

**FOREST STEWARDSHIP-GREEN CERTIFICATION MANAGEMENT PLAN FOR THE
PROPERTY OF CITY OF HOLYOKE WATER WORKS
THE MACLEAN RESERVOIR LANDS
Located on Westfield Road, Holyoke, Massachusetts
TOTAL FORESTED AREA 336.1 ACRES**



**Presented by Holyoke Water Works: Our Mission: "Providing High Quality Water
to our Customers at Competitive Rates"
Manager David Conti, 20 Commercial Street, Holyoke, Massachusetts**

**Prepared By: Wigmore Forest Resource Management, Mary K. Wigmore (MLF 250), John W.
LeBlanc (CA RPF 2324), Richard Valcourt (MLF 277) and Technicians: Kurt P. Wigmore and Jackie
Kulig**

**1637 West Road
Williamsburg, MA 010196
January 2016**



FOREST MANAGEMENT PLAN

Submitted to: Massachusetts Department of Conservation and Recreation
For enrollment in CH61/61A/61B and/or Forest Stewardship Program



CHECK-OFFS					Administrative Box			
CH61	CH61A	CH61B	STWSHP	C-S	Case No.	Orig. Case No.		
cert. <input type="checkbox"/>	cert. <input type="checkbox"/>	cert. <input type="checkbox"/>	new <input checked="" type="checkbox"/>	EEA <input checked="" type="checkbox"/>	Owner ID	Add. Case No.		
recert. <input type="checkbox"/>	recert. <input type="checkbox"/>	recert. <input type="checkbox"/>	renew <input type="checkbox"/>	Other <input type="checkbox"/>	Date Rec'd	Ecoregion		
amend <input type="checkbox"/>	amend <input type="checkbox"/>	amend <input type="checkbox"/>	Green Cert <input checked="" type="checkbox"/>	Conservation Rest. <input type="checkbox"/>	Plan Period	Topo Name		
Plan Change: _____ to _____			CR Holder		Rare Sp. Hab.	River Basin		

OWNER, PROPERTY, and PREPARER INFORMATION

Property Owner(s): City of Holyoke – Holyoke Water Works
 Mailing Address: 20 Commercial Street, Holyoke, MA 01040 Phone: 413.536.0442
 Email Address: _____

Property Location: Town(s): Holyoke Road(s) Highway #202-Westfield Road

Plan Preparer: Mary K. Wigmore Mass. Forester License #: 250
 Mailing Address: 1637 West Road – Williamsburg, MA 01096 Phone: 413.628.4594

RECORDS

Assessor's Map No.	Lot/Parcel No.	Deed Book	Deed Page	Total Acres	Ch61/61A 61B Excluded Acres	Ch61/61A 61B Certified Acres	Stewshp Excluded Acres	Stewshp Acres
<u>183</u>	<u>014</u>	<u>27.1</u>	<u>xx</u>	<u>27.1</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>27.1</u>
<u>180</u>	<u>001</u>	<u>903.8</u>	<u>xx</u>	<u>903.8</u>	<u>0</u>	<u>0</u>	<u>594.80</u>	<u>309</u>
TOTALS				<u>930.9</u>	<u>0</u>	<u>0</u>	<u>594.80</u>	<u>336.1</u>

Excluded Area Description(s) (if additional space needed, continue on separate paper)
 Please see Page 1-a for the excluded area description.

HISTORY Year acquired 1800's Year management began 1970

Are boundaries marked: Yes blazed/painted/flagged/signs posted (circle all that apply)? No Partially

What treatments have been prescribed, but not carried out (last 10 years if plan is a recert.)?
 stand no. _____ treatment _____ reason _____
 (if additional space needed, continue on separate page)

Previous Management Practices (last 10 years)

Stand #	Cutting Plan #	Treatment	Yield	Acres	Date
_____	_____	_____	_____	_____	_____

Remarks: (if additional space needed, continue on separate page)
 Archive at City Hall missing.

Front Page Overflow Form: EXCLUDED AREA DESCRIPTION

The Holyoke Assessors maps site Lot **Map #183 Parcel #014 as 538.5 acres**. This is an obvious mistake, and this report does not comply with DCR regulations about the congruency of Assessor Acres and Map Acres. The management plan uses the GIS determined area of **27.1 acres** for all computations. Several calls to the Holyoke Assessors' office have not resolved this matter. Total exclusion from Assessors' **Map #180-Lot #001 equals 594.80 acres**.

Excluded Area A from Map 180-Lot 001: Begin at a point on Highway #202 at the main gate to the McLean Reservoir thence along the main access road on the following courses: S for 561 feet; S17E for 462 feet; S55W for 297 feet; S88W for 135 feet to a point on McLean Reservoir; thence along the banks of the reservoir for 2,178 feet; thence S89E for 130 feet; thence N 37E for 429 feet; thence N82E for 198 feet; thence N36E for 231 feet; thence S53E for 167 feet; thence N2E for 128 feet; thence S87E for 130 feet; thence N6E for 465 feet; thence N26E for 330 feet; thence S88E for 120 feet; thence N70E for 310 feet; thence N24E for 200 feet; thence N65E for 325 feet; thence N for 200 feet along the access road between McLean and Ashley Ponds sub-watersheds; thence N27W for 178 feet; thence S61W for 200 feet; thence S66W for 264 feet; thence W for 150 feet; thence N22W for 175 feet to a point on the main access road from Highway #202, and following this road north to the point of beginning at the main gate. This area contains **13 acres** and surrounds the McLean Reservoir dam and spillway, the treatment and pumping facilities, and the mowing. The excluded area is defined on the Forest Stewardship and Boundary map in black slash marks.

Excluded Area B from Map: #180 – Lot: 001: 57.8 acres: The McLean Reservoir.

Excluded Area C from Map: #180 – Lot #001: -Assessors' parcel Map-#180- Lot-#001 contains **903.80 acres**. In addition to the two above exclusions from this total, the entire southern portion of the Ashley Ponds sub-watershed is excluded, which includes all lands east of the access road that divides the two sub-watersheds. This area equals **524 acres**.

Deed References: The Holyoke Water Works archives were destroyed years ago by fire. The Assessor and the Holyoke Water Works engineers have been working on deed reconstruction process for almost one year. Data will be provided when available. The Tighe Carmody Watershed documents were completed in the fall of 2015.

Landowner Goals

Please **check** the column that best reflects the importance of the following goals:

Goal	Importance to Me			
	High	Medium	Low	Don't Know
Enhance the Quality/Quantity of Timber Products*	X			
Generate Immediate Income		X		
Generate Long Term Income	X			
Produce Firewood			X	
Defer or Defray Taxes				
Promote Biological Diversity	X			
Enhance Habitat for Birds	X			
Enhance Habitat for Small Animals	X			
Enhance Habitat for Large Animals	X			
Improve Access for Walking/Skiing/Recreation			X	
Maintain or Enhance Privacy	X			
Improve Hunting or Fishing			X	
Preserve or Improve Scenic Beauty	X			
Protect Water Quality	X			
Protect Unique/Special/ Cultural Areas	X			
Attain Green Certification	X			
Other:				

*This goal must be checked "HIGH" if you are interested in classifying your land under Chapter 61/61A.

In your own words, describe your goals for the property:

Stewardship Purpose

By enrolling in the Forest Stewardship Program and following a Stewardship Plan, I understand that I will be joining with many other landowners across the state in a program that promotes ecologically responsible resource management through the following actions and values:

1. Managing sustainably for long-term forest health, productivity, diversity, and quality.
2. Conserving or enhancing water quality, wetlands, soil productivity, carbon sequestration, biodiversity, cultural, historical and aesthetic resources.
3. Following a strategy guided by well-founded silvicultural principles to improve timber quality and quantity when wood products are a goal.
4. Setting high standards for foresters, loggers and other operators as practices are implemented; and minimizing negative impacts.
5. Learning how woodlands benefit and affect surrounding communities, and cooperation with neighboring owners to accomplish mutual goals when practical.

Signature(s): _____ **Date:** _____

Stewardship Issues

Massachusetts is a small state, but it contains a tremendous variety of ecosystems, plant and animal species, management challenges, and opportunities. This section of your plan will provide background information about the Massachusetts forest landscape as well as issues that might affect your land. **The Stand Descriptions and Management Practices sections of your plan will give more detailed property specific information** on these subjects tailored to your management goals.



Biodiversity: Biological diversity is, in part, a measure of the variety of plants and animals, the communities they form, and the ecological processes (such as water and nutrient cycling) that sustain them. With the recognition that each species has value, individually and as part of its natural community, maintaining biodiversity has become an important resource management goal.

While the biggest threat to biodiversity in Massachusetts is the loss of habitat to development, another threat is the introduction and spread of invasive non-native plants. Non-native invasives like European Buckthorn, Asiatic Bittersweet, and Japanese Honeysuckle spread quickly, crowding out or smothering native species and upsetting and dramatically altering ecosystem structure and function. Once established, invasives are difficult to control and even harder to eradicate. Therefore, vigilance and early intervention are paramount.

Another factor influencing biodiversity in Massachusetts concerns the amount and distribution of forest growth stages. Wildlife biologists have recommended that, for optimal wildlife habitat on a landscape scale, 5-15% of the forest should be in the seedling stage (less than 1" in diameter). Yet we currently have no more than 2-3% early successional stage seedling forest across the state. There is also a shortage of forest with large diameter trees (greater than 20"). See more about how you can manage your land with biodiversity in mind in the "Wildlife" section below. (Also refer to *Managing Forests to Enhance Wildlife Diversity in Massachusetts* and *A Guide to Invasive Plants in Massachusetts* in the binder pockets.)

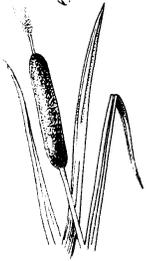


Rare Species: Rare species include those that are **threatened** (abundant in parts of its range but declining in total numbers, those of **special concern** (any species that has suffered a decline that could threaten the species if left unchecked), and **endangered** (at immediate risk of extinction and probably cannot survive without direct human intervention). Some species are threatened or endangered globally, while others are common globally but rare in Massachusetts.

Of the 2,040 plant and animal species (not including insects) in Massachusetts, 424 are considered rare. About 100 of these rare species are known to occur in woodlands. Most of these are found in wooded wetlands, especially vernal pools. These temporary shallow pools dry up by late summer, but provide crucial breeding habitat for rare salamanders and a host of other unusual forest dwelling invertebrates. Although many species in Massachusetts are adapted to and thrive in recently disturbed forests, rare species are often very sensitive to any changes in their habitat

Indispensable to rare species protection is a set of maps maintained by the Division of Fisheries and Wildlife's Natural Heritage & Endangered Species Program (NHESP) that show current and

historic locations of rare species and their habitats. The maps of your property will be compared to these rare species maps and the result indicated on the upper right corner of the front page of the plan. Prior to any regulated timber harvest, if an occurrence does show on the map, the NHESP will recommend protective measures. Possible measures include restricting logging operations to frozen periods of the year, or keeping logging equipment out of sensitive areas. You might also use information from NHESP to consider implementing management activities to improve the habitat for these special species.



Riparian and Wetlands Areas: Riparian and wetland areas are transition areas between open water features (lakes, ponds, streams, and rivers) and the drier terrestrial ecosystems. More specifically, a **wetland** is an area that has hydric (wet) soils and a unique community of plants that are adapted to live in these wet soils. Wetlands may be adjacent to streams or ponds, or a wetland may be found isolated in an otherwise drier landscape. A **riparian area** is the transition zone between an open water feature and the uplands (see Figure 1). A riparian zone may contain wetlands, but also includes areas

with somewhat better drained soils. It is easiest to think of riparian areas as the places where land and water meet.

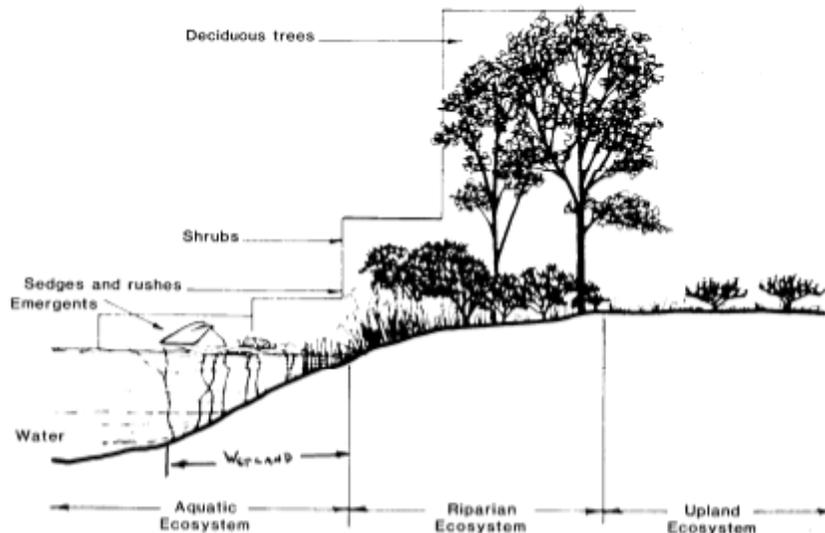


Figure 1: Example of a riparian zone.

The presence of water in riparian and wetland areas make these special places very important. Some of the functions and values that these areas provide are described below:

Filtration: Riparian zones capture and filter out sediment, chemicals and debris before they reach streams, rivers, lakes and drinking water supplies. This helps to keep our drinking water cleaner, and saves communities money by making the need for costly filtration much less likely.

Flood control: By storing water after rainstorms, these areas reduce downstream flooding. Like a sponge, wetland and riparian areas absorb stormwater, then release it slowly over time instead of in one flush.

Critical wildlife habitat: Many birds and mammals need riparian and wetland areas for all or part of their life cycles. These areas provide food and water, cover, and travel corridors. They are often the most important habitat feature in Massachusetts' forests.

Recreational opportunities: Our lakes, rivers, streams, and ponds are often focal points for recreation. We enjoy them when we boat, fish, swim, or just sit and enjoy the view.

In order to protect wetlands and riparian areas and to prevent soil erosion during timber harvesting activities, Massachusetts promotes the use of "Best Management Practices" or BMPs. Maintaining or reestablishing the protective vegetative layer and protecting critical areas are the two rules that underlie these common sense measures. DCR's Massachusetts Forestry Best Practices Manual (included with this plan) details both the legally required and voluntary specifications for log landings, skid trails, water bars, buffer strips, filter strips, harvest timing, and much more.

The two Massachusetts laws that regulate timber harvesting in and around wetlands and riparian areas are the Massachusetts Wetlands Protection Act (CH 131), and the Forest Cutting Practices Act (CH132). Among other things, CH132 requires the filing of a cutting plan and on-site inspection of a harvest operation by a DCR Service Forester to ensure that required BMPs are being followed when a commercial harvest exceeds 25,000 board feet or 50 cords (or combination thereof).



Soil and Water Quality: Forests provide a very effective natural buffer that holds soil in place and protects the purity of our water. The trees, understory vegetation, and the organic material on the forest floor reduce the impact of falling rain, and help to insure that soil will not be carried into our streams and waterways.

To maintain a supply of clean water, forests must be kept as healthy as possible. Forests with a diverse mixture of vigorous trees of different ages and species can better cope with periodic and unpredictable stress such as insect attacks or windstorms.

Timber harvesting must be conducted with the utmost care to ensure that erosion is minimized and that sediment does not enter streams or wetlands. Sediment causes turbidity which degrades water quality and can harm fish and other aquatic life. As long as Best Management Practices (BMPs) are implemented correctly, it is possible to undertake active forest management without harming water quality.



Forest Health: Like individual organisms, forests vary in their overall health. The health of a forest is affected by many factors including weather, soil, insects, diseases, air quality, and human activity. Forest owners do not usually focus on the health of a single tree, but are concerned about catastrophic events such as insect or disease outbreaks that affect so many individual trees that the whole forest community is impacted.

Like our own health, it is easier to prevent forest health problems than to cure them. This preventative approach usually involves two steps. First, it is desirable to maintain or encourage a wide diversity of tree species and age classes within the forest. This diversity makes a forest less susceptible to a single devastating health threat. Second, by thinning out weaker and less desirable trees, well-spaced healthy individual trees are assured enough water and light to thrive. These two steps will result in a forest of vigorously growing trees that is more resistant to environmental stress.



Fire: Most forests in Massachusetts are relatively resistant to catastrophic fire. Historically, Native Americans commonly burned certain forests to improve hunting grounds. In modern times, fires most often result from careless human actions.

The risk of an unintentional and damaging fire in your woods could increase as a result of logging activity if the slash (tree tops, branches, and debris) is not treated correctly.

Adherence to the Massachusetts slash law minimizes this risk. Under the law, slash is to be removed from buffer areas near roads, boundaries, and critical areas and lopped close to the ground to speed decay. Well-maintained woods roads are always desirable to provide access should a fire occur.

Depending on the type of fire and the goals of the landowner, fire can also be considered as a management tool to favor certain species of plants and animals. Today the use of prescribed burning is largely restricted to the coast and islands, where it is used to maintain unique natural communities such as sandplain grasslands and pitch pine/scrub oak barrens. However, state land managers are also attempting to bring fire back to many of the fire-adapted communities found elsewhere around the state.



Wildlife Management: Enhancing the wildlife potential of a forested property is a common and important goal for many woodland owners. Sometimes actions can be taken to benefit a particular species of interest (e.g., put up Wood Duck nest boxes). In most cases, recommended management practices can benefit many species, and fall into

one of three broad strategies. These are **managing for diversity, protecting existing habitat, and enhancing existing habitat.**

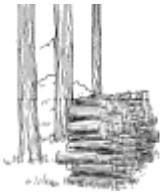
Managing for Diversity – Many species of wildlife need a variety of plant communities to meet their lifecycle requirements. In general, a property that contains a diversity of habitats will support a more varied wildlife population. A thick area of brush and young trees might provide food and cover for grouse and cedar waxwing; a mature stand of oaks provides acorns for foraging deer and turkey; while an open field provides the right food and cover for cottontail rabbits and red fox. It is often possible to create these different habitats on your property through active management. The appropriate mix of habitat types will primarily depend on the composition of the surrounding landscape and your objectives. It may be a good idea to create a brushy area where early successional habitats are rare, but the same practice may be inappropriate in the area's last block of mature forest.

Protecting Existing Habitat – This strategy is commonly associated with managing for rare species or those species that require unique habitat features. These habitat features include vernal pools, springs and seeps, forested wetlands, rock outcrops, snags, den trees, and large blocks of unbroken forest. Some of these features are rare, and they provide the right mix of food, water, and shelter for a particular species or specialized community of wildlife. It is important to recognize their value and protect their function. This usually means not altering the feature and buffering the resource area from potential impacts.

Enhancing Existing Habitat – This strategy falls somewhere between the previous two. One way the wildlife value of a forest can be enhanced is by modifying its structure (number of

canopy layers, average tree size, density). Thinning out undesirable trees from around large crowned mast (nut and fruit) trees will allow these trees to grow faster and produce more food. The faster growth will also accelerate the development of a more mature forest structure, which is important for some species. Creating small gaps or forest openings generates groups of seedlings and saplings that provide an additional layer of cover, food, and perch sites.

Each of these three strategies can be applied on a single property. For example, a landowner might want to increase the habitat diversity by reclaiming an old abandoned field. Elsewhere on the property, a stand of young hardwoods might be thinned to reduce competition, while a “no cut” buffer is set up around a vernal pool or other habitat feature. The overview, stand description and management practice sections of this plan will help you understand your woodland within the context of the surrounding landscape and the potential to diversify, protect or enhance wildlife habitat.



Wood Products: If managed wisely, forests can produce a periodic flow of wood products on a sustained basis. Stewardship encompasses finding ways to meet your current needs while protecting the forest’s ecological integrity. In this way, you can harvest timber and generate income without compromising the opportunities of future generations.

Massachusetts forests grow many highly valued species (white pine, red oak, sugar maple, white ash, and black cherry) whose lumber is sold throughout the world. Other lower valued species (hemlock, birch, beech, red maple) are marketed locally or regionally, and become products like pallets, pulpwood, firewood, and lumber. These products and their associated value-added industries contribute between 200 and 300 million dollars annually to the Massachusetts economy.

By growing and selling wood products in a responsible way you are helping to our society’s demand for these goods. Harvesting from sustainably managed woodlands – rather than from unmanaged or poorly managed forest – benefits the public in a multitude of ways. The sale of timber, pulpwood, and firewood also provides periodic income that you can reinvest in the property, increasing its value and helping you meet your long-term goals. Producing wood products helps defray the costs of owning woodland, and helps private landowners keep their forestland undeveloped.



Cultural Resources: Cultural resources are the places containing evidence of people who once lived in the area. Whether a Native American village from 1,700 years ago, or the remains of a farmstead from the 1800’s, these features all tell important and interesting stories about the landscape, and should be protected from damage or loss.

Massachusetts has a long and diverse history of human habitation and use. Native American tribes first took advantage of the natural bounty of this area over 10,000 years ago. Many of these villages were located along the coasts and rivers of the state. The interior woodlands were also used for hunting, traveling, and temporary camps. Signs of these activities are difficult to find in today’s forests. They were obscured by the dramatic landscape impacts brought by European settlers as they swept over the area in the 17th and 18th centuries.

By the middle 1800's, more than 70% of the forests of Massachusetts had been cleared for crops and pastureland. Houses, barns, wells, fences, mills, and roads were all constructed as woodlands were converted for agricultural production. But when the Erie Canal connected the Midwest with the eastern cities, New England farms were abandoned for the more productive land in the Ohio River valley, and the landscape began to revert to forest. Many of the abandoned buildings were disassembled and moved, but the supporting stonework and other changes to the landscape can be easily seen today.

One particularly ubiquitous legacy of this period is stone walls. Most were constructed between 1810 and 1840 as stone fences (wooden fence rails had become scarce) to enclose sheep within pastures, or to

exclude them from croplands and hayfields. Clues to their purpose are found in their construction. Walls that surrounded pasture areas were comprised mostly of large stones, while walls abutting former cropland accumulated many small stones as farmers cleared rocks turned up by their plows. Other cultural features to look for include cellar holes, wells, old roads and even old trash dumps.

History of Natural Disturbance:

As noted above, the mid 19th century was the height of forestland clearing for agriculture and pasturing. The availability of richer, more productive farmland in the Midwest resulted in farm abandonment and subsequent regrowth of white pine, chestnut, and mixed hardwoods including red oak. In the early 20th century these stands, particularly white pine, were cut to supply the wood container industry. Farm activity on the newly cleared land was truncated by World Wars I and II and brought about another wave of farm abandonment and regrowth. Natural disturbances since 1900 include the Chestnut blight of 1900-1908, the hurricane of 1938, the Gypsy Moth outbreak of 1980-1982, wind events, and ice damage, most notably in December 2008.



Recreation and Aesthetic Considerations: Recreational opportunities and aesthetic quality are the most important values for many forest landowners, and represent valid goals in and of themselves. Removing interfering vegetation can open a vista or highlight a beautiful tree, for example. When a landowner's goals include timber, thoughtful forest management can be used to accomplish silvicultural objectives while also

reaching recreational and/or aesthetic objectives. For example, logging trails might be designed to provide a network of cross-country ski trails that lead through a variety of habitats and reveal points of interest.

If aesthetics is a concern and you are planning a timber harvest, obtain a copy of this excellent booklet: *A Guide to Logging Aesthetics: Practical Tips for Loggers, Foresters & Landowners*, by Geoffrey T. Jones, 1993. (Available from the Northeast Regional Agricultural Engineering Service, (607) 255-7654, for \$7). Work closely with your consultant to make sure the aesthetic standards you want are included in the contract and that the logger selected to do the job executes it properly. The time you take to plan ahead of the job will reward you and your family many times over with a fuller enjoyment of your forest, now and well into the future.



Invasive Species Management: Invasive species pose

immediate and long-term threats to the woodlands of MA. Defined as a non-native species whose introduction does or is likely to cause economic or environmental harm or harm to human, animal, or plant health, invasives are well-adapted to a variety of environmental conditions, out-compete more desirable native species, and often create monocultures devoid of biological diversity. The websites of the Invasive Plant Atlas of New England, www.nbiin.ciesin.columbia.edu/ipane, and the New England Wildflower Society, www.newfs.org are excellent sources of information regarding the identification and management of invasive plants. Some of the common invasive plants found in MA are listed below.

- ☐ Oriental Bittersweet (Celastrus orbiculata)
- ☐ Glossy Buckthorn (Frangula alnus)
- ☐ Multiflora Rose (Rosa multiflora)
- ☐ Japanese Barberry (Berbis thunbergii)
- ☐ Japanese Knotweed (Fallopia japonica)
- ☐ Autumn Olive (Eleaeagnus umbellata)

Early detection and the initiation of control methods soon after detection are critical to suppressing the spread of invasive species. Selective application of the proper herbicide is often the most effective control method. See the next section for information on the use of chemicals in forest management activities.



Asian Longhorned
Beetle

Pesticide Use

Pesticides such as herbicides, insecticides, fungicides, and rodenticides are used to control “pests”. A pest is any mammal, bird, invertebrate, plant, fungi, bacteria or virus deemed injurious to humans and/or other mammals, birds, plants, etc. The most common forest management use of a pesticide by woodland owners is the application of herbicide to combat invasive species. MA DCR suggests using a management system(s) that promotes the development and adoption of environmentally friendly no-chemical methods of pest management that strives to avoid the use of chemical pesticides. If chemicals are used, proper equipment and training should be utilized to minimize health and environmental risks. In Massachusetts, the application of pesticides is regulated by the MA Pesticide Control Board. For more information, contact MA Department of Agricultural Resources (MDAR), Pesticide Bureau at (617) 626-1776

Please refer to FSC Pesticides Policy: Guidance on Implementation (FSC-GUI30-001 Version 2-0 EN, May 5, 2007) for information on chemicals banned from use on MA Private Lands Group Certification member properties.

This is your Stewardship Plan. It is based on the goals that you have identified. The final success of your Stewardship Plan will be determined first, by how well you are able to identify and define your goals, and second, by the support you find and the resources you commit to implement each step.

It can be helpful and enjoyable to visit other properties to sample the range of management activities and see the accomplishments of others. This may help you visualize the outcome of alternative management decisions and can either stimulate new ideas or confirm your own personal philosophies. Don't hesitate to express your thoughts, concerns, and ideas. Keep asking questions! Please be involved and enjoy the fact that you are the steward of a very special place.

Purpose of the Plan

The Holyoke Water Works (HWW) is charged with the delivery of clean, potable water to the City of Holyoke. One hundred percent of the drinking water for Holyoke comes from the Tighe Carmody Reservoir. The three in-town reservoirs are off line, reserve supplies. HWW operates under a waiver from The Massachusetts Department of Environmental Protection for the filtration requirements of the Surface Water Treatment Rules, which were established in 1986 in response to the Safe Drinking Water Act. Water quality protection is the highest priority with any activity on the watershed. HWW accepts the working hypothesis that healthy, resilient forests are the best natural filter for water.

The basic premise of this model is that with maintenance an ideal watershed forest ecosystem offers the least expensive natural filter for drinking water. The maintenance of a healthy forest requires its continual replacement through natural regeneration of its trees. This first section (The Overview) of this document explains the silvicultural techniques that HWW will apply to maintain and regenerate the watershed filtration forest upon the McLean Reservoir, Ashley Ponds Reservoir, and Whiting Street Reservoir watershed lands. Silviculture requires the harvesting of trees from the watershed, and this document explains the strategies for the protection of water quality during the necessary silvicultural projects.

The City owns a 1,350.8 forest ecosystem within these three watershed drainage systems. HWW plans to certify these lands under the Forest Stewardship Council Green Certification Program. Management plans are necessary for all certified acreage. HWW plans to make the management plan available in the public libraries with the expectation that community members and citizens and water rate payers of Holyoke will appreciate the valuable resource these lands bring to the City of Holyoke. Education raises awareness, which can motivate stewardship of a community's natural resources. These lands are often used unofficially for walking, hiking, nature study, and other benign activities. No official access is permitted onto these lands in order to protect water quality.

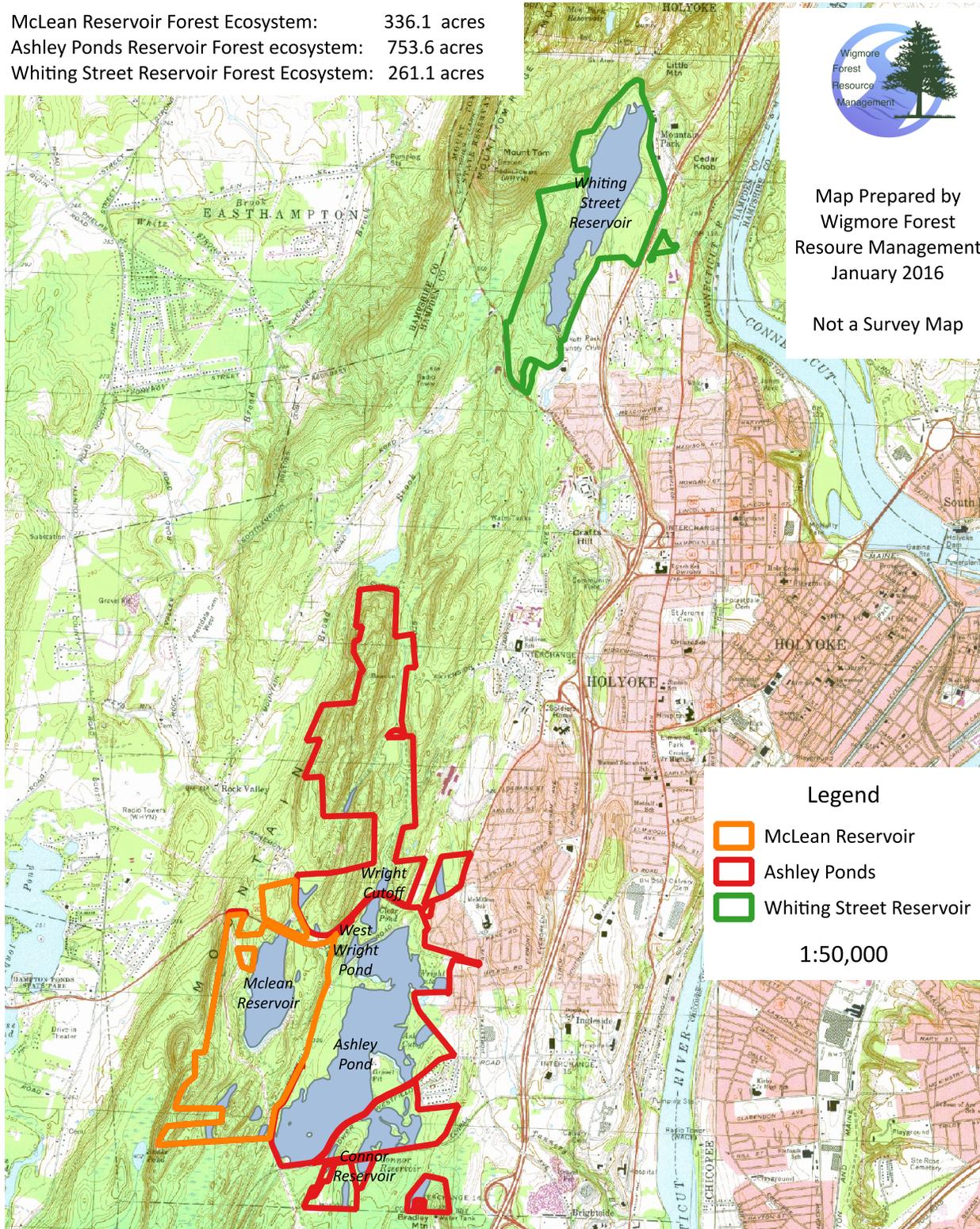
The In-Town Holyoke Reservoir System

Established in 1872, the Holyoke Board of Water Commissioners had the vision and foresight to design, plan and build one of the most reliable water systems known today. This network of reservoirs located within the City of Holyoke impounds billions of gallons of water ensuring the City's water supply needs are met under all operating conditions. An energy efficient gravity based system conveys water from the reservoirs to a centralized treatment facility to meet all State and Federal water quality regulations. Treated water is then distributed to a series of storage tanks and pumping stations that service the five individual pressure zones within the City.

Figure #1: The 1,350.80 acre Three-Reservoir System Locus Map

Holyoke Water Works Mclean Reservoir, Ashley Ponds, and Whiting Street Reservoir Watersheds Locus Map

McLean Reservoir Forest Ecosystem: 336.1 acres
 Ashley Ponds Reservoir Forest ecosystem: 753.6 acres
 Whiting Street Reservoir Forest Ecosystem: 261.1 acres



The McLean Reservoir

The McLean Reservoir was constructed in 1903, and it has an impound capacity of 365 million gallons and a safe yield of 0.5 million gallons of water per day. The Reservoir drainage area is 319 acres, all of which is owned by the Holyoke Water Works. The McLean Reservoir dam is an earth fill dam with a total height of 35 feet and an approximate length of 700 feet. The Massachusetts Department of Conservation and Recreation (DCR) classifies the dam as a Large Size Structure and a Significant (Class II) Hazard Dam.

The fill system is quite simple for McLean Reservoir. A small wetland adjacent to the east side of Apremont Way pumps ground water out of springs into a small in-take reservoir directly north of Route #202. System complexity manifests at its exit point. Water both seeps under the dam into a web of ponds, forested wetlands, and swamps, and drains directly out of the sluiceway into a high velocity stream. This water joins the feeder system for Paucutuck Brook after working its way through the Ashley Ponds reservoir pond matrix.

The Ashley Ponds Reservoir

The Ashley Reservoir was constructed in 1897, and it has an impound capacity of 795 million gallons and a safe yield of 2.1 million gallons of water per day. The Reservoir drainage area is 1,261 acres, 86% of which Holyoke Water Works owns. The Ashley Reservoir dam is an earthen fill dam with a total height of 12 feet and an approximate length of 640 feet. The dam is classified by the Massachusetts Department of Conservation and Recreation (DCR) as an Intermediate Size Structure and a Significant (Class II) Hazard Dam.

An aquifer recharge zone north of Cherry Street at the northern tip of the Ashley Ponds Reservoir north section drains its waters both east and west. The western flow funnels into the Broad Brook watershed, and the eastern flow drains a saddle formation into a long narrow wetland paralleling the west side of Cherry Street. This wetland surrounds a spring field through which the aquifer pumps out the headwaters of Paucutuck Brook. After about two thirds of its track through the northern Ashley Ponds watershed, it is joined by two small tributaries with their origin in upslope springs. All of this water collects in a small pond that functions as an in-take reservoir to Clear Pond and the Ashley Ponds matrix. Water slowly makes its way through these ponds flowing down gradient until exiting Ashley Pond and flowing downstream to the Bearhole Watershed.

Whiting Street Reservoir

The Whiting Street Reservoir was constructed in 1888, and it has an impound capacity of 479 million gallons and a safe yield of 1.5 million gallons of water per day. The Reservoir drainage area is 897 acres, of which 42% is owned by the Holyoke Water Works. The Whiting Street Reservoir dam is a stone masonry and earthen embankment dam with a height of 19 feet and an approximate length of 1,900 feet. The dam is classified by the Massachusetts Department of Conservation and Recreation (DCR) as a Large Size Structure and a High (Class I) Hazard Dam.

Whiting Street reservoir fills with stream flow from the north and south. Water collects from the run-off on upper Mount Tom slopes and gushes down into Whiting. Spring seep flow augments this volume along the down gradient. Whiting Brook originates in a wetland near the HWW water tanks on Homestead Avenue. Here water is pulled from the aquifer and pumped north into Whiting Street Reservoir across a series of wetlands and small ponds.

Geology

Over 200 million years ago in the Triassic Period, the North American, Eurasian, and African plates drifted towards each other and eventually collide. The collision force shoved the northern Appalachian Mountains upwards along the spine of New England. These rifts were also the sites of lava bursts onto the earth and cooling in thick slabs. This volcanic rock, basalt, orientated in narrow

north south columns. Erosion wore down many of these ridge tops leaving behind the curving spur of the East Mountain formation. As time passed the new land formation also split, which began the split of the Connecticut River peneplain .

Less than 2 million years ago Wisconsin Ice Sheet covered the valley. Its slow, grinding flow scoured the earth. Its melt water collected behind a massive dam of sand and gravel and formed a giant lake that stretched to the Canadian border. Less than 12,000 years ago, this sand dam burst, and Lake Hitchcock drained leaving the matrix of terraced floodplains above deep sands and gravels and the kettle ponds formation found today.

Terrain

East Mountain Ridge, which is part of the long, narrow, spur of Metacomet Ridge, lies to the west of the Connecticut River Valley. The ridge tops stretch through the western edges of both the McLean Reservoirs and Whiting Street Reservoir lands and the central core of the northern Ashley Ponds lands. The basalt rock juts up into cliffs and exposed bedrock on the crests and upper slopes and crumbles into the richer talus lower slopes. The landscape transitions to the deep, stratified sands and gravels of the alluvial outwash plains. Another common feature is the north-south orientated small hills of gravel and sands (drumlins or drumloidal hills), which alternate with the stream and run-off terraces across the Ashley Ponds area.

History

The level alluvial terraces and floodplains of the valley were frequented by native peoples as evidenced in fishing sites, and in tools found in the uplands made from basalt. The current forest structures, the dry site oak transition forest ecosystem, developed about 15,000 years ago as proven by tree pollen and seed found in the sands. European influence began on the native peoples and ecosystems around 1600. Europeans walked the trail systems of the Nashawannuck and Pascounmuck. Springfield plantation was established in 1627. It included all of West Holyoke, both ridges and floodplains. Most of the land was too wet for agriculture across the Ashley Pond area and too steep up the ridges and upper slopes. In the mid-1800's a group of financiers planned the industrial city of Holyoke. The population grew by 400% from 1870 to 1920 for workers in the mills. Timber harvesting stretched up into the ridges and higher slopes in search of lumber and fuel for the growing valley. People moved into the urban core of the city, and the uplands to the west were reverted to forest.

History of Disturbance to the Forest

The history of disturbance on this property from the 1830's is like that of the typical woodlot in Southern New England. The mid-19th century was the height of the forestland clearing for agriculture and pasturing. The availability of richer, more productive farmland in the Midwest resulted in the farm abandonment and subsequent regrowth of the forests. Industrial patterns and modes of production also shifted with the advent of the 20th century, and the factories were abandoned.

The forestland reverted to the dense mixed oaks, white pine, hemlock, chestnut, and mixed hardwoods cover typical on old farms lands. These forests began the successional transition toward a more diverse species composition. Wood products industry surges in the early 20th century interrupted the development of these forests. This new upswing in land clearing for wood products and reversion to open land was cut short by the World War period. The forests have been maturing into their current condition since this time

More recent natural disturbance to the forests have been the Chestnut Blight in 1900 to 1908, the hurricane of 1938, the Gypsy Moth outbreak of 1980 to 1982, recent severe storm events, that are driven by climate change including the ice storm of 2008 and the October 2011 snow storm.

The City planted areas of red pine and white pine for shoreline stability around the reservoir through the late 1950's. HWW began an active program of watershed management in the early 1970's. Timber harvests for the improvement of the growing stock were completed through the 1980's and late 1990's. Timber crop management began again in 2003 upon the reservoir lands. The forestry program renewal started on Ashley Ponds Reservoir lands in 2007 with a red pine plantation salvage operation.

Forest Soils

Time and weather eroded the once jagged, stately ridge tops into exposed basalt rocks and the crumbling talus lower slopes. The movement of water across the alluvial outwash plains and terraces constantly alters these soils. The United States Department of Agriculture -Soil Conservation Service classified all of the soils within the three watersheds into categories dependent upon their texture, depth, topography, and productivity. Many areas are designated as Highly Erodible in the soils survey. Protection measures are essential during any forest management work. Continual use of the trails and roads by illegal recreationists causes massive loss of sediment along the road and trail system.

The Rock Outcroppings- Holyoke Complex soils cover most of the three reservoir system lands. These shallow, upland soils do not grow trees very well. These soils are characterized by the talus slope formations that arise from the crumbling basalt due to erosion. The coarse texture loams lose their water quickly through evaporation and percolation. This droughtiness can kill off seedlings and discourage tree vigor. They are easily carried away with rainwater and wind forces. Use of these upper slopes for road construction for any management purposes is difficult as they tend to gully quickly without proper erosion control installations. Descending the terrain across the lower slopes and into the alluvial outwash plains, the soils deepen and sequester more fertile organic material in some areas mixed with the silts, sands and gravels. Exposed basalt rock is less common here. Tree productivity varies with the averages from poor/fair on the rocky slopes and moderately high across the outwash terraces and plains.

Table 1.: Soil Classifications and Descriptions for the Three Reservoir In—Town System

Terrain/ Topography	USDA Classification	Soil Name	Soil Description	Forest Productivity
Upper slopes, ridgeline tops, and rock outcroppings	RHD	Rock Outcroppings and Holyoke Complex	Coarse textured, shallow soils in uplands formed in a thin layer of glacial till or simply exposed bedrock. Holyoke component is excessively well-drained.	Poor to very poor- for productive tree growth.
Lower slopes, and drumlin hills.	CkB, CkC, CmB, CnB, CnC, CnB, CnC	Charlton Close minor associates: Meckesville and Woodbridge.	Coarse textured, fine, stony, sandy loams, which are deep and well-drained. Tend to seepage and they are useful for earthen dams for reservoirs.	High- very productive for tree growth.
	PaB	Paxton	These soils lie along the side hills of drumlins. They have a seasonal perched water table.	High- well suited to productive tree growth.
	WgF, WgC, WgB	Wethersfield	Deep, well-drained sandy loams that formed on drumloidal hills and ridges.	High- well suited to productive tree growth.
Outwash Plains, stream terraces, and alluvial terraces.- lowlands of the system and surrounding the ponds.	En	Enfield Minor associate Freetown	Nearly level, deep, well-drained silt loams.	High- well suited to productive tree growth.
	SeA	Swansea	Nearly level fine sandy loam found on the alluvial terrace formations of the central Ashley Ponds section. They are very well-drained.	Moderate to low productivity for oak and white pine.
	SrB	Sudbury	Nearly level, fine, sandy loams found on the alluvial terrace formations in the central Ashley Ponds section. They are very well-drained.	Moderate to low productivity for oak and white pine.
	HgB, HgC, HgD	Hinckley	Deep, excessively, well-drained sands that formed on the glacial outwash plains. Too dry for good tree growth.	Poor/Low Productivity.
Alluvial floodplain depressions, old lake bed deposits, and depressions on upper slopes.	Ra	Raynham	Silts and loams that formed in the glacio-lacustrine deposits of the old lake Hitchcock bed. Water sits at surface for most of the year.	Moderate tree productivity
	RgA, RgB	Ridgebury	A stony, moderately deep sandy loam found in the low depressions across the landscape.	Fair to Moderate tree productivity

Figure #2. Soil Classification Map for the McLean and Ashley Ponds Reservoir Lands
Soils Classification Map for the McLean Reservoir and Ashley Ponds Reservoir Lands
Ashley Ponds Reservoir Forest Ecosystem: 753.6 acres
McLean Reservoir Forest Ecosystem: 336.1 acres



Map Prepared by
 Wigmore Forest
 Resource
 Management
 January 2016

Developed from
 MassGIS Sources

Not a Survey Map

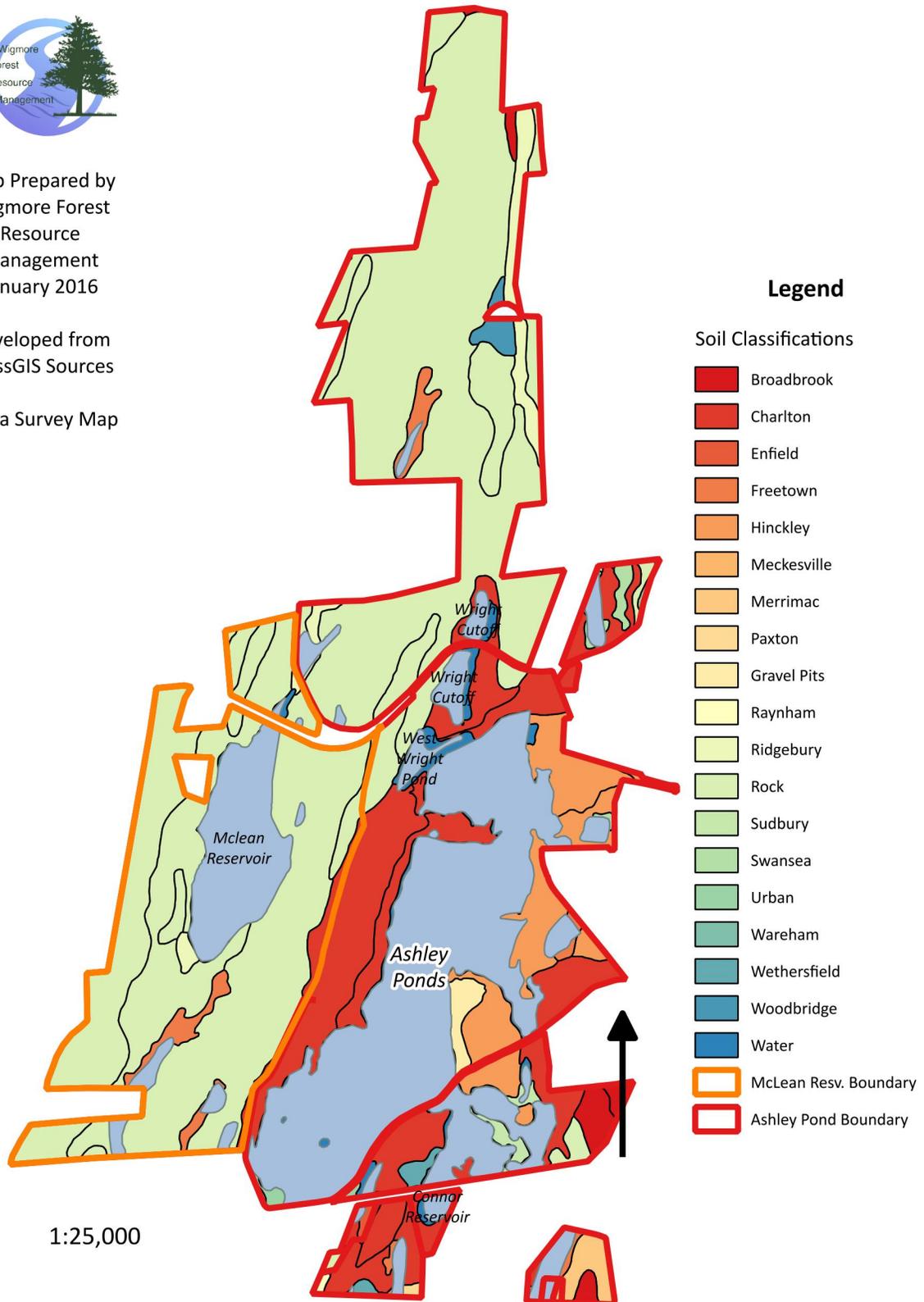
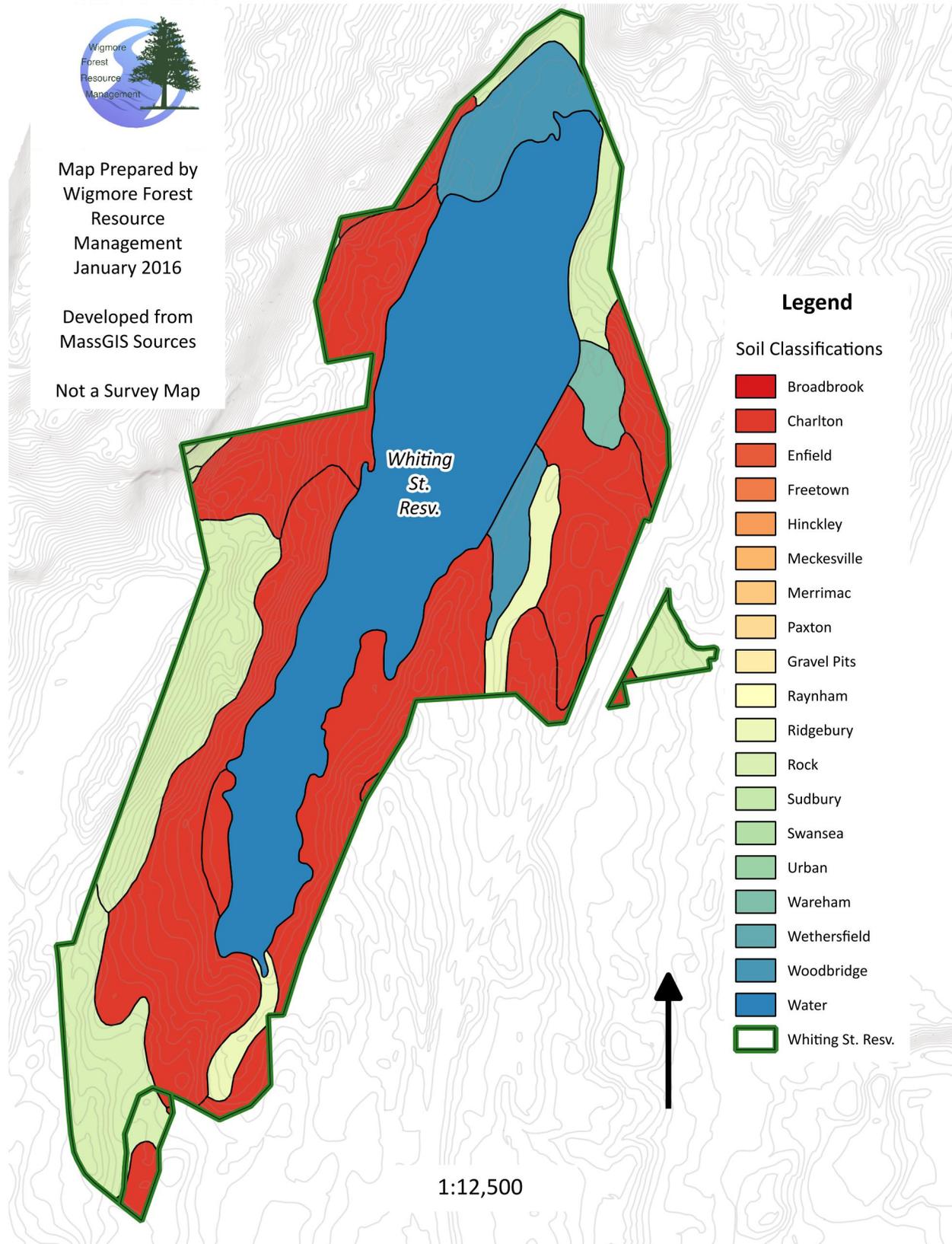


Figure #3: Soil Classification Map for the Whiting Street Reservoir Lands

Soil Classification Map for the Whiting Street Reservoir Lands
Forest Ecosystem: 261.1 acres



Map Prepared by
Wigmore Forest
Resource
Management
January 2016

Developed from
MassGIS Sources

Not a Survey Map

Overview of Forest Ecosystem on the McLean Reservoir Watershed Lands

This discussion will first examine the broad forested landscape of the three-reservoir system, and it will finish with an overview of the specific reservoir forest ecosystem. The HWW lands are nestled within a vast, continuous green band along the north-south axis of the East Mountain ridge formation. This emerald spine offers a valuable habitat refuge deep within the urban Connecticut River valley landscape. These forests grow in the natural landscape feature known as the Berkshire Transition Forest. The vegetation here shifts between the true northern hardwood groves (beech, birches, ash, and maples) of north Berkshire and Franklin County and the oak and hickory forest of southern New England.

The forest is a predominantly deciduous. Dominant trees in the upland forests are Red Oak, White Oak, Paper Birch, Hickories, with some American Beech, White Pine, Black Birch, Yellow Birch, Eastern Hemlock, Sugar maple, and Red Maple. Along the mountaintops, Chestnut Oak and Scarlet Oak are common. Forested wetlands and lowlands consist predominantly of Red Maple in association with American Elm, White Ash, Silver Maple, Swamp Oak, Yellow Birch, and Tulip Poplar. Common understory shrubs include Spicebush, Highbush and Low-bush Blueberry, Speckled Alder, Mountain Laurel, Maple-leaved Viburnum, Beaked Hazelnut, and Witch Hazel

The forest exists in a rudimentary all-aged structure with the exception of the white pine and red pine plantation stocking. This complex, vast forest ecosystem functions as an ideal natural filter. The maturing overstory oak, mixed hardwood, white pine and hemlock trees of the main canopy ranging in age from 85 to 145 years and the immature, mid-canopy layer ranging in age from 30 to 65 years of age. Past timber harvests and natural decline opened gaps in the two upper layers for the development of seedlings and saplings (less than 30 years). Scattered old farm relics (mostly sugar maple, white oak, red oak, and hickory) and small groves of surviving hemlock may even be older than 200 years.

These forests are generally healthy, vigorous, and productive with the exception of the hemlock, white ash, and paper birch crops. The hemlock component is under attack by the elongated hemlock scale and the hemlock woolly adelgid. These pathogens are systematically destroying the genetically ancient *Tsuga* species east of the Appalachian Mountains. The full ramifications of their loss from the watershed forest ecosystem are not understood. White ash suffers environmental decline, and paper birch is a short-lived species with many stems approaching their biological maturity across the watershed. The black birch crop suffers from minor infestation of the *Nectria* bacteria.

McLean Reservoir

Larger, older trees (greater than 16 inches in diameter) grow above a moderate layer of 4 to 8-inch sapling and pole trees across the nine forest stands. Regeneration is fair, and these stands are replacing themselves slowly. Red oak seedlings were limited. Species composition includes red oak (45% all stocking), black oak, white oak, hemlock, hickory, white ash, white pine, red maple, sugar maple, black birch, paper birch, gray birch, elm, hickory, scarlet oak, chestnut oak, aspen, black cherry, linden, and butternut. The stand relative density (thickness of trees) is 98%, which indicates full utilization of the growing space. Many immature healthy and vigorous oaks, maple, birch, pine, hemlock, and other hardwood trees are producing seed, volume, and beneficial habitat. The site supports 1,979,000 board feet of timber crops and over 2,800 cords of younger growing stock.

Table #2: Forest Stand Summary By Number, Forest Type, and Area:

Reservoir Name	Stand Number	Forest Type	Stand Description	Area
McLean	1	OM	Mixed red, black, scarlet, chestnut, and white oak timber crops share this site with sugar maple, red maple, black birch, paper birch, and hickory. This site is located north of Route #202. The terrain drains into a small in-take reservoir for the McLean Reservoir system.	23 acres
McLean	2	OM	All the native oak species grow in these small along the ridge tops.	16 acres
McLean	3	OH	Maturing red oak timber shares this stand with birch, maple, hickory, and some of the true northern hardwoods. The stand stretches across the lower talus slopes. Invasive plants pose a threat. It is suitable for silviculture work.	48 acres
McLean	4	RZ-OH-RM	This riparian zones move water through the watershed in a system of ponds, vernal pools, stream, forested wetlands, shallow marshes, and a beaver pond. The aquatic habitat completes the vital ecosystems function of this Priority Habitat.	26 acres
McLean	5	RP-SP	A small strip of maturing white pine and spruce timber towers above a mix of native and invasive plants. This stand sits on the western shore of McLean Reservoir.	2.5 acres
McLean	6	OH	Similar to Stand 2.03, but located in the southern section of the property. Maturing red oak timber shares this stand with birch, maple, hickory, and some of the true northern hardwoods. These trees grow upon a broad talus slope. 30 acres is suitable for silviculture.	52 acres
McLean	7	OH	This stand stretches across most of the southern portion of the property. The mixed oak and northern hardwood stand protects valuable habitat attributes such as vernal pools, shrub swamps, and talus cliffs. Some of the oldest and highest quality red oak grows upon the more fertile sites in this stand.	133.1 acres
McLean	8	OH	Red oak, black oak, black birch, and sugar maple timber trees dominate the overstory of this small stand, which sweeps down a short slope to the east of the treatment facility. Invasive plants grow more aggressively than our native species in the understory of this stand.	13.0 acres
McLean	9	HH	This stand greet the visitor to McLean Reservoir. It stretches across a gentle slope into a forested wetland at the northern access to the land. A grove of mixed oaks, northern hardwood, hemlock, and white pine shade these dry lower slope. The stand provides a pleasing aesthetic landscape along the main access road. It is suitable for silviculture.	22.5 acres
Subtotals Stewardship and Green Certified Area				336.1 acres

Invasive Plant Communities and Their Management

Invasive plants threaten local biodiversity with their aggressive displacement of native species. Invasive plants can significantly inhibit regeneration and the future productivity of a forest stand. They have few natural enemies, and often have little to no wildlife value. In general preventing the spread of invasive plants is easier and less expensive than trying to control them. This plan often recommends treatment of existing invasive plants before any timber harvest work and the use of non-toxic practices to avoid their spread. Manual removal, stem cutting, and application of vinegars and borax, brush cutting, and mowing in cycles reduce stocking and prevent spread. Retention of high crown closure uses shade as a deterrent of their spread. Scheduling and planning efforts for the treatment with natural correctives will be coordinated with income production.

The plants are found in dense volumes along all the access road, on the shoreline western shoreline of McLean reservoir, in a strip extending west from the access road up to 200 feet into the forest, in the moist depressions, and woven into the interior of some of the upland stands. Annual monitoring inspections of the forest conditions after any harvest activity for early detection and rapid response will reduce their spread onto the seedbed. Completion of a detailed assessment and mapping of the invasive plant communities with mapping will direct the treatment program and its budget.

Table #3: Invasive species plants observed across the Three-Reservoir System from a 2012 Williams College Study

Autumn Olive	Winged Euyonomous	Coltsfoot	Common Buckthorn
Japanese barberry	Glossy Buckthorn	Swallow-wort	Common Reed
Asiatic bittersweet	Bush Honeysuckle	Privet	Multiflora rose
Purple loosestrife	Climbing nightshade	Spotted nightshade	Norway Maple

Wildlife

Many groups through the years have done extensive studies of the East Mountain Ridge and reservoir plains habitat including Massachusetts Audubon, Massachusetts Division of Fisheries and Wildlife, Trustees of Reservations, Nature Conservancy, and the Sierra Club. A summary of the most recent data is summarized in this section of the management plan. This is a rich natural heritage, and this list does not include all of the many invertebrates in the City. Because of the richness of undisturbed habitats on the East Mountain Ridge and the expansive ponds, the three-reservoir system has many more species of both plants and animals than most people realize.

Birds

Data on the bird populations is the best for the three-reservoir system land base. The Connecticut River valley is a major pathway for migratory birds. Their movement attracts a lot of enthusiasm with special attention to hawks and birds of prey. Hawk watching is common on East Mountain ridge during their fall migration. The large tracts of forest provide important breeding habitat for interior forest birds.

Massachusetts Audubon (2012 Count) defines these forests as historic nesting site for Peregrine Falcons on rocky cliffs, with the potential for future nesting there. It is also an important nesting habitat for the Whip-poor-will; Worm-eating, Black-and-White, Blackburnian, Black-throated Blue and Cerulean Warblers; Louisiana Water thrush; Eastern Towhee; Eastern Wood-Pewee; Hairy Woodpecker; Baltimore Oriole; Rose-breasted Grosbeak; Scarlet Tanager; Wood Thrush; and Veery-priority species by Partners In Flight for southern New England.

The ranges are a migration route for large concentrations of Broad-winged, Sharp-shinned and Cooper's Hawks, and American Kestrel, as well as several other species including the Northern Goshawk, Red-shouldered Hawk, Merlin, Peregrine Falcon, Osprey, and Bald Eagle. They are also a significant stopover for numerous migrant songbirds including 22 warbler species, as well as good numbers of breeding interior forest birds. Important habitat for birds includes mixed oak habitat of the ridge tops, large continuous tracks of mature mixed oak and hardwood forests. A full list from the Massachusetts Audubon 2014 Christmas Count includes over 110 species.

Mammals, Reptiles, and Amphibians

The diversity of habitat support a wide number of wildlife species. No conclusive species lists were found for the east Mountain Ridge and Ponds area. The extensive three-reservoir system provides a corridor for large mammal and other wildlife. The Department of Conservation and Recreation (Cardoza and Mirick (2009)) conducted the most recent survey and noted the following species as common to the three-reservoir system watershed lands.

Vernal Pools

Vernal pools are temporary bodies of fresh water that provide critical breeding habitat for many vertebrate and invertebrate wildlife species. They are defined as "basin depressions where water is confined and persists for at least two months during the spring and early summer of most years, and where reproducing populations of fish do not survive." Vernal pools may be very shallow, holding only five or six inches of water, or they may be quite deep. They range in size from fewer than 100 square feet to several acres (Natural Heritage & Endangered Species Program, Massachusetts Division of Fisheries & Wildlife, Massachusetts Aerial Photo Survey of Potential Vernal Pools, Spring 2001).

Vernal pools are found across this landscape in small woodland depressions, swales, or kettle holes, which collect spring runoff or intercept seasonal high groundwater. Many species of amphibians and vertebrates are completely dependent on vernal pools to reproduce. Loss of vernal pools can endanger entire populations of these species. According to NHESP, clusters indicate particularly good habitat for species. Also, with clusters, there are alternate habitats if something happens to one pool, and slightly different conditions in each may provide different habitats for species dependent upon the pools.

Table #4: 2009 DCR Wildlife Species Lists

Reptiles:

Snapping Turtle	Northern painted Turtle	Milk Snake	Common Garter Snake
American Mud Turtle	Eastern Race Turtle	Brown Snake	Copperhead
Pond Turtle	Ring Necked Snake	Northern Water Snake	Timber Rattler Snake
Wood Turtle	Eastern Rat Snake	Red Bellied Snake	
Eastern Box Turtle	Eastern Hog Nosed Snake	Eastern Ribbon Snake	

Amphibians:

Mudpuppy	Marble Salamander	Spring Salamander	Fowler’s Toad
Jefferson Salamander	Eastern Newt	Northern Two Lined Salamander	Green Frog Bullfrog
Blue Spotted Salamander	Redbacked Salamander	Spadefoot Salamander	Wood Frog
Spotted Salamander	Four Toed Salamander	American Toad	Pickerel Frog

Mammals:

Feral Cat	Mink	Beaver	Northern Shrew	Porcupine
Bobcat	Striped Skunk	Jumping Mouse	Smoky Shrew	Snowshoe Hare
Coyote	Raccoon	Meadow Vole	American water Shrew	Eastern Cottontail
Mountain Lion	Moose	Woodlands Vole	Mole	New England Cottontail
Gray Fox	White Tailed Deer	Common Muskrat	Red Squirrel	
Red Fox	Virginia Opossum	Deer Mouse	Woodchuck	Woodchuck
American Black Bear	Gray Squirrel	Rat	Northern Flying Squirrel	Fisher
North American Otter	Ermine	Northern Flying Squirrel	Chipmunk	Longtailed Weasel
Brown Bat	Eastern Red Bat	Tri-Color bat	Silver bat	Myotis

Biodiversity:

The Massachusetts Division of Fish and Game through its Natural Heritage and Endangered Species Program designates these lands as Priority Habitat and Core Habitat, which is essential for the long-term health of native communities. Priority Habitat is land desirable for habitat use by the rare and special concern plant and animal species in western Massachusetts. The ecosystem provides high quality wetlands, vernal pools, habitat, and range for rare and vulnerable or uncommon animals, birds, reptiles, amphibians, invertebrates, and plants. Much of the area is also designated as Critical Natural Landscape, which provides good habitat for wide ranging species, nurtures intact ecosystems, and protects habitat integrity. The protection of both Priority Core Habitat and Critical Natural Landscapes (especially their overlap zones) assures healthy ecosystem functioning and rich biodiversity. The continuous acreage provides connectivity for species to cross the landscape.

Massachusetts Audubon designated this area as an Important Bird Area (IBA), which provide essential habitat to migrating birds for mating and roosting. Twenty-seven state listed birds whose population is decreasing were noted here. Habitat is variable across the three-reservoir system from the upland oak talus slopes, rocky outcrops and the alluvial floodplains. Peregrine falcons have been seen soaring above East Mountain, and many documented wood turtle observations exist. A few rare plants grow on the ridge tops and rocky outcroppings. Massachusetts DFG, The Nature Conservancy, and Massachusetts Audubon support the use of this area for the protection of many habitats of species of greatest need of conservation. The entire three-reservoir system provides both resiliency (the capacity of an ecosystem to recover from stress) and resistance (the ability of ecosystem to stay stable) to the climate crisis.

Biodiversity Protection:

Holyoke is remarkably rich in rare plant and animal species. The East Mountain Ridge and glacial ponds are cited by the Massachusetts Natural Heritage and Endangered Species Program (NHESP) as one of the most important and ecologically significant rare species localities within the Commonwealth. It is a high priority Special Focus Area for protection given the rare species habitat, the extent of contiguous habitat types, and the habitat for migratory land birds available

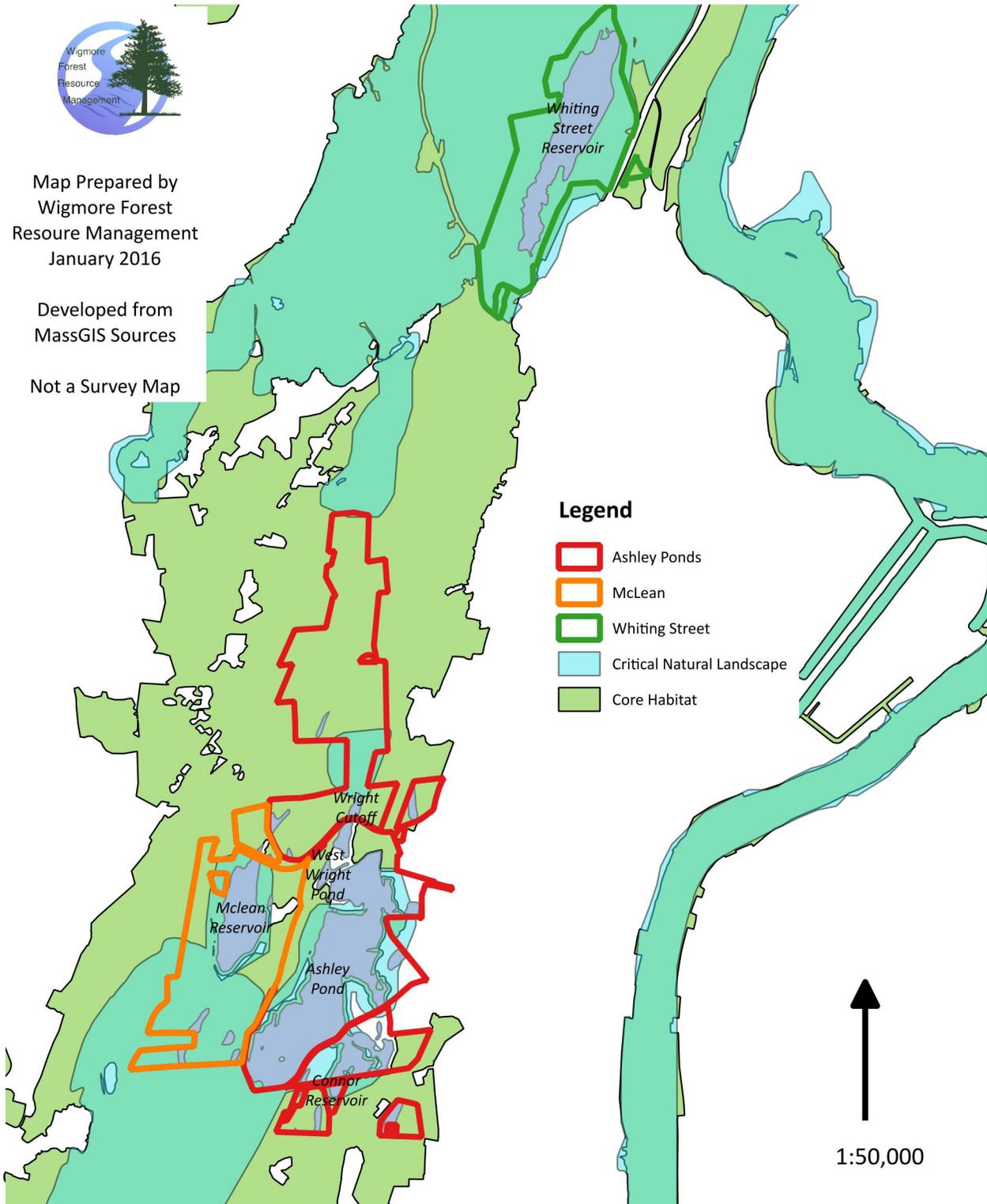
All projects within Priority Habitats undergo a review by DFG NHESP . Most of the watershed area is designated as a sensitive resource not suitable for timber harvest or silviculture work. No access is encouraged to the extensive vernal pool network across the McLean lands. Holyoke Water Works supports the diligent use of Forest Conservation Management Practices. All CMP's published by the DFG NHESP will be followed during any management work on these reservoir lands.

Conservation Management Practices (CMPs) are specific, science-based guidelines for conservation of rare species during forest harvesting. CMPs are somewhat analogous to Forestry Best Management Practices (BMPs), except whereas BMPs focus mainly on protection of water resources, CMPs specialize in protection of rare wildlife. The primary objective of CMPs is to guide harvesting activities such that rare species listed under the Massachusetts Endangered Species Act (MESA) are not impacted in a way that jeopardizes long-term viability of local populations. CMPs first identify and describe potential impacts of forest harvesting to state-listed species, whether impacts may be direct (e.g., physical injury or death of individual animals) or indirect (e.g., alteration of habitat in a way that reduces overall reproductive success of a local population). Then, CMPs provide specific guidelines to avoid or minimize impacts that would be considered negative or potentially detrimental to a local population; the guidelines are based on scientific knowledge of the habitat requirements, reproductive strategy, dispersal ability, survivorship, and other ecological factors that influence population dynamics of the species.

CMPs aim to maintain adequate opportunity for sustainable management of timber products in Massachusetts. To this end, CMPs tend to focus forest harvesting restrictions on the critical areas within known habitat of state-listed species, thereby allowing timber management to proceed with

Figure #4: Priority habitat and natural Critical Landscape Map from the BioMap2 Project for the McLean Reservoir, Ashley Ponds Reservoir, and Whiting Street Reservoir lands

Biomap 2 Classifications for the
Ashley Ponds Reservoir Forest Ecosystem: 753.6 acres
McLean Reservoir Forest Ecosystem: 336.1 acres
Whiting Street Reservoir Forest Ecosystem: 261.1 acres



fewer restrictions over as large an area as possible. This strategy is based, in part, on recognition that forest harvesting typically results in temporary habitat change or sometimes even habitat improvement rather than permanent habitat loss. Thus, the CMP strategy is designed to help maximize the protection of state-listed species and the ability of Massachusetts landowners to manage their forests for timber and other wood products.

Principles Guiding Forest Watershed Management

The science of watershed management continues to evolve, although many basic principles are long established and are now widely accepted as the precedent for the stewardship of watershed lands. This section is presented as the scientific defense synopsis for the City of Holyoke's watershed forest management program. The focus is on water quality, which can be directly impacted by active silviculture work. Although water yield is important to watershed management, the proposed silvicultural program restricts harvest levels to a less than 20% threshold, which is not significant enough to impact yield.

Watershed Protection

Forested watersheds generally yield higher water quality than non-forested cover types.

Maintaining vigorously growing forests across a watershed provides the best regulation of nutrients in a watershed.

Watershed management activities depend upon an adequate, well-designed, and well-maintained watershed road system.

Water Quality

Surface water collected from fully forested watersheds with minimal exposed soils generally carries low turbidity.

In actively managed forests, Best Management Practices, correctly designed and applied effectively will protect water sources from sediment/nutrient losses otherwise associated with forest management work.

The most common sources of water quality degradation by timber harvesting are intersections in harvesting roads and staging areas near water sources. Disconnecting roads/staging areas from water sources prevents this degradation.

To prevent contamination of surface or ground waters, petroleum products on water supply watersheds must be tightly regulated.

Maintaining a species and age/size diverse forest cover may increase the forest's resistance to natural disturbance. Active forest management can increase size and species diversity of forest cover.

The Water Protection Forest: A Working Hypothesis

The ideal watershed protection forest has the capacity to recover from natural disturbances with or without active forest management.

Healthy, well-distributed diverse age groups and size classes across the watershed increase the forest's ability to withstand environmental stress and disturbance.

Research has shown that harvesting less than 25% of the forested watershed in any given ten year period can minimize the loss of nutrients or sediments.

Separation of the roads and staging areas from water resources is the first rule to protecting these resources from any negative impact due to logging.

Roads should be designed to minimize stream crossings and storm water drainage structures need to be properly designed and managed.

Staging areas must be remote from water resources.

Forest Management Objectives/Strategies:

To maintain the ability of the forest to regenerate itself;

To encourage the development of the ideal all-aged, species diverse natural filtration forest structure on the forest stand suitable for silviculture treatment.

To continually regenerate these lands in order to maintain multi-age structure and diverse species composition;

Strict adherence with Best Management Practices as stated the Department of Conservation and Recreation Best Management Practices Manual (2103) with compliance with both the mandatory and suggested practices.

To limit harvesting to no more than 20% of the total stocking on any given forest stand over a 15 to 20 year cutting cycle.

Delineation and marking of the boundaries of the entire reservoir lands with documentation of all monumentation for archive purposes.

Water Quality Objectives/Strategies for 2016 to 2026

Silvicultural practices, as described in this management plan, are employed to bring about ideal filtration forest conditions. These practices require the cutting and removal of overstory trees to diversify structural and species compositions, and to maintain the vigor of the residual overstory. The process of removing trees disturbs the forest and the watershed soils, which are essential to protecting water quality. The areas of greatest concern are the hauling roads for timber products and log landings. Proper location of these in relation to streams, rivers, reservoirs, ponds, vernal pools, springs, and vegetated wetlands is important to prevent soil loss.

- 1)** Prevent the movement of sediments into the water system and the reservoirs from the upland during any silvicultural work;
- 2)** The compliance with the best BMP's (Explicitly described in the Massachusetts Forestry best Management Practices 2013 Manual) for harvest techniques in order to minimize the risks of sediment and nutrient loading into the water system.
- 3)** Establish a program of public outreach to the local community users about erosion prevention and trail use.
- 4)** Conduct a detailed survey of the trail and road system condition and record and document high erosion concern areas.
- 5)** Installation of erosion control measures and appropriate stream crossing approaches for stabilization along the existing access road and trail system through all of the reservoir lands.
- 6)** Establish a community partnership for volunteer maintenance projects on erosion control and site monitoring and a forum for discussion about adaptive watershed management.

Biodiversity Objectives/Strategies for 2016 to 2026

- 1) Protect and encourage native plant communities through the study and control of the invasive plant infestations across the reservoir lands.
- 2) Seek grant funding for analysis and control measures against the invasive plants.
- 3) Establish non-disturbance preservation areas within each reservoir property for the conservation and development of intact natural communities and the diverse species within each area.
- 4) Monitoring for forest health, which poses a threat to biodiversity if a species is threatened by a pathogen.
- 5) Strict adherence to all CMP's as published by Massachusetts NHESP during any silviculture work.

The Role of The Forest in the Landscape and Local Economy

The three-reservoir system stretches on a north-south axis over more than three miles of the East Mountain Ridge. It provides a unifying corridor for a vast habitat and forest core. Most is in municipal or state ownership though 800 acres are in private hands. Much of the Protected Open Space lies within a matrix of forested vegetation that while unprotected is barely distinguishable from the adjacent protected spaces. Protected properties include the Mount Tom Reservation State lands, the Trustees of Reservations Little Mount Tom Reservation, Division of Fish and Game lands, and the Bearhole watershed lands owned by the City of West Springfield to the south.

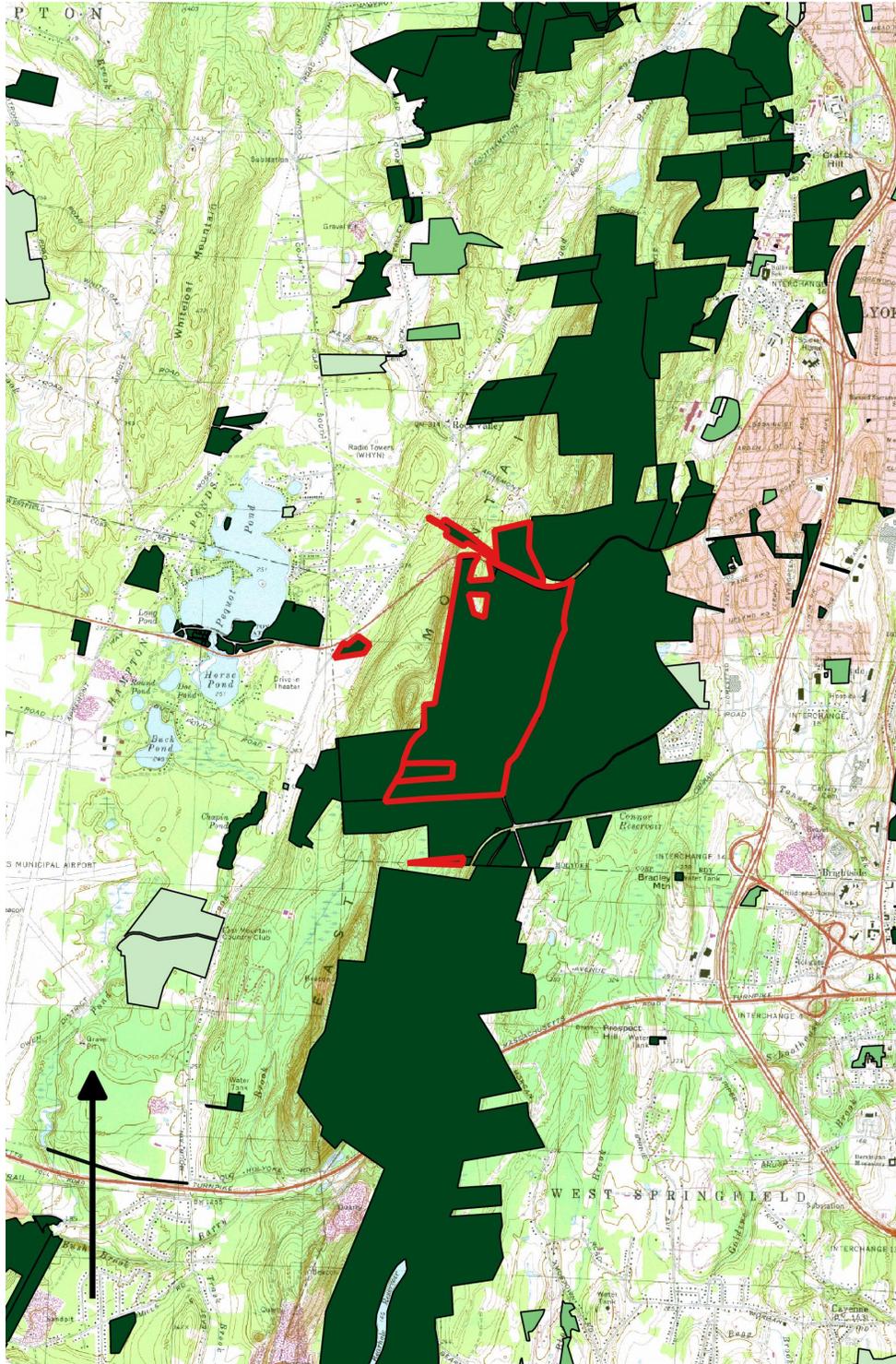
Protected open space is important in the maintenance of individual populations, species richness, and biological diversity. Population viability of many wildlife species within a regional context is reported to be dependent on large tracts of contiguous habitat that are minimally isolated from similar habitats. Often, area-sensitive species are not present or do not breed successfully in isolated, small, or fragmented tracts of land. The landscape context in relation to a given habitat can have an important effect on wildlife reproductive success and population health. Diversity of habitats and microhabitats within an area influences wildlife species richness and presence/absence of individual species. The three-reservoir watershed increases the ecological resiliency and biodiversity of the regional landscape.

The active silvicultural program on these three watershed areas will produce moderate volumes of merchantable timber products over ten years. Local and regional forest products businesses will complete the physical management work on these lands. They rely on local small businesses for the necessary materials and tools for the production and processing of these timber products. The City of Holyoke relies on the timber revenues from their silvicultural program for the funding of special water related projects and maintenance needs. Their use of the forest as a natural filtration system saves the City millions of dollars in the costs of construction and maintenance of a water filtration plant.

Figure #5: Protected Open Space in and around the McLean Reservoir, Ashley Ponds Reservoir, and Whiting Street Reservoir lands

**McLean Watershed
Holyoke Water Works**

Protected Open Space



Map Prepared by
Wigmore Forest Resource
Management

From MassGIS data
Not a Survey Map
Nov. 2015

1:48,000

Legend

- OPENSOURCE_POLY
- In Perpetuity
 - Term Limited
 - Limited
 - None
 - Unknown

The Role of Silviculture

Applying ecological principles to a forest stand to enhance growth of desirable species or native plant communities or to promote regeneration is termed silviculture. Silvicultural treatments are generally divided into procedures designed to reproduce forest stands, and intermediate treatments that maintain vigor and desired composition and stand structure. All of the tree species growing within the three-reservoir properties are biologically immature. The oak species might approach senescence near 275 years, white pine near 250 years. Although some red oak can live for over 400 years, and some white pine have been recorded well over 300 years. The average age range of trees across these properties is 85 to 135 years with anomalies in all species. These trees are mid-way through their life cycles. If a tree is not under stress from pathogen or environmental stress, it is likely to continue growing.

The forest stands upon the three reservoir properties were assessed for their suitability for silviculture. Suitability depends upon the ability of a given forest stand to support the main objectives for water quality and biodiversity of this management plan. Therefore, forest stands upon steep slopes with a high erosion factor were not deemed suitable, nor were forest stands that function solely for the filtration, collection, or transfer of water (wetlands, swamps, or stream banks). Some areas were deemed not suitable for silviculture because of their support function for habitat and their important values for ecological resiliency such as biodiversity or habitat value.

Only 98 acres (29% of the total reservoir holding) are suitable for silviculture upon the McLean Reservoir forest watershed. This acreage has been managed historically for timber production with Improvement Harvests done over this area in the late 1990's. The threshold for reproductive success of 2,000 seedlings per acre was met in many areas. An attempt will be made during the application of silviculture during 2016 to 2026 to meet the primary goal of forest regeneration or the introduction of a new age class across the 98 acres. The transition of these forests a well balanced all-aged, species rich condition will take many decades. Even a conservative approach (less than 20% removals during any entry) will further encourage the all-aged, species diverse, ecologically resilient ideal watershed structure. Secondary gains from the work will be the improvement of the quality and condition of the timber crops and the generation of immediate and long-term income.

Table #5. Summary of Silviculture or Management Practices on the McLean Reservoir from 2016 to 2026.

Stand Number	Forest Type	Area	Silviculture or Management Practice	Costs/Benefits	Date
1 3,7,8,9 5	OM OH WP-SP	55+/- acres	Detailed GIS mapping and assessment of the invasive plant communities and planning for control strategies.	Costs	2016 to 2017
All	All	Over 200 acres	Detailed GIS mapping, assessment, and engineering solution proposals of the erosion problems along the interior road and trail network. Collaboration with Holyoke Conservation Commission at this point of the planning.	Costs	2016 to 2017
3	OH	48 acres	Crop Tree Management and some minor Salvage Harvest in the hemlock crops.	Revenue: 50 MBF 60 cords firewood 20 cords pulp	2017 to- 2019
6	OH	30 acres	Crop Tree Management	Revenue: 35 MBF 50 cords firewood	2017 to 2019
9	HH	20 acres	Crop Tree Management and some minor Salvage Harvest in the hemlock crops.	Revenue: 35 MBF 30 cords firewood 20 cords pulp	2017 to 2019
1 3,7,8,9 5	OM OH WP-SP	55+/- acres	Invasive Plant Control- methods include natural correctives such as plant removal, propane torch, stem cutting and vinegar and borax treatments, brushing, and mowing.	Costs-any grant funds for invasive plant work will be researched.	2018 to 2020- Initial
All	All	Over 200 acres	Site restoration, erosion control measures installation, trail blockading, and educational outreach about erosion and illegal trail use. Application and collaborating with Holyoke Conservation Commission as necessary.	Costs	2018 to 2026
All	All		Annual Monitoring: Invasive plant treatment success, invasive plant advance into harvest sites, erosion problems on road and trail network, and general forest health.	Costs	
All	All		Boundary Research and Maintenance		2016
All	All		Re-inventory of the site and completion of a new management plan.		2026

Crop Tree Management, Salvage Harvests, and Non-Harvest Techniques Employed:

The following discussion addresses the harvest technique and other non-harvest techniques necessary for the maintenance and regeneration of the ideal watershed filtration forest upon the 98 acres of McLean Reservoir.

Crop Tree Management (CTM)

CTM is a thinning technique used to promote the growth of trees that HWW wants to favor through the removal of less desirable trees. CTM increases the health and present value of a stand, and also enhances the stand's future value, by concentrating growth on the most desirable trees. Desirability depends upon the owner's objectives, and upon HWW reservoir lands suitable for silviculture, the desirability criteria is variable. The mechanics of the application of a CTM program are as follows:

- 1) Inventory the stand, choosing crop trees based upon the following criteria.
 - a) Timber Value: Crop trees should have high economic value, a dominant or co dominant healthy crown, few or no epicormic branches, no open wounds, no v-shaped or forked splits and must be well-adapted to the site.
 - b) Habitat: Crop trees will concentrate on oak, hickory, and beech mast bearing trees and those with cavities and holes for denning and nesting by wildlife.
 - c) Aesthetics: Crop Trees include tall ,stately pine or hemlock, oak trees with large, spreading crowns, hardwood trees with bright foliage along the shore line or trail sides.
- 2) Harvest only trees in direct competition with the crop trees. For best results, a four-sided release of a crop tree is optimal. (Cornell University 2009, by Bruce Ponsaran, Arnot Forest Intern). The openings will allow for seed germination and seedling development. Wise choice of the crop trees and diligent removals around them will assure adequate seed dispersal.
- 3) Less than 20% of the stocking levels would be removed in the forest stands from 2016 to 2016;
- 4) Relative density within the forest stands will be maintained between 65% to 85% in order to encourage optimal growth of this stand;
- 5) Crown closure will be maintained at or above 65% to 70% across the forest stands;
- 6) NHESP Conservation Management Practices for all species within the Priority Habitat Zones will be integrated into the harvest Cutting Practice Plan for the site;

Salvage Harvest

Salvage Harvests along with sanitation cuttings are prescribed to remove trees infested with insects or disease. These infested or infected trees may pose a threat to the remaining stand. In general, losses to insects and disease can be minimized through a regular thinning program. Proper thinning maintains the trees in the best physiological condition making them less susceptible to attack. Hemlock is currently under attack by the non-native wooly adelgid, and elongated hemlock scale. Most of the hemlock trees on the McLean Reservoir are advanced in their decline, and many have died. The emerald ash borer, another non-native pest, threatens white ash. The beech bark complex that includes both insect and fungal components heavily infects beech. Removing infected trees allows potentially resistant in the stand to flourish and provide possibly resistant seed. A common characteristic of stressed trees is to seed heavily just before they die. Unfortunately, facing an uncontrollable threat, these are not desirable trees to reproduce.

- 1) Less than 20% of the stocking levels would be removed in the forest stands from 2016 to 2016;
- 2) Relative density within the forest stands will be maintained between 65% to 85% in order to encourage optimal growth of this stand;
- 3) Crown closure will be maintained at or above 65% to 70% across the forest stands;
- 4) Integration of all applicable NHESP CMP's during the salvage work.

Disturbance of the Dense Native Shrubs:

Witch-hazel, ironwood, and mountain laurel in particular, along with other native shrubs can grow in thickets beneath the best seed producing trees. Removal of this understory shade is often more useful in procuring advance regeneration than altering the overstory stocking conditions. Their removal also frees water and soil resources for the crop trees. Some of these plants will be displaced with a timber harvest, but it may be necessary to enter the stand manually to reduce understory shrub stocking. Often it is too expensive to treat the entire stand pre or post harvest. In these instances, dense patches of native shrubs can be treated around just the future crop trees. Another benefit is that a greater diversity of forest floor herbaceous plants has access to sunlight, soil moisture, and nutrients, leading to greater diversity.

Invasive Plant Management:

Invasive plants, like Japanese barberry, Asiatic bittersweet, and multiflora rose can significantly inhibit regeneration and the future productivity of a forest stand. Usually escaped ornamentals, they have few natural enemies, and often have little to no wildlife value. In general preventing the spread of invasive plants is easier and less expensive than trying to control them. This plan recommends treatment of existing invasive plants prior to any timber harvest work with natural correctives. Treatment is necessary along the McLean Reservoir shoreline, along the main access roads, in a 200-foot wide strip adjacent to the Ashley Ponds access road and the McLean Reservoir loop road around the reservoir, and into the interior of Stands 2.01, 2.03, 2.06, and 2.08. Shade will be used throughout much of the forest ecosystems for control. Without any new sunlight across the forest floor, the current stocking densities may be managed at a low, non-threatening volume.

Annual monitoring inspections of the forest conditions post harvest for detection of spread into the regeneration zones of the stands which are suitable for silviculture (2.03, 2.06, and 2.09) will direct the use of resources for plant removals. Some of the removal work can be done manually with the removal of the plants from the soils. Brush cutting and mowing along the access roads and in some of the open zones near the reservoir is feasible. Toxic methods and the use of chemicals will not be permitted on the McLean Reservoir lands. HWW's management philosophy subscribes to the opinion that invasive plans, although a threat to the native ecosystem, should not introduce a more dangerous threat to water quality in their treatment. Other natural corrections include propane torch application, stem cutting and vinegar and borax application, and direct plant removal by tool or hand.

Hazard Tree Removals

The main access roads through McLean Reservoir lands and many of the trail networks are lined with stately, tall hardwoods and conifers. Severe weather events common with the climate change era, can create hazardous conditions within the crowns of these trees or with their toppling over or displacement of tree tops onto the forest floor. Adaptive watershed management allows for new decision making if a hazardous tree event arises. Amendments would be made to the management plan after review by all stakeholders, which would include the development of a prudent plan for hazard tree removal.

Adaptive Watershed Management

Adaptive resource management (ARM), is a structured, iterative process of robust decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring. In this way, decision making about the use and management of the forest resources on the McLean Reservoir simultaneously meets one or more resource management objectives and, either passively or actively, accrues information needed to improve future management. Adaptive management is a tool that will be used not only to change the watershed management system, but also to learn about the system.

Because adaptive management is based on a learning process, it improves long-run management outcomes. The challenge in using the adaptive management approach lies in finding the correct balance between gaining knowledge to improve management in the future and achieving the best short-term outcome based on current knowledge. The use of these lands as a primary biodiversity protection area is a new direction for HWW. The reproduction of the forest trees species is essential to the maintenance of the forest's filtration function. Diligent monitoring, documentation, and analysis will inform the watershed manager and all stakeholders about the effectiveness of this approach for the achievement of HWW stated Forest Stewardship and Green Certification Goals. This approach allows for the flexibility to evaluate the forest when a new threat to forest health, ecosystem function, or habitat condition develops in the future and change direction when necessary.

Methodology

Inventory Methodology: A sampling system was devised that used probability parameters proportional to the size of the trees sampled and the relationship between basal area and volume. The "double point" sampling system relies on the measurement of the basal area in all trees with a 20 basal factor gauge and the measurement of the tree metrics (diameter, height, and condition class) of a sub-set of these trees with a 40 basal area factor gauge. Its core is the method, known as variable plot sampling work, assigns chance of measurement of trees on each sample plot based upon its relative size with larger trees, which have a greater chance of measurement. One hundred and thirty seven points were taken across the watershed on a systematic grid design that was executed with a GPS field system throughout all three compartments of the watershed. The placement on the plots on the grid was generated by a random plot function in QGIS. The DS Cruiser computer program calculated the stand volumes, basal areas, and stand structure metrics. The raw field data is stored in an electronic file, as well as the computed reports on each stand's condition.

Site Index Methodology: Site index for each stand was estimated using data from Natural Resources Conservation Service, United States Department of Agriculture Web Soil Survey. This survey is available online at <http://websoilsurvey.nrcs.usda.gov/>. Site index by species was determined by weighted average based on the estimated percentage of the soil types within a stand.

Soils Methodology: Soils data were obtained from MassGIS, Office of Geographic Information, and Commonwealth of Massachusetts from the layer GISDATA_SOILS_POLY_SV_MUNAME. Stand maps were geo-referenced to the soils layer to delineate soil types.

Mapping Methodology: GIS data was obtained from MassGIS, Office of Geographic Information, and Commonwealth of Massachusetts. Layers included the following and the appropriate aerial imagery from the same source.

GISDATA_L3_TAXPAR_POLY_ASSESS

GISDATA_EOTROADS_ARC

GISDATA_HYDRO25K_ARC

GISDATA_HYDRO25K_POLY GISDATA_SOILS_POLY_SV_MUNAME

Stand maps, developed from aerial imagery and further refined during field investigation using GPS were geo-referenced to a base layer that covered the watershed. Forest Stands were numbered as a decimal (.01 – .15) within a watershed so that they can be sorted correctly. For example, the Hemlock Hardwood stand in the Manhan sub-watershed is numbered 3.08 – stand # 8 in watershed # 3.

Growth Rate Methodology: Growth rates were determined using the method that the state determines Chapter 61 tax valuations using an expected volume increase of 162 board feet per acre per year calculated from state Forest Inventory Analysis (FIA) data. The total expected average volume increase was determined by multiplying the total acreage of the stand by 162 board feet per acre.

Simple Regeneration Metric: Regeneration is described at different points in the inventory data and the management plan in the following manner using a simple metric.

- A – High Very dense regeneration.
- B – Moderate – intermediate level of stocking.
- C – Low – low to negligible stocking.

Simple Invasive Plant Metric: The stocking level of invasive plants is described using a simple metric.

- A – High Very dense stocking of invasive plants.
- B – Moderate – intermediate level of stocking.
- C – Low – low to negligible stocking.

Boundary Consideration:

The archives in the City of Holyoke –Holyoke water Works are not complete. Deeds and old property maps have been misplaced or lost. A boundary research and delineation project is underway for these lands with an anticipated completion date of December 2016. The record of the deed transfers is also incomplete. The City engineer is working with WFRM on the deed review. Revised Assessor records will be added to the management pan upon completion of this research.

Combination Forest Stand Descriptions and Management Practices for 2016 to 2026 by Stand

For the purposes of this report, a forest stand is an easily defined area that is relatively uniform in composition, and structure. If a stand is suitable for silviculture, the management data was presented directly after the stand descriptions. A summary of all the management strategies for the protection of water quality and biodiversity across the entire McLean Reservoir property was presented in the first section of the plan. Specific stand attributes that support the value of its habitat are mentioned in the stand description narratives.

Objective	Stand #	Forest Type	Stand Area (acres)	MSD or Size Class (inches)	Basal Area (sq.ft./ac)	Volume Per Acre	Site Index	DCR/FIA Growth Rate (MBF/yr.)
Stewardship Green Cert.	2.01	OM	23.0	12.9	98	4.393 MBF 7.5 cords	WP:55 RO:55	3.275

Water Quality Concerns: The goal for water quality protection on these watershed lands is the prevention of the movement of sediment and nutrients from the upland forests through the soils and streams into the McLean Reservoir during or after any silviculture treatments in the forested watershed. Preservation of current stocking levels will prevent any sediment movement.

Silviculture Status: Not Suitable.

Terrain/Topography: This area sits at the northern tip of the McLean Reservoir property north of Route #202. The terrain rises quickly to the west from Apremont Way, crests at two small hills, and then descends along a broad slope to the western bound.

Soils: The marginally productive Rock Outcropping Holyoke Complex soils lie beneath the stand. The small hilltops are covered in talus rock.

Timber Harvesting: Not applicable.

Overstory: This stand supports a two-aged structure with a composition of red oak (54% of stocking), black oak, white oak, chestnut oak, scarlet oak, hickory, red maple, and black birch. One small level terrace in the center of the stand supports a grove of maturing sugar maple (larger than 20 inches in diameter) trees with excellent cavities. A late 1990's harvest opened the canopy for the establishment of scattered dense thickets of red maple, red oak, black birch, and beech saplings and small pole trees. The quality of the red oak timber is fair, because many trees have bacterial wet wood at their base. The red maple crop of all sizes and ages is poorly formed with many stem defects. Small pockets of mature white pine trees dot the overstory.

Understory

Regeneration: The stand began its reproduction after the last harvest work. Red, black, white, scarlet, and chestnut oak, hickory, red maple, black birch, and white pine seedlings grow on the forest floor. Their density is variable dependent upon loam cover (overall rating of B), but all the seedlings appear healthy. Chestnut seedlings grow quickly to average heights of six feet across the lower strata.

Shrub and Herbaceous Cover: These dry, talus slopes support a unique blend of xeric shrub and plant cover. Plants cited include wintergreen, Christmas fern, tree club moss, broad-leaved beech fern, running cedar, hay scented fern, whorled loosestrife, and lamb's quarter. Dense thickets of

native shrubs were found in this area. Most prominent shrubs include witchhazel, sheep laurel, mountain laurel, low bush blueberry, maple leaved viburnum, and beaked hazelnut. A small native tree, ironwood, grows prolifically in this stand

Invasive Plants: The areas of the stand that adjoin both Apremont Way and Route #202 have been infiltrated with invasive plants. They have moved out of the small riparian area adjacent to this stand on Apremont Way. Closer to the road, they grow in dense thickets, yet they are consistently found in individual stems for a distance of 200 feet from the road edges. Species include Japanese barberry, bush honeysuckle, winged euonymous, and Asiatic bittersweet. These density rating is variable with an average of B+, and select zones near the in-take reservoir have an A rating.

Habitat: High nutrition hard and soft mast is set each year by the beech, oak, hickory, and birch trees. The stocking of white oak is a valuable habitat attribute, because these trees set ample annual crops of acorns. The severe winter storms in the last decade produced large amounts of coarse woody debris for invertebrate use across the forest floor. Ironwood holds its catkin-like fruit late into winter for a dense food source. Scattered tall white pine timber stems offer perching opportunity for the larger birds of prey neat the reservoirs. The small grove of sugar maple stems mid-stand provides excellent denning and nesting cavity.

Fire Protection: This stand is accessible from Apremont Way and Route #202 with a four-wheel drive pumper truck for fire management. Water is readily available in various sections. No fire events have occurred across this area for decades.

Desired Future Condition: The stand exists in a rudimentary all-age condition with its distinct two-storied structure. Each year more seedlings make it past the dense shrub layer into a larger size class. The natural development of the desirable watershed filtration forest will proceed slowly on these talus soils. Stand density is adequate for optimal growth of the oak and hardwoods crops on this dry site at this time. Overstory cover (estimate 84%) is a strong preventive measure against the spread of the invasive plants through the stand and protection of this priority habitat.

Recommended Management Practices: 1. Assessment of trail and access road condition, and subsequent maintenance of the trail surfaces for water quality protection. 2. Delineation and mapping of the invasive plants communities, and the initiation of a control problem within the next five years.

Objective	Stand #	Forest Type	Stand Area (acres)	MSD or Size Class (inches)	Basal Area (sq.ft./ac)	Volume Per Acre	Site Index	DCR/FIA Growth Rate (MBF/yr.)
Stewardship Green Cert.	2.02	OM	16.0	13.0	140	5.771 MBF 5 cords	WP:55 RO:55	2.592

Water Quality Concerns: The goal for water quality protection on these watershed lands is the prevention of the movement of sediment and nutrients from the upland forests through the soils and streams into the McLean Reservoir during or after any silviculture treatments in the forested watershed. The stand's location on the hilltops results in loss of talus rock, yet the stand is hydrologically remote.

Silviculture Status: Not Suitable.

Terrain/Topography: Three small sites cap the ridge tops of the old East Mountain.

Soils: Bedrock outcroppings and exposed basalt are common amongst the Rock Outcropping Holyoke Complex soils.

Timber Harvesting: Not applicable.

Overstory: The grove of red oak, scarlet oak, chestnut oak, black oak, and birches is slowly maturing on these ridge tops. The trees have short stature, many bole defects, and stunted vigor due to their rock base. Some scarring on the oldest red oak stems evidenced a history of fire.

Understory

Regeneration: Mixed oak seedlings poke above the dense shrub layer (stocking rating =C). Prolific Chestnut seedlings were noted. All of these young trees found little niches for survival amongst the rocks.

Shrub and Herbaceous Cover: Acidic Rock Cliff Communities are the least diverse of local habitats. They support low nutrient demanding plants such as blueberry, Virginia creeper, cliff fern, and harebell. The native shrubs common to the southern Massachusetts transition forest were common here in lower stocking densities (witchhazel, blueberry, and mountain laurel). Some areas of bald rocks support no ground cover.

Invasive Plants: Individual stems of Japanese barberry and winged euonymus were noted clinging to the rocks. Stocking rating is a C. These plants pose no threat to this ridge top ecotype.

Habitat: Small caves provide denning and nesting opportunities for bobcat, porcupine, and small mammals up on the high slopes. Peregrine falcons and other predator birds use the high cliffs and rocks as resting places and perching spots during the hunt.

Fire Protection: This stand is not accessible with a four-wheel drive pumper truck for fire management. Water is not readily available from any source up here. Scarring indicates an old fire in the area. If a fire event spread to these upper slopes, it would easily burn itself out of fuel.

Desired Future Condition: The high stocking level of mixed oak trees is slowly replacing itself on the high slopes. These groves provide soil and rock stability from their rooting systems. Viewed as a small sub-section of the ideal watershed filtration forest, they represent a maturing age class. No management work is recommended in this area.

Objective	Stand #	Forest Type	Stand Area (acres)	MSD or Size Class (inches)	Basal Area (sq.ft./ac)	Volume Per Acre	Site Index	DCR/FIA Growth Rate (MBF/yr.)
Stewardship Green Cert.	2.03	OH	48.0	14.0 Lower canopy: 6	115	5.500 MBF 11 cords	WP:55 RO:55	7.776

Water Quality Concerns: The goal for water quality protection on these watershed lands is the prevention of the movement of sediment and nutrients from the upland forests through the soils and streams into the McLean Reservoir during or after any silviculture treatments on the forested watershed. This area sits directly upslope of the McLean Reservoir, and management work here could affect water quality. Retention of 70% or more of crown closure will protect the forest soils from displacement.

Silviculture Status: Suitable.

Terrain/Topography: The stand drops off the talus cliffs onto a long, undulating slope with some terracing before its terminus on the reservoir shore.

Soils: The marginally productive Rock Outcropping Holyoke Complex soils lie beneath this stand. Basalt rock is exposed on sections of the slope, yet the lower slope soils are stone free. These shallow, draughty soils grow timber crops very slowly.

Timber Harvesting: Careful design of harvest road system should avoid direct descent of the slopes and run across the contour. Placement of erosion control measures along all hauling roads after any work will reduce the velocity of overland flow and retain sediment. Restoration of the old road system will prevent further site degradation and minimize threats to water quality.

Overstory: A rudimentary all-age stand structure developed across this stand. The 1990's harvest created canopy openings, which filled with sapling now almost 30 years of age. Above these trees grows a maturing layer of red oak (51% of the stocking), white oak, hickory, red maple, black birch, paper birch, and sugar maple. The hemlock crop survived across the lower slopes (9% of the stocking), yet many standing dead stems succumbed to the combination of elongated scale and wooly adelgid attacks. Surviving trees have lost over 75% of their needles. The red oak crop has good form and high value, and the young black birch, red oak, hickory, and white pine have good quality. Red maple of all ages suffers from dry site defects. Severe ice and snow events damaged the crowns of over 60% of the trees.

Understory

Regeneration: Beneath this middle layer, one finds a sparse, yet consistent stocking of oak, birch, hickory, hemlock, pine, and maple seedlings. The stocking rating is a C. Hemlock seedling have needle dieback also, yet the other species appear healthy. This stocking has not adequately regenerated the maturing stand of oak and hardwood yet.

Shrub and Herbaceous Cover: These dry, talus slopes support a unique blend of xeric shrub and plant cover. Plants cited include wintergreen, Christmas fern, tree club moss, broad-leaved beech fern, running cedar, hay scented fern, whorled loosestrife, and lamb's quarter. Dense thickets of native shrubs were found in this area. Their stocking levels are prohibitive for the further development of the tree seedling class. Most prominent shrubs include witchhazel, sheep laurel, mountain laurel, low bush blueberry, maple leaved viburnum, and beaked hazelnut. Musclewood and ironwood (two small native trees) grow here

Invasive Plants: The invasive plant community spread into this stand from the access road along the McLean Reservoir. The edge and transition zone into the forest supports dense thickets of these plants. An old AT&T cable line crossing this stand is heavily seeded to these plants. Individual plants dot the interior of the stand. Species include Japanese barberry, bush honeysuckle, winged euonymous, and Asiatic bittersweet. These density rating is variable with an average of B+, and the edge and the old AT&T line have an A rating.

Habitat: High nutrition hard and soft mast is set each year by the beech, oak, hickory, and birch trees. The severe winter storms in the last decade produced large amounts of coarse woody debris for invertebrate use across the forest floor. Ironwood holds its catkin-like fruit late into winter for a available food source. A small grove of maturing white pine trees at the northern end of the reservoir provides an excellent perching zone for birds near the water. Tracks were observed in the first snow from raccoon, white tailed deer, otter, and coyote.

Fire Protection: This stand is accessible from the gravel access road along the reservoir with a four-wheel drive pumper truck for fire management. Water is readily available from the reservoir for protection in the event of a fire. No fire events have occurred across this area for decades.

Special Stewardship Considerations: Abuse of the existing trail network by trespassers has destroyed the integrity of these trails and the old AT&T line. Although much of the sediment does

not enter the reservoir, maintenance and restoration of these trail surfaces will protect water quality.

Desired Future Condition: It is advisable to further develop the all-aged, species diverse, resilient watershed filtration structure in this stand. Reproductive stocking is limited and in competition with native shrubs and invasive plants. Even conservative canopy openings will introduce a new age class. Stand density is over 100%, which indicates that the stand is overstocked for optimal utilization of the trees here.

Recommended Management Practices: 1. Delineation and mapping of the invasive plants communities, and the initiation of a control program within the next five years. This work must be done before any silviculture work in the forest stands. 2. Assessment of trail and access road condition, and subsequent maintenance of the trail surfaces for water quality protection and restoration of site integrity. 3. Application of a Crop Tree Management program across the stand, and the salvage of the dying hemlock crops. 4. Seedbed Preparation: Treatment of the dense native shrub plants in the immediate area of seed bearing crop trees and disturbance to the thick leaf litter.

Stand Number	Forest Type	Silviculture Practice	Stand Area (acres)	Basal Area Removal (sq.ft/ac)	Volume Removal (MBF)	Firewood Removal (Cords)	Pulpwood Removal (Cords)	Timing
2.03	OH	Crop Tree Management	48	<=20	50 MBF	60 cords	<20 cords hemlock	2022-2024

Management Practice Objective: The long-term objective for this stand is the further development of the all-aged, species diverse, ecologically resilient watershed forest capable of natural water filtration and purification. These stands are lacking the youngest age classes. Crown openings result from a carefully planned Crop Tree Management harvest encourage the development of the desired optimal watershed forest condition. The Salvage Harvest of the minor components of hemlock across this stand addresses financial issues. The release of the crowns of the red oak, aspen, hickory, and black birch (in both upper and lower strata) crop trees improves their growth and quality. Harvest levels will not exceed 20% of stocking, and crown closure will be maintained at 70% or greater. Use of the Massachusetts Best Management Practices for timber harvesting will protect water quality.

Trees to be removed and retained: Crop trees in this stand will be selected for timber value improvement, seed dispersal, and habitat value retention. Red oak trees larger than 20 inches in diameter with full, vigorous crowns will be retained as desirable crop trees. Scattered maturing white pine and sugar maple “wolf trees”, and any uncommon species such as linden, tulip poplar, and butternut will be retained for diversity. An estimate of 35 to 50 crop trees will be retained per acre. All of the crop trees hold dominant and co-dominant crown positions. These trees will be released on all four sides. Space will be made on the forest floor for seedling development, so trees in all canopy layers will be removed from all four sides of these crop trees. Trees for harvest include sapling and small pole black birch, red maple, white oak, and hickory, dying hemlock trees of all sizes, and a small portion of the high value red oak sawtimber, pallet birch, hickory and oak timber sized trees

Regeneration Concerns: Intentional disturbance to the native shrub layer during the harvest work should allow for seedling development.

Soil Considerations: The existing road system hauled timber products directly downhill, which is undesirable as it is more likely to lead to erosion and sedimentation. Cross contour road building is

suggested for the proposed work. These soils drain water into the McLean Reservoir, and the forest biofilter works to pull out sediment and nutrients before its transfer to the reservoir. Careful engineering and the installation of emergency erosion control measures at the necessary minor stream crossings will minimize sediment loss into the stream flow. Scheduling of all harvest work during suitable conditions such as in the winter months will prevent undue disturbance to the roads and soils. Priority habitat zones require frozen ground disturbance under Massachusetts Endangered Species regulations.

Boundary Concerns: The boundaries in this area are not delineated. Research of the deeds and boundary delineation is necessary before the preparation of a harvest project.

Invasive Plant Management: Treatment of the plants in the stand interior and on the edges is recommended to prevent their spread. Annual monitoring inspections of the forest conditions post harvest for detection of spread into the regeneration zones will direct the use of resources for plant removals. The removal work can be done manually with the removal of the plants from the soils and with mowing and brushing along the road edge and the old AT&T line.

Habitat Considerations: The proposed harvest will increase the vertical stratification within this stand and enhance biodiversity. Retention of some of the dying hemlock crop provides future cavity trees. Release of the oak crop trees will also increase available mast for feed. The silviculture practices will incorporate the guidelines of existing Conservation Management Practices from Massachusetts Division of Fish and Game NHESP publications. Retention of over 75% crown closure assures upland habitat integrity.

Objective	Stand #	Forest Type	Stand Area (acres)	MSD or Size Class (inches)	Basal Area (sq.ft./ac)	Volume Per Acre	Site Index	DCR/FIA Growth Rate (MBF/yr.)
Stewardship Green Cert.	2.04	RZ-HH-RM	26.0	14.0 inches Lower canopy: 6 inches	85 SF Forested Zones	2.500 MBF 3 cords	WP:55 RO:55	1.025

Water Quality Concerns: The goal for water quality protection on these watershed lands is the prevention of the movement of sediment and nutrients from the upland forests through the soils and streams into the McLean Reservoir during or after any silviculture treatments in the forested watershed. The water moves through these riparian zones as it leaves the reservoir.

Silviculture Status: Not Suitable.

Terrain/Topography: This stand is scattered across the McLean Reservoir property filling in the depressions and sinkholes in the bedrock and alluvial outwash sands.

Soils: Riparian zones on the upper slope lay above the Rock Outcroppings and Holyoke Complex soils, yet the lower slopes and alluvial plain formations support these wetlands above the deep, poorly drained Swansea and Freetown soils. These stratified sands are subject to frequent flooding.

Timber Harvesting: Not applicable.

Narrative: Riparian areas are lands that occur along watercourses and water bodies. On this property they include flood plains, forested wetlands, beaver ponds, shallow marshes, shrub swamps, vernal pools, ponds, and reservoir and stream banks. They are distinctly different from

surrounding lands because of unique soil and vegetation characteristics that are influenced by the presence of water. The following is a brief summary of each riparian ecotype on the property:

Forested wetland: FW: 13.5 acres: Two of the forested wetland areas lie at the base of talus cliffs and steep slopes. An interconnected web of forested wetlands lies south of the earthen dam, and one small spot is found in the northeast corner of the property adjacent to Ashley Ponds. Dense red maple poles and small timber sized trees grow beneath scattered hemlock and oak timber trees. All of these areas have substantial dead standing material within them.

Small floodplain on the west shore of McLean Reservoir: 2.0 acres A dying red pine plantation was removed from this area over ten years ago. An even blend of native and invasive plants covers this site now. Native plants cited here included spicebush, red osier dogwood, grey-pinnacled dogwood, winterberry, speckled alder, cinnamon fern, sensitive fern, sumac, and blue flag iris. All of the invasive plants noted in the 2009 Williams College study were found in this small circle of land. A stream arcs around the western bound of the stand, and a small marsh adjoins this stream.

Vernal Pools: 3.5 acres: Vernal pools formed across this property in the low depression areas that are underlain with impenetrable volcanic rock. Water is prevented from percolating underground, leaving evaporation the only means of escape. Vernal pools are essential to the lifecycle of the obligate species such as fairy shrimp, mole salamanders, and wood frog.

Shrub Swamp: 2.0 acres: Several areas of moist swamps that support dense thickets of witchhazel, blueberry, alder, and winterberry dot the landscape. These areas are surprisingly free of invasive plants.

Ponds: 3.0 acres: Inclusive of the small in-take reservoir north of Route #202:.

Beaver Pond: 2.0 acres: This narrow beaver pond lies between two small ridge tops of basalt rock in the southern area of the property.

Invasive Plants: The invasive plant communities have spread into the riparian and wetland stands. Native plants compete very well on the most soils, and they appear to co-exist. No control treatments would be used within the riparian zones. Retention of closed canopy around these small ecotypes will prevent spread of the exotic plants.

Function: Because these riparian zones occupy low areas in the landscape, ground water is generally nearer to the surface and available for plants. The fine-textured sediments in flood plains hold large amounts of water. These two conditions promote productive and diverse plant communities. Nutrients for plant growth in riparian ecosystems depend on sedimentation of nutrient-rich organic matter and on the dissolved nutrients in the water. Riparian zones are often nutrient-rich ecosystems. Because flooding occurs periodically, and ground water moves through flood plain soils, the surface layers of soils are wetted and dried seasonally. The presence and movement of the surface and ground water enhance the recycling of nutrients and other chemical reactions beneficial to plant growth within the riparian zone.

Fire Protection: High water table throughout these areas does not pose a fire hazard.

Desired Future Condition: These sites function as core habitat and water filtration strips across the landscape. No disturbance is recommended in these sites.

Objective	Stand #	Forest Type	Stand Area (acres)	MSD or Size Class (inches)	Basal Area (sq.ft./ac)	Volume Per Acre	Site Index	DCR/FIA Growth Rate (MBF/yr.)
Stewardship Green Cert.	2.05	WP -SP	2.5	20	65 Forested Zones	6.500 MBF 11 cords	WP:60 RO:60	.405

Water Quality Concerns: The goal for water quality protection on these watershed lands is the prevention of the movement of sediment and nutrients from the upland forests through the soils and streams into the McLean Reservoir during or after any silviculture treatments in the forested watershed. This stand sits on the western shore of McLean Reservoir, and it represents the last natural filter for sediment moving down slope. Retention of full crown cover will protect water quality.

Silviculture Status: Not Suitable.

Terrain/Topography: This small stand rests in a narrow sliver of land upon the alluvial flood plain on the banks of the reservoir.

Soils: The marginally productive Rock Outcropping Holyoke Complex soils lie beneath the stand.

Timber Harvesting: Not applicable.

Narrative: Maturing white pine and Norway spruce tower above a layer of dense native shrub layer. Invasive plants compete strongly in the lower strata. The overstory shade prevents their full exploitation of the small site. The tall, stately trees offer ideal perching and nesting sites for birds and small mammals. The trees are healthy with vigorous needles. The vertical stratification between the trees and the shrub and herbaceous layer invites songbird use. The extensive branching in both conifers provides nesting material and locations. Invasive plants grow through this narrow band. Species cited include bush honeysuckle, winged euonymous, Japanese barberry, privet, and Asiatic bittersweet. Native grapes also climb into many of the tall pines.

Desired Future Condition: As long as these trees stay healthy without threat of blow down, their retention along the reservoir shore increases the habitat quality and local biodiversity. If hazardous conditions develop or their health declines, their removal is recommended.

Recommended Management Practices: The plants cannot migrate to the east so their control is low priority. An assessment of the plant composition and the best strategy for control is recommended during 2016. Treatment is recommended within five years. Mechanical control is recommended with hand pulling, plant removal, and mowing/brush cutting. The trees exposure on the reservoir edge increases the chances of snapping or toppling over in a storm event. Hazard tree monitoring each year could determine the need for some hazard tree removals.

Fire Protection: The site is very accessible and close to available water. No fire event occurred over the last decade. The hazard is low in this stand.

Objective	Stand #	Forest Type	Stand Area (acres)	MSD or Size Class (inches)	Basal Area (sq.ft./ac)	Volume Per Acre	Site Index	DCR/FIA Growth Rate (MBF/yr.)
Stewardship Green Cert.	2.06	OH	52.0	13.4	113	5.105 MBF 8 cords	WP:55 RO:55	8.240

Water Quality Concerns: The goal for water quality protection on these watershed lands is the prevention of the movement of sediment and nutrients from the upland forests through the soils and streams into the McLean Reservoir during or after any silviculture treatments in the forested watershed. The stand is remote from direct impact on the reservoir. Retention of 70% or more of crown closure will protect the forest soils from displacement.

Silviculture Status: Suitable on 30 acres of the stand. The southern portion is not accessible without a private lands right-of-way. Trespassers have damaged this road with illegal all terrain vehicle use.

Terrain/Topography: The stand stretches along the upper and mid-talus slope in the southern portion of the property. Two sections are separated by a private ownership and connected by an old road.

Soils: The marginally productive Rock Outcropping Holyoke Complex soils lie beneath the stand. Basalt rock is exposed on sections of the slope, and the talus rock is sloughing down slope in many areas. These shallow, draughty soils grow timber crops very slowly.

Timber Harvesting: Careful design of harvest road system should avoid direct descent of the slopes and run across the contour. Placement of erosion control measures along all hauling roads after any work will reduce the velocity of overland flow and retain sediment.

Overstory: The past harvest pattern produced the rudiments of an all-aged mixed oak and hardwood stand. Maturing red oak (56% of stocking), sugar maple (12%), scarlet oak red maple, paper birch, black birch, white ash, and white oak grow above scattered pockets of sapling and pole sized trees of predominantly red oak, chestnut oak, black birch, sugar maple, and red maple. The quality of the red oak timber crop is very good. The hemlock trees are dying quickly in this area from the scale and wooly adelgid dual attack. Paper birch is also declining with age.

Understory

Regeneration: Seedling development was better in this area than in Stand 2.03. Healthy seedlings of birch, maple, all the oaks, and white pine dot the forest floor. The stocking rating is a B+. Chestnut seedlings were prolific.

Shrub and Herbaceous Cover: These dry, talus slopes support a unique blend of xeric shrub and plant cover. Plants cited include wintergreen, Christmas fern, tree club moss, broad-leaved beech fern, running cedar, hay scented fern, whorled loosestrife, and lamb's quarter. Dense thickets of native shrubs were found in this area. Their stocking levels are prohibitive for the further development of the tree seedling class. Most prominent shrubs include witchhazel, sheep laurel, mountain laurel, low bush blueberry, maple leaved viburnum, and beaked hazelnut. Low bush blueberry mats some sections of the forest.

Invasive Plants: No substantial invasive plant community has found its way to this stand at this time. No threat exists here to the native plant community.

Habitat: High nutrition hard and soft mast is set each year by the beech, oak, hickory, and birch trees. The severe winter storms in the last decade produced large amounts of coarse woody debris for invertebrate use across the forest floor. The dense shrub cover provides forage and breeding sites for songbirds. A small grove of mature white pine sits on top a small knoll in the southern section adjacent to a beaver swamp. They offer perching and denning opportunities. The standing hemlock trees are also good cavity trees.

Fire Protection: This stand is not easily accessible with a four-wheel drive pumper truck for fire management. No fire events have occurred across this area for decades. Reliance on the local firefighting community and shared equipment would be the protocol for response to a fire event.

Special Stewardship Considerations: Abuse of the existing trail network by trespassers has destroyed the integrity of these trails and the old AT&T line into this remote area. Although much of the sediment does not access the reservoir, maintenance and restoration of these trail surfaces will protect water quality. An old cart road is still visible across the mid-slope area. The path was cut into the slope by hand and a stone embankment was placed below its bed. Timber trespass activity occurred along the western boundary.

Desired Future Condition: It is advisable to further develop the all-aged, species diverse, resilient watershed filtration structure in this stand. Reproductive stocking is limited and in competition with native shrubs and invasive plants. Even conservative canopy openings will introduce a new age class. Stand density is 98%, which indicates that the stand is overstocked for optimal utilization of the trees here.

Recommended Management Practices: 1.. Application of a Crop Tree Management program across 30 acres of the stand. 2. Seedbed Preparation: Treatment of the dense native shrub plants in the immediate area of seed bearing crop trees and disturbance to the thick leaf litter. 3. Assessment of trail and access road condition, and subsequent maintenance of the trail surfaces for water quality protection.

Stand Number	Forest Type	Silviculture Practice	Stand Area (acres)	Basal Area Removal (sq.ft)	Volume Removal (MBF)	Firewood Removal (Cords)	Pulpwood Removal (Cords)	Timing
2.06	OH	Crop Tree Management	30	<=20	35 MBF	50	--	2017 to 2019

Management Practice Objective: The long-term objective for this stand is the mature development of the all-aged, species diverse, ecologically resilient watershed forest capable of natural water filtration and purification. These stands are lacking the youngest age classes. Crown openings result from a carefully planned Crop Tree Management harvest encourage the development of the desired optimal watershed forest condition. The release of the crowns of the crop trees improves their growth and quality. Harvest levels will not exceed 20% of stocking, and crown closure will be maintained at 70% or greater. Use of the Massachusetts Best Management Practices for timber harvesting will protect water quality.

Trees to be removed and retained: Crop trees in this stand will be selected for timber value improvement, seed dispersal, and habitat value retention. Desirable crop trees are red oak trees larger than 20 inches in diameter with full, vigorous crowns and large sized white pine and sugar maple “wolf” trees. An estimate of 30 or more crop trees will be retained per acre, all in the

dominant and co-dominant crown position. These trees will be released on all four sides. Space will be made on the forest floor for seedling development, so trees in all canopy layers will be removed from all four sides of these crop trees. Trees for harvest include sapling and small pole black birch, red maple, white oak, and hickory, scattered high value mature white pine overstory remnants, and a small portion of the high value red oak sawtimber, pallet birch, hickory and oak timber sized trees

Regeneration Concerns: Intentional disturbance to the native shrub layer during the harvest work should allow for seedling development.

Soil Considerations: The existing road system into this area is not suitable for future use. Restoration of these trails and roads is recommended for water quality protection. A new road will be constructed for the proposed harvest work upslope to the west close to the western boundary. Careful engineering, and the installation of emergency erosion control will minimize sediment loss into the stream flow. Scheduling of all harvest work during suitable conditions such as the winter months will prevent undue disturbance to the rods and soils. Priority habitat zones require frozen ground disturbance under Massachusetts Endangered Species regulations.

Boundary Concerns: The boundaries in this area are not delineated. Research of the deeds and boundary delineation is necessary before the preparation of a harvest project.

Habitat Considerations: The proposed harvest will increase the vertical stratification within this stand and enhance biodiversity. Release of the oak crop trees will also increase available mast for feed. The silviculture practices will incorporate the guidelines of existing Conservation Management Practices from Massachusetts Division of Fish and Game NHESP publications. Retention of over 75% crown closure assures upland habitat integrity.

Objective	Stand #	Forest Type	Stand Area (acres)	MSD or Size Class (inches)	Basal Area (sq.ft./ac)	Volume Per Acre	Site Index	DCR/FIA Growth Rate (MBF/yr.)
Stewardship Green Cert.	2.07	OH	133.1	12.9	135	8.075 MBF 8 cords	WP:60 RO:60	3.275

Water Quality Concerns: The goal for water quality protection on these watershed lands is the prevention of the movement of sediment and nutrients from the upland forests through the soils and streams into the McLean Reservoir during or after any silviculture treatments in the forested watershed. Preservation of current stocking levels will prevent any sediment movement.

Silviculture Status: Not Suitable.

Terrain/Topography: This stand spreads across the southern tier of the watershed with a long narrow arm stretching north on the Ashley Ponds access road. The terrain consists of rolling slopes and undulating ridge tops in the southern most portion, and a broad alluvial outwash terraces as one moves north in the stand. Small depressions were gouged in the landscape from the glaciers, which support ponds, vernal pools, and shrub swamps.

Soils: The marginally productive Rock Outcropping Holyoke Complex soils lie beneath the bulk of the stand with its corresponding low forest productivity. The eastern portion of the stand lies above the deep, productive Charlton soils. Some of the largest red oak on the property is growing in these moist, rich soils. Talus rock juts out of the small ridge tops, and one calciferous cliff drops into the beaver pond.

Timber Harvesting: Not applicable.

Overstory: The general stand composition is mixed oak, birch, maple, ash, and scattered pockets of maturing white pine. The quality of the trees is fair to good with some exceptionally high value red oak timber crops. More importantly the stand is healthy and vigorous with minimal health threats from disease and insects. Sections of the stand were harvested in the 1990's. Several unique ecotypes are found within this larger oak hardwood grove.

Immediately south of the earthen dam across the reservoir, groves of immature red oak, yellow, paper, and black birch, and sugar and red maple pole trees are growing fast in a moist flood terrace. Water seeps out of the dam into this area in a down slope gradient pump system. Invasive plant communities cover the forest floor in this moist site. Their control is not a high priority, as their spread seems to be limited out of the wet zone.

The land rises from the large forested wetland in the southern portion of the stand and undulates across two ridge tops, which are separated by a beaver pond. The beaver are desperate for food and are climbing into the upland and chewing on trees over 16 inches in diameter.

This stand supports the vast riparian formations in shrub swamps, vernal pools, and small volcanic rock lined ponds.

A narrow band of white pine forest is nested within this stand along the Ashley Ponds access road on the eastern stand bound. Invasive plants have exploited most of the growing space beneath these trees. This band extends north along the gravel access road, and Scotch pine trees were growing in this strip.

Understory

Regeneration: The stand is slowly replacing itself with the mixed oak species, red and sugar maple, hickory, white pine (dense thickets near any seed source), cherry, and birch seedlings. These young trees are healthy, and they compete heavily with the shrub layer. Reproduction began after the last harvest work. Their density is variable dependent upon loam cover (overall rating of B), but all the seedlings appear healthy. Chestnut seedlings grow quickly to average heights of six feet across the lower strata.

Shrub and Herbaceous Cover: These dry, talus slopes support a unique blend of xeric shrub and plant cover. Plants cited include wintergreen, Christmas fern, tree club moss, broad-leaved beech fern, running cedar, hay scented fern, whorled loosestrife, and lamb's quarter. Dense thickets of native shrubs were found in this area. Most prominent shrubs include witchhazel, sheep laurel, mountain laurel, low bush blueberry, maple leaved viburnum, and beaked hazelnut. The terrace between the two ridge tops in the southern portion is covered in a mat of mountain laurel and blueberry.

Invasive Plants: The areas of the stand that adjoin the old AT&T line and the gravel access road in Ashley Ponds have been exploited by these plant communities. Closer to the road, they grow in dense thickets, yet they are consistently found in individual stems for a distance of 200 feet from the road edges. Species include Japanese barberry, bush honeysuckle, winged euonymus, privet, and Asiatic bittersweet. These density rating is variable with an average of B+, and select zones have an A rating. Although these plant communities are thriving, retention of the full forest cover should contain their further spread. The edges along the road can be controlled with mowing and brush cutting.

Habitat: High nutrition hard and soft mast is set each year by the beech, oak, hickory, and birch trees. The stocking of white oak is very valuable, as these trees set ample annual crops of acorns. The severe winter storms in the last decade produced large amounts of coarse woody debris for invertebrate use across the forest floor. A grove of maturing hemlock adjacent to the beaver pond

offers excellent habitat trees near a water source. The dense mat of blueberry and laurel is ideal cover for foraging and breeding of songbirds and small mammals. Moose sign was obvious during the field inventory in tracks, scat, and browsing damage.

Fire Protection: This stand is accessible from the Ashley Ponds access road with a four-wheel drive pumper truck for fire management. Water is readily available in various sections. No fire events have occurred across this area for decades.

Desired Future Condition: The stand exists in the ideal all-age, species diverse, resilient water filtration structure condition. Each year more seedlings make it past the dense shrub layer into larger size classes. Its natural development into the desirable watershed filtration forest will proceed slowly on these talus soils. Stand density is adequate for optimal growth of the oak and hardwoods crops on this dry site at this time. Overstory cover (estimate 78%) is a strong preventive measure against the spread of the invasive plants through the stand.

Recommended Management Practices: 1. Assessment of trail and access road condition, and subsequent maintenance of the trail surfaces for water quality protection. 2. Delineation and mapping of the invasive plants communities, and the initiation of a control problem over the next five years on the eastern edge of the stand.

Objective	Stand #	Forest Type	Stand Area (acres)	MSD or Size Class (inches)	Basal Area (sq.ft./ac)	Volume Per Acre	Site Index	DCR/FIA Growth Rate (MBF/yr.)
Stewardship Green Cert.	2.08	OH	13.0	13.0	144	5.950 MBF 9 cords	WP:70 RO:70	2.106

Water Quality Concerns: The goal for water quality protection on these watershed lands is the prevention of the movement of sediment and nutrients from the upland forests through the soils and streams into the McLean Reservoir during or after any silviculture treatments in the forested watershed. Retention of crown closure without disturbance will protect water quality from sediment displacement in this small stand.

Silviculture Status: Not Suitable.

Terrain/Topography: The terrain sweeps eastward from the water treatment facility across abroad slope.

Soils: The stand grows above the marginally productive, shallow Rock Outcrop and Holyoke Complex talus soils.

Timber Harvesting: Not applicable.

Overstory: A heavy timber harvest in the late 1990's removed large volumes of high value red oak from this small stand. The residual stand is naturally developing into an all-aged aggregate with the mature overstory red, chestnut, black, and white oak, beech, sugar maple, and black birch above sapling and pole stems of red oak, black birch, red and sugar maple, and aspen. The oak crop is valuable. The black birch crop is infected here with the nectria complex.

Understory

Regeneration: Mixed oak, birch, and maples seedlings have developed on the forest floor. The stocking rating is a B+. Chestnut seedlings grow quickly to average heights of six feet across the lower strata. All the seedlings appear healthy and vigorous.

Shrub and Herbaceous Cover: A dense native shrub and herbaceous plant layer mats sections of this slope between the talus rocks. Some of the species cited include mountain laurel, beaked hazelnut, maple leaved viburnum, blueberry, sheep-laurel, Christmas fern, hay scented fern, and sweet fern.

Invasive Plants: The large crown openings gave the invasive plant community an edge in the exploitation of this stand. The stocking rating of these plants is an A here. The most common species were Japanese barberry, bush honeysuckle, winged euyonomous, and Asiatic bittersweet.

Habitat: The hemlock crop died out of this stand and left in its wake ample standing dead cavity trees. The dense herbaceous and shrub layer provides foraging and breeding cover for small mammals and songbirds. The beech crop provides palatable, high nutritive value mast.

Fire Protection: This stand is accessible with a four-wheel drive pumper truck for fire management. Water is readily available. There is no evidence of a past fire event.

Desired Future Condition: This stand will further develop its all-aged, species diverse, natural filtration forest structure over the next decade. The relative stand density is 108%, which indicates full stocking by the overstory trees. Retention of the closed canopy will prevent the advancement of the invasive plants westward.

Objective	Stand #	Forest Type	Stand Area (acres)	MSD or Size Class (inches)	Basal Area (sq.ft./ac)	Volume Per Acre	Site Index	DCR/FIA Growth Rate (MBF/yr.)
Stewardship Green Cert.	2.09	HH	22.5	13.8	103	5.486 MBF 6.5 cords	WP:55 RO:55	3.645

Water Quality Concerns: The goal for water quality protection on these watershed lands is the prevention of the movement of sediment and nutrients from the upland forests through the soils and streams into the McLean Reservoir during or after any silviculture treatments in the forested watershed. Retention of the current full crown closure (85%) will protect the forest soils from displacement.

Silviculture Status: Suitable.

Terrain/Topography: This stand greets the visitor to the McLean facility with its location near the main gate. The stand rises up to the crest of two small hilltops from the east shore of the reservoir before its steady descent across a wide slope into a small, forested wetland at the northeast corner of the property.

Soils: The marginally productive Rock Outcropping Holyoke Complex soils lie beneath the stand. These shallow, draughty soils grow timber crops very slowly.

Timber Harvesting: Careful design of harvest road system should avoid direct descent of the slopes and run across the contour. Placement of erosion control measures along all hauling roads after any work will reduce the velocity of overland flow and retain sediment.

Overstory: The past harvest pattern produced the rudiments of an all-aged mixed red oak, black oak, white oak, red maple, black birch, tulip poplar, hemlock, and white pine stand. The quality of the red oak timber crop is very good. The hemlock trees are dying quickly in this area from the scale and wooly adelgid dual attack. Hazard tree removals have been made throughout the stand near the access road.

Understory

Regeneration: Overstory shade prevents prolific seedling development. Seedlings of chestnut, birch, maple, all the oaks, and white pine dot the forest floor. The stocking rating is a C here.

Shrub and Herbaceous Cover: These dry, talus slopes support a unique blend of xeric shrub and plant cover. Plants cited include wintergreen, Christmas fern, tree club moss, broad-leaved beech fern, running cedar, hay scented fern, whorled loosestrife, and lamb's quarter. Dense thickets of native shrubs were found in this area. Most prominent shrubs include witchhazel, sheep laurel, mountain laurel, low bush blueberry, maple leaved viburnum, and beaked hazelnut. Low bush blueberry mats some sections of the forest.

Invasive Plants: Invasive plants were found along the access road, the reservoir edge, and vey dense thickets were found along the edge of the forested wetland on the east bound. The most common plants were Japanese barberry, winged euyonomous, bush honeysuckle, and Asiatic bittersweet. Retention of full crown shade should prevent their further spread into this stand.

Habitat: High nutrition hard and soft mast is set each year by the beech, oak, hickory, and birch trees.

The proximity of this stand to Route 202 seem like a deterrent for wildlife, yet during the field inventory a hawk was observed perched in a tall pine tree. Use of the dying hemlock by the pileated woodpecker was also noted.

Fire Protection: This stand is easily accessible with a four-wheel drive pumper truck for fire management. Available water is also accessible for prevention. No fire events have occurred across this area for decades.

Special Stewardship Considerations: This shady grove lines the access road providing a peaceful appearance to the visitor. Water collects on the west ditch of the access road, and a small marsh niche is forming with common reed and sedges. A pleasant vista onto the reservoir can be found on the small knoll to the west of the access road.

Desired Future Condition: It is advisable to further develop the all-aged, species diverse, resilient watershed filtration structure in this stand. Reproductive stocking is limited and in competition with native shrubs and invasive plants. Even conservative canopy openings that result from salvage cuttings will introduce a new age class.

Recommended Management Practices: 1.. Application of a Salvage Harvest amongst the dying hemlock crop. 2. Assessment of the invasive pant community and the initiation of a control program within five years.

Stand Number	Forest Type	Silviculture Practice	Stand Area (acres)	Basal Area Removal (sq.ft)	Volume Removal (MBF)	Firewood Removal (Cords)	Pulpwood Removal	Timing
2.09	HH	Salvage Harvest	22	<=20	35	--	20 cords hemlock	2017 to 2019

Management Practice Objective: The long-term objective for this stand is the further development of the all-aged, species diverse, ecologically resilient watershed forest capable of natural water filtration and purification. These stands are lacking the youngest age classes. The salvage of the declining hemlock crop will open the canopy for seedling development. Harvest levels will not exceed 20% of stocking, and crown closure will be maintained at 70% or greater. Use of the Massachusetts Best Management Practices for timber harvesting will protect water quality.

Trees to be removed and retained: Hemlock trees of all sizes and ages will be removed in this proposed harvest. Trees with more than 75% of their crown dead will be harvested.

Regeneration Concerns: Intentional disturbance to the native shrub layer during the harvest work should allow for seedling development.

Soil Considerations: Careful engineering and the installation of emergency erosion control measures along the road system will minimize sediment loss. Scheduling of all harvest work during the winter months will prevent undue disturbance to the rods and soils. Priority habitat zones require frozen ground disturbance under Massachusetts Endangered Species regulations.

Habitat Considerations: The proposed harvest will increase the vertical stratification within this stand and enhance biodiversity. Retention of some the dying hemlock crop provides future cavity trees. Release of the oak crop trees will also increase available mast for feed. The silviculture practices will incorporate the guidelines of existing Conservation Management Practices from Massachusetts Division of Fish and Game NHESP publications. Retention of over 75% crown closure assures upland habitat integrity.

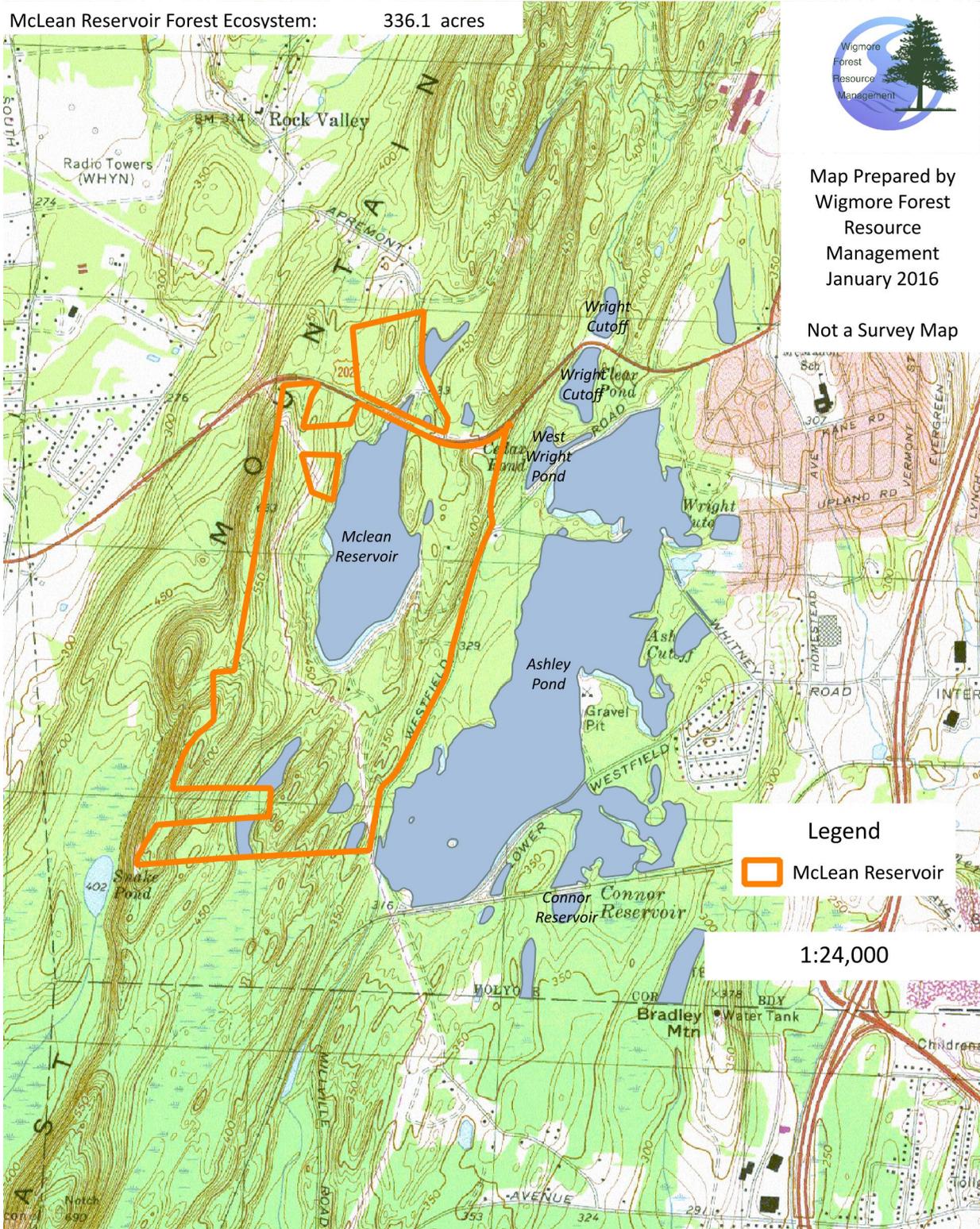
Holyoke Water Works McLean Reservoir Watershed Locus Map

McLean Reservoir Forest Ecosystem: 336.1 acres



Map Prepared by
Wigmore Forest
Resource
Management
January 2016

Not a Survey Map



1:24,000

**FOREST STEWARDSHIP STAND AND BOUNDARY MAP
FOR THE PROPERTY OF THE HOLYOKE WATER WORKS
THE MCLEAN RESERVOIR WORKING FOREST
WESTFIELD ROAD-HOLYOKE, MASSACHUSETTS
STEWARDSHIP AREA: 336.1 ACRES**

Map Scale
1 inch = 660 feet

True North

Physical Feature Legend

ATT Right-of-Way 

Barbed Wire Fence 

Beaver Pond 

Beaver dam 

Cement bound 

Forest Stand Boundary 

Forest Stand Number 1

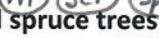
Iron Pipe 

Hydric Soils/Wetland Site 

Excluded sites

Forested Wetland 

Gravel Road 

Groves of pine and spruce trees 

Hiking Trail 

Paved Road 

Pond 

Rock Outcroppings 

Shrub swamp 

Spring Seep 

Steep slopes

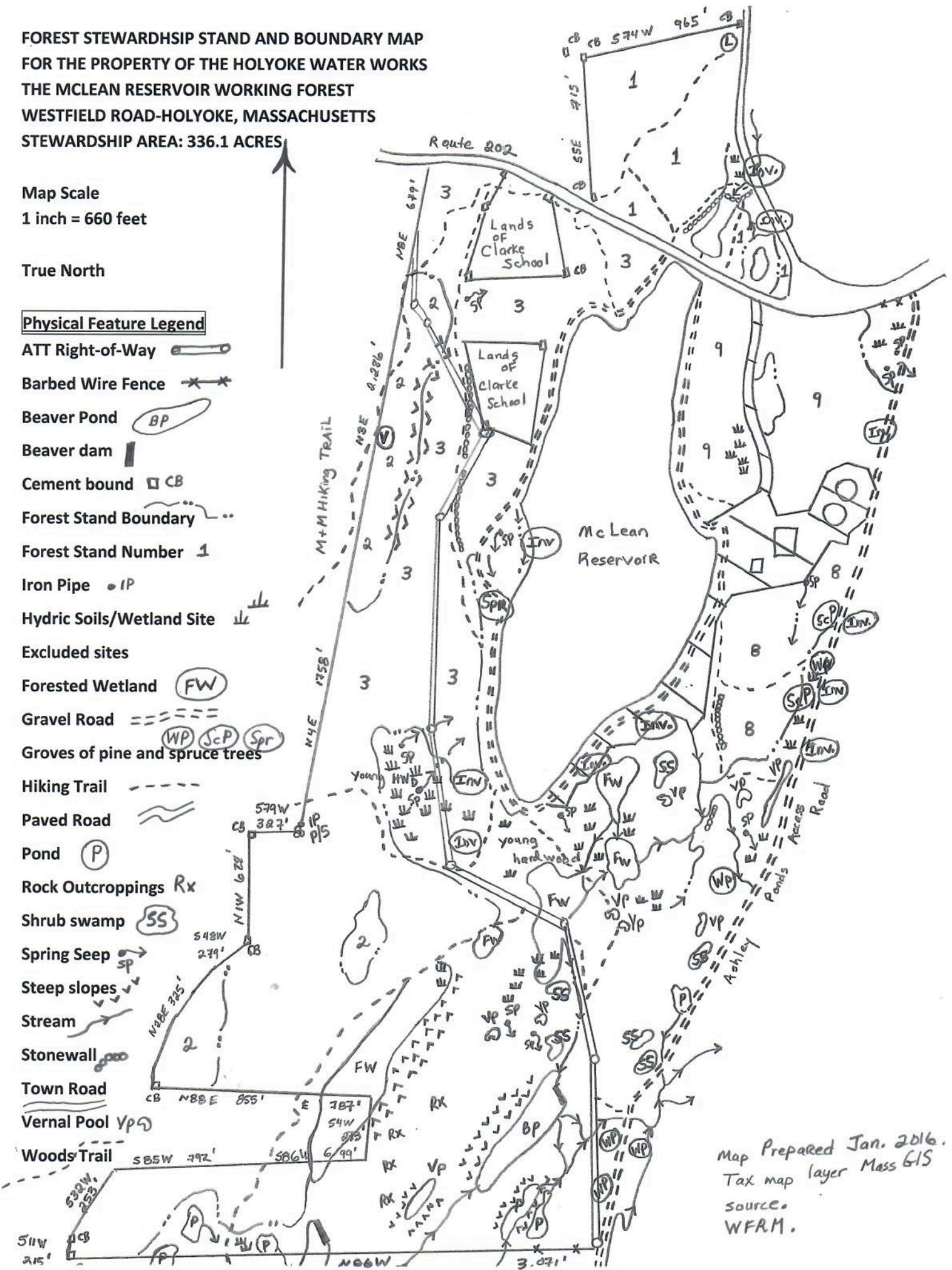
Stream

Stonewall 

Town Road 

Vernal Pool 

Woods Trail 



Map Prepared Jan. 2016.
Tax map layer Mass GIS
source: WFRM.

Soils Classification Map for the McLean Reservoir and Ashley Ponds Reservoir Lands

Ashley Ponds Reservoir Forest Ecosystem: 753.6 acres

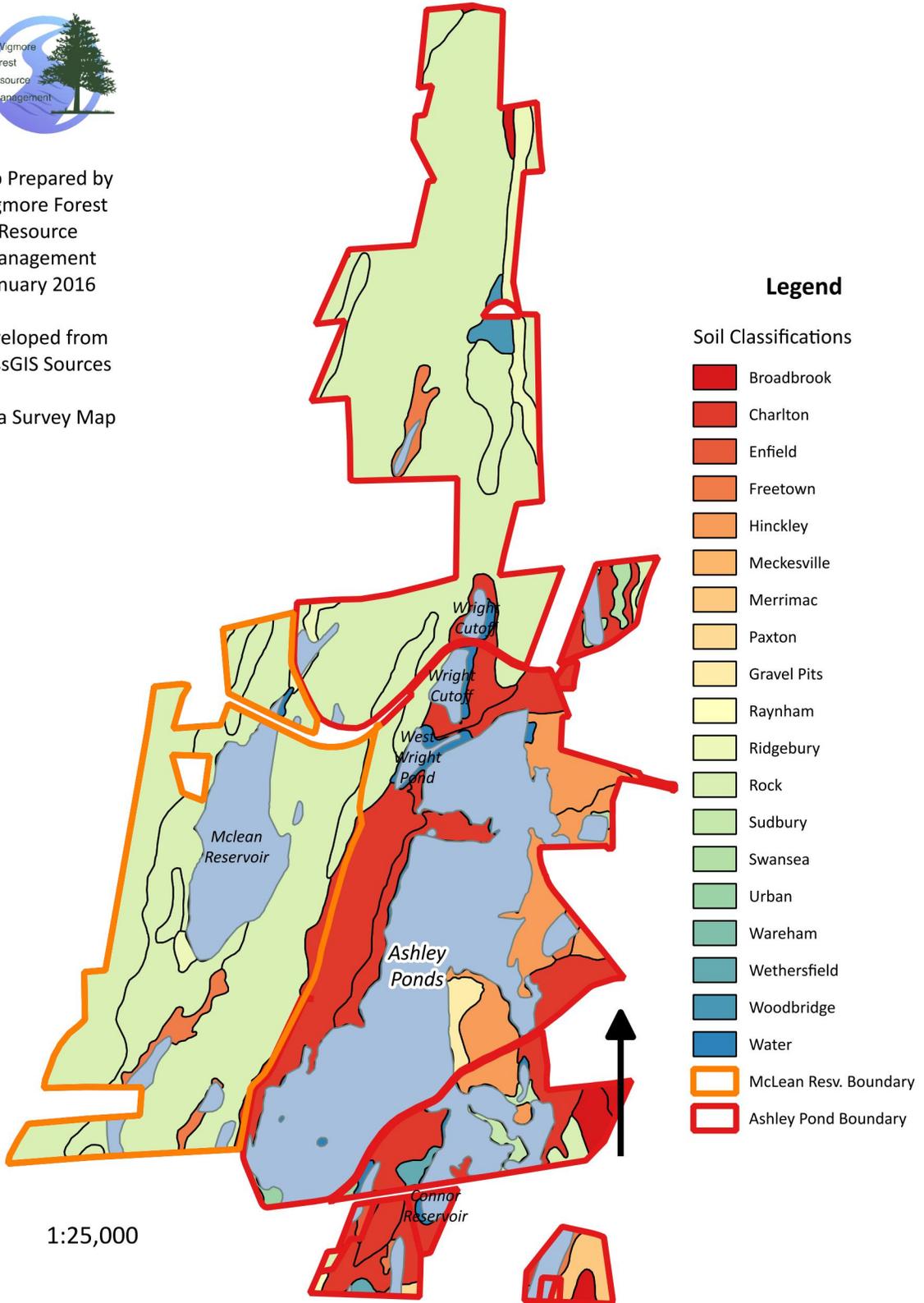
McLean Reservoir Forest Ecosystem: 336.1 acres



Map Prepared by
Wigmore Forest
Resource
Management
January 2016

Developed from
MassGIS Sources

Not a Survey Map



Signature Page Please check each box that applies. _____

CH. 61/61A Management Plan I attest that I am familiar with and will be bound by all applicable Federal, State, and Local environmental laws and /or rules and regulations of the Department of Conservation and Recreation. I further understand that in the event that

I convey all or any portion of this land during the period of classification, I am under obligation to notify the grantee(s) of all obligations of this plan which become his/hers to perform and will notify the Department of Conservation and Recreation of said change of ownership.

Forest Stewardship Plan. When undertaking management activities, I pledge to abide by the management provisions of this Stewardship Management Plan during the ten year period following approval. I understand that in the event that I convey all or a portion of the land described in this plan during the period of the plan, I will notify the Department of Conservation and Recreation of this change in ownership.

Green Certification. I pledge to abide by the FSC Northeast Regional Standards and MA private lands group certification for a period of five years. To be eligible for Green Certification you must also check the box below.

Tax considerations. I attest that I am the registered owner of this property and have paid any and all applicable taxes, including outstanding balances, on this property.

Signed under the pains of perjury:

Owner(s) _____ Date _____

Owner(s) _____ Date _____

I attest that I have prepared this plan in good faith to reflect the landowner's interest.

Plan Preparer _____ Date _____

I attest that the plan satisfactorily meets the requirements of CH61/61A and/or the Forest Stewardship Program.

Approved, Service Forester _____ Date _____

Approved, Regional Supervisor _____ Date _____

Owner(s): City of Holyoke-Holyoke Water Works-McLean Reservoir Page xx of xx