require large blocks of forestland (300+ acres) to successfully nest and breed. Several species of migratory forest interior birds (red-eyed vireo, black–throated green warbler, American redstart, ovenbird, and hooded warbler) have declined in numbers in several preserves located in Connecticut's suburban areas over the past 20-30 years. There are numerous explanations for such declines: increasing isolation of forestland blocks due to fragmentation by development and increased nest parasitism and predation by raccoons, feral cats, crows, blue jays, and brown headed cowbirds, all of which are more abundant near the forest edge. Isolation is more of a factor within larger forest preserves (larger than 180 acres), while nest parasitism and predation is more of a factor within smaller preserves.

Another factor in the decline of migratory forest interior birds that may be affecting forests of all sizes, including those within or outside suburban areas, is the destruction of forest habitat in Central and South America where many of the forest interior bird species winter. As forests in these areas are further destroyed, this factor may prove to be far more important than habitat changes in the US. A third factor is the mortality caused by Caribbean storms that intersect with the migrating flocks.

Forest thinning has been shown to have minimal negative effect on most forest interior birds, provided about 70% of the canopy is retained. Thinning usually enhances the understory and thus benefits many bird species, including most forest interior birds.

Standing dead trees benefit the hairy and pileated woodpeckers, barred owl, and prothonotary warbler. Standing dead trees also provide nesting sites for cavity nesters and act as reservoirs for insects on which many forest interior birds feed.

Patch cutting as part of forest management activities creates small temporary openings in the forest canopy. Patch cut openings will provide essential young forest habitat without significantly impacting forest interior birds. One study of patch cutting in New York showed that only one out of nine species of forest interior birds declined, while tree species increased in numbers. As patch cuts revegetate, the forest edge disappears and forest interior birds recolonize the openings, sometimes within three years. Patch cuts have the least impact on forest interior birds if they are kept small (less than 3 acres).

A.6.8 Wildlife Population Problems

A.6.8.1 White Tailed Deer

A high population of white tailed deer can cause a problem when trying to maintain a healthy, productive forest. Normal populations of about 10 deer per square mile are rare in most of Connecticut. More commonly, populations of 100 or more deer per square mile are found in areas with suitable habitat that are protected from hunting. The population of white tailed deer on the watershed is probably moderate to high, based on our observations during the inventory process. There is some hunting on adjacent land and it can be safely assumed that some limited hunting occurs on the city's lands as well. The effect of a high deer population on regenerating a forest can be devastating.

Many shade tolerant shrubs are not palatable to deer. Species such as hophornbeam, musclewood, witchhazel, mountain laurel and sweet pepperbush quickly consume the understory and prevent many tree seedlings from becoming established. Once a regeneration harvest is complete, both tree and non-tree species quickly invade the opening in the forest. As the deer feed on the tree species in these areas the undesirable shrubs can quickly reduce the land's ability to regenerate to trees without expensive site preparation work.

We recommend deer exclosures and control plots with yearly monitoring by forest managers to help understand the effects of the high deer population on the watershed. Allowing hunting on the property is an option that could also help to control deer populations while creating a positive relationship with community of hunters in the area. Allowing such limited use of the property could act as a patrol since those who use the land may also report damaging uses on the property.

A.6.8.2 Beaver

"Beaver activity can cause degradation of certain water quality parameters that are important to drinking water supplies. Their impacts also can alter critical resources, which provide habitats for a wide range of flora and fauna, take 100+ years to replicate following alterations, and are critical to the flow of pure water. "[18]

[18] Spencer, Bruce, 1993. Beaver Impacts on The Quabbin Reservoir & Ware River Watersheds.

The limited research that has been done in the northeast on the impact that beaver do have on water quality suggests that high populations of beaver can have some adverse impacts on the quality of water flowing from the watershed. "Beaver activity has been shown to result in the downstream erosion of substantial amounts of dissolved organic carbon (DOC), suspended organic carbon (SOC) and iron, all of which can cause negative changes to water chemistry. The breach of marginal dam sites by storm events can also move tons of muddy sediments downstream and increase turbidity and fecal coliform levels. Furthermore, beaver activity decreases flood buffering by increasing basin water storage and eliminating most of the vertical woody structure (tree trunks) which helps slow down and disperse floodwaters. In this context beaver act as a powerful erosion force."[19] Damming by beaver can also cause substantial private property damage through the creation of beaver 'ponds'.

During the Fall, 2008 stand investigation process some beaver activity was observed. Low population levels of beaver away from important water quality control points and private property should not necessarily be considered targets for removal. In fact, beaver ponds create new habitats and can increase diversity that is sometimes much needed in some landscapes.

A.5 Invasive Species

A.7 Japanese Barberry

Japanese barberry, introduced from Japan in the late 1800s, is found through extensive portions of the Aspetuck-Hemlock Watershed. Many stands contain heavy infestations. It was commonly planted, and sometimes still is planted, as an ornamental, for erosion control and for wildlife habitat. It has easily naturalized into the landscape mainly because birds readily eat the fruits, and then subsequently disperse the seeds. The plants also regenerate by creeping roots and drooping branches that root easily when they touch the ground.

Plants are common along roadsides and fences, and in old fields and open woods, but it can also survive under the shade of a dense oak canopy. Well-drained soils are preferred, but plants will tolerate a variety of soil conditions.

Removal of Japanese barberry has been historically challenging. Mechanical removal of the entire plant, including the root system, in winter or early spring is recommended. If the plants are cut, a stump treatment of Triclopyr has proven successful. Glyphosate has also proven effective, but it is a non-selective herbicide that will also kill native vegetation, so care in application is extremely important. Chemical controls are generally recommended only for plants that are difficult to remove mechanically. Studies by Dr. Jeffery Ward at the Connecticut Agricultural Experiment Station have found that use of propane torches to burn root collars can be extremely effective at barberry removal. The lack of chemicals required for this removal method make it recommended for consideration on watershed lands.

[19] Spencer, Bruce, 1993.

A.7 Oriental Bittersweet Vine
Oriental bittersweet was first introduced to North America in 1879. It was used as a way to control soil erosion along roadsides, and was popular within the horticulture industry. The primary means of reproduction is through fruit dispersal by birds, small mammals and sometimes humans.

Plants are commonly found along roadsides, fences and other "edges", but they are also found in thickets and open woods.

Currently mechanical and chemical control methods are the most effective. Cutting followed by an herbicide application to the new foliage or the vine stump surface has produced excellent results. There is also some research with biological controls, but none have proven to be effective.

A.7 Winged Euonymus
Winged euonymus (also known as "burning bush") was introduced to the United States from Asia around 1860. Many stands within the watershed contains varying amounts of this plant, with occurrences along roadsides most common. The bright red fall foliage made it popular as an ornamental planting in urban settings, but as it spread to woodlands and pastures it has become problematic. The main means of seed dispersal is through birds.

Plants can tolerate a wide range of soil, moisture and light requirements. They have been found in pastures, mature, upland forests, open, lowland forests and even shady hillsides and small ravines.

Control of this plant is often difficult because they are capable of producing huge amounts of seed annually. However, mechanical, chemical and even ecological controls have proven to be effective at reducing small, isolated populations of this species.

A.7 Tree of Heaven
Introduced from China, this tree is often found along roadsides in Fairfield County. The seeds are spread primarily by wind. The trees can also spread by root suckering and stump sprouts, so mechanical control is not usually successful. Recommended control is a foliar spray on young trees. On bigger trees, girdling and injection with herbicide works well.

A.7 Japanese Honeysuckle
Japanese honeysuckle was introduced to the United States in 1862 as ornamental ground cover and wildlife food. It grows mostly in areas converting to forest or at the edge of an existing forest. It grows quickly horizontally and vertically, which can lead to trees being damaged or malformed. It also hinders the ability of native vegetation to germinate because of the dense ground cover it can create.

Control of Japanese honeysuckle can be done by mechanical means or chemical. Pulling the plants out of the ground can work for small areas, and mowing and prescribed burning can control the spread, but they do not eradicate the plant. The use of a glyphosate herbicide can

be very effective because the Japanese honeysuckle retains living leaves longer than most surrounding plants.

A.7 Autumn Olive

Surprisingly little research about this species was found. It is a shrub or small tree introduced from Asia that has a spreading crown and is found on a variety of sites. In general the plant is hardy and grows moderately fast throughout its range. The primary means of reproduction is through fruit dispersal by birds, small mammals and sometimes humans.

Plants are commonly found along roadsides, old pastures and waste areas in dense thickets. They were initially recommended as desirable plantings for erosion control along roadside slopes and bridge abutments, and as screening.

Seedlings and sprouts can be hand pulled, but the entire root system must be removed. On larger plants, cutting and burning result in vigorous resprouting. Therefore, herbicides are often recommended. Foliar applications of glyphosate work well, but it is a nonselective herbicide so it kills many native plants it comes in contact with. Application of this herbicide to freshly cut stumps also works well where selectivity
is important. Roundup when used as a 10-20% solution has also proven effective when applied directly to a fresh cut stump. This treatment is also particularly effective in July through September or during the dormant season. Use of livestock, such as goats or sheep, have also proven to be effective in controlling this species as well as many others.

A.8 Best Management Practices for Timber Harvesting

A practice or set of practices determined by responsible state and federal agencies to be an effective and practicable means of controlling nonpoint source pollutants are commonly referred to as best management practices (BMPs). The most important BMPs in forestry involve roads, streams, and their interactions. The key provisions include the proper location of all roads and trails, adequate protection of streams and their banks at all crossing points and use of water diversion structures (water bars) on logging roads where necessary. BMPs are extremely effective in protecting against changes in physical water quality parameters. It is very important that BMPs be used when harvesting trees to ensure that potential impacts are minimized.

The following general guidelines for minimizing erosion and sedimentation problems during harvesting operations are from The Forestry Handbook[20]:

1. Consider the use of buffer strips along stream channels, seeps, swamps and other sensitive areas.

[20] The Forestry Handbook, Second Edition. Society of American Foresters, edited by Karl F. Wenger, 1984.

2. Carefully select logging methods and equipment in order to minimize roads and to reduce disturbance to soils and stream channels.

3. Maximum grade on truck roads and skid trails should not exceed 10%, except for short stretches. A minimum grade of 3% is desirable for adequate drainage.

4. Cross-drains or broad-based dips are necessary to channel flowing water from roads and trails. Placement interval in feet can be calculated by 1,000 divided by percent of grade.

5. During logging minimize tire ruts to minimize ponding of drainage waters.

6. Require care and flexibility in logging operations. For example skidding should be discontinued during wet periods.

7. Finish the operation as soon as possible without increasing the potential for erosion.

8. At the completion of logging operations remove all temporary stream crossings and revegetate problem areas.

BMPs designed specifically for Connecticut are detailed in "Best Management Practices for Water Quality While Harvesting Forest Products – 2007 Connecticut Field Guide" published in 2007 by the Connecticut Department of Environmental Protection Bureau of Natural Resources. These BMPs, specific to Connecticut, should be included as a requirement for all timber harvests.

A.9 Watershed Operations

A.9.1 Roads & Access

It has been estimated that 99% of all sediment in New England waterways originates from roads with inadequate drainage provisions and road maintenance. Our experience shows that most forest erosion occurs after one or two key spring storms. A regular forest road maintenance program should include regular spring and fall inspections as well as inspections following major storm occurrences (2" of rain in the winter and spring and 3" of rain in the summer). A report should be submitted and minor repair work done on any erosion problems that could lead to lower water quality through increased erosion and siltation. Also, improved access can increase revenues from timber harvests dramatically in some cases.

In general, the existing road system throughout the watershed is in good condition. Most areas can be accessed either from town roads or from woods roads that would need a small amount of maintenance to make them passable with log trucks. However, all of the roads could use annual maintenance and some need specific upgrades at the time of the harvest in that area. Evidence of ATV traffic exists, but is somewhat minimal.

As areas are harvested, upgrades to the road system should be done to provide access to these areas. This will provide periodic maintenance on a regular basis that will likely improve these roads over time requiring less future maintenance. Where access is needed for multiple sales from a certain road, upgrades in these areas should be a greater priority if resources are limited.

In some areas ATV traffic using woods roads and skid trails have consistently crossed streams and other watercourses over the years. This has caused erosion of the stream banks and widening of the crossing. Some siltation has also occurred downstream from these crossings. Aside from increasing turbidity of stream water, these areas require longer bridges and more corduroy when harvesting timber. This extra work decreases timber revenues as buyers anticipate the extra work involved here. The best solution is to keep all ATV's out of the property. However, this is very difficult since many woods roads have a history of use that goes back many years and neighbors feel entitled to the use of the roads. One recommendation is to build simple bridges on the main streams designed to allow ATV traffic to cross over the stream. These bridges can control damage to perennial watercourses by concentrating ATV use on an area protected by a bridge. For smaller watercourses and intermittent streams an open-topped culvert can be used. This type of culvert concentrates the stream flow into the area between two logs allowing the tires of all terrain vehicles and log skidders alike to cross a small intermittent stream without requiring corduroy.

A.9.2 Security

Some residents in the surrounding neighborhoods have a long history of using the property for walking, riding bikes and ATVs, camping, dumping unwanted yard waste and cutting firewood. Over the years a combination of boundary marking, posting of signage on all interior and road boundaries, and the maintenance gates has likely reduced some trespassing.

While some uses such as dumping yard waste and walking dogs are quite benign, heavy ATV traffic during the wet time of the year can do serious damage to roads and can affect water quality by increasing erosion from the roads on the watershed. Also, while no significant fires have happened in the last 10 years, fires can burn significant acreage of forestland. Fires started by camping on the watershed and on adjacent lands can be dangerous to residents of adjacent properties and can reduce the quality and quantity of harvestable timber. Regardless of the use, trespassing on the watershed property creates a security issue in that it becomes normal to see unknown people using the roads and trails. Therefore, others are less likely to report or take seriously trespassing because it is perceived as a normal occurrence. This makes it very difficult to prevent the likelihood of someone tampering with the water system or vandalizing equipment.

Some of the unauthorized users of the property enter the property from adjacent private ownerships at very remote locations on the property. These areas are both hard to patrol and hard to control through fencing and gating of access roads. Fencing and gates in these locations can easily be cut or circumvented. Implementing a schedule of patrols in these areas especially on weekends would likely reduce ATV use in these areas.

Also, a small portion of the road frontage of the water department land is currently fenced with chain link fencing. Adding new guardrails in key locations where illegal access is the worst is recommended to block easy access areas along roads. Along with and regular patrols, this sends a message that illegal access will not be tolerated. Federal funds may be available through homeland security legislation.

A.9.3 Public Awareness

Publicizing the positive accomplishments (via newspaper articles, talks and professional meetings, etc.) of the management program on the watershed may help promote a local feeling of pride and partnership in protecting public water systems. These efforts could include some discussion of the importance of careful management of privately owned lands within the watershed, the proper use and disposal of lawn care products, and other issues relating to water quality.

The management of the watershed could possibly also provide educational benefits if watershed managers provide information about the management program to outside groups through professional workshops or talks.

A.9.4 Boundaries

Most of the property boundaries have been located, blazed, painted and posted with signs. Limited sections of boundary lines have not been recently painted and/or have not been posted with Centennial Watershed Forest signs. The process of locating new boundaries and repainting previously located ones should continue in order to insure that a well-marked, well-defined boundary is maintained.

A.9.5 Public Access

There is a long history of positive connections between good forest management practices and hiking in Connecticut. Much of the 500-mile Blue Trail System is located on abandoned or active logging roads, some of which are found on other watershed lands throughout the state. The Aspetuck Valley Trail, which passes through the Aspetuck-Hemlock Watershed, is an example of part of this system.

However, these hiking trails do have some impacts on the forest management programs. While there is a long history of good compatibility of forest management and hiking in Connecticut, forest management techniques are often modified near trails as follows to lessen the overall impact of the project:

- Fewer trees are harvested in any given harvest
- Higher stocking levels are maintained
- Lopping of felled timber tree tops is increased
- More aesthetic clean up work is performed near trails.

In addition, efforts to explain the forest management program (via informational signs posted along trails during active forest management operations within view of the trail system) are often included.

A.9.6 Forest Fire Prevention & Control

While large-scale forest fires are uncommon in New England, fires can occur and do represent a risk to the forest of the watershed. An important aspect of fire prevention is reducing fire risk and fire hazard. Fire risk refers to things that cause fires to start, while fire hazard refers to the presence of materials that will burn. The foremost potential cause of fire on the property is from accidental ignition. The spring fire season (April 1 to May 15) is the most vulnerable period, depending on the weather. While reducing the number of people on the watershed during periods of high fire danger can reduce the risk of accidental fires. The best way to accomplish this is to more strictly enforce the No Trespassing policy through patrols of high risk areas and areas.

The easiest way to prevent large areas from being burned by intense fires is by detecting them before they get too large to easily extinguish. The only practical means of doing this is for employees and contractors to be on the lookout for fire risks that may start fires and any small fires that have already gotten started. This effort is most important during spring fire season or during any prolonged drought**.**

Also, detailed maps showing access points and road layouts on the watershed could be prepared and given to the Bethel, Easton, Fairfield, Newtown, and Redding police and fire departments, as well as the DEP. This would be useful for fire and other emergency response purposes. Scheduling a field meeting to tour the watershed with these groups would also be beneficial.

A.10 Forest Stewardship Council Principles

The core set of Forest Stewardship Council (FSC) principles and a brief description of each follows[21]:

Principle 1: Compliance with laws and FSC principles. Forest management shall respect all applicable laws of the country in which they occur, and international treaties and agreements to which the country is signatory, and comply with all FSC Principles and Criteria.

Principle 2: Tenure and use rights and responsibilities. Long-term tenure and use rights to the land and forest resource shall be clearly defined, documented and legally established.

[21] Excerpted from *Forest Stewardship Council Principles and Criteria for Forest Management*, Revised version: January 1999. http://www.fscus.org/standards_criteria/. Accessed December 29, 2005.

Principle 3: Indigenous Peoples' rights. The legal and customary rights of indigenous peoples to own, use and manage their lands, territories, and resources shall be recognized and respected.

Principle 4: Community relations and worker's rights. Forest management operations shall maintain or enhance the long-term social and economic well being of forest workers and local communities.

Principle 5: Benefits from the forest. Forest management operations shall encourage the efficient use of the forest's multiple products and services to ensure economic viability and a wide range of environmental and social benefits.

Principle 6: Environmental impact. Forest management shall conserve biological diversity and its associated values, water resources, soils, and unique and fragile ecosystems and landscapes, and, by so doing, maintain the ecological functions and the integrity of the forest.

Principle 7: Management plan. A management plan – appropriate to the scale and intensity of the operations – shall be written, implemented, and kept up to date. The long-term objectives of management, and the means of achieving them, shall be clearly stated.

Principle 8: Monitoring and assessment. Monitoring shall be conducted – appropriate to the scale and intensity of forest management – to assess the condition of the forest, yields of forest products, chain of custody, management activities and their social and environmental impacts.

Principle 9: Maintenance of high conservation value forests. Management activities in high conservation value forests shall maintain or enhance the attributes which define such forests. Decisions regarding high conservation value forests shall always be considered in the context of a precautionary approach.

Principle 10: Plantations. Plantations shall be planned and managed in accordance with Principles and Criteria 1 – 9, and Principle 10 and its Criteria. While plantations can provide an array of social and economic benefits, and can contribute to satisfying the world's needs for forest products, they should complement the management of, reduce pressures on, and promote the restoration and conservation of natural forests.

Appendix B: References:

References used in creating this plan are:

Ferrucci & Walicki, LLC, Feb. 2012. Forest Management Plan for the Aspetuck-Hemlock Watershed Forest.

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Twery, Mark J.; Knopp, Peter D.; Thomasma, Scott A.; Rauscher, H. Michael; Nute, Donald E.; Potter, Walter D.; Maier, Frederick; Wang, Jin; Dass, Mayukh; Uchiyama, Hajime; Glende, Astrid; Hoffmann, Robin E. 2005. NED-2: A Decision Support System for Integrated Forest Ecosystem Management. Elsevier, Computers and Electronics in Agriculture. 49:24-43

Appendix C: Glossary

This glossary contains a list of commonly used forestry terms.

Size Classes

- **Sawtimber** - hardwood trees 12-inch dbh (diameter breast height or 4.5 feet off the ground) and larger, and softwood trees 10-inch dbh and larger, that contain at least one 8-foot sawlog.
- **Poletimber**- hardwood trees between 5 and 11 inches dbh, and softwood trees 5 to 9 inches dbh. These trees are too small for sawlogs, but could be sold as pulpwood, fuelwood, or other small products where such markets exist.
- **Saplings** - trees 1 to 5 inches dbh.
- **Seedlings** - Trees less than 1 inch dbh.
- **Stand** - an area of trees of a certain species composition (cover type), age class or size class distribution and condition (quality, vigor, risk), usually growing on a fairly homogeneous site.

An **even-aged** stand contains trees in the main canopy that are within 20 years of being the same age. Even-aged stands sometimes are designated by age-class (e.g. a 40- year old stand) or broad size-class (e.g. seedling/sapling, poletimber, sawtimber).

An **uneven-aged** stand contains trees of several 15-20 year age-classes. These stands generally contain trees of many sizes (seedlings through sawtimber) due to the range in ages and the differences in growth rates among species.

Types of SilviculturalTreatments

- **Clearcut**- Used in even-aged management to regenerate a new forest using seeds already in the soil, seeds brought in from adjacent areas by wind or animals, and/or sprouts from stumps. All stems are removed to provide maximum sunlight for the new forest. Trees such as black cherry, yellow poplar, aspen, and paper birch often regenerate after clearcuts. Often used to create early successional wildlife habitat.
- **Selection harvest**- Used in uneven-aged management. Trees are removed singly or in small groups up to an acre in size, maintaining a fairly continuous canopy.
Selection harvests tend to favor trees that can grow in partial shade such as sugar and red maples, black and yellow birch, beech, and hemlock.
- **Single-tree selection** An uneven-aged silvicultural technique involving the removal of trees singly or in groups of 2 or 3, which maintains a continuous canopy and an uneven-aged or uneven-sized mixture.
- **Group selection** An uneven-aged silvicultural technique involving the removal of trees in groups usually 1/10 to 2/3 acre in size, but sometimes up to 1 to 2 acres on large properties. Group selection can be applied in combination with single-tree selection between groups.
- **Shelterwood**- Used in even-aged management. Understory and lower crown canopy trees are removed to allow the new stand to regenerate in partial sunlight. Trees to be retained are usually of the best quality to serve as a desirable source of seed. After adequate

regeneration is established, the overstory is removed in one or two cuts. Shelterwoods are often used to regenerate species such as oak and white pine that have irregular crops of seed.

- **Thinning** The removal of some trees to improve and enhance the vigor and growth of other trees. Thinning enhances forest health and allows you to recover any excess of potential mortality.

Forest Types (from the U.S. Forest Service)

- **Forest Type** is based on species composition of the overstory, with the overstory defined as all trees in the 1" dbh class and larger. Species composition is based on the proportion of total stand basal area represented by each species or species group. Forest type designations are not assigned to stands until they grow out of the seedling stage into the sapling class.

Forest Types mentioned in this plan are:

- **Conifer plantation:** Can be made up of one or more of the following species- Norway spruce, Eastern white pine, Scotch pine, Douglas fir, and White spruce.
- **Mixed upland hardwoods**: Associates – Any mixture of hardwood species typical of the upland central hardwood region, should include some oak. Sites--wide variety of upland sites.
- **Northern red oak**: Associates – black oak, scarlet oak, chestnut oak, and yellow-poplar. Sites--spotty distribution on ridge crests and north slopes in mountains but also found on rolling land, slopes, and benches on loamy soil.
- **Yellow-poplar/white oak/northern red oak**: Associates – black oak, hemlock, and hickory. Sites--northern slopes, coves, and moist flats.
- **Eastern White Pine:** Associates – pitch pine, gray birch, aspen, red maple, pin cherry, white oak, paper birch, sweet birch, yellow birch, black cherry, white ash, northern red oak, white oak, sugar maple, basswood, hemlock, northern white-cedar, yellow-poplar, chestnut oak, and scarlet oak. Sites—wide variety, but best development on well drained sands and sandy loams.
- **Spruce-pine:** Spruce pine comprise majority of the stocking. Associates – any of the moist site softwood or hardwood species. Sites—moist or poorly drained areas.
- **Eastern red cedar/hardwood:** Associates – oak, hickory, walnut, ash, locust, dogwood, blackgum, and hackberry. Sites—usually dry uplands and abandoned fields.
- **White oak/red oak/hickory:** Associates – scarlet oak, bur oak, pin oak, white ash, sugar maple, red maple, walnut, basswood, locust, beech, sweetgum, blackgum, yellow-poplar, and dogwood. Sites—wide variety of well drained upland soils.
- **Red maple/oak:** Associates – Any mixture of hardwoods of species typical of the upland central hardwood region, should include at least some oak. Sites—wide variety of upland sites.
- **Sugar maple/beech/yellow birch:** Associates – basswood, red maple, hemlock, northern red oak, white ash, white pine, black cherry, sweet birch, American elm, and eastern hophornbeam. Sites—fertile, moist, well-drained sites.
- **Red maple/lowland:** Generally a wetland. Associates – American elm, white ash, spicebush.
- **Red maple/upland:** The type is dominated by red maple and some of the wide variety of northern hardwoods associates include sugar maple, beech, birch, aspen, as well as some

northern softwoods like white pine, red pine, and hemlock; this type is often man-made and may be the result of repeated cuttings. Sites—uplands. Similar to red maple/oak group.

Definitions:

- **age class** The trees in a stand that became established at, or about, the same time. The range of tree ages in a single age class is usually less than 20 percent of the expected age of that class.
- **basal area** The area of the cross section of a tree's stem at 4 1/2 feet above ground, or breast height, in square feet. Basal area of a forest stand is the sum of the basal area's of the individual trees in the stand. It is usually reported in square feet of BA per acre and is used as a measure of stand stocking, stand density, and stand volume.
- **Best Management Practices** Procedures and treatments that lessen soil erosion, sedimentation, stream warming, movement of nutrients, and visual quality during or following activities that alter the land.
- **biological diversity** The variety and abundance of species, their genetic composition, and the communities, ecosystems, and landscapes in which they occur. Also, the variety of ecological structures and functions at any one of these levels.
- **board-foot volume** The amount of wood products expressed as the number of boards 1 foot wide by 1 foot long and 1 inch thick that are sawn from logs.
- **mature tree** A tree that has reached the age where its growth declines or decay begins to increase. Also, a tree is mature when the benefits begin to decline, as in its ability to produce mast or the value of its wood.
- **native plant** A species that naturally occurs in a given location where its requirement for light, warmth, moisture, shelter, and nutrients are met.
- **NED** A computerized decision support model developed by the US Forest Service for forest managers to provide assistance on integrated resource management. NED is a tool to incorporate wildlife habitats, visual and scenic qualities, wood production, water quality and quantity, and ecological aspects in forest planning and development of silvicultural treatments. In early versions of the software, including NED/SIPS and NED-1, the NED acronym was rooted in the concept of a "Northeastern Decision Model". As the geographic scope as well as our set of collaborators expanded, the name has remained but with expanded applicability that includes the temperate forest zone of the eastern United States.
- **non-commercial treatment** Any activity that does not produce at least enough value to cover the direct costs of that treatments.
- **nutrient** Elements, and other chemical substances, that enhance biological activity. Nitrogen, phosphorus, potassium, and sulfur are some of the nutrients necessary for plants to grow.
- **old growth** A forest community that is very old, generally with several age classes older than 80 years.
- **overland flow** The portion of rain or snowmelt that flows over the surface until it reaches a stream channel. It is not absorbed by the soil. Overland flow in forests is rare unless leaf litter and organic horizons of the soil have been severely disturbed or mineral soils have been compacted.
- **overmature** A stage in a tree's life when it has declined in vigor and is no longer

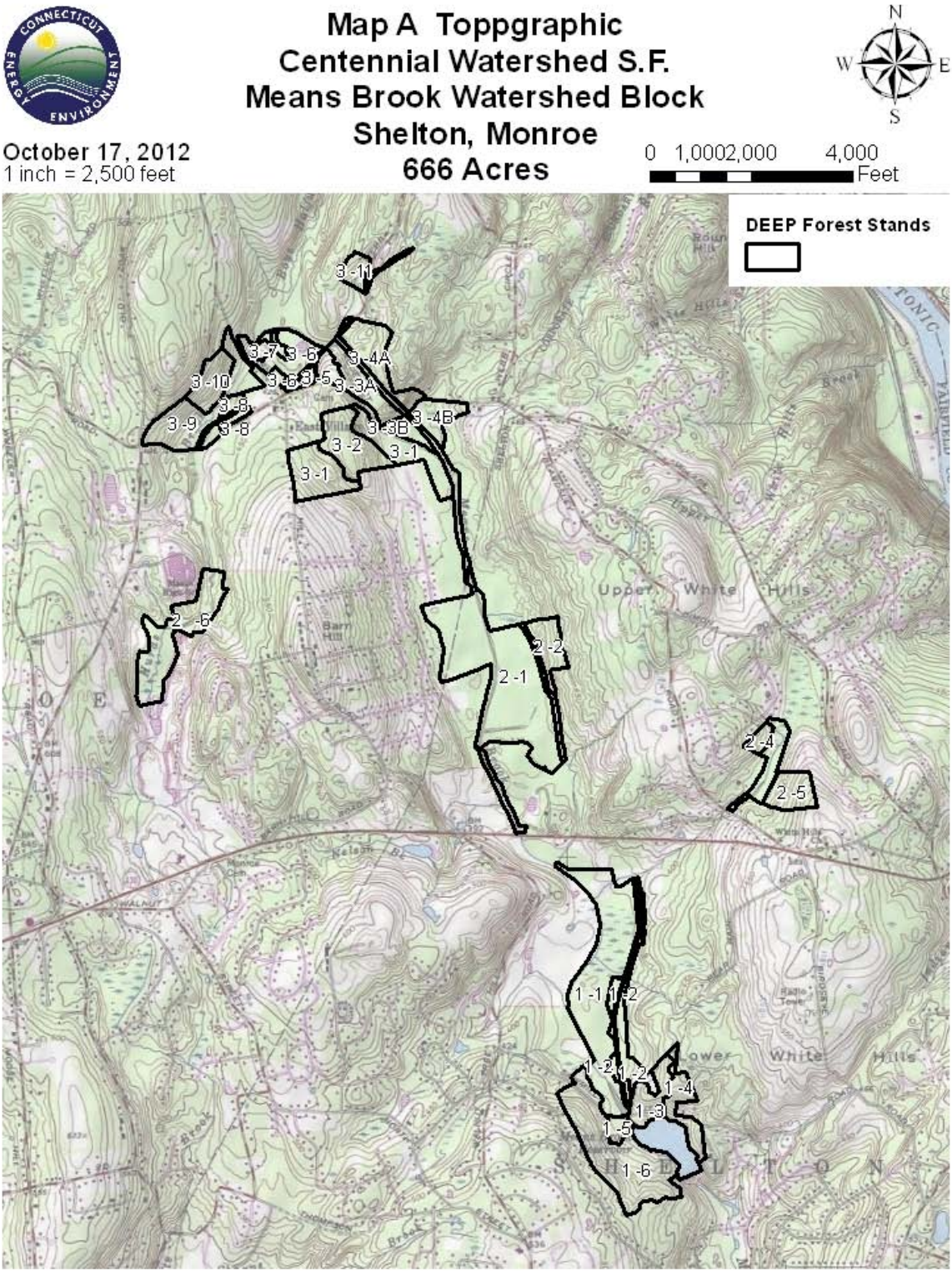
growing due to old age.

- **patch** A patch is a relatively homogeneous area that differs in some way from its surroundings (e.g., woodlot in a corn field, conifer plantation in a mixed-deciduous forest).
- **peak water flow** The instantaneous maximum flow of water, often occurring as the result of an intense storm, snowmelt, or a combination of both.
- **plantation** A forest stand in which most trees are planted or established from seed sown by people. Typically, planted trees are in rows, with equal spacing between each tree in a row and between rows.
- **regeneration cuttings** Silvicultural cuttings designed to naturally regenerate the stand by providing for seedling (or vegetative stems) establishment or development, or both. Two even-aged techniques; clearcutting and shelterwood, and two unevenaged techniques; single-tree selection and group selection.
- **relative density** An index of crowding for forest stands, also called the tree-area ratio; a measure of the absolute stand density expressed as a ratio to the density of some reference level. The reference level is usually the stand density of a fully stocked stand for a particular species composition, site, and method of treatment.
- **sedimentation** The accumulation of organic and mineral soil particles and rocks in streams and water bodies due to erosion. Sedimentation often accompanies flooding. The application of Best Management Practices will usually protect against sedimentation during and after treatments.
- **seed tree** A tree that produces seed. Seed trees are usually mature and high in Quality
- **shade intolerance** The relative inability of a plant to become established and grow in the shade.
- **shade tolerance** The relative capacity of a plant to become established and grow in the shade
- **silviculture** The art, science, and practice of establishing, tending, and reproducing forest stands with desired characteristics.
- **species diversity** The number of different plants and animals, and other life forms, coexisting in a community.
- **stand condition** The number, size, species, quality, and vigor of trees in a forest stand.
- **stand density** A quantitative measure of the proportion of area in a stand actually occupied by trees. This is an absolute measure rather than a relative measure, or percentage.
- **stocking** A subjective indication of the number of trees present on a stand compared to the optimum number for your desired outcomes expressed as a percentage.
- **sustainable** The indefinite and steady supply of something.
- **understory** The small trees, shrubs, and other vegetation growing beneath the canopy of forest trees and above the herbaceous plants on the forest floor.
- **vertical diversity** The extent to which plants are layered within an area. The degree of layering is determined by three factors: 1. the arrangement of different growth forms (trees, shrubs, vines, herbs, mosses and lichens); 2. the distribution of different tree and shrub species having different heights and crown characteristics; and 3. the

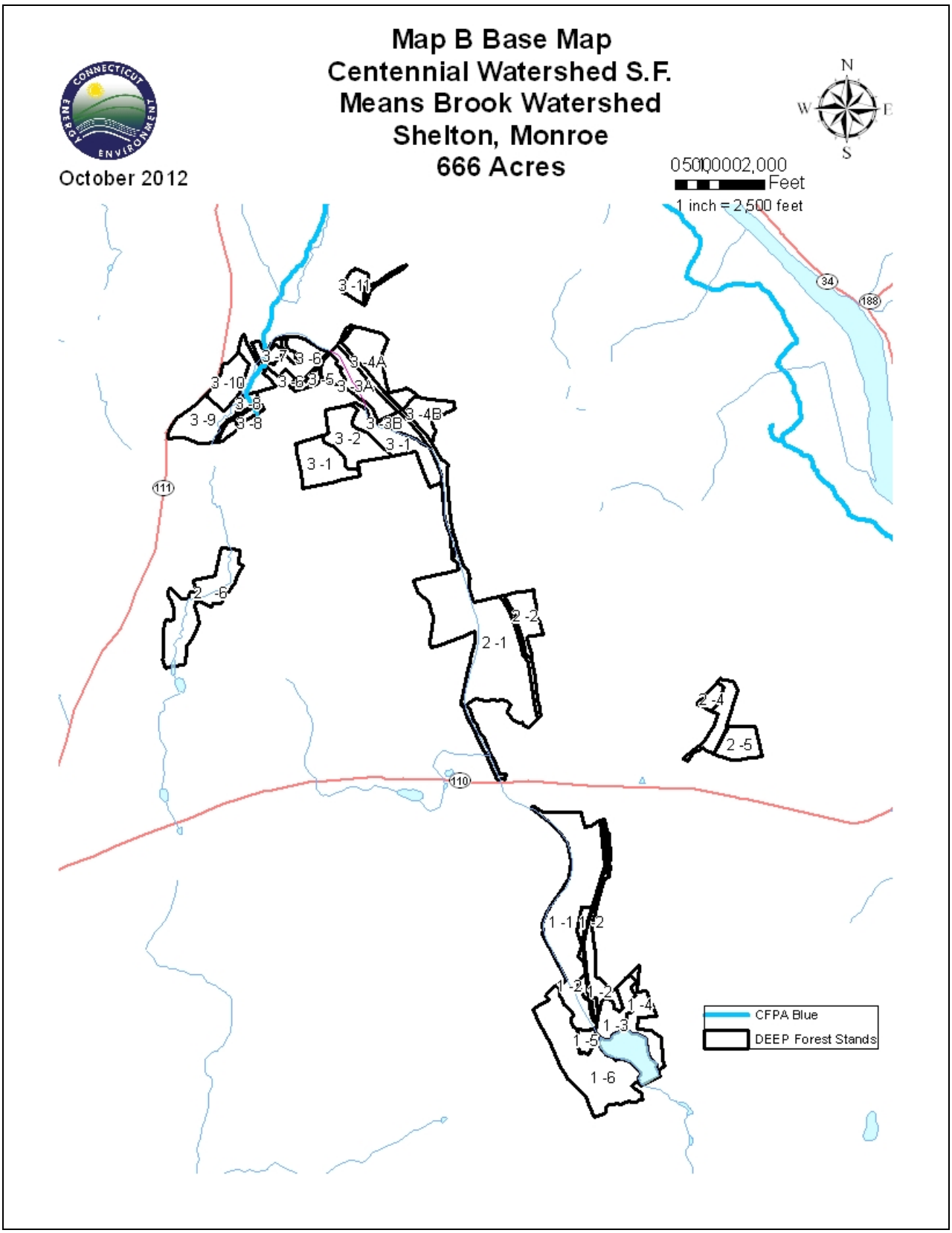
number of trees of different ages.

- **water quality and quantity** A category of factors associated with forests thatincludes intensive protection of water quality, riparian areas, wetlands, and fisheries;and the amount of water that flows from the forest.
- **water yield** The distribution and total quantity of runoff, usually considered over some specified period of time. Water yield may be characterized by total volume ofrunoff and flow duration curves.
- **watershed** An area of land through which precipitation is redistributed into components of the hydrologic cycle, including evaporation, groundwater, and streamflow. A watershed is all the land giving rise to streamflow at a selected point in a stream channel; the area drained by a river or stream and its tributaries.
- **wetland** In the absence of a single, universally recognized definition, a wetland is a land/water ecosystem characterized by periodic inundation. The soils developed under the influence of saturation. It supports plants and animals adapted to these conditions.

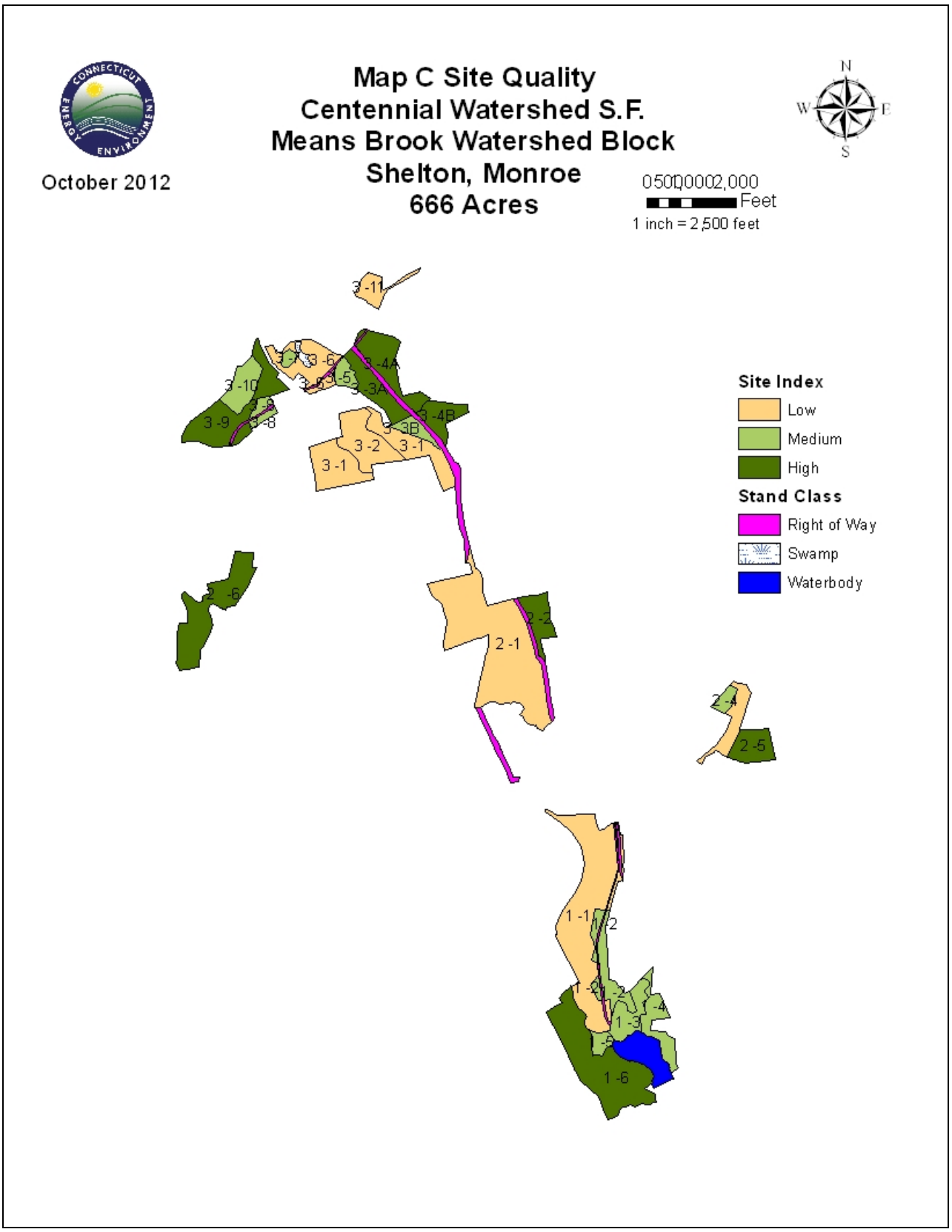
Map A: Topographic



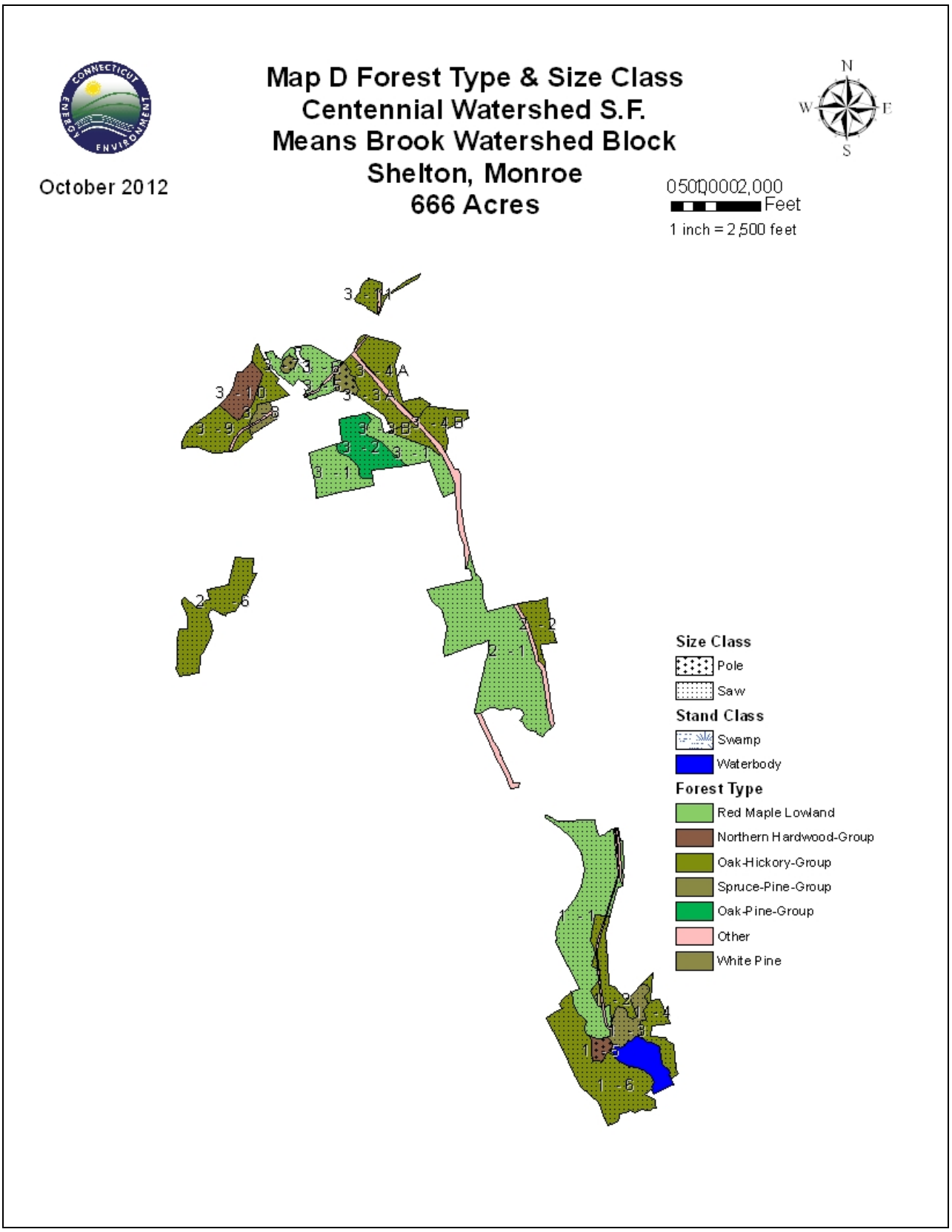
Map B: Base


Map B Base Map
Centennial Watershed S.F.
Means Brook Watershed
Shelton, Monroe
666 Acres
October 2012
N
W
E
S
0 500 1,000 2,000
Feet
1 inch = 2,500 feet
3 -11
3 -7
3 -6
3 -4A
3 -10
3 -5
3 -3A
3 -8
3 -9
3 -8
3 -4B
3 -3B
3 -2
3 -1
3 -1
2 -6
2 -2
2 -1
2 -4
2 -5
1 -1
1 -2
1 -2
1 -4
1 -3
1 -5
1 -6
34
188
111
110
CFPA Blue
DEEP Forest Stands

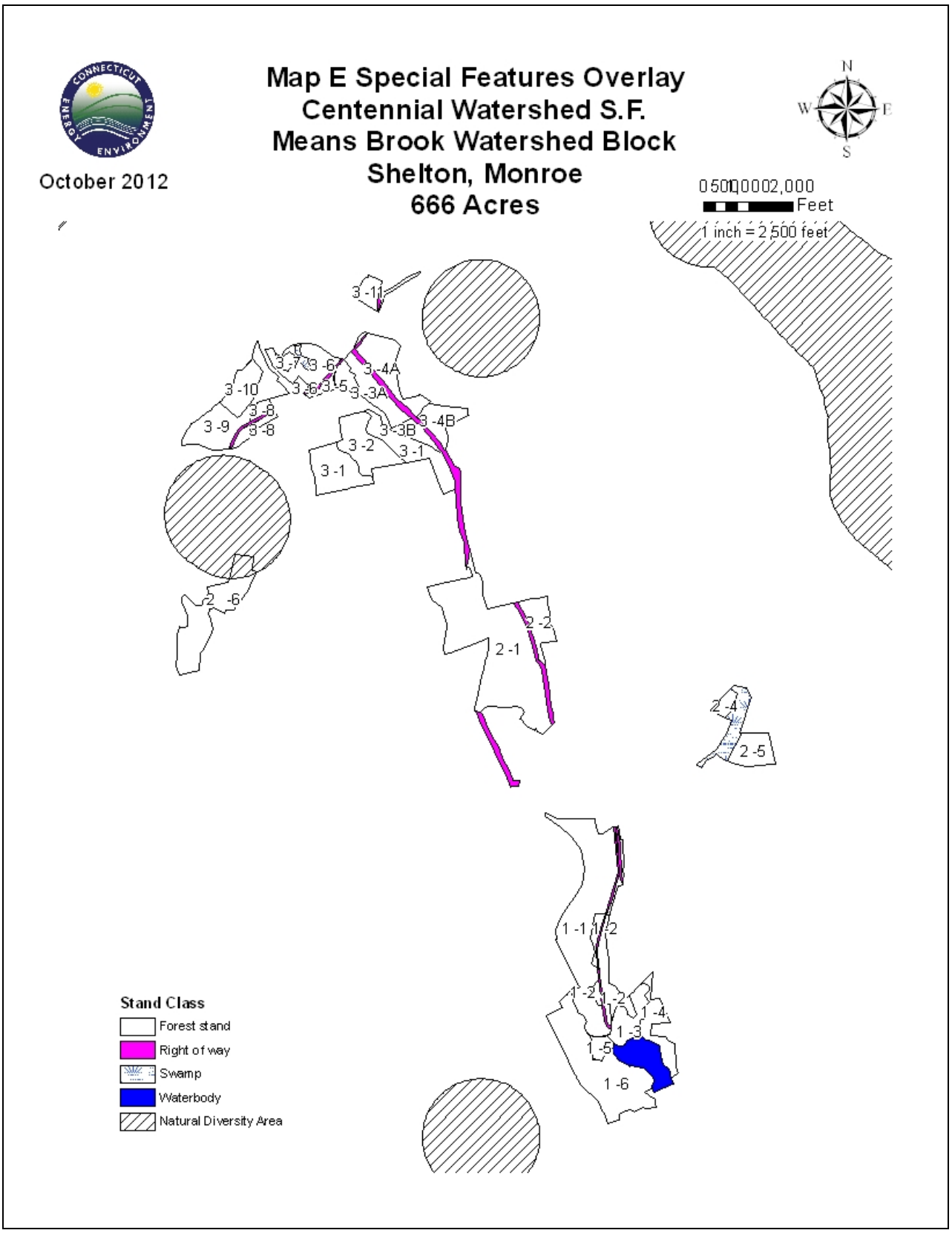
Map C: Site Quality



Map D: Forest Type & Size Class



Map E: Special Feature Overlay



Map F: Work Plan