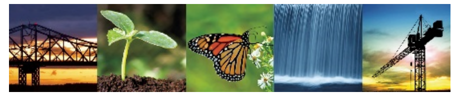
GZA

Known for excellence.
Built on trust.

GEOTECHNICAL
ENVIRONMENTAL
ECOLOGICAL
WATER
CONSTRUCTION MANAGEMENT

1350 Main Street
Suite 1400
Springfield, MA 01103
T: 413.726.2100
F: 413.732.1249
www.gza.com



March 15, 2019
15.0166700.00

<u>Submitted Via Electronic Notification</u>

Wayne Feiden, FAICP
Department of Planning & Sustainability
City Hall
210 Main Street
Northampton, MA 01060

Re: Conceptual Design Summary
Northampton Designs with Nature to Reduce Storm Damage
Northampton, Massachusetts

Dear Mr. Feiden:

GZA GeoEnvironmental, Inc. (GZA) is pleased to submit to the City of Northampton (the City) the enclosed **Conceptual Design Summary** detailing eleven conceptual projects within the City as part of the "Northampton Designs with Nature to Reduce Storm Damage" Program (the Program). The enclosed summary report documents the conceptual designs prepared by GZA with support from our subconsultant, Nitsch Engineering, to satisfy Task 3 of the Scope of Work under GZA's Contract with the City ("Horizontal Design of Stormwater Design, Northampton Designs with Nature to Reduce Storm Damage", City Contract # 81-19, dated August 29, 2018).

The **Conceptual Design Summary** includes narrative descriptions of each project location and proposed conceptual design, along with an assessment of project benefits and potential challenges for each project. Also included are estimates of cost for each project. The **Conceptual Design Summary** is subject to the limitations contained in Appendix A of the enclosed report.

GZA appreciates the opportunity to provide these services to the City of Northampton. We look forward to discussing the **Conceptual Design Summary,** as well as the path to moving forward with the overall Program, with you and other City representatives at our scheduled meeting on March 25. In the meantime, please do not hesitate to reach out with any questions or comments as you review the report.

Very truly yours,
GZA GEOENVIRONMENTAL, INC.

Rosalie Starvish, M.S., P.E., CFM, CPMSM
Project Manager

Thomas Jenkins, P.E.
Principal-in-Charge

Peter Baril, P.E.
Consultant / Reviewer

Enclosure: Conceptual Design Summary – Northampton Designs with Nature to Reduce Storm Damage; GZA, March 15, 2019

CONCEPTUAL DESIGN SUMMARY

NORTHAMPTON DESIGNS WITH NATURE TO REDUCE STORM DAMAGE

Elm Street Brook; December 21, 2018

PREPARED FOR:

NORTHAMPTON
Massachusetts
PLANNING & SUSTAINABILITY

PREPARED BY:

GZA in conjunction with: Nitsch Engineering

March 15, 2019
File No. 15.0166700.00

TABLE OF CONTENTS

INTRODUCTION

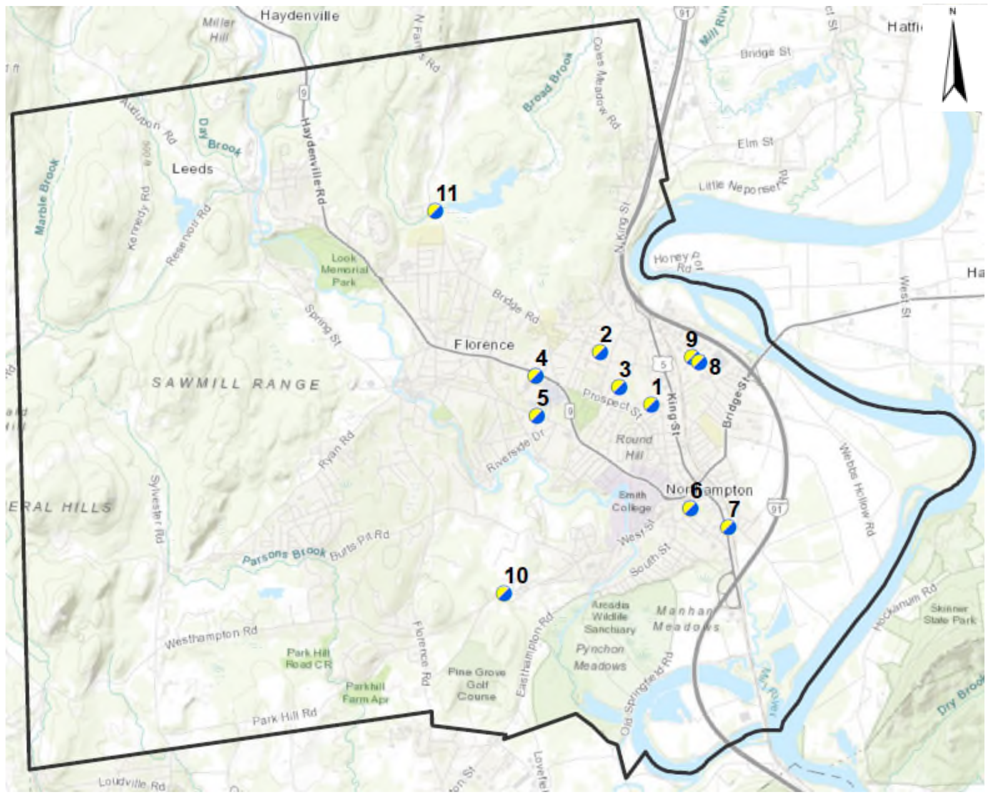
The City of Northampton (the City), through its Office of Planning & Sustainability, was the recipient of an "Action Grant" from the Massachusetts Municipal Vulnerability Preparedness (MVP) Program, for the "Northampton Designs with Nature to Reduce Storm Damage" program. GZA was retained by the City of Northampton to provide engineering services associated with implementation of the grant, with a scope of work that includes the design (both concept-level and final design) and permitting of green infrastructure to detain, retain, and treat stormwater using nature-based solutions. The Massachusetts Executive Office of Energy & Environmental Affairs defines nature-based solutions as *"…strategies that conserve, create, restore and employ natural resources to enhance climate adaptation, resilience and mitigation to mimic natural processes or work in tandem with man-made engineering approaches to address natural hazards like flooding, erosion, drought, and heat islands and to maintain healthy natural cycles to sequester and maintain carbon and other greenhouse gases"* (MA EOEEA, 2019).

The overarching goals of the "Northampton Designs with Nature to Reduce Storm Damage" program are to improve stormwater quality, reduce stormwater quantity in problem areas, maximize social and environmental co-benefits, and provide demonstration projects to inspire future longer term and positive impact projects. The City identified ten opportunity sites on public land, which GZA evaluated for the City to identify potential projects that would address the City's goals. GZA reviewed all of the sites and developed a list of 20 recommended individual projects which had the potential to advance the City's goals. The potential projects were evaluated by GZA and City of Northampton stakeholders to result in the selection of 11 projects for advancement to conceptual design. This Conceptual Design Summary report describes the conceptual designs which have been prepared by GZA and its subconsultant team. This report is subject to the Limitations provided in Appendix A. A common graphical legend for figures presented in this report is included in Appendix B.

Conceptual designs for the following implementation projects are described herein:

- Barrett Street Marsh / King Street Brook Watershed:
    1. King Street Brook Flood Control Berm
    2. Jackson Street Elementary School Stormwater Retrofits
    3. Adare Place Outlet Improvements and Stream Channel Restoration
- Elm Street Brook Watershed:
    4. Smith Vocational and Agricultural High School Bioretention
    5. Elm Street Brook Flood Mitigation
- Historic Mill River Watershed:
    6. Old South Street Outfalls
    7. Pleasant Street Outfalls
- Industrial Drive:
    8. Industrial Drive Rotary Stormwater Retrofit
    9. Industrial Drive Channel Improvements
- Ice Pond:
    10. Ice Pond Outlet Improvements
- North Farms Road / Broad Brook:
    11. North Farms Road/ Broad Brook Culvert Upgrade

Hereinafter, this report will refer to each proposed implementation as a separate, numbered "Project". Included for each Project is a general description of the opportunity site and setting, the proposed conceptual design to address the City's goals, and a summary of Project benefits and challenges. A Locus Map for the eleven projects is presented below.



Locus Map

This Conceptual Design Summary report also includes estimates of cost (see Appendix F). The conceptual-level opinions of individual Project construction cost presented in this report have been developed prior to any significant amount of information is available from detailed design and with incomplete work scope definition. In preparing the cost opinions, GZA has developed approximate quantities of work and has utilized a combination of sources of unit cost information which may include published RS Means Cost Data; past bid documents; cost data from federal, state, or local transportation agency web sites; discussions with local experienced contractors; and GZA's experience with costs for similar projects at similar locations. Because these preliminary estimates are made prior to the completion of detailed design, the margin of error is expected to be relatively large; thus, a significant contingency has been applied to cover the occurrence of eventual refinements to the conceptual scope of work and to also mitigate the potential for unplanned events or discoveries during construction. Costs associated with survey; geotechnical investigations; design services; permitting; designer services during construction; resident engineer services; unforeseen utility impacts or wetland mitigation requirements; or temporary and permanent easements are not included in the estimates of cost. Notwithstanding these limitations, the opinions of Project cost are provided to inform the City of Northampton about the magnitude of anticipated construction costs and to furnish information for the City's use in evaluating the economic feasibility of proceeding with a particular Project and the Project's potential for further development. The estimates of cost may also be used to help define a preliminary construction budget and may reduce the risk of construction cost escalation during the design development of any Project that advances beyond the conceptual stage.

PROJECT 1 - KING STREET BROOK FLOOD CONTROL BERM

King Street Brook is a tributary to the Connecticut River and originates from drainage in the Round Hill Road / Woodlawn Avenue neighborhood. The open channel portion of the brook begins at an outfall located beyond the rear yards of the homes along Winter Street. The brook conveys flow in a northeasterly direction, into the Barrett Street Marsh via a box culvert through the elevated Northampton Bike Path (former railroad embankment) between Hayes Avenue and Stoddard Street. Until the early 1900s, King Street Brook did not flow into Barrett Street Marsh but instead took a sharp southeasterly turn towards State Street (Figure 1-1). The box culvert diverting King Street Brook through the elevated railroad embankment and into Barrett Street Marsh was constructed circa 1905. It is presumed that Barrett Street marsh was dredged and channelized at the same time, to provide the gradient for the brook to continue northward and ultimately into the Connecticut River. The channel through the marsh has not been maintained by periodic dredging over the last 30 or more years and causes an excessive tailwater condition on the box culvert. Reportedly, during high flow events, the brook backs up and then overflows its banks at a low point located approximately 130 feet upstream of the box culvert. The floodwaters are then conveyed through the bordering wetlands and generally follow the path of the historic channel, causing flooding of developed properties in the Stoddard/ Church/ State Streets neighborhood.

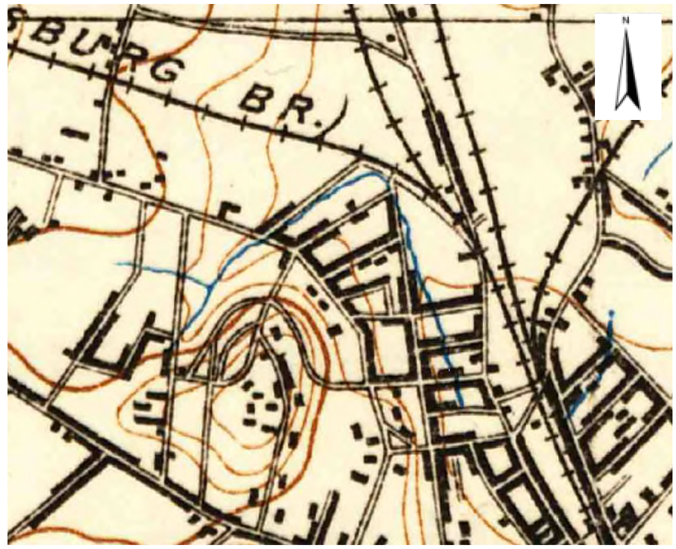


Figure 1-1. Former path of King Street Brook (USGS Topographic Map, Northampton, MA, July 1895)

Previous studies have identified that the placement of a flood control berm within the valley of the historic channel could minimize the potential for overflows from the brook to reach the Stoddard/ Church/ State Streets neighborhood (CDM, 2014, 2016). The placement of a flood control berm was selected for conceptual design and evaluation by the City of Northampton stakeholders because of its potential to significantly reduce the occurrence of flooding impacts to the neighborhood.

PROPOSED CONCEPTUAL DESIGN

As documented in the “King Street Brook Culvert Evaluation” (October 2014) and the “King Street Brook Hydraulic Analyses Memorandum” (March 2, 2016), CDM conducted an alternatives analysis to evaluate options for reducing the risk of flooding to the Stoddard/ Church/ State Streets neighborhood by overflows from King Street Brook. CDM performed hydrologic and hydraulic modeling to evaluate the alternatives that would not result in significant adverse impacts to downstream water levels and potential flooding in the downstream Barrett Street Marsh. The options evaluated by CDM included (1) a berm of varying heights placed across a low point in the wetlands to the north of the end of Winter Street, (2) increasing the culvert size of the King Street Brook culvert under the bike

KEY OPPORTUNITIES

- Reduction in neighborhood flooding potential
- Use of natural area
- Wetland enhancement / invasive species reduction potential

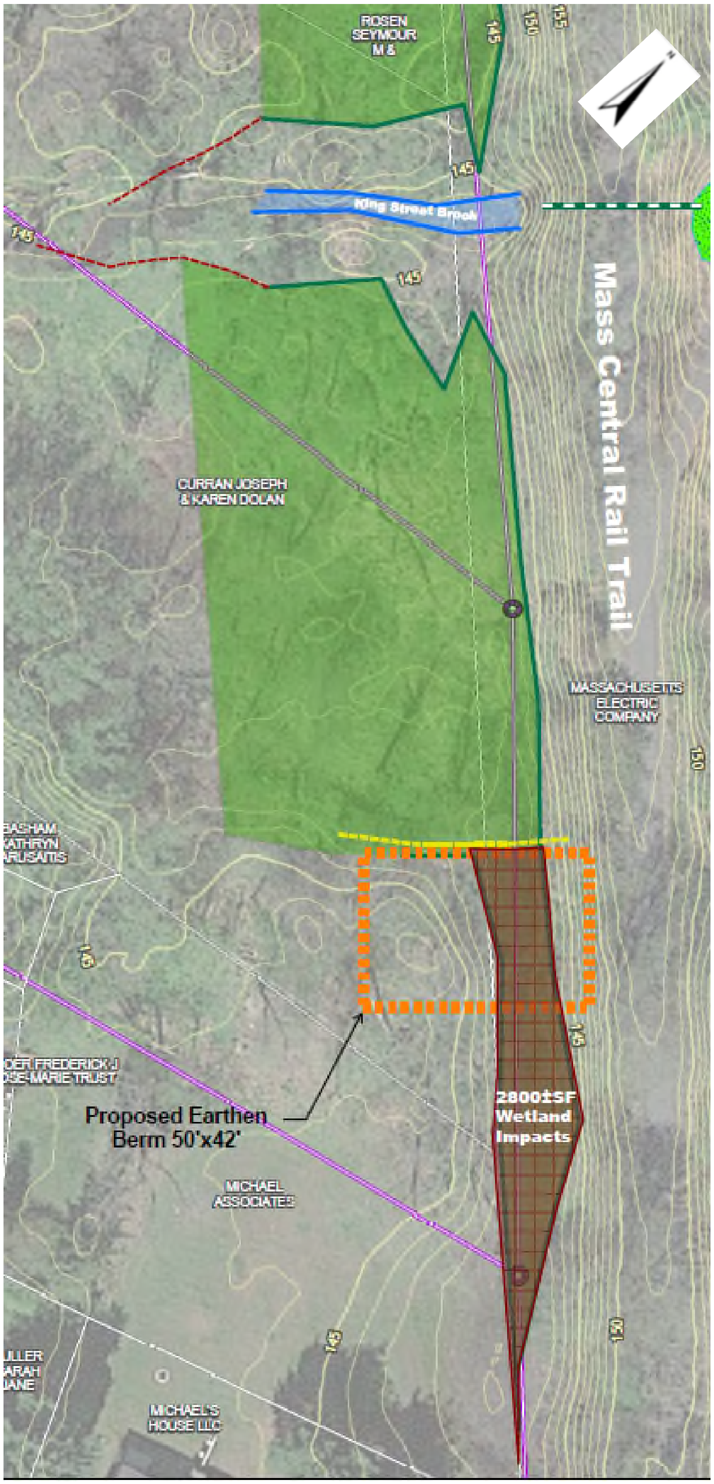


Figure 1-2. Conceptual Design for King Street Brook Flood Control Berm (Imagery © Google)

path embankment, (3) adding a relief culvert, and various combinations of options (1), (2), and (3). CDM concluded that the construction of a berm to an elevation of 146 feet (option 1) would provide protection from flooding of the Stoddard/ Church/ State Streets neighborhood up to a 10-year, 24-hour storm event. Adding capacity to the King Street Brook culvert in addition to constructing the berm did not prove effective as it would not provide additional flood relief but would add significantly to project costs.

Essentially, the proposed conceptual design of this Project has adopted the CDM option 1: the construction of an earthen berm with a crest elevation of 146 feet (about 4 feet in height relative to the surrounding topography) placed adjacent to the bike path embankment at a location approximately 240 feet from the end of Winter Street. With side slopes of 3 horizontal to 1 vertical, and including a top width of 18 feet, the berm would have a footprint of approximately 50 feet by 42 feet (Figures 1-2 & 1-3).

Figure 1-3. Proposed Grading for Flood Control Berm (Imagery © Google)

Hydrology & Hydraulics

The CDM study (March 2, 2016) predicted that the berm would provide protection from flooding to the Stoddard/ Church/ State Streets neighborhood up to and including a 10-year, 24-hour storm event. For flows in King Street Brook greater than the 10-year, 24-hour storm event, the berm may be overtopped. The King Street Brook Flood Mitigation Hazard Mitigation Grant Program Application (CDM, November 2015) indicated that a significant neighborhood flooding event occurred on May 23, 2014, which was equivalent to a 2-year storm. Although the berm may not prevent flooding during the more extreme storm events (greater than a 10-year, 24-hour storm), such larger events have an overall lesser frequency of occurring than the 10-year or smaller events. For example, the 2-year storm has a 50 percent probability of occurring in any given year, while a 25-year storm has a 4 percent probability of occurring in any given year. When evaluated statistically over a period of 30 years, the overall risk of flooding by a 2-year storm is high (nearly 100 percent), without the berm in place. With the berm in place, the smaller but more frequent storm events will no longer cause flooding to the downstream neighborhood. Although larger storm events may still overtop the berm and result in neighborhood flooding downstream of the berm, the overall risk of flooding over a 30-year span is decreased by 30 percent.

CONCEPTUAL DESIGN ASSESSMENT

Project Benefits

LOW MAINTE-NANCE

REDUCES FLOODING POTENTIAL

The placement of a flood control berm in an open space area adjacent to the Northampton Bike Path will reduce the potential for flooding and storm-related damages in the Stoddard/ Church/ State Streets residential neighborhood by King Street Brook overflows. Once constructed and stabilized by dense turfgrass, the berm will require little maintenance by the City. As the project would result in wetland impacts (see below), the potential exists for developing a beneficial invasive species removal program as part of an overall wetland mitigation program which will likely be necessary to satisfy environmental permitting requirements. The work would not occur in Natural Heritage and Endangered Species Program (NHESP) Estimated or Priority Habitat areas.

Potential Challenges

WETLAND IMPACTS

EXISTING UTILITIES

The placement of the earthen berm within a wetland will result in up to 2,800± square feet of wetland impacts, including 1,000± square feet of permanent impact (fill). The remaining portion of wetland impact is related to disconnecting the eastern portion of the wetland from King Street Brook and thus converting the wetland type from Bordering Vegetated Wetland (BVW) to isolated wetland. During design development, it may be desirable to consider using this disconnected wetland area as the location for future maintenance access, which would render the wetland area as permanently impacted. Some form of mitigation for these wetland impacts is anticipated to be required. The location of the proposed berm also should be further considered during design development. Placing the berm 40-50 feet further eastward could lessen total wetland impacts and provide adequate space for wetland mitigation/replacement. Under any scenario, this work will require an Order of Conditions from the Northampton Conservation Commission and appropriate mitigation for the wetland impacts. The work is most likely eligible for Self-Verification under General Permit (GP) 23 of the U.S. Army Corps of Engineers General Permits for Massachusetts. An existing 8-inch diameter sewer pipe passes through the proposed berm location; thus, the City may wish to consider options for future access to that portion of the pipe should any future maintenance or repairs of the pipe beneath the berm be required. Lastly, the proposed location of the berm is on private property, and the City will need to obtain easements to construct the berm and for temporary and permanent access to the site for maintenance.

Construction Costs

The conceptual-level opinion of construction cost for Project 1 - King Street Brook Flood Control Berm is $180,000, as outlined in Appendix F. Refer to page 2 of this Conceptual Design Summary report for a description of the cost estimating methodology and limitations. Potential funding sources include Hazard Mitigation Assistance from the Federal Emergency Management Agency (FEMA), future MVP Action Grants, and supplemental environmental projects. As the City had previously applied for, but did not receive funding through, the FEMA Hazard Mitigation Grant Program (HMGP) in 2015, GZA would recommend meeting with the Massachusetts Emergency Management Agency (MEMA) to review the previous application, discuss any means to improve upon the application, and consider the probabilities of grant award, prior to submitting a second HMGP application.

PROJECT 2 - JACKSON STREET ELEMENTARY SCHOOL STORM-WATER RETROFITS

Jackson Street Elementary School is located at 120 Jackson Street in the eastern portion of Northampton, approximately one mile north of the downtown area. The school property includes the school building, parking, driveways and drop-off areas, and play spaces including basketball courts, playgrounds, and athletic fields (Figure 2-1). A wetland is located in the western portion of the property, which contains a perennial stream that is piped through the property to the closed drainage system in Jackson Street.

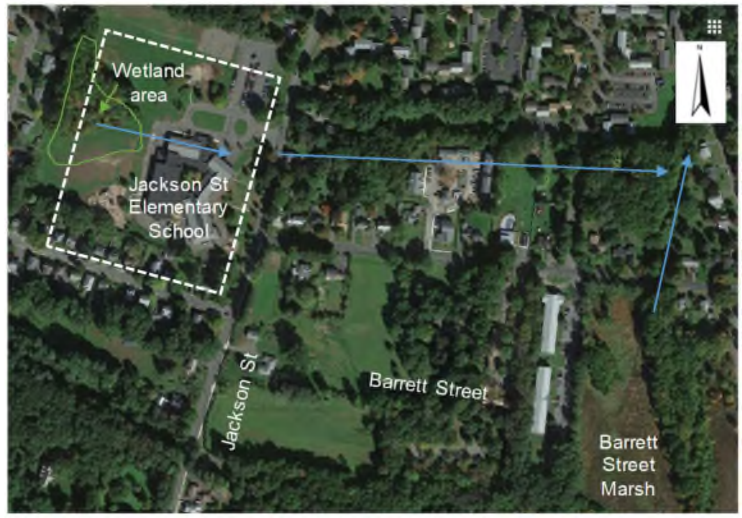


Figure 2-1. Aerial locus of Jackson Street Elementary School and the surrounding area, blue arrows indicate stormwater flow direction (Imagery ©

The existing stormwater management system at the school includes primarily gray infrastructure – catch basins piped to manholes – that discharges into the closed drainage system in Jackson Street. The Jackson Street Elementary School drainage system flows to the east and converges with the outflow from the Barrett Street Marsh.

Jackson Street Elementary School was selected for conceptual design of a stormwater retrofit by City of Northampton stakeholders because of its potential to reduce flows towards the area downstream of Barrett Street Marsh, which experiences flood conditions in periods of high rainfall. The school property has potential to incorporate green infrastructure retrofits that would mitigate stormwater runoff volumes from impervious cover and would collect, treat, and detain stormwater, while also providing educational opportunities for students, their families, and the public.

PROPOSED CONCEPTUAL DESIGN

The existing Jackson Street School property has significant areas of lawn and open spaces that have potential to disconnect impervious area from the existing closed drainage system, reducing peak flow rates in the downstream drainage system and promoting infiltration. Specifically, two grassed low points along the school driveway offer an opportunity to construct green infrastructure retrofits (Figure 2-2). The first area, a shallow depression that could be converted into a meadow bioretention basin, is located at the western edge of the driveway loop. The second area is located behind the school along the paved play space, which could be retrofitted into a linear manicured bioswale.

KEY OPPORTUNITIES

- Retrofit existing gray infrastructure using green infrastructure to treat and detain stormwater
- Reduce flow towards the vulnerable area downstream of Barrett Street Marsh
- Provide educational opportunity on stormwater and green infrastructure for students, their families, and the public.

The NRCS soils map indicates that the soils in the project site are fine sandy loam and udorthents, which have the potentially to be moderately infiltrative. However, based on record information and on-site observations, groundwater may be very close to the surface.

The bioretention basin would consist of meadow vegetation, including stormwater-tolerant grasses and wildflowers, underlain by a 2-foot soil filter media layer that would provide treatment. Below the soil media, a 2-foot crushed stone reservoir would provide storage and detention in larger storm events. An underdrain would be installed at the top of the reservoir layer and connect to the existing infrastructure. The bioswale to the rear of the school would be constructed with a similar subsurface filter profile, but with a surface of grass for ease of crossing by students accessing the athletic fields and the playground (Figure 2-3).

In addition to these landscape-based stormwater retrofits, a larger underground storage system could be constructed below the open space in the front of the building (Figure 2-3). The underground storage system would consist of plastic chambers surrounded by crushed stone. Surface areas would be maintained as in the existing condition. This system would provide detention for the runoff generated by the building roofs and provide significant reductions in the peak runoff rate discharging from the site.

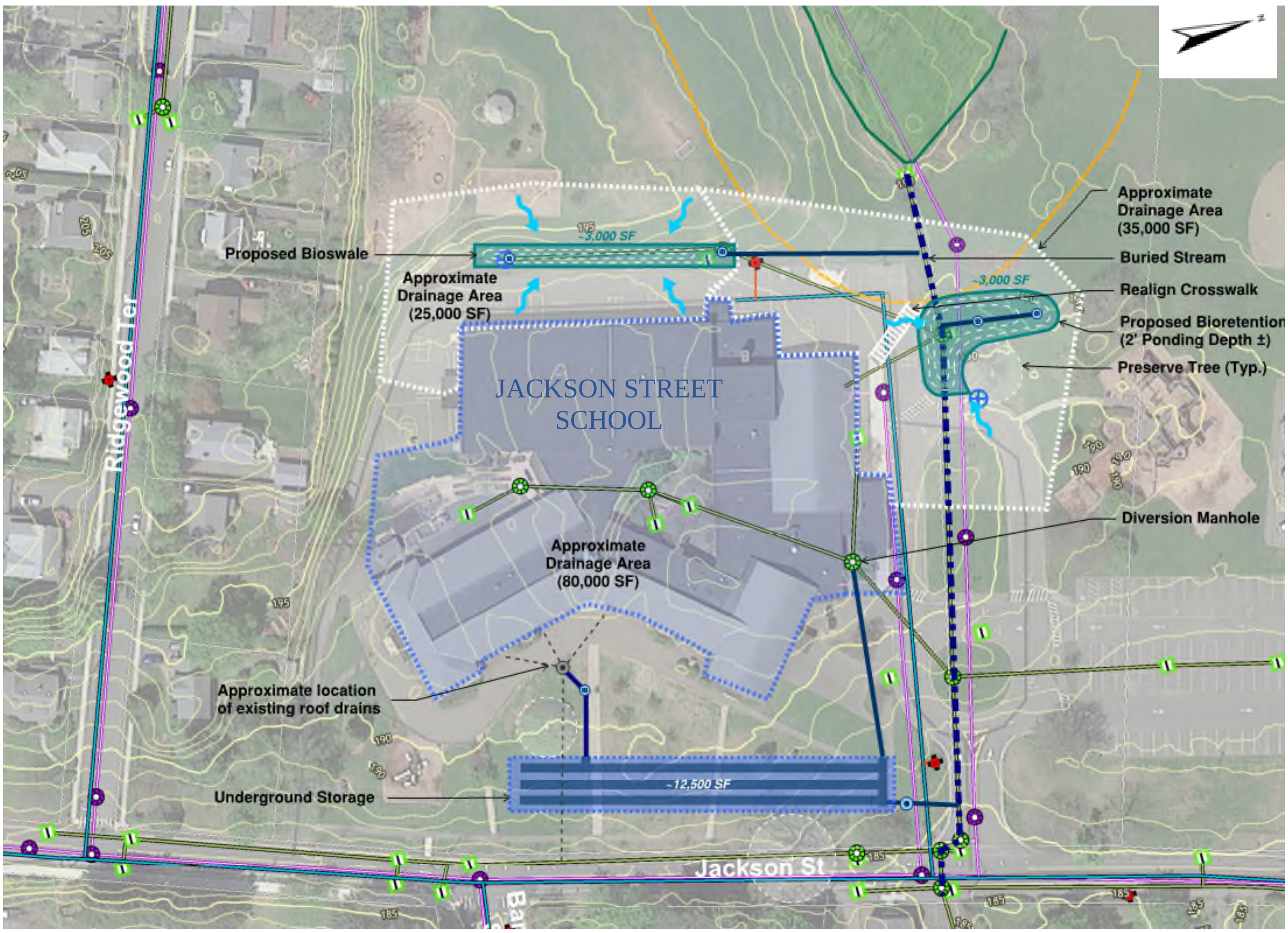


Figure 2-2. Conceptual design for Jackson Street Elementary School stormwater retrofits. See full size Figure with legend in Appendix. (Imagery © Google)

Preliminary Hydrologic Modeling Results

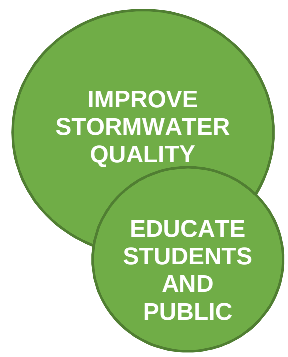
A preliminary hydrologic model was developed to perform a conceptual sizing analysis for the proposed stormwater retrofits. The combined catchment area that would drain to the bioswale and bioretention basin is approximately 60,100± square feet, including landscaped areas and 25,700± square feet of paved surfaces. The peak stormwater runoff rate and volume through the systems were reviewed for the 2-, 10-, and 100-year, 24-hour storm events (Atlas 14 rainfall data). Our preliminary calculations indicate the bioswale and bioretention basin can provide filtration and treatment for up to the 5-year, 24-hour storm event (4 inches of rainfall). Together, they could reduce the peak rate discharge from the 1.4-acre catchment area to the Jackson Street closed drainage system by almost 60 percent in the 100-year storm.

The potential subsurface detention system located in front of the school is anticipated to detain stormwater generated by the 80,000± square foot roof and courtyard areas. Using a chamber system with dimensions of 44 feet wide x 280 long x 3.5 deep, the peak runoff rate from this subcatchment in the 100-year storm could be reduced by almost 90 percent.

For the preliminary modeling, infiltration was assumed to be minimal (0.27 inches per hour) in the surface features (bioswale and bioretention basins). No infiltration was assumed for the subsurface system (detention only). This assumption was made due to concerns with variable soil types and high groundwater conditions. On-site subsurface investigation should be performed in the next design phase to determine if credit can be taken for higher levels of infiltration, which would result in additional peak rate reduction and volume mitigation.

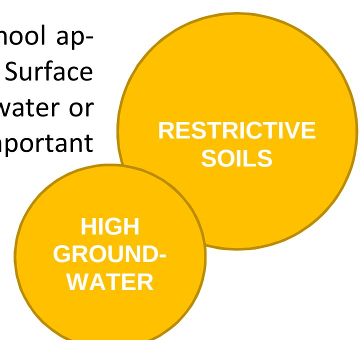
CONCEPTUAL DESIGN ASSESSMENT

Project Benefits



The Jackson Street School Stormwater Retrofit project would capture and treat stormwater generated by a 1.4-acre catchment at the school, while providing significant peak rate reductions for an additional 1.8 acres of school rooftop. The project's primary benefits include improving the quality of runoff from the school property and reducing peak flows from the school property. The construction of visible green infrastructure at a school allows for educational opportunities regarding stormwater issues including integration into the school curriculum, as well as education of their families and other visitors.

Potential Challenges



Based on record information and on-site observations, the Jackson Street Elementary School appears to have highly-variable soil conditions that could range from low to high permeability. Surface ponding was also observed on-site, which could be attributable to either shallow groundwater or very restrictive soils causing surface water ponding. These subsurface conditions will be important to confirm so that the designs of each stormwater retrofit can be appropriately refined. As part of the next design phase, the underlying soils and groundwater conditions at each proposed retrofit area should be confirmed by performing test pits.

Construction Costs

The conceptual-level opinion of construction cost for Project 2 - Jackson Street Elementary School Stormwater Retrofits is $830,000, as outlined in Appendix F. Refer to page 2 of this Conceptual Design Summary report for a description of the cost estimate methodology limitations.

Potential funding sources include future MVP Action Grants, Section 319 Nonpoint Source Grants, and supplemental environmental projects.

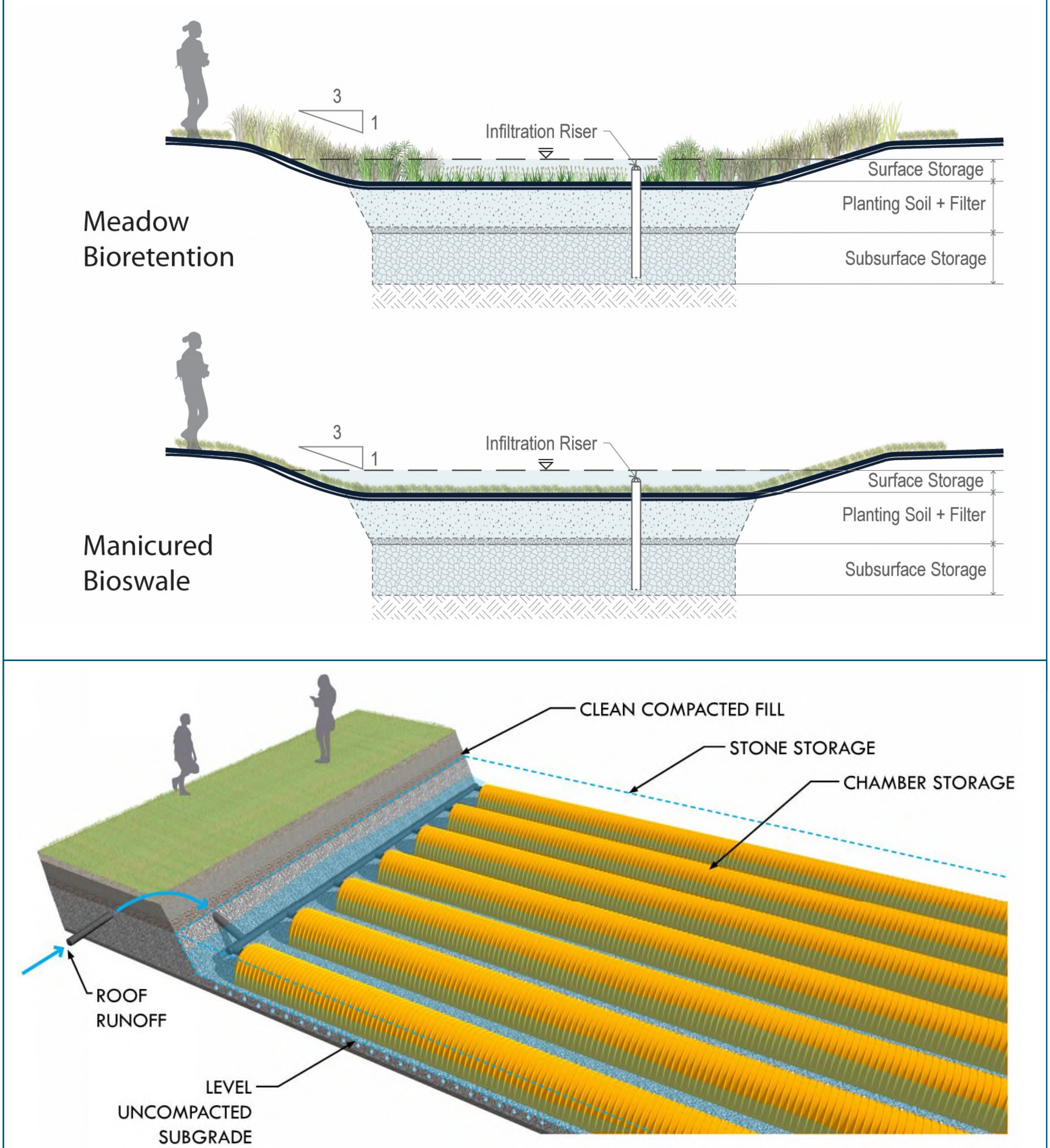
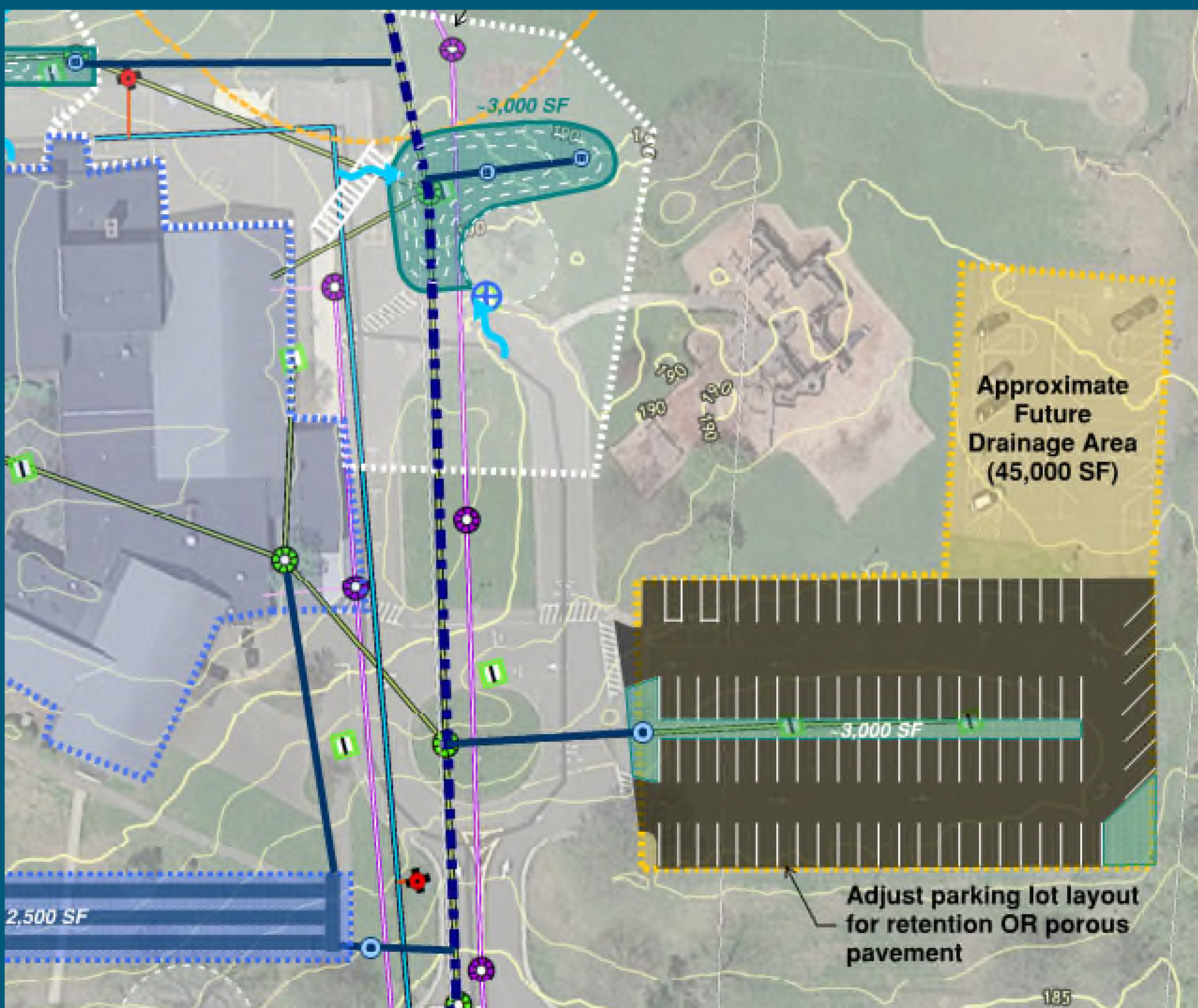


Figure 2-3. Conceptual Bioretention, Bioswale, and Underground Storage Cross Sections.

FUTURE OPPORTUNITY

Another large impervious area at the Jackson Street Elementary School is the parking lot and basketball court located on the northern portion of the site. Due to the locations of the existing catch basins in the center of the parking lot, it is difficult to construct a stormwater retrofit without impacting the number of parking spaces. However, if the parking lot were to be re-paved as part of a future maintenance project, there is potential to construct green infrastructure that would provide treatment and reduction of stormwater quantities from the catchment. The green infrastructure strategies may include porous pavement for the parking lot or the creation of an island in the center of the parking lot that could become a bioretention basin.



PROJECT 3 - ADARE PLACE OUTLET IMPROVEMENTS AND STREAM CHANNEL RESTORATION

The Barrett Street Marsh is a large wetland system located primarily within a 22± acre parcel owned by the City of Northampton and located west of King Street, between the Northampton Bike Path embankment to the south and Barrett Street to the north (Figure 3-1). The marsh is tightly surrounded by residential, commercial, and light industrial development and provides valued natural habitat within an urbanized environment. Over time, as the marsh has slowly infilled with sediment and decaying vegetative matter, the standing surface water levels have increased, posing potential conflict with the surrounding developments. Due to its status as a wetland resource, the options for improving the marsh's flow-through characteristics, such as dredging, may be limited. One of the largest stormwater outfalls which discharge into Barrett Street Marsh is located on the north side of the Northampton Bike Path embankment, near the end of Adare Place. The Adare Place Outlet is a 36-inch diameter corrugated metal pipe (CMP) outfall which discharges stormwater from a developed catchment area of approximately 86 acres. Based on the *Construction Plan for the Northampton Bikeway, State Street – Bridge Road* (Almer Huntley, Jr. and Associates, Inc., Nov. 1978), a riprap energy dissipator and stone and mortar channel was provided at the outfall to prevent erosion caused by high velocity flows from the outfall. No evidence of the riprap energy dissipator or stone and mortar channel remains at the site, as observed by GZA in the Fall of 2018. Erosion has undermined the outfall, such that the unsupported outfall pipe has collapsed, and high velocity flows have severely scoured the channel downstream of the outfall. The continued scour caused by discharges from this unprotected outfall is a source of sediments to the downstream Barrett Street Marsh. This site presents a unique opportunity as it is a natural area isolated from the surrounding urban environment, where the stream channel may be restored using soft engineering approaches without the constraints of an adjacent developed environment. This site was selected for conceptual design by the City of Northampton stakeholders because it offers an increase in resiliency of the downstream Barrett Street Marsh system to withstand and absorb high flows from the outfall and improvement in water quality by minimizing sedimentation of the marsh.

Figure 3-1. Aerial locus of Adare Place Outlet (Imagery from GoogleEarth)

KEY OPPORTUNITIES

- Reduction in potential storm damage
- Use of natural area
- Water quality improvement

PROPOSED CONCEPTUAL DESIGN

The proposed improvements at the Adare Place Outlet include repair of the outfall, the provision of energy dissipation, and restoration of the downstream channel (Figure 3-2). GZA reviewed several options for energy dissipation, including an armored plunge pool, concrete stilling well, concrete stilling basin, and proprietary "green" reinforced mat products. GZA concluded that the proprietary reinforced mat products are not rated to withstand the flow velocities that are expected from the outfall. Of the remaining three options for velocity dissipation, an adequately-sized plunge pool was deemed to have the capability of providing the necessary velocity dissipation and erosion protection while keeping in character with the natural area. Figure 3-3 presents a photo of an example plunge pool. At this site, the existing outfall pipe would be extended and connected to a new headwall, from which discharges would "plunge" into the newly-constructed plunge pool below.

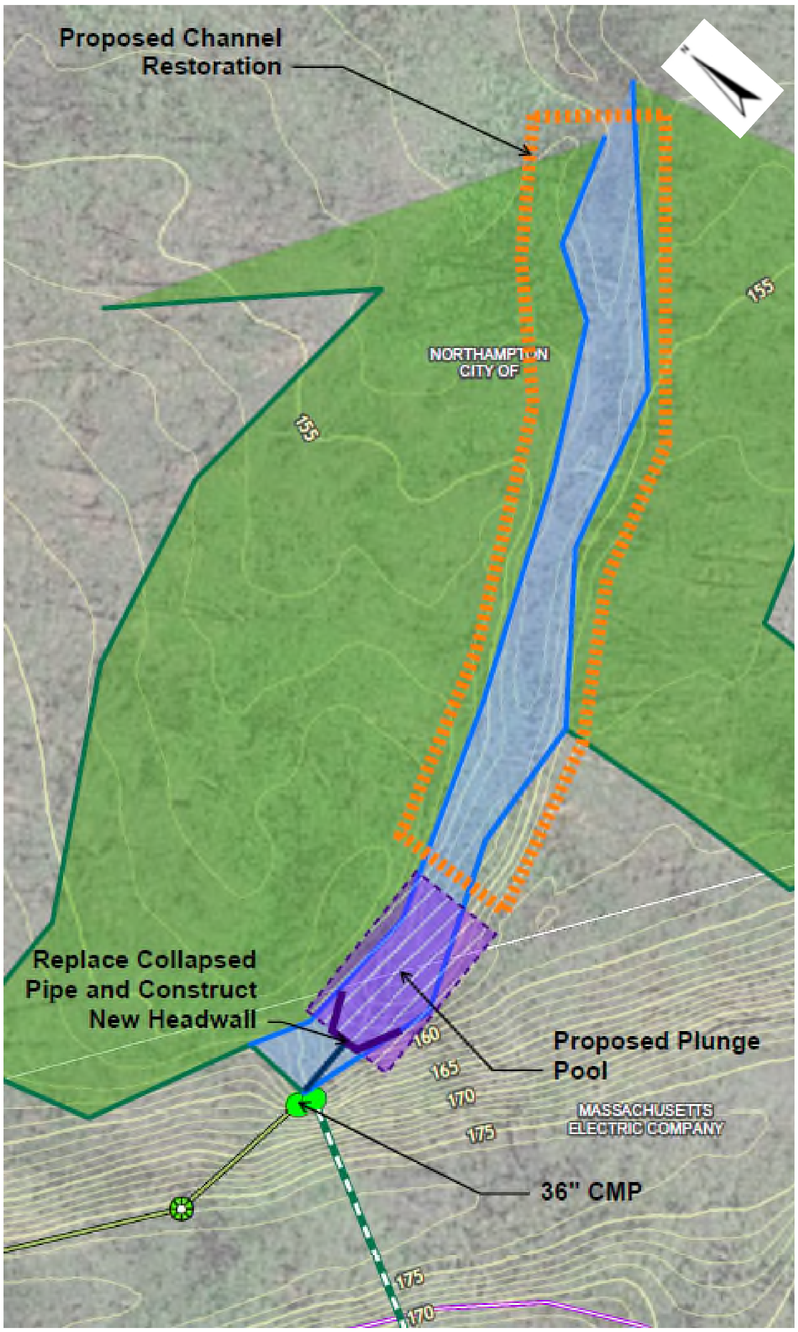


Figure 3-2. Conceptual Design for Adare Place Outlet Improvements and Stream Channel Restoration (Imagery © Google)

The unmitigated high velocity flows have scoured the downstream channel, resulting in a widened, incised channel cross-section. Given adequate energy dissipation, further erosion of the downstream channel would be arrested. As an optional component of this improvement project, restoration of the downstream channel would restore its natural cross-section and improve habitat characteristics (Figure 3-4). The restoration would consist of grading to restore the channel cross-section and vegetative plantings.

Design Details

The proposed plunge pool was conceptually designed by GZA in accordance with the United States Department of Agriculture (USDA) Soil Conservation Service (SCS) *Design Note No. 6: "Riprap Lined Plunge Pool for Cantilever Outlet"*. GZA estimated a design discharge of 70± cfs at a velocity of about 10 feet per second, based on the size, depth, and geometry of the terminal sections of the 36-inch diameter pipe. For the design discharge of 70 cfs and an assumed mean riprap diameter of 15 inches, the calculated size of the plunge pool is between approximately 600 and 1,100 square feet, depending on side slopes (2H:1V to 3H:1V).

CONCEPTUAL DESIGN ASSESSMENT

Project Benefits

This project will repair damage to the existing stormwater drainage infrastructure and will arrest future damage to the Northampton Bike Path embankment caused by erosion. Erosion protection will improve the resiliency of the system to accommodate high velocity flows, and the restored stream channel will be more resilient to high flows. There are no anticipated utility conflicts. There will be an improvement in water quality by reducing scour and downstream sedimentation. The work would not occur in NHESP Estimated or Priority Habitat areas. It is anticipated that maintenance requirements would be minimal, once the project was constructed and stabilized.

Figure 3-3. Example of Outfall Restoration and Plunge Pool (Fairfax County, VA; Department of Public Works and Environmental Services)

Potential Challenges

The plunge pool will be located within a regulated wetland, impacting 1,000± square feet total of Land Under Water and Bordering Vegetated Wetland. Additional wetland impacts will be unavoidable to replace the collapsed culvert section and construction of a cast-in-place headwall to stabilize the culvert end and the embankment. Moderate wetland impacts associated with construction and future maintenance access may be unavoidable. The channel restoration would result in temporary impacts to Bank resource and Bordering Vegetated Wetlands. This project will require an Order of Conditions from the Northampton Conservation Commission and is most likely eligible for Self-Verification under GP 7 of the U.S. Army Corps of Engineers General Permits for Massachusetts. Appropriate mitigation for the wetland impacts may be required. A portion of the work, including access for construction and future maintenance, will extend onto the Northampton Bike Path embankment, which is owned by National Grid.

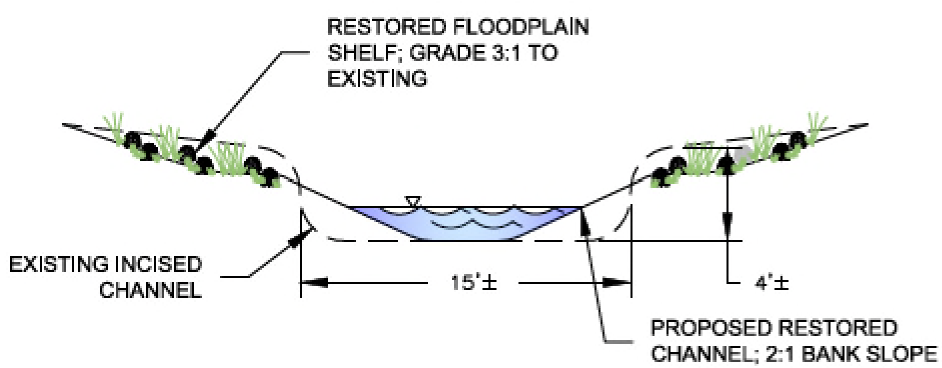


Figure 3-4. Conceptual Design for Adare Place Outlet Channel Restoration

Construction Costs

The conceptual-level opinion of construction cost for Project 3 - Adare Place Outlet Improvements and Stream Channel Restoration is $360,000, as outlined in Appendix F. Refer to page 2 of this Conceptual Design Summary report for a description of the cost estimating methodology and limitations.

Potential funding sources include future MVP Action Grants, Section 319 Nonpoint Source Grants through Massachusetts Department of Environmental Protection (MassDEP), and supplemental environmental projects.

PROJECT 4 - SMITH VOCATIONAL AND AGRICULTURAL HIGH SCHOOL BIORETENTION

Smith Vocational and Agricultural High School (Smith Voc) is located at 80 Locust Street in Northampton. The school complex consists of four large buildings and numerous smaller support buildings, as well as parking, driveways, athletic fields and agricultural land (Figure 4-1). A wetland system including Elm Street Brook is located west and south of the school complex, and its 100-foot buffer zone encroaches into the northwestern parking lot of the school.

The existing stormwater management system consists of primarily closed gray infrastructure – catch basins connected to underground piping to manholes – that discharge into the closed drainage system in Locust Street. Stormwater from that portion of the Locust Street drainage system flows to the west and discharges into the Elm Street Brook. South of the school, along Elm Street, the Brook is prone to frequent flooding which causes periodic road closures (Refer to description of Project No. 5).

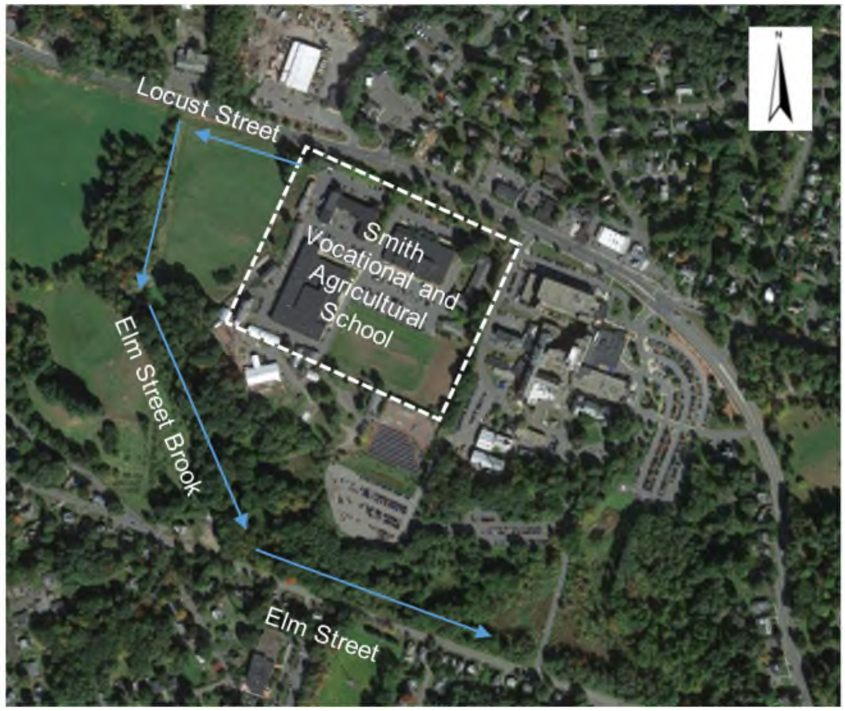


Figure 4-1. Aerial locus of Smith Vocational and Agricultural School and the surrounding area, including the Elm Street Brook (blue arrows). (Google Maps)

Smith Voc was selected for the conceptual design of a stormwater retrofit by City of Northampton stakeholders because of its potential to reduce flow in the Elm Street Brook watershed, which experiences flood conditions during periods of moderate to high rainfall. The school property contains open spaces that provide opportunities to construct green infrastructure that could collect, treat, detain, and infiltrate stormwater and reduce the volume and rate of stormwater runoff being directed to Elm Street Brook. Building these facilities on a school property also provides educational opportunities for students, their families, and the public.

PROPOSED CONCEPTUAL DESIGN

The large grassed area in the front of Smith Voc along Locust Street is well-sited to receive stormwater runoff from the front parking lots. These parking areas include approximately 1.5 acres of impervious surfaces. The grassed area could be gradually deepened into three shallow bioretention basins and could be designed to preserve the existing mature trees (Figure 4-2). Stormwater would be directed to the bioretention basin from the parking lots through curb cuts created along the northern edges of the parking lot.

KEY OPPORTUNITIES

- Retrofit existing gray infrastructure using green infrastructure to treat and detain stormwater
- Mitigate stormwater runoff within the Elm Street Brook watershed to alleviate flooding along Elm Street
- Provide educational opportunity on stormwater and green infrastructure for students, their families, and the public.

The bioretention basins would consist of a vegetated surface underlain by a 2’ soil filter media and 3’ stone layer that would provide treatment. Consistent with the current character of the area, the central bioretention basin would have a manicured grass surface, while the outer basins would be integrated into the existing landscape and planted with woodland, meadow, and wildflower plants. Below these layers, a crushed stone reservoir would provide storage, infiltration, and detention for larger storm events (Figure 4-3). Based on the NRCS soils map, the soils in the front lawn of the school are classified as Hinckley fine sandy loam, which generally have a high infiltrative capacity.

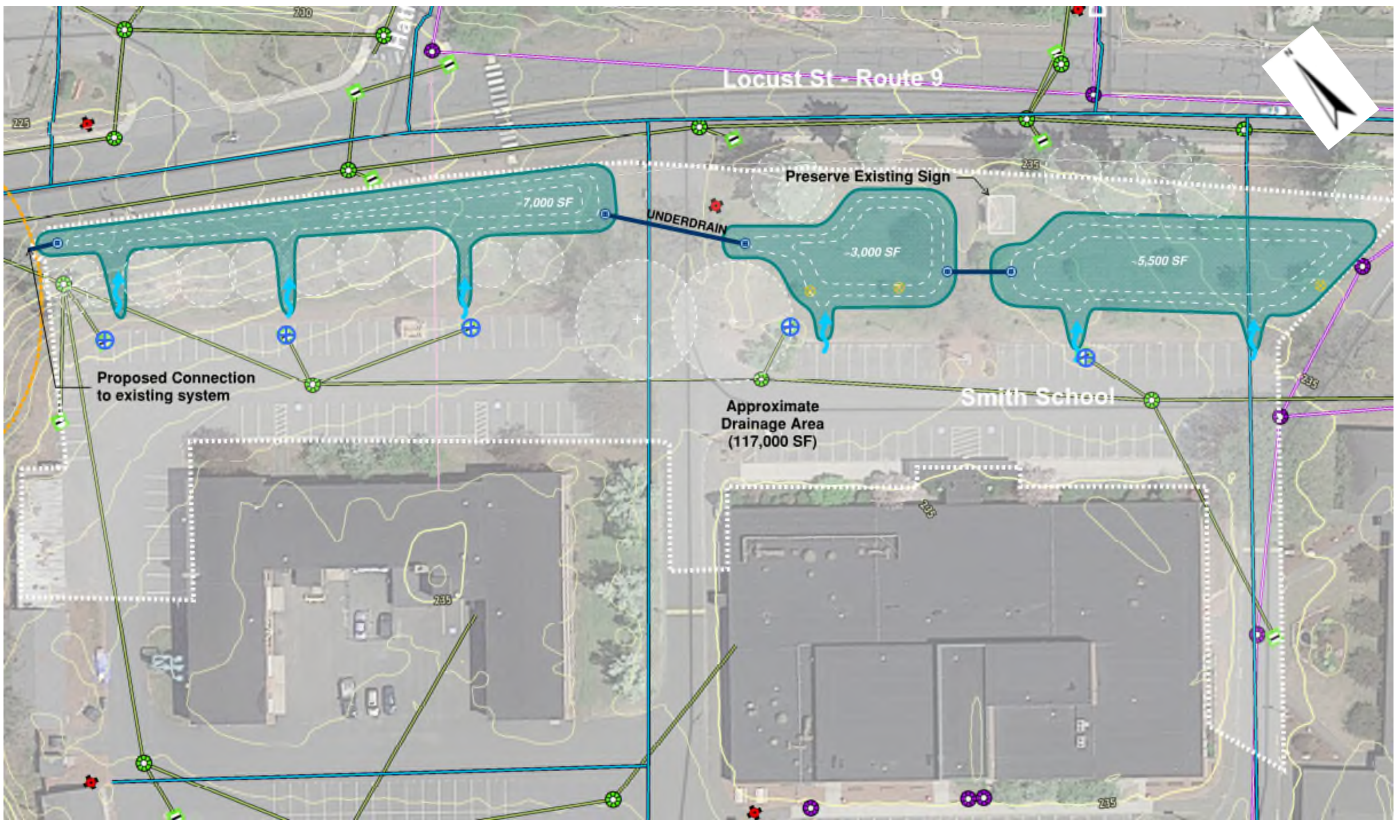


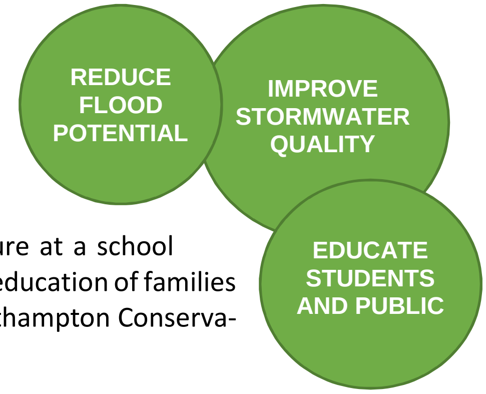
Figure 4-2. Conceptual design for Smith VOC bioretention basins. (Imagery © Google)

Preliminary Hydrologic Modeling Results

A preliminary hydrologic model was developed by the project team to perform a conceptual-level sizing analysis for the proposed bioretention basins. The potential combined catchment is approximately 117,000± square feet, including landscaped areas and 67,500± square feet of paved surfaces. The peak runoff rate and volume through the bioretention basins were reviewed for the 2-, 10-, and 100-year, 24-hour storm events (Atlas 14 rainfall data). The bioretention basins could provide filtration and treatment for up to the 2-year, 24-hour storm event (3.0 inches of rainfall). Together, they combine to potentially reduce the peak rate discharge to the Locust Street drainage system from the 2.7-acre contributing drainage area by over 90 percent in the 100-year, 24-hour storm (7.9 inches of rainfall). Additionally, because the soils at Smith Voc are indicated by NRCS as highly-infiltrative, the bioretention basins could provide a 74 percent decrease in the runoff volume in the 100-year, 24-hour storm event. On-site subsurface investigation should be performed in the next design phase to confirm subsurface soil and groundwater conditions.

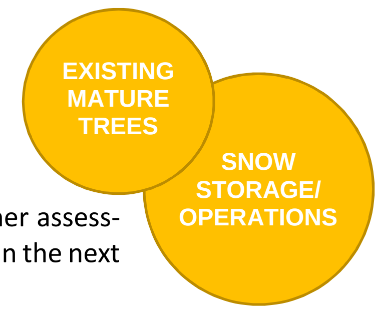
CONCEPTUAL DESIGN ASSESSMENT

Project Benefits



The Smith Voc bioretention basins could provide significant reductions in peak rate and volume of stormwater being discharged from the school and towards the Elm Street Brook. The project's primary benefits would include improving the quality of runoff from the school, reducing the risk of flooding within the Elm Street Brook watershed, and providing additional infiltration which helps restore the natural hydrology of the site. The construction of visible green infrastructure at a school allows for integration into the school curriculum and research projects, as well as education of families and other visitors. This project will require an Order of Conditions from the Northampton Conservation Commission for work within a buffer zone.

Potential Challenges



Due to the available open space on the property, distance from wetland resource areas, and minimal existing utilities, there are not anticipated to be many challenges associated with the design, permitting, and construction of the bioretention basins. We note that some areas of the potential bioretention basins are currently used for snow storage, which would be prohibited if the basins were to be constructed. Care should be taken to design the basins in a manner that protects the existing mature trees in the grassed area. Further assessment of the existing conditions, including the subsurface conditions, should be performed in the next phase to confirm design assumptions.

Construction Costs

The conceptual-level opinion of construction cost for Project 4 – Smith Vocational and Agricultural High School Bioretention is $710,000, as outlined in Appendix F. Refer to page 2 of this Conceptual Design Summary report for a description of the cost estimating methodology and limitations.

Potential funding sources include future MVP Action Grants, Section 319 Nonpoint Source Grants, and supplemental environmental projects.

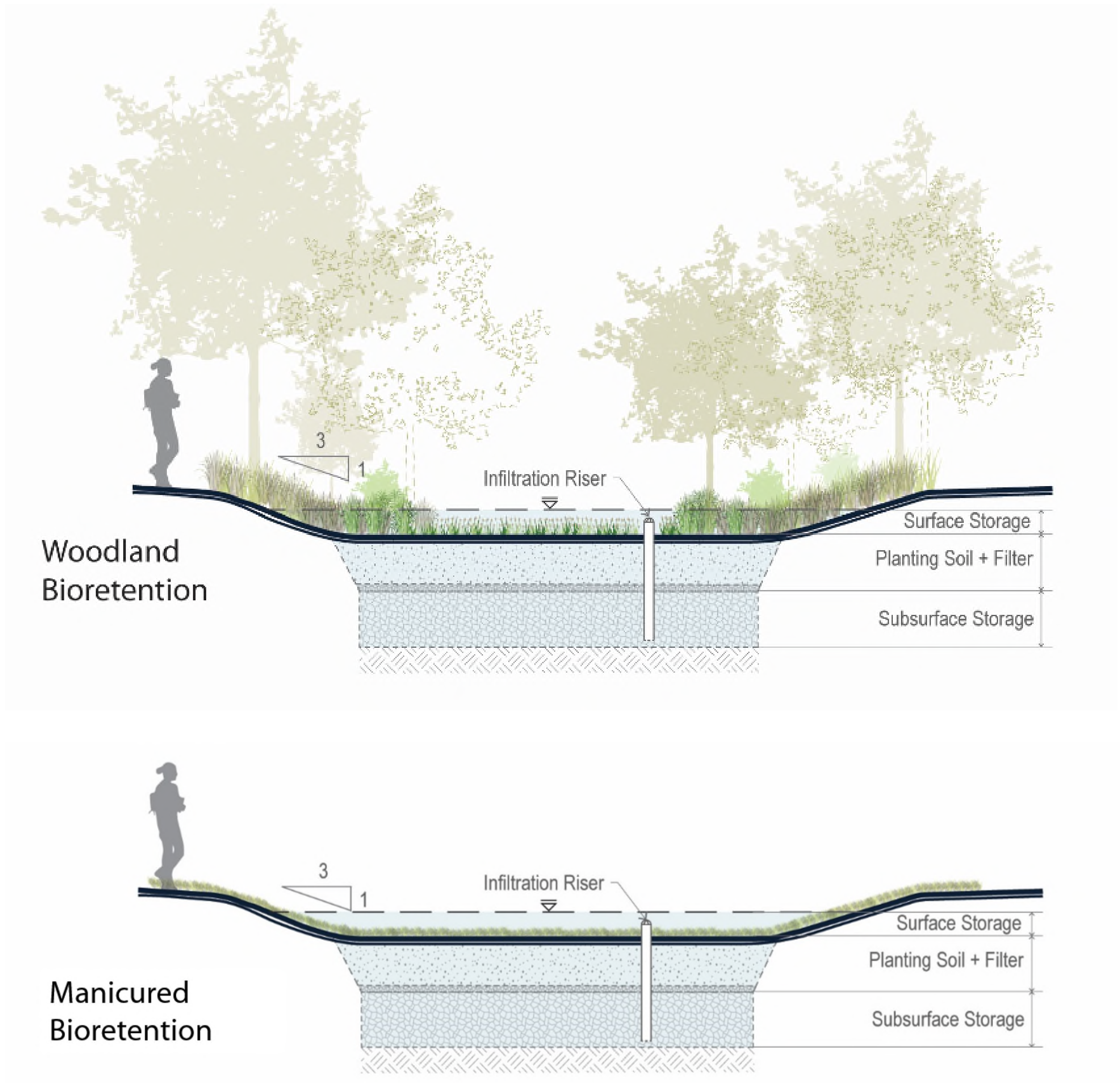


Figure 4-1. Conceptual Bioretention Cross Sections

PROJECT 5 - ELM STREET BROOK FLOOD MITIGATION

Elm Street Brook (also known as Broughtons Brook) originates in the vicinity of Bridge Road in Northampton and passes through the property of Smith Vocational and Agricultural High School (Smith Voc). Where the brook approaches Elm Street, it veers to the east and runs parallel to Elm Street for approximately 1,500 feet before entering a closed drainage system, near the Northampton High School, that ultimately discharges to the Mill River (see Figure 4-1). Within the Smith Voc property, the brook travels through a wooded corridor and is bordered in some locations by agricultural fields. There are a few culvert constrictions along the brook within the Smith Voc property; however, the brook generally has room to meander and overtop its banks when necessary (Photo 5-1). As the brook approaches Elm Street, the channel narrows and straightens, and flows through alternating segments of steep upland valley walls and reaches that have adjacent overbank areas offering storage for high water during significant hydrologic events. In many locations, the brook must squeeze between the steep upland valley walls to the north and Elm Street to the south. Consequently, high water has nowhere else to go but to overflow into Elm Street (Photo 5-2), interrupting traffic and causing flooding of residential properties. High water in the channel or flooding of Elm Street and the surrounding developed areas was observed by GZA three times over the course of three months in late 2018. The steep upland areas flanking the brook currently prevent overbank storage yet could be regraded to provide some flood storage for the brook. This site was selected for conceptual design by the City of Northampton stakeholders because of its potential for offering a cost-effective solution to a recurrent flooding problem.

Photo 5-1. Elm Street Brook through Smith VOC property, October 5, 2018

Photo 5-2. Elm Street Brook adjacent to Elm Street, December 21, 2018

PROPOSED CONCEPTUAL DESIGN

GZA evaluated the potential flood reduction that could be realized by adding a floodplain shelf to Elm Street Brook along Elm Street within the two segments that are currently constricted by steep upland valley walls. The existing channel within these segments ranges from about three and a half to five feet wide and about three to four feet deep. Preliminary hydraulic calculations suggest that the addition of substantially-broad floodplain shelves would not provide for complete protection from flooding of Elm Street. Therefore, some type of flood barrier along Elm Street would be necessary to prevent flood flows from spilling into Elm Street. With a flood barrier, the width of the floodplain shelves could be narrowed to reduce excavation and

KEY OPPORTUNITIES

- Reduction in flooding potential
- Use of natural area
- Wildlife habitat enhancement/connectivity

grading impacts (Figure 5-1). The flood barrier could be either an earthen berm or a more vertical structure with a lesser width. At this site, an earthen berm presents challenges due to the footprint required to accommodate the necessary side slopes. With the brook being very close to the road in many locations, the placement of an earthen berm would require relocation of the brook away from the road. This relocation may be undesirable from an environmental permitting perspective. A flood wall has a narrow footprint and could be placed between the existing brook location and the edge of the road (Figure 5-2). Based on GZA's preliminary hydraulic calculations, the recommended proposed conceptual design is for the addition of floodplain shelves approximately 20 to 40 feet wide, and a floodwall with a height of two to four feet.

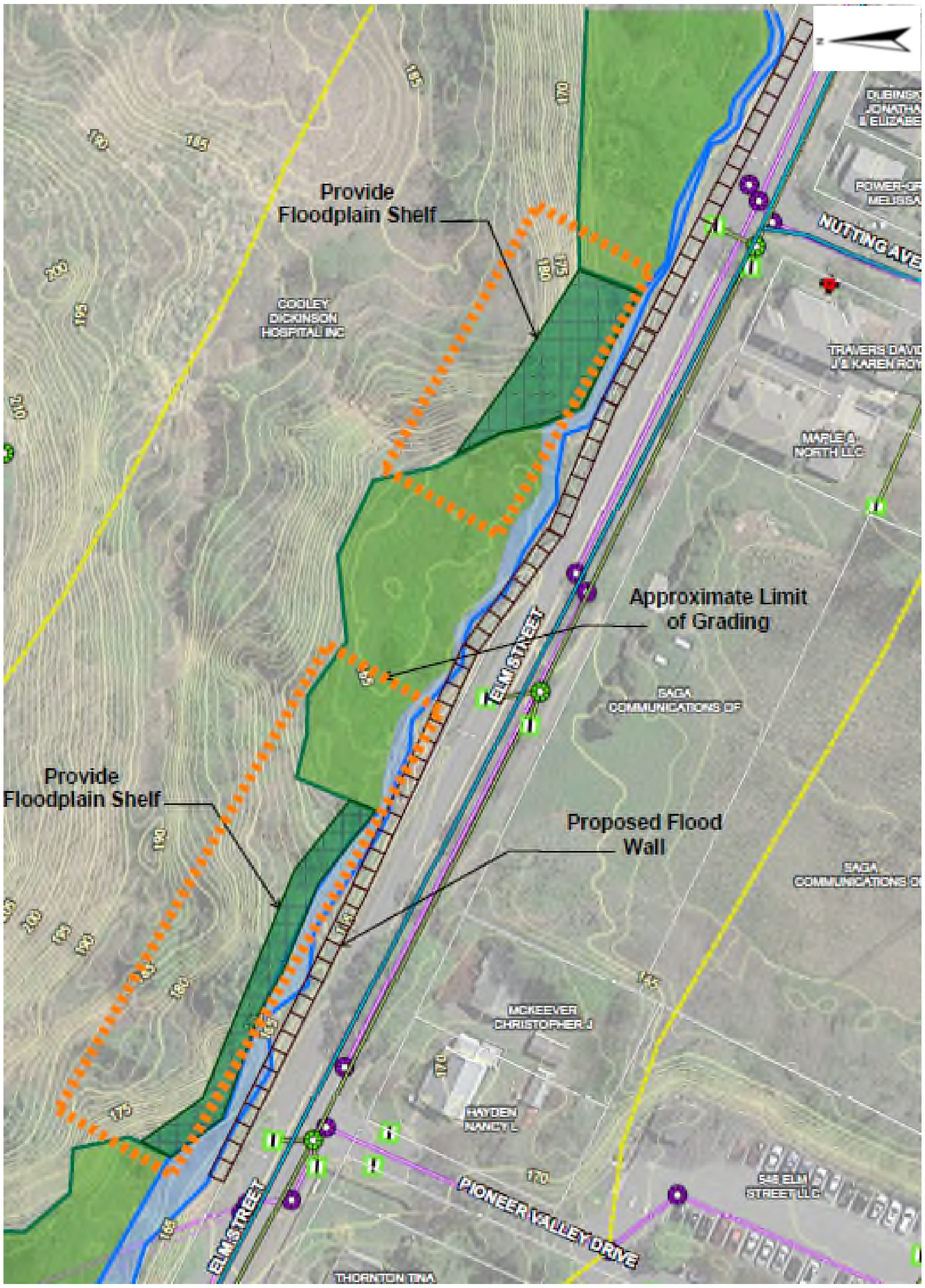


Figure 5-1. Conceptual Design for Elm Street Brook Flood Mitigation (Imagery © Google)

Hydrology & Hydraulics

GZA used HydroCAD® to preliminarily evaluate the existing channel cross-sections along Elm Street under the 2-year and 10-year frequency storm events. Flowrates were taken from the prior detailed study of the watershed described in the "Stormwater and Flood Control System Assessment and Utility Plan" (CDM, 2012). The model predicted that the channel overtops in the 2-year storm and floods Elm Street. This is consistent with observations that were made by GZA on September 18, 2018, in which water over the road was observed after a rainfall of 2 inches over 9 hours, which is approximately equivalent to a 2-year storm. This model was then used to estimate the impacts of varying widths of expanded floodplain shelf and flood control berm for the conceptual design. A minimum floodwall height of two feet would be necessary to prevent flooding of Elm Street during the two-year event, while it may need to be increased up to four feet

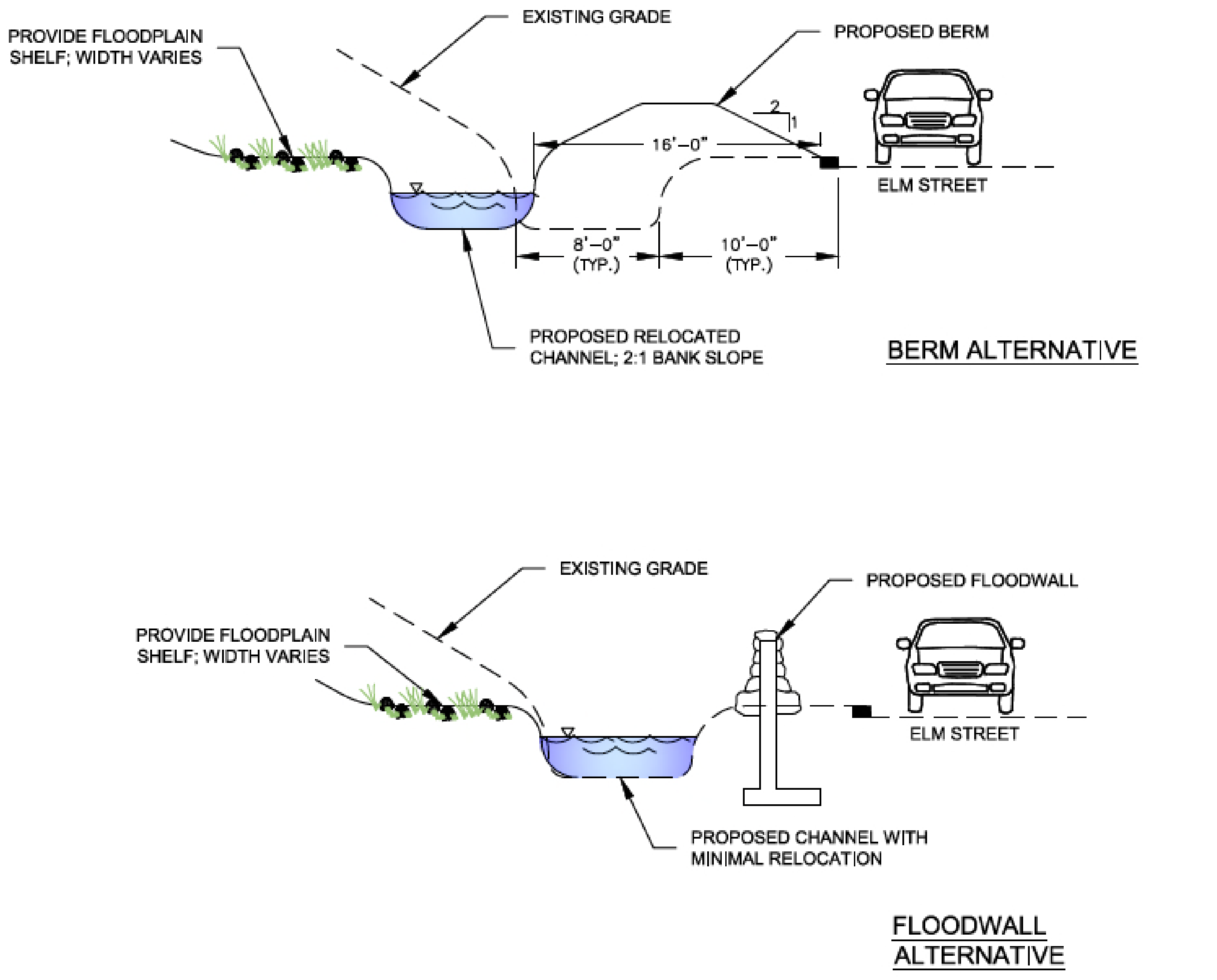
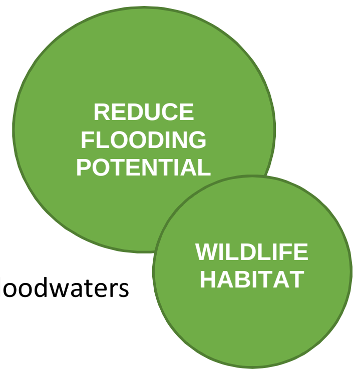


Figure 5-2. Elm Street Brook Flood Mitigation Conceptual Cross-Sections

in some locations to meet a 10-year design storm criterion. Another option could include significantly widening the channel, although such action is anticipated to ultimately be disallowed under current environmental regulations. In fact, many of the work activities that would be required by the conceptual design would conflict with many specific performance standards under the Massachusetts Wetlands Protection Act, the Northampton Wetlands Protection Ordinance, and other regulatory statutes. For subsequent design phases, a more detailed HEC-RAS riverine model should be developed to evaluate existing and proposed conditions. Further analysis may reveal that the actual required length of flood barrier may be less than that shown in the conceptual design.

CONCEPTUAL DESIGN ASSESSMENT

Project Benefits



The addition of floodplain storage to the brook along with the placement of a floodwall along Elm Street will reduce the frequency of the brook overtopping and flooding of Elm Street and neighboring properties. The proposed floodplain storage would provide wildlife habitat connectivity between sections of existing bordering vegetated wetlands. This project offers an enhancement of natural drainage patterns to direct the flow of water away from the road. A potential co-benefit of the project is enhanced water quality by keeping floodwaters out of the road. The work would not occur in NHESP Estimated or Priority Habitat areas.

Potential Challenges

The creation of floodplain storage along the brook must be carefully designed to minimize grading impacts within existing wetlands or disturbance to the brook itself. Although the majority of grading and earthwork would be limited to upland areas, these areas are within Riverfront Area, which is a regulated resource area under the Massachusetts Wetlands Protection Act. The project would require the removal of trees from within the Riverfront Area, which would likely need to be replanted to meet permitting requirements. Some alteration of the stream channel would be unavoidable and construction of the floodwall in close proximity to the brook would present constructability issues likely leading to more wetland impacts than can be envisioned by simple concepts. Close consultation with regulators early on in subsequent design phases is recommended to establish an appropriate course of action relative to the environmental permits required for any version of the conceptual design. It is anticipated that this work will require an Order of Conditions from the Northampton Conservation Commission and appropriate mitigation for the wetland impacts. Authorization for the wetland impacts must be obtained from the U.S. Army Corps of Engineers, most likely under an Individual Permit. A 401 Water Quality Certification will also be required from MassDEP. In addition to the various wetland permits from local, state, and federal agencies, the project would likely require review under the Massachusetts Environmental Policy Act (MEPA).

A flood wall along Elm Street might interfere with typical roadside maintenance (mowing) and snow storage during winter months.

Construction Costs

The conceptual-level opinion of construction cost for Project 5 - Elm Street Brook Flood Mitigation is $2,800,000, as outlined in Appendix F. Refer to page 2 of this Conceptual Design Summary report for a description of the cost estimating methodology and limitations.

Potential funding sources include FEMA Hazard Mitigation Assistance, future MVP Action Grants, and supplemental environmental projects.

PROJECT 6 - HISTORIC MILL RIVER – OLD SOUTH STREET OUTFALLS

The Old South Street Municipal Parking Lot is located in downtown Northampton. The parking lot is heavily used by visitors to the downtown area and Manhan Rail Trail, which is located along the northern edge of the lot. The parking lot includes concrete islands that contain trees, many of which are dead or moribund.

Figure 6-1. Aerial locus of Old South Street Municipal Parking Lot and surrounding area (Google Maps).

The Parking Lot is located directly west of the historic Mill River channel (Figure 6-1). When the Mill River was relocated around downtown Northampton (ca. 1940), portions of the historic Mill River channel were left in place and currently function to convey stormwater runoff from the downtown area. At present, runoff from the Old South Street Municipal Parking Lot is collected into stormwater catch basins and discharged into the Old Mill River channel, unmitigated and only minimally treated. Starting adjacent to the Old South Street Parking Lot, the open channel of the Historic Mill River is approximately 1,000 feet long, and enters a pipe at the parking lot west of Pleasant Street. This pipe discharges to a second open channel portion of the Historic Mill River channel south of the intersection of Pleasant Street and Hockanum Road, as described in Section 8.0. GZA performed a field review of the affected portions of the historic Mill River channel adjacent to the Old South Street Parking Lot, and determined that the area is juridictional under the Wetlands Protection Act and includes Bank and Bordering Vegetated Wetland resource areas. The 100-foot Buffer Zone to the Bank and BVW extends into the eastern side of the Parking Lot.

The City of Northampton Department of Public Works is currently advancing a municipal project to replace the concrete pavement in the parking lot islands with porous paving (i.e., Flexipave®) to reduce the impervious area and allow for more rainwater to be directed to the existing trees. The Old South Street Municipal Parking Lot was selected for conceptual design by City of Northampton stakeholders because of its potential to improve the work being done by the pavement replacement project by adding stormwater treatment benefits. The project will also increase the urban tree canopy in a highly paved area, which will help mitigate the increasing temperatures and resulting heat island impacts associated with climate change.

KEY OPPORTUNITIES

- Use green infrastructure to collect and treat stormwater runoff from the municipal parking lot prior to discharging into the Historic Mill River channel
- Increase urban canopy and reduce heat island impacts by planting new trees
- Provide public education on history of the Mill River and the benefits of green infrastructure

PROPOSED CONCEPTUAL DESIGN

Currently, stormwater runoff flows from northwest to southeast within the parking lot and the curbed islands within the parking lot serve to intercept and direct runoff to nearby catch basins. Record drawings from the 1987 Hampton Ave Parking Lot Modification Project indicate that these existing catch basins were designed to have 2-foot sumps. There does not appear to be any other stormwater treatment and the parking lot does not align with the current MassDEP Stormwater Management Standards associated with the Wetlands Protection Act.

These islands provide an opportunity for a stormwater retrofit that would remove the existing pavement in the islands (as part of the current municipal project) and create tree filters in these locations that could absorb and filter the runoff prior to discharging into the historic Mill River channel (Figure 6-2). Based on the NRCS soils map, the soils underlying the municipal parking lot are classified as Hadley-Winooski-Urban Land complex, which have soil textures of silt loam and fine sandy loam. NRCS further designates the soils as being Hydrologic Soil Group “B”, which have moderate infiltration rates when wet.

The tree filters would consist of two (2) feet of structural soils underlain by a 1-foot crushed stone reservoir (Figure 6-3). In combination, these layers provide additional soils to promote tree health, and filtration, detention, and infiltration for stormwater runoff. To increase urban canopy, new trees would be planted within the islands to replace trees that have died, are moribund, or that have been removed.

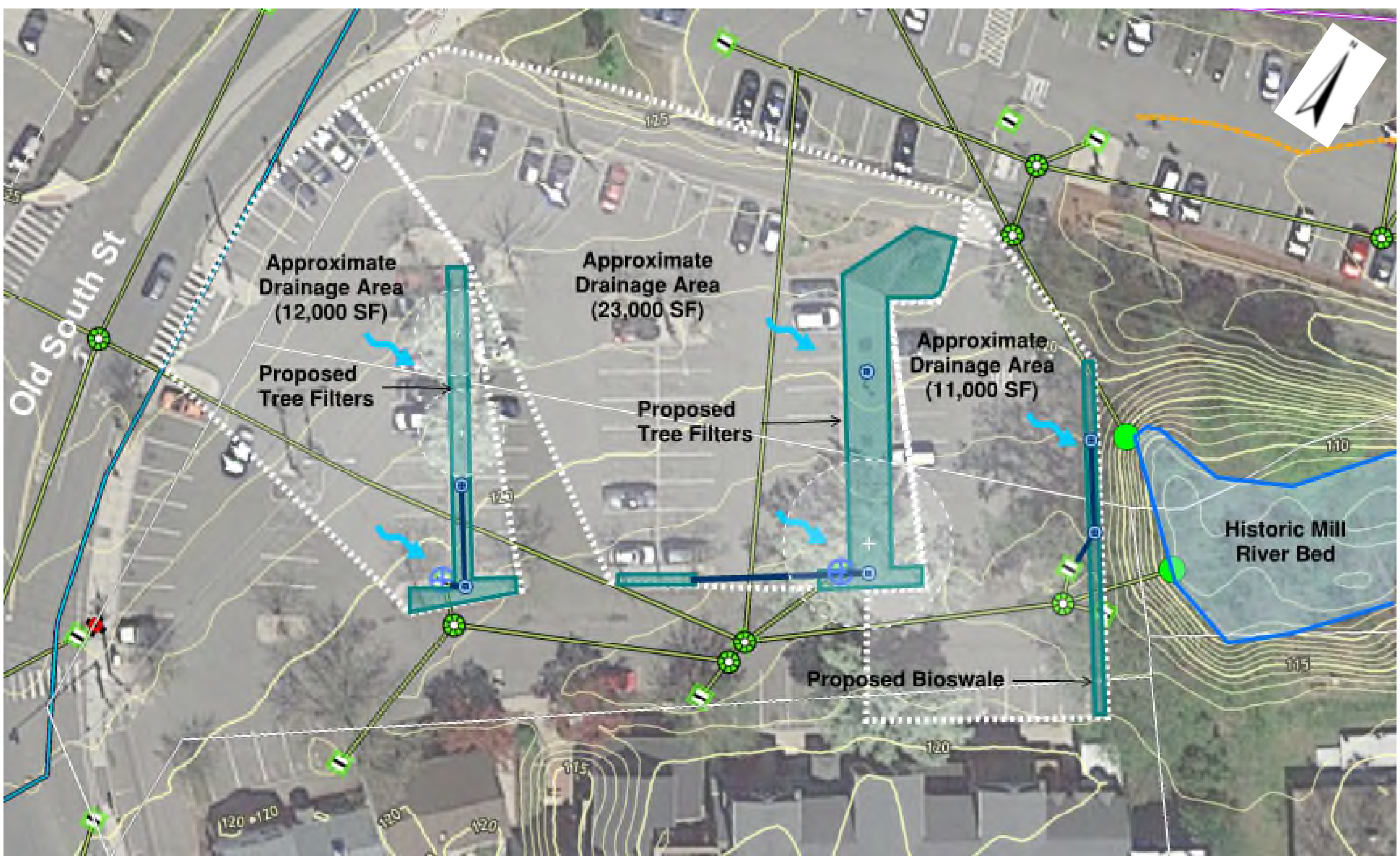


Figure 6-2. Conceptual design for Old South Street Municipal Parking Lot stormwater improvements. (Imagery © Google)

On the eastern side of the parking lot, at the top of the slope of the historic Mill River channel, a manicured bioswale is proposed to capture additional stormwater runoff from the eastern portion of the parking lot. The bioswale would include meadow vegetation underlain by a soil filter media that would provide stormwater treatment (Figure 6-3). Below these layers, a crushed stone reservoir would provide storage and detention in larger storm events before discharging to the historic Mill River channel.

Preliminary Hydrologic Modeling Results

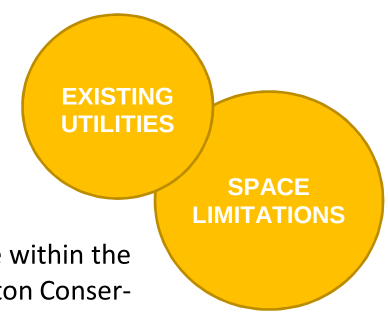
A preliminary hydrologic model was developed to perform a conceptual-level sizing analysis for the proposed stormwater retrofits in the Old South Street Municipal Parking Lot. The combined catchment for the tree filters and bioswale is approximately 0.8 acres. The peak runoff rate and volume through the system were reviewed for the 2-, 10-, and 100-year, 24-hour storm events (Atlas 14 rainfall data). Using the space available within the existing islands, the proposed tree filters provide filtration and treatment for up to the 5-year, 24-hour storm event (first 4 inches of rainfall). The proposed bioswale also provides treatment for the first 2 inches of rainfall from its 0.25-acre subcatchment. Because of the limited space available, the systems do not provide substantial mitigation of runoff quantities for higher storms. However, the increased canopy and vegetation, in combination with the storage and moderate infiltration within the proposed systems, are anticipated to provide minor reductions in the peak runoff rates and volumes being discharged to the historic Mill River channel. On-site subsurface investigation should be performed in the next design phase to confirm subsurface soil and groundwater conditions.

CONCEPTUAL DESIGN ASSESSMENT

Project Benefits

Enhancing a project already underway by the City of Northampton, the Old South Street Municipal Parking Lot project would remove impervious area and treat stormwater from a 1.1-acre drainage area. The project's primary benefits include increasing the urban tree canopy, reducing heat island impacts in downtown, and improving stormwater quality. The parking lot currently experiences heavy pedestrian and bicycle traffic, so it is an ideal location to install signage to educate visitors regarding the function and value of green infrastructure, as well providing a glimpse into the rich history of the Mill River. The proposed tree filter retrofits for this project would incorporate design features easily replicable by the City of Northampton in other municipal parking lots, which could assist the City in achieving a more widespread impact on stormwater quality.

Potential Challenges



The tree filters and bioswale will need to be carefully designed to work with the existing drainage infrastructure already in place within the parking lot. The tree filter designs must capture the runoff that currently flows unmitigated to the closed drainage system, overflows from the tree filters must be connected to the existing drain system. There are also challenges associated with limiting the footprint of the tree filters to stay within the existing curbline of the islands. Any new trees will need to be carefully selected to thrive within the available soil volume. This project will require an Order of Conditions from the Northampton Conservation Commission for work within a buffer zone and also potentially within Riverfront Area.

Construction Costs

The conceptual-level opinion of construction cost for Project 6 - Historic Mill River – Old South Street Outfalls is $250,000, as outlined in Appendix F. Refer to page 2 of this Conceptual Design Summary report for a description of the cost estimating methodology and limitations. Potential funding sources include future MVP Action Grants, Section 319 Nonpoint Source Grants, and supplemental environmental projects.

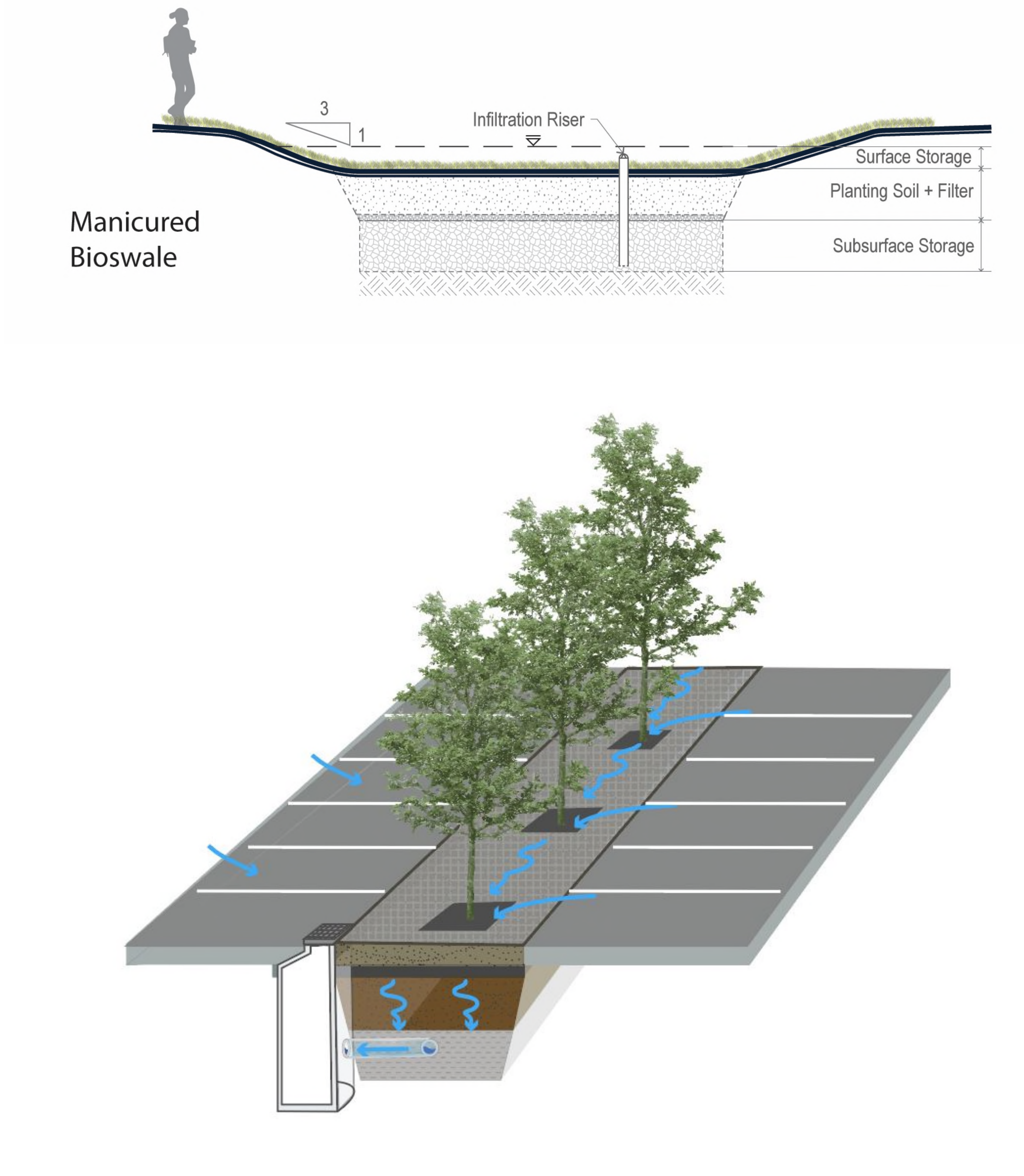


Figure 6-2. Cross Sections of Bioswale and Tree Filters

PROJECT 7 - HISTORIC MILL RIVER – PLEASANT STREET OUTFALLS

At this location, three (3) municipal stormwater catchments have outfalls (referred to herein as Outfalls A, B, and C) that discharge into the remnants of the historic Mill River channel, south of the intersection of Pleasant Street and Hockanum Road. These remnants of the historic Mill River channel provide storage for the Hockanum Road Pumping Station, part of the City of Northampton's Connecticut River Flood Control System. The Hockanum Road Pumping Station is located approximately 1,500 feet downstream from Outfalls A, B, and C. The City has indicated that sediment accumulation in the historic Mill River channel could potentially affect the storage capacity and functionality of the channel and downgradient storage associated with the Hockanum Road Pumping Station. Rather than just addressing sediment accumulation at this location by channel or basin dredging, the City's goal is to proactively reduce sediment infill in the channel and basin areas by capturing and removing it prior to discharge from the outfalls of these drainage systems.

Referring to Figure 7-1 below, Outfall A is a 12-inch diameter concrete pipe outfall which discharges stormwater runoff from a catchment area of approximately 2.5 acres along Pleasant Street to the north of the outfall area. Outfall B is a 60-inch diameter concrete pipe outfall which discharges stormwater runoff collected over a large area of the City's downtown. The system also appears to collect and discharge runoff from the King Street Brook system (not to be confused with the King Street Brook associated with the Barrett Street Marsh). Overall, the drainage catchment to Outfall B appears to be approximately 388 acres in extent. Outfall C is a 24-inch diameter concrete pipe outfall which discharges stormwater runoff from a catchment area of approximately 39 acres located to the south and west of the outfall.

Due to the heavily-urbanized nature of the stormwater catchments and the lack of significant City-owned property within the catchments, any sediment-reduction solution would most likely need to be structural and subsurface in nature. As an opportunity, GZA identified that the City owns land in the immediate vicinity of Outfalls A, B, and C that could be used for the siting of structural, subsurface water quality treatment and sediment capture devices.

PROPOSED CONCEPTUAL DESIGN

Each of the three outfalls was evaluated for its contributing catchment and potential flow rates to determine if structural water quality treatment unit retrofits (proprietary end-of-pipe devices) would be feasible for that location.

For the systems that discharge via Outfalls A and C, treatment systems have been conceptualized that will provide for at least 80 percent removal of total suspended solids for the first one-inch of runoff from the catchments. The systems reviewed would also provide removal for debris, floatables, oil and grease, and associated contaminants for a resulting improvement in the water quality of discharges, as well as the sediment removal desired by the City to address sedimentation below the outfalls.

For Outfall A, a proprietary subsurface, inline hydrodynamic separation treatment 5-ft diameter manhole-style device could be utilized to achieve the desired treatment. Because Outfall C has a larger overall catchment area, a proprietary system comprised of a bypass structure and dual offline tank-style hydrodynamic separator units would be needed to achieve the desired treatment. The overall system would have a footprint of approximately 40' W x 20' L and could be located within land owned by the City.

KEY OPPORTUNITIES

- City-owned property adjacent to outfalls is available for placement of water quality treatment devices
- Provide water quality treatment of urban stormwater runoff including removal of sediment, trash, and oil/floatables

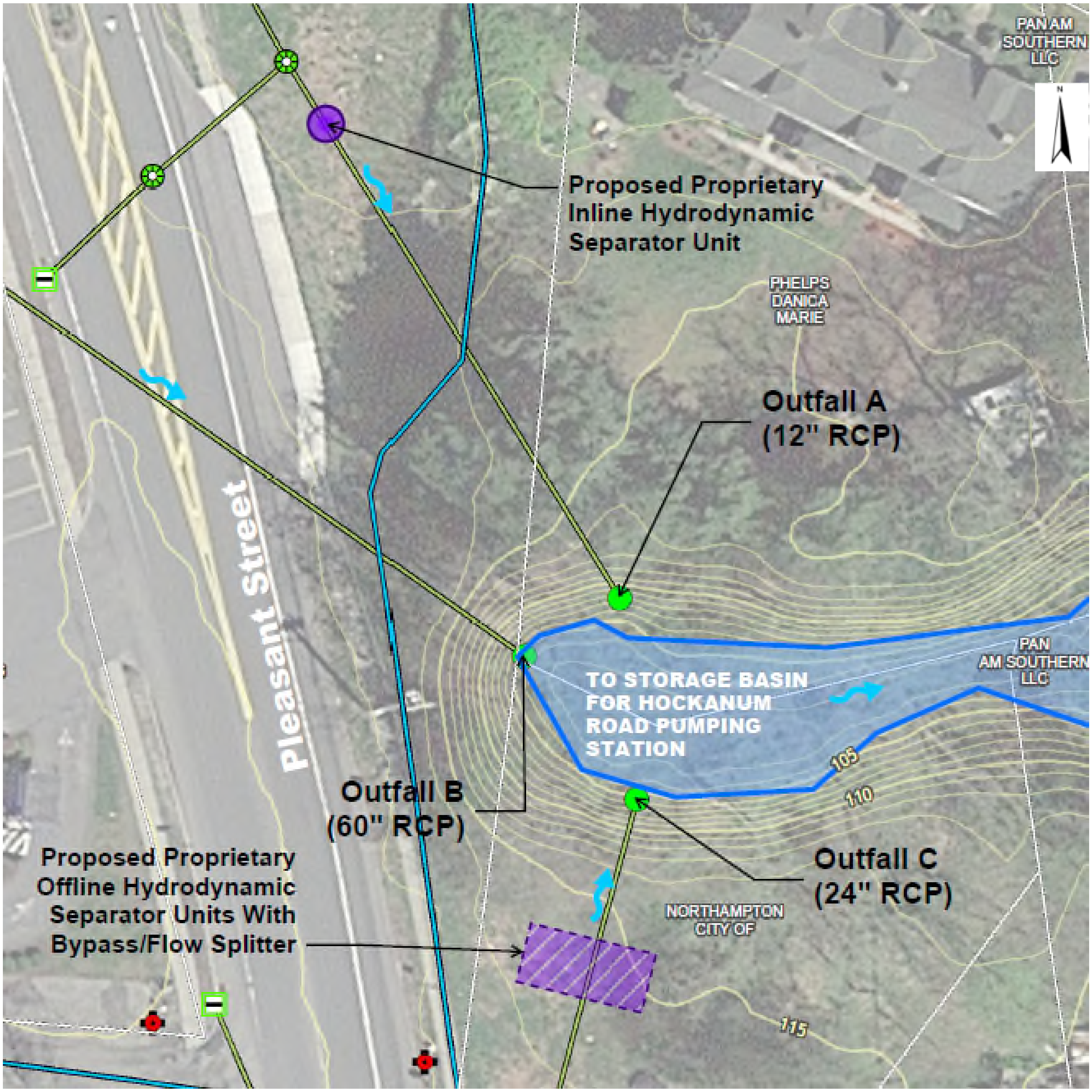


Figure 7-1. Conceptual Design for Pleasant Street Outfalls Water Quality Treatment (Imagery © Google)

At Outfall B, a portion of the first one-inch of runoff could be treated by a system similar to that proposed for Outfall C, although with larger bypass structure and separator units, increasing the total overall footprint. The placement of this system would be offline from the existing stormdrain and would need to be sited carefully to avoid impacting the existing water main through the site. If treatment is desired to remove sediment from the stormwater system in this catchment, the placement of smaller treatment devices at key junctions at locations upgradient within the catchment, focusing on treating smaller contributing areas, would be more practical. Such systems could be installed within the municipal right-of-way. Alternately, green infrastructure could be considered for smaller subcatchments within the overall 388± acre catchment. Implementation of green infrastructure at the City-owned parking lot at Old South Street (Project No. 6, as previously described herein) might serve as a demonstration project for additional locations controlled by the City or within the right-of-way.

Hydrology & Hydraulics

Hydrologic information for the catchments discharging via Outfalls A, B, and C was taken from either the "Stormwater and Flood Control System Assessment and Utility Plan" (CDM, 2012) or portions of the Draft 2018 "Hockanum Road Flood Pumping Station Evaluation" prepared by Tighe and Bond for the City. Catchment information from Tighe and Bond was used for the hydrologic evaluation of the systems to Outfalls A and C. For Outfall B, information from both sources was combined to gather the needed inputs to generate discharge estimates.

The 2.5-acre catchment area to Outfall A is a subset of catchment M14 identified by Tighe and Bond. Outfall B is identified as the "Old Mill River Channel system" in mapping provided by Tighe and Bond. The system also appears to collect and discharge runoff from the King Street Brook system. The catchment area for Outfall C aligns with catchments identified as M3 and M4 by Tighe and Bond.

The proposed systems were conceptualized and sized to treat one-inch of stormwater runoff from the associated catchments to Outfalls A and C. For Outfall B, the approach involved estimating the level of treatment that could be provided by one of the larger proprietary systems. The proposed water quality treatment devices would not reduce flooding potential or provide for system storage, but the reduction in sediment loading would be expected to have a positive effect on downstream areas by reducing sedimentation in the downstream channel and preserving the available volume within the storage basin, which is an integral component of the Hockanum Road Pumping Station.

CONCEPTUAL DESIGN ASSESSMENT

Project Benefits

WATER QUALITY

The proposed water quality treatment devices will not provide additional flood storage or directly reduce potential flood impacts, as discussed above, but will provide for water quality improvements and reduce sedimentation that could impact reservoir storage in the basin upstream of the Hockanum Road Pumping Station. Preserving storage within the basin is integral to the long-term performance and effectiveness of the City's Connecticut River Flood Control System.

The proposed water quality treatment devices would be located in an upland area, either within or adjacent to the existing right-of-way and will not result in direct wetland resource impacts, although work would require temporary construction-phase work within the 200' Riverfront Area and potentially wetland buffer zones. The work would be to install the subsurface units and would not change the outfall pipe locations or sizes. The land cover would remain as maintained turf, except for manhole/access covers that would be installed and the potential for graveled access-ways for future ongoing maintenance. The work would not occur in NHESP Estimated or Priority Habitat areas. It appears that an Order of Conditions from the Northampton Conservation Commission may be the only environmental permit required to complete this project.

The proposed water quality treatment devices would result in stormwater quality improvements for discharges from Outfalls A, B, and C through sediment, debris, floatables, and oil and grease removals by the proprietary treatment structures. Due to the highly-urbanized nature of the catchment area and limited space near the outfalls, structural treatment devices were selected. These water quality treatment devices would not have direct impact toward improving wildlife habitat or connectivity, enhancing wetlands, decreasing invasive species, or increasing tree canopy. However, it is expected that the improvement in the water quality of discharges will enhance the surrounding natural environment.

Potential Challenges

MAINTENANCE

If these water quality treatment devices are selected for future design and implementation, the existing soils, utility conflicts, and depth to groundwater would need to be reviewed in detail to confirm constructability of these structural treatment devices. Future ongoing maintenance in the form of cleaning accumulated sediments and debris from the devices will be a recurring expense that will need to be budgeted for by the City.

Construction Costs

The conceptual-level opinion of construction cost for Project 7 - Historic Mill River – Pleasant Street Outfalls is $350,000, as outlined in Appendix F. Refer to page 2 of this Conceptual Design Summary report for a description of the cost estimating methodology and limitations.

This project, taken alone, is less likely to be competitive for grant funding; however, it may be viewed as a favorable component of improving the overall resiliency of the City's Connecticut River Flood Control System by serving to preserve storage capacity for the Hockanum Road Pumping Station.

PROJECT 8 - INDUSTRIAL DRIVE ROTARY STORMWATER RETROFIT

Industrial Drive extends between Damon Road and the intersection of Bradford and Bates Streets in eastern Northampton. The site is generally located north of downtown Northampton and close to the Connecticut River. Industrial Drive serves as the main access road for the Northampton Industrial Park and is heavily used by tractor trailer trucks and other vehicles visiting the businesses located in the Park. The Industrial Park is generally comprised of established development parcels with buildings, parking, and grassed areas (Figure 8-1). There is minimal tree canopy that is primarily located near the wetlands resource areas in the southwesterly quadrant of the Park.

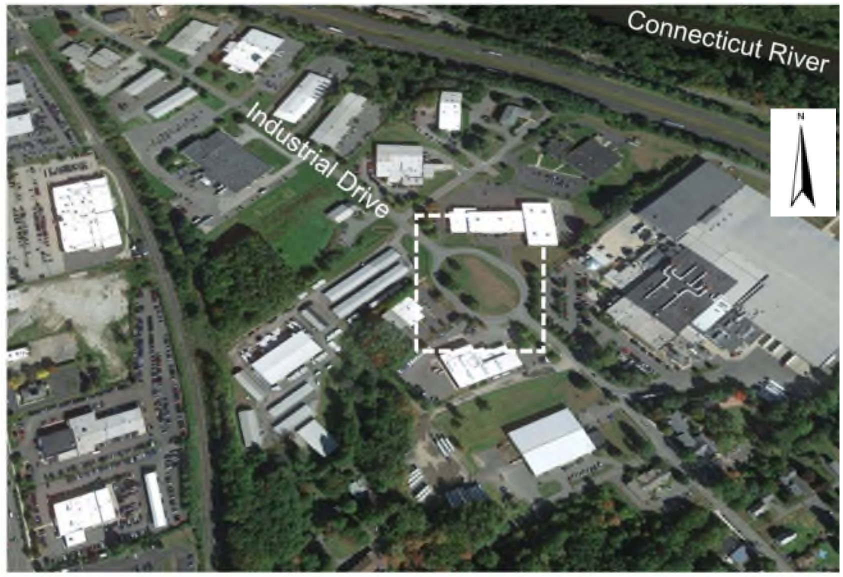


Figure 8-1. Aerial locus of Northampton Industrial Park, including the Industrial Drive rotary highlighted within the box (Google Maps).

The Industrial Drive rotary is located approximately 600 feet north of the intersection of Bradford and Bates Streets. The grassed island within the rotary is elliptical and approximately 300 feet long by 190 feet wide. Record plans indicate that there is a utility corridor in the central portion of the rotary running north/south, including drainage, sewer, gas, water, and electrical services. There are three mature trees located in the western portion of the grassed area.

Record drawings indicate that the drainage utilities within the rotary consist of two separate systems. There is a 30-inch drainage main that traverses the rotary from east to west and discharges into the Damon Road outfall into the Connecticut River. The subcatchment for the 30-inch drainage main appears to include a significant portion of the Industrial Park. A second 24-inch drainage pipe traverses the rotary from north to south and eventually connects into the drainage system that flows towards downtown Northampton to the south. The subcatchment for the 24-inch drainage pipe appears to include the rotary itself and immediately surrounding area (approximately 2.2 acres).

KEY OPPORTUNITIES

- Redirect stormwater away from downtown Northampton
- Collect and treat stormwater runoff from Industrial Drive rotary and immediately surrounding area
- Increase urban canopy and provide public gathering space for workers in the Park

The Industrial Drive Rotary was selected for conceptual design of a stormwater retrofit by City of Northampton stakeholders because of its potential to redirect stormwater away from downtown Northampton, as well as improve the water quality within the Industrial Park drainage system.

PROPOSED CONCEPTUAL DESIGN

Based on record drawings and observations of the area, there is an opportunity to construct curb cuts and divert local drainage from Industrial Drive and the immediately surrounding area into the rotary island. The island would be deepened into a shallow bioretention basin that would encompass much of the existing grassed area, while allowing existing mature trees and utilities to remain in place (Figure 8-2). Water would be directed to the bioretention basin from the roadway through four existing low points around the perimeter of the rotary.

The bioretention basin would consist of meadow vegetation, including stormwater-tolerant grasses and wildflowers, underlain by a 2-foot soil filter media that would provide treatment. Below the soil media, a 2-foot crushed stone reservoir would provide stormwater storage and detention for larger storm events. An underdrain would be installed at the top of the reservoir layer to provide an overflow to the drainage system. To install the bioretention section, six feet of existing earth will need to be excavated, removed, and replaced with the bioretention soil mix and crushed stone reservoir (Figure 8-3).

New trees would be planted within the rotary island to increase urban tree canopy coverage. In the future, there is the potential to add pedestrian access from adjacent businesses to engage the space within the rotary as a park for walking or enjoying lunch.

The NRCS Web Soil Survey indicates that the underlying soil conditions within the rotary are silt loam. Record test pit information from 1970 found the soils in this area to consist of fine sand. These soil textures should be confirmed, but generally indicate that the potential for infiltration may be limited. The 1970 records also indicated observed groundwater of approximately 7 feet below then-existing grade.

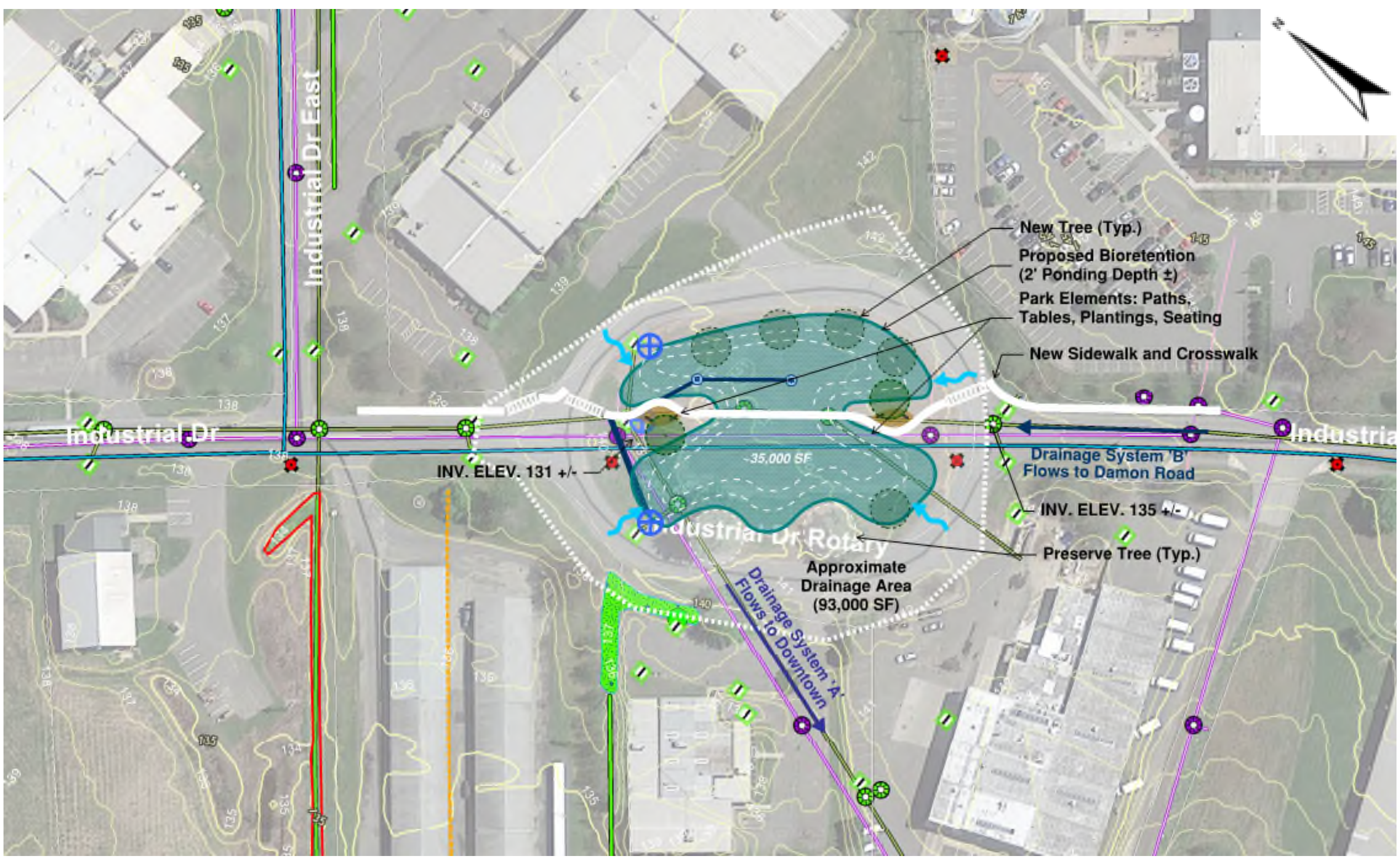


Figure 8-2. Conceptual design for Industrial Drive rotary stormwater improvements. See full size Figure with legend in Appendix. (Imagery © Google)

Preliminary Hydrologic Modeling Results

A preliminary hydrologic model was developed to perform a conceptual-level sizing analysis for the proposed bioretention basin. The subcatchment that drains to the 24-inch drainage pipe, approximately 2.2 acres of roadway and landscape, would be redirected into the proposed bioretention basin. The peak runoff rate and volume through the system were reviewed for the 2-, 10-, and 100-year, 24-hour storm events (Atlas 14 rainfall data). Because of the large footprint of the bioretention basin, the preliminary model indicates that it has the potential to reduce the contributing peak runoff rate by over 85 percent in all storm events. The runoff volume reduction ranged from 25 percent in the 100-year storm to 75 percent in the 2-year storm. For the preliminary modeling, infiltration was assumed to be minimal (0.27 inches per hour) due to concerns with variable soil types. On-site subsurface investigation should be performed in the next design phase to determine if credit can be taken for higher levels of infiltration, which would result in additional peak rate reduction and volume mitigation.

Because the 30-inch Industrial Drive drainage main passes beneath the rotary, the GZA/Nitsch team also evaluated the potential to divert runoff from the larger system catchment into the new bioretention basin for additional mitigation. The estimated catchment area for the Industrial Drive drainage main leading into the western end of the rotary is 5.8± acres. Based on the results of the preliminary hydrologic model, the team determined that diverting even a small portion of runoff from the regional catchment does not appear to yield a substantial runoff reduction benefit. It appears that this is due to the potential storage volume being significantly smaller than the estimated runoff generated by the larger regional watershed.

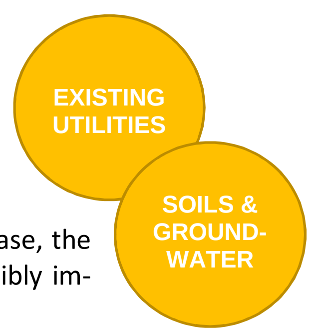
Accordingly, the construction of the bioretention basin in the rotary should collect, treat, and mitigate only that stormwater runoff generated by the 2.2-acre catchment area that flows overland to the rotary. Because of the large open space areas within the Industrial Park, there may be additional opportunities to partner with a private landowner to build additional stormwater improvements for the regional watershed, which could be designed to reduce flooding issues at the local and regional scale.

CONCEPTUAL DESIGN ASSESSMENT

Project Benefits

The Industrial Drive Rotary Stormwater Retrofit project will capture, treat, and mitigate stormwater from an approximately 2-acre drainage area that currently flows towards the vulnerable downtown area through the Industrial Park's existing closed stormwater management system. The project's primary benefits include improving stormwater quality and providing flood protection by reducing runoff to the downtown watershed. The project will also increase urban tree canopy within the Industrial Park. Due to its location, this project does not require work on private property and is not anticipated to impact wetland resource areas or require environmental permitting.

Potential Challenges



Industrial Drive, including the rotary, contains a subsurface utility corridor that serves the businesses within the Park. Therefore, the surface and subsurface components of the rain garden must be carefully designed to avoid impacts to the utilities. Additional investigation is needed to understand the depths of the existing utilities and whether there would be a conflict between the existing utilities and the subsurface components of the bioretention basin. The new bioretention basin must also be designed to work with the existing closed drainage system—providing outlets that can overflow from the basin by gravity. Finally, as part of the next design phase, the underlying soils and groundwater conditions should be reviewed on-site to confirm and possibly improve upon the design assumptions for infiltration.

Construction Costs

The conceptual-level opinion of construction cost for Project 8 – Industrial Drive Rotary Stormwater Retrofit is $880,000, as outlined in Appendix F. Refer to page 2 of this Conceptual Design Summary report for a description of the cost estimating methodology and limitations.

Potential funding sources include future MVP Action Grants, Section 319 Nonpoint Source Grants, and supplemental environmental projects.

PROJECT 9 - INDUSTRIAL DRIVE CHANNEL IMPROVEMENTS (SPACES FOR RENT)

KEY OPPORTUNITIES

- Redirect stormwater away from downtown Northampton
- Reduce localized flooding potential
- Removal of invasive species

The "Spaces for Rent" self-storage facility is located within the Northampton Industrial Park. A drainage channel is located between the Spaces for Rent property and the adjacent property to the northeast. Flows in the drainage channel are conveyed by piping beneath Industrial Drive and ultimately out to the Connecticut River. During heavy rain events, the drainage channel sometimes overflows and causes flooding to the self-storage facility. The drainage channel receives flow from a wetland system to the west of the property, including an open drainageway behind the property. Within this drainageway there is a topographic high point that divides the flow direction between north and south (Figure 9-1). The flow going south eventually enters the overtaxed downtown Northampton drainage system. The portion of the drainageway flowing north enters the drainage channel. This site was selected for conceptual design by City stakeholders because of the opportunity to reduce flows to the downtown Northampton drainage system, as well as the potential for mitigation of flooding.

PROPOSED CONCEPTUAL DESIGN

Based on City records of prior wetlands permitting efforts in the area, it appears the City may have maintained the drainage channel; however, it has not been maintained in recent years and has accumulated sediment and vegetative growth and debris that have severely limited its flow capacity. Restoration of the flow capacity by removal of accumulated material would significantly reduce the risk of flooding at the self-storage facility. While stormwater runoff from the majority of the self-storage facility's impervious cover is mitigated by constructed wetlands at the site, there is approximately 6,000 square feet of rooftop at the rear of the property that discharges directly to the rear drainageway. The topographic divide in the drainageway could potentially be removed or shifted southward, to encourage flow towards the north and thereby removing the rooftop runoff from the overburdened downtown Northampton drainage system (Figure 9-2).

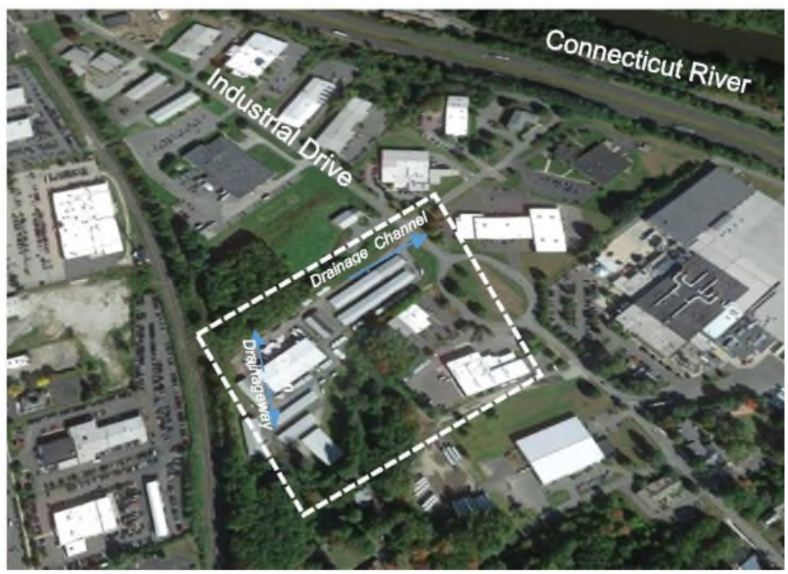


Figure 9-1. Aerial locus of Industrial Drive Channel (Imagery from Google Earth)

Design Details

The proposed conceptual design would include the following elements:

1. Restoration of approximately 750 linear feet of an existing drainage channel to improve flow-through characteristics.

2. Re-grading of approximately 450 linear feet of open drainageway to redirect flow to the north instead of towards the downtown drainage system.

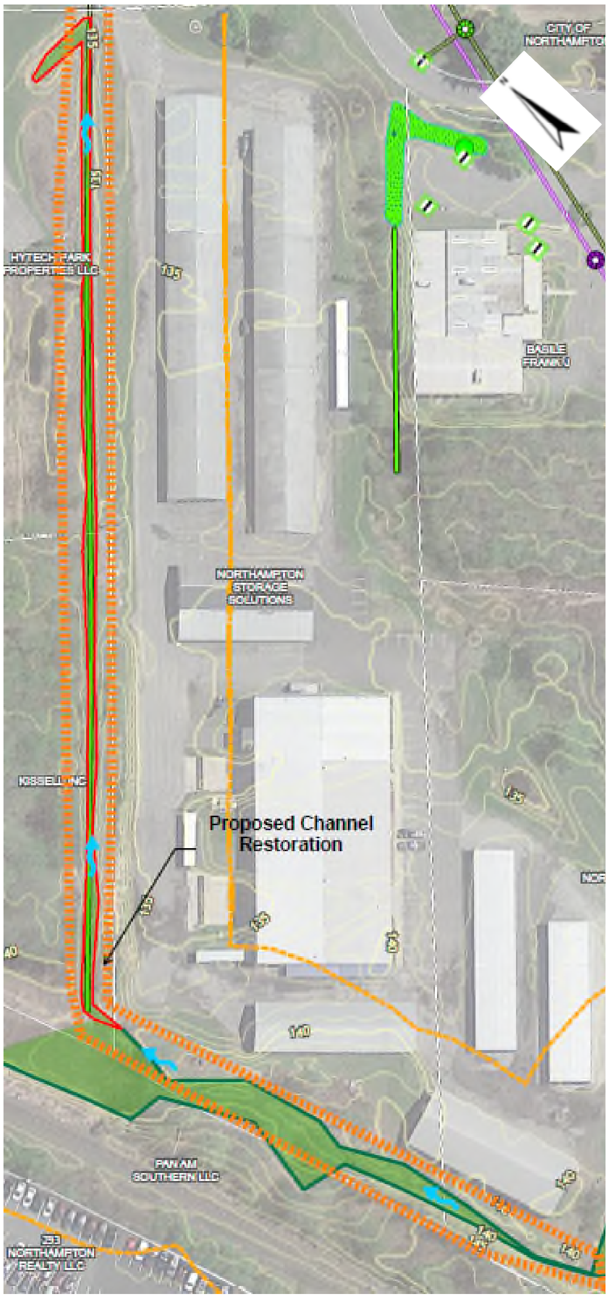
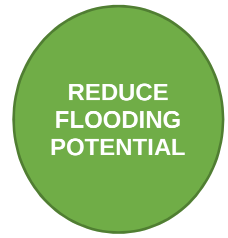


Figure 9-2. Conceptual Design for Industrial Drive Channel Improvements (Imagery © Google)

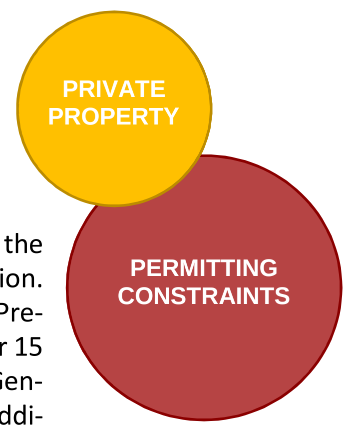
CONCEPTUAL DESIGN ASSESSMENT

Project Benefits



The Industrial Drive Channel Improvements will reduce the potential for flooding of the self-storage facility property and remove stormwater runoff that currently contributes to the downtown drainage system. The channel restoration will provide a co-benefit by removal of invasive species. The work would not occur in NHESP Estimated or Priority Habitat areas.

Potential Challenges



Although the drainage channel has been maintained by the City as such in the past, it may now be considered a regulated wetland, and efforts to restore its functioning are expected to require permitting under the Massachusetts Wetlands Protection Act by obtaining an Order of Conditions from the Northampton Conservation Commission. The work is most likely eligible for a Pre-construction Notification under GP 5 or 15 of the U.S. Army Corps of Engineers General Permits for Massachusetts. In addition to the various wetland permits from local, state, and federal agencies, the project would likely require review under the Massachusetts Environmental Policy Act (MEPA), due to greater than 500 linear feet of Bank resource impacts, and a 401 Water Quality Certification from MassDEP. The project would be located entirely on private property; thus, concurrence from the property owners will be required.

Construction Costs

The conceptual-level opinion of construction cost for Project 9 – Industrial Drive Channel Improvements is $80,000, as outlined in Appendix F. Refer to page 2 of this Conceptual Design Summary report for a description of the cost estimating methodology and limitations.

Potential funding sources include FEMA Hazard Mitigation Assistance, future MVP Action Grants, and supplemental environmental projects. The probability of funding of this project by these types of grants would likely increase if it were combined with the Industrial Drive Rotary Stormwater Retrofit project for overall improved flood resiliency within the Industrial Park.

PROJECT 10 - ICE POND OUTLET IMPROVEMENTS

The Ice Pond (Rocky Hill Pond) refers to a former pond located on the north side of Rocky Hill Road (State Route 66) between the Hampshire County Jail and the Ice Pond Drive residential subdivision. The historical pond receives flow from a 400± acre watershed and has one perennial tributary, known as Rocky Hill Pond Brook. The pond was reportedly constructed to supply ice to the Northampton State Hospital. Under normal, dry-weather conditions, the former pond does not impound water. Rather, flows entering the low area are allowed to exit through a 16-inch pipe that discharges into a riser structure that is connected to a 6-ft x 5-ft box culvert beneath Rocky Hill Road. Near the top of the riser structure is a secondary, high-level outlet with a 8-ft x 4-ft vertical rectangular opening (drop inlet). The 16-inch pipe and the high-level outlet are believed to be infrastructure associated with the former pond. During hydrologic events causing significant flows in the brook, the capacity of the 16-inch outlet pipe can be exceeded, and water is temporarily impounded within the footprint of the former pond. If the 16-inch pipe becomes clogged or if inflows are excessive, rising water within the pond may also discharge through the high-level outlet.

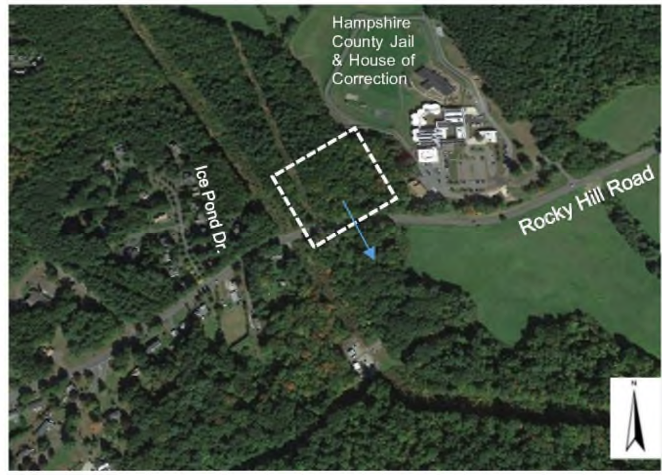


Figure 10-1. Aerial locus of Ice Pond (Imagery from GoogleEarth)

KEY OPPORTUNITIES

- Improve flood resiliency, reduce potential flooding and storm damage
- Enhance natural drainage feature with limited impacts to infrastructure

The former pond essentially acts as a detention basin and mitigates peak flow rates downstream of Rocky Hill Road. In fact, the Ice Pond Drive subdivision does not have separate detention for its stormwater runoff and instead utilizes the former pond's flow attenuation capabilities to mitigate potential increases in downstream flow rates. Both the 16-inch low-level outlet and the high-level outlet are covered with gratings to prevent large debris from getting into the system and also, presumably, for human safety purposes. Although the grates are maintained monthly, access is difficult and potentially a safety risk when the brook is flowing full or when waters begin to rise within the former pond. Further, high flow events often carry leaves and organic debris from the mostly-wooded watershed, clogging the grates and posing a major flood risk. The Ice Pond overflowed across Rocky Hill Road during a severe storm in April 2007, which dropped approximately 4 inches of rain according to Westfield Barnes Airport precipitation data. This event caused damages to the roadway infrastructure, including washout of the southern (downstream) roadway shoulder and exposure of underground utilities.


Photo 10-1. Example of Proposed Inlet Structure

This site was selected for conceptual design by City of Northampton stakeholders because of the need for a more resilient outlet structure that will have a lower risk of clogging during storm events when the need for a free-flowing outlet is most critical.

PROPOSED CONCEPTUAL DESIGN

The objectives of the conceptual design include improvements to both the low-level outlet and drop inlet structure to provide safe access for maintenance, to not unnecessarily impede flows despite some accumulation of leaves or debris during a storm event, and to continue to provide for human health and safety. In addition, the detention capacity of the pond must be maintained, for continued mitigation of peak downstream flow rates. The proposed conceptual design includes a retrofit at both the low-level outlet and the drop inlet structure, providing each with an inclined bar grating and including a new accessway to facilitate safe maintenance (Figure 10-2). The retrofit inlet structures will not result in changes to the hydraulic capacity of the existing outlet structure configuration, and the overall detention capacity of the former pond is expected to be maintained. The inclined bar gratings will allow for the accumulation of some debris without completely blocking the ability of the structure to pass flow. In addition, the configuration allows for the ability to remove debris by raking upward from the top of the structure.

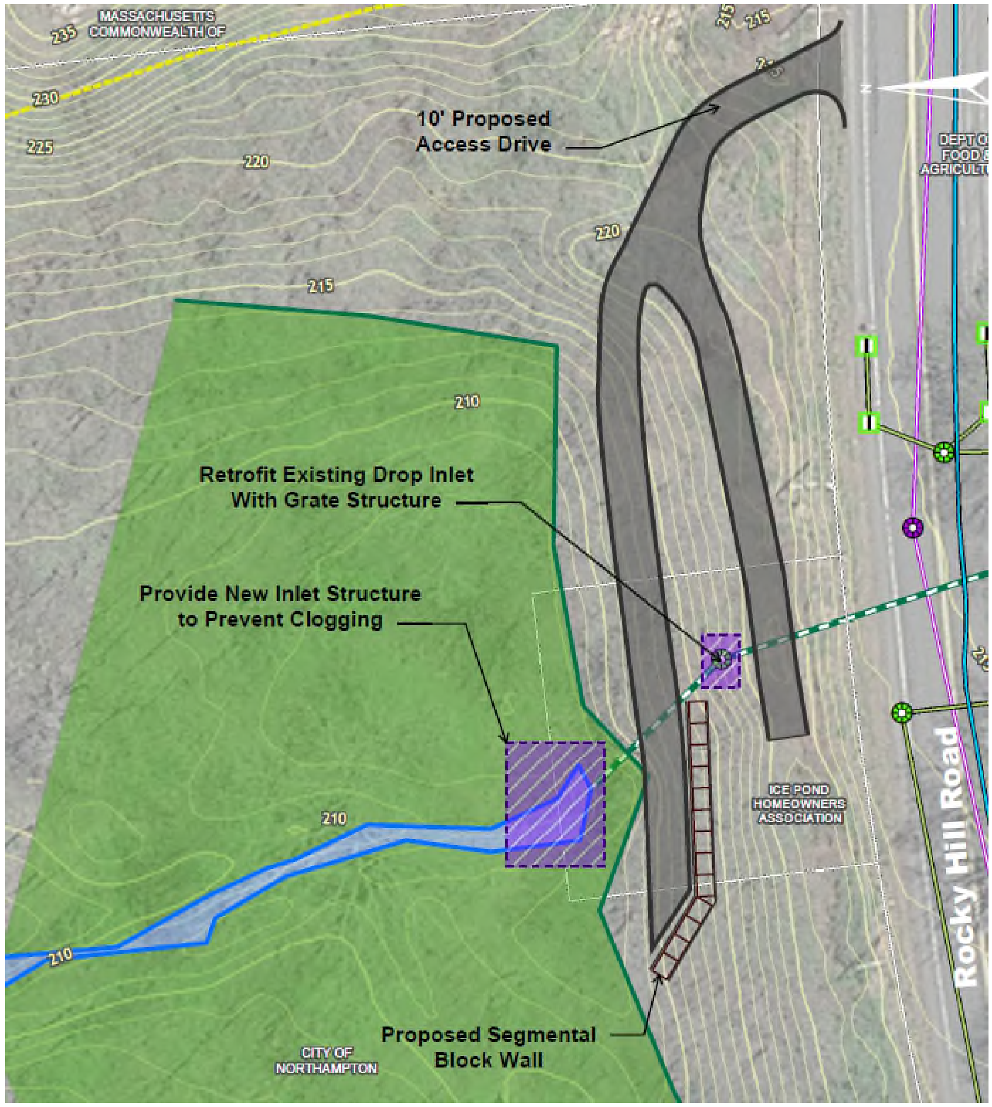


Figure 10-2. Conceptual Design for Ice Pond Outlet Improvements (Imagery © Google)

CONCEPTUAL DESIGN ASSESSMENT

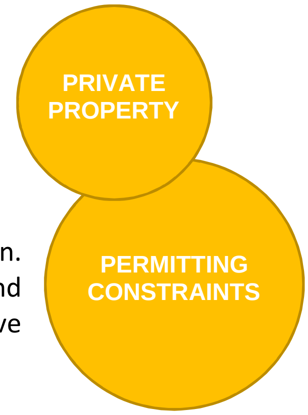
Project Benefits

This project will improve flood resiliency and reduce the potential for flooding over Rocky Hill Road, as well as the potential for future storm damages such as that which occurred in 2007. The project takes advantage of existing natural drainage features and will not impact NHESP Estimated or Priority Habitat areas.

REDUCE FLOODING POTENTIAL

The retrofit inlet structures will not eliminate the need for maintenance but will allow for safer access to maintain the structures on a regular basis and provide a greater margin of safety against clogging from leaves and other natural debris from the watershed.

Potential Challenges



There will be wetland impacts associated with construction of the low-level outlet structure retrofit. Direct impacts will likely be less than 500 square feet but will require an Order of Conditions from the Northampton Conservation Commission. The work is most likely eligible for Self-Verification under GP 1 of the U.S. Army Corps of Engineers General Permits for Massachusetts. Some of the work will occur on property owned by the Ice Pond Homeowners Association. It is anticipated that the Ice Pond Homeowners' Association will be amenable to the Project and allow City access for construction and future maintenance and operation, as the work will improve conditions at the structures that they are responsible for maintaining.

Construction Costs

The conceptual-level opinion of construction cost for Project 10 – Ice Pond Outlet Improvements is $280,000, as outlined in Appendix F. Refer to page 2 of this Conceptual Design Summary report for a description of the cost estimating methodology and limitations.

Potential funding sources include FEMA Hazard Mitigation Assistance.

PROJECT 11 - NORTH FARMS ROAD / BROAD BROOK CULVERT UPGRADE

PROJECT 11 - NORTH FARMS ROAD / BROAD BROOK CULVERT UPGRADE

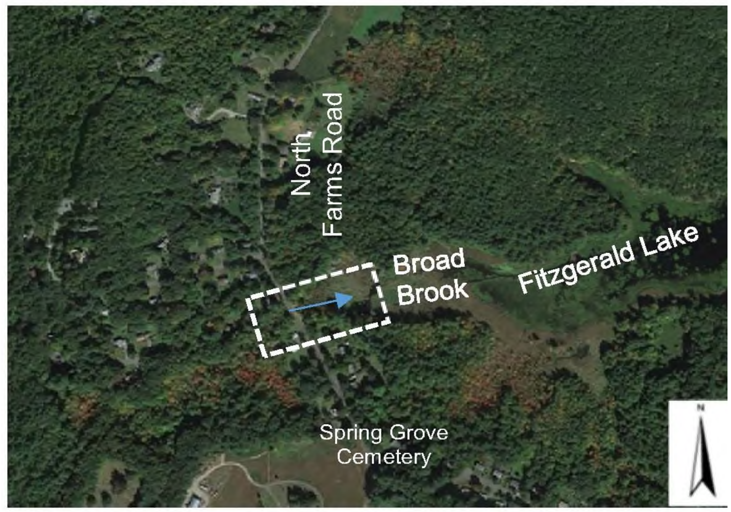


Figure 11-1. Aerial locus of North Farms Road / Broad Brook (Imagery from GoogleEarth)

Located in the northeasterly quadrant of Northampton, Broad Brook flows from west to east under North Farms Road and into Fitzgerald Lake within the Fitzgerald Lake Conservation Area (Figure 11-1). North Farms Road bisects the Burke Conservation Area to the west from the Fitzgerald Lake Conservation Area to the east. The City's nearby Spring Grove Cemetery is identified as Priority Habitat under the Massachusetts Natural Heritage and Endangered Species Program (NHESP). Upland and wetland areas along the western and southern shores of Fitzgerald Lake (downstream of the culvert) are identified as NHESP Priority and Estimated Habitat. The existing cross culvert is a 3-ft diameter reinforced concrete pipe that appears to be in good condition. The City has indicated that there is no history of significant flooding related to this location; however, the size of the culvert is an impediment to wildlife passage. At the Northampton Designs with Nature community engagement public forum on October 23, 2018, residents from neighboring areas indicated that they often see turtles and amphibians killed on the roadway in this location. According to the *Massachusetts River and Stream Crossing Standards* (River and Stream Continuity Partnership, 2011), to facilitate wildlife movement some species may require more open structures as well as dry passage along the banks or within the streambed at low flow. When wildlife are able to move through road-stream crossings they are less likely to be killed crossing over the road surface. This site was selected for conceptual design by City of Northampton stakeholders because of the opportunity for connecting two conservation areas with high ecological value by an improved open culvert that would allow for wildlife passage.

PROPOSED CONCEPTUAL DESIGN

KEY OPPORTUNITIES

- Improve wildlife habitat connectivity
- Educational co-benefit

The *Massachusetts River and Stream Crossing Standards* specify General Openness Criteria that include an openness ratio of at least 0.25 meters and a crossing that is wide and high relative to its length. The "optimum" criteria are 0.50 meters openness and 6 feet in height.

The North Farms Road site could accommodate a culvert with a height of 4.5 feet and an openness ratio of 0.29 meters, which meets the "general" criteria. To provide for the openness ratio of 0.29 meters for a 45-foot long culvert, the proposed culvert is a rectangular box culvert with an opening of 10 feet wide by 4.5 feet high (from the channel invert). The 10-ft width accommodates the criteria for spanning the channel width a minimum of 1.2 times the bankfull width, which is assumed for this conceptual design to be eight feet and will be confirmed by more detailed field review as a part of design development. Natural stream bottom substrate would be placed inside the structure to a depth of two feet. Relocation of the existing catch basins in the vicinity of the culvert may be necessary, and slight increase in the height of the roadway surface may be necessary. A concept detail of the proposed culvert is shown in Figure 11-3 below.

The replacement of a 3-ft diameter culvert with a 10-ft wide by 4.5-ft high culvert will increase the hydraulic capacity of the structure; thereby potentially increasing peak flow rates downstream. However, as the downstream area is conservation area and the brook flows into Fitzgerald Lake with its outflow controlled by a dam, an increase in peak flow rates is not expected to result in adverse impacts to existing infrastructure or developed areas. However, a more detailed hydrologic and hydraulic analysis should be conducted as this project moves beyond the conceptual design phase.

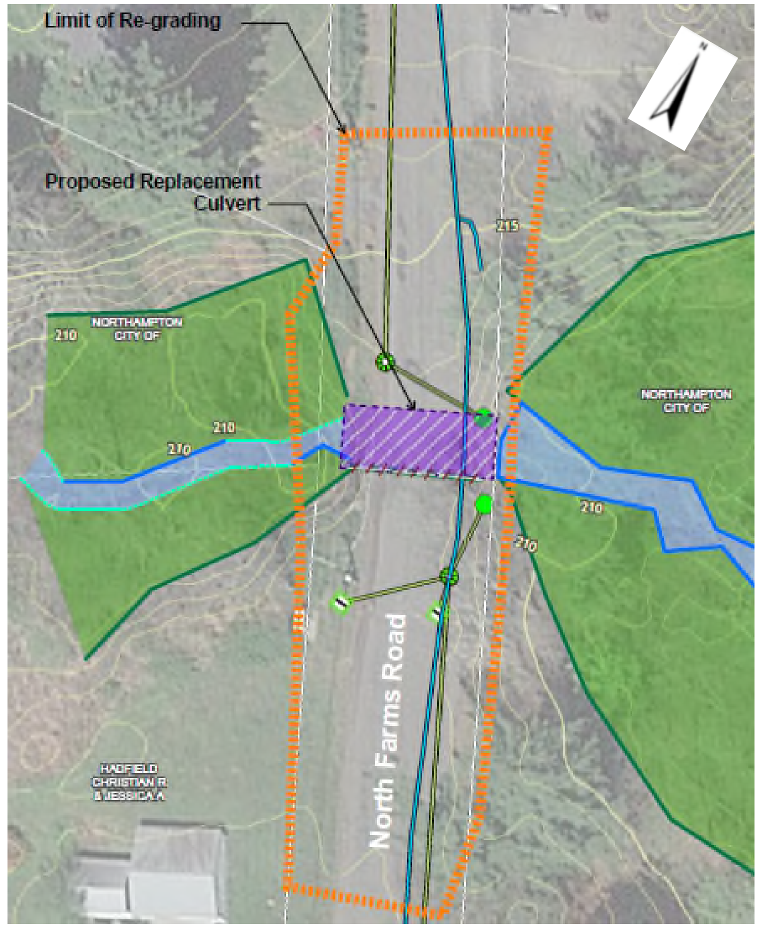


Figure 11-2. Conceptual Design for North Farms Road Culvert Improvement (Imagery © Google)

CONCEPTUAL DESIGN ASSESSMENT

Project Benefits

Replacement of the existing culvert with a culvert meeting the *Massachusetts River and Stream Crossing Standards* could allow for greater connection between the conservation areas upstream and downstream of North Farms Road. This would benefit the ecological value of these resource areas and increase safe wildlife passage for aquatic organisms and other wildlife.

The parking area for the Fitzgerald Lake Conservation Area is located on North Farms Road approximately 100 feet from the culvert. This project could have a co-benefit of education to the public regarding the value of open stream crossings with the addition of interpretive signage at the parking area regarding the improved culvert.

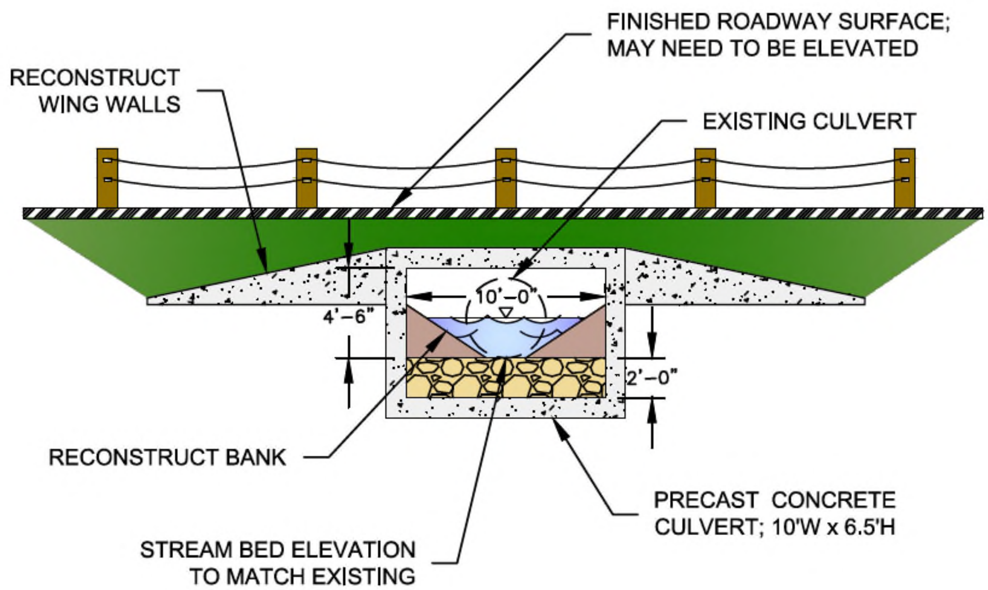
Potential Challenges

Although the proposed culvert would not meet the "optimum" criteria standards, the *Massachusetts River and Stream Crossing Standards* allow for a reduction in meeting the optimum standards for replacement culverts when site constraints, such as a limited road profile, make it impossible. The increased culvert height might result in the need to raise the road, which has secondary impacts to the accommodation of roadway drainage and adjacent private properties. This project will also result in wetland impacts, requiring an Order of Conditions from the Northampton Conservation Commission and a design complying with the Massachusetts Stream Crossing Standards. The work is most likely eligible for Self-Verification under GP 8 of the U.S. Army Corps of Engineers General Permits for Massachusetts. Appropriate mitigation for the wetland impacts may be required. The culvert is crossed by an 8-inch water main so utility conflicts are possible and have the potential to increase the cost of construction. Construction may require temporary and permanent easements for construction access and placement of culvert wingwalls.

WILDLIFE HABITAT / CONNECTIVITY

EDUCATIONAL VALUE

SECONDARY CONSTRUCTION IMPACTS



Construction Costs

The conceptual-level opinion of construction cost for Project 11 – North Farms Road / Broad Brook Culvert Upgrade is $490,000, as outlined in Appendix F. Refer to page 2 of this Conceptual Design Summary report for a description of the cost estimating methodology and limitations.

Potential funding sources include the Culvert Replacement Municipal Assistance Grant Program administered by the Massachusetts Division of Ecological Restoration, and supplemental environmental projects. The culvert conveying Broad Brook under North Farms Road is not identified on the Massachusetts Wildlife Climate Action Tool for "Maintain habitat connectivity: Retrofit or replace culverts" (https://climateactiontool.org/content/maintain-habitat-connectivity-retrofit-or-replace-culverts); therefore, it does not rank within the top 15 percent of culverts prioritized by the Commonwealth of Massachusetts for replacement, which are given preference for funding by the Culvert Replacement Municipal Assistance Grant Program. The culvert is also not identified on the North Atlantic Aquatic Connectivity Collaborative (NAACC) database. Other factors may make this culvert replacement less favorable for priority under the grant program. The contributing stream, Fitzgerald Lake, and the downstream Broad Brook are not coldwater fisheries. The nearest coldwater fishery is Running Gutter Brook, located almost three miles downstream of North Farms Road. There are no coldwater fisheries upstream of the site. There is another impediment to fish passage downstream with the dam on Fitzgerald Lake. Also, a culvert in disrepair would receive priority over a culvert in good repair, given all other factors being equal. Notwithstanding, this culvert replacement project would provide aquatic organism passage between two areas of high ecological value, including close proximity to NHESP Estimated and Priority Habitats. The improved passage would likely reduce mortality of turtles and amphibians often observed at this location. Therefore, there is likely a potential for this culvert replacement project to receive grant funding.

References

Alderman & MacNeish. (1975). Additions & Alterations, Jackson Street School, Northampton, Massachusetts. Drawing #s CD1-CD10.

Alderman & MacNeish. (1975). Additions & Alterations, Smith Vocational-Agricultural School, Northampton, Massachusetts. Drawing # CD11.

Almer Huntley, Jr. & Associates. (1982). Northampton Industrial Park Drainage Plan & Profile. Drawing # 4 of 13.

Almer Huntley, Jr. & Associates. (1987). Downtown Parking Hampton Avenue Parking Lot Modifications, City of Northampton, Massachusetts.

CDM (May 2012). "Stormwater and Flood Control System Assessment and Utility Plan", Northampton, Massachusetts Department of Public Works.

CDM Smith (October 2014). King Street Brook Culvert Evaluation, Northampton, Massachusetts.

Massachusetts Department of Environmental Protection (10/24/2014). 314 CMR 9.00: 401 Water Quality Certification (https://www.mass.gov/regulations/314-CMR-9-401-water-quality-certification).

CDM Smith (March 2, 2016). King Street Brook Hydraulic Analyses Memorandum.

City of Northampton (as amended). Chapter 337 Wetlands Protection (https://www.ecode360.com/13265228?#13265228).

Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs, Department of Fish and Game, Division of Ecological Restoration (May 2018). Massachusetts Stream Crossings Handbook, 2nd Edition.

Department of the Army (April 16, 2018). General Permits for the Commonwealth of Massachusetts (https://www.nae.usace.army.mil/Portals/74/docs/regulatory/StateGeneralPermits/MA/PN-GPFinal-RevApril2018.pdf?ver=2018-07-31-142949-100)

E. H. Lord-Wood Associates, Inc. (1971). Property Map and Soil Test Data, Northampton Industrial Park, Industrial Redevelopment Project.

Massachusetts Department of Environmental Protection. (2008). Massachusetts Stormwater Handbook and Stormwater Standards as incorporated in the Wetlands Protection Act Regulations, 310 CMR 10.05(6)(k) and the Water Quality Certification Regulations, 314 CMR 9.06(6)(a).

Massachusetts Department of Environmental Protection (10/04/2017). 310 CMR 10.00: Wetlands Protection Act Regulations (https://www.mass.gov/regulations/310-CMR-1000-wetlands-protection-act-regulations).

Massachusetts Executive Office of Energy and Environmental Affairs (05/10/2013). 301 CMR 11: MEPA Regulations (https://www.mass.gov/regulations/301-CMR-11-mepa-regulations).

Massachusetts Executive Office of Energy and Environmental Affairs (January 9, 2019). Grant Announcement Commbuys Bid # BD-19-1042-ENV-ENV01-34410 Request for Responses (RFR) ENV 19 MVP 01, Municipal Vulnerability Preparedness Grant Program (MVP) FY19 Planning Grant.

National Oceanic and Atmospheric Administration (NOAA) National Weather Service Hydrometeorological Design Studies Center. Precipitation Frequency Data Server – NOAA Atlas 14 Point Precipitation Frequency Estimates (https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html).

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey Hampshire County, Massachusetts, Central Part (MA609). Available online at the following link: https://websoilsurvey.sc.egov.usda.gov/. Accessed December 2018-February 2019.

The Berkshire Design Group, Inc. (2009). Topographic/Detail Plan, Existing Conditions, Land in Northampton.

Tighe and Bond (2018). Draft "Hockanum Road Flood Pumping Station Evaluation", Northampton, Massachusetts.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service. (2015). NOAA Atlas 14 Precipitation-Frequency Atlas of the United States, Volume 10 Version 2.0: Northeastern States (Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, Vermont). Silver Spring, Maryland. Available online at the following link: https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html. Accessed December 2018-February 2019.

Appendix A - Limitations

LIMITATIONS

USE OF REPORT

1. GeoEnvironmental, Inc. (GZA) prepared this Report on behalf of, and for the exclusive use of our Client at the stated time for the stated purpose(s) and location(s) identified in the Report. Use of this Report, in whole or in part, at other locations, or for other purposes, may lead to inappropriate conclusions; and we do not accept any responsibility for the consequences of such use(s). Further, reliance by any party not identified in the agreement, for any use, without our prior written permission, shall be at that party's sole risk, and without any liability to GZA.

STANDARD OF CARE

2. GZA's findings and conclusions are based on the work conducted as part of the Scope of Services set forth in the Report and/or proposal, and reflect our professional judgment. These findings and conclusions must be considered not as scientific or engineering certainties, but rather as our professional opinions concerning the limited data gathered during the course of our work.

3. GZA's services were performed using the degree of skill and care ordinarily exercised by qualified professionals performing the same type of services at the same time, under similar conditions, and at the same or a similar property. No warranty, expressed or implied, is made.

4. Basis of Opinion of Cost Unless otherwise stated, our opinions of cost are only for comparative and general planning purposes. These opinions are based on the limited data and the conditions and assumptions described in the Report. The cost estimates may involve approximate quantity evaluations and are not intended to be sufficiently accurate to develop construction bids, or to predict the actual cost of work addressed in the Report. Further, since we have no control over when the work will take place nor the labor and material costs required to plan and execute the anticipated work, our cost opinions were made by relying on our experience, the experience of others, and other sources of readily available information. Actual costs may vary over time and could be significantly more, or less, than stated in the Report.

5. Cost opinions presented in the Report are based on a combination of sources and may include published RS Means Cost Data; past bid documents; cost data from federal, state or local transportation agency web sites; discussions with local experienced contractors; and GZA's experience with costs for similar projects at similar locations. GZA did not attempt to independently verify the accuracy or completeness of all information reviewed or received during the course of this evaluation. Actual costs will likely vary depending on the quality of materials and installation; manufacturer of the materials or equipment; field conditions; geographic location; access restrictions; phasing of the work; subcontractor mark-ups; quality of the contractor(s); project management exercised; and the availability of time to thoroughly solicit competitive pricing. In view of these limitations, the costs presented in the Report should be considered "order of magnitude" and used for budgeting and comparison purposes only. Detailed quantity and cost estimating should be performed by experienced professional cost estimators to evaluate actual costs. The opinions of cost in the Report should not be interpreted as a bid or offer to perform the work. Unless stated otherwise, all costs are based on present value.

6. The opinions of costs are based only on the quantity and/or cost items identified in the Report, and should not be assumed to include other costs such as legal, administrative, permitting or others. The estimate also does not include any costs with respect to third-party claims, fines, penalties, or other charges which may be assessed against any responsible party because of either the existence of present conditions or the future existence or discovery of any such conditions.

ADDITIONAL SERVICES

7. It is recommended that GZA be retained to provide engineering services during any final design, construction and/or implementation of any measures recommended in this Report. This will allow us the opportunity to: i) observe conditions and compliance with our design concepts and opinions; ii) allow for changes in the event that conditions are other than anticipated; and iii) provide modifications to our design.

Appendix B – Graphical Legend

LEGEND

EXISTING

Wetlands

100' Buffer

200' Riverfront Area

Bank/Intermittent

Channel

Est. Mean Annual High Water Line

Est. Wetland Boundary

Mean Annual High Water Line

Wetland Boundary

Bordering Vegetated Wetland

Land Under Water

Stormwater System

Manholes

Culvert Point

Channel Point

Intake

Outfall

Stations

Pipe

Channel

Abaondoned Drains

Culvert

Detention Basin

Water System

Hydrants

Water Valves

Hydrant Lateral

Water Mains

Abandoned Water Mains

Water Service

Sewer System

Manholes

Abandoned Manholes

Sewer Cleanout

Sewer Flowmeters

Sewer Stations

Sewer Pipes

Abandoned Sewer

Sewer Service

Other

Parcel Lines

5 ft/10 ft Contours

1 ft/2 ft Contours

PROPOSED

- Bioretention
- Flared End
- Drain Pipe
- Drain Manhole
- Flow
- Remove CB
- Remove Tree
- Remove/Abandon Pipe
- Structure
- Treatment Device
- Limit of Earthwork
- Impacted Wetlands
- 1-ft Contours
- Floodplain Shelf

Appendix C – Conceptual Design Assessment Matrix

NORTHAMPTON DESIGNS WITH NATURE TO REDUCE STORM DAMAGE

BASED ON THE CONCEPTUAL DESIGN SUMMARY

Conceptual Design Assessment Criteria

0 = Does not promote or favor the Criterion

5 = Substantially promotes or favors the Criterion

Scores are subjective and are for discusion purposes only

Watershed	Project Site and Concept	Stormwater Management						Human Impacts				Infrastructure			Environmental		
		Mitigating Stormwater Quantity	Reduction in Flooding Potential	Reduction in Storm Damage	Improvement to Flood Resiliency	Enhancement of Natural Drainage	**Stormwater Management/ Flooding Score**	Educational Value as a Demonstration Project	Creating or Promoting Public Use/Recreation Areas	Walkability/Connectivity	**Positive Human Impacts Score**	Avoids Impacts to Existing Assets/Structures	Avoids Utility Conflicts	**Infrastructure Impacts Avoided Score**	Avoids Wetland Impacts	Avoids Estimated and Priority Habitats Impacts	**Environmental Impacts Avoided Score**
Barret Street Marsh / King Street Brook Watershed	**PROJECT 1 - King Street Brook Flood Control Berm** - *construct berm near end of Winter Street to prevent flooding to State St./Stoddard St. area*	0	4	4	4	1	**13**	1	0	3	**4**	4	4	**8**	2	5	**7**
	PROJECT 2 - Jackson Street Elem. School Stormwater Retrofits - *add bioretention of school's stormwater to reduce peak flows and volume entering King St. Brook downstream of Barrett Street*	5	3	3	3	3	**17**	5	2	1	**8**	3	4	**7**	5	5	**10**
	PROJECT 3 - Adare Place Outlet Improvements and Stream Channel Restoration - *repair outlet, add velocity dissipation, stabilize streambank*	0	0	4	4	4	**12**	1	1	0	**2**	4	5	**9**	3	5	**8**
Elm Street Brook	**PROJECT 4 - Smith VOC Bioretention** - *add bioretention in front lawns of Smith VOC to reduce peak flows and volume entering Elm Street Brook*	5	3	3	3	3	**17**	5	2	1	**8**	3	4	**7**	5	5	**10**
	PROJECT 5 - Elm Street Brook Flood Mitigation - *restore and enhance stream channel and add floodplain shelf to enhance storage*	0	4	4	4	3	**15**	2	0	1	**3**	2	2	**4**	1	5	**6**
Historic Mill River	**PROJECT 6 - Historic Mill River - Old South Street Outfalls** - *add green infrastructure for water quality improvements*	2	1	1	1	3	**8**	4	1	1	**6**	3	3	**6**	5	5	**10**
	PROJECT 7 - Historic Mill River / Pleasant Street Outfalls - *provide water quality treatment and sediment capture for outfalls discharging to the storage basin for Hockanum Rd. Pumping Station*	0	0	1	1	0	**2**	1	0	0	**1**	3	3	**6**	5	5	**10**
Industrial Drive	**PROJECT 8 - Industrial Drive Rotary Stormwater Retrofit** - *redirect drainage from south to north, add roadside green infrastructure inside circle*	5	3	3	3	3	**17**	4	4	3	**11**	2	2	**4**	5	5	**10**
	PROJECT 9 - Industrial Drive Channel Improvements - *improve channel conveyance*	0	4	3	3	2	**12**	1	0	0	**1**	5	5	**10**	1	5	**6**
Rocky Hill Greenway - Ice Pond	**PROJECT 10 - Ice Pond Outlet Improvements** - *improve capacity of the pond and outlet structure to reduce downstream peak flows and reduce vulnerability to flooding of Rocky Hill Road*	0	5	4	4	2	**15**	3	0	0	**3**	4	4	**8**	3	5	**8**
Fitzgerald Lake - Broad Brook	**PROJECT 11 - North Farms Road / Broad Brook Culvert Upgrade** - *replace culvert with one that meets the Massachusetts Stream Crossing Standards*	0	3	2	3	5	**13**	4	3	2	**9**	2	2	**4**	4	5	**9**

NORTHAMPTON DESIGNS WITH NATURE TO REDUCE STORM DAMAGE

BASED ON THE CONCEPTUAL DESIGN SUMMARY

Conceptual Design Assessment Criteria

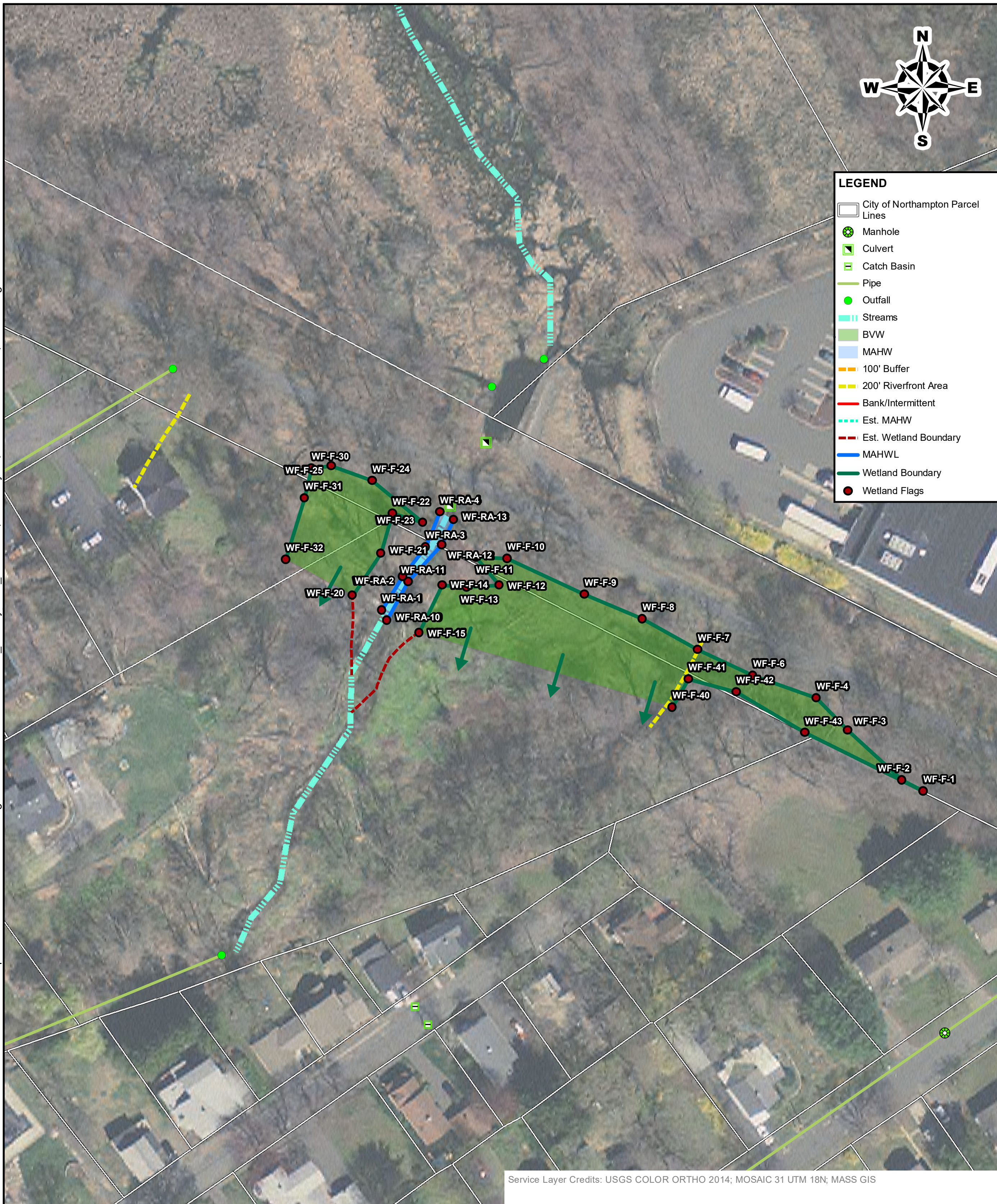
0 = Does not promote or favor the Criterion

5 = Substantially promotes or favors the Criterion

Scores are subjective and are for discusison purposes only

Watershed	Project Site and Concept	Permitting Considerations	Property Ownership Limitations	Construction Access Issues	Staging Area Availability	Secondary Constr. Impacts to Surrounding Area	**Feasibility Score**	Future Funding Potential	Future O&M Needs & Costs	Relative Construction Costs	**Financial Score**	Wildlife Habitat Enhancement/Restoration	Wildlife Connectivity	Water Quality Improvement	Wetland Enhancement/Restoration	Invasive Species Reduction	Increasing the Urban Tree Canopy	Consistency with other City of Northampton Planning Goals	**Co-Benefits Score**
		Feasibility / Design Challenges						**Financial**				**Co-Benefits**							
Barret Street Marsh / King Street Brook Watershed	**PROJECT 1 - King Street Brook Flood Control Berm** - *construct berm near end of Winter Street to prevent flooding to State St./Stoddard St. area*	3	1	1	3	2	**10**	3	4	5	**12**	1	1	1	2	0	0		**5**
	PROJECT 2 - Jackson Street Elem. School Stormwater Retrofits - *add bioretention of school's stormwater to reduce peak flows and volume entering King St. Brook downstream of Barrett Street*	5	5	4	4	4	**22**	5	3	2	**10**	3	1	5	0	0	4		**13**
	PROJECT 3 - Adare Place Outlet Improvements and Stream Channel Restoration - *repair outlet, add velocity dissipation, stabilize streambank*	3	3	2	3	2	**13**	1	5	3	**9**	4	1	4	4	1	1		**15**
Elm Street Brook	**PROJECT 4 - Smith VOC Bioretention** - *add bioretention in front lawns of Smith VOC to reduce peak flows and volume entering Elm Street Brook*	5	4	4	4	4	**21**	5	3	2	**10**	3	1	5	0	0	4		**13**
	PROJECT 5 - Elm Street Brook Flood Mitigation - *restore and enhance stream channel and add floodplain shelf to enhance storage*	0	1	1	1	0	**3**	3	4	0	**7**	3	2	3	3	1	0		**12**
Historic Mill River	**PROJECT 6 - Historic Mill River - Old South Street Outfalls** - *add green infrastructure for water quality improvements*	4	5	4	4	4	**21**	4	3	4	**11**	1	1	5	1	1	5		**14**
	PROJECT 7 - Historic Mill River / Pleasant Street Outfalls - *provide water quality treatment and sediment capture for outfalls discharging to the storage basin for Hockanum Rd. Pumping Station*	4	5	4	4	4	**21**	1	3	4	**8**	0	0	5	1	1	1		**8**
Industrial Drive	**PROJECT 8 - Industrial Drive Rotary Stormwater Retrofit** - *redirect drainage from south to north, add roadside green infrastructure inside circle*	5	5	4	4	4	**22**	5	3	2	**10**	3	1	5	0	0	4		**13**
	PROJECT 9 - Industrial Drive Channel Improvements - *improve channel conveyance*	1	2	2	3	4	**12**	1	4	5	**10**	0	1	2	0	2	1		**6**
Rocky Hill Greenway - Ice Pond	**PROJECT 10 - Ice Pond Outlet Improvements** - *improve capacity of the pond and outlet structure to reduce downstream peak flows and reduce vulnerability to flooding of Rocky Hill Road*	3	4	3	4	3	**17**	1	3	4	**8**	0	0	1	0	0	0		**1**
Fitzgerald Lake - Broad Brook	**PROJECT 11 - North Farms Road / Broad Brook Culvert Upgrade** - *replace culvert with one that meets the Massachusetts Stream Crossing Standards*	3	5	4	4	4	**20**	3	5	4	**12**	5	5	1	4	1	1		**17**

Appendix D – Wetland Delineation Figures



0 50 100 200

SCALE IN FEET

NORTHAMPTON DESIGNS WITH NATURE
NORTHAMPTON, MA

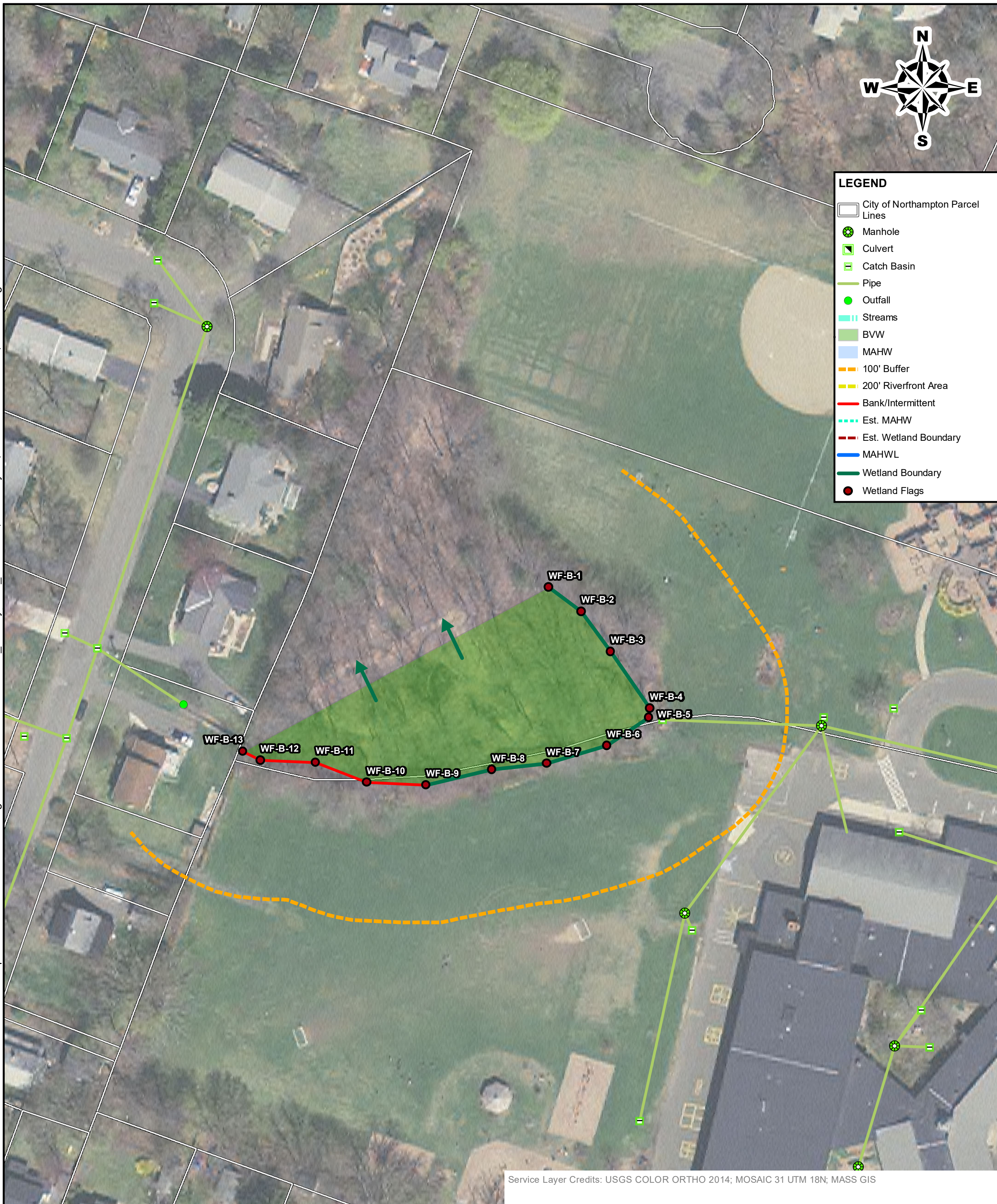
WETLANDS AREA
KING STREET BROOK

PREPARED BY:

GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR:

PROJ MGR: RTS	REVIEWED BY: NYA	CHECKED BY: RTS	SITE
DESIGNED BY: RTS	DRAWN BY: NJG	SCALE: 1 in = 100 ft	1
DATE: 02/06/2019	PROJECT NO: 15.0166700.00	REVISION NO:	



J:\0 166700 - 0 166799\15.0166700.00 Northampton Green Infrastructure Designs\GIS\mxd\Not Used\700.00_SurveySites_8x11.mxd, February 06, 2019 - 10:07:11 AM, nathaniel.gosselin

0 50 100 200

SCALE IN FEET

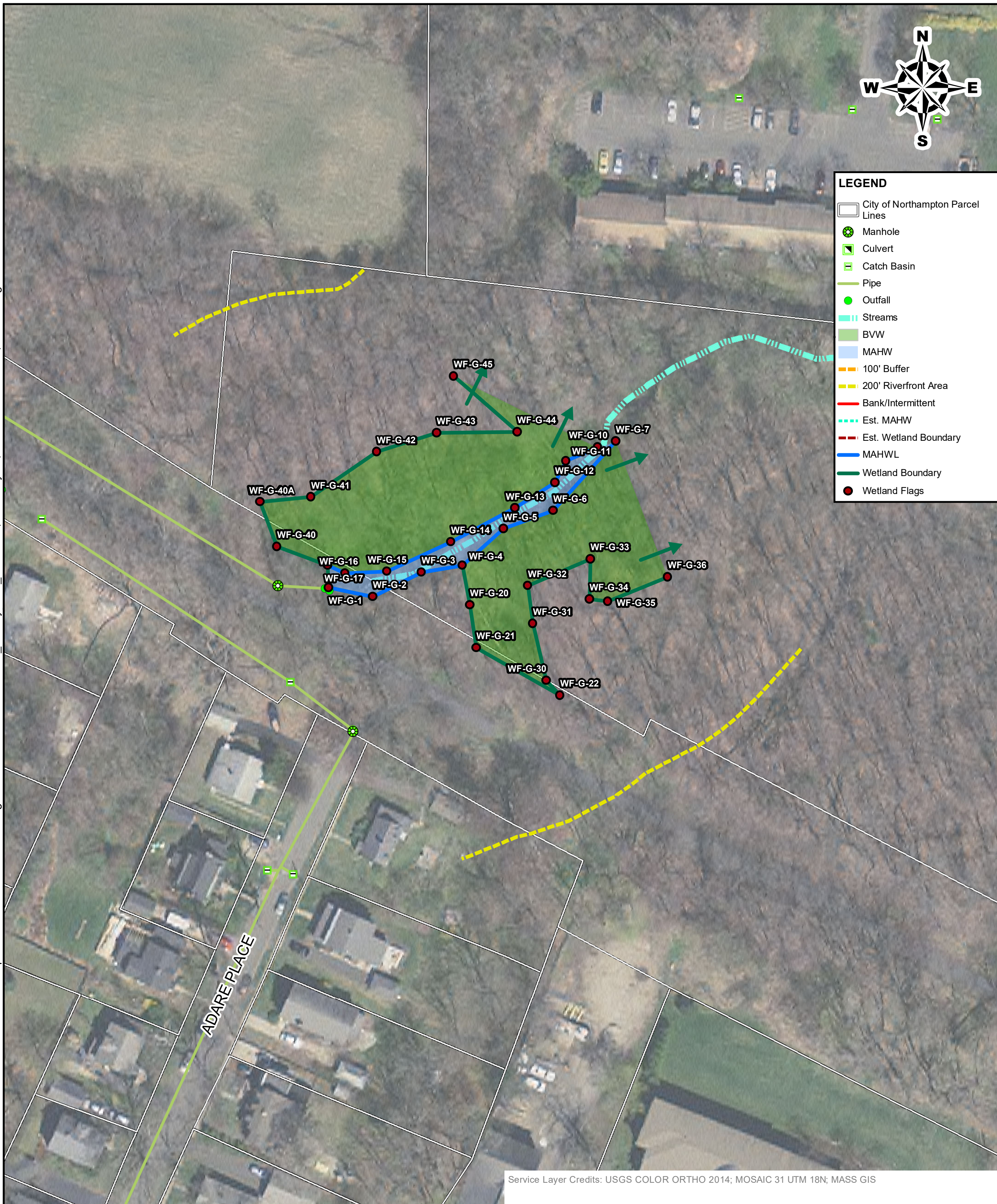
NORTHAMPTON DESIGNS WITH NATURE
NORTHAMPTON, MA

PREPARED BY:
GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR:

WETLANDS AREA
JACKSON STREET SCHOOL

PROJ MGR: RTS	REVIEWED BY: NYA	CHECKED BY: RTS	SITE
DESIGNED BY: RTS	DRAWN BY: NJG	SCALE: 1 in = 100 ft	2
DATE: 02/06/2019	PROJECT NO: 15.0166700.00	REVISION NO:	



J:\0 166700 - 0 166799\15.0166700.00 Northampton Green Infrastructure Designs\GIS\mxd\Not Used\700.00_SurveySites_8x11.mxd, February 06, 2019 - 10:06:42 AM, nathaniel.gosselin

0 50 100 200

SCALE IN FEET

NORTHAMPTON DESIGNS WITH NATURE
NORTHAMPTON, MA

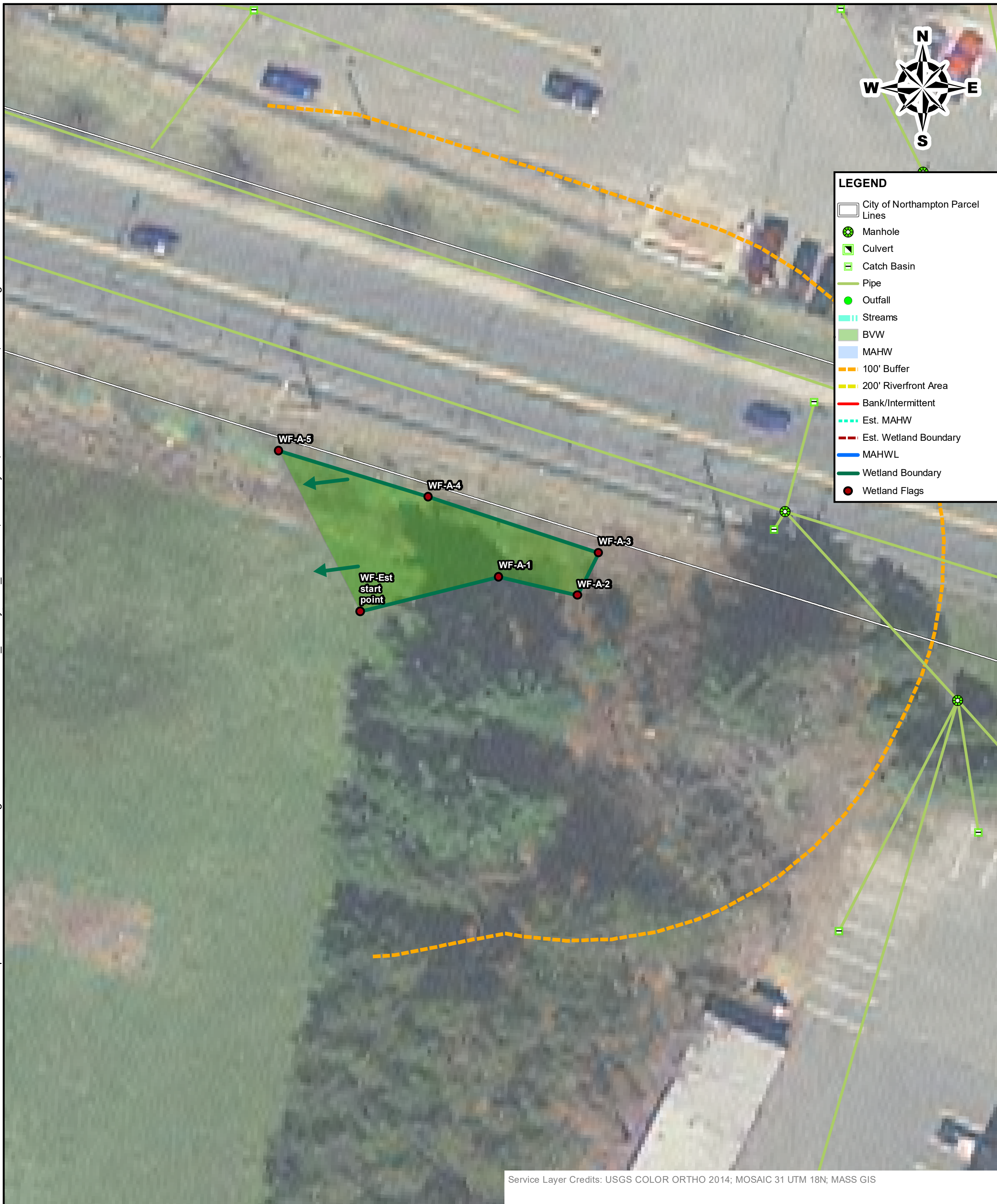
PREPARED BY:

GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR:

WETLANDS AREA
ADARE PLACE OUTLET

PROJ MGR: RTS	REVIEWED BY: NYA	CHECKED BY: RTS	SITE	
DESIGNED BY: RTS	DRAWN BY: NJG	SCALE: 1 in = 100 ft	3	
DATE: 02/06/2019	PROJECT NO: 15.0166700.00	REVISION NO:		



 J:\10 166700 - 0 166799\15.0166700.00 Northampton Green Infrastructure Designs\GIS\mxd\Not Used\700.00_SurveySites_8x11.mxd, February 06, 2019 - 10:07:20 AM, nathaniel.gosselin

0 20 40 80

SCALE IN FEET

NORTHAMPTON DESIGNS WITH NATURE
NORTHAMPTON, MA

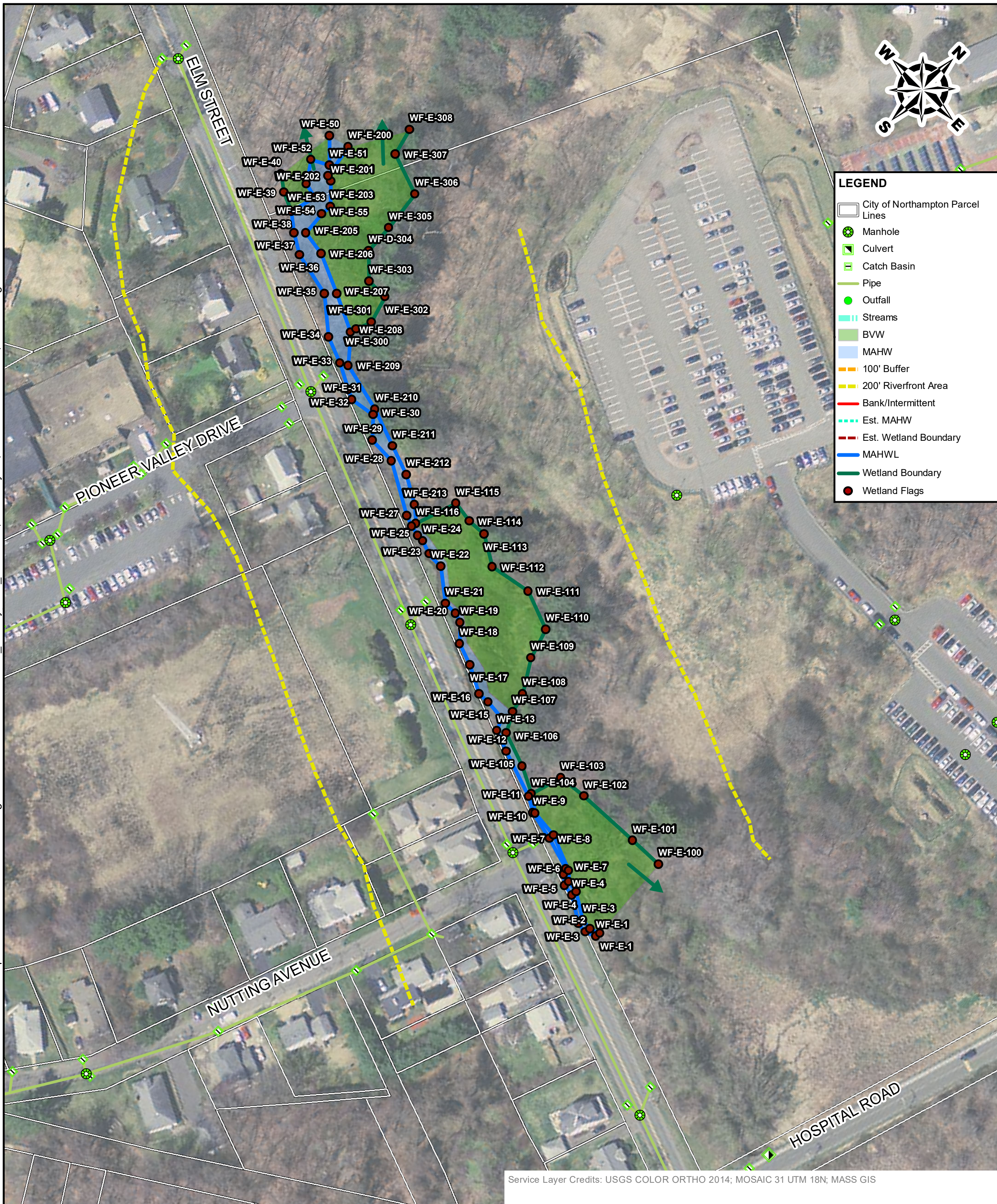
PREPARED BY:

GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR:

WETLANDS AREA
SMITH VOCATIONAL & AG. HIGH SCHOOL

PROJ MGR: RTS	REVIEWED BY: NYA	CHECKED BY: RTS	SITE
DESIGNED BY: RTS	DRAWN BY: NJG	SCALE: 1 in = 40 ft	4
DATE: 02/06/2019	PROJECT NO: 15.0166700.00	REVISION NO:	



0 75 150 300

SCALE IN FEET

NORTHAMPTON DESIGNS WITH NATURE
NORTHAMPTON, MA

PREPARED BY:
GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR:

WETLANDS AREA
ELM STREET BROOK

PROJ MGR: RTS	REVIEWED BY: NYA	CHECKED BY: RTS	SITE 5
DESIGNED BY: RTS	DRAWN BY: NJG	SCALE: 1 in = 150 ft	
DATE: 02/06/2019	PROJECT NO: 15.0166700.00	REVISION NO:	

J:\0 166700 - 0 166799\15.0166700.00 Northampton Green Infrastructure Designs\GIS\mxd\Not Used\700.00_SurveySites_8x11.mxd, February 06, 2019 - 10:06:30 AM, nathaniel.gosselin

0 30 60 120

SCALE IN FEET

NORTHAMPTON DESIGNS WITH NATURE
NORTHAMPTON, MA

WETLANDS AREA
OLD SOUTH STREET

PREPARED BY:

GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR:

PROJ MGR: RTS	REVIEWED BY: NYA	CHECKED BY: RTS	SITE
DESIGNED BY: RTS	DRAWN BY: NJG	SCALE: 1 in = 60 ft	6
DATE: 02/06/2019	PROJECT NO: 15.0166700.00	REVISION NO:	

UNLESS SPECIFICALLY STATED BY WRITTEN AGREEMENT, THIS DRAWING IS THE SOLE PROPERTY OF GZA GEOENVIRONMENTAL, INC. (GZA). THE INFORMATION SHOWN ON THE DRAWING IS SOLELY FOR THE USE BY GZA'S CLIENT OR THE CLIENT'S DESIGNATED REPRESENTATIVE FOR THE SPECIFIC PROJECT AND LOCATION IDENTIFIED ON THE DRAWING. THE DRAWING SHALL NOT BE TRANSFERRED, REUSED, COPIED, OR ALTERED IN ANY MANNER FOR USE AT ANY OTHER LOCATION OR FOR ANY OTHER PURPOSE WITHOUT THE PRIOR WRITTEN CONSENT OF GZA. ANY TRANSFER, REUSE, OR MODIFICATION TO THE DRAWING BY THE CLIENT OR OTHERS, WITHOUT THE PRIOR WRITTEN EXPRESS CONSENT OF GZA, WILL BE AT THE USER'S SOLE RISK AND WITHOUT ANY RISK OR LIABILITY TO GZA.

NORTHAMPTON DESIGNS WITH NATURE
NORTHAMPTON, MA

WETLANDS AREA
WASTEWATER TREATMENT PLAN

PREPARED BY:
GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

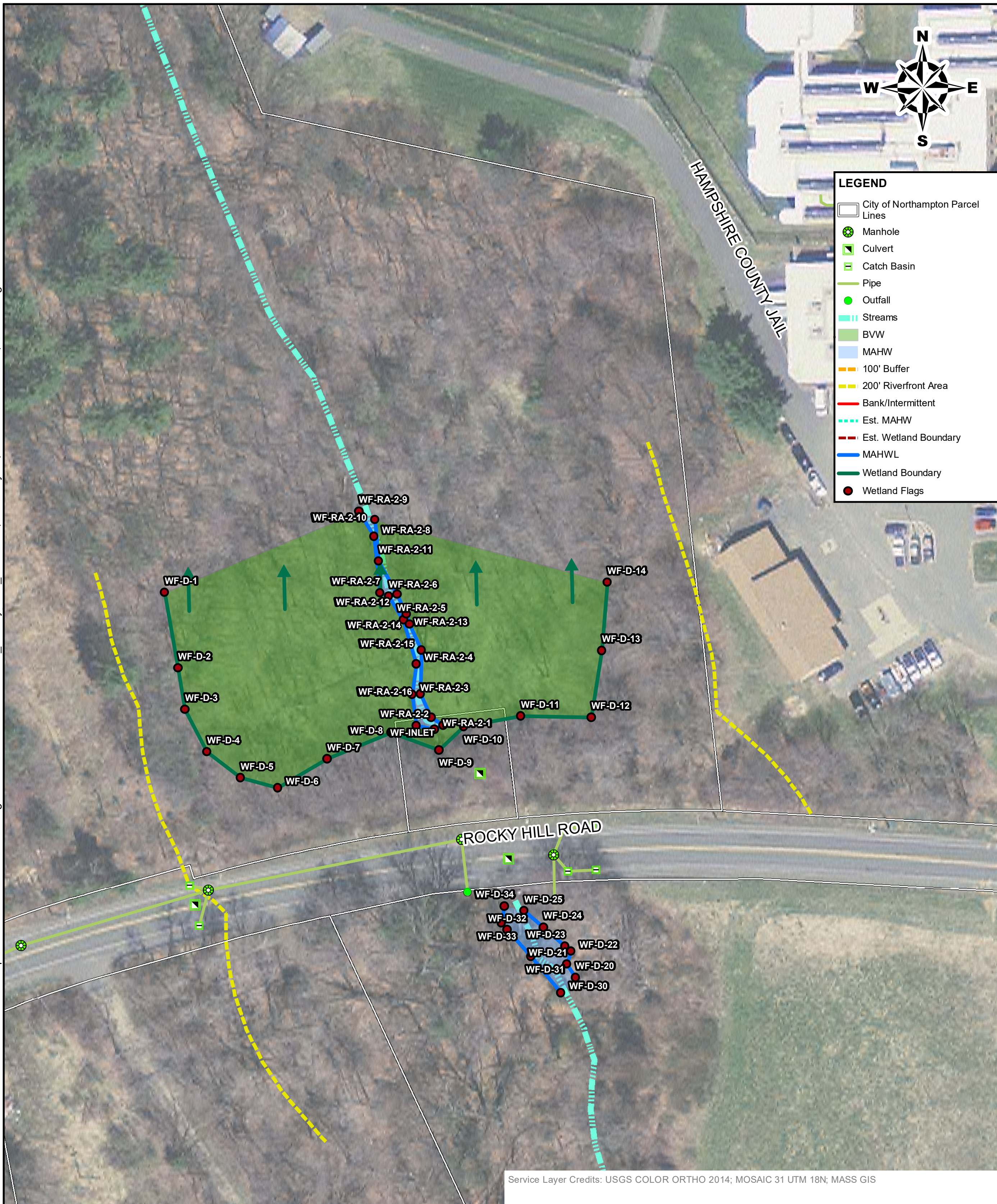
PREPARED FOR:

PROJ MGR: RTS	REVIEWED BY: NYA	CHECKED BY: RTS	SITE
DESIGNED BY: RTS	DRAWN BY: NJG	SCALE: 1 in = 100 ft	7
DATE: 02/06/2019	PROJECT NO: 15.0166700.00	REVISION NO:	

NORTHAMPTON DESIGNS WITH NATURE
NORTHAMPTON, MA

WETLANDS AREA
INDUSTRIAL DRIVE

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR:	
PROJ MGR: RTS	REVIEWED BY: NYA	CHECKED BY: RTS	SITE
DESIGNED BY: RTS	DRAWN BY: NJG	SCALE: 1 in = 100 ft	9
DATE: 02/06/2019	PROJECT NO: 15.0166700.00	REVISION NO:	



0 50 100 200

SCALE IN FEET

NORTHAMPTON DESIGNS WITH NATURE
NORTHAMPTON, MA

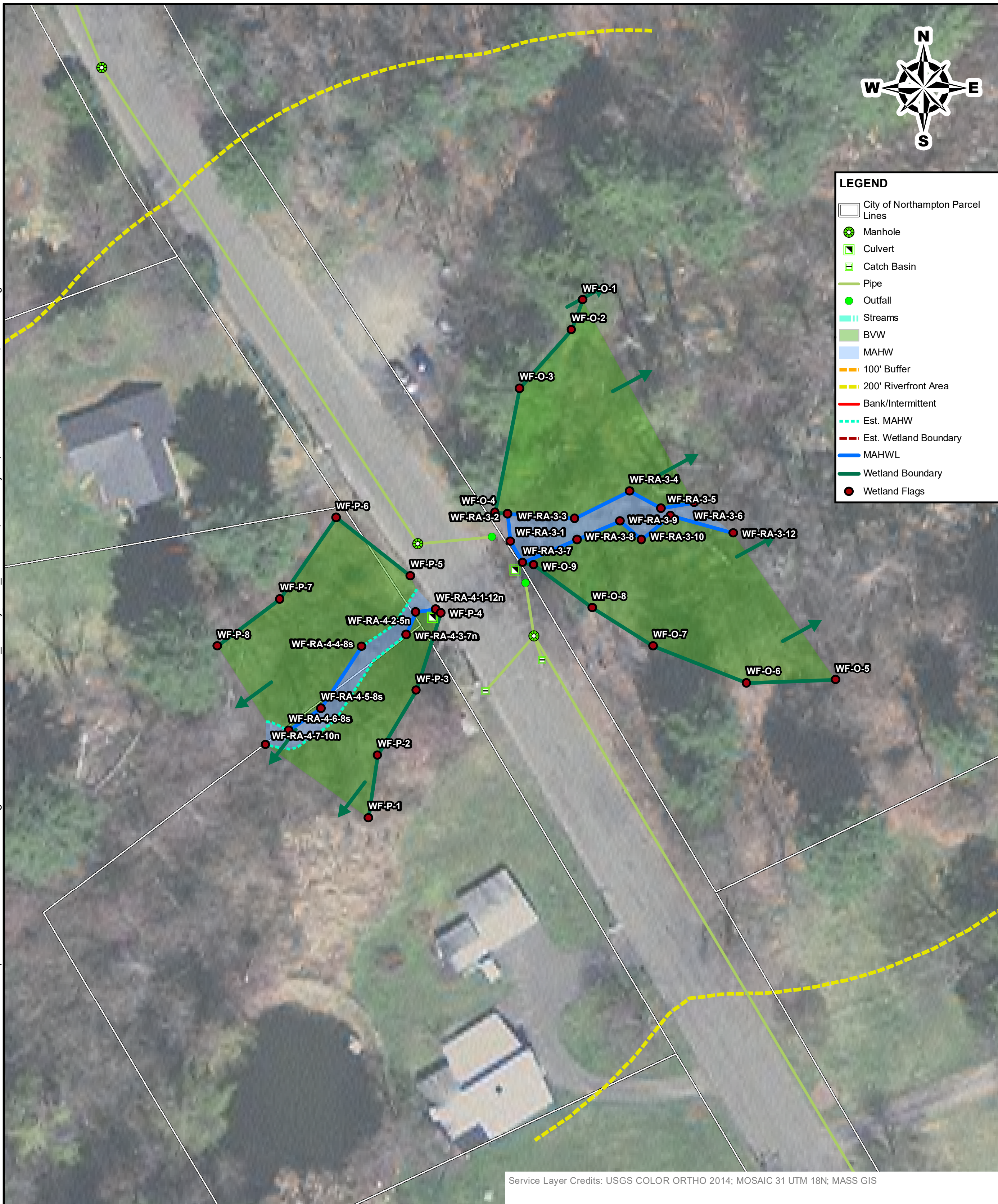
WETLANDS AREA
ICE POND - ROCKY HILL ROAD

PREPARED BY:

GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR:

PROJ MGR: RTS	REVIEWED BY: NYA	CHECKED BY: RTS	SITE
DESIGNED BY: RTS	DRAWN BY: NJG	SCALE: 1 in = 100 ft	10
DATE: 02/06/2019	PROJECT NO: 15.0166700.00	REVISION NO:	



0 30 60 120

SCALE IN FEET

NORTHAMPTON DESIGNS WITH NATURE
NORTHAMPTON, MA

PREPARED BY:

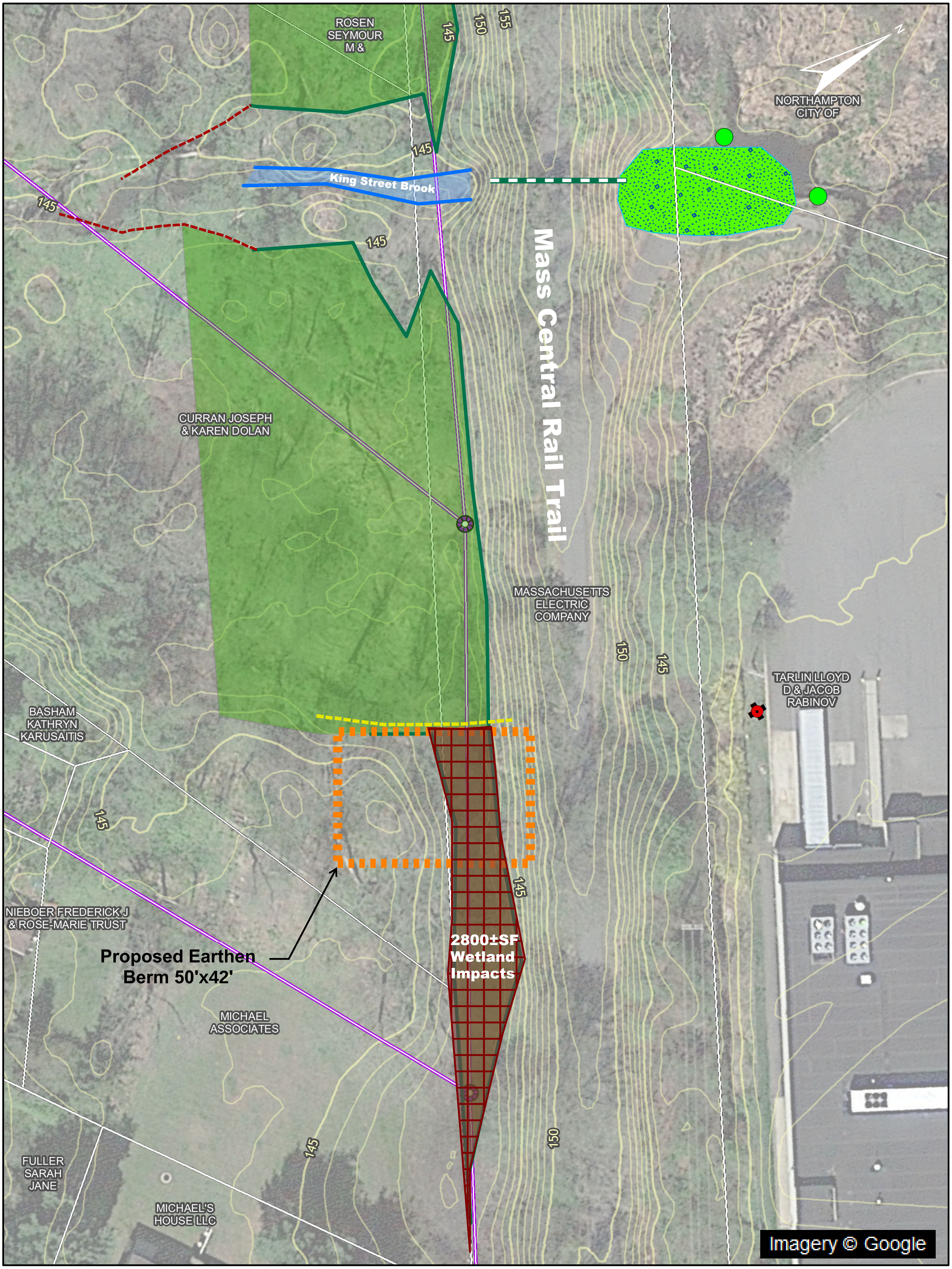
GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR:

WETLANDS AREA
NORTH FARMS ROAD - BROAD BROOK

PROJ MGR: RTS	REVIEWED BY: NYA	CHECKED BY: RTS	SITE	
DESIGNED BY: RTS	DRAWN BY: NJG	SCALE: 1 in = 60 ft		11
DATE: 02/06/2019	PROJECT NO: 15.0166700.00	REVISION NO:		

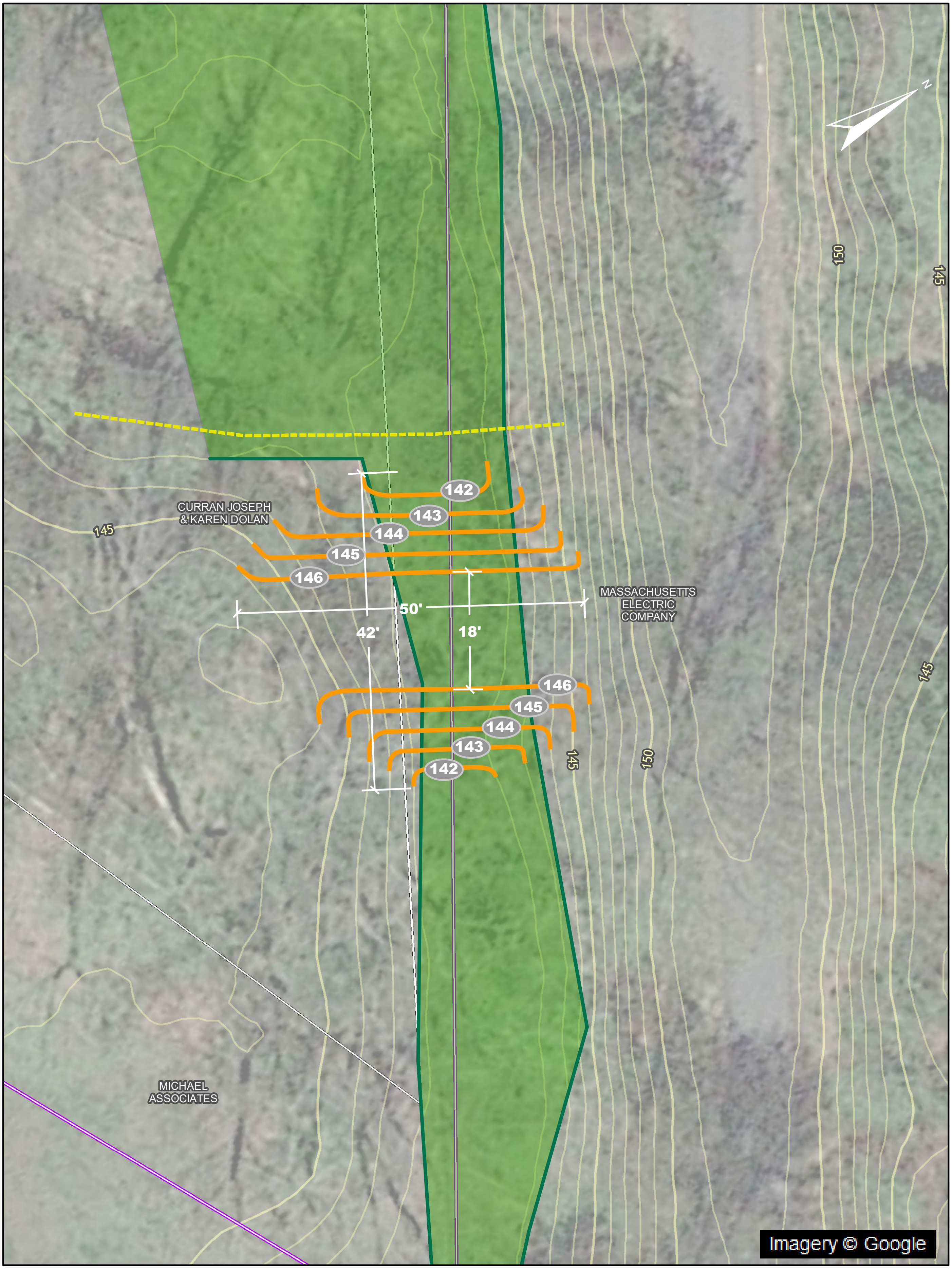
Appendix E – Full Conceptual Design Figures



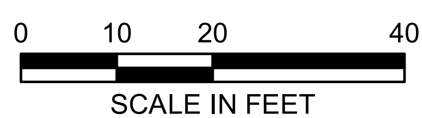
King Street Brook - Bike Path Culvert

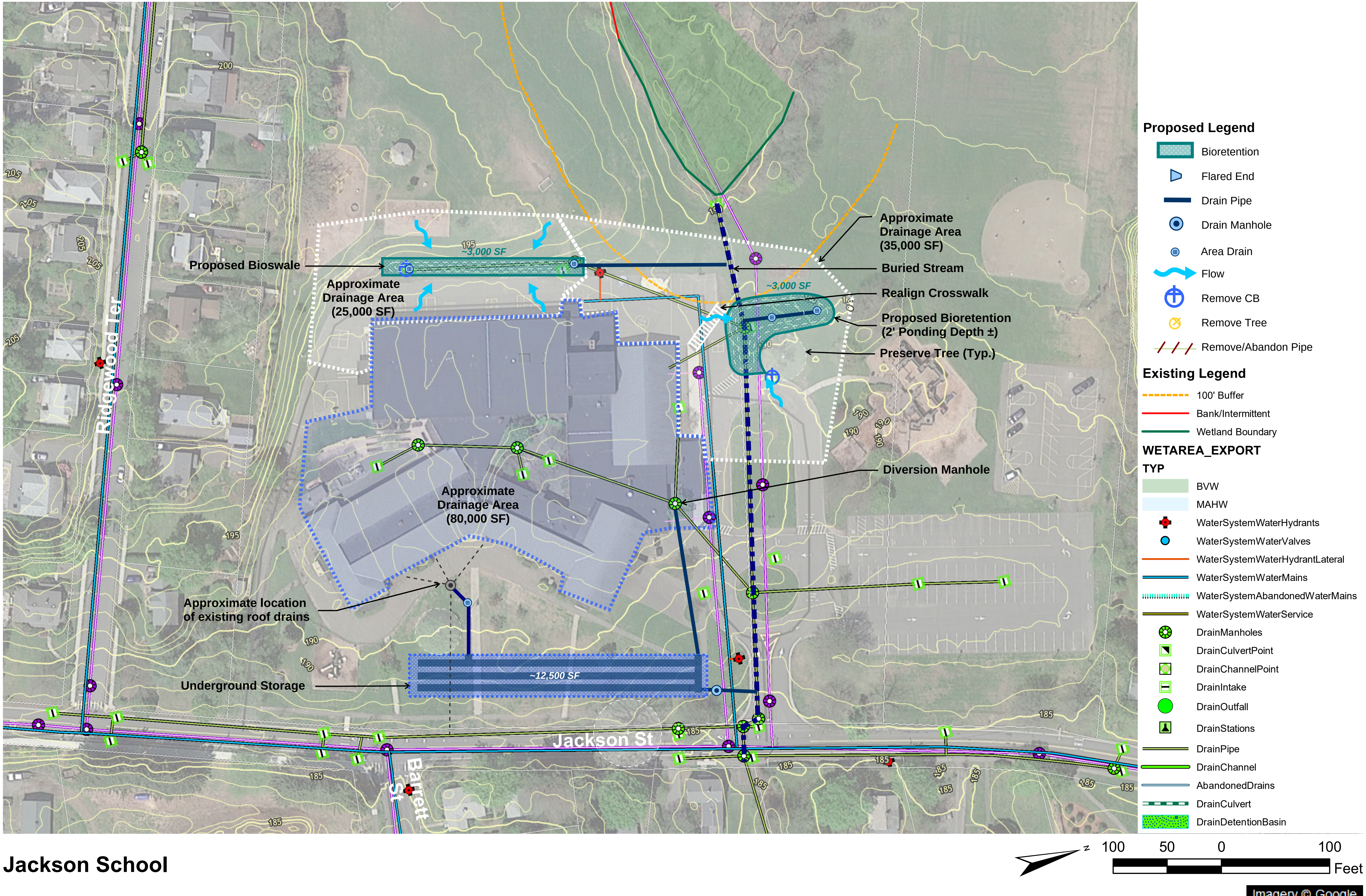
50 25 0 50

SCALE IN FEET

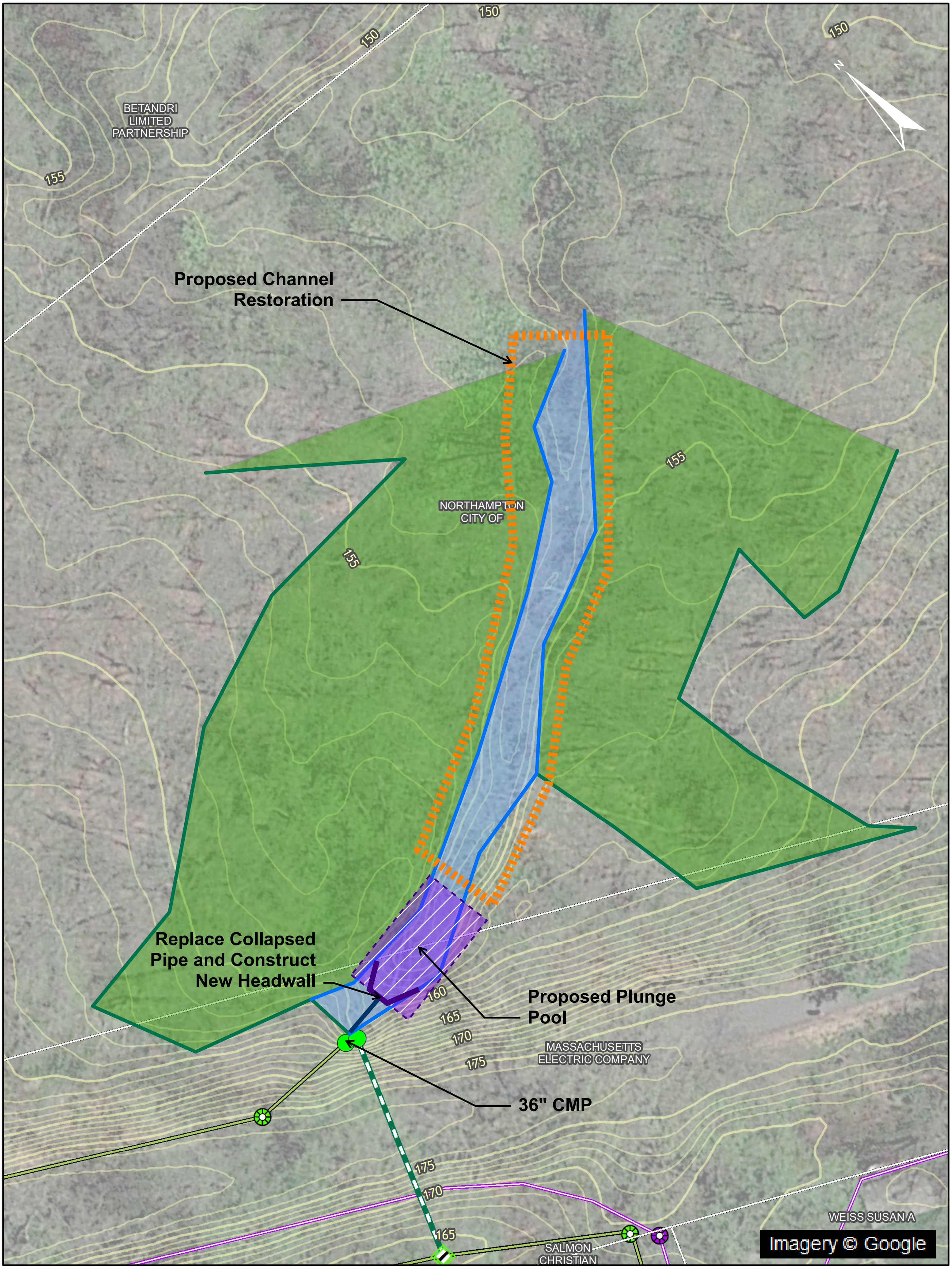


King Street Brook - Berm

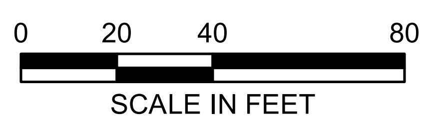


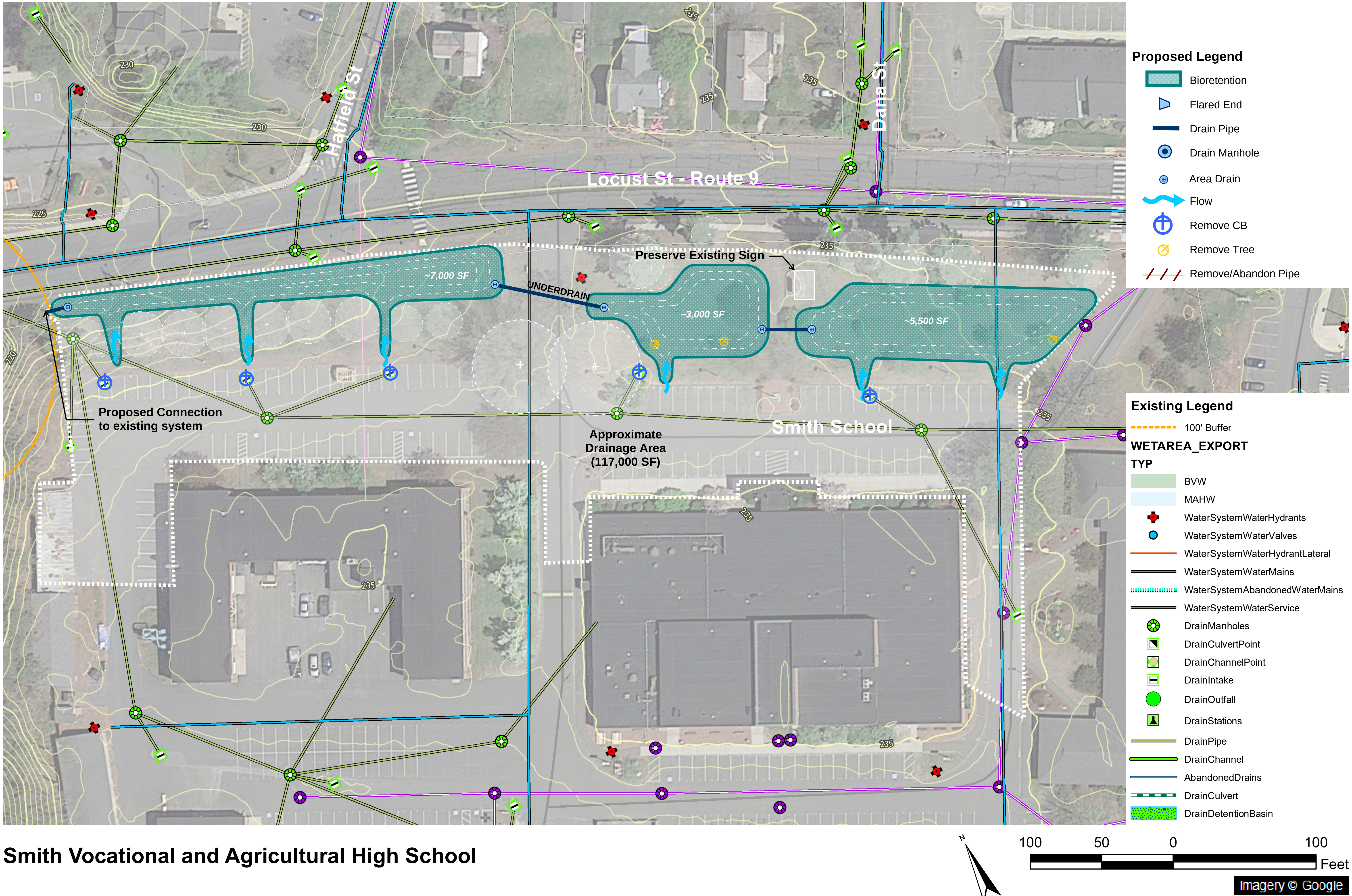


Jackson School

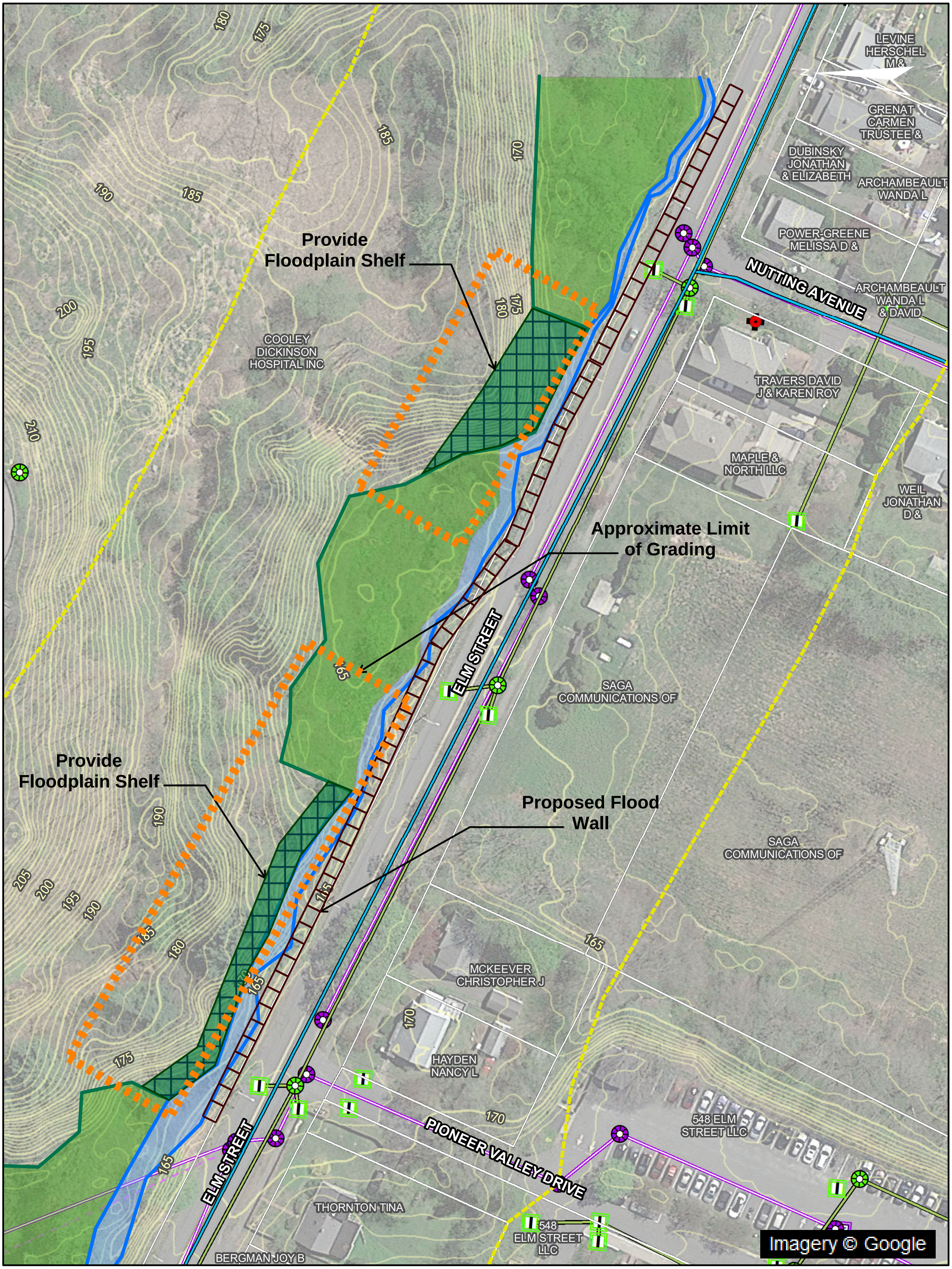


Adare Place Outlet





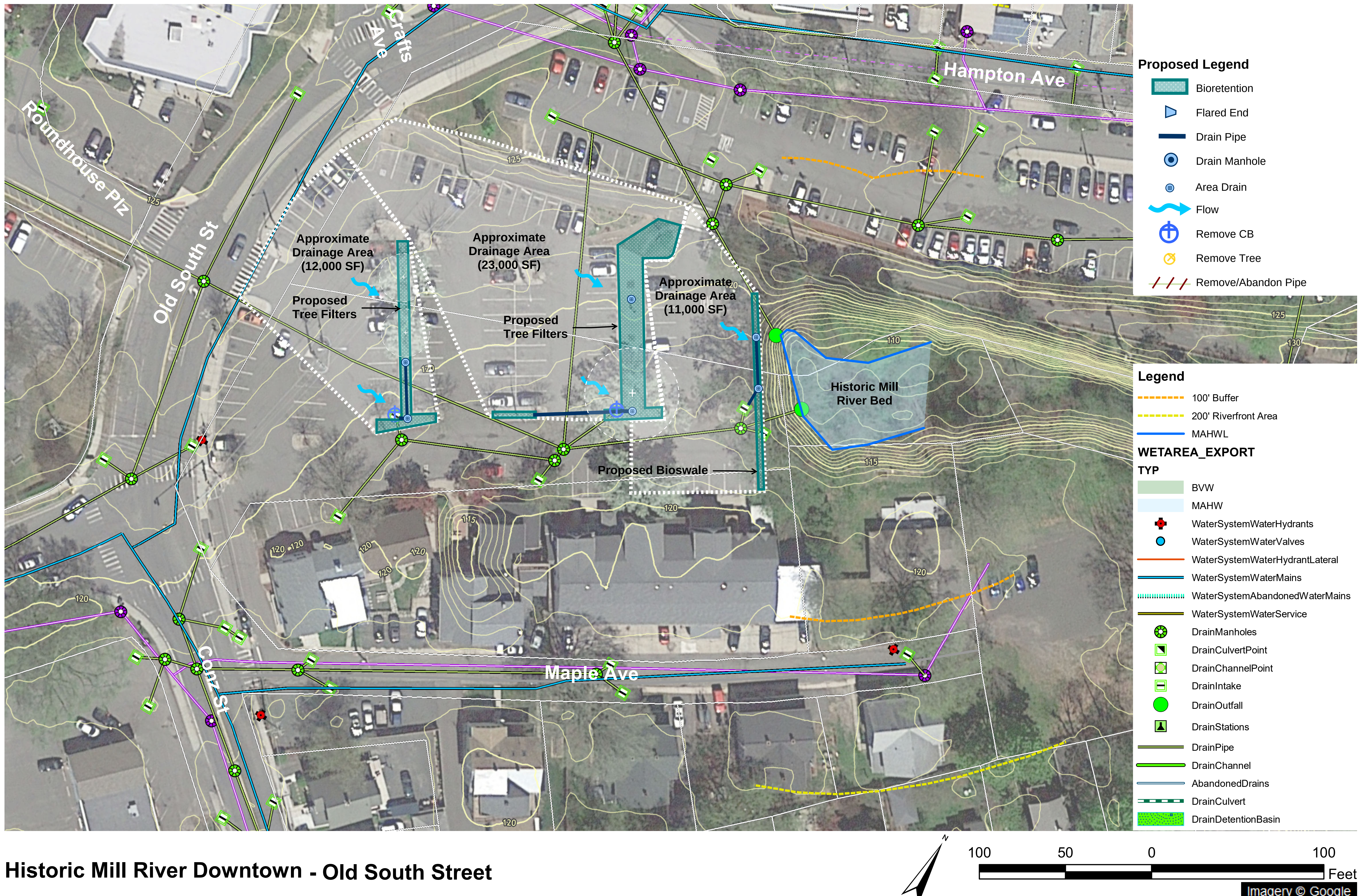
Smith Vocational and Agricultural High School



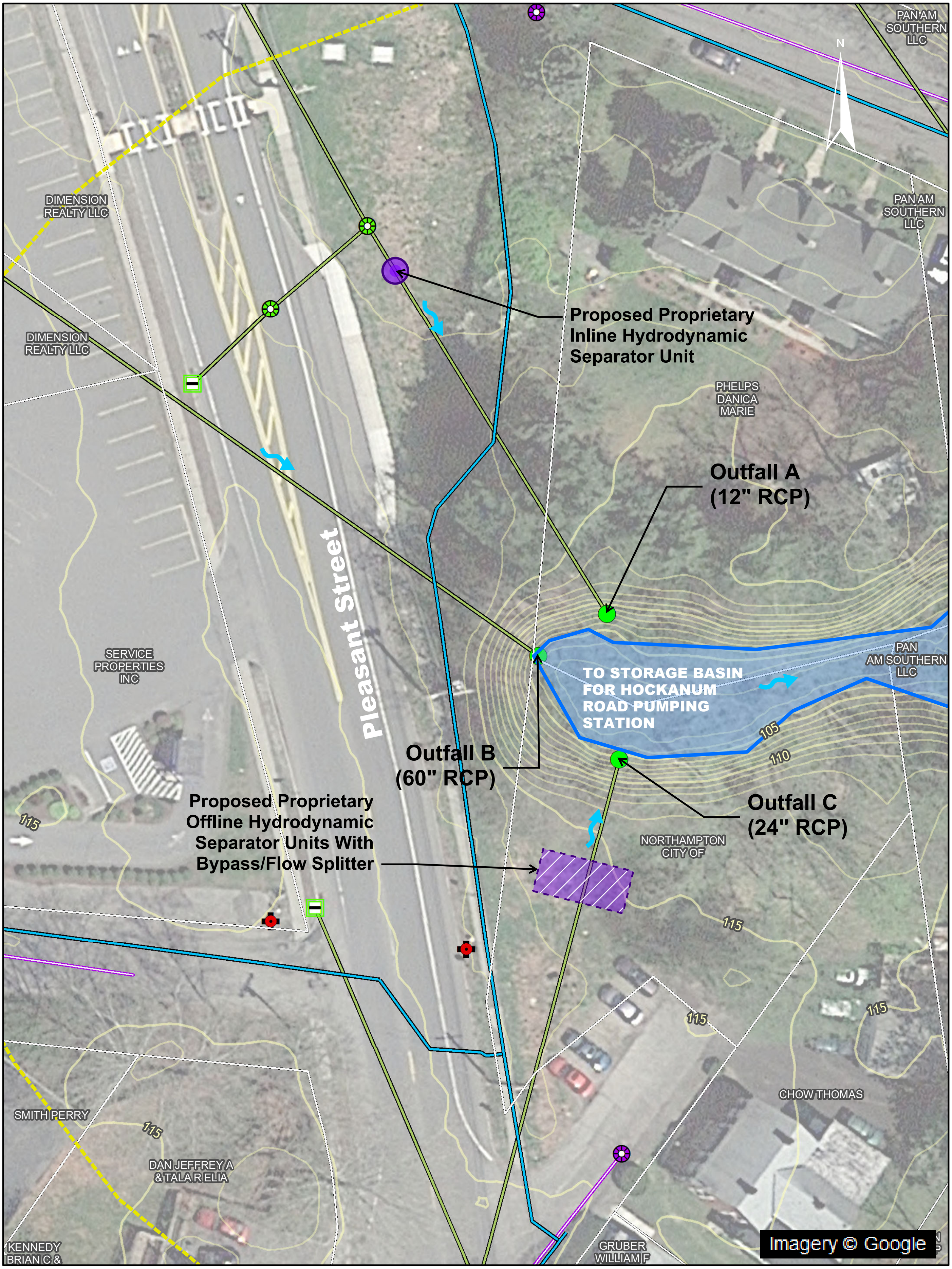
Elm Street Brook

80 40 0 80

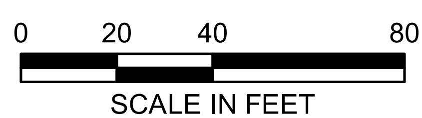
SCALE IN FEET

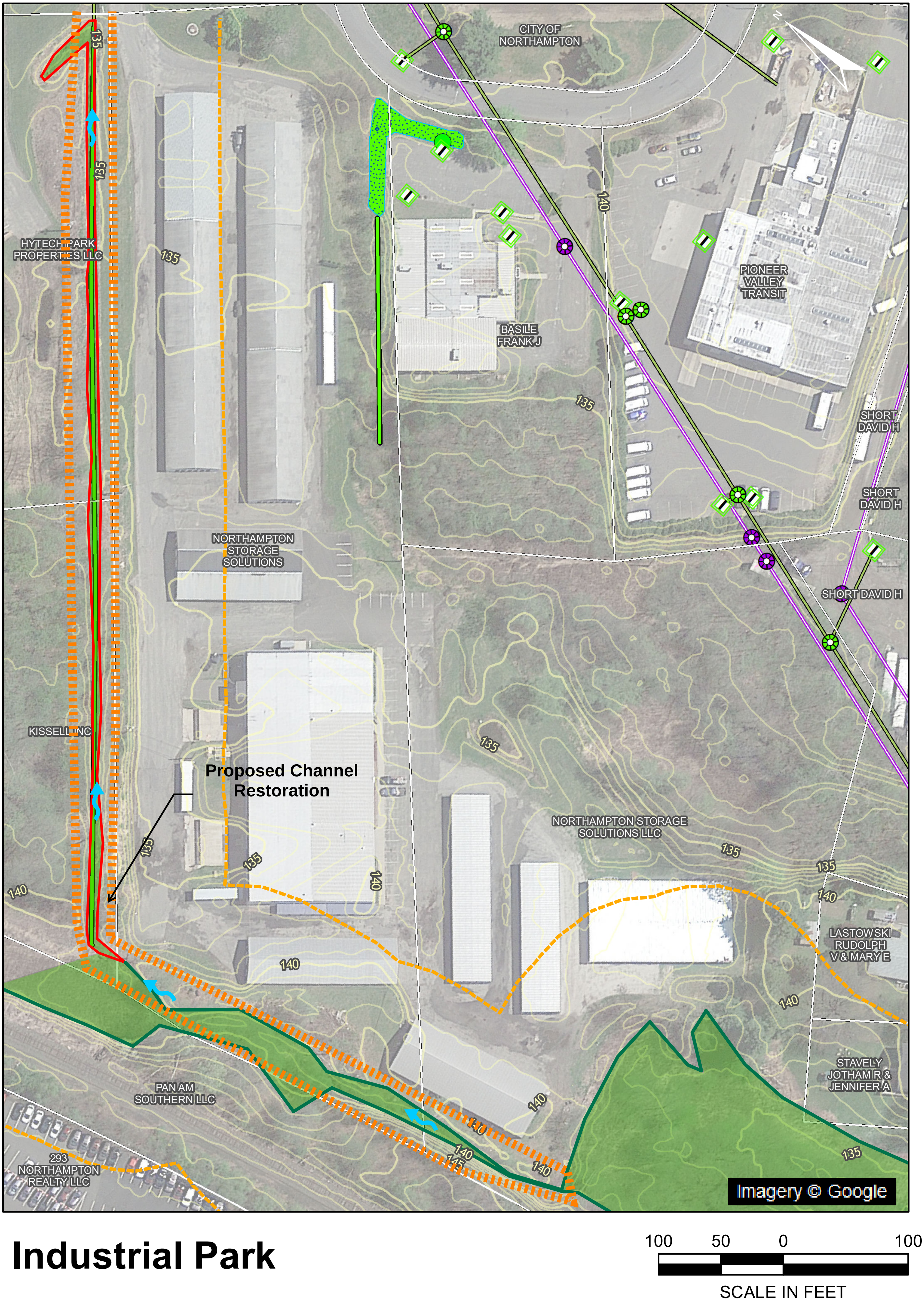


Historic Mill River Downtown - Old South Street

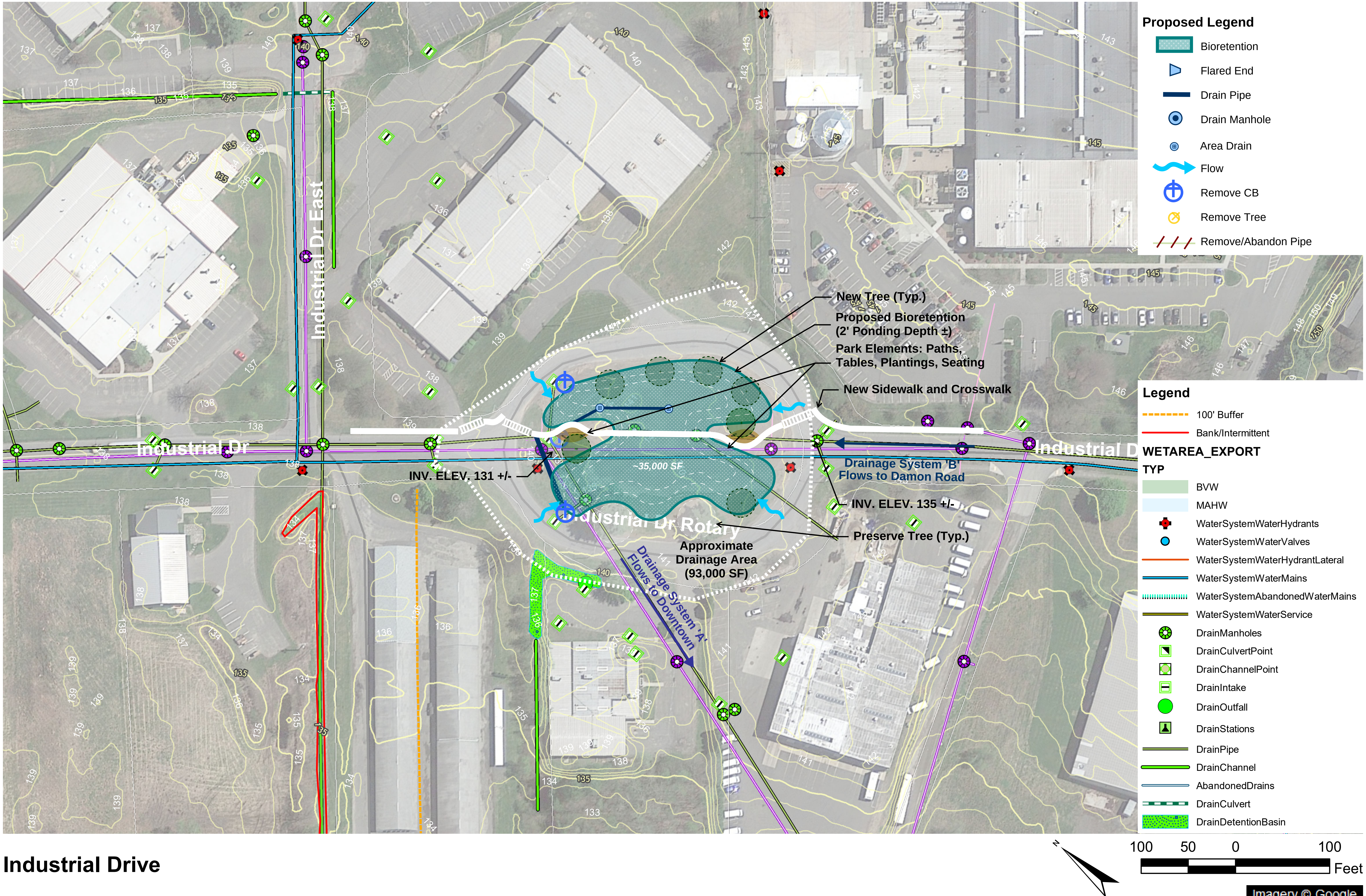


Pleasant Street Outfalls

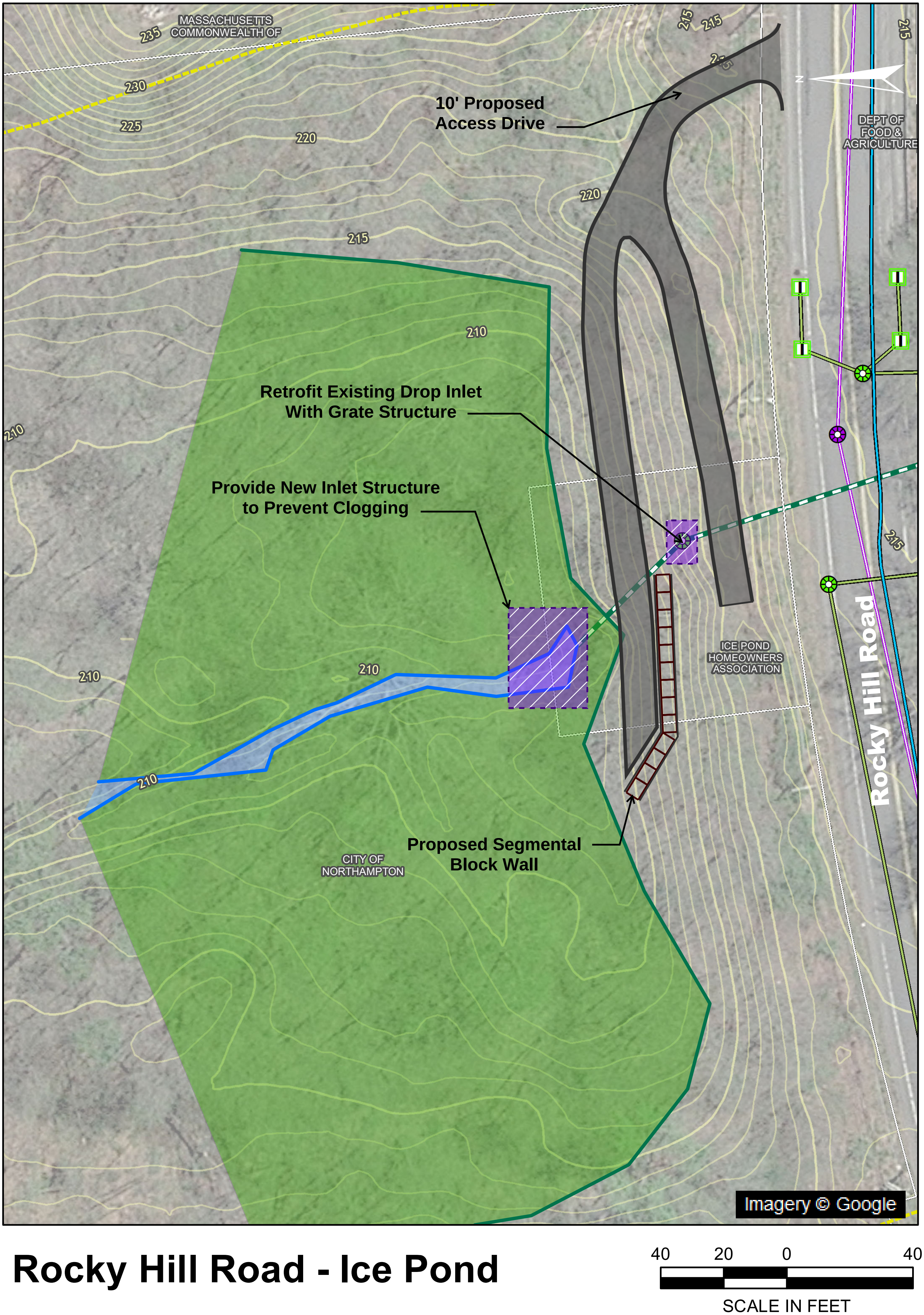




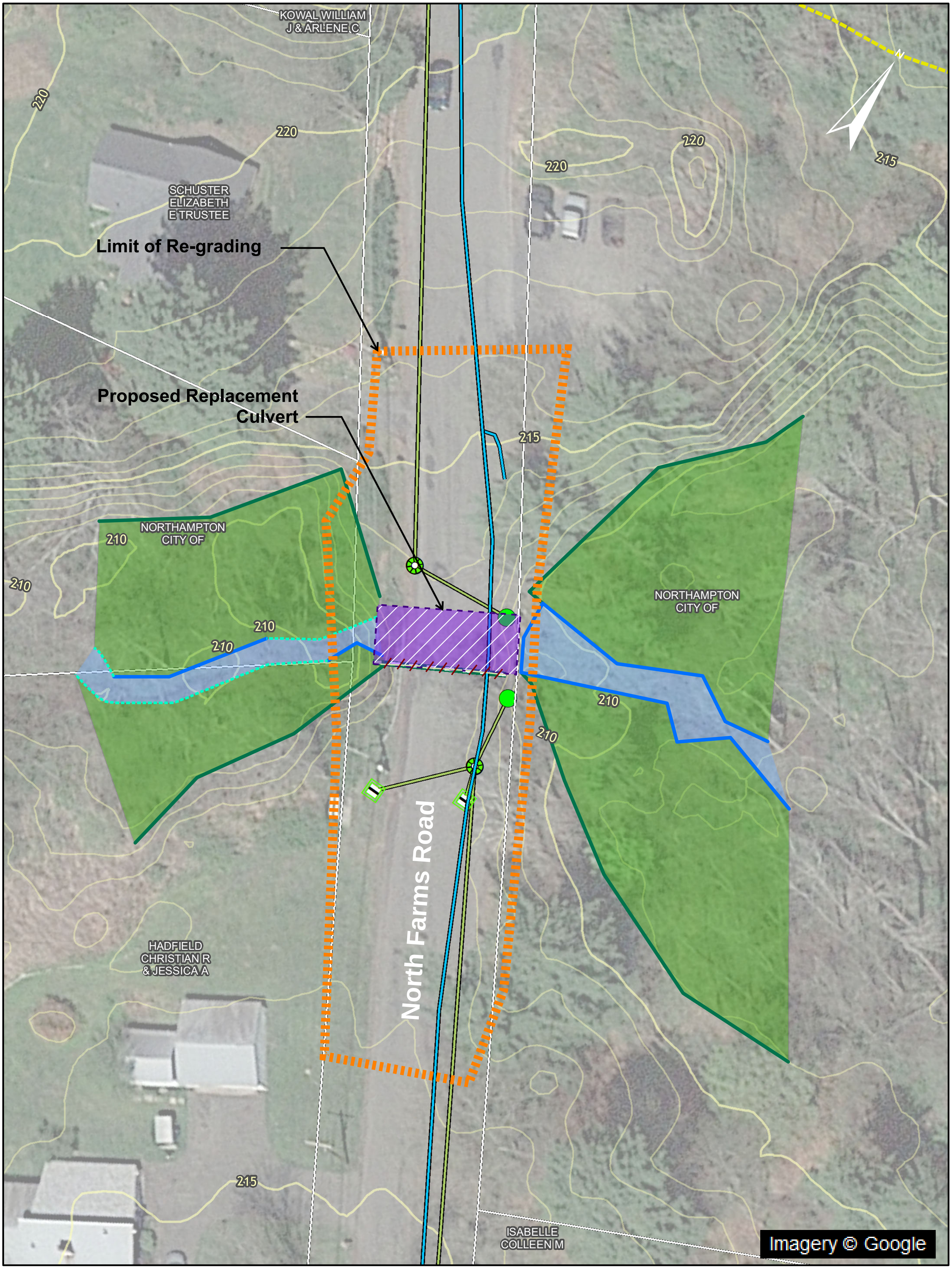
Industrial Park



Industrial Drive



Rocky Hill Road - Ice Pond



North Farms Road Culvert

0 20 40 80
SCALE IN FEET

Appendix F – Engineer's Conceptual-Level Opinions of Project Construction Cost

NORTHAMPTON DESIGNS WITH NATURE TO REDUCE STORM DAMAGE
ENGINEER'S CONCEPTUAL-LEVEL OPINIONS OF PROJECT CONSTRUCTION COST
BASED ON THE CONCEPTUAL DESIGN SUMMARY

PROJECT 1
KING STREET BROOK FLOOD CONTROL BERM

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	EXT.	TOTAL
MOBILIZATION / DEMOBILIZATION / ENG. LAYOUT (10%±)	1	LS	$13,000	$13,000	$13,000
SITE PREPARATION & SITE DEMOLITION					$30,500
CONSTRUCTION ENTRANCE / ACCESS / SECURITY	1	LS	$7,500	$7,500	
SITE PREP & DEMOLITION / LIGHT CLEARING	0.65	AC	$25,000	$16,250	
PERIMETER EROSION CONTROL	450	LF	$15	$6,750	
EARTHWORK (Associated earthwork is included in cost of site improvements & utility work below)					$53,150
STRIP, STACK, SCREEN, & RESPREAD ON-SITE TOPSOIL	370	CY	$25	$9,250	
EXCAVATION / EMBANKMENT (from mitigation area to berm embankment)	150	CY	$30	$4,500	
LOW-PERMEABILITY SOIL BORROW	50	CY	$60	$3,000	
EXCESS EXCAVATION - TRUCK OFF SITE - DISPOSAL	150	CY	$40	$6,000	
DENSE GRADED CRUSHED STONE ACCESS (INCL. STONE BASE)	2,000	SF	$5	$10,000	
ROUGH GRADE SITE	28,000	SF	$0.30	$8,400	
FINE GRADE SITE	20,000	SF	$0.60	$12,000	
SITE IMPROVEMENTS					$17,000
WETLAND MITIGATION SOIL MEDIA	120	CY	$100	$12,000	
EROSION CONTROL BLANKET	2,500	SF	$2.00	$5,000	
LANDSCAPE WORK					$23,950
WETLAND MITIGATION LANDSCAPE AND PLANTING ALLOWANCE	3,000	SF	$2.00	$6,000	
GENERAL SEEDING / TURF ESTABLISHMENT	23,000	SF	$0.65	$14,950	
GENERAL PLANTING ALLOWANCE FOR MISC. TREES AND SHRUBS	1	LS	$3,000	$3,000	
			SUB-TOTAL =	$137,600	
			CONTINGENCY (@ 25%±)	$34,400	
			GRAND TOTAL (2019 DOLLARS) =	$172,000	
			SAY,	$180,000	

GZA's Conceptual-Level Opinions of Project Construction Cost are subject to the assumptions and limitations referenced in the Conceptual Design Summary

NORTHAMPTON DESIGNS WITH NATURE TO REDUCE STORM DAMAGE
ENGINEER'S CONCEPTUAL-LEVEL OPINIONS OF PROJECT CONSTRUCTION COST
BASED ON THE CONCEPTUAL DESIGN SUMMARY

PROJECT 2
JACKSON STREET ELEMENTARY SCHOOL STORMWATER RETROFITS

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	EXT.	TOTAL
MOBILIZATION / DEMOBILIZATION / ENG. LAYOUT (10%±)	1	LS	$61,000	$61,000	$61,000
SITE PREPARATION & SITE DEMOLITION					$49,000
CONSTRUCTION ENTRANCE / ACCESS / SECURITY	1	LS	$10,000	$10,000	
SITE PREP & DEMOLITION	1	LS	$30,000	$30,000	
CATCH BASIN INLET PROTECTION	6	EA	$250	$1,500	
PERIMETER EROSION CONTROL	500	LF	$15	$7,500	
EARTHWORK (Associated earthwork is included in cost of site improvements & utility work below)					$187,450
STRIP, STACK, SCREEN, & RESPREAD ON-SITE TOPSOIL	330	CY	$25	$8,250	
EXCESS EXCAVATION - TRUCK OFF SITE - DISPOSAL	3,700	CY	$40	$148,000	
EXCAVATION / BACKFILL	200	CY	$30	$6,000	
ROUGH GRADE SITE	24,000	SF	$0.30	$7,200	
FINE GRADE SITE	30,000	SF	$0.60	$18,000	
SITE IMPROVEMENTS					$318,100
1-1/2" CRUSHED STONE	2,000	CY	$50	$100,000	
BIORETENTION SOIL MEDIA	450	CY	$100	$45,000	
3/8" CRUSHED STONE (PEASTONE)	80	CY	$50	$4,000	
SAND BORROW	60	CY	$40	$2,400	
12"-DIA. RCP DRAIN	310	LF	$70	$21,700	
ARCH PIPE (STORAGE CHAMBER)	350	CELL	$300	$105,000	
AREA DRAIN	5	EA	$1,200	$6,000	
DRAIN MANHOLE	1	EA	$7,500	$7,500	
AREA DRAIN FRAME/GRATE	3	EA	$500	$1,500	
DRAIN CONNECTION	5	EA	$5,000	$25,000	

NORTHAMPTON DESIGNS WITH NATURE TO REDUCE STORM DAMAGE
ENGINEER'S CONCEPTUAL-LEVEL OPINIONS OF PROJECT CONSTRUCTION COST
BASED ON THE CONCEPTUAL DESIGN SUMMARY

PROJECT 2
JACKSON STREET ELEMENTARY SCHOOL STORMWATER RETROFITS

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	EXT.	TOTAL
LANDSCAPE WORK					$46,300
BIORETENTION LANDSCAPE AND PLANTING ALLOWANCE	18,000	SF	$2.00	$36,000	
GENERAL SEEDING / TURF ESTABLISHMENT	12,000	SF	$0.65	$7,800	
GENERAL PLANTING ALLOWANCE FOR MISC. TREES AND SHRUBS	1	LS	$2,500	$2,500	
	SUB-TOTAL =			$661,850	
	CONTINGENCY (@ 25%±)			$166,000	
GRAND TOTAL (2019 DOLLARS) =				$827,850	
			SAY,	$830,000	

GZA's Conceptual-Level Opinions of Project Construction Cost are subject to the assumptions and limitations referenced in the Conceptual Design Summary

NORTHAMPTON DESIGNS WITH NATURE TO REDUCE STORM DAMAGE
ENGINEER'S CONCEPTUAL-LEVEL OPINIONS OF PROJECT CONSTRUCTION COST
BASED ON THE CONCEPTUAL DESIGN SUMMARY

PROJECT 3
ADARE PLACE OUTLET IMPROVEMENTS AND STREAM CHANNEL RESTORATION

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	EXT.	TOTAL
MOBILIZATION / DEMOBILIZATION / ENG. LAYOUT (10%±)	1	LS	$26,000	$26,000	$26,000
SITE PREPARATION & SITE DEMOLITION					$48,000
CONSTRUCTION ENTRANCE / ACCESS / SECURITY	1	EA	$7,500	$7,500	
CLEARING AND GRUBBING	0.35	AC	$50,000	$17,500	
CONTROL & DIVERSION OF WATER	14	DAYS	$1,000	$14,000	
PERIMETER EROSION CONTROL	600	LF	$15	$9,000	
EARTHWORK (Associated earthwork is included in cost of site improvements & utility work below)					$59,700
STRIP, STACK, SCREEN, & RESPREAD ON-SITE TOPSOIL	200	CY	$25	$5,000	
EXCESS EXCAVATION - TRUCK OFF SITE - DISPOSAL	370	CY	$40	$14,800	
EXCAVATION / BACKFILL	150	CY	$30	$4,500	
GRAVEL BORROW	200	CY	$40	$8,000	
DENSE-GRADED CRUSHED STONE	30	CY	$50	$1,500	
3/4" CRUSHED STONE	50	CY	$50	$2,500	
BORROW TOPSOIL	120	CY	$50	$6,000	
GEOTEXTILE FILTER FABRIC	5,000	SF	$0.60	$3,000	
ROUGH GRADE SITE	16,000	SF	$0.30	$4,800	
FINE GRADE SITE	16,000	SF	$0.60	$9,600	
DRAINAGE / SITE IMPROVEMENTS					$122,200
36"-DIA. RCP DRAIN	24	LF	$300	$7,200	
INCORPORATE STONE CROSS-DRAIN (from Adare Place)	1	LS	$10,000	$10,000	
4,000 PSI CEMENT CONCRETE, incl. reinf. steel	25	CY	$1,400	$35,000	
STREAMBED SAND/GRAVEL/COBBLE MIX	150	CY	$120	$18,000	
RIPRAP	190	CY	$100	$19,000	
BEDDING STONE	40	CY	$50	$2,000	

NORTHAMPTON DESIGNS WITH NATURE TO REDUCE STORM DAMAGE
ENGINEER'S CONCEPTUAL-LEVEL OPINIONS OF PROJECT CONSTRUCTION COST
BASED ON THE CONCEPTUAL DESIGN SUMMARY

PROJECT 3
ADARE PLACE OUTLET IMPROVEMENTS AND STREAM CHANNEL RESTORATION

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	EXT.	TOTAL
HANDRAIL / GUARD	40	LF	$150	$6,000	
6-FT CHAIN LINK FENCE	150	LF	$60	$9,000	
EROSION CONTROL BLANKET / STREAMBANK STABILIZATION	8,000	SF	$2.00	$16,000	
LANDSCAPE WORK					$27,400
STREAMSIDE LANDSCAPE AND PLANTING ALLOWANCE	6,000	SF	$2.00	$12,000	
GENERAL SEEDING / TURF ESTABLISHMENT	16,000	SF	$0.65	$10,400	
GENERAL PLANTING ALLOWANCE FOR MISC. TREES AND SHRUBS	1	LS	$5,000	$5,000	
			SUB-TOTAL =	$283,300	
			CONTINGENCY (@ 25%±)	$71,000	
			GRAND TOTAL (2019 DOLLARS) =	$354,300	
			SAY,	$360,000	

NORTHAMPTON DESIGNS WITH NATURE TO REDUCE STORM DAMAGE
ENGINEER'S CONCEPTUAL-LEVEL OPINIONS OF PROJECT CONSTRUCTION COST
BASED ON THE CONCEPTUAL DESIGN SUMMARY

PROJECT 4
SMITH VOCATIONAL AND AGRICULTURAL HIGH SCHOOL BIORETENTION

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	EXT.	TOTAL
MOBILIZATION / DEMOBILIZATION / ENG. LAYOUT (10%±)	1	LS	$52,000	$52,000	$52,000
SITE PREPARATION & SITE DEMOLITION					$34,000
CONSTRUCTION ENTRANCE / ACCESS / SECURITY	1	LS	$7,500	$7,500	
SITE PREP & DEMOLITION / LIGHT CLEARING	0.43	AC	$25,000	$10,750	
CATCH BASIN INLET PROTECTION	3	EA	$250	$750	
PERIMETER EROSION CONTROL	1,000	LF	$15	$15,000	
EARTHWORK (Associated earthwork is included in cost of site improvements & utility work below)					$153,570
STRIP, STACK, SCREEN, & RESPREAD ON-SITE TOPSOIL	290	CY	$25	$7,250	
EXCESS EXCAVATION - TRUCK OFF SITE - DISPOSAL	3,160	CY	$40	$126,400	
EXCAVATION / BACKFILL	100	CY	$30	$3,000	
ROUGH GRADE SITE	18,800	SF	$0.30	$5,640	
FINE GRADE SITE	18,800	SF	$0.60	$11,280	
SITE IMPROVEMENTS					$295,200
1-1/2" CRUSHED STONE	1,150	CY	$50	$57,500	
BIORETENTION SOIL MEDIA	1,720	CY	$100	$172,000	
3/8" CRUSHED STONE (PEASTONE)	190	CY	$50	$9,500	
SAND BORROW	150	CY	$40	$6,000	
12"-DIA. RCP DRAIN	500	LF	$70	$35,000	
AREA DRAIN	6	EA	$1,200	$7,200	
AREA DRAIN FRAME/GRATE	6	EA	$500	$3,000	
DRAIN CONNECTION	1	EA	$5,000	$5,000	

NORTHAMPTON DESIGNS WITH NATURE TO REDUCE STORM DAMAGE
ENGINEER'S CONCEPTUAL-LEVEL OPINIONS OF PROJECT CONSTRUCTION COST
BASED ON THE CONCEPTUAL DESIGN SUMMARY

PROJECT 4 SMITH VOCATIONAL AND AGRICULTURAL HIGH SCHOOL BIORETENTION					
DESCRIPTION	**QUANTITY**	**UNIT**	**UNIT PRICE**	**EXT.**	**TOTAL**
LANDSCAPE WORK					**$31,460**
BIORETENTION LANDSCAPE AND PLANTING ALLOWANCE	12,400	SF	$2.00	$24,800	
GENERAL SEEDING / TURF ESTABLISHMENT	6,400	SF	$0.65	$4,160	
GENERAL PLANTING ALLOWANCE FOR MISC. TREES AND SHRUBS	1	LS	$2,500	$2,500	
			SUB-TOTAL =	$566,230	
			CONTINGENCY (@ 25%±)	$142,000	
			GRAND TOTAL (2019 DOLLARS) =	$708,230	
			SAY,	**$710,000**	

NORTHAMPTON DESIGNS WITH NATURE TO REDUCE STORM DAMAGE
ENGINEER'S CONCEPTUAL-LEVEL OPINIONS OF PROJECT CONSTRUCTION COST
BASED ON THE CONCEPTUAL DESIGN SUMMARY

PROJECT 5
ELM STREET BROOK FLOOD MITIGATION

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	EXT.	TOTAL
MOBILIZATION / DEMOBILIZATION / ENG. LAYOUT (10%±)	1	LS	$200,000	$200,000	$200,000
SITE PREPARATION & SITE DEMOLITION					$689,200
CONSTRUCTION ENTRANCE / ACCESS / SECURITY	1	LS	$15,000	$15,000	
CLEARING AND GRUBBING	1.5	AC	$50,000	$75,000	
SITE PREP & DEMOLITION	1	LS	$25,000	$25,000	
BIT.CONC. PAVEMENT REMOVAL AND DISPOSAL	9,600	SF	$2	$19,200	
CONTROL & DIVERSION OF WATER	120	DAYS	$2,000	$240,000	
MAINTENANCE & CONTROL OF TRAFFIC	180	DAYS	$1,500	$270,000	
PERIMETER EROSION CONTROL	3,000	LF	$15	$45,000	
EARTHWORK (Associated earthwork is included in cost of site improvements & utility work below)					$427,400
STRIP, STACK, SCREEN, & RESPREAD ON-SITE TOPSOIL	1,000	CY	$25	$25,000	
EXCESS EXCAVATION - TRUCK OFF SITE - DISPOSAL	6,340	CY	$40	$253,600	
EXCAVATION / BACKFILL	1,300	CY	$30	$39,000	
GRAVEL BORROW	360	CY	$40	$14,400	
DENSE-GRADED CRUSHED STONE	180	CY	$50	$9,000	
3/4" CRUSHED STONE	220	CY	$50	$11,000	
BORROW TOPSOIL	140	CY	$50	$7,000	
GEOTEXTILE FILTER FABRIC	15,000	SF	$0.60	$9,000	
ROUGH GRADE SITE	66,000	SF	$0.30	$19,800	
FINE GRADE SITE	66,000	SF	$0.60	$39,600	
SITE IMPROVEMENTS					$750,000
4,000 PSI CEMENT CONC. FLOODWALL, incl. reinf. steel	460	CY	$1,400	$644,000	
EROSION CONTROL BLANKET / FLOODPLAIN STABILIZATION	53,000	SF	$2.00	$106,000	

NORTHAMPTON DESIGNS WITH NATURE TO REDUCE STORM DAMAGE
ENGINEER'S CONCEPTUAL-LEVEL OPINIONS OF PROJECT CONSTRUCTION COST
BASED ON THE CONCEPTUAL DESIGN SUMMARY

PROJECT 5
ELM STREET BROOK FLOOD MITIGATION

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	EXT.	TOTAL
BITUMINOUS CONCRETE PAVING	300	TON	$150	$45,000	
BITUMINOUS CONCRETE CURB	800	LF	$10	$8,000	
PAVEMENT STRIPING	1	LS	$2,500	$2,500	
GUARDRAIL	250	LF	$45	$11,250	
LANDSCAPE WORK					**$115,450**
STREAMSIDE / FLOODPLAIN LANDSCAPE AND PLANTING ALLOWANCE	53,000	SF	$2.00	$106,000	
GENERAL SEEDING / TURF ESTABLISHMENT	13,000	SF	$0.65	$8,450	
GENERAL PLANTING ALLOWANCE FOR MISC. TREES AND SHRUBS	1	LS	$1,000	$1,000	
			SUB-TOTAL =	$2,239,350	
			CONTINGENCY (@ 25%±)	$560,000	
			GRAND TOTAL (2019 DOLLARS) =	$2,799,350	
			SAY,	$2,800,000	

NORTHAMPTON DESIGNS WITH NATURE TO REDUCE STORM DAMAGE
ENGINEER'S CONCEPTUAL-LEVEL OPINIONS OF PROJECT CONSTRUCTION COST
BASED ON THE CONCEPTUAL DESIGN SUMMARY

PROJECT 6
HISTORIC MILL RIVER - OLD SOUTH STREET OUTFALLS

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	EXT.	TOTAL
MOBILIZATION / DEMOBILIZATION / ENG. LAYOUT (10%±)	1	LS	$19,000	$19,000	**$19,000**
SITE PREPARATION & SITE DEMOLITION					**$32,500**
CONSTRUCTION ENTRANCE / ACCESS / SECURITY	1	LS	$7,500	$7,500	
SITE PREP & DEMOLITION	1	LS	$5,000	$5,000	
MAINTENANCE & CONTROL OF TRAFFIC	1	LS	$5,000	$5,000	
CONCRETE SIDEWALK REMOVAL AND DISPOSAL	3,000	SF	$3	$9,000	
CATCH BASIN INLET PROTECTION	6	EA	$250	$1,500	
PERIMETER EROSION CONTROL	300	LF	$15	$4,500	
EARTHWORK (Associated earthwork is included in cost of site improvements & utility work below)					**$36,000**
STRIP, STACK, SCREEN, & RESPREAD ON-SITE TOPSOIL	20	CY	$25	$500	
EXCESS EXCAVATION - TRUCK OFF SITE - DISPOSAL	700	CY	$40	$28,000	
EXCAVATION / BACKFILL	100	CY	$30	$3,000	
ROUGH GRADE SITE	5,000	SF	$0.30	$1,500	
FINE GRADE SITE	5,000	SF	$0.60	$3,000	
SITE IMPROVEMENTS					**$101,800**
1-1/2" CRUSHED STONE	190	CY	$50	$9,500	
BIORETENTION SOIL MEDIA	280	CY	$100	$28,000	
3/8" CRUSHED STONE (PEASTONE)	50	CY	$50	$2,500	
SAND BORROW	40	CY	$40	$1,600	
12"-DIA. RCP DRAIN	500	LF	$70	$35,000	
AREA DRAIN	6	EA	$1,200	$7,200	
AREA DRAIN GRATE	6	EA	$500	$3,000	
DRAIN CONNECTION	3	EA	$5,000	$15,000	

NORTHAMPTON DESIGNS WITH NATURE TO REDUCE STORM DAMAGE
ENGINEER'S CONCEPTUAL-LEVEL OPINIONS OF PROJECT CONSTRUCTION COST
BASED ON THE CONCEPTUAL DESIGN SUMMARY

PROJECT 6 HISTORIC MILL RIVER - OLD SOUTH STREET OUTFALLS					
DESCRIPTION	**QUANTITY**	**UNIT**	**UNIT PRICE**	**EXT.**	**TOTAL**
LANDSCAPE WORK					**$10,650**
BIORETENTION LANDSCAPE AND PLANTING ALLOWANCE	4,000	SF	$2.00	$8,000	
GENERAL SEEDING / TURF ESTABLISHMENT	1,000	SF	$0.65	$650	
GENERAL PLANTING ALLOWANCE FOR MISC. TREES AND SHRUBS	1	LS	$2,000	$2,000	
			SUB-TOTAL =	$199,950	
			CONTINGENCY (@ 25%±)	$50,000	
			GRAND TOTAL (2019 DOLLARS) =	$249,950	
			SAY,	$250,000	

NORTHAMPTON DESIGNS WITH NATURE TO REDUCE STORM DAMAGE
ENGINEER'S CONCEPTUAL-LEVEL OPINIONS OF PROJECT CONSTRUCTION COST
BASED ON THE CONCEPTUAL DESIGN SUMMARY

PROJECT 7
HISTORIC MILL RIVER - PLEASANT STREET OUTFALLS

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	EXT.	TOTAL
MOBILIZATION / DEMOBILIZATION / ENG. LAYOUT (10%±)	1	LS	$26,000	$26,000	$26,000
SITE PREPARATION & SITE DEMOLITION					$57,250
CONSTRUCTION ENTRANCE / ACCESS / SECURITY	1	LS	$7,500	$7,500	
SITE PREP & DEMOLITION	1	LS	$10,000	$10,000	
MAINTENANCE & CONTROL OF TRAFFIC	1	LS	$15,000	$15,000	
CONTROL & DIVERSION OF WATER	14	DAYS	$1,500	$21,000	
CATCH BASIN INLET PROTECTION	3	EA	$250	$750	
PERIMETER EROSION CONTROL	200	LF	$15	$3,000	
EARTHWORK (Associated earthwork is included in cost of site improvements & utility work below)					$42,600
STRIP, STACK, SCREEN, & RESPREAD ON-SITE TOPSOIL	30	CY	$25	$750	
TEMPORARY SUPPORT OF EXCAVATIONS	1	LS	$25,000	$25,000	
EXCESS EXCAVATION - TRUCK OFF SITE - DISPOSAL	200	CY	$40	$8,000	
EXCAVATION / BACKFILL	100	CY	$30	$3,000	
3/4" CRUSHED STONE	50	CY	$50	$2,500	
BORROW TOPSOIL	10	CY	$50	$500	
GEOTEXTILE FILTER FABRIC	1,000	SF	$0.60	$600	
ROUGH GRADE SITE	1,500	SF	$0.30	$450	
FINE GRADE SITE	3,000	SF	$0.60	$1,800	
SITE IMPROVEMENTS					$149,000
PROPRIETARY HYDRODYNAMIC SEPARATOR UNIT	1	EA	$21,000	$21,000	
PROPRIETARY HYDRODYNAMIC SEPARATOR UNITS WITH BYPASS	1	EA	$128,000	$128,000	

NORTHAMPTON DESIGNS WITH NATURE TO REDUCE STORM DAMAGE
ENGINEER'S CONCEPTUAL-LEVEL OPINIONS OF PROJECT CONSTRUCTION COST
BASED ON THE CONCEPTUAL DESIGN SUMMARY

PROJECT 7
HISTORIC MILL RIVER - PLEASANT STREET OUTFALLS

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	EXT.	TOTAL
LANDSCAPE WORK					$3,450
GENERAL SEEDING / TURF ESTABLISHMENT	3,000	SF	$0.65	$1,950	
GENERAL PLANTING ALLOWANCE FOR MISC. TREES AND SHRUBS	1	LS	$1,500	$1,500	
	SUB-TOTAL =			$278,300	
	CONTINGENCY (@ 25%±)			$70,000	
GRAND TOTAL (2019 DOLLARS) =				$348,300	
			SAY,	$350,000	

NORTHAMPTON DESIGNS WITH NATURE TO REDUCE STORM DAMAGE
ENGINEER'S CONCEPTUAL-LEVEL OPINIONS OF PROJECT CONSTRUCTION COST
BASED ON THE CONCEPTUAL DESIGN SUMMARY

PROJECT 8
INDUSTRIAL DRIVE ROTARY STORMWATER RETROFIT

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	EXT.	TOTAL
MOBILIZATION / DEMOBILIZATION / ENG. LAYOUT (10%±)	1	LS	$64,000	$64,000	$64,000
SITE PREPARATION & SITE DEMOLITION					$32,000
CONSTRUCTION ENTRANCE / ACCESS / SECURITY	1	LS	$7,500	$7,500	
SITE PREP & DEMOLITION	1	LS	$15,000	$15,000	
CATCH BASIN INLET PROTECTION	2	EA	$250	$500	
PERIMETER EROSION CONTROL	600	LF	$15	$9,000	
EARTHWORK (Associated earthwork is included in cost of site improvements & utility work below)					$243,250
STRIP, STACK, SCREEN, & RESPREAD ON-SITE TOPSOIL	450	CY	$25	$11,250	
EXCESS EXCAVATION - TRUCK OFF SITE - DISPOSAL	4,900	CY	$40	$196,000	
EXCAVATION / BACKFILL	150	CY	$30	$4,500	
ROUGH GRADE SITE	35,000	SF	$0.30	$10,500	
FINE GRADE SITE	35,000	SF	$0.60	$21,000	
SITE IMPROVEMENTS					$305,200
1-1/2" CRUSHED STONE	1,800	CY	$50	$90,000	
BIORETENTION SOIL MEDIA	1,800	CY	$100	$180,000	
3/8" CRUSHED STONE (PEASTONE)	290	CY	$50	$14,500	
SAND BORROW	220	CY	$40	$8,800	
12"-DIA. RCP DRAIN	50	LF	$70	$3,500	
AREA DRAIN	2	EA	$1,200	$2,400	
AREA DRAIN FRAME/GRATE	2	EA	$500	$1,000	
DRAIN CONNECTION	1	EA	$5,000	$5,000	

NORTHAMPTON DESIGNS WITH NATURE TO REDUCE STORM DAMAGE
ENGINEER'S CONCEPTUAL-LEVEL OPINIONS OF PROJECT CONSTRUCTION COST
BASED ON THE CONCEPTUAL DESIGN SUMMARY

PROJECT 8
INDUSTRIAL DRIVE ROTARY STORMWATER RETROFIT

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	EXT.	TOTAL
LANDSCAPE WORK					**$56,650**
BIORETENTION LANDSCAPE AND PLANTING ALLOWANCE	24,000	SF	$2.00	$48,000	
GENERAL SEEDING / TURF ESTABLISHMENT	11,000	SF	$0.65	$7,150	
GENERAL PLANTING ALLOWANCE FOR MISC. TREES AND SHRUBS	1	LS	$1,500	$1,500	
			SUB-TOTAL =	$701,100	
			CONTINGENCY (@ 25%±)	$176,000	
			GRAND TOTAL (2019 DOLLARS) =	$877,100	
			SAY,	$880,000	

GZA's Conceptual-Level Opinions of Project Construction Cost are subject to the assumptions and limitations referenced in the Conceptual Design Summary

NORTHAMPTON DESIGNS WITH NATURE TO REDUCE STORM DAMAGE
ENGINEER'S CONCEPTUAL-LEVEL OPINIONS OF PROJECT CONSTRUCTION COST
BASED ON THE CONCEPTUAL DESIGN SUMMARY

PROJECT 9
INDUSTRIAL DRIVE CHANNEL IMPROVEMENTS

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	EXT.	TOTAL
MOBILIZATION / DEMOBILIZATION / ENG. LAYOUT (10%±)	1	LS	$6,000	$6,000	$6,000
SITE PREPARATION & SITE DEMOLITION					$15,000
CONSTRUCTION ENTRANCE / ACCESS / SECURITY	1	EA	$4,000	$4,000	
CONTROL & DIVERSION OF WATER	7	DAYS	$500	$3,500	
PERIMETER EROSION CONTROL	500	LF	$15	$7,500	
EARTHWORK (Associated earthwork is included in cost of site improvements & utility work below)					$33,000
CHANNEL EXCAVATION - TRUCK OFF SITE - SEDIMENT DISPOSAL	300	CY	$100	$30,000	
ROUGH GRADE DISTURBED AREAS OF SITE	10,000	SF	$0.30	$3,000	
LANDSCAPE WORK					$9,000
GENERAL SEEDING / TURF ESTABLISHMENT	10,000	SF	$0.65	$6,500	
GENERAL PLANTING ALLOWANCE FOR MISC. TREES AND SHRUBS	1	LS	$2,500	$2,500	
			SUB-TOTAL =	$63,000	
			CONTINGENCY (@ 25%±)	$16,000	
			GRAND TOTAL (2019 DOLLARS) =	$79,000	
			SAY,	$80,000	

NORTHAMPTON DESIGNS WITH NATURE TO REDUCE STORM DAMAGE
ENGINEER'S CONCEPTUAL-LEVEL OPINIONS OF PROJECT CONSTRUCTION COST
BASED ON THE CONCEPTUAL DESIGN SUMMARY

PROJECT 10
ICE POND OUTLET IMPROVEMENTS

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	EXT.	TOTAL
MOBILIZATION / DEMOBILIZATION / ENG. LAYOUT (10%±)	1	LS	$21,000	$21,000	$21,000
SITE PREPARATION & SITE DEMOLITION					$47,200
CONSTRUCTION ENTRANCE / ACCESS / SECURITY	1	LS	$7,500	$7,500	
CLEARING AND GRUBBING	0.28	AC	$40,000	$11,200	
CONTROL & DIVERSION OF WATER	14	DAYS	$1,500	$21,000	
PERIMETER EROSION CONTROL	500	LF	$15	$7,500	
EARTHWORK (Associated earthwork is included in cost of site improvements & utility work below)					$35,800
STRIP, STACK, SCREEN, & RESPREAD ON-SITE TOPSOIL	300	CY	$25	$7,500	
EXCESS EXCAVATION - TRUCK OFF SITE - DISPOSAL	100	CY	$40	$4,000	
GRAVEL BORROW	200	CY	$40	$8,000	
3/4" CRUSHED STONE	50	CY	$50	$2,500	
GEOTEXTILE FILTER FABRIC	5,000	SF	$0.60	$3,000	
ROUGH GRADE SITE	12,000	SF	$0.30	$3,600	
FINE GRADE SITE	12,000	SF	$0.60	$7,200	
SITE IMPROVEMENTS					$113,300
LARGE-BLOCK WALL ($/SF-WALL FACE)	300	SF	$50	$15,000	
DENSE GRADED CRUSHED STONE ACCESS (INCL. STONE BASE)	5,500	SF	$5	$27,500	
4,000 PSI CEMENT CONCRETE, incl. reinf. steel	15	CY	$1,400	$21,000	
GALVANIZED STEEL TRASH RACKS	3,600	LB	$8	$28,800	
RIPRAP	20	CY	$100	$2,000	
BEDDING STONE	5	CY	$50	$250	
HANDRAIL / GUARD	25	LF	$150	$3,750	
6-FT CHAIN LINK FENCE	150	LF	$60	$9,000	
EROSION CONTROL BLANKET	3,000	SF	$2.00	$6,000	

NORTHAMPTON DESIGNS WITH NATURE TO REDUCE STORM DAMAGE
ENGINEER'S CONCEPTUAL-LEVEL OPINIONS OF PROJECT CONSTRUCTION COST
BASED ON THE CONCEPTUAL DESIGN SUMMARY

PROJECT 10
ICE POND OUTLET IMPROVEMENTS

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	EXT.	TOTAL
LANDSCAPE WORK					**$4,050**
STREAMSIDE LANDSCAPE AND PLANTING ALLOWANCE	300	SF	$2.00	$600	
GENERAL SEEDING / TURF ESTABLISHMENT	3,000	SF	$0.65	$1,950	
GENERAL PLANTING ALLOWANCE FOR MISC. TREES AND SHRUBS	1	LS	$1,500	$1,500	
			SUB-TOTAL =	$221,350	
			CONTINGENCY (@ 25%±)	$56,000	
			GRAND TOTAL (2019 DOLLARS) =	$277,350	
			SAY,	$280,000	

GZA's Conceptual-Level Opinions of Project Construction Cost are subject to the assumptions and limitations referenced in the Conceptual Design Summary

NORTHAMPTON DESIGNS WITH NATURE TO REDUCE STORM DAMAGE
ENGINEER'S CONCEPTUAL-LEVEL OPINIONS OF PROJECT CONSTRUCTION COST
BASED ON THE CONCEPTUAL DESIGN SUMMARY

PROJECT 11
NORTH FARMS ROAD / BROAD BROOK CULVERT UPGRADE

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	EXT.	TOTAL
MOBILIZATION / DEMOBILIZATION / ENG. LAYOUT (10%±)	1	LS	$36,000	$36,000	$36,000
SITE PREPARATION & SITE DEMOLITION					$120,000
CONSTRUCTION ENTRANCE / ACCESS / SECURITY	1	LS	$10,000	$10,000	
SITE PREP & DEMOLITION	1	LS	$25,000	$25,000	
BIT.CONC. PAVEMENT REMOVAL AND DISPOSAL	3,500	SF	$2	$7,000	
CONTROL & DIVERSION OF WATER	30	DAYS	$1,500	$45,000	
MAINTENANCE & CONTROL OF TRAFFIC	1	LS	$25,000	$25,000	
PERIMETER EROSION CONTROL	500	LF	$15	$7,500	
CATCH BASIN INLET PROTECTION	2	EA	$250	$500	
EARTHWORK (Associated earthwork is included in cost of site improvements & utility work below)					$38,230
STRIP, STACK, SCREEN, & RESPREAD ON-SITE TOPSOIL	50	CY	$25	$1,250	
EXCESS EXCAVATION - TRUCK OFF SITE - DISPOSAL	100	CY	$40	$4,000	
EXCAVATION / BACKFILL	500	CY	$30	$15,000	
GRAVEL BORROW	130	CY	$40	$5,200	
DENSE-GRADED CRUSHED STONE	70	CY	$50	$3,500	
3/4" CRUSHED STONE	50	CY	$50	$2,500	
GEOTEXTILE FILTER FABRIC	1,300	SF	$0.60	$780	
ROUGH GRADE SITE	8,000	SF	$0.25	$2,000	
FINE GRADE SITE	8,000	SF	$0.50	$4,000	

NORTHAMPTON DESIGNS WITH NATURE TO REDUCE STORM DAMAGE
ENGINEER'S CONCEPTUAL-LEVEL OPINIONS OF PROJECT CONSTRUCTION COST
BASED ON THE CONCEPTUAL DESIGN SUMMARY

PROJECT 11
NORTH FARMS ROAD / BROAD BROOK CULVERT UPGRADE

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	EXT.	TOTAL
SITE IMPROVEMENTS / UTILITIES					$193,600
10' W X 6.5' HT PRECAST BOX CULVERT incl. ends/wingwalls	45	LF	$2,000	$90,000	
STREAMBED SAND/GRAVEL/COBBLE MIX	40	CY	$120	$4,800	
CATCH BASIN	2	EA	$5,000	$10,000	
RCP DRAIN	270	LF	$100	$27,000	
DRAIN MANHOLE	2	EA	$7,500	$15,000	
WATER MAIN MODIFICATIONS	125	LF	$120	$15,000	
EROSION CONTROL BLANKET	150	SF	$2.00	$300	
BITUMINOUS CONCRETE PAVING	110	TON	$150	$16,500	
PAVEMENT STRIPING	1	LS	$1,500	$1,500	
GUARDRAIL	300	LF	$45	$13,500	
LANDSCAPE WORK					$2,950
STREAMSIDE LANDSCAPE AND PLANTING ALLOWANCE	500	SF	$2.00	$1,000	
GENERAL SEEDING / TURF ESTABLISHMENT	3,000	SF	$0.65	$1,950	
			SUB-TOTAL =	$390,780	
			CONTINGENCY (@ 25%±)	$98,000	
			GRAND TOTAL (2019 DOLLARS) =	$488,780	
			SAY,	$490,000	

GZA's Conceptual-Level Opinions of Project Construction Cost are subject to the assumptions and limitations referenced in the Conceptual Design Summary

GZA GeoEnvironmental, Inc.