KINGSTON CAMPUS DRAINAGE MASTER PLAN

University of Rhode Island, Kingston Campus
South Kingstown, Rhode Island

PREPARED FOR:

THE
UNIVERSITY
OF RHODE ISLAND

Office of Capital Projects

PREPARED BY:

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February 2018

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Civil and Environmental Engineers

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Cover Photo: Plains Road infiltration basin, northwest of intersection with Flagg Road and Tootell Road

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1.0 Introduction and Overview

The University of Rhode Island (URI) Office of Capital Projects has retained the services of Gordon R. Archibald, Inc. (GRA) to develop an updated *Drainage Master Plan* for the University's Kingston Campus in South Kingstown, Rhode Island. Situated in a predominantly rural area, the 600+-acre main URI campus is comprised of a number of developed uses (including academic, administrative, student housing, and plant operations facilities; university-owned rights-of-way and parking lots; athletic and recreational facilities) along with expansive agricultural fields and undeveloped woodlands along its northerly and westerly periphery. The location of the campus within the surrounding natural and built environment is shown in Figure 1 below.

With the exception of lands in the southwest quadrant of the campus along Plains Road, virtually all campus facilities are located within the watershed of White Horn Brook, a first-order tributary of the Chipuxet River. This watercourse originates just north of Flagg Road and flows in a general southerly direction, passing through Ellery Pond and several culverts along the campus reach above State Route 138 (Kingstown Road). Over the past several decades, the development of university facilities has gradually increased the extents of impervious surfaces (e.g., building roofs and pavements) throughout the watershed – particularly within the hillside portion of the campus east of the brook, where impervious cover now exceeds 50 percent – resulting in increased stormwater runoff (volumes and peak flows) and reduced recharge of rainfall to the ground by infiltration (due to the decrease in pervious surfaces).

In general, the build-out of the campus facilities occurred in an intermittent and fragmentary manner, with appurtenant drainage collection and conveyance system elements (predominantly closed catch basin and pipe systems) either tied-in to previously constructed systems or constructed to outfall directly to natural or manmade watercourses. Typical of facilities developed prior to the implementation of environmental protection regulations (including the federal *Clean Water Act* and National Pollutant Discharge Elimination System[1]) and the advent of stormwater management standards and best practices, new systems and connections were built to convey runoff from the new construction as efficiently as possible (so as to minimize the potential for flooding of the site), often with little or no consideration given to the capacity of the existing drainage infrastructure or the potential for downstream flooding, erosion/sedimentation, and water quality impacts. While a number of remedial measures have been implemented over the past decade to improve conditions, cumulative effects of this development have been (a) increased frequency and severity of flooding along White Horn Brook and other locations throughout the campus, and (b) degradation of the natural functions and values this watercourse and its wetlands. These impacts have been incurred in large part to through the direct discharge of untreated runoff from legacy drainage systems to receiving waters.

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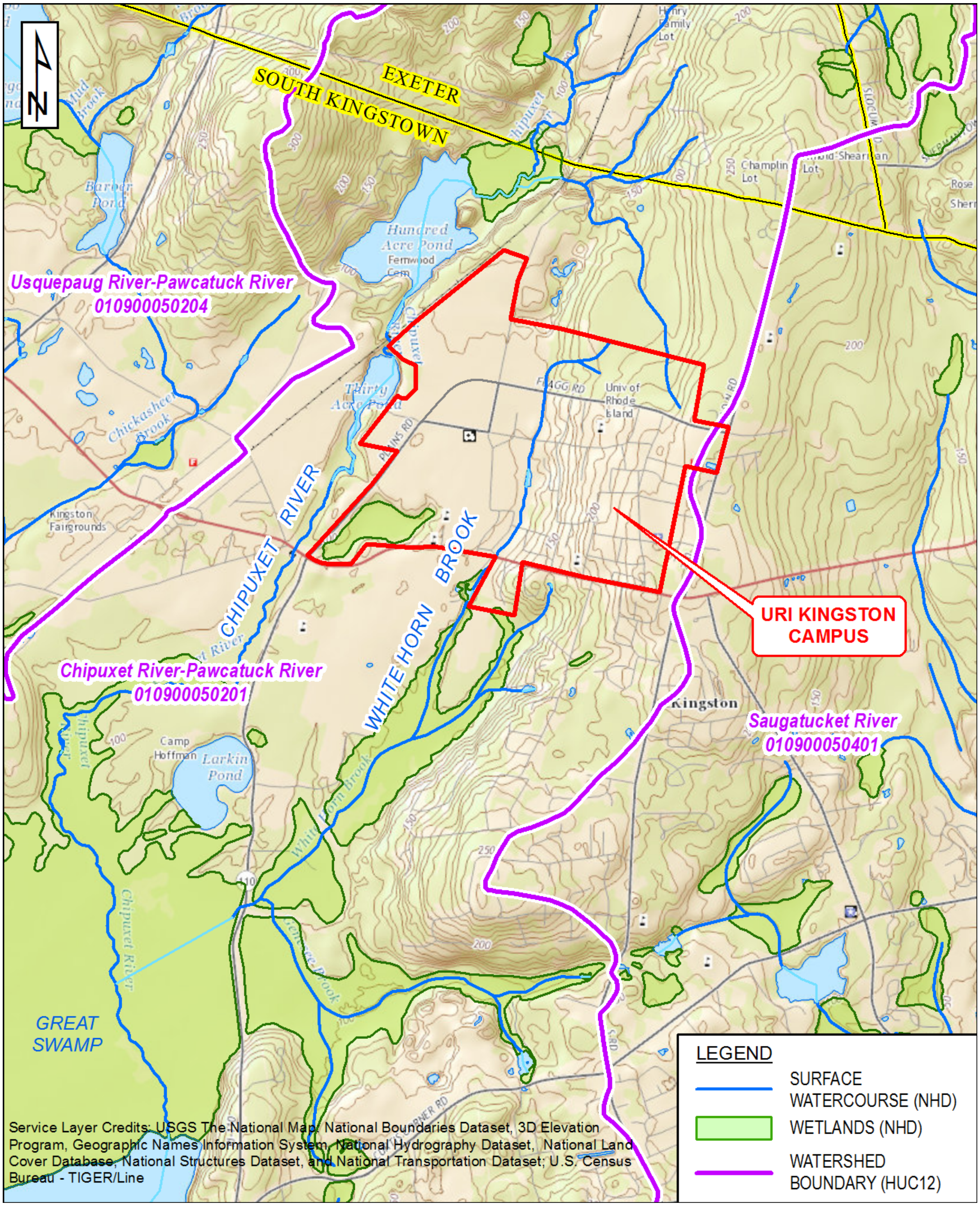
[1] https://www.epa.gov/npdes/npdes-stormwater-program



Service Layer Credits: USGS The National Map: National Boundaries Dataset, 3D Elevation Program, Geographic Names Information System, National Hydrography Dataset, National Land Cover Database, National Structures Dataset, and National Transportation Dataset; U.S. Census Bureau - TIGER/Line

Figure 1 – Kingston Campus Area Map

Approx. Scale 1" = 3,000' • Data Sources: RIGIS, U.S. Geological Survey National Hydrography Dataset

2.0 Study Context

A Drainage Master Plan for the Kingston Campus was first prepared in 2006 by Joe Casali Engineering, Inc. as a tool to guide campus planning efforts and ensure consistency with regulatory requirements (see Section 2.1 below). In the time since its publication, there have been a number of developments in environmental regulations pertaining to stormwater management (including issuance of the updated *Rhode Island Stormwater Design and Installation Standards Manual* in 2010), and several new/renovated facilities have been constructed within the Kingston Campus. For brevity and consistency, portions of the 2006 document have been integrated into this report where appropriate.

This updated *Kingston Campus Drainage Master Plan* document is intended to assist University officials in planning, policy, and management decisions as they relate to stormwater management and natural resources protection / restoration within the Kingston Campus. It has been developed to inform the University's ongoing efforts to update its *Kingston Campus Master Plan* [2] (and to reflect any plan elements with stormwater management considerations) as well as for consistency with the University's requirements as a stormwater facilities owner/operator under the Rhode Island Pollutant Discharge Elimination System (RIPDES) Program administered by the Rhode Island Department of Environmental Management (RIDEM).

2.1 Regulatory Framework

The University of Rhode Island is a small municipal separate storm sewer systems (Small MS4) operator regulated by the RIDEM Office of Water Resources (RIDEM/OWR) under the RIPDES Phase II Storm Water Program.[3] To comply with the conditions of its authorization under the RIPDES General Permit [4] for the discharge of stormwater from Kingston Campus drainage systems, the University has developed a Storm Water Management Program Plan (SWMPP) for the operation of its facilities that addresses the following six minimum control measures to mitigate the impacts of stormwater runoff on receiving waters:

1. Public Education and Outreach
2. Public Involvement/Participation
3. Illicit Discharge Detection and Elimination
4. Construction Site Runoff Control
5. Post-Construction Runoff Control
6. Pollution Prevention / Good Housekeeping

Operators of small MS4s are required to submit annual reports to the RIPDES Program documenting compliance and progress in these six areas, as well as amend the SWPPP as needed to address any Total Maximum Daily Load (TMDL) restrictions placed on receiving waters. URI's SWMPP was prepared by Beta Engineering, Inc. in 2004 and remains the effective instrument (along with required annual reports) for documenting the planning and implementation of its stormwater program towards meeting measurable goals. For reference, a copy of the most recent (Year 12 / 2015) annual report is provided herewith as Appendix A.

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[2] http://web.uri.edu/cpd/cmp/

[3] http://www.dem.ri.gov/programs/water/permits/ripdes/stormwater/ms4s-program.php

[4] http://www.dem.ri.gov/pubs/regs/regs/water/ms4final.pdf

In 2010 the Rhode Island Coastal Resources Management Council (CRMC) and RIDEM promulgated a major update to the *Rhode Island Stormwater Design and Installation Standards Manual* (Stormwater Manual)[5] superseding the previous (1993) version of the manual. Since amended in 2015 with minor revisions, the current Stormwater Manual establishes more stringent minimum standards for the planning, design, construction, and maintenance of stormwater facilities for new development and redevelopment projects, placing particular emphasis on low-impact development (LID) strategies and best management practices (BMPs) for water quality protection. Applicants seeking project authorization from the RIDEM/OWR under applicable regulatory programs (e.g., Groundwater Discharge, Freshwater Wetlands) must demonstrate compliance with the Stormwater Manual through the preparation and submission of a Stormwater Management Plan (SWMP) as part of the permit application.

The current Stormwater Manual requires that stormwater management systems for development projects (including the design, construction, and operation/maintenance thereof) meet all applicable minimum standards and performance criteria set forth in Chapter 3 of the manual. The eleven Minimum Stormwater Management Standards pertain to:

1. Low Impact Development (LID) Planning and Design Strategies
2. Groundwater Recharge
3. Water Quality
4. Conveyance and Natural Channel Protection
5. Overbank Flood Protection
6. Redevelopment and Infill Projects (alternative requirements)
7. Pollution Prevention
8. Land Uses with Higher Potential Pollutant Loads (LUHPPLs)
9. Illicit Discharges
10. Construction Erosion and Sedimentation Control
11. Stormwater Management System Operation and Maintenance

The Stormwater Manual also sets forth standards, policies, and design guidance for implementation of specific LID strategies (Chapter 4), the use of structural BMPs to meet water quality criteria (Chapter 5) and for quantity control (Chapter 7), and pretreatment practices (Chapter 6) for maintaining BMP effectiveness. An excerpt of the Stormwater Manual describing the above standards and requirements for compliance is provided in Appendix B of this report.

As previously noted, most all Kingston Campus facilities are within the watershed of White Horn Brook. Through its water quality monitoring and assessment efforts, the RIDEM identified the downstream segment of the brook (below Route 138 / Kingstown Road) as being impaired due to levels of bacteria exceeding water quality standards. In 2011 the RIDEM/OWR issued the *Statewide Bacteria TMDL*[6] to address impairments to several watercourses throughout the state (including White Horn Brook), establishing (a) the pollutant load reductions necessary to meet water quality standards and support designated uses and (b) requirements for MS4 permittees

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[5] http://www.dem.ri.gov/programs/water/permits/ripdes/stormwater/stormwater-manual.php
[6] http://www.dem.ri.gov/programs/water/quality/restoration-studies/ri-bacteria-tmdl.php

having facilities within TMDL watersheds. Through assessment of White Horn Brook and its watershed, a bacteria load reduction requirement of 52% was effected for the impaired segment. This watercourse is discussed further under Section 3.1 below, and a copy of its *Statewide Bacteria TMDL* waterbody summary is provided for reference in Appendix C.

2.2 **Past Campus Development** (adapted in part from 2006 *Drainage Master Plan*)

The University has grown a great deal since its beginnings as an agricultural research station in the mid-1800s. While the Kingston Campus has had various periods of major expansions and improvements, it was not until the recent decades that a more holistic approach to stormwater management (maintaining pre-development peak discharges, providing stormwater quality treatment, etc.) was considered in the planning and design of new facilities. As build-out of the campus continued through the latter half of the 20th century, the increased occurrence of localized flooding and drainage problem areas brought more attention to existing drainage systems and the deficiencies thereof.

An excerpt of the 1942 U.S. Geological Survey (USGS) topographic quadrangle showing the campus and its facilities at the time is provided in Figure 2 below. At this time the main tributary to White Horn Brook (originating near Kingston Hill) was largely intact in its natural state, and the main stem of White Horn Brook was spanned by only two roadway culverts, i.e., Route 138 and the Thirty Acre Road loop (now West Alumni Avenue). In the decades that followed, nearly the entire length of the tributary was culverted to accommodate further development, and several additional roadway and pedestrian culverts were constructed provide access across the campus reach of the brook.

Figure 2 – Excerpt of 1942 Kingston Quadrangle (USGS / Army Corps of Engineers)
Not to scale • Source: USGS

Table 1 summarizes the major campus facilities and buildings that were developed over the years. Drainage infrastructure improvements throughout the campus, until recently, have consisted of predominately a closed system of catch basins, manholes, and pipes with direct discharges White Horn Brook.

For more recent construction projects in the 1990s and 2000s, stormwater management measures such as detention facilities and underground infiltration systems were incorporated in site designs to attenuate the increased runoff associated with the development (i.e., increased impervious surface cover). At the time, RIDEM stormwater policies required only the net increase in runoff to be attenuated. By this criterion, projects involving redevelopment of existing facilities or previously developed areas (buildings, parking lots, etc.) were typically designed and constructed with only limited improvements to stormwater management.

TABLE 1
Historical Development of the Kingston Campus

Decade / Time Period	Approximate No. of Development Projects	Facilities Constructed
1880-1889	1	Taft Laboratory
1890-1899	5	South, College, and Lippitt Halls
1900-1909	1	East Hall
1910-1919	2	Ranger Hall, Beta Phi
1920-1929	9	Washburn, Bliss, Edwards, Rodman and Roosevelt Halls
1930-1939	2	Green Hall and Meade Field
1940-1949	0	-
1950-1959	13	Butterfield, Bressler, Peck and Adams Halls, Memorial Union, Keaney Gym
1960-1969	32	Independence, Tucker, Merrow, Browning, Gilbreth, Crawford, Tyler, Weldin, Barlow, Heathman & Burnside Halls, University Library, Memorial Union Addition, Roger Williams Center, Fine Arts (Phase I)
1970-1979	14	Fayerweather, Gorham, and White halls, Chafee, Tootell, Fine Arts (Phase II)
1980-1989	11	Library Addition, Mackal Field House, Engineering Building, Kirk Addition, Memorial Addition
1990-1999	4	Dining Services, Distribution Center, IEP House
2000-2005	16	Coastal Institute, Ryan Center, Boss Arena, Ballentine Renovations, Browning, Adams, Weldin, and Barlow Hall Renovations, West Alumni Ave. Parking, Plains Road Parking, Hope Reconstruction

2.3 Recently Completed and Planned Future Development Projects

Through consultation with the URI Office of Capital Projects and other Business Services departments, an inventory of major campus development projects completed since 2005 has been compiled and is presented in Table 2 below. Provided with each project entry is a map reference identifier (see Attachment 4) along with summary of the stormwater controls provided for the development.

TABLE 2
Major Kingston Campus Projects Completed Since 2005

Ref #	Year Completed	Project Name	Description	Stormwater Improvements
E1	2005	URI Alumni Center	New 21,000 square foot Alumni Center located on the former site of the Sigma Chi fraternity house	Remediation of oil contamination from leaking underground storage tank
E2	2005	Rodman Hall Renovation	Building renovation located south of Chafee Hall and north of Carothers Library	Riprap swale (with underdrain) installed on east side of hall to collect surface drainage and roof runoff, with underdrain pipe flowing to catch basin on north side of Library.
E3	2006	Independence Hall Renovation	Building renovation including major structural improvements, technology upgrades, a new enclosed lounge, and landscaping	Landscape improvements
E4	2007	Hope Commons Student Dining Facility	Construction of a new two-story, 47,000 square foot dining facility (including a 600-seat main dining hall) and demolition of the old Hope Dining Hall	Sedimentation chamber
E5	2007	Eddy, Wiley, and Garrahy Residence Halls	Construction of two new apartment style residence halls and one suite-style complex, providing a combined 800 new beds of on-campus housing.	Each new dormitory provided with infiltration systems for roof runoff.
E6	2009	Center for Biotechnology and Life Sciences	Construction of one 140,000 square foot facility housing laboratories, one 100-seat classroom, and a two-story, 300-seat auditorium	Rain gardens, vegetated swales, and green roof
E7	2011	Ranger-Green Campus Landscaping and Beautification	Landscape and infrastructure project including new walkways, new drainage systems, landscaping and tree and shrub trimming, and lawn restoration	Grass swale west of Swan Hall

Ref #	Year Completed	Project Name	Description	Stormwater Improvements
E8	2011	White Horn Brook Culvert Replacements	Removal and replacement of four deteriorated and substandard culverts	Improved flow capacity, reduced frequency and severity of flooding
E9	2012	College of Pharmacy Building	Construction of one 144,000 square foot facility housing laboratories, 160-seat auditorium, and 18 research labs	Drainage swales parallel to Flagg Road, medicinal garden (see E13 below)
E10	2012	Hillside Residence Hall	Residence Hall for 430 pharmacy, nursing, and international students. Including roof solar panel water heaters, bioretention and filtering controls integrated with landscaping	Green roof, bioretention areas, swales, water quality structure, permeable pavers, underground storage
E11	2013	Sherman Building Parking Lot and Drainage Restoration	Restoration of 85,000-square-foot parking facility	Sediment storage/pre-treatment and subsurface infiltration systems
E12	2013	Athletic Courts	Construction of two basketball courts and a sand volleyball court	Infiltration trenches
E13	2013	College of Pharmacy Courtyard and Heber W. Youngken Jr. Medicinal Plant Garden	Garden with 200 medicinal plants, 500 ornamental plants, 9 birch trees, sodded areas, and walkways	Rain gardens and vegetative swales
E14	2013	White Hall Parking Lot Improvements	Restoration of 23,000 square foot parking facility	Vegetated swale
E15	2013	Greenhouse Road Parking Lot	Restoration and expansion of a new parking lot (1.2 acres)	Bioretention facilities
E16	2014	The Ryan Family Student-Athlete Center and the Eleanor Carlson Strength & Conditioning Center	Conversion of Tootell East Gymnasium space to a 8,000-square-foot strength and conditioning center	None
E17	2014	Flagg Road Extension and Parking Lot	Roadway bypass/extension from Flagg Road to Plains Road (2,000 feet) and the construction of a pervious parking lot for 400 vehicles	Detention ponds (4), infiltration basins (1), pervious pavement system, grass swales
E18	2014	White Horn Brook Stream Channel Improvements	Removal of debris, sediments, and invasive vegetation from stream, pilot channel restoration, management and disposal of noncompliant sediments	Wetland and habitat restoration
E19	2015	Gender and Sexuality Center	Demolition of existing building and construction of a new 4,300 square foot building facility	Landscape improvements, impervious cover reduction

Ref #	Year Completed	Project Name	Description	Stormwater Improvements
E20	2015	Butterfield Dining Hall Renovated and Expansion	Construction of a new 7,500-square-foot building addition and renovation to existing facility	Vegetated swales
E21	2016	Richard E. Beaupre Center for Chemical and Forensic Sciences	Construction of a new 135,000 square foot building facility	Rain gardens and vegetative swales
E22	2016	Tootell Road Roadway Improvements	Roadway resurfacing/restoration (1,000 feet) and retrofit drainage facilities for recharge	Subsurface infiltration system
E23	2016	Washburn Hall Improvements	Replacement of clogged roof collection system in parking lot	Manholes with cleanout sumps added to system
E24	2016	Electrical Substation 1 & 2	Upgrade of electrical power and transformer facilities	Vegetated swale

In addition to the above, a number of capital improvement projects are currently under construction, with several more scheduled be constructed within the Kingston Campus in the near future. Table 3 below summarizes the projects commenced in 2017 or scheduled for construction shortly thereafter, along with a description of each and measures to be provided for stormwater management (see Attachment 4 for locations of proposed facilities). URI has received permit approval from the RIDEM/OWR Freshwater Wetlands and RIPDES programs for the restoration of the Fine Arts Parking Lot, and will soon be submitting permit applications (where applicable) for other projects with scheduled start dates in 2018.

TABLE 3
Major Kingston Campus Projects Currently In Development

Ref #	Scheduled Start	Project Name	Description	Stormwater Improvements
P1	TBD	Fine Arts Parking Lot	Project involves the restoration of the existing, deteriorated 8.5-acre parking lot.	Vegetated swales, bio-retention, extended detention, sediment storage/pretreatment
P2	TBD	Butterfield Road and Hope Commons Drainage Improvements	Portions of the existing closed drainage trunkline system will be “daylighted” to provide an open stream channel to improve flow conveyance and reduce localized flooding. The work also includes pipe replacement, increased flood storage, and stream channel stabilization.	Removal of existing culverted sections of tributary stream & replacement with stabilized, vegetated stream channel; reduced flooding at Butterfield Road culvert and connected closed drainage branches

Ref #	Scheduled Start	Project Name	Description	Stormwater Improvements
P3	2017	College of Engineering - New Engineering Building	The new building (currently under construction) will provide 182,000 gross square feet of program space. Work to date has included the demolition of five existing buildings to facilitate the new site pad.	Subsurface infiltration, bioretention, overland flow, extended detention; attenuation of up-system/ offsite stormwater flows
P4	2018	White Horn Brook Apartments	The planned building will contain with 4-bedroom apartment-style units (500 beds total) for upperclassmen housing.	Subsurface infiltration, vegetated swales, flood mitigation, bioretention
P5	2018	Visitor Center and Campus Gateway	The planned building will replace the existing visitor center and upgrade the parking facilities.	Bioretention, grass swales
P6	TBD	Fine Arts Center Renovations	Restoration of the building and reduction in the building footprint	To be determined in final design
P7	TBD	Fuel Depot Relocation	Relocation of existing fuel depot to Tootell Road	To be determined in final design
P8	TBD	Salt Storage Building Relocation	Relocation of existing covered salt storage facility (location TBD)	To be determined in final design
P9	TBD	Upper College Road Mixed Development	Initial plans call for the development of a new 100-guestroom hotel and a separate mixed use (lower retail / upper apartments) along the east side of Upper College Road between Fortin Road and Bills Road.	To be determined in final design
P10	2018	Fraternity Circle Improvements	Reconstruction of Fraternity Circle loop, including streetscape, parking, pedestrian/bicycle circulation, and drainage improvements	Improved drainage definition, erosion protection, retrofit bioretention cells/swales in shoulders, LID measures
P11	2018	Lower College Road	Reconstruction of Lower College Road with extensive streetscape improvements, including new sidewalks, curbing, crosswalks, lighting, landscaping, and gateway signage	New collection system, diversion of collected runoff to existing infiltration basin at southwest corner of Lower College Road and Campus Avenue
P12	2018	Green Hall Parking Lot	Resurfacing of existing lot along north side of Campus Avenue	Vegetated swales, bioretention
P13	2018	50 Campus Avenue Parking Lot	Demolition of existing Tau Epsilon Phi house (completed), construction of new parking lot along south side of Campus Avenue	Vegetated swales, bioretention

Ref #	Scheduled Start	Project Name	Description	Stormwater Improvements
P14	TBD	Upper College Road Reconstruction	Complete streets redesign of main campus gateway, including bicycle lanes; new sidewalks, raised crosswalks, and intersection improvements; new lighting, landscaping, and gateway signage – design to commence in 2018	To be determined in final design; complete streets approach to integrate stormwater management with landscaping and incorporate LID principles
P15	TBD	Flagg Road Reconstruction	Reconstruction of the roadway including implementation of a “road diet” (reduced travel lane widths and elimination of on-street parking), incorporation of dedicated bicycle and pedestrian facilities, landscaping, and improved stormwater management	To be determined in final design; offline treatment cells (e.g., bioretention, infiltration) designed to reduce pollutant loads and peak flows discharging to White Horn Brook headwaters
P16	TBD	URI Bicycle Path Spur	New, dedicated bicycle path running through lower campus along White Horn Brook corridor, continuing south across Route 138 (and west of Peckham Farm) to connect with the existing South County / William C. O’Neill Bike Path	Grassed shoulder swales and qualifying pervious areas (QPAs) and other LID measures

In addition to the above, the University’s *Draft Transportation and Parking Master Plan* (currently in development) envisions certain “gateway” and circulation improvements, including the conversion of several key intersections (West Alumni Avenue at Plains Road, Upper College Road at Plains Road and Flagg Road, etc.) within the Kingston Campus to modern roundabouts. Should these be implemented, these improvements would offer additional opportunities for pavement reduction, landscaping, and stormwater treatment.

2.4 Previous Studies and Plans

In developing this updated *Kingston Campus Drainage Master Plan*, GRA conducted reviews of the University’s *Kingston Campus Master Plan* (2000, see discussion below), MS4 SWMPP (2004), and the 2006 *Drainage Master Plan* itself. In addition to these core references, GRA has drawn upon extensive recent experience in preparing a number of studies, designs, analyses, and permit applications for various initiatives within the Kingston Campus. The following documents (along with the hydrologic and hydraulic analyses contained therein) were reviewed in the development of the plan update:

- *RIDEM Freshwater Wetlands Application Supporting Documentation* for the replacement of multiple culverted footpaths spanning White Horn Brook (2010);
- *Flagg Road Drainage Study* supporting the design and permitting of the Flagg Road/Plains Road extension and related development in the northwesterly quadrant of the campus (2010);

- *Service District Master Plan, Conceptual Stormwater Management and Utility Relocation Plan* (2012)
- *Supporting Documentation / Stormwater Management Plan* for the redevelopment of the Fine Arts Parking Lot (2014);
- *Supporting Documentation* and analysis for the proposed replacement of the Butterfield Road / Hope Commons Culvert (2016, in development);
- *Upper White Horn Brook Flood Study* for the planning of the White Horn Brook Apartments (2016, in development)

As the most recent version of the *Campus Master Plan* dates back to 2000 and is largely outdated, the University's Campus Planning & Design department has commenced efforts to develop an updated master plan for the Kingston Campus. Development of the updated *Campus Master Plan* and finalization of this *Drainage Master Plan* will be advanced in a manner that ensures consistency between these documents. A summary of those 2000 *Campus Master Plan* elements pertaining to stormwater and environmental resource management (originally presented in the 2006 *Drainage Master Plan*) is provided below.

University of Rhode Island Kingston Campus Master Plan, April 2000 (adapted from 2006 Drainage Master Plan)

The University implemented the Master Plan in 2000 as a guide for future planning and development of campus. The Master Plan provides goals and policies for all future renovations and new construction.

The plan details the following four main goals, which are to:

1. Cultivate a sense of community;
2. Recognize the value of its varied resources;
3. Demonstrate a match between programs and facilities; and
4. Create a "green" campus.

The plan encourages the preservation of natural ecosystems to increase the awareness of their importance. The Master Plan divides the campus into the following eight districts: Quadrangle, Mall, North Campus, Marketplace, Hillside, Service, Athletics, and a Wetland District, with the lattermost intended to serve preservation and educational purposes.

> *"The wetlands district is a narrow sliver of land running all the way along the base of the hill from north of Flagg Road to south of Route 138. The regional watershed system also includes a small creek (Whitehorn Creek)*[7] *that runs east to west through the campus, from the top of the hill near the Fine Arts Center, under the Engineering buildings and the Library, through the Roger Williams residential area, into the main stream. The wetlands serve many functions: they are scenic areas, particularly for the residence halls; a living laboratory for students of botany, biology and environmental*

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[7] This largely culverted watercourse is referred to as the "White Horn Brook Tributary" or "Main Campus Tributary" in this document – see Section 4.1.

> *science; and a reminder of the fundamental ecological forces shaping URI's environment. The Master Plan recommends a more active role for these wetlands areas in highlighting environmental education initiatives. Where feasible, manageable, and appropriate, some aspects of this local watershed system should be removed from culverts and restored to natural stream-like condition. One area of campus where this treatment may be appropriate is in the North Campus district, by the horticulture garden and greenhouses. This sector of campus is increasingly the focus for environmental programs at URI."*

Consistent with the goals of the *Kingston Campus Master Plan* and the University's stormwater management program (SWMPP), this updated *Drainage Master Plan* seeks to identify deficiencies in existing campus drainage system (along with practicable corrective actions) as well as opportunities to improve the environmental quality of the Wetland District, including the functions and values provided by White Horn Brook and its riparian corridors.

3.0 Natural Resources

Together with West Kingston (including the Amtrak Kingston Station) and the largely residential village of Kingston to the south, the Kingston Campus is an area of relatively concentrated development in an otherwise rural region of South Kingstown and Southern Rhode Island. Much of the land surrounding this area remains undeveloped (with several properties designated by the Town of South Kingstown as protected open space), with farmland/agricultural and lower-density residential uses interspersed throughout the landscape.

Most all of the developed campus lies within the watershed of White Horn Brook (RIDEM Waterbody ID RI0008039R-27A), a first-order stream that originates north of Flagg Road and flows southerly through the campus, passing thorough several culverts and Ellery Pond and continuing under Route 138, where it is ultimately received by the Great Swamp / Chipuxet River approximately 1.8 river miles downstream. Draining a watershed of approximately 480 acres, the headwater reach of the brook above Route 138 is designated as Class A surface waters (as defined under the State's current surface *Water Quality Regulations)* by the RIDEM Office of Water Resources – see Section 3.1 below.

Two perennial watercourses – the Chipuxet River and White Horn Brook – flow south through the area (see Figure 1) and continue to the Great Swamp, a vast state management area spanning over 3,000 acres southeast of the campus. Along its southerly periphery, the Great Swamp is hydrologically connected to Worden Pond, a 1,000-acre waterbody that outflows to the Pawcatuck River. The Pawcatuck River Basin drains most of southerly Rhode Island and portions of Connecticut, ultimately discharging to the tidal waters of Little Narragansett Bay (an inlet of Long Island / Block Island Sound) just south of Westerly, Rhode Island.

3.1 Surface Waters and Watersheds

The RIDEM/OWR implements the state's Water Quality Standards Program,[8] the purpose of which is to restore, preserve, and enhance the quality of Rhode Island waters so as to maintain

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[8] See http://www.dem.ri.gov/programs/water/quality/surface-water/

existing uses and protect public health/welfare and the environment. As a fundamental element of the state's *Water Quality Regulations* (2010), water quality standards have been established for all surface waters of the state, which set water quality goals for waterbodies and watercourses based on their designated uses (e.g., water supply, fish and wildlife habitat, recreation, etc.) and the criteria necessary to protect and support identified uses. In addition to establishing water quality goals for state waters, surface water quality standards also serve as the regulatory basis for the establishment of controls and strategies to address impairments (i.e., levels of bacteria, nutrients, metals or other pollutants) that prevent waters from achieving designated uses.

The RIDEM/OWR continually assesses current water quality conditions within state waters through the recurrent preparation of the *Integrated Water Quality Monitoring and Assessment Report* (Integrated Report). This document contains both the state's Section 305(b) water quality assessment report and Section 303(d) List of Impaired Waters, developed in accordance with the respective requirements of the federal Clean Water Act. Table 4 summarizes the current water quality standards and assessment data based on the most recent (2014) Integrated Report data available from the RIDEM, and the features listed are depicted on Figure 3 below.

TABLE 4
RIDEM Surface Water Quality Assessment

Waterbody	Waterbody ID #	Water Quality Standard	Assessment Category	TMDL
White Horn Brook (Above Route 138)	RI0008039R-27A	A	3	No
White Horn Brook & Tributaries (Below Route 138)	RI0008039R-27B	B	4A	YES
Thirty Acre Pond	RI0008039L-12	B	4C	No
Chipuxet River (Downstream of Thirty Acre Pond)	RI0008039R-06C	B	4C	No

The waters of Thirty Acre Pond, the Chipuxet River, and the lower reach of White Horn Brook are designated as Class B, defined in the *Water Quality Regulations* as being "…designated for fish and wildlife habitat and primary and secondary contact recreational activities. They shall be suitable for compatible industrial processes and cooling, hydropower, aquacultural uses, navigation, and irrigation and other agricultural uses. These waters shall have good aesthetic value." The upper, campus reach of White Horn Brook is designated as Class A, identical to Class B waters in designated uses but required to meet more stringent standards for aesthetic value and water quality criteria. The assessment category for this watercourse segment (3) indicates that it has not been assessed for designated uses to date.

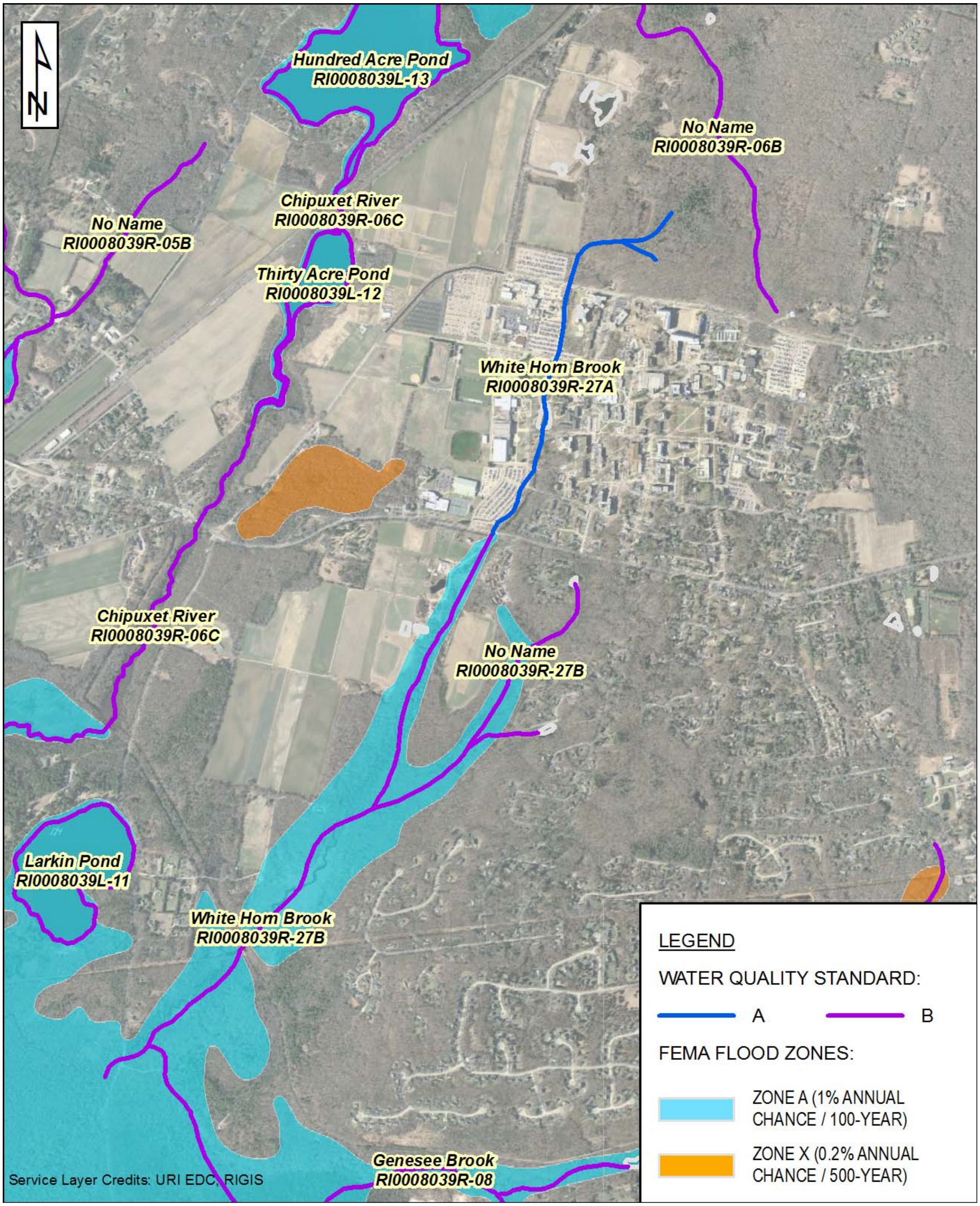

Figure 3 – Surface Water Quality Standards and Flood Zones
Approx. Scale 1" = 2,000' • Data Sources: RIGIS/RIDEM, FEMA National Flood Hazard Layer

Thirty Acre Pond, the Chipuxet River, and the lower reach of White Horn Brook are currently listed under Assessment Category 4 as being "impaired or threatened for one or more designated uses." In both Thirty Acre Pond and the Chipuxet River, fish and wildlife habitat are not supported due to the presence of non-native aquatic plants (invasive species), and in White Horn Brook human recreational contact is impaired due to elevated levels of pathogenic bacteria. For waters impaired by a pollutant, the RIDEM is required to develop a Total Maximum Daily Load (TMDL), which establishes the pollutant load reductions necessary in order for the watercourse or waterbody to meet ambient water quality standards and support designated uses.

Through the 2011 *Statewide Bacteria TMDL*, a bacteria TMDL has been effected for the lower waterbody segment of White Horn Brook (RI0008039R-27B) which identifies a number of potential sources contributing to elevated levels of bacteria, including onsite wastewater treatment systems (failed or failing systems), agricultural activities, waterfowl and other animal wastes, and stormwater runoff from developed areas (see Appendix C). Given the high level of imperviousness within the Kingston Campus subwatersheds (nearly 40%, compared to 13.4% for the White Horn Brook watershed as a whole), it is likely that the direct discharge of untreated runoff from campus drainage systems (mobilizing sediments, nutrients, and other surface pollutants) has contributed to the impairment of the downstream segment of White Horn Brook.

As noted in Section 2.1, a 52% reduction in the pollutant load (bacteria, Enterococci) across all sources is required to meet the TMDL requirement and Class B water quality standards for this segment. Recommendations for and requirements of MS4 operators within the watershed (including URI) are set forth in the *Statewide Bacteria TMDL* waterbody summary for White Horn Brook provided in Appendix C.

3.2 Floodplains

Also depicted on Figure 3 above are the flood hazard areas in the vicinity of the Kingston Campus established by the Federal Emergency Management Agency (FEMA) through the National Flood Insurance Program.[9] According to the current, effective FEMA mapping for this area of Washington County, Rhode Island (Panel No. 44009C0185H, 10/19/2010), there is a designated 100-year (1% annual chance) flood zone (Zone A) associated with the segment of White Horn Brook downstream of Route 138 / Kingstown Road, along with an 500-year (0.2% annual chance) flood zone associated with the expansive forested wetland at the southwest corner of the campus. The University does not presently maintain any campus facilities or improvements in either of these designated zones.

While there are no designated flood zones associated with White Horn Brook above Route 138, low-lying areas flanking the watercourse along this upper reach (and its tributary) are nonetheless prone to flooding during extreme rainfall/runoff events. Build-out of the campus over the latter half of the 20th century increased the overall imperviousness of the watershed above Route 138, increasing in the volume and peak flows of surface runoff to drainage systems. The existing structures and conveyances originally constructed to drain these areas of

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[9] https://www.fema.gov/national-flood-insurance-program-flood-hazard-mapping

the campus soon proved inadequate, increasing the frequency and severity of localized flooding in areas throughout the campus. Also during this time a number of additional culverted crossings (roadways and footpaths) were constructed along the reach of White Horn Brook above Route 138. These too became increasingly insufficient for the conveyance of peak flows, resulting in more frequent and severe flooding of roadways and low-lying areas flanking the watercourse.

Through a project completed in 2011 (See Table 2, entry E8), the four undersized barrel culverts between Ellery Pond and Route 138 were replaced with new box culvert and open span structures, significantly improving flow conveyance and reducing the frequency and extents of flooding along this segment. Certain other locations within the campus do however remain more susceptible to flooding and are discussed in Section 4 of this document.

3.3 Wetlands

Major areas of freshwater wetlands in the vicinity of the Campus (as mapped by the USGS through the National Hydrography Dataset) are depicted on Figure 1. Wetland features within the Kingston Campus proper include the expansive (30+-acre) forested wetland in the southwesterly quadrant (which drains to the Chipuxet River by culvert under Plains Road), along with wetlands flanking the White Horn Brook and its tributary. These latter riparian wetlands are minor in extent so as to not appear on USGS mapping but are nonetheless resources managed and protected by the RIDEM/OWR though the Freshwater Wetlands Program and its regulations.[10] The watercourse and small waterbodies within the campus (including Ellery Pond, Roger Williams Pond, and Ballantine Pond) are also considered wetland features within the jurisdiction of the Wetlands Program. Depending on their size and connectivity, these features may also have associated perimeter and/or riverbank wetlands within RIDEM jurisdiction as well.

In the development of this update to the University's *Drainage Master Plan*, a wetland and wildlife habitat analysis of the campus and its environs was completed by GRA's subconsultant, Applied-Bio Systems, Inc. (ABS) to inform recommendations for the protection and enhancement of natural resources. A copy of the ABS *Wetland and Wildlife Habitat Analysis* report is provided herewith as Appendix D, providing an overview of land uses in and around the campus, wetland and upland habitat resources (including functions and values currently provided), and locations where opportunities exist to improve environmental quality through stormwater attenuation and treatment.

In general, the wetlands along White Horn Brook are limited in the functions and values they provide due to their location within highly developed surroundings and the long-term impacts of untreated stormwater discharges (water quality, erosion and sedimentation, etc.). Recently completed projects to improve flow conveyance and habitat conditions along the lower campus reach (from Ellery Pond to Route 138) have greatly improved the environmental quality and natural character of this area.

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[10] http://www.dem.ri.gov/pubs/regs/regs/water/wetlnd14.pdf

3.4 Groundwater

The URI Kingston Campus is reliant on groundwater for its potable water supply, drawing from a system of wells situated just east of Thirty Acre Pond. The University owns and operates facilities for the treatment, pumping (to the campus water tower along the north side of Flagg Road, across from the Fine Arts Lot) and distribution of water to campus buildings and other uses.

Groundwater and groundwater quality[11] within the State of Rhode Island is administered and managed by the RIDEM/OWR in a manner analogous to its surface water protection program. According to the current (2010) *Groundwater Quality Rules* and groundwater classification mapping maintained by the RIDEM/OWR, virtually the entire campus is underlain by groundwater resources classified as GAA, defined as "…those groundwater resources which the [RIDEM] Director has designated to be suitable for public drinking water use without treatment…" A 660-acre Community Wellhead Protection Area (WHPA) also encompasses the campus and portions of West Kingston, designated to ensure that this groundwater resource is adequately protected.

While the highly protected nature of groundwater resources in the area does not preclude the use of stormwater infiltration practices (for water quality and recharge), their presence requires that such practices are designed to ensure that contaminants potentially mobilized by stormwater do not impact the aquifer. For recently constructed facilities in the area of the Plains Road extension (including infiltration basins and permeable pavement systems for the Plains Road Parking Lot), enhanced design features such as sand filtration layers have been employed provide additional protection from potential adverse impacts.

4.0 Campus Stormwater Management System

Depicted on the attachment maps provided herewith, developed portions of the Kingston Campus are served by an array of open and closed drainage facilities, including over 900 catch basins (CBs), 300 drainage manholes (DMHs), several structural stormwater best management practices (BMPs), and 89 system outfalls. These facilities comprise the University's MS4, which is operated and maintained in accordance with URI's SWMPP and the RIPDES Small MS4 General Permit. Runoff collected and conveyed by campus drainage systems is ultimately received by the natural watercourses with watersheds intersecting the developed campus, i.e. White Horn Brook and the Chipuxet River. These watercourses (including their associated wetlands and other natural characteristics) are described in Section 3.0, and a discussion of Kingston Campus drainage systems by subwatershed follows in the subsections below.

A series of thematic large format maps (see Attachments 1-4) are provided with this *Drainage Master Plan* which depict campus drainage systems and major campus subwatersheds, along with other data pertinent to stormwater management planning efforts, including property boundaries and ownership (data obtained from the Town of South Kingstown), topography, mapped soils units, surface cover (pervious/impervious), and the locations of structural BMPs inventoried and tracked through the University's MS4 Stormwater Program. These maps are

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[11] http://www.dem.ri.gov/programs/water/quality/groundwater/

intended to support and augment the discussions of facilities and conditions that follow. In addition, the following supporting information is compiled in Appendices D and E of this report:

- Soils Data (Appendix E) – Data sheets have been extracted from the current (2015) USDA Natural Resources Conservation Service Soil Survey of Rhode Island database[12] for those mapped soil units underlying the campus and its watersheds (see Attachment 2). Summary data sheets for the general/hydrologic, physical, and engineering properties for each soil type are provided in Appendix E, and mapped units depicted on the Subwatershed Map (Attachment 2) have been color-coded by their Hydrologic Soil Group (HSG). With the general exception of urban fills (due to their variability), soils are designated a HSG based on their general drainage characteristics, ranging from well-draining Group A soils to poorly drained Group D soils.

  While Soil Survey mapping (including HSGs, estimated depth to the seasonal high groundwater table, and other characteristics of mapped soils) is an essential tool in planning and analysis for stormwater management, the spatial resolution of these data is rather coarse, and soils by their nature are inhomogeneous. This is apparent in the hillside portion of campus, where an expansive tract of Canton-Urban land complex (CB, HSG B) is in locations underlain by dense, poorly draining strata beneath the topsoil that are generally unconducive to infiltration. To better inform the planning and design of possible future infiltration practices in this and other areas, the University should consider undertaking a subsurface exploration program to characterize subsoils throughout the campus.

- BMP List / Inventory (Appendix F) – GRA obtained the University's current list of Structural BMPs, an inventory that is maintained in compliance with the RIPDES MS4 General Permit. This list has been reproduced in Table F.1 of Appendix F, along will appended columns indicating GRA's annotation and comment on particular facilities where warranted. The locations of these structural stormwater practices are depicted on Attachment 3, in which all applicable BMPs have been mapped based on best available information (including descriptions, URI Utilities Department geographic data, aerial photography, and past projects information).

  Also depicted on Attachment 3 are certain facilities that appear as structural BMPs on drainage layers in the current URI Utilities Department GIS database (e.g., roof drainage recharge chambers, hydrodynamic separator chambers), but are not included in the current MS4 Structural BMP list. These possible un-inventoried stormwater practices are listed in Table F.2 of Appendix F.

4.1 Drainage Collection System / Subwatersheds

Based on stormwater facilities data obtained through the URI Utilities Department along with statewide geographic data sets obtained through the Rhode Island Geographic Information System (RIGIS), GRA delineated the major campus subwatersheds and computed general hydrologic characteristics of each. The 480+-acre watershed of the upper segment of White Horn Brook (RI0008039R-27A, above Route 138) was parsed into seven (7) major

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[12] http://www.rigis.org/datasets/soils

subwatersheds based on topography, existing drainage facilities, and the connectivity thereof. In addition to these, the University maintains drainage facilities within four other subwatersheds. The extents, characteristics, and facilities within each of these subwatersheds are depicted on Attachments 1-3. Through mapping and analysis conducted by GRA as part of this update to the *Drainage Master Plan*, key characteristics of each subwatershed (catchment area, imperviousness, and weighted NRCS runoff curve number) are presented in Table 5 below, followed by a brief narrative summary of facilities by subwatershed.

TABLE 5
Kingston Campus Subwatersheds – Catchment Characteristics

Subwatershed	Area (Acres)	Percent Impervious	Composite Runoff Curve Number (CN)
Headwater	29.3	2%	72
Plains	172.9	19%	65
Flagg Road	42.1	67%	88
Heathman	24.9	52%	82
Meade	7.0	40%	76
Tributary	97.9	51%	81
Ellery Pond – Route 138	109.3	49%	82
Total, White Horn Brook above Route 138	**483.5**	**37%**	-
Lower W. Horn Brook 1	21.6	35%	73
Lower W. Horn Brook 2	22.1	37%	72
Thirty Acre Pond	16.5	7%	64
Plains Road – Chipuxet	89.6	19%	63

Headwater

The Headwaters of White Horn Brook consist of an expanse of undeveloped forest north of Flagg Road, where wetlands gradually converge to a defined channel just north of Flagg Road. There are no stormwater facilities within this subarea, and it is passed under Flagg Road to via a twin-barrel (2 x 24-inch) culvert. Adjacent to the culvert outlet, this downstream segment also receives discharges from the 30-inch trunk line draining the Flagg Road subwatershed (see heading below). While this culvert has insufficient capacity to convey expected peak flows for major events (e.g. 25-year and greater), little if any roadway flooding occurs, since surcharge waters first overtop to the expansive detention basin to the west (serving the Flagg Road lot).

Plains Subwatershed

This large (170+-acre) catchment spans most all of the developed campus north of West Alumni Avenue and west of White Horn Brook, including the University's "Service District", the expansive Flagg Road and Plains Road parking lots (the latter a permeable pavement facility), and portions of the University's agronomy fields further north. Certain developments in this area are relatively recent (parking lots, Plains-Flagg Road extension) and as such have been provided with appropriate stormwater management facilities including permeable pavement systems, infiltration/detention basins, swales, and other BMPs. During extreme events where inflows exceed the infiltration/attenuation capacity of these facilities, overflows enter the system trunk line, which nominally begins at the swale just south of Central Receiving. This closed system also drains road runoff from West Alumni Avenue, ultimately discharging to White Horn Brook via a 42-inch outfall just south of West Alumni Avenue.

While lower-lying areas in the Service District were prone to more frequent flooding in the past, the up-gradient attenuation of flows provided by recently constructed stormwater BMPs (particularly by the interconnected and oversized infiltration basins in the system) along with improvements within the Service District itself (e.g., Sherman Lot subsurface infiltration system) have significantly reduced susceptibility of facilities to flooding.

Flagg Road Subwatershed

The systems draining the largely impervious Flagg Road catchment east of the brook are largely closed in nature. In addition to draining the steep-gradient roadway itself, the trunk line that runs along the south side of the roadway (discharging to White Horn Brook by 30-inch outfall) also receives inflows from a number of campus facilities to its immediate south, including the Fine Arts Parking Lot, Greenhouses, Center for Biotechnology and Life Sciences (CELS), and new Chemistry Building. This area has undergone extensive redevelopment over the past decade, with stormwater quality/quantity measures included in the designs of new and renovated facilities, including grassed swales, bioretention facilities, and other treatment measures. Pending improvements to the Fine Arts Parking Lot will further attenuate runoff within the uppermost reaches of the catchment.

Heathman Subwatershed

This subwatershed is drained by a number of smaller-scale closed systems discharging to White Horn Brook along the reach between Flagg Road and West Alumni Avenue. These include overflows from the Garrahy, Wiley, and Heathman Hall roof drain systems, along with White Hall and a southerly treatment system for the new Chemistry Building. Certain systems (including the Heathman Road swale) discharge to Merrow Pond, which provides for some degree of flow attenuation. Recent improvements and redevelopment in this area have seen improvements to stormwater management, with most roof runoff now taken offline and infiltrated by recharge systems. Despite these recent improvements, lower-lying areas along the reach – particularly portions of the Dairy Barn Lot – are still subject to periodic flooding. This is due in large part to the undersized (single 36-inch) culvert installed to carry the brook under the Diary Barn Lot. Exacerbated by poor conditions at the inlet (including brush, debris, and sediment accumulation), upstream flows quickly exceed the capacity of the culvert during extreme flow events, resulting in flooding along West Alumni Avenue and in Meade Stadium.

Meade Subwatershed

As the smallest of the campus subwatersheds delineated, this catchment is drained by small closed systems to the reach of White Horn Brook between West Alumni Avenue and the confluence with the Main Campus Tributary (see heading below). This reach (and the Meade Stadium Field itself) is prone to periodic flooding due to the undersized nature of both the upstream culvert and the stream channel itself. There are no BMPs for water quality or quantity within this subwatershed, however there exists the potential to alleviate flooding in the area through improvements to the West Alumni Avenue culvert, the stream channel, and the downstream confluence area just above Ellery Pond.

Tributary Subwatershed

This subwatershed is associated with the Main Campus Tributary of White Horn Brook, which is presently culverted along almost its entire length. With headwaters beginning near Kingston Hill, this stream flows north and west through the developed hillside portion of the campus, receiving inflows from numerous lateral tie-ins and “daylighting” at certain locations along its length (including Ballentine Pond, Hope Commons rock swale, and Roger Williams Pond) before discharging to a lowermost open channel reach west of Complex Road. This subwatershed is largely lacking BMPs for attenuation, and consequently areas along the trunk line are prone to periodic flooding. Flooding problems remain pronounced in the area of Butterfield Road and Hope Commons, where the twin-barrel (2 x 30-inch) culvert carrying the stream around Carothers Library discharges to the rock swale. This swale flows down a steep gradient to an extremely undersized single 24-inch headwall inlet, with the culvert thence taking a 90-degree bend north and discharging to Roger Williams Pond. The frequency and severity of flooding in this area is evident by severe erosion along the perimeter of the rock swale, which has exposed tree roots and outlet pipes from small contributing systems.

Plans to alleviate flooding in this area include (a) the daylighting of a greater channel area east/upstream of Butterfield Road and (b) replacement of the existing culvert with a box culvert with improved capacity. This project is expected to commence in 2018 or shortly thereafter, following completion of the new Engineering Building near where the trunk line crosses Upper College Road. The design of this new College of Engineering facility – currently under construction – includes reductions in impervious cover and stormwater BMPs for offline management of stormwater quality and quantity. While the above two projects will realize tangible stormwater and flow management benefits, most all closed drainage branches within the network remain undersized, and the potential for localized flash flooding will remain at certain locations within this catchment.

Ellery Pond – Route 138

This 100+-acre subwatershed consists of the area of the campus that drains to the reach of White Horn Brook between Ellery Pond and Route 138, including the Tootell-Keaney-Mackal complex (and parking lot) to the west and hillside campus facilities (including Memorial Union, Campus Avenue, and Fraternity Circle) to the east. As previously noted, culvert improvements along this reach of the brook (along with subsequent stream restoration) have greatly reduced flooding along the wetland corridor. Drainage conditions along the hillside portion of the catchment are similar to those of the Tributary subwatershed, however a far greater number of structural BMPs have been implemented to attenuate runoff impacts (either retrofit or provided in the reconstruction of facilities). Improvements to Butterfield Hall and Hillside Hall have includes swales, bioretention, and detention facilities, effectively taking much of the roof runoff in this catchment offline, and an offline infiltration system is in place along the Butterfield Road trunk line.

The vast Keaney Parking lot to the east remains deficient from a stormwater management perspective, as all runoff from this 9+-acre impervious area continues to be directly discharged to the brook via legacy drainage systems. Measures to improve stormwater management should be included in any future initiatives to redevelop or resurface this facility.

Lower White Horn Brook Subwatersheds 1 and 2

Two subwatersheds of the Kingston Campus discharge to White Horn Brook below Route 138: (1) the area drained by closed systems serving the Graduate Village Apartments south of Route 138 and (2) an area drained by closed system at the southerly end of Lower College Road, which discharges across Route 138 to a tributary wetland. While neither system is significantly prone to flooding, no attenuation measures have been provided with development in these areas, and discharges are effectively untreated. A large majority of the land comprising Subwatershed 2 is privately owned by others. There exists the potential to provide retrofit controls within the apartment complex of Subwatershed 1, however its close proximity to the watercourse poses constraints to the type and extent to which BMPs can be implemented at this location.

Thirty Acre Pond Subwatershed

A small closed system drains an area west of Plains Road, discharging to the waters of Thirty Acre Pond via an 8-inch outfall. Land use over this catchment is limited to agronomy fields and the wellhead area, and while there are no BMPs providing attenuation, the need for improvements in this area would be considered low priority due to its low-intensity use. RIDEM regulations also preclude the use of certain water quality BMPs in the vicinity of drinking water supply wells.

Plains Road – Chipuxet Subwatershed

Much of the southwest quadrant of the campus – including athletic fields, the Ryan Center, the Boss Ice Arena, and facilities along West Independence Way – drains to the vast forested wetland bounded by Plains road to the west and Route 138 to the south. A northerly trunk line (draining Ryan Center facilities) and an easterly trunk line (draining the Boss Arena and overflows from the Beck Baseball Field) converge and discharge to the wetland at its northeast corner via a 36-inch outfall. Certain BMPs have been implemented in recent years, including an offline level spreader along the Boss Arena spur, drywells for baseball field runoff, and a hydrodynamic "vortex" sediment separator along the trunk line from the Ryan Center. While there is potential for improvements, existing facilities and uses with this catchment do not warrant high prioritization.

4.2 Stormwater Controls and Best Management Practices

The University's inventory of stormwater BMPs, reproduced from its MS4 BMP list, is provided herewith in Appendix F (Table F.1), and the locations of these numbered facilities are plotted on Attachment 3. Stormwater controls that may have been omitted from previous inventory efforts have been identified and are listed under Table F.2. As development (and redevelopment) throughout the campus is expected to continue in the short and mid-term future (see Section 2.3), it is recommended that the university continue in its efforts to improve tracking and management systems, including the geographic database of its drainage facilities.

4.3 Deficiencies Requiring Corrective Action

The University's Small MS4 Annual Report (see Appendix A) describes those deficiencies that were identified in the reporting year and the corrective actions taken to address them. In general, reported deficiencies consisted of erosion and sedimentation impacts at outfalls and other high-flow locations, and are routinely addressed by the University's Lands and Grounds Department through the issuance of work orders (to remove sediments, stabilize slopes, etc.).

As previously noted, key areas where flow management and flooding issues remain are (a) the existing White Horn Brook culvert under West Alumni Avenue and (b) the existing tributary culvert under Butterfield Road. While improvements to address the latter are in final design, there are presently no plans replace or otherwise improve the West Alumni Avenue culvert. Both the relatively long length of this culvert (over 300 feet) and the heavily trafficked West Alumni Avenue corridor pose significant constraints to addressing flooding issues both upstream and downstream of this crossing.

It is understood that the University remains in compliance with its obligations as an MS4 owner/operator and has received no significant notices of violation (NOVs) since inception of Phase II of the RIPDES Stormwater Program. Additional measures may be required however to meet the recommendations and requirements set forth for MS4 operators in the Bacteria TMDL for White Horn Brook. University officials should continue to engage in discussions with the RIDEM regarding updates to the *Kingston Campus Master Plan*, which will afford the opportunity to identify any key issues of concern and to establish a mutual understanding for the future planning and implementation of stormwater management measures throughout the campus.

5.0 Summary and Recommendations

The University of Rhode Island made significant strides in recent years towards improving the management of stormwater throughout its Kingston Campus. Development and redevelopment over the past decade has seen new facilities provided with structural stormwater controls of several types and designs, which continue to be maintained by the Utilities Department in accordance with the University's authorization to discharge under the RIPDES MS4 General Permit.

Despite these recent advances, certain legacy issues remain in the drainage systems that presently serve the Kingston Campus, particularly those that discharge runoff to the receiving waters of White Horn Brook and its Main Campus Tributary. Most of the facilities that presently drain these watersheds were constructed prior to modern stormwater policy and standards, and while development of new campus facilities continued steadily through the latter half of the 20th Century, measures to increase the capacity of systems or provide attenuation for the increases in impervious cover were seldom incorporated. This has resulted in certain areas of the campus becoming more susceptible to flooding from major rainfall events, particularly at "pinch points" where closed conveyances are undersized to pass peak flows. By far the most problematic of these are the undersized culverts that presently carry White Horn Brook under West Alumni Avenue and the Main Campus Tributary under Butterfield Road.

It is recommended that the University, in planning future initiatives to improve stormwater management and environmental conditions throughout the Kingston Campus, adopt an approach that seeks to, in parallel, address issues pertaining to stormwater quantity (management of peak flows and flooding) and stormwater quality (containment of sediments and other surface pollutants mobilized by runoff). Careful and prudent prioritization of efforts (and the funding thereof) will allow the university to implement measures to (a) reduce the frequency and severity of flooding at locations throughout campus, (b) reduce pollutant loads in runoff received by White Horn Brook and the Chipuxet River, and (c) improve groundwater recharge characteristics over the campus to protect and sustain groundwater resources in the area.

5.1 Stormwater Quantity and Flood Protection

To date, GRA has developed separate hydrologic/hydraulic models for the Main Campus Tributary (to its confluence just above Ellery Pond), the headwater reach of White Horn Brook (to West Alumni Avenue and Meade Stadium), and the main campus segment of White Horn Brook (Ellery Pond to Route 138) in support of various recent development and restoration initiatives. Taking into account the inherent uncertainties and assumptions underlying rainfall-runoff and riverine hydraulic models, the capability of each of these reaches to convey peak flows arising from severe rainfall events can be summarized as follows.

- Upper White Horn Brook Reach: flows greater than the estimated *1-year* return period peak flow exceed the capacity of the existing 36-inch diameter culvert under West Alumni Avenue, resulting in surcharge and flooding of the roadway, along with low-lying areas of the Service District and Dairy Barn Lots. More severe events, including estimated peak flows for the 10- and 100-year events, result in extensive overtopping and flooding across Meade Stadium.
- Main Campus Tributary Reach: flows greater than the estimated *1-year* return period peak flow exceed the capacity of the existing 24-inch diameter culvert under Butterfield Road,

resulting in surcharge and flooding of the roadway and areas around the down-gradient Fascitelli Center building. As with the West Alumni Avenue Culvert, more extreme rainfall-runoff events produce flooding of greater depth, breadth, and disruption.

- White Horn Brook (downstream of Ellery Pond): by virtue of the recently completed culvert replacement and wetland restoration projects implemented along this reach, the brook (along with the hydraulic openings at its several crossings) can pass flows up to the *10-year* event without encroachment upon susceptible campus facilities along the fringes of the stream corridor (e.g., dormitories and athletics buildings) and with only minor roadway overtopping at the lowermost culverts (above Route 138). Facilities along this reach are now also far less susceptible to erosive effects of flood flows through the inclusion of riprap slope protection and other countermeasures in the replacement of culverts.

Given the current state of conditions along these main branches of the hydrologic network, it is recommended that the University seek to improve flood protection along the Upper White Horn Brook and Main Campus Tributary reaches, through the implementation of measures to attenuate runoff flows and improve capacity in conveyances. The highly-developed nature of the campus limits the extent to which improvements are feasible (e.g., the largely culverted Tributary could not be daylighted without incurring exorbitant costs and disruption); however it is within reason (both hydraulically and economically) to improve conditions such that these branches can also safely pass flows up to and including the 10-year rainfall-runoff event.[13] In order to ensure that improvements in conveyance do not exacerbate peak flows and flooding downstream – both along the campus reach (Ellery Pond to Route 138) and beyond – improvements should be implemented in conjunction with measures to attenuate flows, such as removing existing impervious surfaces, disconnecting impervious surfaces, providing BMPs for both quality and quantity control, etc. This strategy has been successfully employed in the Plains Subwatershed, where controls directing runoff offline (for infiltration/recharge) have achieved significant reductions in flows through the closed system, and consequently, the frequency and severity of surcharge.

In addition to the above, designs for all new campus development (including those ongoing/pending projects depicted on Attachment 4) should strive to provide runoff flow reductions above and beyond that required for compliance with the Stormwater Manual. This can be achieved through impervious cover reduction, measures to increase recharge (where subsurface conditions permit), and stormwater BMPs providing detention/attenuation functions.

5.2 Stormwater Quality

GRA, in the development of this updated *Drainage Master Plan*, has completed an inventory and of the major existing impervious cover assets contained within each campus subwatershed, (roadways, parking lots, building roofs), including the current treatment status of facilities. A Campus Roadways, Lots, and Roofs Inventory map has been developed is provided herewith

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[13] This is defined in the Stormwater Manual (see Appendix B for excerpt) as 4.9 inches of rainfall over a 24-hour period, modeled with a Type III intensity distribution as defined by the Natural Resources Conservation Service (NRCS).

as Attachment 5, on which these surface areas have been color-coded based on the extent to which runoff is presently managed. This is accompanied by a series of inventory spreadsheets (see Appendix G) tabulating the areal quantities and treatment status of facilities by subwatershed, along with recommendations for potential future stormwater BMPs (further discussed below) based on preliminary assessments of technical feasibility.

Within the developed schema, paved roadways and lots indicated as having “treatment” are served by structural controls providing water quality functions (e.g., permeable pavement, infiltration, vegetated swales, bioretention, or other practices providing removal of sediments and pollutants), whereas those indicated as having “partial” treatment are drained by facilities that provide only a degree of sediment containment (e.g. catch basins or other structures with sumps). While most campus roofs are connected to closed drainage facilities, those building roofs presently served by infiltration/recharge facilities or rain gardens have also been inventoried as receiving treatment.

By geospatial analysis of University-held properties and impervious surfaces[14] intersecting the delineated campus subwatersheds depicted on map attachments, the approximately 556 acres held by the university within these watersheds contains approximately 202 acres (36%) impervious surface cover (see Appendix G – Impervious Cover and Treatment Summary Table). Of this total impervious, approximately 136 acres can be accounted for in the inventory of roadways, paved lots, and building roofs. The remaining 66 acres is comprised of walkways, sidewalks, ramps, and other impervious surfaces across the campus. This quantity of remaining impervious may vary slightly from the actual amount of un-inventoried impervious cover, as a number of major capital projects have been completed throughout the Kingston Campus since creation of the Statewide Impervious Surfaces dataset (from 2011 imagery) used to compute total impervious cover across each watershed.

Of the 136 acres of impervious cover tabulated in the accounting of existing facilities, approximately 11% of campus roadways and 47% of paved lot surfaces receive treatment through a water quality practice, with 8% of the total roof area managed through recharge or other treatment. Much of the area treated is accounted for in the Plains Subwatershed, where development over the past two decades has included extensive use of permeable pavement systems (Plains Road Lots, Dairy Barn Lot 1) along with new (Flagg Road North Lot) and retrofit (Sherman Lot) infiltration facilities. Elsewhere, facilities identified as being currently treated are so due to their more recent construction, as since the early 1990s site designs have been required to include provisions for stormwater management in accordance with effective stormwater policies/regulatory requirements.

Both the Campus Roadways and Paved Lots spreadsheets (Appendix G), in addition to indicating the current treatment status of facilities, include a matrix of potential stormwater quality controls that could be implemented to provide water quality treatment for surfaces presently receiving partial or no treatment. The University’s *Draft Transportation and Parking Master Plan* (currently in development) has thus far identified approximately 2.3 acres of parking

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[14] RIGIS, Statewide Impervious Surfaces raster dataset (from 2011 imagery capture) – see http://www.rigis.org/datasets?q=impervious

and other impervious surfaces to be eliminated within the campus core, which have been accounted for in these tables. In addition to these, numerous additional opportunities have been identified where further pavement reductions (e.g., road dieting) appear feasible. In general, impervious cover reduction is a far more cost-effective means of achieving reductions in runoff volumes and pollutant loads compared to the implementation of structural BMPs for the same purposes. Many of the areas flagged as viable for potential stormwater controls are already in planning or design (including Fraternity Circle, Briar Lane Lots, Fine Arts Lot) and are indicated as such under the Notes columns of these tables.

As a regulated MS4 owner/operator, the University is obligated to develop and implement controls to address impairments to receiving waters for which a TMDL has been established, which in the University's case is the downstream waterbody segment of White Horn Brook (see Section 3.1 and Appendix C). This segment has an effected TMDL for bacteria (enterococci), requiring a 52% reduction in pollutant load to meet established (Class B) water quality standards.

The RIDEM/OWR, in establishing bacteria TMDLs for various waterbodies state-wide, assumes that watercourses with watersheds having greater than 10% impervious cover are adversely affected by stormwater runoff. While it is unreasonable to expect the University to achieve such a standard across its Kingston Campus properties (existing impervious would need to be reduced by upwards of 120 acres), numerous opportunities exist throughout the campus to implement stormwater quality controls (see Appendix G spreadsheets, potential stormwater control matrices). Through prudent planning and programming of improvements, these measures will achieve tangible, steady reductions pollutant and sediment loads in runoff received by the White Horn Brook.

Based on the inventories developed for this *Drainage Master Plan* update, structural BMPs can feasibly increase the percentages of inventoried campus roadways and lots receiving treatment to approximately 70% and 86% respectively. Additional pavement removal (beyond areas identified in the *Draft Transportation and Parking Master Plan*) and other impervious cover reductions (such as disconnecting building roofs, further discussed under Section 5.3 below) can further increase these percentages of impervious cover treated. Large expanses of untreated or under-treated pavement – such as the Keaney and Boss area parking lots and circulation roads – offer the greatest opportunities for significant near-term stormwater quality and quantity improvements.

5.3 Recharge

Groundwater is and will continue to be a crucial resource for the greater Kingston area and for the University, which is reliant on the aquifer underlying the Community Wellhead Protection Area for its potable water supply. RIDEM Groundwater Regulations require that the groundwater resources (Standard GAA) underlying the campus to be managed and protected accordingly.

The build-out of campus facilities over the past century has seen the overall imperviousness of the campus, particularly around its hillside core, increase steadily. The general effect of this increase is an increase in the fraction of rainfall that is converted to runoff, with a corresponding decrease in the fraction that infiltrates through pervious surfaces and recharges the groundwater table. Despite the preponderance of HSG B subsoils throughout the highly developed hillside portion of the Campus (Flagg Road, Tributary, and Ellery Pond-Route 138 subwatersheds), recharge characteristics throughout this area are, based on past project facilities management experience, generally poor; this is due to a combination of factors that vary throughout the landscape, including shallow ledge, perched/aquitard layers, and interactions with wetlands and surface waters of the White Horn Brook and Main Campus Tributary. In contrast, the HSG B soils that underlie the Plains portion of the campus west of White Horn Brook (including athletic and agricultural fields, pervious pavement parking lots, and Service District facilities) are far more hydraulically conductive. Groundwater is generally encountered at greater depths (upwards of 10 feet below grade) throughout these areas as well.

Given the limitations in the resolution and spatial accuracy of soils mapped by the NRCS on a statewide level, the completion of a campus-wide subsurface exploration program would be of significant benefit to the University's stormwater management planning (and overall master planning) efforts. Prior to such an undertaking, all available information that can be obtained from borings and other subsurface explorations completed to date (i.e., those conducted in the design of past and ongoing campus development/redevelopment projects) should be compiled to determine where gaps exist and inform planning of the exploration program. There also exists ample opportunity for the University to partner with academic departments/faculty and the USDA Rhode Island State Office in such an endeavor.

All future campus development/redevelopment projects should, to the maximum extent practicable, conform to the Groundwater Recharge standard (Minimum Standard 2) of the Stormwater Manual (see Appendix B). At present, major drainage facilities providing recharge functions consist of the permeable pavement and infiltration facilities in the Plains subwatershed. Across the hillside campus core, recharge facilities are far more limited due to soil conditions, but nonetheless include small roof drainage subsurface recharge facilities (galley or drywell systems) as well as rain gardens for the management of roof runoff from newer campus buildings (e.g., Hillside Hall, Pharmacy Building).

Building roofs have been tabulated as part of the impervious cover inventory (see Appendix G spreadsheets and Attachment 5) and at over 44 acres in total, constitute a significant portion of the overall impervious cover. These surfaces generate significantly less pollutant load than ground-level impervious cover (paved roadways, lots, and walks), and as such, are generally not considered high a priority for retrofit water quality treatment practices; however, within the constraints posed by subsurface conditions, any opportunity to disconnect existing building roofs from closed drainage systems will serve the dual purpose of reducing peak flows and providing recharge. To this end, the technical feasibility disconnecting roof drains from individual buildings should be investigated in further detail, particularly where the roof areas are large and proximate to amenable subsoil conditions (such as the athletic complex buildings and other roofs west of White Horn Brook).

5.4 Operations and Maintenance

To date, the University has remained in compliance with its obligations as an owner/operator of drainage facilities authorized to discharge under the RIPDES Small MS4 General Permit, submitting annual reports to the RIPDES Program documenting its progress towards (and maintenance of compliance with) the six minimum control measures required of permittees. While the University has not yet been required to develop a TMDL Implementation Plan, such a plan will need to be developed to document how it will address the White Horn Brook Bacteria TMDL (see Appendix C) and specific permit requirements for MS4 operators discharging to TMDL waters.

In addition to implementing new structural BMPs for the control of stormwater quality and quantity, any improvements in operations and maintenance to reduce pollutant and sediment loads should be explored, and where technically and fiscally feasible, implemented. The legacy, direct-discharge drainage systems that present drain much of the campus provide are limited in the extent to which they containment sediments from being discharged. Along with the detrimental effects of sedimentation itself, hydrocarbons and other surface pollutants are more readily mobilized by suspended sediments in runoff. The recently completed restoration of White Horn Brook (Ellery Pond to Route 138) involved the removal of invasive species and significant quantities of sediment from the stream channel. As these sediments were found to contain pollutant concentrations exceeding exposure criteria, their disposal required as a Short-Term Response Action in accordance with RIDEM Remediation Regulations

Non-structural controls that can reduce the overall sediment load to White Horn Brook and other receiving waters should be strongly considered. To the extent they are available, resources should be allocated to the more frequent sweeping (of campus roadways, parking lots, and walkways) and cleanout of catch basins (along with forebays, check dams, and other drainage system elements providing containment of sediments). Increasing the frequency of sweeping catch basin cleanout to two (2) times per year will improve the natural character of receiving waters/wetlands and defer the need to conduct more costly and intensive wetland restoration projects.

6.0 References

Note: All hyperlinks referenced by footnote throughout the document were accessed at the time of report publication (February 2018)

Beta Group, Inc., *University of Rhode Island, Phase II Storm Water Management Program Plan* (SWMPP), March 2004.

Joe Casali Engineering, Inc., *University of Rhode Island, Drainage Master Plan, Kingston Campus*, June 2006.

Rhode Island Department of Environmental Management (RIDEM) and Coastal Resources Management Council (CRMC), *Rhode Island Stormwater Design and Installation Standards Manual*, December 2010, Amended March 2015.

Rhode Island Department of Environmental Management (RIDEM) and USEPA New England, Region 1, *Rhode Island Statewide Total Maximum Daily Load (TMDL) for Bacteria Impaired Waters*, September 2011.

University of Rhode Island, RIPDES Small MS4 Annual Report (Permit #RIR040019), Year 12 (Jan 2015-Dec 2015), February 2016.

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Appendix A

Copy of
RIPDES Small MS4 Annual Report (Year 12 / 2015)

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RHODE ISLAND DEPARTMENT OF
ENVIRONMENTAL MANAGEMENT
Office of Water Resources

DEM USE ONLY

Date Received ____________

RIPDES SMALL MS4 ANNUAL REPORT

GENERAL INFORMATION PAGE

RIPDES PERMIT #RIR040 019

REPORTING PERIOD: ☒ **YEAR 12**
Jan 2015-Dec 2015

OPERATOR OF MS4

Name: The University of Rhode Island			
Mailing Address: Sherman Building; 60 Tootell Road			
City: Kingston	State: RI	Zip: 02881	Phone: (401) 874-5488
Contact Person: Jerome Sidio	Title: Director: Facilities Services		
	Email:jerrysidio@uri.edu		

Legal status (circle one):
PRI - Private PUB - Public BPP - Public/Private [✓ STA - State] FED – Federal
Other (please specify):

OWNER OF MS4 (if different from OPERATOR)

Name: Same			
Mailing Address:			
City:	State:	Zip:	Phone: ( )
Contact Person:	Title:		
	Email:		

CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under the direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, I certify that the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Print Name Jerome Sidio

Print Title Director of Facilities Services

Signature Jerome B Sidio Date 2/3/16

MINIMUM CONTROL MEASURE #1:
PUBLIC EDUCATION AND OUTREACH (Part IV.B.1 General Permit)

SECTION I. OVERALL EVALUATION:

GENERAL SUMMARY, STATUS, APPROPRIATENESS AND EFFECTIVENESS OF MEASURABLE GOALS:

Include information relevant to the implementation of each measurable goal, such as activities, topics addressed, audiences and pollutants targeted. Discuss activities to be carried out during the next reporting cycle. If addressing TMDL requirements, please indicate rationale for choosing the education activity to address the pollutant of concern.

(Note: Identify parties responsible for achieving the measurable goals and reference any reliance on another entity for achieving measurable goals.)

Responsible Party Contact Name: Andy Alcusky

Phone: (401) 874 2448 **Email:** aalcusky@uri.edu

IV.B.1.b.1	Use the space below to provide a General Summary of activities implemented to educate your community on how to reduce stormwater pollution. For TMDL affected areas, with stormwater associated pollutants of concern, indicate rationale for choosing the education activity. List materials used for public education and topics addressed. Summarize implementation status and discuss if the activity is appropriate and effective.

The University requires all staff employees to attend training sessions annually for the proper handling of contaminants and the proper disposal of contaminants. All employees are reminded that nothing can be disposed into the storm drainage system. These safety sessions and presentations are conducted by the URI Safety and Risk Dept. Messages to educate the community also continued in the school website. The RI NEMO continued to sponsor education programs for all communities of the state. The director and staff are members of the URI community and provide resources for all communities in developing their storm water pollution prevention program and maintaining their program.
The parties involved include the URI Utilities Dept., URI Safety and Risk Dept., and the RI NEMO Program.

IV.B.1.b.2	Use the space below to provide a general summary of how the public education program was used to educate the community on how to become involved in the municipal or statewide stormwater program. Describe partnerships with governmental and non-governmental agencies used to involve your community.

The University continued its support with various student groups for campus cleanup activities such as Earth Day events.
In what may appear as unrelated to stormwater pollution prevention, the University has entered into a contract for energy savings which includes a behavior change measure. One item discussed with all on-campus students is changing their behavior concerning trash and recycling materials. Any reduction of trash considerably helps the amount of pollution entering the storm water system. Some of the cleanup events occurred off campus as well as on campus. The RI NEMO continued to sponsor education programs for all communities of the state. The director and staff are members of the URI community and provide resources for all communities in developing their storm water pollution prevention program and maintaining their program.

Check all topics that were included in the Public Education and Outreach program during this reporting period. For each of the topics selected, provide the target pollutant (e.g. construction sites, total suspended solids):

Topic	**Target Pollutant(s)**
☒ Construction Sites	TSS
☒ Pesticide and Fertilizer Application	Nitrogen/phosphorus
☐ General Stormwater Management Information	
☐ Pet Waste Management	
☐ Household Hazardous Waste Disposal	
☒ Recycling	Floatables
☐ Illicit Discharge Detection and Elimination	
☐ Riparian Corridor Protection/Restoration	
☐ Infrastructure Maintenance	
☒ Trash Management	Floatables
☐ Smart Growth	
☐ Vehicle Washing	
☐ Storm Drain Marking	
☒ Water Conservation	
☐ Green Infrastructure/Better Site Design/LID	
☐ Wetland Protection	
☐ Other:	
☐ None	

Specific audiences targeted during this reporting period:

☒ Public Employees
☐ Residential
☐ Businesses
☐ Restaurants
☐ Other:

☒ Contractors
☐ Developers
☒ General Public
☐ Industries
☐ Agricultural

Additional Measurable Goals and Activities

Please list all stormwater training attended by your staff during the 2015 calendar year and list the name(s) and municipal position of all staff who attended the training.

Trainings: Overview of Roadway Drainage, Geotextiles and Erosion Control; 6/25/15

Attending name of staff and title: Sheleen Clark Assistant Director Facilities (Lands and Grounds)
Attending name of staff and title: Andy Alcusky Project Manager Utilities Dept.

MINIMUM CONTROL MEASURE #2:
PUBLIC INVOLVEMENT/PARTICIPATION (Part IV.B.2 General Permit)

SECTION I. OVERALL EVALUATION:

GENERAL SUMMARY, STATUS, APPROPRIATENESS AND EFFECTIVENESS OF MEASURABLE GOALS:

Include information relevant to the implementation of each measurable goal, such as types of activities and audiences/groups engaged. Discuss activities to be carried out during the next reporting cycle. If addressing TMDL requirements, please indicate rationale for the activities chosen to address the pollutant of concern.

(Note: Identify parties responsible for achieving the measurable goals and reference any reliance on another entity for achieving measurable goals.)

Responsible Party Contact Name: Andy Alcusky

Phone: (401) 874 2448 **Email:** aalcusky@uri.edu

IV.B.2.b.2.ii	Use the space below to describe audiences targeted for the public involvement minimum measure, include a description of the groups engaged, and activities implemented and if a particular pollutant(s) was targeted. If addressing TMDL requirements indicate how the audience(s) and/or activity address the pollutant(s) of concern. Name of person(s) and/or parties responsible for implementation of activities identified. Assess the effectiveness of BMP and measurable goal.

Audiences targeted include the students living on campus especially the freshman students new to the campus. Others targeted include staff both educational as well as support staff. Activities implemented include the storm drain marking program by the students. Support staff is required to attend annual review sessions on the prohibition of illicit discharges into the storm drainage system and the proper handling and disposal of all materials. Other activities targeted for involvement include the campus wide cleanup to reduce floatables and Earth day activities. Responsible parties include the URI Utilities Dept. Lands and Ground Dept., the Trash and Recycling dept. and the URI Safety and Risk Dept.

Opportunities provided for public participation in implementation, development, evaluation, and improvement of the Stormwater Management Program (SWMP) Plan during this reporting period. Check all that apply:

☒ Cleanup Events
☐ Comments on SWMP Received
☐ Community Hotlines
☐ Community Meetings
☐ Other (describe)

☐ Storm Drain Markings
☐ Stakeholder Meetings
☐ Volunteer Monitoring
☒ Plantings

Additional Measurable Goals and Activities

SECTION II. Public Notice Information (Parts IV.G.2.h and IV.G.2.i) *Note: attach copy of public notice

Was the availability of this Annual Report and the Stormwater Management Program Plan (SWMPP) announced via public notice? ☒ YES ☐ NO	If YES, Date of Public Notice: 2/18/16

How was public notified:

☐ List-Serve (Enter # of names in List: ________)
☐ TV/Radio Notices
☒ Newspaper Advertising
☐ Other:

Enter Web Page URL: ______________________

Was public meeting held? ☐ YES ☒ NO

Date:

Where:

Summary of public comments received: None at this time

Planned responses or changes to the program: None at this time

MINIMUM CONTROL MEASURE #3:
ILLICIT DISCHARGE DETECTION AND ELIMINATION (Part IV.B.3 General Permit)

SECTION I. OVERALL EVALUATION:

GENERAL SUMMARY, STATUS, APPROPRIATENESS AND EFFECTIVENESS OF MEASURABLE GOALS

Include information relevant to the implementation of each measurable goal, such as activities implemented (when reporting tracked and eliminated illicit discharges, please explain the rationale for targeting the illicit discharge) to comply with on-going requirements, and illicit discharge public education activities, audiences and pollutants targeted. Discuss activities to be carried out during the next reporting cycle. If addressing TMDL requirements, please indicate rationale for the activities chosen to address the pollutant of concern.

(Note: Identify parties responsible for achieving the measurable goals and reference any reliance on another entity for achieving measurable goals.)

Responsible Party Contact Name: Andy Alcusky

Phone: (401) 874-2448 **Email:** aalcusky@uri.edu

IV.B.3.b.1: If the outfall map was not completed, use the space below to indicate reasons why, proposed schedule for completion of requirement and person(s)/ Department responsible for completion. (The Department recommends electronic submission of updated EXCEL Tables if this information has been amended.)

Number of Outfalls Mapped: 89

Percent Complete: 100%

If 100% Complete, Provide Date of Completion: 11/2014

The outfall map was completed by the URI Utilities Dept. Outfall Location Tables have been completed and were included with the Year 5 report. The outfall map was updated in 2013 and was submitted to DEM as part of the 2013 report. The updated EXCEL tables will also be submitted (electronically) as part of this report. The Utilities Dept. used the original information from our consultant for the initial outfall map. In 2012through 2014 the Utility Dept. expanded the list from field observations during inspections and review of plans. No additional outfalls were identified in 2015. There will be new outfalls identified in 2016 as a couple of construction projects are completed.

IV.B.3.b.2 Indicate if your municipality chose to implement the tagging of outfalls activity under the IDDE minimum measure, activities and actions undertaken under the 2015 calendar year.

The University Utilities Dept chose to implement the tagging of outfalls under the IDDE minimum measure and tagged the outfalls in 2008. URI did not have any additions to the outfall list in 2015.

IV.B.3.b.3 Use the space below to provide a summary of the implementation of recording of system additional elements (catch basins, manholes, and/or pipes). Indicate if the activity was implemented as a result of the tracing of illicit discharges, new MS4 construction projects, and inspection of catch basins required under the IDDE and Pollution Prevention and Good Housekeeping Minimum Measures, and/or as a result of TMDL related requirements and/or investigations. Assess effectiveness of the program minimizing water quality impacts.

The Kingston Campus drainage system and its records were updated during 2015. Some of the updates are a result of new construction work on campus. Areas of new construction included the new Chemistry Building, the Butterfield Dining Hall modifications, electrical Sub-Station 1&2 and the new fraternity house (Sigma Chi). Other catch basins and drainage components were added to control flooding and erosion issues in a number of areas such as north of the steam plant, north of Coddington Hall and west of Quinn Hall. As noted in previous years more catch basins were discovered as drainage lines are traced and structures are uncovered. As a result of the construction activity and field inspection an additional 20 catch basins and 40 drain manholes were added to our inventory and 17 catch basins and 7 DMH's were removed from the inventory list. The entire drainage system is now recorded in GIS which allows for easier updates in the future. The changes in the quantities were a result of further mapping of the system, inspection of the system and updating changes due to recent construction. In addition to changes found during the field inspections, URI will continue to update the drainage system records as they receive the as-built drawings of the projects completed during the past calendar year. URI's Capital Projects Group provides a status of all projects on campus to the Facilities Dept. and as projects are closed out, the URI Utilities Dept. will then update the drainage records using the as-built drawings as well as any new info discovered during the yearly inspections.

IV.B.3.b.4 Indicate if the IDDE ordinance was not developed, adopted, and submitted to RIDEM, explain reasons why, submit proposed schedule for completion and identify person(s) / Department and/or parties responsible for the completion of this requirement.

Date of Adoption: ________

If the Ordinance was amended in 2015, please indicate why changes were necessary.

The University of Rhode Island has not developed this ordinance in the 2015 calendar year. The University owns the entire subject area and controls all activities on their property. The University is a state agency that has policies in place to ensure proper compliance to prohibit and enforce illicit discharges to the MS4. Policy enforcement is through a combination of inspections by Safety and Risk Management and Facilities Services Departments. The SR&M department receives, responds, investigates and files all incidents involving hazmat and other illicit discharge activities that might occur on campus. Investigations, corrective actions and enforcement activities are monitored and implemented through this office. We also conduct annual inspections throughout the campus for potential illicit discharges into the storm and waste water systems. We have developed a Spill Prevention and Containment Plan as required by the EPA that is designed to reduce the potential for illicit discharges into the sanitary and storm water systems.

IV.B.3.b.5.ii, iii, iv, & v	Use the space below to provide a summary of the implementation of procedures for receipt and consideration of complaints, tracing the source of an illicit discharge, removing the source of the illicit discharge and program evaluation and assessment as a result of removing sources of illicit discharges. Identify person(s) / Department and/or parties responsible for the implementation of this requirement.

All complaints (of any nature) are referred to the URI Control Center. The Control Center will log each call and then notify the appropriate department responsible for the complaint. If the complaint is relative to an illicit discharge to the storm system, the URI Utilities Dept will be responsible to respond to the complaint. The Utilities Dept. will evaluate the complaint, trace the origin of the illicit discharge, ensure that the illicit discharge is stopped immediately and assess if other procedures need to be implemented.

IV.B.3.b.5.vi	Use the space below to provide summary of implementation of catch basin and manhole inspections for illicit connections and non-stormwater discharges. If the required measurable goal of inspecting all catch basins and manholes for this purpose was not accomplished, please indicate reasons why, the proposed schedule of completion and identify person(s) / Department and/or parties responsible for the implementation of this requirement. Evaluate effectiveness of the implementation of this requirement. The operator must keep records of all inspections and corrective actions required and completed. **Number of Catch Basins and Manholes Inspected for illicit connections/IDDE:** 1241 **Percent Complete:** 98 % **Date of Completion:** 12/18/15

During 2015, the URI Utilities Dept. inspected all catch basins that were accessible throughout the Kingston Campus for illicit connections and non-storm water discharges. Approximately 2% of the drainage structures were not accessible (such as under platforms or large dumpsters) or under construction and were not inspected. The inspections were performed in conjunction with the surveying of the drainage system for inventory of the system and noting condition of the structures. Inspection of the catch basins also help determined which structures were in need of cleaning. URI recorded the inspection results in an Excel database in 2015. A total of 29 Work orders were issued as a result of these inspections. In most cases, work orders consisted of catch basins requiring a re-build or broken grates. URI will continue to inspect 100% of the accessible catch basins in 2016.

IV.B.3.b.5.vii	If dry weather surveys including field screening for non-stormwater flows and field tests of selected parameters and bacteria were not completed, indicate reasons why, proposed schedule for the completion of this measurable goal and person(s) / Department and/or parties for the completion of this requirement. Evaluate effectiveness of the implementation of this requirement. The results of the dry weather survey investigations must be submitted to RIDEM electronically, if not already submitted or if revised since 2009, in the RIDEM-provided EXCEL Tables and should include visual observations for all outfalls during both the high and low water table timeframes, as well as sample results for those outfalls with flow. The EXCEL Tables must include a report of all outfalls and indicate the presence or absence of dry weather discharges. **Number of Outfalls Surveyed once:** 89 **Number of Outfalls Surveyed twice:** 89 **Percent Complete:** 100 % **Date of Completion:** 07/07/2015

The University conducted two dry weather surveys in 2015. The University Utilities Dept. performed dry weather surveys on April 21, 2015 and July 7, 2015. In the first survey, flow was noted at twenty-three of the outfall sites. The origin of the flow in all cases was traced back to ground water or natural flow from wet areas. Flow was observed at five of the outfalls during the July 7, 2015 survey. The results of the surveys are shown in the Year 12 Report. The URI Utilities Dept conducted the surveys and the testing was performed by ESS Labs.

IV.B.3.b.7	Use the space below to provide a description of efforts and actions taken as a result of for coordinating with other physically interconnected MS4s, including State and federal owned or operated MS4s, when illicit discharges were detected or reported. Identify person(s) / Department and/or parties responsible for the implementation of this requirement. Evaluate effectiveness of the implementation of this requirement.

During 2015 the University did not have any issues with illicit discharges associated with other MS4's. The only interconnections with another MS4 are two drainage lines that connect 12 catch basins from the South Kingston MS4 to the URI drainage system. Since there are rather limited interconnections, the University has not encountered any illicit discharges from other MS4's to date.

IV.B.3.b.8	Use the space below to provide a description of efforts and actions taken for the referral to RIDEM of non-stormwater discharges not authorized in accordance to Part I.B.3 of this permit or another appropriate RIPDES permit, which the operator has deemed appropriate to continue discharging to the MS4, for consideration of an appropriate permit. Identify person(s) / Department and/or parties responsible for the implementation of this requirement. Evaluate effectiveness of the implementation of this requirement.

The University identified one new unauthorized non-storm water discharges during 2015. In Woodward Hall a sump pump in the mechanical room was found to be discharging into the storm drain system. A work order was issued and the sump pump discharge was re-directed into the sanitary system. One illicit discharge has not been resolved to date. In the Tootell Gym mechanical room, the sump pump discharges into Ellery Pond. The overflow from the pool can flow to this sump. Plans are being made to re-direct the sump pump discharge into the sanitary sewer system in 2016. The work to re-direct the sump pump discharge from the sump in Tootell could not be done in the building and is rather complicated and requires a significant amount of re-piping on the exterior of the building. A consulting engineer Gordon R Archibald, is currently preparing plans to re-direct this discharge into the sanitary system.

IV.B.3.b.9	Use the space below to provide a description of efforts and actions taken to inform public employees, businesses, and the general public of hazards associated with illegal discharges and improper disposal of waste, as well as allowable non-stormwater discharges identified as significant contributors of pollutants. Include a description on how this activity was coordinated with the public education minimum measure and the pollution prevention/good housekeeping minimum measure programs. Identify person(s) / Department and/or parties responsible for the implementation of this requirement. Evaluate effectiveness of the implementation of this requirement.

All of the University's Facility Services personnel must attend annual training on identifying the materials that the employees are exposed, spill prevention plans, spill control procedures and the proper means of material disposal. The University's Safety & Risk Dept. conducts numerous trainings throughout the year in proper disposal of wastes and especially hazardous wastes. All employees working with the waste stream are required to attend re-fresher courses. The Safety and Risk Dept. added another module to their training program to reinforce the fact that dumping anything down a storm drain is a violation of the law and employees could face disciplinary action if they ignore this requirement. Staff employees have been trained to comply with spill control procedures and the proper disposal of waste. A campus wide effort to inform students, staff and visitors was implemented. By directing the lawn mower discharge back into vegetated areas where possible, the University's Lands and Grounds personnel have been can limit the amount of lawn waste from being blown on impervious surfaces where it will flow into the storm drainage system.
All contractors working on campus are required per contract to properly dispose of all waste material and are allowed only permitted discharges into the storm drainage system.
The University's Utilities Dept, The Safety and Risk Dept. and the Office of Capital Projects are tasked to monitor this requirement.

Additional Measurable Goals and Activities

SECTION II.A Other Reporting Requirements - Illicit Discharge Investigation and System Mapping (Part IV.G.2.m)

# of Illicit Discharges Identified in 2015: 1	# of Illicit Discharges Tracked in 2015: 2
# of Illicit Discharges Eliminated in 2015:	# of Complaints Received: 0
# of Complaints Investigated: 0	# of Violations Issued: 0
# of Violations Resolved: 0	# of Unresolved Violations Referred to RIDEM: 0
Total # of Illicit Discharges Identified to Date (since 2003): 8	Total # of Illicit Discharges remaining unresolved at the end of 2015: 1

Summary of Enforcement Actions:
The university will need to re-pipe the sump discharge from the mechanical room of the Tootell Gym. The sump can collect some of the pool overflow. Currently the pool discharges into a storm drainage line that flows into Ellery Pond. The University has procured the services of a Gordon R Archibald to re-design the discharge of this sump to a proper destination.
The University identified one new illicit discharge in 2015 located in the mechanical room in Woodward Hall where a sump pump was discharging into the drainage system. A work order was issued and the discharge from this sump pump has been re-directed into the sanitary sewer system.

Extent to which the MS4 system has been mapped: 99%.
The University continued updating drainage data and maps on GIS during 2015. Maps were updated mostly in new construction areas such as the new Chemistry Building and the expansion of the Butterfield Dining Hall. Other additions included some recent work by the URI Lands and Grounds Dept. The Utilities Dept. also uncovered three more buried drainage structures in 2015. A total of 89 outfalls have been identified. No new outfalls were identified in 2015.

Total # of Outfalls Identified and Mapped to date: **89**

SECTION II.B Interconnections (Parts IV.G.2.k and IV.G.2.l)

Interconnection:	Date Found:	Location:	Name of Connectee:	Originating Source:	Planned and Coordinated Efforts and Activities with Connectee:
24" Storm Drain	2-8-11	Briar Lane	South Kingston	Wetlands south of Briar Lane	Agreed to notify SK Engineer of any issues
12" Storm Drain	2-8-11	Fortin Road	South Kingston	2 Catch Basins on Fortin Road	Agreed to notify SK Engineer of any issues
12" Storm Drain	2-8-11	Chapel Road	South Kingston	10 Catch Basins on Chapel Road	Agreed to notify SK Engineer of any issues

MINIMUM CONTROL MEASURE #4:
CONSTRUCTION SITE STORMWATER RUNOFF CONTROL
(Part IV.B.4 General Permit)

SECTION I. OVERALL EVALUATION:

GENERAL SUMMARY, STATUS, APPROPRIATENESS AND EFFECTIVENESS OF MEASURABLE GOALS:

Include information relevant to the implementation of each measurable goal, such as activities implemented to support the review, issuance and tracking of permits, inspections and receipt of complaints. Discuss activities to be carried out during the next reporting cycle. If addressing TMDL requirements, please indicate rationale for the activities chosen to address the pollutant of concern.

(Note: Identify parties responsible for achieving the measurable goals and reference any reliance on another entity for achieving measurable goals.)

Responsible Party Contact Name: Andy Alcusky

Phone: (401) 874-2448 **Email:** aalcusky@uri.edu

IV.B.4.b.1	Indicate if the Sediment and Erosion Control and Control of Other Wastes at Construction Sites ordinance was not developed, adopted, and submitted to RIDEM, explain reasons why, submit proposed schedule for completion and identify person(s) / Department and/or parties responsible for the completion of this requirement. **Date of Adoption:** ________ If the Ordinance was amended in 2015, please indicate why changes were necessary. Please also indicate if amendments have been made based on the 2010 *RI Stormwater Design and Installation Standards Manual*, and provide references to the amended portions of the local codes/ordinances.

An ordinance for Sediment and Erosion Control and Control of Other Wastes at Construction Sites ordinance was not developed. The University does not have a mechanism to develop ordinances. The University owns all of the subject area and controls all activities on its properties. The mechanism to ensure proper erosion and sediment controls and control of other wastes is our "General Plans and Specifications" developed for and under the direction of the Office of Capital Projects by an A/E firm. Under Division 2, Site Construction, we require erosion and sediment control as well as the control of other wastes. These requirements are site specific and are developed by the A/E firm for each project. The requirements are enforced and managed by the project manager of each construction project. If the requirements are not met, we impose corrective actions in order to bring the project back into compliance. Failure to comply with the contract requirements results in a breach of contract and is dealt with according to contract law.

IV.B.4.b.6	Use the space below to describe actions taken as a result of receipt and consideration of information submitted by the public.

Information from the public would be documented and evaluated by the University with a response provided after the evaluation. In 2015 the University did not receive any information or requests for information from the public.

IV.B.4.b.8	Use the space below to describe activities and actions taken as a result of referring to the State non-compliant construction site operators. The operator may rely on the Department for assistance in enforcing the provisions of the RIPDES General Permit for Stormwater Discharges Associated with Construction Activity to the MS4 if the operator of the construction site fails to comply with the local and State requirements of the permit and the non-compliance results or has the potential to result in significant adverse environmental impacts.

The University did not have any referrals to the State for assistance in enforcing any part of RIPDES General Permit for Storm Water Discharge Associated with Construction Activity to this MS4 in 2015.

Additional Measurable Goals and Activities

SECTION II. A - Plan and SWPPP/SESC Plan Reviews during Year 12 (2015), Part IV.B.4.b.2: Issuance of permits and/or implementation of policies and procedures for all construction projects resulting in land disturbance of greater than 1 acre. **Part IV.B.4.b.4:** Review 100% of plans and SWPPPs/SESC Plans for construction projects resulting in land disturbance of 1-5 acres must be conducted by adequately trained personnel and incorporate consideration of potential water quality impacts.

# of Construction Reviews completed: 0
# of Permits/Authorizations issued: 0
% of Total: N/A

Summary of Reviews and Findings, include an evaluation of the effectiveness of the program. Identify person(s) /Department and/or parties responsible for the implementation of this requirement.

There was no new development in 2015 that would require the plan reviews. It is expected that the plans for the new Engineering Complex would be ready for review in 2016.

SECTION II.B - Erosion and Sediment Control Inspections during Year 12 (2015), Parts IV.G.2.n and IV.B.4.b.7: Inspection of 100% of all construction projects within the regulated area that discharge or have the potential to discharge to the MS4 (the program must include two inspections of all construction sites, first inspection to be conducted during construction for compliance of the Erosion and Sediment controls at the site, the second to be conducted after the final stabilization of the site).

# of Active Construction Projects: 4	
# of Site Inspections: 5	# of Complaints Received: 5
# of Violations Issued: 0	# of Unresolved Violations Referred to RIDEM: 0

Summary of Enforcement Actions, include an evaluation of the effectiveness of the program. Identify person(s) /Department and/or parties responsible for the implementation of this requirement.

Final inspections were conducted by URI Utilities Dept. personnel at the Butterfield Dining Hall Expansion, new Electrical Sub-Station 1&2 and the Sigma Chi Fraternity. Initial construction inspections were performed at the new electrical Sub-Station 1&2. The Chemistry Project will not be complete until 2016.

Our records do not indicate any un-resolved complaints at any of these projects.

MINIMUM CONTROL MEASURE #5:
POST CONSTRUCTION STORMWATER MANAGEMENT IN NEW DEVELOPMENT AND REVELOPMENT
(Part IV.B.5 General Permit)

SECTION I. OVERALL EVALUATION:

GENERAL SUMMARY, STATUS, APPROPRIATENESS AND EFFECTIVENESS OF MEASURABLE GOALS:

Include information relevant to the implementation of each measurable goal, such as activities implemented to support the review, issuance and tracking of permits, inspections and receipt of complaints, etc. Please indicate if any projects have incorporated the use of Low Impact Development techniques. Discuss activities to be carried out during the next reporting cycle. If addressing TMDL requirements, please indicate rationale for the activities chosen to address the pollutant of concern.

(Note: Identify parties responsible for achieving the measurable goals and reference any reliance on another entity for achieving measurable goals.)

Responsible Party Contact Name: Andy Alcusky

Phone: (401) 874-2448 **Email:** aalcusky@uri.edu

IV.B.5.b.5	Use the space below to describe activities and actions taken to coordinate with existing State programs requiring post-construction stormwater management.

Long term BMP maintenance schedules are required to be included as part of the approval process for new development. Maintenance schedules are developed in accordance to the Rhode Island Stormwater design and Installation Standards Manual.

IV.B.5.b.6	Use the space below to describe actions taken for the referral to RIDEM of new discharges of stormwater associated with industrial activity as defined in RIPDES Rule 31(b)(15) (the operator must implement procedures to identify new activities that require permitting, notify RIDEM, and refer facilities with new stormwater discharges associated with industrial activity to ensure that facilities will obtain the proper permits).

There was not any new industrial activity at this MS4 in 20015. Therefore there were no referrals to the State for any new discharges of storm water associated with industrial activity.

IV.B.5.b.9	Indicate if the Post-Construction Runoff from New Development and Redevelopment Ordinance was <u>**not**</u> developed, adopted, and submitted to RIDEM, explain reasons why, submit proposed schedule for completion and identify person(s) / Department and/or parties responsible for the completion of this requirement. **Date of Adoption:** ________ If the Ordinance was amended in 2015, please indicate why changes were necessary. Please also indicate if amendments have been made based on the 2010 *RI Stormwater Design and Installation Standards Manual*, and provide references to the amended portions of the local codes/ordinances.

The Post-Construction Runoff from New Development and Redevelopment Ordinance was not developed. The University does not have a mechanism to develop ordinances. The University owns the subject area and controls all activities on its property. The mechanism to ensure proper post construction erosion and sediment controls and control of other wastes post construction is also our "General Plans and Specifications" developed for and under the direction of the Office of Capital Projects by an A/E firm. Under Division 2, Site Construction, we require erosion and sediment control as well as the control of other wastes. Post construction requirements are included in the storm water prevention plans developed for each project by the A/E firm. The requirements are enforced and managed by the project manager of each construction project in conjunction with our own certified inspector. If the requirements are not met, we impose corrective actions in order to bring the project back into compliance. Failure to comply with the contract requirements results in a breach of contract and is dealt with according to contract law.

IV.B.5.b.12	Use the space below to describe activities and actions taken to identify existing stormwater structural BMPs discharging to the MS4 with a goal of ensuring long term O&M of the BMPs.

A list of BMPs was formulated in the Drainage Master Plan of 2006. In 2008, the list of BMPs was updated to include new BMPs since the Master Drainage Plan was developed. The procedure to add new BMPs and delete the BMP's removed during new construction is an annual task for the Utilities Dept. The Utilities Dept. updates the maintenance requirements for each new BMP. Each year the University updates this list as new work is completed on campus. In 2015 the number of BMP's increased and the updated list is included with the report. The BMP list increased due to a number of projects completed in the past year. The University uses the BMP list to schedule BMP maintenance.

Additional Measurable Goals and Activities

SECTION II.A. - Plan and SWPPP/SESC Plan Reviews during Year 12 (2015), Part IV.B.5.b.4: Review 100% of post-construction BMPs for the control of stormwater runoff from new development and redevelopment projects that result in discharges to the MS4 which incorporates consideration of potential water quality impacts (the program requires reviewing 100% of plans for development projects greater than 1 acre, not reviewed by other State programs).

# of Post-Construction Reviews completed: 0
# of Permits/Authorizations issued: 0
% of Total: N/A

Summary of Reviews and Finding, include an evaluation of the effectiveness of the program. Identify person(s) /Department and/or parties responsible for the implementation of this requirement.
There was no new development in 2015 that would require the plan reviews. It is expected that the plans for the new Engineering Complex would be ready for review in 2016.

SECTION II.B. - Post Construction Inspections during Year 12 (2015), Parts IV.G.2.o and IV.B.5.b.10 - Proper Installation of Structural BMPs: Inspection of BMPs, to ensure these are constructed in accordance with the approved plans (the program must include inspection of 100% of all development greater than one acre within the regulated areas that result in discharges to the MS4 regardless of whom performs the review).

# of Active Construction Projects: 3	
# of Site Inspections for proper Installation of BMPs: 9	# of Complaints Received: 0
# of Violations Issued: 0	# of Unresolved Violations Referred to RIDEM: 0

Summary of Enforcement Actions:
No enforcement actions were required. The URI Utilities Dept. conducted post construction inspections of four new BMP's at the new Chemistry Building, 2 new BMP's at the expanded Butterfield Dining Hall, one new BMP at the new electrical Sub-Stations, and two BMP's installed by URI's Lands and Grounds Dept.

SECTION II.C. - Post Construction Inspections during Year 12 (2015), Parts IV.G.2.p and IV.B.5.b.11 - Proper Operation and Maintenance of Structural BMPs: Describe activities and actions taken to track required Operations and Maintenance (O&M) actions for site inspections and enforcement of the O&M of structural BMPs. Tracking of required O&M actions for site inspections and enforcement of the O&M of structural BMPs.

# of Site Inspections for proper O&M of BMPs: 94	# of Complaints Received: 0
# of Violations Issued: 0	# of Unresolved Violations Referred to RIDEM: 0

Summary of Activities and Enforcement Actions. Evaluate the effectiveness of the Program in minimizing water quality impacts. Identify person(s) /Department and/or parties responsible for the implementation of this requirement.
The Utilities Dept. conducted inspections of all structural BMP's throughout the campus. The post construction inspections are done as part of the overall BMP inspections throughout campus. A total of 37 work orders were issued to the Lands & Grounds Dept. for maintenance. The inspections provide a good mechanism to identify potential problems (such as flooding risks to buildings) in addition to the environmental concerns. When the work orders are completed the Utilities Dept. verifies that the work was properly completed.

Strategies being implemented to ensure long-term Operation and Maintenance (O&M) of privately-owned BMPs, check all that apply in your municipality/MS4:

☒ None, No privately owned BMP's
☐ Ordinances or by-laws identify BMP inspection responsible party
☐ Ordinances or by-laws identify BMP maintenance responsible party
☐ Ordinances or by-laws identify BMP inspections and maintenance requirements
☐ Ordinances or by-laws provide for easements or covenants for inspections and maintenance
☐ Ordinances or by-laws require for every constructed BMP an inspections and maintenance agreement
☐ Ordinances or by-laws contain requirements for documenting and detailing inspections
☐ Ordinances or by-laws contain requirements for documenting and detailing maintenance
☐ Ordinances or by-laws contain authority to enforce for lack of maintenance or BMP failure
☐ The MS4 is responsible for inspections of all privately-owned BMPs
☐ The MS4 is responsible for maintenance of all privately-owned BMPs
☐ Establishment of escrow account for use in case of failure of BMP
☐ Other strategies to ensure long-term O&M of privately-owned BMPs, describe:
☒ The University does not have any privately owned BMP's. All BMP's are MS4 owned BMP's.

Do you have an inventory of privately owned BMPs? ☐ YES ☒ N/A

Do you have a system for tracking:

a.	Agreements and arrangements to ensure O&M of BMPs?	☐ YES	☒ N/A
b.	Inspections?	☐ YES	☒ N/A
c.	Maintenance plans and schedules of privately-owned BMPs?	☐ YES	☒ N/A
d.	Complaints?	☐ YES	☒ N/A
e.	Non-Compliance?	☐ YES	☒ N/A
f.	Enforcement actions?	☐ YES	☒ N/A

Do you use an electronic tool (e.g. GIS, database, spreadsheet) to track post-construction BMPs, inspections, and maintenance? ☒ YES ☐ NO

If yes, please elaborate on which tools are used:

URI uses electronic spread sheets to track post construction BMP's

NOTE: BMP maintenance tasks can be a great way to involve and educate the community to their purpose and function. BMPs have the potential to create a highly interactive environment for community members and volunteers to get involved.

MINIMUM CONTROL MEASURE #6:
POLLUTION PREVENTION AND GOOD HOUSEKEEPING IN MUNICIPAL OPERATIONS
(Part IV.B.6 General Permit)

SECTION I. OVERALL EVALUATION:

GENERAL SUMMARY, STATUS, APPROPRIATENESS AND EFFECTIVENESS OF MEASURABLE GOALS:

Include information relevant to the implementation of each measurable goal, such as activities and practices used to address on-going requirements, and personnel responsible. Discuss activities to be carried out during the next reporting cycle. If addressing TMDL requirements, please indicate rationale for the activities chosen to address the pollutant of concern.

(Note: Identify parties responsible for achieving the measurable goals and reference any reliance on another entity for achieving measurable goals.)

Responsible Party Contact Name: Andy Alcusky

Phone: (401) 874-2448 **Email:** aalcusky@uri.edu

IV.B.6.b.1.i

Use the space below to describe activities and actions taken to identify structural BMPs owned or operated by the small MS4 operator (the program must include identification and listing of the specific location and a description of all structural BMPs in the SWMPP and update the information in the Annual Report). Evaluate appropriateness and effectiveness of this requirement.

Do you have an inventory of MS4-owned BMPs? ☒ YES ☐ NO

The University updates the list of BMP's annually. BMP's are added/removed as a result of new construction activity. The BMP list is also updated as a result of various other stormwater inspections such as catch basin and outfall inspections. Other BMP's are discovered during storm events when we observe storm water flow throughout the campus. In 2015, eleven new BMP's were added to our inventory of BMP's. The University's Utilities Dept. uses this inventory for planned inspections/maintenance of the BMP's. The BMP inventory list is a useful tool to ensure proper inspection of all BMP's.

IV.B.6.b.1.ii

Use the space below to describe activities and actions taken for inspections, cleaning and repair of detention/retention basins, storm sewers and catch basins with appropriate scheduling given intensity and type of use in the catchment area. Evaluate appropriateness and effectiveness of this requirement.

Do you have a system for tracking:

a. Inspection schedules of MS4-owned BMPs? ☒ YES ☐ NO
b. Maintenance/cleaning schedules of MS4-owned BMPs? ☒ YES ☐ NO
c. Repairs, corrective actions needed? ☒ YES ☐ NO
d. Complaints? ☒ YES ☐ NO

Do you use an electronic tool (e.g. GIS, database, spreadsheet) to track stormwater BMPs, inspections, and maintenance? ☒ YES ☐ NO

The University's BMP inventory spreadsheet lists the inspection and maintenance requirements for each BMP. Results of the inspections and any maintenance /corrective actions taken are included in an expanded portion of the BMP inventory spreadsheet.

IV.B.6.b.1.iii	Use the space below to describe activities and actions taken to support the requirement of yearly inspection and cleaning of all catch basins (a lesser frequency of inspection based on at least two consecutive years of operational data indicating the system does not require annual cleaning might be acceptable). Evaluate appropriateness and effectiveness of this requirement.

Total # of CBs within regulated area (including SRPW and TMDL areas): 926

Total # of CB's within regulated area with sumps: 724

Total # of CBs inspected in 2015: 916

Total # of CBs cleaned in 2015: 512 **% of Total:** 56% (all CB's) **70%** CB's w/Sumps

Quantity of sand/debris collected by cleaning of catch basins: 38 small dump trucks about 2800 CF

Location used for the disposal of debris: On university property at soil stockpile compost area

Do you use an electronic tool (e.g. GIS, database, spreadsheet) to track the inspections and cleaning of catch basins? ☒ YES ☐ NO

The University uses their catch basin inventory spread sheet to record inspection and cleanings on drainage structures. Generally the catch basins along all roads are cleaned yearly. These basins generally need annual cleanings due mainly to the amount of leaves that flow into the basins. Basins located in turf areas usually do not require the annual cleanings but are inspected annually. Basins in turf areas are usually cleaned every other year.

IV.B.6.b.1.iv	Use the space below to describe activities and actions taken to minimize erosion of road shoulders and roadside ditches by requiring stabilization of those areas. Evaluate appropriateness and effectiveness of this

In 2015, the University worked in a number of areas to minimize erosion of road shoulders and sloped areas throughout the campus.

Additional Improvements included the following:

- Curbing was installed on the north side of West Alumni Ave in the vicinity of the new electrical sub-stations. The curbing was installed to limit erosion from water flowing west down West Alumni Ave and then cutting across the new sub-station site and eroding a slope on the west side of the sub-station site.
- A contractor working for the URI Lands and Grounds Dept. installed new asphalt berms on the westerly and southerly roads of Fraternity Circle. The berms were used to direct storm water to the closed drainage system and stop the flow from eroding the shoulders.
- A catch basin and associated discharge piping was installed in a parking lot north of the steam plant. The catch basin was installed to capture water that flowed downed the sides of an adjacent walkway with erosion as a result. The new catch basin captures most of this flow.
- On the north side of the Library precast curbing was installed on the south side of west Alumni Ave to direct storm water flow to the closed drainage system. Prior to this change some of the storm flow would be eroding the adjacent shoulder and flooding the basement of the Library.
- At a walkway just south of Quinn Hall, a drain manhole was converted into a catch basin to capture storm flow traveling on the north side of the walkway.
- Precast concrete curbing was installed on the west side of Tootell Road opposite the Sherman building to direct storm flow to the adjacent paved waterways.

Most roadways throughout campus have curbs to minimize erosion. Swales and ditches are also used to limit erosion of road side shoulders. Areas that have been disturbed by winter activities are repaired and seeded in the spring. The University has been making a concerted effort to funnel pedestrian traffic to remain on walkways and have been trying to restrict pedestrian traffic from shortcuts across landscaped areas. Other areas that could be subject to erosion are being identified to be addressed in 2016. The effects of repaired areas are readily apparent with less eroded material accumulating in the roads and drainage system.

IV.B.6.b.1.v	Use the space below to describe activities and actions taken to identify and report known discharges causing scouring at outfall pipes or outfalls with excessive sedimentation, for the Department to determine on a case-by-case basis if the scouring or sedimentation is a significant and continuous source of sediments. Evaluate appropriateness and effectiveness of this requirement.

During the annual inspection of outfalls, the outfalls are inspected for scouring and excessive sedimentation. Areas that are in need of repair are reported to the URI Control Center and a work order is generated.

There were eleven outfalls identified in 2015 where there was extensive sedimentation. There were ten outfalls with excessive vegetation identified in 2015. These outfalls were cleaned up by the URI Lands & Grounds Dept.

The inspections of the outfalls are not only a requirement but provide a tremendous tool to identify potential storm water flow issues prior to a significant rain event.

IV.B.6.b.1.vi	Use the space below to indicate if all streets and roads within the urbanized area were swept annually and if not indicate reason(s). Evaluate appropriateness and effectiveness of this requirement.

Total roadway miles within regulated area (including SRPW and TMDL areas): 4 miles

Total roadway miles that were swept in 2015: 4 miles **% of Total:** 100%

Type of sweeper used: ☒ Rotary brush street sweeper ☒ Vacuum street sweeper

Quantity of sand/debris collected by sweeping of streets and roads: About 200 CF

Location used for the disposal of debris: Soil stockpile site on University Property

Do you use an electronic tool (e.g. GIS, database, spreadsheet) to track the annual sweeping of streets and roads? ☐ YES ☒ NO

All roadways and most parking lots are swept each spring to remove sand and sediment as a result of winter storms. Parking lots not swept such as porous pavement parking lots are vacuumed. Additional sweeping of roads also occurs just prior to commencement activities in May as well as needed throughout the year. The work is required not only for runoff concerns but as well as safety issues with bicycles and other modes of transport across campus and for general aesthetics. The sweeping of the roads is performed by outside contractors under the direction of the Lands and Ground Dept. The University uses only a limited amount of sand during the winter months.

IV.B.6.b.1.vii	Use the space below to describe activities and actions taken for controls to reduce floatables and other pollutants from the MS4. Evaluate appropriateness and effectiveness of this requirement.

The vast majority of the floatables encountered was trash. During 2015 the University has continued staffing part time workers in the trash and recycling crews in order to provide trash and recycling coverage seven days per week. Locations of trash and recycling bins have increased and locations changed to better suit the foot traffic. Trash and recycle bins are emptied daily during the week. Local building superintendents and custodian staff have been instructed to call the Control center if they see a trash or recycle container full.

A number of community events were scheduled to reduce trash throughout the campus. Events included a Fraternity Circle cleanup event with approximately 200 students, a student senate campus cleanup that involved 30 students, an off campus event in November that concentrated on some of the major roads leading to the campus, and a cleanup of the wetlands north of the new electric substation.

Another source for litter cleanup is the use of students needing to perform community service. Most of these students are tasked with cleaning certain sections of the campus to meet the community service mandates.

The added efforts to increase recycling has had a noticeable effect on the campus, as recycle tonnage has increased, trash tonnage has decreased and the campus appearance has significantly improved.

IV.B.6.b.1.viii	Use the space below to describe the method for disposal of waste removed from MS4s and waste from other municipal operations, including accumulated sediments, floatables and other debris and methods for record-keeping and tracking of this information. Do you have a system for tracking actions to remove and dispose of waste? ☐ YES ☒ NO

Sediments removed from drainage structures and ponds (if tests indicate that they are acceptable) are re-used for fill projects throughout the campus. Trash and recyclable materials are trucked off campus. The URI Lands and Grounds Dept. and Utilities Dept. are responsible for this activity. Presently the amount of waste has not been estimated. Sediment waste is estimated by the quantity of full truckloads of sediment removed. URI has not developed a means to track the sediment removed from each drainage structure. Floatables are removed on a regular basis from waterways and adjacent areas, but quantities are not kept. Efforts to limit the litter on campus have shown significant improvement over the past five years. Our outfall inspections noted fewer areas with trash present.

IV.B.6.b.4 and IV.B.6.b.5	Use the space below to describe and indicate activities and corrective actions for the evaluation of compliance. This evaluation must include visual quarterly monitoring; routine visual inspections of designated equipment, processes, and material handling areas for evidence of, or the potential for, pollutants entering the drainage system or point source discharges to a waters of the State; and inspection of the entire facility at least once a year for evidence of pollution, evaluation of BMPs that have been implemented, and inspection of equipment. A Compliance Evaluation report summarizing the scope of the inspection, personnel making the inspection, major observations related to the implementation of the Stormwater Management Plan (formerly known as a Stormwater Pollution Prevention Plan), and any actions taken to amend the Plan must be kept for record-keeping purposes.

The URI Utilities Dept. conducted quarterly monitoring and routing inspections of the URI Facilities Areas in 2015. A full inspection of the Facilities Services area of the campus was also performed and is documented in the evaluation report. URI has a SPCC Plan in place. This Facilities Area is monitored on a regular basis and routine walkthroughs occur at least once a month.

<table>
<tr><td>IV.B.6.b.6</td><td>Use the space below to describe all employee training programs used to prevent and reduce stormwater pollution from activities such as park and open space maintenance, fleet and building maintenance, new construction and land disturbances, and stormwater system maintenance for the past calendar year, including staff municipal participation in the URI NEMO stormwater public education and outreach program and all in-house training conducted by municipality or other parties. Evaluate appropriateness and effectiveness of this requirement.

How many stormwater management trainings have been provided to <i>municipal employees</i> during this reporting period? 1 Training Session Repeated Five Times during the Year Part of Annual Waste Disposal Training

What was the date of the last training? 09/24/15

How many <i>municipal employees</i> have been trained in this reporting period? 215

What percent of <i>municipal employees</i> in relevant positions and departments receive stormwater management training? 100%</td></tr>
<tr><td colspan="2">The University requires the Facilities Dept staff to attend refresher courses on material handling and proper disposal annually. These courses are conducted by the URI Safety and Risk Dept.
The annual refresher courses for the staff, is needed not only per regulations, but it is a useful tool to reinforce the reasons why the regulations are required. Attendees of the material handling safety course have noted some potential issues with disposal of some of their cleaning products. The custodial staff had noted the difficulty emptying their waxing machines in the proper manner. As a result of the safety sessions the University's Safety and Risk Dept is working with the custodial staff to ensure the waste products are not discharged into the storm water system. The training program has also eliminated potential illicit discharges into the storm water system. Inquiries have been made prior to the work starting on acceptable methods of cleaning equipment and acceptable means of disposing the waste water.</td></tr>
<tr><td>IV.B.6.b.7</td><td>Use the space below to describe actions taken to ensure that new flow management projects undertaken by the operator are assessed for potential water quality impacts and existing projects are assessed for incorporation of additional water quality protection devices or practices. Evaluate appropriateness and effectiveness of this requirement.</td></tr>
<tr><td colspan="2">RIDEM permitting will be required for all new flow management projects to assess water quality impacts. The University encourages infiltration and groundwater recharge utilization in new projects and re-developments. The College of Pharmacy, the Hillside Residence Hall, the Wellness & Fitness Center, and the Flagg Road Extension are examples of recent completed projects where multiple water quality practices have been utilized. The new Chemistry Building is an example of a project currently under construction following this requirement. In addition, the University is considering other small detainage/infiltration areas in small scale projects to decrease storm water impacts. The planned renovation of the Fine Arts Parking Lot and the construction of the new Engineering Complex will also incorporate a variety of flow management practices as well. All of these projects will improve not only water quality but also decrease the severity of flood events.</td></tr>
<tr><td colspan="2">Additional Measurable Goals and Activities</td></tr>
</table>

SECTION II.A - Structural BMPs (Part IV.B.6.b.1.i)

POLLUTION PREVENTION AND GOOD HOUSEKEEPING IN MUNICIPAL OPERATIONS cont'd

BMP ID:	Location:	Name of BMP Owner/Operator:	Description of BMP:
BMP-01	Northwest of Independence Square and south of the Intramural athletic	URI	Level Spreader
BMP-02	Ballentine Hall Detention Pond, north of Ballentine Hall	URI	Detention Pond
BMP-03	Butterfield Rd Sedimentation box; North of Hope Dining Hall	URI	Sedimentation Box
BMP-04	CBLS Rain Garden	URI	Rain Garden
BMP-05	North of CHI PHI Fraternity House, NW of Weldin Hall	URI	Detention structure, Stormceptor
BMP-06	BMP removed	URI	Detention Area removed as part of College of Pharmacy Project
BMP-07	Culvert at Route 138 Crossing White Horn Brook	URI	Culvert
BMP-08	White Horn Brook Culvert at Fraternity Circle Footpath	URI	Culvert
BMP-09	White Horn Brook Culvert at Fraternity Circle	URI	Culvert
BMP-10	White Horn Brook Culvert East of Mackal Gym	URI	Culvert
BMP-11	White Horn Brook Culvert at Elephant Walk	URI	Culvert
BMP-01	White Horn Brook Culvert West of Dorr Hall	URI	Culvert
BMP-02	White Horn Brook Culvert West Alumni Avenue	URI	Culvert
BMP-14	White Horn Brook Culvert at Flagg Road	URI	Culvert
BMP-15	Culvert Crossing Plains Road just South of Central Receiving Warehouse	URI	Culvert
BMP-16	Dairy Barn Parking Lot; North of Meade Stadium	URI	Pervious Parking Surface
BMP-17	Eddy Hall Infiltration System	URI	Infiltration System for Roof Drainage
BMP-18	Ellery Pond	URI	Detention Pond
BMP-19	Flagg Road Parking Lot West detention Basin	URI	Detention Pond
BMP-20	Flagg Road Parking Lot East Detention Basin	URI	Detention Pond
BMP-21	Swale East of Heathman Road	URI	Swale
BMP-22	Merrow Hall Detention Area West of Merrow Hall	URI	Detention Pond
BMP-23	Plains Road Parking Lot	URI	Swales, Infiltration System
BMP-24	Plains Road Parking Lot	URI	Pervious Parking Surface
BMP-25	Ryan Center/Tootell Vortechnics Units	URI	Vortechnics
BMP-26	Swale North of Sherman Building	URI	Swale
BMP-27	Fraternity Circle Swale – North of Sigma Chi	URI	Swale
BMP-28	White Horn Brook	URI	Stream/drainage Conduit
BMP-29	Infiltration Systems at Wiley/Garrahy Halls	URI	Infiltration Systems
BMP-30	Hope Dining Hall Drainage	URI	CB/DMH & Piping Drainage system

POLLUTION PREVENTION AND GOOD HOUSEKEEPING IN MUNICIPAL OPERATIONS cont'd

BMP-31	Freshman Dorms Drainage System	URI	CB/DMH & Piping Drainage System
BMP-32	Wiley/Garrahy Drainage System	URI	CB/DMH & Piping Drainage System
BMP-33	Eddy Hall Drainage System	URI	CB/DMH & Piping Drainage System
BMP-34	Flagg Road Swale (North of Flagg Road)	URI	Swale
BMP-35	Plains Road Parking Lot drainage	URI	Drainage System
BMP-36	Campus Wide Catch Basins	URI	Drainage System
BMP-37	Campus Wide DMH's	URI	Drainage System
BMP-38	Campus Wide Street Sweeping	URI	Street Sweeping
BMP-39	Campus Wide Parking Lots Sweeping	URI	Parking Lot Sweeping
BMP-40	Flagg Road/Plains Road Catch Basins	URI	Drainage System
BMP-41	Coastal Institute Catch Basins	URI	Drainage System
BMP-42	Campus Wide Streets and Walkways	URI	Inspect on a regular basis for potential erosion issues
BMP-43	Campus Wide Outfalls	URI	Outfalls
BMP-44	Outfall Map	URI	Outfall Map
BMP-45	Independence Square Infiltration System	URI	Infiltration System
BMP-46	Roger Williams Detention Pond	URI	Detention Pond
BMP-47	Open Channel North of Hope Dining Hall	URI	Waterway
BMP-48	Open Channel South of Hutchinson Hall	URI	Waterway
BMP-49	Retaining Wall South of CBLS	URI	BMP Removed in 2015 as Part of New Chemistry Building
BMP-50	CBLS Green Roof	URI	Green roof
BMP-51	CBLS Stormceptor	URI	Sedimentation unit
BMP-52	Hillside Dorm Water Quality Structures	URI	Sedimentation Unit
BMP-53	Hillside Dorms Bio-retention Areas	URI	Bio-retention area
BMP-54	Infiltration Basin south of Baird Hill Road and West of Lower College Road	URI	Infiltration Basin
BMP-55	Bio-Retention Area North of College of Pharmacy	URI	Bio-Retention Area
BMP-56	Swale south of Parking Services Building	URI	Swale
BMP-57	Swale East of Hillside East Access Road	URI	Swale
BMP-58	Paved swales at Keaney Parking Lot	URI	Swale
BMP-59	Sherman East Lot infiltration System	URI	Infiltration System
BMP-60	Wellness Center Infiltration System	URI	Infiltration System
BMP-61	Culverts Crossing Plains Road North of Flagg Road	URI	Culverts

BMP-62	Culverts Crossing Flagg Road West of Plains Road	URI	Culverts
BMP-63	Flagg Road Extension Detention/Infiltration Basin "A"	URI	Infiltration Systems
BMP-64	Flagg Road Extension Porous Paving Lot	URI	Pervious Parking Surface
BMP-65	Central Receiving Infiltration	URI	Infiltration System
BMP-66	Storm Water Test Station	URI	Sampling Station
BMP-67	Infiltration/Detention Basin South of Sherman Building	URI	Infiltration System
BMP-68	Swale East of Butterfield Hall	URI	Swale
BMP-69	COP Medicinal Garden	URI	Rain Garden
BMP-70	Swale West of Davis Hall	URI	Swale
BMP-71	Swale East of Rodman Hall	URI	Swale
BMP-72	Swale East of White Hall (BMP Removed2/14)	URI	Swale – Removed in 2014 as part of new Chemistry Building
BMP-73	Swale South of Fayerweather Hall	URI	Swale
BMP-74	Paved Swales at Gateway Apartments	URI	Swale
BMP-75	Paved Swale at Well House No. 2	URI	Swale
BMP-76	Plains Lot Addition (2013) – Infiltration Channels	URI	Infiltration System
BMP-77	Flagg Road Extension Swales Parallel to Road	URI	Swale
BMP-78	Plains Lot Addition (2013) – New Culverts into Basin "E"	URI	Culverts
BMP-79	Flagg Road Extension – Paved Waterways	URI	Swale
BMP-80	Flagg Road Extension Basin "H" Discharge Structure	URI	Infiltration system
BMP-81	White Hall Lot – Swale at NW Corner of Lot	URI	Swale
BMP-82	Greenhouse Lot – Dry Swales	URI	Swale
BMP-83	Greenhouse Lot – Grass Channel	URI	Swale
BMP-84	Greenhouse Lot – Paved Waterways	URI	Swale
BMP-85	Greenhouse Lot – Forebay/Infiltration System	URI	Infiltration System
BMP-86	Greenhouse Roof Drain infiltration System	URI	Infiltration System
BMP-87	Hillside Dorm Green Roof	URI	Infiltration System
BMP-88	Flagg Road Detention Basin "D"	URI	Infiltration System
BMP-89	Flagg Road Detention Basin "E"	URI	Infiltration System
BMP-90	Flagg Road Detention Basin "H"	URI	Infiltration System
BMP-91	Stone Swale east of Butterfield Residence Hall	URI	Swale

BMP-92	Tree Box Filters in Chemistry Building Area	URI	Detention/Infiltration System
BMP-93	Bioretention/Detention/Forebay System North of New Chemistry Building	URI	Detention/Infiltration System
BMP-94	Bioretention/Detention/Forebay System South of New Chemistry Building	URI	Detention/Infiltration System
BMP-95	Tree Box Filters in Flagg Road Parking Lot	URI	Detention/Infiltration System
BMP-96	Swale North of the CBLS NW Corner	URI	Swale
BMP-97	Rip Rap Swale West of New Electric Sub-Stations 1 & 2.	URI	Swale
BMP-98	Rip Rap Swale East of Butterfield Dining Hall	URI	Swale
BMP-99	Asphalt Berms at Fraternity Circle	URI	Swale
BMP-100	Swale North of Hopkins Hall	URI	Swale
BMP-101	Swale North of Chemistry/White Hall	URI	Swale

SECTION II.B - Discharges Causing Scouring or Excessive Sedimentation (Part IV.B.6.b.1.v)

Outfall ID:	Location:	Description of Problem:	Description of Remediation Taken, include dates:	Receiving Water Body Name/Description:
URI-001	Flagg Road at White Horn brook	Sedimentation	Sedimentation removed by backhoe in July 2015 by URI Lands & Grounds Dept.	White Horn Brook
URI-002	West of Heathman Hall SE Corner	Sedimentation and vegetation	Sedimentation removed by backhoe in July 2015 by URI Lands & Grounds Dept.	White Horn Brook
URI -004	White Horn Brook at West Alumni Ave	Sedimentation	Sediment removed by Bobcat in July 2015 by URI Lands & Grounds Dept.	White Horn Brook
URI-008	South of Coddington Hall	Sedimentation	Sedimentation removed by backhoe in July 2015 by URI Lands & Grounds Dept. Outfall exposed and rip rap adjusted	White Horn Brook
URI-009	North of Dorr Hall	Sedimentation	Sedimentation removed by backhoe in July 2015 by URI Lands & Grounds Dept.	White Horn Brook
URI-012	East of Tootell Gym (North)	Sedimentation	Sedimentation removed by backhoe in July 2015 by URI Lands & Grounds Dept. Outfall exposed and rip rap adjusted	Ellery Pond
URI-013	East of Tootell Gym (South)	Sedimentation	Sedimentation removed and rip rap installed by URI Lands and Grounds Dept. in August 2015	Ellery Pond
URI-020	West of Adams Hall	Sedimentation and vegetation	Sedimentation and vegetation removed by backhoe in July 2015 by URI Lands & Grounds Dept.	White Horn Brook
URI-022	NW of Weldin Hall	Vegetation	Vegetation removed by URI Lands and grounds Dept. in July 2015	White Horn Brook

URI-025	Frat Circle at White Horn Brook	Sedimentation	Sedimentation removed by backhoe in July 2015 by URI Lands & Grounds Dept. Channel re-shaped	White Horn Brook
URI-026	North of Sorority AXD (West Side of Fraternity Circle Westerly Road)	Sedimentation	Sedimentation removed by backhoe in July 2015 by URI Lands & Grounds Dept.	White Horn Brook
URI-028	East of Keaney east lot & south of Fraternity Circle	Sedimentation	Sedimentation removed by backhoe in July 2015 by the URI Lands & Grounds Dept.	White Horn Brook
URI-039	West of Wiley Hall (North)	Vegetation	Vegetation removed by URI Lands and grounds Dept. in July 2015	White Horn Brook
URI-040	West of Wiley Hall (South)	Vegetation	Vegetation removed by URI Lands and grounds Dept. in July 2015	White Horn Brook
URI -041	West of Aldrich Hall	Sedimentation and vegetation	Sediment and Vegetation removed by contractor working for Lands and Grounds in Sept 2015	Roger Williams Pond
URI-056	CBLS Rain Garden	Vegetation	Invasive species removed by URI Lands and Grounds Dept. in July 2015	White Horn Brook
URI-067	West of Sorority AXD	Vegetation	Vegetation removed by URI Lands and grounds Dept. in July 2015	White Horn Brook
URI-070	West of Wiley Hall (Center)	Vegetation	Vegetation removed by URI Lands and grounds Dept. in July 2015	White Horn Brook
URI-080	North of Wellness Center	Vegetation	Vegetation removed by URI Lands and grounds Dept. in July 2015	Roger Williams Pond

SECTION II.C - Note any planned municipal construction projects/opportunities to incorporate water quality BMPs, low impact development, or activities to promote infiltration and recharge (Part IV.G.2.j).

The design for the renovations to the fine Arts Parking Lot has been submitted and approved by DEM. The renovation to the Fine Arts Parking Lot will incorporate a number water quality features such as storage systems with metered outflow, bioretention basins and bioretention swales. This project was designed by Gordon R Archibald Associates and has been reviewed by DEM.
The new Engineering Complex will also incorporate a number of water quality BMP's. The design of this project has just started.

SECTION II.D - Please include a summary of results of any other information that has been collected and analyzed. This includes any type of data (Part IV.G.2.e).

Dry weather survey date is attached to this report and has also been sent to DEM electronically.

TOTAL MAXIMUM DAILY LOAD (TMDL) or other Water Quality Determination REQUIREMENTS

SECTION I. If you have been notified that discharges from your MS4 require non-structural or structural stormwater controls based on an approved TMDL or other water quality determination, please provide an assessment of the progress towards meeting the requirements for the control of stormwater identified in the approved TMDL (Part IV.G.2.d). Please indicate rationale for the activities chosen to address the pollutant of concern.

SPECIAL RESOURCE PROTECTION WATERS (SRPWs)

SECTION I. **In accordance with Rule 31(a)(5)(i)G of the *Regulations for the Rhode Island Pollutant Discharge Elimination System* (RIPDES Regs), on or after March 10, 2008, any discharge from a small municipal separate storm sewer system to any Special Resource Protection Waters (SRPWs) or impaired water bodies within its jurisdiction must obtain permits if a waiver has not been granted in accordance to Rule 31(g)(5)(iii). A list of SRPWs can be found in Appendix D of the *RIDEM Water Quality Regulations* at this link:**
http://www.dem.ri.gov/pubs/regs/regs/water/h20q09a.pdf
The 2008 303(d) Impaired Waters list can be found in Appendix G of the *2008 Integrated Water Quality Monitoring and Assessment Report* at this link: http://www.dem.ri.gov/programs/benviron/water/quality/pdf/iwqmon08.pdf

If you have discharges from your MS4 (regardless of its location) to any of the listed SRPWs or impaired waters (including impaired waters when a TMDL has not been approved), please provide an assessment of the progress towards expanding the MS4 Phase II Stormwater Program to include the discharges to the aforementioned waters and adapting the Six Minimum Control Measures to include the control of stormwater in these areas. Please indicate a rationale for the activities chosen to protect these waters. Please note that all of the measurable goals and BMPs required by the 2003 MS4 General Permit may not be applicable to these discharges.

Appendix B

Excerpt of 2015 Stormwater Manual – Minimum Standards

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3.0 STORMWATER MANAGEMENT STANDARDS AND PERFORMANCE CRITERIA

3.1 OVERVIEW

Rhode Island has seen an increase in commercial and residential development over the last several decades. Controlling stormwater from development sites is a priority with regards to impacts to receiving water bodies. This chapter presents performance standards and criteria for all new and redevelopment projects in the State of Rhode Island. Project applicants are required to meet the eleven minimum standards, as well as comply with specific criteria for the site planning process, groundwater recharge, water quality, channel protection, and peak flow control requirements. In the case of restoration or retrofitting, deviation from these standards may be appropriate at the discretion of the approving agency. All applicable development proposals must include a stormwater management site plan for review by State and local government. A plan must address all of the above minimum standards through compliance with the requirements of this manual (see checklist in Appendix A of this document).

All of the minimum standards contribute to protecting the water and habitat quality of receiving waters from the negative impacts of stormwater runoff. This is achieved by using a combination of both structural controls and non-structural practices (such as LID) as part of an effective stormwater management system. In general, when a project's stormwater management system is designed, installed, and maintained in accordance with the requirements of this manual, its runoff impacts will be presumed to be in compliance with applicable state regulatory standards and requirements. In some cases, the permitting agency may require that an applicant prepare and submit a pollutant loading analysis developed in accordance with the provisions of Appendix H in order to ascertain compliance.

This manual often refers to storm events of various kinds. Unless otherwise noted, all storm events are 24 hours in duration and utilize NRCS Type III precipitation distribution. Rainfall amounts for Rhode Island for various return frequencies are provided in Table 3-1 and shall be used for design unless otherwise specified.

Table 3-1 Design Rainfall Amounts for Rhode Island

RI County	24-hour (Type III) Rainfall Amount (inches)*						
	1-Year	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Providence County	2.7	3.3	4.1	4.9	6.1	7.3	8.7
Bristol County	2.8	3.3	4.1	4.9	6.1	7.3	8.6
Newport County	2.8	3.3	4.1	4.9	6.1	7.3	8.6

RI County	24-hour (Type III) Rainfall Amount (inches)*						
	1-Year	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Kent County	2.7	3.3	4.1	4.8	6.2	7.3	8.7
Washington County	2.8	3.3	4.1	4.9	6.1	7.2	8.5

*All Rhode Island County rainfall values were obtained from the Northeast Regional Climate Center (NRCC) using regional rainfall data processed by NRCC from the period of record through December 2008. The NRCC in collaboration with the Natural Resource Conservation Service has under development an interactive web tool at www.precip.net for analysis of precipitation events based on long-term, station-specific data. Applicants may elect to use site-specific data derived from this web tool once the beta site becomes final rather than the RI County values in Table 3-1.

3.2 MINIMUM STORMWATER MANAGEMENT STANDARDS

3.2.1 Minimum Standard 1: LID Site Planning and Design Strategies

LID site planning and design strategies must be used to the maximum extent practicable[1] in order to reduce the generation of the water runoff volume for both new and redevelopment projects. All development proposals must include a completed Stormwater Management Plan checklist (Appendix A) and Stormwater Management Plan for review by the approving agency that shows compliance with this standard. If full compliance is not provided, an applicant must document why key steps in the process could not be met and what is proposed as mitigation. The objective of the LID Site Planning and Design Strategies standard is to provide a process by which LID is considered at an early stage in the planning process such that stormwater impacts are prevented rather than mitigated for.

3.2.2 Minimum Standard 2: Groundwater Recharge

Stormwater must be recharged within the same subwatershed to maintain baseflow at pre-development recharge levels to the maximum extent practicable in accordance with the requirements and exemptions[2] described in Section 3.3.2. In addition, applicants may be required to provide a water budget analysis for proposed groundwater dewatering. Recharge volume is determined as a function of annual pre-development

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[1] For all references to "maximum extent practicable" in this manual, an applicant must demonstrate the following: (1) all reasonable efforts have been made to meet the standard in accordance with current local, state, and federal regulations, (2) a complete evaluation of all possible management measures has been performed, and (3) if full compliance cannot be achieved, the highest practicable level of management is being implemented.

[2] Some exemptions to the recharge criteria are necessary to ensure public safety, avoid unnecessary threats of groundwater contamination, and avoid common nuisance issues. Stormwater runoff from LUHPPL is not allowed to infiltrate into groundwater. The stormwater recharge requirement may be specifically waived if an applicant can demonstrate a physical limitation that would make implementation impracticable or where unusual geological or soil features may exist such as significant clay deposits, ledge, fill soils, or areas of documented slope failure.

recharge for site-specific soils or surficial materials, average annual rainfall volume, and amount of impervious cover on a site. The objective of the groundwater recharge standard is to protect water table levels, stream baseflow, wetlands, and soil moisture levels. Infiltrating stormwater may also provide significant water quality benefits such as reduction of bacteria, nutrients, and metals when infiltrated into the soil profile. Maintaining pre-development groundwater recharge conditions may also be used to reduce the volume requirements dictated by other sizing criteria (i.e., water quality, channel protection, and overbank flood control) and the overall size and cost of stormwater treatment practices. Recharge must occur in a manner that protects groundwater quality. Recharge practices may include both structural stormwater controls and nonstructural practices (using the Stormwater Credit in Chapter Four).

3.2.3 Minimum Standard 3: Water Quality

Stormwater runoff must be treated before discharge. The amount that must be treated from each rainfall event is known as the required water quality volume (WQ_v) and is the portion of runoff containing the majority of the pollutants. The required WQ_v is calculated as described in Section 3.3.3 and excludes LID credits allowed under Section 4.6. To provide adequate treatment of stormwater, the WQ_v must be treated by at least one of the structural BMPs listed in Chapter Five at each location where a discharge of stormwater will occur. Structural BMPs are generally required to achieve the following minimum average pollutant removal efficiencies: 85% removal of total suspended solids (TSS), 60% removal of pathogens, 30% removal of total phosphorus (TP) for discharges to freshwater systems, and 30% removal of total nitrogen (TN) for discharges to saltwater or tidal systems. Based upon results published in the scientific literature, the structural BMPs listed in Chapter Five will meet these standards when properly designed, constructed, and maintained. Pretreatment is required for water quality treatment practices where specified in the design guidelines within Chapter Five.

BMPs targeted to remove other pollutant(s) of concern and/or to achieve higher pollutant removal efficiencies may be required for impaired receiving waters, drinking water reservoirs, bathing beaches, shellfishing grounds, Outstanding National Resource Waters, Special Resource Protection Waters, tributaries thereto, and for those areas where watershed plans, including Special Area Management Plans (SAMPs) or Total Maximum Daily Load (TMDLs), have been completed. In some cases, the permitting agencies may require that an applicant prepare and submit a pollutant loading analysis developed in accordance with the provisions of Appendix H.

Applicants or other interested parties may petition the permitting agencies to add one or more BMPs to the list of acceptable structural stormwater controls described in Chapter Five by submitting monitoring results and supporting information developed in accordance with the provisions of the Technology Assessment Protocol (TAP) included in Appendix J.

3.2.4 Minimum Standard 4: Conveyance and Natural Channel Protection

Open drainage and pipe conveyance systems must be designed to provide adequate passage for flows leading to, from, and through stormwater management facilities for at least the peak flow from the 10-year, 24-hour Type III design storm event. Protection for natural channels downstream must be supplied by providing 24-hour extended detention of the one-year, 24-hour Type III design storm event runoff volume. If a stormwater discharge is proposed in a watershed draining to a cold-water fishery, additional restrictions apply for surface detention practices based on the distance from the discharge point to streams (and any contiguous natural or vegetated wetlands) as described in Section 3.3.4. Consult DEM's Water Quality Regulations – Appendix A to determine if a project is in a watershed directly draining to a cold-water fishery. This standard is designed to prevent erosive flow within natural channels and drainageways. For hydrologic and hydraulic modeling guidance, applicants should refer to Appendix K.

3.2.5 Minimum Standard 5: Overbank Flood Protection

Larger storm events also can cause flood damage and other impacts. These impacts can be significantly reduced by storing and releasing stormwater runoff in a gradual manner that ensures pre-development peak discharges are not exceeded. Downstream overbank flood protection must be provided by attenuating the post-development peak discharge rate to the pre-development levels for the 10-year and 100-year, 24-hour Type III design storm events. In addition, designers must demonstrate that runoff from the site for storms up to the 100-year, 24-hour Type III design storm events actually reach proposed structural practices designed to meet this criterion. The objective of this standard is to prevent an increase in the frequency and magnitude of overbank flooding and to protect downstream and abutting structures from flooding. For hydrologic and hydraulic modeling guidance, applicants should refer to Appendix K.

3.2.6 Minimum Standard 6: Redevelopment and Infill Projects

The construction of new impervious areas on undeveloped land is subject to the requirements of this manual even if other portions of the site are currently developed, unless the site meets the definition for an infill project. The purpose of this minimum standard is to establish the alternative requirements for projects or portions of a project where existing impervious areas will be redeveloped or where the site qualifies as infill. In no case on a redevelopment or infill project shall the levels of stormwater treatment and recharge be less than the levels prior to initiation of the proposed project.

Redevelopment

Redevelopment is defined as any construction, alteration, or improvement that disturbs a total of 10,000 square feet or more of existing impervious area where the existing land use is commercial, industrial, institutional, governmental, recreational, or multifamily residential. The permitting authority may take into consideration prior projects or multi-phase projects in determining if the redevelopment threshold has been met. Building demolition is included as an activity defined as "redevelopment," but building renovation is not. Similarly, removal of roadway materials down to the erodible soil surface is an activity defined as "redevelopment," but simply resurfacing of a roadway surface is not. Pavement excavation and patching that is incidental to the primary project purpose, such as replacement of a collapsed storm drain, is not classified as redevelopment. In general, the requirements in this manual do not apply to projects or portions of projects when the total existing impervious area disturbed is less than 10,000 square feet. However, specific regulatory programs may impose additional requirements. Any creation of new impervious area over portions of the site that are currently pervious is required to comply fully with the requirements of this manual.

Because redevelopment may present a wide range of constraints and limitations, this minimum standard allows for flexibility and an evaluation of options that can work in conjunction with broader state watershed goals and local initiatives. Stormwater requirements for redevelopment vary based upon the surface area of the site that is covered by existing impervious surfaces.

In order to determine the stormwater requirements for redevelopment projects, the percentage of the site covered by existing impervious areas must be calculated. The term “site” is defined as one or more lots, tracts, or parcels of land to be developed or redeveloped for a complex of uses, units or structures, including but not limited to commercial, residential, institutional, governmental, recreational, open space, and/or mixed uses. When calculating site size, jurisdictional wetland areas defined by DEM or CRMC regulations and undeveloped lands protected by conservation easements should be subtracted from the total site area. Doing so provides incentive to preserve and protect natural resources near redevelopment projects.

For sites with less than 40% existing impervious surface coverage, the stormwater management requirements for redevelopment will be the same as for new development. The applicant, however, can meet those requirements either on-site or at an approved off-site location within the same watershed provided the applicant satisfactorily demonstrates that impervious area reduction, LID strategies, and/or structural BMPs have been implemented on-site to the maximum extent practicable. An approved off-site location must be identified, the specific management measures identified, and an implementation schedule developed in accordance with local review and with DEM/CRMC concurrence, as appropriate. The applicant must also demonstrate that there are no downstream drainage or flooding impacts as a result of not providing on-site management. The intent of this provision is to allow flexibility to meet the goals of improved recharge, water quality, and channel and flood protection to receiving waters while still promoting redevelopment in urban and urban fringe areas.

For redevelopment sites with 40% or more existing impervious surface coverage, only Standards 2, 3, and 7-11 must be addressed. Specifically, recharge and stormwater quality[1] shall be managed for in accordance with one or more of the following techniques:

- Reduce existing impervious area by at least 50% of the redevelopment area; or
- Implement other LID techniques to the maximum extent practicable to provide recharge and water quality management for at least 50% of the redevelopment area; or

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[1] For redevelopment sites with 40% or more existing impervious surface coverage, only Standards 2, 3, and 7-11 must be addressed. However, the permitting agency may require peak flow control on a case-by-case basis within a watershed with a history of flooding problems.

- Use on-site structural BMPs to provide recharge and water quality management for at least 50% of redevelopment area; or
- Any combination of impervious area reduction, other LID techniques, or on-site structural BMPs for at least 50% of redevelopment area.
- If none of the above options are practical in terms of water quality management, alternatives may be proposed that would achieve an equivalent pollutant reduction by using a combination of other types of BMPs and strategies, including treating 100% of the redevelopment area by BMPs with a lesser pollutant removal efficiency than stipulated in Standard 3.

Off-site structural BMPs to provide recharge and water quality management for an area equal to or greater than 50% of redevelopment areas may be used to meet these requirements provided that the applicant satisfactorily demonstrates that impervious area reduction, LID strategies, and/or on-site structural BMPs have been implemented to the maximum extent practicable. An approved off-site location must be identified, the specific management measures identified, and an implementation schedule developed in accordance with local review and with DEM/CRMC concurrence, as appropriate. The applicant must also demonstrate that there are no downstream drainage or flooding impacts as a result of not providing on-site management for large storm events.

Infill

For infill[1] sites, the stormwater management requirements will be the same as for new development except that existing impervious area may be excluded from the stormwater management plan (unless subject to local approval or necessary for mitigation by regulation) and only Standards 2, 3, and 7-11 need be applied. The applicant, however, can meet the recharge and water quality requirements either on-site or at an approved off-site location within the same watershed, provided the applicant satisfactorily demonstrates that impervious area reduction, LID strategies, and/or structural BMPs have been implemented on-site to the maximum extent practicable. An approved off-site location must be identified, the specific management measures identified, and an implementation schedule developed in accordance with local review and with DEM/CRMC concurrence, as appropriate. The applicant must also demonstrate that there are no downstream drainage or flooding impacts as a result of not providing on-site management. The intent of this provision is to allow flexibility to meet the goals of improved recharge, water quality, and channel and flood protection to receiving waters while still promoting infill in urban and urban fringe areas.

3.2.7 Minimum Standard 7: Pollution Prevention

All development sites require the use of source control and pollution prevention measures to minimize the impact that the land use may have on stormwater runoff

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[1] An infill project is a development site that meets all of the following: the site is currently predominately pervious (less than 10,000 sf of existing impervious cover); it is surrounded (on at least three sides) by existing development (not including roadways); the site is served by a network of existing infrastructure and does not require the extension of utility lines or new public road construction to serve the property; and the site is one (1) acre or less where the existing land use is commercial, industrial, institutional, governmental, recreational, or multifamily residential.

quality. These measures shall be outlined in a stormwater pollution prevention plan. Representative pollution prevention techniques are described in Appendix G. The intent of this standard is to prevent, to the maximum extent practicable, pollutants from coming into contact with stormwater runoff.

3.2.8 Minimum Standard 8: Land Uses with Higher Potential Pollutant Loads

Stormwater discharges from land uses with higher potential pollutant loads (LUHPPLs) require the use of specific source control and pollution prevention measures and the specific stormwater BMPs approved for such use. Allowable BMPs for LUHPPLs are included in Table 3-3 (design details for these practices are provided in Chapter Five). Many LUHPPLs require additional special permits such as a Rhode Island Pollutant Discharge Elimination System (RIPDES) Multi-Sector General Permit (MSGP), and sector-specific required BMPs are included in Section VI of the MSGP. Stormwater runoff from a LUHPPL (classified in Table 3-2) shall not be recharged to groundwater, unless it has been adequately treated for the pollutant of concern as determined by the approving agency. The recharge prohibition at LUHPPLs applies only to stormwater discharges that come into contact with the area or activity on the site that may generate the higher potential pollutant load. In addition, infiltration practices should not be used where subsurface contamination is present from prior land use due to the increased threat of pollutant migration associated with increased hydraulic loading from infiltration systems, unless the contamination is removed and the site has been remediated, or if approved by DEM on a case-by-case basis. In these areas where infiltration is not appropriate, other LID practices can be used, as long as they are lined (e.g., lined bioretention areas). The intent of this standard is to prevent, to the maximum extent practicable, pollution from entering water resources.

Table 3-2 Classification of Stormwater LUHPPLs

The following land uses and activities are considered stormwater LUHPPLs
1. Areas within an industrial site (as defined in RIPDES Rule 31(b)(15)) that are the location of activities subject to the RIPDES Multi-Sector General Permit (except where a No Exposure Certification for Exclusion from RIPDES Stormwater Permitting has been executed); 2. Auto fueling facilities (i.e., gas stations); 3. Exterior vehicle service, maintenance and equipment cleaning areas; 4. Road salt storage and loading areas (if exposed to rainfall); and 5. Outdoor storage and loading/unloading of hazardous substances.

Table 3-3 Acceptable BMPs for Use at LUHPPLs

Group	**Practice**[1]	**Description**
Wet Vegetated Treatment Systems (WVTS)	Shallow WVTS	A wet stormwater basin that provides water quality treatment primarily in a shallow vegetated permanent pool. Must be lined for use at LUHPPLs.
	Gravel WVTS	A wet stormwater basin that provides water quality treatment primarily in a wet gravel bed with emergent vegetation. Must be lined for use at LUHPPLs.
	Permeable Paving[2]	A practice that stores the water quality volume in the void spaces of a clean sand or gravel base before it is infiltrated into an underlying constructed filtration media. Must be lined for use at LUHPPLs.
Filtering Practices	Sand Filter	A filtering practice that treats stormwater by settling out larger particles in a sediment chamber, and then filtering stormwater through a surface or underground sand matrix. Must be lined for use at LUHPPLs.
	Organic Filter	A filtering practice that uses an organic medium such as compost in the filter, or incorporates organic material in addition to sand (e.g., peat/sand mixture). Must be lined for use at LUHPPLs.
	Bioretention	A shallow depression that treats stormwater as it flows through a soil matrix, and is returned to the storm drain system, or infiltrated into underlying soils or substratum. Must be lined for use at LUHPPLs.
Green Roofs	Extensive	Rooftop vegetated with low, drought-tolerant plant species and a shallow planting media designed for performance. Not typically designed for public access.
	Intensive	Rooftop vegetated with trees and shrubs with a deeper planting soil and walkways, typically designed for both performance and public access.
Open Channels	Dry Swale	An open vegetated channel or depression explicitly designed to detain and promote filtration of stormwater runoff into an underlying fabricated soil matrix. Must be lined for use at LUHPPLs.

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[1] Refer to Chapter Five for detailed descriptions and design criteria for these practices.

[2] Direct infiltration through permeable paving is not permitted for LUHPPL; applicants may use permeable surface materials above a sand or organic filtration media in a lined facility.

3.2.9 Minimum Standard 9: Illicit Discharges

All illicit discharges to stormwater management systems are prohibited, including discharges from OWTS, and sub-drains and French drains near OWTSs that do not meet the State's OWTS Rules (setbacks vary depending on the capacity of the OWTS, the type of conveyance system, and the sensitivity of the receiving waters). The stormwater management system is the system for conveying, treating, and infiltrating stormwater on site, including stormwater best management practices and any pipes intended to transport stormwater to ground water, surface water, or municipal separate storm sewer system (MS4). Illicit discharges to the stormwater management system, i.e., illicit connections, are discharges not entirely comprised of stormwater that are not specifically authorized by a National Pollutant Discharge Elimination System (NPDES) or RIPDES permit. The objective of this standard is to prevent pollutants from being discharged into MS4s and Waters of the State, and to safeguard the environment and public health, safety, and welfare.

3.2.10 Minimum Standard 10: Construction Activity Soil Erosion, Runoff, Sedimentation, and Pollution Prevention Control Measure Requirements

Soil Erosion and Sedimentation Control (SESC) measures must be utilized during the construction phase as well as during any land disturbing activities. The objective of this standard is to reduce mobilization, transport and discharge of pollutants associated with erosion and sedimentation from construction site runoff through implementation of SESC measures that 1) avoid and protect sensitive areas and natural features, 2) minimize disturbances and preserve top soil 3) protect structures, conveyances, receiving waters, and 4) control overland and concentrated stormwater flows.

All soil erosion, runoff, sedimentation, and construction activity pollution prevention control measures must be designed and implemented in accordance with the Soil Erosion and Sediment Control (SESC) Plan requirements outlined in the Performance Criteria in Section 3.3.7 and the most recent edition of the Rhode Island Soil Erosion and Sediment Control Handbook (as amended). The component of the Stormwater Management Plan that addresses this standard is referred to as a Soil Erosion and Sediment Control (SESC) Plan.

For all land disturbance activities that require a permit from the RI DEM or the CRMC, a qualified SESC Plan preparer shall be a Rhode Island Registered Professional Engineer, a Certified Professional in Erosion and Sediment Control (CPESC), a Certified Professional in Storm Water Quality (CPSWQ), or a Rhode Island Registered Landscape Architect who certifies that the SESC Plan meets the Performance Criteria in 3.3.7 and requirements of the Rhode Island Soil Erosion and Sediment Control Handbook (as amended). The Preparer shall have the specific credentials and experience needed to select the appropriate practices for the application. If the project involves significant land grading or requires an engineered site design, then the SESC Plan must be prepared by a Professional Engineer licensed in the State of RI.

For activities that do not require a permit from the RI DEM or the CRMC and are subject to only local ordinances or Municipal Separate Storm Sewer System (MS4) requirements (e.g. site disturbing < 1 acre that is not part of a larger common plan and not subject to CRMC, Freshwater Wetlands, Water Quality, and Groundwater Discharge Regulations) the preparer should consult local ordinances or MS4 requirements as part of developing a stormwater management plan for their project.

3.2.11 Minimum Standard 11: Stormwater Management System Operation and Maintenance

The stormwater management system, including all structural stormwater controls and conveyances, must have an operation and maintenance plan to ensure that it continues to function as designed.

The long-term Operation and Maintenance Plan shall at a minimum include:

1. Stormwater management system(s) owners;
2. The party or parties responsible for operation and maintenance, including how future property owners will be notified of the presence of the stormwater management system and the requirement for proper operation and maintenance;
3. The routine and non-routine maintenance tasks for each BMP to be undertaken after construction is complete and a schedule for implementing those tasks;
4. A plan that is drawn to scale and shows the location of all stormwater BMPs in each treatment train along with the discharge point;
5. A description and delineation of public safety features;
6. An estimated operation and maintenance budget; and
7. Funding source for operation and maintenance activities and equipment.

The Operation and Maintenance Plan shall identify measures for implementing maintenance activities in a manner that minimizes stormwater runoff impacts.

3.3 PERFORMANCE CRITERIA

3.3.1 LID Site Planning and Design Criteria

The LID Site Planning and Design Criteria requires that the site planning process be documented and include how the proposed project will meet the following measures and/or methods to:

1. Protect as much undisturbed open space as possible to maintain pre-development hydrology and allow precipitation to naturally infiltrate into the ground;

Appendix C

Copy of
Rhode Island Statewide Bacteria TMDL Waterbody Summary for White Horn Brook (RI0008039R-27B)

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White Horn Brook

Watershed Description

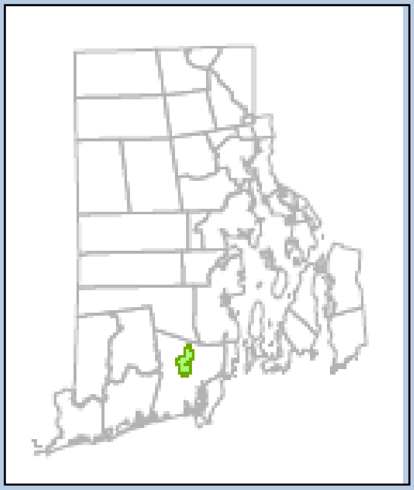
This **TMDL** applies to the White Horn Brook assessment unit (RI0008039R-27B), a 4.7-mile long stream located in South Kingstown, RI (Figure 1). The Town of South Kingstown is located in the southern portion of the state. White Horn Brook is located in the northern section of town. The White Horn Brook watershed is presented in Figure 2 with land use types indicated.

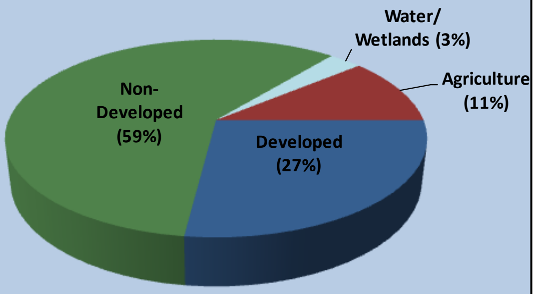
White Horn Brook begins in a developed area in the northern section of South Kingstown, just south of Flagg Road. The brook flows south through the University of Rhode Island campus and crosses Route 138. The brook continues southeast, parallel to Route 110, through a predominately agricultural area to the east of Larkin Pond. White Horn Brook then enters the western edge of the Great Swamp Management Area through the Genesee Swamp, and ends in a wetland area east of Worden Pond.

The White Horn Brook watershed covers 4 square miles. Non-developed areas occupy a large portion (59%) of the watershed, including the Great Swamp Management Area. As shown in Figure 3, developed uses (including residential and commercial uses and the University of Rhode Island campus) occupy approximately 27%. Agricultural land uses occupy 11%. Wetlands and other surface waters, including Larkin Pond occupy 3%. Impervious surfaces cover a total of 13.4%.

Assessment Unit Facts (RI0008039R-27B)

- **Town:** South Kingstown
- **Impaired Segment Length:** 4.7 miles
- **Classification:** Class B
- **Direct Watershed:** 4 mi^2 (2536 acres)
- **Impervious Cover:** 13.4%
- **Watershed Planning Area:** Wood – Pawcatuck (#23)





Watershed Land Uses

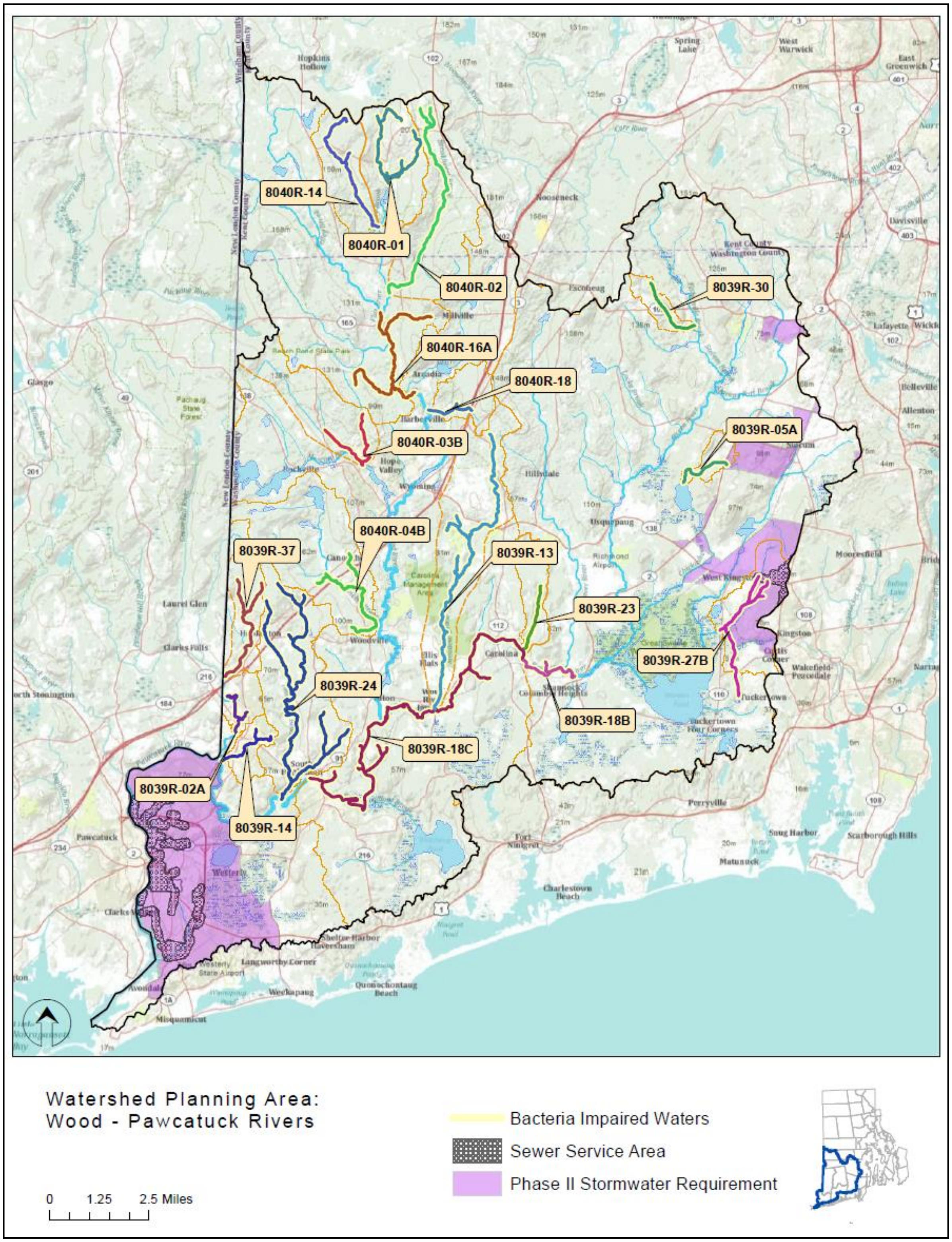


Figure 1: *Map of the Wood-Pawcatuck Watershed Planning Area with impaired segments addressed by the Statewide Bacteria TMDL, sewered areas, and stormwater regulated zones.*

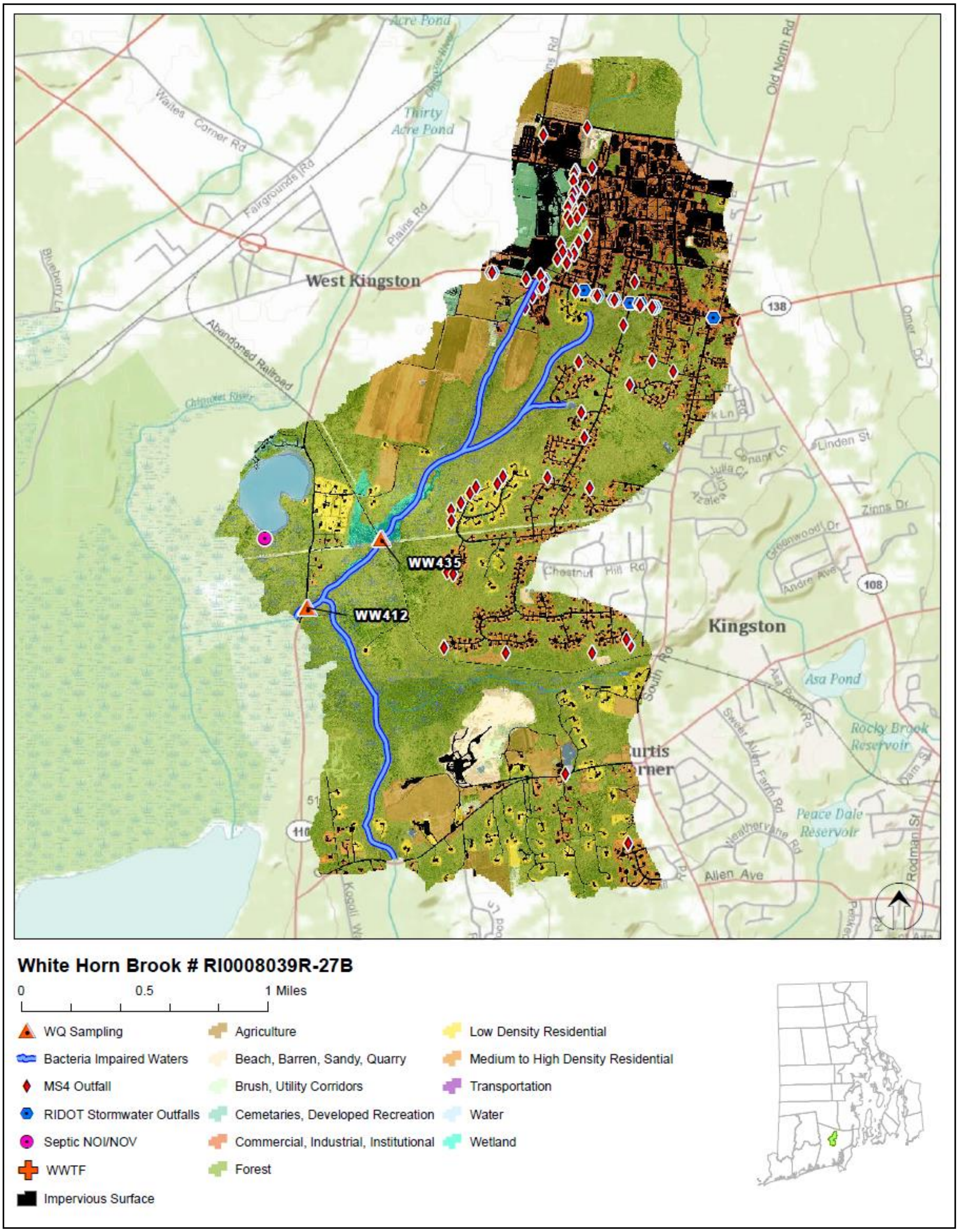


Figure 2: ***Map of the White Horn Brook watershed with impaired segment, sampling locations, and land cover indicated.***

Why is a TMDL Needed?

White Horn Brook is a Class B freshwater stream, and its applicable designated uses are primary and secondary contact recreation and fish and wildlife habitat (RIDEM, 2009). From 2007-2008, water samples were collected from two sampling locations (WW412 and WW435) and analyzed for the indicator bacteria, enterococci. The water quality criteria for enterococci, along with bacteria sampling results from 2007-2008 and associated statistics are presented in Table 1. The geometric mean was calculated for both stations and exceeded water quality criteria for enterococci.

Figure 3: ***Partial aerial view of the White Horn Brook watershed (Source: Google Maps)***

To aid in identifying possible bacteria sources, the geometric mean was also calculated for each station for wet-weather and dry-weather sample days, where appropriate. Wet and dry geometric mean values exceeded the water quality criteria for enterococci at both stations. Wet-weather values were higher than dry-weather values at both stations, with the highest value at station WW412. Possible bacteria sources are described in the sections below. Potential sources include improperly operating onsite wastewater treatment systems (OWTS), wastes from agriculture activities, as well as wastes from waterfowl, wildlife, and domestic pets.

Due to the elevated bacteria measurements presented in Table 1, White Horn Brook does not meet Rhode Island's bacteria water quality standards, was identified as impaired and was placed on the 303(d) list (RIDEM, 2008). The Clean Water Act requires that all 303(d) listed waters undergo a TMDL assessment that describes the impairments and identifies the measures needed to restore water quality. The goal is for all waterbodies to comply with state water quality standards.

Potential Bacteria Sources

There are several potential sources of bacteria in the White Horn Brook watershed including stormwater runoff from developed areas, illicit discharges from leaking sewer pipes, malfunctioning onsite wastewater treatment systems, agricultural activities, and waterfowl, wildlife, and domestic animal waste.

Onsite Wastewater Treatment Systems

Most residents in the White Horn Brook watershed rely on onsite wastewater treatment systems (OWTS) such as cesspools and septic systems. A small section of the watershed, located in and around the University of Rhode Island campus, relies on municipal sewer systems. Failing OWTS can be significant sources of bacteria by allowing improperly treated waste to reach surface waters (RI HEALTH, 2003). Most of the unsewered portions of South Kingstown have soils with moderate to severe septic system limitations (Geremia, 2006). As shown in Figure 2, one OWTS Notice of Violation/Notice of Intent to Violate has been issued by the RIDEM Office of Compliance and Inspection in the White Horn Brook watershed.

South Kingstown enacted a town-wide wastewater management district in 1999, which requires OWTS-owners to inspect OWTS systems to ensure their maintenance and to replace cesspools. The goal of the program is to decrease the amount of ground and surface water contamination from OWTS that do not function properly. Almost 50 percent of the unsewered, residentially zoned land under two acres in South Kingstown has constraints relative to the proper functioning of OWTS. In 1990, according to the Facilities Element of the Comprehensive Plan sixty percent of South Kingstown residents relied on OWTS. The percentage of OWTS users relative to sewer users will continue to increase due to a limited town-wide sewer expansion plan and the location of potentially developable land outside sewer service areas. In 2000, South Kingstown estimated that there were 5,973 OWTS. Based on a record of which houses were constructed prior to 1970, approximately 2,360 systems or 39.5 percent predate OWTS regulations, although some of these of systems have been upgraded over the years.

Illicit Discharges

Other illicit discharges, or any discharge to a municipal separate storm sewer system (MS4) that is not composed entirely of stormwater, may also be contributing bacteria to White Horn Brook. As shown in Figure 2, multiple MS4 outfalls have been identified along the brook.

Developed Area Stormwater Runoff

Though most of the White Horn Brook watershed is undeveloped, the headwaters of the brook originate in a heavily developed area in the center of the University of Rhode Island campus. The White Horn Brook watershed has an impervious cover of 13.4%. Impervious cover is defined as land surface areas, such as roofs and roads that force water to run off land surfaces, rather than infiltrating into the soil. Impervious cover provides a useful metric for the potential for adverse stormwater impacts. As discussed in Section 6.3 of the Core TMDL Document, as a general rule, impaired streams with watersheds having higher than 10% impervious cover are assumed to be affected by stormwater runoff.

In accordance with Phase II requirements, the Rhode Island Department of Transportation (RIDOT), University of Rhode Island, and the Town of South Kingstown have identified and mapped all stormwater outfalls in the White Horn Brook watershed. Multiple stormwater outfalls are found in the watershed, particularly along major highways and in the eastern portion of the watershed. As stormwater is known to carry a suite of pollutants, including bacteria, stormwater is a likely source of bacterial contamination to White Horn Brook.

Agricultural Activities

Agricultural operations are an important economic activity and landscape feature in the state's rural areas. Agricultural land use occupies 11% of the land area in the White Horn Brook watershed. Much of this land is adjacent to White Horn Brook, particularly near the intersection of Route 138 and Route 110, just northwest of Larkin Pond. Agricultural runoff may contain multiple pollutants, including bacteria, and may be contributing bacteria to White Horn Brook.

Waterfowl, Wildlife, and Domestic Animal Waste

The White Horn Brook watershed is predominately undeveloped, particularly in the southern portion of the watershed in the Great Swamp Management Area. These large wetland and surface water areas are also home to various wildlife and waterfowl. Wildlife, including waterfowl, may be a significant bacteria source to surface waters. With the construction of roads and drainage systems, these wastes may no longer be retained on the landscape, but instead may be conveyed via stormwater to the nearest surface water. As such these physical land alterations can exacerbate the impact of these natural sources on water quality.

Though only a small portion of the watershed is characterized by residential development, much of this development is located near the northern section of the brook. Waste from domestic animals such as dogs, may also be contributing to bacteria concentrations in White Horn Brook.

Existing Local Management and Recommended Next Steps

Additional bacteria data collection would be beneficial to support identification of sources of potentially harmful bacteria in the White Horn Brook watershed. These activities could include sampling at several different locations and under different weather conditions (e.g., wet and dry). Field reconnaissance surveys focusing on stream buffers, stormwater runoff, and other source identification may also be beneficial.

Based on existing ordinances and previous investigations, the following steps are recommended to support water quality goals.

Onsite Wastewater Management

Many residents of the White Horn Brook watershed rely on OWTS (septic systems or cesspools). The Town of South Kingstown has an approved Onsite Wastewater Management Plans that provides a framework for managing the OWTS. As all of the drinking water for the Town of South Kingstown comes from groundwater, the town is particularly interested in protecting the quality of their groundwater through measures such as limiting contamination from OWTS. As such, the Town of South Kingstown has adopted an ordinance (2001) requiring all OWTS to be inspected and pumped routinely. Cesspools discovered via the inspection program are to be upgraded within 5 years of the date of the First Maintenance Inspection or within 12 months of the sale of a property, whichever comes first. South Kingstown zoning also contains more stringent setbacks from natural features than the current state requirements. South Kingstown's Public Services Department is responsible for overseeing and enforcing this program. Once malfunctioning or failing OWTS have been identified, programs are in place to assist with the financial costs of replacement or repair to residents (Town of South Kingstown, 2011). South Kingstown should continue to track the maintenance history of all OWTS, and enforce the inspection and pump-out ordinance.

The Town of South Kingstown is eligible for Rhode Island's Community Septic System Loan Program (CSSLP). South Kingstown has obtained 1.2 million dollars in CSSLP money since 2002. The CSSLP program provides low-interest loans to residents to help with maintenance and replacement of OWTS. South Kingstown should also continue to provide funds to residents through CSSLP.

Stormwater Management

The Town of South Kingstown (RIPDES permit RIR040037), the University of Rhode Island (RIPDES permit RIR040019), and RIDOT (RIPDES permit RIR040036) are municipal separate storm sewer (MS4) operators in the White Horn Brook watershed and have prepared the required Phase II

Stormwater Management Plans (SWMPP). Only the eastern portion of the watershed is regulated by the Phase II program.

South Kingstown's SWMPP outlines goals for the reduction of stormwater runoff to White Horn Brook through the implementation of Best Management Practices (BMPs). Many of these BMPs are now in place, including mapping all stormwater outfalls, instituting annual inspections and cleaning of the town's catch basins, implementing an annual street sweeping program, adopting construction erosion and sediment control and post-construction stormwater control ordinances, and conducting public education activities (RIDEM, 2010a).

In 2010, South Kingstown also adopted an illicit discharge detection and elimination ordinance (RIDEM, 2010a). These ordinances prohibit illicit discharges to the MS4 and provide enforcement mechanisms. It is recommended that any stormwater outfalls discharging in the near vicinity of the sampling location be monitored to check for illicit discharges. Illicit discharges can be identified through continued dry weather outfall sampling and microbial source tracking.

URI's SWMPP outlines its stormwater program goals through the implementation of BMPs. URI has mapped its stormwater outfalls and instituted an inspection and cleaning program for its catch basins. URI also has policies in place to prohibit and enforce illicit discharges to the MS4 and has policies to ensure construction erosion and sediment control and post-construction stormwater control activities are appropriate and in place (RIDEM, 2010a).

RIDOT also has completed a SWMPP for state-owned roads in the watershed. RIDOT's SWMPP and its 2011 Compliance Update outline its goals for compliance with the General Permit statewide. It should be noted that RIDOT has chosen to enact the General Permit statewide, not just for the urbanized and densely populated areas that are required by the permit. RIDOT has finished mapping its outfalls throughout the state and is working to better document and expand its catch basin inspection and maintenance programs along with its BMP maintenance program. Stormwater Management Pollution Prevention Plans (SWPPPs) are being utilized for RIDOT construction projects. RIDOT also funds the University of Rhode Island Cooperative Extension's Stormwater Phase II Public Outreach and Education Project, which provides participating MS4s with education and outreach programs that can be used to address TMDL public education recommendations.

As mentioned previously, the White Horn Brook watershed has an impervious cover of 13.4%, a level where stormwater impacts are expected. At this threshold, RIDEM is requiring MS4 operators to revise their post-construction stormwater ordinances as described in Section 6.3 of the Core TMDL Document. RIDEM also requires the MS4 operators to continue to comply with and adapt the minimum measures to reflect the bacteria impairments in the regulated areas. Information regarding plans to revise the post construction ordinance should be documented in a TMDL Implementation Plan (TMDL IP). Unless otherwise noted in this waterbody summary, any other TMDL IP requirements described in Section 6.2 of the Core TMDL Document are not applicable to the MS4 operators for watershed areas having impervious cover between 10 and 15 %. Information regarding how the MS4 operators' minimum measures are addressing the pollutant of concern (i.e. bacteria) should be documented in the MS4 operators' annual report, consistent with Part IV.G.2.d of the RIPDES General Permit (RIDEM, 2010b). Further detail is also included in Sections 6.3 of the core document.

Agricultural Activities

If not already in place, agricultural producers should work with the RIDEM Division of Agriculture, and the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) to develop conservation plans for their farming activities within the watershed. NRCS and the RIDEM Division of Agriculture should continue to work with agricultural operation in the watershed, particularly near the intersection of Routes 110 and 138, to ensure that there are sufficient stream buffers, have fencing to restrict access of livestock and horses to streams and wetlands, and have animal waste handling, disposal, and other appropriate BMPs in place.

Waterfowl, Wildlife, and Domestic Animal Waste

South Kingstown's education and outreach programs should highlight the importance of picking up after dogs and other pets and not feeding waterfowl. Animal wastes should be disposed of away from any waterway or stormwater system. South Kingstown should work with volunteers to map locations where animal waste is a significant and chronic problem. This work should be incorporated into the town's Phase II plans and should result in an evaluation of strategies to reduce the impact of animal waste on water quality. This may include installing signage, providing pet waste receptacles or pet waste digester systems in high-use areas, enacting ordinances requiring clean-up of pet waste, and targeting educational and outreach programs in problem areas.

Towns and residents can take several measures to minimize waterfowl-related impacts. They can allow tall, coarse vegetation to grow in areas along the shores of White Horn Brook that are frequented by waterfowl. Waterfowl, especially grazers like geese, prefer easy access to the water. Maintaining an uncut vegetated buffer along the shore will make the habitat less desirable to geese and encourage migration. With few exceptions, Part XIV, Section 14.13, of Rhode Island's Hunting Regulations prohibits feeding wild waterfowl at any time in the state of Rhode Island. Educational programs should emphasize that feeding waterfowl, such as ducks, geese, and swans, may contribute to water quality impairments in White Horn Brook and can harm human health and the environment.

Land Use Protection

Woodland and wetland areas within the White Horn Brook watershed, particularly in the southern portion of the watershed in the Great Swamp Management Area, absorb and filter pollutants from stormwater runoff, and help protect both water quality in the stream and stream channel stability. As these areas represent over half of the land use in the White Horn Brook watershed, it is important to preserve these undeveloped areas, and institute controls on development in the watershed.

The steps outlined above will support the goal of mitigating bacteria sources and meeting water quality standards in White Horn Brook.

Table 1: White Horn Brook Bacteria Data

Waterbody ID**:** RI0008039R-27B

Watershed Planning Area: 23 – Wood-Pawcatuck

Characteristics: Freshwater, Class B, Primary and Secondary Contact Recreation, Fish and Wildlife Habitat

Impairment: Enterococci (colonies/100mL)

Water Quality Criteria for Enterococci: Geometric Mean: 54 colonies/100 mL

Percent Reduction to meet TMDL: **52% (Includes 5% Margin of Safety)**

Data: 2007-2008 from RIDEM

Single Sample Enterococci (colonies/100 mL) Results for White Horn Brook (2007-2008) with Geometric Mean Statistics

Station Name	Station Location	Date	Result	Wet/Dry	Geometric Mean
WW435	White Horn Brook @ Bike Trail	10/25/2008	42	Dry	**102[†] (52%)***
WW435	White Horn Brook @ Bike Trail	9/20/2008	155	Dry	
WW435	White Horn Brook @ Bike Trail	8/25/2008	38	Dry	
WW435	White Horn Brook @ Bike Trail	6/7/2008	190	Wet	
WW435	White Horn Brook @ Bike Trail	5/10/2008	411	Wet	
WW435	White Horn Brook @ Bike Trail	9/15/2007	157	Wet	
WW435	White Horn Brook @ Bike Trail	8/18/2007	39	Dry	
WW412	White Horn Brook @ Ministerial Rd.	10/25/2008	15	Dry	81
WW412	White Horn Brook @ Ministerial Rd.	9/20/2008	1414	Dry	
WW412	White Horn Brook @ Ministerial Rd.	8/25/2008	81	Dry	
WW412	White Horn Brook @ Ministerial Rd.	6/7/2008	43	Wet	
WW412	White Horn Brook @ Ministerial Rd.	5/10/2008	36	Wet	
WW412	White Horn Brook @ Ministerial Rd.	9/15/2007	1298	Wet	
WW412	White Horn Brook @ Ministerial Rd.	8/18/2007	245	Dry	
WW412	White Horn Brook @ Ministerial Rd.	7/16/2007	20	Dry	
WW412	White Horn Brook @ Ministerial Rd.	5/12/2007	9	Dry	

Shaded cells indicate an exceedance of water quality criteria
*Includes 5% Margin of Safety
[†]Geometric mean used to determine percent reduction

Wet and Dry Weather Geometric Mean Enterococci Values for all Stations

Station Name	Station Location	Years Sampled	Number of Samples		Geometric Mean		
			Wet	Dry	All	Wet	Dry
WW435	White Horn Brook @ Bike Trail	2007-2008	3	4	102	230	56
WW412	White Horn Brook @ Ministerial Rd.	2007-2008	3	6	81	126	64
Shaded cells indicate an exceedance of water quality criteria Weather condition determined from rain gage at URI in Kingston, RI							

References

James J. Geremia & Associates Inc. (2006). Town of South Kingstown, Regional Facilties Plan for Wastewater Management (August 2006).

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RIDEM (2009). State of Rhode Island and Providence Plantations Water Quality Regulations. Amended December, 2009. Rhode Island Department of Environmental Management.

RIDEM (2010a). MS4 Compliance Status Report for RI Statewide Bacteria TMDL. Rhode Island Department of Environmental Management.

RIDEM (2010b). Total Maximum Daily Load Analysis for the Pawcatuck River and Little Narragansett Bay Waters (Bacteria Impairments. Rhode Island Department of Environmental Management.

RI HEALTH (2003). Aquidneck Island Drinking Water Assessment Results, Source Water Protection Assessment conducted by the University of Rhode Island for the Rhode Island Department of Health, Office of Drinking Water Supply.

Town of South Kingstown (2011). Onsite Wastewater Management Program. Online: http://www.southkingstownri.com/town-government/municipal-departments/public-services/onsite-wastewater-management

Appendix D

Wetland and Wildlife Habitat Analysis, Kingston Campus
Applied Bio-Systems, Inc.

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University of Rhode Island Wetland and Wildlife Habitat Analysis
Kingston Campus, Rhode Island

I. Methodology: Applied Bio-Systems, Inc. inspected the project area as defined by the Kingston Campus Drainage Master Plan to evaluate the property for wildlife species, vegetative habitats and land use. Other information used in this review was RIDEM wetlands mapping, RIDEM Natural Heritage rare species data and the RI Ecological Communities Classification. It is expected that the number of wildlife and vegetative species that inhabit the project area is much greater than what was observed. The field inspections to the URI Campus during January and February of 2017 should only be considered a snapshot of the URI natural resources. Refer to Appendix A for Digital Photos of overall project area and TO Figure 1 for Photo Points Locations.

II. Natural Resources and Land Use

Existing Habitat and Land Use Units: The following paragraphs describe the habitat units within the University of Rhode Island (URI) property (Refer to Figures 2, 3 and 4 for habitat and Land Use Maps). Please Note: The habitat and land use units were classified using "Rhode Island Ecological Communities Classification" (RIECC) (Enser, 2011) and the RIDEM Land Use Planning (http://maps.edc.uri.edu/ArcGIS/services/Atlas_planningCadastre/Land_Use_200304_NEMO). These habitat units are a compilation of data from these sources and data from RIGIS wetlands (Figure 5) plus on-site field inspections performed by Applied Bio-Systems, Inc. These habitat units as described below and are meant to be interpreted generally due to the nature of this assessment.

Upland Habitat Areas: ***(data taken from RI Ecological Communities Classification).***
Refer to Figure 2 for full extend of RIECC mapping of the area.

Nursery / Christmas Trees**:** "Land used for the production of annual-cycle crops including (corn, potatoes, small grains, vegetables, flowers, etc.), and perennial crops associated with orchards, vineyards, nurseries, sod farms, and Christmas tree farms. Plant cover may vary by season or from time to time depending on farm activities but in Rhode Island types that can commonly be described include: a. Vegetables, b. Turf, c. Orchard, d. Vineyard, e. Christmas trees."

Oak Forest: RIECC classifies this habitat type as "forest communities dominated by oaks (*Quercus*). Species composition generally dependent on site conditions, especially soil type and hydrology." These communities are a subclass of Deciduous Woodlands and Forests within the Upland System.

Ruderal Forest: This habitat type is classified by RIECC as "undifferentiated upland forests, typically even-aged, resulting from succession following removal of native woody cover for agriculture or logging. Soil alteration from agriculture tends to lead to low-diversity forests, often with exotic species in the understory that do not resemble natural forest systems. Generally, a ruderal forest is characterized by a combination of early-successional trees that cannot be identified as natural ecological systems even in an incipient state. (If a forest has sufficient cover of indicator trees for a particular "natural" community, even with a presence of early-successional trees, it is classed as that forest system.) These forests often contain substantial amounts of red maple (Acer), white pine (Pinus), red cedar (Juniperus), aspen (Populus), and gray birch (Betula), with associates of sassafras, (Sassafras), black locust (Robinia), hawthorn (Crateagus), apple (Pyrus), pin cherry (Prunus), and sometimes walnut (Juglans). Where soil disturbance has not been severe, many sites will follow a trajectory towards one of the later successional and more natural forest communities."

This habitat unit is classified under Plantation and Ruderal Forests which are a subcategory of Upland Systems. The majority of Forested Upland Habitat located within the URI property is Ruderal Forest. Wildlife species observed included: American robin,

Turf: " Land used for the production of annual-cycle crops including (corn, potatoes, small grains, vegetables, flowers, etc.), and perennial crops associated with orchards, vineyards, nurseries, sod farms, and Christmas tree farms. Plant cover may vary by season or from time to time depending on farm activities but in Rhode Island types that can commonly be described include: a. Vegetables, b. Turf, c. Orchard, d. Vineyard, e. Christmas trees."

Wildlife observed includes American kestrel, American robin, white-breasted nuthatch, song sparrow and northern cardinal. Expected Species include: Eastern bluebird, white-tailed deer (*Odocoileus virginianus*), woodchuck (*Marmota monax*).

Land Use: ***(data taken from 2003-04 Rhode Island land use and land cover data available from RIGIS. These data have been interpreted and subsequently generalized by the Rhode Island NEMO Program at*** http://maps.edc.uri.edu/ArcGIS/services/Atlas_planningCadastre/Land_Use_200304_NEMO***).*** The following land use units are present within the URI property. Only descriptions of those land use units which were not classified under the RIECC habitat map were described below in this report. Refer to Figure 3 for full extent of Land Use Map.

Institutional, Developed Recreation and Cemetery: Institutional land and buildings are public or quasi-public facilities with or without green space designed to serve large numbers of people such as government buildings, schools, colleges, hospitals, prisons, churches, town halls, public works facilities, police stations or fire stations. The maintained areas around the facilities are included as are parking facilities. Some of the facilities at a large college, for example, may be pulled out into other categories (such as an athletic field - 161). However, all dormitories, family and faculty housing and other buildings are included in this category as are grassy areas that are on the property of the institution as are usually noted on USGS topographic maps.

Vacant Land (Urband) Transitional Area: Land is classified as vacant if it is abandoned land that isn't being used for any other land use. It isn't being prepared for another use (see 750 Transitional Area below) and does not have enough tree growth to be classified as forest or enough vegetation to be classified as brushland (300). It may include structures and indicates that the land was previously used for one of the urban categories.

<u>Fresh Water Wetlands:</u> (data taken from RIGIS and previous wetland delineation data prepared by Applied Bio-Systems, Inc.)
Refer to Wetlands Map Figure 4.

Forested Swamp: This habitat is comprised of a red maple overstory and relatively open understory. Vegetation observed within the Forested Wetland areas include: winterberry (*Ilex verticillata*), cinnamon fern (*Osmunda cinnamomea*), northern arrowwood (*Viburnum dentatum*), bristly dewberry, red maple, and sensitive fern (*Onoclea sensibilis*). Greater than 80% of the Forest is listed as hardwood. Wildlife observed within the habitat unit included: red-tailed hawk, mallard duck, blue jay and beaver (*Castor canadensis*) and gray squirrel (*Scuirus carolinensis*). Flooded areas within the wetland were observed that may provide Vernal Pool habitat for breeding amphibians and reptiles such as wood frog (*Rana sylvatica*), spotted salamander (*Ambystoma maculatum*) and habitat for spotted (*Clemmys guttata*) and other turtles. The mature trees within this habitat may provide roosting and breeding areas for the northern long-eared bat. This habitat unit is classified under Palustrine System as a Forested Mineral Soil Wetland. Forested Wetland Habitat borders the length of White Horn Brook located within the western central portion of the project area.There are also two area of forested swamp within the “North Woods” located north of Flagg Road.

Palustrine Open Water: Several small ponds exist within the project area at URI. The largest pond, Ellery Pond, is located west of the Roger Williams Complex dormitories. The pond is approximately 30,000 square feet in size with a reduce vegetative buffer except for the some contiguous forested wetland. The dominant vegetation observed within the contiguous forested wetland includes: red maple, dogwood species (*Cornus* sp.) and cinnamon fern (*Osmunda cinnamomea*). The Soil Survey classifies the wetland as a water body with Adrian muck (Aa) soils on the east and south of the pond. Adrian soils are no longer mapped in the Northeast Region, Swansea soils are now mapped for areas of shallow (16 to 51 inches) organic soils over glacial fluvial deposits. This nearly level, very poorly drained soil is in depressions and small drainageways of glacial till uplands and outwash plains. Most areas are oval and range from 2 to 20 acres. Slopes are dominantly less than 2 percent. The wildlife observed within the pond and adjacent forested wetland included: mallard pair, beaver sign, white-throated sparrow, white breasted nuthatch, purple finch, gray squirrel and frog species. Other ponds within the project area include “Roger Williams Pond” and “Ballentine Pond”.

Riverine Nontidal Open Water: White Horn Brook is a perennial river as classified by the USGS Kingston Quadrangle Topographic Map. The White Horn Brook Wetland Complex is hydrologically connected to a large wetland complex that flows southerly within the University of Rhode Island Kingston Campus. The river continues to flow southerly until it meets with Genessee Brook and eventually becomes part of the large Great Swamp wetland resource, part of which is a State Management Area. Four pedestrian crossings bisect the river within the project area (Ellery Pond south to Route 138). This habitat unit is classified as Forested Swamp on the RIECC habitat areas map (Figure 2) and the RI Nemo Land Use map depicts the area as Deciduous Forest (Figure 3). However, it is shown on the RIGIS Wetlands and Surface Water Map (Figure 4). The dominant vegetation observed included: green brier (*Smilax rotundifolia*), common reed (*Phragmites australis*), northern arrowwood (*Viburnum dentatum*), large-leaf cattail (*Typha latifolia*), Japanese bamboo (*Polygonum cuspidatum*) and red maple (*Acer rubrum*), and northern arrowwood (Viburnum dentatum). The Soil Survey classifies the wetland soil unit as having an Adrian muck (Aa); a nearly level, very poorly drained soil.

Wildlife species observed within the White Horn Brook wetlands complex include: red-tailed hawk, mallard duck, skunk (*Mephites mephitis*) and deer (*Odocoileus virginianus*).

Scrub-Shrub Wetland Shrub Swamp: There are two small polygons classified within the project area as Scrub-Shrub Swamp. There is one that is associated with the tributary brook that flows into Ellery Pond and it is located west of the new volleyball court and east of the "Dairy Barn Lot". However, this area appears to be presently maintained as mown grass. The other small area of Scrub -Shrub Wetland is south of the existing police station on campus. See Digital Image Photo #9. The RIECC classifies these communities as **"**Wetland communities dominated by shrubs 0.5 to 5 m tall that occur along the margin of a pond or river, isolated in a wet depression or valley, or as a transition community between a marsh and upland communities. This type is highly variable with the dominant shrub species dictated by local conditions, including water depth, topographic position, and microclimate. At wetter sites buttonbush (*Cephalanthus*) or water willow (*Decodon*) may dominate with over 90% cover. Sites not permanently flooded may support a mix of shrubs with characteristic species including highbush blueberry *(Vaccinium)*, sweet pepperbush (*Clethra*), winterberry (*Ilex*), alders (*Alnus*), silky dogwood (*Cornus*), maleberry (*Lyonia*), spicebush (*Lindera*), spiraea (*Spiraea*), and swamp azalea (*Rhododendron*)."

Rare Species:

The southwestern corner of the project area is listed as a Natural Heritage Area by RIDEM. Refer to Figure 5. This area of the property is currently comprised of Managed Recreational Fields, Oak Forest and Forested Swamp Habitats. It is unknown at the time of this report what rare species or rare habitat is classified within this Natural Heritage Area. A request by email was sent to Paul Jordan, RIDEM Supervising GIS Specialist (Personal Communication 2/15/2017) requesting further information on the adjacent RI Natural Heritage Areas. There are no known state or federally threatened, rare or endangered plant or wildlife species within the remaining project area.

III. Recommendations for native plant/rain gardens and stormwater filter/buffers to provide non-pointsource pollutant control and enhance wildlife habitat diversity

Native plantings of grasses, shrubs and trees can be used to provide water quality improvements to ponds, streams, and wetlands that result from direct stormwater flows into these wetlands. Vegetated strips of plants can be designed as rain gardens or simply a buffer/filter strip adjacent to a wetland. A rain garden is a shallow landscaped depression designed to capture, filter and infiltrate stormwater before it reaches the wetlands. It can remove nonpoint source pollutants such as those pollutants in sheetflow from impermeable parking areas such as between the Meade Parking Lot and the White Horn Brook. The native plant buffer strips may be more appropriate as a filter between a wetland and a mowed grassed area that may have a higher probability of erosion but not nonpoint source pollutants, and example would be a shrub border around the Roger Williams Pond.

There are numerous locations along the length of White Horn Brook and other locations throughout campus that would currently be suitable for the addition of native plantings. These plantings would provide a filtering buffer adjacent to the brook and forested wetlands. They would slow down sheet flow velocity, catch trash and sediment, and provide additional wildlife habitat adjacent to the wetlands. These native plant buffers will provide an overall improvement of water quality by helping to control erosion and increasing ground infiltration before stormwater flow reaches the wetlands. Areas such as the shoreline of Ellery Pond; the mowed grass strip between the Ryan Center Parking lots and the White Horn Brook; and between Meade Field and White Horn Brook are locations where there is room to install these buffers strips (See Figure 7).

Other locations that these native plant filter/buffers could be added are around the Roger Williams Pond, the Hope Complex rock basin, and the Ballentine Pond. These borders of plants, not only provide a visual buffer, but will also provide small areas of additional wildlife habitat and plant biodiversity along the existing stream and wetland features. Table 1 contains a list of native vegetation suitable for use in planted stormwater facilities.

Table 1. List of native plants appropriate for rain gardens and/or buffer/filter strips adjacent to wetlands:

Grasses:

Sedges, various species (*Carex* sp.)
Switchgrass (*Panicum virgatum*)
Broomsedge, various species (*Andropogon* spp.)

Trees and Shrubs for Wet and High Water Table Areas:

Cranberry bush viburnum (*Viburnum trilobum*)
Arrowwood (*Viburnum dentatum*)*
Highbush blueberry (*Vaccinium corymbosum*)
Inkberry (*Ilex glabra*)*
Lowbush blueberry (*Vaccinium angustifolium*)
Meadowsweet (*Spirea latifolia*)
Pussy willow (*Salix discolor*)*

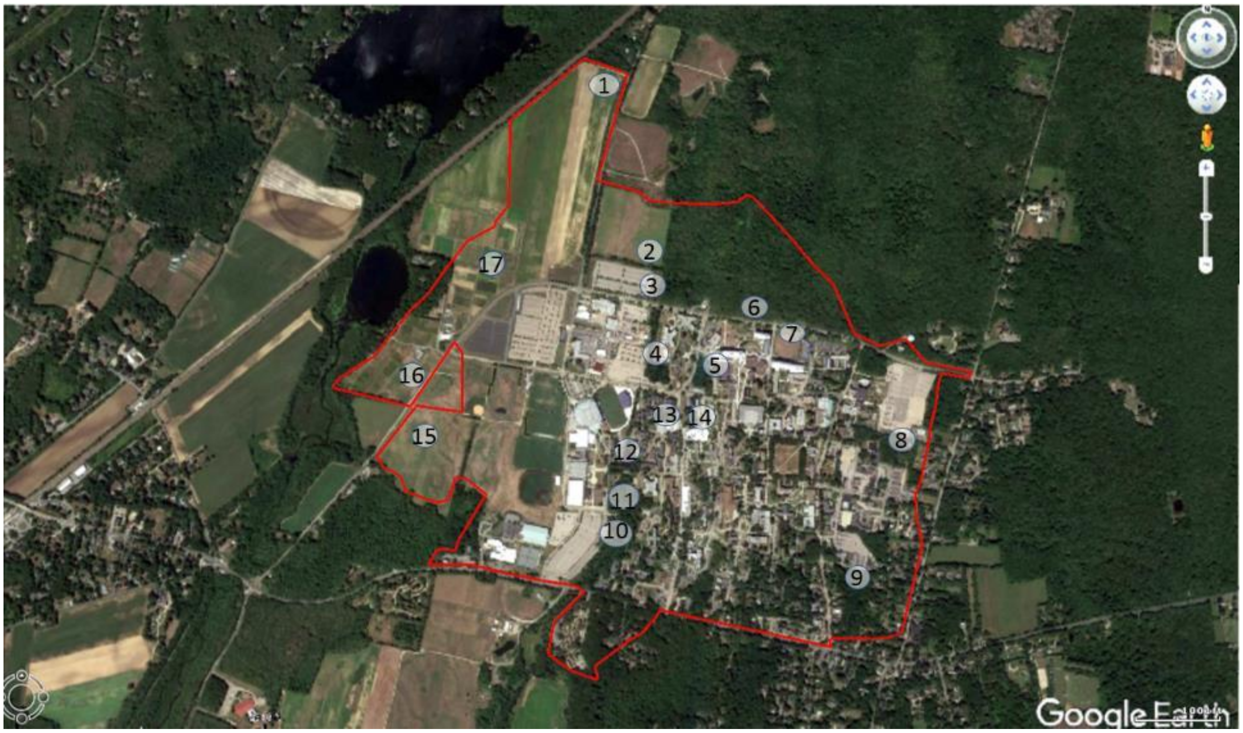
Red maple (*Acer rubrum*)*
Red-twig/red-osier dogwood (*Cornus sericea*)
Shadbush/Serviceberry (*Amelanchier canadensis*)*
Silky dogwood (*Cornus amomum*)
Spicebush (*Lindera benzoin*)*
Sweet pepperbush (*Clethra alnifolia*)*
Winterberry holly (*Ilex verticillate*)

*Suitable for shade

Shrubs for Dry, Sunny Upland Areas

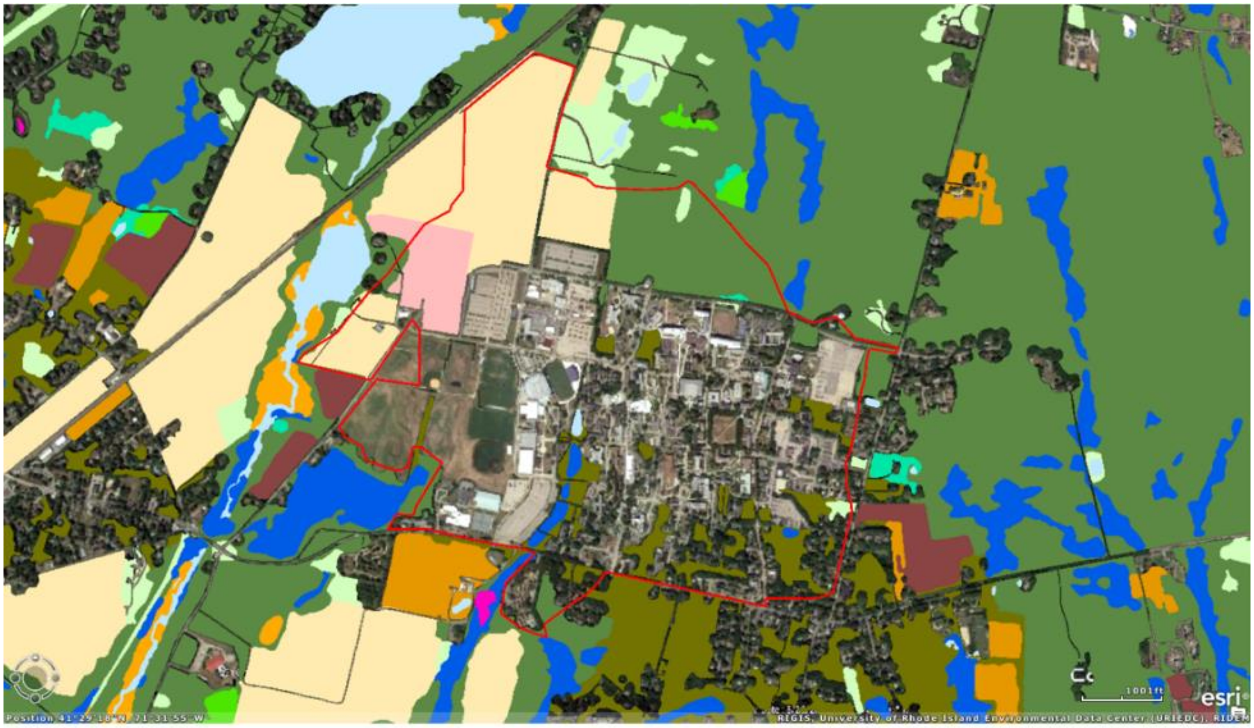
Bayberry (*Myrica pensylvanica*)
St. John’s wort (*Hypericum perforatum*)
Sweet fern (*Comptonia peregrine*)
Huckleberry (*Gaylussacia baccata*)
Dwarf huckleberry (*Gaylussacia dumosa*)

FIGURE 1. PHOTO POINTS LOCATION MAP FOR APPENDIX A PHOTOGRAPHS



Map Google Earth 2016

FIGURE 2. RI ECOLOGICAL COMMUNITIES CLASSIFICATION



Map Google Earth 2016

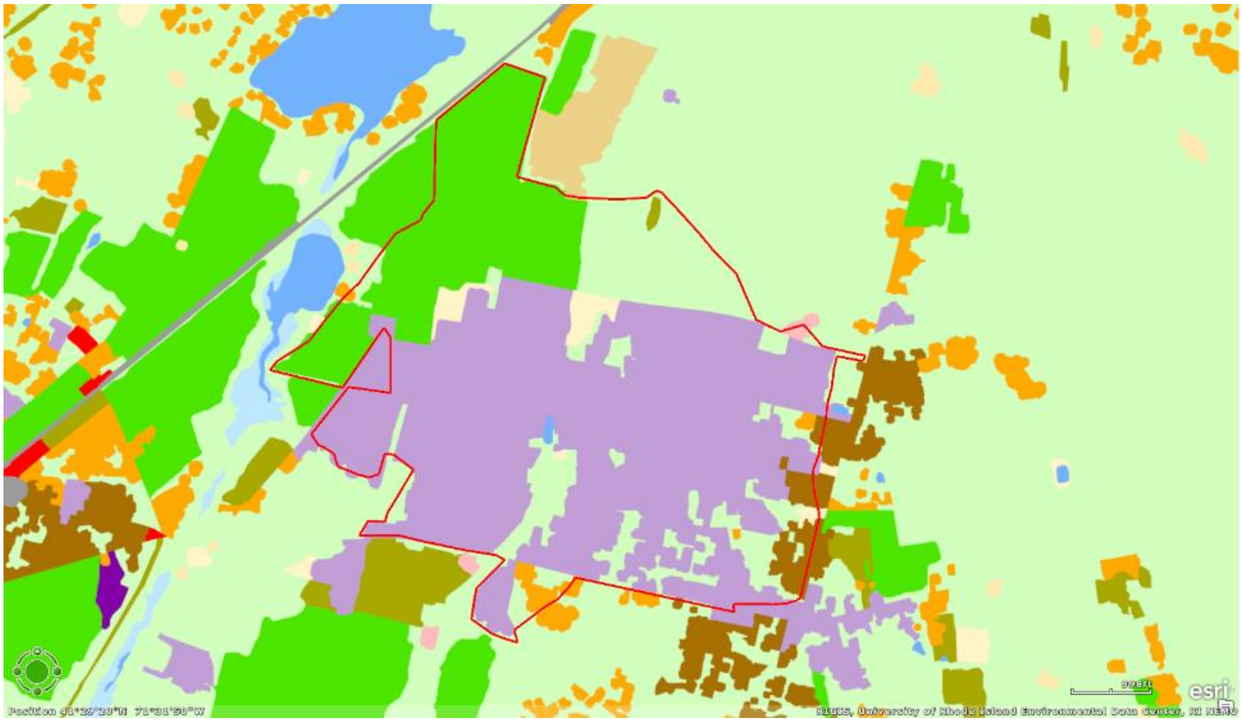
https://gis.ri.gov/arcgis/services/RIDEM/RI_Ecological_Communities_Classification

RI_Ecological_Communities_Classification

RI Ecological Communities Classification

- ■ Coastal Grassland
- ■ Cropland
- ■ Developed Recreation
- ■ Emergent Marsh
- ■ Floodplain Forests
- ■ Forested Swamp
- ■ Fresh Water
- ■ Hayfields
- ■ Hemlock/Hardwood Forest
- ■ Inland Sand Barren
- ■ Intertidal Shore
- ■ Maritime Bluff
- ■ Maritime Shrub Dune
- ■ Maritime Shrubland
- ■ Maritime Woodlands
- ■ Mixed Deciduous/Coniferous Forests
- ■ Modified Managed Marsh
- ■ Mud Flat
- ■ Northern Hardwood Forest
- ■ Nursery/Christmas Trees
- ■ Oak Forest
- ■ Orchard
- ■ Pasture
- ■ Peatlands
- ■ Pitch Pine Woodland/Barrens
- ■ Power Lines
- ■ Ruderal Forest
- ■ Ruderal Grassland/Shrubland
- ■ Salt Marsh
- ■ Salt Water
- ■ Shrub Swamp
- ■ Tidal Creek
- ■ Tidal River/Stream
- ■ Transitional/Vacant Land
- ■ Tree Plantation
- ■ Turf
- ■ Vineyard

FIGURE 3. LAND USE UNITS



Map Google Earth 2016

http://maps.edc.uri.edu/ArcGIS/services/Atlas_planningCadastre/Land_Use_200304_NEMO

◢ Land Use / Land Cover 2003-2004

categories as consolidated by RI NEMO Program

🟫 High - Medium High Density Residential
🟧 Medium - Medium Low Density Residential
▨ Low Density Residential
🟥 Commercial or Industrial
▨ Transportation
🟪 Waste Disposal
▨ Institutional, Developed Recreation, Cemetery
▨ Pasture, Idle Agriculture or Power Lines
🟩 Cropland, Orchards and Nurseries
▨ Forested wetlands, Forest and Brushland
▨ Sandy/Beaches, Quarries and Outcrop
▨ Water and Sewage Treatment Facilities
▨ Vacant Land (Urban) and Transitional Areas
🟦 Water
▨ Wetland

FIGURE 4. WETLANDS BY TYPE

Map Google Earth 2016

http://maps.edc.uri.edu/ArcGIS/services/Atlas_biota/Wetland_Types

Wetland by Type

Wetland Types

- 🟩 ESTUARINE EMERGENT WETLAND
- 🟩 EMERGENT WETLAND: MARSH/WET MEADOW
- 🟩 EMERGENT WETLAND: EMERGENT FEN OR BOG
- 🟩 MARINE/ESTUARINE ROCKY SHORE
- 🟩 ESTUARINE SCRUB-SHRUB WETLAND
- 🟩 MARINE/ESTUARINE UNCONSOLIDATED SHORE
- 🟩 FORESTED WETLAND: CONIFEROUS
- 🟩 FORESTED WETLAND: DECIDUOUS
- 🟩 FORESTED WETLAND: DEAD
- 🟩 PALUSTRINE OPEN WATER
- 🟩 RIVERINE NONTIDAL OPEN WATER
- 🟩 RIVERINE TIDAL OPEN WATER
- 🟩 SCRUB-SHRUB WETLAND: SHRUB SWAMP
- 🟩 SCRUB-SHRUB WETLAND: SHRUB FEN OR BOG

TABLE 2. OBSERVED WILDLIFE

Birds	**2/1/2010**	**11/11/2010**	**12/16/2011**	**1/31/2017**	**2/10/2017**	Wetlands	Oak Forest	Agricultural Land
American crow (*Corvus brachyrhynchos*)				X		X		X
American kestrel (*Falco sparverius*)					X			X
American robin (*Turdus migratorius*)	X	X	X	X	X	X	X	X
black capped chickadee (*Parus atricapillus*)	X	X		X		X		
Carolina wren (*Thryothorus ludovicianus*)			X			X		X
dark eyed junco (*Junco hyemalis*)	X		X			X		
downy woodpecker (*Picoides pubescens*)	X	X	X	X		X		
European starling (*Sturnus vulgaris*)				X			X	X
mallard (*Anas platyrhynchos*)		X	X			X		
northern cardinal (*Cardinalis cardinalis*)				X				
northern mockingbird (*Mimus polyglottos*)				X		X		X
purple finch (*Carpodacus purpureus*)		X				X		
red-tailed hawk (*Buteo jamaicensis*)			X			X		
song sparrow (*Melospiza melodia*)			X	X	X	X	X	X
tufted titmouse (*Parus bicolor*)	X	X	X			X		
white-breasted nuthatch (*Sitta carolinensis*)		X			X	X	X	
white-throated sparrow (*Zonotrichia albicollis*)	X	X	X			X		
Fish								
fingerlings (unknown species)			X			X		
Mammals								
gray squirrel (*Sciurus carolinensis*)		X	X			X		
beaver sign (*Castor canadensis*)	X	X				X		
striped skunk (*Mephites mephites*)		X				X		
Amphibians / Reptiles								
frog species (unknown species)		X				X		

Wetlands: Emergent Meadow, Forested Swamp, Fresh Water, Scrub/Shrub Swamp and Riverine Open Water

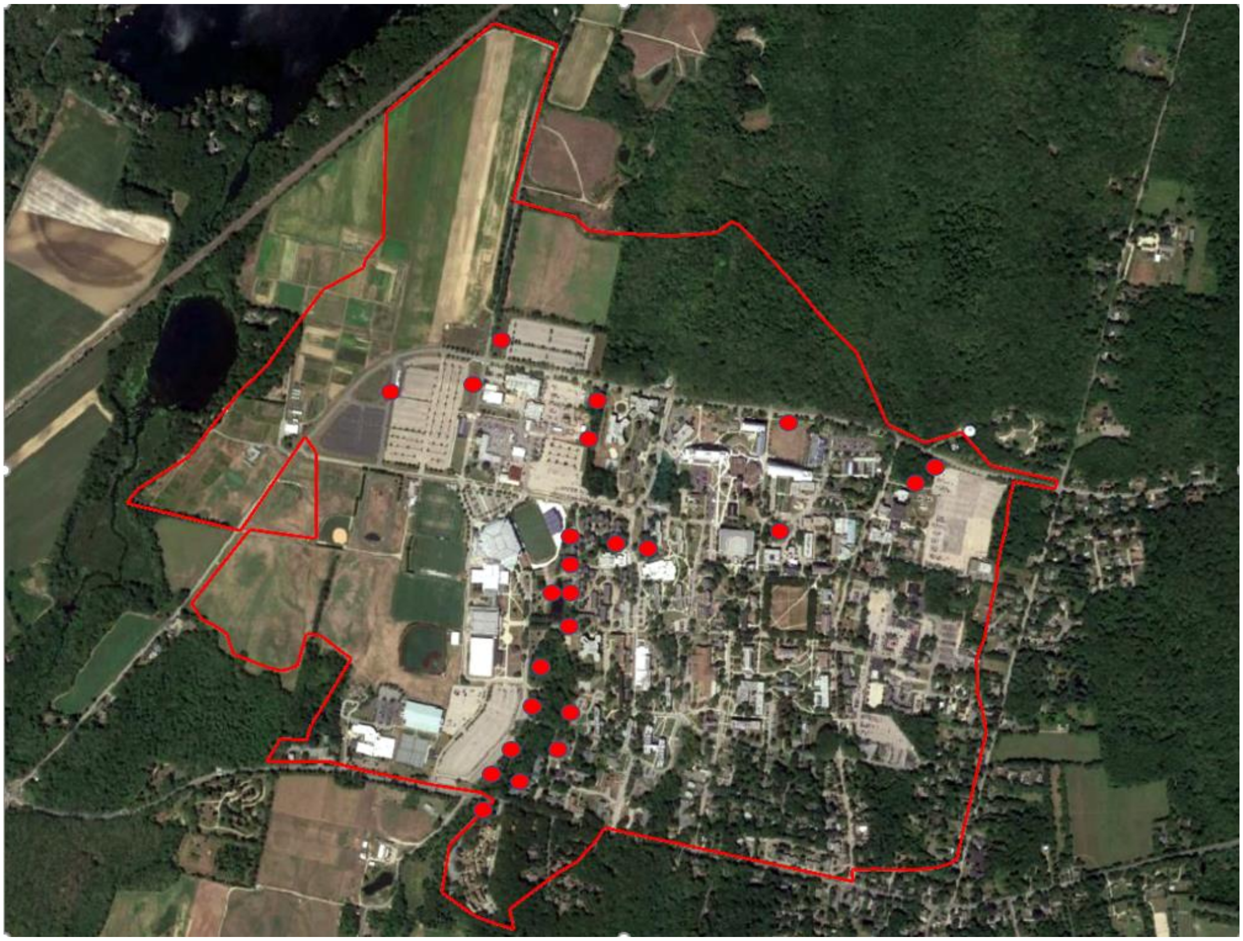
Upland Forest: Oak Forest and Ruderal Forest

FIGURE 5. NATURAL HERITAGE AREAS

Map Google Earth 2016

http://maps.edc.uri.edu/ArcGIS/services/Atlas_biota/Natural_Heritage_Areas

FIGURE 6. POTENTIAL LOCATIONS FOR RAIN GARDENS AND BUFFER / FILTER STRIPS



● **Suggested Locations**

Map Google Earth 2016

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Enser, R., D. Gregg, C. Sparks, P. August, P. Jordan, J. Coit, C. Raithel, B. Tefft, B. Payton, C. Brown, C. LaBash, S. Comings, and K. Ruddock. 2011. *Rhode Island Ecological Communities Classification*. Technical Report. Rhode Island Natural History Survey, Kingston, RI. (available at: www.rinhs.org)

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"Rhode Island Coastal Plant Guide." CELS-CRMC Coastal Plant Guide. Coastal Resources Management Council, n.d. Web. 20 Feb. 2017. <http://cels.uri.edu/testsite/coastalPlants/CoastalPlantGuide.htm>.

ArcGIS Data Layers:

http://maps.edc.uri.edu/ArcGIS/services/Atlas_biota/Natural_Heritage_Areas

http://maps.edc.uri.edu/ArcGIS/services/Atlas_biota/Wetland_Types

http://maps.edc.uri.edu/ArcGIS/services/Atlas_planningCadastre/Land_Use_200304_NEMO

https://gis.ri.gov/arcgis/services/RIDEM/RI_Ecological_Communities_Classification

APPENDIX A

DIGITAL PHOTOS

all photos taken February 2017 unless otherwise noted.

Photo 1 – Plains Road looking southwest at "Turf" Habitat

Photo 2 – Plains Road Lot looking north at "Turf" Habitat

Photo 3 – Flagg Road Lot looking southeast in "Transitional/Vacant Land" Habitat

Photo 4 – looking south at "Scrub / Shrub" Habitat and "Riverine Nontidal Open Water" Habitat, (volleyball court to left side of photograph)

Photo 5 – looking southwest at planted sunflowers in "Transitional/Vacant Land" Habitat

Photo 6 – Flagg Road looking north at "Oak Woods" Habitat

Photo 7 – Flagg Road looking south at “Developed Land”

Photo 8 – looking south at “Oak Forest” and “Forested Swamp” Habitats

Photo 9 – Briar Lane looking south at "Forested Swamp" Habitat

White Horn Brook Photos #10 - 12

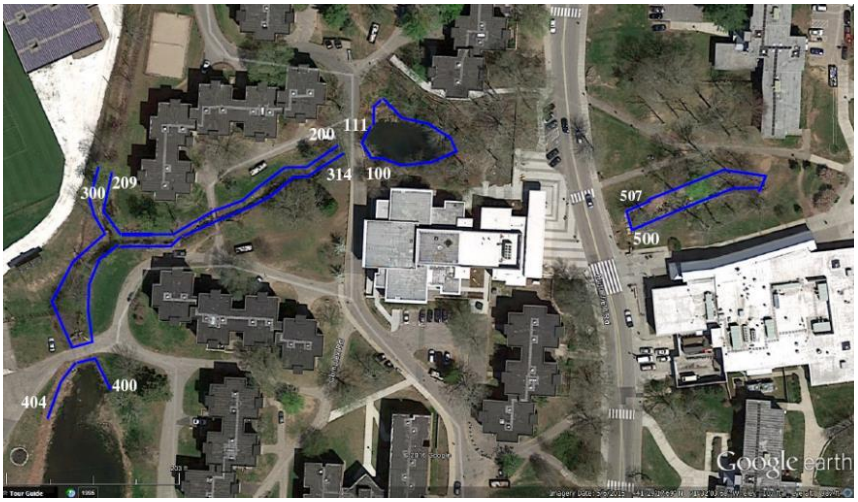
Photo 10 – looking south at "Forested Swamp" Habitat and "Riverine Nontidal Open Water" Habitat

Photo 11 – looking south at “Forested Swamp” Habitat and “Riverine Nontidal Open Water” Habitat

Photo 12– looking north at Ellery Pond “Fresh Water” Habitat

Photo taken 4-6-2011

Photo 13– Wetland Sketch of Ponds "Fresh Water" Habitat and stream channel "Riverine Nontidal Open Water" Habitat



This wetland sketch from ABS delineation 2/29/2016 depicts the small waterbody named "Roger Williams Pond" (Flags 100-111) and the "Hope Commons Rock Swale" (flags 500-507). Flags 400-404 depict Ellery Pond and a stream channel which flows draining into Ellery Pond (200 and 300 Flag Series).

Photo 14 – Plains Road looking east at "Developed Land"

Photo 15 – Plains Road looking west at “Turf” Habitat

Photo 16 – Plains Road looking north at “Nursery / Christmas Trees” and “Turf” Habitat

Appendix E

Soil Survey of Rhode Island, Data Sheets for Mapped Soils

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Map Unit Description (Brief, Tabular)

State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties

[Absence of an entry indicates that the feature is not a concern or that data were not estimated. Data applies to the entire extent of the map unit within the survey area. Map unit and soil properties for a specific parcel of land may vary somewhat and should be determined by onsite investigation]

BhA--Bridgehampton silt loam, 0 to 3 percent slopes

Composition

- Bridgehampton and similar soils: 90 percent of the unit
- Agawam and similar soils: 3 percent of the unit
- Enfield and similar soils: 3 percent of the unit
- Scio and similar soils: 2 percent of the unit
- Tisbury and similar soils: 2 percent of the unit

Setting

Landform(s): outwash plains on outwash plains

Elevation:

Precipitation: 44 to 50 inches

Slope gradient: 0 to 3 percent

Air temperature: 48 to 50 ºF

Frost-free period: 130 to 160 days

Characteristics of Bridgehampton and similar soils

Average total avail. water in top five feet (in.): 11.9

Available water capacity class: High

Parent material: coarse-silty loess over sandy and gravelly glaciofluvial deposits derived from granite and gneiss

Restrictive feature(s): none

Depth to Water table: none within the soil profile

Drainage class: well drained

Flooding hazard: none

Ponding hazard: none

Saturated hydraulic conductivity class: Moderately High

Soil loss tolerance (T factor): 4

Wind erodibility group (WEG): 2

Wind erodibility index (WEI): 134

Land capability class, irrigated:

Land capability class, nonirrigated: 1

Hydric soil: no

Hydrologic group: B

Runoff class: low

Potential frost action: high

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
Ap -- 0 to 8	Silt loam	1.6 to 2.0	4.5 to 6.0	Null	Null
B -- 8 to 41	Silt loam	6.6 to 11.2	4.5 to 6.0	Null	Null
2C -- 41 to 60	Gravelly sand	0.2 to 1.9	4.5 to 6.0	Null	Null

Ecological class(es):

BhB--Bridgehampton silt loam, 3 to 8 percent slopes

Composition

- Bridgehampton and similar soils: 90 percent of the unit
- Agawam and similar soils: 3 percent of the unit
- Enfield and similar soils: 3 percent of the unit
- Scio and similar soils: 2 percent of the unit
- Tisbury and similar soils: 2 percent of the unit

Setting

Landform(s): outwash plains on outwash plains

Elevation:

Precipitation: 44 to 50 inches

Slope gradient: 3 to 8 percent

Air temperature: 48 to 50 ºF

Frost-free period: 130 to 160 days

Characteristics of Bridgehampton and similar soils

Average total avail. water in top five feet (in.): 11.9

Available water capacity class: High

Parent material: coarse-silty loess over sandy and gravelly glaciofluvial deposits derived from granite and gneiss

Restrictive feature(s): none

Depth to Water table: none within the soil profile

Drainage class: well drained

Flooding hazard: none

Ponding hazard: none

Saturated hydraulic conductivity class: Moderately High

Soil loss tolerance (T factor): 4

Wind erodibility group (WEG): 2

Wind erodibility index (WEI): 134

Land capability class, irrigated:

Land capability class, nonirrigated: 2e

Hydric soil: no

Hydrologic group: B

Runoff class: medium

Potential frost action: high

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
Ap -- 0 to 8	Silt loam	1.6 to 2.0	4.5 to 6.0	Null	Null
B -- 8 to 41	Silt loam	6.6 to 11.2	4.5 to 6.0	Null	Null
2C -- 41 to 60	Gravelly sand	0.2 to 1.9	4.5 to 6.0	Null	Null

Ecological class(es):

CB--Canton-Urban land complex

Composition

- Canton and similar soils: 40 percent of the unit
- Urban land: 30 percent of the unit
- Charlton and similar soils: 6 percent of the unit
- Gloucester and similar soils: 6 percent of the unit
- Narragansett and similar soils: 5 percent of the unit
- Paxton and similar soils: 5 percent of the unit
- Udorthents and similar soils: 5 percent of the unit
- Sutton and similar soils: 3 percent of the unit

Setting

Landform(s): hills on uplands
Elevation: 0 to 810 feet
Precipitation: 44 to 50 inches

Slope gradient: 0 to 15 percent
Air temperature: 48 to 50 ºF
Frost-free period: 120 to 160 days

Characteristics of Canton and similar soils

Average total avail. water in top five feet (in.): 5.6
Available water capacity class: Low
Parent material: coarse-loamy over sandy and gravelly melt-out till derived from granite and/or schist and/or gneiss
Restrictive feature(s): none
Depth to Water table: none within the soil profile
Drainage class: well drained
Flooding hazard: none
Ponding hazard: none
Saturated hydraulic conductivity class: High

Soil loss tolerance (T factor): 3
Wind erodibility group (WEG): 5
Wind erodibility index (WEI): 56
Land capability class, irrigated:
Land capability class, nonirrigated: 2e
Hydric soil: no
Hydrologic group: B
Runoff class: low
Potential frost action: low

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
Oe -- 0 to 1	Moderately decomposed plant material	0.1 to 0.5		0.0	0
A -- 1 to 3	Gravelly fine sandy loam	0.2 to 0.3	3.5 to 6.0	0.0	0
Bw1 -- 3 to 15	Gravelly loam	1.2 to 1.8	3.5 to 6.0	0.0	0
Bw2 -- 15 to 24	Gravelly loam	0.9 to 1.4	3.5 to 6.0	0.0	0
Bw3 -- 24 to 30	Gravelly loam	0.6 to 0.9	3.5 to 6.0	0.0	0
2C -- 30 to 60	Very gravelly loamy sand	0.9 to 2.7	3.5 to 6.0	0.0	0

Ecological class(es):

Characteristics of Urban land

Average total avail. water in top five feet (in.):
Available water capacity class: NA
Parent material: human transported material
Restrictive feature(s):
Depth to Water table:
Drainage class:
Flooding hazard:
Ponding hazard:

Soil loss tolerance (T factor):
Wind erodibility group (WEG):
Wind erodibility index (WEI):
Land capability class, irrigated:
Land capability class, nonirrigated: 8s
Hydric soil: no
Hydrologic group:
Runoff class: very high
Potential frost action:

Saturated hydraulic conductivity class: Very Low

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
R -- 0 to 6	Variable			Null	Null

Ecological class(es):

ChB--Canton and Charlton very stony fine sandy loams, 3 to 8 percent slopes

Composition

- Canton and similar soils: 0 to 90 percent of the map unit (RV=60 percent)
- Charlton and similar soils: 0 to 90 percent of the map unit (RV=30 percent)
- Gloucester and similar soils: 4 percent of the unit
- Narragansett and similar soils: 2 percent of the unit
- Paxton and similar soils: 2 percent of the unit
- Sutton and similar soils: 2 percent of the unit

Setting

Landform(s): hills on uplands
Elevation: 0 to 810 feet
Precipitation: 44 to 50 inches

Slope gradient: 3 to 8 percent
Air temperature: 48 to 50 ºF
Frost-free period: 115 to 185 days

Characteristics of Canton and similar soils

Average total avail. water in top five feet (in.): 5.6
Available water capacity class: Low
Parent material: coarse-loamy over sandy and gravelly melt-out till derived from granite and/or schist and/or gneiss
Restrictive feature(s): none
Depth to Water table: none within the soil profile
Drainage class: well drained
Flooding hazard: none
Ponding hazard: none
Saturated hydraulic conductivity class: High

Soil loss tolerance (T factor): 3
Wind erodibility group (WEG): 5
Wind erodibility index (WEI): 56
Land capability class, irrigated:
Land capability class, nonirrigated: 6s
Hydric soil: no
Hydrologic group: B
Runoff class: low
Potential frost action: low

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
Oe -- 0 to 1	Moderately decomposed plant material	0.1 to 0.5		0.0	0
A -- 1 to 3	Gravelly fine sandy loam	0.2 to 0.3	3.5 to 6.0	0.0	0
Bw1 -- 3 to 15	Gravelly loam	1.2 to 1.8	3.5 to 6.0	0.0	0
Bw2 -- 15 to 24	Gravelly loam	0.9 to 1.4	3.5 to 6.0	0.0	0
Bw3 -- 24 to 30	Gravelly loam	0.6 to 0.9	3.5 to 6.0	0.0	0
2C -- 30 to 60	Very gravelly loamy sand	0.9 to 2.7	3.5 to 6.0	0.0	0

Ecological class(es):

Characteristics of Charlton and similar soils

Average total avail. water in top five feet (in.): 6.4

Available water capacity class: Moderate

Parent material: coarse-loamy melt-out till derived from granite and/or schist and/or gneiss

Restrictive feature(s): none

Depth to Water table: none within the soil profile

Drainage class: well drained

Flooding hazard: none

Ponding hazard: none

Saturated hydraulic conductivity class: High

Soil loss tolerance (T factor): 5

Wind erodibility group (WEG): 3

Wind erodibility index (WEI): 86

Land capability class, irrigated:

Land capability class, nonirrigated: 6s

Hydric soil: no

Hydrologic group: B

Runoff class: low

Potential frost action: low

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
Ap -- 0 to 4	Fine sandy loam	0.5 to 0.6	4.5 to 6.0	0.0	0
Bw1 -- 4 to 7	Fine sandy loam	0.3 to 0.4	4.5 to 6.0	0.0	0
Bw2 -- 7 to 19	Fine sandy loam	1.1 to 1.7	4.5 to 6.0	0.0	0
Bw3 -- 19 to 27	Gravelly fine sandy loam	0.7 to 1.2	4.5 to 6.0	0.0	0
C -- 27 to 65	Gravelly fine sandy loam	3.0 to 4.9	4.5 to 6.0	0.0	0

Ecological class(es):

EfA--Enfield silt loam, 0 to 3 percent slopes

Composition

- Enfield and similar soils: 90 percent of the unit
- Bridgehampton and similar soils: 3 percent of the unit
- Agawam and similar soils: 2 percent of the unit
- Hinckley and similar soils: 2 percent of the unit
- Merrimac and similar soils: 2 percent of the unit
- Tisbury and similar soils: 1 percent of the unit

Setting

Landform(s): outwash plains on valleys, terraces on valleys

Elevation:

Precipitation: 44 to 50 inches

Slope gradient: 0 to 3 percent

Air temperature: 48 to 50 ºF

Frost-free period: 120 to 195 days

Characteristics of Enfield and similar soils

Average total avail. water in top five feet (in.): 6.8

Available water capacity class: Moderate

Parent material: coarse-silty eolian deposits over sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss

Restrictive feature(s): none

Depth to Water table: none within the soil profile

Drainage class: well drained

Flooding hazard: none

Ponding hazard: none

Saturated hydraulic conductivity class: Moderately High

Soil loss tolerance (T factor): 3

Wind erodibility group (WEG): 3

Wind erodibility index (WEI): 86

Land capability class, irrigated:

Land capability class, nonirrigated: 1

Hydric soil: no

Hydrologic group: B

Runoff class: low

Potential frost action: moderate

[EfA - Enfield silt loam, 0 to 3 percent slopes]

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
Oi -- 0 to 3	Slightly decomposed plant material	0.3 to 1.3		0.0	0
Oe -- 3 to 4	Moderately decomposed plant material	0.1 to 0.3		0.0	0
Ap -- 4 to 12	Silt loam	1.4 to 1.7	4.5 to 6.0	0.0	0
Bw1 -- 12 to 20	Silt loam	1.2 to 1.7	4.5 to 6.0	0.0	0
Bw2 -- 20 to 26	Silt loam	0.8 to 1.2	4.5 to 6.0	0.0	0
Bw3 -- 26 to 30	Silt loam	0.6 to 0.8	4.5 to 6.0	0.0	0
2C -- 30 to 37	Stratified coarse sand to very gravelly loamy sand	0.1 to 0.8	4.5 to 6.0	0.0	0
3C -- 37 to 65	Stratified very gravelly coarse sand to loamy sand	0.3 to 2.2	4.5 to 6.0	0.0	0

Ecological class(es):

EfB--Enfield silt loam, 3 to 8 percent slopes

Composition

- Enfield and similar soils: 90 percent of the unit
- Bridgehampton and similar soils: 3 percent of the unit
- Agawam and similar soils: 2 percent of the unit
- Hinckley and similar soils: 2 percent of the unit
- Merrimac and similar soils: 2 percent of the unit
- Tisbury and similar soils: 1 percent of the unit

Setting

Landform(s): outwash plains on valleys, terraces on valleys
Elevation:
Precipitation: 44 to 50 inches
Slope gradient: 3 to 8 percent
Air temperature: 48 to 50 ºF
Frost-free period: 120 to 195 days

Characteristics of Enfield and similar soils

Average total avail. water in top five feet (in.): 6.8
Available water capacity class: Moderate
Parent material: coarse-silty eolian deposits over sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss
Restrictive feature(s): none
Depth to Water table: none within the soil profile
Drainage class: well drained
Flooding hazard: none
Ponding hazard: none
Saturated hydraulic conductivity class: Moderately High
Soil loss tolerance (T factor): 3
Wind erodibility group (WEG): 3
Wind erodibility index (WEI): 86
Land capability class, irrigated:
Land capability class, nonirrigated: 2e
Hydric soil: no
Hydrologic group: B
Runoff class: medium
Potential frost action: moderate

[EfB - Enfield silt loam, 3 to 8 percent slopes]

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
Oi -- 0 to 3	Slightly decomposed plant material	0.3 to 1.3		0.0	0
Oe -- 3 to 4	Moderately decomposed plant material	0.1 to 0.3		0.0	0
Ap -- 4 to 12	Silt loam	1.4 to 1.7	4.5 to 6.0	0.0	0
Bw1 -- 12 to 20	Silt loam	1.2 to 1.7	4.5 to 6.0	0.0	0
Bw2 -- 20 to 26	Silt loam	0.8 to 1.2	4.5 to 6.0	0.0	0
Bw3 -- 26 to 30	Silt loam	0.6 to 0.8	4.5 to 6.0	0.0	0
2C -- 30 to 37	Stratified coarse sand to very gravelly loamy sand	0.1 to 0.8	4.5 to 6.0	0.0	0
3C -- 37 to 65	Stratified very gravelly coarse sand to loamy sand	0.3 to 2.2	4.5 to 6.0	0.0	0

Ecological class(es):

FeA--Freetown muck, 0 to 1 percent slopes

Composition

- Freetown and similar soils: 85 percent of the unit
- Scarboro and similar soils: 5 percent of the unit
- Swansea and similar soils: 5 percent of the unit
- Whitman and similar soils: 5 percent of the unit

Setting

Landform(s): depressions on alluvial plains, bogs, kettles, marshes, outwash plains, swamps, depressions on uplands

Elevation: 0 to 1109 feet

Precipitation: 36 to 71 inches

Slope gradient: 0 to 1 percent

Air temperature: 39 to 55 ºF

Frost-free period: 140 to 240 days

Characteristics of Freetown and similar soils

Average total avail. water in top five feet (in.): 25.3

Available water capacity class: High

Parent material: highly decomposed organic material

Restrictive feature(s): none

Depth to Water table: 0 inches

Drainage class: very poorly drained

Flooding hazard: none

Ponding hazard: none

Soil loss tolerance (T factor): 2

Wind erodibility group (WEG): 8

Wind erodibility index (WEI): 0

Land capability class, irrigated:

Land capability class, nonirrigated: 5w

Hydric soil: yes

Hydrologic group: B/D

Runoff class: negligible

Potential frost action: high

Saturated hydraulic conductivity class: High

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
Oe -- 0 to 2	Mucky peat	0.6 to 1.2		0.0	0
Oa -- 2 to 79	Muck	23.0 to 46.1		0.0	0

Ecological class(es):

HkA--Hinckley loamy sand, 0 to 3 percent slopes

Composition

- Hinckley and similar soils: 85 percent of the unit
- Merrimac and similar soils: 5 percent of the unit
- Sudbury and similar soils: 5 percent of the unit
- Windsor and similar soils: 5 percent of the unit

Setting

Landform(s): kame terraces on valleys, outwash deltas on valleys, outwash plains on valleys, outwash terraces on valleys

Elevation: 0 to 1424 feet

Precipitation: 36 to 71 inches

Slope gradient: 0 to 3 percent

Air temperature: 39 to 55 ºF

Frost-free period: 140 to 240 days

Characteristics of Hinckley and similar soils

Average total avail. water in top five feet (in.): 3.3

Available water capacity class: Low

Parent material: sandy and gravelly glaciofluvial deposits derived from gneiss and/or granite and/or schist

Restrictive feature(s): none

Depth to Water table: none within the soil profile

Drainage class: excessively drained

Flooding hazard: none

Ponding hazard: none

Saturated hydraulic conductivity class: Very High

Soil loss tolerance (T factor): 3

Wind erodibility group (WEG): 2

Wind erodibility index (WEI): 134

Land capability class, irrigated:

Land capability class, nonirrigated: 3s

Hydric soil: no

Hydrologic group: A

Runoff class: negligible

Potential frost action: low

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
Oe -- 0 to 1	Moderately decomposed plant material	0.2 to 0.4		0.0 to 2.0	0
A -- 1 to 8	Loamy sand	0.3 to 1.8	3.5 to 6.0	0.0 to 2.0	0
Bw1 -- 8 to 11	Gravelly loamy sand	0.1 to 0.5	3.5 to 6.0	0.0 to 2.0	0
Bw2 -- 11 to 16	Gravelly loamy sand	0.1 to 0.6	3.5 to 6.0	0.0 to 2.0	0
BC -- 16 to 19	Very gravelly loamy sand	0.1 to 0.3	3.5 to 6.0	0.0 to 2.0	0
C -- 19 to 65	Very gravelly sand	0.9 to 2.8	3.5 to 6.0	0.0 to 2.0	0

Ecological class(es):

HkC--Hinckley loamy sand, 8 to 15 percent slopes

Composition

- Hinckley and similar soils: 85 percent of the unit
- Merrimac and similar soils: 5 percent of the unit
- Sudbury and similar soils: 5 percent of the unit
- Windsor and similar soils: 5 percent of the unit

Setting

Landform(s): moraines on uplands, eskers on valleys, kame terraces on valleys, kames on valleys, outwash deltas on valleys, outwash plains on valleys, outwash terraces on valleys

Elevation: 0 to 1480 feet

Precipitation: 36 to 71 inches

Slope gradient: 8 to 15 percent

Air temperature: 39 to 55 ºF

Frost-free period: 140 to 240 days

Characteristics of Hinckley and similar soils

Average total avail. water in top five feet (in.): 3.3

Available water capacity class: Low

Parent material: sandy and gravelly glaciofluvial deposits derived from gneiss and/or granite and/or schist

Restrictive feature(s): none

Depth to Water table: none within the soil profile

Drainage class: excessively drained

Flooding hazard: none

Ponding hazard: none

Saturated hydraulic conductivity class: Very High

Soil loss tolerance (T factor): 3

Wind erodibility group (WEG): 2

Wind erodibility index (WEI): 134

Land capability class, irrigated:

Land capability class, nonirrigated: 4e

Hydric soil: no

Hydrologic group: A

Runoff class: very low

Potential frost action: low

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
Oe -- 0 to 1	Moderately decomposed plant material	0.2 to 0.4		0.0 to 2.0	0
A -- 1 to 8	Loamy sand	0.3 to 1.8	3.5 to 6.0	0.0 to 2.0	0
Bw1 -- 8 to 11	Gravelly loamy sand	0.1 to 0.5	3.5 to 6.0	0.0 to 2.0	0
Bw2 -- 11 to 16	Gravelly loamy sand	0.1 to 0.6	3.5 to 6.0	0.0 to 2.0	0
BC -- 16 to 19	Very gravelly loamy sand	0.1 to 0.3	3.5 to 6.0	0.0 to 2.0	0
C -- 19 to 65	Very gravelly sand	0.9 to 2.8	3.5 to 6.0	0.0 to 2.0	0

Ecological class(es):

NaA--Narragansett silt loam, 0 to 3 percent slopes

Composition

- Narragansett and similar soils: 90 percent of the unit
- Bridgehampton and similar soils: 3 percent of the unit
- Canton and similar soils: 2 percent of the unit
- Charlton and similar soils: 2 percent of the unit
- Wapping and similar soils: 2 percent of the unit
- Woodbridge and similar soils: 1 percent of the unit

Setting

Landform(s): hills on uplands, till plains on uplands

Elevation:

Precipitation: 44 to 50 inches

Slope gradient: 0 to 3 percent

Air temperature: 48 to 50 ºF

Frost-free period: 120 to 190 days

Characteristics of Narragansett and similar soils

Average total avail. water in top five feet (in.): 6.3

Available water capacity class: Moderate

Parent material: coarse-loamy eolian deposits over sandy and gravelly melt-out till derived from gneiss and/or schist and/or granite

Restrictive feature(s): none

Depth to Water table: none within the soil profile

Drainage class: well drained

Flooding hazard: none

Ponding hazard: none

Saturated hydraulic conductivity class: Moderately High

Soil loss tolerance (T factor): 3

Wind erodibility group (WEG): 5

Wind erodibility index (WEI): 56

Land capability class, irrigated:

Land capability class, nonirrigated: 1

Hydric soil: no

Hydrologic group: B

Runoff class: low

Potential frost action: moderate

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
Ap -- 0 to 6	Silt loam	0.9 to 1.2	4.5 to 6.0	0.0	0
Bw1 -- 6 to 15	Silt loam	1.0 to 1.9	4.5 to 6.0	0.0	0
Bw2 -- 15 to 24	Silt loam	1.0 to 1.9	4.5 to 6.0	0.0	0
Bw3 -- 24 to 28	Gravelly silt loam	0.4 to 0.8	4.5 to 6.0	0.0	0
2C -- 28 to 60	Very gravelly loamy coarse sand	0.6 to 3.2	4.5 to 6.0	0.0	0

Ecological class(es):

NaB--Narragansett silt loam, 3 to 8 percent slopes

Composition

- Narragansett and similar soils: 90 percent of the unit
- Bridgehampton and similar soils: 3 percent of the unit
- Canton and similar soils: 2 percent of the unit
- Charlton and similar soils: 2 percent of the unit
- Wapping and similar soils: 2 percent of the unit
- Woodbridge and similar soils: 1 percent of the unit

Setting

Landform(s): hills on uplands, till plains on uplands

Elevation:

Precipitation: 44 to 50 inches

Slope gradient: 3 to 8 percent

Air temperature: 48 to 50 ºF

Frost-free period: 120 to 190 days

Characteristics of Narragansett and similar soils

Average total avail. water in top five feet (in.): 6.3

Available water capacity class: Moderate

Parent material: coarse-loamy eolian deposits over sandy and gravelly melt-out till derived from gneiss and/or schist and/or granite

Restrictive feature(s): none

Depth to Water table: none within the soil profile

Drainage class: well drained

Flooding hazard: none

Ponding hazard: none

Saturated hydraulic conductivity class: Moderately High

Soil loss tolerance (T factor): 3

Wind erodibility group (WEG): 5

Wind erodibility index (WEI): 56

Land capability class, irrigated:

Land capability class, nonirrigated: 2e

Hydric soil: no

Hydrologic group: B

Runoff class: medium

Potential frost action: moderate

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
Ap -- 0 to 6	Silt loam	0.9 to 1.2	4.5 to 6.0	0.0	0
Bw1 -- 6 to 15	Silt loam	1.0 to 1.9	4.5 to 6.0	0.0	0
Bw2 -- 15 to 24	Silt loam	1.0 to 1.9	4.5 to 6.0	0.0	0
Bw3 -- 24 to 28	Gravelly silt loam	0.4 to 0.8	4.5 to 6.0	0.0	0
2C -- 28 to 60	Very gravelly loamy coarse sand	0.6 to 3.2	4.5 to 6.0	0.0	0

Ecological class(es):

NbB--Narragansett very stony silt loam, 0 to 8 percent slopes

Composition

- Narragansett and similar soils: 90 percent of the unit
- Bridgehampton and similar soils: 4 percent of the unit
- Canton and similar soils: 2 percent of the unit
- Charlton and similar soils: 1 percent of the unit
- Scio and similar soils: 1 percent of the unit
- Wapping and similar soils: 1 percent of the unit
- Woodbridge and similar soils: 1 percent of the unit

Setting

Landform(s): hills on uplands, till plains on uplands

Elevation:

Precipitation: 44 to 50 inches

Slope gradient: 0 to 8 percent

Air temperature: 48 to 50 ºF

Frost-free period: 120 to 190 days

Characteristics of Narragansett and similar soils

Average total avail. water in top five feet (in.): 6.3

Available water capacity class: Moderate

Parent material: coarse-loamy eolian deposits over sandy and gravelly melt-out till derived from gneiss and/or schist and/or granite

Restrictive feature(s): none

Depth to Water table: none within the soil profile

Drainage class: well drained

Flooding hazard: none

Ponding hazard: none

Saturated hydraulic conductivity class: Moderately High

Soil loss tolerance (T factor): 3

Wind erodibility group (WEG): 5

Wind erodibility index (WEI): 56

Land capability class, irrigated:

Land capability class, nonirrigated: 6s

Hydric soil: no

Hydrologic group: B

Runoff class: medium

Potential frost action: moderate

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
Ap -- 0 to 6	Silt loam	0.9 to 1.2	4.5 to 6.0	0.0	0
Bw1 -- 6 to 15	Silt loam	1.0 to 1.9	4.5 to 6.0	0.0	0
Bw2 -- 15 to 24	Silt loam	1.0 to 1.9	4.5 to 6.0	0.0	0
Bw3 -- 24 to 28	Gravelly silt loam	0.4 to 0.8	4.5 to 6.0	0.0	0
2C -- 28 to 60	Very gravelly loamy coarse sand	0.6 to 3.2	4.5 to 6.0	0.0	0

Ecological class(es):

NbC--Narragansett very stony silt loam, 8 to 15 percent slopes

Composition

- Narragansett and similar soils: 90 percent of the unit
- Bridgehampton and similar soils: 3 percent of the unit
- Canton and similar soils: 2 percent of the unit
- Charlton and similar soils: 2 percent of the unit
- Scio and similar soils: 1 percent of the unit
- Wapping and similar soils: 1 percent of the unit
- Woodbridge and similar soils: 1 percent of the unit

Setting

Landform(s): hills on uplands, till plains on uplands

Elevation:

Precipitation: 44 to 50 inches

Slope gradient: 8 to 15 percent

Air temperature: 48 to 50 ºF

Frost-free period: 120 to 190 days

Characteristics of Narragansett and similar soils

Average total avail. water in top five feet (in.): 6.3

Available water capacity class: Moderate

Parent material: coarse-loamy eolian deposits over sandy and gravelly melt-out till derived from gneiss and/or schist and/or granite

Restrictive feature(s): none

Depth to Water table: none within the soil profile

Drainage class: well drained

Flooding hazard: none

Ponding hazard: none

Saturated hydraulic conductivity class: Moderately High

Soil loss tolerance (T factor): 3

Wind erodibility group (WEG): 5

Wind erodibility index (WEI): 56

Land capability class, irrigated:

Land capability class, nonirrigated: 6s

Hydric soil: no

Hydrologic group: B

Runoff class: medium

Potential frost action: moderate

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
Ap -- 0 to 6	Silt loam	0.9 to 1.2	4.5 to 6.0	0.0	0
Bw1 -- 6 to 15	Silt loam	1.0 to 1.9	4.5 to 6.0	0.0	0
Bw2 -- 15 to 24	Silt loam	1.0 to 1.9	4.5 to 6.0	0.0	0
Bw3 -- 24 to 28	Gravelly silt loam	0.4 to 0.8	4.5 to 6.0	0.0	0
2C -- 28 to 60	Very gravelly loamy coarse sand	0.6 to 3.2	4.5 to 6.0	0.0	0

Ecological class(es):

PD--Paxton-Urban land complex, 3 to 15 percent slopes

Composition

- Paxton and similar soils: 45 percent of the unit
- Urban land: 35 percent of the unit
- Woodbridge and similar soils: 9 percent of the unit
- Charlton and similar soils: 6 percent of the unit
- Udorthents and similar soils: 4 percent of the unit
- Ridgebury and similar soils: 1 percent of the unit

Setting

Landform(s): drumlins on uplands, ground moraines on uplands, hills on uplands

Elevation: 0 to 932 feet

Precipitation: 36 to 71 inches

Slope gradient: 3 to 15 percent

Air temperature: 39 to 55 ºF

Frost-free period: 145 to 240 days

Characteristics of Paxton and similar soils

Average total avail. water in top five feet (in.): 8.4

Available water capacity class: Moderate

Parent material: coarse-loamy lodgment till derived from gneiss, granite, and/or schist

Restrictive feature(s): densic material at 20 to 39 inches

Depth to Water table: 24 inches

Drainage class: well drained

Flooding hazard: none

Ponding hazard: none

Saturated hydraulic conductivity class: Moderately Low

Soil loss tolerance (T factor): 3

Wind erodibility group (WEG): 3

Wind erodibility index (WEI): 86

Land capability class, irrigated:

Land capability class, nonirrigated: 3e

Hydric soil: no

Hydrologic group: C

Runoff class: medium

Potential frost action: moderate

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
Ap -- 0 to 8	Fine sandy loam	0.8 to 1.9	4.5 to 6.5	0.0 to 2.0	0
Bw1 -- 8 to 15	Fine sandy loam	0.6 to 1.3	4.5 to 6.5	0.0 to 2.0	0
Bw2 -- 15 to 26	Fine sandy loam	1.0 to 1.9	4.5 to 6.5	0.0 to 2.0	0
Cd -- 26 to 65	Gravelly fine sandy loam	2.7 to 6.6	4.5 to 6.5	0.0 to 2.0	0

Ecological class(es):

Characteristics of Urban land

Average total avail. water in top five feet (in.): 0.0

Available water capacity class: Very low

Parent material:

Restrictive feature(s): manufactured layer at 0 to 0 inches

Depth to Water table:

Drainage class:

Flooding hazard:

Ponding hazard:

Saturated hydraulic conductivity class: Very Low

Ecological class(es):

Soil loss tolerance (T factor):

Wind erodibility group (WEG):

Wind erodibility index (WEI):

Land capability class, irrigated:

Land capability class, nonirrigated: 8

Hydric soil: no

Hydrologic group: D

Runoff class:

Potential frost action:

RaA--Rainbow silt loam, 0 to 3 percent slopes

Composition

- Rainbow and similar soils: 90 percent of the unit
- Broadbrook and similar soils: 3 percent of the unit
- Ridgebury and similar soils: 2 percent of the unit
- Wapping and similar soils: 2 percent of the unit
- Woodbridge and similar soils: 2 percent of the unit
- Paxton and similar soils: 1 percent of the unit

Setting

Landform(s): drumlins on uplands, hills on uplands
Elevation:
Precipitation: 44 to 50 inches
Slope gradient: 0 to 3 percent
Air temperature: 48 to 50 ºF
Frost-free period: 120 to 190 days

Characteristics of Rainbow and similar soils

Average total avail. water in top five feet (in.): 8.4
Available water capacity class: Moderate
Parent material: coarse-loamy eolian deposits over coarse-loamy lodgment till derived from granite and gneiss and/or schist
Restrictive feature(s): densic material
Depth to Water table: 24 inches
Drainage class: moderately well drained
Flooding hazard: none
Ponding hazard: none
Saturated hydraulic conductivity class: Moderately Low
Soil loss tolerance (T factor): 3
Wind erodibility group (WEG): 5
Wind erodibility index (WEI): 56
Land capability class, irrigated:
Land capability class, nonirrigated: 2w
Hydric soil: no
Hydrologic group: C
Runoff class: low
Potential frost action: high

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
Ap -- 0 to 6	Silt loam	1.0 to 1.2	4.5 to 6.0	0.0	0
Bw1 -- 6 to 18	Silt loam	1.5 to 2.6	4.5 to 6.0	0.0	0
Bw2 -- 18 to 26	Silt loam	0.9 to 1.7	4.5 to 6.0	0.0	0
2Cd -- 26 to 65	Gravelly fine sandy loam	1.9 to 4.7	4.5 to 6.0	0.0	0

Ecological class(es):

RaB--Rainbow silt loam, 3 to 8 percent slopes

Composition

- Rainbow and similar soils: 90 percent of the unit
- Broadbrook and similar soils: 3 percent of the unit
- Ridgebury and similar soils: 2 percent of the unit
- Wapping and similar soils: 2 percent of the unit
- Woodbridge and similar soils: 2 percent of the unit
- Paxton and similar soils: 1 percent of the unit

Setting

Landform(s): drumlins on uplands, hills on uplands

Elevation:

Precipitation: 44 to 50 inches

Slope gradient: 3 to 8 percent

Air temperature: 48 to 50 ºF

Frost-free period: 120 to 190 days

Characteristics of Rainbow and similar soils

Average total avail. water in top five feet (in.): 8.4

Available water capacity class: Moderate

Parent material: coarse-loamy eolian deposits over coarse-loamy lodgment till derived from granite and gneiss and/or schist

Restrictive feature(s): densic material

Depth to Water table: 24 inches

Drainage class: moderately well drained

Flooding hazard: none

Ponding hazard: none

Saturated hydraulic conductivity class: Moderately Low

Soil loss tolerance (T factor): 3

Wind erodibility group (WEG): 5

Wind erodibility index (WEI): 56

Land capability class, irrigated:

Land capability class, nonirrigated: 2e

Hydric soil: no

Hydrologic group: C

Runoff class: medium

Potential frost action: high

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
Ap -- 0 to 6	Silt loam	1.0 to 1.2	4.5 to 6.0	0.0	0
Bw1 -- 6 to 18	Silt loam	1.5 to 2.6	4.5 to 6.0	0.0	0
Bw2 -- 18 to 26	Silt loam	0.9 to 1.7	4.5 to 6.0	0.0	0
2Cd -- 26 to 65	Gravelly fine sandy loam	1.9 to 4.7	4.5 to 6.0	0.0	0

Ecological class(es):

Rf--Ridgebury, Leicester, and Whitman soils, 0 to 8 percent slopes, extremely stony

Composition

- Ridgebury, extremely stony and similar soils: 40 percent of the unit
- Leicester, extremely stony and similar soils: 35 percent of the unit
- Whitman, extremely stony and similar soils: 20 percent of the unit
- Woodbridge, extremely stony and similar soils: 3 percent of the unit
- Swansea and similar soils: 2 percent of the unit

Setting

Landform(s): ground moraines on uplands, hills on uplands, depressions on uplands, drainageways on uplands

Elevation: 0 to 1480 feet

Precipitation: 36 to 71 inches

Slope gradient: 0 to 8 percent

Air temperature: 39 to 55 ºF

Frost-free period: 140 to 240 days

Characteristics of Ridgebury, extremely stony and similar soils

Average total avail. water in top five feet (in.): 7.2

Available water capacity class: Moderate

Parent material: coarse-loamy lodgment till derived from gneiss, granite, and/or schist

Restrictive feature(s): densic material at 14 to 32 inches

Depth to Water table: 3 to 9 inches

Drainage class: poorly drained

Flooding hazard: none

Ponding hazard: none

Saturated hydraulic conductivity class: Moderately Low

Soil loss tolerance (T factor): 2

Wind erodibility group (WEG): 3

Wind erodibility index (WEI): 86

Land capability class, irrigated:

Land capability class, nonirrigated: 7s

Hydric soil: yes

Hydrologic group: D

Runoff class: very low

Potential frost action: high

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
A -- 0 to 5	Fine sandy loam	0.6 to 1.0	4.5 to 6.5	0.0 to 2.0	0
Bw -- 5 to 9	Sandy loam	0.4 to 0.7	4.5 to 6.0	0.0 to 2.0	0
Bg -- 9 to 18	Gravelly sandy loam	0.8 to 1.4	4.5 to 6.0	0.0 to 2.0	0
Cd -- 18 to 65	Gravelly sandy loam	4.2 to 7.0	4.5 to 6.5	0.0 to 2.0	0

Ecological class(es):

Characteristics of Leicester, extremely stony and similar soils

Average total avail. water in top five feet (in.): 7.4

Available water capacity class: Moderate

Parent material: coarse-loamy melt-out till derived from gneiss, granite, and/or schist

Restrictive feature(s): none

Depth to Water table: 9 inches

Drainage class: poorly drained

Flooding hazard: none

Ponding hazard: none

Saturated hydraulic conductivity class: High

Soil loss tolerance (T factor): 5

Wind erodibility group (WEG): 3

Wind erodibility index (WEI): 86

Land capability class, irrigated:

Land capability class, nonirrigated: 7s

Hydric soil: yes

Hydrologic group: B/D

Runoff class: very low

Potential frost action: high

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
Oe -- 0 to 1	Moderately decomposed plant material	0.1 to 0.5		0.0	0
A -- 1 to 7	Fine sandy loam	0.7 to 0.8	4.5 to 5.5	0.0	0
Bg1 -- 7 to 10	Fine sandy loam	0.2 to 0.5	4.5 to 5.5	0.0	0
Bg2 -- 10 to 18	Fine sandy loam	0.7 to 1.4	4.5 to 5.5	0.0	0
BC -- 18 to 24	Fine sandy loam	0.5 to 1.0	4.5 to 5.5	0.0	0
C1 -- 24 to 43	Gravelly fine sandy loam	1.3 to 2.6	4.5 to 6.0	0.0	0
C2 -- 43 to 65	Gravelly fine sandy loam	1.1 to 3.1	4.5 to 6.0	0.0	0

Ecological class(es):

Characteristics of Whitman, extremely stony and similar soils

Average total avail. water in top five feet (in.): 4.1

Available water capacity class: Low

Parent material: coarse-loamy lodgment till derived from gneiss, granite, and/or schist

Restrictive feature(s): densic material at 12 to 20 inches

Depth to Water table: 0 to 9 inches

Drainage class: very poorly drained

Flooding hazard: none

Ponding hazard: none

Saturated hydraulic conductivity class: Moderately Low

Soil loss tolerance (T factor): 2

Wind erodibility group (WEG): 3

Wind erodibility index (WEI): 86

Land capability class, irrigated:

Land capability class, nonirrigated: 7s

Hydric soil: yes

Hydrologic group: D

Runoff class: negligible

Potential frost action: high

Map Unit Description (Brief, Tabular)

State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties

[Rf - Ridgebury, Leicester, and Whitman soils, 0 to 8 percent slopes, extremely stony]

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
Oi -- 0 to 1	Slightly decomposed plant material	0.1 to 0.5		0.0	0
A -- 1 to 9	Fine sandy loam	0.9 to 1.0	4.5 to 6.5	0.0	0
Bg -- 9 to 16	Fine sandy loam	0.6 to 0.9	4.5 to 6.5	0.0	0
Cdg1 -- 16 to 22	Fine sandy loam	0.2 to 0.4	4.5 to 6.5	0.0	0
Cdg2 -- 22 to 60	Fine sandy loam	1.1 to 2.6	4.5 to 6.5	0.0	0

Ecological class(es):

ScA--Scio silt loam, 0 to 3 percent slopes

Composition

- Scio and similar soils: 90 percent of the unit
- Bridgehampton and similar soils: 2 percent of the unit
- Rainbow and similar soils: 2 percent of the unit
- Raypol and similar soils: 2 percent of the unit
- Ridgebury and similar soils: 2 percent of the unit
- Tisbury and similar soils: 2 percent of the unit

Setting

Landform(s): lakebeds on lake plains, terraces on lake plains

Elevation: 98 to 810 feet

Precipitation: 44 to 50 inches

Slope gradient: 0 to 3 percent

Air temperature: 48 to 50 ºF

Frost-free period: 120 to 180 days

Characteristics of Scio and similar soils

Average total avail. water in top five feet (in.): 10.4

Available water capacity class: High

Parent material: coarse-silty loess over coarse-loamy lodgment till derived from granite and gneiss

Restrictive feature(s): none

Depth to Water table: 24 inches

Drainage class: moderately well drained

Flooding hazard: none

Ponding hazard: none

Soil loss tolerance (T factor): 4

Wind erodibility group (WEG): 5

Wind erodibility index (WEI): 56

Land capability class, irrigated:

Land capability class, nonirrigated: 2w

Hydric soil: no

Hydrologic group: C

Runoff class: low

Potential frost action: high

Saturated hydraulic conductivity class: Moderately High

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
Ap -- 0 to 9	Silt loam	1.6 to 1.9	4.5 to 6.0	Null	Null
Bw -- 9 to 46	Silt loam	6.3 to 7.4	4.5 to 6.0	Null	Null
2Cg -- 46 to 60	Stratified very gravelly sand to silt loam	0.3 to 2.6	5.1 to 7.8	Null	Null

Ecological class(es):

SdB--Scio very stony silt loam, 0 to 8 percent slopes

Composition

- Scio and similar soils: 90 percent of the unit
- Wapping and similar soils: 3 percent of the unit
- Rainbow and similar soils: 2 percent of the unit
- Ridgebury and similar soils: 2 percent of the unit
- Tisbury and similar soils: 2 percent of the unit
- Bridgehampton and similar soils: 1 percent of the unit

Setting

Landform(s): lakebeds on lake plains, terraces on lake plains

Elevation: 98 to 810 feet

Precipitation: 44 to 50 inches

Slope gradient: 0 to 8 percent

Air temperature: 48 to 50 ºF

Frost-free period: 120 to 180 days

Characteristics of Scio and similar soils

Average total avail. water in top five feet (in.): 10.4

Available water capacity class: High

Parent material: coarse-silty loess over coarse-loamy lodgment till derived from granite and gneiss

Restrictive feature(s): none

Depth to Water table: 24 inches

Drainage class: moderately well drained

Flooding hazard: none

Ponding hazard: none

Saturated hydraulic conductivity class: Moderately High

Soil loss tolerance (T factor): 4

Wind erodibility group (WEG): 5

Wind erodibility index (WEI): 56

Land capability class, irrigated:

Land capability class, nonirrigated: 6s

Hydric soil: no

Hydrologic group: C

Runoff class: medium

Potential frost action: high

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
Ap -- 0 to 9	Silt loam	1.6 to 1.9	4.5 to 6.0	Null	Null
Bw -- 9 to 46	Silt loam	6.3 to 7.4	4.5 to 6.0	Null	Null
2Cg -- 46 to 60	Stratified very gravelly sand to silt loam	0.3 to 2.6	5.1 to 7.8	Null	Null

Ecological class(es):

Ss--Sudbury sandy loam

Composition

- Sudbury and similar soils: 90 percent of the unit
- Hinckley and similar soils: 3 percent of the unit
- Ninigret and similar soils: 2 percent of the unit
- Agawam and similar soils: 1 percent of the unit
- Deerfield and similar soils: 1 percent of the unit
- Merrimac and similar soils: 1 percent of the unit
- Walpole and similar soils: 1 percent of the unit
- Windsor and similar soils: 1 percent of the unit

Setting

Landform(s): outwash plains on valleys, terraces on valleys
Elevation: 0 to 801 feet
Precipitation: 44 to 50 inches

Slope gradient: 0 to 3 percent
Air temperature: 48 to 50 ºF
Frost-free period: 100 to 195 days

Characteristics of Sudbury and similar soils

Average total avail. water in top five feet (in.): 4.2
Available water capacity class: Low
Parent material: sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss
Restrictive feature(s): none
Depth to Water table: 27 inches
Drainage class: moderately well drained
Flooding hazard: none
Ponding hazard: none
Saturated hydraulic conductivity class: High

Soil loss tolerance (T factor): 4
Wind erodibility group (WEG): 3
Wind erodibility index (WEI): 86
Land capability class, irrigated:
Land capability class, nonirrigated: 2w
Hydric soil: no
Hydrologic group: B
Runoff class: very low
Potential frost action: moderate

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
Oe -- 0 to 1	Moderately decomposed plant material	0.1 to 0.5		0.0	0
A -- 1 to 5	Sandy loam	0.4 to 0.5	4.5 to 6.5	0.0	0
Bw1 -- 5 to 17	Gravelly sandy loam	0.8 to 1.8	4.5 to 6.5	0.0	0
Bw2 -- 17 to 25	Sandy loam	0.6 to 1.2	4.5 to 6.5	0.0	0
2C -- 25 to 60	Stratified g to sand	0.3 to 2.1	4.5 to 6.5	0.0	0

Ecological class(es):

SwA--Swansea muck, 0 to 1 percent slopes

Composition

- Swansea and similar soils: 80 percent of the unit
- Freetown and similar soils: 10 percent of the unit
- Scarboro and similar soils: 5 percent of the unit
- Whitman and similar soils: 5 percent of the unit

Setting

Landform(s): bogs, swamps on outwash plains, uplands

Elevation: 0 to 1138 feet

Precipitation: 36 to 71 inches

Slope gradient: 0 to 1 percent

Air temperature: 39 to 55 ºF

Frost-free period: 140 to 240 days

Characteristics of Swansea and similar soils

Average total avail. water in top five feet (in.): 17.5

Available water capacity class: High

Parent material: highly decomposed organic material over loose sandy and gravelly glaciofluvial deposits

Restrictive feature(s): none

Depth to Water table: 0 inches

Drainage class: very poorly drained

Flooding hazard: none

Ponding hazard: none

Saturated hydraulic conductivity class: High

Soil loss tolerance (T factor): 1

Wind erodibility group (WEG): 8

Wind erodibility index (WEI): 0

Land capability class, irrigated:

Land capability class, nonirrigated: 8w

Hydric soil: yes

Hydrologic group: B/D

Runoff class: negligible

Potential frost action: high

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
Oa1 -- 0 to 24	Muck	7.2 to 12.5		0.0	0
Oa2 -- 24 to 34	Muck	3.0 to 5.1		0.0	0
Cg -- 34 to 79	Coarse sand	0.4 to 7.2	3.5 to 6.0	0.0	0

Ecological class(es):

UD--Udorthents-Urban land complex

Composition

- Udorthents and similar soils: 60 to 90 percent of the map unit (RV=70 percent)
- Urban land: 10 to 40 percent of the map unit (RV=20 percent)
- Merrimac and similar soils: 0 to 5 percent of the map unit (RV=5 percent)
- Quonset and similar soils: 0 to 5 percent of the map unit (RV=5 percent)

Setting

Landform(s): fills on uplands
Elevation:
Precipitation: 44 to 50 inches

Slope gradient: 0 to 15 percent
Air temperature: 48 to 50 ºF
Frost-free period: 120 to 195 days

Characteristics of Udorthents and similar soils

Average total avail. water in top five feet (in.): 5.5
Available water capacity class: Low
Parent material: human transported material
Restrictive feature(s): none
Depth to Water table: 48 inches
Drainage class: not determined
Flooding hazard: none
Ponding hazard: none

Soil loss tolerance (T factor): 3
Wind erodibility group (WEG): 3
Wind erodibility index (WEI): 86
Land capability class, irrigated:
Land capability class, nonirrigated:
Hydric soil: no
Hydrologic group: A
Runoff class: very low
Potential frost action:

Saturated hydraulic conductivity class: High

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
A -- 0 to 12	Sandy loam	1.7 to 2.2	3.6 to 6.0	Null	Null
C1 -- 12 to 25	Sandy loam	1.9 to 2.3	3.6 to 6.0	Null	Null
C2 -- 25 to 60	Stratified sand to very gravelly coarse sand	0.3 to 2.1	3.6 to 6.0	Null	Null

Ecological class(es):

Characteristics of Urban land

Average total avail. water in top five feet (in.):

Available water capacity class: NA

Parent material: human transported material

Restrictive feature(s):

Depth to Water table:

Drainage class:

Flooding hazard:

Ponding hazard:

Soil loss tolerance (T factor):

Wind erodibility group (WEG):

Wind erodibility index (WEI):

Land capability class, irrigated:

Land capability class, nonirrigated: 8s

Hydric soil: no

Hydrologic group:

Runoff class: very high

Potential frost action:

Saturated hydraulic conductivity class: Very Low

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
R -- 0 to 6	Variable			Null	Null

Ecological class(es):

Ur--Urban land

Composition

- Urban land: 85 percent of the unit
- Udorthents and similar soils: 5 percent of the unit
- Canton and similar soils: 2 percent of the unit
- Charlton and similar soils: 2 percent of the unit
- Pittstown and similar soils: 2 percent of the unit
- Merrimac and similar soils: 1 percent of the unit
- Newport and similar soils: 1 percent of the unit
- Sudbury and similar soils: 1 percent of the unit
- Sutton and similar soils: 1 percent of the unit

Setting

Landform(s):
Elevation:
Precipitation: 44 to 50 inches

Slope gradient: 0 to 10 percent
Air temperature: 48 to 50 ºF
Frost-free period:

Characteristics of Urban land

Average total avail. water in top five feet (in.):
Available water capacity class: NA
Parent material: human transported material
Restrictive feature(s):
Depth to Water table:
Drainage class:
Flooding hazard:
Ponding hazard:

Saturated hydraulic conductivity class: NA

Ecological class(es):

Soil loss tolerance (T factor):
Wind erodibility group (WEG):
Wind erodibility index (WEI):
Land capability class, irrigated:
Land capability class, nonirrigated:
Hydric soil: no
Hydrologic group:
Runoff class: very high
Potential frost action:

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Appendix F

Annotated List of Kingston Campus Structural BMPs

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Table F.1
University of Rhode Island
Structural BMP List

Adapted from URI MS4 Structural BMP List; see Attachment 3 - Existing Facilities and BMP Map – *locations depicted are based on URI Utilities Department's GIS data (URI Drain GDB) and other best available information*

NO.	ID	TYPE	BMP	MAINTENANCE REQUIREMENTS	*GRA Comments / Notes*	*GRA Mapped*
BMP-01	CV	Culverts	Level Spreader Northwest of Independence Square	Inspect and clean annually		*YES*
BMP-02	W	Detention Pond	Ballentine Pond	Inspect every quarter, remove sediment when depth increases by one foot, inspect slopes	*Pond considered a regulated freshwater wetland feature by RIDEM OWR*	*YES*
BMP-03	SB	Sedimentation Box	Butterfield Rd Sedimentation Box	Inspect and clean annually.		*YES*
BMP-04	WQ	Rain garden	CBLS BMP	Inspect annually and remove accumulated sediments		*YES*
BMP-05	SD	Stormtrap Detention Structure	CHI PHI Stormwater Detention Structure	Vacuum structures annually (Spring). (Twice annually if necessary or every 2-3 years after site has stabilized.		*YES*
BMP-05	WQ	Stormceptor Water Quality Structure	CHI PHI Stormwater Water Quality Structure	Vacuum structures annually (Spring). (Twice annually if necessary or every 2-3 years after site has stabilized.		*YES*
BMP-05	WQ	Oil/Water Separator Deep Sump CBs	CHI PHI Oil/Water Separator and Deep Sump Catch Basins	Inspect and clean annually (minimum).		*YES*
BMP-06		BMP Removed	Pharmacy Detention Area			
BMP-07	CV	Culverts	Culvert at 138	Inspection/Annual maintenance as required.		*YES*
BMP-08	CV	Culverts	Culvert at Frat Circle Path	Inspection/Annual maintenance as required.		*YES*
BMP-09	CV	Culverts	Culvert at Frat Circle (Rd)	Inspection/Annual maintenance as required.		*YES*
BMP-10	CV	Culverts	Culvert East of Mackal	Inspection/Annual maintenance as required.		*YES*
BMP-11	CV	Culverts	Culvert at Elephant Walk	Inspection/Annual maintenance as required.		*YES*

KEY: Campus-wide BMP BMP Removed * Denotes location depicted on Map is approximate

BMP Not Applicable (or N/A to management of Kingston Campus MS4)

NO.	ID	TYPE	BMP	MAINTENANCE REQUIREMENTS	*GRA Comments / Notes*	*GRA Mapped*
BMP-12	CV	Culverts	Culvert at Dorr	Inspection/Annual maintenance as required.		*YES*
BMP-13	CV	Culverts	Culvert at West Alumni	Inspection/Annual maintenance as required.		*YES*
BMP-14	CV	Culverts	Culvert at Flagg Rd	Inspection/Annual maintenance as required.		*YES*
BMP-15	CV	Culverts	Culvert at Plains Rd	Inspection/Annual maintenance as required.	*Could not locate in URI Drain GDB; presumed to be culvert connecting wetlands at SW corner of campus to Chipuxet River; location depicted is approximate*	*YES **
BMP-16	PPS	Pervious Parking Surface	Dairy Barn Lot	Vacuum sweep with a commercial cleaning unit four times annually (min), inspect annually for deterioration and spalling.		*YES*
BMP-17	IS	Infiltration System	Eddy Hall Infiltration System	Inspect and clean annually.		*YES*
BMP-18	W	Detention Pond	Ellery Pond	Inspect every quarter, remove sediment when depth increases by one foot, inspect slopes	*Pond considered a regulated freshwater wetland feature by RIDEM/OWR*	*YES*
BMP-19	D	Detention Pond	Flagg Rd Detention Pond - West	Inspect every quarter, remove sediment when depth increases by one foot, inspect slopes	*BMP-63 appears to be a duplicate of this*	*YES*
BMP-20	D	Detention Pond	Flagg Rd Detention Pond - East	Inspect every quarter, remove sediment when depth increases by one foot, inspect slopes		*YES*
BMP-21	SW	Swales	Heathman Rd Swale	Inspect and clean twice annually.		*YES*
BMP-22	D	Detention Pond	Merrow Hall Detention	Inspect and clean annually	*Pond considered a regulated freshwater wetland feature by RIDEM/OWR*	*YES*
BMP-23	SW	Swales/Infiltration System	Plains Rd Parking Lot	Inspect and clean twice annually.	*See BMP Nos. 24 and 35;*	*YES*
BMP-23	SW	Swales	Plains Rd Parking Lot	Inspect and replant (if necessary) every growing season. Grass within swales must be mowed at least once per mowing season to a height no shorter than 4". Remove any accumulated sediments yearly.	*BMP Nos. 23, 24 & 35 appear to be for larger, original/east lot;* *BMP Nos. 64 & 76 appear to apply to westerly expansion area*	*YES*

KEY: Campus-wide BMP BMP Removed * Denotes location depicted on Map is approximate

BMP Not Applicable (or N/A to management of Kingston Campus MS4)

NO.	ID	TYPE	BMP	MAINTENANCE REQUIREMENTS	*GRA Comments / Notes*	*GRA Mapped*
BMP-23	SW	Swales/Infiltration System	Plains Rd Parking Lot	Till infiltration areas when loss of infiltration is obvious (5-10 years).	*See above*	*YES*
BMP-24	PPS	Pervious Parking Surface	Plains Rd Parking Lot	Vacuum sweep with a commercial cleaning unit four times annually (min), inspect annually for deterioration and spalling.	*See BMP Nos. 23 and 35* *BMP Nos. 64 and 76 appear to apply to westerly expansion area*	*YES*
BMP-25	WQ	Vortechnics Unit	Ryan Center/Tootell Vortechnics Unit	Inspect and clean annually.		*YES*
BMP-26	SW	Swales	Sherman Building Swale (North of Sherman Building)	Inspect and clean twice annually.		*YES*
BMP-27	SW	Swales	Frat Circle Swale, north of Sigma Chi	Inspect and clean twice annually.		*YES*
BMP-28	W	Stream	White Horn Brook	Inspect quarterly and remove sediment and debris as required.	*Brook considered a regulated freshwater wetland feature by RIDEM/OWR*	*YES*
BMP-29	IS	Infiltration System	Wiley/Garrahy Dorms/Infiltration Systems	Inspect and clean annually.	*Two (2) systems*	*YES*
BMP-30	SS	Catch Basins / Manholes	Hope Dining Hall Catch Basins/Manholes	Inspect and clean annually.	*See BMP Nos. 36 & 37 (campus-wide CBs/DMHs)*	*YES*
BMP-31	CB	Catch Basins	Butterfield Rd/Elephant Walk Dorms	Inspect and clean annually.	*See below*	*YES **
BMP-31	IS	Infiltration System	Butterfield Rd/Elephant Walk Dorms	Inspect and clean annually.	*Could not locate in URI Drain GDB; location shown is approximate*	*YES **
BMP-32	SS	Catch Basins / Manholes	Wiley/Garrahy Dorms/Catch Basins/Manholes	Inspect and clean annually.	*See BMP Nos. 36 & 37 (campus-wide CBs/DMHs)*	*YES*
BMP-33	CB	Catch Basins / Manholes	Eddy Hall Catch Basins/Manholes	Inspect and clean annually.	*See BMP Nos. 36 & 37 (campus-wide CBs/DMHs)*	*YES*
BMP-34	SW	Swale	Flagg Rd. Swale (North of Flagg Rd Lot)	Inspect and clean twice annually.		*YES*
BMP-35	CB	Catch Basins	Plains Rd Parking Lot	Inspect and clean annually.	*See BMP Nos. 23 & 24*	*YES*
BMP-36	CB	Catch Basins	Campus Wide Catch Basins	Inspect and clean annually.	*Campus-wide BMP*	*N/A*
BMP-37	DMH	Manholes	Campus Wide DMHs	Inspect and clean annually.	*Campus-wide BMP*	*N/A*
BMP-38	-	Streets	Campus Wide Streets	Sweep roads annually.	*Campus-wide BMP*	*N/A*
BMP-39	P	Parking	Campus Wide Parking Lots	Sweep all Parking Lots annually (Spring).	*Campus-wide BMP*	*N/A*

KEY: Campus-wide BMP BMP Removed * Denotes location depicted on Map is approximate

BMP Not Applicable (or N/A to management of Kingston Campus MS4)

NO.	**ID**	**TYPE**	**BMP**	**MAINTENANCE REQUIREMENTS**	***GRA Comments / Notes***	***GRA Mapped***
BMP-40	SS	Catch Basins / Manholes	Flagg Rd/Plains Rd Catch Basins/Manholes	Inspect and clean annually.	*See BMP Nos. 36 & 37 (campus-wide CBs/DMHs)*	*YES*
BMP-41	CB	Catch Basins	Coastal Institute Catch Basins	Inspect and clean annually	*Narragansett Bay Campus, N/A*	*N/A*
BMP-42	-	Streets and Walks	Campus Wide Streets and Walkways	Inspect Roads and Shoulders for Erosion Issues	*Campus-wide BMP*	*N/A*
BMP-43	-	Outfalls	Campus Wide Outfalls	Locate, list type, size, condition, and name of receiving waters by 2006.	*MS4 GP requirement completed according to latest Annual Report; not a structural BMP*	*N/A*
BMP-44	-	Outfalls	Campus Wide Outfalls	Update map.	*MS4 GP requirement completed according to latest Annual Report; Outfalls labeled on map by from URI Utilities GDB field query*	*YES*
BMP-45	IS	Infiltration System	Independence Square	Inspect and clean annually.		*YES*
BMP-46	W	Detention Pond	Roger Williams Pond	Inspect every quarter, remove sediment when depth increases by one foot, inspect slopes	*Considered a regulated freshwater wetland feature by RIDEM/OWR*	*YES*
BMP-47	W	Stream	Open Channel -North of Hope	Inspect twice a year and clean as required.	*Considered a regulated freshwater wetland feature by RIDEM/OWR*	*YES*
BMP-48	W	Stream	Open Channel -South of Hutchinson Hall	Inspect twice a year and clean as required.	*BMP appears to be a rock swale and not a stream*	*YES*
BMP-49	SS	BMP Removed	CBLS Retaining Wall			
BMP-50		Green Roof	CBLS - Green Roof	Inspect Annually		*YES*
BMP-51	WQ	Water Quality Structures	CBLS Hydroceptor	Inspect twice a year and clean as required.		*YES*
BMP-52	WQ	Water Quality Structures	Hillside WQ Structures	Inspect twice a year and clean as required.		*YES*
BMP-53	IS	Infiltration System	Hillside Bio-Retention Areas	Inspect twice a year and clean as required.	*Not clear from URI Utilities GDB whether this includes apparent roof drainage area*	*YES **
BMP-54	IS	Infiltration System	Hillside Infiltration Basin (West of Lower College Road)	Inspect twice a year and clean as required.		*YES*
BMP-55	IS	Infiltration System	COP Bio-Retention Area	Inspect twice a year and clean as required.		*YES*
BMP-56	SW	Swale	Swale south of Parking Services Building	Inspect twice a year and clean as required.		*YES*

KEY: Campus-wide BMP BMP Removed * Denotes location depicted on Map is approximate

BMP Not Applicable (or N/A to management of Kingston Campus MS4)

NO.	ID	TYPE	BMP	MAINTENANCE REQUIREMENTS	*GRA Comments / Notes*	*GRA Mapped*
BMP-57	SW	Swale	Swale East of Hillside East Access Road	Inspect twice a year and clean as required.		*YES*
BMP-58	SW	Swale	Paved swales at Keaney Parking Lot	Inspect twice a year and clean as required.		*YES*
BMP-59	IS	Infiltration System	Sherman East Lot Infiltration System	Inspect twice a year and clean as required.		*YES*
BMP-60	IS	Infiltration System	Wellness Center Infiltration System	Inspect twice a year and clean as required.		*YES*
BMP-61	CV	Culverts	Culverts Crossing Plains Road North of Flagg Road	Inspect twice a year and clean as required.	*Twin-barrel culverts connecting Basins "A" & "D" (see BMP Nos. 19, 63 & 88)*	*YES*
BMP-62	CV	Culverts	Culverts Crossing Flagg Road West of Plains Road	Inspect twice a year and clean as required.	*Twin-barrel culverts installed under roadway extension project (Plains Road) connecting Basin "D" to "H" (see BMP Nos. 88 & 90)*	*YES*
BMP-63	IS	Infiltration System	Flagg Road Extension Detention/Infiltration Basin "A"	Inspect twice a year and clean as required.	*Duplicate of BMP No. 19; basin was enlarged under roadway extension project*	*YES*
BMP-64	PPS	Pervious Parking Surface	Flagg Road Extension Porous Paving Lot	Inspect twice a year and clean as required.	*Appears to apply to westerly/ expansion portion of lot, see BMP No. 76; see also BMP Nos. 23, 24 & 35*	*YES*
BMP-65	SW	Swales	Central Receiving (Flowing south to larger channel)	Inspect twice a year and clean as required.		*YES*
BMP-66	TS	Sampling Station	Flagg Road Test Station	Inspect once a year and clean as required.	*Could not locate in URI Drain GDB; not a structural BMP*	*NO*
BMP-67	IS	Infiltration System	Infiltration/Detention Basin South of Sherman Building	Inspect twice a year and clean as required.		*YES*
BMP-68	SW	Swale	Swale East of Butterfield Hall and east of walkway.	Inspect twice a year and clean as required.		*YES*
BMP-69			COP Medicinal Garden	Inspect once a year and clean as required.	*Described as rain garden in MS4 Annual Report*	*YES*
BMP-70	SW	Swale	Swale West of Davis Hall	Inspect twice a year and clean as required.		*YES*
BMP-71	SW	Swale	Swale East of Rodman Hall	Inspect twice a year and clean as required.		*YES*
BMP-72		BMP Removed	Swale East of White Hall			

KEY: Campus-wide BMP BMP Removed * Denotes location depicted on Map is approximate

BMP Not Applicable (or N/A to management of Kingston Campus MS4)

NO.	ID	TYPE	BMP	MAINTENANCE REQUIREMENTS	*GRA Comments / Notes*	*GRA Mapped*
BMP-73	SW	Swale	Swale South of Fayerweather Hall	Inspect twice a year and clean as required.		*YES **
BMP-74	SW	Swale	Paved swales at Gateway Apartments	Inspect once a year and clean as required.	*Could not locate in URI Drain GDB; location shown is approx.*	*YES **
BMP-75	SW	Swale	Paved Swale at Well House No. 2	Inspect twice a year and clean as required.	*Could not locate in URI Drain GDB; depicted at end of access road*	*YES **
BMP-76	IS	Swales/Infiltration System	New Plains Lot Infiltration Channels	Inspect twice a year and clean as required.	*Appears to apply to westerly/ expansion portion of lot, see BMP No. 76; see also BMP Nos. 23, 24 & 35*	*YES*
BMP-77	SW	Swales	Flagg Ext Swales	Inspect twice a year and clean as required.	*Shoulder swales along both sides of roadway extension north of West Alumni Ave*	*YES*
BMP-78	CV	Culverts	Flagg Extension Culverts into Basin "E"	Inspect twice a year and clean as required.	*Culverts draining swales to Basin "E" (BMP No. 89)* *- under lot access (to SW corner of basin)* *- twin-barrel under Plains Rd (to north corner of basin)*	*YES*
BMP-79	SW	Swale	Flagg Road Extension Paved Waterways	Inspect twice a year and clean as required.	*Seven (7) total along Plains Road, from intersection w/ West Alumni Ave to just north of Plains/Tootell/ Flagg Rd intersection*	*YES*
BMP-80	IS	Detention/Infiltration System	Basin "H" Discharge Structure	Inspect twice a year and clean as required.		*YES*
BMP-81	SW	Swale	White Hall Parking Lot Swale at NW corner	Inspect twice a year and clean as required.		*YES*
BMP-82	SW	Swale	Greenhouse Lot Dry Swales	Inspect twice a year and clean as required.	*Not clear from URI Utilities GDB which facility is dry swale (No. 82) and grass channel (No. 83)*	*YES **
BMP-83	SW	Swale	Greenhouse Lot Grass Channel	Inspect twice a year and clean as required.	*See comment above*	*YES **
BMP-84	SW	Swale	Greenhouse Lot Paved Waterways	Inspect twice a year and clean as required.		*YES*
BMP-85	IS	Detention/Infiltration System	Greenhouse Lot Forebay/Infiltration System	Inspect twice a year and clean as required.		*YES*

KEY: Campus-wide BMP BMP Removed * Denotes location depicted on Map is approximate

BMP Not Applicable (or N/A to management of Kingston Campus MS4)

NO.	ID	TYPE	BMP	MAINTENANCE REQUIREMENTS	*GRA Comments / Notes*	*GRA Mapped*
BMP-86	IS	Infiltration System	Greenhouse Roof Drain Infiltration System	Inspect twice a year and clean as required.	*Could not locate in URI Drain GDB; location shown (west of greenhouses) is assumed*	*YES **
BMP-87	IS	Infiltration System	Hillside Dorm Green Roof	Review Annually	*Location on building roof is approximate*	*YES **
BMP-88	IS	Infiltration System	Flagg Road Detention Basin "D"	Review Annually		*YES*
BMP-89	IS	Infiltration System	Flagg Road Detention Basin "E"	Review Annually		*YES*
BMP-90	IS	Infiltration System	Flagg Road Detention Basin "H"	Review Annually		*YES*
BMP-91	SW	Swale	Stone Swale east of Butterfield Residence Hall	Review Annually	*Trench along east face of building; grassed swale w/ catch basins runs parallel to immediate east*	*YES*
BMP-92	IS	Detention/Infiltration System	Tree Box Filters in Chemistry Area	Review Annually	*See comment below*	*YES **
BMP-93	IS	Detention/Infiltration System	Bioretention/Detention/ Forebay System north of new Chemistry Building	Review Annually	*Depicted locations of BMP Nos. 92, 93, 94 are approximate (date of aerial orthos is 2014)*	*YES **
BMP-94	IS	Detention/Infiltration System	Bioretention Areas South of new Chemistry Building	Review Annually	*See comment above*	*YES **
BMP-95	IS	Detention/Infiltration System	Tree Box Filter in Flagg Road Parking Lot	Review Annually		*YES*
BMP-96	SW	Swale	Swale north of the CBLS NW Corner	Review Annually		*YES*
BMP-97	SW	Swale	Rip Rap swale west of new sub-station 1 & 2	Review Annually	*Location depicted is approximate*	*YES **
BMP-98	SW	Swale	Rip Rap Swale east of Butterfield Dining Hall	Review Annually	*Could not locate in URI Drain GDB; location shown is approx.; may be connected to BMP Nos. 102-104*	*YES **
BMP-99	SW	Swale	Asphalt Berms at Fraternity Circle	Review Annually	*Could not locate in URI Drain GDB; location shown is approx.*	*YES **
BMP-100	SW	Swale	Swale North of Hopkins Hall	Review Annually	*Location depicted is approximate*	*YES **
BMP-101	SW	Swale	Swale North of Chemistry/White Hall	Review Annually	*Location depicted is approximate*	*YES **

KEY: Campus-wide BMP BMP Removed * Denotes location depicted on Map is approximate

BMP Not Applicable (or N/A to management of Kingston Campus MS4)

NO.	ID	TYPE	BMP	MAINTENANCE REQUIREMENTS	*GRA Comments / Notes*	*GRA Mapped*
BMP-102	IS	Detention Basin	Detention Basin South of Elephant Walk 250' East of Butterfield Road	(URI Note: Installed July 2016)	*Locations of BMP Nos. 102-104 based on descriptions and are approximate*	*YES **
BMP-103	IS	Detention Basin	Detention Basin East of Butterfield Hall	(URI Note: Installed July 2016)	*Locations of BMP Nos. 102-104 based on descriptions and are approximate*	*YES **
BMP-104	IS	Detention Basin	Detention Basin 100' East of Butterfield Hall	(URI Note: Installed July 2016)	*Locations of BMP Nos. 102-104 based on descriptions and are approximate*	*YES **
BMP-105	SW	Swale	Rip Rap Swale at SW corner of Chafee Hall Parking Lot		*Location depicted is approximate*	*YES **

KEY: Campus-wide BMP BMP Removed * Denotes location depicted on Map is approximate

BMP Not Applicable (or N/A to management of Kingston Campus MS4)

Table F.2
University of Rhode Island
List of Possible Un-inventoried Stormwater Practices

The following features appear in the URI Utilities Department's GIS data (URI Drain GDB) but are not included in the MS4 BMP Inventory; see Attachment 3 - Existing Facilities and BMP Map

Number	Description and Location
U-01	Weldin Hall roof drain infiltration chambers (2), west side of Weldin Hall
U-02	Sigma Chi roof drain infiltration system, west side of Sigma Chi along Fraternity Circle
U-03	"Stormwater Quality Unit" in parking lot just north of Alpha Delta Pi
U-04	Browning Hall infiltration chamber, west side of Browning Hall)
U-05	Infiltration system ("Cultec Recharger") in loading lot south of Dining Services, east of Central Receving
U-06	Drywells (4) for Beck Baseball Field subdrainage along outfield fence
U-07	Vortechnics unit at Lincoln Almond Plaza / Ryan Center access, south side of West Alumni Ave just north of Meade Stadium
U-08	Roof drain "leach chambers" (4) for International Scholar Athlete Hall of Fame, west side of West Independence Way
U-09	Drywell for Fogarty Hall roof drainage, north side of building
U-10	Drywell south of Green Hall
U-11	Retention/infiltration basin for Tennis Courts
U-12	Tootell Road Infiltration System (recently completed)
U-13	Deep-sump catch basins, Washburn Hall Lot reconstruction
U-14	Infield infiltration drywells, Athletic Track

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Appendix G

Campus Roadways, Lots, and Roofs Inventory and Recommendations

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University of Rhode Island
2017 Kingston Campus Drainage Master Plan
CAMPUS ROADWAYS

PR: Pavement Reduction **SC**: Sediment Containment/Sumps **SW**: Swales **PP**: Permeable Paving **BIO**: Bioretention / Filtration **INF**: Infiltration **FS**: Filter Strip

				Existing									**Potential Stormwater Controls**								
				(Y/N/Partial)									* from *Draft Transportation and Parking Master Plan*								
Name	**Area (SF)**	**Area (Ac)**	**Sub-WS**	**Treatment**	**Curb/Berm**	**Sidewalks**	**SC**	**SW**	**PP**	**BIO**	**INF**	**FS**	**PR**	**PR Area (SF)***	**SC_**	**SW_**	**PP_**	**BIO_**	**INF_**	**FS_**	**Notes**
PLAINS RD 1	3,000	0.07	Chipuxet	N	N	N												•			Potential controls at NW & NE corners of Rte 138 intersection
PLAINS RD 2	96,000	2.20	Chipuxet	P	N	N						•				•				•	Potential for improvements along unpaved shoulders
TOOTELL RD 3	12,300	0.28	Chipuxet	P	Y	N	•											•	•		Potential controls at field area near outfall
BUTTERFIELD RD 1	14,750	0.34	Ellery-138	P	Y	Y	•														
BUTTERFIELD RD 2	15,600	0.36	Ellery-138	P	Y	Y	•														
CAMPUS AVE 1	11,000	0.25	Ellery-138	P	Y	Y	•														
CAMPUS AVE 2	8,750	0.20	Ellery-138	P	Y	Y	•														
CAMPUS AVE 3	6,900	0.16	Ellery-138	P	Y	Y	•														
COMPLEX RD N-S 1	5,800	0.13	Ellery-138	N	N	N												•		•	
COMPLEX RD N-S 2	1,950	0.04	Ellery-138	N	Y	N										•		•			
COMPLEX RD N-S 3	6,600	0.15	Ellery-138	P	Y	Y	•						•	3,100				•		•	Integrate w/ controls for Complex Rd N-S 2
COMPLEX RD N-S 4	10,400	0.24	Ellery-138	P	Y	Y	•						•	6,000				•			Bioretention in areas of removed pavement
ELEPHANT WALK 1	5,550	0.13	Ellery-138	P	N	N	•									•					
ELEPHANT WALK 2	6,000	0.14	Ellery-138	N	N	N										•					
FRATERNITY CIRCLE 2	15,500	0.36	Ellery-138	P	Y/N	N	•						•		•	•		•			In design - Fraternity Circle improvements
FRATERNITY CIRCLE 3	10,500	0.24	Ellery-138	P	Y/N	N	•						•		•	•		•			In design - Fraternity Circle improvements
KEANEY RD 1	22,250	0.51	Ellery-138	N	Y/N	N															
KEANEY RD 2	2,500	0.06	Ellery-138	P	Y	N	•								•				•		
KEANEY RD 3	10,800	0.25	Ellery-138	P	Y	Y	•								•				•		
KEANEY RD 4	32,400	0.74	Ellery-138	P	Y	Y	•								•			•	•	•	
KEANEY RD 5	8,700	0.20	Ellery-138	P	Y	N	•								•			•	•	•	
KEANEY RD 6	23,000	0.53	Ellery-138	P	Y	N	•								•			•	•	•	
LOWER COLLEGE RD 2	6,000	0.14	Ellery-138	P	Y	N	•			•					•						Existing treatment for 50% of area
LOWER COLLEGE RD 3	11,100	0.25	Ellery-138	P	Y	Y	•						•		•						
LOWER COLLEGE RD 4	15,000	0.34	Ellery-138	P	Y	Y	•						•		•						
QUARRY RD 1	3,250	0.07	Ellery-138	P	Y	N	•														
QUARRY RD 2	19,500	0.45	Ellery-138	P	Y	N	•									•					
QUARRY RD 3	21,000	0.48	Ellery-138	P	Y	Y	•														
TOOTELL RD 4	18,600	0.43	Ellery-138	Y	Y	N	•				•										Recently completed improvements (incl. infiltration)
FLAGG RD 1	31,150	0.72	Flagg Road	Y	Y	Y	•	•			•										
FLAGG RD 2	118,300	2.72	Flagg Road	P	Y	Y	•								•	•		•			Potential treatment area(s) along north shoulder
FLAGG RD 3	12,250	0.28	Flagg Road	P	Y	N	•								•	•		•			Potential treatment area(s) along north shoulder
GREENHOUSE RD	10,000	0.23	Flagg Road	P	Y	Y	•						•	2,100							Parking to be eliminated per Trans. & Parking MP
UPPER COLLEGE RD 1	20,100	0.46	Flagg Road	P	Y	Y	•								•						
BUTTERFIELD RD 6	22,250	0.51	Heathman	P	Y	Y	•											•			
WEST ALUMNI AVE 4	14,250	0.33	Heathman	P	Y	Y	•														
FRATERNITY CIRCLE 1	40,950	0.94	Lower WHB 1	P	Y/N	N	•						•		•	•		•			In design - Fraternity Circle improvements
GRAD CIRCLE 1	38,000	0.87	Lower WHB 1	P	Y	Y	•								•			•		•	
GRAD CIRCLE 2	6,750	0.15	Lower WHB 1	P	Y	N	•								•						
GRAD CIRCLE 3	35,100	0.81	Lower WHB 1	P	Y/N	Y	•								•			•	•	•	
FACULTY CIRCLE	37,250	0.86	Lower WHB 2	N	N	N							•		•	•		•		•	
LOWER COLLEGE RD 1	27,900	0.64	Lower WHB 2	P	Y	N	•						•		•			•			In design
COMPLEX RD N-S 6	5,750	0.13	Meade	P	Y	N	•								•						
BUTTERFIELD RD 4	6,600	0.15	Plains	P	Y	Y	•														
COMPLEX RD N-S 7	800	0.02	Plains	N	Y	N									•						
PLAINS RD 3	75,600	1.74	Plains	Y	N	N	•	•			•										
RANGER RD 1	24,000	0.55	Plains	P	Y	Y	•								•						
TOOTELL RD 1	13,500	0.31	Plains	Y	Y	N	•	•		•											
TOOTELL RD 2	16,500	0.38	Plains	N	Y	N										•		•	•		
WEST ALUMNI AVE 1	30,900	0.71	Plains	P	N	N						•			•	•		•	•		

University of Rhode Island
2017 Kingston Campus Drainage Master Plan
CAMPUS ROADWAYS

PR: Pavement Reduction **SC**: Sediment Containment/Sumps **SW**: Swales **PP**: Permeable Paving **BIO**: Bioretention / Filtration **INF**: Infiltration **FS**: Filter Strip

				Existing (Y/N/Partial)									**Potential Stormwater Controls** * from *Draft Transportation and Parking Master Plan*								
Name	**Area (SF)**	**Area (Ac)**	**Sub-WS**	**Treatment**	**Curb/Berm**	**Sidewalks**	**SC**	**SW**	**PP**	**BIO**	**INF**	**FS**	**PR**	**PR Area (SF)***	**SC_**	**SW_**	**PP_**	**BIO_**	**INF_**	**FS_**	**Notes**
WEST ALUMNI AVE 2	9,300	0.21	Plains	P	Y/N	Y						•			•	•		•	•		
WEST ALUMNI AVE 3	35,250	0.81	Plains	P	Y	Y	•								•				•		
BUTTERFIELD RD 3	6,600	0.15	Tributary	P	Y	Y	•											•			
BUTTERFIELD RD 5	2,800	0.06	Tributary	P	Y	Y	•														
COMPLEX RD N-S 5	8,000	0.18	Tributary	N	Y	N															
DAVIS RD	14,400	0.33	Tributary	P	Y	N	•								•			•			
EAST ALUMNI AVE 1	21,350	0.49	Tributary	P	Y	Y	•								•			•			Roadway drainage to connect to new COE bioretention sys.
EAST ALUMNI AVE 2	5,600	0.13	Tributary	P	Y	Y	•														
EAST ALUMNI AVE 3	8,800	0.20	Tributary	P	Y	N	•														
FARMHOUSE RD 1	4,000	0.09	Tributary	P	Y	Y	•														
FARMHOUSE RD 2	5,000	0.11	Tributary	P	Y	Y	•														
LIPPITT RD 1	10,800	0.25	Tributary	P	Y	Y	•								•						
LIPPITT RD 2	6,200	0.14	Tributary	P	Y	N	•								•						
POWER LANE	15,000	0.34	Tributary	P	Y	N	•						•					•			Under construction - new COE Building
POWER LANE LOT	10,450	0.24	Tributary	P	N	N	•						•								Under construction - to be removed
UPPER COLLEGE RD 2	16,200	0.37	Tributary	P	Y	Y	•								•						
UPPER COLLEGE RD 3	90,400	2.08	Tributary	P	Y	Y	•								•						
UPPER COLLEGE RD 4	4,400	0.10	Tributary	P	Y	Y	•								•						
	1,287,150	**29.55**												**11,200**							

University of Rhode Island
2017 Kingston Campus Drainage Master Plan
PAVED LOTS

PR: Pavement Reduction **SC**: Sediment Containment/Sumps **SW**: Swales **PP**: Permeable Paving **BIO**: Bioretention / Filtration **INF**: Infiltration **FS**: Filter Strip

				Existing (Y/N/Partial)							**Potential Stormwater Controls** * from *Draft Transportation and Parking Master Plan*								
Name	**Area (SF)**	**Area (Ac)**	**Sub-WS**	**Treatment**	**SC**	**SW**	**PP**	**BIO**	**INF**	**FS**	**PR**	**PR Area (SF)***	**SC_**	**SW_**	**PP_**	**BIO_**	**INF_**	**FS_**	**Notes**
INDEPENDENCE LOT	53,300	1.22	Chipuxet	Y	•					•									
RYAN CENTER/RAM LOT	81,000	1.86	Chipuxet	P	•												•		Potential offline treatment above system outlet
TENNIS COURTS	53,100	1.22	Chipuxet	Y					•										
ADAMS HALL	13,700	0.31	Ellery-138	P	•						•	8,700							Lot to be eliminated per Trans. & Parking Master Plan
BOSS ARENA	85,500	1.96	Ellery-138	N							•				•	•	•		
CHI PHI	11,900	0.27	Ellery-138	Y	•														Proprietary separator device
FOGARTY	7,200	0.17	Ellery-138	P	•							7,200							Lot to be eliminated per Trans. & Parking Master Plan
KEANEY 1 (NORTH)	54,400	1.25	Ellery-138	P	•						•				•				
KEANEY 2 (MIDDLE)	167,700	3.85	Ellery-138	P	•						•				•				
KEANEY 3 (SOUTH)	9,000	0.21	Ellery-138	N							•				•	•		•	
KEANEY 4 (SOUTHEAST)	34,000	0.78	Ellery-138	N							•				•	•		•	
KEANEY 5 (EAST)	12,500	0.29	Ellery-138	N							•				•	•		•	
MEMORIAL UNION	29,000	0.67	Ellery-138	P	•						•		•						
MORRILL HALL	21,900	0.50	Ellery-138	P	•									•					
PASTORE	6,200	0.14	Ellery-138	P	•							6,200							Lot to be eliminated per Trans. & Parking Master Plan
PECK HALL	12,300	0.28	Ellery-138	P	•						•	9,400							Lot to be eliminated per Trans. & Parking Master Plan
FINE ARTS	365,400	8.39	Flagg Road	P	•						•		•	•		•			Stormwater improvements designed, approved by RIDEM FWW
GREENHOUSE ROAD	58,400	1.34	Flagg Road	Y	•	•		•											
TYLER HALL	6,700	0.15	Flagg Road	P	•						•	6,700							Lot to be eliminated per Trans. & Parking Master Plan
NEW CHEMISTRY LOT	45,500	1.04	Heathman	P	•														
PHI GAMMA DELTA	15,700	0.36	Heathman	N														•	
WHITE HALL	27,900	0.64	Heathman	P	•						•	14,500							Portion to be eliminated per Trans. & Parking Master Plan
ADMINISTRATIVE SERVICES	19,500	0.45	Plains	Y	•				•										
DAIRY BARN 1	61,800	1.42	Plains	Y			•												In design / under construction - White Horn Apartments
DAIRY BARN 2	131,400	3.02	Plains	N															In design / under construction - White Horn Apartments
DINING SERVICES	16,900	0.39	Plains	Y	•	•		•											
FLAGG ROAD - NORTH	222,900	5.12	Plains	Y	•	•		•	•										
FLAGG ROAD - SOUTHEAST	69,300	1.59	Plains	P	•														In design / under construction - White Horn Apartments
PLAINS ROAD 1	467,000	10.72	Plains	Y			•												
PLAINS ROAD 2	238,700	5.48	Plains	Y			•		•										
SHERMAN LOT	85,900	1.97	Plains	Y	•				•										
BRIAR LANE 1	31,800	0.73	Tributary	P	•						•					•			
BRIAR LANE 2	92,800	2.13	Tributary	P	•						•					•			In design / under construction
BRIAR LANE 3	7,700	0.18	Tributary	P	•						•					•			In design / under construction
DAVIS	1,300	0.03	Tributary	N								1,300							Lot to be eliminated per Trans. & Parking Master Plan
FARMHOUSE ROAD	32,600	0.75	Tributary	P	•						•	19,400							Portion to be eliminated per Trans. & Parking Master Plan
LIBRARY	17,800	0.41	Tributary	P	•						•	3,700	•						Portion to be eliminated per Trans. & Parking Master Plan
MERROW 1	6,500	0.15	Tributary	N							•	6,500							Lot to be eliminated per Trans. & Parking Master Plan
MERROW 2	6,600	0.15	Tributary	P	•								•						
TUCKER HOUSE	29,700	0.68	Tributary	N															Site of planned hotel/mixed-use development
WASHBURN HALL	14,200	0.33	Tributary	P	•						•	3,400							Portion to be eliminated per Trans. & Parking Master Plan
	2,726,700	**62.60**										**87,000**							

University of Rhode Island

2017 Kingston Campus Drainage Master Plan

BUILDING ROOFS

Name	Area	Area (Ac)	Sub-WS	Treatment/Recharge
ATHLETIC MAINTENANCE	8,200	0.19	Chipuxet	N
BOSS ARENA	61,900	1.42	Chipuxet	N
INDEPENDENCE SQUARE II	56,900	1.31	Chipuxet	N
RYAN CENTER	100,700	2.31	Chipuxet	N
SCHOLAR-ATHLETE HALL OF FAME	5,800	0.13	Chipuxet	N
SKOGLEY	4,400	0.10	Chipuxet	N
TENNIS PAVILION	3,000	0.07	Chipuxet	N
UNIVERSITY FIELDS APARTMENTS	12,000	0.28	Chipuxet	N
17 FRATERNITY	7,000	0.16	Ellery-138	N
44 LOWER COLLEGE	3,100	0.07	Ellery-138	N
8 FRATERNITY	6,400	0.15	Ellery-138	N
ADAMS	9,400	0.22	Ellery-138	N
ALPHA XI DELTA	10,900	0.25	Ellery-138	N
BARLOW	12,800	0.29	Ellery-138	N
BATTING BARN	5,800	0.13	Ellery-138	N
BRESSLER	9,200	0.21	Ellery-138	N
BROWNING	13,100	0.30	Ellery-138	Y
BUTTERFIELD	27,200	0.62	Ellery-138	N
CHI OMEGA	5,600	0.13	Ellery-138	N
DELTA ZETA	9,300	0.21	Ellery-138	N
DORR	10,800	0.25	Ellery-138	N
EDDY	18,400	0.42	Ellery-138	N
EDWARDS	10,800	0.25	Ellery-138	N
ELLERY	8,200	0.19	Ellery-138	N
FAYERWEATHER	12,600	0.29	Ellery-138	N
FOGARTY	16,500	0.38	Ellery-138	N
GORHAM	12,500	0.29	Ellery-138	N
GREEN	11,000	0.25	Ellery-138	N
HILLEL	7,300	0.17	Ellery-138	N
HILLSIDE	24,000	0.55	Ellery-138	Y
HOPKINS	8,200	0.19	Ellery-138	N
HUTCHINSON	9,400	0.22	Ellery-138	N
KAPPA DELTA	4,700	0.11	Ellery-138	N
MEMORIAL UNION	56,400	1.29	Ellery-138	N
MULTICULTURAL	4,600	0.11	Ellery-138	N
PASTORE-MORRILL	36,500	0.84	Ellery-138	N
PECK	9,400	0.22	Ellery-138	N
POTTER	16,300	0.37	Ellery-138	N
PRESIDENT'S HOUSE	2,700	0.06	Ellery-138	N
QUINN	14,100	0.32	Ellery-138	N
RANGER	10,200	0.23	Ellery-138	N
SIGMA CHI	6,200	0.14	Ellery-138	Y

University of Rhode Island
2017 Kingston Campus Drainage Master Plan
BUILDING ROOFS

Name	Area	Area (Ac)	Sub-WS	Treatment/Recharge
SIGMA DELTA TAU	10,800	0.25	Ellery-138	N
SIGMA KAPPA	9,400	0.22	Ellery-138	N
SIGMA PI	9,500	0.22	Ellery-138	N
TOOTELL-KEANEY-MACKAL	195,500	4.49	Ellery-138	N
WELDIN	12,300	0.28	Ellery-138	Y
ZETA TAU ALPHA	8,600	0.20	Ellery-138	N
BIOTECH & LIFE SCIENCES	26,500	0.61	Flagg Road	Y
CHEMISTRY	23,900	0.55	Flagg Road	N
COASTAL INSTITUTE	21,100	0.49	Flagg Road	N
FINE ARTS	76,600	1.76	Flagg Road	N
FIRE STATION	6,000	0.14	Flagg Road	N
GREENHOUSES	28,400	0.65	Flagg Road	N
PHARMACY	34,400	0.79	Flagg Road	Y
SOCIAL SCIENCE RESEARCH CENTER	17,800	0.41	Flagg Road	N
TYLER	12,600	0.29	Flagg Road	N
WOODWARD	12,600	0.29	Flagg Road	N
CHAFEE	41,300	0.95	Heathman	N
GARRAHY	20,900	0.48	Heathman	Y
HEATHMAN	21,800	0.50	Heathman	N
PHI GAMMA DELTA	7,100	0.16	Heathman	N
WHITE	20,700	0.47	Heathman	N
WILEY	20,800	0.48	Heathman	Y
(PECKHAM FARM)	2,500	0.06	Lower WHB 1	N
ALPHA DELTA PI	9,900	0.23	Lower WHB 1	N
CHILD DEVELOPMENT CENTER	4,700	0.11	Lower WHB 1	N
GRADUATE VILLAGE APARTMENTS	48,300	1.11	Lower WHB 1	N
PECKHAM FARMHOUSE	4,800	0.11	Lower WHB 1	N
PHI SIGMA SIGMA	8,200	0.19	Lower WHB 1	N
TRANSITION CENTER	5,600	0.13	Lower WHB 1	N
29 LOWER COLLEGE	3,100	0.07	Lower WHB 2	N
GATEWAY APARTMENTS	11,100	0.25	Lower WHB 2	N
NEWMAN HALL	5,500	0.13	Lower WHB 2	N
WOMEN'S CENTER	4,200	0.10	Lower WHB 2	N
BURNSIDE	13,500	0.31	Meade	N
210 FLAGG	14,900	0.34	Plains	N
ADMINISTRATIVE SERVICES	6,400	0.15	Plains	N
AUTOMOTIVE GARAGE	11,400	0.26	Plains	N
CENTRAL RECEIVING	18,800	0.43	Plains	N
DINING SERVICES	35,900	0.82	Plains	N
FUTURE SALT BARN	11,500	0.26	Plains	F
FUTURE WHITE HORN APARTMENTS	42,000	0.96	Plains	F
GARDNER	15,800	0.36	Plains	N

University of Rhode Island

2017 Kingston Campus Drainage Master Plan

BUILDING ROOFS

Name	Area	Area (Ac)	Sub-WS	Treatment/Recharge
MAINTENANCE	6,200	0.14	Plains	N
SHERMAN	22,000	0.50	Plains	N
STORAGE	4,200	0.10	Plains	N
ALDRICH	8,200	0.19	Tributary	N
ALUMNI CENTER	8,900	0.20	Tributary	N
BALLENTINE	19,800	0.45	Tributary	N
BLISS	13,300	0.31	Tributary	N
CARLOTTI	7,400	0.17	Tributary	N
CAROTHERS LIBRARY	63,900	1.47	Tributary	N
CODDINGTON	13,600	0.31	Tributary	N
DAVIS	5,300	0.12	Tributary	N
EAST	8,200	0.19	Tributary	N
FASCITELLI	14,600	0.33	Tributary	N
FUTURE COLLEGE OF ENGINEERING	38,400	0.88	Tributary	F
FUTURE WELCOME CENTER	11,000	0.25	Tributary	F
GENDER & SEXUALITY CENTER	5,300	0.12	Tributary	N
GRANDIN IEP HOUSE	4,000	0.09	Tributary	N
HOPE COMMONS	31,100	0.71	Tributary	N
KIRK	21,500	0.49	Tributary	N
LIPPITT	16,300	0.38	Tributary	N
MALLON	3,700	0.08	Tributary	N
MERROW	10,200	0.23	Tributary	N
RODMAN	9,700	0.22	Tributary	N
ROOSEVELT	12,500	0.29	Tributary	N
SWAN	27,400	0.63	Tributary	N
TAFT	3,900	0.09	Tributary	N
TI HOUSE	3,400	0.08	Tributary	N
TUCKER	10,200	0.23	Tributary	N
UNIVERSITY POLICE	4,200	0.10	Tributary	N
URI FOUNDATION	4,700	0.11	Tributary	N
VISITORS CENTER-UCLUB	8,300	0.19	Tributary	N
WASHBURN	7,500	0.17	Tributary	N
		46.58		

University of Rhode Island
2017 Kingston Campus Drainage Master Plan

IMPERVIOUS COVER AND TREATMENT SUMMARY

EXISTING CONDITIONS

				(1)			(2)			(2)			(2)						
	Total			URI Property			Estimates By Impervious Type												
Subwatershed	*Area (Ac)*	*Imperv. (Ac)*	*% Imp.*	*Area (Ac)*	*Imperv. (Ac)*	*% Imp.*	*Roadways*	*Treated*	*%*	*Paved Lots*	*Treated*	*%*	*Roofs*	*Treated / Recharged*	*%*	*Total Accounted*	*Treated / Recharged*	*%*	*Walkways & Other Imp.*
Headwater	29.3	0.5	2%	29.3	0.5	2%	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0		0.5
Plains	172.9	32.7	19%	170.7	45.4	27%	4.9	2.1	42%	30.2	25.5	85%	3.1	0.0		38.1	27.6	72%	7.3
Flagg Road	42.1	28.2	67%	41.9	28.2	67%	4.4	0.7	16%	9.9	1.3	14%	6.0	1.4	23%	20.3	3.5	17%	7.9
Heathman	24.9	13.0	52%	24.9	13.0	52%	0.8	0.0		2.1	0.0		3.0	1.0	32%	5.9	1.0	16%	7.1
Meade	7.0	2.8	40%	7.0	2.8	40%	0.1	0.0		0.0	0.0		0.3	0.0		0.4	0.0		2.4
Tributary	97.9	50.2	51%	54.1	32.1	59%	5.3	0.0		5.5	0.0		8.0	0.0		18.8	0.0		13.3
Ellery Pond – Route 138	109.3	53.8	49%	106.2	52.7	50%	7.2	0.4	6%	10.7	0.3	3%	15.5	1.3	8%	33.4	2.0	6%	19.3
Lower W. Horn Brook 1	21.6	7.6	35%	12.8	5.8	45%	2.8	0.0		0.0	0.0		1.9	0.0		4.7	0.0		1.1
Lower W. Horn Brook 2	22.1	8.3	37%	7.4	4.1	56%	1.5	0.0		0.0	0.0		0.6	0.0		2.1	0.0		2.1
30-Acre Pond	16.5	1.1	7%	16.5	1.1	7%	0.0	0.0		0.0	0.0		0.1	0.0		0.1	0.0		1.0
Plains Road – Chipuxet	89.6	16.8	19%	85.1	16.5	19%	2.6	0.0		4.3	2.4	57%	5.7	0.0		12.6	2.4	19%	3.9
Total (All Subwatersheds)	**633.3**	**215.0**	**34%**	**556.0**	**202.3**	**36%**	29.6	3.2	11%	62.6	29.6	47%	44.2	3.6	8%	**136.3**	**36.4**	**27%**	**66.0**

POTENTIAL/RECOMMENDED FUTURE TREATMENT

					(3)		(3)	(4)		(3)	(4)			(5)					
	Total			URI Property			Estimates By Impervious Type												
Subwatershed	*Area (Ac)*	*Imperv. (Ac)*	*% Imp.*	*Area (Ac)*	*Imperv. (Ac)*	*% Imp.*	*Roadways*	*Treated*	*%*	*Paved Lots*	*Treated*	*%*	*Roofs*	*Treated / Recharged*	*%*	*Total Accounted*	*Treated / Recharged*	*%*	*Walkways & Other Imp.*
Headwater	29.3	0.5	2%	29.3	0.5	2%	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0		0.5
Plains	172.9	32.7	19%	170.7	45.4	27%	4.9	4.2	85%	30.2	25.5	85%	3.1	1.2	40%	38.1	30.9	81%	7.3
Flagg Road	42.1	28.2	67%	41.9	28.0	67%	4.4	3.7	85%	9.7	9.7	100%	6.0	1.4	23%	20.1	14.8	74%	7.9
Heathman	24.9	13.0	52%	24.9	12.7	51%	0.8	0.5	61%	1.7	0.4	21%	3.0	1.0	32%	5.6	1.8	33%	7.1
Meade	7.0	2.8	40%	7.0	2.8	40%	0.1	0.0		0.0	0.0		0.3	0.0		0.4	0.0		2.4
Tributary	97.9	50.2	51%	54.1	31.3	58%	5.3	1.3	25%	4.7	3.0	65%	8.0	1.1	14%	18.0	5.5		13.3
Ellery Pond – Route 138	109.3	53.8	49%	106.2	51.7	49%	7.0	4.2	60%	10.0	9.1	91%	15.5	1.3	8%	32.5	14.6	45%	19.3
Lower W. Horn Brook 1	21.6	7.6	35%	12.8	5.8	45%	2.8	2.6	95%	0.0	0.0		1.9	0.0		4.7	2.6		1.1
Lower W. Horn Brook 2	22.1	8.3	37%	7.4	4.1	56%	1.5	1.5	100%	0.0	0.0		0.6	0.0		2.1	1.5		2.1
30-Acre Pond	16.5	1.1	7%	16.5	1.1	7%	0.0	0.0		0.0	0.0		0.1	0.0		0.1	0.0		1.0
Plains Road – Chipuxet	89.6	16.8	19%	85.1	16.5	19%	2.6	2.6	100%	4.3	4.3	100%	5.7	0.0		12.6	6.9	55%	3.9
Total (All Subwatersheds)	**633.3**	**215.0**	**34%**	**556.0**	**200.1**	**36%**	29.3	20.6	70%	60.6	52.1	86%	44.2	6.0	14%	**134.1**	**78.7**	**59%**	**66.0**

(1) Computed by clipping URI-held properties (and 2011 Statewide Impervious Cover dataset) to delineated subwatersheds
(2) Roadway, paved lots, and roof acreages tabulated from inventory of existing facilities; see Attachment 5 - Campus Roadways, Lots, and Roofs Inventory Map
(3) Accounts for proposed reductions in impervious parking areas (from *Draft Transportation and Parking Master Plan*)
(4) Accounts for areas where water quality controls (e.g., infiltration, bioretention) are feasible
(5) Accounts for planned future building roofs to be recharged and/or treated

THE
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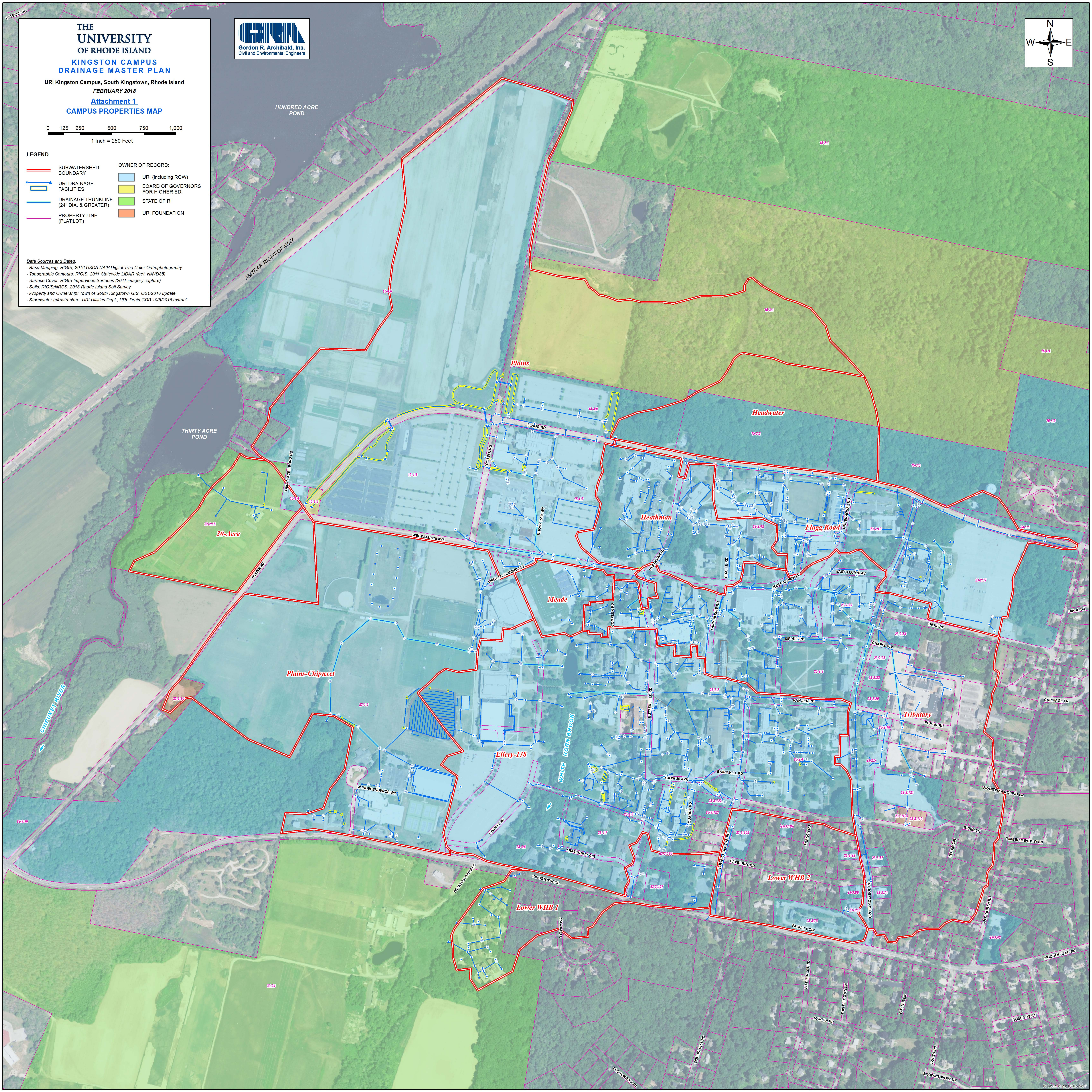
KINGSTON CAMPUS DRAINAGE MASTER PLAN

URI Kingston Campus, South Kingstown, Rhode Island

FEBRUARY 2018

Attachment 1
CAMPUS PROPERTIES MAP

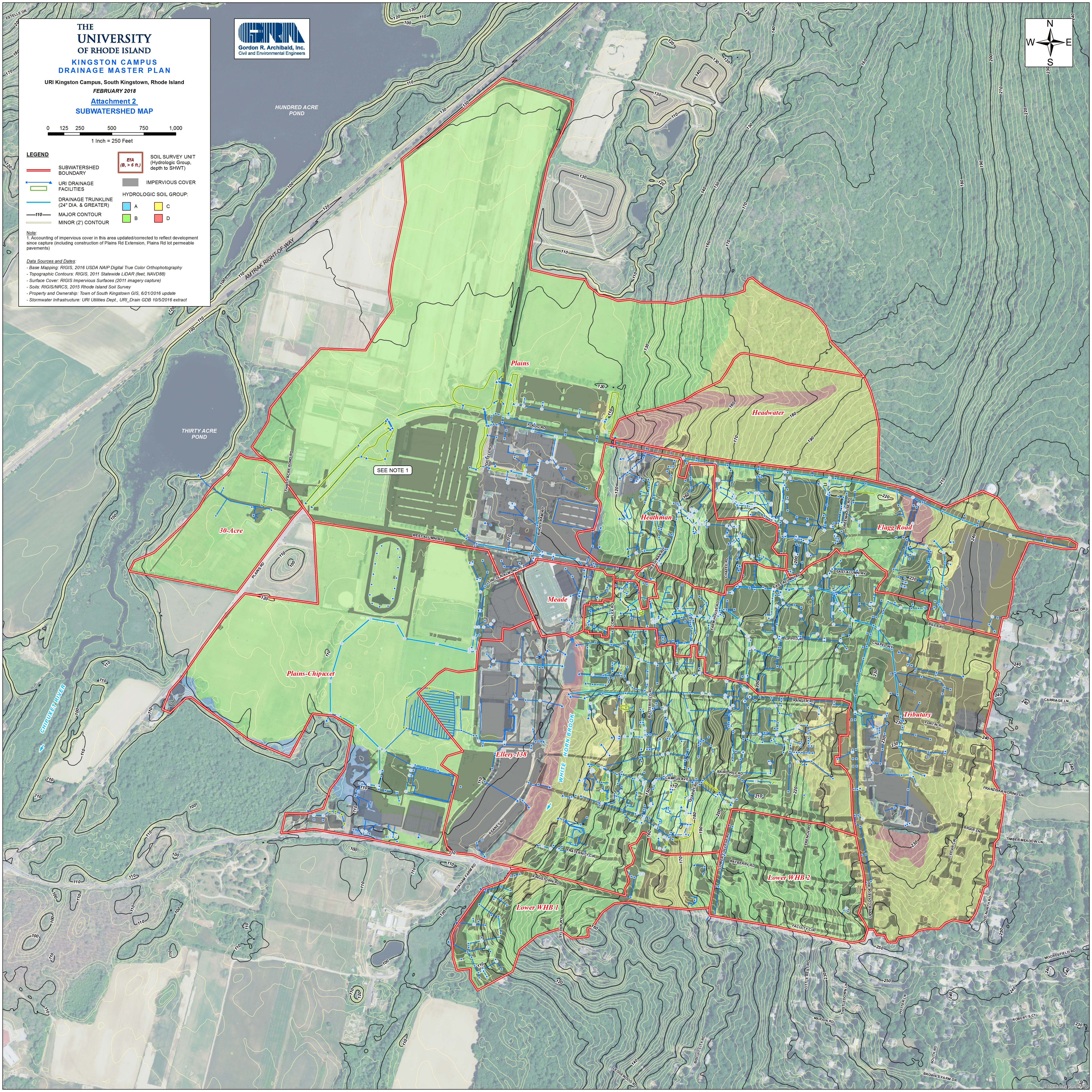
Gordon R. Archibald, Inc.
Civil and Environmental Engineers



LEGEND

			OWNER OF RECORD:
🟥	SUBWATERSHED BOUNDARY	🟦	URI (including ROW)
▭	URI DRAINAGE FACILITIES	🟨	BOARD OF GOVERNORS FOR HIGHER ED.
―	DRAINAGE TRUNKLINE (24" DIA. & GREATER)	🟩	STATE OF RI
―	PROPERTY LINE (PLAT:LOT)	🟧	URI FOUNDATION

Data Sources and Dates:
- *Base Mapping: RIGIS, 2016 USDA NAIP Digital True Color Orthophotography*
- *Topographic Contours: RIGIS, 2011 Statewide LiDAR (feet, NAVD88)*
- *Surface Cover: RIGIS Impervious Surfaces (2011 imagery capture)*
- *Soils: RIGIS/NRCS, 2015 Rhode Island Soil Survey*
- *Property and Ownership: Town of South Kingstown GIS, 6/21/2016 update*
- *Stormwater Infrastructure: URI Utilities Dept., URI_Drain GDB 10/5/2016 extract*



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KINGSTON CAMPUS DRAINAGE MASTER PLAN

URI Kingston Campus, South Kingstown, Rhode Island

FEBRUARY 2018

Attachment 2
SUBWATERSHED MAP

0 125 250 500 750 1,000

1 Inch = 250 Feet

LEGEND

	SUBWATERSHED BOUNDARY
	URI DRAINAGE FACILITIES
	DRAINAGE TRUNKLINE (24" DIA. & GREATER)
—110—	MAJOR CONTOUR
	MINOR (2') CONTOUR
EfA (B, > 6 ft.)	SOIL SURVEY UNIT (Hydrologic Group, depth to SHWT)
■	IMPERVIOUS COVER

HYDROLOGIC SOIL GROUP:

🟦	A	🟨	C
🟩	B	🟥	D

Note:
1. Accounting of impervious cover in this area updated/corrected to reflect development since capture (including construction of Plains Rd Extension, Plains Rd lot permeable pavements)

Data Sources and Dates:
- *Base Mapping: RIGIS, 2016 USDA NAIP Digital True Color Orthophotography*
- *Topographic Contours: RIGIS, 2011 Statewide LiDAR (feet, NAVD88)*
- *Surface Cover: RIGIS Impervious Surfaces (2011 imagery capture)*
- *Soils: RIGIS/NRCS, 2015 Rhode Island Soil Survey*
- *Property and Ownership: Town of South Kingstown GIS, 6/21/2016 update*
- *Stormwater Infrastructure: URI Utilities Dept., URI_Drain GDB 10/5/2016 extract*

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KINGSTON CAMPUS DRAINAGE MASTER PLAN

URI Kingston Campus, South Kingstown, Rhode Island

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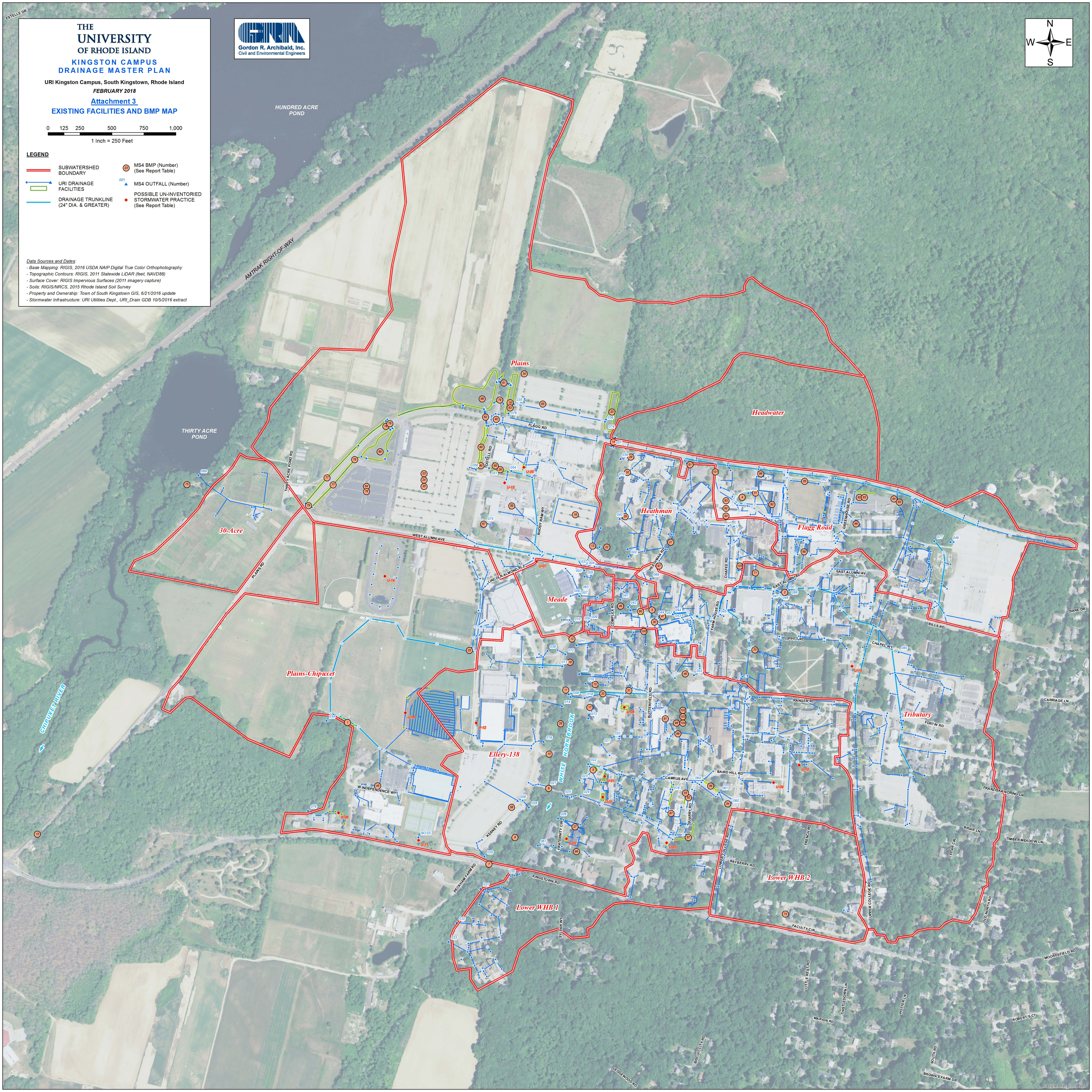
Attachment 3
EXISTING FACILITIES AND BMP MAP

Gordon R. Archibald, Inc.
Civil and Environmental Engineers



THE UNIVERSITY OF RHODE ISLAND

KINGSTON CAMPUS DRAINAGE MASTER PLAN

URI Kingston Campus, South Kingstown, Rhode Island

FEBRUARY 2018

ATTACHMENT 4
RECENTLY COMPLETED AND PLANNED DEVELOPMENT PROJECTS

0 250 500 750 1,000
Feet

Sources: RIGIS (2016 USDA-NAIP Statewide Orthophotography), URI Utilities Department, Office of Capital Projects

Gordon R. Archibald, Inc.
Civil and Environmental Engineers

LEGEND

PROJECT LIMITS ▨

PLAN LOCATION	YEAR COMPLETED	PROJECT NAME
E1	2005	URI Alumni Center
E2	2005	Rodman Hall Renovation
E3	2006	Independence Hall Renovation
E4	2007	Hope Commons Student Dining Facility
E5	2007	Eddy, Wiley, and Garrahy Residence Halls
E6	2009	Center for Biotechnology and Life Sciences
E7	2011	Ranger-Green Campus Landscaping and Beautification
E8	2011	White Horn Brook Culvert Replacements
E9	2012	College of Pharmacy Building
E10	2012	Hillside Residence Hall
E11	2013	Sherman Building Parking Lot and Drainage Restoration
E12	2013	Athletic Courts
E13	2013	College of Pharmacy Courtyard and Heber W. Youngken Jr. Medicinal Plant Garden
E14	2013	White Hall Parking Lot Improvements
E15	2013	Greenhouse Road Parking Lot
E16	2014	The Ryan Family Student-Athlete Center and the Eleanor Carlson Strength & Conditioning Center
E17	2014	Flagg Road Extension and Parking Lot
E18	2014	White Horn Brook Stream Channel Improvements
E19	2015	Gender and Sexuality Center
E20	2015	Butterfield Dining Hall Renovated and Expansion
E21	2016	Richard E. Beaupre Center for Chemical and Forensic Sciences
E22	2016	Tootell Road Roadway Improvements
E23	2016	Washburn Hall Improvements
E24	2016	Electrical Substation 1 & 2
PLAN LOCATION	**SCHEDULED START**	**PROJECT NAME**
P1	TBD	Fine Arts Parking Lot
P2	TBD	Butterfield Road and Hope Commons Drainage Improvements
P3	2017	College of Engineering - New Engineering Building
P4	2018	White Horn Brook Apartments
P5	2018	Visitor Center and Campus Gateway
P6	TBD	Fine Arts Center Renovations
P7	TBD	Fuel Depot Relocation
P8	TBD	Salt Storage Building Relocation
P9	TBD	Upper College Road Mixed Development
P10	2018	Fraternity Circle Improvements
P11	2018	Lower College Road
P12	2018	Green Hall Parking Lot
P13	2018	50 Campus Avenue Parking Lot
P14	TBD	Upper College Road Reconstruction
P15	TBD	Flagg Road Reconstruction
P16	TBD	URI Bicycle Path Spur

RI Digital Atlas, USDA-NAIP

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KINGSTON CAMPUS DRAINAGE MASTER PLAN

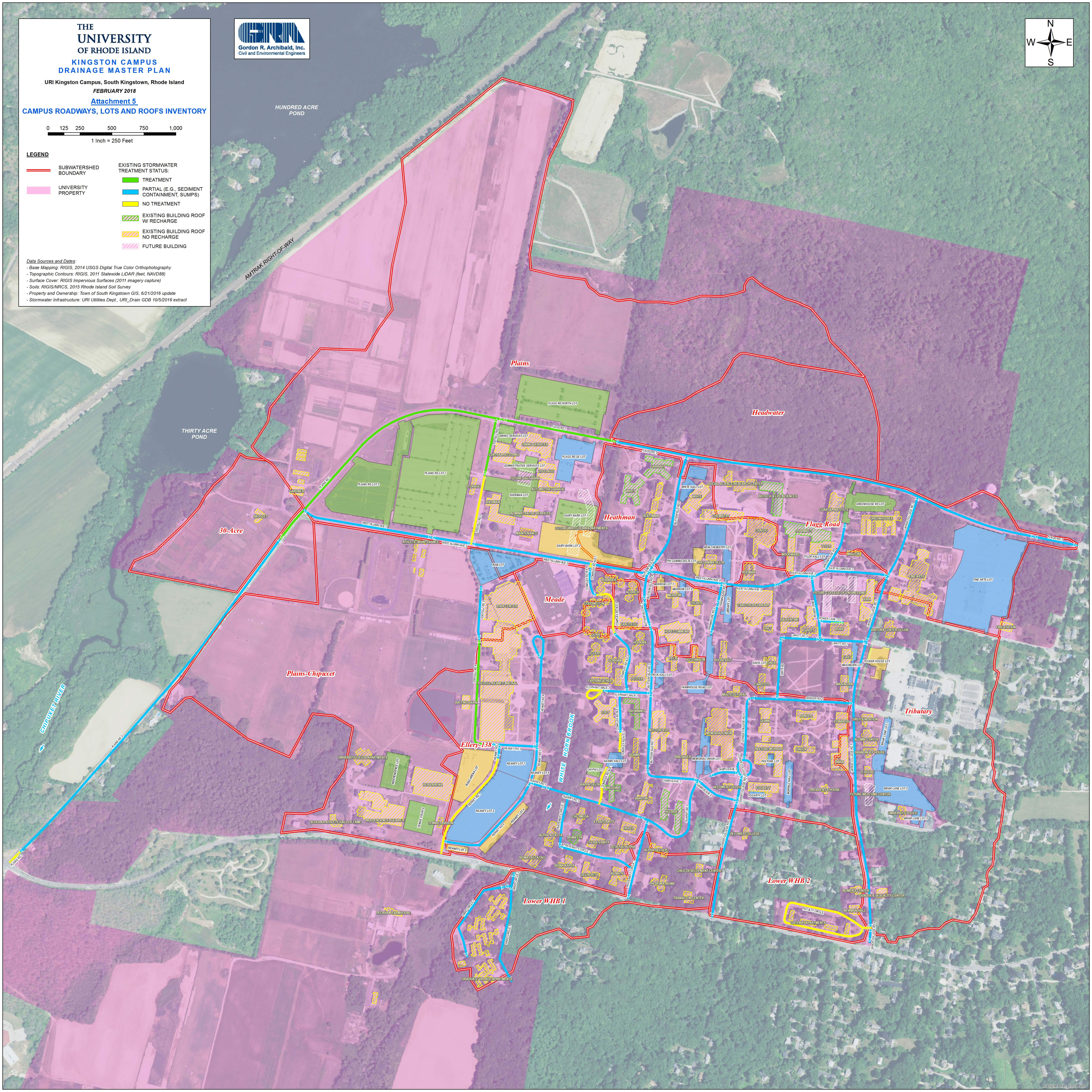
URI Kingston Campus, South Kingstown, Rhode Island

FEBRUARY 2018

Attachment 5

CAMPUS ROADWAYS, LOTS AND ROOFS INVENTORY

Gordon R. Archibald, Inc.
Civil and Environmental Engineers



LEGEND

🟥 SUBWATERSHED BOUNDARY

🟪 UNIVERSITY PROPERTY

EXISTING STORMWATER TREATMENT STATUS:

- 🟩 TREATMENT
- 🟦 PARTIAL (E.G., SEDIMENT CONTAINMENT, SUMPS)
- 🟨 NO TREATMENT
- ▨ EXISTING BUILDING ROOF W/ RECHARGE
- ▨ EXISTING BUILDING ROOF NO RECHARGE
- ▨ FUTURE BUILDING

Data Sources and Dates:

- *- Base Mapping: RIGIS, 2014 USGS Digital True Color Orthophotography*
- *- Topographic Contours: RIGIS, 2011 Statewide LiDAR (feet, NAVD88)*
- *- Surface Cover: RIGIS Impervious Surfaces (2011 imagery capture)*
- *- Soils: RIGIS/NRCS, 2015 Rhode Island Soil Survey*
- *- Property and Ownership: Town of South Kingstown GIS, 6/21/2016 update*
- *- Stormwater Infrastructure: URI Utilities Dept., URI_Drain GDB 10/5/2016 extract*