Massachusetts Department of Conservation and Recreation

Silviculture Prescription
Barker Hill Lot

Massachusetts Department of Conservation and Recreation
Bureau of Forestry

Northeast District
Townsend State Forest
Townsend, MA

Prepared by:

Mike Waterman-Management Forester-Northeast District
Massachusetts Department of Conservation and Recreation
25 Shattuck Street, Lowell- MA 01852
michael.j.waterman@state.ma.us 978-937-2092 ext. 109

July 13, 2020

Approved by:

Management Forestry
Program Supervisor _____ Date: July 13, 2020

William N. Hill, CF

Site Data:

Cultural and Historical:

The Townsend State Forest is located in the north central section of the Town of Townsend, Middlesex County, Massachusetts. This project area is located North of Dudley Road and West of Barker Hill Road (Appendix Maps 1 and 2). This area of Townsend State Forest is part of approximately 3000 acres acquired by the Commonwealth beginning in the 1930's. These lands, along with other acquisitions, were consolidated into what is now Townsend State Forest.

Previous land use of this area was subsistence farming, livestock grazing and timber extraction. Evidence of previous land use prior to state ownership can be seen by the old stone walls located along the eastern side of the project. At the time of acquisition these properties were heavily cut over to provide the raw material necessary for the manufacture of barrels and other lumber products. Cutting was focused on trees that could provide the material necessary for industry and little focus was placed on promoting the long term viability of the forest. Extractive cutting of these forest lands left them in a degraded condition subject to outbreaks of wildfire.

Photo-Townsend Historical Society

Periodic fires are documented throughout the history of this area both anthropogenic caused and naturally occurring. The historical natural fire regime is classified as a "Type III" (35-100 years frequency, mixed severity). There was a small brush fire that burned several acres in the northwest section of Stand 2 within the past decade along with several other brush fires that have occurred over the years in and around the State Forest.

Geology and Soils:

Several thousand years ago this area was covered by the Wisconsin Glacier. It is estimated at its peak that this glacier was over 2 miles thick in some areas. The current landscape bears witness to this period and the subsequent retreat of the glacier and the soils deposited during this time. This area of Middlesex County has, in general, relatively thin soils

and rocky outcrops, with the underlying bedrock close to the surface. The soils in this area generally fall into the glaciofluvial (glacial outwash) and glacial till types.[i]

Elevations within the project area range from approximately 350 feet in the southerly and easterly portions of the project area, and rises to approximately 550 feet in the northerly sections. The topography can be described as generally rolling (0%-10% slope) in nature interrupted by short steep rocky outcrops (15%-25% slope) with an easterly and southerly aspect.

Generally, the soils found in the project area fall into the Charlton, Hollis, Windsor, Montauk, Scituate and Canton soils series respectively (Appendix Map 3). The common theme among these soils is a sandy-loamy-stony nature due to glacial origin. Soil productivity is moderate to good on these soils with site indexes ranging from 57 (eastern white pine (*Pinus strobus*)) for the Windsor series to 69 (northern red oak (*Quercus rubra*)) for the Montauk series.[ii] Soil productivity, as it pertains to this project, will be protected during this project, since harvesting can only occur during dry stable conditions (i.e. no operations during "spring breakup").

DCR Management Guidelines of 2012 state that "*Forests stands will be classed on a continuum and considered for silvicultural treatments that generally fit their productivity, structural complexity (or potential thereof) and diversity.*" Analyzing the site productivity and complexity using Geographical Information System (GIS) data layers of prime forest soils, potential vegetation complexity, late successional potential, forest diversity, early successional potential, continuous forest inventory (CFI) site index, and CFI stand structure verifies a generally moderate to good productivity of these forest stands.[iii]

Climate:

The weather in this area of Massachusetts is typical with seasonally changing conditions. According to the National Weather Service data set this area has an annual average precipitation of 48.07" and a mean annual temperature of 47.5°F.[iv]

Major episodic weather events (i.e. hurricanes, ice, etc.) are major factors in forest development throughout New England. The 2008 ice storm and October 2010 snow storm caused significant damage to established regeneration within portions of the project area. Mature trees were not spared either as both hardwood and softwood trees were damaged by these events.

Variable weather events are common for the area and effect forest development over time. Wind is the most significant driver of forest development. These winds, in general, originate from the south and southwest during warmer months, and north and northwest during cooler periods of the year.

Hydrology and Watershed:

The Barker Hill project area has one small intermittent stream, no vernal pools (certified or potential) and there are no wetlands located within the project area (see detail maps). As rainfall and snowmelt are introduced into the project area it drains southward towards a wetland complex and then towards the Squannacook River. The Squannacook flows approximately 10 miles southeast and discharges into the Nashua River. The closest public water supply is approximately 1.25 miles southwest of the of the project area.

The project areas are located within the Squannassit Area of Critical Environmental Concern (ACEC). ACEC are unique clusters of natural and human resource values which are worthy of a high level of concern and protection that require DCR to minimize adverse effects on aquatic productivity, groundwater quality, habitat values and biodiversity, and other natural resource values of the area. The DCR Upland Ecologist affirmed in comments provided for this project, that in order to minimize any site impacts there will be no cutting within 50 feet of streams or wetlands (except trees that need to be removed at an approved stream crossing).

Resource areas will be buffered in the field with flagging and paint. These areas will be mapped in accordance with regulations found within the most recent edition of the Massachusetts Forestry, Best Management Practices Manual.[v] There are no wetland crossings in the project areas, and the one stream crossing will be made with a temporary bridge that will be removed at close of operations.

Archeological Features:

Located within the project areas is evidence of prior ownership and land use. Prior to State ownership these properties were used for livestock grazing, subsistence farming and timber extraction. The southeast section of the project contains the remains of a few old stone walls. Existing breaches in the stone walls will be used for access by equipment.

Old granite boundary marker

A review conducted by the DCR Archeologist of the project areas, indicates that there are no known pre-contact sites recorded within or adjacent to the project.

Recreation:

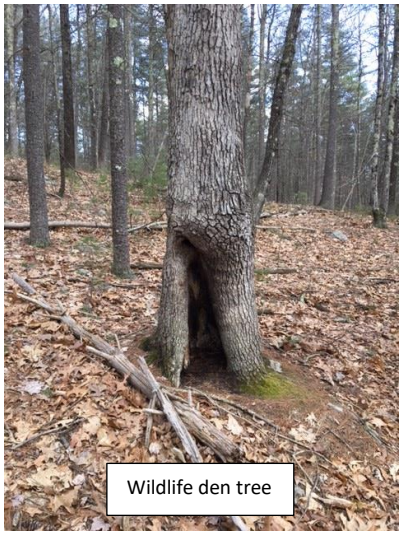
This area is most widely used for passive recreation. Hunting, hiking, and mountain biking are the most prevalent activities in this forest. Illegal all-terrain vehicle use is an issue but confined mostly to the main forest trails. There are no developed parking areas located near the project, so recreation use is light. The harvest area will be posted to alert constituents to program activities and closed during operational hours.

Existing legal trails within the project areas will be utilized to access the project areas. Slash will be treated to promote rapid decomposition and a light appearance by lopping or crushing by equipment. As noted in the management guidelines document forest management activities occurring within trail corridors will focus on retaining larger diameter, healthy trees and promote a safe experience for recreational users. Forest management activity will help to reduce the number of dead and dying trees located along forest trails.

Wildlife:

The Barker Hill project area is used by a variety of native wildlife species. There is evidence of ungulate species (white tail deer (*Odocoileus viginianus*)) feeding and bedding. Other animal species that have been noted locally around the project area are; black bear (*Ursus americanus*), bobcat (*Lynx rufus*), coyote (*Canis latruns*), opossum (*Didelphis virginiana*), moose (*Alces alces*), and a variety of avian species.

Beaver (*Castor canadensis*) activity is noted where Stand 1 interfaces with the adjacent wetland. Dam building in the wetland has resulted in several acres of flooded snags. These snags provide habitat for invertebrates and the avian species that feed on them. These snags also provide perches for raptor species present in the area for hunting.


Wildlife den tree

The proposed activity for the Barker Hill project area will provide positive benefits to wildlife by increasing species diversity and vertical structure of the forest. Opening the forest canopy through cutting will establish tree and shrub regeneration which will be a benefit to animals that utilize younger forests as part of their life cycle. MassWildlife in their

comments provided for this project concluded that this was a positive benefit. Creation of gaps within the forest will provide an "edge" effect that is attractive to many bird species for nesting and foraging. These gaps will also stimulate the herbaceous and shrub vegetation due to increased sunlight penetration to the forest floor benefitting foraging animal species.

Retention of large (>18"DBH) known cavity trees, snag trees, and coarse woody material on the forest floor will benefit invertebrates, amphibians, and small mammal species that depend on them for their life cycles. Retention and release of large mast producing species (oak and cherry) will benefit native wildlife through the increased production of nuts and fruits. Reserving areas from management (filter strips) will benefit species that require these features for parts or all of their life cycles.

Rare and Endangered Species:

Review of the 13th edition of the Massachusetts Natural Heritage Atlas shows that the project area does not fall within priority habitats for rare and endangered species. [vi] Additionally, a direct review of the project conducted by the MA Natural Heritage and Endangered Species Program also confirmed that the project area did not contain priority habitat.

Insects and pathogens:

This area of the forest was subject to Gypsy moth (*Lymantria dispar*) outbreaks in the early 1980's. The spring of 2016 saw a resurgence of this forest pest as a result of environmental conditions favorable to population growth of this introduced pest in other areas of Massachusetts. A small number of caterpillars were observed during the course of stand examination, but no significant amount of defoliation was observed. Oak species are preferred by this destructive pest, and repeated defoliation can lead to crown dieback and eventual mortality affecting the diversity of the forest.[vii]

Red Pine declining due to scale-Marlboro-Sudbury State Forest

Within the project area is a red pine-white pine plantation (Stand 1). Unfortunately, the red pine (*Pinus resinosa*) found on this site are susceptible to the fungal pathogen diplodia blight (*Diplodia pinea*), and red pine scale (*Matsucoccus resinosae*). Red pine infected by these pathogens can experience rapid decline in vigor leading to extensive mortality.[viiiix]

Caliciopsis canker (*Caliciopsis pinea*) is another concern for white pine forests in New England. The native fungus damages the thin bark of pine trees causing trees to ooze pitch profusely. Trees affected by this can suffer reduced crown density and reduced vigor. Over the long term these weakened trees may become more susceptible to secondary attacks eventually leading to mortality. Caliciposis can be found in high density stands of white pine on sandy well drained soils and was noted on some trees within the project area. Management strategies that allows for greater temperature and sunlight may decrease risks to white pine.[x]

Current and Potential Vegetation:

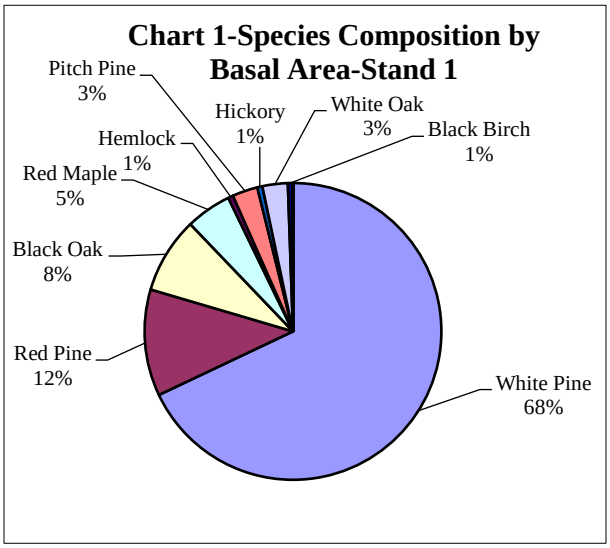
Methodology:

A GIS grid was developed in order to conduct a thorough stand exam of the project areas. Two phase or "Big BAF" sampling was conducted at 42 inventory plots collecting attributes on the over and understory of the project. New Hampshire Forests and Lands, Fox DS Cruiser version 2007.2 was used to process the overstory data. Understory vegetation was sampled at each inventory plot using standards set forth in the DCR Manual for Continuous Forest Inventory for regeneration plots (0.300 acre plot size).[xi] One hundred foot course woody material transects were conducted from each inventory plot.

Evaluating data gathered during stand examination helps inform the decision making process and provides a basis to guide vegetation management. Foresters use basal area, relative density, trees per acre and other data to recommend a course of action (prescription) for forested landscapes.

Results:

The project area consists of 2 stands of native and non-native vegetation. Stand 1 (± 40 acres) is an even aged white pine-red pine plantation stand that has been treated on three separate occasions (1982, 1995, & 1998).[xii] The forest canopy of this stand consists of (in decreasing order of dominance) eastern white pine, red pine (*Pinus resinosa*), black oak, and red maple (*Acer rubrum*), and other species scattered throughout the stand



such as hemlock (*Tsuga canadensis*), black birch (*Betula nigra*), white oak (*Quercus alba*), pitch pine (*Pinus rigida*) and hickories (*Carya spp*) making up the remainder of the stand (Chart 1, Appendix Tables 1 & 2).

The forest canopy of this area is a combination of white pine and red pine planted by the CCC crews in the 1930's. Stand 1 is generally even aged and composed of large sawtimber sized trees with a median stand diameter of 14.2". The majority of the white pine and red pine are in a dominant or co-dominant canopy position, while the other species observed within the stand occupy the lower intermediate and suppressed size classes. The stand contains approximately 103 square feet of basal area, 140 trees per acre with white pine being the most common tree species and is moderately stocked with an estimated relative density of 46.

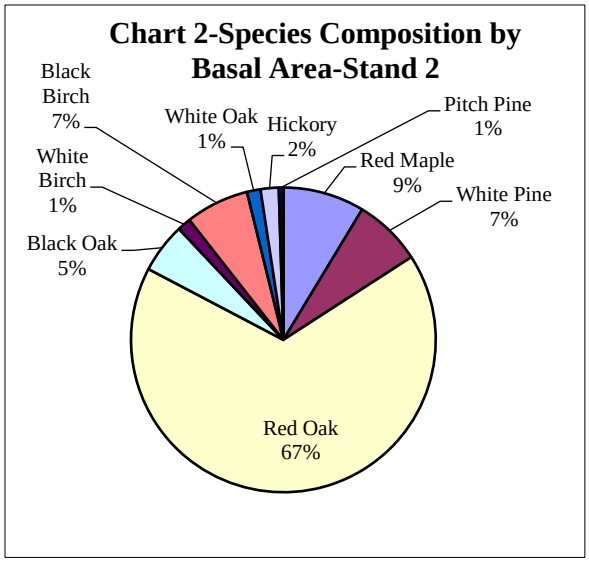
The understory and potential vegetation of Stand 1 is comprised of native tree and shrub species. Red oak, white pine, and red maple were most commonly found in the understory along with lesser amounts of other species (Appendix Table 3).

Herbaceous vegetation found in this stand is comprised of native species with eastern teaberry (*Gaultheria procumbens*), low bush blueberry (*Vaccinimum angustifolium*) and grasses being the most commonly observed species. Other species noted in the stand include dewberry (*Rubus flagellaris*), partridgeberry (*Mitchella repens*), and other small shrubs (Appendix Table 4). No invasive species were noted in this stand during the course of field work

Coarse wood material (CWM) and snags are found throughout the stand. It is estimated there is 156 cubic feet of CWM and 7 (<12"DBH, all softwood) snags per acre within the stand. This stand was previously harvested utilizing a whole tree type operation which accounts for the low number of snags and CWM as this material would have been cut and chipped. Management guidelines recommend maintaining a minimum of 256 cubic feet per acre of CWM and a minimum of 5 dead snags (> 10" DBH) per acre. To remedy this shortfall, harvesting will be conducted with a cut to length harvester and forwarder which will increase the amount of coarse woody material post-harvest as tops, limbs and un-merchantable pieces of wood or various sizes and species will be scattered throughout the stand post-harvest. Snags, or live trees with the potential to become snags for wildlife purposes (e.g. cavity trees, trees with extensive rot, etc.), will be retained during operations unless they are next to forest trails, in which case they will be cut and left onsite as coarse woody material.

The management for this stand is to release and establish a new cohort of trees within it by using an irregular shelterwood silvicultural system. With this system small gaps (up to 1 acre) will be made in the canopy to stimulate the regeneration process and release advanced

regeneration. Over time these gaps are expanded giving rise to different age classes within the stand. Trees outside of the gaps are thinned to promote increment and canopy growth. Over time trees of various heights and ages give the stand an "irregular" structure that is more complex vertically and horizontally.



Previous treatments established an excellent cohort of white pine and hardwood seedling and saplings particularly in areas where red pine is the predominant overstory species. (This is due to the crown density of red pine allowing greater amounts of sunlight to penetrate to the forest floor stimulating the regeneration process.) In areas where mature white pine dominate, previous treatments established regeneration, however no follow up treatments were made to release those trees to grow, and most pine seedlings/saplings have succumbed to shade suppression as the closed canopy allows insufficient light penetration to the forest floor.

Stand 2 (± 50 acres) is an even aged oak-white pine forest type and consists of (in decreasing order of dominance), northern red oak, white pine, red maple, black birch (*Betula lenta*), and other tree species (Chart 2, Appendix Tables 5 & 6).

The trees in this stand are generally even aged and are a result of trees that were either too small to be harvested prior to State ownership or established after the forest fire. This stand contains approximately 80 square feet of basal area and approximately 173 trees per acre. The stand is moderately stocked with an estimated relative density of 70.

The understory of stand 2 consists of native tree and shrub vegetation. Red oak, red maple and white pine are the most common species of trees found in the regeneration portion of the understory along with lesser amounts of white oak, hickory and American chestnut (*Castanea dentata*) sprouts (Appendix Table 7). No invasive species were noted during stand examination.

Shrub vegetation found in this section of the project is dominated by mountain laurel (*Kalmia latifolia*), with lesser amounts of eastern teaberry, lowbush blueberry, highbush blueberry *(Vaccinimum corymbosum)*, American witch-hazel (*Hamamelis virginiana),* starflower (*Trintalis sp*.), and cinnamon fern (*Osmunda cinnamomea*). Other species such as sheep laurel

(*Kalmia angustifolia*), clubmoss (*Lycopodium sp.*), Canada mayflower (*Maianthemum canadense*), northern dewberry (*Rubus flagellaris*), and various unidentified grasses were noted in this stand (Appendix Table 8).

The high proportion of mountain laurel (up to 75% cover in many inventory plots) found in the ground cover component of this stand is an extreme impediment to forest regeneration. This high percentage of cover limits the ability of seedlings, specifically size classes 1 & 2, to become established in the understory of the forest due to shading.

Coarse woody material (CWM) and snags are scattered throughout the stand. It is estimated that there is approximately 235 cubic feet per acre of course woody material. This material consists of both sound and decayed types. CWM retention will follow same standards as Stand 1.

It is estimated that there are approximately 12 standing snags per acre in this stand. All snag observations were less than 12" and of hardwood species. Standing snags will be retained following the same standards as Stand 1.

Evaluation of Data and Projected Results:

Objectives:

As documented in the Landscape Designations for DCR Parks and Forests: Selection Criteria and Management Guidelines document, Townsend State Forest is designated as a Woodland. As noted in the Management Approach for Woodlands section of the document this project fulfills the ecosystem services that Woodlands provide. Woodlands provide a range of ecosystem services such as, but not limited to, clean water, wildlife habitat, recreation opportunities and sustainable production of renewable wood products.

The Barker Hill Lot Project major objectives are:

- Remove all hazard trees along trails within project area to protect public safety.
- Use multi-age forest management (irregular shelterwood) to increase species diversity and forest structure for the benefit of wildlife.
- Promote vigorous regeneration of native species within forest stands currently limited due to competition for resources.
- Release established regeneration to grow freely into the forest canopy.
- Remove red pine trees susceptible to disease and insect infestations.

Silvicultural Prescription:

Trees will be individually marked for removal (cut tree marked) using DCR standard marking regime. Cutting boundaries will be triple marked with 45 degree slashes to denote cutting areas. Wetland resources will be buffered minimum of 50 feet where no cutting will occur and no principal skid trails (except existing forest roads) will be located within 100 feet of these features. Fifty foot no cut filter strips will be placed along intermittent streams and no trees will be removed in these filter strips except those required for equipment access at approved stream crossings. All features will be marked with paint and identified as required by law when filing a Ma Ch132 Forest Cutting Plan with the Bureau of Forestry and the local conservation commission.

Stands 1 and 2:

The major goals for these stands are:

- Demonstrate multi aged silviculture techniques that will release and establish regeneration.
- Remove red pine trees susceptible to disease and insects.
- Remove poorly formed, less vigorous and damaged trees.
- Create diverse habitats that benefit native wildlife and build forest resilience to stressors by increasing vertical and horizontal structure.
- Improve soil structure through the retention of coarse woody material of all sizes.

Both stands will be treated using an expanding gap irregular shelterwood system. Gaps between 1/3 and 1 acre will be placed randomly across the stands to mimic natural disturbance patterns with the intent of regenerating approximately 15%-20% of the stands. Outside of these gaps, trees will be thinned to promote canopy expansion, diameter increment, and tree vigor. Desirable species such as red and white oaks and white pine will be favored for retention, while low grade black birch, black oak and red maple will be targeted for removal.

Stand 2 – Pre-harvest example

Gap placement within these stands will focus on:

- Advance regeneration that may be released.

- Areas of pure red pine that are susceptible to pathogens (Stand 1).
- Proximity to preferred crop trees that can provide a source of seed.
- Areas where trees have damaged crowns or composed of low vigor specimens.
- High densities of Mt Laurel preventing tree regeneration (Stand 2).

Post-harvest example: Irregular Shelterwood - Brookline Road Project-Harvested 2018

Target residual basal area within gaps will be between 0-20 ft² BA/ac, with residual BA consisting of existing advance regeneration (oak or pine) or potential legacy/wildlife tree(s). (Legacy/wildlife trees will grouped together with random distribution across both stands retaining 1 to 3 >18”DBH where possible and/or 4 live trees 12”-18” DBH.) Follow up treatments within 15-20 years will focus on expanding these gaps with the intention of regenerating the stand over 100 years.

Target residual basal areas outside of gaps will be between 60-80ft² BA/ac within both stands focusing on retaining trees within the dominant and co-dominant canopy positions with well-developed crowns while removing suppressed, diseased and damaged trees. These overstory trees will serve as a seed bank for seedling recruitment, wildlife benefits and potential legacy trees.

Thick patches of Mt Laurel in Stand 2 will be treated mechanically by harvesting equipment. Harvesting operators will be instructed to cut, crush and run over thickets of Mt Laurel. Scarification to mineral soil in these areas will be encouraged to provide a seed bed for desirable species (e.g. white pine).

Post treatment, outside of gaps, the residual stands will consist of larger trees in the dominant and codominant canopy position. Within gaps, sunlight will penetrate to the forest floor stimulating shrub and herbaceous vegetation to increase their abundance and diversity. Increased sunlight availability will create conditions favorable for the establishment of a new cohort of trees and also release advance regeneration to accelerate growth into the canopy.

As noted in prior sections of this document, forest fires are not uncommon in this forest type. Therefore, the potential exists to incorporate prescribed fire as a management tool

within the stands to manage for fuel loading and desirable tree species (i.e. oak and hickory species). If prescribed fire is deemed appropriate after this harvest a separate fire plan may be developed for the site.

Forwarder hauling forest products to landing area

Sale Layout and Harvesting Systems:

Access to the project area will be off Barker Hill Road. It is anticipated that one landing will be used for this project (See detail map) and that several skid trails will need to be laid out prior to harvesting activity. Principal skid trails will be laid out with flagging and paint during marking operations avoiding wetland resources and steep slopes. Any stream crossings required for harvesting operations will meet or exceed those specifications found in the Massachusetts Forestry Best Management Practices Manual. There will be no harvesting in wetlands or filter strips along streams unless removals are needed at an approved stream crossing for equipment access. Crossings will be removed at the cessation of operations and principle skid trails will be stabilized with water bars and seed as needed and directed by the forester in charge.

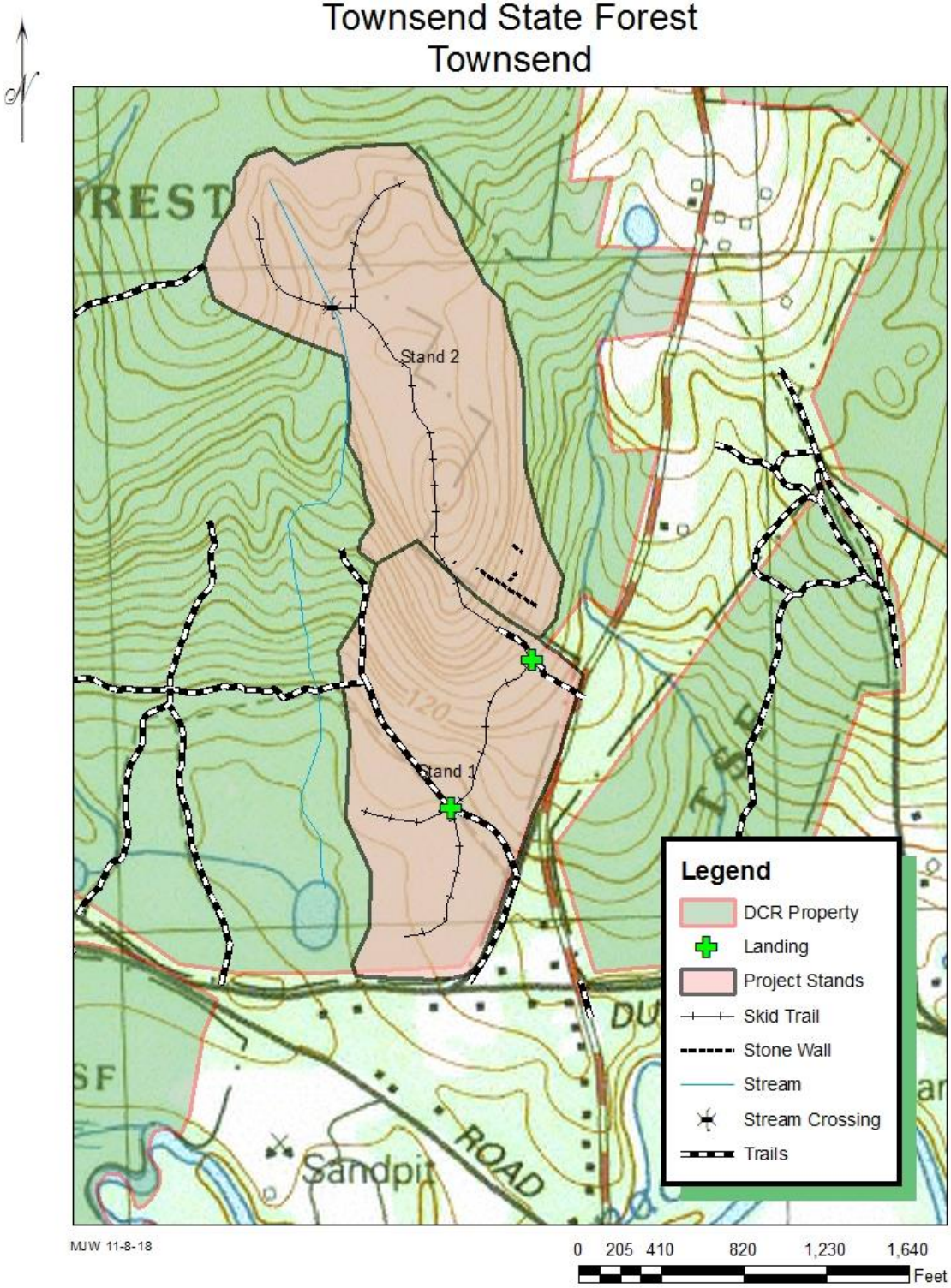
A cut to length harvester and forwarder will be used to harvest forest products. Scarification to bare mineral soil will be encouraged throughout the project area to provide a suitable seed bed for desirable species.

A MGL Ch. 132 Forest Cutting Plan will be filed with the Massachusetts Department of Conservation and Recreation-Service Forestry Program and local conservation commission prior to harvesting operations. Mandatory best management practices, as required by law, will be implemented to safeguard important ecological features (wetlands, potential vernal pools, streams, etc.).

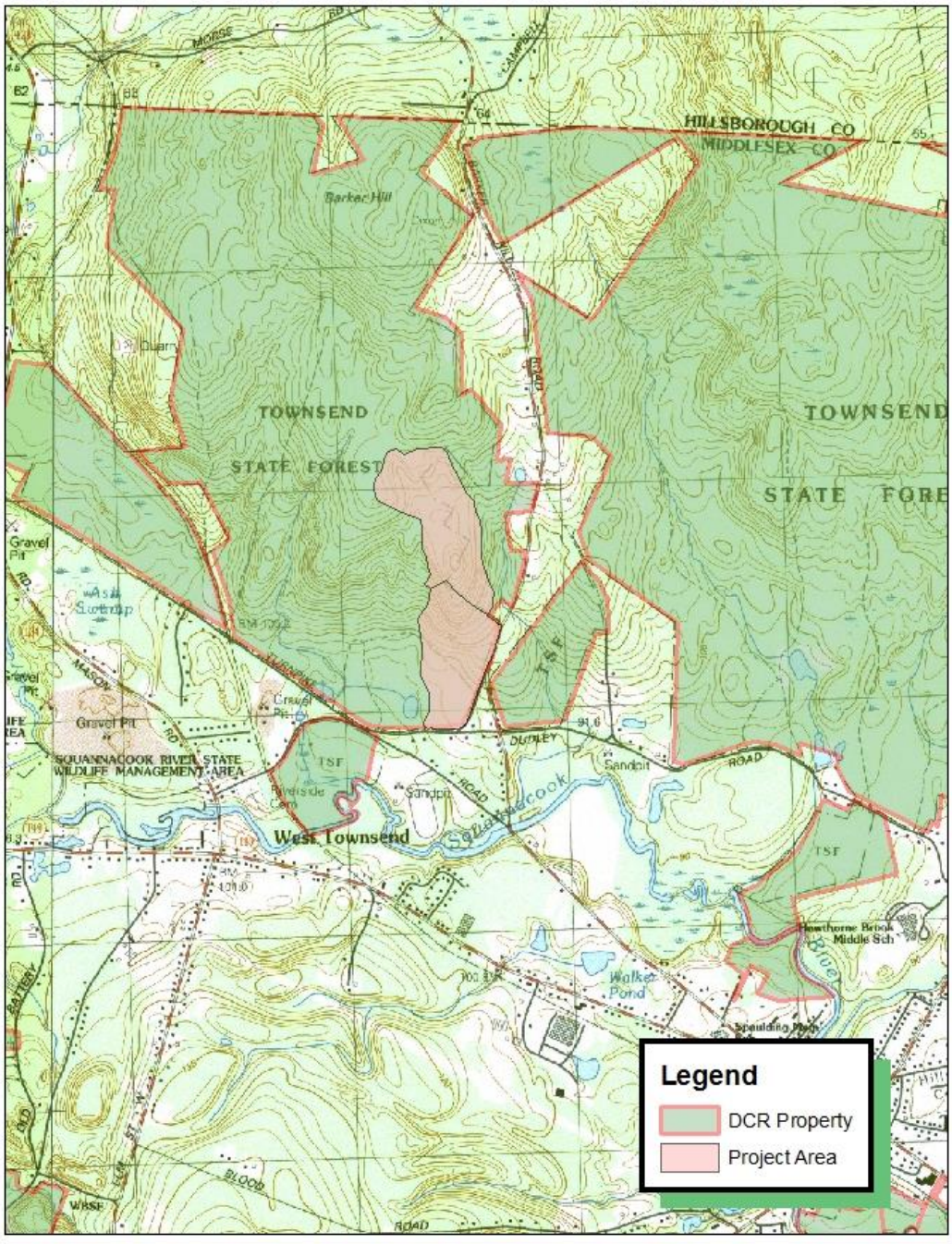
In Kind Services:

Rough grading along with typical gravel and stone installation at the entrance to the landing off of Barker Hill Road are anticipated as part of this project.

Appendix


Barker Hill Lot-Detail
Townsend State Forest
Townsend
Stand 2
Stand 1
Sandpit
ROAD
Legend
DCR Property
Landing
Project Stands
Skid Trail
Stone Wall
Stream
Stream Crossing
Trails
MJW 11-8-18
0 205 410 820 1,230 1,640
Feet

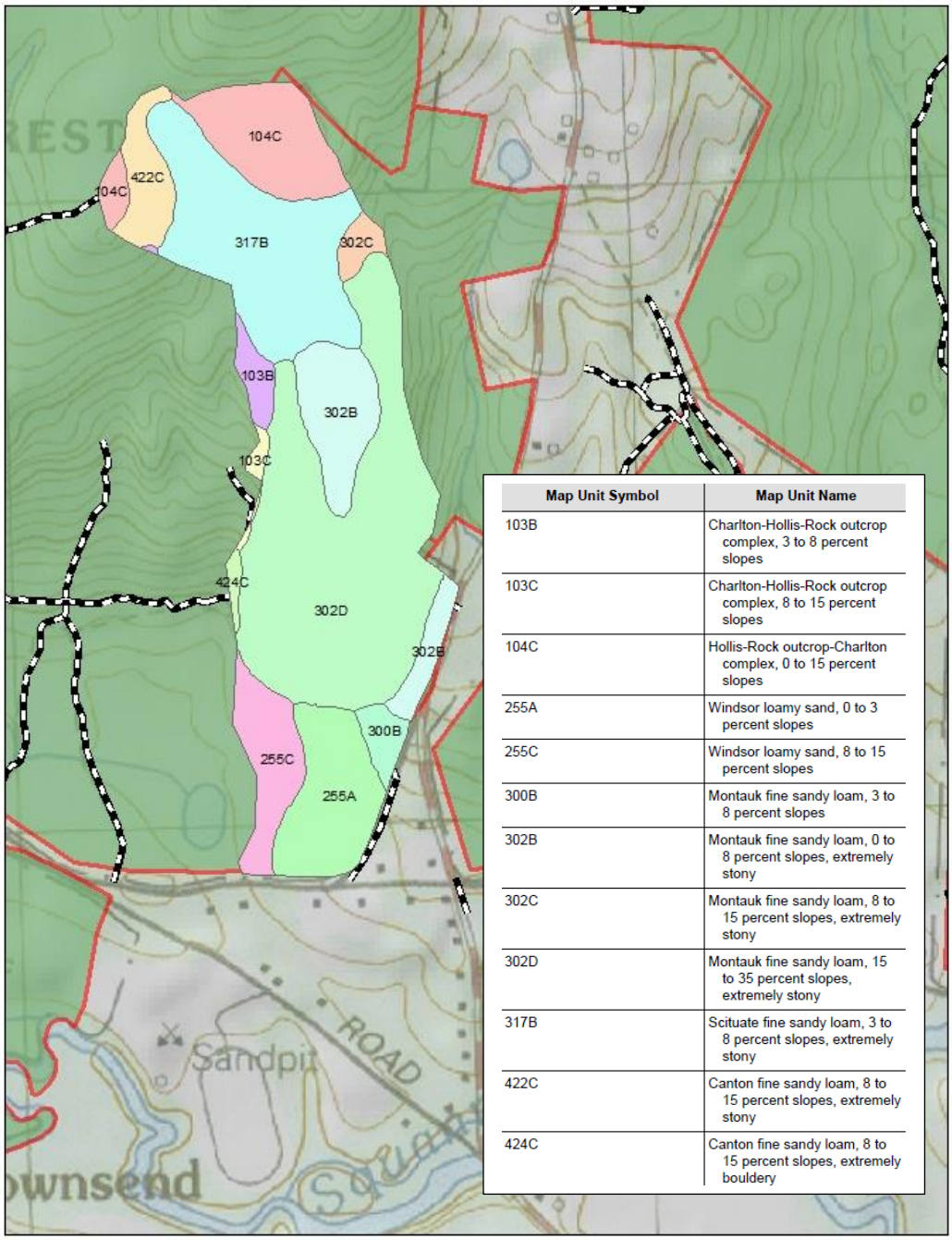
Barker Hill Lot-Locus
Townsend State Forest
Townsend



MJW 11-8-18

0 650 1,300 2,600 3,900 5,200
Feet

Barker Hill Lot-Soils
Townsend State Forest
Townsend



Map Unit Symbol	Map Unit Name
103B	Charlton-Hollis-Rock outcrop complex, 3 to 8 percent slopes
103C	Charlton-Hollis-Rock outcrop complex, 8 to 15 percent slopes
104C	Hollis-Rock outcrop-Charlton complex, 0 to 15 percent slopes
255A	Windsor loamy sand, 0 to 3 percent slopes
255C	Windsor loamy sand, 8 to 15 percent slopes
300B	Montauk fine sandy loam, 3 to 8 percent slopes
302B	Montauk fine sandy loam, 0 to 8 percent slopes, extremely stony
302C	Montauk fine sandy loam, 8 to 15 percent slopes, extremely stony
302D	Montauk fine sandy loam, 15 to 35 percent slopes, extremely stony
317B	Scituate fine sandy loam, 3 to 8 percent slopes, extremely stony
422C	Canton fine sandy loam, 8 to 15 percent slopes, extremely stony
424C	Canton fine sandy loam, 8 to 15 percent slopes, extremely bouldery

MJW 1-7-20

0 230 460 920 1,380 1,840

Feet

Table 1			Sawtimber	Total	Total	Topwood
	Sawlog	Pulp	Mean	Bf	Cords	Cords
Species`	Bf/Acre	Cords/Acre	Ht (logs)	(Stand)	(Stand)	(Stand)
Eastern White Pine	11012.6	3.5	3.0	440505.0	139.3	58.1
Red Pine	1869.5	0.3	3.1	74781.9	11.6	7.9
Black Oak	50.8	2.1	1.2	2030.9	83.9	1.6
Red Maple	0.0	1.4		0.0	56.0	
Hemlock	0.0	0.2		0.0	6.1	
Pitch Pine	300.8	0.0		12030.6	1.8	
Hickory	0.0			0.0		
White Oak	0.0			0.0		
Black Birch	0.0			0.0		
Total	**13233.7**	**7.5**		**529348.6**	**298.6**	**67.5**

Table 2			%					
	Total	Total	BA/ac					
Species	Trees/Acre	BA/Acre	by Spp	QMD	Rel Density	% AGS		
Eastern White Pine	81.1	68.3	65.8%	12.4	25.7	86.2%		
Red Pine	14.7	11.7	11.2%	12.1	5.6	95.2%		
Black Oak	14.0	8.3	8.0%	10.5	7.1	6.7%		
Red Maple	20.2	5.0	4.8%	6.7	4.5	0.0%		
Hemlock	2.2	0.6	0.5%	6.8	0.2	0.0%		
Pitch Pine	2.6	2.8	2.7%	14.1	2.8	80.0%		
Hickory	0.9	0.6	0.5%	10.8	0.0	100.0%		
White Oak	4.3	2.8	2.7%	10.8	0.0	0.0%		
Black Birch	0.9	0.6	0.5%	10.8	0.0	0.0%		
Total	**140.8**	**103.9**	**96.8%**	**11.6**	**45.9**	**70.6%**		
		Median Stand Diameter ->>		**14.2**	**49.3**	**<<- Estimated Relative Density**		

Table 3					
Total	**1**	**2**	**3**	**4**	**Total**
Red Maple	212	0	88	53	353
Eastern White Pine	653	353	88	18	1112
Black Oak	71	0	0	18	88
Red Pine	18	0	0	0	18
Red Oak	935	35	106	18	1094
White Oak	194	0	18	35	247
Black Cherry	18	0	0	18	35
Total	**2100**	**388**	**300**	**159**	**2947**

Table 4	
Species	**AVG. % COVER**
Teaberry	12.1
Canada Mayflower	3.8
Lowbush Blueberry	8.6
Ferns	2.8
Moss	0.6
Grass	19.1
Star Flower	1.5
Tree Club Moss	0.6
Partridgeberry	0.3
Huckleberry	5.3
Dewberry	0.3

Table 5			Sawtimber	Total	Total	Topwood
	Sawlog	Pulp	Mean	Bf	Cords	Cords
Species	**Bf/Acre**	**Cords/Acre**	**Ht (logs)**	**(Stand)**	**(Stand)**	**(Stand)**
Red Maple	0.0	1.6		0.0	82.1	
Eastern White Pine	494.5	1.2	3.0	24724.0	61.6	3.0
Northern Red Oak	3349.3	6.8	2.0	167463.1	341.8	46.9
Black Oak	133.2	0.6	1.6	6659.2	32.1	3.2
White Birch	0.0	0.3		0.0	16.7	
Black Birch	0.0	0.4		0.0	18.5	
White Oak	53.7	0.2		2687.1	8.5	
Hickory	0.0	0.4		0.0	18.7	
Pitch Pine	0.0			0.0		
Total	**4030.7**	**11.6**		**201533.4**	**579.9**	**53.1**

Table 6			%					
	Total	Total	BA/ac					
Species	**Trees/Acre**	**BA/Acre**	**by Spp**	**QMD**	**Rel Density**	**% AGS**		
Red Maple	29	6.9	8.7%	6.7	6.3	0.0%		
Eastern White Pine	7	5.8	7.2%	12.0	2.2	73.3%		
Northern Red Oak	100	53.5	66.8%	9.9	48.9	82.0%		
Black Oak	7	4.2	5.3%	10.7	3.6	27.3%		
White Birch	3	1.2	1.4%	8.7	1.1	0.0%		
Black Birch	20	5.4	6.7%	7.0	4.8	0.0%		
White Oak	4	1.2	1.4%	7.7	1.1	66.7%		
Hickory	4	1.5	1.9%	8.4	1.5	100.0%		
Pitch Pine	1	0.4	0.5%	9.3	0.0	0.0%		
Total	**174**	**80.0**	**100.0%**	**9.2**	**69.3**	**64.4%**		
		Median Stand Diameter ->>		**11.4**	**69.7**	**<<- Estimated Relative Density**		

Table 7					
Species	**1**	**2**	**3**	**4**	**Total**
Red Oak	717	0	0	13	730
Red Maple	117	0	39	170	326
White Oak	0	0	0	13	13
Eastern White Pine	26	39	52	117	235
Chestnut	0	0	39	0	39
Shagbark Hickory	0	0	0	52	52
Black Birch	39	0	0	0	39
Total	**900**	**39**	**130**	**365**	**1435**

Table 8	
Species	**AVG. % COVER**
Ferns	1.5
Highbush Blueberry	0.1
Teaberry	6.9
Mt Laurel	35.3
Lowbush Blueberry	2.6
Witch hazel	1.9
Sheep Laurel	0.2
Tree Club Moss	0.2
Grass	1.3
Canada Mayflower	1.0
Solomon Seal	0.1
Maple Leaf Viburnham	0.3
Huckleberry	0.1
Star Flower	0.1

[i] USDA, NRCS, Soil Survey of Middlesex County, 2009

[ii] USDA, Web Soil Survey, Generated 1-13-20

[iii] Goodwin, D.W. and Hill, W.N., 2012. Forest Productivity and Stand Complexity Model (A GIS Analysis using ACRGIS), Massachusetts Department of Conservation and Recreation, Amherst, MA

[iv] National Weather Service-Climate Data (Worcester), https://w2.weather.gov/climate/getclimate.php?wfo=box, generated 1-14-20

[v] Catanzaro, P., Fish, J., Kittredge, D., Massachusetts Forestry Best Management Practice Manual, 2013 Second Edition, Massachusetts Department of Conservation and Recreation

[vi] http://maps.massgis.state.ma.us/PRI_EST_HAB/viewer.htm Reviewed 1-16-20

[vii] https://ag.umass.edu/fact-sheets/gypsy-moth

[viii] http://na.fs.fed.us/spfo/pubs/fidls/diplodia/diplodiafidl.htm

[ix] http://www.nhstateparks.org/uploads/pdf/RP_pestalert.pdf

[x] https://extension.unh.edu/resources/files/Resource000999_Rep1148.pdf

[xi] Manual for Continuous Forest Inventory Field Procedures, Bureau of Forestry, Division of State Parks and Recreation, February 2014 Edition, Massachusetts Department of Conservation and Recreation

[xii] MS282T, NEM995T, NEM398T, DCR Management Forestry Archives, Lowell