A Master Plan for

Beaver Brook Farm

Prepared for the Town of Dracut, MA and the Beaver Brook Farm Committee

Eric Giordano & Lisa Krause
The Conway School
Spring 2019

A Master Plan for

Beaver Brook Farm

Eric Giordano & Lisa Krause
The Conway School
Spring 2019

Prepared for the Town of Dracut and the
Beaver Brook Farm Committee

Town Manager: James A. Duggan

Beaver Brook Farm Committee (BBFC):
Ellis Neofotistos
May Paquette
Don Plummer
Warren Shaw
David Paquin
Andrew Graham
Louise Tremblay

BBFC Staff:
Elizabeth Ware, Director of Community Development
Samantha A. Carver, Executive Secretary, Town Manager's Office

INDEX

Designed by: Eric Giordano & Lisa Krause
For the Town of Dracut, MA
Spring 2019

Graduate Program in Sustainable Landscape Planning + Design
the ConwaySchool
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

Introduction

A RICH HISTORY

In 1736, Abraham Varnum purchased 80+ acres of land in Dracut, Massachusetts, and began farming the site that would eventually become known as Beaver Brook Farm. Elisha Ford bought the land from Abraham in 1844, and in 1851, Justus Richardson bought it from Elisha. Over the next century, under the stewardship of the Richardson family, the farm evolved into a town agricultural landmark. Justus' primary crops were corn, hay, and fruit, and he built several of the buildings still standing on the site today. His son George A.H. Richardson expanded the operation to include dairy production and was active in the community as the organizer of the local grange and trustee of the Middlesex County North Agricultural Society. George's son Justus C. (JC) Richardson, a graduate of Boston University and Massachusetts Agricultural College (UMASS Amherst), along with his brother Lester, carried the torch and made significant and innovative improvements to the farm's infrastructure between 1915 and 1925. They pumped water from Beaver Brook to a water tower that gravity-irrigated the fields, constructed an on-site power plant, and even built a small airport. It was in this era that the farm had its heyday with expansive orchards, greenhouses, livestock, dairy production, and crop fields that yielded famously gigantic rhubarb and squash (Lowell Sun).

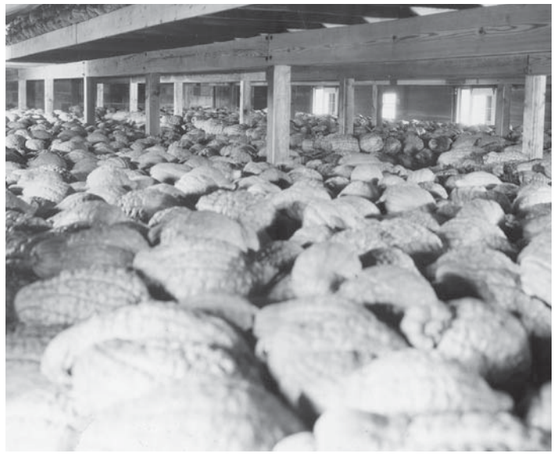
THE TOWN SAVES BEAVER BROOK FARM

In the latter half of the twentieth century, production on the farm declined, portions of the land were sold off, and a 50-acre parcel east of Beaver Brook was donated to the town of Dracut, which became the town's school complex. By the year 2000, only 24 acres remained, and in 2014, the land was put on the market. Saving it from the likely fate of being developed as condominiums, the people of Dracut voted at a town meeting to purchase the property with Community Preservation Act funds for its value as open space, its rich history, and its advantageous location near the town's school complex and in a highly populated area. The Beaver Brook Farm Committee was appointed by the Town Manager, James Duggan, as a volunteer group to steward the property and develop a master plan.

The first building erected on site was the main farmhouse that Abraham Varnum and family moved into in 1736. The house still stands as the second oldest house in Dracut.

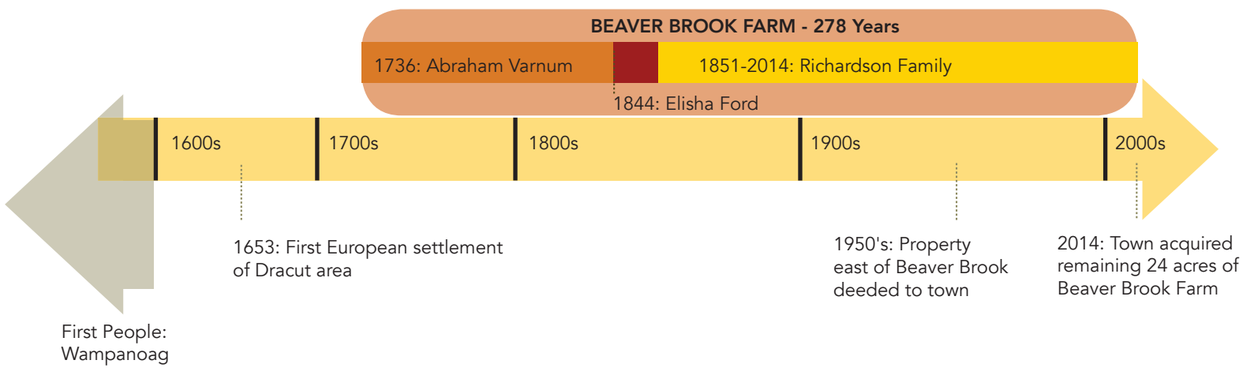
Produce from the farm was sold throughout the northeast. Pictured here is Beaver Brook Farm's stand at the Lowell Street Market in 1910.

In the early twentieth century major infrastructure improvements were made on the farm. Pictured above, a group of farm laborers build the large greenhouses that have since been removed from the site. It was common for young people in Dracut to work summers on the farm.



The squash barn was built in 1925 specifically to store the farm's staple crop: blue hubbard squash. The building still stands on the property today. Photo: Lowell Sun

Beaver Brook Farm at the height of its productivity in 1939. The squash barn and market building remain on site, the latter heavily damaged by fire, but much of what is pictured has been torn down and removed. Photo: Lowell Sun



JC Richardson led the farm through its most successful and productive period. He is pictured here in his workshop (left) and at the head of the table (right) negotiating with local produce buyers. Photos: Lowell Sun

Not for construction. Part of a student project and not based on a legal survey.

Graduate Program in Sustainable Landscape Planning + Design
the ConwaySchool
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

Designed by: Eric Giordano & Lisa Krause
For the town of Dracut, MA
Spring 2019

Project Overview

BEAVER BROOK FARM COMMITTEE

Since the town's purchase of the property, the Beaver Brook Farm Committee (BBFC) has overseen several projects. The conditions of the farm buildings were assessed and lead and asbestos mostly abated from the buildings. In partnership with the Open Space Committee, mowed walking trails were created on site with signs at the farm's entrance and at the parking area. A major planned project is the creation of a path on the northeast side of Beaver Brook (off-site) that will connect the property with the nearby school complex over an old farm bridge. Under the direction of the BBFC, the bridge was restored and the Town is currently searching for contractors to create the path. Primary users of the path, bridge, and on-site trails will be the high school cross-country running team, for practices and meets. Under contract with a local farmer, the fields are maintained with a one-a-month haying regime during the growing season.

The BBFC approached the Conway School to facilitate a process of community outreach to assess Dracut residents' needs and wants for the site, determine the feasibility and appropriateness of their ideas given site conditions, and ultimately create a master plan that will guide the future of Beaver Brook Farm for the next several decades.

DRACUT'S VISION FOR BEAVER BROOK FARM

On May 2, 2019, the Conway team facilitated a community meeting in which 25 attendees brainstormed potential uses of the land and buildings at Beaver Brook Farm. Ideas suggested by the community* fell broadly under five categories. The analysis that follows is aimed at determining the appropriateness and feasibility of these uses of the site given site conditions.

Productive Farm
Market farming, community gardening

"A Place for All"
A commons, village green

Open Space
Gathering, events, trails, recreation

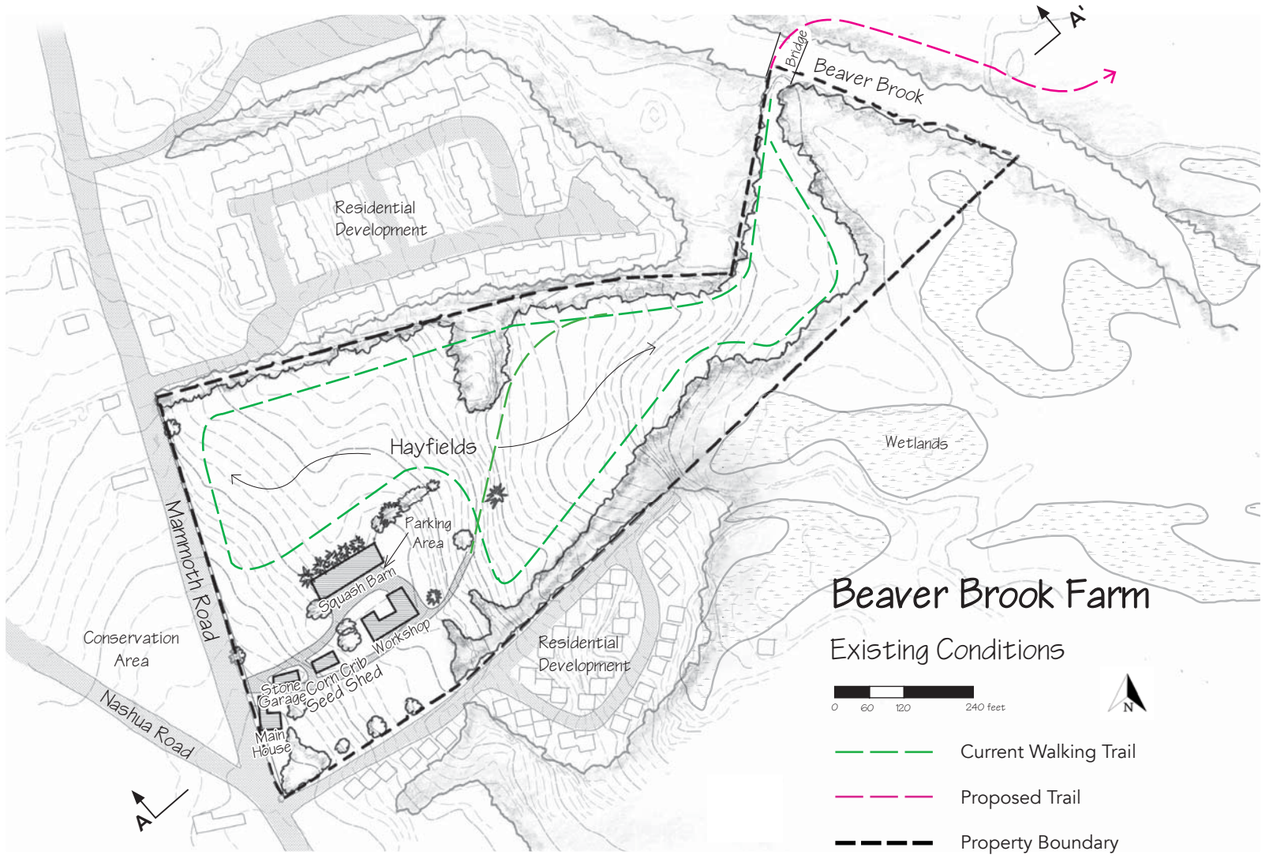
Ecological Integrity
& Sustainability

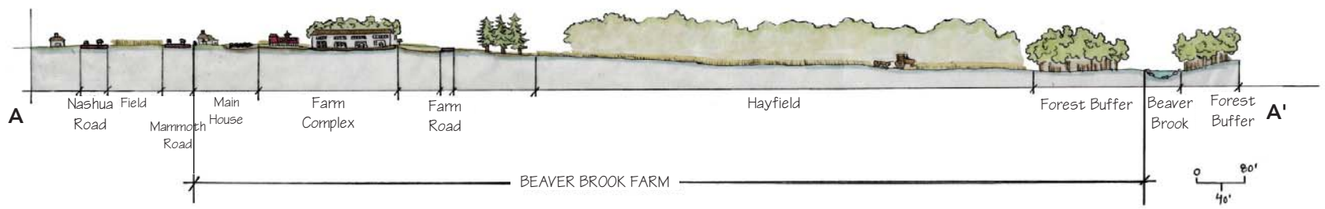
Education
Agritourism & nature interpretation

*A complete list of the ideas that emerged during the community meeting is included in Appendix A of this document.

EXISTING CONDITIONS

The site is characterized by its historic (though deteriorating) farm buildings; open hayfields; woodland edges to the north, east, and south; and gently rolling hills that slope down to Beaver Brook along the property's northeastern boundary. Walking trails allow visitors to explore the site year round. Condominium developments directly abut the property to the north and south.





The main house and farm complex sit close to Mammoth road at a higher elevation than the rest of the property which slopes gently down to Beaver Brook.

Designed by: Eric Giordano & Lisa Krause
For the Town of Dracut, MA
Spring 2019

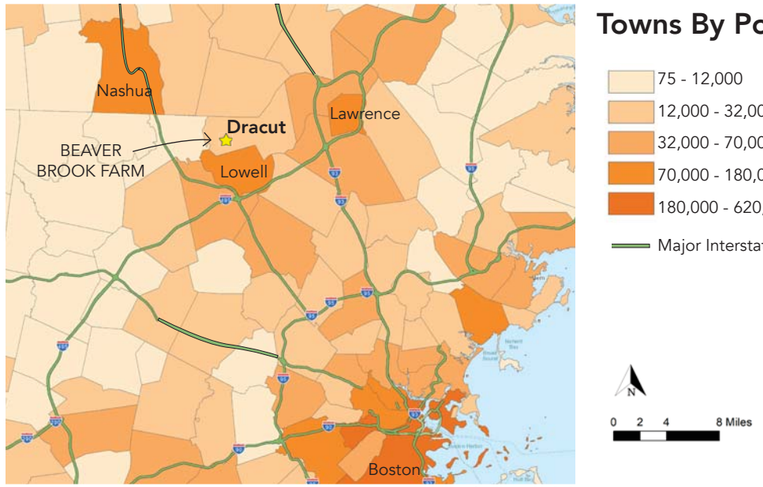
the ConwaySchool
Graduate Program in Sustainable Landscape Planning + Design
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

Project Overview
Beaver Brook Farm Master Plan
761 Mammoth Road, Dracut, MA 01826

Regional & Neighborhood Demographics

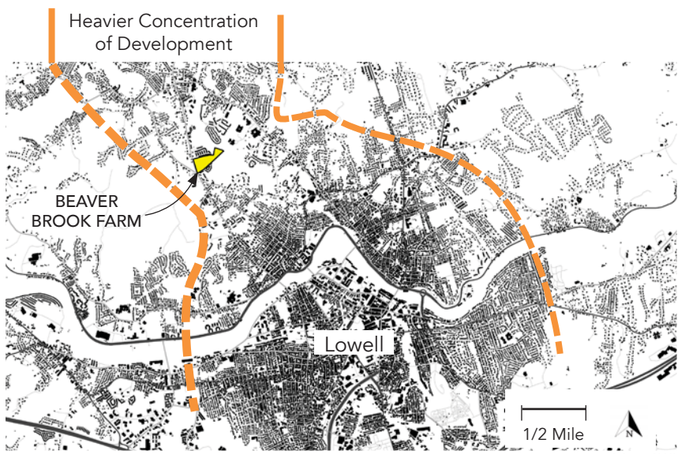
DRACUT, MASSACHUSETTS

Dracut (population 31,619) sits about 30 miles northwest of Boston and directly north of the historic mill city of Lowell. The cities of Lawrence, MA, and Nashua, NH, are also relatively close by. No major highway, however, runs through the town, and due to the inconvenience of public transportation options to and from Beaver Brook Farm, the site is unlikely to be heavily used by residents of the larger region on a regular basis.



data: MassGIS

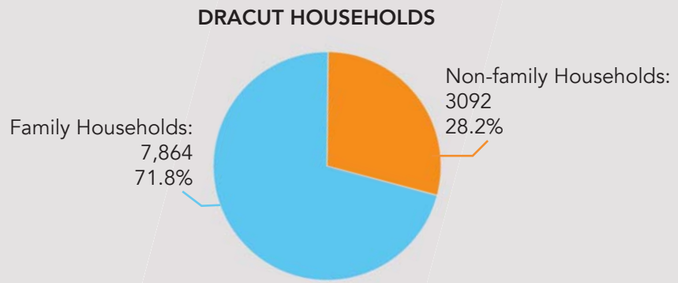
The site lies within a heavily developed suburban corridor that extends north of Lowell. This suggests that there are many potential local users of the site and highlights the benefit of preserving this as public open space in an area where much of the nearby land has been built upon.



data: MassGIS

FAMILIES & KIDS

Family households (two or more related people residing) make up 71.8% of households in Dracut. Of those households, 48.5% have children under the age of 18 (2010 US Census). The planned path connecting Beaver Brook Farm to the school complex will provide a direct passageway for school children to reach the site. Areas on the property designed for family activities or education could provide more reasons for children and families to visit Beaver Brook Farm.



AN AGING POPULATION

Between the years 2010 and 2017, Dracut's senior population (65+) rose by 22.9% while the total population only grew by 5.6% (US Census). The town's senior center and a large senior housing complex are situated just 1,500 feet north of Beaver Brook Farm on Mammoth Road. This presents an opportunity to partner with the senior center for programing and for elements on site to serve the town's aging population.

ENVIRONMENTAL JUSTICE

Beaver Brook Farm is located in the center of a low-income area as determined by the 2010 US census. People living in this area are considered to be an Environmental Justice population by the Commonwealth of Massachusetts. These are populations that meet thresholds for low income, racial minority, or English isolation that have historically been denied access to open space and/or subjected to high levels of pollution from industrial development. With few other public spaces in this neighborhood, it may be important to preserve the site as public open space for this potentially vulnerable population and provide outdoor recreation opportunities for neighbors.

Graduate Program in Sustainable Landscape Planning + Design
the ConwaySchool
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

Designed By: Eric Giordano
& Lisa Krause
For the Town of Dracut, MA
Spring 2019

Views

The site's expansive views were a main reason for its purchase by the Town. According to a survey in Dracut's Open Space and Recreation Plan (2009), residents prize farmland as their favorite landscape feature in town. At the community meetings held for this master plan, many participants said that preserving the open views on Beaver Brook Farm, especially from Mammoth Road, was of primary importance to them.

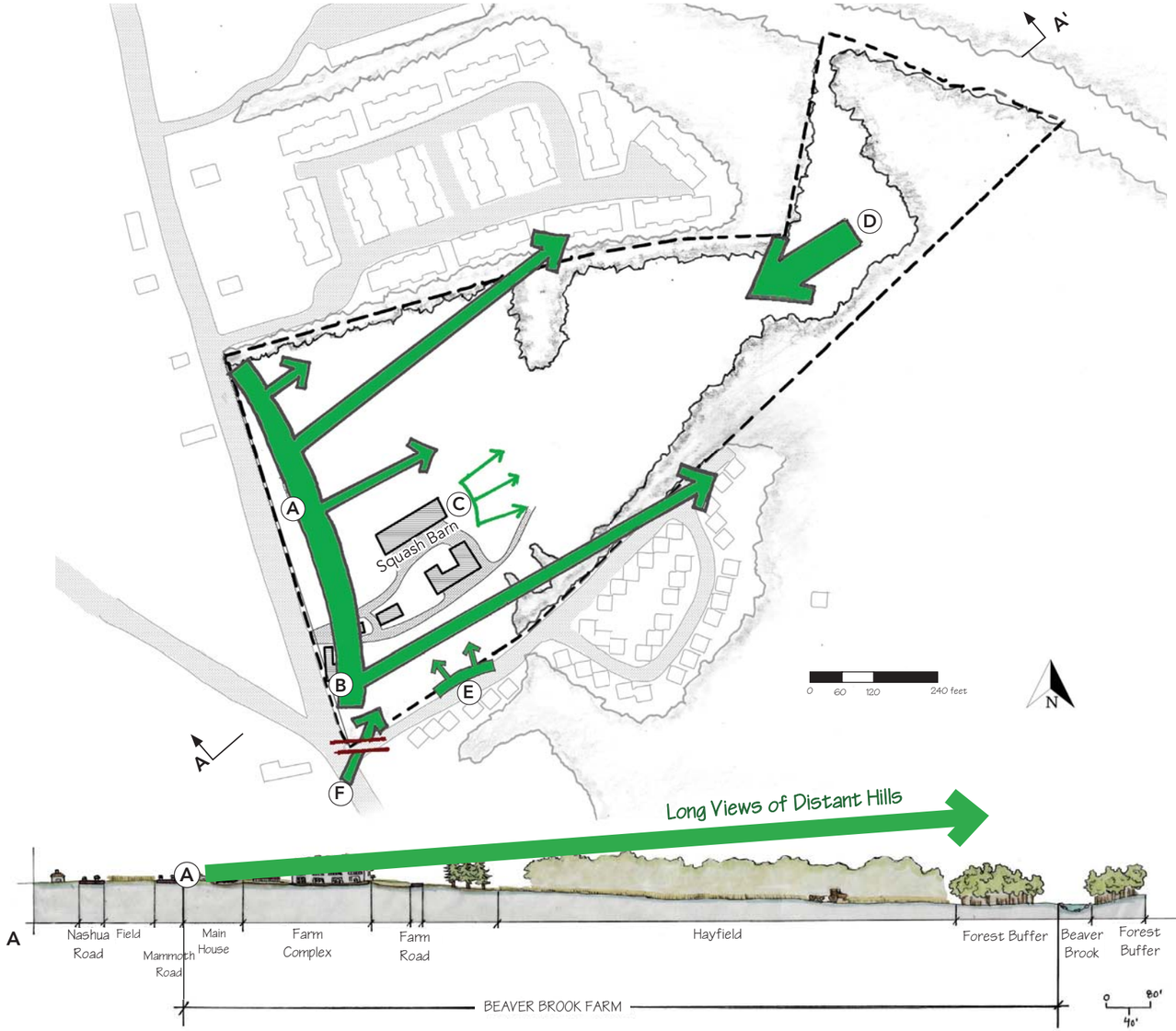
The areas of the property along the western boundary, being at the highest elevation, present the most stunning vistas of the site's wide open fields and of the distant hills to the northeast.

A landing just east of the squash barn stands above a relatively steep drop in elevation, acting as an overlook to the eastern half of the site.

From the eastern end of the site, the open fields and gently rising slope to the west offer another face of the property.

Views in from abutting properties are prized by residents who live there.

The heavily trafficked intersection at the southwest corner of the property could present a beautiful view from the road but a dense cluster of vegetation currently stands in the way.



IMPLICATIONS

Preserving these desirable views, as many residents would like to do, may conflict with other uses (agricultural and recreational) that the community would like to have on site. Siting new features on the property will change the viewsheds, and residents' reactions to these changes may vary.

Placing gathering areas or trails just east of the squash barn or at the eastern end of the property could better allow visitors to enjoy views from these locations.

Designed By: Eric Giordano & Lisa Krause
For the Town of Dracut, MA
Spring 2019

the ConwaySchool
Graduate Program in Sustainable Landscape Planning + Design
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

Slopes & Circulation

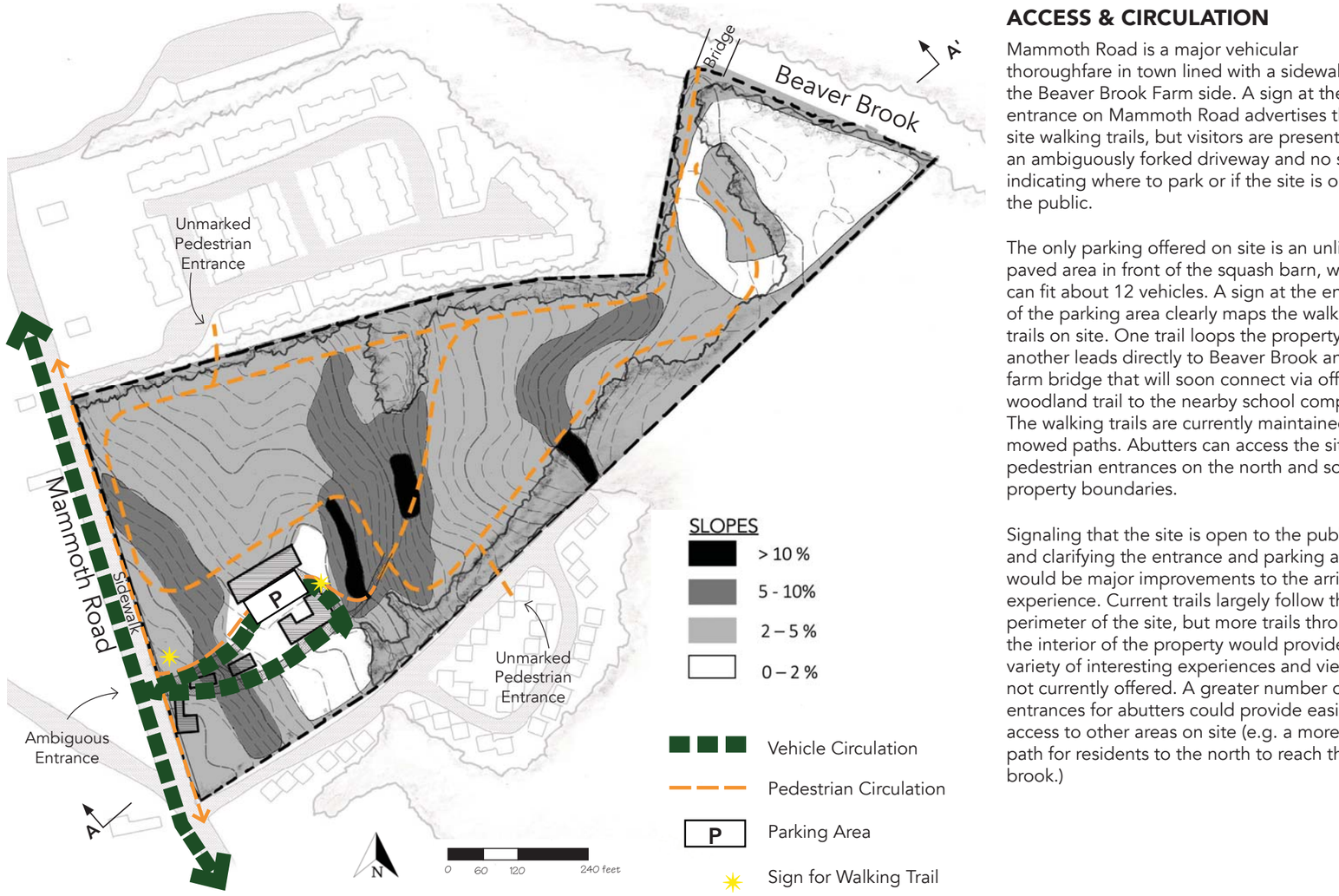
SLOPES

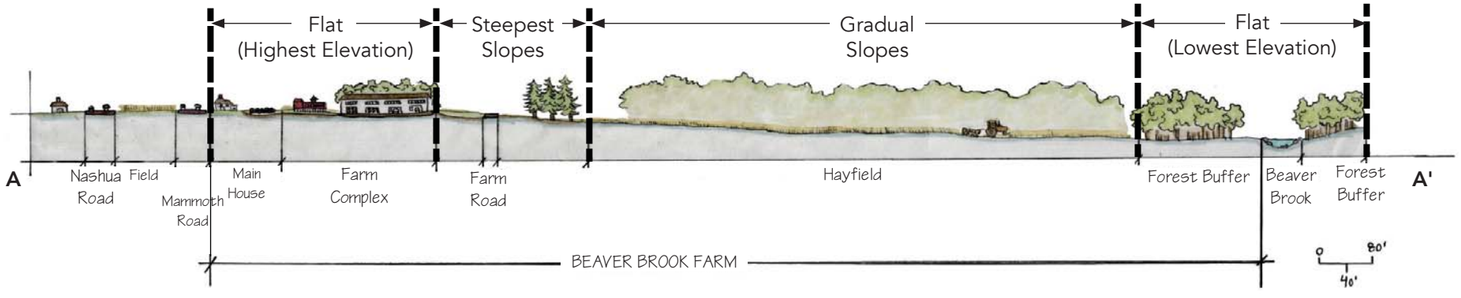
There are two relatively flat areas of 0-2% slope on site, one near the farm buildings and the other near Beaver Brook, that each occupy about 1/8th of the property. Flat areas like these may be poorly draining, and the area near Beaver Brook might be prone to flooding in large storms. Since it is at the base of a hill, it may also hold cold air that drains from the higher elevations, creating frost pockets. If the soil is well draining enough, flat areas like these may be well suited for farmland providing areas that are easy to manage and harvest and have little/no soil erosion. They may also be suitable for accessible paths or gathering areas that would not require regrading.

Most of the property is sloped at 2-5% grade, which is appropriate for farming because water will usually infiltrate but not pool on these slopes. Walking trails that are universally accessible can be created on these slopes with limited regrading of the site.

In the center of the property, east of the farm complex, there is a band of mostly 5-10% slope, punctuated by steep slopes greater than 10%. This area occupies roughly 1/6th of the total site and separates the higher-elevation land near Mammoth Road from the lower-elevation eastern half of the site. Farming on these steeper slopes may require terracing or rows oriented on the slope contour in order to retain water and reduce loss of nutrients. Areas of 5 to 10% slope can be desirable for vineyards due to the drainage of denser cold air, which grapes don't like, from those areas. Some segments of the existing trails are not accessible and experience erosion. New trail segments should adhere to standards for designing trails and paths that will allow universal accessibility and greater walkability. Shedding water with frequent grade reversals and intercepting runoff with drainage ditches or bioswales may prevent erosion.

Creating paths for universal accessibility requires a minimum of 3' wide paths over slopes that do not exceed 5%. Where slopes exceed 5%, universal accessibility can often be achieved through regrading and/or creating a switchback trail.





ACCESS & CIRCULATION

Mammoth Road is a major vehicular thoroughfare in town lined with a sidewalk on the Beaver Brook Farm side. A sign at the farm's entrance on Mammoth Road advertises the on-site walking trails, but visitors are presented with an ambiguously forked driveway and no signs indicating where to park or if the site is open to the public.

The only parking offered on site is an unlined paved area in front of the squash barn, which can fit about 12 vehicles. A sign at the end of the parking area clearly maps the walking trails on site. One trail loops the property and another leads directly to Beaver Brook and the farm bridge that will soon connect via off-site woodland trail to the nearby school complex. The walking trails are currently maintained as mowed paths. Abutters can access the site via pedestrian entrances on the north and south property boundaries.

Signaling that the site is open to the public and clarifying the entrance and parking areas would be major improvements to the arrival experience. Current trails largely follow the perimeter of the site, but more trails through the interior of the property would provide a variety of interesting experiences and views not currently offered. A greater number of side entrances for abutters could provide easier access to other areas on site (e.g. a more direct path for residents to the north to reach the brook.)

Graduate Program in Sustainable Landscape Planning + Design
the ConwaySchool
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

Designed by: Eric Giordano & Lisa Krause
For the Town of Dracut, MA
Spring 2019

Slopes & Circulation
Beaver Brook Farm Master Plan
761 Mammoth Road, Dracut, MA 01826

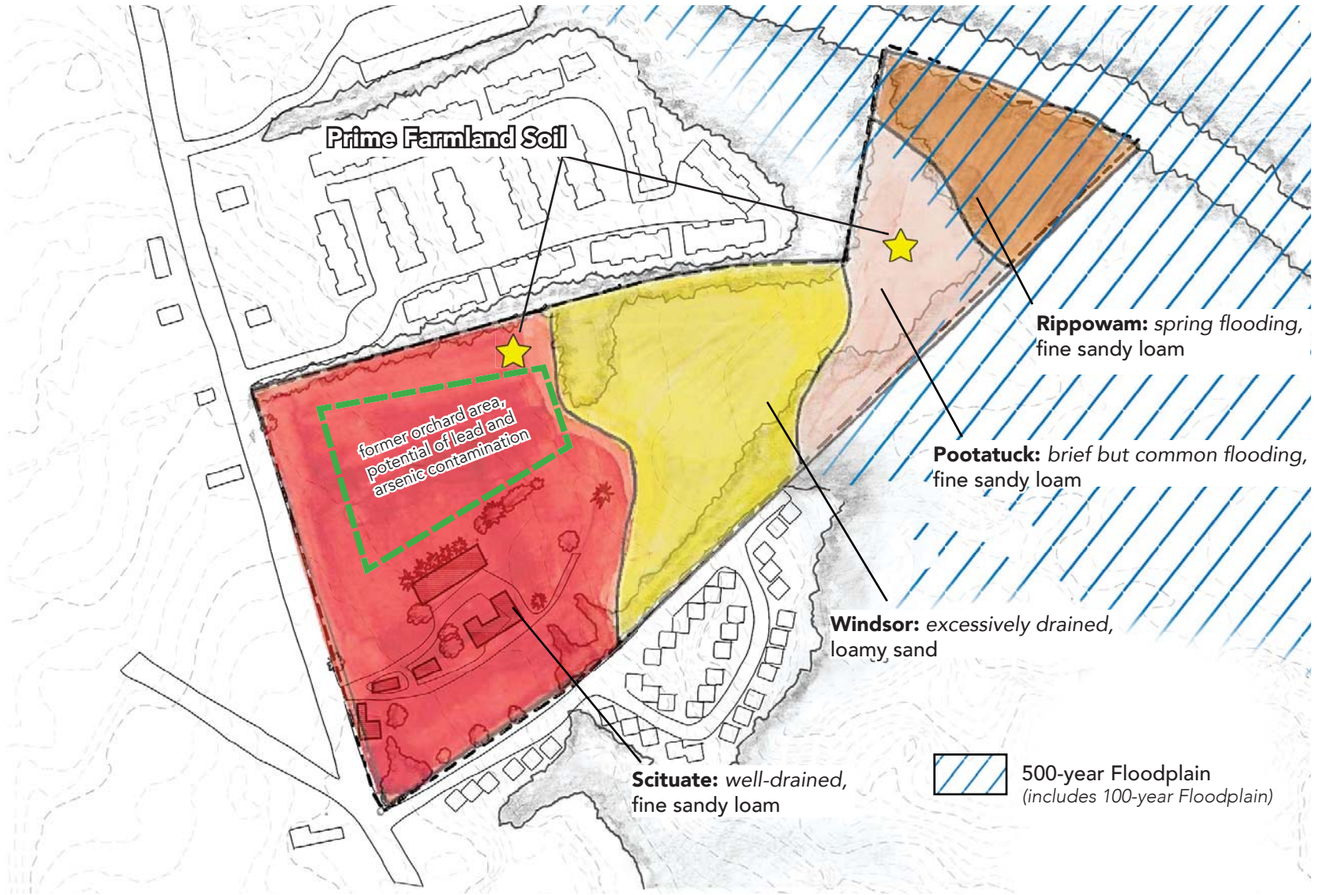
Soil & Floodplain

The four different soil types shown within the Beaver Brook Farm site according to NRCS maps include Rippowam, Pootatuck, Windsor, and Scituate. Pootatuck and Schituate soils are considered USDA Prime Farmland Soils and should be prioritized for agriculture if possible. Prime farmland is a designation assigned by the U.S. Department of Agriculture to soil with the best combination of physical and chemical characteristics to support agricultural production, requiring less amending and fewer inputs than other types of soils.

The 100- and 500-year floodplain overlaps portions of two soil types closest to Beaver Brook (Rippowam, Pootatuck), which are fine sandy loams and sandy loams prone to occasional or seasonal flooding. This flooding may restrict farming or recreational activities, and any trails through this area should be designed to flood or be flood-proof. Along the brookside occurs the Rippowam soil, typically with a high water table of 6 to 18". Just inland is the Pootatuck soil which has a seasonal high water table of 18 to 24". It had once been common practice to clear these riparian areas for cultivated crops, hay, or pasture but there is a risk of flooding and contamination from polluted waterways.

The central band of the property is characterized by Windsor soil, which is excessively draining loamy sand, typically with a depth of 80" to the water table. This rapid permeability implies that agricultural crops with high water needs may need irrigation. Well-draining areas are less likely to hold standing water, so they would be appropriate for gathering spaces, depending on microclimates and site characteristics like sun, views, and slope.

Roughly a third of the property is considered well-drained fine sandy loam (Scituate soil), which is gently sloping and can support farming. If any agricultural ponds are to be located in this area, they would require a clay liner due to the well-drained nature of the soil. This soil type has a seasonal high water table of 18 to 24" and can be stony. According to NRCS, these areas are commonly used for forests, hay, pasture, and silage corn. Depending on additional microclimate analysis, areas near the house may support agriculture due to presence of well-draining, prime farmland soil that is safe from occasional flooding. However, historic photographs reveal the area behind the squash barn was the location of an orchard in the 1930s and 1940s. During that time, heavy metals such as lead and arsenic were used as part of pesticide treatments for orchards. These heavy metals tend to persist, bonded to the soil. When contaminated dust is breathed in by people working on site or ingested on foods grown in contaminated soil, it can cause developmental problems in children. Adults may experience problems like decreased reaction time and nausea (Wuana).



Heavy Metal Contamination

Preliminary soil testing shows the presence of lead and arsenic in the area behind the squash barn, the location of the former orchard. Further soil testing should be conducted to identify the extent of contamination, which will have implications for where food is to be grown or where potential children's play areas should be located. (Hood)

For agriculture: the results exceed recommended maximum trace levels of arsenic and lead in the soil in that location.

For non-food gardens: the site is within limits for lead but exceed recommended maximum for arsenic.

	Non-food gardens	Agriculture	Results
	Recommended maximum	Recommended maximum	Beaver Brook Farm
Lead	<400 mg/kg	<100 mg/kg	217.02 mg/kg
Arsenic	<16 mg/kg	<16 mg/kg	57.04 mg/kg

Orchard Remediation

The practice of using lead and arsenic on orchards was widespread and a number of studies have been conducted on methods of remediating contaminated soils. While used in other types of site remediation, the practice of working with plants or mushrooms to absorb toxins (phytoremediation or mycoremediation) is not particularly effective for mitigating lead or arsenic in soils to be used for farming, as plants take many years to absorb toxins and the soil bacteria needs to be kept wet, which is difficult on the well-draining sites traditionally used for orchards (Hood, 2006). An effective but more expensive method of remediating sites contaminated with metals includes complete removal of the affected topsoil, which is then treated as hazardous waste. A less expensive approach is to leave the soil in place, and cap it by paving over the affected topsoil or adding new clean soil that is then planted with perennial vegetation such as grasses, trees, and shrubs.

Another method of addressing contamination is to introduce new soil and blend it into the existing soil, thereby diluting the impacts of the contaminant, reducing it to below actionable levels. The downside of this procedure is that it may be difficult to thoroughly blend the soils and may require multiple procedures to ensure success. Blending in new soil can be labor intensive on a large site, but there is a possibility that this may be an effective method on a small scale, such as for individual garden plots or raised beds. Further soil testing, research, and ongoing monitoring is recommended.

Designed By: Eric Giordano & Lisa Krause
For the Town of Dracut, MA
Spring 2019

Graduate Program in Sustainable Landscape Planning + Design
the ConwaySchool
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

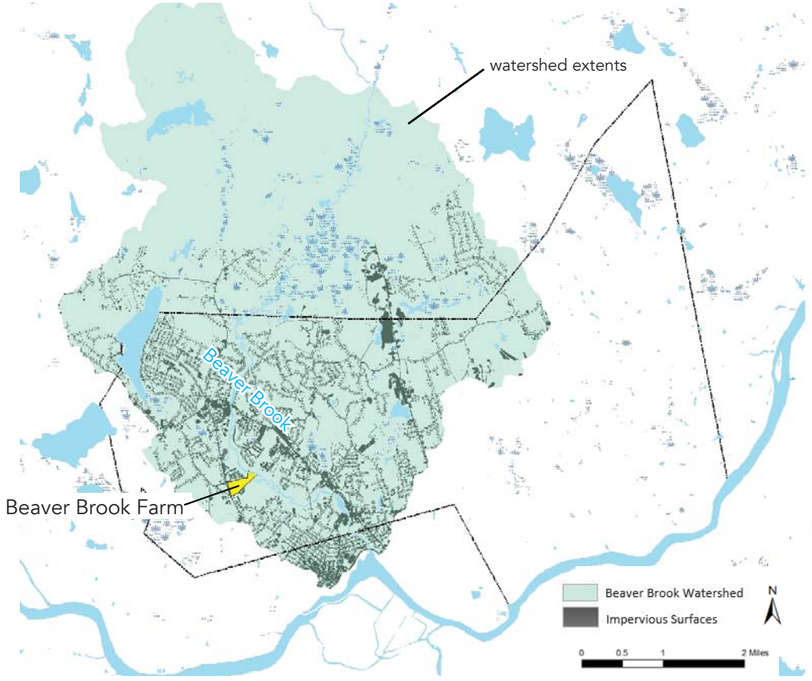
Beaver Brook Watershed

Watershed Context

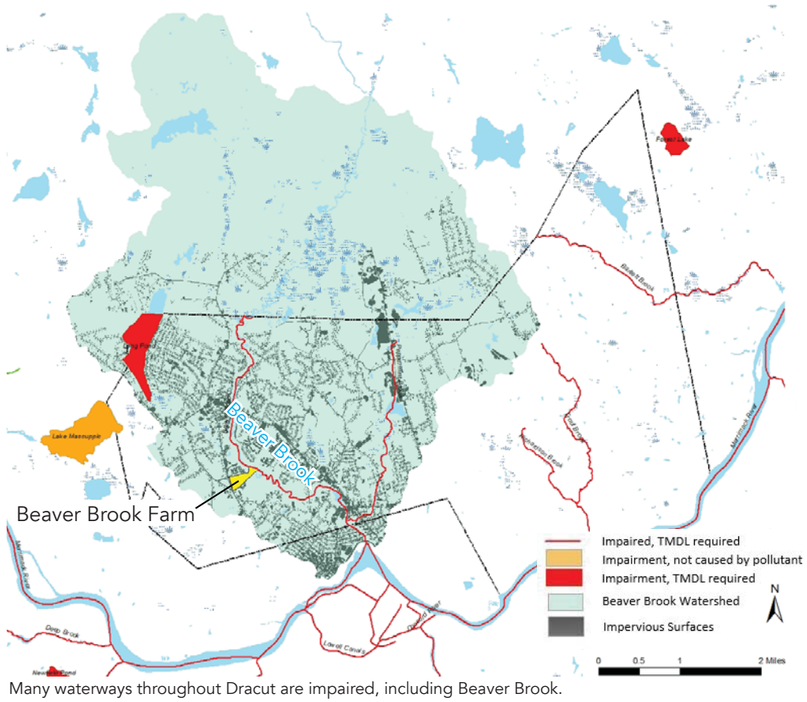
The namesake of Beaver Brook Farm is a 30-mile-long river, which begins in Chester, New Hampshire, crossing into Massachusetts in Dracut and leading to the Merrimack River just two miles south of the farm in Lowell. Beaver Brook passes through the more heavily developed western side of Dracut, where there is a high concentration of impervious surfaces.

The amount of impervious surface in a given area is closely tied to watershed health. Researchers found that biological, chemical, and physical water quality indicators in streams declined in health in watersheds with >10% impervious cover, resulting in a decrease in insect and fish diversity and an increase in pollutants and sediment (Center for Watershed Protection). Many waterways throughout Dracut, including Beaver Brook, are considered impaired by the Massachusetts Department of Environmental Protection (CDM Smith). This means bacteria or pollutants exceed safe levels for particular uses. Beaver Brook is considered impaired due to high levels of phosphorous and e.coli bacteria. These pollutants may possibly originate from runoff from lawns and farm fields containing fertilizer, pet waste, or droppings from geese flocks, and/or illegal wastewater connections. Until water quality improves, recreation activities such as kayaking, tubing, or fishing should be limited within the brook due to high pollutant levels.

The town has expressed interest in developing a trail along the banks of Beaver Brook that would ultimately link to the planned connection to the Bay Circuit Trail in Lowell. Beaver Brook Farm could serve as a trailhead to this greenway, resolving an issue mentioned in the most recent Open Space and Recreation Plan for Dracut (2009) where “the banks have potential as a recreational trail, but with no public access.” There are currently plans to link the local high school to the farm with a cross-country running trail on the eastern side of the brook. Continuing this trail along the brook could bring people to Beaver Brook Farm for its connection to Lowell and passive recreational opportunities like hiking, biking, and wildlife viewing.



Although it was not possible to calculate the percent impervious surface in the entire watershed due to data limitations, there is a concentration of impervious surfaces along Beaver Brook, on the western side of Dracut. The Beaver Brook watershed extends north into New Hampshire, where data on impervious surfaces is not yet available.



Many waterways throughout Dracut are impaired, including Beaver Brook.

Managing Stormwater Runoff in Dracut

Dracut has a Municipal Separate Storm Sewer System (MS4) permit, which means that the town has been permitted by the Environmental Protection Agency (EPA) to release untreated stormwater runoff into waterways. In order to comply with this permit, certain measures need to be in place to minimize pollution of waterways.

Dracut is currently reviewing its stormwater management plan and the MS4 permit requirements (CDM Smith). The Environmental Protection Agency recommendations for stormwater management include six minimum control measures including a requirement for water quality monitoring, community outreach, and education.

With proper infrastructure in place to support public events, Beaver Brook Farm could be a site for educational outreach about green infrastructure and watershed stewardship. Outreach can include demonstrations of ways to reduce lawn size and maintenance requirements. Educational hands-on workshops can include residential water catchment training including creating rainbarrels and residential rain gardens that support local wildlife and pollinators. Perhaps educational signage can be erected to explain how bioretention gardens work and how fertilizers and pesticides in runoff impact the watershed and wildlife habitats. The water quality monitoring requirement may be filled through partnership with the local high school science department. Boardwalks and water quality monitoring platforms along the brook and wetland could allow adjacent high school biology classes to conduct water quality monitoring, habitat monitoring, species identification, and other educational watershed activities.

What is Green Infrastructure?

- Using plants and soils to slow, clean, and infiltrate stormwater
- Treating stormwater as a resource

Ecological Benefits:

- Filters pollutants, cools runoff
- Preserves and restores watersheds
- Recharges aquifers by "slowing, spreading, and sinking" rainfall
- Provides habitat and migration corridors for birds and pollinators

Economical Benefits:

- Prevents overwhelming storm systems by intercepting stormwater
- Irrigates gardens in urban and rural settings for agriculture

Graduate Program in Sustainable Landscape Planning + Design
the ConwaySchool
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

Designed By: Eric Giordano & Lisa Krause
For the Town of Dracut, MA
Spring 2019

Site Drainage

The slopes within Beaver Brook Farm create natural swales that collect and direct water to the east into Beaver Brook. Some areas drain northward, causing potential impact on neighboring properties. Runoff from impervious surfaces on these abutting properties crosses back through Beaver Brook Farm at its lowest point, eventually entering Beaver Brook and the adjacent wetland to the south of the farm.

As stormwater runoff crosses impervious surfaces like roads, parking lots, and rooftops, it picks up contaminants and becomes warmed from stored thermal heat from the sun. This hot, contaminated runoff enters storm sewer systems that empty into waterways, where potential impacts can include depleting habitats for fish and other wildlife, stream bank erosion from heavy flushes of stormwater from outfalls, and decreasing water quality because of high amounts of pollutants. Measures should be made to intercept, slow, cool, filter, and infiltrate polluted runoff on site, as close to the source of runoff as possible.

With increasing frequency and severity of storms predicted throughout the northeast of the United States, developing a stormwater management plan that addresses potential flooding and pollutants in runoff is becoming a critical issue for communities. It is important for each landowner to understand potential runoff volumes in order to design appropriately-sized interventions to intercept, filter, infiltrate and/or temporarily store and slowly release runoff after the storm event passes. Potential stormwater runoff volume can be understood through calculating runoff by comparing average rainfall volumes from storm events and multiplying this amount by the area of impervious surfaces like rooftops, driveways, and heavily compacted soil.

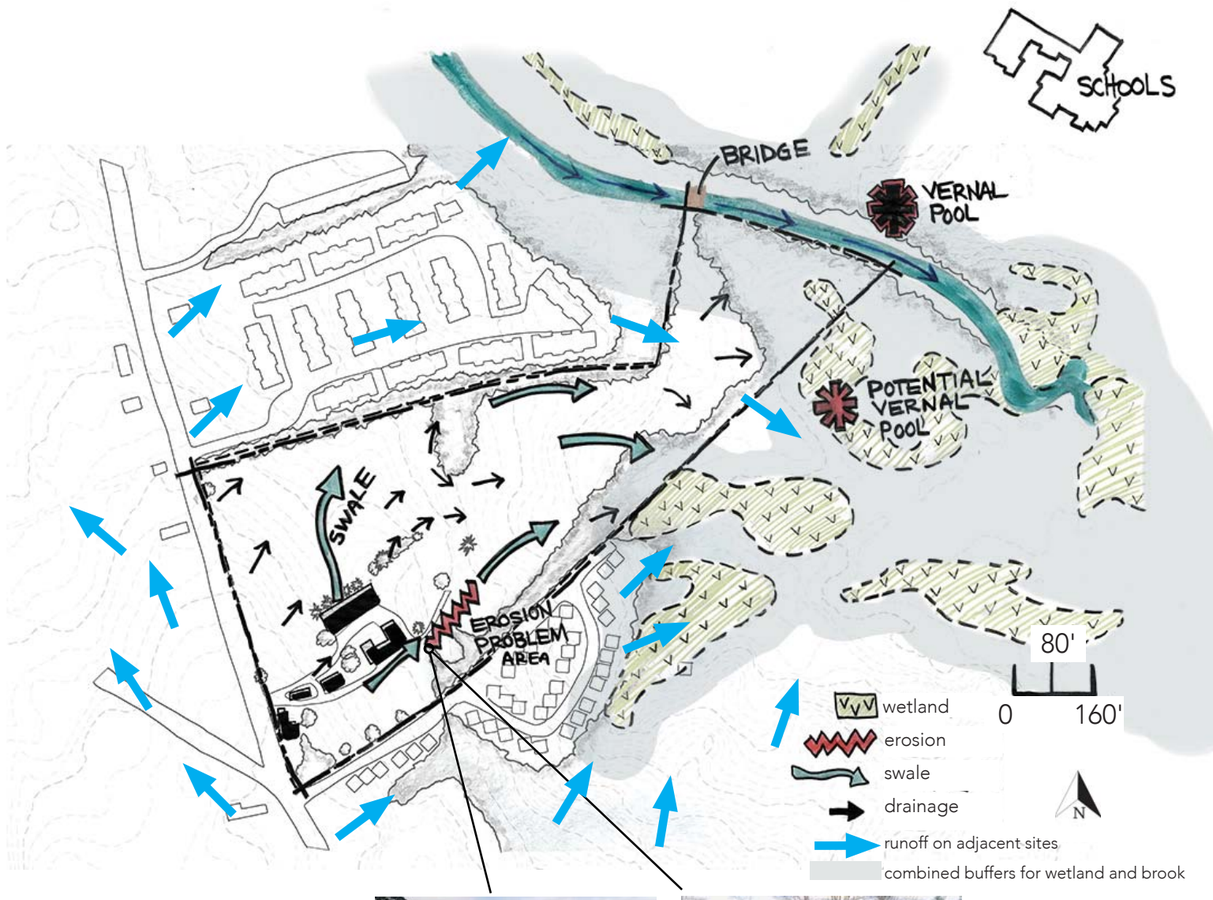
Currently at Beaver Brook Farm, hydrocarbon pollutants from parking areas could potentially enter the site in stormwater runoff. If left untreated, this runoff may have introduce pollutants into the farm's soil and downslope waterbodies such as the brook and wetland.

If polluted stormwater runoff entering the site from the road, driveway, and adjacent properties is abated before reaching agricultural areas, the slopes on site present the opportunity to catch water for irrigation. Rainwater harvesting can be achieved through agricultural ponds and swales designed for conveyance or infiltration of surface runoff.

The building rooftops and driveway at Beaver Brook Farm are impervious surfaces which channel runoff toward a small drainage basin at the base of the driveway. This driveway runoff is creating erosion issues as evident by the photographs of ruts at the top of the farm road. The farm road is used as a walking trail and for tractors that mow the hayfield. Trail erosion makes walking difficult, requires ongoing maintenance, and will likely continue unless runoff is redirected or the trail is redesigned. Instead of becoming runoff, the rainwater from building rooftops could be intercepted with rain barrels and cisterns to be used for irrigation or washing farm tools. In addition to capturing this runoff for agricultural use, designs could include interventions for redesign of this trail to stop erosion and intercept and filter rainwater with bioswales.

The area behind the farm complex is a site of well draining soil which could suitable for gathering spaces. However, the steep slopes would need regrading to shed water and allow accessible paths. Runoff could be potentially directed into bioswales planted with drought tolerant small trees, shrubs, flowers, and grasses that can also handle periodic inundation, and may help with infiltration or filtering pollutants. (See Planting Palette for rain garden species suggestions.)

Activities within 200' of streams and 100' of wetlands are regulated by the state. A permitting process will be required if interventions are proposed within these buffers.



Stormwater Runoff Calculations There is 6,874 cubic feet of total runoff from the rooftop of the squash barn, market building, and driveway at Beaver Brook Farm during a 90-minute 50-year storm (2" of rainfall per hour). In order to intercept this stormwater runoff, 3,437 square feet of property would need to be dedicated to 2' deep infiltration basins.

	storm runoff (ft ³/sec)	runoff coefficient	rainfall intensity (inches/hour)	area in acres
a) squash barn	0.228	.95	2	0.12
b) market building	0.171	.95	2	0.09
c) driveway	0.874	.95	2	0.46
Total volume of runoff	(a+b+c) = 1.273 ft ³/second			
(1.273.ft³/second x 60 seconds/minute) x 90 min. storm duration = 6,842 ft³ of runoff				
Total surface area required for 2' deep infiltration basins	6,842 ft ³ ÷ 2 = 3,437 ft ²			

Erosion at top of the farm road, just beyond the drain at the base of the parking lot.

Runoff is eroding creating large ruts in the farm road, which is also part of the walking trail.

Not for construction. Part of a student project and not based on a legal survey.

Designed By: Eric Giordano & Lisa Krause
For the Town of Dracut, MA
Spring 2019

the ConwaySchool
Graduate Program in Sustainable Landscape Planning + Design
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

Site Drainage
Beaver Brook Farm Master Plan
761 Mammoth Road, Dracut, MA 01826

Wildlife Habitat & Vegetation

Beaver Brook Farm is situated less than a mile from the 1,000-acre Lowell-Dracut-Tyngsborough State Forest, which includes several trails through primarily wetland habitat: a spruce swamp with a brook and pond. Portions are open to seasonal hunting, which may contribute to the community's perceived need for other walking trails listed in the Open Space and Recreation Plan (2009).

Beaver Brook Farm currently consists of four different types of habitat. It is characterized by approximately 10 acres of hayfield, with scattered trees and shrubs through the site and a mixed deciduous and coniferous edge that is thickest nearest the brook, which defines the northeastern boundary of the site. There are a few clusters of conifers near the farm complex that provide windbreaks and opportunity for nesting habitat and cone forage.

What is a wildlife habitat? A habitat is a landscape that provides for all the basic needs of wildlife. Wildlife habitats include sources of food and water, shelter and escape habitat, and places for breeding and raising young, resting, and sun-basking.

Plants/ Source	Example	Wildlife Benefits
evergreens, conifers	white pine, Eastern hemlock	thermal cover (for ruffed grouse), nest sites (for mourning dove), food (for red squirrel)
nut trees	oak, hickory, beech	food (for wood duck, ruffed grouse, wild turkey, blue jay, black bear, eastern chipmunk, squirrels, white-tailed deer)
fruit trees, shrubs, and vines	black cherry, elderberry, choke cherry, dogwood, grape vine	food (for wild turkey, gray catbird, cedar waxwing, many songbirds, black bear, gray fox, white-tailed deer, and small mammals)
cool season grasses, legumes	Kentucky bluegrass, orchardgrass, red clover, birdsfoot trefoil	insects (for poults of ruffed grouse, wild turkey) food (for meadow vole, eastern cottontail, white-tailed deer), nest sites (for field sparrow, song sparrow, meadow vole) hunting sites (for hawks, owls, foxes, snakes)
warm season grasses, legumes	switchgrass, big bluestem, little bluestem, Indian grass, side oats grama	nesting cover (for upland game birds, waterfowl, and ground nesting songbirds), foraging cover (for upland game birds, waterfowl, songbirds, Eastern cottontail), seeds (for songbirds), winter cover (for game birds, waterfowl, cottontail rabbits)
wildflowers, forbs	cardinal flower, New England aster, beebalm, joe-pye weed, columbine	nectar (for butterflies, moths, bees, hummingbirds), seeds (for songbirds), forage (for white-tailed deer)
dead organic matter	standing dead snags, brush piles, leaves, dead perennial stems	food and food storage (for woodpeckers, songbirds, insects, and small mammals), nesting cavities (for owls, small mammals, insects), perches for hunting (for hawks)
exposed ground	soil, sand, rock piles	minerals, water (for butterflies, bees) nesting (for bees, reptiles) sunning (for butterflies, reptiles), escape habitat (reptiles)

(Brittingham, University of Pennsylvania Extrension)

Vines, brambles, and rocks create escape habitat.

Oak leaves blanket the ground at the forest edge.

Mixed deciduous and coniferous edge of the property.

Four habitats are found at Beaver Brook Farm: a brook, wetland, woodland, and hayfield.

Looking west across the hayfield toward the farm complex.

Looking south from the farm bridge crossing Beaver Brook.

The woodland at Beaver Brook Farm is a patchy mix of deciduous and coniferous trees. The property edges are tangled with vines, brambles, and brush that create escape habitat for wildlife, such as cottontails and songbirds. Escape habitat is used by animals to flee predators. Snags, which are standing dead trees, are visible along the property line and provide valuable space for nesting and perching, and food sources for insect-eating birds, reptiles, and amphibians. Mast-producing trees like oak grow on the property, providing valuable wildlife habitat and support to butterflies, moths, and insects necessary for ecosystem health, and foraging opportunities for hundreds of birds and mammals including deer, squirrels, chipmunks, wild turkeys, crows, rabbits, raccoons, opossums, blue jays, quail, and wood ducks (Schaefer). Wild turkey and evidence of deer have been found on site, and neighbors have reported seeing fox and a variety of birds.

On the southern and eastern perimeter of the property, habitat can be increased by expanding woodland into the site's floodplain through introducing additional trees and improving the diversity of the understory, creating more varied habitats. Improved habitat ecology could provide opportunity for experiencing wildlife and support agricultural goals through increasing pollinator habitat (See Plant Palette section for Native Hedgerow).

The woodland includes portions of a riparian buffer along Beaver Brook that extends behind housing developments through the developed western side of Dracut. Ripairan buffers help to improve the water quality and function of adjacent waterbodies through stabilizing the brook edges, managing flooding, and remediating runoff. This riparian portion potentially hosts different species compared with the woodland edge in upland areas. There is a heavy presence of invasive Asiatic bittersweet and multiflora rose mixed among the vegetation, which can displace native species necessary for local wildlife. This area may benefit from some level of forest management such as planting native species and invasive species management. (see Plant Palette section for Floodplain). It may be advisable to include exclosures for new vegetation in heavily deer-traveled areas, where fencing encircles planting areas and keeps deer out.

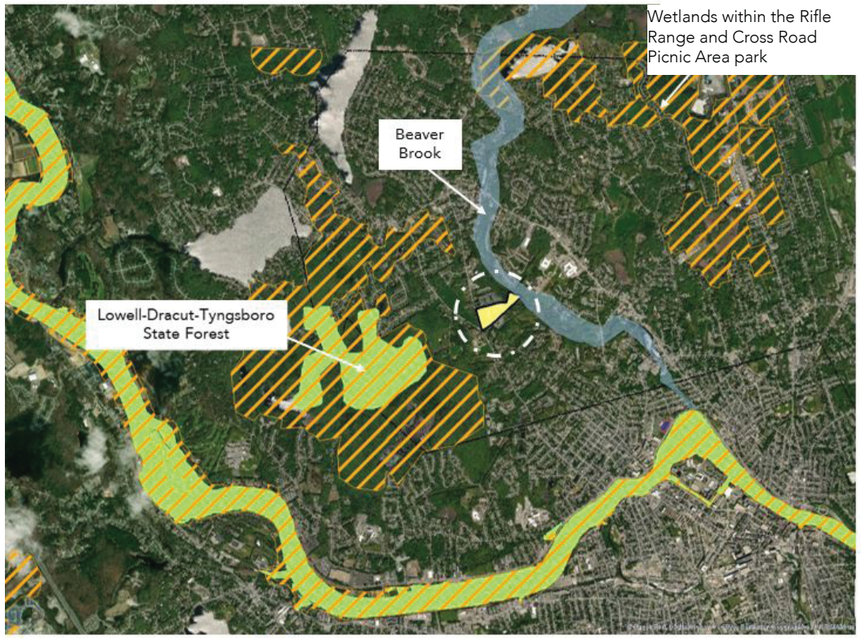
Given that a trail is planned along the eastern side of the brook, it will continue to be important to maintain vegetation. Such improvements to wildlife habitat may eventually continue along the riparian corridor, as the town is investigating purchasing additional property along the brook for an extended trail link to other town-owned properties. But increased human activity through these riparian corridors by the addition of trails may have adverse impacts on wildlife. With the high school cross-country season being in the fall, species that breed in the other seasons may be less disturbed than those who breed then. Some trails can be closed seasonally to protect breeding areas for species such as grassland birds. Yet, hiking activity in spring and summer may be beneficial for agriculture because trail usage may scare deer from garden areas, and help protect new planted trees and understory from deer browse.

Graduate Program in Sustainable Landscape Planning + Design
the ConwaySchool
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

Designed By: Eric Giordano & Lisa Krause
For the Town of Dracut, MA
Spring 2019

Wildlife Habitat & Vegetation II

Potential to Support Nearby Places of Conservation Value



Species of Conservation Concern

Blanding's turtle *(threatened)*

leopard frog

Looking south, a cattail marsh on the abutting property is visible through the trees.

Tire tracks in the low-lying southeastern side of the property, where saturated springtime soil is present.

The hay field provides a pastoral view and is one of the community's most treasured aspects of the Beaver Brook Farm. Approximately 10 acres of land are on a short 32-day haying rotation, creating a potential ecological trap for grassland birds: the birds may misidentify hay fields for grassland nesting sites, mowing disrupts the breeding cycle, and birds are not able to nest again for the season, creating a population sink where the number of deaths of a species exceed the number of births (Crone, et al.).

Grassland birds require large acres of grassy fields in order to nest and commonly mistake hayfields for grassland habitat. According to MassAudubon, grassland birds throughout Massachusetts are in decline, which include bobolink, Eastern meadowlark, grasshopper sparrow, and savannah sparrow. In Middlesex County, the rare bobolink and vesper sparrow are most likely to be seen in late spring and early fall (eBird). At Beaver Brook Farm mowing the 10-acres on a short haying rotation disrupts potential breeding cycles and habitats for grassland birds that require less acreage like the bobolink and vesper sparrow, but also small mammals, like rabbits, and reptiles and amphibians who may need these habitats. Changing Beaver Brook Farm from hayfield to grassland meadow could provide many benefits. Grassland meadows attract wildlife that provide numerous environmental benefits to agriculture, from pollination to pest control. These fields could be overseeded with native grasses and flowering species to become grassland meadows, providing pollinator support and habitat for grassland birds that eat pests, which creates an opportunity for passive recreation including birding and recording sightings with eBird and MassAudubon's Citizen Scientist Grassland Bird Monitoring Program.

There are programs researching practices that alleviate the tension between providing habitat for wildlife and generating income for farmers. At grassland bird sanctuaries like Arcadia Wildlife Sanctuary in Easthampton, MA, fields are maintained by a mowing schedule that requires planning and public outreach based on bird's nesting cycles which helps to balance of the needs of wildlife, farmers, and the ecological concerns of the community (Fieldman). Farmers can alter mowing patterns to reduce harm to wildlife and can be compensated for wildlife-friendly practices. Funded through private donations to MassAudubon, The Bobolink Project incentivizes farmers to postpone mowing from May through August, allowing for two cuts per season while protecting breeding habitat (Atwood). As part of the Bobolink Project, the University of Vermont Extension Center for Sustainable Agriculture is in the process of identifying focus groups of farmers in Vermont, Connecticut, Massachusetts, and New Hampshire with over 10 acres of hay fields as consultants on the financial impacts of delaying mowing. If they choose to be involved in the study, they will be compensated for managing their land in a way that supports grassland birds on working farms (Alvez).

The need for a wildlife corridor in the more heavily-developed west side of town was established in Dracut's most recent Open Space and Recreation Plan (2009). Beaver Brook Farm's location on the west side of town positions it to contribute to the formation of a wildlife corridor especially if habitats are improved on site, allowing species to travel safely from one habitat to another. The value of improving habitat on small sites is supported by research from the University of Michigan, which has shown substantial improvements in biodiversity can be made from wildlife corridors as little as 75 feet wide (Conniff).

Currently, forested areas 60 to 80 feet wide can be found along the eastern portion of Beaver Brook Farm. Introducing a more dynamic understory and eliminating invasive species within the forested edges and riparian areas along the stream and wetland can help to create, preserve, and maintain corridor linkages. Increasing biodiversity of the site can also improve the trail experience, providing educational and recreational opportunities for visitors.

The wetland on the adjacent property to the south of Beaver Brook Farm is a valuable habitat for numerous species. It is the site of a potential vernal pool and is a mixed marsh of cattails (see map on Site Drainage section). In addition to habitat, wetlands provide ecological services including flood storage and purification of waterways. On the Beaver Brook Farm side of the forested edge along the property line, long grass for hay grows in wet soils prone to spring flooding. If forested, these areas could be part of a floodplain ecosystem with floodable trails or boardwalk decking extending into the wetland for birdwatching, habitat observation, hiking, and connection to a larger trail system. When considering a boardwalk, it will be important to consult with an ecologist to determine potential impacts on existing habitats, which will also help determine the route of the boardwalk path (Kusler).

The riparian buffer and area wetlands may also be functioning as a wildlife corridor from a series of wetlands within the 63-acre Rifle Range and Cross Road Picnic Area, which has been identified by the Natural Heritage and Endangered Species Program (NHESP) as core habitat containing species of conservation concern and is located less than a mile north of Beaver Brook Farm. The threatened Blanding's turtle and leopard frog are species of conservation concern identified in area wetlands. They will travel to multiple wetlands throughout their breeding cycle and require habitats similar to those found at Beaver Brook Farm as nesting sites. While Beaver Brook Farm is not listed as Core Habitat by the NHESP, the site conditions support these species needs, which suggests that the site may already be breeding habitat. Protecting this area from polluted runoff would help in supporting the ecological health of the potential vernal pool identified in the wetland.

Looking across the hayfield south toward the farm complex.

Grassland meadow flowers www.quietnature.ca

bobolink

vesper sparrow

Graduate Program in Sustainable Landscape Planning + Design
the ConwaySchool
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

Designed by: Eric Giordano & Lisa Krause
For the town of Dracut, MA
Spring 2019

Wildlife Habitat & Vegetation II
Beaver Brook Farm Master Plan
761 Mammoth Road, Dracut, MA 01826

Summary Analysis

AN APPROPRIATE SITE FOR A VARIETY OF USES

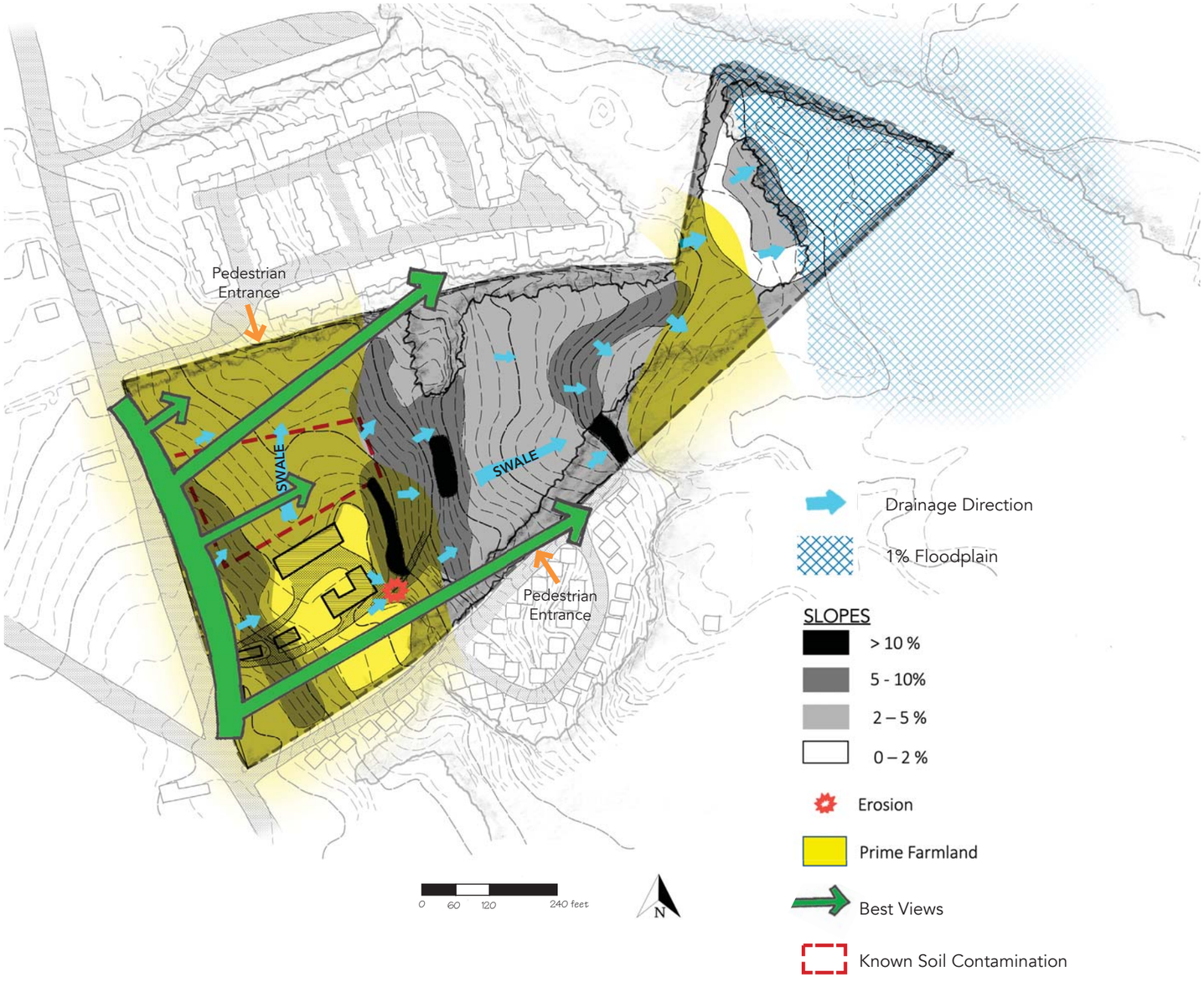
The site conditions of Beaver Brook Farm are amenable to many of the agricultural, recreational, and educational uses that community members would like to see on site. The slopes, drainage patterns, and other site characteristics suggest optimal or necessary placement of certain elements. Overlap or conflict between some desired uses requires decisions to be made about the community's priorities.

Most of the site is gently sloped down from west to east, with only a few areas sloped above 5% where paths would need special design for universal accessibility. The largest of these areas is just east of the building complex where water drains quickly eastward down the hill carrying potentially polluted stormwater from the asphalt driveway, presenting a need and an opportunity to catch and infiltrate the runoff. If any paths or gathering areas are considered for this steeper sloped area, special attention must be given to how water can be shed or diverted to avoid erosion and/or pooling.

There are two bands of prime farmland on site that would be ideal areas for growing crops. The larger of the two bands occupies the entire western third of the property. While this area may support agricultural use, many residents have expressed a desire to preserve the open pastoral view from Mammoth Road. Agricultural uses such as large fruit trees, greenhouses, or other farm structures might block this view. Furthermore, a soil test indicates that the heavy metals lead and arsenic are in the area north of the squash barn that was once an orchard; growing crops here should be avoided until contaminants are remediated. This area was the only one that was tested and the extent of contamination in other areas on the property is unknown. Further testing and delineation is recommended.

In a large rainstorm, one that has a 1% chance of happening in any year, Beaver Brook will flood the entire forested area along the eastern boundary. With climate change, however, storms could be more frequent and more severe, and floods might extend further into the property. Extending the forested riparian buffer on site could help absorb floodwater while slowing, spreading, and sinking stormwater at the higher elevations to the west could lessen the extent of flooding, and also turn the site into a learning laboratory for stormwater management.

Residents in abutting properties to the north and south have access to Beaver Brook Farm by only one entrance on each side. Designs may consider increasing the number or improving the design of access points to give abutters convenient access to other areas on site.



Not for construction. Part of a student project and not based on a legal survey.

Graduate Program in Sustainable Landscape Planning + Design
the ConwaySchool
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

Designed By: Eric Giordano & Lisa Krause
For the Town of Dracut, MA
Spring 2019

Preliminary Design Alternative 1
Naturalist Park

With consideration of input from the community meeting on May 2, 2019, and analysis of site conditions, three preliminary design alternatives were generated. The first, titled "Naturalist Park," preserves much of the land as grassland meadow, extends the riparian corridor, creates new walking trails and gathering spaces, and provides community gardening space in the southwest corner of the property.

All 3 preliminary design alternatives:

- Meet Community Preservation Act criteria by providing open space and recreation and preserving the historic farm buildings.
- Preserve pastoral views from the road.
- Provide spaces for agriculture, educational opportunities, and recreation.
- Address stormwater and increase habitat.

PROS

- Least expensive of the three concepts to implement, this design dedicates 10 acres to grassland habitat by overseeding the existing hayfields with meadow plant species and mowing only after nesting season or once every 3 years to maintain.
- Habitats are expanded by reforesting the floodplain and adding flowering and fruiting hedges to the woodland edge and creating a green roof that attracts pollinators on top of the newly renovated market building.
- Nature education opportunities are supported by a nature center and field lab in re-purposed buildings, a wetland boardwalk with viewing and water quality monitoring platforms, and informational habitat signs.
- Community gardens are located in the southwestern corner of the property. Nearby parking areas are not expanded, keeping the human footprint small on the land.
- Trails meander through the fields, bringing visitors into the meadow and to a ropes course and treehouses for additional outdoor recreation options. The trail system maintains the existing link to the farm bridge that connects to a trail to the school complex and connections to the neighborhoods to the north and south.

CONS

- There is little to no space for large gatherings or active recreation.

Graduate Program in Sustainable Landscape Planning + Design
the ConwaySchool
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

Designed By: Eric Giordano & Lisa Krause
For the Town of Dracut, MA
Spring 2019

Alternative 1: Naturalist Park
Beaver Brook Farm Master Plan
761 Mammoth Road, Dracut, MA 01826

Preliminary Design Alternative 2
Farmland Focus

The second alternative, titled "Farmland Focus," uses most of the site's land for growing crops.

PROS

- Dedicates most of the land to farming at many scales. Community gardeners can learn from market farmers, who can begin on half-acre plots and expand to several acres.
- Ponds provide water for irrigation, habitats, and winter sports like pond hockey and ice skating.
- The trail system maintains the existing link to the farm bridge that connects to a trail to the school complex and connections to the neighborhoods to the north and south.
- Universally accessible gardens are terraced on-contour on the eastern slope, with a nearby vineyard and orchard.
- A community food forest provides food and medicine from all the layers of the forest, including fruit and nut trees and shrubs, vines and herbaceous understory plants, mushrooms, and roots.
- Pollinator hedgerows line the perimeter of the fields and western frontage, providing support for agriculture and a welcoming entry to the site.

CONS

- There is little to no space for large gatherings or active recreation.
- Heavy tractors may create uneven surfaces on the farm roads that also serve as walking trails, which could make roads inaccessible for some visitors.

Designed By: Eric Giordano & Lisa Krause
For the Town of Dracut, MA
Spring 2019

the ConwaySchool
Graduate Program in Sustainable Landscape Planning + Design
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

Alternative 2: Farmland Focus
Beaver Brook Farm Master Plan
761 Mammoth Road, Dracut, MA 01826

Preliminary Design Alternative 3
A Place for All

The third alternative, titled "A Place for All" provides a variety of agricultural, recreational, and educational opportunities.

PROS

- Accommodates the most variety of uses of all the alternatives including agriculture, public events, and passive and active recreation.
- The pastoral view from the road is preserved with an open field dedicated to picnic gatherings.
- The trail system maintains the existing link to the farm bridge that connects to a trail to the school complex and connections to the neighborhoods to the north and south.
- Active recreation opportunities include courts for tennis and basketball, a graded sports field for soccer, yoga or t'ai chi, and a pond for winter sports like ice skating and pond hockey, as well as trails usable for cross country skiing and snowshoeing.
- A parking lot covered with solar panels, keeps cars cool in the shade and provides electricity for the buildings and facilities within the park.

CONS

- Most expensive of the alternatives and requires the most management for sports fields and most frequent mowing.
- Minimal use of prime farmland soils for growing crops, community gardening, or market agriculture.

Designed By: Eric Giordano & Lisa Krause
For the Town of Dracut, MA
Spring 2019

the ConwaySchool
Graduate Program in Sustainable Landscape Planning + Design
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

Alternative 3: A Place for All
Beaver Brook Farm Master Plan
761 Mammoth Road, Dracut, MA 01826

Preferred Design
A Naturalist Park with Room to Grow

The community's preferred design most closely resembles the Naturalist Park alternative, increasing and enhancing the variety of wildlife habitats on site, improving public access and circulation on the property, and providing an array of educational opportunities.

Ⓐ The design preserves **ten acres of grassland meadow,** seeded with native wildflowers, keeping the pastoral views desired by the community while supporting area ecosystems. The meadow retains the farmland aesthetic without requiring the same degree of maintenance as a hayfield.

Ⓑ **A reforested riparian zone** includes canopy trees, native understory tree and shrub species, flowering and fruiting hedges, and herbaceous species that can tolerate flood events and provide habitat diversity for songbirds and pollinators.

Ⓒ **Trails** are increased in number and improve access and circulation on site. A cross-country running trail offers a loop of the scenic property to be used by the high school running team. Universally accessible paths in some areas provide access for visitors with mobility issues. New trail connections to the abutting communities allow neighbors to better access the property through the wooded edge.

Ⓓ **Interpretive signs** erected throughout the property help to improve the nature trail experience and provide context, creating sense of place through interpreting the habitats and history of the site.

Ⓔ **Boardwalks and platforms** allow students or other community members to view wildlife and monitor Beaver Brook water quality from the brook edge. The boardwalk extending through the wetland on the adjacent property leads to observation decks for viewing birds, amphibians, and other wildlife. This boardwalk may eventually become part of a connection to a future two-mile greenway multi-use trail along Beaver Brook to Lowell.

Ⓕ The southwest corner of the property becomes a **hub of activity** that includes a community garden, a picnic area, a pick-your-own berry and fruit orchard, and an amphitheater for performances and outdoor classes/workshops. (Details on Sheet 16.) Buildings are adaptively reused and integrate with the educational and agricultural uses of the site. (Details on Sheet 18.)

Not for construction. Part of a student project and not based on a legal survey.

Graduate Program in Sustainable Landscape Planning + Design
the ConwaySchool
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

Designed by: Eric Giordano & Lisa Krause
For the Town of Dracut, MA
Spring 2019

Preferred Design
Beaver Brook Farm Master Plan
761 Mammoth Road, Dracut, MA 01826

Design Detail
Farm Village

The area at the southwest corner of the property becomes a hub of activity, allowing wildlife habitat to flourish on the rest of the site.

Ⓐ Inviting perennial gardens line the **main entrance**, which has been streamlined to one driveway. The driveway takes a right turn just after the stone garage leading to a new parking lot for the Bed and Breakfast that occupies the main house. Patio seating in the rear of the B&B offers a relaxing area, buffered from the road, for visitors to enjoy the view overlooking the community garden.

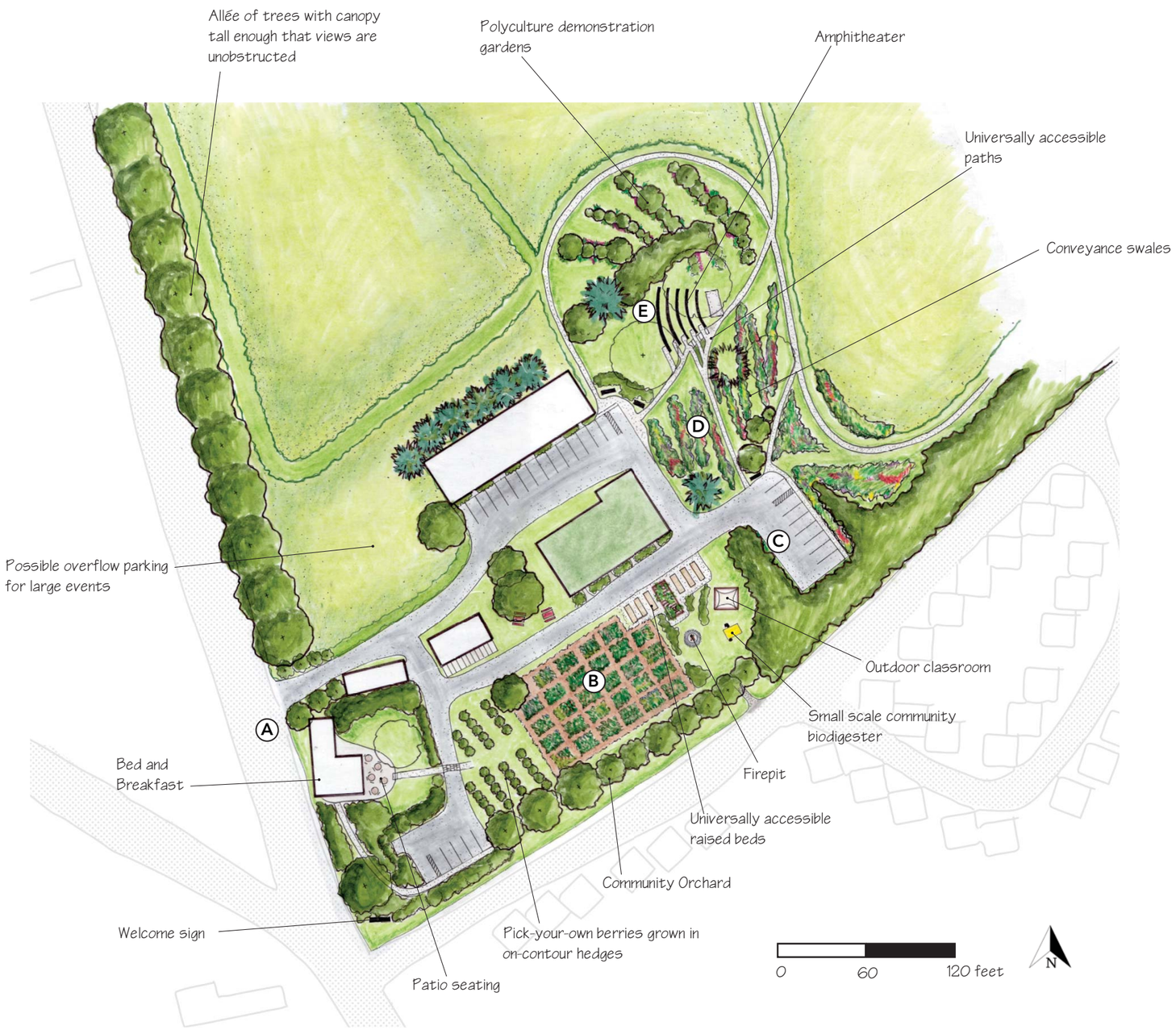
Ⓑ **A community garden** south of the buildings provides garden beds for the public. Pending soil tests that indicate clean soil, crops can be planted in the ground, utilizing the prime farmland of this area. Its location near the parking areas and structures makes it readily accessible for visitors and for integration with potential building uses such as a workshop, tool library, and/or field lab/classroom.

Raised beds and tabletop gardens are available in the community garden on a crushed stone pad for community members with mobility issues. Fruit trees line the garden along the southern property boundary, while on-contour berry hedges buffer the garden from the main house to the west.

Ⓒ **A new parking area** adds eight new spaces on the flat landing adjacent to the community garden allowing for larger attendance to site activities. All parking areas on site are bordered by bioswale gardens designed to create pollinator habitat while intercepting, conveying, and filtering runoff.

Ⓓ **Conveyance swales** intercept stormwater runoff from the driveway, infiltrating it as it slowly travels downslope. Berms are planted with native perennial wildflowers that attract beneficial insects that pollinate the crops in the nearby community garden and other plants, supporting biodiversity on site and in the larger region.

Ⓔ **An open-air amphitheater** is nestled into the east-facing hillside near the site of the former dairy barn and provides views of the eastern half of the property. The stage faces west, with the existing row of mature trees protecting the audience and performers from the late-afternoon sun. Universally accessible paths with a max slope of 5% lead from the parking lots to the amphitheater and to polyculture demonstration gardens directly to the north. These trails continue eastwards to Beaver Brook and to the boardwalk, providing a universally accessible loop of the entire breadth of the property



Not for construction. Part of a student project and not based on a legal survey.

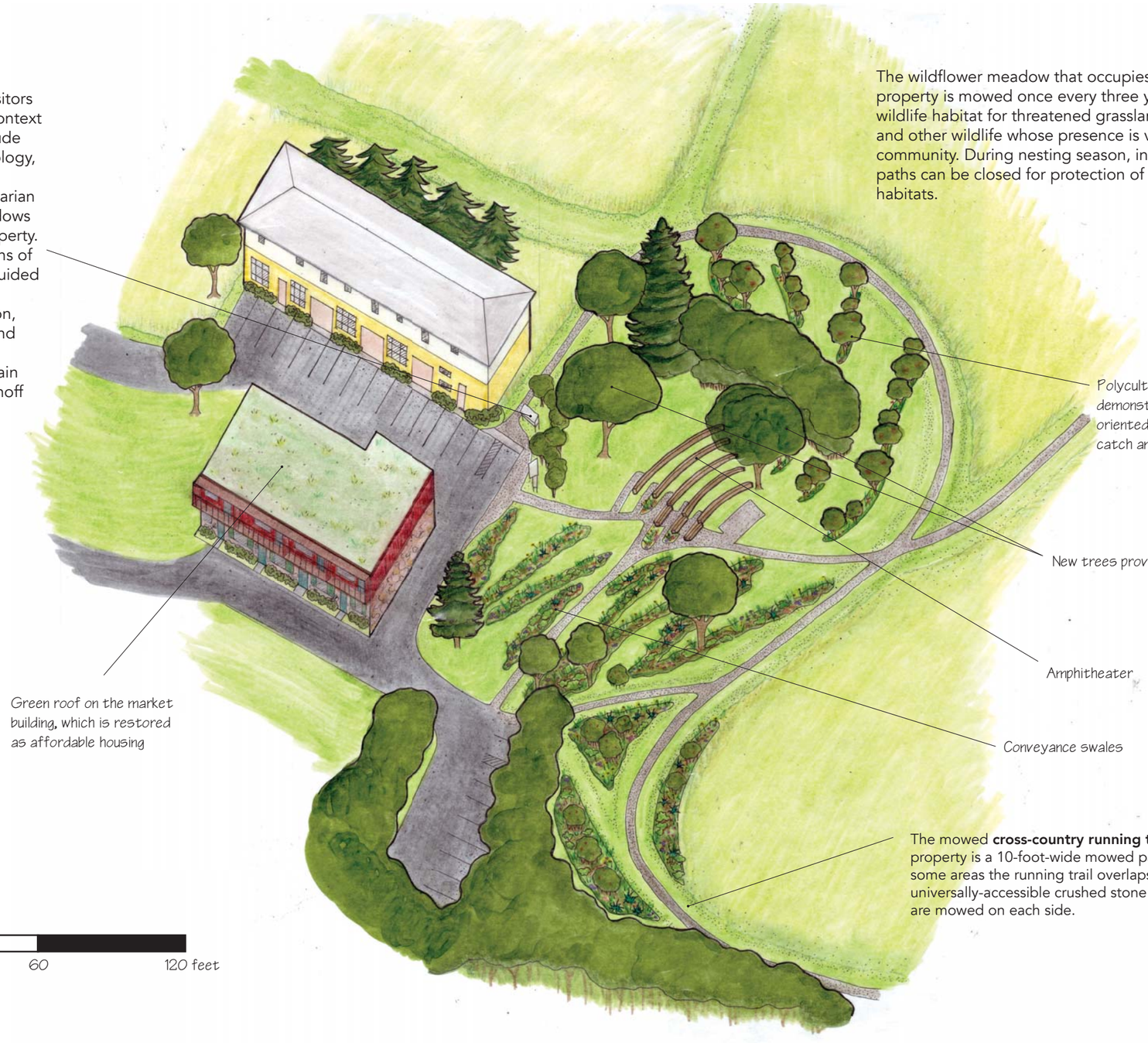
Graduate Program in Sustainable Landscape Planning + Design
the ConwaySchool
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

Designed By: Eric Giordano & Lisa Krause
For the Town of Dracut, MA
Spring 2019

Design Detail: Farm Village
Beaver Brook Farm Master Plan
761 Mammoth Road, Dracut, MA 01826

Design Detail
Hillside

Interpretive signs throughout the property give visitors an understanding of the ecological and historical context of elements on site. Within each habitat, signs include information on ecosystem functions, species phenology, and identification of plants and wildlife common to grassland, floodplain, forest edge, wetland, and riparian habitats. Signs erected at historic views create windows into time, strategically installed throughout the property. They include photographs and historical descriptions of Beaver Brook Farm from Dracut residents for self-guided tours. Green infrastructure systems and ecological services are explained on signs near each installation, educating visitors about watershed management and conservation, including creative ways to minimize watershed impacts using bioswales, rain gardens, rain barrels, cisterns, and green roofs for stormwater runoff interception.



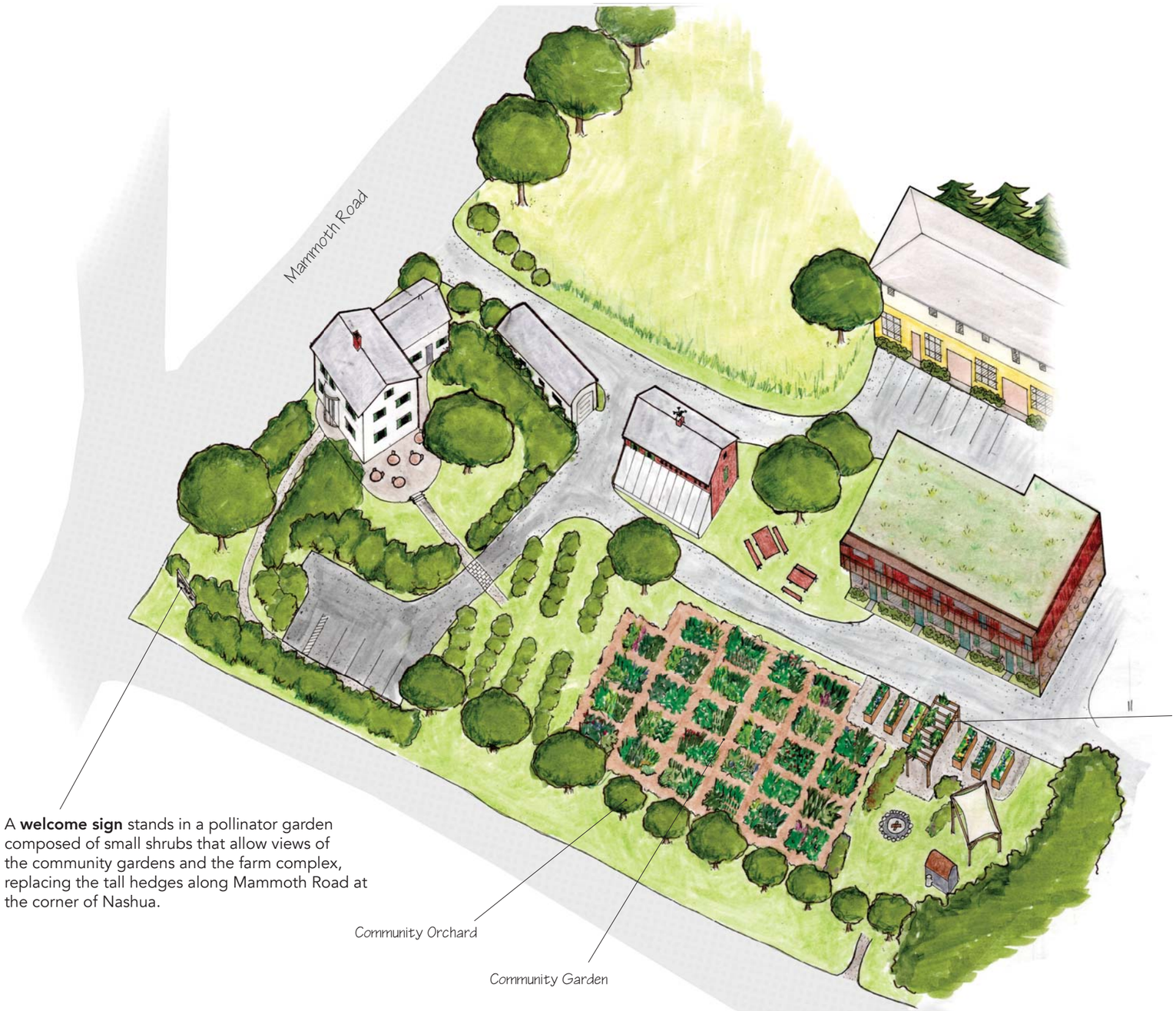
Not for construction. Part of a student project and not based on a legal survey.

Designed by: Eric Giordano & Lisa Krause
For the town of Dracut, MA
Spring 2019

Graduate Program in Sustainable Landscape Planning + Design
the **Conway**School
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

Design Detail: Hillside
Beaver Brook Farm Master Plan
761 Mammoth Road, Dracut, MA 01826

Design Detail:
Entrance and Community Garden



Adaptive reuse of the existing buildings might include a nature center, field lab, and community classroom established in the squash barn, adding to the educational experience by providing access to field guides and opportunities to record field data on water quality, sitings of grassland birds and songbirds, migrating threatened pollinators like monarch butterflies and other wildlife sitings. Students and community members can use this site to contribute to Citizen Science programs through organizations like Audubon and Xerces Society, as well as log observations of water quality for Dracut's Municipal Separate Storm Sewer System permit requirements. Classrooms provide space for events like nature interpretation or botanical illustration classes, as well as small meeting rooms or offices for local citizens groups or organizations. The seed shed can become a farm museum and community greenhouse, with a community tool-bank in the nearby stone garage. If zoning allows, affordable housing for up to ten small apartments may be possible on the footprint of the former market building. The farmhouse could be re-purposed as a bed & breakfast with a public cafe, including outdoor seating in a garden with views of the historic farm complex.

A **welcome sign** stands in a pollinator garden composed of small shrubs that allow views of the community gardens and the farm complex, replacing the tall hedges along Mammoth Road at the corner of Nashua.

An **arbor** marks the entry to the garden over which grows a grape vine.

Not for construction. Part of a student project and not based on a legal survey.

Designed By: Eric Giordano & Lisa Krause
For the Town of Dracut, MA
Spring 2019

the ConwaySchool
Graduate Program in Sustainable Landscape Planning + Design
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

Design Detail: Entrance and Community Garden
Beaver Brook Farm Master Plan
761 Mammoth Road, Dracut, MA 01826

Community Engagement

COMMUNITY MEETING 1

On **May 2, 2019**, the Conway team facilitated a community meeting with 25 Dracut residents. Participants brainstormed ideas for use of the land and buildings on Beaver Brook Farm. Results fell under two main categories: Agriculture and Open Space/Community Space/Recreation. Full results from the brainstorm are shown below:`

Agriculture

Uses of the Buildings
Farmers market
Farm-to-table dinners
Terraponics
"Make It in Dracut" event
Food processing
Use by North Bennet School
Agri-tourism (look at Stone Barns NY, Wrightlock Farm, Maker Farm in Westford)
Adult-education farming classes
Tools and farm resource storage

Uses of the Land
Flower beds
Agri park
Orchards (fruit, pick-your-own apples)
Grow squash
Hay
Pick-your-own berries
Community gardens (in general, and for seniors)
Educational programs (field trips, summer
Agriculture Education for high school kids, adult classes in Agriculture)
Harvest festival
Incubator farms
Agri-tourism (look at Wrightlock, Stone Barns, Maker Farm in Westford)
Compost operation

Open Space/Community Space/Recreation

Uses of the Buildings
Venue, events, small events
Community center
Senior housing
Multifunctional meeting rooms
Offices/HQs
Farm-to-table dinners
Bed & breakfast
Cafe for seniors
Historical restrictions
Dracut land trust take over, HQs
Friends of BBF office
Condo associations meeting space
Memory cafe
Retreat space
Wedding venue
Festivals and fairs (craft fair)
Farm museum

Uses of the Land
Open space on hill by Mammoth Rd.
Old Home Day (1,200 people)
Amphitheater/gazebo (natural setting, where dairy complex was)
Concert venue
Play park
Picnic (picnic tables, town picnic)
Swings
Bird watching
Yoga in the fields (goat yoga)
Cross-country skiing
Sledding
Walking Paths (universally accessible, nature trails, path in wooded area to explore)
Greenway bikepath (floodable?)
Sports fields
Kayak rental
Hockey/skating rink
Volleyball court
Running paths (cross-country, road race route, Greater Lowell Road Runners)
Connect to state forest
Driving range (open weekends and manned by a golf team somehow beaver brook gets revenue)
Outdoor exercise equipment for seniors
Water Tank - Cell Tower

Overall Values

The space should be a commons
Open to the whole community
All-ages (gardens, trails, activities)
Strong sense of place
"Less is More"
Preserve the expansive views
Economic viability
Get rid of non-essential buildings
No motorized vehicles
Outdoor community gathering
Eco-Agritourism hub
Educational opportunities
Modern sustainable agriculture
"Community garden idea is great" (if someone can oversee it)
Local food
"Make it in Dracut"
Precedents: Mill City Grows, Stone Barns, Wrightlock Farm, Maker Farm, Pettengill Farm in Salisbury, Brooksby Farm in Peabody, MA.

COMMUNITY MEETING 2

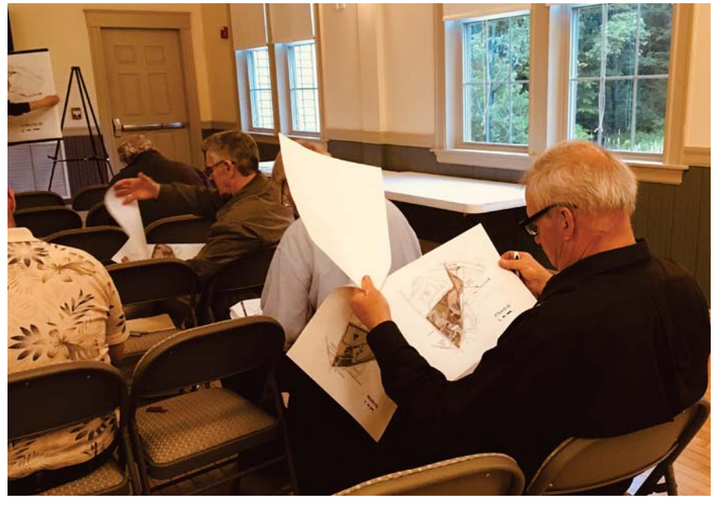
With consideration of the input from the first community meeting and analysis of the site conditions, the Conway Team generated three preliminary design alternatives (Sheets 12-14). These alternatives were presented at a second community meeting on **May 30, 2019**, which was attended by 21 Dracut residents who gave feedback on the designs. In summary, adhering to their value of "less is more", most attendees preferred the "Naturalist Park" design that preserves most of the land as grassland meadow, extends the riparian corridor, creates new walking trails and gathering spaces, and provides community gardening space in the southwest corner of the property.

SELECTED COMMUNITY FEEDBACK ON EACH ALTERNATIVE DESIGN:

Naturalist Park
"Make sure trail network is ADA"
"Love combination of meadows and farm plots"
"Consider abutter entrances"
"Wonderful to get kids outdoors with the ropes course"
"Squash Barn could be event space"
"Love U-Pick berries and fruit"
"Add boardwalk connecting to other property"
"Love universally accessible gardens"
"Concerned there's not enough parking"
"Add affordable housing"
"Dislike the idea of affordable housing"

Farmland Focus
"Love the community gardens"
"Keep open views from Mammoth Road"
"Concerned about smell of chickens"
"Love trail connections for abutters"

A Place For All
"Sports fields not needed, school already has them"
"Dislike parking lot on mammoth road"
"Concerns about parking for events"
"Love amphitheater"
"Too much activity in this plan. Less is more."
"Boardwalks are a great long term goal"
"Love pond for winter hockey"



Not for construction. Part of a student project and not based on a legal survey.

Graduate Program in Sustainable Landscape Planning + Design
the ConwaySchool
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

Designed By: Eric Giordano & Lisa Krause
For the town of Dracut, MA
Spring 2019

Community Engagement
Beaver Brook Farm Master Plan
761 Mammoth Road, Dracut, MA 01826

Appendix
A

Resources

Grassland Management

Should the Town of Dracut decide to convert the hayfields into grassland habitat and meadow trails at Beaver Brook Farm, procedures for grassland management should be instituted to help maintain the long-term ecological health of the grassland and to better support wildlife.

Recommended procedures include:

Seeding the hayfield in fall and spring with native warm-season grasses and wildflowers, which creates a more dynamic ecosystem that meets grassland bird nesting needs and supports pollinators while allowing mowing for a hay crop and improves the trail experience for visitors with seasonal flowers and increased wildlife activity.

A mix of native grasses hardy to the northeast includes Virginia wildrye *(Elymus virginicus)*, Canada wildrye *(Elymus canadensis)*, little bluestem *(Schizachyrium scoparium)*, Indiangrass *(Sorghastrum nutans)*, and switchgrass *(Panicum virgatum)*. These 2 to 5' tall native perennial grasses can be planted alone or with wildflowers such as annual baby's breath, black-eyed Susan, catchfly, cornflower, corn poppy, dwarf evening primrose, foxglove, gayfeather, Indian blanket, lance-leaved coreopsis, New England aster, perennial lupine, purple coneflower, scarlet flax, shasta daisy, Siberian wallflower, smooth penstemon, spurred snapdragon and sweet William pinks.

One option for a regional supplier of bulk seed mixes is NE SEED in East Hartford, CT (www.neseed.com).

Grasslands in Massachusetts are often maintained through annual mowing and a prescribed fire once every three years. Such a controlled burn mimics a natural disturbance that eliminates built up organic matter, enriches the soil, and spurs renewed growth of perennials. This type of management helps to maintain the open field by preventing the establishment of trees and shrubs and preventing invasive plant advancement, but may not be advisable for Beaver Brook Farm, given the close proximity of neighboring residential communities and schools. At Beaver Brook Farm, it may be more appropriate to maintain the grasslands through annual mowing. In order to preserve habitat for grassland birds, mowing the grassland should not occur during the nesting season, between May 15 and August 15 (Atwood).

Pond Feasibility Requires Further Study

Creating a pond on site may have risks that outweigh its potential agricultural and recreational benefits. While a pond creates wildlife habitat, can be used for irrigation or fire control, and presents an opportunity for winter recreation like ice skating and pond hockey, the risks associated with creating a pond on land potentially contaminated with lead and arsenic requires further study.

Heavy metals from past agricultural practices and roadways bond to soil particles, which travel through runoff as suspended sediments. While the proposed site design includes bioswales and rain gardens intended to help slow runoff and capture sediment, a pond may collect these sediments, which bond strongly to clay, of which ponds generally have higher quantities (Liebens).

Initial soil testing indicates the presence of arsenic and lead in the soil on the site of the former orchard behind the squash barn. It is possible that the contamination is localized to the former orchard area, but it is also possible that contamination is more widespread. Further testing is required in order to determine which areas may be impacted, which has implications for farming, community gardening, children's play areas, and community gathering spaces. This also has potential implications for any areas where soil sediment may collect, like ponds, bioswales, or rain gardens.

If further soil tests indicate that construction of a pond is appropriate and a pond is built, ongoing water quality testing of the pond is recommended, as would a maintenance regime for the pond and any bioswales or green infrastructure capturing polluted sediments.

Funding for Green Infrastructure

Strategies to fund green infrastructure programs across the United States have included both incentive programs and stormwater utility fees. These fees are applied in order to fund launching such a program, in conjunction with public education, and outreach campaigns (Staddon, 332). For more guidance on finding funding for green infrastructure, consult the Environmental Protection Agency's website (www.epa.gov/green-infrastructure/green-infrastructure-funding-opportunities).

Returning Agriculture to Beaver Brook Farm

There is a strong desire among many in the community to see agriculture return to Beaver Brook Farm. The form of this can vary from small community gardens on public land, to providing access to farmland for small, incubator-style farm business projects. These options could also support each other, as in the case of Just Roots Community Farm, which has a 30-year lease with the town of Greenfield, Massachusetts. Just Roots began with a desire for community gardens on town-owned land and has since become a nonprofit engaged in community outreach programming to address food access issues for vulnerable populations in Franklin County. Through a USDA grant, it was able to hire a farmer and grow into a 65-acre farm which has a Community Supported Agriculture program and sub-lease land to a 1-acre herb farm, while still hosting a community garden on the same land.

Farming operations can also include nonprofit therapeutic farming alternatives like TALMAR in Maryland, which is a perennial flower farm on state-owned land that offers training opportunities to people with developmental and physical disabilities. It sells flowers at farmers markets and through local grocery stores and provides flowers for weddings.

Clem Clay, the Executive Director of Grow Food Northampton, credits its project success to first identifying a "Flagship Farmer," a small-scale farmer in need of land who is willing to enter a long-term lease with the Town, providing stability for both the Town and the farmer and helping to coalesce community support for long-term investments and improvements to the land. Grow Food Northampton contracted with Crimson & Clover Farm to operate on city-owned land, and the town of Amherst's community-owned farm has Simple Gifts Farm in a long-term lease. These leases provide stability to farm operations and motivation for fundraising programs that help improve the sites for public use. Both farm sites also offer community festivals, farm dinners, tours, educational programming, and open space recreation that includes community gardens, walking trails and workshops.

Finding a Flagship Farmer may be possible through listing Beaver Brook Farm on Massachusetts farm-matching program websites for new farmers. Some of these programs include:

- New England Land Link through the New England Small Farms Institute (NESFI)
- New England Farmland Matching Service through the New Entry Sustainable Food Project, affiliated with Tufts University.
- Massachusetts Agriculture Commissions
- Our Land Here! program through Land for Good, Farm Seekers Program Land For Good (LFG)
- Agriculture Preservation Restriction Program (APR) through Massachusetts Department of Agriculture Resources (MDAR)
- Farms Forever program through Southeastern Massachusetts Agricultural Partnership (SEMAP)
- Massachusetts Land Trust Coalition
- American Farmland Trust – Massachusetts Chapter

Graduate Program in Sustainable Landscape Planning + Design
the ConwaySchool
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

Designed By: Eric Giordano & Lisa Krause
For the Town of Dracut, MA
Spring 2019

Plant Palette

The following groupings list plants hardy to Dracut, Massachusetts' USDA hardiness zone 6a. Plants chosen are listed in groups according to where they are recommended in the landscape for Beaver Brook Farm. Plant sizes, bloom times, and sun exposure were considered. Rain garden plants were chosen for drought tolerance. A planting plan should be tailored to each site's specific conditions.

Floodplain Forest Community

Botanical Name	Common Name	Size	Exposure
Acer rubrum	red maple	70' x 50'	sun to part shade
Acer saccharinum	silver maple	80' x 70'	sun to part shade
Beoehmeria cylindrica	false nettle	3' x 3'	sun to shade
Betula nigra	river birch	70' x 60'	sun to part shade
Cephalanthus occidentalis	buttonbush	12' x 8'	sun to part shade
Cornus amomum	silky dogwood	12' x 12'	sun to part shade
Fraxinus pennsylvanica	green ash	70' x 50'	sun
Lysimachia terrestris	swamp candles	6" x 1.5"	sun to part shade
Onoclea sensibilis	sensitive fern	4' x 4'	part shade to shade
Ulmus americana	American elm	80' x 70'	sun

Hedgerow: native small trees, shrubs, and tall flowers

Botanical Name	Common Name	Height	Exposure	Soil Type	Bloom Time
Amorpha fruticosa	false indigo bush	15′	sun	medium-wet	late spring
Cephalanthus occidentalis	buttonbush	15′	sun	wet	summer
Crataegus crus-galli	cockspur hawthorn	30′	sun	wet-dry	spring
Crataegus mollis	downy hawthorn	30′	sun	dry-moist	spring
Prunus virginiana	chokecherry	25′	sun	wet-dry	spring
Salix serissima	autumn willow	10′	sun	wet	autumn
Ceanothus americanus	New Jersey tea	6′	sun-part shade	dry-medium, drought tolerant	early summer
Cornus sericea	redtwig dogwood	6-8′	sun	moist	summer
Helianthus divaricatus	woodland sunflower	5′	part shade	dry-medium, drought tolerant	summer
Spirea tomentosa	steeplebush	4′	sun	medium-wet	summer
Rosa carolina	Carolina rose	5′	sun	medium-wet	summer
Rosa paulustris	swamp rose	8′	sun	wet	summer

Green Roof: native plants, hardy to zone 6

Botanical Name	Common Name	Height	Exposure	Depth of Planting Medium	Bloom Time
Agastache rupestris	threadleaf giant hyssop	2′	sun to part shade	6″	midsummer to midautumn
Fragaria chiloensis	coastal strawberry	8″	sun to part shade	6″	late spring
Penstemon smallii	smalls penstemon	2′	sun to part shade	6″	early to late summer
Sedum lanceolatum	lanceleaf stonecrop	4″	sun	4″	midsummer
Sporobolus heterolepis	prairie dropseed	30″	sun to part shade	6″	midsummer to early autumn
Talinum calycinum	flameflower	4″	sun	4″	midsummer to midautumn
Talinum parviflorum	small-flower flameflower	8″	sun	4″	midsummer to midautumn
Talinum teretifolium	quill flameflower	12″	sun	4″ deep	midsummer to midautumn

button bush *(Cephalanthus occidentalis)*

swamp candles *(Lysimachia terrestris)*

threadleaf giant hyssop *(Agastache rupestris)*

Not for construction. Part of a student project and not based on a legal survey.

Graduate Program in Sustainable Landscape Planning + Design
the ConwaySchool
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

Designed By: Eric Giordano & Lisa Krause
For the Town of Dracut, MA
Spring 2019

Plant Palette
Beaver Brook Farm Master Plan
761 Mammoth Road, Dracut, MA 01826

Appendix C

Plant Palette II

Perennial Polyculture Communities for Fruit Trees

Botanical Name	Common Name	Size	Exposure	Landscape Use
Asarum canadense	wild ginger	1' x 1'	part shade to shade	ground cover
Asimina triloba	paw paw	30' x 30'	sun to part shade	canopy tree, fruiting
Baptisia australis	false blue indigo	3-5′	sun to part shade	shrubby perennial, nitrogen fixer
Caragana arborescens	Siberian pea shrub	20' x 15'	sun	large shrub, nitrogen fixer
Cercis canadensis	redbud	30' x 35'	part shade to shade	canopy tree
Coptis trifolia	goldthread	6" x 6"	part shade to shade	groundcover, insecticide
Cornus alternifolia	pagoda dogwood	25'x 30'	sun to part shade	canopy tree
Hydrastis canadensis	goldenseal	1' x 1'	shade	groundcover
Panax quinquefolius	ginseng	1' x 1'	shade	groundcover
Prunus tomentosa	bush cherry	8' x 8'	sun	shrub
Pyrus pyrifolia	Asian pear	25' x 25'	sun	canopy tree, fruiting
Ribes hirtellum	gooseberry	4' x 4'	part shade	fruiting shrub
Sambucus canadensis	elderberry	5-12′ x 5'-12'	part shade	fruiting shrub
Symphytum officianale	comfrey	3' x 2.5'	sun to part shade	low herbaceous, nutrient accumulator
Trifolium pratense	red clover	6"	sun to part shade	ground cover, nitrogen fixer
Valerinia officinalis	valerian	4"	shade	herbaceous layer, medicinal
Viola spp	violet	6"	shade	groundcover

Rain Garden: drought-tolerant, habitat for pollinators, birds and butterflies

Botanical Name	Common Name	Height	Exposure	Soil Type	Bloom Time
Aronia arbutifolia	red chokeberry	4-10′	sun	dry-wet	May to June
Aronia melanocarpa	black chokeberry	3-5′	sun	dry-wet	May to June
Physocarpus opulifolius	ninebark	8-10′	sun	moist-dry	May to June
Asclepias tuberosa	butterfly milkweed	1-2′	sun	dry-moist, drought tolerant	June to Aug
Aster laevis	smooth aster	2-4′	sun	moist-dry	Aug to Oct
Baptesia australis	false blue indigo	3-5′	sun	moist-dry	May to June
Coreopsis verticillata	tickseed	2-3′	sun	dry-moist	June to July
Echinacea purpurea	coneflower	3′	sun	moist-dry, drought tolerant	July to Aug
Eupatorium maculatum	Joe Pye weed	5-8′	sun	wet-dry	July to Aug
Geranium spp.	perennial geranium	10″-18″	sun to part shade	moist-dry	May to July
Heliopsis helianthoides	ox-eye sunflower	3-6′	sun	drought tolerant	June to Aug
Liatris aspera	rough blazingstar	2-3′	sun	dry-moist, drought tolerant	July to Aug
Rudbeckia spp.	black eyed Susan	2-5′	sun	dry-moist	June to Sept
Solidago spp.	goldenrod	18″-4′	sun	dry-moist	July to Oct
Andropogon gerardii	big bluestem	3-5′	sun	dry-moist	Aug to Sept
Panicum virgatum	switchgrass	3-6′	sun	dry-moist	July to Sept
Schizacyrium scoparium	little bluestem	3-4′	sun	dry-moist	Aug
Sporobolus heterolepis	prairie dropseed	30″	sun to part shade	drought tolerant	July to Sept
Ceratostigma plumbaginoides	leadwort	<1′	sun to shade	moist-dry	Aug to Sept
Chrysogonum virginianum	green and gold	<1′	part shade	moist-dry	May to June
Phlox subulata	moss phlox	<1′	sun to part shade	moist-dry	April to May

paw paw *(Asimina triloba)*

bush cherry *(Prunus tomentosa)*

black chokeberry *(Aronia melanocarpa)*

false blue indigo *(Baptisia australis)*

Not for construction. Part of a student project and not based on a legal survey.

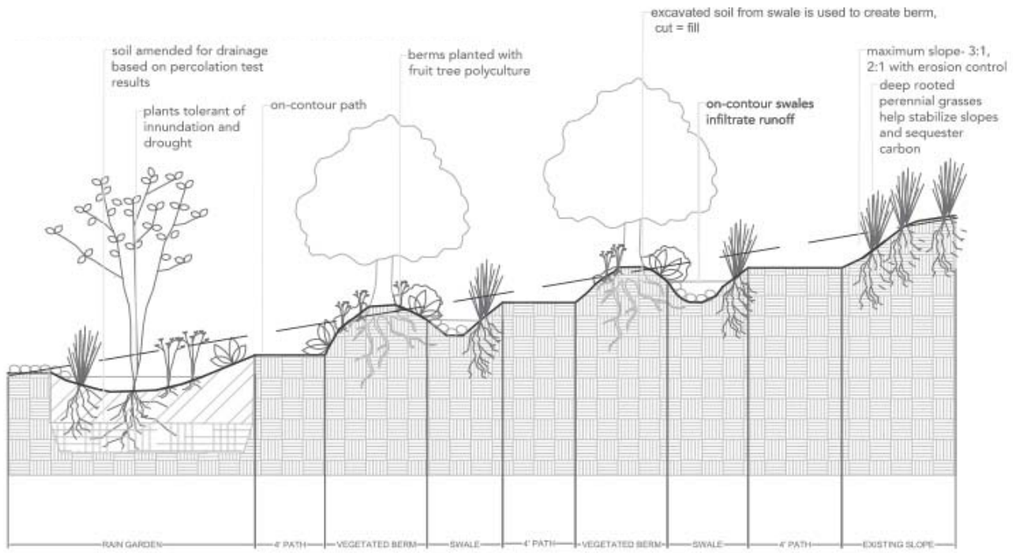
Graduate Program in Sustainable Landscape Planning + Design
the ConwaySchool
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

Designed By: Eric Giordano & Lisa Krause
For the Town of Dracut, MA
Spring 2019

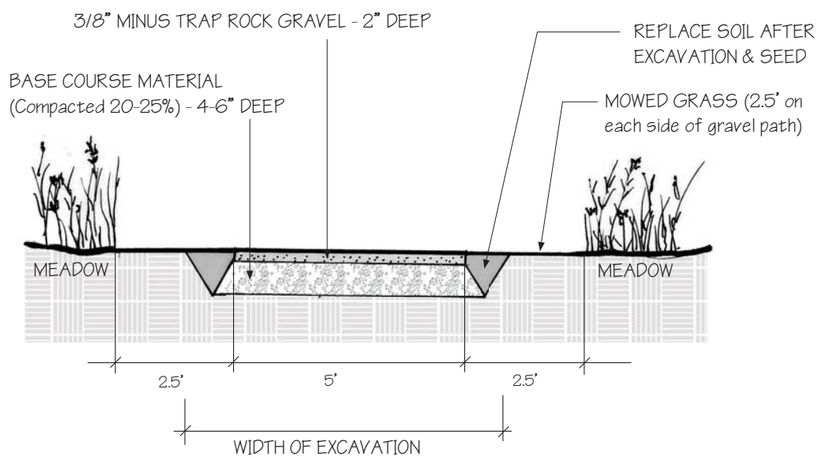
Plant Palette II
Beaver Brook Farm Master Plan
761 Mammoth Road, Dracut, MA 01826

Appendix
D

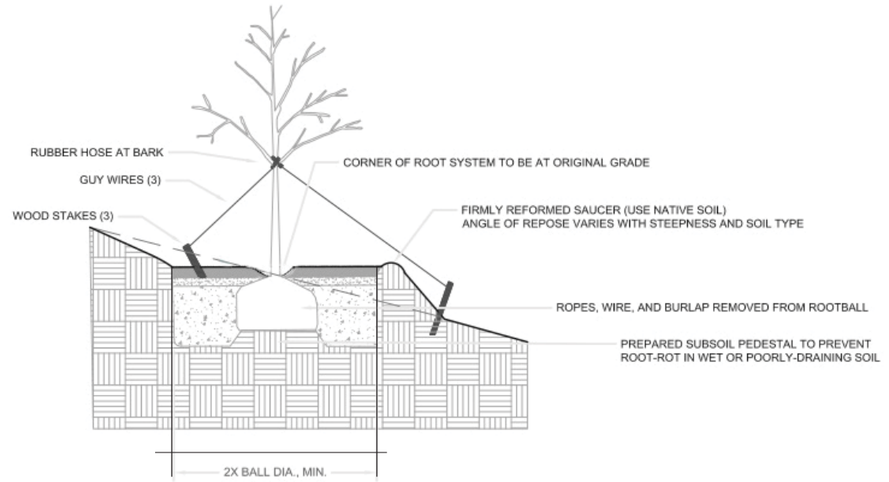
Construction Details



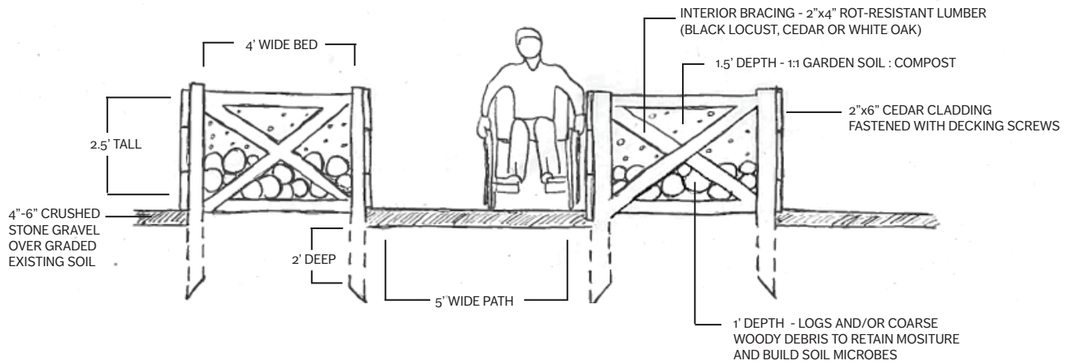
CONTOUR SWALES FOR RUNOFF INFILTRATION USING FRUIT TREE POLYCULTURES - N.T.S.
Where soil percolation tests allow, runoff can be intercepted as it flows downslope in swales dug along contour. Excavated soil is mounded as a downhill berm that is planted with fruit trees and understory shrubs and herbaceous plants. The runoff can percolate into the soil and can be used as passive irrigation for polycultures, which are communities of plants offering support for pollination and pest control, while providing yields of food, medicine, fibers or other materials. (see recommendations for Fruit Tree Polycultures in the Plant Palette Section)



TRAPROCK GRAVEL WALKING PATH - N.T.S.
A trap rock gravel path provides a firm surface for wheelchair accessibility and a comfortable walking path. The design calls for a 5 foot wide path with 2.5 feet mowed on each side (10 feet total width). This allows it to seamlessly overlap with the cross country running trail, which is a 10 foot mowed path the loops the property.



PLANTING DETAIL: BALL & BURLAP DECIDUOUS TREE ON SLOPE - N.T.S.
When planting a tree on a slope, excavate a planting hole 2x the root ball diameter of the tree, where the base of the tree (root flair) is at grade. In areas of poor drainage, a subsoil pedestal may be necessary to elevate roots, allowing for drainage and preventing root-rot. Any ropes, wire, and burlap must be removed from the rootball so the tree can become established in the new soil. Planting holes should be filled with native soil amended with compost (2:1). Apply a 2-3" layer of mulch over the soil of the newly planted tree in order to increase moisture retention. Make sure mulch creates a ring or donut around the tree hole, so that mulch is not mounded against the base of the tree trunk. Mulch mounded against a tree trunk causes moisture retention, rot, and insect damage, leading to disease or death of trees.



RAISED HUGELKULTUR GARDEN BEDS - UNIVERSALLY ACCESSIBLE - N.T.S.
A universally accessible vegetable garden can be created with raised beds constructed of rot-resistant lumber. These beds should be no lower than 2.5' allowing for universal access. Beds created 4' wide, can be accessed from either side of the path, and allows for more planting space using less construction materials. Beds are filled with 1' of logs or coarse woody debris that helps to retain moisture and build soil microbes, then with 1.5' of garden soil and compost mixed at 1:1. Paths should be excavating to a depth of 4-6" and filling with 4-6" of trap rock gravel, regrading for a 2% slope that allows for drainage, compacted to 50%.

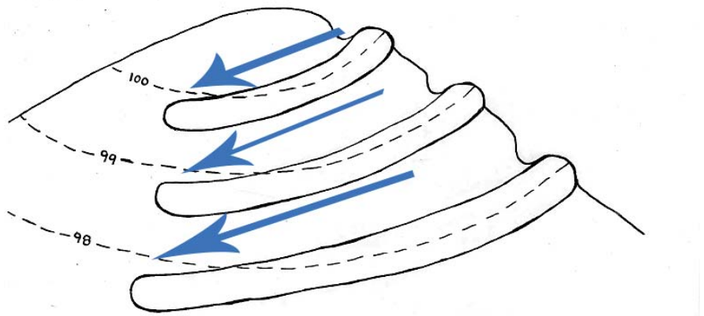
Graduate Program in Sustainable Landscape Planning + Design
the ConwaySchool
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

Designed By: Eric Giordano & Lisa Krause
For the town of Dracut, MA
Spring 2019

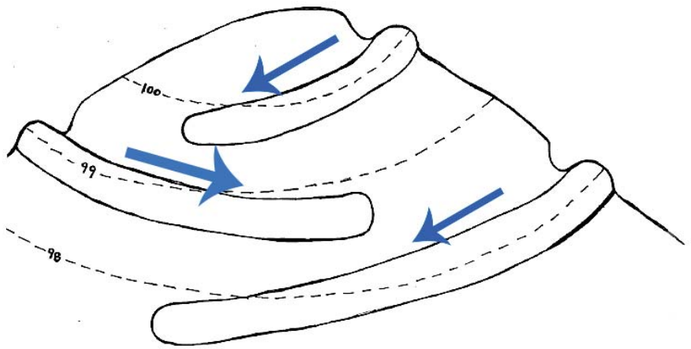
Construction Details
Beaver Brook Farm Master Plan
761 Mammoth Road, Dracut, MA 01826

Appendix
E

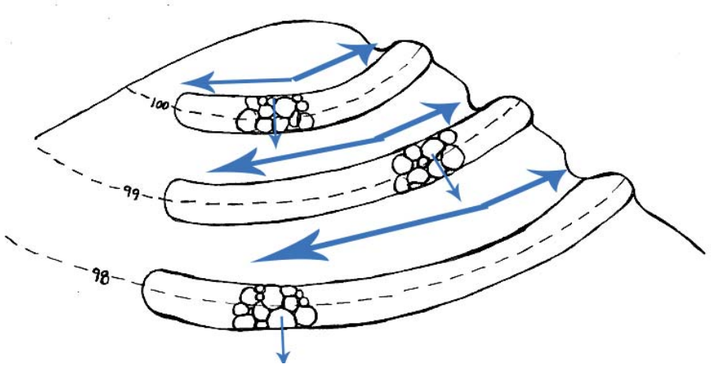
Construction Details II



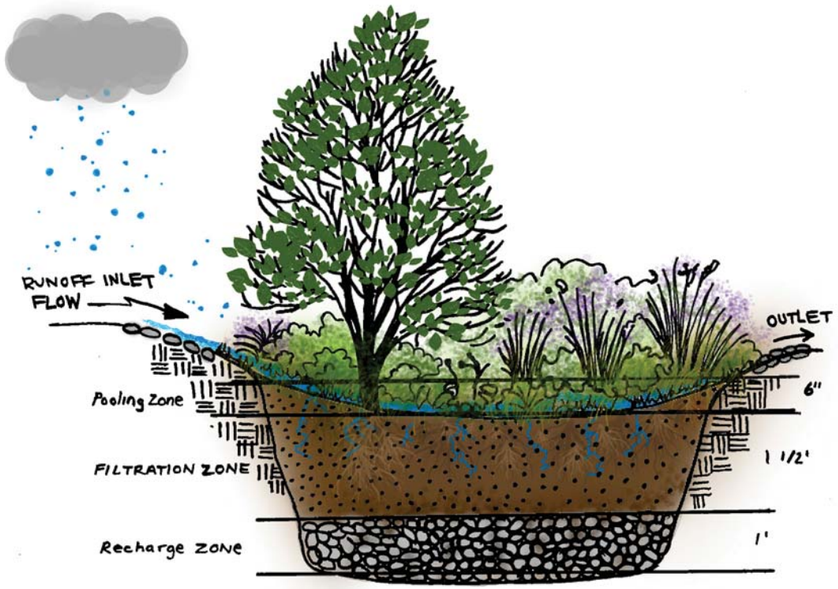
CONVEYANCE SWALE (OFF-CONTOUR) N.T.S.
When runoff exceeds amounts that can be infiltrated on site, conveyance swales can channel excess runoff elsewhere. Conveyance swales are excavated ditches dug off-contour with soil bermed on the downhill side.



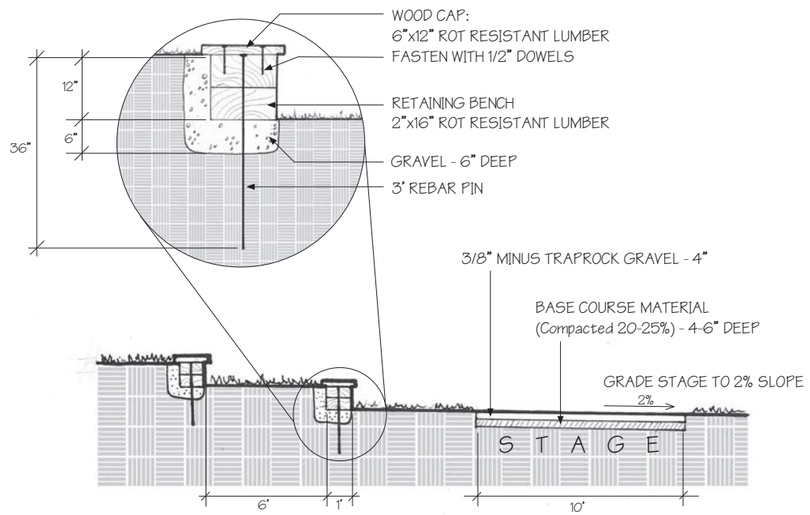
DRIFT SWALE (OFF-CONTOUR) N.T.S.
Another type of conveyance swale, drift swales slow runoff by passing it across the landscape and allowing for infiltration as it moves across contour.



INFILTRATION SWALE (ON-CONTOUR) N.T.S.
Infiltration swales follow contours, dug evenly so that runoff moving across contours is caught behind the berm and distributed evenly through the swale. Runoff infiltrates slowly, soaking into the ground. Using stones to create a spillway allows for overflow. Infiltration swales are good for sites with well-draining soil and a deep water table.



RAIN GARDEN N.T.S
A rain garden is a depression in the ground planted with vegetation and designed to intercept, temporarily hold, and filter stormwater runoff. Rain gardens should be sited near the source of runoff, downslope and at least 10' from buildings and structures. Rain garden soil should be amended for drainage according to percolation test results and planted with trees, shrubs, flowers, and grasses tolerant of periodic inundation and drought. (see recommendations for Drought-tolerant Native Rain garden plants in Plant Palette section)



AMPHITHEATER
This minimalist amphitheater design uses two 6"x12" beams to create a 1-foot bench that acts as a retaining wall for each level. The bench is capped with a 2"x16" board of rot resistant lumber such as black locust or cedar. Dowels connect the cap to the beams and a 3' rebar pin through the beams and into the ground stabilizes the bench. Traprock gravel provides a firm surface for the stage.

Designed By: Eric Giordano
& Lisa Krause
For the Town of Dracut, MA
Spring 2019

the ConwaySchool
Graduate Program in Sustainable Landscape Planning + Design
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

Construction Details II
Beaver Brook Farm Master Plan
761 Mammoth Road, Dracut, MA 01826

Appendix
F

Cost Estimate

The following costs are rough estimates for the most intensive elements called for in the preferred design. Several details in the design and construction of these elements would need to be determined to give more accurate estimates. Certain elements, like the universally accessible trails, the raised beds, and the plants, could be phased in with smaller pieces of the design installed first and additions made at later times. Costs are given as "installed costs," meaning they include the labor required to complete the installation. Enlisting volunteer help where possible could reduce expenses. Maintenance costs are not accounted for in these estimates.

sf = square foot
lf = linear foot

Item	Qty	Unit	Unit Cost	TOTAL
UNIVERSALLY ACCESSIBLE TRAILS			**TOTAL:**	**$42,750**
(5' wide. Estimate is for entire 4,500 feet of trail called for in the design)				
Excavation (8"deep, 5' wide)	4,500	lf	$4.5	$20,250
Base course (6" deep, 5' wide)	4,500	lf	$3.00	$13,500
Traprock gravel (2" deep, 5' wide)	4,500	lf	$2.00	$9,000
AMPHITHEATER			**TOTAL:**	**$13,010**
Excavation (10'x20' stage)	200	sf	$0.90	$180
Base course (10'x20' stage)	200	sf	$0.60	$120
Traprock gravel (10'x20' stage)	200	sf	$0.40	$80
Lumber	210	lf	$60	$7,350
Gravel beds (Excavation + Gravel)	210	lf	$3	$630
Dowels	150	1 Dowel	$5	$750
Rebar Pins	45	1 Pin	$20	$900
Grading	10,000	sf	$0.30	$3000
INTERPRETIVE SIGNS			**TOTAL:**	**$3,150**
Design	7	1 Sign	$200	$1,400
Materials	7	1 Sign	$250	$1,750
BOARDWALK			**TOTAL:**	**TBD**

Item	Qty	Unit	Unit Cost	TOTAL
UNIVERSALLY ACCESSIBLE RAISED BEDS			**TOTAL:**	**$14,390**
(Includes 6 raised beds on a 2,300-square-foot gravel pad)				
Excavation	2,300	sf	$0.90	$2,070
Base course	2,300	sf	$0.60	$1,380
Traprock gravel	2,300	sf	$0.40	$920
Lumber	6	1 10' Bed	$1,200	$7,200
Hardware	6	1 10' Bed	$20	$120
Soil & Compost	6	1 10' Bed	$450	$2,700
NEW PARKING AREA				
Option 1: Permeable Pavement	4,200	sf	$10	**$42,000**
Option 2: Standard Pavement	4,200	sf	$4.50	**$18,900**
Option 3: Gravel	4,200	sf	$2.50	**$10,500**
PLANTS			**TOTAL:**	**$30,450**
Seeding wildflowers in meadow	10	1 acre	$400	$4,000
Reforested riparian zone	45	1 Plant	$110	$4,950
Bioswales	900	lf	$15	$13,500
Other trees & shrubs	100	1 Plant	$80	$8,000

Graduate Program in Sustainable Landscape Planning + Design
the ConwaySchool
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

Designed By: Eric Giordano & Lisa Krause
For the Town of Dracut, MA
Spring 2019

Cost Estimate
Beaver Brook Farm Master Plan
761 Mammoth Road, Dracut, MA 01826

Appendix
G

Cornell Nutrient Analysis Laboratory
804 Bradfield Hall
Ithaca, New York 14853-4203
t.607.255.5410
f.607.255.7656
soiltest-mailbox@cornell.edu
web. http://www.cnal.cals.cornell.edu

2021 Soil Acid Package

Lisa Krause
krause19@csld.edu

FN 28093

5/29/2019

Sample ID	As 189.042	Ba 455.404	Be 313.042	Cd 214.438	Cr 267.716	Cu 324.754	Ni 231.604	Pb 220.353	Zn 213.856
	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
28093	57.04	197	1.56	0.48	22.82	11.09	10.56	217.02	46.27

Al 308.215	B 249.773	Ca 211.276	Co 228.616	Fe 275.573	K 766.491	Li 670.780	Mg 279.079	Mn 257.61	Mo 202.095	Na 330.298	P 213.618	S 182.034
mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
38458	6.81	7342	3.92	10161	9438	18.40	2490	326	0.49	4127	1186	330

Sr 421.552	Ti 334.941	V 292.464
mg/Kg	mg/Kg	mg/Kg
76	1090	29.64

Cornell University

College of Agriculture and Life Sciences
Crop and Soil Sciences

Cornell Nutrient Analysis Laboratory
Tatyana Dokuchayeva,
Manager
806 Bradfield Hall
Ithaca, New York 14853-4203
t.607.2555410
f. 607.255.7656
e. td47@cornell.edu
e.soiltest@cornell.edu
web. http://www.cnal.cals.cornell.edu

04/23/2011
The table below is provided for interpreting data from the heavy metal analysis you requested on the sample(s) you submitted to the Cornell Nutrient Analysis Laboratory

Recommended Maximum Soil Trace Element Concentrations for Agriculture[1] in the Northeast US

Metal	Concern	Soil concentration (mg/kg)[1]		
		Sandy soil	Sandy loam to silt loam	Silty clay to clay soil
Arsenic (As)	Human toxicity		16	
Cadmium (Cd)	Human toxicity	1.2	2	3
Copper (Cu)[2]	Plant toxicity	50	75	120
Molybdenum (Mo)[3]	Livestock toxicity		2	
Nickel (Ni)[2]	Plant toxicity	30	40	60
Lead (Pb)	Human toxicity		100	
Zinc (Zn)[2]	Plant toxicity	90	150	230

[1] Limits are for total metals in soil (ppm or mg/kg, dry soil weight basis) , where soil is maintained at pH 6 or above.
The lower concentrations are for coarser-textured and the higher concentrations are for finer textured soils. Some fraction of these metals may not be biologically available. Concentration limits are intended to prevent phytotoxicity. Higher concentrations can be tolerated in calcareous soils.
[3] Molybdenum is a concern for forage crops and pastures where soil pH is higher than 6.0 .

For additional information, contact Tatyana Dokuchayva td47@cornell.eduand and other *Resources for Healthy Soils*

Cornell University

College of Agriculture and Life Sciences
Crop and Soil Sciences

Cornell Nutrient Analysis Laboratory
Tatyana Dokuchayeva,
Manager
806 Bradfield Hall
Ithaca, New York 14853-4203
t.607.2555410
f. 607.255.7656
e. td47@cornell.edu
e.soiltest@cornell.edu
web. http://www.cnal.cals.cornell.edu

.
04/23/2011
The table below is provided for interpreting data from the heavy metal analysis you requested on the sample(s) you submitted to the Cornell Nutrient Analysis Laboratory

Recommended Maximum Soil Trace Element Concentrations for Garden Soils in the Northeast US[1]

Metal	Concern	Soil concentration (mg/kg)[1]
Arsenic (As)	Human toxicity	16
Barium (Ba)	Human toxicity	350
Cadmium (Cd)	Human toxicity	2.5
Chromium (Cr)[2]	Human toxicity	36
Copper (Cu)[3]	Plant toxicity	75
Nickel (Ni)[3]	Plant toxicity	40
Lead (Pb)[4]	Human toxicity	400
Zinc (Zn)[3]	Plant toxicity	150

[1] Limits are for total metals in soil (ppm or mg/kg, dry soil weight basis), where soil is maintained at pH 6 or higher by liming. Liming to pH greater than 7 is not recommended because it may lead to deficiencies in essential plant micronutrients such as manganese and iron.
[2] Chromium is generally not a health concern unless it is present as the hexavalent form (chromate). Organic matter additions to soil normally ensure no chromate will be present.
[3] Some fraction of these metals may not be biologically available. Concentration limits are given to prevent plant toxicity. However, plants can tolerate higher concentrations than these limits in calcareous soils or soils with high organic matter content (> 5%) .
[4] To minimize plant uptake of lead, it is important to maintain pH above 6.0, and frequently amend with uncontaminated compost. Exposure to lead from dust can be reduced by mulching and carefully washing vegetables.

For additional information, contact Tatyana Dokuchayva td47@cornell.eduand and other *Resources for Healthy Soils*

Not for construction. Part of a student project and not based on a legal survey.

Graduate Program in Sustainable Landscape Planning + Design
the ConwaySchool
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

DESIGNED BY: ERIC GIORDANO & LISA KRAUSE
FOR THE TOWN OF DRACUT, MA
SPRING 2019

SOIL TESTS

BEAVER BROOK FARM MASTER PLAN
761 MAMMOTH ROAD, DRACUT, MA 01826

APPENDIX
H

References

ADA Network "The Universal Garden" www.adata.org/universal-garden

Alvez, J., and Herrick, C. "Managing hayfields to include nesting birds." UVM Extension, Center for Sustainable Agriculture. March 29th, 2018 blog.uvm.edu/pasture-vtpasture/2018/03/29/managing-hayfields-to-include-nesting-birds/

Atwood, J., Collins, J., Kidd, L., Servison, M., and Walsh, J. "Best Management Practices for Nesting Grassland Birds." MassAudubon www.massaudubon.org/content/download/19413/274073/file/Best-Management-Practices_Grasslands.pdf

Brittingham, M., and DeLong, C. "Management practices for enhancing wildlife habitat." Penn State Extension. April 15, 2016. https://extension.psu.edu/management-practices-for-enhancing-wildlife-habitat

Bureau, U. S. Census. "American FactFinder - Community Facts." Accessed June, 2019. https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml

CDM Smith. "Town of Dracut, MA: Stormwater Utility Feasibility Study." 2017. www.dracutma.gov/sites/dracutma/files/news/stormwater_slide_show_0.pdf

Center for Watershed Protection. "Impacts of Impervious Cover on Aquatic Systems." Monograph no. 1, 2003, pp. 1-7.

Conniff, Richard. "Habitat on the Edges: Making room for wildlife in an urbanized world." YaleEnvironment360. Yale School of Forestry & Environmental Studies. January 3, 2018 www.e360.yale.edu/features/habitat-on-the-edges-making-room-for-wildlife-in-an-urbanized-world

Crone, E., Morris, W., Schultz, C., Haddad, N., Hudgens, B., and Damiani, C. "Endangered butterflies as a model system for managing source-sink dynamics on Department of Defense lands." Institute for Wildlife Studies: Source/Sink Dynamics Project www.iws.org/projects_source_sink.html

Dracut Open Space Guide Brochure www.dracutma.gov/sites/dracutma/files/file/file/open_space_guide_10-30-09.pdf

eBird. "Illustrated Checklist of Bird Sightings in Middlesex County." www.ebird.org/region/US-MA-017/media?yr=all&m=

Environmental Protection Agency. "Green Infrastructure Funding Opportunities." www.epa.gov/green-infrastructure/green-infrastructure-funding-opportunities

Fieldman, Luis. "Meadow cleared on Arcadia property raises eyebrows." 7/25/2018 www.gazettenet.com/Questions-raised-over-mowing-of-meadows-by-Oxbow-19059649

Hood, E. "The Apple Bites Back: Claiming Old Orchards for Residential Development." Environmental Health Perspectives. vol.114, no. 8, Aug 2006, pp. A470-476 www.ncbi.nlm.nih.gov/pmc/articles/PMC1551991/

Kafka Granite's Guide to Wheelchair-Accessible Pathway Materials. www.kafkagranite.com/kafka-granites-guide-wheelchair-accessible-pathway-materials

Kusler, J. "Common questions: constructing wetland boardwalks and trails." 2006 guide. International Institute for Wetland Science and Public Policy. www.aswm.org/pdf_lib/2_boardwalk_6_26_06.pdf

Liebens, J. "Heavy metal contamination of sediments in stormwater management systems: the effect of land use, particle size, and age." Environmental Geology (2001) 41 p.341-351. doi. 10.10007/s002540100392 August 17, 2001.

Lowell Sun. "60 Years of Farming (and lots of blue hubbard squash) at Beaver Brook Farm". 2017. http://blogs.lowellsun.com/history/2017/10/28/60-years-of-farming-and-lots-of-blue-hubbard-squash-at-beaver-brook-farm/

MassGIS (Bureau of Geographic Information), Commonwealth of Massachusetts EOTSS. https://docs.digital.mass.gov/dataset/massgis-data-layers

Schaefer, L. "Nine Reasons to Plant an Oak." Plants, Why Natives? October 1, 2017. www.edgeofthewoodsnursery.com/nine-reasons-plant-oak

Graduate Program in Sustainable Landscape Planning + Design
the ConwaySchool
88 Village Hill Rd. Northampton, MA 01060
413-369-4044
www.csld.edu

Designed by: Eric Giordano & Lisa Krause
For the Town of Dracut, MA
Spring 2019

References
Beaver Brook Farm Master Plan
761 Mammoth Road, Dracut, MA 01826