A REPORT BY

EVERGREEN ENGINEERING

NORTHEASTER UNIVERSITY

DEPARTMENT OF CIVIL AND ENVIRONMNETAL ENGINEERING

SUBMITTED

APRIL 17, 2020

ROCK MEADOW PARKING LOT DESIGN

Submitted to the Belmont Conservation Commission

Photo courtesy of Jessica L. Hatlen via Business Yab

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1.0 Introduction

On behalf of the Belmont Conservation Commission (Client), Evergreen Engineering (Evergreen) has prepared a design plan for the main entrance and parking lot at Belmont's Rock Meadow Conservation Area, located off of Mill Street in Belmont, MA (Site). The parking lot redesign is the first step in a series of improvements to the Site, based in part on *Rock Meadow – A Conservation Master Plan for the Town of Belmont, Massachusetts*[1] (Master Plan), a conceptualization of the Client's vision for the Site.

1.1 Project Description

Evergreen will provide background on the community of Belmont and the Site to provide context for the design choices.

1.1.1 Community Background

The town of Belmont is a suburb of Boston, located three miles west of the city's nearest border. It spans an area of 4.7 square miles,[2] and as of 2018 the population was 26,330. Based on the last estimate, 24.6% of the population is under the age of 18, 58.8% are between 18 and 64, and 16.6% are above the age of 65. Belmont's median household income was last estimated at $118,370, more than $60,000 above the national average. Of Belmont's residents, 22.3% were born in a foreign country. Almost 73% of Belmont's residents have earned at least a Bachelor's degree, and 96.5% of residents have earned a high school degree.[3] Belmont is accessible via the Fitchburg Line of the Commuter Rail and several bus lines, including the 73, 74, 75, and 554 buses.

Belmont's parks are utilized not only by its residents, but also by those of surrounding towns such as Arlington, Lexington, and Watertown. These greenspaces include Mass Audubon, the Town Field, and Rock Meadow Conservation Area. Rock Meadow forms part of the Western Greenway, a 1,200 acre interconnected open space that runs through Waltham, Lexington, and Belmont.[4]

1.1.2 Site Background

The Site is near the border between Belmont and Waltham, shown in Figure 1.1 (included with scale as Attachment 1). Rock Meadow itself borders Beaver Brook, a stream that the meadow

1 Rock Meadow A Conservation Master Plan for the Town of Belmont, Massachusetts, https://www.belmontma.gov/sites/belmontma/files/uploads/2018_rockmeadow_springfinalsetlow.pdf

2 Google Maps, www.google.com/maps

3 Belmont MA Real Estate and & Demographic Data, https://www.neighborhoodscout.com/ma/belmont

4 The Western Greenway Project, https://www.massaudubon.org/get-outdoors/wildlife-sanctuaries/habitat/about/western-greenway

drains into before emptying into the Charles River. Rock Meadow is part of a 71-acre parcel, consisting of about 50% grassland cover plus wetland, woodland, and shrubland areas. The Site's man-made features include Victory Gardens, a trail system, an old piggery foundation, a non-operational incinerator and landfill transfer facility, and a historic barn. These features are a tribute to Rock Meadow's history through the years.

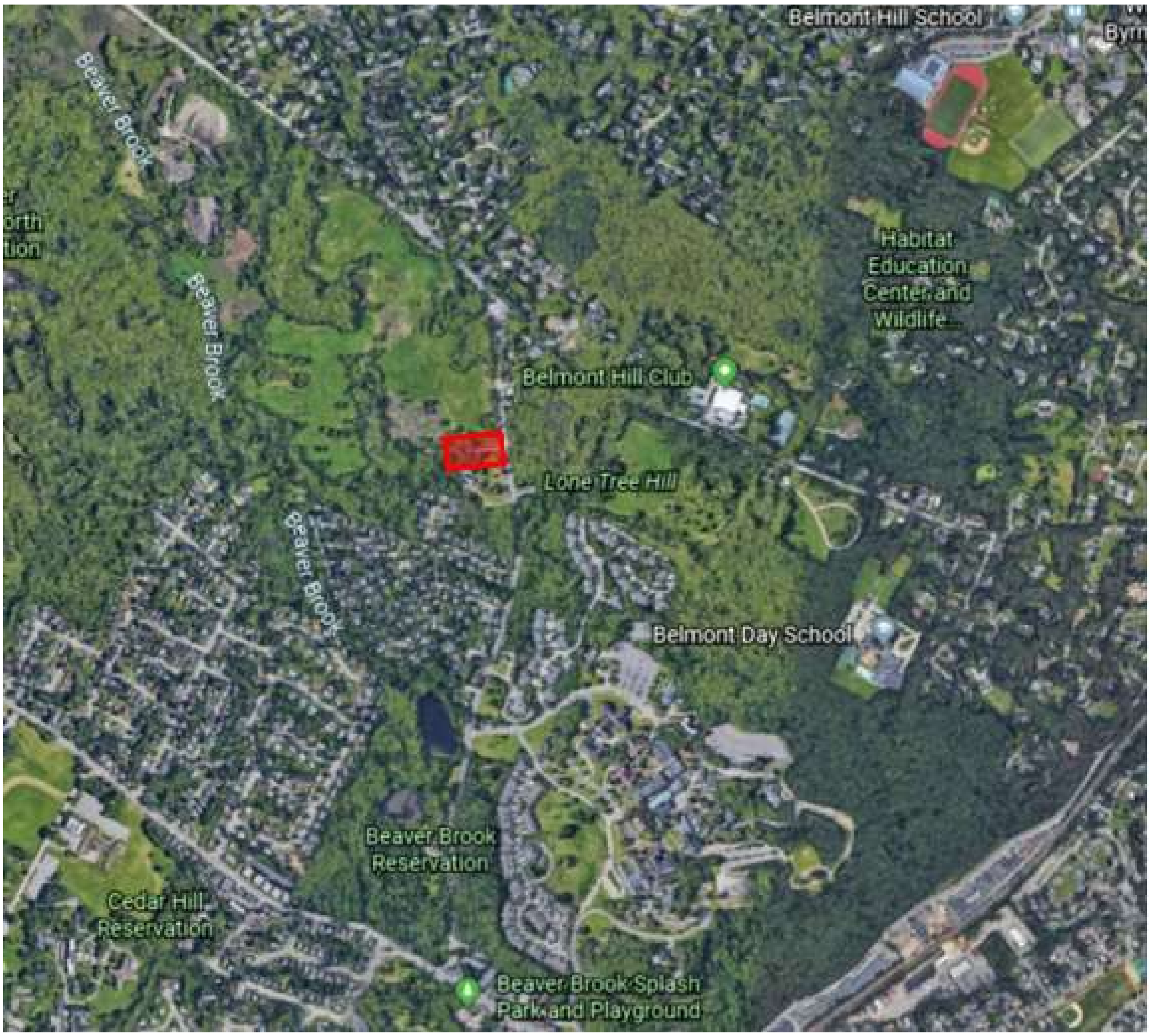

Figure 1.1 Site within the greater Boston area.[5]

Over the years, Rock Meadow has grown as a diverse ecosystem of many wildlife species. This includes plants like deep emergent marsh, maple-ash swamp, coastal hardwoods, and cultural

[5] googlemaps.com

meadows and animals like birds (such as the most frequently sighted common grackle), reptiles, amphibians, and mammals. The public has expressed significant interest in continuing to grow the populations of grassland birds, pollinating insects, and bats. In addition, the public hopes to control "opportunistic" (typically referred to as invasive) species such as black swallow-wort, buckthorn, and honeysuckle.

Visitors to the Site are appreciative of the cultural and natural value that Rock Meadow provides, but wary of the unpleasant arrival experience. The issues associated with entering the park have been a documented complaint from community members since as early as 1968. The driveway is too steep and narrow, the parking lot is heavily eroded and puddled, and the vegetation choices are displeasing and unintentional.

1.2 Project Goals

Evergreen has outlined three main goals for this project, which are: sustainability, adaptability, and community satisfaction. These parameters have been identified by the Client and design team as essential to the success of the parking lot design project at Rock Meadow.

1.2.1 Sustainability

Evergreen's mission is to provide design solutions with an emphasis on sustainable, low-impact development. The final design is one that utilizes green infrastructure while minimizing dependence on gray infrastructure, waste, power demand, and invasive species intrusion. Our sustainability goals align with the Client's preferences for the Rock Meadow redevelopment as expressed at a site visit and as outlined in the Master Plan: providing a space "where humans and nature meet." To achieve this goal, Evergreen's design process has included the evaluation of site improvements such as native plants, composting toilets, and low-energy lights. These green features shall be presented to the community as an opportunity to exemplify Belmont's commitment to sustainable public spaces. Our environmentally conscious approach to the entrance and parking lot design will aim to foster continued appreciation for Rock Meadow and a shared responsibility to its conservation.

1.2.2 Adaptability

The Client has expressed that the proposed design should account for impending climate change. With the climate continuously changing, it cannot be assumed that the depth of rainfall in a storm of a given return period will remain consistent. In our assessment of green infrastructure, Evergreen has determined the design infiltration rate to allow water to pass through the ground quickly, avoiding overflow. In addition to the standard 2-year and 10-year return periods, Evergreen has evaluated the design alternatives for a storm with a 25-year return period. This is more conservative than the typical design storm for a small parking lot. Various alternatives for handling these flows were evaluated and the final recommendations account for factors such as sustainability, community satisfaction, and cost. These considerations have ensured that the redeveloped Site is adaptable to the ever-changing conditions and higher volumes of runoff associated with them.

1.2.3 Community Satisfaction

As green spaces contribute to a sense of community, Rock Meadow is an essential hub of Belmont. It has been shown that individuals who live in areas with more green spaces have lower rates of mental distress, anxiety, and depression compared to those living in areas with less green space.[6] In addition, language, knowledge, and nature have been closely linked throughout the entire human history. Biodiversity, ecosystems and natural landscapes have been the foundation of inspiration for much of our art, culture and science. For these reasons, Rock Meadow and the surrounding area must be designed in a way that encourages individuals to visit. The parking area and entrance will jumpstart an inviting experience, and all services must be convenient to use by the community.

The Master Plan highlights large participation from community members. In the last design phase, the Conway School conducted two meetings to collect public opinions on the present and future designs. Residents vocalized the parking experience as one of the most notable aspects of the Site they would like to change. Evergreen has incorporated the values and priorities outlined in the community vision statement to produce an intentional design. Our firm recognizes that community satisfaction is an essential element to the project.

1.3 Scope of Work

The scope of work for this project can be classified into two categories: evaluation of the Master Plan and design of the site.

6 Morbidity is related to a green living environment, https://jech.bmj.com/content/63/12/967.short?casa_token=yIZ5yRBCmAIAAAAA:aOpuZrcQ0uqCeA7luGMWGahOiAuXfNBPxhP_9EUTi9CJm0sr8EozzIiVmyZlvNMcCHOEpLSSHS4

1.3.1 Master Plan Evaluation

In addition to the main entrance redesign, the Master Plan for Rock Meadow also includes an expansion to 40+ acres of grassland, the implementation of an eco-historical walking tour, and targeted plant replacement. Evergreen's evaluation of the Master Plan will focus on the initial stage of the redevelopment of Rock Meadow, the parking lot redesign.

The elements proposed by the Conway School were researched, verified, and compared with alternatives developed by Evergreen. In turn, Evergreen has expanded the conceptual design proposed in the Master Plan into detailed construction-ready plans.

1.3.2 Design

Evergreen Engineering has built on the Master Plan by modifying and detailing the proposed design of the parking lot, stormwater management system, grading, and site improvements. The following design recommendations have been issued to the client and community.

Parking Lot Design

The parking lot was one of the main complaints that residents had about the experience at Rock Meadow. Described as having an awkward circulation pattern, poorly defined edges, and a steep slope, the driveway and lot needed a full redesign. Evergreen addressed these concerns by providing the Site with more intentional traffic patterns, a smooth surface, and edges clearly lined with native vegetation.

The number of parking spots necessary was determined based on both regulatory statutes and daily parking necessity. Therefore, prior to initial designs, a full parking analysis was conducted to understand the average daily demand for parking spots. This was completed by the Belmont Animal Care and Control Officer and documented the total number of cars that parked at Rock Meadow in a forty-five minute period, with data from twelve days.

Though multiple traffic circulation patterns were considered in order to provide a better flow in the parking lot, the decision was made to keep the current structure with one entrance, one exit, and non-angled parking spaces. Additionally, the designed driveway was widened for better circulation between entering and exiting vehicles.

In addition to an upgraded traffic circulation pattern, the design had to account for filling, regrading, and repaving according to the Town's requirements. The parking lot was graded in such a way that stormwater runoff was discharged toward the drainage system. This corrected the steep slope and prevented future road degradation and pollution. To create this, Evergreen analyzed all available land data from the town and the project team at The Conway School. Surface data was used to produce an accurate existing surface on which the proposed grading plan was based. A final implementable design of the Site was modeled with AutoCAD Civil 3D and provided in the final construction documents.

Stormwater Management

Evergreen approached the stormwater management design using low-impact development. This aligns with the Rock Meadow Vision Statement, which states that the residents envision the Site as "a refuge that supports both tranquil stillness and mindful movement through the experience of nature." Maintaining as many natural features in the design as possible best achieves the sentiment of this vision. To this effect, Evergreen evaluated multiple stormwater best management practices (BMPs). Some of the considered BMPs can be found in Table 1.1.

Table 1.1. Stormwater Management BMPs Evaluated for the Site

BMP	**Function Evaluated**
Bioswale	Treatment/Infiltration
Constructed Stormwater Wetland	Treatment
Infiltration Basin	Infiltration
Infiltration Trench	Infiltration
Pervious Pavement	Treatment/Infiltration
Proprietary Media Filter	Treatment
Rain Garden	Infiltration
Sediment Forebay	Treatment
Treebox Filter	Treatment
Vegetated Filter Strip	Treatment

Due to the proximity of Rock Meadow to Beaver Brook and wetlands located within the park itself, it is important to treat the runoff from the parking lot as effectively as possible. Evergreen has selected the most suitable alternative using a decision matrix that weighed adherence to the project goals. In the design, Evergreen has followed the guidelines according to the Massachusetts Stormwater Handbook to ensure that the level of treatment, rate of infiltration, and groundwater table restoration are sufficient. The chosen method was designed for the 2-year and 10-year, 24-hour storms. Evergreen has also evaluated the design's effectiveness in the event of a 25-year, 24-hour storm to assess the changes needed to withstand a larger storm in coming years due to the changing climate.

Site Improvements

Additional considerations that Evergreen evaluated are bathroom facilities, a signage plan, and a security system. These site improvements, directed by the Client, are intended to bolster the Site as an inviting community center.

An improvement to the bathroom facilities will ensure a comfortable experience for all visitors. Options that were evaluated included a composting toilet and a traditional full-service bathroom structure. The final specification consists of appropriate sizing, detailed installation costs, recommended operation and maintenance guidelines, and a summary of ecological benefits of a composting toilet as the recommended alternative.

The proposed signage plan ensures an accessible experience at Rock Meadow that begins at the entrance. This signage can be used as a foundation for the signs that will be installed for the eco-historical tour. Parking lot signage includes ADA compliant signs that highlight handicapped parking and traffic patterns.

To provide increased security, Evergreen has recommended an upgrade of the current video surveillance system for the parking lot redesign. Evergreen evaluated the condition of the existing utilities on the Site and the conservation restriction for these improvements. We have ensured that this plan will provide improved security throughout the lot to make the parking experience and the Site as safe as possible.

1.4 Project Team

This section introduces the five team members of Evergreen Engineering. It outlines relevant project experience in the realms of stormwater engineering, construction management, and sustainable design. This provides the opportunity to gain insight into each associate's key responsibilities on this project.

Samantha Kinnaly has academic experience in environmental engineering coupled with professional experience in construction management. Her studies include modeling of climate change and hydrology, design of water and wastewater infrastructure, and control of air and water pollution. She also has professional exposure to the drafting process of drainage, utility, and as-built plans in AutoCAD. In the construction management realm, she has worked as a scheduler, performed financial management, and engaged in daily meetings between the design teams and contractors on multimillion dollar projects. For the purposes of this project, Samantha will serve as the project manager.

Kate Engler has academic experience in civil engineering with a concentration in environmental engineering. Through her coursework, she has experience with stormwater management design, including the use of programs HEC-HMS and HEC-RAS. From her co-ops, she has experience ranging from utility planning and record-keeping to transportation engineering. Also through her professional experience, she has developed literacy in AutoCAD and ArcGIS. She has extensive experience drafting construction and utility plans. In addition, she has practiced stormwater design, including the drafting of rock swales, culvert design, and watershed GIS mapping. For the purposes of this project, Kate will serve as a civil engineer, researching and evaluating the stormwater management best practices.

Abdullah Fadol has academic experience with hydrologic and hydraulic design. He was responsible for an extended project that involved laying out impervious area and controlling runoff for a site in Wrentham, MA. The project included calculating assorted values to be used in modeling the discharge in HEC-HMS hydrologic modeling software and using those values to design a detention basin according to Massachusetts stormwater management standards. For the purposes of this project, Abdullah will serve as an environmental engineer, modeling the hydrology of the Site and evaluating the stormwater alternatives.

Annie Lamonte's academic experience focuses primarily in environmental engineering, while her professional experience has been mainly in land development. She has drafted site, utility, and concept plans in AutoCAD Civil 3D for a variety of projects, both commercial and residential. Her academics have included designing water and wastewater treatment systems, environmental chemistry, and writing intensive courses. For the purposes of this project, Annie will be working as an environmental engineer, designing the parking lot layout, undertaking zoning research, and analyzing traffic patterns for existing conditions and proposed designs.

Emma Totsubo has professional engineering experience in environmental consulting and site civil design. She specializes in AutoCAD Civil 3D and has worked extensively on plans for land development and environmental remediation projects including existing conditions, site, grading, utility, stormwater management, remedial excavation, and erosion control plans. Past projects she has worked on include the design of private roads, parking lots, industrial sites, company campuses, and bioswales. For the purposes of this project, she will serve as an environmental engineer and manage the modeling, grading, and drafting aspects of the project in AutoCAD.

1.5 Report Organization

This comprehensive report outlines the proposed plan for parking lot design, stormwater management, grading, and site improvements at Rock Meadow. Using the Master Plan, Evergreen identified multiple design alternatives for the Site. This report will include an evaluation of the Master Plan and the extrapolated alternatives based on the existing conditions and design considerations. Evergreen has identified a preferred design for the parking lot and entrance at Rock Meadow, accompanied by a cost estimate and the engineers' final recommendations. An outline of the detailed report is as follows:

> **Chapter 1.0 Introduction** highlights key components of Evergreen's approach to the parking lot redesign at Rock Meadow in Belmont. This chapter includes background to the project, the goals that Evergreen has set, the scope of work, and an introduction to the team. In addition, it includes a rendering of the final design for the parking lot at Rock Meadow.
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> **Chapter 2.0 Existing Conditions** outlines the current state of Rock Meadow Conservation Area and the attached parking lot off of Mill Street. This includes a summary of land use,

existing limitations of the Site, an analysis of soil and hydrologic conditions, and an assessment of climate vulnerability.

Chapter 3.0 Design Considerations provides the best management practices for the parking lot, stormwater management system, and site improvements. It provides technical context for the forthcoming design by listing the design considerations for the project and the advantages and disadvantages of each alternative. Overall, this chapter summarizes the requirements that Evergreen had to meet for an effective redesign at Rock Meadow.

Chapter 4.0 Design Alternatives explains how the final parking lot and stormwater management alternatives were chosen. It includes an outline of the five key criteria for alternative selection as defined by Evergreen and the Client. In addition, it includes decision matrices to weigh the two parking lot designs and the ten stormwater management BMPs respectively.

Chapter 5.0 Preferred Alternative Specification defines the design of the engineers' recommended systems for parking, stormwater management, and site improvements when considering all alternatives. The specifications include information on the sizing, maintenance, and placement of each system on the Site.

Chapter 6.0 Cost Estimate provides a cost estimate for the Rock Meadow Parking Lot Redesign project. This cost estimate addresses five key areas: earthwork, hardscaping, landscaping, green infrastructure, and additional site improvements. It includes the projected upfront costs of both materials and man-hours for installation.

Chapter 7.0 Final Recommendations summarizes the final design of the parking lot, stormwater management system, and site improvements on the Site. It also provides an evaluation of the Master Plan from an engineering feasibility perspective. These improvements will contribute to a more sustainable and more aesthetically pleasing parking experience at Rock Meadow. In addition, it includes suggestions of future work to further enhance Rock Meadow.

Chapter 8.0 Acknowledgements recognizes and thanks the individuals that assisted Evergreen throughout the duration of the Rock Meadow Parking Lot Redesign project.

In addition, a rendering of the final design has been included as Figure 1.2. This site plan can also be found as C-4.0 in Appendix A.

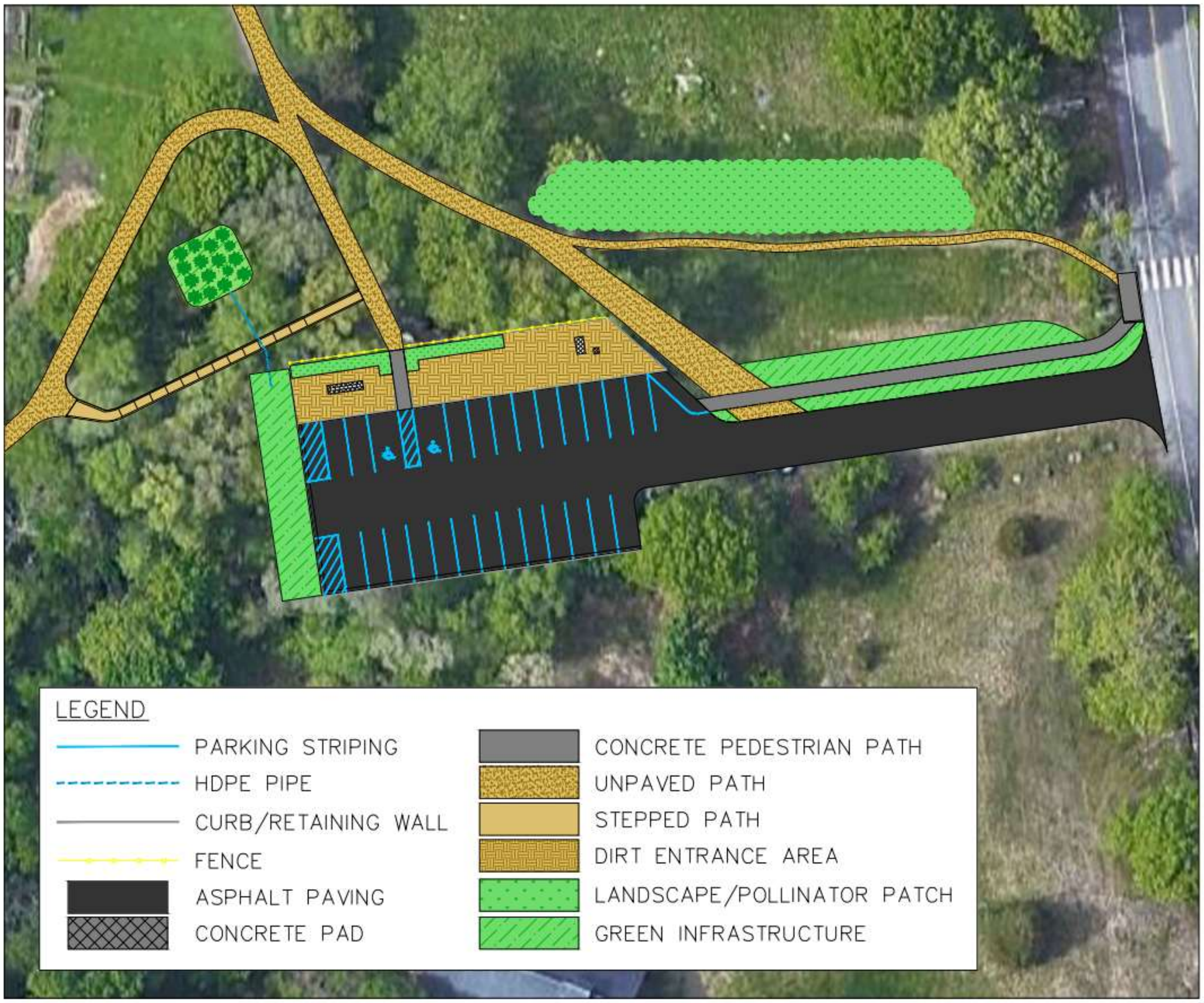

Figure 1.2. The final site design for the parking lot at Rock Meadow.

2.0 Existing Conditions

This chapter outlines the existing conditions of Rock Meadow Conservation Area and the attached parking lot off of Mill Street in Belmont. It includes a summary of land use, existing limitations of the Site, an analysis of soil and hydrologic conditions, and an assessment of climate vulnerability.

2.1 Site Land Use

2.1.1 Historical Background

The history of Rock Meadow dates back to the year 8000 B.C.E. in the Neolithic, or New Stone Age.[7] During this time, Rock Meadow was believed to have been part of a glacial pond, characterizing the soil as sandy loam and rocks. Through the 1600s C.E., it is estimated that about 500 indigenous people of the Pequossette tribe lived off of the land at Rock Meadow.[8] They pioneered controlled burning to continually restore ecosystem health and to shape the land.[9] When British colonists purchased a large parcel in 1638, this land included Rock Meadow, which consisted of mostly grassy meadows and little dense woodland at the time. Rock Meadow was utilized by the colonists as the heart of an agricultural economy; the abundant grassland provided plenty of space for livestock to graze. The addition of a railroad in 1843 attracted affluent Bostonians to the area.[10] In 1859, these community members created Belmont as we know it today from parts of West Cambridge, Waltham, and Watertown. This new town of 1,175 people included the plot of land that is Rock Meadow.

From 1908 to 1945, Rock Meadow was operated as the farm of McLean Hospital, a world-class psychiatric treatment facility in Belmont. The farm provided pork, milk, fresh produce, and clean water to the hospital. Operations eventually ceased in 1945 due to a war-related labor shortage. Rock Meadow saw little use between this time and 1968, when it was purchased by the Town and eventually entrusted to the Belmont Conservation Commission. Since then, the Commission has been responsible for ensuring that Rock Meadow's grasslands are used for four seasons of recreational activities. Horticulturalists are attracted to the Site's Victory Gardens, a collection of

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7 Human Heritage: A World History, Glencoe, https://www.cdschools.org/cms/lib04/PA09000075/Centricity/Domain/527/chap02.pdf

8 https://books.google.com/books?id=xNzbJqCTX9wC&printsec=frontcover&dq=inauthor:%22The+Belmont+Historical+Society%22&hl=en&newbks=1&newbks_redir=0&sa=X&ved=2ahUKEwiSla_iwKvnAhXYl3IEHfWOAUgQ6AEwAHoECAAQAg#v=snippet&q=Pequosette&f=false

9 https://www.ecolandscaping.org/07/installing-and-maintaining-landscapes/land-management/a-synopsis-of-prescribed-fire-in-new-england

10 https://www.belmont-ma.gov/home/pages/history-facts

140 plots rented each season. Hikers, dog-walkers, bikers, and cross-country skiers make use of the extensive trail system connecting Rock Meadow to the rest of the Western Greenway. In addition, birders, botanists, and environmental enthusiasts alike are drawn to the diverse plant and animal communities.

2.1.2 Management

Today, Rock Meadow continues to be managed by the Belmont Conservation Commission, a group of seven board members and one staff contact from the Town.[11] The Commission works closely with the Land Management Committee for Lone Tree Hill, a group of nine property managers for the 119 acres of hospital campus, municipal cemetery, and McLean Barn adjacent to Rock Meadow.[12] This group is focused on trail creation, site cleanup, and restoration. The Site for the parking lot project crosses property lines, giving both the Belmont Conservation Commission and the Land Management Committee for Lone Tree Hill partial jurisdiction over the design.

2.1.3 Current Limitations

The Site's existing conditions are not conducive to a positive visitor experience. The lot has no distinct circulation pattern or parking layout, insufficient drainage, a steep slope, damaged signage, and widespread erosion. The Site's current state was observed during a site visit on January 24, 2020. Some of the findings are presented in Figures 2.1 to 2.5.

11 https://www.belmont-ma.gov/conservation-commission

12 https://www.belmont-ma.gov/land-management-committee-for-lone-tree-hill

Figure 2.1. Existing parking lot layout.

Figure 2.2. Lack of drainage due to erosion and potholing.

Figure 2.3. View of steep driveway from the parking lot.

Figure 2.4. Existing dilapidated signage.

Figure 2.5. Inconsistent paving and erosion.

Overall, the parking lot is undersized, subject to unwanted activities, and lacking in facilities. The small lot cannot accommodate all visitors to the Site. Using the standard parking space size of 8 feet by 20 feet, only around 12 vehicles can park of the lot at once. This estimation does not take into account the disorganization caused by the odd lot shape and no striping. On days with high attendance, such as community events and good weather days, the insufficient capacity forces cars to park along Mill Street, causing inconvenience, roadway hazards, and accessibility issues for handicapped visitors. Another concern of the Client was misuse of the property by unwelcome visitors. The McLean Barn had a history of break-ins and graffiti, which threaten the World War 1 era structure. In addition, there have been reports of individuals who take advantage of the tranquility of Rock Meadow and engage in misconduct described as distasteful, uninviting, and sometimes illegal. The owners of Lone Tree Hill have even taken the precaution of installing video surveillance at the Barn, though the system and its feed to the police department are limited. With regards to the Site's facilities, the only bathrooms at Rock Meadow have been portable restrooms made available seasonally. These detracted from the aesthetics of the site, required frequent maintenance, and were a common complaint to the Client. These facilities also lacked a source of running water for visitors and their dogs.

Rock Meadow faces the ongoing loss of grasslands from encroaching woodlands. Native grassland habitats in the Northeast are only 10% of the size they were before colonial settling. This habitat loss threatens grassland birds, nine species of which are listed as endangered, extinct, or of special concern in the Northeast alone.[13] To combat this, the Belmont Conservation Commission implemented a Mass Audubon management plan in 2007 with goals of restoration to 50% grassland coverage at Rock Meadow, clear edges between habitats, and the control of invasive species. The poorly defined edges between the impervious parking lot and the start of Rock Meadow are shown in Figure 2.6.

Figure 2.6. Existing boundary between the parking lot and conservation area.

2.1.4 Existing Utilities

The only known existing utilities on the is water. There is a small lateral water line coming from the main line on Mill Street, which provides seasonal irrigation access to the Victory Gardens. An

13 https://www.fs.fed.us/psw/publications/documents/psw_gtr191/psw_gtr191_0511-0518_shriver.pdf

electrical line is believed to extend from the main line on Mill Street to provide video surveillance to the McLean Barn. In addition, an unknown utility line, previously identified by DigSafe, runs across the parking lot parallel to Mill Street. Although it is likely abandoned, its status is not known at this time.

There are no known sewer, gas, or stormwater services to the Site, but there is potential for access from the existing storm and sewer mains along Mill Street. There is one sewer manhole close to the intersection of the driveway and Mill Street, but no storm drain manholes near the site. The elevation of the parking lot makes a normal gravity line to the utilities on Mill Street unrealistic.

The existing conditions at the Rock Meadow parking lot, as outlined above, are modeled in the Existing Conditions Map, included as Drawing C2.0 in Appendix A.

2.2 Soil Conditions

Stormwater is rainwater or melted snow that runs off streets, lawns and other sites. When stormwater is infiltrated, it is filtered by the porous soils and rocks in soil and it eventually recharges aquifers. In developed areas such as parking lots, impervious surfaces such as pavement and roofs hinder precipitation from being infiltrated by the ground by blocking access to the soil. When impervious surfaces are challenged by large quantities of runoff, flooding results if sufficient management is not in place.[14] Within the Site, there are currently 10,400 ft^2 of existing impervious area, which includes the parking lot, driveway, and other miscellaneous paved surfaces.

Soil data was needed for the selection of the stormwater management system. The USDA's Soil Survey[15] was used to obtain the soil data for the Site. Figure 2.9 shows that the soil type remains consistent over the majority of the Site, with most of the parking lot area designated as type 302B, and and a small section as type 311B. The USDA describes the area denoted as 302B as extremely stony Montauk fine sandy loam with 0 to 8% slopes. The area denoted as 311B is described as a very stony Woodbridge fine sandy loam with 0 to 8% slopes. Soil texture is classified according to the size of the component particles (i.e. clay, silt, or sand). Soil texture was critical for

14 https://www.epa.gov/greeningepa/epa-facility-stormwater-management

15 https://websoilsurvey.nrcs.usda.gov

forecasting the potential infiltration, movement, and storage of water in the soil.[16] As a combination of the soil types, loamy soils are fertile, moderately workable, and have an average water-holding capacity.[17]

Figure 2.9. Soil Classification Map of Site.

2.3 Hydrologic Conditions

Rock Meadow is part of the Charles River Watershed, which drains into Beaver Brook, then the Charles River, and finally the Boston Harbor. The Charles River Watershed is an important source of drinking water for the City of Cambridge and many smaller groundwater recharging wells in the area. Roughly 900,000 residents fall within the nearly 200,000-acre watershed.[18] Over 8,000 acres of wetlands in the Charles River Watershed have been designated as protected in order to reduce downstream flooding. Though parts of Rock Meadow border areas with a 1% chance of flooding,[19] the parking lot itself is not designated as a major risk for flooding during extreme storm events.[20] Figure 2.10 shows Rock Meadow's parking lot in proximity to FEMA

16 http://ftp.comet.ucar.edu/memory-stick/hydro/basic_int/runoff/navmenu.php_tab_1_page_4.1.0.htm

17 https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/loam

18 The Charles River, https://www.umass.edu/ecologicalcities/watershed/charles.htm

19 Zone Classifications, http://www.floodmaps.com/zones.htm

20 Belmont, MA MapsOnline, https://www.mapsonline.net/belmontma/#x=-7926878.378634,5221249.330714,-7925500.123468,5222024.449954

Flood Zones, Flood Hazards, Wetlands, and Marshes and Bogs. Unfortunately, there is little information available on groundwater levels under the site. USGS has no well data within a couple miles of the Site.

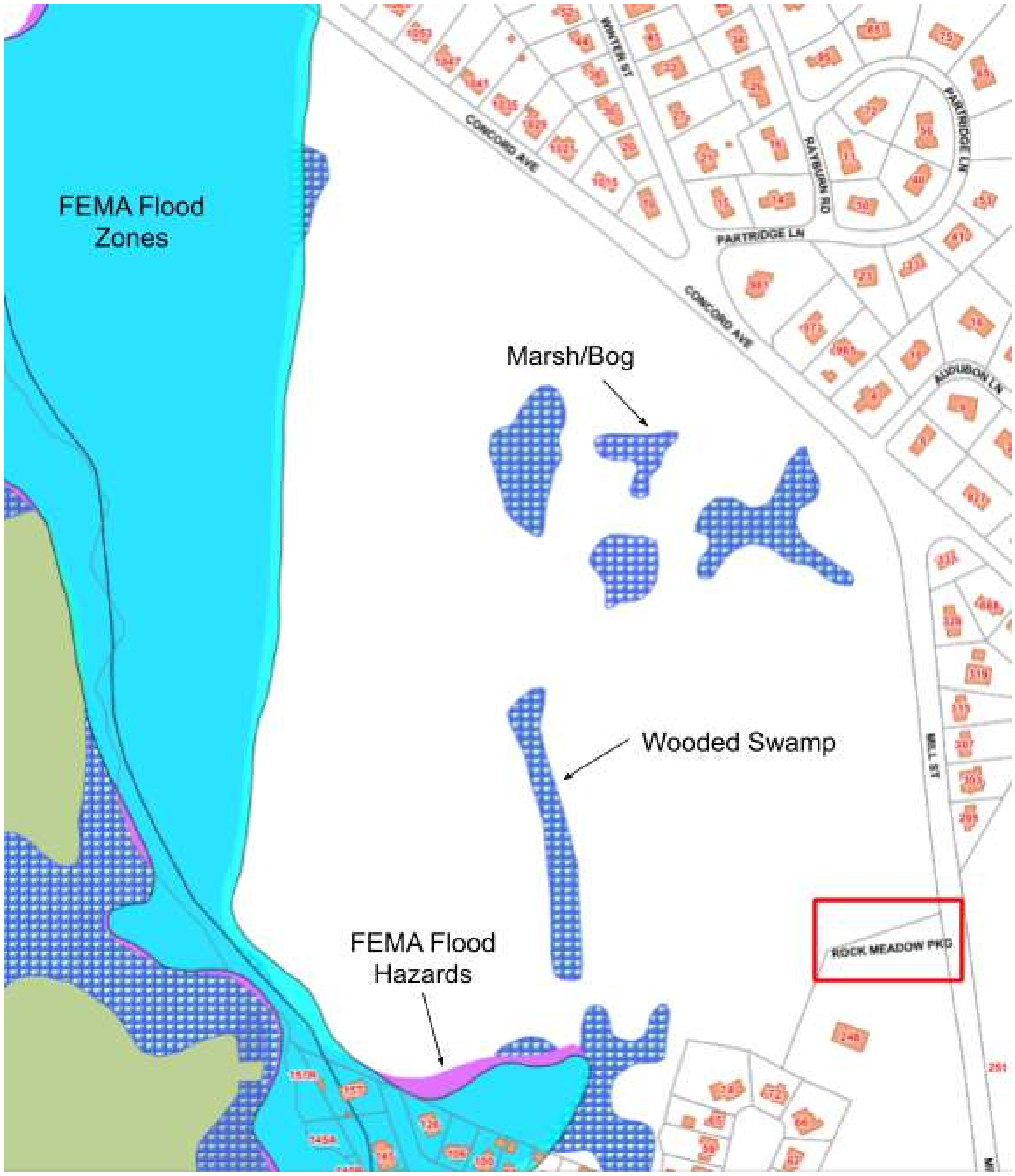

Figure 2.10. Localized watershed map of Rock Meadow's parking area (ArcGIS).

The existing parking lot at Rock Meadow is not well equipped for storm events. The runoff flow has no direction over the uneven surface, and there are no designated areas for the water to flow into for treatment or infiltration. Due to these conditions, the stormwater pooled in various areas in the lot, leading to accelerated erosion and degradation of the pavement.

2.4 Climate

Table 2.1 shows the total monthly precipitation for the Boston area, including the Site, from the years 2015 through 2019. Table 2.2 and Table 2.3 contain temperature information for the site area including the monthly maximum and minimum temperatures.[21]

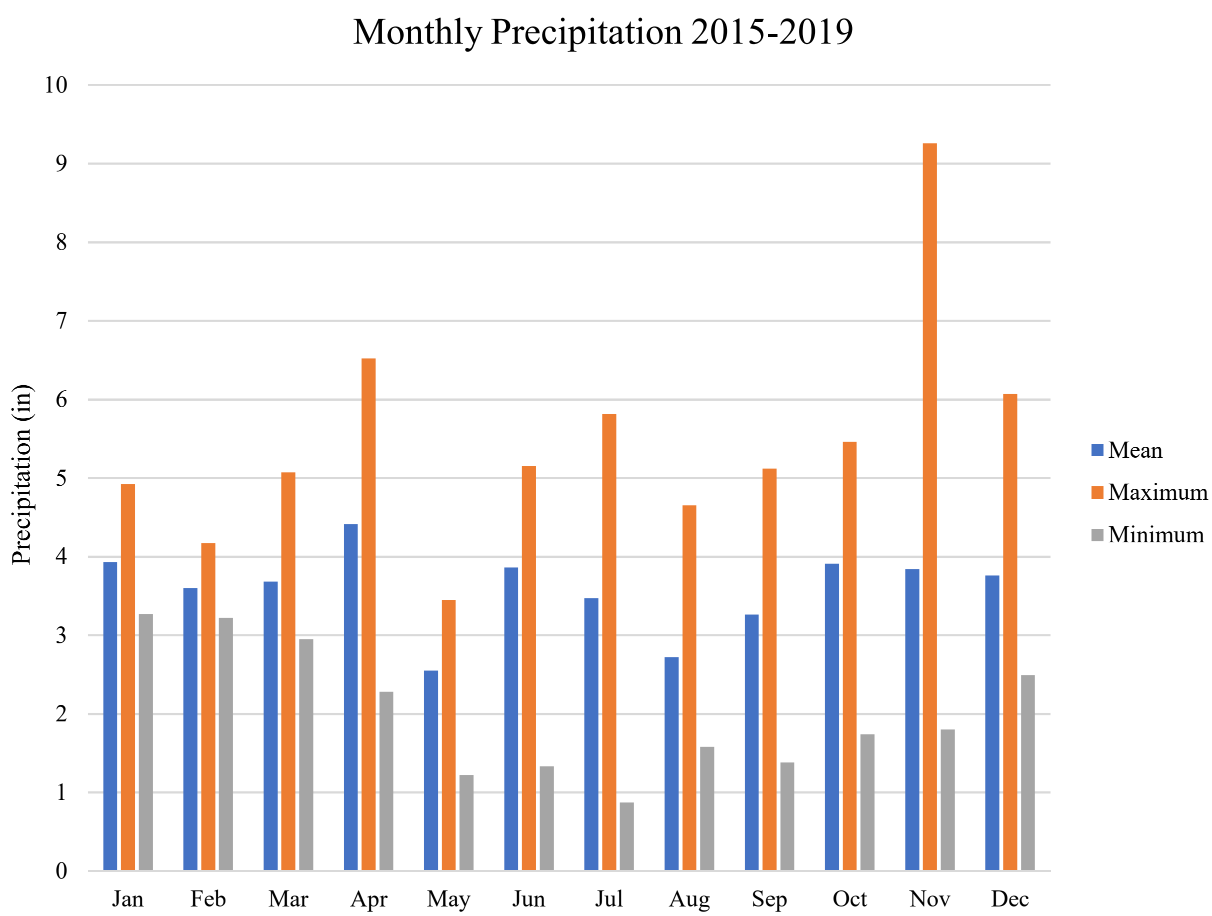

Figure 2.11. Monthly Total Precipitation (in) for Boston Area Over 5 Years (NOAA)

21 National Weather Service Forecast Office, https://w2.weather.gov/climate/xmacis.php?wfo=box

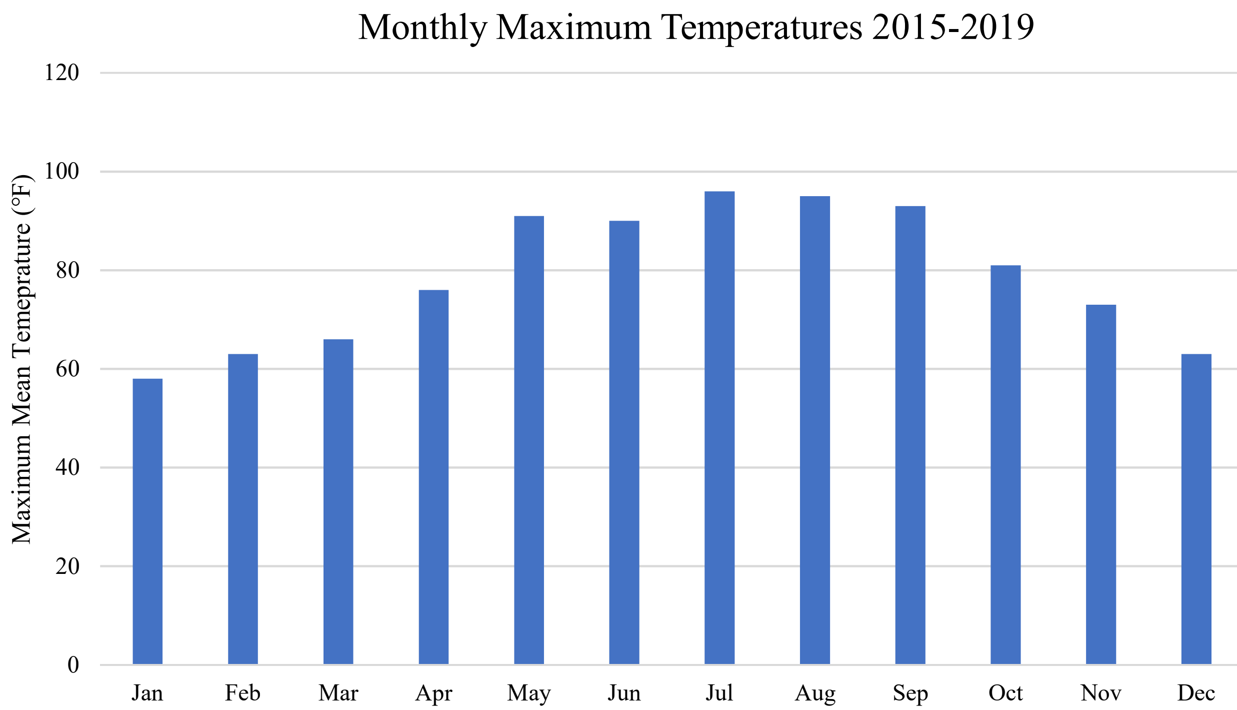

Figure 2.12. Monthly Max Temperature (°F) for Boston Area Over 5 Years (NOAA)

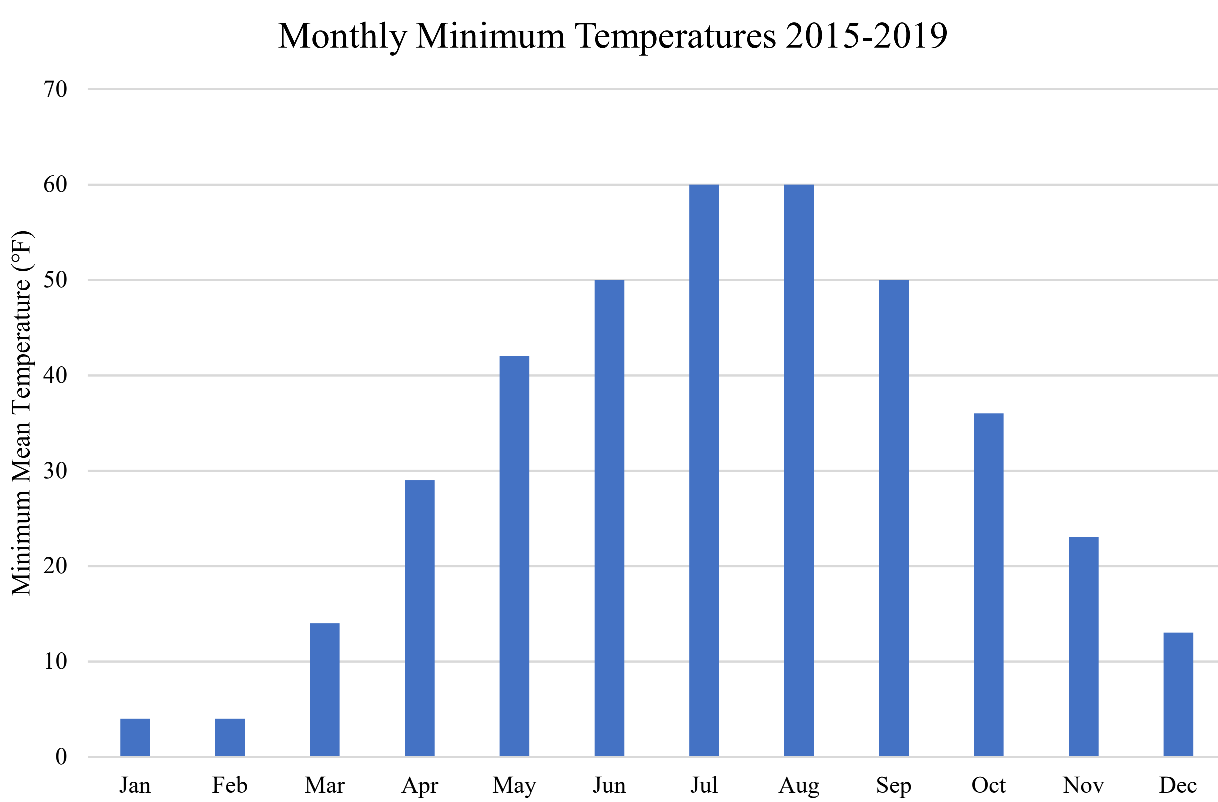

Figure 2.13. Monthly Min Temperature (°F) for Boston Area Over 5 Years (NOAA)

2.5 Pollutant Loading

The Client identified two pollutants of concern for the Site: total suspended solids (TSS) and phosphorus. In addition, phosphorus is specifically cited as a pollutant of concern in the Charles River Watershed.[22] The redeveloped parking lot and driveway were designed to positively impact the water quality in the surrounding ecosystems. A demonstrable improvement of the Site's runoff water quality would make the project a candidate for the EPA's 319 Grant,[23] which focuses on reducing the amount of non-point source pollution into water bodies. This is pollution that does not come from an obvious source, such a pipe emptying into a pond, but rather from surface runoff that gradually picks up pollutants from agriculture, forestry, construction, and urban areas. The stormwater management plan (SWMP) is designed to remove pollutants from non-point sources.

TSS

TSS was a pollutant of concern because small particles related to Rock Meadow's construction, forestry activities, and vehicle usage were likely to be picked up by snowmelt and stormwater runoff. TSS can be harmful to ecosystems downstream.[24] Suspended particles impact water quality and can be carriers of toxins. The concentration of TSS found in runoff stormwater varies greatly depending on land use and location. As there is no specific data for the Site, TSS loading was estimated from typical parking lot values. An estimate of TSS concentration for open space land can range from less than 1 mg/L to 4168 mg/L, with a median value of 58 mg/L, based on data from the International Stormwater Database.[25]

Phosphorous

Nutrient pollution in stormwater runoff is a serious environmental risk to ecosystems down-gradient. Phosphorus is a nutrient often found in fertilizers and organic waste.[26] When too much phosphorus is introduced to an ecosystem, it can trigger an algal bloom, which has happened in the Charles River Watershed. Excessive algae growth in water bodies can have negative health implications for human and aquatic life. It can lead to eutrophication, a phenomenon in which

22 Charles River Watershed Association, https://www.crwa.org/charles-river.html

23 Section 319 Grants: A Guide for State Nonpoint Source Agencies, https://www.epa.gov/sites/production/files/2015-09/documents/319applying-guide-revised.pdf

24 Total Solids, EPA Archive, https://archive.epa.gov/water/archive/web/html/vms58.html

25 Minnesota Stormwater Manual, https://stormwater.pca.state.mn.us/index.php/Total_Suspended_Solids_(TSS)_in_stormwater

26 Phosphorus - USGS, https://www.usgs.gov/special-topic/water-science-school/science/phosphorus-and-water?qt-science_center_objects=0#qt-science_center_objects

the resulting decay of the algae uses up oxygen to a point where the water cannot sustain other life. As there is no specific data for the Site, phosphorus loading was estimated from typical parking lot values. Phosphorus concentrations in stormwater range from 0.12 mg/L to 0.31 mg/L for open space land, but a reported recommended value is 0.19 mg/L.[19]

3.0 Design Considerations

This chapter highlights the best management practices for the parking lot, stormwater management system, and site improvements. It provides technical context for the forthcoming design by listing the design considerations for the project and the advantages and disadvantages of each alternative. Overall, this chapter summarizes the requirements that Evergreen had to meet for an effective redesign at Rock Meadow.

3.1 Parking Lot

Prior to any design, research regarding Belmont's parking regulations was done in order to meet the requirements in town ordinances. Parking spaces parallel to each other are required to be 8 feet wide by 20 feet long, and parking spaces at 30° are required to be 8 feet wide by 18 feet long. Additionally, each accessible space is required to be 8 feet by 20 feet long, with a 5-foot access aisle adjacent to each spot.[27] In order to accommodate vans, each accessible parking spot was actually designed to be 11 feet wide by 20 feet long with a 5-foot access aisle.[28] Two van accessible parking spots were included in the design for each alternative.

Parking lot use data at Rock Meadow was gathered by Animal Control Officer Suzanne Trasavage over a period of several weeks. During a forty-five minute period, the maximum amount of cars utilizing the parking lot at Rock Meadow was not more than seventeen. Therefore, it can be empirically proven that the existing parking lot at Rock Meadow is undersized and unable to accommodate the full capacity of visitors.

The possibility for expansion into the surrounding grassy area was an immediate consideration in the design process. Two potential options for design were examined: a parking lot expansion and a parking lot relocation. Both alternatives were analyzed on a qualitative level and discussed with town officials for consideration before more detailed plans were drafted.

3.1.1 Parking Lot Expansion

The first alternative was redesigning the existing parking lot and expanding into the surrounding grassy area in order to achieve maximum parking availability. This alternative would not require relocating pedestrian and vehicular access paths in the surrounding area, but, it would require the

27 Belmont Zoning Ordinance Amendment Adding Section 31, Village Districts https://www.belmont.gov/Home/ShowDocument?id=16511

28 21 CMR 23.00: PARKING AND PASSENGER LOADING ZONES, https://www.mass.gov/files/documents/2018/04/11/521cmr23.pdf

removal of seventeen trees. Figure 3.1 illustrates a parking lot design with expansion in its current location.

Figure 3.1. Parking lot redesign with expansion

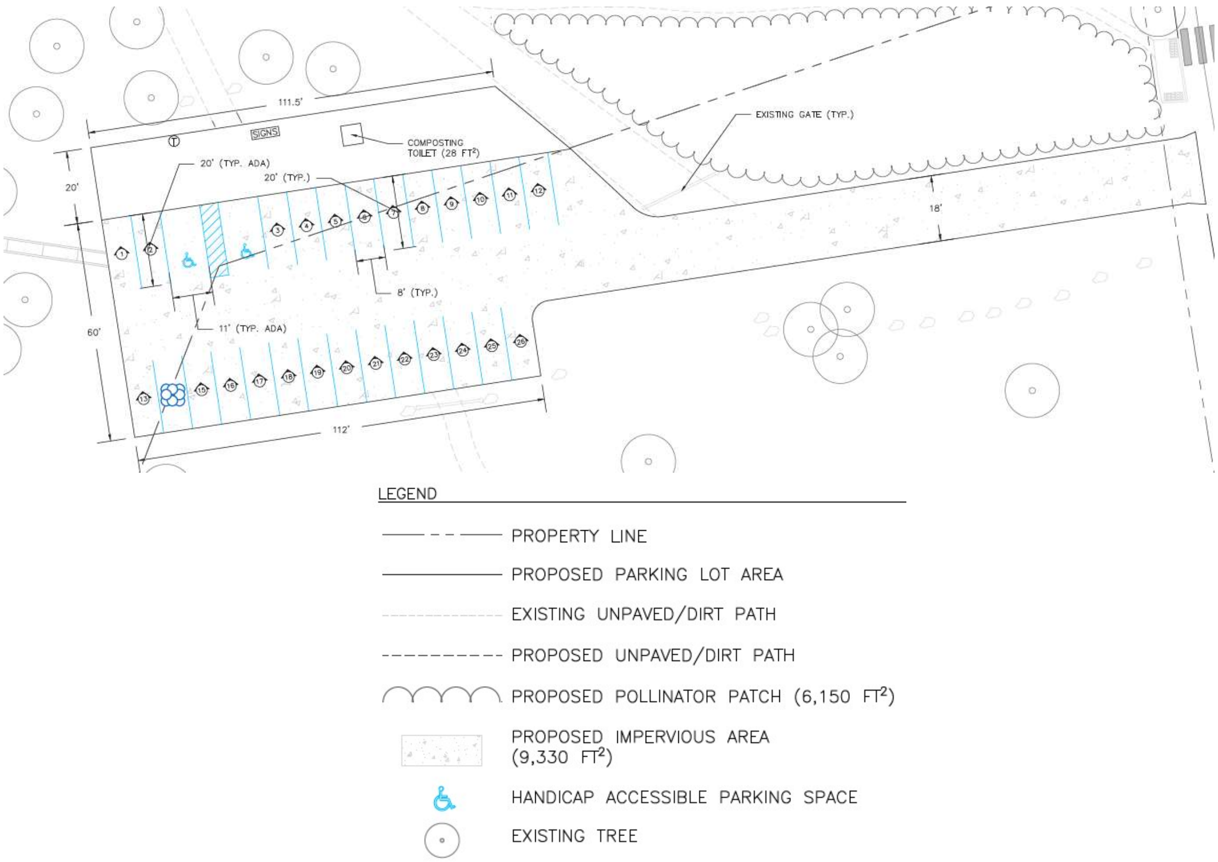

Table 3.1. Parking Lot Expansion Advantages and Disadvantages

Advantages	Disadvantages
• Minimal added costs for backfill • Familiarity to residents	• Lot on Lone Tree Hill property • Requires removal of more trees

3.1.2 Parking Lot Relocation

The second alternative was moving the parking lot east of the current driveway and designing it with similar parking spacing to the expansion alternative. However, there may be the possibility for further parking spaces in the form of a middle aisle, pending the data from the parking use study. Unlike the expansion alternative, this design requires the relocation of pedestrian paths, vehicular access paths for park staff, the driveway entrance, and a telecommunications manhole.

Additionally, it would require the removal of eight trees. Figure 3.2 illustrates a design where the parking lot is moved to an adjacent space.

Figure 3.2. Parking lot redesign with relocation

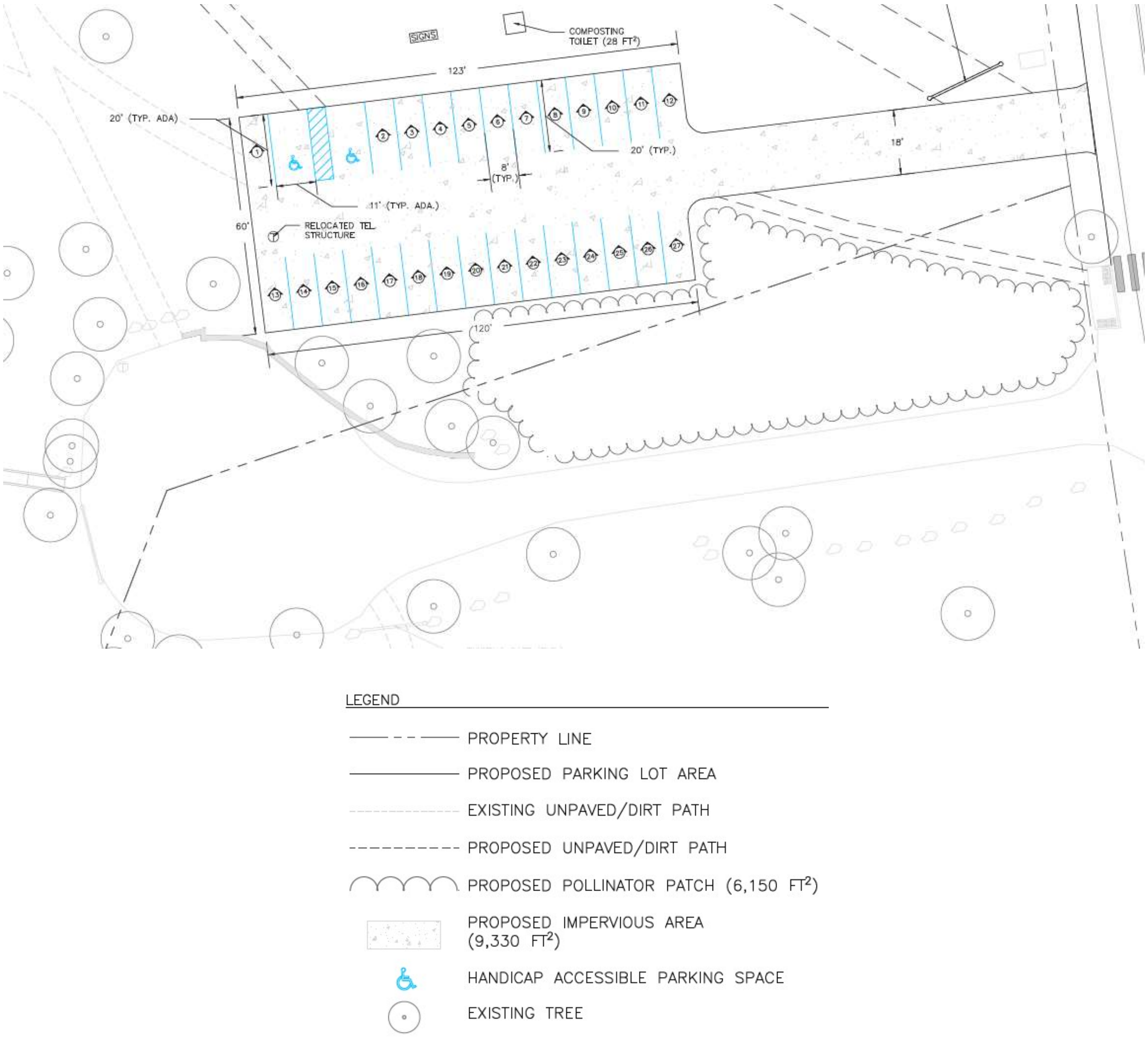

Table 3.2. Parking Lot Relocation Advantages and Disadvantages

Advantages	Disadvantages
• Potential for additional expansion • Gives full jurisdiction to Belmont Conservation Commission	• Added costs for earthwork • Land conversion of existing lot • Relocate access paths for park staff

3.2 Stormwater Management

3.2.1 Climate Vulnerability

Climate change continues to be an important consideration when it comes to site evaluation. In future years, it is expected that temperatures will continue to rise, yielding unpredictable effects on the hydrologic cycle. It can be expected that in coming years, intense weather conditions will continue to escalate, meaning hotter heat waves and heavier rainfalls.[29] Though it is difficult to predict the rates at which temperatures will rise and how weather patterns will be affected, it is clear that higher temperatures lead to greater quantities of evaporated water. Because of this, there will be more water held in the atmosphere, giving a high possibility of more intense precipitation events than the recent ones outlined in Chapter 2. For these reasons, Evergreen has taken the precaution of analyzing the rainfall data for 2-year, 10-year, and 25- year, 24-hour storm events.

3.2.2 Hydrology

The parking lot serving Rock Meadow required a full redesign to address poor drainage and a lack of erosion control. The composite curve number (CN) was determined using the permeability of the proposed paved surface and Site's soil composition, which is known to be a fine sandy loam with moderate soil drainage. An estimated accumulation of water for 2-year, 10-year, and 25-year 24-hour storm events was calculated using data from the Extreme Precipitation in New York and New England web tool published by the Northeast Regional Climate Center (NRCC) and the National Resource Conservation Service (NRCS).[30] These water depths can be found in Table 3.3. The watershed lag method and the velocity method were used to estimate the time of concentration. The rational method[31] and graphical peak discharge method[32] were used to estimate the peak discharge rates, which were modeled in HEC-HMS. See Table 3.4 for a summary of the modeled results. The discharge and run-off rates were utilized to determine the minimum slope for the parking lot that would provide sufficient drainage for the Site's runoff.

Massachusetts Stormwater Management Regulations[33] were used to evaluate and redesign the stormwater management system in the parking lot. The most pertinent regulation for the Site

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29 Environmental Defense Fund, https://www.edf.org/climate/climate-change-and-extreme-weather

30 Extreme Precipitation in New York and New England, http://precip.eas.cornell.edu/

31 The Rational Method, David B. Thompson, http://drdbthompson.net/writings/rational.pdf

32 Urban Hydrology for Small Watersheds, https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1044171.pdf

33 Stormwater Management Standards, Commonwealth of Massachusetts. https://s3.us-east-1.amazonaws.com/blackboard.learn.xythos.prod/5a3148150d016/18772921?response-content-disposition=inline%3B%20filename%2A%3DUTF-8%27%27MASS_SWregs_v1c1.pdf&response-content-type=application%2Fpdf&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-

required that the stormwater management system does not directly discharge untreated stormwater. The SWMP was designed such that the peak discharge rate on the impervious developed surface did not exceed the peak discharge rate on the unpaved, undeveloped surface. The peak discharge rates for the Site both pre- and post-development were calculated. The stormwater management alternatives were considered and evaluated based on these loading calculations. Appendix B.1. details the process of modeling the three design storms for the current conditions and two proposed alternatives.

Table 3.3. Predicted Depth of Rainfall for Design Storms

Design Storm	Depth of Rainfall (in)
2-year, 24-hour	3.21
10-year, 24-hour	4.85
25-year, 24-hour	6.14

Table 3.4. Key hydrologic parameters for the current Site and the two planned alternatives.

	Current	Expansion	Relocation
Curve Number	60.9	65.4	78.3
2-yr Peak Discharge (ft^3/s)	0.2	0.3	0.4
10-yr Peak Discharge (ft^3/s)	0.7	0.9	0.9
25-yr Peak Discharge (ft^3/s)	1.2	1.4	1.3
Time of Concentration (min)	9.3	9.0	5.4
Lag Time (min)	5.6	5.4	3.2

3.2.3 Green Infrastructure

There were several design considerations used to evaluate the stormwater BMPs. The selected BMP(s) needed to have a sufficient residence time for the runoff that will be generated on the Site during the design storm. The BMP also had to meet all treatment and groundwater recharge requirements. Additionally, there had to be enough space on the Site for the selected BMP(s) and

Date=20200116T220858Z&X-Amz-SignedHeaders=host&X-Amz-Expires=21600&X-Amz-Credential=AKIAIL7WQYDOOHAZJGWQ%2F20200116%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Signature=f130cf20f34e001b0ba25deefb6c58b4fc8d06d8489c260c666e86c055eac1b3

overall costs had to be minimized. Evergreen has extensively investigated potential stormwater BMPs and has provided more information on the ten most feasible options.

Bioswale

Bioswales are vegetated depressions that are graded to allow water to move across lengthwise, as shown in Figure 3.3.[34] A bioswale is a low-impact development alternative that can introduce native plant life to the parking area and potentially serve as a wildlife habitat. Bioswale systems allow for both infiltration and evapotranspiration. As they accept both sheet flow and pipe flow, they can be used as pretreatment and combined with other BMPs. However, bioswales require a long residence time (a minimum of nine minutes) and provide limited filtration depending on the types of plants used.[35]

Figure 3.3. Bioswale

Table 3.5. Bioswale Advantages and Disadvantages

Advantages	Disadvantages
• Introduces native vegetation • Can both treat and infiltrate	• Limited filtration • Requires high residence time

Constructed Stormwater Wetland

Constructed stormwater wetlands use vegetation to improve water quality, as shown in Figure 3.4.[36] This system must be combined with a pretreatment BMP. The introduction of a small, man-made wetland has relatively low maintenance costs and enhances aesthetics. Compared to other BMPs, constructed wetlands have very high pollutant removal efficiencies. However, they provide no groundwater recharge and can require a large amount of space. Depending on the types of plant life used, they can be difficult to

Figure 3.4. Constructed Stormwater Wetland

34 https://nacto.org/publication/urban-street-design-guide/street-design-elements/stormwater-management/bioswales/

35 Structural BMP Specifications for the Massachusetts Stormwater Handbook, https://www.mass.gov/files/documents/2016/08/qi/v2c2.pdf

36 https://www.crwa.org/uploads/1/2/6/7/126781580/crwa_stormwater_wetlands.pdf

maintain. It could also potentially confuse wildlife who are on their way to a nearby wetland or vernal pool.[9]

Table 3.6. Constructed Stormwater Wetland Advantages and Disadvantages

Advantages	Disadvantages
• Enhances aesthetics • Removes many pollutant types	• Can require a large area • Difficult to maintain

Infiltration Basin

An infiltration basin is a runoff impoundment, as shown in Figure 3.5.[37] In this scenario, the underlying soils must be permeable. This BMP must be preceded by another process for pretreatment. Infiltration basins store and infiltrate water, providing groundwater recharge. Because of their storage capacity, they can effectively prevent flooding on the Site. However, they can only be used for small drainage areas and they take up a relatively large amount of space. These systems also require frequent maintenance.[9]

Figure 3.5. Infiltration Basin

Table 3.7. Infiltration Basin Advantages and Disadvantages

Advantages	Disadvantages
• Provides groundwater recharge • Prevents flooding	• Requires frequent maintenance • Good only for small drainage areas

Infiltration Trench

An infiltration trench is similar to an infiltration basin, except its construction consists of shallow excavations that require less space. This BMP is shown in Figure 3.6.[9] They must be used in conjunction with a pretreatment BMP. Infiltration trenches provide groundwater recharge

Figure 3.6. Infiltration Trench

37 https://www.stormwaterpartners.com/facilities-infiltration-basin

and reduce area flooding. They occupy a relatively small area, but are susceptible to clogging.[9]

Table 3.8. Infiltration Trench Advantages and Disadvantages

Advantages	Disadvantages
• Provides groundwater recharge • Prevents flooding	• Susceptible to clogging • Good only for small drainage areas

Media Filter

Figure 3.7. Media Filter

A media filter consists of two underground chambers, as shown in Figure 3.7.[9] As water flows through the first chamber, coarse sediments settle out. In the second chamber, specific pollutants can be targeted. This can be used as pretreatment. Media filters take up a small amount of space and no surface space. They can be designed to remove various types of pollutants, such as TSS, heavy metals, and soluble nutrients. However, they require frequent maintenance. Their performance and removal efficiency vary depending on the media.[9]

Table 3.9. Media Filter Advantages and Disadvantages

Advantages	Disadvantages
• Occupies no surface space • Can reduce various pollutant types	• Requires frequent maintenance • Performance varies based on media

Pervious Pavement

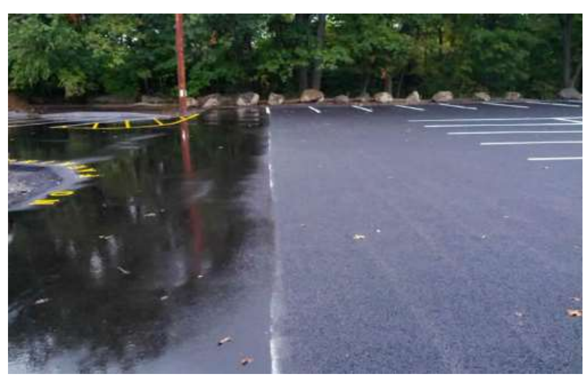

Figure 3.8. Pervious Pavement

Pervious pavement allows for water to be directly stored and infiltrated as it enters the Site, as shown in Figure 3.8.[38] This limits contaminant transport and promotes groundwater recharge. There are many different types of pervious pavement materials, allowing for customization to each specific site. However, specific site conditions are required for this BMP to be a success. Subgrade

38 https://www.epa.gov/soakuptherain/soak-rain-permeable-pavement

materials must be sufficiently permeable and the compaction of subgrade soils must be avoided. It also requires special maintenance.[9]

Table 3.10. Pervious Pavement Advantages and Disadvantages

Advantages	Disadvantages
• Stand alone BMP • Various types available	• Difficulty in maintenance • Requires specific subgrade conditions

Rain Garden

Rain gardens contain an array of plant life in a delineated garden area where runoff can flow to be infiltrated, as shown in Figure 3.9.[39] Rain gardens must be combined with a pretreatment BMP. These systems are suitable for sites where available space is a constraint. They can be designed to either provide or prevent groundwater recharge as the site calls for it. Rain gardens also have the ability to remove many pollutants, including TSS, phosphorus, nitrogen, and metals. Vegetation improves aesthetics.[9]

Figure 3.9. Rain Garden

Table 3.11. Rain Garden Advantages and Disadvantages

Advantages	Disadvantages
• Can provide or prevent groundwater recharge • Enhances aesthetics	• High maintenance requirements

Sediment Forebay

A sediment forebay is an excavated pit or a bermed area where water can flow and be stored prior to flowing into another BMP, as shown in Figure 3.10.[9] A sediment forebay serves as a pretreatment BMP. It removes sediment from the runoff and slows the stormwater's velocity before it is

Figure 3.10. Sediment Forebay

39 https://www.epa.gov/soakuptherain/soak-rain-rain-gardens

transferred to following BMPs. They are relatively inexpensive systems to construct. However, they provide no groundwater recharge, do not remove soluble pollutants, and require frequent maintenance for upkeep.[9]

Table 3.12. Sediment Forebay Advantages and Disadvantages

Advantages	Disadvantages
• Removes sediment • Relatively inexpensive	• Only removes coarse sediments • Requires frequent maintenance

Tree Box Filter

A tree box filter consists of a subgrade concrete box or barrel filled with permeable soil, as shown in Figure 3.11.[9] A tree is planted in this soil to allow incoming runoff to be treated before being sent to a subsequent BMP or infiltrated. In this way, a tree box filter can serve as pretreatment. This system is ideal for urban environments, as they takes up a small area and introduce a tree to the site. However, they are only suitable for treating small volumes of runoff.[9]

Figure 3.11. Tree Box Filter

Table 3.13. Tree Box Filter Advantages and Disadvantages

Advantages	Disadvantages
• Low space requirements • Enhances aesthetics	• Suitable for only small runoff volumes

Vegetated Filter Strip

A vegetated filter strip is a graded surface that slows runoff velocities and traps sediment, as shown in Figure 3.12.[9] They also reduce runoff volume by promoting infiltration. They fit well into low-impact development and are easy to maintain. However, pollutant removal efficiencies vary depending on their size. With that being said, the systems can require a relatively large area. Additionally, they require gentle slopes (< 6%) to be effective.[9]

Figure 3.12. Vegetated Filter Strip

Table 3.14. Vegetated Filter Strip Advantages and Disadvantages

Advantages	Disadvantages
• Removes sediment • Low maintenance	• Variable removal efficiencies • Requires gentle slopes

Table 3.15 provides quantitative information on the aforementioned stormwater BMPs. This includes the typical storage capacity, pollutant removal efficiencies, and cost. Typical land consumption is by the percent of impervious area.

Table 3.15. A summary of typical design parameters for the ten stormwater management BMPs.

BMP	Typical Land Consumption	TSS Removal Efficiency	TP Removal Efficiency	Construction Cost	Maintenance Cost (Annual)
Bioswale	10-20%[15]	70%[9]	20-90%[9]	$15/sq. ft.[14]	$0.12/sq. ft.[40]
Constructed SW Wetland	3-5%[15]	80%[9]	40-60%[9]	$0.60-$1.25 /cu. ft.[15]	$0.012-0.025 /cu. ft.[41]
Infiltration Basin	2-3%[15]	80%[9]	60-70%[9]	$1.30/cu. ft.[15]	$0.065-0.13 /cu. ft.[15]
Infiltration Trench	2-3%[15]	80%[9]	40-70%[9]	$4-12/cu. ft.[16]	$0.20-$1.20 /cu. ft.[42]
Media Filter	0-3%[15]	80%[9]	10-50%[9]	$3-6/cu. ft.[15]	$.33-$0.78 /cu. ft.[15]
Pervious Pavement	0%[15]	Insufficient data	Insufficient data	$11-13/sq. ft.[43]	$0.036-$0.19 /sq. ft.[14]
Rain Garden	5%[15]	90%[9]	30-90%[9]	$7/sq. ft.[14]	$0.34/sq. ft.[14]
Sediment Forebay	Insufficient data	25%[9]	Insufficient data	Insufficient data	Insufficient data
Tree Box Filter	Insufficient data	80%[9]	Insufficient data	$222 /sq. ft.[14]	$8.69/sq. ft.[14]
Vegetated Filter Strip	100%[15]	10-45%[9]	Insufficient data	$1.45 /sq. ft.[14]	$0.07/sq. ft.[14]

40 Green Values Cost Sheet, https://greenvalues.cnt.org/national/cost_detail.php

41 EPA Urban Stormwater Preliminary Data Summary, https://www3.epa.gov/npdes/pubs/usw_d.pdf

42 Pennsylvania Stormwater Management Manual, https://bfenvironmental.com/pdfs/InfiltrantionTrench.pdf

43 EPA Ohio Low Impact Development Grant, https://epa.ohio.gov/Portals/41/storm_workshop/lid/CRWP_LID_Cost%20Study.pdf

3.3 Site Improvements

In order to provide a better parking experience at Rock Meadow, site improvements in the following areas were investigated: bathroom facilities, signage, and security. The selected alternatives had to be affordable for the community to finance and feasible to design with limited existing utilities on the Site. Above all, they had to enrich the user's experience by providing a higher level of comfort, information, and safety, respectively. In addition to these site improvements, the final design also includes other new features for visitors and pets, such as a spigot with running water.

3.3.1 Bathroom Facilities

These facilities would be an improvement to the current seasonal portable toilets on the Site. It was important to consider the space requirements that each alternative required on the Site as well as the connection to existing utilities. Two alternatives were evaluated for the bathroom facilities site improvement: a composting toilet and a traditional full-service bathroom.

Composting Toilet

The modern composting toilet takes advantage of factors such as temperature, drainage, aeration, and ventilation to break down waste. It requires supplementation from carbonaceous material such as straw or wood chips, typically added after each use. Composting toilets rely on a warm environment to speed up decomposition and kill pathogens, which can be achieved in the colder months with the addition of a heater. Composting toilets for commercial use range in cost from $1,500 to $8,000 based on factors such as capacity, electrical use, and water use.[44] A typical unit has an outhouse structure constructed around it, with a footprint of about 28 square feet.[45] This restroom alternative is a gender-neutral option because space and budget constraints limited the design to one composting toilet for the Site.

44 https://www.go-gba.org/resources/green-building-methods/composting-toilets/

45 https://ekolet.com/product/outhouse-oh-for-happy-loo-toilet/

Table 3.16. Composting Toilet Advantages and Disadvantages.

Advantages	Disadvantages
• Water conservation • Shows commitment to sustainability • Gender-neutral • Educational opportunity	• Potential problem with odor/insects • Periodic mixing and emptying • Only accommodates one user at a time

Traditional Full-Service Bathroom

The traditional full-service bathroom alternative consisted of an enclosed structure with plumbing that services a chosen number of toilets and sinks. This bathroom was sized based on the current daily use and the projected maximum daily use of Rock Meadow as discussed in Section I - Parking Lot. This restroom has the potential to have gender-specific sections or be fully gender-neutral, based on the Town's preferences.

Table 3.17. Traditional Full-Service Bathroom Advantages and Disadvantages.

Advantages	Disadvantages
• Year-round access to facilities • Aesthetically pleasing • Can accommodate a larger capacity	• Requires connection to water supply • Higher cost • Larger footprint

3.3.2 Signage

Signage on the Site was needed to provide the necessary information to visitors. In addition to being informative, the signage was designed to be clear and resistant to weather over time. Locations for the signs in and around the parking lot were identified based on pedestrian and vehicular flow. Two alternatives were evaluated for the signage site improvement: required signage only and required signage plus educational signage.

Required Signage

Per regulation, some signage was required in the parking lot: signs that indicate van accessible areas, handicapped parking, designated no parking zones, and traffic circulation patterns. This alternative refers to only providing the signage that is required.

Table 3.18. Required Signage Advantages and Disadvantages.

Advantages	Disadvantages
• Lower cost • Potential to be expanded in the future	• No recognition of sustainability initiatives

Required Signage Plus Educational Signage

This alternative refers to, in addition to the required signage outlined above, more signage in the form of a welcome kiosk and an informational display on the new sustainability features of the site. The informational display can be added as a stop on the eco-historical tour of Rock Meadow, one of the main objectives of the Master Plan.

Table 3.19. Required Signage Plus Educational Signage Advantages and Disadvantages.

Advantages	Disadvantages
• Opportunity for community development • Aesthetically pleasing	• Higher cost • Maintenance required

3.3.3 Security

The surveillance system was designed to provide the Belmont Police Department with a more complete live stream of video from the Site, ensuring that visitors are safer at all hours of the day and night. Locations for the cameras in and around the parking lot were identified based on pedestrian and vehicular flow, as well as positioned around design features that were a significant investment, such as the restrooms. Two alternatives were evaluated for the security site improvement: video surveillance only and video surveillance plus lighting.

Video Surveillance

This alternative refers to an expansion of the existing surveillance system on the Site by adding more cameras with different angles. In addition to the camera on McLean Barn, there were two new cameras to provide views of the entire parking lot. One camera can be positioned to face the new bathroom facilities to ensure that they will not be vandalized in the future. This improves the police department’s monitoring of the Site.

Table 3.20. Video Surveillance Advantages and Disadvantages.

Advantages	Disadvantages
• Lower cost • Connection to existing system	• Less footage in the dark • Less safe experience at night

Video Surveillance Plus Lighting

This alternative refers to the expansion of the existing surveillance system as outlined above with the addition of lighting in the parking lot. In addition to providing more views to Belmont Police, lighting on the outskirts of the Site would ensure that these images are clearer. This alternative ensures a safer visitor experience at night. Within the lighting scope, solar and traditional options were evaluated.

Table 3.21. Video Surveillance Plus Lighting Advantages and Disadvantages.

Advantages	Disadvantages
• Better quality footage in the dark • Safer visitor experience at night	• Higher cost • Potential for light pollution • More electrical connections

4.0 Design Alternatives

This chapter explains how the final parking lot and stormwater management alternatives were chosen. It includes an outline of the five key criteria for alternative selection as defined by Evergreen and the Client. In addition, it includes decision matrices to weigh the two parking lot designs and the ten stormwater management BMPs respectively.

4.1 Criteria

To encapsulate the objectives for a suitable design, the following key criteria were selected by Evergreen and the Client: sustainability, adaptability, community satisfaction, effectiveness, and cost. These criteria were based on the project goals outlined in Chapter 1, with additional considerations to ensure that the design was ultimately a feasible one. Then, they were weighted by the Client in order of priority for this project.

4.1.1 Community Satisfaction

The design alternatives were evaluated for the level of community satisfaction they are expected to achieve. Evergreen has presented the design alternatives to the community, emphasizing aesthetics and functionality. This criterion ensures that the chosen alternatives are the ones that will best fulfill the needs and desires of the individuals who utilize Rock Meadow the most. A design that is aesthetically pleasing and aligns with the Rock Meadow vision statement was one that received a higher score than a design that is visually unappealing and out of touch with nature. Community satisfaction is weighted the most for this project with effectiveness.

4.1.2 Effectiveness

The design alternatives were evaluated for their efficacy, particularly as it relates to efficiencies in parking management and stormwater treatment. Each alternative's ability to perform its respective function was quantified based on site-specific practicality using available technical information and statistical data. A design that is more productive was one that received a higher score than a design that is not as strong at its function. Effectiveness is weighted the most for this project.

4.1.3 Cost

The design alternatives were evaluated for their cost, or the required financial investment over the lifetime of the system. This criterion is important because the designed system needs to be affordable in order to be built to the specification. In addition, this criterion reflects the ease of installation, as labor and time are costly. The Belmont Conservation Commission and the Town must be able to afford the initial cost as well as any maintenance costs for replacements, cleaning, or inspections over time. A design that meets the project goals at an affordable monetary cost was one that received a higher score than a design with higher construction, operation, and maintenance costs. Cost is the third priority for this project.

4.1.4 Sustainability

The design alternatives were evaluated for their sustainability, or their commitment to development that would not compromise ecological balance. This criterion was a tribute to Rock Meadow's roots as a greenspace throughout history. It was essential that the Site design only accentuated the natural experience, innovating to protect the meadow for generations of visitors to come. In this way, the parking lot at Rock Meadow can serve as a pillar of sustainability in the community and beyond. A design that has minimized land use change and incorporates green solutions was one that received a higher score than a design that depends on extensive redevelopment and gray infrastructure. Sustainability is the fourth priority for this project.

4.1.5 Adaptability

The design alternatives were evaluated for their adaptability, or their capacity to adjust to changing conditions. This criterion accounts for the changes in precipitation that are associated with climate change. As it is predicted that chances of heavy rainfall will increase and that it will be produced by more intense events, the designed systems needed to accommodate this changing environment to avoid a higher risk of floods. This criterion also accounts for the potential for changes in the use of the Site over time. A design that will be easier to adapt to changing visitor volumes and park use was one that received a higher score than a design that is more difficult or costly to expand. Adaptability is the fifth priority for this project.

4.2 Decision Matrices

To compare the expansion and relocation options and select an alternative for the parking lot design, a decision matrix was developed. This allowed for the understanding of how each alternative was weighed for each of the five selected criteria.

4.2.1 Parking Lot Design

The evaluation tool for the parking lot design and stormwater management alternatives was decision matrices. Each alternative was scored for the five criteria outlined above, where a score of one indicates poor performance and a score of five indicates great performance. The scores for each criteria were weighted by the level of priority for the project: community satisfaction (5), effectiveness (5), cost (3), sustainability (2), and adaptability (1).

Community Satisfaction

This criterion was evaluated using a survey at the community meeting on March 10, 2020. Evergreen found that the average approval for the expansion alternative was a 4 and that the average approval for the relocation alternative was a 2.

Effectiveness

Both the expansion and the relocation alternatives were scored with fives because they are equally effective at providing an improved parking experience. Each would more than double the current amount of parking spaces and correct the potholes, harsh slopes, and lack of circulation pattern.

Cost

This criterion was evaluated by comparing the amount of earthwork required for each scenario. Due to the topology and existing features of the Site, relocation would involve bringing in an large amount of backfill material and was subsequently scored a one. A preliminary model of the relocated parking lot without factoring in the grading for facilities and accessible pathways resulted in an estimated net fill volume of 4,435 cubic yards of material (about 6,950 to 8,100 tons[46]). This value is also conservative in that the fill slope was modeled to be 2:1, the maximum ideal slope.[47] Relocation was scored a one because of these extensive costs needed for acceptable grading. In comparison, the expansion alternative would require a net fill volume of about 500 cubic yards of fill. It was scored a four because there will lower backfill costs for correcting the steep slope.

Sustainability

[46] http://www.geotechnicalinfo.com/soil_unit_weight.html
[47] https://www.fs.fed.us/t-d/programs/forest_mgmt/projects/lowvolroads/ch11.pdf

Relocation was scored a two because of the additional meadow that would be disturbed by moving the parking lot and converting previously undeveloped land into impervious surface. A minimum estimated area of 2,100 previously undeveloped square yards of Rock Meadow would be disturbed. The environmental effects of redeveloping the existing parking lot were also factored into the low score of the relocation alternative. Expansion was rated highest in sustainability due to the low level of environmental impact relative to relocation.

Adaptability

As both scenarios would be complemented by stormwater management plans sized to handle the design storm loads, the adaptability rating was decided by land use and space limitations. Expansion was scored a three because the parking lot would still reside partially on Lone Tree Hill’s property, limiting any further expansion projects to the south to the limits set in the conservation restriction. Relocation was scored a five because the parking lot would be entirely on Rock Meadow property, providing much more room and ease for future expansion by the Belmont Conservation Commission as they see fit.

Table 4.1. Decision matrix for the redevelopment alternatives.

	Weight	Expansion	Relocation
Community Satisfaction	*5*	4	2
Effectiveness	*5*	5	5
Cost	*3*	4	1
Sustainability	*2*	4	2
Adaptability	*1*	3	5
Weighted Total		**68**	**47**

Based on the results of the parking lot design decision matrix, the expansion alternative was found to be the best option for the new parking lot at Rock Meadow. While the relocation alternative does have some key advantages, namely adjusting the parking lot to be completely on Rock Meadow’s property, the high environmental and monetary costs needed to backfill and bring the slope in the area to an acceptable grade were deemed too unfavorable to proceed with this alternative.

4.2.2 Stormwater Management

To compare the ten stormwater management best management practices and select an alternative for the final system, a decision matrix was developed. This allows the reader to understand how each alternative was weighed for each of the five selected criteria.

Community Satisfaction

This criterion was evaluated using a survey at the community meeting on March 10, 2020. Evergreen found that the average approval for the bioswale and rain garden was a 5 and that the average approval for the relocation alternative was a 4.

Effectiveness

The alternatives were scored based on the BMPs' pollutant removal efficiencies and their relative infiltration and storage capabilities, as outlined in Table 3.15. The highest scoring alternatives for effectiveness were the bioswale, pervious pavement, and vegetated filter strip.

Cost

The alternatives were scored based on their respective construction and maintenance costs. Evergreen also accounted for the ease of implementation of each BMP given the existing conditions of the site. The highest scoring (least costly) alternative was the infiltration basin. The lowest scoring (most costly) alternative was the pervious pavement.

Sustainability

The alternatives were scored based on their expected environmental impact throughout their respective life cycles. High scoring practices mimic natural hydrology. Additionally, they maintain the areas they occupy as a place for plants and wildlife. The highest scoring alternatives were the bioswale, stormwater wetland, rain garden, and tree box filter.

Adaptability

The alternatives were scored based on their ability to manage higher discharges in the event of a large storm and based on their ability to be expanded or changed in the future. The highest scoring alternatives were the bioswale and the vegetated filter strip. The lowest scoring alternatives were the pervious pavement and the tree box filter.

Table 4.2. Decision matrix for the stormwater management BMPs.

	Weight	Bioswale	SW Wetland	Infiltration Basin	Infiltration Trench	Media Filter	Pervious Pavement	Rain Garden	Sediment Forebay	Tree Box Filter	Vegetated Filter Strip
Community Satisfaction	*5*	5	4	2	3	4	5	5	3	3	4
Effectiveness	*5*	5	3	4	3	4	5	4	3	2	5
Cost	*3*	3	3	5	4	4	1	4	3	3	3
Sustainability	*2*	5	5	3	3	3	4	5	3	5	4
Adaptability	*1*	4	2	3	2	2	1	2	3	1	4
Weighted Total		73	56	54	50	60	62	69	48	45	66

Based on the results of the decision matrix, a bioswale is determined to be the best option for a pretreatment BMP and a rain garden is determined to be the best option for an infiltration BMP. Other highly ranked alternatives include a vegetated filter strip, which could provide pretreatment or stand on its own.

4.2.3 Site Improvements

The alternative site improvements in the bathroom facility, signage, and security categories were not evaluated using decision matrices, as the parking lot design and stormwater management alternatives were. Instead, these alternatives were selected by the community and Client with advising from Evergreen.

4.3 Design Layouts

To present a visualization of the design alternatives, Evergreen has prepared two design layouts based on the aforementioned decision matrices. For these potential layouts, one demonstrates the feasibility of expansion and the other demonstrates relocation. With regards to stormwater management, the two highest-scoring BMPs (bioswale and rain garden; vegetated filter strip) were depicted, where the preliminary dimensions were included based on stormwater manuals because final sizing has not been completed at this point. Site improvements were also included to show the opportunities for their placement in the parking lot. It is important to note the flexibility of the individual components in their placement and that they can be mixed to provide a different final overall design. These preliminary design layouts were presented to the Belmont Conservation Commission and community members in a meeting on March 10, 2020.

4.3.1 Layout 1: Expansion + Bioswale and Rain Garden

This layout depicts a parking lot expansion combined with the bioswale and rain garden stormwater management BMPs. Gutters are utilized in this design to collect water from the impervious area, and underdrains are utilized to direct the water from the gutters to the bioswale and from the bioswale to the rain garden. The bioswale, positioned to pretreat the flow from the driveway and parking lot, was placed along the west side of the driveway to allow for maximum drainage for the slope of the parking lot. As bioswales are recommended to be within the range of 10-20% of the total impervious area, the preliminary sizing for this design was selected to be 15%.[15] The rain garden, positioned to infiltrate the flow from the bioswale fed by gravity, was placed directly north of the bioswale to keep it secluded from other park activities while allowing for maximum drainage. As rain gardens are recommended to be 5-7% of impervious area for appropriate recharge capacity, the preliminary sizing was selected to be 5%.[15] For a complete visualization of the site, Evergreen has also included the more maximized site improvements in this layout: a full-service bathroom, required signage plus educational signage, and video surveillance plus lighting.

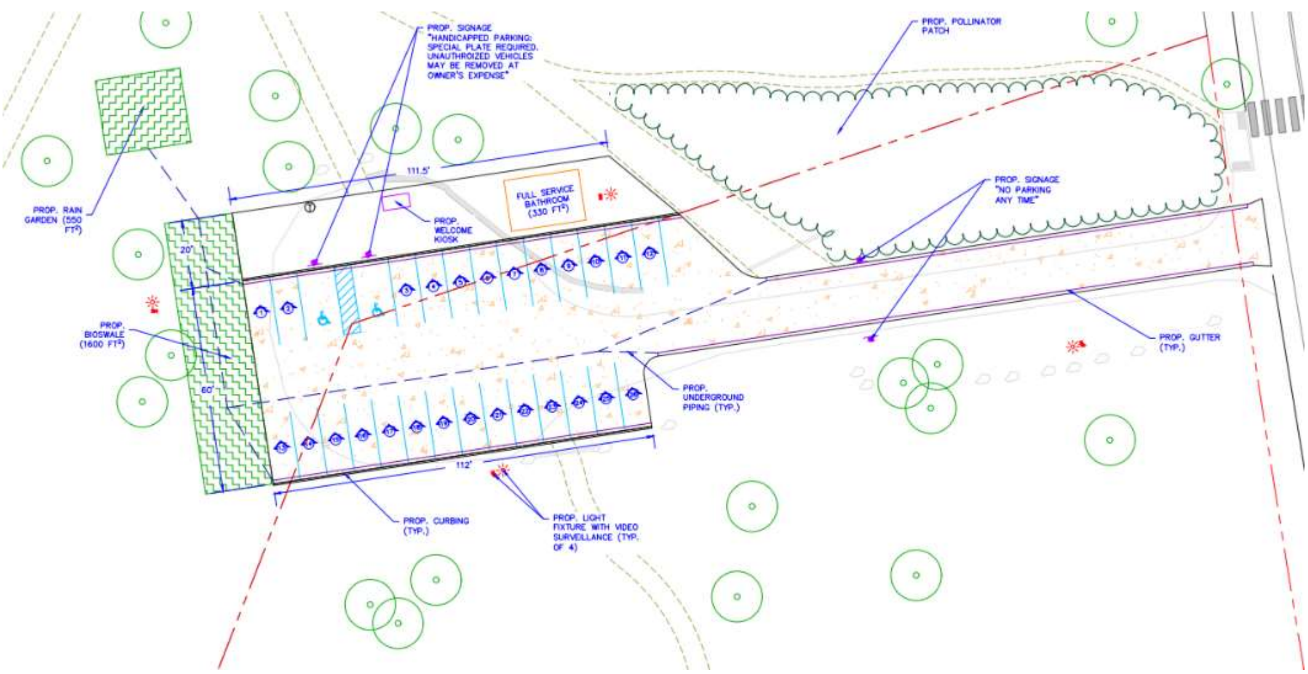

Figure 4.1. Potential parking lot layout with expansion and bioswale with rain garden.

4.3.2 Layout 2: Relocation + Vegetated Filter Strip

This layout depicts a parking lot relocation combined with the vegetated filter strip stormwater management BMP. These alternatives were combined because of the two highest-scoring BMPs, the vegetated filter strip requires more space, and the relocation alternative provides more space without crossing property lines. Gutters are utilized in this design to collect water from the impervious area and direct it to the vegetated filter strip, gravity-fed based on the proposed slope of the lot. The vegetated filter strip, positioned to pretreat and infiltrate the flow, was placed on the southern side of the lot due to the space available and the slope of the lot. As vegetated filter strips are recommended to have a minimum width of 25 feet for sufficient pretreatment, the preliminary sizing for this design was selected to be 25 feet wide.[9] For a complete visualization of the site, Evergreen has also included the more cost-conscious site improvements in this layout: a composting toilet, required signage, and video surveillance.

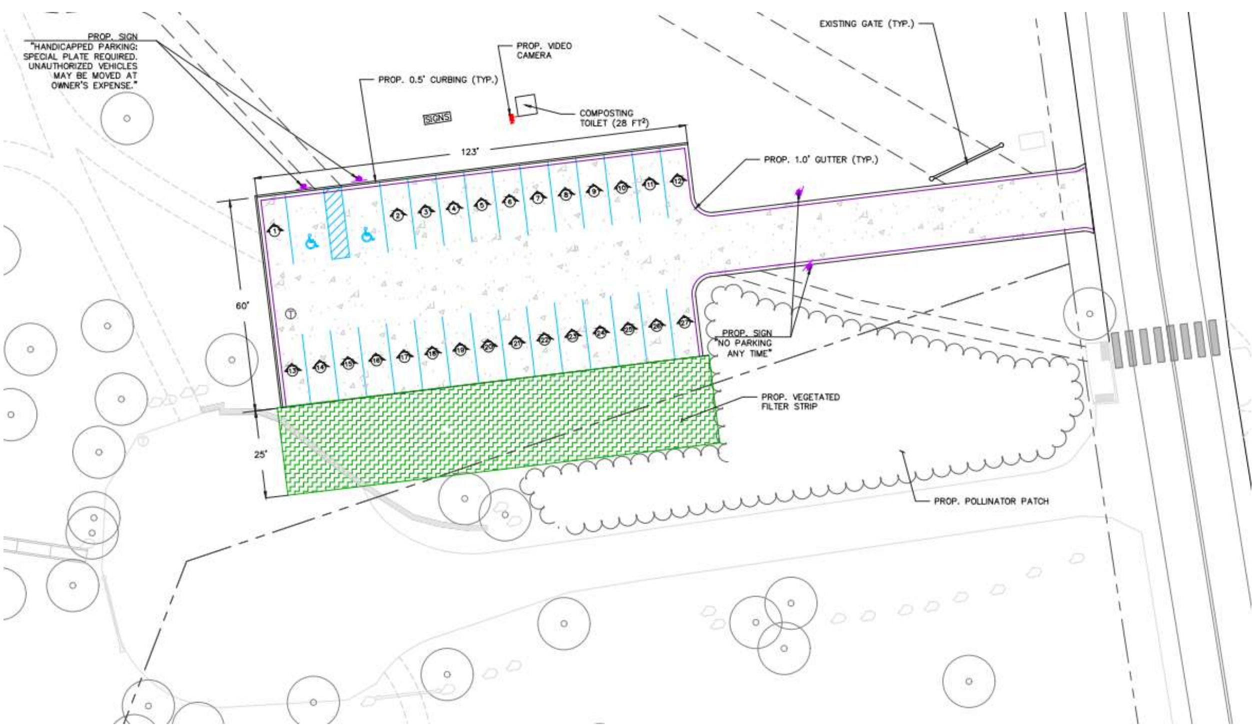

Figure 4.2. Potential parking lot layout with relocation and vegetated filter strip.

4.3.3 Preferred Alternative

These preliminary design layouts were presented to the Belmont Conservation Commission and community members in a meeting on March 10, 2020. After discussion, it was concluded that the community would prefer the parking lot expansion alternative over relocation. In addition, the community would prefer to see a vegetated filter strip along the edge of the driveway and a system of a rain garden and bioswale at the west edge of the parking lot. Other key features that the community expressed interest in include: a pedestrian path from Mill Street to Rock Meadow, bike racks, video surveillance, and a composting toilet.

5.0 Preferred Alternative

This chapter defines the design of the engineers' recommended systems for parking, stormwater management, and site improvements when considering all alternatives. The specifications include information on the sizing, maintenance, and placement of each system on the Site.

5.1 Parking Area

5.1.1 Driveway

To allow better access to cars entering and exiting Rock Meadow, the driveway to the parking lot will be widened from 14 feet to 18 feet. This will allow for two-way traffic to move smoothly through to the parking lot. It will require the removal of 2 trees and several landscaped boulders along the driveway. In addition, a pollinator patch of about 3,250 square feet will be planted in the meadow north of the driveway to encourage native wildlife to return to the area. The plants for the pollinator patch are to be selected from Plant Palette 5 provided in the Master Plan by the Conway School. All relevant plant palettes are provided in Appendix H.

The driveway length will be slightly reduced from 220 feet to 170 feet to accommodate an increase in parking availability. A paved path running parallel to the driveway on its north edge will be added to address the need for a more accessible pedestrian entrance from Mill Street. The gate that closes the emergency vehicle access path to mainstream traffic will be relocated eight feet north to accommodate this new path. Operations and maintenance considerations include plowing during the winter, leaf removal during the fall, and cleaning and sweeping after storm events year-round. The driveway will have a total impervious area of 2,730 square feet.

The driveway paving will consist of a surface layer, an intermediate layer and a base layer. The surface layer will be 1.5 inches of Super-Pave Surface Course (9.5), the intermediate layer will be 2.0 inches of Super-Pave Intermediate Course (12.5), and the base layer will be 8 inches of gravel borrow. The driveway paving detail is shown below in Figure 5.1. All detail drawings are included on Sheets C-7.0 and C-7.1 in Appendix A.

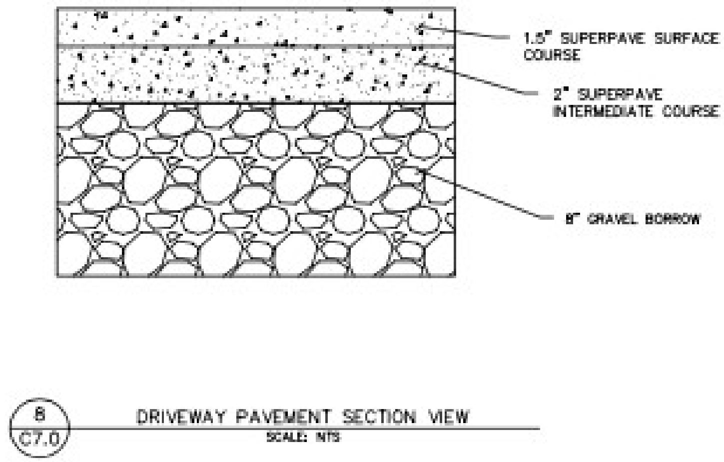

Figure 5.1. The driveway paving detail.

The driveway will be repaved with a more even slope to allow for easier entrance into the park. The driveway will begin by tying into the existing road surface and sloping approximately 2% towards the parking lot. As a rural developed/suburban low intensity local road, the majority of the driveway shall have a maximum slope of 11%, per Massachusetts Design Guide Section 4.3.[48] The cross slope of the driveway is 2% flowing south towards the vegetated filter strip and adjacent rain garden. The driveway transitions to a 2% slope and 2% cross slope as it widens into the parking area. The paved pedestrian path along the northern edge shall have the same slope as the driveway but a cross slope of 2% away from it. The unpaved vehicular access road connected to the driveway shall be graded to tie in to the new surface elevation and have a maximum slope of 12% to qualify as a viable access route for fire/emergency services.

Per the MassDOT Design Guide requirements for vertical curves, the length of the driveway's parabolic vertical curves were calculated based on K values from Civil 3D profiles. Using the equation: K=LA, where L is the length of vertical curve and A is the change in grade as a percent, the minimum vertical curve lengths were found to be 9 feet at the Mill Street transition into 10 feet at the parking lot transition. These dimensions are shown in the driveway profile on Sheet C5.2 in Appendix A.

[48] MassDOT; https://www.mass.gov/doc/2006-project-development-and-design-guide/download

5.1.2 Parking Lot

In order to address the need for more parking, the current parking lot at Rock Meadow will be expanded in its existing location. This will require the removal of 19 trees and several landscaped boulders in the new parking area. A total of 26 parking spaces will be available for use, including 2 handicap van accessible spaces. A 2,400 square foot dirt landing with landscaped beds and a handrail along its northern border will be added to enhance the entrance into the meadow area and provide a scenic viewpoint to visitors as they enter Rock Meadow. The 108-foot long wooden handrail will include 11 pressure-treated wood fence rails and 12 4-foot wood posts that are placed a typical 10 feet apart. The handrail detail is shown below in Figure 5.2.

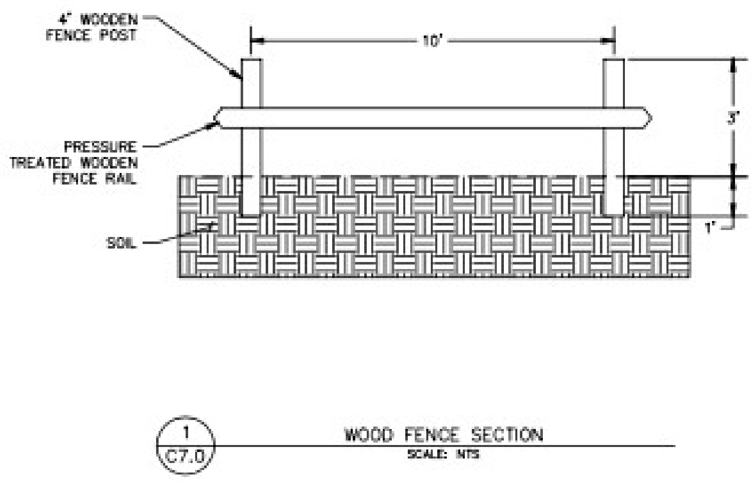

Figure 5.2. The handrail detail.

The pedestrian access path running parallel to the driveway will end at the eastern-most section of the dirt landing area. A concrete handicap ramp with curb returns will run from the end of the handicap access aisle to the main entrance into the meadow area. The stepped path previously leading from the west part of the driveway into the conservation area will be redirected to meet with the main path leading into the meadow. This construction will consist of fill material at a depth of 1 foot across an area of 200 square feet, calling for about 7.5 cubic yards of material. The new path will be built to match the existing 3-foot-wide path with the fill material and 266 feet of pressure-treated landscape timber on trail edges. A gate leading to a barn on the adjacent property will be removed and relocated during construction per Belmont's Conservation Commission's recommendation. Operations and maintenance considerations will be the same as those previously listed for the driveway. The parking lot will have a total impervious area of 8,040 square feet.

The parking lot paving will consist of a surface layer, an intermediate layer, a base layer, and a sub-base layer. The surface layer will be 1.75 inches of Super-Pave Surface Course (12.5), the intermediate layer will be 1.75 inches of Super-Pave Intermediate Course (12.5), and the base layer will be 4.5 inches of Super-Pave Base Course (37.5). The sub-base layer will consist of 4 inches of dense graded crushed stone and 8 inches of gravel borrow. The parking lot paving detail is shown below in Figure 5.3.

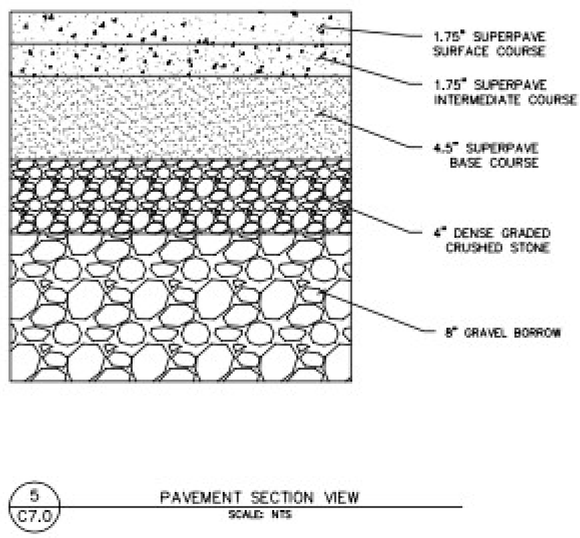

Figure 5.3. The parking lot paving detail.

The parking lot will be repaved and regraded with an even gradient to reduce the amount of pooling and erosion from storm events. The parking area will have a 2% slope along the centerline with a 2% cross slope directing water towards the southwest border, along which there is a 6-inch curb. This curb shall direct water towards the 2-foot curb cut in the southwest corner of the parking lot, draining to the bioswale. Additionally, there will be a 6-inch curb along the northern border of the parking lot separating the asphalt pavement from the dirt entrance area. This dirt area will slope 2% parallel to the parking lot and have a 2% cross slope away from the parking area. For the purposes of construction, erosion control will consist of tree protection on 16 trees, catch basin protection on 1 basin, and synthetic erosion control with jute mesh on approximately 8,100 square feet of steep slopes.

5.2 Stormwater Management

To manage stormwater, Evergreen has chosen to address the driveway and the parking lot as separate drainage areas. A summary of the modeled hydrologic conditions of the site is presented in Table 5.1. See Appendix B.2 for the detailed modeling process. To attenuate expected discharges from the site, three management practices have been selected: a vegetated filter strip, a bioswale, and a rain garden. A vegetated filter strip will be placed along the northern edge of the driveway to receive the driveway runoff. To address the runoff from the parking lot, a bioswale and rain garden system will be used. The bioswale is placed on the west side of the lot adjacent to the west curb. The runoff will enter the bioswale through 172 feet of gutter on the west and south sides of the lot. The bioswale will convey the water to a rain garden by means of a 36-foot long, 4-inch diameter HDPE underdrain. The water will then be infiltrated by the rain garden. Detailed equations are provided in Appendix C: Stormwater Management Sizing Calculations. These BMPs were designed in accordance with the Massachusetts stormwater standards as laid out in Volume 1, Chapter 1 of the Massachusetts Stormwater Handbook. Compliance with these standards is demonstrated in Appendix D: Stormwater Report. The locations of the three BMPs situated in the site can be seen in Appendix A plan C-4.0, whereas cross sections and design details can be found in Appendix A plan C-7.1.

Table 5.1. Summary of the hydrologic results

	Existing Driveway	Existing Parking Lot	Proposed Driveway	Proposed Parking Lot
Curve Number	51.2	84.0	54.0	78.8
Time of Concentration (min)	8.9	1.366	6.18	4.28
2-yr Peak Discharge (cfs)	0.0	0.2	0.0	0.4
10-yr Peak Discharge (cfs)	0.2	0.5	0.2	0.8
25-yr Peak Discharge (cfs)	0.5	0.8	0.4	1.1
2-yr Runoff Depth (in)	0.11	0.99	0.23	1.33
10-yr Runoff Depth (in)	0.59	2.17	0.85	2.65
25-yr Runoff Depth (in)	1.14	3.21	1.52	3.78

5.2.1 Vegetated Filter Strip

The vegetated filter strip was sized for a maximum flow path of 100 feet, based on the proposed grade of the driveway. The guidelines in the Massachusetts Stormwater Handbook focus on TSS, stating that a filter strip must be at least 25 feet wide to achieve 10% removal and at least 50 feet wide to achieve 45% removal, while phosphorus removal (the other pollutant of interest) is more variable.[49] Therefore, the selected width was 50 feet, which is greater than the requirement of 20 feet, as guidelines state that a filter strip width must be at least 20% of the length of the flow path.[9] The filter strip will be graded at an 11% longitudinal slope west and 2% cross slope towards north to be with the grade of the driveway. This complies with the guideline that states the slope must be less than 15%.[3] See Table 5.2 for a summary of the filter strip design. See Table 5.3 for the expected velocity of the runoff over the filter strip for each design storm.

Table 5.2. Vegetated filter strip velocities and residence times.

Sizing Criteria	Velocity (ft/s)	Residence Time (min)
2-Year Storm	N/A	N/A
10-Year Storm	0.08	10.8
25-Year Storm	0.12	6.8

Table 5.3. Vegetated filter strip sizing standard and chosen design measurements.

Sizing Criteria	Standard	Selected Design
Width (for 45% TSS Removal Requirement)	≥50 ft	50 ft
Width (for 20% of Flow Path Requirement)	≥20 ft	50 ft
Longitudinal Slope	<15%	11%

The vegetated filter strip will consist of new topsoil and a native grass known as path rush. Path rush is a dense, hardy grass. It can withstand drought, flooding, and moderate salinity levels, making it a good choice for this BMP. Additionally, it survives through all seasons and is fairly fast growing.[50]

[49] https://www.mass.gov/files/documents/2016/08/qi/v2c2.pdf
[50] http://www.newmoonnursery.com/plant/Juncus-tenuis

5.2.2 Bioswale

The bioswale is designed to treat the runoff from the parking lot. The bioswale will be graded at a 2% longitudinal slope. The slope must be less than 15% with optimal slopes of less than 4% to avoid the need for check dams to slow the water.[51] The proposed length of the bioswale is 80 feet in order to align the system with the west edge of the parking lot. Beneath the bioswale, a 2-foot layer of soil will be placed to provide a permeable layer. The bioswale will have a bottom width of 4 feet and a top width of 14 feet, with sides sloped at a ratio of 5:1. This configuration was chosen to produce the minimum velocity through the swale, while maintaining suggested ranges of dimensions and slopes, as outlined in Table 5.5. The cross-section of the bioswale is shown in Figure 5.4.

Additionally, these dimensions were chosen to treat the proper water quality volume according to Massachusetts Stormwater Standard 4. The bioswale must treat 1 inch of runoff for every acre of impervious area, therefore 668 cubic feet of water. The swale must also be able to convey the 10-year storm. Evergreen has also taken the 25-year storm's peak discharge into account due to the goal of adaptability. The expected peak discharge for the 25-year storm is 1.1 cfs. This discharge would result in a ponding depth of 2.5 inches, less than the 4 inch maximum required according to Volume 2 of the Massachusetts Stormwater Handbook. The proposed bioswale has a surface volume of 720 cubic feet, providing one foot of surface depth. This volume ensures that the swale could potentially hold the entire water quality volume, a step taken to lessen the risk of overflow. Therefore Evergreen has designed the bioswale to successfully convey both the 25-year discharge and the water quality volume.

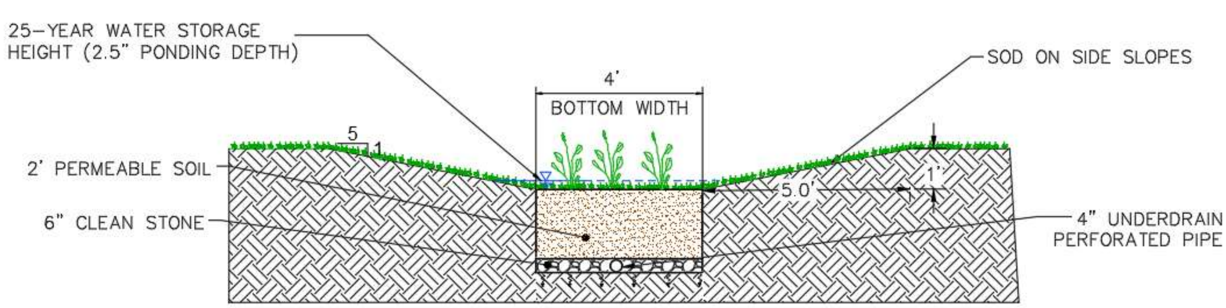

Figure 5.4. Bioswale cross section.

[51] https://nacto.org/publication/urban-street-design-guide/street-design-elements/stormwater-management/bioswales/

The expected velocity through the bioswale based on Manning's Equation for an area with a roughness coefficient of 0.2, as recommended by the Delaware BMP standards[52] can be found in Table 5.4. The surface storage of the swale when entirely full would be expected to drain within 15 hours, given a subsurface soil mix with an infiltration rate of 0.8 inches/hour. The subsurface storage would be expected to drain in 18 hours based on the in-situ soil design infiltration rate of 0.4 inches/hour and a soil mix void ratio of 0.3. The underlying soil mixture should consist of 50% sand and 50% loam to provide a permeable layer.[9] The vegetation in the bioswale is to be selected from the grasses, forbs, and shrubs found in Plant Palette 1 provided in the Master Plan by the Conway School.

Table 5.4. Bioswale velocities and residence times

Sizing Criteria	Velocity (ft/s)	Residence Time (min)
2-Year Storm	0.20	6.71
10-Year Storm	0.29	4.66
25-Year Storm	0.33	4.0

Table 5.5. Bioswale sizing standard and chosen design measurements.[53]

Sizing Criteria	Standard	Selected Design
Bottom Width	2-8 ft	4 ft
Max Bottom Width to Depth Ratio	12:1	4:1
Side Slopes	3:1-5:1	5:1
Longitudinal Slope	<4%	2%
Subsurface Soil Depth	≥12 in	18 in
Residence Time	≥5 min	9 min
25-Year Volume (for Required Residence Time)	594 ft^3	720 ft^3

[52]http://www.dnrec.delaware.gov/swc/Drainage/Documents/Sediment%20and%20Stormwater%20Program/Technical%20Document/Tech%20Doc%20Updates%202014/Article%203/3.06.2.8.%20Vegetated%20Channel%202014-12-03.pdf
[53] LID Manual for Michigan, https://www.washtenaw.org/DocumentCenter/View/15214/Bioswale

5.2.3 Rain Garden

The rain garden was designed to have a total depth of 4 feet due to the fact that 36 inches of design soil mix is required for the planting of shrubs, 3 inches of mulch is to be laid on top of the soil mix, 6 inches of ponding depth is allowed, and 3 inches of freeboard is required.[54] An area of 560 square feet was chosen as this value is about 7% of the impervious area. Volume 2 of the Massachusetts Stormwater Handbook recommends that the area be 5-7% of the drainage area. To calculate the time it will take for the soil filter layer to drain, a void ratio of 0.3 was chosen for the soil mix. Therefore, the depth of water in the soil layer is 10.8 inches. Based on the design infiltration rate, the subsurface infiltration time would be 27 hours, which is less than the required 72 hours. This value was selected to be between 1-2 days to avoid potential mosquito breeding issues. Based on Massachusetts Stormwater Standard 3, the required recharge volume is 401 cubic feet, as found by multiplying 0.6 inches by the acres of impervious area. Based on the selected depth and area, the volume of the proposed rain garden is 2240 cubic feet. Based on this sizing, the volume of soil mix for the rain garden is 1680 cubic feet. Considering the void ratio of the soil, this allows for 504 cubic feet of water as subsurface storage. The soil mix recommended in Massachusetts Stormwater Handbook Volume 2 is 40% sand, 20-30% topsoil, and 30-40% compost. Figure 5.5 shows the cross section of the rain garden. See Table 5.6 for a summary of the rain garden design criteria. The vegetation in the rain garden is to be selected from Plant Palette 1 provided in the Master Plan.

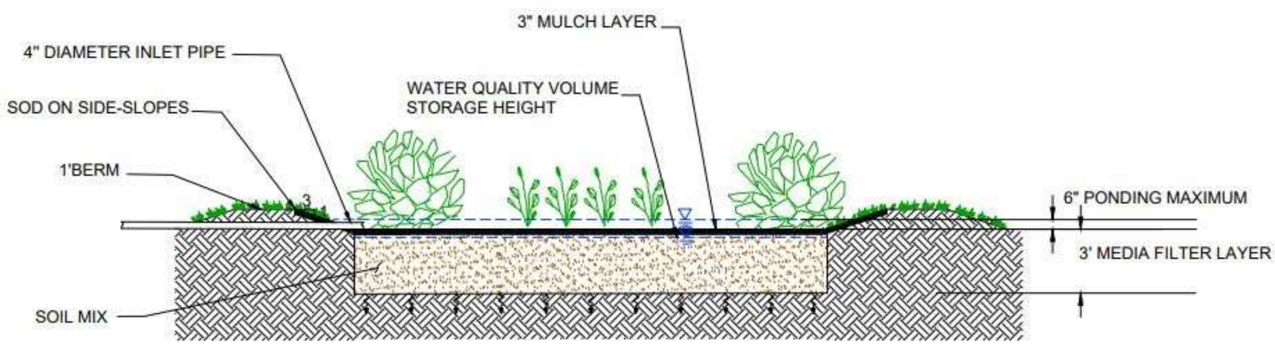

Figure 5.5. Rain garden cross section

To account for the total 25-year runoff, we have evaluated the system of conveyance from the bioswale to the rain garden and the storage capacity of the rain garden. The maximum flow through

[54]https://doee.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/Section%203.6%20%20Bioretention.pdf

the 4-inch diameter inlet pipe would be 0.655 cubic feet per second. This flow rate is able to convey a maximum of 2,360 cubic feet of water over one hour. This is significantly more water than expected from the 25-year runoff (the total volume of which would be 2593 cubic feet). The expected depth of water to accumulate per hour in the rain garden is 2.3 inches for the 25-year storm. This depth of water takes 2.5 hours to infiltrate into the subsurface storage and 5.8 hours to infiltrate into surrounding in situ soils. The expected accumulated runoff depth in 5.8 hours is 13.4 inches. As the allowed depth of water in the designed rain garden is 16.8 inches, this depth of water is within the allowed depth, meaning the rain garden is equipped to handle the total runoff from the 25-year storm.

Table 5.6. Rain garden sizing standard and chosen design measurements.

Sizing Criteria	Standard	Selected Design
Soil Depth	24-48 in	36 in
Area (for 5-7% of Drainage Area)	400-560 ft^2	560 ft^2
Infiltration Time	<72 hr	27 hr
Recharge Volume (for 0.6 in/Acre of Impervious Area)	401 ft^3	784 ft^3

5.3 Site Improvements

Evergreen has selected the preferred alternative for the bathroom facilities, signage, and video surveillance on the Site. This includes a composting toilet, required signage, and video security (without lighting), respectively.

5.3.1 Bathroom Facilities

After discussing with the manufacturer's representative, Evergreen recommends the Sun-Mar CENTREX 3000 Non-Electric Waterless Ultra High Capacity Central Composting Toilet System. The CENTREX 3000 model was chosen because it meets the capacity needs for the Site and it does not require connection to electrical or water utilities. This model is listed to accommodate a seasonal capacity of 9 adult users per day. With regards to utilities, it does not require connection because it is non-electric and waterless. This is an important consideration given the conservation restriction for Rock Meadow.

Sun-Mar Corporation leads the composting toilet industry with their patented Bio-drum, a system that allows for aerobic bacteria to break down waste in an odorless environment. The system is acceptable for general outdoor use, although the bacteria function best at an ambient temperature at or above 55°F. This temperature requirement suggests that the composting toilet would function best if it were offline for the colder winter months.[55] With regards to maintenance, the bacteria respond best to natural solutions such as vinegar and water. Toilet paper is acceptable to use because it provides a carbon source to the bacteria. It can be expected to empty the unit and remove compost about once every four months.

The central unit is purchased separately from the dry toilet and a structure can be constructed around the entire system to provide privacy to the user and protect it from the elements. This structure will be elevated about 2.5 feet off the ground with stairs or a ramp to provide a false bottom large enough to fit the unit, which is 30.25 inches high by 27.5 inches wide by 71 inches long. Therefore, the structure will have a footprint of about 6 feet long by 3 feet wide by 8 feet tall. The structure will include a 4-inch PVC pipe to the outdoors for ventilation and a small hose to an adjacent recycling bed for overflow drainage. This recycling bed will be a small gravel area, similar in design to the infiltration trench but sized to only accommodate a trickle in overflow situations. Sun-Mar identified Eastman's Hardware in Falmouth, MA as the nearest dealer of this unit and the accompanying dry toilet. They can be found at 150 Main Street in Falmouth, MA or reached by phone at (508) 548-0407. A specification sheet is included in Appendix E.

Figure 5.6. The CENTREX 3000 composting toilet and dry toilet.

[55] https://sun-mar.com/our-patented-design/

5.3.2 Signage

Evergreen recommends installing only required signage for the scope of this project. This includes 2 signs for no parking and 2 signs for handicapped parking. The "NO PARKING ANY TIME" signs are to be placed on each side of the driveway to ensure that cars will not trample the new vegetated filter strip or pedestrian path. The "HANDICAPPED PARKING. SPECIAL PLATE REQUIRED. UNAUTHORIZED VEHICLES MAY BE REMOVED AT OWNER'S EXPENSE" signs will be placed in front of each ADA-compliant handicapped parking space to ensure an accessible parking experience for handicapped visitors. Standard signs are 12 inches wide by 18 inches long.[56] The signs are to be installed at least 6 feet from the ground using 7-foot posts.[57]

5.3.3 Video Surveillance

Evergreen recommends a more robust video surveillance system of two new cameras. These will be oriented with one on the north side of the lot to face the new composting toilet and the other on the south side of the driveway to monitor the parking lot. Based on the unknown availability of an electrical utility in the existing conditions survey, Evergreen recommends a non-electrical camera model such as the Reolink Argus 2 security camera. It offers 33 feet of night vision, 6 infrared LEDs, 1080 pixels of HD picture, and a 130-degree field of vision. This unit is battery-operated where one charge provides 180 days of surveillance, and it can also be accompanied by a solar panel attachment for a rechargeable power supply. It is weatherproof, certified for outdoor use, and can be attached to most surfaces, including the composting toilet structure or a tree. The camera records video to an SD card for local storage and to the encrypted cloud for live access remotely.[58] A specification sheet is included in Appendix E.

Figure 5.7. The Argus 2 security camera and solar panel.

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[56] https://adacentral.com/resources/ada-sign-installation-guide
[57] https://www.myparkingsign.com/MPS/article_ADA-Handicapped-Parking-Rules.aspx
[58] https://reolink.com/product/argus-2/#overview

6.0 Cost Estimate

This chapter provides a cost estimate for the Rock Meadow Parking Lot Redesign project. This cost estimate addresses seven key areas: demolition, earthwork, hardscaping, landscaping, green infrastructure, additional site improvements, and labor. It includes the projected upfront costs of both materials and man-hours for installation.

6.1 Demolition

The demolition scope for the cost estimate includes the removal of the asphalt, trees, stepped path, gates, light pole, and boulders. Demolition cost estimating was performed with the 2020 RSMeans data.[59] The asphalt estimate is for the equipment cost of removing 1-3-inch-deep asphalt pavement. The tree estimate is for the equipment cost of selective clearing of trees 14-24 inches in diameter using chainsaws and a chipper. The removal of the stepped path, gates, light pole, and boulders was estimated using the daily equipment costs of a mini excavator, skid steer, and hand tools. Table 6.1 summarizes the projected costs for each demolition line item.

Table 6.1. The cost estimate for the demolition scope.

Description		Qty	Unit	Unit price	Total price
1. Demolition					
1.1	ASPHALT REMOVAL/HAULING	1159	sq yd	$0.19	$220.21
1.2	TREE REMOVAL	21	ct	$131.00	$2,751.00
1.3	MINI EXCAVATOR	3	wk	$1,980.00	$5,940.00
1.4	SKID STEER	3	wk	$445.00	$1,335.00
1.5	HAND TOOLS	3	wk	$200.00	$600.00
Demolition Total					$10,846.21

6.2 Earthwork

The earthwork scope for the cost estimate includes the material costs of backfill and topsoil with the equipment cost of hauling both. Earthwork cost estimating was performed with the 2020 RSMeans data. The backfill line item is the medium estimate for the delivery of backfill material with up to a 20-mile haul distance. The topsoil line item is for weed-free topsoil borrow. The

59 https://www.rsmeans.com/

hauling line item is for the cost of cycle hauling an 8 cubic yard truck with a 25-minute wait/load time. The erosion control line item is for the rolls of jute mesh. Table 6.2 summarizes the projected costs for each earthwork line item.

Table 6.2. The cost estimate for the earthwork scope.

Description		Qty	Unit	Unit price	Total price
2. Earthwork					
2.1	BACKFILL MATERIAL	915	cu yd	$25.00	$22,875.00
2.2	TOPSOIL MATERIAL	240	cu yd	$24.00	$5,760.00
2.3	HAULING	1155	cu yd	$2.19	$2,529.45
2.4	EROSION CONTROL	900	sq yd	$0.76	$684.00
Earthwork Total					$31,848.45

6.3 Hardscaping

The cost estimating for the hardscaping includes all paving and curbing for the parking lot, driveway, pedestrian path, and handicap ramp. This estimate includes the 1-2 feet of backfilling needed to bring each area to an acceptable grade. The paving layers include a surface course, an intermediate course, and a base and/or sub-base course. Estimates were made using MassDOT's weighted bid estimates[60] with the mean prices for each element and the 2020 RSMeans data. Table 6.3 summarizes the projected costs for each hardscaping line item.

[60] https://hwy.massdot.state.ma.us/CPE/WeightedAverageBook.aspx

Table 6.3. The cost estimate for the hardscaping scope.

Description		Qty	Unit	Unit price	Total price
3. Hardscaping					
3.1	PARKING LOT				
3.1.1	1.75" Super-Pave Surface Course (12.5)	84.4	ton	$118.80	$10,026.72
3.1.2	1.75" Super-Pave Intermediate Course (12.5)	84.4	ton	$137.09	$11,570.40
3.1.3	4.5" Super-Pave Base Course (37.5)	217	ton	$124.74	$27,068.58
3.1.4	4" Dense Graded Crushed Stone	98.6	cu yd	$73.40	$7,237.24
3.1.5	8" Gravel Borrow	197.1	cu yd	$44.68	$8,806.43
3.2	DRIVEWAY				
3.2.1	1.5" Super-Pave Surface Course (9.5)	24.8	ton	$158.39	$3,928.07
3.2.2	2" Super-Pave Intermediate Course (12.5)	33	ton	$137.09	$4,523.97
3.2.3	8" Gravel Borrow	67.5	cu yd	$44.68	$3,015.90
3.3	ASPHALT SIDEWALK				
3.3.1	1" Super-Pave Surface Core (12.5)	4.7	ton	$118.80	$558.36
3.3.2	1.5" Super-Pave Intermediate Course (12.5)	7	ton	$127.09	$889.63
3.3.3	8" Gravel Borrow	18.9	cu yd	$44.68	$844.45
3.4	HANDICAPPED RAMP				
3.4.1	4" Cement Concrete Wheelchair Ramp	11.7	sq yd	$103.09	$1,206.15
3.4.2	8" Gravel Borrow	2.6	cu yd	$44.68	$116.17
3.5	CONCRETE CURB				
3.51	Precast Concrete Curbs, Straight, 6"x18"	310	ft	$8.64	$2,678.40
Hardscaping Total					$82,470.47

6.4 Landscaping

The cost estimate for landscaping includes the following areas: regrassing of regraded areas, the pollinator patch in the meadow north of the driveway, and the scenic vista bordering the entrance into Rock Meadow from the parking lot. These landscaped areas will require grass seed, topsoil, mulch, and plants. The estimates used for the mulch and the topsoil are from the 2020 RSMeans data. The estimate for the grass seed is from MassDOT's weighted bid estimates. The estimate for the plants is rough, as the plants will vary in size depending on whether they are grasses, forbs, shrubs, or trees. The planting estimate was based on the plant palettes presented in the Conway

School's Master Plan. The estimates for these specific plants were found from MassDOT's weighted bid estimates and from Home Depot. An average of the forb prices was used. It was assumed that each plant would occupy a 16 square foot area. Table 6.4 summarizes the projected costs for each landscaping line item.

Table 6.4. The cost estimate for the landscaping scope.

Description		Qty	Unit	Unit price	Total price
4. Landscaping					
4.1	POLLINATOR PATCH				
4.1.1	Topsoil	80	cu yd	$24.00	$1,920.00
4.1.2	Plants	203	ct	$21.97	$4,459.91
4.3	SCENIC VISTA				
4.3.1	Mulch	42	sq yd	$1.95	$81.90
4.3.2	Topsoil	12	cu yd	$24.00	$288.00
4.3.3	Plants	24	ct	$27.91	$669.84
4.4	GRASS SEED	444	sq yd	$1.90	$843.60
Landscaping Total					$8,263.25

6.5 Green Infrastructure

The cost estimate for the green infrastructure scope includes the vegetated filter strip, bioswale, and rain garden. For the vegetated filter strip, the estimates used for the mulch and the topsoil are from the 2020 RSMeans data. The estimate used for the Path Rush grass that is for the vegetated filter strip is from MassDOT's weighted bid estimates. For the bioswale, the components of the engineered soil mix are from MassDOT's weighted bid estimates. The curbs and gutters are cast-in-place concrete where the curbs are 6" high and the gutters are 6" thick and 24" wide. The 6-inch clean stone is from the RSMeans data as an estimate for stone aggregate. The estimate for the underdrain pipe was found from the 2020 RSMeans data. For the rain garden, the estimate for the compost soil was from Home Depot. The planting estimate was performed as described in the Section IV where one plant is assumed to occupy 16 square feet. Table 6.5 summarizes the projected costs for each landscaping line item.

Table 6.5. The cost estimate for the green infrastructure scope.

Description		Qty	Unit	Unit price	Total price
5. Green Infrastructure					
5.1	VEGETATED FILTER STRIP				
5.1.1	Topsoil	33.8	cu yd	$24.00	$811.20
5.1.2	Path Rush Grass Seed	2	lb	$300.00	$600.00
5.2	BIOSWALE				
5.2.1	Engineered Soil Mix	23.7	cu yd	$51.39	$1,217.94
5.2.2	6" Clean Stone	5.9	cu yd	$35.50	$209.45
5.2.3	4" Perforated PVC Pipe	36	ft	$1.85	$66.60
5.2.4	Curbs and Gutters	170	ft	$11.83	$2,011.10
5.2.5	Plants	70	ct	$27.91	$1,953.70
5.2.6	Sod	816	sq ft	$11.71	$9,555.36
5.3	RAIN GARDEN				
5.3.1	Engineered Soil Mix	62.2	cu yd	$42.47	$2,641.63
5.3.2	Mulch	5.2	cu yd	$1.95	$10.14
5.3.3	Plants	35	ct	$21.97	$768.95
5.3.4	Sod	112	sq ft	$11.71	$1,311.52
Green Infrastructure Total					$21,157.60

6.6 Additional Site Improvements

The cost estimating for the additional site improvements scope includes the composting toilet, signage, and video surveillance. The toilet estimate is based on the prices listed online at Home Depot for the CENTREX 3000 composting system, dry toilet, and miscellaneous toilet hardware.[61] It also includes the material costs for the wooden structure and gravel recycling bed. The signage estimate is from the RSMeans Manual for 12” by 18” reflectorized guide and directional traffic signs. The listing excludes sign posts, so they were added with information from a manufacturer.[62]

[61] https://www.homedepot.com/p/Sun-Mar-Centrex-3000-Non-Electric-Waterless-Ultra-High-Capacity-Central-Composting-Toilet-System-in-Bone-CENTREX-3000-NE/203503052
[62] https://www.compliancesigns.com/Post-SQ1_300.shtml?ref=champ

The video surveillance estimate is based on the prices listed online at the Reolink website for the Argus 2 and solar panel.

Other costs carried in this category are for the wooden handrail, bike rack, and stepped path relocation. The handrail estimate is from the RS Means Manual for treated lumber handrail posts and an average between the minimum and maximum for custom architectural-grade hardwood railings ($9.50-$50.00). The bicycle rack estimate is from the RSMeans Manual for a 10-foot permanent rack. The stepped path relocation value consists of the RSMeans Manual's medium estimate for the delivery of backfill material with up to a 20-mile haul distance and the estimate for pressure-treated timber cross ties. Table 6.6 summarizes the projected costs for each additional site improvements line item.

Table 6.6. The cost estimate for the additional site improvements scope.

Description		Qty	Unit	Unit price	Total price
6. Additional Site Improvements					
6.1	VIDEO SURVEILLANCE	2	ct	$125.00	$250.00
6.2	COMPOSTING TOILET	1	ct	$3,400.00	$3,400.00
6.3	SIGNAGE	4	ct	$80.00	$320.00
6.4	HANDRAIL				
6.4.1	Posts	12	ct	$32.00	$384.00
6.4.2	Railing	108	ft	$29.75	$3,213.00
6.5	BIKE RACK	1	ct	$555.00	$555.00
6.6	STEPPED PATH RELOCATION				
6.6.1	Backfill Material	7.5	cy	$25.00	$187.50
6.6.2	Landscape Timber (8'-6" L)	16	ct	$46.00	$719.76
Additional Site Improvements Total					$9,029.26

6.7 Labor

The cost estimating for labor was performed using the 2020 crew data in the RSMeans Manual. The unit prices were extrapolated based on an 8-hour work day for laborers, operators, drivers, and foremen. The quantities were calculated based on the following crew assumptions:

- *Demolition* has a crew of 1 foreman, 1 operator, and 2 laborers.
- *Earthwork* has a crew of 1 foreman, 1 operator, 2 laborers, and 3 drivers.
- *Hardscaping* has a crew of 1 foreman, 1 operator, 2 laborers, and 1 driver.
- *Landscaping* has a crew of 4 laborers and 1 operator.
- *Green Infrastructure* has a crew of 1 foreman, 1 operator, and 2 laborers.
- *Additional Site Improvements* has a crew of 1 foreman and 2 laborers.

Table 6.7 summarizes the projected costs for each labor line item.

Table 6.7. The cost estimate for the labor scope.

Description		Qty	Unit	Unit price	Total price
7. LABOR					
7.1	OPERATOR	29	d	$678.80	$19,685.20
7.2	DRIVER	57	d	$586.80	$33,447.60
7.3	FOREMAN	34	d	$530.00	$18,020.00
7.4	LABORER	96	d	$506.00	$48,576.00
Labor Total					$119,728.80

6.8 Summary

The largest contributors to the cost are hardscaping (29%) and labor (42%). The total estimated cost for the Rock Meadow parking lot design is $283,344.04. A summary of the seven key scope areas is provided in Table 6.8 below. The full cost estimate is provided in Appendix F.

Table 6.8. The summarized cost estimate.

Scope	Total Price
1. Demolition	$10,846.21
2. Earthwork	$31,848.45
3. Hardscaping	$82,470.47
4. Landscaping	$8,263.25
5. Green Infrastructure	$21,157.60
6. Additional Site Improvements	$9,029.26
7. Labor	$119,728.80
PRELIMINARY COST ESTIMATE ONLY - NOT FOR FINAL CONSTRUCTION	$283,344.04

7.0 Final Recommendations

This chapter summarizes the final design of the parking lot, stormwater management system, and site improvements on the Site. It also provides an evaluation of the Master Plan from an engineering feasibility perspective. These improvements will contribute to a more sustainable and more aesthetically pleasing parking experience at Rock Meadow. In addition, it includes suggestions of future work to further enhance Rock Meadow.

7.1 Parking Area

In summary, Evergreen recommends a widened and regraded driveway with the parking lot expanded in its existing location. The final driveway design is 18 feet wide by 145 long and has a maximum slope of 11% with a cross slope of 2%. It is connected to an unpaved vehicular access road with a maximum slope of 12% for emergency vehicles. The final parking lot design is about 8,000 square feet, enough to accommodate 24 parking spaces and 2 handicap van accessible parking spaces. This includes a concrete handicap ramp from the lot into Rock Meadow. The parking lot will be graded with a 2% slope along the centerline and a 2% cross slope. Other considerations for the construction of the parking area are the removal of trees, relocation of the two gates onsite, and the installation of curbing.

7.2 Stormwater Management

Evergreen recommends managing the stormwater onsite with a vegetated filter strip along the north edge of the driveway and a bioswale and rain garden system on the west side of the parking lot. All design was performed in accordance with the Massachusetts Stormwater Handbook for the maximum possible TSS and phosphorus removal from the stormwater. The complete stormwater management system is in compliance with the ten standard MassDEP Stormwater Management Policy guidelines within the handbook.

The vegetated filter strip will consist of new topsoil and grass and will be 50 feet wide and graded at an 11% longitudinal slope. The bioswale will consist of a sand and loam soil mixture and new vegetation. It will have measurements of 80 feet in length, 4 feet in bottom width, and 14 feet in top width for a total volume of 720 cubic feet. In addition, the bioswale will have a 2% longitudinal slope. The rain garden will consist of a soil mixture of sand, topsoil, and compost with new vegetation. It will have a depth of 4 feet and an area of 560 square feet. Other considerations for the construction of the stormwater management system are a gutter from the lot to the bioswale and an underdrain connecting the bioswale to the rain garden.

7.3 Site Improvements

With regards to site improvements, Evergreen has selected a composting toilet, applicable signage, and a video surveillance system for the Site. The recommended composting toilet is the Sun-Mar CENTREX 3000, a non-electric and waterless system that is accompanied by a dry toilet. A wood structure will be constructed around the unit with dimensions of about 6 feet long by 3 feet wide by 8 feet high. Additional considerations should be made for a small adjacent recycling bed and a ventilation pipe. For signage, Evergreen recommends 2 signs for no parking along the driveway and 2 signs for handicapped in the designated spots, all to be designed and installed per ADA requirements. For video surveillance, Evergreen recommends a security camera model comparable to the Reolink Argus 2. Cameras are to be installed on the north side of the parking lot to face the composting toilet and on the south side of the driveway to face the entire parking lot.

In addition, considerations were made for landscaping including a scenic vista and pollinator patch. The scenic viewpoint will consist of a 2,400 square foot dirt landing along the north edge of the parking lot and a 108-foot long wooden handrail. The handrail will provide a habitat boundary between the developed parking area and the untouched Rock Meadow, as well as an opportunity for reflection upon entering the park. Another new landscaped area will be the 3,250 square foot pollinator patch in the meadow on the north side of the driveway. Vegetation will be selected in accordance with Plant Palette V in the Master Plan to promote native wildlife at Rock Meadow. This includes forbs such as the partridge pea and ox-eye sunflower as well as sentinel trees such as the Kentucky coffeetree and black walnut.

The final recommendations also include a relocated and regraded stepped path and a new pedestrian path. About 200 square feet of the stepped path west of the parking lot will be redirected into the main path leading into the meadow in order to accommodate the bioswale and rain garden. In addition, a path will be added along the north edge of the driveway to provide pedestrian access to Rock Meadow from Mill Street. This will be paved with the same slope as the adjacent driveway. The park will be accessible to pedestrians and bikers, who can utilize the new bike rack on the north side of the parking lot. See Figure 7.1 for the rendering of the proposed design.

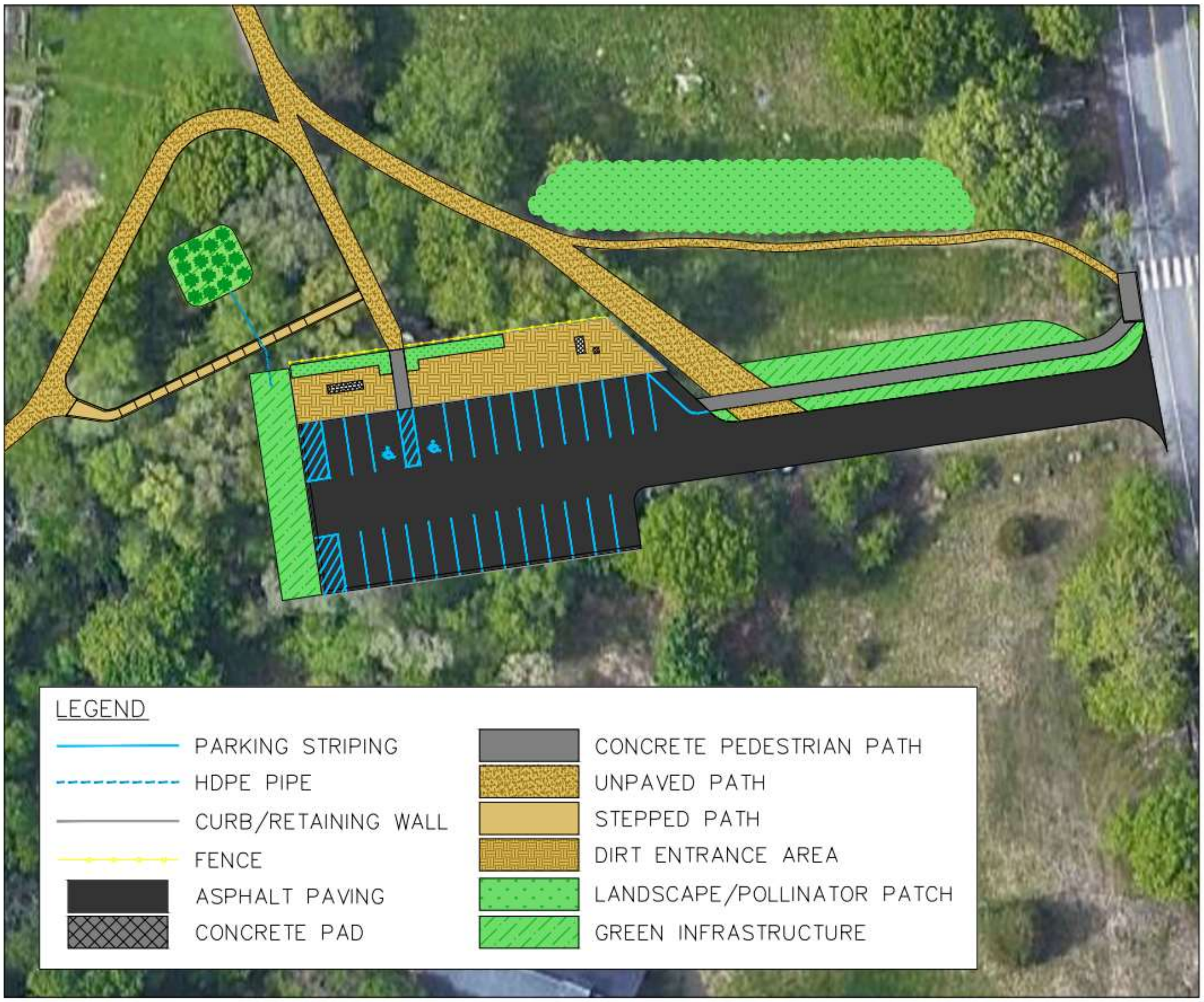


Figure 7.1. The rendering of the proposed Rock Meadow design.

7.4 Evaluation of the Master Plan

The scope of Evergreen's design work included an evaluation of the Master Plan developed by the Conway School. The plan outlines the existing conditions of all of Rock Meadow, providing direction for the parking lot redesign and general goals for the conservation area from a landscape architecture perspective. Evergreen's design aligns with much of the Master Plan. For example, Evergreen incorporated the suggestions for the pollinator patch, composting toilet, and relocated stepped path into the new design. In addition, Evergreen relied on Plant Palette I and Plant Palette V as outlined in the Master Plan for the vegetation of the stormwater management BMPs and pollinator patch.

In other areas, Evergreen was able to build on the conceptual ideas and supplement them with additional engineered systems. Where the Master Plan recommends a parking lot to fit 18 parking spots, Evergreen has conducted a use study for the existing conditions and sized the lot to fit 28 spots accordingly. Where the Master Plan suggests a regraded driveway, Evergreen has calculated the most reasonable longitudinal and cross slopes for the driveway, parking lot, stormwater management systems, access road, and paths. Where the Master Plan suggests the use of green infrastructure, Evergreen has designed a vegetated filter strip, bioswale, and rain garden in accordance with state stormwater guidelines.

8.0 Acknowledgements

This chapter recognizes and thanks the individuals that assisted Evergreen throughout the duration of the Rock Meadow Parking Lot Redesign project.

Evergreen Engineering would like to recognize the key individuals that invested in our firm and project throughout its duration. The parking lot redevelopment at Rock Meadow would not have been possible without the time and effort of these key contributors.

We would like to thank Professor Annalisa Onnis-Hayden of the Northeastern University Department of Civil and Engineering for her commentary, structure, and advice throughout our project. She provided critical feedback on our report, design, and presentations that allowed us to charge forward throughout the semester.

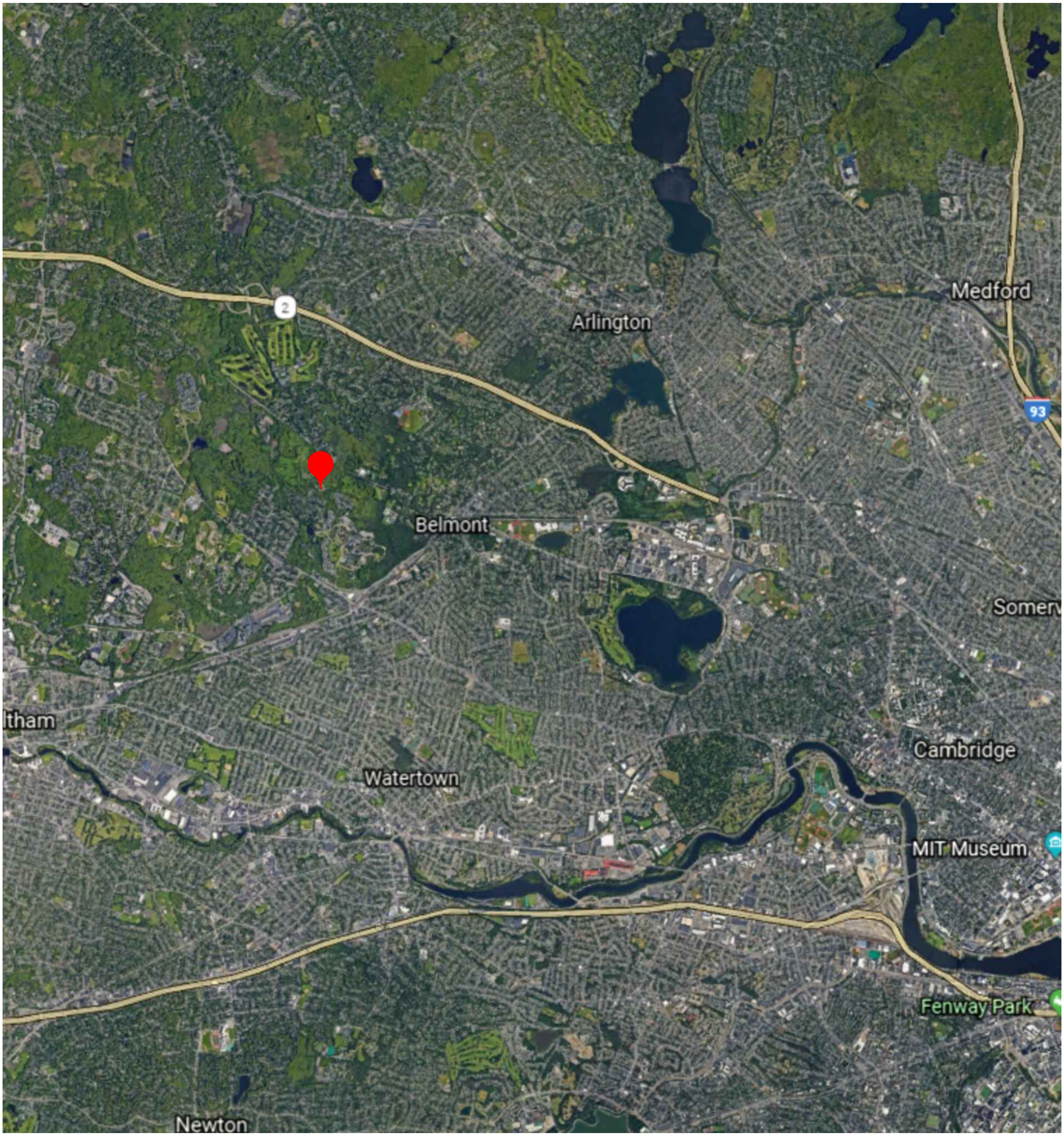
Our team would like to thank Mr. Tom Spall, Senior Superintendent at Suffolk Construction, for consulting with the team on the schedule for this project. His extensive experience in the construction industry allowed us to verify the feasibility and timeliness of our designs.

In addition, we would like to thank Mr. Chris Morris, PE for his engagement in the project as both our industry mentor and a stakeholder on the Belmont Conservation Commission. Based on his expertise, Chris provided us with insightful suggestions and guidance on the grading, sizing, and placement of our stormwater management infrastructure.

Finally, Evergreen would like to thank Jeff North and Mary Trudeau of the Belmont Conservation Commission for engaging us on this project. We have greatly appreciated the opportunity to hone our skills by completing a design on this scale, a critical milestone in our development as engineers. Presenting our design for construction has been a fantastic experience and we are humbled to know that it has the potential to be implemented by the Town.

Appendix A – Drawing Set

1. Construction Drawings
2. Superseded Drawings



LEGEND

SITE LOCATION

N

5,000' 0 5,000'

Title:

VICINITY MAP

MILL STREET
BELMONT, MA 02478

Prepared for:

BELMONT CONSERVATION COMMISSION
OFFICE OF COMMUNITY DEVELOPMENT

Evergreen Engineering

Prepared by: ET	Date: 03APR2020	EXHIBIT
Project Mgr: SK	Scale: 1"=5,000'	1
Principal: AOH	Project: ROCK MEADOW	
File: VICINITYMAP.DWG		

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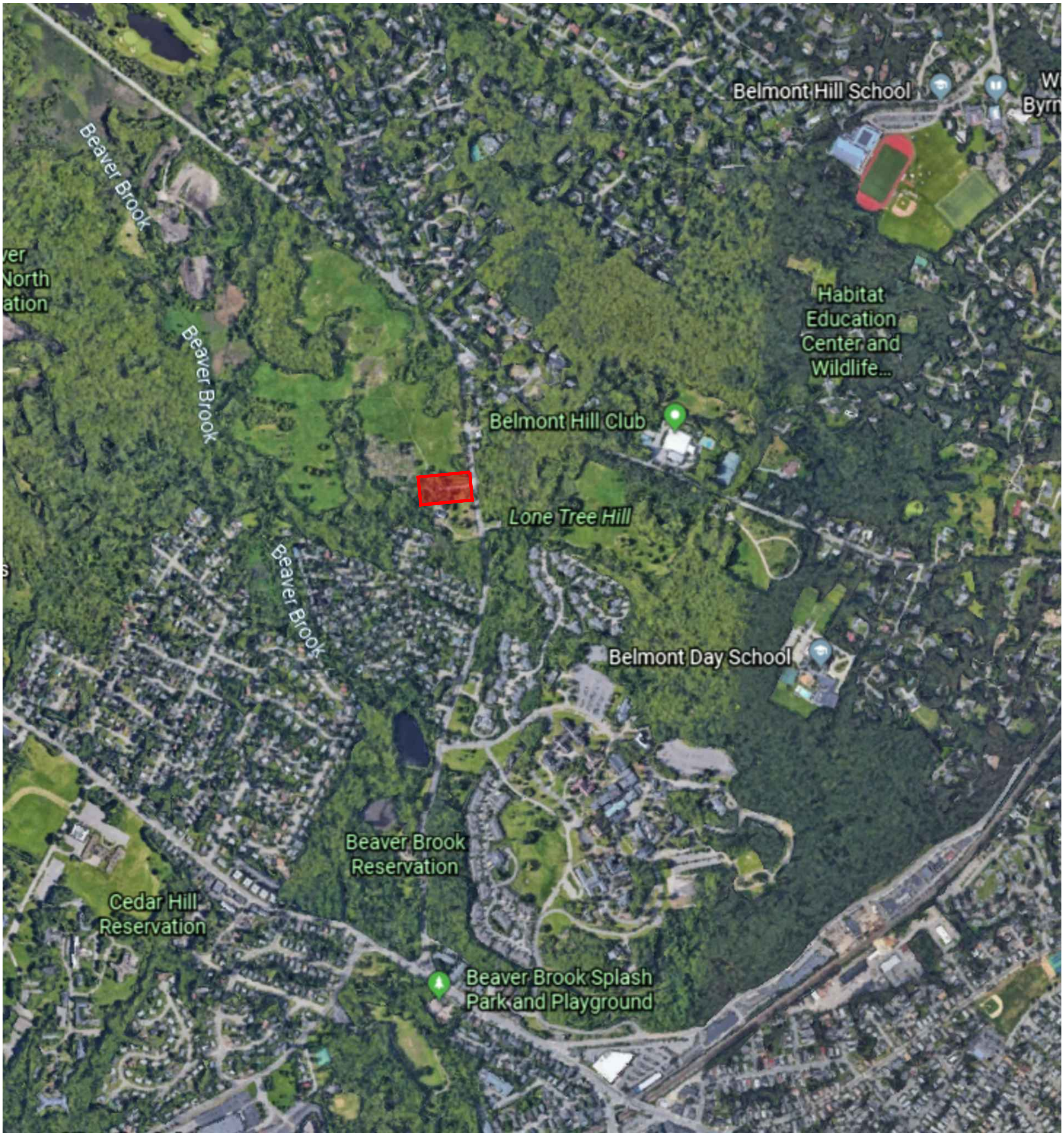

LEGEND

APPROXIMATE SITE BOUNDARY

N

1000' 0 1000'

Title:

SITE LOCATION MAP

MILL STREET
BELMONT, MA 02478

Prepared for:

BELMONT CONSERVATION COMMISSION
OFFICE OF COMMUNITY DEVELOPMENT

Evergreen Engineering

Prepared by: ET	Date: 03APR2020	EXHIBIT
Project Mgr: SK	Scale: 1"=1000'	2
Principal: AOH	Project: ROCK MEADOW	
File: VICINITYMAP.DWG		

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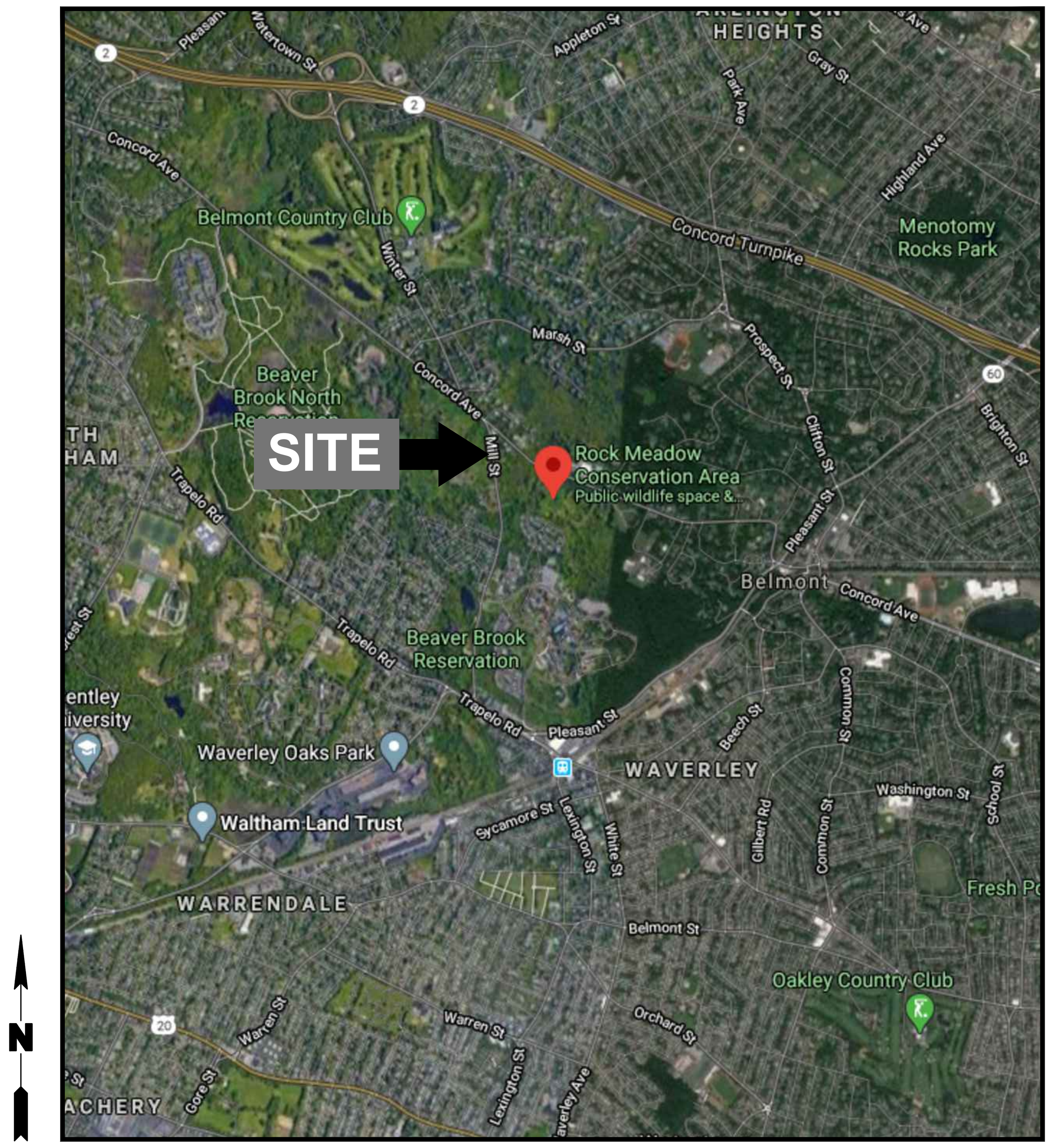
ROCK MEADOW CONSERVATION AREA
MAIN ENTRANCE AND PARKING LOT REDESIGN
BELMONT, MASSACHUSETTS



LOCATION MAP
1"=2000'

SITE INFORMATION

ADDRESS:	MILL STREET BELMONT, MA 02478
SITE AREA:	48,000 SQFT (1.1 AC)
PROJECT PRINCIPAL:	ANNALISA ONNIS-HAYDEN, Ph.D.
PROJECT MANAGER:	SAMANTHA KINNALY
PROJECT ENGINEERS:	KATHLEEN ENGLER, ABDULLAH FADOL, ANNIE LAMONTE, AND EMMA TOTSUBO

LIST OF DRAWINGS

PREPARED FOR

BELMONT CONSERVATION COMMISSION
OFFICE OF COMMUNITY DEVELOPMENT

PREPARED BY

Evergreen Engineering
Designing for Sustainability

NORTHEASTERN UNIVERSITY DEPARTMENT OF
CIVIL AND ENVIRONMENTAL ENGINEERING
BOSTON, MA 02115

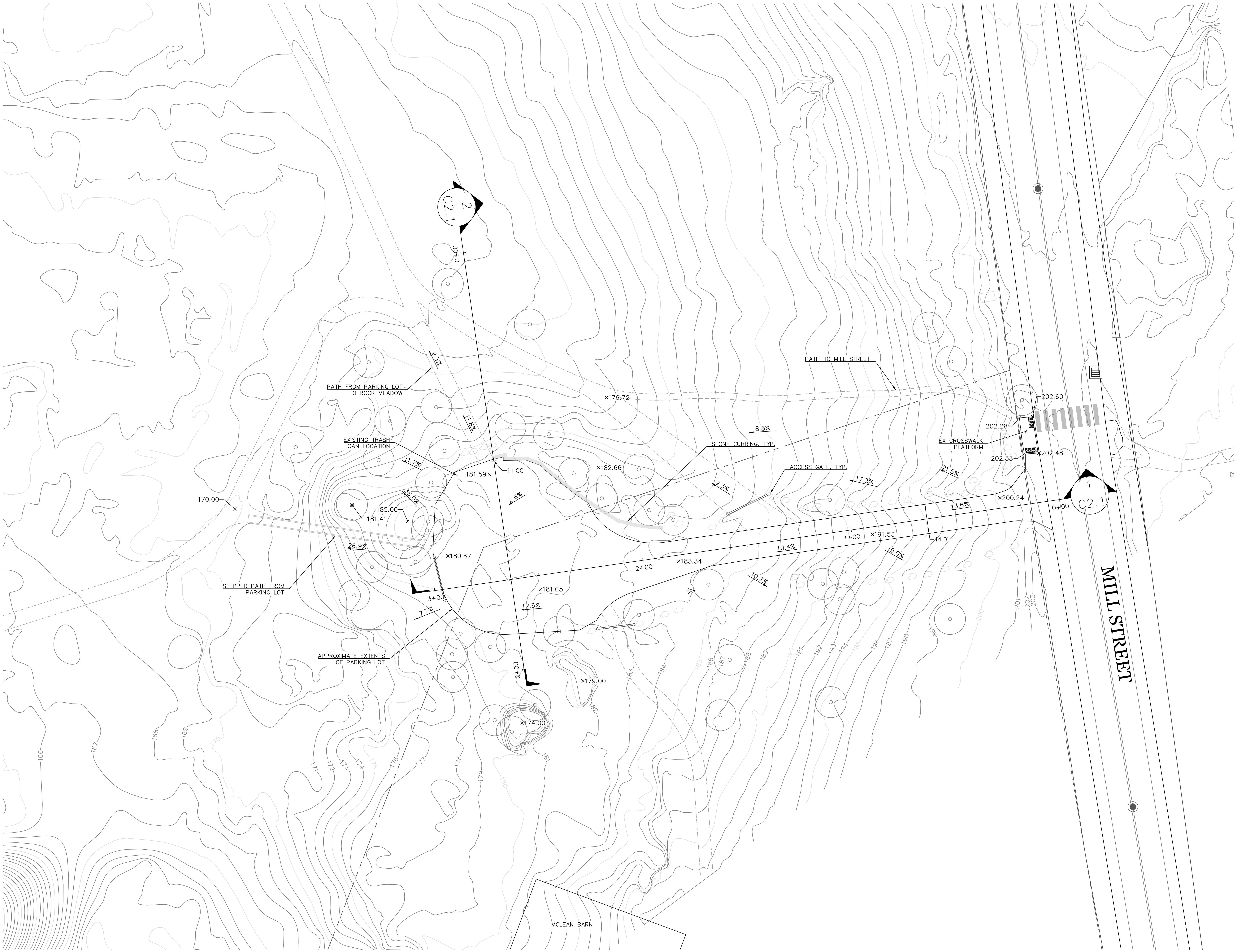
APRIL 2020

GENERAL NOTES

1. PROPERTY LINES SHOWN ARE BASED UPON ELECTRONIC FILES PROVIDED BY THE TOWN OF BELMONT.
2. EXISTING CONDITIONS SHOWN HEREON ARE BASED UPON ORTHOPHOTOS AND SURVEY CONDUCTED ON APRIL 11, 2019 BY ENEL GREEN POWER NORTH AMERICA, INC.
3. LOCATION AND STATUS OF EXISTING UTILITIES SHOWN ARE APPROXIMATE AND ARE TO BE CONFIRMED BY THE CONTRACTOR.
4. CONTRACTOR SHALL COORDINATE ACTIVITIES WITH ONGOING TOWN OPERATIONS.
5. THIS CONSTRUCTION PLAN WAS PREPARED AS A CAPSTONE SENIOR DESIGN PROJECT BY NORTHEASTERN UNIVERSITY UNDERGRADUATE STUDENTS UNDER PROFESSOR ANNALISA ONNIS-HAYDEN.

ABBREVIATIONS

AC	ACRE
ADA	AMERICANS WITH DISABILITIES ACT
BC	BOTTOM OF CURB
BVCE	BEGINNING OF VC ELEVATION
BVCS	BEGINNING OF VC STATION
BW	BOTTOM OF WALL
CL	CENTERLINE
CY	CUBIC YARDS
DIA	DIAMETER
DWG	DRAWING
EG	EXISTING GRADE
ELEV	ELEVATION
EP	EDGE OF PAVEMENT
EVCE	END OF VC ELEVATION
EVCS	END OF VC STATION
EX	EXISTING
FG	FINISHED GRADE
GB	GRADE BREAK
HDPE	HIGH-DENSITY POLYETHYLENE
INV	INVERT
LVC	LENGTH OF VC
LF	LINEAR FEET
NTS	NOT TO SCALE
PR	PROPOSED
PVC	POLYVINYL CHLORIDE
PVI	POINT OF VERTICAL INTERSECTION
SD	STORMDRAIN
SL	SIGHT LIGHT
SQFT	SQUARE FEET
SS	SANITARY SEWER
STA	STATION
TC	TOP OF CURB
TW	TOP OF WALL
TYP	TYPICAL
VC	VERTICAL CURB



LEGEND

- PROPERTY LINE
- EXISTING PAVEMENT
- EXISTING UNPAVED/DIRT PATH
- ×170.72 EXISTING SPOT ELEVATION
- 2.0% EXISTING SURFACE SLOPE
- 200 EXISTING MAJOR CONTOUR
- 198 EXISTING MINOR CONTOUR
- STORMDRAIN CATCH BASIN
- SANITARY SEWER MANHOLE
- EXISTING SIGHT LIGHT
- DETECTABLE WARNING SURFACE
- EXISTING TREE

NOTES

1. ALL LOCATIONS AND ELEVATIONS ARE BASED OFF ORTHOPHOTOS AND SURVEY BY ENEL GREEN POWER NORTH AMERICA, INC. (APRIL 11, 2019).
2. AN UNKNOWN UTILITY IS BELIEVED TO EXIST BENEATH THE PARKING LOT. CONTRACTOR TO VERIFY PRIOR TO CONSTRUCTION.

Title:

ROCK MEADOW
EXISTING CONDITIONS

MILL STREET
BELMONT, MA 02478

Prepared for:

BELMONT CONSERVATION COMMISSION
OFFICE OF COMMUNITY DEVELOPMENT

Evergreen Engineering

Prepared by: SK	Date: 17APR2020	DWG
Project Mgr: AOH	Scale: 1"=20'	C2.0
Principal:	Project: ROCK MEADOW	
File: C2.0 - EXCOND.DWG		

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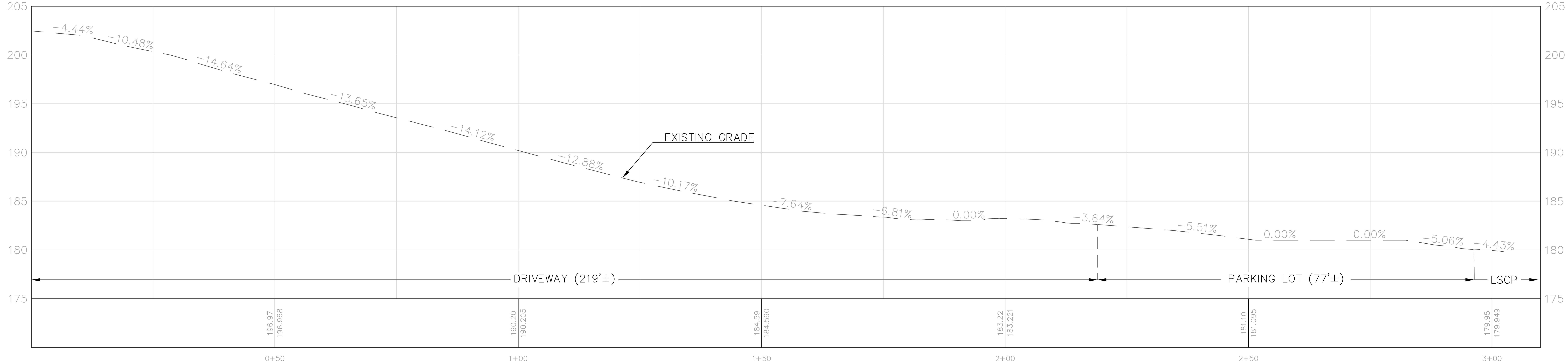
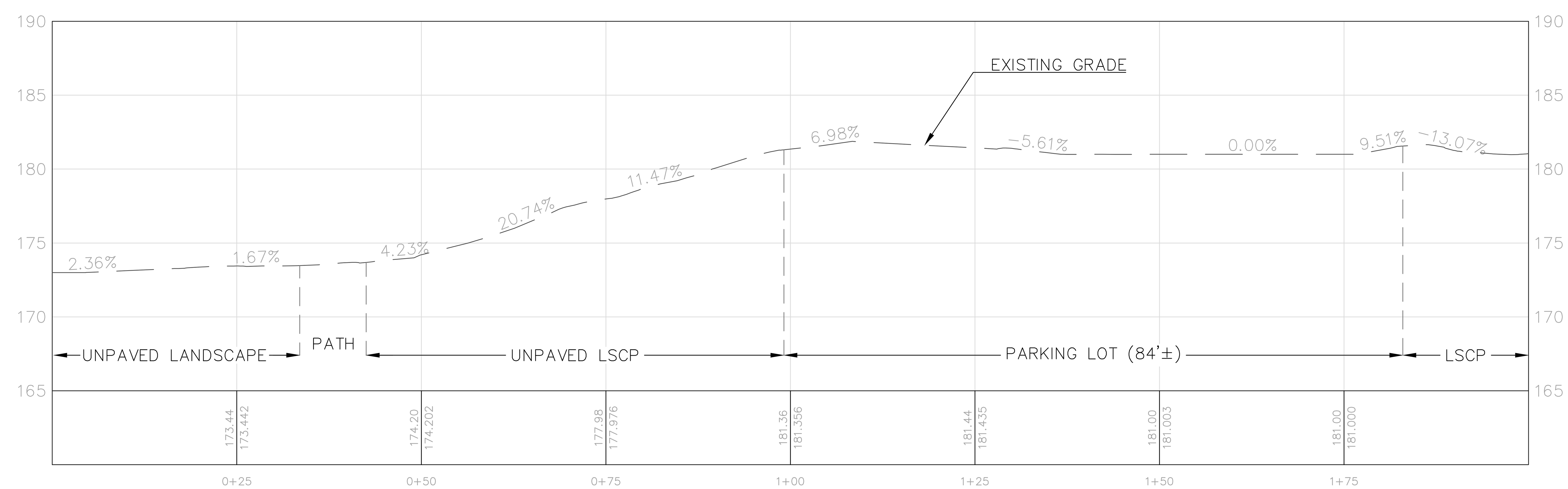


1 C2.1 EXISTING DRIVEWAY AND PARKING LOT PROFILE

SCALE: NTS



2 C2.1 EXISTING PARKING LOT PROFILE

SCALE: NTS

Title:

ROCK MEADOW
EXISTING SURFACE PROFILES

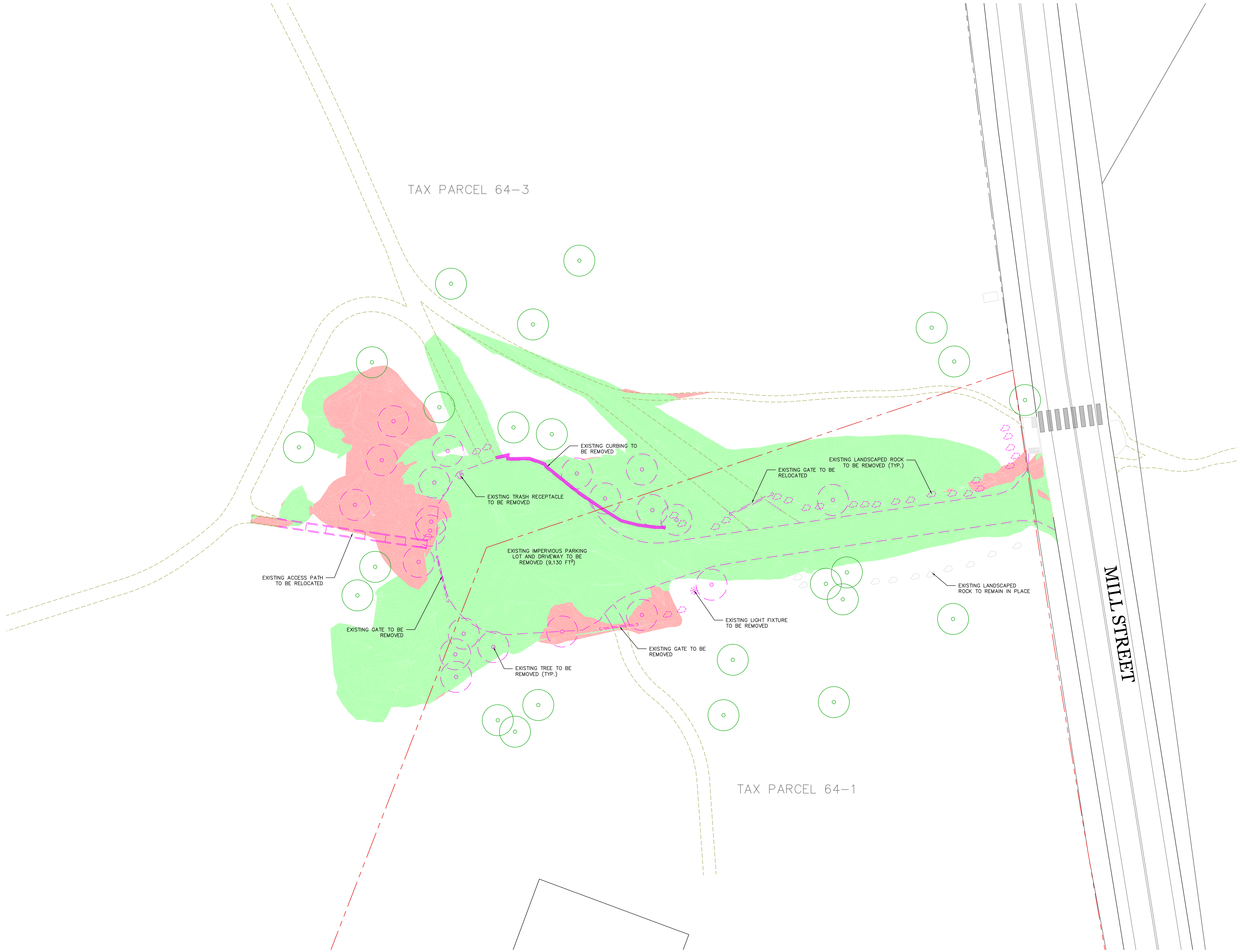
MILL STREET
BELMONT, MA 02478

Prepared for:

BELMONT CONSERVATION COMMISSION
OFFICE OF COMMUNITY DEVELOPMENT

Evergreen Engineering

Prepared by: ET	Date: 17APR2020	DWG
Project Mgr: SK	Scale: AS SHOWN	C2.1
Principal: AOH	Project: ROCK MEADOW	
File: C2.0 - EXCOND.DWG		



LEGEND

- PROPERTY LINE
- REMOVED PARKING LOT AREA
- EXISTING UNPAVED/DIRT PATH
- REMOVED UNPAVED/DIRT PATH
- EXISTING TREE TO BE REMOVED
- EXISTING TREE
- AREA TO BE BACKFILLED
- AREA TO BE CUT

DEMOLITION NOTES

1. ALL LOCATIONS AND ELEVATIONS ARE BASED OFF ORTHOPHOTOS AND SURVEY BY ENEL GREEN POWER NORTH AMERICA, INC. (APRIL 11, 2019)
2. CONTRACTOR TO COORDINATE WITH THE TOWN OF BELMONT WATER DEPARTMENT AS REQUIRED TO FACILITATE THE COMPLETION OF THIS WORK.
3. THE PROPERTY IS OWNED BY THE TOWN OF BELMONT. ANY REFERENCES TO 'OWNER' SHALL MEAN THE TOWN OF BELMONT.
4. CONTRACTOR SHALL REMOVE ALL HAZARDOUS MATERIALS PRIOR TO DEMOLITION.
5. EROSION CONTROLS SHALL BE INSTALLED BY CONTRACTOR PRIOR TO START OF DEMOLITION AS SHOWN ON SHEET C-6.0.
6. CONTRACTOR SHALL MAKE ALL NECESSARY CONSTRUCTION NOTIFICATIONS INCLUDING DIGSAFE AND APPLY FOR AND OBTAIN ALL NECESSARY CONSTRUCTION PERMITS. THE CONTRACTOR SHALL ALSO PAY ALL FEES AND POST ALL BONDS ASSOCIATED WITH THE SAME.
7. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING A DEMOLITION PERMIT FROM THE TOWN OF BELMONT FROM THE OFFICE OF COMMUNITY DEVELOPMENT. THE CONTRACTOR IS RESPONSIBLE FOR PAYING ALL FEES ASSOCIATED WITH THE PERMIT. THE CONTRACTOR SHALL SUBMIT A COPY OF THE DEMOLITION PERMIT AND ANY OTHER RELATED PERMITS TO THE ENGINEER PRIOR TO INITIATING BUILDING DEMOLITION ACTIVITIES.
8. WHERE THE WORD "REMOVE" IS USED, IT SHALL MEAN TO REMOVE AND LEGALLY DISPOSE OR RECYCLE OFF-SITE AT A REGULATED PROCESSING OR DISPOSAL FACILITY. DEMOLITION SHALL BE COMPLETED IN ACCORDANCE WITH, BUT NOT LIMITED TO SPECIFICATION SECTION 02060 DEMOLITION. THE INTENT IS TO RECYCLE TO THE EXTENT PRACTICAL, ALL ASPHALT, BRICK, AND CONCRETE OFF-SITE. SUBMIT THE TOTAL AMOUNT OF DEBRIS REMOVED FROM THE SITE AND THE TOTAL AMOUNT RECYCLED, IN TONS AT PROJECT COMPLETION.
9. CONTRACTOR TO RELOCATE ALL INDICATED SOIL AND DEBRIS WITHIN THE LIMIT OF WORK TO A LOCATION IDENTIFIED BY THE TOWN (ON-SITE). COORDINATE THE LOCATION WITH THE TOWN. THIS INCLUDES ALL MATERIALS INCLUDING BUT NOT LIMITED TO SOIL, PAVEMENT, GRANITE CURBING, BOULDERS, AND CONCRETE DEBRIS. ALL SOLID WASTE ENCOUNTERED WITHIN THE LIMIT OF WORK SHALL BE LEGALLY DISPOSED OFF-SITE AT A LICENSED FACILITY.
10. CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR JOB SITE SAFETY AND ALL CONSTRUCTION MEANS AND METHODS.
11. IT IS THE CONTRACTOR'S RESPONSIBILITY TO VERIFY ALL CONDITIONS IN THE FIELD AND REPORT DISCREPANCIES BETWEEN PLANS AND ACTUAL CONDITIONS TO THE ENGINEER.
12. DEMOLITION SHALL BE COMPLETED IN ACCORDANCE WITH, BUT NOT LIMITED TO SECTION 02060 DEMOLITION.
13. ANY AREA OUTSIDE THE LIMIT OF WORK THAT IS DISTURBED SHALL BE RESTORED TO ITS ORIGINAL CONDITION AT NO ADDITIONAL COST TO THE OWNER.

Title:

ROCK MEADOW DEMOLITION PLAN

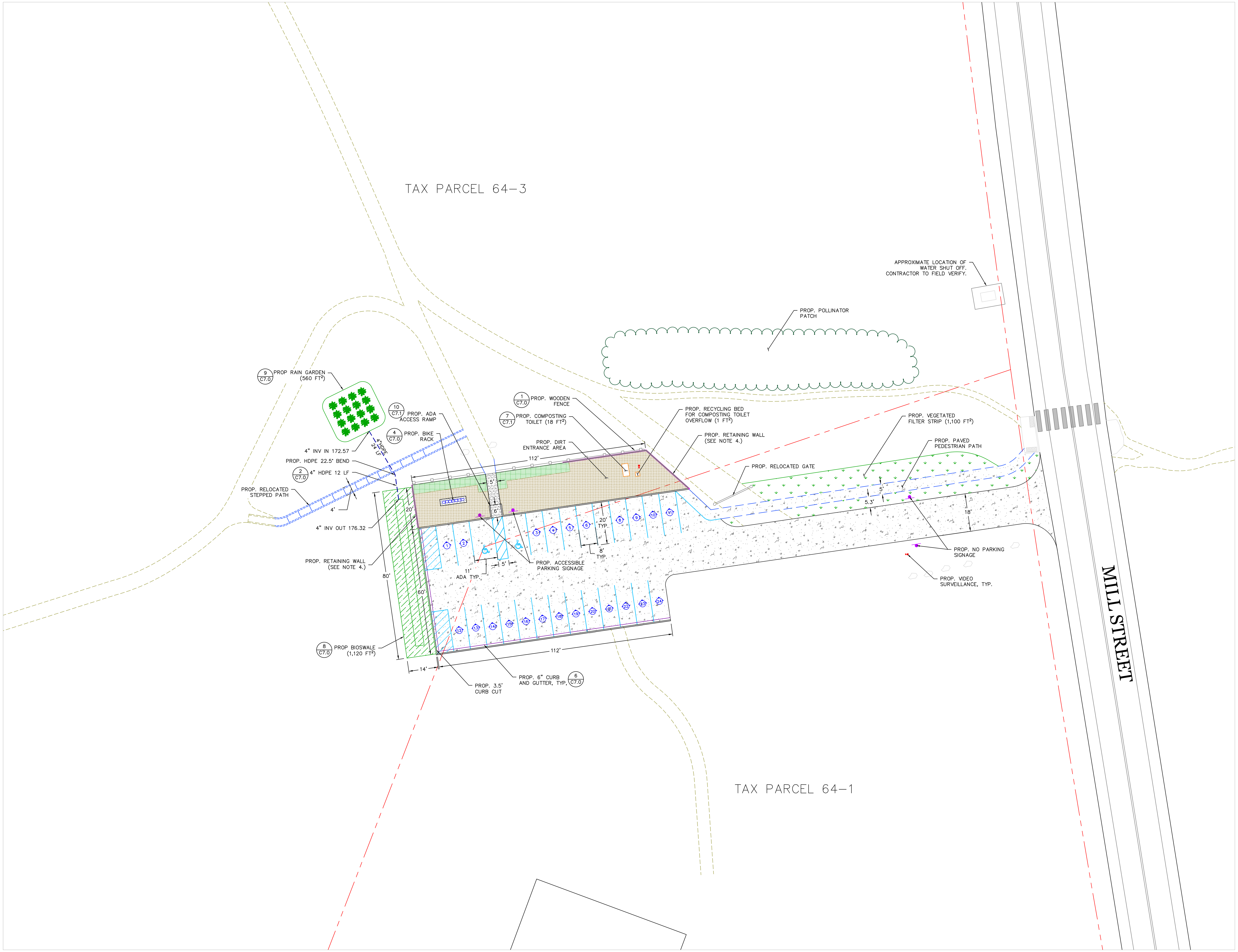
MILL STREET
BELMONT, MA 02478

Prepared for:

BELMONT CONSERVATION COMMISSION
OFFICE OF COMMUNITY DEVELOPMENT

Evergreen Engineering

Prepared by: AL	Date: 17APR2020	C3.0
Project Mgr: SK	Scale: 1"=20'	
Principal: AOH	Project: ROCK MEADOW	
File: C-3.0 DEMOLITION PLAN.DWG		



LEGEND

- PROPERTY LINE
- PROPOSED EDGE OF PAVEMENT
- PARKING STRIPING
- EXISTING UNPAVED/DIRT PATH
- PROPOSED CONCRETE PEDESTRIAN PATH
- PROPOSED STEPPED PATH RELOCATION
- PROPOSED 6" VERTICAL CURB
- PROPOSED CURB AND GUTTER
- PROPOSED DEPRESSED CURBING
- PROPOSED RETAINING WALL
- PROPOSED POLLINATOR PATCH (3,250 FT²)
- PROPOSED IMPERVIOUS AREA (10,615 FT²)
- PROPOSED DIRT AREA
- PROPOSED HANDICAPPED RAMP
- PROPOSED VEGETATED FILTER STRIP
- PROPOSED BIOSWALE
- PROPOSED RAIN GARDEN
- PROPOSED SCENIC VISTA LANDSCAPING
- HANDICAP ACCESSIBLE PARKING SPACE
- EXISTING TREE

NOTES

1. ALL LOCATIONS AND ELEVATIONS ARE BASED OFF ORTHOPHOTOS AND SURVEY BY ENEL GREEN POWER NORTH AMERICA, INC. (APRIL 11, 2019).
2. AS PER BELMONT PARKING ORDINANCE, PARKING STALLS SHALL HAVE A WIDTH OF 8 FEET AND A LENGTH OF 20 FEET.
3. 4" HDPE UNDERDRAIN SHALL HAVE PROTECTIVE SLEEVE AND 1.85 FEET OF COVER BELOW STEPPED PATH FINISHED GROUND.
4. RETAINING WALL TO BE DESIGNED BY OTHERS.

20' 0 20'

Title:

ROCK MEADOW SITE PLAN

MILL STREET
BELMONT, MA 02478

Prepared for:

BELMONT CONSERVATION COMMISSION
OFFICE OF COMMUNITY DEVELOPMENT

Evergreen Engineering

Prepared by: AL	Date: 17APR2020	C4.0
Project Mgr: SK	Scale: 1"=20'	
Principal: AOH	Project: ROCK MEADOW	
File: C-4.0 SITE PLAN.DWG		

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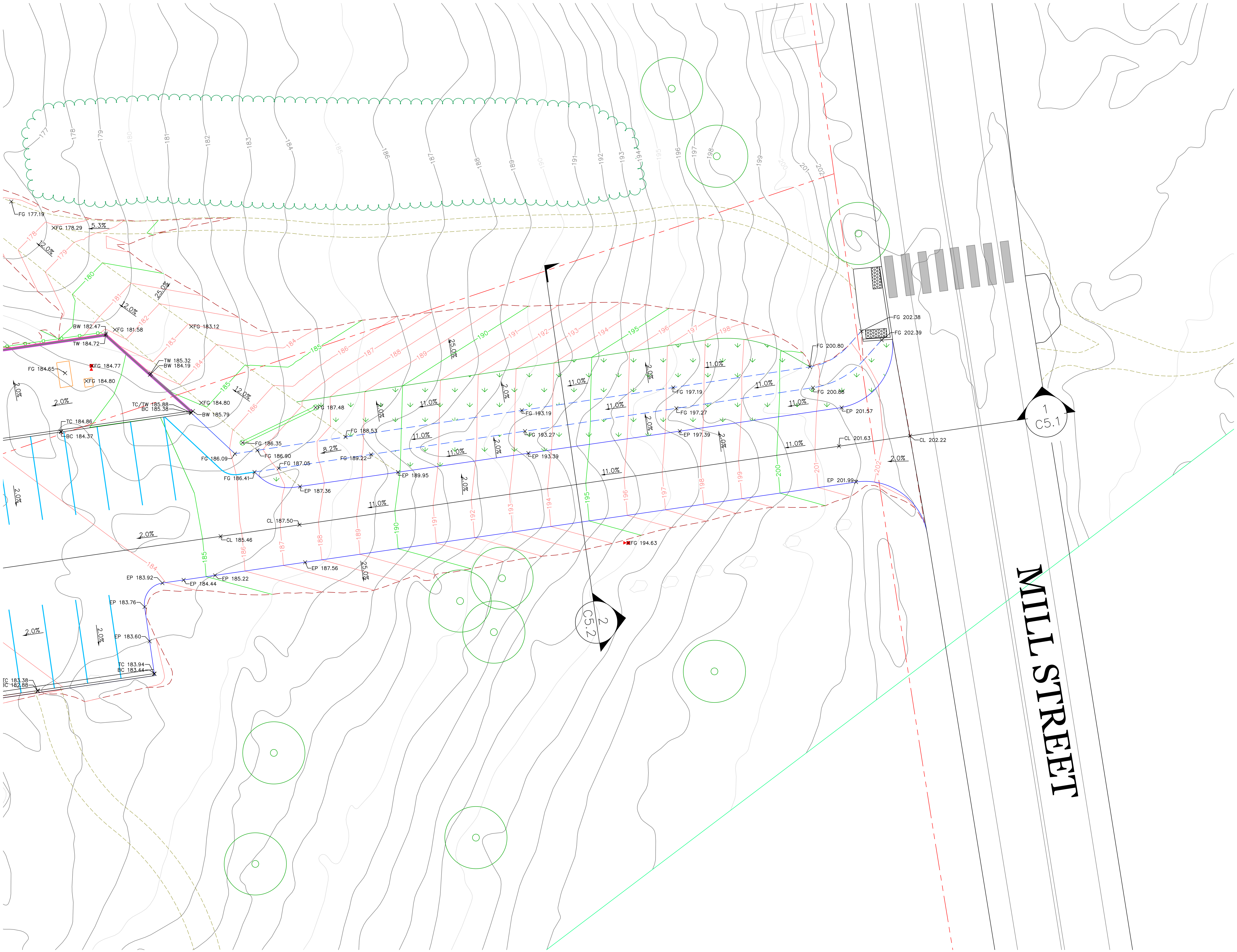

LEGEND

- PROPERTY LINE
- LIMITS OF GRADING
- GRADE BREAK (GB)
- PROPOSED UNPAVED/DIRT PATH
- EXISTING UNPAVED/DIRT PATH
- ×170.72 PROPOSED SPOT ELEVATION
- 200 PROPOSED MAJOR CONTOUR
- 198 PROPOSED MINOR CONTOUR
- 200 EXISTING MAJOR CONTOUR
- 198 EXISTING MINOR CONTOUR
- PROPOSED POLLINATOR PATCH
- PARKING STRIPING
- EXISTING TREE

NOTES

1. ALL EXISTING LOCATIONS AND ELEVATIONS ARE BASED OFF ORTHOPHOTOS AND SURVEY BY ENEL GREEN POWER NORTH AMERICA, INC. (APRIL 11, 2019)
2. FEATURES WERE GRADED AT A 4:1 SLOPE TO EXISTING GRADE.
3. EARTHWORK QUANTITIES:

CUT:	270± CY
FILL:	1,610± CY
NET (FILL):	1,340± CY

Title:

ROCK MEADOW GRADING AND DRAINAGE PLAN DRIVEWAY

MILL STREET
BELMONT, MA 02478

Prepared for:

BELMONT CONSERVATION COMMISSION
OFFICE OF COMMUNITY DEVELOPMENT

Evergreen Engineering

Prepared by: ET	Date: 17APR2020	DWG
Project Mgr: SK	Scale: 1"=10'	C5.0
Principal: AOH	Project: ROCK MEADOW	
File: C5.0 - GRADING.DWG		

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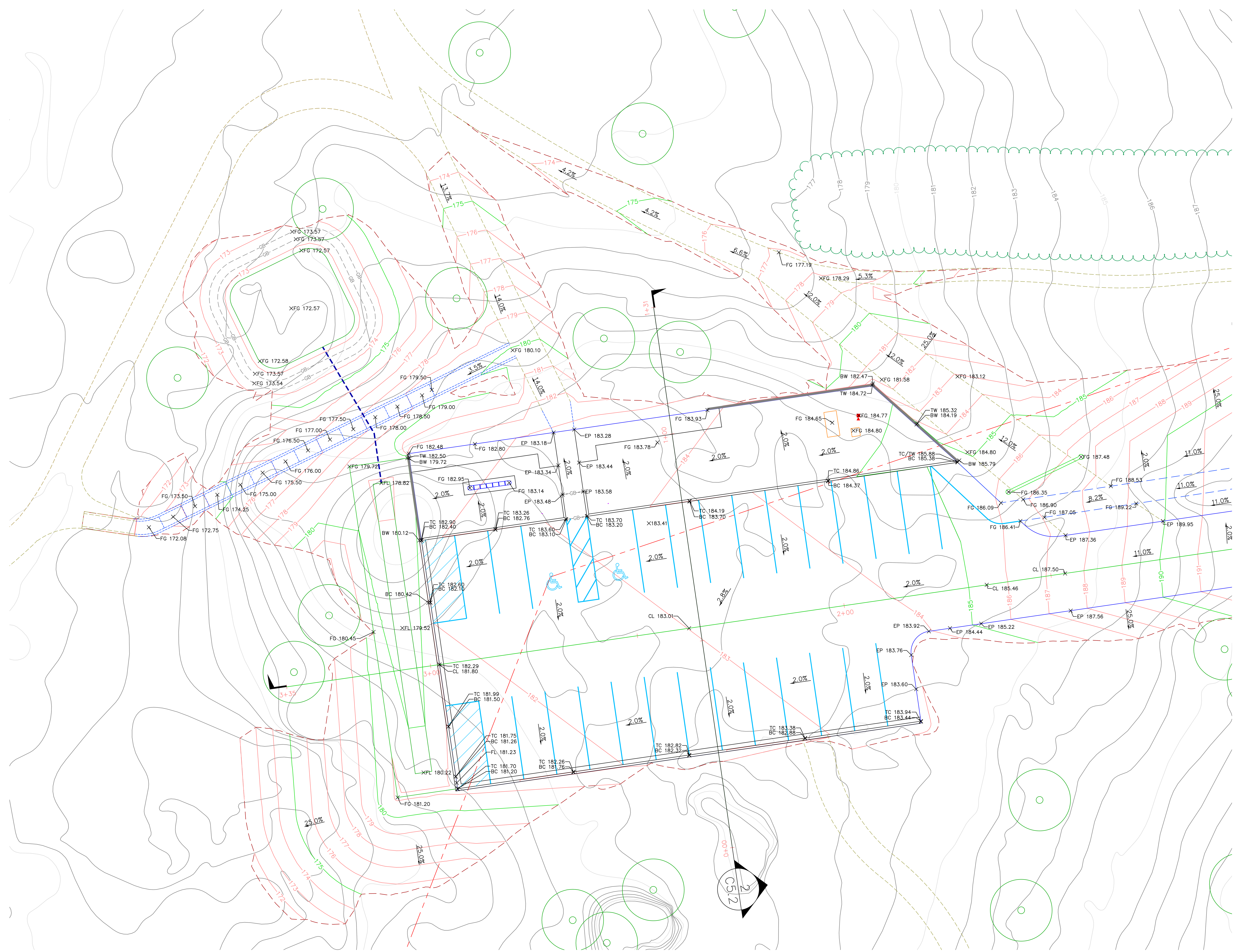

LEGEND

	PROPERTY LINE
	LIMITS OF GRADING
-GB-	GRADE BREAK
	PROPOSED UNPAVED/DIRT PATH
	EXISTING UNPAVED/DIRT PATH
×170.72	PROPOSED SPOT ELEVATION
200	PROPOSED MAJOR CONTOUR
198	PROPOSED MINOR CONTOUR
200	EXISTING MAJOR CONTOUR
198	EXISTING MINOR CONTOUR
	PROPOSED POLLINATOR PATCH
	PARKING STRIPING
	EXISTING TREE

NOTES

1. ALL EXISTING LOCATIONS AND ELEVATIONS ARE BASED OFF ORTHOPHOTOS AND SURVEY BY ENEL GREEN POWER NORTH AMERICA, INC. (APRIL 11, 2019)
2. FEATURES WERE GRADED AT A 4:1 SLOPE TO EXISTING GRADE.
3. EARTHWORK QUANTITIES:
   CUT: 270± CY
   FILL: 1,610± CY
   NET (FILL): 1,340± CY

N

10' 0 10'

Title:

ROCK MEADOW GRADING AND DRAINAGE PLAN PARKING LOT

MILL STREET
BELMONT, MA 02478

Prepared for:

BELMONT CONSERVATION COMMISSION
OFFICE OF COMMUNITY DEVELOPMENT

Evergreen Engineering

Prepared by: ET	Date: 17APR2020	DWG
Project Mgr: SK	Scale: 1"=10'	C5.1
Principal: AOH	Project: ROCK MEADOW	
File: C5.0 - GRADING.DWG		

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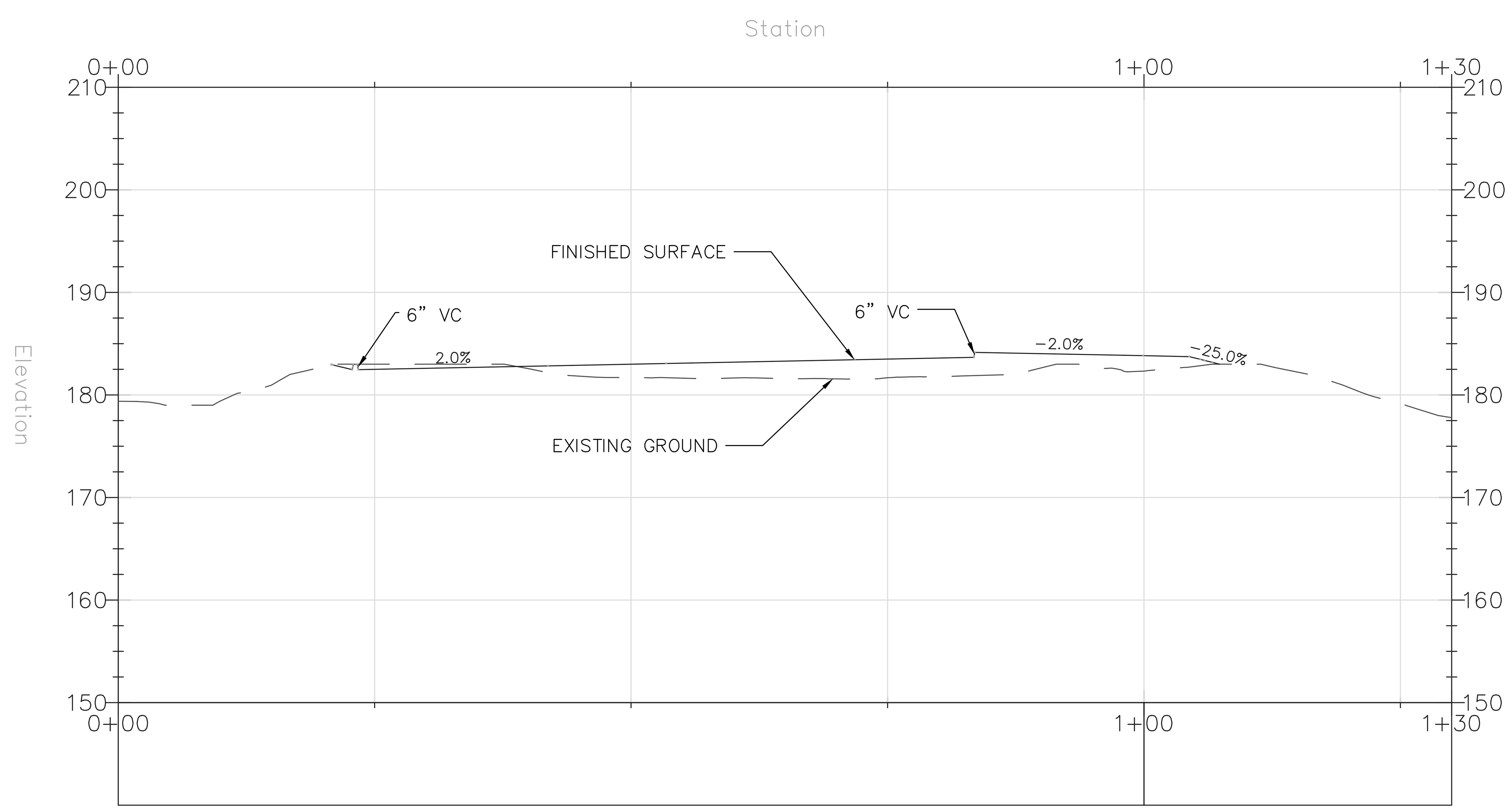
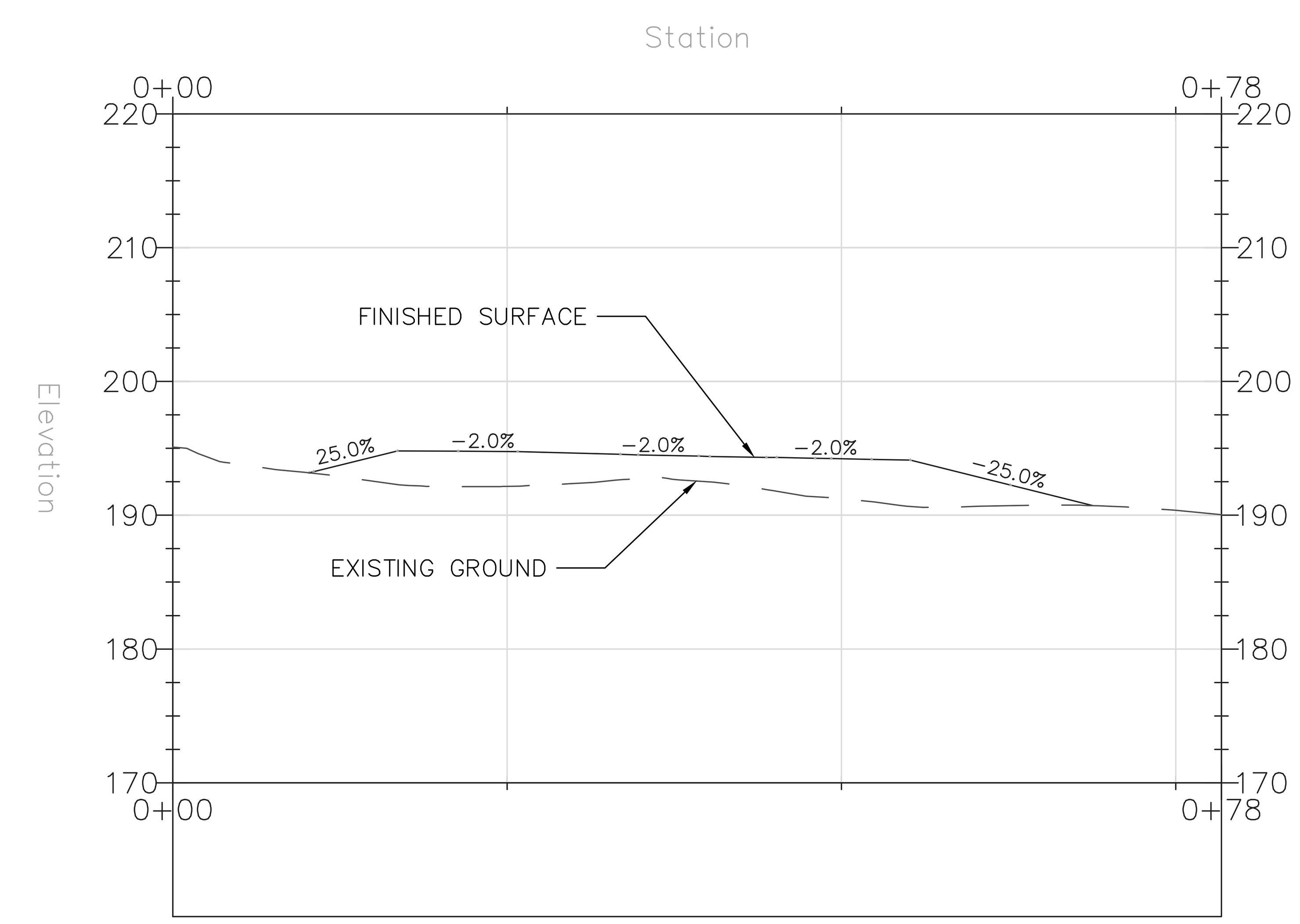
1 C5.2 PROPOSED DRIVEWAY AND PARKING LOT PROFILE

SCALE: NTS



2 C5.2 PROPOSED PARKING LOT PROFILE

SCALE: NTS



3 C5.2 PROPOSED DRIVEWAY LOT PROFILE

SCALE: NTS

Title:

ROCK MEADOW
GRADING AND DRAINAGE PLAN
PROFILES

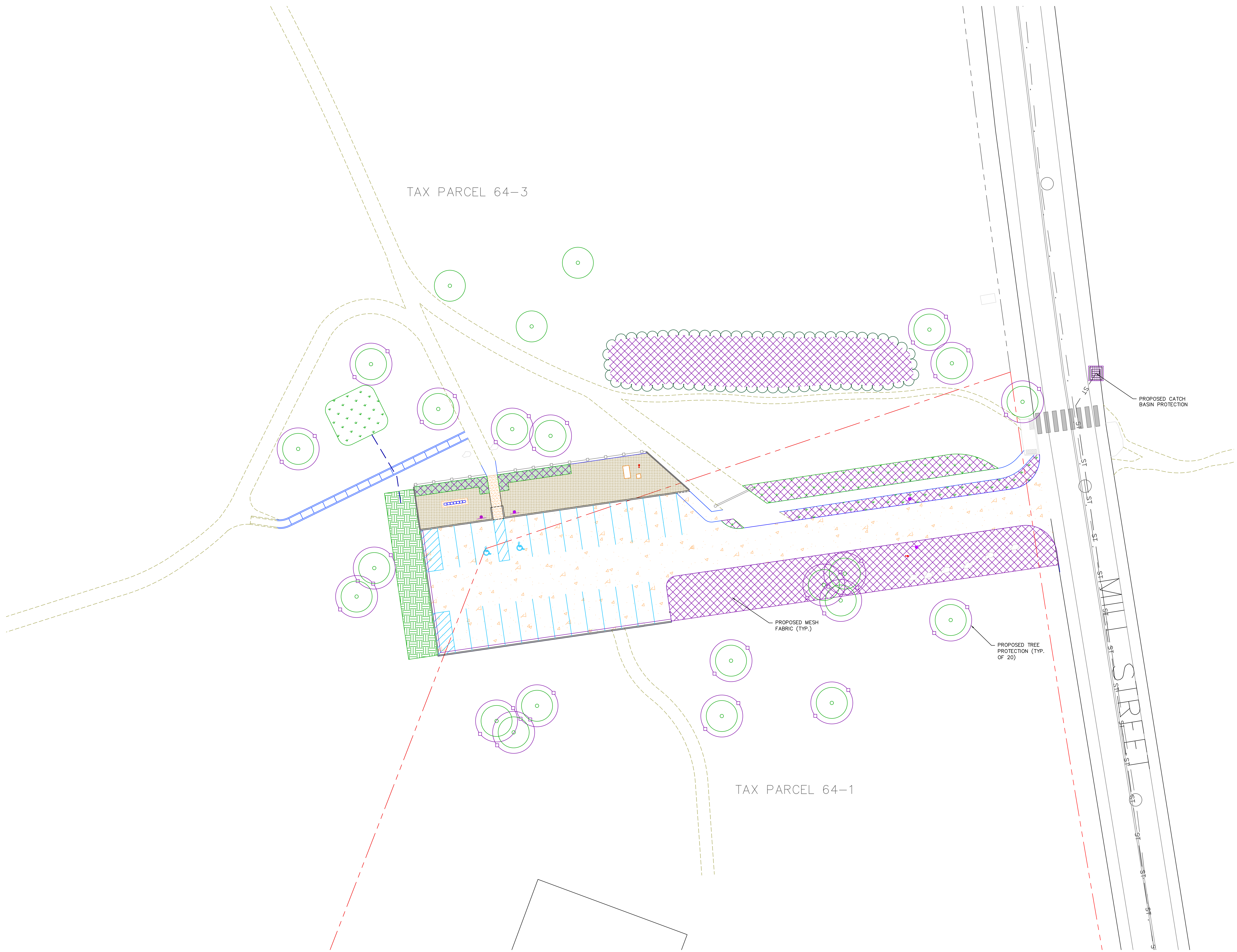
MILL STREET
BELMONT, MA 02478

Prepared for:

BELMONT CONSERVATION COMMISSION
OFFICE OF COMMUNITY DEVELOPMENT

Evergreen Engineering

Prepared by: ET	Date: 17APR2020	DWG
Project Mgr: SK	Scale: 1"=10'	C5.2
Principal: AOH	Project: ROCK MEADOW	
File: C5.0 - GRADING.DWG		



LEGEND

- PROPERTY LINE
- PROPOSED PARKING LOT AREA
- UNPAVED/DIRT PATH
- PROPOSED UNPAVED/DIRT PATH
- PROPOSED CURBING
- PROPOSED DEPRESSED CURBING
- PROPOSED POLLINATOR PATCH ($4{,}870\ FT^2$)
- PROPOSED IMPERVIOUS AREA ($10{,}615\ FT^2$)
- PROPOSED DIRT AREA
- PROPOSED HANDICAPPED RAMP
- PROPOSED VEGETATED FILTER STRIP
- PROPOSED RAIN GARDEN
- PROPOSED SCENIC VISTA
- PROPOSED CURBING
- PROPOSED DEPRESSED CURBING
- HANDICAP ACCESSIBLE PARKING SPACE
- EXISTING TREE
- PROPOSED TREE PROTECTION
- PROPOSED CATCH BASIN PROTECTION

NOTES

1. ALL LOCATIONS AND ELEVATIONS ARE BASED OFF ORTHOPHOTOS AND SURVEY BY ENEL GREEN POWER NORTH AMERICA, INC. (APRIL 11, 2019)
2. THE PROPERTY IS OWNED BY THE TOWN OF BELMONT. ANY REFERENCES TO 'OWNER' SHALL MEAN THE TOWN OF BELMONT.
3. EROSION CONTROLS SHALL BE INSTALLED BY CONTRACTOR PRIOR TO SITE WORK AS SHOWN ON THIS SHEET. CONTRACTOR IS RESPONSIBLE FOR INSPECTION, MAINTENANCE, AND REPLACEMENT OF EROSION CONTROLS AT THEIR OWN EXPENSE IF EROSION CONTROLS ARE DISTURBED OR OVERLOADED. SEE SPECIFICATIONS.
4. CONTRACTOR TO INSTALL & MAINTAIN A WHEEL WASH/ANTI–TRACKING PAD AT SITE ENTRANCE/EXIT TO PREVENT SEDIMENT MIGRATION OFF–SITE FROM TRUCK TIRES. CONTACT THE BELMONT WATER DEPARTMENT TO OBTAIN A TEMPORARY HYDRANT METER FOR DUST CONTROL AND WATER NEEDS.
5. ANY AREA OUTSIDE THE LIMIT OF WORK THAT IS DISTURBED SHALL BE RESTORED TO ITS ORIGINAL CONDITION AT NO ADDITIONAL COST TO THE OWNER.
6. CONTRACTOR SHALL BE RESPONSIBLE FOR SECURING THE JOB SITE AT THE END OF EACH WORK DAY. CONTRACTOR SHALL PROVIDE TEMPORARY FENCING AS REQUIRED TO KEEP THE PUBLIC FROM ENTERING THE DEMOLITION WORK AREA. SITE SECURITY IS THE CONTRACTOR'S RESPONSIBILITY.
7. MESH FABRIC SHALL BE INSTALLED IN ANY NEWLY VEGETATED AREA OR AREAS WITH STEEP SLOPES

Title:

ROCK MEADOW
EROSION CONTROL PLAN

MILL STREET
BELMONT, MA 02478

Prepared for:

BELMONT CONSERVATION COMMISSION
OFFICE OF COMMUNITY DEVELOPMENT

Evergreen Engineering

Prepared by: AL	Date: 17APR2020	C6.0
Project Mgr: SK	Scale: 1"=20'	
Principal: AOH	Project: ROCK MEADOW	
File: C-6.0 EROSION CONTROL PLAN.DWG		

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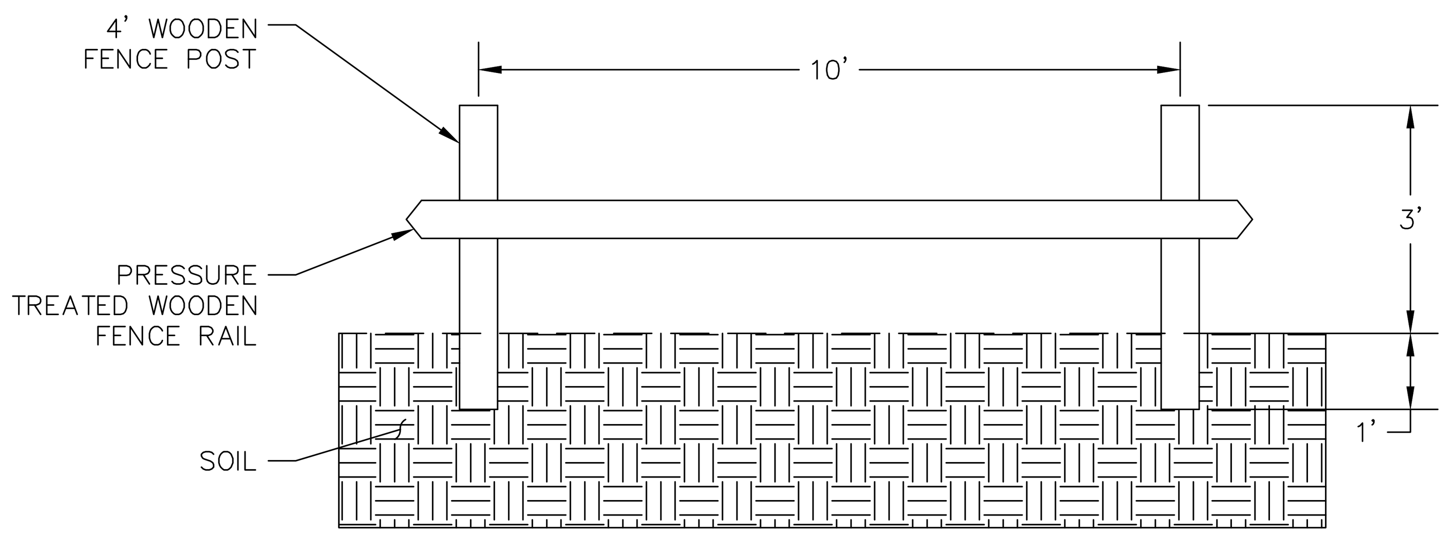
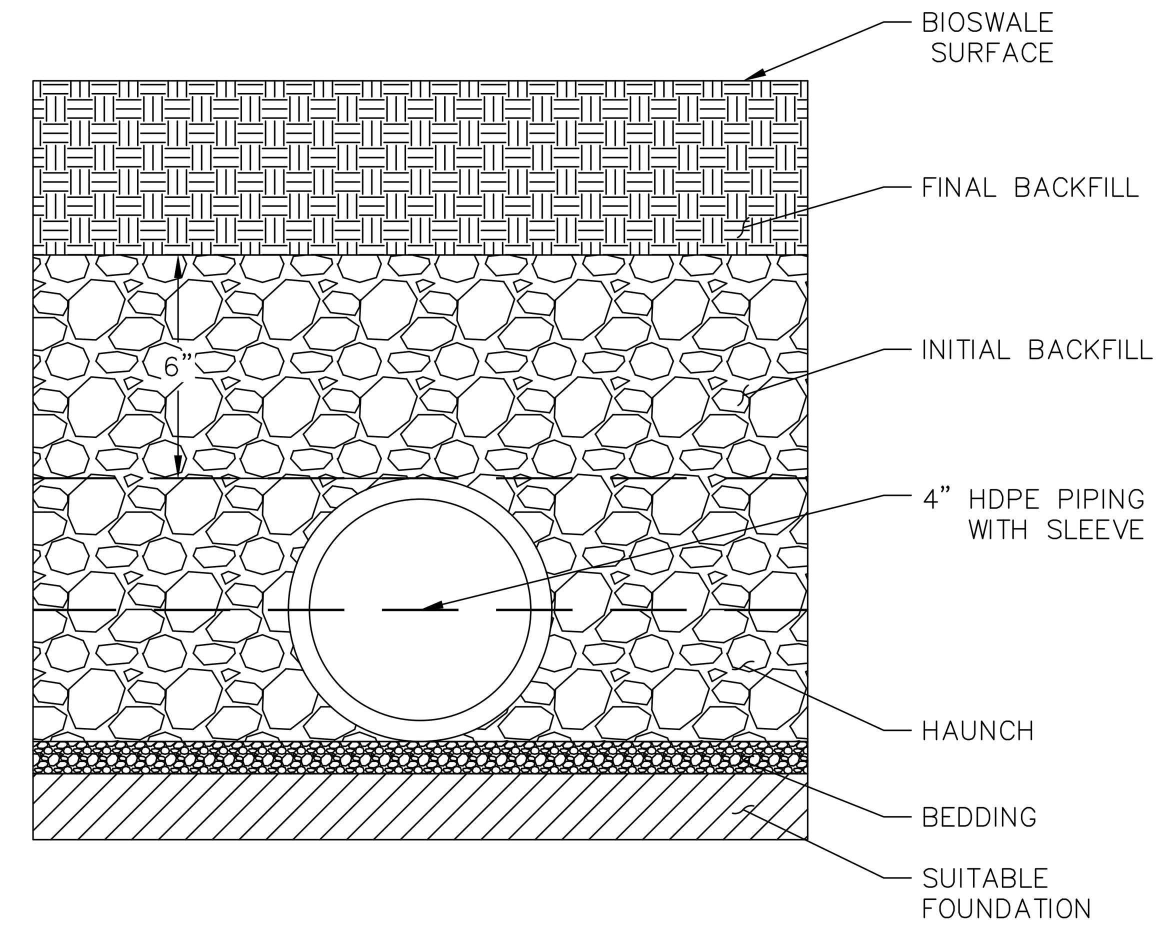


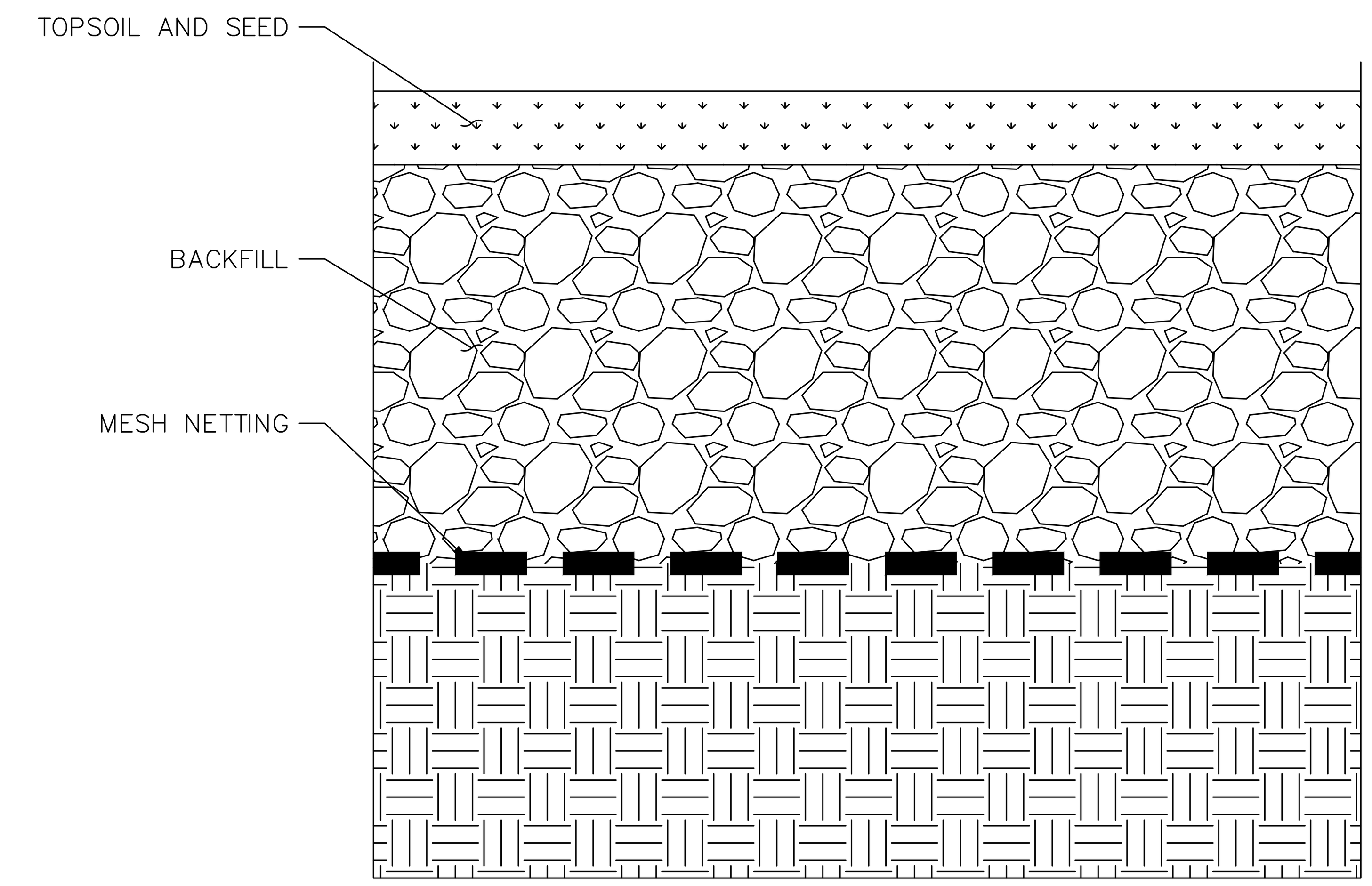
1 C7.0 WOOD FENCE SECTION

SCALE: NTS



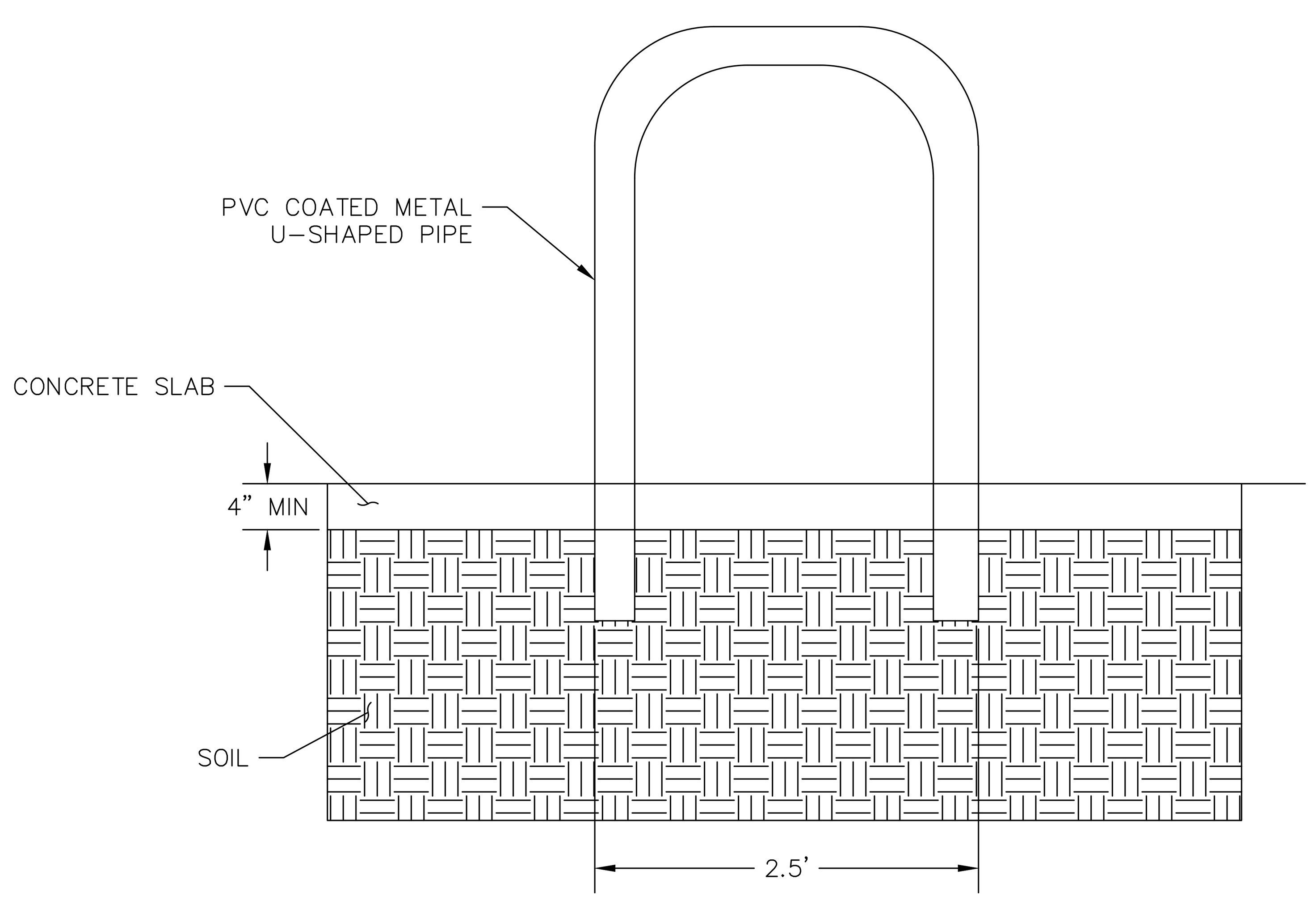
2 C7.0 4" HDPE UNDERDRAIN SECTION VIEW

SCALE: NTS



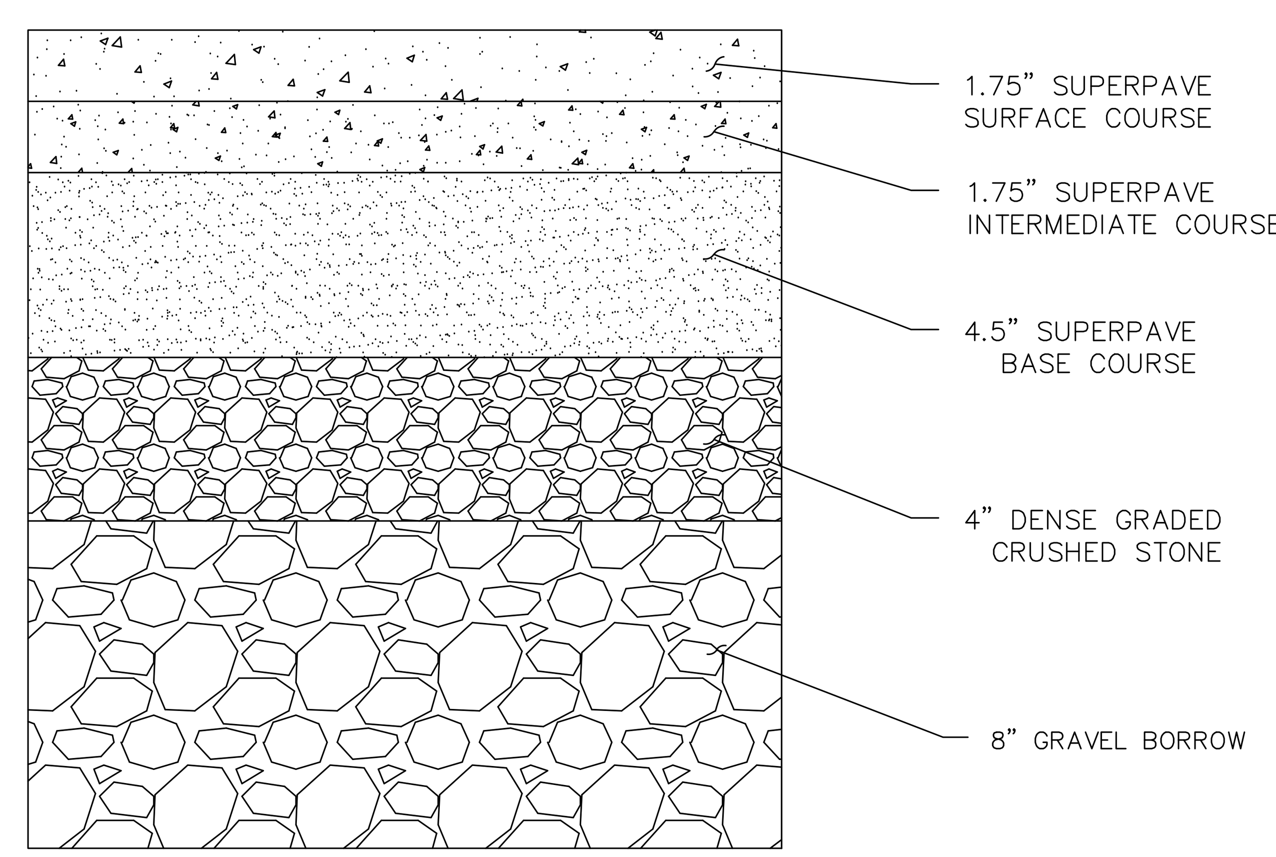
3 C7.0 MESH NETTING SECTION VIEW

SCALE: NTS



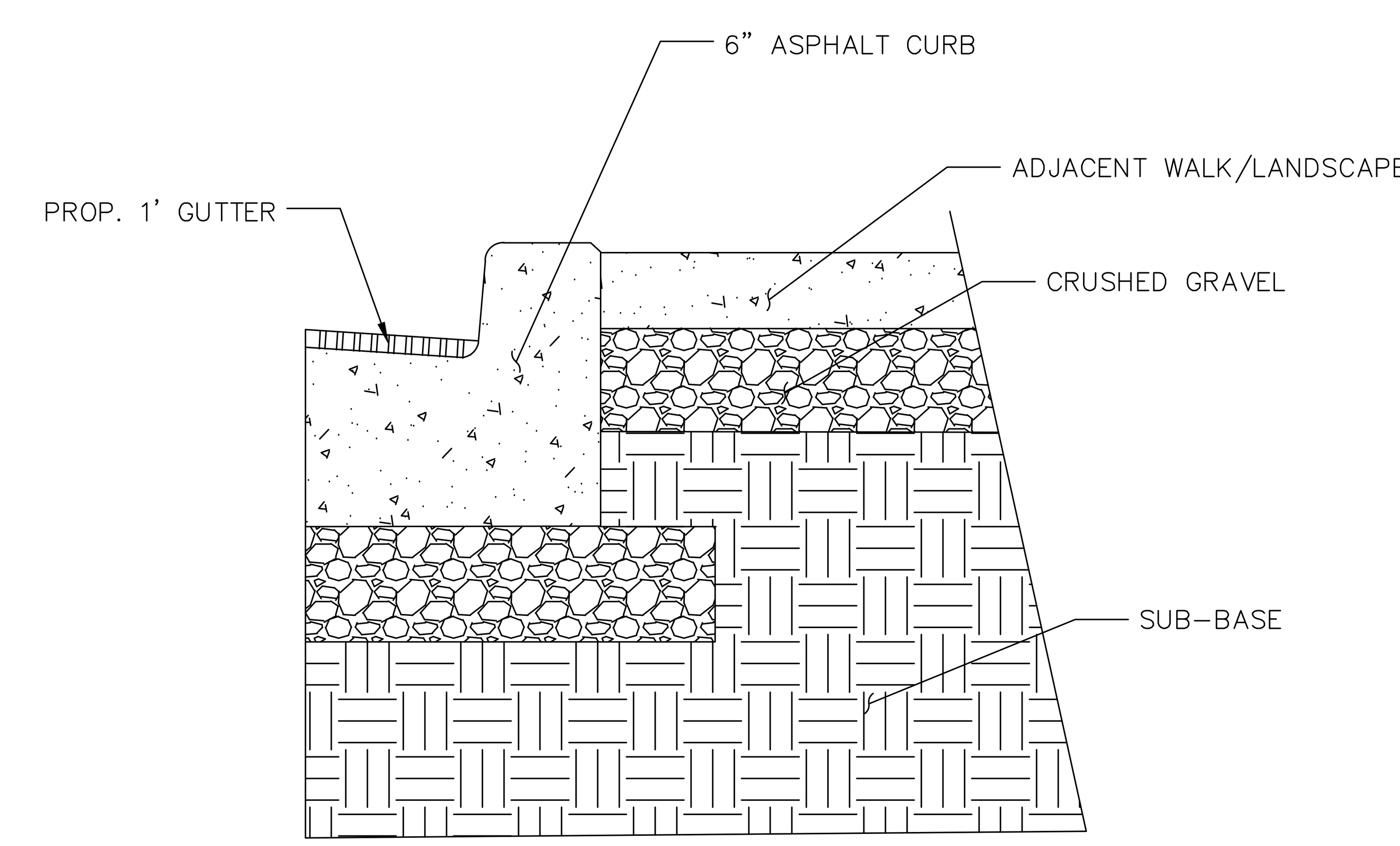
4 C7.0 BIKE RACK SECTION VIEW

SCALE: NTS



5 C7.0 PAVEMENT SECTION VIEW

SCALE: NTS



6 C7.0 CURB AND GUTTER SECTION VIEW

SCALE: NTS

Title:

ROCK MEADOW DETAILS

MILL STREET
BELMONT, MA 02478

Prepared for:

BELMONT CONSERVATION COMMISSION
OFFICE OF COMMUNITY DEVELOPMENT

Evergreen Engineering	Prepared by: AL	Date: 17APR2020	C7.0
	Project Mgr: SK	Scale: 1"=20'	
	Principal: AOH	Project: ROCK MEADOW	
	File: C7.0 DETAILS.DWG		

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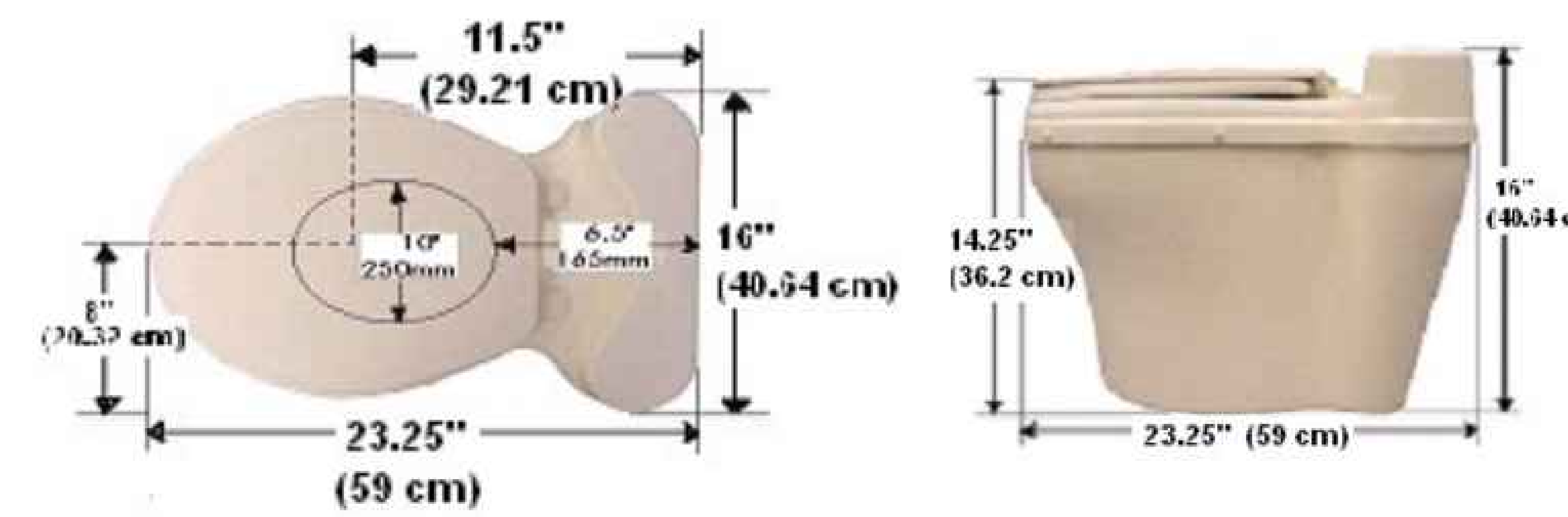
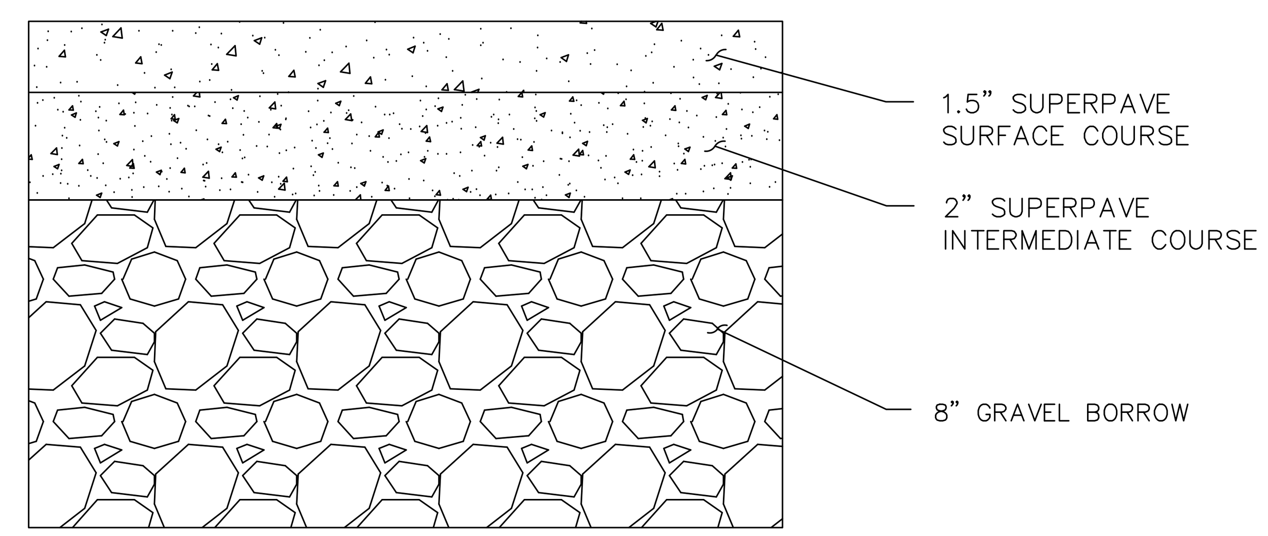
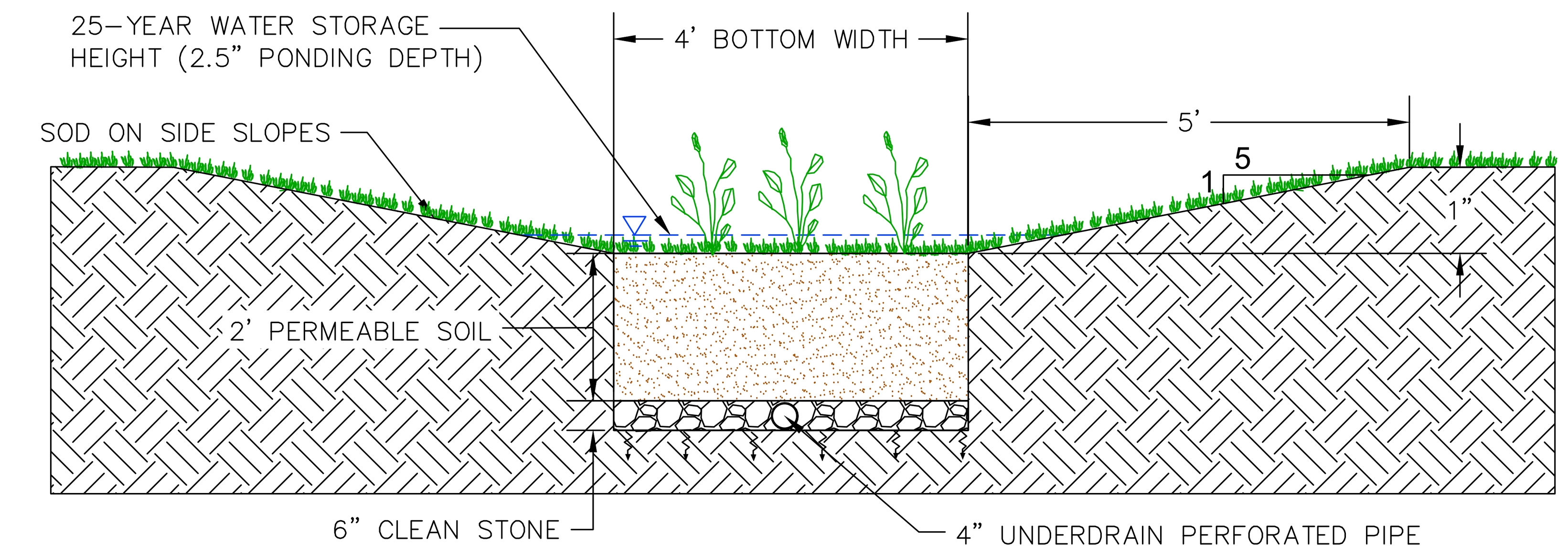


7
C7.1
COMPOSTING TOILET
SCALE: NTS



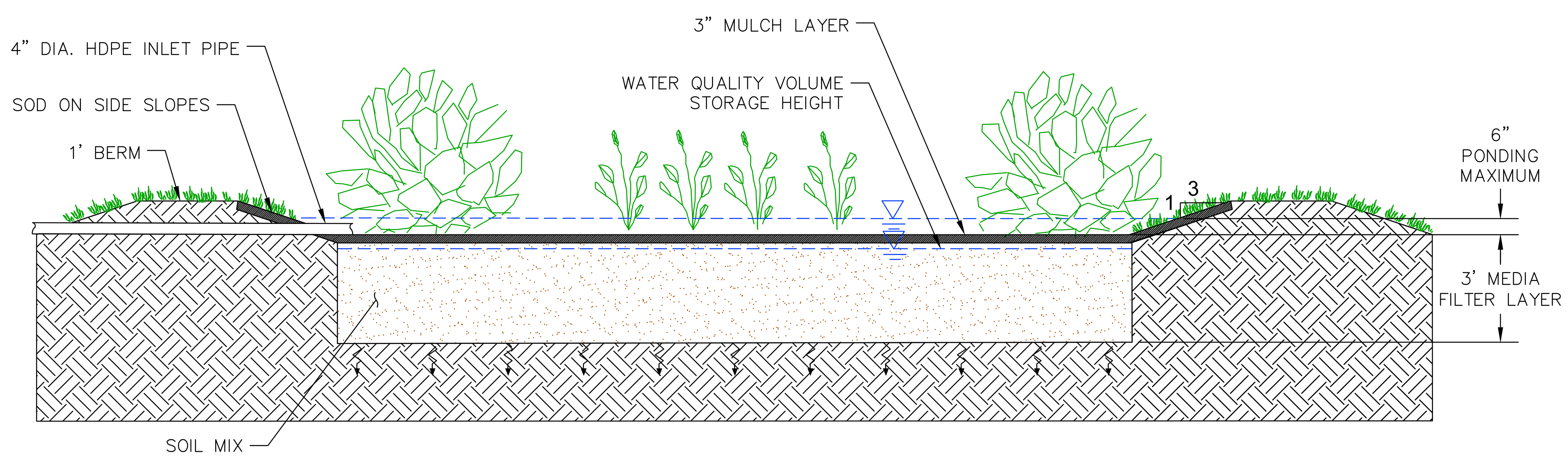
8
C7.0
DRIVEWAY PAVEMENT SECTION VIEW
SCALE: NTS



NOTES:

1. REFER TO THE CONWAY SCHOOL MASTER PLAN FOR APPROPRIATE PLANTING PALETTES.
2. SOIL MIX FOR FILTER LAYER SHALL BE ENGINEERED TO HAVE A VOID RATIO CLOSE TO 0.3, CONSISTING OF LOAM AND SAND.

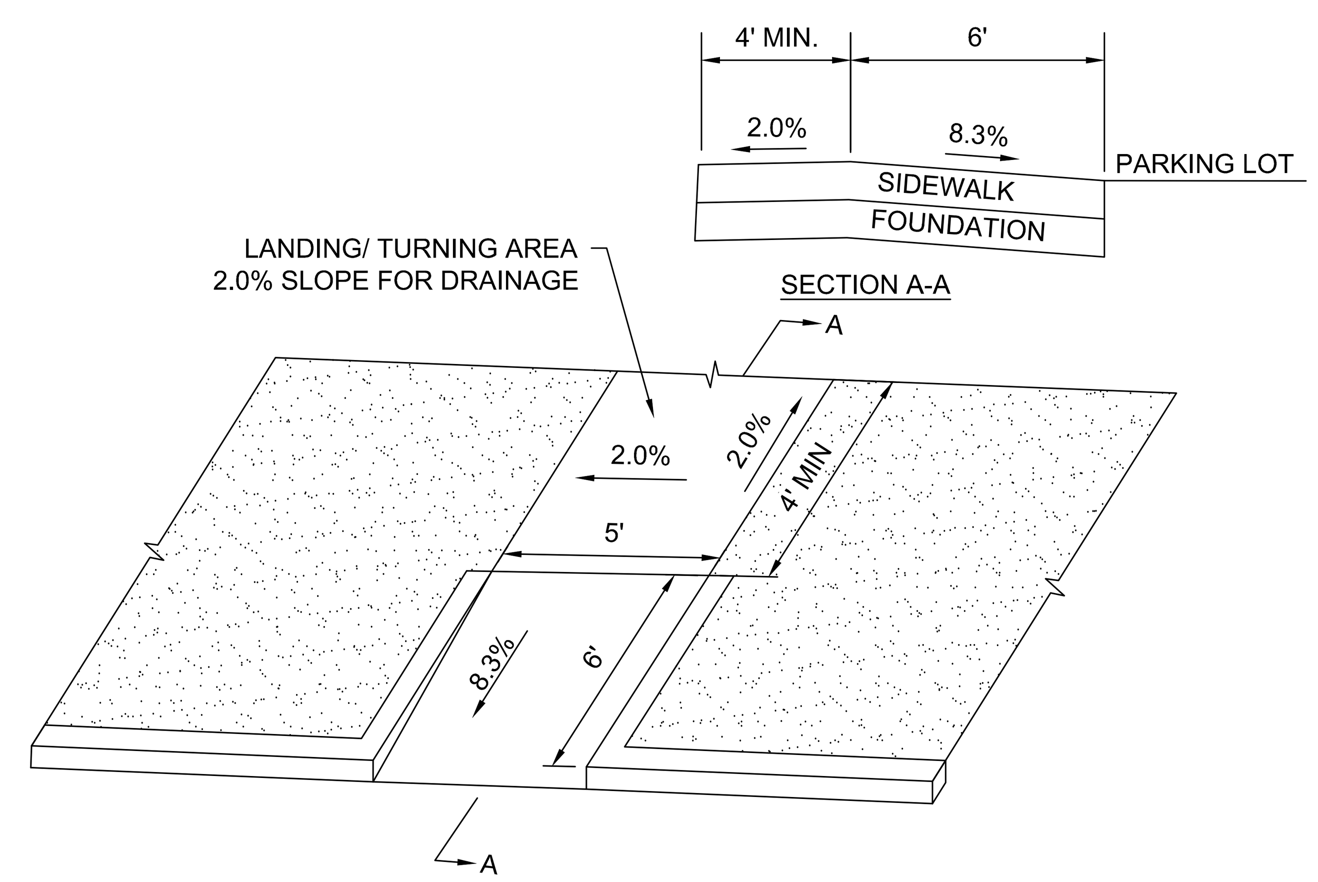
8
C7.1
BIOSWALE SECTION VIEW
SCALE: NTS



NOTES:

1. REFER TO THE CONWAY SCHOOL MASTER PLAN FOR APPROPRIATE PLANTING PALETTES.
2. RAISED BERM SHALL BE FIRM, UNDISTURBED NATIVE SOILS OR DISTURBED COMPACTED SITE SOILS.
3. 3"MULCH LAYER SHALL BE COMPOSED OF WOODY MULCH.
4. SOIL MIX FOR FILTER LAYER SHALL BE ENGINEERED TO HAVE A VOID RATIO CLOSE TO 0.3.

9
C7.1
RAIN GARDEN SECTION VIEW
SCALE: NTS



NOTES:
1. ALL WHEELCHAIR RAMPS SHALL CONFORM TO THE REQUIREMENTS OF THE MASSACHUSETTS ARCHITECTURAL ACCESS BOARD (AAB), THE AMERICANS WITH DISABILITIES ACT (ADA) AND THE LATEST MASSDOT HIGHWAY DIVISION WHEELCHAIR RAMP STANDARDS.
2. THE LOCATIONS OF THE PROPOSED WHEELCHAIR RAMPS ARE SHOWN ON THE CONSTRUCTION ADDITIONAL TYPICAL DETAILS AND WHEELCHAIR RAMP DATA TABLES ARE SHOWN IN THE CONSTRUCTION DETAILS.
3. PROPOSED WHEELCHAIR RAMP SLOPES SHALL BE VERIFIED BY THE CONTRACTOR PRIOR TO THE POURING OF CONCRETE, AND ADJUSTED, IF NECESSARY, TO CONFORM TO THE LATEST ADAAG/PROWAG/MAAB STANDARDS, AS DIRECTED BY THE ENGINEER.
4. ALL PROPOSED CURB FOR WHEELCHAIR RAMP TRANSITIONS SHALL BE CUT AND TRANSITIONED AS NECESSARY TO PROVIDE THE CORRECT TRANSITION LENGTHS FOR EACH WHEELCHAIR RAMP, AS SHOWN ON THE WHEELCHAIR RAMP DETAILS OR AS REQUIRED BY THE ENGINEER. ANY EXISTING CURB INLETS IN AREAS OF NEW WHEELCHAIR RAMP TRANSITIONS SHALL BE REMOVED AND REPLACED WITH APPROPRIATE TRANSITION CURB AS DIRECTED BY THE ENGINEER.
5. IN NO CASE, EXCEPT FOR MAXIMUM LENGTH HIGH SIDE TRANSITIONS (SLOPES GREATER THAN 4%) SHALL ANY TRANSITION SLOPE OF ANY WHEELCHAIR RAMP EXCEED 8.3% OR 1:12.
6. WHEN PLACEMENT OF THE PROPOSED WHEELCHAIR RAMP IS SUCH THAT IT IS UNAVOIDABLE FOR EXISTING STRUCTURES, THAT CANNOT BE MOVED OR RESET, TO BE WITHIN THE WHEELCHAIR RAMP, EXTREME CARE SHALL BE TAKEN SUCH THAT THE EXISTING STRUCTURE IS WITHIN THE RAMP TRANSITIONS ONLY, IF POSSIBLE, WHEN THE NEW WHEELCHAIR RAMP IS PLACED AND THAT A FOUR FOOT WIDE (MIN). CLEAR PATH OF TRAVEL EXISTS BETWEEN THE EXISTING STRUCTURE AND EITHER THE CURBLINE OR THE BACK OF SIDEWALK, AS DIRECTED BY THE ENGINEER.
7. IN RARE INSTANCES WHERE AN EXISTING MANHOLE, HANDHOLE OR OTHER EXISTING "SURFACE" TYPE STRUCTURE WHICH CANNOT BE REMOVED AND RESET, IS WITHIN THE ACTUAL WHEELCHAIR RAMP PATH, THE STRUCTURE SHALL BE CAREFULLY ADJUSTED SUCH THAT THE TOPMOST SURFACES OF THE STRUCTURE COVER SHALL BE FLUSH WITH THE NEW RAMP SURFACE AND SHALL MATCH THE SLOPE OF THE NEW WHEELCHAIR RAMP EXACTLY, AS DIRECTED BY THE ENGINEER.

10
C7.1
CONCRETE ISLAND ACCESS RAMP
SCALE: NTS

Title:
ROCK MEADOW DETAILS
MILL STREET
BELMONT, MA 02478

Prepared for:
BELMONT CONSERVATION COMMISSION
OFFICE OF COMMUNITY DEVELOPMENT

Evergreen Engineering

Prepared by: AL	Date: 17APR2020
Project Mgr: SK	Scale: 1"=20'
Principal: AOH	Project: ROCK MEADOW
File: C7.0 DETAILS.DWG	

C7.1

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Superseded Drawings

Included for Reference Only

3.0	SUPERSEDED Existing Conditions
4.0	SUPERSEDED Existing Surface Profiles
5.0	SUPERSEDED Demolition Plan – Expansion
6.0	SUPERSEDED Demolition Plan – Relocation
7.0	SUPERSEDED Site Plan – Relocation
8.0	SUPERSEDED Site Plan – Expansion
9.0	SUPERSEDED Layout 1 – Expansion
10.0	SUPERSEDED Layout 2 – Relocation

LEGEND

- PROPERTY LINE
- AC PAVEMENT
- UNPAVED/DIRT PATH
- ×170.72 SPOT ELEVATION (EXISTING)
- 200 MAJOR CONTOUR (EXISTING)
- 198 MINOR CONTOUR (EXISTING)
- ST STORM DRAIN LINE
- SANITARY SEWER LINE
- SDCB
- SSMH
- EXISTING IMPERVIOUS AREA
- EXISTING PERVIOUS AREA
- SIGHT LIGHT
- DETECTABLE WARNING SURFACE
- EXISTING TREE

NOTES

1. ALL LOCATIONS AND ELEVATIONS ARE BASED OFF ORTHOPHOTOS AND SURVEY BY ENEL GREEN POWER NORTH AMERICA, INC. (APRIL 11, 2019)

N

20' 0 20'

Title:

ROCK MEADOW EXISTING CONDITIONS

MILL STREET
BELMONT, MA 02478

Prepared for:

BELMONT CONSERVATION COMMISSION
OFFICE OF COMMUNITY DEVELOPMENT

Evergreen Engineering	Prepared by: SK	Date: 10FEB2020	EXHIBIT
	Project Mgr: AOH	Scale: 1"=20'	3
	Principal:	Project: ROCK MEADOW	
	File: C2.0 - EXCOND.DWG		

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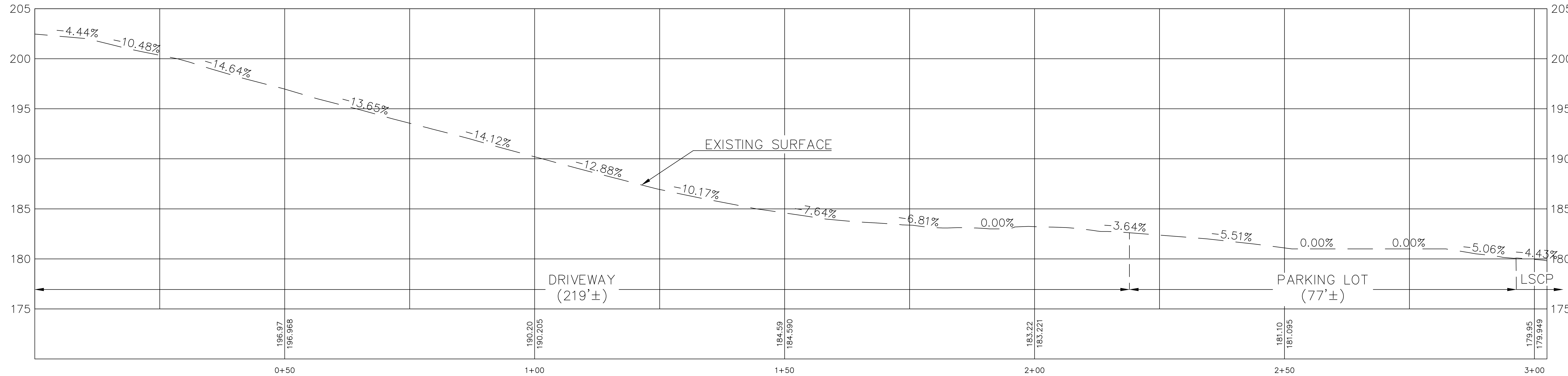
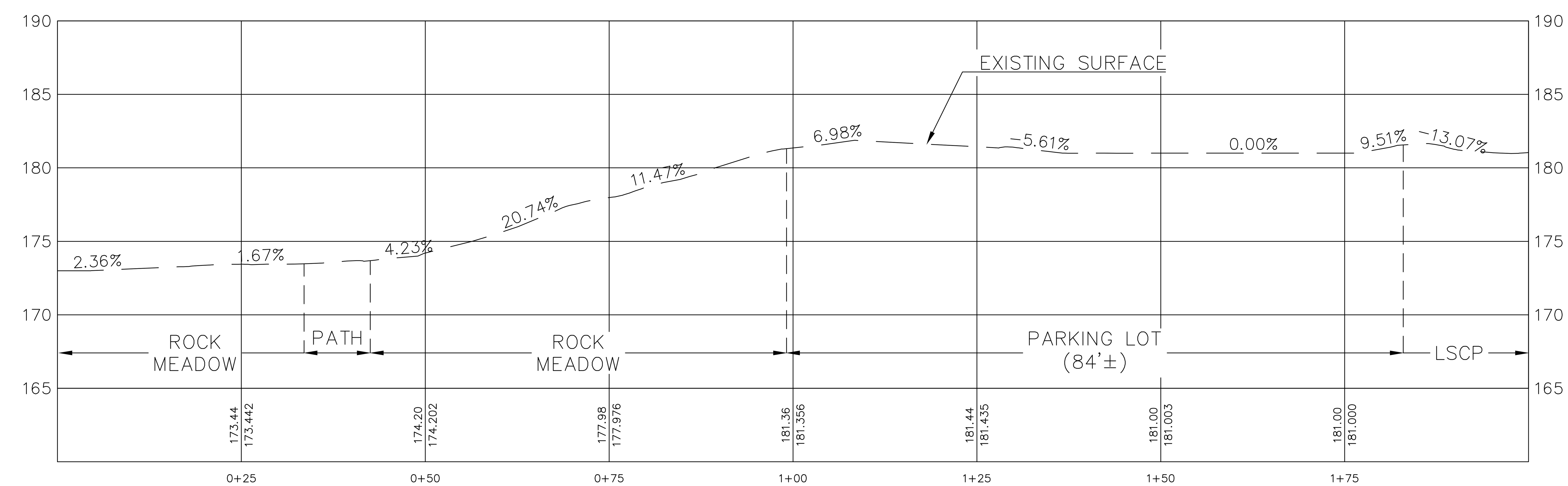


1 C2.1 EXISTING DRIVEWAY AND PARKING LOT PROFILE
SCALE: RELATIVE



1 C2.1 EXISTING PARKING LOT CROSS SECTION
SCALE: RELATIVE

Title:

ROCK MEADOW
EXISTING SURFACE PROFILES

MILL STREET
BELMONT, MA 02478

Prepared for:

BELMONT CONSERVATION COMMISSION
OFFICE OF COMMUNITY DEVELOPMENT

Evergreen Engineering			
	Prepared by: ET	Date: 10FEB2020	EXHIBIT
	Project Mgr: SK	Scale: AS SHOWN	4
	Principal: AOH	Project: ROCK MEADOW	
	File: C2.0 - EXCOND.DWG		

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Title:

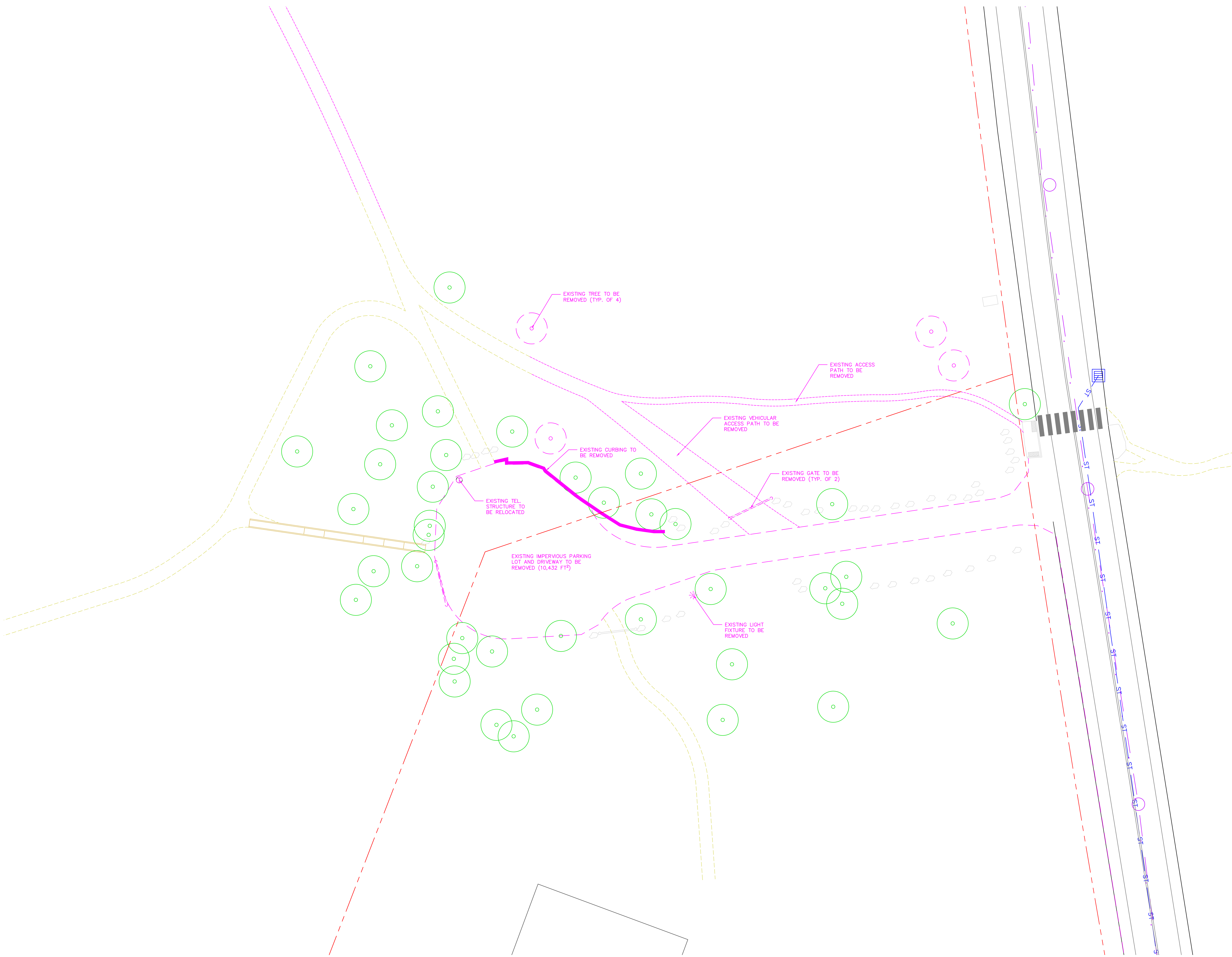
ROCK MEADOW
EXPANSION - DEMOLITION

MILL STREET
BELMONT, MA 02478

Prepared for:

BELMONT CONSERVATION COMMISSION
OFFICE OF COMMUNITY DEVELOPMENT

Evergreen Engineering	Prepared by: AL	Date: 20FEB2020	**EXHIBIT**
	Project Mgr: SK	Scale: 1"=20'	**5**
	Principal: AOH	Project: ROCK MEADOW	



Title:

ROCK MEADOW
RELOCATION - DEMOLITION

MILL STREET
BELMONT, MA 02478

Prepared for:

BELMONT CONSERVATION COMMISSION
OFFICE OF COMMUNITY DEVELOPMENT

Evergreen Engineering			EXHIBIT
	Prepared by: AL	Date: 20FEB2020	6
	Project Mgr: SK	Scale: 1"=20'	
	Principal: AOH	Project: ROCK MEADOW	

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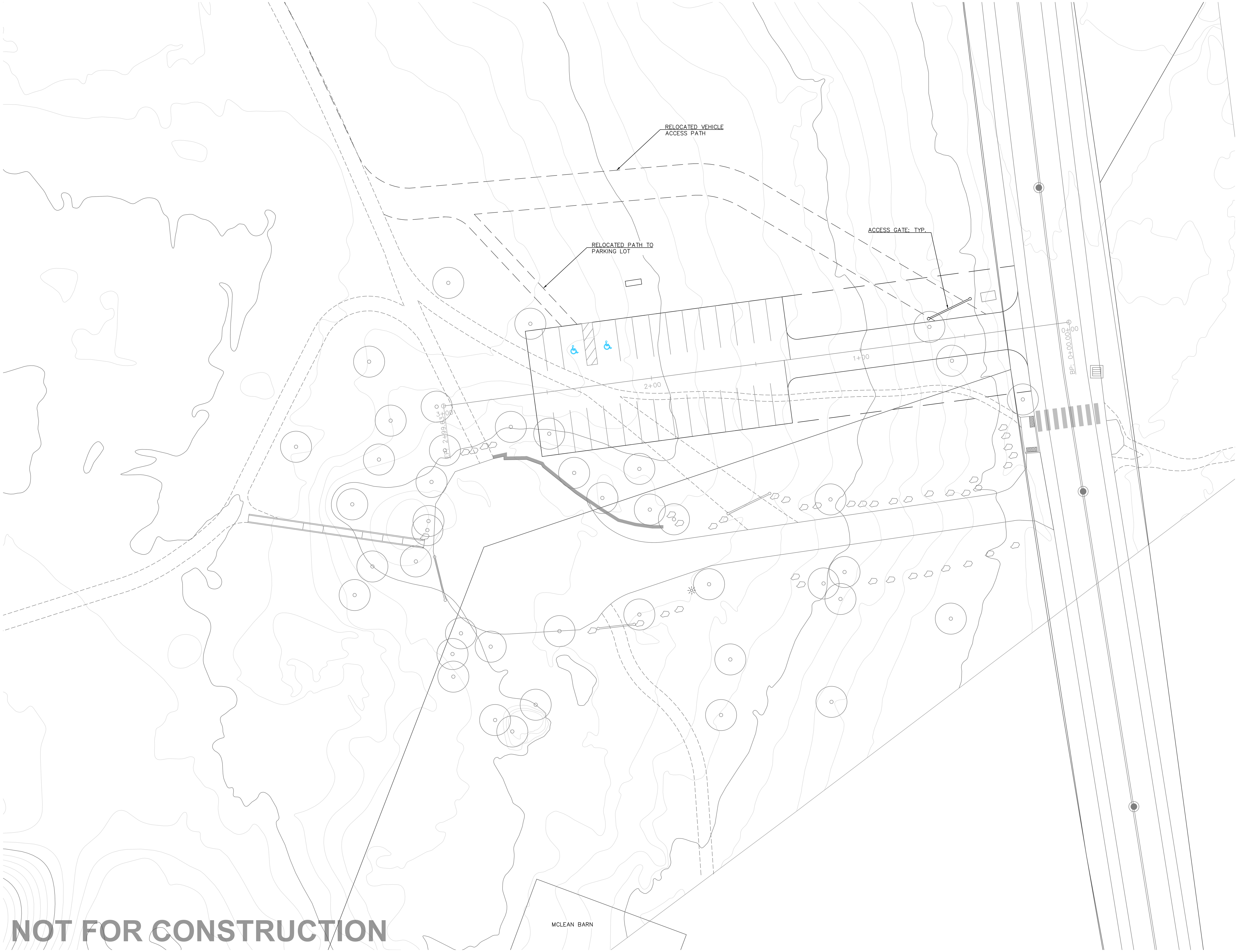


LEGEND

- PROPERTY LINE
- PROPOSED PAVEMENT
- UNPAVED/DIRT PATH (EX)
- ×170.72 SPOT ELEVATION (PR)
- 200 MAJOR CONTOUR (PR)
- 198 MINOR CONTOUR (PR)
- 200 MAJOR CONTOUR (EX)
- 198 MINOR CONTOUR (EX)
- SDCB
- SSMH
- SIGHT LIGHT (EX)
- DETECTABLE WARNING SURFACE
- EXISTING TREE

NOTES

1. ALL LOCATIONS AND ELEVATIONS ARE BASED OFF ORTHOPHOTOS AND SURVEY BY ENEL GREEN POWER NORTH AMERICA, INC. (APRIL 11, 2019)

N

20' 0 20'

Title:

ROCK MEADOW
SITE PLAN - RELOCATION

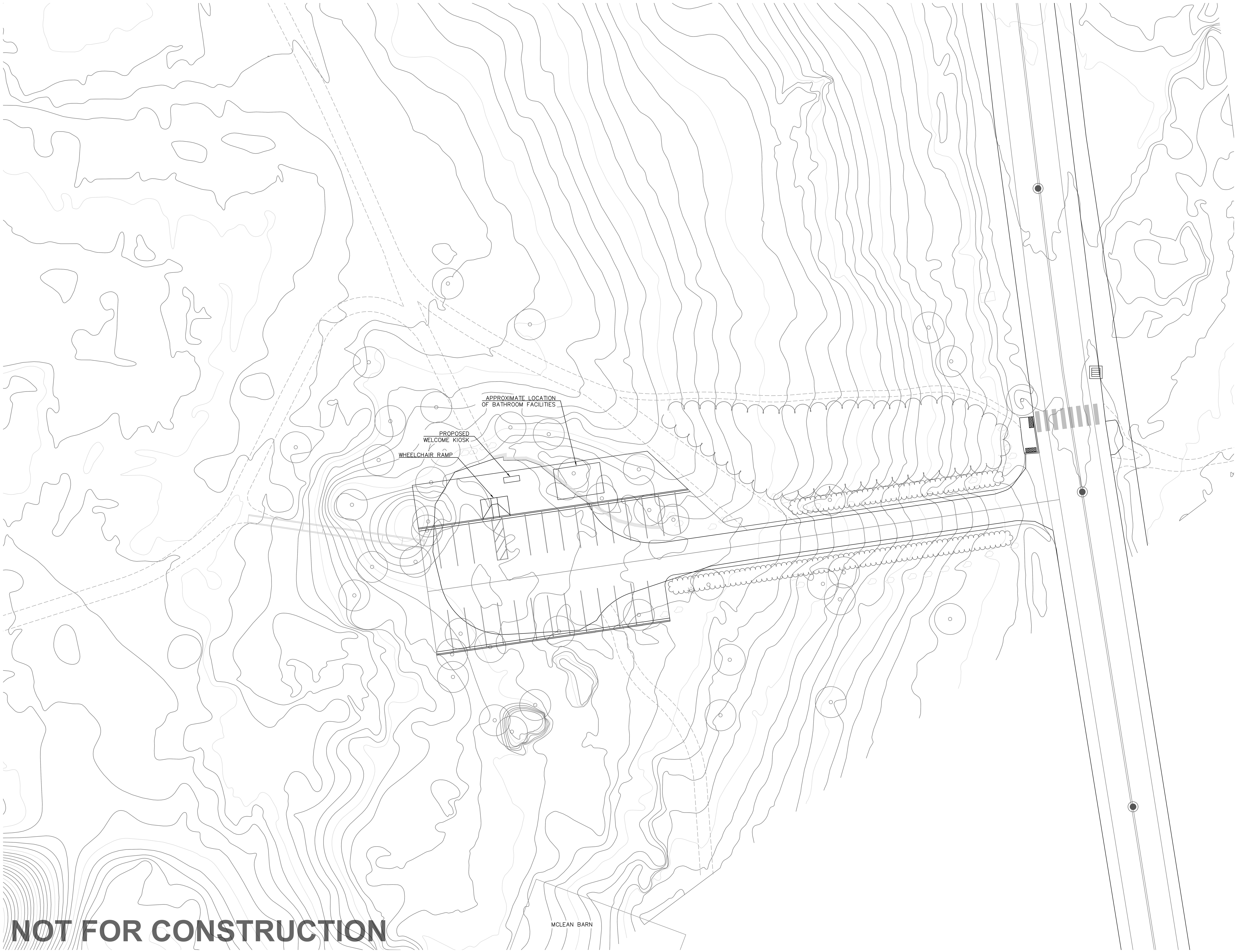
MILL STREET
BELMONT, MA 02478

Prepared for:

BELMONT CONSERVATION COMMISSION
OFFICE OF COMMUNITY DEVELOPMENT

Evergreen Engineering

Prepared by: ET	Date: 28FEB2020	EXHIBIT
Project Mgr: SK	Scale: 1"=20'	7
Principal: AOH	Project: ROCK MEADOW	
File: C4.0 - SITE - RELOC.DWG		



NOT FOR CONSTRUCTION

LEGEND

- PROPERTY LINE
- PROPOSED PAVEMENT
- UNPAVED/DIRT PATH (EX)
- ×170.72 SPOT ELEVATION (PR)
- 200 MAJOR CONTOUR (PR)
- 198 MINOR CONTOUR (PR)
- PARKING PAVEMENT MARKING
- PROPOSED POLLINATOR PATCH/VEGETATION
- VAN ACCESSIBLE ADA PARKING SPACE
- EX SDCB
- EX SSMH
- PROPOSED IMPERVIOUS AREA
- PROPOSED PERVIOUS AREA
- EX SIGHT LIGHT
- DETECTABLE WARNING SURFACE
- EXISTING TREE

NOTES

1. ALL LOCATIONS AND ELEVATIONS ARE BASED OFF ORTHOPHOTOS AND SURVEY BY ENEL GREEN POWER NORTH AMERICA, INC. (APRIL 11, 2019)

N

20' 0 20'

Title:

ROCK MEADOW
SITE PLAN - EXPANSION

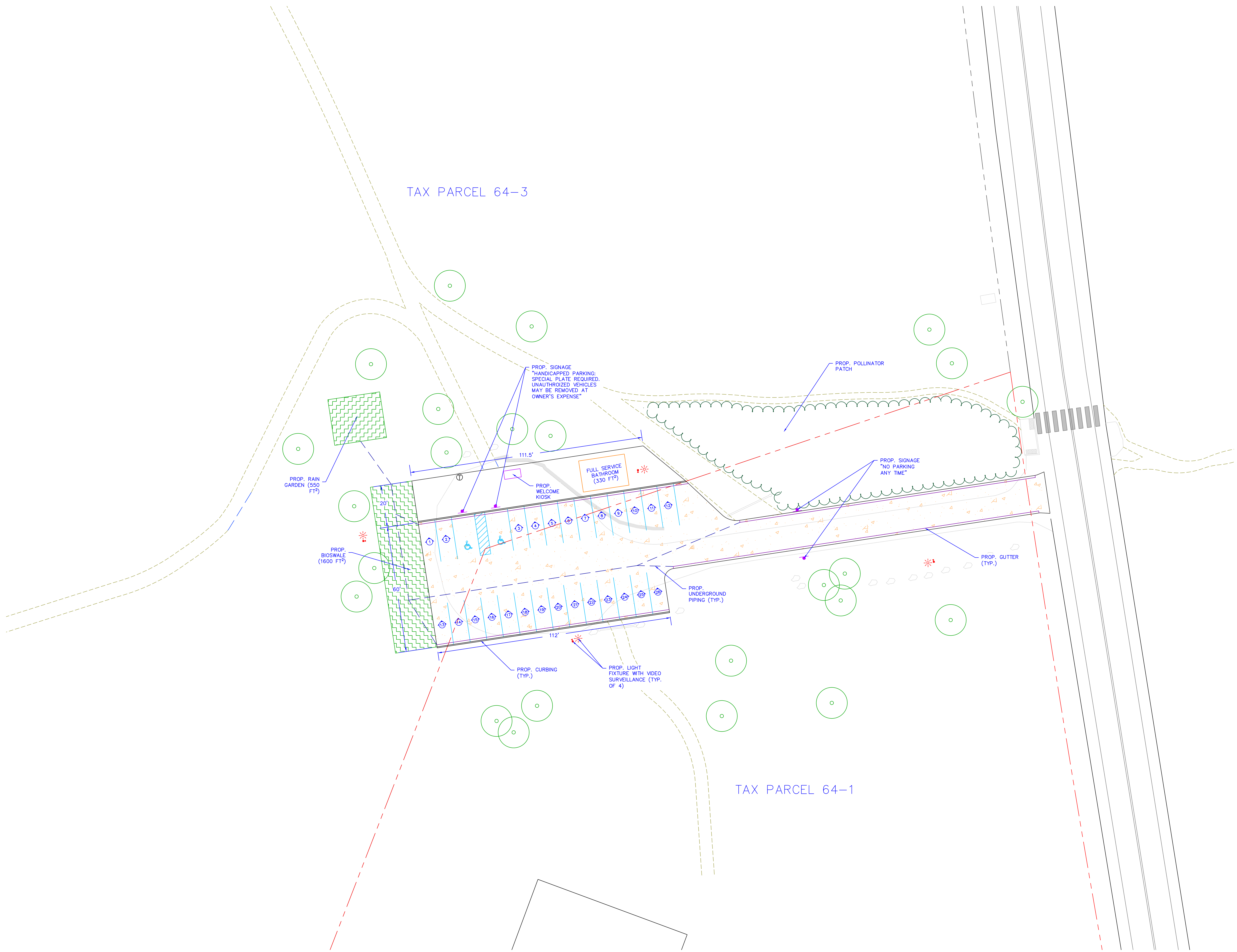
MILL STREET
BELMONT, MA 02478

Prepared for:

BELMONT CONSERVATION COMMISSION
OFFICE OF COMMUNITY DEVELOPMENT

Evergreen Engineering

Prepared by: ET	Date: 28FEB2020	EXHIBIT
Project Mgr: SK	Scale: 1"=20'	8
Principal: AOH	Project: ROCK MEADOW	
File: C4.0 - SITE.DWG		



LEGEND

- PROPERTY LINE
- PROPOSED PARKING LOT AREA
- UNPAVED/DIRT PATH
- PROPOSED UNPAVED/DIRT PATH
- PROPOSED POLLINATOR PATCH (5,600 FT²)
- PROPOSED IMPERVIOUS AREA (10,660 FT²)
- HANDICAP ACCESSIBLE PARKING SPACE
- EXISTING TREE

NOTES

1. ALL LOCATIONS AND ELEVATIONS ARE BASED OFF ORTHOPHOTOS AND SURVEY BY ENEL GREEN POWER NORTH AMERICA, INC. (APRIL 11, 2019)

N

20' 0 20'

Title:

ROCK MEADOW EXPANSION

MILL STREET
BELMONT, MA 02478

Prepared for:

BELMONT CONSERVATION COMMISSION
OFFICE OF COMMUNITY DEVELOPMENT

Evergreen Engineering

Prepared by: AL	Date: 13FEB2020	EXHIBIT
Project Mgr: SK	Scale: 1"=20'	9
Principal: AOH	Project: ROCK MEADOW	
File: EXPANSION - LAYOUT 1.DWG		

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LEGEND

- PROPERTY LINE
- PROPOSED PARKING LOT AREA
- EXISTING UNPAVED/DIRT PATH
- PROPOSED UNPAVED/DIRT PATH
- PROPOSED POLLINATOR PATCH (6,150 FT²)
- PROPOSED IMPERVIOUS AREA (9,330 FT²)
- HANDICAP ACCESSIBLE PARKING SPACE
- EXISTING TREE

NOTES

1. ALL LOCATIONS AND ELEVATIONS ARE BASED OFF ORTHOPHOTOS AND SURVEY BY ENEL GREEN POWER NORTH AMERICA, INC. (APRIL 11, 2019)

20' 0 20'

Title:

ROCK MEADOW
Layout 2

MILL STREET
BELMONT, MA 02478

Prepared for:

BELMONT CONSERVATION COMMISSION
OFFICE OF COMMUNITY DEVELOPMENT

Evergreen Engineering

Prepared by: KE	Date: 13FEB2020	EXHIBIT
Project Mgr: SK	Scale: 1"=20'	10
Principal: AOH	Project: ROCK MEADOW	
File: RELOCATION_CONSERVATIVELAYOUT.DWG		

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PRODUCED BY AN AUTODESK STUDENT VERSION

Appendix B – Hydrology Calculations

APPENDIX B.1 : ALTERNATIVE EVALUATION HYDROLOGY CALCULATIONS

Scenario 1: Existing Conditions

Step 1: Calculate percent of impervious area

Site Drainage Area = 24,918 = 0.000894 mi^2

Impervious Area = 9,249 ft^2

% Impervious Area = $\frac{9{,}249\,ft^2}{24{,}918\,ft^2}$ *100% = 37.12%

Step 2: Find the soil group distribution

HSG	Soil textures
A	Sand, loamy sand, or sandy loam
B	Silt loam or loam
C	Sandy clay loam
D	Clay loam, silty clay loam, sandy clay, silty clay, or clay

Figure B.1. Source: "Urban Hydrology for Small Watersheds," USDA

Our area is defined solely by sandy loam ⇒ 100% A

Step 3: Calculate the curve number

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82

Figure B.2. Source: "Urban Hydrology for Small Watersheds," USDA

The site is classified as an “open space” area. The conditions are good, due to the fact that grass cover is greater than 75%. The weighted curve number was calculated based on the chart above:
CN = (0.3712 * 98) + (0.6288 * 39)= 60.9

Step 4: Measure the flow length
The flow length was defined as the length of the driveway and parking lot.
L = flow length, ft = 257.71 ft

Step 5: Calculate the maximum potential retention
$S = \frac{1000}{CN} - 10 = 6.42\ in$

Step 6: Calculate the average watershed land slope

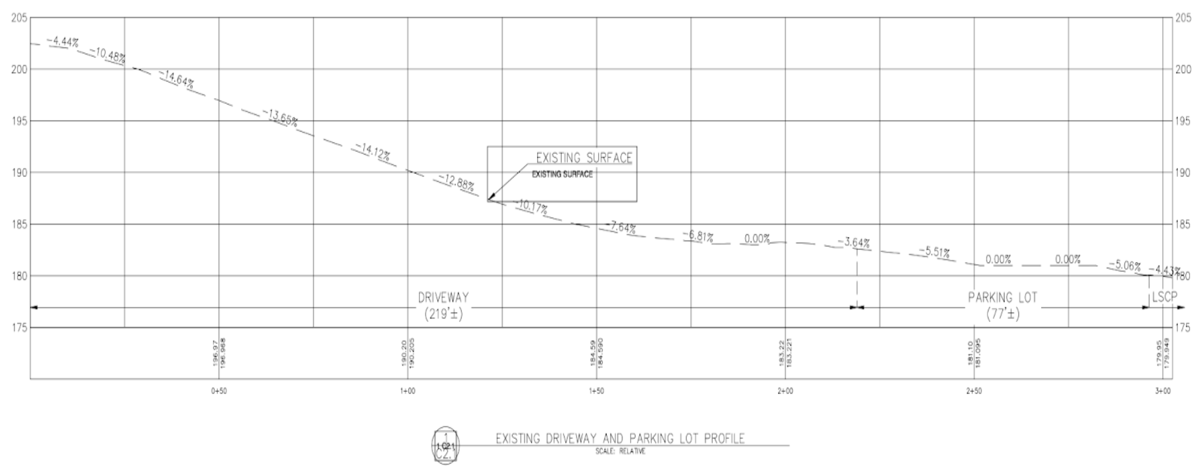

Figure B.3. The existing conditions of the driveway and parking lot profile

Figure B.3 was used to calculate the average watershed land slope.

To calculate Y, the average watershed land slope, %:
Average slope of the impervious area = (0.04165*4.44%) + (0.04165*10.48%) + (0.0833*14.64%) + (0.0833*13.65%) + (0.0833*14.12%) + (0.0833*12.88%) + (0.0833*10.17%) + (0.0833*7.64%) + (0.04165*6.81%) + (0.04165*0%) (0.0833*3.64%) + (0.0833*5.51%) + (0.0833*0%) + (0.0278*0) + (0.0278*0%) + (0.0278*5.06%) + (0.0278*4.43%) + (0.783*4%) = 8.02%

Average slope of the pervious area ⇒ The slopes of the soils are 0 - 8% ⇒ Average = 4%

Overall slope = (percentage of impervious area * average slope of impervious area) + (percentage of pervious area * average slope pervious area) = (0.3712*8.02%) + (0.6288*4%) = 5.49%

Step 7: Calculate the time of concentration

To calculate the time of concentration (T_c) in hours, the following equation is used:

$$T_c = \frac{L^{0.8}(S+1)^{0.7}}{1140Y^{0.5}}$$

Where:

T_c = Time of concentration, hr
L = flow length, ft
Y = Average watershed land slope, %
S = Maximum potential retention, in

Therefore, T_c = 0.129 hrs = 7.76 mins

Step 8: Lag time

$T_{lag} = 0.6T_c$ = 4.66 min

Step 9: Calculate the initial abstraction

Initial abstraction = 0.2S = 1.28 in

Step 10: Input the numbers into HEC-HMS

Scenario 2: Expansion

Step 1: Calculate percent of impervious area

Site drainage area = 24,300 ft^2 = 0.00087 mi^2

Impervious area = 11,026ft^2

% Impervious = $\frac{11{,}026\,ft^2}{24{,}300\,ft^2} * 100\% = 45.4\%$

Step 2: Find the soil group distribution

As above, the area is sandy loam.

Step 3: Calculate/interpolate the curve number

The site is classified as an "open space" area. The conditions are good, due to the fact that grass cover is greater than 75%. The weighted curve number was calculated based on Figure B.2, where the amount of impervious area is 22.47% and the cover type for the impervious area is "paved parking lots":

CN=(0.454*98) + (0.5462*39)= 65.8

Step 4: Measure the flow length

The flow length was defined as the length of the driveway and parking lot.

L = flow length, ft = 299.3 ft

Step 5: Calculate the maximum potential retention

$S = \frac{1000}{CN} - 10 = 5.2$ in

Step 6: Calculate the average watershed land slope
To calculate Y, the average watershed land slope, %:
The new parking lot is designed to have a slope of <5% ⇒ choose 2% complying with Massachusetts Project Development & Design Guide.[1] Assume driveway slope of 10%.
Average slope of the impervious area = (percentage of concrete entrance area * slope of concrete entrance area) + (percentage of parking lot area * slope of parking lot area) + (percentage of driveway area * slope of driveway area) + (percentage of crosswalk platform area * slope of crosswalk platform area) = (0.18*2%) + (0.577*2%) + (0.225*10%) + (0.01*4.5%) = 3.81%
Overall slope = (percentage of impervious area*average slope of impervious area) + (percentage of pervious area*average slope pervious area) = (0.454*3.81%) + (0.5462*4%) = 3.91%

Step 7: Calculate the time of concentration
T_c = 0.135 hr = 8.1 min

Step 8: Calculate the lag time
T_{lag} = 0.6Tc = 4.86 min

Step 9: Calculate the initial abstraction
Initial Abstraction = 0.2S = 1.04 in

Step 10: Input the numbers into HEC-HMS

Scenario 3: Relocation

Step 1: Calculate percent of impervious area
Site drainage area = 14,059 ft^2 = 0.0005 mi^2
Impervious area = 9374 ft^2
% Impervious = $\frac{9374\ ft^2}{14059\, ft^2} * 100\%$ = 66.68%

Step 2: Find the soil group distribution
As above, the area is sandy loam.

Step 3: Calculate/interpolate the curve number
The site is classified as an "open space" area. The conditions are good, due to the fact that grass cover is greater than 75%. The weighted curve number was calculated based on Figure B.2, where the amount of impervious area is 19.68% and the cover type for the impervious area is "paved parking lots":
CN=(0.6668*98) + (0.3332*39)= 78.34

Step 4: Measure the flow length
The flow length was defined as the length of the driveway and parking lot.

---

[1]https://www.mass.gov/doc/2006-project-development-and-design-guide/download?fbclid=IwAR1lf24yGWI8odQwRbl0_Ht2l1B3KdEmXSPT-mNeaF9uilGilWnDyr-86Ag

L = flow length, ft = 234 ft

Step 5: Calculate the maximum potential retention
$S = \frac{1000}{CN} - 10 = 2.76$ in

Step 6: Calculate the average watershed land slope
To calculate Y, the average watershed land slope, %:
Average slope of the impervious area = (percentage of parking lot area x slope of parking lot area) + (percentage of driveway area x slope of driveway area) = (0.53 x 2%) + (0.139 x 10%) = 2.45%

Average slope of the impervious area = (percentage of impervious area x average slope of impervious area) + (percentage of pervious area x average slope pervious area) = (0.6668 x 2.45%) + (0.3332 x 4%) = 2.97%

Step 7: Calculate the time of concentration
$T_c = 0.109$ hr = 0.109*60 = 6.54 min

Step 8: Calculate the lag time
$T_{lag} = 0.6T_c = 3.92$ min

Step 9: Calculate the initial abstraction
Initial abstraction = 0.2S = 0.552 in

Step 10: Input the numbers into HEC-HMS

Input values into HEC-HMS:

Table B.1. HEC-HMS input values for each scenario.

	Scenario 1	**Scenario 2**	**Scenario 3**
Site Drainage Area (mi^2)	0.000894	0.00087	0.0005
Initial Abstraction (in)	1.28	0.776	0.552
Curve Number	78.34	72.07	78.34
Lag Time (min)	4.66	4.12	3.92

Scenario 1: Existing Conditions

Project: current Simulation Run: current 2-yr
Subbasin: Subbasin-1

Start of Run:	01Jan2020, 00:00	Basin Model:	Basin 1
End of Run:	02Jan2020, 23:55	Meteorologic Model:	2-yr
Compute Time:	20Feb2020, 19:14:34	Control Specifications:	Control 1

Volume Units: (•) IN ( ) AC-FT

Computed Results

Peak Discharge:	0.2 (CFS)	Date/Time of Peak Discharge:	01Jan2020, 12:09
Precipitation Volume:	3.21 (IN)	Direct Runoff Volume:	0.45 (IN)
Loss Volume:	2.76 (IN)	Baseflow Volume:	0.00 (IN)
Excess Volume:	0.45 (IN)	Discharge Volume:	0.45 (IN)

Figure B.4. 2-yr, 24-hr

Project: current Simulation Run: current 10-yr
Subbasin: Subbasin-1

Start of Run:	01Jan2020, 00:00	Basin Model:	Basin 1
End of Run:	02Jan2020, 23:55	Meteorologic Model:	10-yr
Compute Time:	20Feb2020, 19:19:04	Control Specifications:	Control 1

Volume Units: (•) IN ( ) AC-FT

Computed Results

Peak Discharge:	0.7 (CFS)	Date/Time of Peak Discharge:	01Jan2020, 12:08
Precipitation Volume:	4.85 (IN)	Direct Runoff Volume:	1.28 (IN)
Loss Volume:	3.57 (IN)	Baseflow Volume:	0.00 (IN)
Excess Volume:	1.28 (IN)	Discharge Volume:	1.28 (IN)

Figure B.5. 10-yr, 24-hr

Project: current Simulation Run: current 25-yr
Subbasin: Subbasin-1

Start of Run:	01Jan2020, 00:00	Basin Model:	Basin 1
End of Run:	02Jan2020, 23:55	Meteorologic Model:	25-yr
Compute Time:	20Feb2020, 19:20:22	Control Specifications:	Control 1

Volume Units: (•) IN ( ) AC-FT

Computed Results

Peak Discharge:	1.2 (CFS)	Date/Time of Peak Discharge:	01Jan2020, 12:07
Precipitation Volume:	6.14 (IN)	Direct Runoff Volume:	2.09 (IN)
Loss Volume:	4.05 (IN)	Baseflow Volume:	0.00 (IN)
Excess Volume:	2.09 (IN)	Discharge Volume:	2.09 (IN)

Figure B.6. 25-yr, 24-hr

Scenario 2: Expansion

Project: expansion   Simulation Run: expansion 2-yr
Subbasin: Subbasin-1

Start of Run:	01Jan2020, 00:00	Basin Model:	Basin 1
End of Run:	02Jan2020, 23:55	Meteorologic Model:	2yr
Compute Time:	20Feb2020, 22:25:02	Control Specifications:	Control 1

Volume Units: (•) IN ( ) AC-FT

Computed Results

Peak Discharge:	0.3 (CFS)	Date/Time of Peak Discharge:	01Jan2020, 12:08
Precipitation Volume:	3.21 (IN)	Direct Runoff Volume:	0.64 (IN)
Loss Volume:	2.57 (IN)	Baseflow Volume:	0.00 (IN)
Excess Volume:	0.64 (IN)	Discharge Volume:	0.64 (IN)

Figure B.7. 2-yr, 24-hr

Project: expansion   Simulation Run: expansion 10-yr
Subbasin: Subbasin-1

Start of Run:	01Jan2020, 00:00	Basin Model:	Basin 1
End of Run:	02Jan2020, 23:55	Meteorologic Model:	10-yr
Compute Time:	20Feb2020, 22:26:04	Control Specifications:	Control 1

Volume Units: (•) IN ( ) AC-FT

Computed Results

Peak Discharge:	0.9 (CFS)	Date/Time of Peak Discharge:	01Jan2020, 12:07
Precipitation Volume:	4.85 (IN)	Direct Runoff Volume:	1.61 (IN)
Loss Volume:	3.24 (IN)	Baseflow Volume:	0.00 (IN)
Excess Volume:	1.61 (IN)	Discharge Volume:	1.61 (IN)

Figure B.8. 10-yr, 24-hr

Project: expansion   Simulation Run: expansion 25-yr
Subbasin: Subbasin-1

Start of Run:	01Jan2020, 00:00	Basin Model:	Basin 1
End of Run:	02Jan2020, 23:55	Meteorologic Model:	25-yr
Compute Time:	20Feb2020, 22:26:52	Control Specifications:	Control 1

Volume Units: (•) IN ( ) AC-FT

Computed Results

Peak Discharge:	1.4 (CFS)	Date/Time of Peak Discharge:	01Jan2020, 12:07
Precipitation Volume:	6.14 (IN)	Direct Runoff Volume:	2.53 (IN)
Loss Volume:	3.61 (IN)	Baseflow Volume:	0.00 (IN)
Excess Volume:	2.53 (IN)	Discharge Volume:	2.53 (IN)

Figure B.9. 25-yr, 24-hr

Scenario 3: Relocation

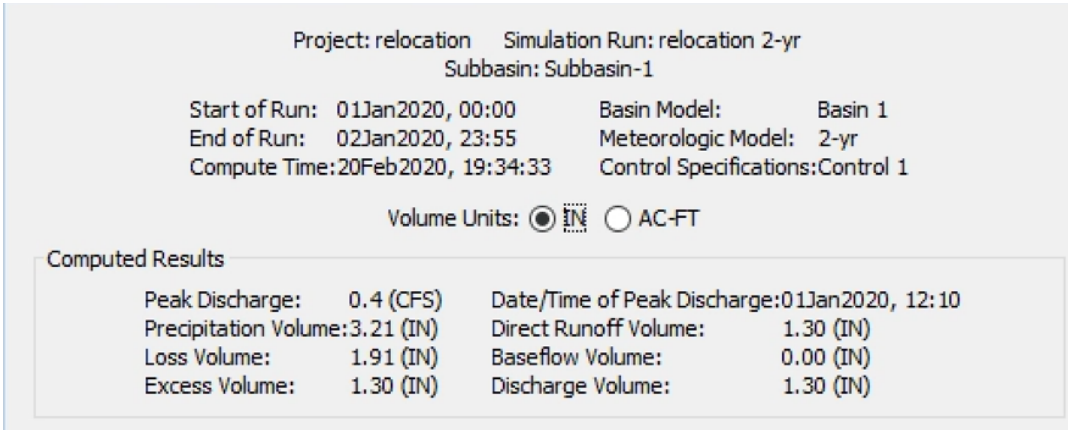

Figure B.10. 2-yr, 24-yr

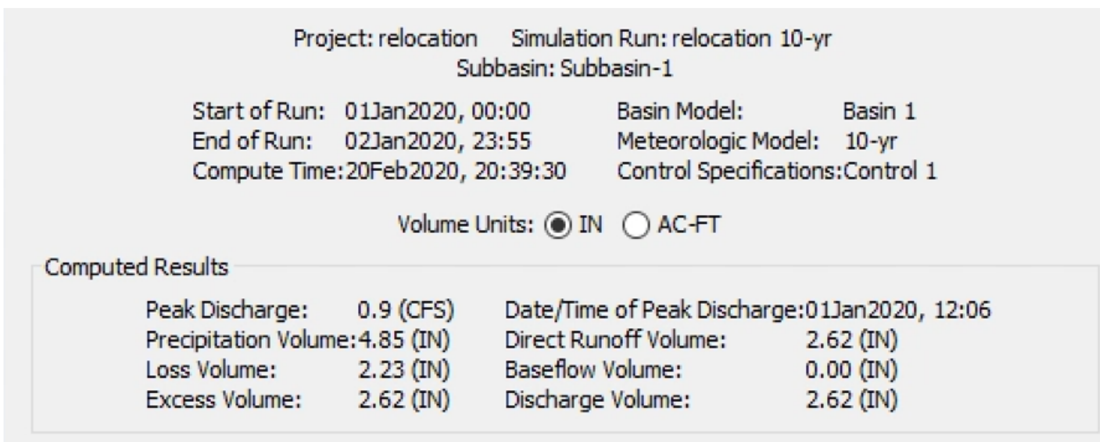

Figure B.11. 10-yr, 24-hr

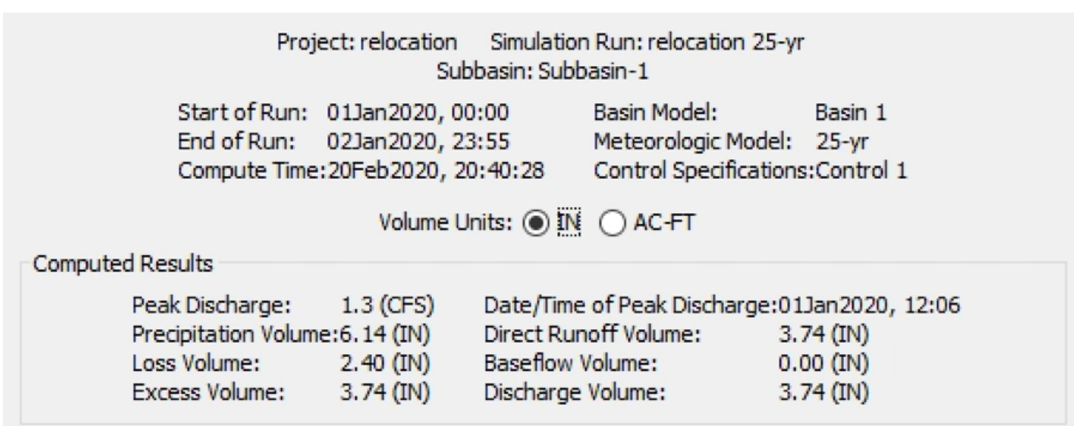

Figure B.12. 25-yr, 24-hr

APPENDIX B.2: FINAL DESIGN HYDROLOGY CALCULATIONS

Existing Driveway:

Step 1: Calculate percent of impervious area
Site Drainage Area = 17,547 ft^2
Impervious Area = 3,627 ft^2
% Impervious Area = $\frac{3,627\,ft^2}{17,547\,ft^2} * 100\% = 20.67\%$

Step 2: Find the soil group distribution
As above, the area is sandy loam.

Step 3: Calculate the curve number
The site is classified as an "open space" area. The conditions are good, due to the fact that grass cover is greater than 75%. The impervious area is classified as a "Paved parking lot". The resulting weighted curve number was calculated based on the chart above:
CN = (0.2067 * 98) + (0.7933 * 39) = 51.2

Step 4: Measure the flow length
L = flow length = 204.2 ft

Step 5: Calculate the maximum potential retention
S = $\frac{1000}{CN} - 10 = 9.53\ in$

Step 6: Calculate the average watershed land slope
Figure B.3 was used to calculate the average watershed land slope for the impervious area.

To calculate Y, the average watershed land slope:
Average slope of the impervious area = (0.04165*4.44%) + (0.04165*10.48%) + (0.0833*14.64%) + (0.0833*13.65%) + (0.0833*14.12%) + (0.0833*12.88%) + (0.0833*10.17%) + (0.0833*7.64%) + (0.04165*6.81%) + (0.04165*0%) + (0.0833*3.64%) = 7.3%

Overall average slope = (fraction of impervious area * average slope of impervious area) + (fraction of pervious area * average slope pervious area) = (0.2067 * 7.3%) + (0.7933 * 4%) = 4.68%

Step 7: Calculate the time of concentration
T_c = 0.148 hr = 8.9 min

Step 8: Calculate the lag time
$T_{lag} = 0.6T_c$ = 5.34 min

Step 9: Calculate the initial abstraction
Initial abstraction = 0.2S = 1.906 in

Step 10: Input the numbers into HEC-HMS

Existing Parking Lot:

Step 1: Calculate percent of impervious area
Site Drainage Area = 7,370.6 ft^2
Impervious Area = 5,622 ft^2
% Impervious Area = $\frac{5{,}622\, ft^2}{7{,}370.6\, ft^2} * 100\% = 76.28\%$

Step 2: Find the soil group distribution
As above, the area is sandy loam.

Step 3: Calculate/interpolate the curve number
The site is classified as an "open space" area. The conditions are good, due to the fact that grass cover is greater than 75%. The weighted curve number was calculated based on Figure B.2, where the amount of impervious area is 76.28% and the cover type for the impervious area is "paved parking lots":
CN = (0.7628*98) + (0.2372*39)= 84

Step 4: Measure the flow length
L = flow length = 53.51 ft

Step 5: Calculate the maximum potential retention
S = $\frac{1000}{CN} - 10 = 1.905\ in$

Step 6: Calculate the average watershed land slope
Figure AB.3 was used to calculate the average watershed land slope.

To calculate Y, the average watershed land slope:
Average slope of the impervious area = (0.0833*5.51%) + (0.0833*0%) + (0.0278*0) + (0.0278*0%) + (0.0278*5.06%) + (0.0278*4.43%) + (0.783*4%) = 3.85%

Overall average slope = (fraction of impervious area * average slope of impervious area) + (fraction of pervious area * average slope pervious area) = (0.7628 * 3.85%) + (0.2372 * 4%) = 3.88%
Step 7: Calculate the time of concentration
T_c = 0.023 hr = 1.366 min

Step 8: Calculate the lag time
T_{lag} = 0.6Tc = 0.82 min

Step 9: Calculate the initial abstraction
Initial Abstraction = 0.2S = 0.381 in

Step 10: Input the values into HEC-HMS

Proposed Driveway Area:

Step 1: Calculate percent of impervious area
Site drainage area = 12,595.5 ft^2
Impervious area = Driveway + Crosswalk platform = 30,50 ft^2 + 144 ft^2 = 3,194 ft^2
% Impervious = $\frac{3,194\, ft^2}{12,595.5\, ft^2} * 100\% = 25.36\%$

Step 2: Find the soil group distribution
As above, the area is sandy loam.

Step 3: Calculate/interpolate the curve number
The site is classified as an "open space" area. The conditions are good, due to the fact that grass cover is greater than 75%. The weighted curve number was calculated based on Figure B.2, where the amount of impervious area is 22.47% and the cover type for the impervious area is "paved parking lots."
CN = (0.2536*98) + (0.7464*39)= 53.96

Step 4: Measure the flow length
L = flow length = 155.5 ft

Step 5: Calculate the maximum potential retention
$S = \frac{1000}{CN} - 10 = 8.53$ in

Step 6: Calculate the average watershed land slope
Y = Overall average slope = (fraction of driveway * slope of driveway) + (fraction of crosswalk platform) + (fraction of pervious area * average slope pervious area) = (0.243 * 10%) + (0.0114 * 4.5%) + (0.7464 * 4%) = 5.47%

Step 7: Calculate the time of concentration
T_c = 0.103 hr = 6.18 min

Step 8: Calculate the lag time
T_{lag} = 0.6Tc = 3.71 min

Step 9: Calculate the initial abstraction
Initial Abstraction = 0.2S = 1.706

Step 10: Input the numbers into HEC-HMS

Proposed Parking Lot Area:

Step 1: Calculate percent of impervious area
Site drainage area = 11,615.4 ft^2
Impervious area = 7,832 ft^2
% Impervious = $\frac{7,832\, ft^2}{11,615.4\, ft2} * 100\% = 67.43\%$

Step 2: Find the soil group distribution
As above, the area is sandy loam.

Step 3: Calculate/interpolate the curve number
The site is classified as an "open space" area. The conditions are good, due to the fact that grass cover is greater than 75%. The weighted curve number was calculated based on Figure B.2, where the amount of impervious area is 67.43% and the cover type for the impervious area is "paved parking lots":
CN = (0.6743*98) + (0.3257*39) = 78.78

Step 4: Measure the flow length
The flow length was defined as the length of the driveway and parking lot.
L = flow length = 143.4 ft

Step 5: Calculate the maximum potential retention
S = $\frac{1000}{CN} - 10$ = 2.69 in

Step 6: Calculate the average watershed land slope
Y = Overall average slope = (fraction of impervious area * slope of impervious area) + (fraction of pervious area * average slope pervious area) = (0.6743 * 2%) + (0.3257 * 4%) = 2.65%

Step 7: Calculate the time of concentration
T_c = 0.07 hrs = 4.283 mins

Step 8: Lag time
$T_{lag} = 0.6T_c$ = 2.57 min

Step 9: Calculate the initial abstraction
Initial abstraction = 0.2S = 0.538 in

Step 10: Input the numbers into HEC-HMS

	Existing Driveway	**Existing Parking Lot**	**Expansion Driveway**	**Expansion Parking Lot**
Site Drainage Area (sq mi)	0.00063	0.000264	0.00045	0.000417
Initial Abstraction (in)	1.906	0.381	1.706	0.538
Curve Number	51.2	84	53.96	78.78
Lag Time (min)	5.34	0.82	3.71	2.57

Existing Driveway:

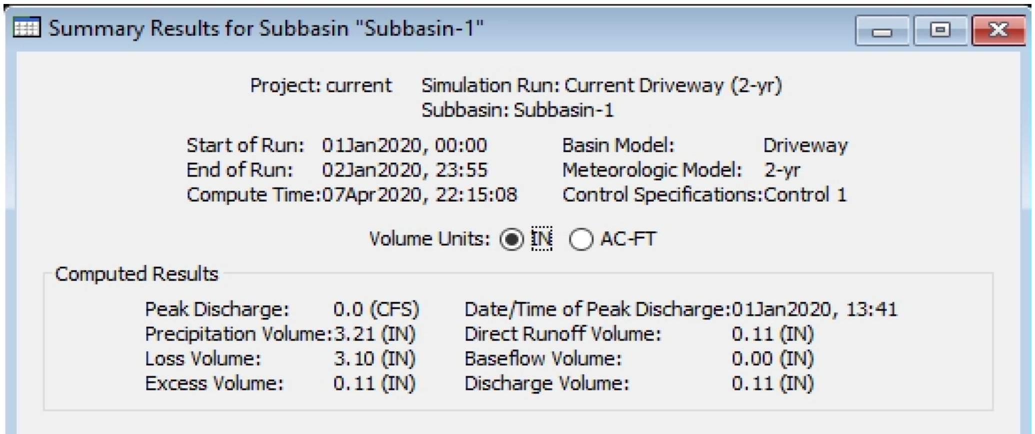

Figure B.13. Existing Driveway: 2-yr, 24-hr

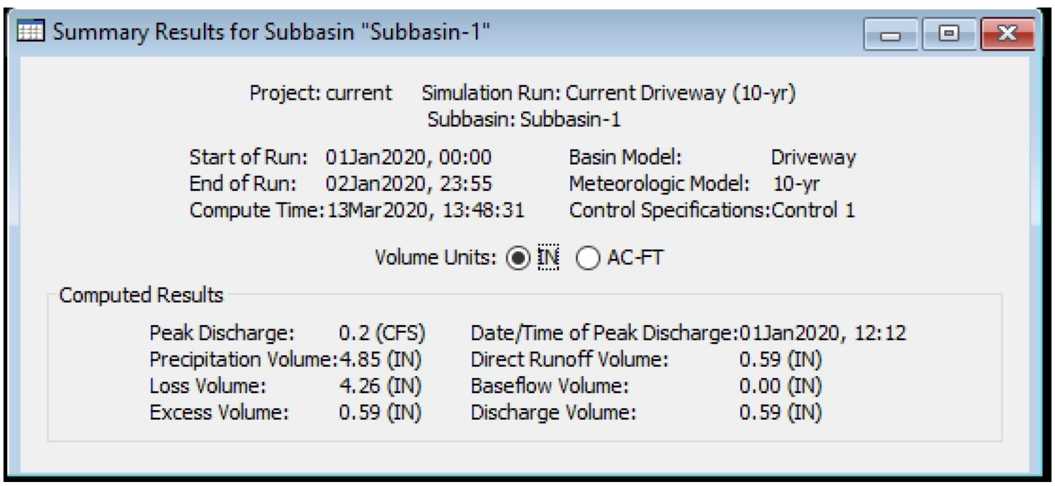

Figure B.14. Existing Driveway: 10-yr, 24-hr

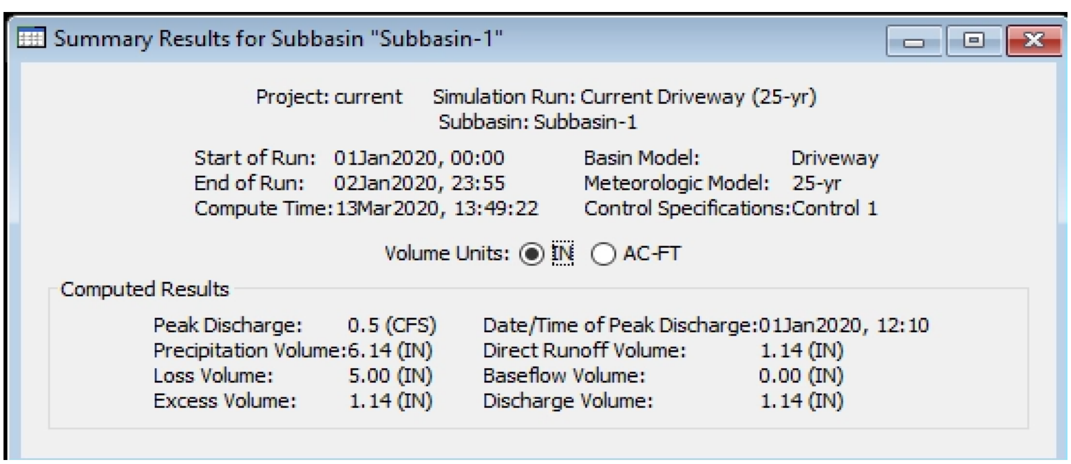

Figure B.15. Existing Driveway: 25-yr, 24-hr

Existing Parking Lot:

Project: current Simulation Run: Current Parking Lot (2-yr)
Subbasin: Subbasin-1

Start of Run:	01Jan2020, 00:00	Basin Model:	Parking Lot
End of Run:	02Jan2020, 23:55	Meteorologic Model:	2-yr
Compute Time:	13Mar2020, 13:50:21	Control Specifications:	Control 1

Volume Units: (•) IN ( ) AC-FT

Computed Results

Peak Discharge:	0.2 (CFS)	Date/Time of Peak Discharge:	01Jan2020, 12:04
Precipitation Volume:	3.21 (IN)	Direct Runoff Volume:	0.99 (IN)
Loss Volume:	2.22 (IN)	Baseflow Volume:	0.00 (IN)
Excess Volume:	0.99 (IN)	Discharge Volume:	0.99 (IN)

Figure B.16. Existing Parking Lot: 2-yr, 24-hr

Project: current Simulation Run: Current Parking Lot (10-yr)
Subbasin: Subbasin-1

Start of Run:	01Jan2020, 00:00	Basin Model:	Parking Lot
End of Run:	02Jan2020, 23:55	Meteorologic Model:	10-yr
Compute Time:	13Mar2020, 13:51:14	Control Specifications:	Control 1

Volume Units: (•) IN ( ) AC-FT

Computed Results

Peak Discharge:	0.5 (CFS)	Date/Time of Peak Discharge:	01Jan2020, 12:03
Precipitation Volume:	4.85 (IN)	Direct Runoff Volume:	2.17 (IN)
Loss Volume:	2.68 (IN)	Baseflow Volume:	0.00 (IN)
Excess Volume:	2.17 (IN)	Discharge Volume:	2.17 (IN)

Figure B.17. Existing Parking Lot: 10-yr, 24-hr

Project: current Simulation Run: Current Parking Lot (25-yr)
Subbasin: Subbasin-1

Start of Run:	01Jan2020, 00:00	Basin Model:	Parking Lot
End of Run:	02Jan2020, 23:55	Meteorologic Model:	25-yr
Compute Time:	13Mar2020, 13:53:34	Control Specifications:	Control 1

Volume Units: (•) IN ( ) AC-FT

Computed Results

Peak Discharge:	0.8 (CFS)	Date/Time of Peak Discharge:	01Jan2020, 12:03
Precipitation Volume:	6.14 (IN)	Direct Runoff Volume:	3.21 (IN)
Loss Volume:	2.93 (IN)	Baseflow Volume:	0.00 (IN)
Excess Volume:	3.21 (IN)	Discharge Volume:	3.21 (IN)

Figure B.18. Existing Parking Lot: 25-yr, 24-hr

Proposed Driveway Area:

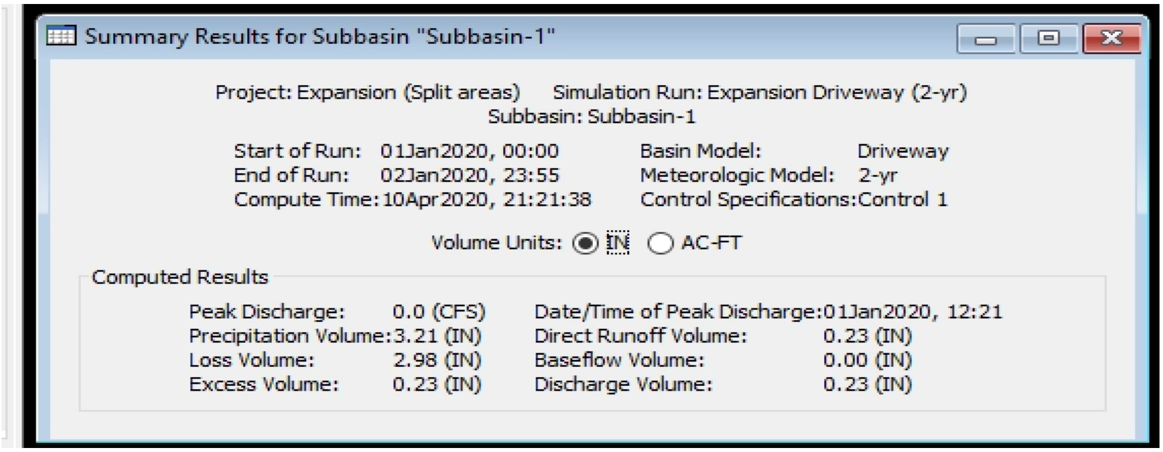

Figure B.19. Proposed Driveway: 2-yr, 24-hr

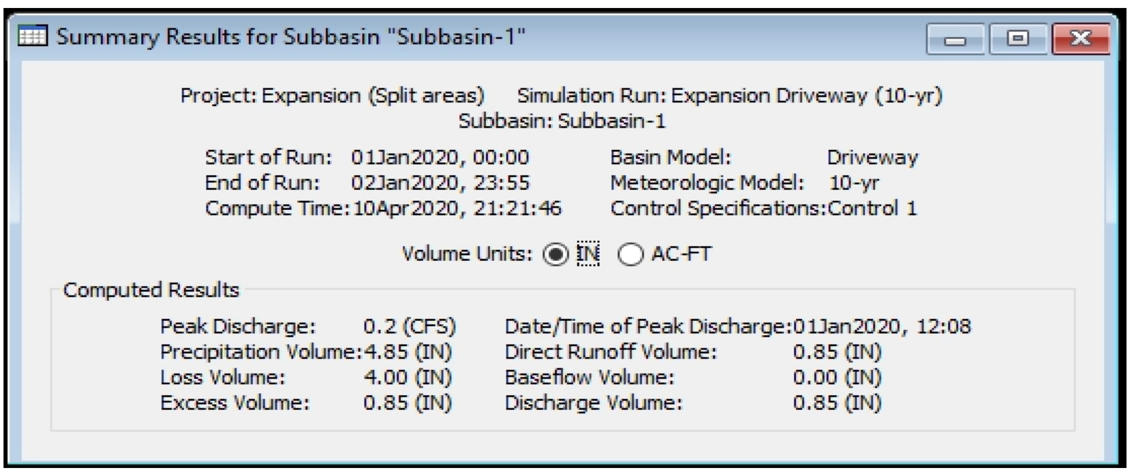

Figure B.20. Proposed Driveway: 10-yr, 24-hr

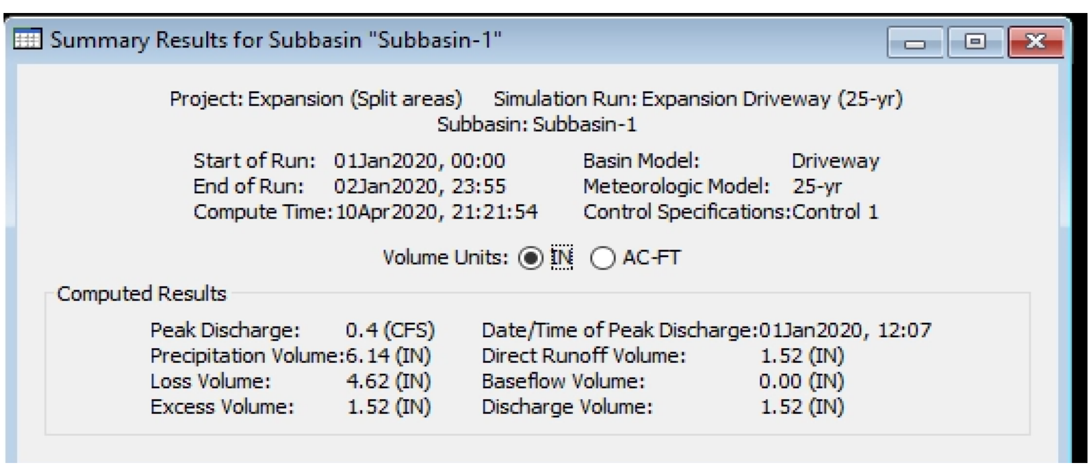

Figure B.21. Proposed Driveway: 25-yr, 24-hr

Proposed Parking Lot Area:

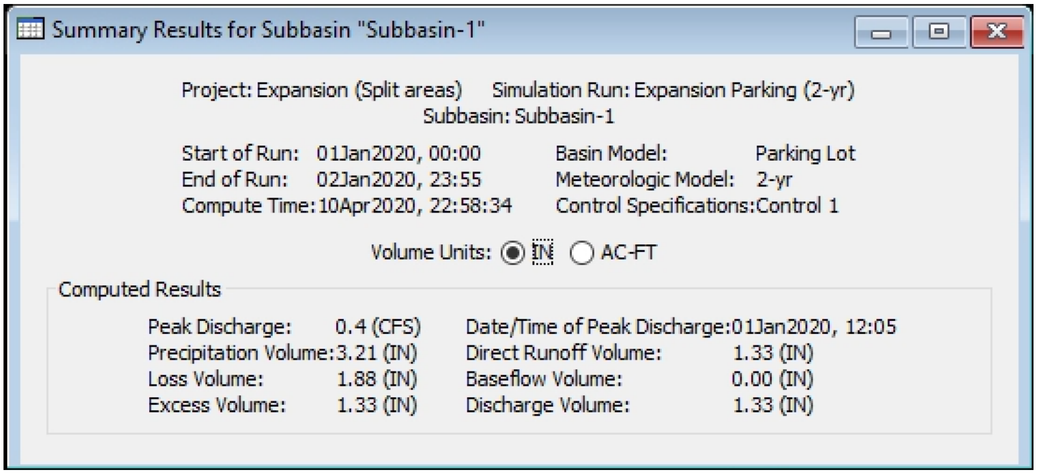

Figure B.22. Proposed Parking Lot: 2-yr, 24-hr

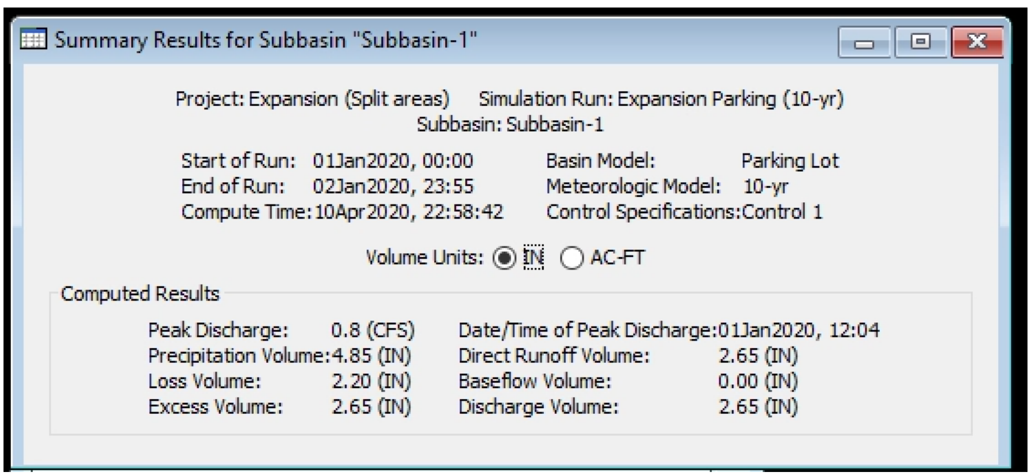

Figure B.23. Proposed Parking Lot: 10-yr, 24-hr

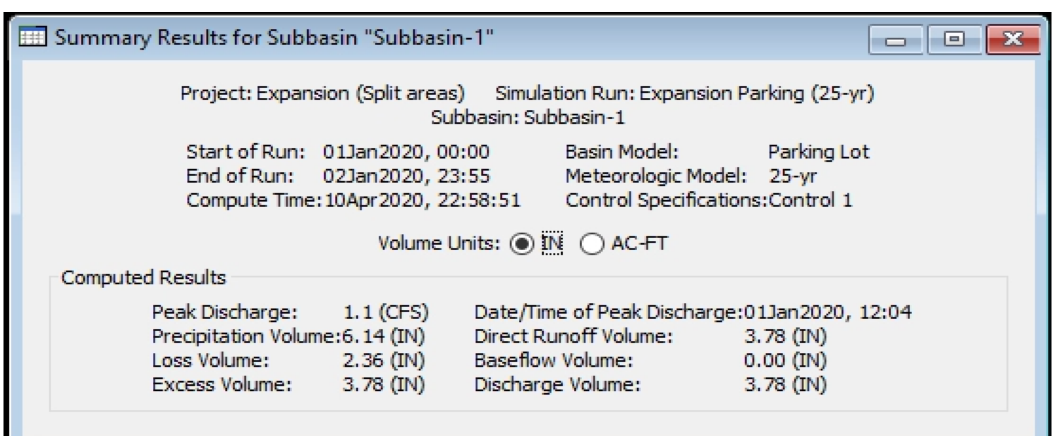

Figure B.24. Proposed Parking Lot: 25-yr, 24-hr

Appendix C – Stormwater BMP Sizing Calculations

APPENDIX C: STORMWATER BMP SIZING CALCULATIONS

Vegetated Filter Strip:

Table C.1. Discharge entering the filter strip in each design storm (See Appendix B.2).

Design Storm	Peak Discharge (cfs)
2-year	N/A
10-year	0.2
25-year	0.4

Step 1: Determine width of filter strip
Flow path = 100 ft
Minimum required width = 0.2*100 ft > 8 ft = 20 ft
Minimum width for 10% TSS removal = 25 ft
Minimum width for 45% TSS removal = 50 ft
Design width chosen as 50 ft
50 ft > 20 ft

Step 2: Determine flow velocity across filter strip
Design slope = 0.11
Hydraulic radius = 0.5 in (based on recommendations from MAPC)
Roughness coefficient = 0.2 for mowed grass slope
Manning's equation:

$$v = (1.496/n)*R_h^{2/3}*S^{1/2}$$

$$v = (1.496/0.2)*(0.5/12)^{2/3}*0.11^{1/2} = \mathbf{0.298\ ft/s}$$

Calculate for each design storm using depth as hydraulic radius:
2-year storm depth = Qp/l = (N/a)/36.5 ft = N/a
2-year storm velocity = N/a
10-year storm depth = 0.2 cfs/36.5 ft = 0.0055 ft^2/s = 0.0055 ft depth per square ft
10-year storm velocity = $(1.496/0.2)*(0.0055)^{2/3}*0.11^{1/2}$ = **0.077 ft/s**
25-year storm depth = 0.4 cfs/36.5 ft = 0.011 ft^2/s = 0.011 ft depth per square ft
25-year storm velocity = $(1.496/0.2)*(0.011)^{2/3}*0.11^{1/2}$ = **0.122 ft/s**

Bioswale:

Table C.2. Discharge entering the bioswale in each design storm (See Appendix B.2).

Design Storm	Peak Discharge (cfs)
2-year	0.2
10-year	0.4
25-year	0.8

Step 1: Determine water quality volume based on treatment requirements

Bioswale is designed for the parking lot area.

Site area = 11,472 ft^2

Impervious area = 8020.5 ft^2 = 0.1841 ac

Treatment volume = 1 in * 0.1841 ac = 0.1841 ac-in = 668.28 ft^3

Water quality volume = **668.28 ft^3**

Step 2: Determine cross-sectional area of practice

Bottom width = 4 ft

Top width = 14 ft

Side slopes 5:1

Cross-sectional area = **9 ft^2**

Determine cross-section of flow for each design storm:

2-year flow depth (d) per ft: $5d^2+48d = (0.4 \text{ cfs}*144 \text{ in}^2/\text{ft}^2)$

$d = 1.08$ in

2-year Pw = $[(26 * 1.08 \text{ in})^{½}*2+48 \text{ in}]/12$ in/ft = 4.917 ft

10-year flow depth (d) per ft: $5d^2+48d = (0.8 \text{ cfs}*144 \text{ in}^2/\text{ft}^2)$

$d = 1.99$ in

10-year Pw = $[(26 * 1.99 \text{ in})^{½}*2+48 \text{ in}]/12$ in/ft = 5.69 ft

25-year flow depth (d) per ft: $5d^2+48d = (1.1 \text{ cfs}*144 \text{ in}^2/\text{ft}^2)$

$d = 2.6$ in

25-year Pw = $[(26 * 2.6 \text{ in})^{½}*2+48 \text{ in}]/12$ in/ft = 6.21 ft

Step 3: Check sizing for water quality volume

Swale length = 80 ft

Swale volume = 9 ft^2 * 80 ft = 720 ft^3

720 ft^3 > 668.28 ft^3

Step 4: Check depth for 25-year storm

Max allowed ponding = 4 in

2.6 in < 4 in

Step 5: Determine flow velocity

Design slope = 0.02

Hydraulic radius = 9 ft^2/14.20 ft = 0.634 ft

Roughness coefficient = 0.2

Manning's equation:

$v = (1.496/0.2)*0.634^{2/3}*0.02^{1/2} =$ **0.78 ft/s**

2-year velocity = $(1.496/0.2)*(4.917/0.4)^{2/3}*0.02^{1/2} =$ **0.199 ft/s**

10-year velocity = $(1.496/0.2)*(5.69/0.8)^{2/3}*0.02^{1/2} =$ **0.286 ft/s**

25-year velocity = $(1.496/0.2)*(6.21/1.1)^{2/3}*0.02^{1/2} =$ **0.334 ft/s**

Step 6: Determine drainage time

Subsurface planting soil depth = 24 in

Surface depth of swale = 12 in

Allowable surface water depth = 4 in

Planting soil void ratio = 0.3

Planting soil infiltration rate = 0.8 in/hr

In-situ soil infiltration rate = 0.4 in/hr

Subsurface drainage time = (24 in*0.3)/0.4 in/hr = **18 hr**

Full surface drainage time = 12 in/0.8 in/hr = **15 hr**

4 in depth surface drainage time = 0.4 in/0.8 in/hr = **0.5 hr**

Rain Garden:

Table C.3. Runoff depths over the area draining to the rain garden (See Appendix B.2).

Design Storm	Runoff Depth (in)
2-year	1.33
10-year	2.65
25-year	3.78

Step 1: Determine water quality volume based on recharge requirements
Rain garden is designed for the parking lot area.
Site area = 11,472 ft^2
Impervious area = 8020.5 ft^2 = 0.1841 ac
Recharge volume = 0.6 in * 0.1841 ac = 0.110 ac-in = 401.025 ft^3
Water quality volume = **401.0 ft^3**

Step 2: Determine depth of practice
Maximum allowed drainage time = 72 hrs
In-situ soil infiltration rate = 0.4 in/hr
Void ratio of planting soil = 0.3
Minimum soil depth for planting shrubs = 30 in
Design soil depth = **36 in = 3 ft**
Water depth in soil layer = 0.3*36 in = 10.8 in
Drainage time = 10.8 in/0.4 in/hr = 27 hrs
27 hrs < 72 hrs

Step 3: Determine area of practice
Area = 5-7% of impervious area
Design area = 7%*8020.5 ft^2 ≃ **560 ft^2**

Step 4: Check sizing for water quality volume
Subsurface storage = 3 ft*560 ft^2*0.3 = 504 ft^3
504 ft^3 > 401.0 ft^3

Step 5: Check sizing for 25-year storm
Subsurface storage = 3 ft*560 ft^2*0.3 = 504 ft^3
Surface storage = 0.5 ft*560 ft^2 = 280 ft^3

Total storage = 504 ft^3 + 280 ft^3 = 784 ft^3
Total allowed water depth = 10.8 in + 6 in = 16.8 in
Underdrain inlet diameter = 4 in
Pipe slope = 0.298
Manning's n for PVC pipe = 0.009
Inlet flow : Manning's equation:
$Q = (\pi * 4 \text{ in})\ (1.496/0.009) * 1^{2/3} * 0.298^{1/2} = 0.655$ cfs
Water inflow possible over 1 hr = 0.655 cfs * 3600 s/hr = 2359.7 ft^3
25-year runoff = 3.78 in
Runoff over impervious area = 3.78 in/12ft * 8020 ft^2 = 2593 ft^3
Runoff volume per hour = 2593 ft^3/24 hr = 108 ft^3
108 ft^3 < 2359.7 ft^3
Water depth for hourly runoff = 108 ft^3/560 ft^2 = 0.193 ft = 2.31 in
1 hour runoff drainage time = 2.31 in / 0.4 in/hr = 5.8 hrs
Accumulated runoff depth in 5.8 hrs = (5.8 hrs*108 ft^3/hr)/560 ft^3 = 1.12 ft = 13.4 in
13.4 in < 16.8 in

Appendix D – Stormwater Report

APPENDIX D: STORMWATER MANAGEMENT REPORT

On behalf of the Belmont Conservation Commission (Client), Evergreen Engineering (Evergreen) has prepared a stormwater management plan for the main entrance and parking lot at Belmont's Rock Meadow Conservation Area, located off of Mill Street in Belmont, Massachusetts (Site).

I. Introduction

a. Project Description

Evergreen has prepared a redevelopment plan for the Site, which encompasses Rock Meadow's main entrance, driveway, and parking lot. The current Site is in poor condition with widespread erosion of impervious surfaces due to a lack of any stormwater management system. The redesign of this portion of Rock Meadow shall be the first step in the Client's long term plan for the whole conservation area. The Client proposed a parking lot and driveway designed to properly manage stormwater runoff, utilizing green infrastructure and minimizing dependence on gray infrastructure.

b. Property Description

The Site is near the border between the town of Belmont and the city of Waltham, as shown in Figure D.1. Rock Meadow is part of a 71-acre parcel, consisting of about 50% grassland cover plus wetland, woodland, and shrubland areas.

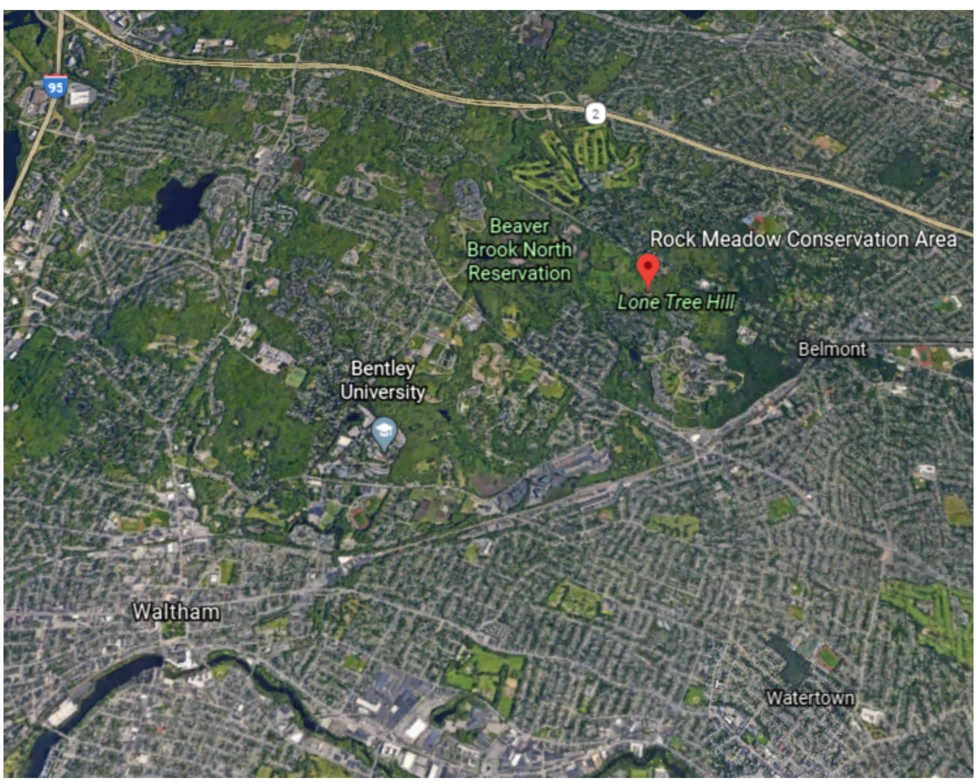

Figure D.1. Localized Rock Meadow map (Google Earth).

The USDA's Soil Survey[1] was used to obtain site-specific data on soil types, which remain consistent throughout the Site. The majority of the parking lot area is designated as extremely stony Montauk fine sandy loam with 0 to 8% slopes (type 302B), and a smaller section as very stony Woodbridge fine sandy loam with 0 to 8% slopes (type 311B).

II. Hydrologic Analysis

The hydrologic analysis was performed using HEC-HMS to simulate the complete hydrologic processes of the Site's watershed. Rainfall volumes used for this analysis are based on the NRCS Type III, 24-hour storm event for the town of Belmont, MA.

a. *Existing Conditions*

Rock Meadow is part of the Charles River Watershed, which drains into Beaver Brook, then the Charles River, and finally the Boston Harbor. The existing impervious area in the Site is approximately 9,400 square feet and consists of the parking lot, driveway, and crosswalk platform. The driveway has a steep, inconsistently graded slope reaching 14% in some places. The parking lot area is gently sloped but uneven due to inconsistent paving and potholing. The time of concentration and curve number values calculated and inputted into HEC-HMS to model the existing conditions were 7.76 mins, and 60.9, respectively.

b. *Proposed Conditions*

The driveway will be widened to allow better access to Rock Meadow and shortened to accommodate more parking stalls. The proposed conditions are a lot expansion to 10,770 square feet of impervious area, or 45.4% of the total site drainage area. This total redeveloped site area was split into two drainage areas: the driveway and the parking lot.

Evergreen proposes the use of a vegetated filter strip to address the runoff from the driveway and a bioswale and rain garden system to address the runoff from the parking lot. The vegetated filter strip will be placed along the north edge of the driveway. The bioswale will be placed along the west edge of the parking lot and the rain garden will be positioned in the meadow between trails north of the bioswale. The runoff will enter the bioswale through gutters on the south and west sides of the lot. The bioswale will convey the water to the rain garden through a 4-inch underdrain.

The proposed site grading facilitates the flow of stormwater to be properly treated and infiltrated by the aforementioned systems. The driveway will be repaved at an 11% longitudinal grade and the parking lot will be repaved at a 2% longitudinal grade. Both

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1 https://websoilsurvey.nrcs.usda.go

the driveway and parking lot will have 2% cross slopes, the driveway graded toward the north and the parking lot graded toward the south. This will result in runoff from the driveway flowing north onto the vegetated filter strip and runoff from the parking lot flowing towards the southwest corner of the lot before entering the bioswale. The bioswale will have a 2% longitudinal grade toward the north, allowing the runoff to flow through the bioswale before conveyance into the rain garden.

c. *Hydrologic Results*

The rainfall-runoff response of the property under existing and proposed conditions was analyzed for storm events with recurrence intervals of 2, 10, and 25 years. Estimated accumulation was calculated using data from the Extreme Precipitation in New York and New England web tool published by the Northeast Regional Climate Center (NRCC) and the National Resource Conservation Service (NRCS)[2]. Rainfall volumes used for this analysis for the three recurrence intervals were based on the NRCS Type III, 24-hour storm event for Belmont, MA: 3.2, 4.85, and 6.14 inches, respectively. Table D.1 summarizes relevant inputs and outputs from the model run in HEC-HMS.

Table D.1. Summary of the hydrologic results.

	Existing Driveway	**Existing Parking Lot**	**Proposed Driveway**	**Proposed Parking Lot**
Curve Number	51.2	84.0	54.0	78.8
Time of Concentration (min)	8.9	1.366	6.18	4.28
2-yr Peak Discharge (cfs)	0.0	0.2	0.0	0.4
10-yr Peak Discharge (cfs)	0.2	0.5	0.2	0.8
25-yr Peak Discharge (cfs)	0.5	0.8	0.4	1.1
2-yr Runoff Depth (in)	0.11	0.99	0.23	1.33
10-yr Runoff Depth (in)	0.59	2.17	0.85	2.65
25-yr Runoff Depth (in)	1.14	3.21	1.52	3.78

d. *Peak Rate Attenuation*

Massachusetts Stormwater Standard 2 states that the proposed conditions of a site must not result in higher peak discharges than those of the existing site. Due to the proposed

2 Extreme Precipitation in New York and New England, http://precip.eas.cornell.edu/

increase in impervious area, Table AD.1 shows that the peak discharge from the driveway area is not expected to increase, however the parking lot area is expected to have increased discharges under post development conditions. In order to reduce these discharges leaving the Site, we have designed the proposed BMPs for the 25-year storm.

The expected parking lot peak discharge for the 25-year storm is 1.1 cfs. This discharge would be able to enter the bioswale through the proposed curb cut in the southwest corner of the parking lot. This discharge would result in a ponding depth of 2.6 inches in the swale, less than the 4 inch ponding maximum required according to Volume 2 of the Massachusetts Stormwater Handbook. The proposed bioswale has a surface volume of 720 cubic feet, providing one foot of surface depth. This volume ensures that the swale could successfully convey the 25-year discharge.

The system of conveyance from the bioswale to the rain garden and the storage capacity of the rain garden is equipped for the 25-year storm. The maximum flow through the 4 inch diameter pipe that inlets into the rain garden would be 0.655 cfs. This flow rate is able to convey a maximum of 2,360 cubic feet of water over one hour. This is significantly more water than expected from the 25-year runoff (the total volume of which would be 2593 cubic feet). The expected depth of water to accumulate per hour in the rain garden is 2.3 inches for the 25-year storm. This depth of water takes 2.5 hours to infiltrate into the subsurface storage and 5.8 hours to infiltrate into surrounding in situ soils. The expected accumulated runoff depth in 5.8 hours is 13.4 inches. As the allowed depth of water in the designed rain garden is 16.8 inches, this depth of water is within the allowed depth, meaning the rain garden is equipped to handle the total runoff from the 25-year storm. Because the 25-year discharge and runoff can be both conveyed and fully infiltrated, the proposed stormwater management system should eliminate discharges from the Site, meeting Stormwater Standard 2.

III. Water Quality

Total suspended solids (TSS) and phosphorus were identified as pollutants of concern for the Site. TSS was specifically identified by the Client and phosphorus is a pollutant of concern in the Charles River Watershed[3].

a. Water Quality Control Measures

The vegetated filter strip is 50 feet wide to achieve 45% removal of TSS. The bioswale was designed to receive credit for 70% removal of TSS and 20-90% removal of total phosphorus. The rain garden was designed to achieve 90% removal of TSS and 30-90% removal of total phosphorus (in conjunction with the pretreatment from the bioswale).

3 Charles River Watershed Association, https://www.crwa.org/charles-river.html

Massachusetts Stormwater Standard 4 states that the proposed stormwater management system for a site must receive credit for 80% TSS removal. As our project is a redevelopment, Massachusetts Stormwater Standard 7 applies, mandating that redevelopment projects must reach these requirements only to the maximum extents practicable. For the Site, it is expected that the runoff from the parking lot will be significantly more pollutant-heavy than the runoff yielded by the driveway. Therefore, a more extensive parking lot treatment system has been included. Because of the minimal amount of runoff expected from the driveway, the engineers hold that implementing further treatment to the driveway runoff would not be an efficient use of resources. Therefore, the implementation of the design will result in the removal of 45% TSS from the driveway runoff and 90% TSS removal from the parking lot runoff.

Massachusetts Stormwater Standard 4 also states that the bioswale must treat the proper water quality volume, defined as 1 inch of runoff for every acre of impervious area, therefore 668 cubic feet of water. Additionally, it was critical to meet the necessary velocities and residence time requirements to ensure proper treatment of the runoff. These values can be found in Table D.2.

Table D.2. Summary BMP velocities and residence times

	Vegetated Filter Strip		**Bioswale**	
	Velocity (ft/s)	**Residence Time (min)**	**Velocity (ft/s)**	**Residence Time (min)**
2-yr	N/A	N/A	0.20	6.71
10-yr	0.08	10.8	0.29	4.66
25-yr	0.12	6.8	0.33	4.0

b. *Stormwater Recharge*

According to Massachusetts Stormwater Standard 3, the design of a site must account for the groundwater recharge of a specified volume of water, equal to the impervious area multiplied by the target depth factor associated with each hydrologic soil group. For the Site, this target depth factor is 0.6 inch. Therefore, in the design of the rain garden, the recharge volume is 401 cubic feet. Based on the selected depth and area, the volume of soil mix for the rain garden is 1680 cubic feet. As this soil mix will be engineered to have a void ratio of 0.3, this allows for 504 cubic feet of water as subsurface storage. The subsurface drainage time for the rain garden was calculated to be 27 hours, which is in compliance with the Massachusetts Stormwater Handbook's limit of 72 hours.

IV. Regulatory Compliance

The stormwater management system is designed to meet the Massachusetts Stormwater Handbook standards and guidelines. Table D.3 below summarizes the standards and how the project complies.

Table D.3. Summary of compliance with Massachusetts Stormwater Handbook standards.

MA SW Handbook Standard	Item	Compliance	Comments
Standard 1	Untreated Discharge	Yes	No direct discharge of untreated stormwater or cause for erosion/scour to receiving waters
Standard 2	Peak Rate Attenuation	Yes	See Section II
Standard 3	Groundwater Recharge	Yes	See Section III
Standard 4	Required Water Quality	Yes	See Section III
Standard 5	Higher Pollutant Loading	N/A	Site does not qualify as having higher potential pollutant loading
Standard 6	Discharges to Critical Areas	N/A	Site does not discharge within a critical area
Standard 7	Redevelopment	Yes	Project is classified as a redevelopment
Standard 8	Erosion/Sediment Controls	Yes	See CD sheet C-6.0: Erosion Control plan; Construction BMP design outside of scope
Standard 9	Operation and Maintenance Plan	Yes	See Section V
Standard 10	Illicit Discharges	N/A	There are no illicit discharges; Site is not located within a wetland buffer zone

V. Operations and Maintenance

See Table D.4 for information about required operations and maintenance for the proposed BMPs. This information was obtained from the Massachusetts Stormwater Handbook Volume 2.

Table D.4. Maintenance Recommendations

BMP	Activity	Time of Year	Frequency
Vegetated Filter Strip	Inspect vegetation for erosion and bare spots	Year round	Semi-annually during the first year, annually thereafter
	Mow grass	Year round	As needed
	Remove sediment from toe of slope and reseed bare spots	Year round	As needed
Bioswale	Remove sediment from grass channel	Year round	Annually
	Mow the grass	Fall, Spring, and Summer	Monthly
	Repair areas of erosion and revegetate	Year round	As needed
Rain Garden	Inspect and remove trash	Year round	Monthly
	Mulch	Spring	Annually
	Remove dead vegetation	Fall or Spring	Annually
	Replace dead vegetation	Spring	Annually
	Prune	Fall or Spring	Annually

VI. Conclusion

This stormwater management plan has been prepared to be in compliance with state and federal regulations. The Rock Meadow parking lot design includes Best Management Practices for maintaining stormwater runoff quality both during and after construction. It is designed to protect downstream and underlying receiving waters from stormwater-related impacts. The redevelopment project will result in an improvement of stormwater runoff quality and quantity.

Appendix E – Manufacturer's Specifications

1.0 SUN-MAR CENTREX 3000

2.0 SUN-MAR Dry Toilet and Toilet Kit

3.0 Reolink Argus 2 Camera

4.0 Reolink Solar Panel

Serial No.______________

Sun-Mar

Global Composting Experts

CENTREX 3000

OWNER'S MANUAL

CENTREX 3000

CENTREX 3000 NE

Certified to NSF/ANSI Standard 41

Standard 41

Certified for liquid containment, odors, and solid end products in both residential and cottage use

RATED CAPACITY

Residential & Continuous Use

CENTREX 3000: 6 Adults
CENTREX 3000 NE: 5 Adults

Weekend & Vacation Use

CENTREX 3000: 9 Adults
CENTREX 3000 NE: 8 Adults

Models for which the manual applies:

CCEB-02510 Centrex 3000 115V
CCNB-02540 Centrex 3000 NE
CCEB-02515 Centrex 3000 230V

Unit must be installed so electrical components in the base are protected from rain, flooding and melting snow.

Place the warning and cleaning sticker on the inside lid of the ultra low flush toilet.

Metal tools will damage the toilet.

OWNER'S MANUAL

CONTENTS

HOW COMPOSTING WORKS

Composting is the natural process of decomposition that can be helped along by providing the ideal conditions to help your composting toilet work at peak performance. The ideal conditions for decomposition to occur depend on several factors: oxygen, temperature, moisture content, and the carbon/nitrogen ratio.

Oxygen

Oxygen is very important in composting. Your compost should be aerated in order to encourage aerobic bacteria growth. Aerobic bacteria are bacteria that grow and live in the presence of oxygen and are very efficient in breaking down waste. To aerate the compost and encourage the growth of these bacteria, the compost drum should be turned three times per week (10 complete turns of the drum).

Temperature

Temperature is another important consideration when composting. Optimal composting temperatures range between 70-100 ° F (21-38 ° C). Decomposition will slow significantly or stop completely if the compost becomes too cold (below 55 ° F or 13 ° C). If you are in an area that experiences temperatures below 55 °F (13 ° C) additional heat is required if the composting toilet will be used continually or frequently. If used for intermittent cottage application (3 - 4 weekends throughout the cold season) no additional heat is required. The unit will function as a holding tank until the temperature warms up.

Moisture

Moisture is necessary to achieve good compost. Your compost should always be damp, like your garden after you have watered it. This moisture allows the bacteria to travel around in the compost so that they can speed decomposition by digesting the waste. If the compost is too dry, the bacteria cannot survive and decomposition will slow or cease. When adding water to the compost, you are aiming for damp compost, not saturated. Too much liquid in the compost limits the amount of oxygen that aerobic bacteria require to survive. If normal urination is not enough to maintain the correct moisture level in the compost, we encourage you to add additional water to the drum.

Carbon/Nitrogen Ratio

Almost all organic material will compost. The proper bulking material and human waste should be added to the composting toilet. In order to maintain a good balance between carbon-rich materials (SUN-MAR Compost Sure Blue) and nitrogen-rich human waste only.

THE SUN-MAR CENTREX 3000 TOILET

The key to the success of the CENTREX 3000 lies in its three chamber design. Each of the three chambers; patented Bio-drum, compost finishing drawer, and evaporation chamber, have their own independent environments for optimum efficiency. The CENTREX 3000 electric version has a thermostatically controlled heater and fan assembly to help evaporate liquid and should be used where there is a constant electrical supply. The CENTREX 3000 NE (non-electric) version is for use where there is no continuous electric supply. The CENTREX 3000 NE has no heater but does include a 12 volt fan. Odorless operation is achieved by a 4” vent assisted by the fan which acts like a chimney creating a partial vacuum within the unit.

The Patented Bio-Drum

Unique to Sun-Mar, the patented bio-drum provides the necessary mass to maintain good compost and allows easy aeration of the compost by simply turning the drum. Excess liquid will exit through a screen in the bottom of the drum into the evaporation chamber. Mixing the Bio-drum is accomplished by rotating the handle in a clock-wise direction. Compost moves automatically through the drum with SUN-MAR’s unique **Autoflow ®** techology.

The Compost Finishing Drawer

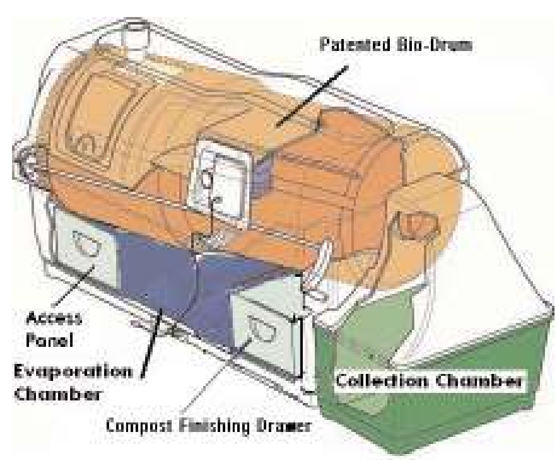
The compost finishing drawer sits in the opening in the front right of the unit. Since the CENTREX 3000 automatically discharges finished compost into the collection chamber at the end of the unit, this drawer is used only if you need to remove all compost from the drum. Removal of the compost finishing drawer and access panel allows access to the evaporation chamber for cleaning and maintenance purposes.

The Evaporation Chamber

The evaporation chamber is the floor of the unit under the compost finishing drawer. This is the area where any excess liquid will gather for evaporation. A safety drain exits from the left side of the composting toilet which will drain over-flow liquid that is not evaporated to an approved facility.

The Collection Chamber

CENTREX 3000 units incorporate SUN-MAR’s unique **Autoflow ®** technology. As the drum rotates, compost moves automatically through the drum and into a separate collection chamber located near the end of the unit.



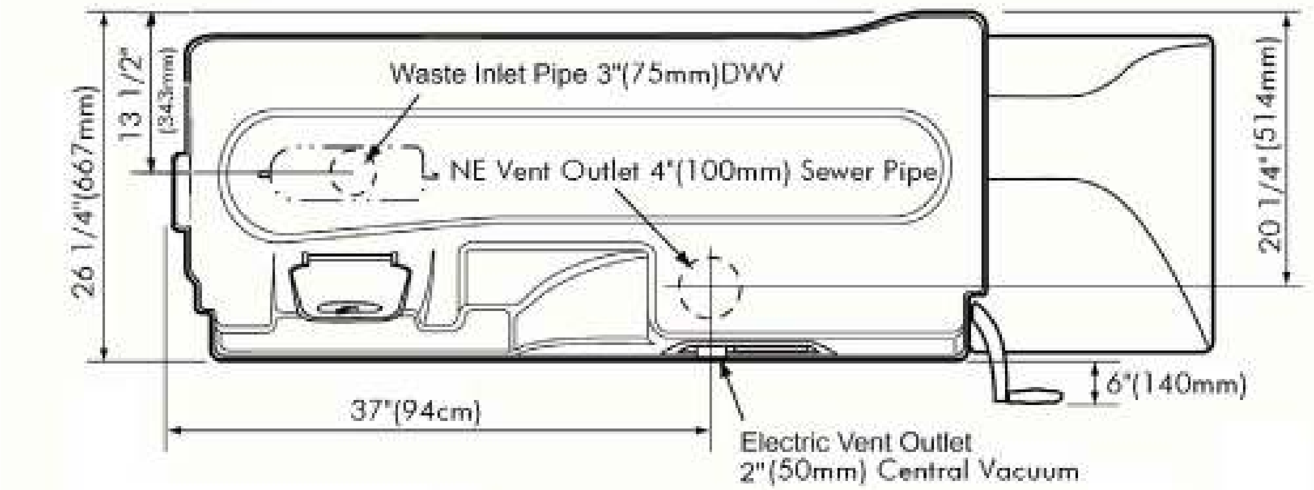
Inspection

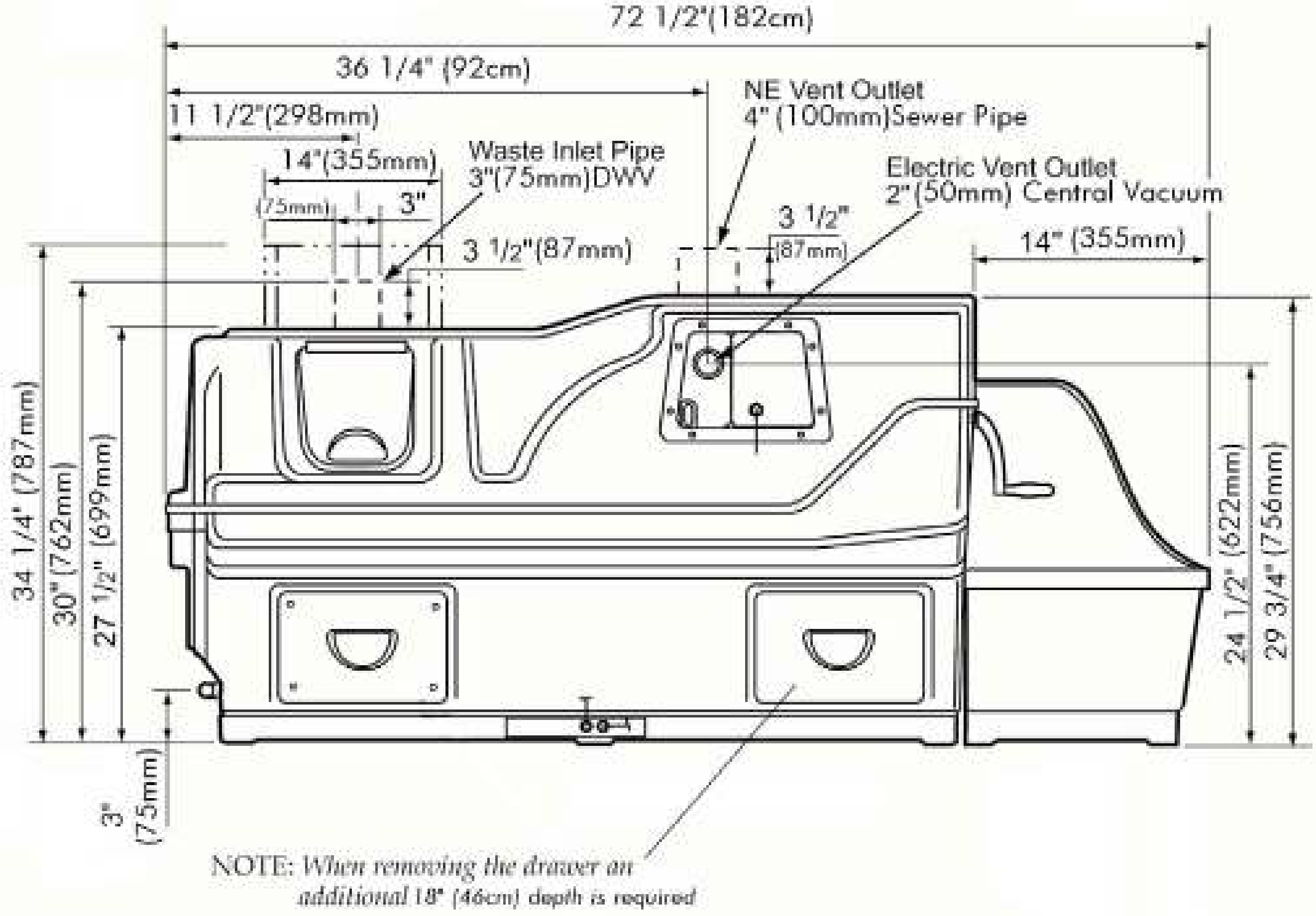
We recommend an inspection of the CENTREX 3000 prior to installation and to make sure you have received all of the parts required as listed below.

Inspecting the unit for Damage	1) If there is any visible damage to the carton- The contents of the carton should be inspected before signing the bill of lading. Damaged units should be refused. Call Sun-Mar immediately. 2) If the shipper has left- Report the damage immediately to the shipping company and call Sun-Mar. 3) Soon after delivery, remove the CENTREX 3000 Toilet carefully from the carton- If there is hidden damage, or for any service questions, contact Sun-Mar to determine the best course of action.
What's in the Box	1- Owners Manual 1- 6" (150mm) Diffusor (NE) 1- Warranty Card 1- Collection Chamber 1- Hardware Kit 6- 2" x 30" (76.2cm)PVC Pipe (Electric) 1- 8' 4" (254cm)1" ID Drain Pipe 2- Compost Sure Blue 1- Rake 1- 4" Diffusor (100mm)(Electric) 1- 12 Volt 2.4 Watt Fan (NE) 5- 4" x30" (10.16 x 76.2cm)ABS Pipe(NE)
Familiarize Yourself with the CENTREX 3000 Toilet	1) Turn the drum handle clockwise to rotate the patented Bio-Drum for mixing and aeration. (The drum rotates counter-clockwise and the drum door closes). This is how you will rotate the drum during regular operation. 2) Lift and remove the access door and rotate the drum until the drum opening is visible through the access door opening for adding "Compost Sure Blue". This is how you will add "Compost Sure Blue" bulking mixture to the drum during regular operation. 3) Plug the unit's electrical cord (Electric) into a standard three-prong Electrical outlet, and feel the air movement from the vent outlet at the front of the unit to ensure the vent system is working properly. 4) Pull out the compost finishing drawer at the bottom right of the unit. After the unit has been plugged in for ten minutes, place a hand on the floor of the evaporating chamber (the area under the finishing drawer) to check it is warm to the touch, and that the heater is working properly.
Placement of Unit	The unit should be installed so that the base is protected from weather. The rubber "u" channel at the bottom of the unit is well-sealed, but if the unit is sitting in water, has snow melting against it, or rain pouring on it, this may eventually wear through and short out the heating element. Install your unit with a protective cover of some kind to protect it from precipitation from reaching it. The composting unit should be placed on a level surface or sloping slightly toward the safety drains assembly to ensure drainage of effluent. **Do not install the unit in a pit where water can accumulate around the composter.**

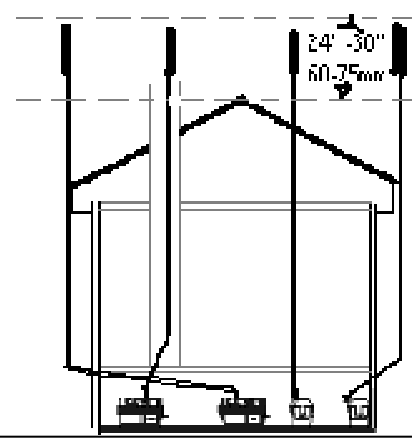
Installation

CENTREX 3000 ROUGH IN DIMENSIONS

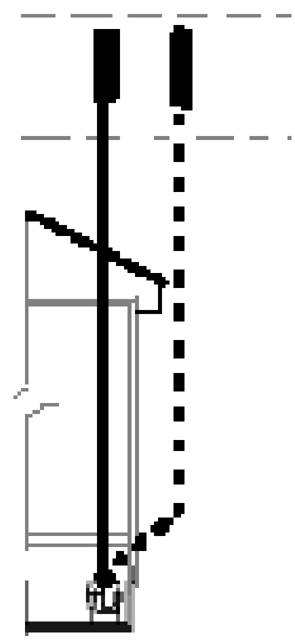




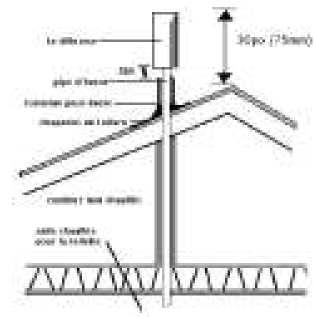
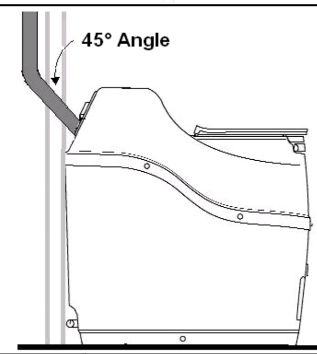
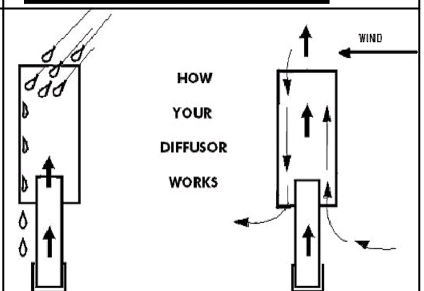
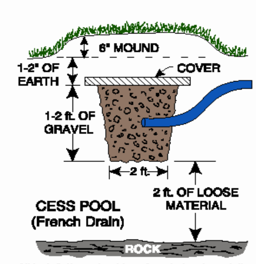
CENTREX 3000 Electric Installation

Space Required and other Installation Considerations	1) To facilitate maintenance and compost removal, ensure that there is at least 17” in front of the CENTREX 3000, for removal of the drawer and access panel. 2) The safety drain is required in **ALL** installations. Install the unit in a location where the safety drain can be connected. This drain exits from the left side of the unit and must slope downward at all points. 3) Install in a location where the vent pipe can be attached as per the instructions listed below. 4) Install in a location that is not air tight. The toilet must be able to vent to ensure odor free operation. 5) Ensure that the CENTREX 3000 is accessible for ongoing maintenance. 6) Ensure that the installation area is a minimum height of 28”. **WE DO NOT RECOMMEND DIGGING BELOW GROUND TO FACILITATE THE INSTALLATION OF THE CENTREX 3000.** 7) Ensure the CENTREX 3000 is protected from precipitation. 8) Ensure that the unit is installed on a level surface or sloping slightly towards the safety drain.
Vent Pipe Location	1) If running a vent through a wall, it should be done at a 45° angle to prevent condensation from accumulating in the vent pipe, causing a constriction**. NO HORIZONTAL SECTIONS OF VENT.** Venting should be installed vertically. 2) All vent pipe that is exposed to the outside or in a non-heated space should be insulated if using the unit during cold weather. 3) **INSTALL VENT SO THAT IT TERMINATES 24” - 30” ABOVE HIGHEST PEAK OF THE ROOF**. 4) If you will be installing venting on a steeply pitched roof where snow shear may occur; Install a heavier pipe through the roof and feed the enclosed vent through the heavier pipe. Seal between the pipes with expandable foam or other such water-tight substance. The heavier pipe should be able to withstand the weight of sliding snow. 5) If there is more than 36” of vent needed above the roof line to reach 24-30” above the highest peak of the roof (diffusor included in measurement), use guy wires to secure the vent above the roof. 6) Limit bends in the vent stack to no more than 4 that have a combined total of 180 °. 7) The vent must be installed separately from ALL other household vents. Venting cannot be merged with other venting. Doing so will prevent the unit from operating in an odorless fashion. 8) All connectors in the vent pipe should be sealed. Use silicone caulking to seal the connection between the vent and the fan. PVC cement may be used on all other vent connections. 9) The diffusor should be glued vertically on to the top of the vent pipe. This assembly helps draw air up the vent pipe. *Possible venting configurations for the 2” electric vent pipe.* 
Electrical Considerations	The fan will run continuously 24 hours per day. A ground fault interrupter (GFI) circuit is recommended for any unit installed in an environment where it will be exposed to moisture. This may be installed directly on the wall socket or at the circuit breaker. If you are in an area where you experience power fluctuations, you may wish to install a surge protector. Some 230V models may have an over current fuse protection on the heating element circuit which is located on the electric box.

CENTREX 3000 NE (Non-Electric) Installation

Space Required and other Installation Considerations	1) To facilitate maintenance and compost removal, ensure that there is at least 17" in front of the CENTREX 3000, for removal of the drawer and access panel. 2) The safety drain is necessary for **ALL** installations. Install the unit in a location where the safety drain can be connected. This drain exits from the left side of the unit and must slope downward at all points. 3) Install in a location where the vent pipe can be attached as per the instructions listed below. 4) Install in a location that is not air tight. The toilet must be able to vent to ensure odor free operation. 5) Ensure that the CENTREX 3000 NE is accessible for ongoing maintenance. 6) Ensure that the installation area is a minimum of 28" in height. **WE DO NOT RECOMMEND DIGGING BELOW GROUND TO FACILITATE THE INSTALLATION OF THE CENTREX 3000.** 7) Bends in the vent, installation near hills or over hanging trees may cause down draft. A 12 volt fan may be necessary. 8) Competing appliances (ie. wood stove) may require an air intake installed from the outdoors if the unit is installed in an enclosed basement. A 12 volt fan may be required. 9) Ensure that the unit is installed on a level surface or sloping slightly towards the safety drain.	
Vent Pipe Location	1) All vent should be vertically installed. 2) Limit bends in the vent stack to no more than 2 - 45 ° bends. **NO HORIZONTAL SECTIONS OF VENT.** 3) **INSTALL VENT SO THAT IT TERMINATES 24" - 30" ABOVE HIGHEST PEAK OF THE ROOF.** If the vent is being installed on a steeply pitched roof where snow shear may occur; Install a heavier pipe through the roof and feed the enclosed vent through the heavier pipe. Seal between the pipes with expanding foam or other such water-tight material. The heavier pipe should be able to withstand the weight of sliding snow. 4) If there is more than 36" of vent needed above the roof line to reach 24-30" above the highest peak of the roof (diffusor included in measurement), use guy wires to secure the vent above the roof. 5) The vent must be installed separately from ALL other household vents. Venting cannot be merged with other venting. Doing so will prevent the unit from operating odorlessly. 6) All connectors in the vent pipe should be sealed. Use silicone caulking to seal the connections. 7) The diffusor should be glued vertically on to the top of the vent pipe. This assembly helps draw air up the vent pipe.	
Vent Inlet Coupling	Place the vent inlet coupling into the hole on the top of the unit for the 4" vent and so that the 1" of smaller diameter pipe is protruding into the hole. This is the first piece of the venting. Once you have finished assembling the vent, run a bead of silicone around where the inlet coupling meets the top of the composting unit to prevent odor from escaping.	
12 Volt Fan	Install the 12 volt fan on the inlet coupling with the large side with the wires protruding facing upwards (as shown in the picture at right). When the 12 volt fan is turned off, it forms an obstruction in the vent, and should therefore run continuously while the cottage or home is occupied. An optional switch (as small as 1 amp) may be installed, and the fan turned off when the toilet will not be used for several weeks. The red wire should be connected to the positive (+) terminal on your battery or DC system, and the blue wire to the negative terminal (-). The 12 volt fan may be powered with a battery that is connected to a generator, solar panel, or other alternative energy system.	

Installation Common To Electric and NE Units

<table>
<tr><td>Leading the vent through the roof</td><td>The vent stack (shown in diagram) should end approximately 30” above the peak of the roof so that it is less subject to downdraft. Where the pipe is taken through the roof, a roof flashing may be required to seal the installation. If you are in an area where snow shear is a danger, you may wish to install a heavier pipe around the vent pipe where it exits from the roof. If you do choose to do this, ensure that you seal the area between the pipes with a waterproof substance to prevent leaks.</td><td></td></tr>
<tr><td>Leading the vent through the wall</td><td>When it is necessary to lead the vent through a wall, connect one 45° elbow on the vent outlet on the unit. Using a hole saw or other appropriate tool, cut a hole through the wall board behind the unit so that the vent pipe can be inserted into the 45° elbow. Cut a similar hole on the other side of the wall that is slightly higher than the inner hole so that the vent pipe will be angled upward at 45°. If installing through an exterior wall, waterproof sealant will be required around the vent pipe where it emerges from the building.</td><td>
</td></tr>
<tr><td>The Diffusor</td><td>The diffusor provided with the unit is a simple device to be installed at the top of the vent stack with the larger pipe protruding above the smaller. To install, simply glue the diffusor vertically on the topmost section of vent pipe. The diffusor design encourages updraft, and discourages wind and weather from going down the vent stack. We do not recommend installing anything else on the top of the vent as it could impede the venting. Unlike wind turbines, diffusors are less likely to freeze in winter, and are more effective in calm weather.</td><td>
</td></tr>
<tr><td>Drain Installation</td><td colspan="2">The safety drain MUST be connected as it will be required in all Centrex 3000 NE installations or Centrex 3000 electric with ultra-low flush toilets.
- Remove the orange cap from one side of the overflow drain assembly.
- Place a 1” hose clamp over the end of the drain hose that will be connected to the overflow drain assembly.
- Push the drain hose over the ribbed end of the over-flow drain and clamp with the 1” SS hose clamp.
- Connect the 1” hose to an approved drainage facility.
- The safety drain is gravity fed. The drain hose must be below the level of the safety drain in order to function.</td></tr>
<tr><td>Handling Effluent</td><td>The following are possible options to take care of the liquid :
- Feed into a lined pit filled with gravel and sand. Such a recycling bed also ensures a closed loop system.
- Feed into a small cesspit or “French drain”.
- Plumb into an existing septic or holding tank line.
Installation should be in accordance with applicable local regulations.</td><td>
</td></tr>
</table>

Positioning The Collection Chamber

Line the bottom of the collection chamber with the plastic bag (provided). Place the collection chamber base on the right side of the CENTREX 3000 so that the base rests under the opening in the patented bio-drum. Place the top of the collection chamber on the base. SUN-MAR **Autoflow®** technology allows compost to automatically deposit into the collection chamber.

Installing the waste pipe

When installing the waste pipe from the toilet to the unit, the following should be considered:-

1) The pipe should be either 45 ° or vertical (if composting unit is directly below toilet), or at a 2-3 ° angle (1/8”-1/4” or 3-13mm drop per foot maximum) so that the waste travels with the liquid.
2) Pipe should not slope upwards at any point.
3) Connections should be snug so that waste does not cause blockage.
4) It is recommended that the waste pipe be no longer than 15 feet (460cm) without installing a clear out port(a Y fitting with screw on end cap) near the toilet to provide easy access should it be required.
5) Use a soft sealant, such as silicone for the connection of the waste pipe to the unit so that the unit can be moved for servicing or other reasons should this ever be required.
6) Insulate pipe if unit is to be used during the winter.
7) For longer installations of waste pipe, ensure the waste pipe is supported to prevent sagging.

Installing the Ultra Low Flush Toilet

1) Make sure the center of the floor flange is at least 11 inches (280mm) from the back wall.
2) When Installing a new floor flange, ensure that the toilet mounting bolts align properly with ultra low flush toilet mounting pattern.
3) Secure flange to floor using flat head screws through counter-sunk holes in flange. Insert bolts into slotted holes in flange(Fig. A)
4) Position floor seal by pressing the floor bolts up through the holes in the seal.
5) Set toilet in place with bolts protruding up through mounting holes in base (Fig C).
6) Install washers and hex nuts provided with toilet. Tighten nuts down equally with standard 7/16” (12mm) open end wrench.
7) Connect water supply line to water valve (1/2” or 13mm MPT) inlet using appropriate fittings (Fig D)
8) Turn on water supply and flush toilet to test for leaks.
9) Attach pedestal and pedal covers to toilet base. See instructions below.

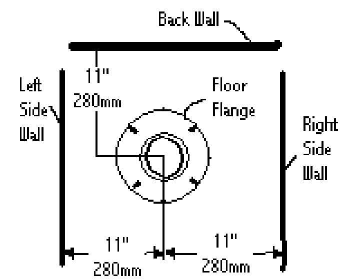


Fig. A

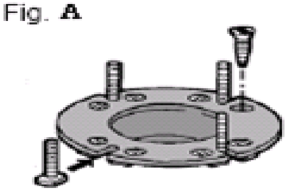


Fig. B

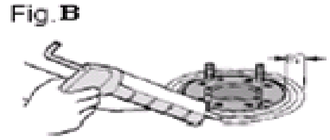


Fig. C

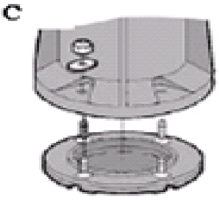
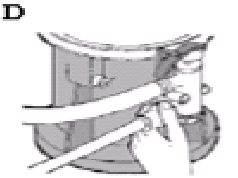


Fig. D



PEDESTAL AND PEDAL COVER INSTALLATION

ALL TRAVELER TOILETS AND TRAVELER LITE MODEL 111:

1. Wrap pedestal cover around base so that it closes as shown.

2. Tall model – screw cover together. Short model – snap together.

3. Slide pedal cover onto foot pedal rod.

4. Secure side plate onto pedal cover with screws.

Initial Start Up and Use

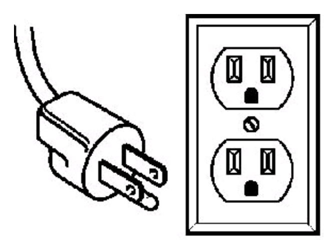
These steps are only used when starting up your CENTREX 3000 toilet for the first time or when you have emptied the drum and need to re-start the compost.

After installation is completed do the following:

Step 1 : Spray Compost Quick: Remove the finishing drawer and spray the whole inner floor of the unit under the finishing drawer. Spray Compost Quick into the patented bio-drum and the inside of the finishing drawer.

Step 2: Pour 1 bag of Compost Sure Blue into a bucket and add 2 quarts of warm water. Add 1/2 of the Microbe Mix packet to the bucket. Allow the Compost Sure Blue to absorb the water (about an hour).

Step 3: Scoop the Compost Sure Blue mixture into the patented Bio-Drum through the access door on the CENTREX 3000. Rotate the drum to mix. The opening in the drum must remain open under the waste pipe. The CENTREX 3000 toilet is now ready for use.



Step 4: For electric units only. The fan will run continuously 24 hours per day.
120 Volt Use: Plug it in to a three prong electrical outlet.
240 Volt Use: The unit must use a mains plug with an earth connection. Replacement of electrical components (including the power cord and mains plug)must be performed by a qualified person to avoid hazard.

When you first start up the CENTREX 3000, it will take approximately 6 weeks at optimum temperatures (70-90 ° F) before you will have sufficient quantities of microbes in the drum to actually achieve good compost. During this time, the contents of the patented bio-drum start out as Compost Sure Blue and waste. Over the first 6 weeks, you will notice that the compost will hold moisture and will become more uniformly dark in color.
During the first six weeks, you may notice that some Compost Sure Blue has fallen through the drum screen onto the evaporation chamber to the left of the finishing drawer. This should be raked out and removed with the rake tool provided with the unit.

NOTE: Regular toilet paper may be used. Toilet paper is a good source of carbon for your compost so it may be added to the Bio-Drum™

Ongoing Toilet Maintenance

Once your CENTREX 3000 toilet is installed and you have gone through the initial start-up procedure, follow the steps outlined below to keep your composting toilet working optimally.

Add one cup of Compost Sure Blue per person per day of use	Even if you only use the toilet for urination then at least one cup of Compost Sure Blue should be added per person per day of use. Add the Compost Sure Blue through the access door CENTREX 3000 toilet. The Compost Sure Blue should be added to the composting unit, just prior to turning the drum.
Spray Compost Quick on the surface of the compost	Every second day before turning the handle, spray 3-4 sprays of Compost Quick on the surface of the compost. Compost Quick is an enzyme that will speed up the composting process.
Turn the handle clockwise every second day to mix the compost	Turn the handle in a clockwise direction to mix and aerate the compost. When mixing, ensure that the drum rotates 10 complete revolutions (70 turns of the handle).
Make sure that the opening in the drum is centered under the waste pipe.	The hole in the drum must be open under the waste pipe, ready to receive waste.
Every two weeks	Add one scoop of Microbe Mix to the patented bio-drum to 'recharge' the pile. This will help to ensure your microbe colony stays constant and healthy.
Every three months	Rake the evaporation chamber: Remove the finishing drawer. Rake any solid debris from the floor of the unit under the drawer (evaporation chamber), paying extra attention to the left corners of the unit as this is where debris may accumulate. Remove the solid debris.
Twice per year	Clean the drum screen. Spray the drum screen with Compost Quick and let sit for 15 minutes (this will help to loosen the debris if the screen is not too encrusted). Scrub the screen vigorously with the wire brush. If brushing the screen does not clear it and liquid is still not draining through the screen, you may have to resort to having to use a screwdriver or nail to puncture each hole in the drum screen.
Periodic maintenance	Empty the collection chamber.

CAUTION

1) **Do NO**T add or clean the toilet bowl liner with chemicals. Chemicals will kill the bacteria. **INSTEAD**, clean the bowl liner with Compost Quick.
2) **Do NOT** add plastic, glass, metal, cleaning fluids, cigarettes. Add only waste and bulking material.
3) Kitchen or garden waste, are **NOT** recommended.
4) **Do NOT** add baby wipes, diapers or feminine paper as they will not compost.

Seasonal Use and Springtime Start Up

Rake

Remove the finishing drawer and access panel completely and use the rake tool to rake any loose material from the floor of the unit. Careful attention should be paid, to the left two corners of the unit (near the safety drain) to ensure that your drains do not get clogged.

Add Water & Microbe Mix

Add some warm water to the remaining compost, enough to ensure that it is quite moist. Also, add some Sun-Mar Microbe Mix (two of scoops) to give the compost pile a “kick-start” and rotate the drum several times to mix. If your composting toilet is electric, plug it in and use for another season.

Winter Use

No Winter Use

Just add water, lots of water. Soak the compost in the drum to prevent it from drying out before Spring. Make sure to unplug the unit if electric. If you have a non-electric unit, it may be a good idea to place something over the diffusor to prevent animals (who are looking for a home at this time of year) from getting in.

Occasional Winter Use

If the unit will be used for 3-4 weekends throughout the winter season then it is considered occasional use. All of the same considerations should be taken with these units to winterize them. When the temperature dips below 55 ° F (13 ° C), composting activity will decrease dramatically. These units do not need to be kept warm and will act only as a holding tank during the winter months until they warm up enough in the spring to begin composting again. During the winter, the compost will freeze into a solid mass so the drum should not be turned as it may damage the composting toilet. With this in mind, it is a good idea to remove enough compost before it gets too cold to make room in the drum for winter use.

Heavy or Residential Winter Use

These units should be kept in a heated area and all winterization tips should be followed, including the following:

1) Vent Pipe - electric models; all 2" vent pipe should be insulated if they are exposed to the outside or in an unheated area. If you are in an area that experiences extreme winter conditions, we recommend that heat tape should be applied to the exposed vent pipe to prevent ice blockages.
2) Safety Drain - all models; we recommend that the safety drain should be installed and insulated above the frost line. There will be less evaporation in the winter so this will help with any excess liquid. If possible, heat tape can be applied to the safety drain to prevent ice blockage.
3) Keep it warm; If the composting toilet is used frequently in the winter then the composting part of the unit should be kept in a warm place. Below 55 ° F (13 ° C), composting actions slows dramatically so if it is in a place that falls below this temperature, a source of heat should be provided for the unit so that it can keep up with constant use.

Warning: The water valve must be drained (or removed) if the ultra low flush toilet is installed in an area where freezing temperatures are anticipated to prevent freezing and cracking of valve.

Compost Troubleshooting

Symptom	Cause	Remedial Action	Prevention
Compost Too Wet	Compost porosity is poor.	Change bulking material to Compost Sure Blue.	Use Sun-Mar Compost Sure Blue
	Drum screen clogged	Spray the drum screen with Compost Quick. Scrub the drum screen with wire brush.	
	Insufficient moisture in compost	A moisture content of 40-60% is ideal for aerobic microbes to thrive.	Add water to patented bio-drum
Waste not Breaking Down at all (the drum will fill up quickly)	Insufficient Microbes	Add Sun-Mar Microbe Mix.	Be sure to add microbe packet at start up.
	Room Temperature Under 55 ° F/13°C	Install heat source to increase temperature. Temperature should be kept above 55 ° F/13°C constantly to ensure the composting action does not stop completely.	Install unit in warm area. The warmer the area, the better your compost will be!
Large Lumps in Compost	Compost Too Dry	Add 1/2 to 1 gallon of warm water to compost in order to bring it up to appropriate moisture level. Remove lumps or break them apart.	Use proper bulking material and add warm water if necessary.
Drum Too Full	Compost Bio-Drum not rotated enough	Remove compost until drum is only half full or less. Rotate compost thoroughly to aerate, and add compost accelerant, (Compost Quick and Microbe Mix) if available.	Rotate the drum, 10 full revolutions, every other day. Do NOT let drum get above 1/2 full. This will lead to lack of aeration, and anaerobic compost.
Flies Present	Kitchen/Garden Waste added	We do not recommend adding kitchen or garden scraps.	Do Not add kitchen or garden waste.
	-compost too dry -compost anaerobic -foreign material added	1)To eliminate flies, you can use any pesticide that is used on your garden. Pesticides used for garden use are not anti-bacterial so are safe to use on your compost. 2) The alternative to using pesticides is to completely clean the toilet out, wash the inside with soap and water IMPORTANT: Application of a pesticide in a SUN-MAR toilet is not a health concern because all SUN-MAR units are vented. If using pesticides, avoid spilling on the outer shell of the composter	1) Keep compost moist. In order to determine a good level of moisture, shine a flashlight into the drum. The compost should have a slight gloss or shine. If it does not, add warm water to it until it reaches this consistency. Fungus gnats tend to be attracted to a dry compost, due to the fungus which begins to form on the surface when it dries out. A good, moist compost will not be attractive to flies. 2) Do not add topsoil from the ground, composted matter, or kitchen scraps to the toilet. Flies may be present in, or attracted to these items. 3) Use "Compost Sure Blue".

MECHANICAL TROUBLE SHOOTING

Symptom	Cause	Remedial Action	Prevention
Urine Odor in Washroom	Horizontal runs or downward slopes on vent pipe	Re-install the vent so there are no horizontal or low points where condensation can collect.	Install wall brackets on vent pipe to prevent settling. DO NOT install horizontal runs as liquid will collect and block ventilation, causing odor.
	Fan has failed	Have your serial number ready and call SUN-MAR for a replacement. Instructions are included with the replacement fan.	The fan is a constantly moving part and has a finite service life.
	Downdraft	If you believe that there may be a downdraft outside of the building, it may be a good idea to remove your fan assembly prior to installation and set the fan gate to '0' to prevent urine odor in the bathroom. (electric)	
	Competing appliances (CENTREX 3000 NE)	Wood stoves or furnaces installed in a tightly sealed room with the composting toilet may draw air in causing a vacuum in the room. This will draw air down the vent pipe.	Downdraft is dependent on wind direction as well as natural obstructions etc. Initially, install the vent above the peak of the roof.
Occasional Urine Odor Outside	1) Vent stack not installed above peak of roof. 2) If vent stack is installed above roof line, natural obstructions, such as tall trees, being located in a valley or close to a hill may be causing downdraft.	1) Check that the vent is installed above the peak of the roof. If not, extend the vent. Guide wires may be necessary. 2) Add lime to the evaporation chamber – as much as you think necessary. You will have to rake more often if you do this. 3) SUN-MAR has a filter box available which will filter the ammonia out of the vented air in a downdraft situation. Call SUN-MAR for details.	If symptoms occur, add lime or a filter box.
Strong Sewage Odor	Compost is anaerobic	Begin following: "Compost troubleshooting" suggestions.	Follow "Ongoing Maintenance" and use proper bulking material.
Fan Noisy	Fan damaged in shipping or bearings are beginning to wear.	1) If it is rattling, it may need to be cleaned or the bearings are worn and the fan needs to be replaced. 2) A hum is the normal sound the fan will make. If you are in a very quiet setting it will be more noticeable. If this is the case, consider purchasing a fan speed control so that the fan may be turned down.	Clean the fan with a small brush and/or compressed air nozzle once a year. This will prevent wear and lengthen the life of your fan.

Symptom	Cause	Remedial Action	Prevention
Fan Not Working	Debris in fan or mechanical failure.	Remove the fan assembly from the unit and vacuum any dust out of the fan blades. Check the power source. If this does not remedy the problem, have your serial number ready and call SUN-MAR	The fan is a continuously moving part which will eventually have to be changed. Do Not turn on and off daily.
Liquid Build up/ Lack of Evaporat-ion	Increased usage.	The amount of liquid varies substantially between installations. The overflow drain needs to be installed.	Install the overflow drain.
	Climactic conditions	Evaporation rates vary substantially with climatic conditions. Expect faster evaporation rates during warm dry weather.	
	Mineral salts may have accumulated in the evaporation chamber over time, reducing evaporation rates.	To remove these, fill the evaporation chamber with very hot water and 1/3 bottle of “Compost Quick” enzyme liquid. Leave overnight.	Rake evaporating chamber at spring start ups for cottage use, and once every other month for residential use.
Liquid Overflow	Drains Blocked	Drain all Liquid through the overflow drain by tipping the unit up (make sure overflow is hooked up first) 1) Rake peat moss away from the safety drains. This is the “build up” area. If drains are still clogged, proceed to step 3. 2) Check drain line for kinks, blockages or Upward bends. Remove and flush if blockages present, un-kink if bent and ensure that the drain pipe is sloping downward. If your drain pipe is in order, proceed to step 3. 3) Use a wire to poke blockage out of the drain assembly. A brown spot will be visible through the opaque assembly.	1) A clogged drain is not very likely to happen if evaporating chamber is raked every 3-4 months. 2) Use premium 1”ID hose for the drain line. A good hose will be less likely to kink. Use elbows or fittings around bends to prevent kinks. 3) Use Compost Sure Blue as a bulking material.
	Overflow drain not hooked up	Connect overflow safety drain	Evaporation will slow during damp weather, make sure drain hose is installed.
	Unit tipped forward	Check and ensure that the unit is level.	

Symptom	Cause	Remedial Action	Prevention
Heating System Not Working	Test to determine whether failure has occurred	Pull finishing drawer out and put your hand in the evaporation chamber (NOT in the liquid). If there is no warmth rising from the floor of the unit, your heating system is not working. It is most commonly the thermostat that has failed. If you notice a lack of evaporation, but there is still warmth in the heating chamber, see "Liquid Build up" for solutions.	A ground fault interrupter circuit is recommended to protect your CENTREX 3000 Toilet from power surges that could cause your heating system to malfunction.
	Thermostat Failure	Have your serial number ready and call SUN-MAR for a replacement. (Detailed instructions are included with the replacement part)	Your thermostat and fan are the two constantly moving parts on the unit, and so are the most likely to fail.
	Heating Element Failure	If the insulation behind the electric box is moist or discolored, or heating does not work after the new thermostat has been connected, then the heating element has failed.	Both are easy to replace. If you ever remove the unit for cleaning, DO NOT use a water hose around the base of the unit.
	Blown fuse (some 230V units ONLY)	Have your serial number ready and call SUN-MAR for a replacement. (Detailed instructions are included with the replacement part) Check fuse located on the electric box to ensure that it is functioning correctly, if the wire in the fuse is charred or broken, replace the fuse.	Power surges can cause the fuse to blow. If this is a possibility in your area, a surge protector is re-commended.
Liquid in Finishing Drawer	Drum Screen Clogged	Remove the finishing drawer. The drum screen is located on the bottom of the patented Bio-drum, to the left of the drawer opening. Scrub drum screen with a wire brush.	Scrub drum screen with a wire brush.
Drum Will Not Turn	Set screw securing handle to shaft has broken	Drill out set screw and replace, or have your serial number ready and call SUN-MAR for a handle replacement kit (instructions included).	Drum should never be more than ½ full.
	Steel roll-pin securing gear wheel to shaft has broken	Have your serial number ready and call SUN-MAR for a replacement small gear kit.	
Drum Door Not Opening/ Closing Properly	Drum too full Hinges Stuck	Spray hinges with Compost Quick. Scrub hinges with toothbrush or other soft nylon bristled brush.	

Basic Maintenance Instructions

Ultra low flush toilet and CENTREX 3000 Units

These instructions are not to replace the owner's manual, but are intended as simple instructions for daily use.

USING THE TOILET

Deposit your toilet paper, step on the foot pedal to flush, close the lid and walk away…your job is done. If you plan on making a more substantial deposit and would like more water in the bowl, simply lift the foot pedal up and the bowl will fill. When you have the desired amount of water, let the pedal drop back in place and do what you have to do.

EVERY OTHER DAY

Turn the handle to mix and aerate the compost. If the toilet is being used predominantly for urination, be sure to add at least one cup of bulking mixture (added at the composting unit) per average amount of users per day. At the composting unit (not the flush toilet), open the access port to the drum. Add Compost Sure at the rate of one cup per person per day, so, if there are two people staying, you would add 4 cups of Compost Sure all at once (2 people x 2 days = 4cups). To avoid messy waste pipe obstructions, Compost Sure should always be added at the composting unit, not the flush toilet. Grasp the crank handle and turn in a clock-wise direction for 10 complete turns of the drum . Keep in mind that one revolution of the drum = 7 complete turns of the handle. When the drum has been turned the required amount of turns, turn the handle counter clockwise until you feel resistance on the handle. THIS IS REALLY IMPORTANT! By turning the handle counter clockwise, you are centering the opening in the drum under the waste pipe. To ensure that there are no messy accidents, do not skip this step!!

CHECK THE VOLUME OF THE BIO-DRUM™

To speed up composting, add one scoop of Microbe Mix every second week, and ensure that the drum is not more than ½ full.

ATTENTION: the Centrex 3000 electric model must remain plugged in to an electrical outlet continuously to function in an odorless fashion. If you will be away from the residence where the composting toilet is installed for longer than three days, the power may be disconnected while the composting toilet lays dormant.

ACCESSORY ITEMS FOR THE CENTREX 3000 TOILET

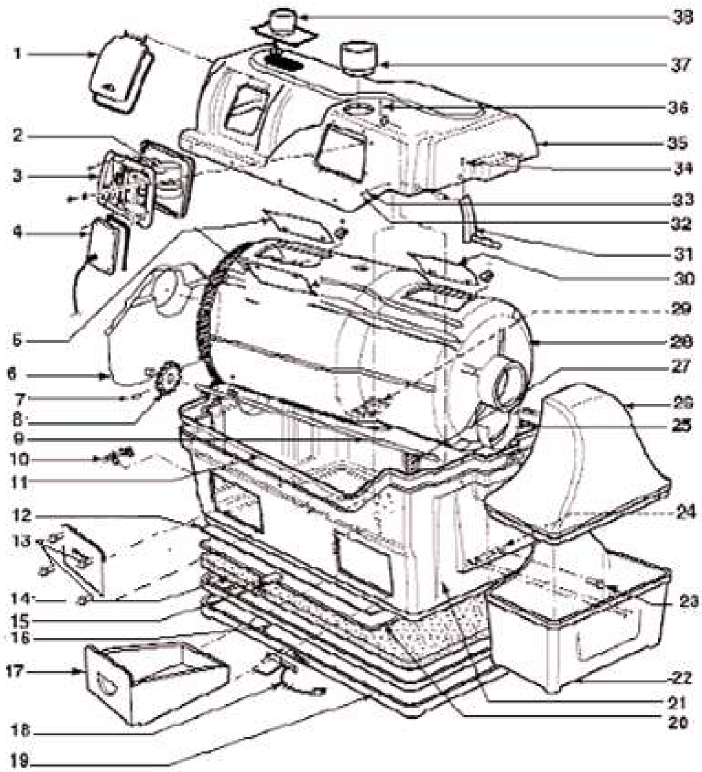
SUN-MAR has developed a number of composting accessory items over the years in response to frequent requests from users. These items may serve to improve composting speeds under some circumstances.

Name	Description	Container
"Compost Quick"	Cleans and accelerates the composting action of your Sun-Mar composting toilet. Compost Quick is a specially selected natural enzyme solution that also assists in the decomposition of waste. 100% natural and non-toxic**. 500ml(16oz) Bottle**	
"Microbe Mix"	100% natural product combining a blend of microbes and enzymes designed to start and accelerate composting in all Sun-Mar toilets. **500g (16oz) Jar**	
"Compost Sure Blue"	For use with all Sun-Mar low water CENTREX systems. Compost Sure Blue's mix enriches compost with organic carbon and also provides drainage of excess liquid ensuring compost remains aerobic and odor-free. **30 Litre/8 Gallon Bag**	
DC Vent Kit	Kit required for conversion of electric units to also operate without electricity or 12 volt DC mode. Includes a 12 volt DC fan.	
AF Waterless Kit	Purchase of a SUN-MAR dry toilet necessary. This kit will adapt a CENTREX 3000 for use without water. Ideal where water supply is limited or low output is desired.	
AC Fan Speed Control	Designed for electric units only, the control kit allows users to adjust the speed of the fan. Ideal for installations where the toilet is used in winter applications or in bunkies where the toilet may be in close proximity to sleeping quarters.	
12 Volt 2.4 Watt Fan	Designed for use in the 4" non-electric vent only. This fan increases the air flow in non-electric units to help overcome down draft.	

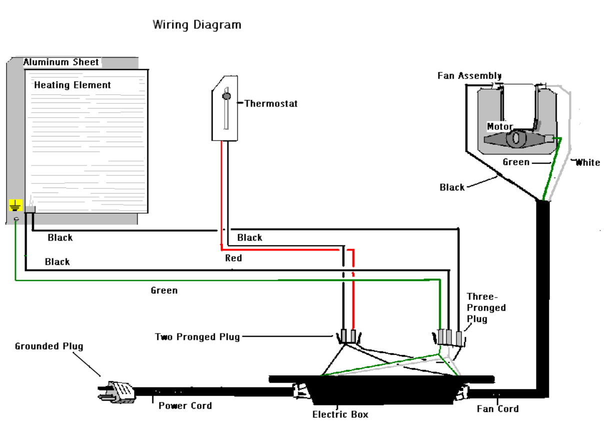
Note: *Use "Compost Sure Blue" for optimum results.*

CENTREX 3000 SPECIFICATIONS

CENTREX 3000 EXPLOSION DIAGRAM & PART NUMBERS



1 Centrex 3000 Access Door
2 Fan (Electric)
3 Fan Assembly Housin (Electric)
4 Plastic Fan Motor Cover (Electric)
5 Centrex 3000 Drum Doors
6 Centrex 3000 Bearing Plate
7 Roll Pin
8 Nylon Drive Gear
9 Centrex 3000 Shaft Assembly
10 1” (25mm)Drain Assembly
11 Rubber U Channel
12 Aluminum Sheet (Electric)
13 Centrex 3000 Access Panel and Thumbscrews
14 Insulation (Electric)
15 Thermostat (Electric)
16 Rubber U Channel
17 Centrex 3000 Drawer
18 Power Cord
19 Centrex 3000 Heating Tray
20 Heating Element
21 Centrex 3000 Tank
22 Collection Bin Bottom
23 Drum Locker Thumb Screw
24 Drum Locker
25 Drum Bearing Strip
26 Collection Bin Top
27 3” (75mm) Air Intake
28 Centrex 3000 Drum
29 Drum Screen
30 Centrex 3000 Drum Door
31 Handle
32 Washer Plastic CSK
33 Screw #8 X 5/8" SS
34 Set Screw
35 Top Centrex 3000
36 Roll Pin
37 4” (100ml) Vent Inlet (NE)
38 Cover Plate



Electrical Specifications	115V	240V
Maximum Amps	3.6	1.69
Fan Watts (Required)	35 req.	35 req.
Heater Watts (When on)	370	370
Average Power Use In Watts (Heater on 1/2 time)	200	200

WARRANTY

SUN-MAR Corp. warrants the original purchaser that this toilet is free from defects in material and workmanship under normal house or cottage use. SUN-MAR Corp. will furnish new parts for any part that fails within three years and five years on the fiberglass tank, provided that our inspection shows that such failure is due to defective material or workmanship. Any part supplied by us to replace another part is warranted for the balance of the original warranty period.

This warranty does not cover:

1. Damage resulting from neglect, abuse, accident or alteration; or damage caused by fire, flood, acts of God or any other casualty.
2. Parts and accessories not sold or manufactured by SUN-MAR Corp. or any damage resulting from the use of such items.
3. Damage or failure resulting from failure of the purchaser to follow normal operating procedure outlined in the Owner's Manual or in any other printed instructions.
4. Labor and service charges incurred in the removal and replacement of any parts found defective under the terms of this warranty.
5. All returns to the factory must be made freight prepaid. All shipments from the factory are made F.O.B. the factory.

This warranty is in lieu of all other warranties expressed or implied, and no person is authorized to enlarge our warranty responsibility, which is limited to the terms of this certificate. The Company reserves the right to change, improve or modify its products without obligation to install these improvements on equipment previously manufactured.

Product Info: (905) 332-1314 Fax: (905) 332-1315 Tech. Service: (888) 341-0782 Ext 218
E-mail: compost@sun-mar.com http://www.sun-mar.com

600 Main St.
Tonawanda, N.Y.
14150-0888 U.S.A.

5370 South Service Rd.
Burlington, ON
L7L 5L1 CANADA

AIR-FLOW TOILET AND AF WATERLESS KIT

Kit required for use with SUN-MAR Dry Toilet and CENTREX 2000 and 3000 systems. Includes 12 volt fan and hardware kit. Replaces all previous AF unit options.

TABLE OF CONTENTS

If using more than one AF extension pipe piece, a separate vent will be required for the dry toilet to ensure odor free operation.
Ensure the rectangular hole in the dry toilet bowl liner and the AF transition piece are aligned.

CONVERTING YOUR COMPOSTING UNIT

This kit is designed for use with the SUN-MAR Dry Toilet to convert the CENTREX 2000 and 3000 systems where little or no liquid output is desired. The CENTREX 2000 or 3000 system must be installed directly below the SUNMAR dry toilet. The drain is required on the non-electric units since evaporation is not assisted by the heating element, there may be overflow liquid.

PARTS IN THE AF WATERLESS KIT

1 X AF extension pipe piece 45”   1 X 12 volt 2.4 watt fan   2 X 4” 45° elbow
1 X 3” air intake plug   1 X 80ml. silicone tube
12 X # 8 - ¾” truss screws
**You will also require a phillips screwdriver

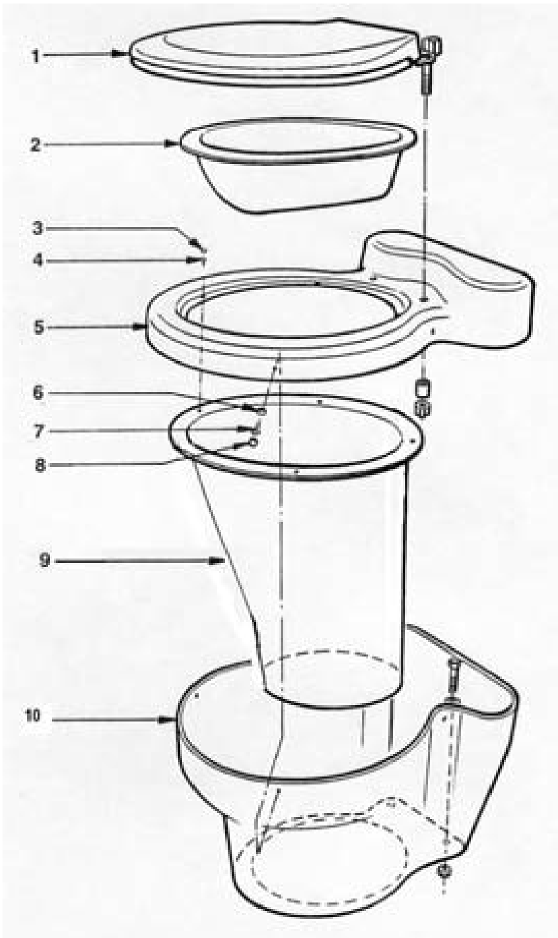
PARTS IN THE AF TOILET KIT

1 X AF Toilet   1 X AF Transition Piece   1 X Bowl Liner
4 X 5/16” x 2 Lag Bolt   1 X 80ml. silicone tube
4 X 5/16” Washer   8 x Snap Caps

REMOVE THE AF COVER PLATE

1. Remove the 6 screws on the AF cover plate.
2. Locate the composting unit directly below where the SUN-MAR Dry Toilet will be installed.
3. Remove AF cover plate.

EXPLOSION VIEW & PARTS FOR DRY TOILET



1 PP-TOILS-0208CX Toilet Seat White
PP-TOILS-0208DX Toilet Seat Bone

2 PF-BOWLL-0246FX AF Bowl Liner

3 PP-CAP00-0587XX Tap Cap Bone
PP-CAP00-0587WX Tap Cap White

4 PM-SCRE0-0250XX #8 X 3/4” (19mm) Flat Head Philips Screw

5 PF-AIRFL-0001BX Toilet Top Bone
PF-AIRFL-0001XX Toilet Top White

6 PM-SCRE0-0251BX #8 X 1/2” (16mm) Stainless Steel Flat Head Screw

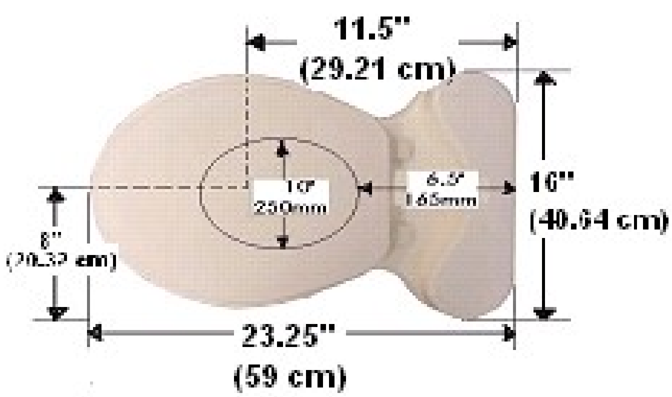
7 PP-WASH0-0274XX CKS Plastic Washer

8 PP-SNAPC-0273XX Snap Cap (Bone)
PP-SNAPC-0273WX Snap Cap (White)

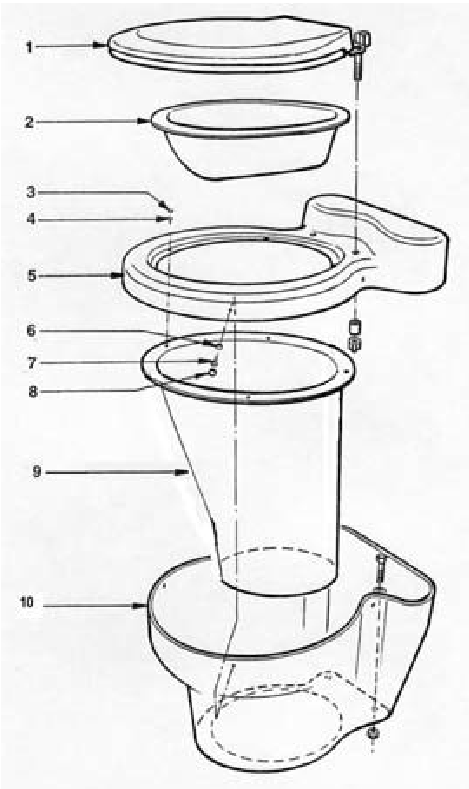
9 PP-AIRFL-003XX Toilet Chute

10 PF-AIRFL-0002BX Toilet Base Bone
PF-AIRFL-0002XX Toilet Base White

AF DRY TOILET ROUGH IN DIMENSIONS

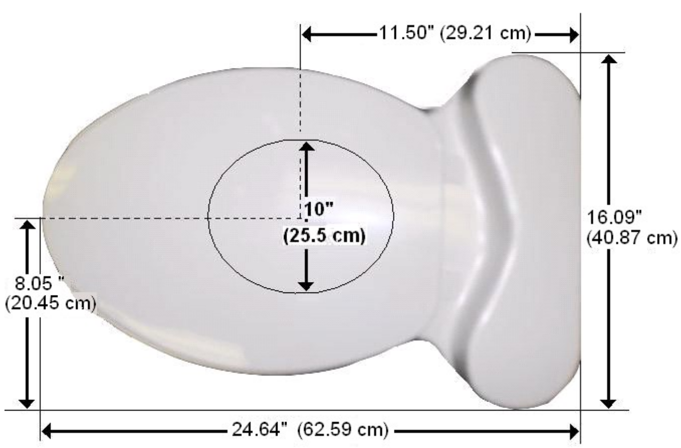


EXPLOSION VIEW & PARTS FOR ELONGATED DRY TOILET



1 PP-TOILS-0209XX Toilet Seat White
2 PF-BOWLL-0246XX AF Bowl Liner
3 PP-CAP00-0587WX Tap Cap White
4 PM-SCRE0-0250XX #8 X 3/4” (19mm) Flat Head Philips Screw
5 PF-AIRFL-0001CX Toilet Top White
6 PM-SCRE0-0251BX #8 X 1/2” (16mm) Stainless Steel Flat Head Screw
7 PP-WASH0-0274XX CKS Plastic Washer
8 PP-SNAPC-0273WX Snap Cap (White)
9 PP-AIRFL-0003BX Toilet Chute
10 PF-AIRFL-0002CX Toilet Base White

AF ELONGATED DRY TOILET ROUGH IN DIMENSIONS



INSTALLING THE SUN-MAR DRY TOILET

Placement Of The SUN-MAR Dry Toilet

Ensure that the floor joists are not in the way and that there is an unobstructed 10” diameter passage from the underside of the AF “Dry Toilet” to the top of the transition piece. The 10” hole should be centered 11.5” (29.21 cm) from the back wall and at least 9” (22.86 cm) dry toilet from the side wall in the room where the toilet will be installed. The transition piece on the top of the composting unit should be located so that the center line of the transition piece is directly below the center of the 10” circular cutout which will be made in the bathroom floor above. The transition piece should be at a right angle to the composting unit.

Installing The SUN-MAR Dry Toilet Base

The SUN-MAR Dry Toilet comes preassembled. For the purpose of explanation, the toilet base is the bottom of the toilet which is secured to the bathroom floor, the toilet chute is the black inner section (shown in Fig. A) that fits through the floor and is attached to the toilet top, the toilet top is the upper part of the toilet that attaches to the toilet base, and the bowl liner which is the black removable funnel shaped piece below the toilet seat.

To install the SUN-MAR Dry Toilet, follow the procedure outlined below:

1. To locate the position of the SUN-MAR Dry Toilet, place the toilet chute in the desired location on the floor in the bathroom and trace the 10”(25 cm) diameter cut out in the bottom of the toilet base on the floor in the bathroom. The centre of the 10” circle should be centered 11.5” (29.21 cm) from the wall against which the toilet will be mounted(See Fig. A)
2. Drill a 1/2”(6mm) hole on the front of traced line and then check under the floor that the hole will be clear of floor joists and will line up with the composting unit below. (See Fig. B)
3. If the position is correct, complete the cutting of the10”(250mm) diameter circle with a jig saw. (See Fig. C)
4. Center the toilet base over the 10”(250mm) diameter hole that Has been cut out of the floor and securely attach to the floor by using the four 5/16” by 2 1/2”(8mm by 64mm) lag bolts that are provided with your kit. (See Fig. D)

**Prior to finishing the SUN-Mar Dry Toilet installation, it is a good Idea at this time to do a pre-assembly check to see if you will need any extension pipe.

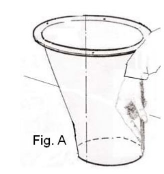


Fig. A

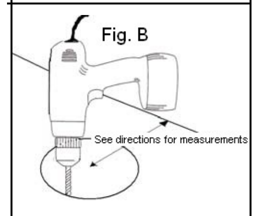


Fig. B

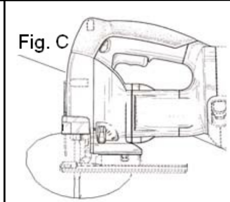


Fig. C

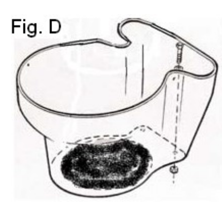
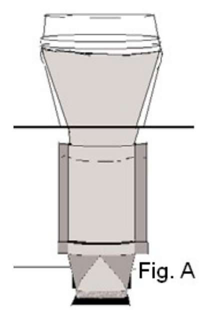
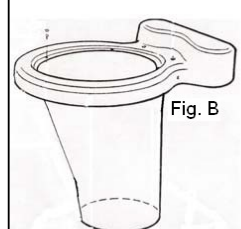


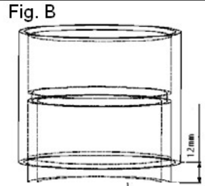
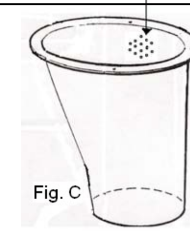
Fig. D

The Transition Piece

Place transition piece (Fig. E) into the rectangular opening on the top of the composting unit. Make sure that the transition piece is completely vertical on the unit, or completely vertical. Important: the transition piece should be completely vertical. The opening in the toilet in bathroom should be oriented above the opening in the transition piece so that waste can drop directly into the patented bio-drum.


Fig. E

Determining If An Extension Pipe Piece Is Required	Place the toilet chute into the toilet base in the bathroom. If the toilet chute extends 1-2"(25 - 50mm) into the transition piece, then no extension pipe pieces will be required. If the transition piece does not extend far enough up to meet the toilet chute, then one or more extension pipe pieces will be needed. These minimum 41" (112cm) pipe sections can be cut down to the correct length, so that when assembled and placed in the transition piece, they extend 1-2"(25-50mm) into the toilet chute. After taking into account the overlap, each pipe piece provides an extension of about 41"(104cm).
Assembling And Installing The Extension Pipe Pieces	Each extension pipe piece, consists of two half pipes. These can be cut to the correct length,by cutting the required amount off the straight ends of each half with a hack saw (do not cut the belled end of the extension pipe piece. It is easier to cut pipe sections to length before joining the two halves together. After cutting, clean up the edges with coarse (40-60 grit) sandpaper. Before joining the two halves of the pipe pieces, spread a bead of silicone caulking from top to bottom along the inside flanges of both halves of pipe pieces (so that the inside of the pipe section will be sealed). Press the two halves together, and secure them by screwing the self tapping screws provided into the pre-drilled holes. Run a finger or spatula up along each joint inside the chute to remove any excess silicone. Insert the non-belled end of the extension pipe piece into the transition piece. Ensure that the transition piece overlaps the extension pipe piece by 1 -2 " (25 - 50 mm).
Finishing The SUN-MAR AF Dry Toilet Base Installation	Pre Assembly Check: Before finishing the installation, make sure all pieces fit together properly. The top of the pipe piece is belled out to accommodate the toilet chute. Place the transition piece in the cut out provided on the top of the composting unit. Place the pipe pieces, if any, inside the transition piece. Next lower the toilet top onto the base so that the chute projects 1-2"(25-50mm) into the pipe piece or directly into the transition piece if no pipe piece is used. Ensure that the toilet top is properly located over the toilet base, that the chute is completely vertical, and that the screws to attach the top to the toilet base, line up properly. (Fig. A) If the pre-assembly check appears OK, then disassemble and reassemble each piece as in the pre-assembly check(see above). To assemble the toilet top with the chute, line up top with the chute and fasten the four screws around toilet opening and cover with the tap caps (Fig B). Insert the toilet chute into the toilet base until the toilet top rests on the base (Fig C). When reassembling use silicone caulking at the joints where the toilet chute sits inside the extension pipe piece, where the extension pipe piece sits inside the transition piece and where the transition piece sits inside the composing unit. Use a finger or spatula to remove any excess silicone. Align the two pre-drilled holes on the front of the toilet top, with the holes on the front of the toilet base, and insert two screws without tightening them. With these front two holes secured, tilt the rear of the top down over the base. Align the last four screws holes. Insert the CKS washers over the screws. Screw in all six screws, making sure not to over-tighten, and push the snap caps over the screw heads. Attach the toilet seat by threading the nylon screws through the toilet seat hinge and into the holes into the toilet top. Put the black removable bowl liner into place under the toilet seat.  Fig. A  Fig. B  Fig. C

Adjusting The Air Intake	The composting unit has a 3”(75mm) air intake vent at the rear of the unit. A 3”(75mm) intake cover is supplied with this kit. Remove the 3” air intake vent and replaced with the 3”(75mm) intake cover. Inserting the 3” intake cover will result in more air to be drawn down SUN-MAR Dry Toilet chute so there is no odor in the bathroom.
Installing The Optional Vent On The SUN-MAR AF Dry Toilet	If more than one extension pipe piece is needed to connect the composting unit to the SUN-MAR Dry Toilet then it may be necessary to vent the SUN-MAR Dry Toilet separately. i) Obtain sufficient pipe and fittings for the vent using either 3”(75mm)sewer pipe or plumbing pipe. ii) Trace the outside outline of the pipe on the circular section at the top rear of the toilet top. (See Fig. A) iii) Cut out the hole by first drilling a hole in the circumference of the traced outline, and then carefully using a jig saw to complete the circle. Use coarse sand paper to enlarge or smooth off the edges if necessary. iv) Cut a short length of 3” pipe and glue it into a 3” pipe coupling, with 1/2” (13mm) of 3” pipe protruding from the 3” coupling (Fig. B). Place this assembly into the hole the was created to accept the vent stack. v) Erect the vent stack as vertically as possible following the same rules as outlined in the manual. vi) If it is not possible to make this vent vertical or close to vertical, a 12 Volt fan may also have to be installed in this vent stack. Since the 12 Volt fan comes in a 12”(300mm)length of 4”(100mm) sewer pipe, two 3” - 4” transition couplings will be required.  Fig. A  Fig. B  Fig. C
Cutting Ventilation Holes In The Toilet Chute	Remove the bowl liner in the toilet top, and drill out a large number (15-20) holes 1/4”(6mm) or bigger at the top rear of the chute piece no more than 3”(75mm) down from the top edge. (See Fig. C) These holes will enable the vent on the top of the toilet to draw air out of the toilet.
Adjusting The Fan Gate (Electric)	If you believe that there may be a downdraft outside of the building, it may be a good idea to remove your fan assembly prior to installation and set the fan gate to ‘0’ to prevent urine odor in the bathroom. (electric) Install a 12 volt fan in vent pipe. (NE) 

12 Volt Fan Installation (NE Units)

Install the 12 volt fan on the inlet coupling with the large side with the wires protruding facing upwards (as shown in the picture at right). When the 12 Volt Fan is turned off, it forms an obstruction in the vent, and should therefore run continuously while the cottage or home is occupied. An optional switch (as small as 1 amp) may be installed, and the fan turned off when the toilet will not be used for several weeks. The red wire should be connected to the positive (+) terminal on your battery or DC system, and the blue wire to the negative terminal (-). Do not glue the fan to the vent stack. The 12 Volt Fan may be powered with a battery that is connected to a generator, solar panel, or other alternative energy system. For use in AC, purchase a 12 Volt to AC Adapter and snip off the female end. Wire the positive wire to the red wire on the fan, and the negative wire to the blue wire on the fan. Tie them off with wire connectors, and plug your AC Adapter into the wall.

Safety Drain Installation

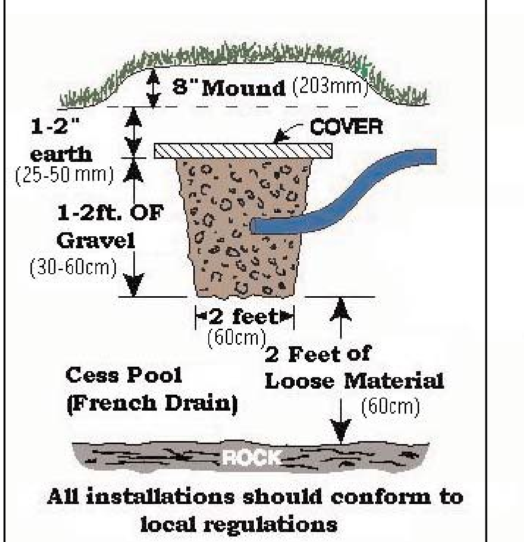
The safety drain should be connected as it will be required if heavy or residential use is anticipated or if the unit operates without electricity (NE).

- Remove the orange cap from one side of the overflow drain assembly.
- Place a 1” hose clamp over the end of the drain hose that will be connected to the overflow drain assembly. Push the drain hose over the ribbed end of the safety drain and clamp with the 1” SS hose clamp. Connect the 1” hose to an approved drainage facility.
- The safety drain is gravity fed. The drain hose must be below the level of the safety drain in order to function.

Handling Effluent

Although there should be very little effluent produced, the following are possible options to take care of the liquid :

- Feed into a lined pit filled with gravel and sand. Such a recycling bed also ensures a closed loop system.
- Feed into a small cesspit or “french drain”.
- Plumb into an existing septic or holding tank line. Installation should be in accordance with applicable local regulations.



Ongoing Maintenance

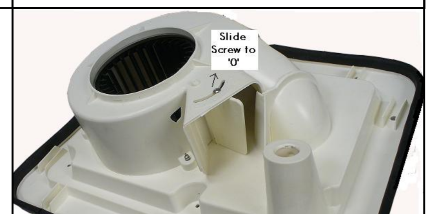
Your Centrex unit has now been converted to a dry toilet. Although your Centrex came equipped with two bags of Compost Sure Blue (for water flush systems), bulking mixture should be switched to Compost Sure Green (waterless toilets) after the initial product has been used up. Compost Sure Green is the ideal bulking agent for your waterless toilet. Compost Sure Green is specially formulated to keep compost enriched with organic carbon, moist and maintain porosity ensuring maximum aeration.

Add one cup of Compost Sure Green per person per day of use	Even if you only use the toilet for urination then at least one cup of Compost Sure Green should be added per person per day of use. Add the Compost Sure Green through the access door on the Centrex prior to mixing the Bio-Drum (every second day).
Spray Compost Quick on the surface of the compost	Every second day before turning the handle, spray 3-4 sprays of Compost Quick on the surface of the compost. Compost Quick is an enzyme that will speed up the composting process.
Turn the handle clockwise every second day to mix the compost	Turn the handle in a clockwise direction to mix and aerate the compost. When mixing, ensure that the drum rotates 6 complete revolutions (42 turns of the handle for Centrex 2000) or 10 complete revolutions (70 turns of the handle for Centrex 3000).
Make sure that the opening in the drum is centered under the toiletseat.	The hole in the drum must be open under the toilet seat, ready to receive waste.
Add water to the Bio-Drum.	Moisture is necessary to achieve good compost. Your compost should always be damp, like your garden after you have watered it. This moisture allows the bacteria to travel around in the compost. If the compost is too dry, the bacteria cannot survive and decomposition will slow or cease.
Every two weeks	Add one scoop of Microbe Mix to the patented bio-drum to ‘recharge’ the pile. This will help to ensure your microbe colony stays constant and healthy.

CAUTION

Competing appliances (ie. wood stove) may need an air intake installed from the outdoors. Competing appliances draw a lot of air and may draw air into the building and may prevent air from being drawn down through the toilet, preventing odor free operation

MECHANICAL TROUBLE SHOOTING

Symptom	Cause	Remedial Action	Prevention
Urine Odor in Washroom	Horizontal runs or downward slopes on vent pipe	Re-install the vent so there are no horizontal or low points where condensation can collect.	Install wall brackets on vent pipe to prevent settling. DO NOT install horizontal runs as liquid will collect and block ventilation, causing odor.
	Downdraft	If you believe that there may be a downdraft outside of the building, it may be a good idea to remove your fan assembly prior to installation and set the fan gate to '0' to prevent urine odor in the bathroom. (electric)	
	Competing appliances	Wood stoves or furnaces installed in a tightly sealed room with the composting toilet may draw air in causing a vacuum in the room. This will draw air down the vent pipe. Install fresh air intakes on any competing appliances.	Downdraft is dependent on wind direction as well as natural obstructions etc. Initially, install the vent above the peak of the roof. NE Units: Install a 12 volt fan in the vent.
	Room Where Air Flow Toilet Installed Is Air Tight	Hold a lighter up to the air intake holes on the back of the unit. Air should be drawn into the holes. If air is not easily pulled in, check venting for too many bends or horizontal lengths and/or provide more ventilation to the room.	Install the Air Flow Toilet in an area with plenty of ventilation and watch for competing appliances such as bathroom fans and wood stoves.
	Too many bends in vent pipe.	Re-install the 2"(50mm) vent stack to reduce the number of bends/eliminate horizontal lengths.	Install the vent with minimal bends (total bends should equal no more than 360 degrees)
	Too many extension pipe pieces used in installation	Install vent on Air Flow Toilet, (see page 7)	Air Flow toilet may be installed with only one extension pipe piece before supplemental venting may be required.
	Not enough air being pulled down the dry toilet	One 3"(75mm) diameter air intake holes cover is supplied with the hardware kit. The air intake hole at the rear of the unit, may be replaced with a solid cover so that more air is pulled down the Air Flow toilet.	Covers should only be inserted if they are needed, as they will reduce airflow over the evaporation chamber, which in turn will reduce evaporation performance.

CTO-00001
SM A/F Waterless Kit
September 2019
Rev.D7

TOOLS REQUIRED

Product Info: (905) 332-1314 Fax: (905) 332-1315 Tech. Service: (888) 341-0782 Ext 218
E-mail: compost@sun-mar.com http://www.sun-mar.com

600 Main St.	5370 South Service Rd.
Tonawanda, N.Y.	Burlington, ON
14150-0888 U.S.A.	L7L 5L1 CANADA

Reolink Digital Technology Co., Ltd.

Picture		
Model	**Reolink Argus 2**	
Video & Audio	Image Sensor	Starlight CMOS Image Sensor
	Video Resolution	1080p HD at 15 frames/sec
	Video Format	H.264
	Field of View	Fixed lens, 130° diagonal
	Night Vision	Up to 10 m (33 ft)
	Digital Zoom	6x digital zoom
	Audio	High-quality speaker and microphone
PIR Detection & Alerts	PIR Detecting Distance	Adjustable up to 9 m (30 ft)
	PIR Detecting Angle	120° horizontal
	Audio Alert	Customized verbal alerts
	Other Alerts	Instant email alerts and push notifications
Wireless	Wireless Standard	IEEE 802.11b/g/n
	Operating Frequency	2.4GHz
	Wireless Security	WEP/WPA-PSK/WPA2-PSK
Power	Battery	5200mAh rechargeable battery (Battery life varies based on settings, usage & temperature)
	Solar	Can be powed by Reolink Solar Panel
	DC Power	Can be powed by 5V/2A power adaptor
Storage	Local Storage	Supports up to 64GB micro SD card
	Cloud Storage	Supports Reolink Cloud
Working Environment	Operating Temperature	-10 to 55° C (14° to 131° F)
	Weather Resistance	Weatherproof
Size & Weight	Size	96 x 58 x 59 mm (3.8 x 2.3 x 2.3 in)
	Weight (Battery included)	260 g (9.2 oz)
Warranty	Limited Warranty	2-year limited warranty. For support, visit https://support.reolink.com/hc/en-us/

Reolink Digital Technology co.,ltd.

Picture		 第三代太阳能板参数
Model	Model	Reolink Solar panel
	material	Monocrystalline silicon
physical parameters	Dimensions	132 x 197 x 13(mm)
	Cable Length	4 Meters
	Weight	280 G
	Interface	Micro USB Port
Electrical Parameters	Max Voltage	6.0V
	Max Current	530MA
	Max	3.2W
	Efficiency	19.50%
Other Parameters	Working Temperature	-10℃~+55℃(14°F~131°F)
	Working Humidity	10%~90%
	Waterproof	IP65

Appendix F – Cost Estimate

Evergreen Engineering
Northeastern University
Boston, MA 02115

Cost Estimate

Submitted on 04/27/2020

Prepared for
Town of Belmont
Conservation Commission
455 Concord Avenue
Belmont, MA 02478

Prepared by
Evergreen Engineering

Project
Rock Meadow

Due date
4/27/2020

	Description	Qty	Unit	Unit price	Total price
1. Demolition					
1.1	**ASPHALT REMOVAL/HAULING**	1159	sq yd	$0.19	$220.21
1.2	**TREE REMOVAL**	21	ct	$131.00	$2,751.00
1.3	**MINI EXCAVATOR**	3	wk	$1,980.00	$5,940.00
1.4	**SKID STEER**	3	wk	$445.00	$1,335.00
1.5	**HAND TOOLS**	3	wk	$200.00	$600.00
	Demolition Total				$10,846.21
2. Earthwork					
2.1	**BACKFILL MATERIAL**	915	cu yd	$25.00	$22,875.00
2.2	**TOPSOIL MATERIAL**	240	cu yd	$24.00	$5,760.00
2.3	**HAULING**	1155	cu yd	$2.19	$2,529.45
2.4	**EROSION CONTROL**	900	sq yd	$0.76	$684.00
	Earthwork Total				$31,848.45
3. Hardscaping					
3.1	**PARKING LOT**				
3.1.1	1.75" Super-Pave Surface Course (12.5)	84.4	ton	$118.80	$10,026.72
3.1.2	1.75" Super-Pave Intermediate Course (12.5)	84.4	ton	$137.09	$11,570.40
3.1.3	4.5" Super-Pave Base Course (37.5)	217	ton	$124.74	$27,068.58
3.1.4	4" Dense Graded Crushed Stone	98.6	cu yd	$73.40	$7,237.24
3.1.5	8" Gravel Borrow	197.1	cu yd	$44.68	$8,806.43
3.2	**DRIVEWAY**				
3.2.1	1.5" Super-Pave Surface Course (9.5)	24.8	ton	$158.39	$3,928.07
3.2.2	2" Super-Pave Intermediate Course (12.5)	33	ton	$137.09	$4,523.97
3.2.3	8" Gravel Borrow	67.5	cu yd	$44.68	$3,015.90
3.3	**ASPHALT SIDEWALK**				
3.3.1	1" Super-Pave Surface Core (12.5)	4.7	ton	$118.80	$558.36
3.3.2	1.5" Super-Pave Intermediate Course (12.5)	7	ton	$127.09	$889.63
3.3.3	8" Gravel Borrow	18.9	cu yd	$44.68	$844.45
3.4	**HANDICAPPED RAMP**				
3.4.1	4" Cement Concrete Wheelchair Ramp	11.7	sq yd	$103.09	$1,206.15
3.4.2	8" Gravel Borrow	2.6	cu yd	$44.68	$116.17
3.5	**CONCRETE CURB**				
3.51	Precast Concrete Curbs, Straight, 6"x18"	310	ft	$8.64	$2,678.40
	Hardscaping Total				$82,470.47
4. Landscaping					
4.1	**POLLINATOR PATCH**				
4.1.1	Topsoil	80	cu yd	$24.00	$1,920.00
4.1.2	Plants	203	ct	$21.97	$4,459.91
4.3	**SCENIC VISTA**				
4.3.1	Mulch	42	sq yd	$1.95	$81.90
4.3.2	Topsoil	12	cu yd	$24.00	$288.00
4.3.3	Plants	24	ct	$27.91	$669.84
4.4	**GRASS SEED**	444	sq yd	$1.90	$843.60
	Landscaping Total				$8,263.25
5. Green Infrastructure					
5.1	**VEGETATED FILTER STRIP**				
5.1.1	Topsoil	33.8	cu yd	$24.00	$811.20
5.1.2	Path Rush Grass Seed	2	lb	$300.00	$600.00
5.2	**BIOSWALE**				
5.2.1	Engineered Soil Mix	23.7	cu yd	$51.39	$1,217.94
5.2.2	6" Clean Stone	5.9	cu yd	$35.50	$209.45
5.2.3	4" Perforated PVC Pipe	36	ft	$1.85	$66.60
5.2.4	Cast-In Place Concrete Curbs and Gutter, Straight, Steel Forms, 6" high curb, 6" thick gutter, 24" wide, straight, includes concrete	170	ft	$11.83	$2,011.10
5.2.5	Plants	70	ct	$27.91	$1,953.70
5.2.6	Sod	816	sq ft	$11.71	$9,555.36
5.3	**RAIN GARDEN**				
5.3.1	Engineered Soil Mix	62.2	cu yd	$42.47	$2,641.63
5.3.2	Mulch	5.2	cu yd	$1.95	$10.14
5.3.3	Plants	35	ct	$21.97	$768.95
5.3.4	Sod	112	sq ft	$11.71	$1,311.52
	Green Infrastructure Total				$21,157.60
6. Additional Site Improvements					
6.1	**VIDEO SURVEILLANCE**	2	ct	$125.00	$250.00
6.2	**COMPOSTING TOILET**	1	ct	$3,400.00	$3,400.00
6.3	**SIGNAGE**	4	ct	$80.00	$320.00
6.4	**HANDRAIL**				
6.4.1	Posts	12	ct	$32.00	$384.00
6.4.2	Railing	108	ft	$29.75	$3,213.00
6.5	BIKE RACK	1	ct	$555.00	$555.00
6.6	**STEPPED PATH RELOCATION**				
6.6.1	Backfill Material	7.5	cy	$25.00	$187.50
6.6.2	Landscape Timber (8'-6" L)	16	ct	$46.00	$719.76
	Additional Site Improvements Total				$9,029.26
7. LABOR					
7.1	**OPERATOR**	29	d	$678.80	$19,685.20
7.2	**DRIVER**	57	d	$586.80	$33,447.60
7.3	**FOREMAN**	34	d	$530.00	$18,020.00
7.4	**LABORER**	96	d	$506.00	$48,576.00
	Labor Total				$119,728.80

Notes: PRELIMINARY COST ESTIMATE ONLY - NOT FOR FINAL CONSTRUCTION

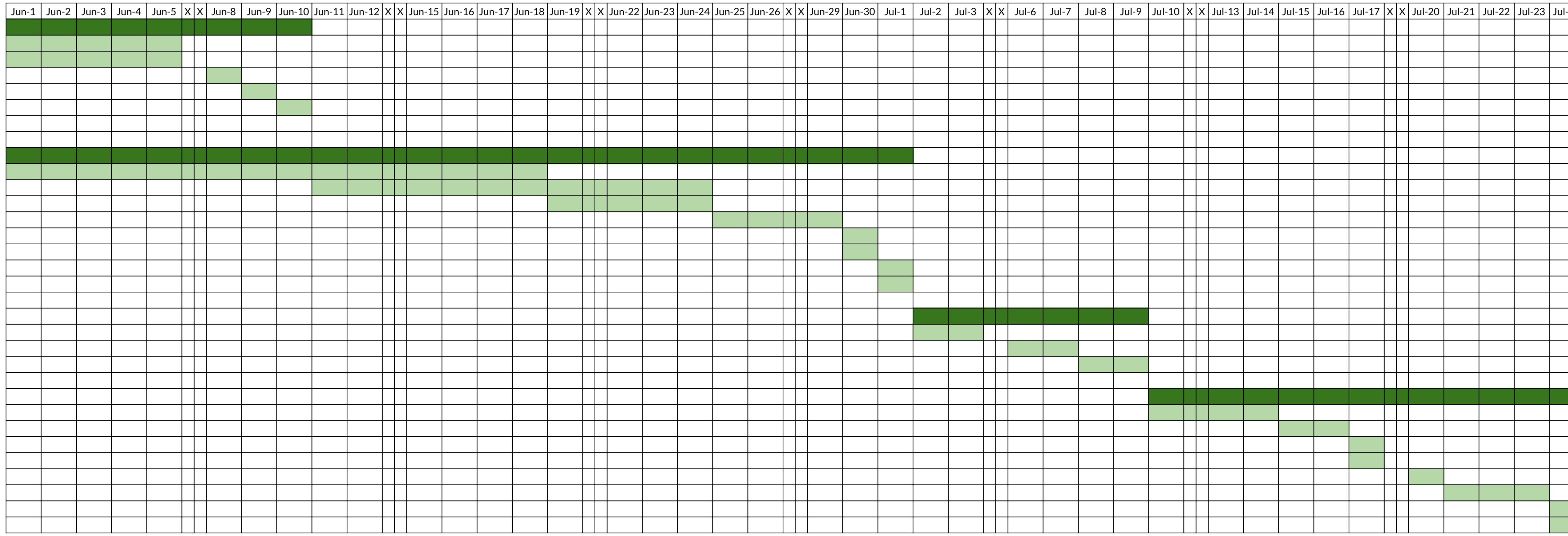
$283,344.04

Appendix G – Construction Schedule

ROCK MEADOW PARKING LOT

Project Start: 6/01/2020

ID	TASK NAME	DURATION	START	FINISH
	DEMOLITION	10	6/1/2020	6/10/2020
1	Tree Removal	5	6/1/2020	6/5/2020
2	Asphalt Removal	5	6/1/2020	6/5/2020
3	Stepped Path Removal	1	6/8/2020	6/8/2020
4	Gate Removal	1	6/9/2020	6/9/2020
5	Light Pole Removal	1	6/9/2020	6/9/2020
6	Boulder Removal	1	6/10/2020	6/10/2020
	EARTHWORK/HARDSCAPING	23	6/1/2020	7/1/2020
7	Truck Fill to Site	14	6/1/2020	6/18/2020
8	Rough Grading	10	6/11/2020	6/24/2020
9	Truck Topsoil to Site	4	6/19/2020	6/24/2020
10	Paving	3	6/25/2020	6/29/2020
11	Curbing	1	6/30/2020	6/30/2020
12	Concrete Pad for Bike Rack	1	6/30/2020	6/30/2020
13	Gutters	1	7/1/2020	7/1/2020
14	Underdrain	1	7/1/2020	7/1/2020
	STORMWATER MANAGEMENT	6	7/2/2020	7/9/2020
15	Vegetated Filter Strip	2	7/2/2020	7/3/2020
16	Bioswale	2	7/6/2020	7/7/2020
17	Rain Garden	2	7/8/2020	7/9/2020
	LANDSCAPING/SITE IMPROVEMENTS	11	7/10/2020	7/24/2020
18	Pollinator Patch	3	7/10/2020	7/14/2020
19	Handrail	2	7/15/2020	7/16/2020
20	Mulch Vista	1	7/17/2020	7/17/2020
21	Parking Lot Striping	1	7/17/2020	7/17/2020
22	Bike Rack	1	7/20/2020	7/20/2020
23	Composting Toilet	3	7/21/2020	7/23/2020
24	Signs	1	7/24/2020	7/24/2020
25	Security Cameras	1	7/24/2020	7/24/2020



Appendix H – Plant Palettes

1.0 Plant Palette I – Main Entrance/Parking Lot

2.0 Plant Palette V – Pollinator Patch

PLANT PALETTE I

MAIN ENTRANCE/PARKING LOT

Trees

Botanical Name	Common Name	Height	Sun Exposure	Season of Interest
Asimina triloba	pawpaw	15-30'	Full sun to part shade	May-September
Fagus grandifolia	American beech	50-80'	Part to full shade	Year-round

Shrubs

Botanical Name	Common Name	Height	Sun Exposure	Season of Interest
Hamamelis virginiana	American witchhazel	10-15'	Part to full shade	September-December
Corylus americana	American hazelnut	6-12'	Part to full shade	April-June
Cornus sericea	red-osier dogwood	6-12'	Part shade	Year-round

Forbs

Botanical Name	Common Name	Height	Sun Exposure	Season of Interest
Asclepias tuberosa	butterflyweed	1-2'	Full sun	May-September
Eutrochium purpureum	purple joe-pye weed	2-6'	Full sun to part shade	July-September
Veronia noveboracensis	New York ironweed	5-8'	Full sun	August-September
Liatris spicata	spiked gayfeather	3-4'	Full sun	July-September
Onoclea sensibilis	sensitive fern	1-3'	Part to full shade	June-Novemeber
Osmunda cinnamomea	cinnamon fern	3-6'	Full sun to part shade	May-June

Grasses

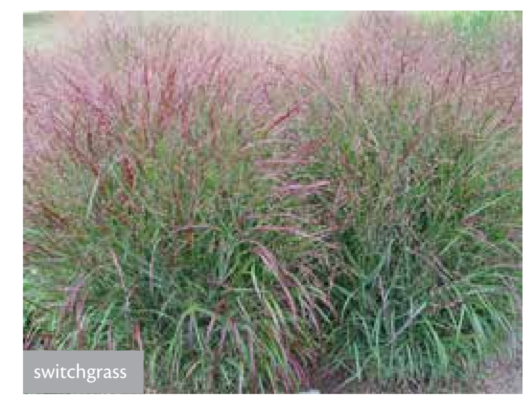
Botanical Name	Common Name	Height	Sun Exposure	Season of Interest
Panicum virgatum	switchgrass	3-6'	Full sun	August-November
Eragrostic spectabilis	purple lovegrass	1-2'	Full sun	August-September
Calamagrostis canadensis	Canada blue joint	3-6'	Full sun to part shade	June-August
Juncus tenuis	path rush	1-3'	Part shade	April-May


pawpaw


witchhazel


hazelnut


New York ironweed


switchgrass


cinnamon fern


butterflyweed


purple lovegrass


red-osier dogwood

PLANT PALETTE V

POLLINATOR PATCHES

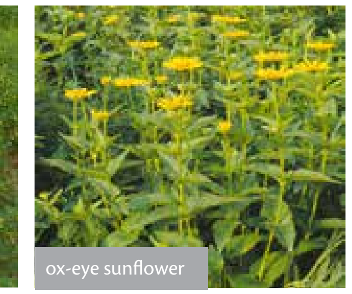
Forbs

Botanical Name	Common Name	Height	Sun Exposure	Season of Interest
Chamaecrista fasciculata	partridge pea	1-3'	Full to part sun	June-October
Heliopsis helianthoides	ox-eye sunflower	3-5'	Full sun	June-September
Coreopsis lanceolata	lanceleaf coreopsis	1-2'	Full to part sun	April-June
Rudbeckia hirta	black-eyed susan	1-2'	Full sun	June-October
Liatris syriaca	spiked gayfeather	3-4'	Full sun	July-September
Asclepias syriaca	common milkweed	3-5'	Full sun	June-August
Veronia noveboracensis	New York ironweed	5-8'	Full sun	August-September
Symphyotrichum novae-angliae	New England aster	3-6'	Full to part sun	August-October
Eutrochium purpureum	purple joe-pye weed	2-6'	Full to part sun	July-September
Asclepias tuberosa	butterflyweed	1-2'	Full sun	May-September
Solidago juncea	early goldenrod	3-10'	Full to part sun	June-August
Eupatorium perfoliatum	boneset	3-6'	Full to part sun	June-October

SENTINEL TREES

Botanical Name	Common Name	Height	Sun Exposure	Season of Interest
Gymnocladus dioicus	Kentucky coffeetree	80-100'	Full to part sun	June-October
Juglans nigra	black walnut	50-75'	Full sun	April-September
Populus deltoides	eastern cottonwood	50-80'	Full sun	March-April
Quercus macrocarpa	bur oak	100'	Full to part sun	March-May


partridge pea


ox-eye sunflower


spiked gayfeather

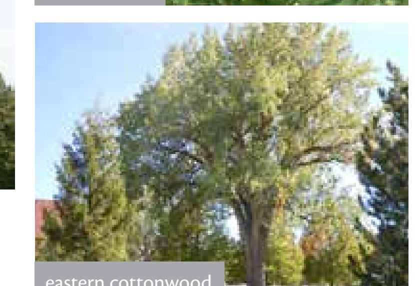

lanceleaf coreopsis


New England aster


early goldenrod


black walnut


Kentucky coffeetree


eastern cottonwood