Replacement of the Midway Bridge, Arcadia Management Area

Exeter,
Rhode Island

Prepared for  Rhode Island Department of Transportation
State Office Building
Two Capitol Hill
Providence, Rhode Island 02903

Prepared by  VHB/Vanasse Hangen Brustlin, Inc.
10 Dorrance Street, Suite 400
Providence, Rhode Island 02903

October 2013
APPLICATION FORM

Please type or print

PART A Purpose of Application:

☐ Request to Determine Presence of Wetlands only (see Rule 9.02(B))
☐ Request to Verify Delineated Edge of Wetlands (see Rule 9.02)
☒ Request for Preliminary Determination (see Rule 9.03)
☐ Application to Alter a Freshwater Wetland (see Rule 9.05)
☐ Application for Renewal (see Rule 9.07)
☐ Application for Permit Transfer (see Rule 9.08)
☐ Application for Permit Modification (see Rule 9.09)
☐ Change in Owner during Application Processing (see Rule 8.06)

PART B Applicant Information:

• Name of Applicant (see Rules 5.06 and 8.02): RI Department of Transportation Attn: Peter Healey, PE

Note: The applicant must be the owner of the property or easement which is the subject of this application or must be the government agency or entity with power of condemnation over such property or easement.

• Mailing Address of Applicant: 2 Capitol Hill Street Road P.O. Box Providence RI 02903 222-2023 ext 4039

• Location of Property subject to this Application:
  Exeter Plain Road
  Barber Road 0.5 miles southwest.

Nearest street intersection and its distance and direction from site

Nearest utility pole number(s): N/A Direction to site from abutting street: N ☒ S ☐ E ☐ W ☐

Tax Assessor’s Plat(s) and Lot No.(s): N/A

Recorded Plat(s) and Lots No.(s) (if no Tax Assessor Plat and Lots available): NA

PART C General Information:

• Any previous application for this site? Yes ☐ No ☒ Provide Application No.(s)

• Any previous enforcement action for this site? Yes ☐ No ☒ Provide File No.(s) __________________________

Amount of wetland area to be altered (if applicable, see Rules 8.03, 8.04):

Square feet: 14,330 Linear feet (if watercourse): 55

• Amount of fee submitted for Application (see Rules 8.03, 8.04): N/A Check No. __________________________

PART D For Application Renewal Only:

• Name of Original or Subsequent Permittee: __________________________

• Application/Permit No. __________________________ Permit Expiration Date: __________________________

• Number of previous renewals issued (if applicable):

Statement of Applicant: I hereby state that I am requesting renewal of the original or subsequently modified permitted project under Application/Permit No. ______. I fully understand the permit limitations and will comply with any and all conditions of the permit.

• Applicant’s name: (print) __________________________ (signature) __________________________

RHODE ISLAND DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
OFFICE OF WATER RESOURCES: PERMITTING PROGRAM
235 Promenade Street, Providence, RI 02908
Telephone: 401-222-6820, Telecommunication Device for the Deaf: 401-222-6800
APPLICATION FORM
PART E  For Application for Permit Transfer Only:

- Name of Original Permittee: ____________________________
- Application/Permit No. ____________________________ Permit Expiration Date: ____________________________

Note: A certified copy of the deed of transfer must be enclosed with application.

Statement of Applicant: I hereby certify that I have reviewed the permit letter issued under Application/Permit No. _____ and hereby agree to comply with all conditions of the permit, including any time limitations imposed.

- Applicant’s name: (print) ____________________________ (signature) ____________________________ Date: ____________________________

Subscribed and sworn before me this _____ day of _____, 20____.

Notary Public
My Commission expires: ____________________________

PART F  For Change in Owner During Application Processing Only:

- Name of Original Applicant: ____________________________ Application No. ____________________________
- Application/Permit No. ____________________________ Permit Expiration Date: ____________________________

Note: A certified copy of the deed of transfer must be enclosed for Applications to Alter only.

PART G  Certification of Professional(s) (if applicable): Note: Any professional (e.g. engineer, biologist, landscape architect, etc.) who participated in the submission and/or preparation of this Application and supporting documentation must sign below.

- Name of professional (print): Bharat Patel, PE
  Address: 10 Dorrance St, Suite 400, Providence, RI 02903
  d/b/a: Vanasse Hangen Brustlin, Inc.
  Signature of professional: ____________________________ Date: ____________________________

  If more than one professional:
  - Name of professional (print): Susan Moberg PWS
    Address: 10 Dorrance St, Suite 400, Providence, RI 02903
    d/b/a: Vanasse Hangen Brustlin, Inc.
    Signature of professional: ____________________________ Date: ____________________________

  - Name of professional (print): ____________________________
    Address: ____________________________
    d/b/a: ____________________________
    Signature of professional: ____________________________ Date: ____________________________

  - Name of professional (print): ____________________________
    Address: ____________________________
    d/b/a: ____________________________
    Signature of professional: ____________________________ Date: ____________________________

PART H  Certification of Applicant:

- I hereby certify that I have requested and authorize the investigation, compilation, and submission of all the information, in whatever form, contained in this Application; that I have personally examined and am familiar with the information submitted herein; and that such information is true, accurate and complete to the best of my knowledge.

  See Rule 8.02 regarding Signatories to Applications

Signature of Applicant: ____________________________ Title (if applicable): Chief Civil Engineer

Print Name Signed Above: Peter Healey, P.E. Date: ____________________________
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1 Introduction

The Rhode Island Department of Transportation (RIDOT), in cooperation with the Rhode Island Department of Environmental Management (RIDEM), proposes to replace the Midway Bridge (Bridge No. 788) which carries Barber Road over the Falls River in Exeter, Rhode Island. The structural integrity of the existing stone bridge abutments has deteriorated and existing steel beam, wood plank superstructure is functionally obsolete. RIDOT proposes to reconstruct the bridge using Geosynthetic Reinforced Soil-Integrated Bridge System (GRS-IBS) technology. This type of construction has been found to be a low cost, rapid construction technology for bridge replacement of small span bridges. The construction method is favored by the U.S. Forest Service and the Federal Highway Administration (FHWA).¹

The reconstruction consists of four separate actions. The first involves demolition of the bridge superstructure. This will expose the top of the existing abutments and the river channel. The second involves installation of water controls to divert the river, excavate the dewatered stream bed and install rip rap scour protection that will match existing channel dimensions around the bridge abutment. This action will stabilize the stone abutments pier which will remain in place. The third action involves the construction of new abutments behind the existing stone abutments. This action involves excavating behind the existing abutments and constructing the new load-bearing GRS abutments. This action is completed when the new bridge superstructure is installed on top of these new abutments. Lastly, the roadway approaches to the bridge will be regraded to raise the profile to meet the new bridge.

The design maintains the existing channel cross section and profile through the bridge crossing. There will be no alteration of the existing hydraulic characteristics of the bridge opening under normal flow conditions. Additional floodway capacity will be provided by raising the bridge elevation and removing the top two feet of the existing abutments which is presently below the level of the 1 percent annual chance flood elevation.

The project involves the replacement of a bridge which carries Barber Road over the Falls River. As such, the project is a water dependent use.

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Existing Site Conditions

Site Location

The project is located on Barber Road in the Arcadia Management Area at the intersection of Midway Trail and Barber Road in Exeter, Rhode Island approximately one half mile north Ten Rod Road (State Route 165).

The project location is provided on the Project Locus Map and the project limits are accurately shown in the appended plan set.

Site Description

The Midway Bridge is approximately 32 feet long and 16 feet wide. The bridge consists of a single span constructed of steel stringers with wood deck planking and wooden railings. The bridge superstructure is supported by stone masonry abutments and conveys a single lane of traffic across the Falls River.

Physical Setting

The site is situated in a generally north-south oriented valley along the Falls River. Roadway elevations within the project area range between 128 feet and 135 feet above the North American vertical datum of 1988 (NAVD88). The bottom of the Falls River is at approximate elevation 121 feet, with the water surface under normal flow conditions at elevation 124.3 feet at the bridge.

Soils and Surficial Geology

The USDA Natural Resource Conservation Service (NRCS) Web Soil Survey identifies four soil mapping units in the project vicinity: Scarboro (Sb), Walpole (Wa), Hinckley (HkA, HkD), Merrimac (MmA), and Windsor (WgB.) The Scarboro and Walpole mapping units consist of poorly drained and very poorly drained hydric soils and are generally mapped consistent with the river channel and adjacent wetlands. The Hinckley, Merrimac and Windsor mapping units consist of
excessively drained and somewhat excessively drained soils and are generally mapped coincident with project area uplands. Surfacial geology in the site vicinity consists of friable glacial till deposits and glaciofluvially deposited sands and gravels.

The Scarboro (Sb) series consists of very deep, very poorly drained soils in sandy glaciofluvial deposits on outwash plains, deltas, and terraces. They are nearly level soils in depressions. Slope ranges from 0 through 3 percent. Saturated hydraulic conductivity is low on the muck surface tier and high or very high in the subsoil and substratum.

The Walpole (Wa) Series consists of very deep, poorly drained sandy soils formed in outwash and stratified drift. They are nearly level to gently sloping soils in low-lying positions on terraces and plains. Slope ranges from 0 to 8 percent. Saturated hydraulic conductivity is moderately high or high in the surface layer and subsoil, and high or very high in the substratum.

The Hinckley series consists of very deep, excessively drained soils formed in glaciofluvial materials. They are nearly level through very steep soils on terraces, outwash plains, deltas, kames, and eskers. Saturated hydraulic conductivity is high or very high. Slope ranges from 0 to 3 percent (HkA) and 15 to 35 percent (HkD).

The Merrimac (MmA) series consists of very deep, somewhat excessively drained soils formed in outwash. They are nearly level through very steep soils on outwash terraces and plains and other glaciofluvial landforms. Slope ranges from 0 through 3 percent. Saturated hydraulic conductivity is high or very high.

The Windsor (WgB) series consists of very deep, excessively drained soils formed in sandy outwash or eolian deposits. They are nearly level through very steep soils on glaciofluvial landforms. Slope ranges from 3 through 8 percent. Saturated hydraulic conductivity is high or very high.

Vegetation

Upland plant associations consist of mature white pine (*Pinus strobus*) and red maple (*Acer rubrum*) mesic forest with an understory containing black cherry (*Prunus serotina*) and red cedar (*Juniperus virginiana*) and clubmoss (*Lycopodium* sp.) A description of wetlands in the project area follows.
Water Resources

Surface Water

The project area lies within the upper watershed of the Wood River. An approximately 18.66 square mile watershed area drains to the bridge site. The river at this location is a 3rd-order stream with well-defined banks, a sandy substrate and an approximate 0.005 percent slope. The channel is constrained by the fill approaches to the bridge and areas of wetland are present adjacent to the river both upstream and downstream of the bridge. Falls River supports a cold water fishery.

The Wood River has been assigned Classification “A” by the RIDEM Water Quality Regulations (RIDEM, July 2006 amended December 2010). According to the Water Quality Regulations Class “A” waters are: designated for primary and secondary contact recreational activities and for fish and wildlife habitat. They shall be suitable for compatible industrial processes and cooling, hydropower, aquacultural uses, navigation, and irrigation and other agricultural uses. These waters shall have excellent aesthetic value.

According to the RIDEM 2012 Integrated Water Quality Monitoring and Assessment Report, Falls River and its tributaries are listed as fully supporting goals for fish and wildlife habitat, and primary and secondary contact recreation. The river is not assessed for Fish Consumption. Falls River is listed in the Report as a Category 2 waterway. Category 2 is defined as "Attaining some of the designated uses; and insufficient or no data and information is available to determine if the remaining uses are attained. Waterbodies will be placed in this Category if there are data and information which, in accordance with the [Consolidated Assessment and Listing Methodology], support a determination that some, but not all, uses are attained and attainment status of the remaining uses is unknown because there is insufficient or no data or information." A Total maximum daily load (TMDL) study is not proposed to be completed for the river.

The project area does not lie within or adjacent to any Special Resource Protection Waters.

Groundwater

The groundwater at the Site is classified as GA. According to the RIDEM Groundwater Quality Rules (June 2010), “Groundwater classified GA shall be those groundwater resources which the Director has designated to be suitable for public or private drinking water use without treatment and which are not described in Rule 9.1.1(A)-(C).”
There are no Community Wellhead Protection Areas proximate to the Midway Bridge. There are several Non-Community Wellhead Protection areas located to the east of the site but these are generally greater than a mile away according to the RIDEM groundwater maps (June 2010.)

### Fisheries

The Falls River in this reach has been identified by the RIDEM Division of Fish and Wildlife (RIDEM F&W) as supporting a cold water trout fishery. Coordination with the RIDEM F&W has resulted in recommended time of year restrictions. Based on the sensitive nature of the native brook trout populations during the early life stages, their recommendation is for no in-water work to be scheduled between the following dates in any calendar year:

- No in-water work between March 20 and June 20 and/or between September 20 and December 20 of any calendar year.

### Floodplains

The Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) identifies the Midway Bridge site as being within a Zone A Floodplain (FIRM Map No. 44009C0055H, effective date October 19, 2010)(Refer to Appendix A. Zone A is defined as a Special Flood Hazard Area subject to inundation by the 1 percent annual chance flood with no base flood elevation determined.

A HEC-RAS analysis of the bridge location was performed by GZA GeoEnvironmental Inc. (June 2013; Revised August 2013)(Refer to Appendix B.) The analysis determined the base flood elevation of the 1 percent annual chance flood to be 127.9 feet NAVD88.

### Wetland Resources

Wetlands were delineated by Ecosystem Solutions, Inc. in March 2004. Two flag series were established to identify the wetland edges of one wetland as follows:

<table>
<thead>
<tr>
<th>Wetland Number</th>
<th>Flag Series</th>
<th>Wetland Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A-1 through A-21 and B-1 through B-25</td>
<td>Riverine and contiguous Forested Wetland Fringe</td>
</tr>
</tbody>
</table>

Wetland flags proximate to the proposed work areas were re-established by VHB scientists on September 27, 2013.

Wetland 1 consists of the river channel and contiguous wetlands including both emergent and shrub/sapling cover types immediately proximate to the river channel.

Delineation documentation forms were prepared by Ecosystem Solutions, Inc. and are provided at Appendix A. Dominant plant species recorded in the wetland documentation plots included red maple in the tree story, silky dogwood (Cornus amomum), arrowwood (Viburnum recognitum), and elderberry (Sambucus canadensis) in the shrub strata, and upright sedge (Carex stricta) and sphagnum moss (Sphagnum sp.) in the herbaceous strata.

VHB recorded additional species proximate to the work areas on September 27, 2013 including the following: alder (Alnus sp.), gray birch (Betula populifolia), black willow (Salix nigra), shadbush (Amelanchier canadensis), maleberry (Lyonia ligustrina), winterberry (Ilex verticillata), fox grape (Vitus labrusca), burreed (Sparganium sp.), three way sedge (Dulichium arundinaceum), bluegrass (Poa sp.), sensitive fern (Onoclea sensibilis), and cardinal flower (Lobelia cardinalis).

### Rare Threatened and Endangered Species

Coordination with the Rhode Island Natural Heritage Program has revealed records for two species listed as State Endangered nearby the bridge (Refer to Table 2.)

<table>
<thead>
<tr>
<th>Species Name</th>
<th>Listing</th>
<th>Life form</th>
<th>Habitat</th>
<th>Life Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Williamsonia linteri Ringed Bog haunter</td>
<td>State Endangered³</td>
<td>dragonfly</td>
<td>Acidic fens and sphagnum bogs with soupy pools or troughs surrounded by woodland⁴</td>
<td>Breeding on warm days between late April and early June</td>
</tr>
<tr>
<td>Margaritifera margaritifera Eastern Pearlshell</td>
<td>State Endangered</td>
<td>bivalve</td>
<td>Cold, nutrient-poor, unpolluted trout streams and smaller rivers with moderate flow rates. Benthic substrate is usually sand, fine gravel, or a sand-gravel mix</td>
<td>Present year-round. Reproduce June through September.</td>
</tr>
</tbody>
</table>

State Endangered Species are native taxa considered to be in imminent danger of extirpation from Rhode Island³. These taxa may meet one or more of the following criteria:

³ Rhode Island Department of Environmental Management Natural Heritage Program, Rare Native Animals Of Rhode Island, Revised: March, 2006.
1. Formerly considered by the U.S. Fish and Wildlife Service for Federal listing as endangered or threatened.
2. Known from an estimated 1-2 total populations in the state.
3. Apparently globally rare or threatened; estimated at 100 or fewer populations range-wide.

The requirements for these two species are provided by several areas of suitable habitat within the Arcadia Management Area.

According to the New England Office of the U.S. Fish and Wildlife Service (USFWS) website, sandplain gerardia (*Agalinis acuta*), an endangered species protected under the federal Endangered Species Act (ESA) may be present within the Town of Exeter. The USFWS endangered species consultation webpage provides guidance on determining whether a project may affect a species listed under the ESA. This includes a review of the habitat requirements of the species followed by field investigations to determine if the species is present.

Sandplain gerardia is an annual species that establishes from seed each year and the number of individuals in a given population can vary widely year to year. It is considered a coastal grassland species and is thought to be a hemiparasite on warm season grasses. According to Nature Serve, sandplain gerardia requires early successional habitats, grasslands and shrubland, maintained by frequent disturbance such as mowing, burning, or grazing. Soils are usually nutrient poor and xeric. An exposed soil substrate was reported as important.

VHB inspected the bridge site on September 24th and 26th, 2012 to look for the species during its late summer to fall flowering period. The road shoulders of the approaches to the Midway Bridge included areas with drier exposed sandy substrates supporting warm season grasses that could serve as habitat for the species, but careful inspection did not result in the location of this taxa (Refer to Appendix D.)

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5 http://www.fws.gov/newengland/
6 http://www.fws.gov/newengland/EndangeredSpec-Consultation_Project_Review.htm
7 http://www.natureserve.org/explorer/servlet/NatureServe?searchName=Agalinis+acuta
Project Description

The reconstruction of the Midway Bridge has been designed to preserve the appearance of the existing stone structure, while minimizing the impact of construction on through traffic and park users, and result in a minimal impact to the natural environment of the bridge vicinity. As planned, the bridge will be closed to traffic for a five day period during which the entire bridge replacement project will be completed. RIDOT has selected the use of the GRS-IBS technology for the design and construction of the new bridge because it substantially meets these identified goals.

GRS-IBS is a method of bridge support that blends the roadway into the superstructure to create a jointless interface between the bridge and the approach. It consists of three main components: the reinforced soil foundation (RSF), the abutment, and the integrated approach. The RSF is composed of granular fill material that is compacted and encapsulated with a geotextile fabric. It provides embedment and increases the bearing width and capacity of the GRS abutment. It also prevents water from infiltrating underneath and into the GRS mass from a river or stream crossing. The abutment is constructed of alternating layers of compacted fill and geosynthetic reinforcement to provide support for the bridge, which is placed directly on the GRS abutment without a traditional joint or cast-in-place concrete. GRS is also used to construct the integrated approach to transition to the superstructure. This bridge system therefore alleviates problems caused by uneven settling between bridge abutments and approach roadways.

Project Activities

The bridge reconstruction consists of four separate actions. The first involves demolition of the bridge superstructure. This will expose the top of the existing abutments and the river channel. The second involves installation of water controls to divert the river, and excavation of the dewatered stream channel so native bed materials can be replaced with adequately sized rip rap to provide scour protection around the bridge abutment. By excavating the native bed material first, the top of the installed rip rap can be placed to match the existing channel cross-section and

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maintain the hydraulic profile. This riprap will also stabilize the existing stone abutments of the bridge which will remain in place, and will provide protection for the new GRS abutments.

The third component involves the construction of new abutments behind the existing stone abutments using the GRS-IBS technology. This action involves excavating behind the existing abutment and constructing the new GRS abutment. The new bridge superstructure will rest on top of these new abutments.

Lastly, the roadway approaches to the bridge will be regraded to raise the profile to meet the new bridge, and one existing parking area will be reconstructed. This will involve limited filling and grading of the roadbed and parking area and top-soiling and seeding of the roadway shoulders. The road surface is proposed to be gravel as under present conditions.

The Project design will not alter the existing hydraulic characteristics of the bridge opening under normal flow conditions. Additional floodplain capacity will be provided by raising the bridge elevation and removing the top two feet of the existing abutments which are presently below the level of the 1 percent annual chance flood elevation.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Total Fill (ft³)</th>
<th>Total Cut (ft³)</th>
<th>Net (ft³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>124.3-125</td>
<td>4.25</td>
<td>0</td>
<td>4.25</td>
</tr>
<tr>
<td>125-126</td>
<td>14.75</td>
<td>0</td>
<td>14.75</td>
</tr>
<tr>
<td>126-127</td>
<td>30</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>127-128</td>
<td>66.45</td>
<td>192</td>
<td>-125.55</td>
</tr>
<tr>
<td>Total</td>
<td>115.45</td>
<td>192</td>
<td>-76.55</td>
</tr>
</tbody>
</table>

Source: GZA, Inc.

Since the bridge will be closed to traffic during the five-day construction window, the roadway and parking areas proximate to the bridge are proposed to be used for dewatering areas and staging equipment and materials stockpiles. The contractor will maintain an off-site construction yard where equipment and materials not immediately in use for construction will be stored minimizing the amount of disturbance at the bridge location.

**Wetland Impacts**

The project will involve permanent and temporary impact to River and its Forested Wetland fringe, and Riverbank Wetlands. Work within the river will include excavation of existing riverbed and replacement with rip rap scour protection. This will result in the alteration of 247 square feet of riverbed habitat. Approximately ## square feet of Forested Wetland fringe along the river will be altered by the rip rap
placement. The remainder of the project activity will occur within the 200-foot Riverbank Wetland. Some portions of the rip rap scour protection will result in new alteration of the riverbank wetland, however, the balance of the activity consists of maintenance work performed on existing roadway features and will therefore not alter the character of these resource areas. Consequently, these activities are viewed as temporary impacts.

Any areas of soil disturbance will be restored and seeded after work has been completed.

### Table 4: Freshwater Wetland Impact Summary

<table>
<thead>
<tr>
<th>Location</th>
<th>Permanent Impact (ft²)</th>
<th>Temporary Impact (ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Riverine/Palustrine Wetland</td>
<td>Perimeter/Riverbank Wetland</td>
</tr>
<tr>
<td>Falls River</td>
<td>247</td>
<td>259</td>
</tr>
<tr>
<td>Wetland 1</td>
<td>730</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>977</td>
<td>259</td>
</tr>
</tbody>
</table>

Source: VHB, Inc.

### Tree Removal

The existing cover type in areas adjacent to the bridge where work will be occurring is limited to shrubs and saplings. Since there is no canopy shading the Falls River at this location, the Project is unlikely to cause any water temperature increase.

### Scour Protection

GZA used HEC-RAS to compute contraction scour and local scour for the Midway Bridge. The HEC-RAS scour assessment was performed in accordance with the methods outlined in *Evaluating Scour at Bridges, Hydraulic Engineering Circular No. 18 (HEC-18, FHWA, 1995)*. The scour analysis uses the data generated by the HEC-RAS hydraulic models, as well as methodologies described in HEC-18 to compute the scour depths. A summary of HEC-RAS results, potential scour elevations, and recommended minimum bottom chord elevations for Midway Bridge is provided in the GZA Hydrologic & Hydraulic Report provided at Appendix B.

Generally, the scour analysis indicated potential scour depths of approximately 14 feet below the base of the existing abutment at Midway Bridge. In order to mitigate for the potential scour, either the new abutments would need to be constructed to account for the potential scour depth (14 feet below existing), or else additional protection to inhibit the development of scour would need to be installed around the...
base of the new GRS abutment\textsuperscript{10}. Additional scour protection at the surface was selected as the least environmentally damaging alternative over the additional excavation required to improve the abutments to the extent required.

As noted above, rip rap is proposed to be installed for scour protection around the new bridge abutments. With the goal of not altering the hydraulic characteristics of the river at the bridge site, the project design involves excavating the river bed to a depth of 18 inches in the vicinity of the bridge as depicted on the plans and placing the riprap such that existing grades are matched to the extent possible. The river in the vicinity of Midway Bridge is a low energy waterway with a sandy bed underlain by cobbles. Replacement of the native material with rip rap will not result in a dramatic alteration of the channel substrate. Since this section of the river is a zone of sediment accretion, it is anticipated that voids within the stone rip rap will accumulate sand deposits, similar to existing conditions. Diversion of the river flow around the excavation area will limit the amount of sediment suspended in the water. Excavated material will be removed and disposed of in an upland location away from wetlands.

The area of scour protection to be installed within the river channel is approximately 247 square feet, or 13.7 cubic yards. No net fill in the waterway is proposed. GZA prepared calculations for the sizing of the scour countermeasures. These calculations are provided at Appendix E.

### Rare Threatened and Endangered Species

As noted above, VHB performed an investigation of the Project Site for the presence of the Federally-listed sandplain gerardia in September 2012. Habitat requirements for this species are not present at Midway Bridge.

Two species listed as State Endangered, Ringed Bog haunter and Eastern Pearlshell, were identified by the RIDEM Natural History Program as present nearby the bridge site. Habitat requirements for ringed bog haunter are acidic fens and sphagnum bogs with soupy pools or troughs surrounded by woodland. While these habitat types are present in the Arcadia Management Area, they are not present within or adjacent to the project limits.

Eastern Pearlshell was previously identified as being present on the Falls River approximately 2100 feet downstream (south) of the Midway Bridge, within 200 feet of Route 165. VHB performed an investigation of the site for the mussel. Refer to Appendix D for a detailed description of the investigation and findings.
The Midway Bridge site is located over a segment of the Falls River characterized by a gentle gradient. The substrate is variable depending on the position in the channel ranging from loose sandy point bars, gravelly sands, to stone and cobbles mid channel. Some stone is present at the surface (<50% cover) and is generally moderate in size (D₅₀ 12 inches.) After minimal probing with a long handled rake, four mussel specimens were recovered: three specimens were alive and one dead.

The Connecticut Department of Environmental Protection *Field Guide to the Freshwater Mussels of Connecticut* (Guide) was used to identify the collected mussels as the Eastern Elliptio (*Elliptio complanata*). This is a very common species that is not listed by the Rhode Island Natural Heritage Program. The Guide notes that this species can be confused with the Eastern Pearlshell due to their similar size, shape and color.

**Erosion and Sediment Control**

During construction, a variety of Best Management Practices will be employed to minimize project impacts. Compost filter socks will be deployed at the limit of work as depicted on the General Plan. Material stockpiles will be located within the limit of work as depicted on the General Plan.

Excavation support for work within the river will be provided in the form of 3-foot by 3-foot square and 3 to 6 feet in height super sandbags which will form a diversion around the excavation area for the rip rap installation first, and then for the abutment excavation where it extends proximate to the waterway. Sandbag locations are depicted on the Scour Countermeasures Plan. GZA has prepared calculations evaluating the anticipated high of water during the diversion. Under normal flow conditions, the anticipated water elevation is 124.9 NAVD88 (Refer to Appendix F.)

Dewatering may be necessary during excavation for the rip rap installation and for the abutment excavation. The contractor will use pre-cleaned 8-foot by 30-foot roll off dumpsters staged on or adjacent to the roadway as depicted on the Demolition and Excavation Plan and Section for dewatering basins.

Disturbed areas will be treated with loam and grass seed as described on Standard Note – 1. Mulch secured by jute mesh or biodegradable fiber mat or blankets (rolled erosion control products) will be used to secure plantable soil and seed in all ditches, swales and slopes adjacent to wetlands and wetland perimeters.
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Drainage Characteristics and Stormwater Management

Water Quantity and Quality Control

The overall scope of work for the Midway Bridge replacement project is very limited. The project is limited to 481 feet in horizontal alignment and 0.21 acres of impervious area. The difference in impervious area between the existing and proposed conditions is approximately 700 square feet.

In accordance with the RI Stormwater Design and Installation Standards Manual (RISDISM) (RIDEM 2010), the project falls under the category of redevelopment. This is because the existing gravel road and bridge are classified as impervious and the rest of the Arcadia Management Area consists of jurisdictional wetlands or conservation land not available for development. Redevelopments do not have to meet Minimum Standards 4 through 6 in the RISDISM.

This project seeks a waiver from the recharge requirement of Minimum Standard 2 of the RISDISM. The project is set in a natural area that has not been impacted by development. Infiltrating runoff in the vicinity of the roadway approach to the bridge is undesirable and could lead to early failure of the GRS structure. Language identifying exceptions is provided in Section 3.2.2 of the RISDISM.

In accordance with the RISDISM Minimum Stand 3: Water Quality, projects proposing new impervious surfaces must provide treatment of the water quality volume draining from that new impervious area. Due to the proposed bridge widening and other design elements, the project will create approximately 700 square feet of new impervious surfaces. These areas largely drain directly off the bridge and cannot be captured for water quality renovation. QPAs have been identified to treat an area equivalent to the increase in impervious surface created at this location.

Given the small proposed change in impervious area between the existing and proposed conditions (700 square feet), the resulting increase in storm water runoff for the different storm events is not significant. The increase in impervious area
Storm water runoff for the proposed 100 year event is 0.1 cubic feet per second (cfs.) The 100 year discharge rate in the river had been estimated as 1140 cfs by GZA, Inc.\textsuperscript{11} Due to the minimal increase in peak discharge rates; no mitigation for conveyance and natural channel protection (RISDISM Minimum Standard 4) or overbank flood protection (RISDISM Minimum Standard 5) is proposed.

\textsuperscript{11} GZA GeoEnvironmental Inc. Hydrologic & Hydraulic Data Report Design/Build Arcadia Management Area Bridges, Exeter, Rhode Island. August 2013.
Alternatives Analysis

The basic project purpose is to replace the Midway Bridge. Replacing the bridge at a new location was eliminated from consideration since significant areas of wetland are present around the bridge and relocation of the bridge would require realignment of the roadway approaches resulting in significant permanent impact to these wetlands.

Alternative designs considered included demolition of the existing bridge and stone abutments and replacement with new abutments constructed of cast-in-place concrete abutments, as well as the proposed GRS abutment design. The new cast in place abutment alternative was anticipated to require significant excavation in order to reach the required design depth, as well as requiring prolonged dewatering and other construction related impacts due the longer construction period. Because the GRS abutment construction is comparatively uncomplicated, it can be accomplished much quicker thus reducing the duration of construction and minimizing the opportunity for unanticipated impacts. The GRS abutment design also maintains the hydraulic opening of the bridge.

Lastly, although the scour protection is dictated by FHWA requirements, the preferred project design involves excavation to install the rip rap such that it matches existing grade. This approach results in no net fill in the waterway and no restriction of flow. VHB observed a nearby bridge in the Arcadia Management Area where scour protection was installed above the existing grade. The rip rap appeared to constrict the flow of water to the center of the channel causing the formation of a deep scour hole downstream of the bridge.

For these reasons, RIDOT selected the proposed project design. The GRS abutment approach was also favored by FHWA which is contributing funding to the project.
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Impact Avoidance, Minimization and Mitigation

Impacts to River and its Forested Wetland fringe, and 200-foot Riverbank Wetland associated with the Falls River are limited to that necessary to reconstruct the structurally deficient bridge.

Avoidance and Minimization

Wetland impacts have been avoided to the greatest extent possible by this water dependent project, which seeks to replace the structurally deficient Midway Bridge. The replacement of the bridge has been designed to maintain the integrity of the stone masonry construction, and avoid and minimize impacts to freshwater wetland resources including the Falls River.

Permanent alteration of the riverbed will occur as part of the rip rap scour protection to be installed around the abutments. A small portion of the scour protection will extend beyond the River into the 200-foot Riverbank Wetland. Other project elements will improve existing roads, parking areas and trailhead proximate to the bridge and within the 200-foot Riverbank Wetland.

Indirect impacts will be minimized by conducting the proposed bridge replacement work from the existing roadway to the extent possible.

The following section addresses issues associated with Rule 9.02D (1) and (2):

- Whether the primary proposed activity is water-dependent or whether it requires access to freshwater wetlands as a central element of its primary purpose (e.g., a pier);

  Replacement of the Midway Bridge over the Falls River is a water dependent use.

- Whether any areas within the same property or other properties owned or controlled by the applicant could be used to achieve the project purpose without altering the natural character of any freshwater wetlands;
No other area within properties controlled by the applicant could be used to achieve the project purpose without altering the natural character of a freshwater wetland. The chosen location maintains the existing layout for Barber Road and preserves the context of the stone masonry bridge within the existing alignment of Barber Road.

- Whether any other properties reasonably available to, but not currently owned or controlled by, the applicant could be used to achieve the project purpose while avoiding wetland alterations. A property is reasonably available if, in whole or in part, it can be acquired without excessive cost, taking individual circumstances into account, or, in the case of property owned or controlled by the same family, entity, group of affiliated entities, or local, state or federal government, may be obtained without excessive hardship;

  Constructing the project on other properties would not maintain the existing layout of Barber Road.

- Whether alternative designs, layouts or technologies could be used to avoid freshwater wetlands or impacts on functions and values on the subject property or whether the project purpose could be achieved on other property that is reasonably available and would avoid wetlands;

  A bridge is a widely accepted technology used to avoid impact to wetlands and waterways. The selected design follows Example 24 found in The Wetland BMP Manual: Techniques for Avoidance and Minimization (RIDEM, 2010) with the addition of measures to preserve the stone masonry bridge structures. The new abutments will be constructed behind the existing stone abutments, eliminating encroachment into the Falls River channel. The new bridge superstructure and abutments will be behind the existing stone abutments and wing walls such that the appearance of the bridge will not change significantly when viewed from the river or the roadway. The reconstruction will preserve the hydraulic characteristics of the existing bridge opening and there will be a net decrease of fill within the floodway and floodplain of the river.

- Whether the applicant has made any attempts (and if so what they were) to avoid alterations to freshwater wetlands by overcoming or removing constraints imposed by zoning, infrastructure, parcel size or the like; and whether the feasible alternatives that would not alter the natural character of any freshwater wetlands on the subject property or on property that is reasonably available, if incorporated into the proposed project would adversely affect public health, safety or the environment.

  The project is not constrained by zoning, infrastructure, parcel size, or the like. The activity proposed in wetlands is limited to installation of the rip rap scour protection which is dictated by FHWA12. All other work required to construct the new bridge.

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abutments and superstructure will be predominately outside of the River and its Forested Wetland fringe and will be conducted from the roadway.

Minimization: For any impact to freshwater wetlands that cannot be avoided, the applicant must satisfactorily demonstrate to the Department in the written narrative that the impact to wetland functions and values have been reduced to the maximum extent possible. At a minimum, applicants must consider and address the following issues:

a) Whether the proposed project is necessary at the proposed scale or whether the scale of the wetland alteration could be reduced and still achieve the project purpose;

The proposed bridge is widened by 2 feet in order to provide a clear travel width of 17 feet. This design meets current safety standards for similar structures.

b) Whether the proposed project is necessary at the proposed location or whether another location within the site could achieve the project purpose while resulting in less impact to the wetland;

The replacement bridge must be constructed at the location of the existing bridge to maintain the existing layout of Barber Road. Constructing a bridge at another location would not achieve the project purpose and would result in significant new wetland impacts.

c) Whether there are feasible alternative designs, layouts, densities or technologies that would result in less impact to the wetland while still achieving the project purpose;

A bridge, versus a pipe or box culvert, is a feasible technology employed to minimize impact to freshwater wetland resources.

d) Whether reduction in the scale or relocation of the proposed project to minimize impact to the wetland would result in adverse consequences to public health, safety or the environment.

Reducing the size of the bridge could result in adverse consequences to public safety. The bridge has been dimensioned to replace the existing deteriorated structure and maintain safe passage over the Falls River for vehicles and pedestrians.

e) Whether the proposed project is necessary at the proposed scale or whether the scale of the wetland alteration could be reduced and still achieve the project purpose;

Replacement of the Midway Bridge must be made at the scale proposed to maintain safe travel lane widths along Barber Road. The Applicant opted to maintain the existing
single travel lane across the bridge rather than widen the bridge to accommodate two lanes. Additionally, the extent of the proposed rip rap scour protection is dictated by FHWA design requirements.

Mitigation

The following section addresses Rule 9.02 D (3):

Mitigation Measures. Measures, methods, or best management practices to avoid alterations of and minimize impacts to wetlands include, but are not limited to:

a) Preserving natural areas in and around wetlands;

Scour protection will alter 1,236 square feet of riverbed, Forested Wetland fringe and Riverbank Wetland. All other new wetland impacts are avoided.

b) Minimizing the extent of disturbed areas and encouraging the preservation of land in its natural state;

Project disturbance is limited to the immediate area of the structure where replacement construction will take place.

c) Designing dense plantings of shrubs and trees between the developed areas and the remaining natural areas (i) to “buffer” impacts from loss of wildlife habitat and loss of natural areas and (ii) to reduce the impacts of noise, lighting and other disturbances upon wildlife and the remaining natural areas;

Screening plants are not useful in this setting.

d) Maintaining unrestricted fish and wildlife passage;

Fish passage in the river will be maintained during repair of the bridge. RIDOT coordinated with the RIDEM F&W Division and received direction regarding time of year restrictions required for the protection of the cold water fishery.

No in-water work between March 20 and June 20 and/or between September 20 and December 20 of any calendar year.

The diversion is anticipated to increase water levels approximately 2.9 feet under normal flow conditions. In water work at Midway Bridge will be completed in one day.

e) Designing structures and alterations so that they are located outside of floodplain, floodway, areas subject to flooding, flowing bodies of water or other freshwater wetlands;
Because of the use of the GRS abutments, existing floodplain fill can be removed resulting in a net increase of floodplain and floodway resources. Approximately 76.5 cubic feet of floodplain fill will be removed as part of the project.

No net permanent fill will be placed in floodplain, floodway, flowing bodies of water, or freshwater wetlands. The proposed rip rap scour protection is proposed to be installed to match existing grades within the riverbed. A sand bag diversion will be deployed to isolate the area planned for scour protection. An excavator will remove approximately 18 inches of gravel across the area, and rip rap will be placed as backfill. This design was proposed in order to avoid placing fill in the floodway or otherwise changing the hydraulic characteristics of the bridge opening.

f) Using best management practices for the stabilization of disturbed areas and the selection, use, and maintenance of temporary or permanent soil erosion and sediment controls in accordance with the latest version of the RISESC Handbook and the RISDIS Manual;

See below for the accompanying RIDOT Small Site Storm Water Pollution Prevention Plan prepared consistent with the RISESC Handbook.

g) Using best management practice selection and design criteria in accordance with the latest version of the RISDIS Manual to reduce stormwater flows and maximize the control, treatment and maintenance of systems associated with reducing stormwater impacts to acceptable levels;

New impervious surfaces will be created that will require storm water quality and/or quantity treatment. The drainage analysis performed determined that the new impervious surfaces would result in a negligible increase in peak discharge rates, therefore, mitigation for these increases is not proposed. QPAs have been identified to treat an area equivalent to the increase in impervious surface created at this location.

h) Minimizing impervious surface areas such as roads, parking, paving or other surfaces;

Impervious surfaces created by the project include the minor bridge widening (2 feet) and impervious surfaces associated with the reconstructed roadway and parking lots which will be surfaced with compacted gravel. These areas have been kept to the minimum size needed to achieve the project purpose.

i) Incorporating compensatory flood storage area(s) where necessary and in compliance with these Rules;

Approximately 76.5 cubic feet of flood storage will be created by the removal of the upper portions of the existing stone abutments.

j) Encouraging infiltration of non-contaminated run-off into uncontaminated soils;
Some infiltration may occur in the water quality swales constructed as part of the project. The project seeks a waiver from Standard 2 of the RISDISM on the basis that infiltrating stormwater in proximity to the GRS approach and abutments is undesirable, and the project setting is in an undeveloped natural where the small increase in impervious surface at the bridge will have no measurable effect on groundwater levels.

k) Preventing channelization or piping of run-off and encouraging sheet flow;

_The design is graded to promote sheet flow into the proposed swales._

l) Landscaping with gradual slopes to maximize sheet flow and infiltration while minimizing channelization;

_The project does not have a landscaping component because it is situated in a natural area._

m) Minimizing or eliminating the use or increase of any pollutants, fertilizers, pesticides, herbicides, or any other chemical or organic application which increase pollutant and nutrient loadings;

_These chemicals are not used in conjunction with this project._

n) Maximizing setbacks of septic systems and other land disturbances from wetlands;

_Not applicable; and_

o) Minimizing the withdrawal of surface water or groundwater from wetlands or uplands adjacent to wetlands, especially during dry periods, and minimizing any reduction in river or stream flow.

_The project does not propose to withdraw water._
Summary and Conclusion

The proposed replacement of the Midway Bridge will result in the temporary disturbance of approximately 15,410 square feet of Freshwater Wetland to reconstruct the bridge and approaches, and the alteration of 1,236 square feet of riverbed, Forested Wetland fringe and Riverbank Wetland for the installation of rip rap scour protection.

The project will disturb less than 10,000 square feet of existing impervious surface and will create approximately 700 square feet of new impervious surface. The project will offer modest improvement to water quality through the addition of roadside swales to treat runoff and promote infiltration.

Table 6: Summary of Freshwater Wetland Impacts

<table>
<thead>
<tr>
<th></th>
<th>Permanent Impact (ft²)</th>
<th>Temporary Impact (ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riverine/Palustrine Wetland</td>
<td>977</td>
<td>259</td>
</tr>
<tr>
<td>Perimeter/Riverbank Wetland</td>
<td>270</td>
<td>15,140</td>
</tr>
</tbody>
</table>

Once completed, the bridge structure will not significantly encroach further into Freshwater Wetland resources than the existing. The proposed GRS abutments will encroach further into the floodway at lower elevations, while the removal of existing fill encroachment, predominately at the higher elevations will create a net increase in floodplain and floodway at the bridge site. Impacts will be minimized through the application of erosion and sediment control BMPs provided in the Rhode Island Soil Erosion and Sediment Control Handbook as provided in the attached RIDOT Small Site SWPPP.

As proposed, the replacement of the Midway Bridge does not represent a significant alteration of wetlands. The bridge repair will not degrade the water quality of Falls River, nor adversely affect significant wildlife habitat. It is the opinion of the engineers and scientist responsible for preparing this report that the project is consistent with the intent of the RIDEM Rules.
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Rhode Island Department of Environmental Management Natural Heritage Program, *Rare Native Plants Of Rhode Island*. September 2007.


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Appendix A – FEMA Flood Insurance Rate Map
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**LEGEND**

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

**ZONE A**
No Base Flood Elevations determined.

**ZONE AE**
Base Flood Elevations determined.

**ZONE AH**
Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

**ZONE AO**
Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

**ZONE AR**
Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

**ZONE A99**
Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

**ZONE V**
Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

**ZONE VE**
Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

**FLOODWAY AREAS IN ZONE AE**
The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

**OTHER FLOOD AREAS**

**ZONE X**
Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

**OTHER AREAS**

**ZONE X**
Areas determined to be outside the 0.2% annual chance floodplain.

**ZONE D**
Areas in which flood hazards are undetermined, but possible.

**COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS**
Appendix B – Hydrologic & Hydraulic Data Report
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Appendix C – Wetland Data Forms
Appendix C – Drainage Memorandum
Wetland Edge Delineation Data Form (UPLAND)

Applicant: __________________________ Wetland No. 1 __________________________

Project: Midway Bridge Flag No. Sequence: A-1 through A-21

Cty/Town: Exeter Date: 03/23/04

Vegetation: List the three dominant species in each vegetative strata along with their NWI status:

<table>
<thead>
<tr>
<th>Tree</th>
<th>Indicator</th>
<th>Status</th>
<th>Herbs</th>
<th>Indicator</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Acer rubrum</td>
<td>FAC</td>
<td></td>
<td>1. Grass spp.</td>
<td>FACU</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td>2.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td>3.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saplings/Shrubs</td>
<td>FACU</td>
<td></td>
<td>Woody Vines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Prunus serotina</td>
<td></td>
<td></td>
<td>1.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Pinus strobus</td>
<td>FACU</td>
<td></td>
<td>2.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td>3.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

List other vegetative species noted which may have affected determination of the wetland edge:

Soil: SCS Soil Survey Mapping Unit: MmA- Merrimac sandy loam, 0 to 3% slopes
On Hydric Soils List? (Y/N): No

Soil Profile (Note wetland flag no. nearest soil test pit): A-8

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Depth</th>
<th>Matrix Color</th>
<th>Mottling Description</th>
<th>Depth to Saturation</th>
<th>Depth to Free Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0-18</td>
<td>10YR 2/2</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Bw</td>
<td>18-20</td>
<td>10YR 4/6</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Other indicators exhibiting an absence of wetland hydrology (e.g. absence of water marks, lack of redoximorphic features, lack of oxidized rhizospheres, etc.):

Landscape Position: Shoulder

Altered/Atypical situation? (describe):

Comments:


Wetland Edge Delineation Data Form (WETLAND)

Applicant: ___________________ Wetland No. ___________________
Project: Midway Trail Bridge Flag No. Sequence: A-1 through A-21
City/Town: Exeter Date: 03/23/04

Vegetation: List the three dominant species in each vegetative strata along with their NWI status:

<table>
<thead>
<tr>
<th>Tree</th>
<th>Indicator</th>
<th>Status</th>
<th>Herbs</th>
<th>Indicator</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Acer rubrum</td>
<td></td>
<td>FAC</td>
<td>1. Sphagnum spp.</td>
<td></td>
<td>OBL</td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td>2. Carex stricta</td>
<td></td>
<td>OBL</td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Saplings/Shrubs</th>
<th>Indicator</th>
<th>Status</th>
<th>Woody Vines</th>
<th>Indicator</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rhododendron viscosum</td>
<td>FACW+</td>
<td></td>
<td>1. Vitis spp.</td>
<td>FACW</td>
<td></td>
</tr>
<tr>
<td>2. Tilia verticillata</td>
<td>FACW+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

List other vegetative species noted which may have affected determination of the wetland edge:

Soil: SCS Soil Survey Mapping Unit; Sb - Scarboro mucky sandy loam
On Hydric Soils List? (Y/N): Yes

Soil Profile (Note wetland flag no. nearest soil test pit): A-8

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Depth</th>
<th>Matrix Color</th>
<th>Mottling Description</th>
<th>Depth to Saturation</th>
<th>Depth to Free Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oe</td>
<td>2-0</td>
<td>5YR 3/4</td>
<td>-</td>
<td>+2&quot;</td>
<td>-</td>
</tr>
<tr>
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<td>0-12</td>
<td>10YR 2/2</td>
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<tr>
<td>C</td>
<td>12-20</td>
<td>10YR 4/4</td>
<td>-</td>
<td>-</td>
<td>8&quot;</td>
</tr>
</tbody>
</table>

Other hydrological indicators (e.g. water marks, drainage patterns, root rhizospheres, etc.; see Appendix 4(A(4) of the Rules):

Landscape Position: Toeslope

Altered/Atypical situation? (describe):

Comments:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
Wetland Edge Delineation Data Form (UPLAND)

Applicant: ________________________________  Wetland No.: ________________________________

Project: Midway Bridge  Flag No. Sequence: B-1 through B-20

City/Town: Exeter  Date: 03/23/04

Vegetation: List the three dominant species in each vegetative strata along with their NWI status:

<table>
<thead>
<tr>
<th>Tree</th>
<th>Indicator Status</th>
<th>Herbs</th>
<th>Indicator Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Acer rubrum</td>
<td>FAC</td>
<td>1. Lycopodium complanatum</td>
<td>FACU</td>
</tr>
<tr>
<td>2. Pinus strobus</td>
<td>FACU</td>
<td>2. Lycopodium clavatum</td>
<td>FAC</td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td>3.</td>
<td></td>
</tr>
</tbody>
</table>

Saplings/Shrubs:

| 1. Juniperus virginiana  | FACU | Woody Vines |
| 2. Tilia verticillata  | FACW+ | 1.  |
| 3.  |  | 3.  |

List other vegetative species noted which may have affected determination of the wetland edge: ________________________________

Soil: SCS Soil Survey Mapping Unit: Wgb- Windsor loamy sand, 3-8% slopes

On Hydric Soils List? (Y/N): No

Soil Profile. (Note wetland flag no. nearest soil test pit): B-5

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Depth</th>
<th>Matrix Color</th>
<th>Mottling Description</th>
<th>Depth to Saturation</th>
<th>Depth to Free Water</th>
</tr>
</thead>
<tbody>
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<td>0-4</td>
<td>10YR 3/2</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>C</td>
<td>4-20</td>
<td>10YR 3/2</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Other indicators exhibiting an absence of wetland hydrology (e.g. absence of water marks, lack of redoximorphic features, lack of oxidized rhizospheres, etc.):

Landscape Position: Backslope

Altered/Atypical situation? (describe):

Comments: Texture changes from fine sandy loam to gravelly sand from A to C horizons.
Wetland Edge Delineation Data Form (WETLAND)

Applicant: ___________________________ Wetland No. 1 ___________________________

Project: Midway Bridge Flag No. Sequence: B-1 through B-20

City/Town: Exeter Date: 03/23/04

Vegetation: List the three dominant species in each vegetative strata along with their NWI status:

<table>
<thead>
<tr>
<th>Tree</th>
<th>Indicator Status</th>
<th>Herbs</th>
<th>Indicator Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <em>Acer rubrum</em></td>
<td>FAC</td>
<td>1. <em>Carex stricta</em></td>
<td>OBL</td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td>3.</td>
<td></td>
</tr>
</tbody>
</table>

Saplings/Shrubs

<table>
<thead>
<tr>
<th>1. <em>Viburnum recognitum</em></th>
<th>FACW+</th>
<th>Woody Vines</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. <em>Sambucus canadensis</em></td>
<td>FACW-</td>
<td>1.</td>
</tr>
</tbody>
</table>

List other vegetative species noted which may have affected determination of the wetland edge:

Soil: SCS Soil Survey Mapping Unit: Sb- Scarboro mucky sandy loam

On Hydric Soils List? (Y/N): Yes

Soil Profile (Note wetland flag no. nearest soil test pit): B-5

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Depth</th>
<th>Matrix Color</th>
<th>Mottling Description</th>
<th>Depth to Saturation</th>
<th>Depth to Free Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0-2</td>
<td>10YR 2/2</td>
<td>-</td>
<td>0'</td>
<td>-</td>
</tr>
<tr>
<td>C</td>
<td>2-16</td>
<td>10YR 3/4</td>
<td>-</td>
<td>-</td>
<td>4'</td>
</tr>
<tr>
<td>Cr</td>
<td>16+</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Other hydrological indicators (e.g. water marks, drainage patterns, root rhizospheres, etc.; see Appendix 4(A)(4) of the Rules):

Landscape Position: Footslope

Altered/Atypical situation? (describe):

Comments: Wetland inundated in part due to beaver dam.
Appendix D – RTE Information
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Memorandum

To: Bharat Patel, PE

Date: September 28, 2012

Project No.: 81391.12

Re: Replacement of Arcadia Management Area Bridges, Exeter, RI

From: Jeffrey Peterson, CPSS, CPESC

The proposed replacement of three bridges in the Arcadia Management Area will occur in Exeter, Rhode Island (refer to the attached Figure). According to the New England Office of the U.S. Fish and Wildlife Service (USFWS) website\(^1\), sandplain gerardia (*Agalinis acuta*), an endangered species protected under the federal Endangered Species Act (ESA) is present within Exeter. The USFWS endangered species consultation webpage\(^2\) provides guidance on determining whether a project may affect a species listed under the ESA. This includes a review of the habitat requirements of the species followed by field investigations to determine if the species is present.

Sandplain gerardia is an annual species that establishes from seed each year and the number of individuals in a given population can vary widely year to year. It is considered a coastal grassland species and is thought to be a hemiparasite on warm season grasses. According to Nature Serve\(^3\) sandplain gerardia requires early successional habitats, grasslands and shrubland, maintained by frequent disturbance such as mowing, burning, or grazing. Soils are usually nutrient poor and xeric. An exposed soil substrate was reported as important.

I visited the three bridge sites on September 24\(^{th}\) and 26\(^{th}\) to look for the species during its late summer to fall flowering period. The species was not observed at any of the sites. Suitable habitat was not present at The Falls River Bridge #784 or Frosty Hollow Bridge #787 which were deeply shaded by moist mesic forest. The road shoulders of the approaches to the Midway Bridge #788 included areas with drier exposed sandy substrates supporting warm season grasses that could serve as habitat for the species, but careful inspection did not result in the location of this taxa.

While I am confident that the work areas proposed for these bridge replacements would not affect a population of sandplain gerardia, it should be noted that there are several areas within the Arcadia Management Area managed in warm season grasses that provide potentially suitable habitat. Any stockpile or equipment storage areas away within the Area should be similarly cleared before they are used to avoid an inadvertent impact.

Based on this investigation and consistent with Step 2 of the Endangered Species Consultation process provided in the USFWS website\(^4\), it is my opinion that a no effect letter under the federal ESA can be issued for this project (appended).

---

\(^1\) http://www.fws.gov/newengland/
\(^2\) http://www.fws.gov/newengland/EndangeredSpec-Consultation_Project_Review.htm
\(^3\) http://www.natureserve.org/explorer/servlet/NatureServe?searchName=Agalinis+acuta
\(^4\) http://www.fws.gov/newengland/EndangeredSpec-Consultation_Project_Review.htm
On Friday September 27, 2013, Jeffrey Peterson and I performed an investigation of the Falls River Bridge site and the Midway Bridge site for the presence of the freshwater mussel, Eastern Pearlshell (*Margaritifera margaritifera*). In 2012, VHB submitted a data request to the Rhode Island Department of Environmental Management Natural Heritage Program (RIDEM) regarding the referenced bridges. Eastern Pearlshell was identified as being present on the Falls River approximately 2100 feet downstream (south) of the Midway Bridge within 200 feet of Route 165. Eastern Pearlshell is identified in RIDEM *Rare Native Animals of Rhode Island Revised: March, 2006* as State Endangered (SE). Eastern Pearlshells are generally found in cold, nutrient-poor, unpolluted trout streams and smaller rivers with moderate flow rates. Benthic substrate is usually sand, fine gravel, or a sand-gravel mix where mussels can bury themselves (Spoo 20081). Salmonids are generally the host species.

The Falls River Bridge site is a third order stream with a 0.02% slope characterized by a stony substrate (D<sub>50</sub> 6-inches+.) Water velocities were generally high through the bridge site, though lower velocities resulted in the northeastern channel under the bridge due to blockage of the bridge opening by a large (>8-inch DBH) tree snag. Downstream of the blockage, some detritus had been deposited in the lee. Generally, suitable habitat for Eastern Pearlshell was not present at the Falls River Bridge site. VHB probed the channel bottom using a long handled rake. No mussels were found.

The Midway Bridge site is located over a segment of the Falls River characterized by a gentler gradient than the Falls River Bridge site. The substrate is variable depending on the position in the channel ranging from loose sandy point bars, gravelly sands, to stone and cobbles mid channel. Some stone is present at the surface (<50% cover) and is generally moderate in size (D<sub>50</sub> 12 inches.) After minimal probing with a long handled rake, four mussel specimens were recovered: three specimens were alive and one dead.

Since VHB had not previously obtained a scientific collector’s permit, the three live specimens were released into the river following photo-documentation and a non-destructive comparative analysis to reach a reasonable level of confidence that the dead and the live mussels were likely to be of the same species.

---

Using the Connecticut Department of Environmental Protection *Field Guide to the Freshwater Mussels of Connecticut (Guide)*, we attempted to identify the mussel specimen. Each of the four mussels found was between 3 and 3.5 inches in length and matched the description of “sub trapezoidal” in shape. Each of the four specimens appeared to be laterally compressed. The color ranged from dark brown in an apparently young individual to black in individuals judged to be older based on thickening of the shell and damage sustained to the shell.

The dead mussel displayed a mottled white nacre which may have been a result of physical damage post mortem. The specimen appeared to display both “lateral” and “pseudocardinal” teeth. Based upon the apparent presence of lateral teeth, we ruled out the Eastern Pearlshell since lateral teeth are absent in this species.

The *Guide* identifies the Eastern Elliptio (*Elliptio complanata*) as often confused with the Eastern Pearlshell due to their similar size, shape and color. The Eastern Elliptio is very common throughout ponds, lakes, rivers and streams and can be found on all substrate types. Its widespread distribution is attributed to its ability to parasitize many different fish species and ability to withstand habitat degradation. The *Guide* describes the presence of lateral teeth in this species consistent with our observations of the dead specimen.

Based upon the forgoing, we concluded that the mussels found at the Midway Bridge site were not the Eastern Pearlshell but rather the Eastern Elliptio. Also, we concluded that the habitat at the Falls River Bridge site is not suitable for the Eastern Pearlshell, while the Midway Bridge site does provide habitat which could support populations of Eastern Pearlshell.

View of mussel investigation at Midway Bridge.
Live mussel specimen, Midway Bridge.

View of live and dead mussel specimens, Midway Bridge. Note the sub trapezoidal form of the mussel on the left.
Appendix E – Scour Countermeasure Calculations
SUBJECT:
Design of rip rap scour countermeasures for the FHWA Geosynthetic Reinforced Soil-Integrated Bridge System (GRS-IBS) abutments and wing walls for the Design/Build Arcadia Management Area Bridges Project for the Rhode Island Department of Transportation. **This calculation will focus on sizing rip rap protection for the Midway Bridge.**

REFERENCES:
2. RIDOT Standard Specification for Road and Bridge Construction, 2010
3. FHWA HEC-23, Bridge Scour and Stream Instability Countermeasures, 1997

PROJECT REQUIREMENTS:
Between 2 and 6 feet of scour is estimated at the Midway Bridge, based on the 100-year storm. Scour countermeasures will be installed at the base of the abutments and wingwalls, therefore the new abutments and wing walls are considered protected from scour and may be set at or near the bottom of the existing abutment/wing walls.

SCOUR COUNTERMEASURE DESIGN:
Scour countermeasures will consist of rip rap armor stone placed along the riverbed and abutment side slopes up to the 100-year flood elevation. Assume abutments have vertical walls. The following are based on the H&H analyses for the Midway Bridge completed by GZA.

SIZE RIP RAP STONE

100 yr flood elevation: $\text{Flood}_{100} := 127.9\text{ft}$

Minimum riverbed elevation: $\text{El}_{\text{riverbed}} := 124.3\text{ft}$

Depth of flow: $y := \text{Flood}_{100} - \text{El}_{\text{riverbed}} = 3.60\text{ft}$

Specific Gravity of rock rip rap: $G_s := 2.65$

Gravitational acceleration: $g = \frac{32.17}{2.00} \text{ft/s}^2$

Maximum effective velocity during 100-yr storm: $V_{100} := 1.4 \text{ft/sec}$

Froude Number: $\text{FN} := \frac{V_{100}}{\sqrt{g \cdot y}} = 0.13$ $\text{FN} < 0.8$, Use EQ 8.1 for $D_{50}$

Velocity Multiplier: $K_{\text{vert}} := 1.02$

Mean stone diameter:

$D_{50_{\text{calc}}} := \frac{K_{\text{vert}}}{(G_s - 1)} \cdot \frac{V_{100}^2}{g \cdot y} = 0.01 \cdot \text{m}$

$D_{50_{\text{calc}}} = 0.45 \cdot \text{in}$

Filename: 33906.00_Rip Rap_Midway.xmcd  Printed: 8:42 AM - 8/16/2013
**Use RIDOT R-3 Rip Rap, \( D_{50}=4.0 \text{ in} \)**

\[
\begin{align*}
D_{50}\text{_riprap} &= 4\text{in} \\
D_{100}\text{_riprap} &= 8\text{in} \\
D_{15}\text{_riprap} &= 2\text{in}
\end{align*}
\]

**FILTER & BEDDING LAYER UNDERLYING RIP RAP**

Riverbed soils minimum \( D_{85} \):

\[
\begin{align*}
D_{85}\text{_sand} &= 1.5\text{in} \\
D_{15}\text{_sand} &= .0232\text{in}
\end{align*}
\]

Filter Soil: 3/4" crushed stone

\( D_{85}, D_{50}, \text{and } D_{15} \) assumed

\[
\begin{align*}
D_{85}\text{_filter} &= .75\text{in} \\
D_{15}\text{_filter} &= .4\text{in} \\
D_{50}\text{_filter} &= .5\text{in}
\end{align*}
\]

Filter Criteria: Filter Stone to Riverbed

\[
\frac{D_{15}\text{_filter}}{D_{85}\text{_sand}} = 0.27 < 5 < \frac{D_{15}\text{_filter}}{D_{15}\text{_sand}} = 17.24 < 40 \quad \text{OK}
\]

Filter Criteria: Rip Rap to Filter Stone

\[
\frac{D_{15}\text{_riprap}}{D_{85}\text{_filter}} = 2.67 < 5 < \frac{D_{15}\text{_riprap}}{D_{15}\text{_filter}} = 5.00 < 40 \quad \text{OK}
\]

Bedding/Filter Layer Thickness:

\[
T_{\text{filter}} := 4 \cdot D_{50}\text{_filter} = 2.00 \cdot \text{in} < 6 \text{ in minimum, use 6in}
\]

**Use 6" thick layer of 3/4" crushed stone (RIDOT M.01.07 - Filter Stone) for bedding/filter immediately below rip rap.**

**DETERMINE EXTENTS OF RIP RAP**

1. Rip rap will be placed along the entire length of the abutment toe, around the corners of the wing walls and to the point of tangency with the plane of the embankment slopes to 2.00 ft (0.6m) above the 100 yr flood elevation.

2. Extent of rip rap apron:

\[
L_{\text{riprap}} := 2 \cdot y = 7.20 \text{ ft} \quad \text{Say 8 feet}
\]

3. Extent of rip rap downstream:

\[
L_{\text{downstream}} := 2 \cdot y = 7.20 \text{ ft} \quad \text{Say 8 feet}
\]

4. Thickness of rip rap layer:

\[
T_{\text{riprap1}} := 2 \cdot D_{50}\text{_riprap} = 8.00 \cdot \text{in} \\
T_{\text{riprap2}} := D_{100}\text{_riprap} = 8.00 \cdot \text{in} \\
T_{\text{riprap3}} := \max\left(T_{\text{riprap1}} \cdot T_{\text{riprap2}}\right) \cdot 1.5 = 12.00 \cdot \text{in}
\]

**Use 12 in thick blanket of RIDOT R-3 rip rap placed 8 ft outward from toe of abutment that extends 8 feet beyond downstream side of abutment.**
Appendix F – Diversion Water Level Calculations
October 1, 2013
File No. 33906.00

Mr. Bharat Patel, P.E.
Vanasse Hangen Brustlin, Inc.
10 Dorrance Street, Suite 400
Providence, Rhode Island 02903

Re: Control of Water Calculations
    Design/Build Arcadia Management Area Bridges
    Exeter, Rhode Island

Dear Mr. Patel:

GZA GeoEnvironmental, Inc. (GZA) is pleased to provide these calculations pertaining to the temporary water control measures to be implemented by Northern Construction Co. during the construction of the Falls River, Frosty Hollow, and Midway bridges in the Arcadia Management Area in Exeter, Rhode Island. The purpose of these calculations was to estimate the impact of the river elevation at each bridge site due to the temporary placement of sand bag barriers under normal flow conditions. These calculations were also performed to estimate if water control measures could be in place at each abutment simultaneously or if the use of water control measures would need to be phased.

Based upon our findings, the water control measures will have to be performed in two phases at Falls River Bridge. Water control measures can be placed simultaneously at Frosty Hollow Bridge and Midway Bridge. A summary of the results are presented below.

<table>
<thead>
<tr>
<th>Bridge</th>
<th>Normal Water Elevation (ft)</th>
<th>Water Control</th>
<th>Estimated Water Elevation (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Falls River</td>
<td>155.0</td>
<td>Phased</td>
<td>157.8</td>
</tr>
<tr>
<td>Frosty Hollow</td>
<td>153.5</td>
<td>Simultaneous</td>
<td>156.1</td>
</tr>
<tr>
<td>Midway</td>
<td>122.0</td>
<td>Simultaneous</td>
<td>124.9</td>
</tr>
</tbody>
</table>

1. The estimated water elevation with control measures in-place.

Very truly yours,

GZA GEOENVIRONMENTAL, INC.

Matthew J. Page, P.E.
Project Manager

David R. Carchedi, Ph.D., P.E.
Senior Principal

MJP/DRC: jm

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An Equal Opportunity Employer M/F/V/H
Estimate water elevation with water control measure in place for the Falls River Bridge with staged installation and simultaneous installation.

1. Estimate volume on north & south sides of center pier

   NORTH SIDE
   - M.D.LINE : ~ 155'
   - NOM. Y : ~ 156.5'
   - Width from exist abt. to pier = 12'
   
   \[ \text{Volume} = (156.5 - 155) \times 12 = 18 \text{ ft}^3/\text{ft} \]

   SOUTH SIDE
   - M.D.LINE : ~ 155
   - NOM. Y : ~ 156.5
   - Width = ± 12'
   
   \[ \text{Volume} = (156.5 - 155) \times 12 = 18 \text{ ft}^3/\text{ft} \]

2. Staged const. (Same for north & south side - geometry similar)

   (a) For scale protection, extend rip rap 13' from face of new cap abutment. Provide 1H:1V cut slope for installation. Provide 3 ft wide sandbag for water control.

   (b) This leaves ±1 pt clear space b/w sandbag & pier.

   (c) footprint now 12' + 1' = 13 ft.

   \[ \left[ 13 \text{ ft}^3 + 18 \text{ ft}^3 \right] = 13 \text{ ft} \times H \Rightarrow H = 2.79' \]

   SAY 155 + 2.8' = 157.8'

   (d) top of sandbag ± el. 158'

3. Simultaneous not practical due to presence of middle pier.
ESTIMATE WATER ELEVATION WITH WATER CONTROL MEASURES IN PLACE FOR THE MIDWAY BRIDGE WITH STAGED INSTALLATION AND SIMULTANEOUS INSTALLATION.

1. ESTIMATE VOLUME IN CHANNEL

\[ V = \frac{1}{2} \times 3' + \frac{1}{2} \times 3' = 4.5 \text{ ft}^3/\text{ft} \]

7. SIMULTANEOUS CONSTRUCTION.

- 8' FROM FACE OF NEW GRS ABOUT 3' FOR SAND BAGS
  \[ = \frac{11}{2} \times 2 = 22 \text{ ft} \]

- TOTAL WIDTH OF CHANNEL (NEW GRS TO NEW GRS) = 36 ft.
  \[ 36 - 22 = 14 \text{ ft} \] B/W SAND BAGS

- HEIGHT OF WATER

\[ 2 \times \frac{7}{2} \times 0.8 = 3.5 \text{ ft}^3/\text{ft} \]

\[ 45 - 3.5 = 41.5 \text{ ft}^3/\text{ft} \]

\[ 41.5 / 14 = 2.9 \text{ ft} \] NEW WATER ELEV = 122' + 2.9'

\[ = 124.9 \text{ ft} \]

- TOP SAND BAG = 125' 

Top of Sand Bag 125ft > 124.9 ft : OK
ESTIMATE WATER ELEVATION WITH WATER CONTROL MEASUREMENTS IN PLACE
FOR THE FROSTY HOLLOW BRIDGE WITH SIMULTANEOUS INSTALLATION
OF SACKS & EXCAVATION FOR ABUTMENTS.

1. ESTIMATE VOLUME PER FOOT IN RIVER UNDER NORMAL CONDITIONS
   MUDLINE = 153.5 ft. (concrete, more closely 154.0 ft)
   NORM Y = 155.0 ft
   WIDTH FROM ABUT TO ABUT = 22 ft.
   VOLUME = (155 - 153.5) x 22 = 33 ft³/ft.

2. SIMULTANEOUS CONDITIONS
   (a) RIPRAP NOT REQUIRED IN FRONT OF EXISTING ABUTMENTS
       DUE TO BEDROCK AT ALL NEAR EXISTING RIVERBED
   (b) SACKS WILL BE PLACED ADJACENT TO EXISTING ABUTMENT
       FACES
   (c) LEAVES 22 - 2 x 3' = 16 ft CLEAR

3. RISE OF WATER LEVEL
   \[
   \frac{33 \text{ ft}^3}{141} = 16' \times H = 2.1 \text{ ft.}
   \]
   \[
   \text{NEW} \frac{1}{2} = 154 + 2.1 = 156.1 \text{ ft.}
   \]
   \[
   \text{TOP OF SACK BAG} = 154 + 3 \text{ ft.} = 157 \text{ ft.}
   \]
   \[
   \frac{1}{2} \text{ 156.1 ft} < 157 \text{ ft. OK.}
   \]
Appendix G – Drainage Report
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Arcadia Management Area,
Midway Bridge
Exeter, Rhode Island

Drainage Report

Prepared for
Rhode Island Department of Environmental Management
Division of Planning & Development
235 Promenade Street
Providence, Rhode Island 02908-5767

and

Rhode Island Department of Transportation
2 Capitol Hill State Office Building
Providence, Rhode Island 02903

Prepared by
VHB/Vanasse Hangen Brustlin, Inc.
10 Dorrance Street
Suite 400
Providence, RI 02903
401-272-8100

October 2, 2013
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3 Proposed Conditions ...................................................................................................... 7
4 Methodology and Design Criteria ............................................................................... 8
5 Conclusion ....................................................................................................................... 9

Appendix A: Hydrologic Calculations .......................................................................... A-1
Appendix B: Stormwater Management Checklist ...................................................... B-1
Introduction

The following report has been prepared by Vanasse Hangen Brustlin, Inc. (VHB) to provide a brief description of existing and proposed drainage areas, design methodology, and soil characteristics for Arcadia Management Area, Midway Bridge project, Exeter, RI.

The proposed redevelopment project is located on Barber Road as it crosses Falls River and intersects with Midway Trail in Exeter, RI. The purpose of the proposed project is to replace the Midway Bridge over Falls River. The existing bridge is approximately 15.5’ wide and the proposed bridge will be widened to be 18’ wide. Barber Road existing approach width varies but is typically 11’ wide. Existing Midway Trail is approximately 18’ wide. The proposed Barber Road approaches will be widened to be 23’ wide. Proposed Midway Trail will maintain similar geometry as the existing condition with no additional widening. The proposed horizontal alignments for both Barber Road and Midway Trail closely mirror that of the existing horizontal alignments. The vertical alignment will require a 1’ raise in elevation compared to the existing bridge to maintain the existing hydraulic opening. (See Falls River hydraulic analysis for additional information.) The profile elevation at the intersection of Barber Road and Midway Trail will be raised to match the proposed Midway Bridge grade. The intersection of Barber Road and Midway Trail is 30’ from the northeast end of the proposed bridge. There is one existing parking area on Midway Trail that will be maintained. The elevation of the parking area will be raised to tie into the proposed Midway Trail profile. The parking area layout will closely match the existing layout. Roadway reconstruction will utilize a 24” gravel borrow typical section for roadway and parking area reconstruction.

The Rational Method was utilized to evaluate / compare the existing and proposed drainage conditions for this bridge replacement project. This project falls within Washington County, RI. The 2yr, 10yr and 100-year design storm events were reviewed to determine if there are any substantial impacts as a result of the bridge replacement and roadway approach widening construction. Only impervious areas (bridge, roadway and parking) are considered for pre and post storm water runoff because of the very limited impact of this project, also because the proposed construction closely mirrors the existing condition. Upon project completion areas outside the roadway, bridge and parking areas will re-vegetate and match the existing conditions.
Figure 1 - Site Location Map
Existing Conditions

Description of Contributing Areas

The study area for the bridge replacement project is within the Falls River watershed and the Flat River watershed. Both watersheds are within the Arcadia Management Area. The project area is heavily wooded with wetlands located throughout. Arcadia Management Area is a recreational forest for public use. The east and west Barber Road approaches drain directly to Falls River. Storm water runoff sheds from the roadway embankment section over the sloped grading to Falls River. These flow lines consist of short distances of wooded area in between the Barber Road and Falls River. Midway Trail is split between two watershed areas. Falls River and Flat River merge to become one approximately 1800' southeast of Midway Bridge. The east half of Midway Trail (roadway crown LT) within the project limits sheds to Flat River. The west half of Midway Trail (roadway crown RT) sheds to Falls River. There is one parking areas adjacent to Midway Trail that sheds east to Flat River.

The roadway approach elevations range from 134’ to 129’. Falls River flows under Midway Bridge at an approximate elev. of 121’. The length of the Midway Bridge project including roadway approach, parking area and intersection construction is 481’.

The existing project area has been broken up into five (5) catchments that drain the impervious areas to Falls River and one (1) catchment that drains to Flat River. The catchment areas were determined based on the topography shown on a USGS contour map of the area, the ground survey, field reconnaissance, and aerial photographs.

The existing project drainage area consists of 0.1 acres of impervious area (bridge, gravel roadway and gravel parking areas) draining to Falls River and 0.09 acres draining to Flat River.
Soil Conditions

The project area is comprised of soil group A and C, as defined by the Natural Resources Soil Conservation Service (NRCS), Soils Survey. Table 1, Soil Groups, lists the soil types.

### Table 1

#### Soil Groups

<table>
<thead>
<tr>
<th>SOIL DESCRIPTION</th>
<th>SOIL GROUP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soils in this group have low runoff potential when thoroughly wet. Water is transmitted freely through the soil. Group A soils typically have less than 10 percent clay and more than 90 percent sand or gravel and have gravel or sand textures. Some soils having loamy sand, sandy loam loam or silt loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments. The limits on the diagnostic characteristics of group A are as follows. The saturated hydraulic conductivity of all soil layers exceeds 40.0 micrometers per second (5.67 inches per hour). The depth to any water impermeable layer is greater than 50 centimeters [20 inches]. The depth to the water table is greater than 60 centimeters [24 inches]. Soils that are deeper than 100 centimeters [40 inches] to a water impermeable layer in group A if the saturated hydraulic conductivity of all soil layers within 100 centimeters [40 inches] of the surface exceeds 10 micrometers per second (1.42 inches per hour).</td>
<td>A</td>
</tr>
<tr>
<td>Soils in this group have moderately low runoff potential when thoroughly wet. Water transmission through the soil is unimpeded. Group B soils typically have between 10 percent and 20 percent clay and 50 percent to 90 percent sand and have loamy sand or sandy loam textures. Some soils having loam, silt loam, silt, or sandy clay loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments. The limits on the diagnostic characteristics of group B are as follows. The saturated hydraulic conductivity in the least transmissive layer between the surface and 50 centimeters [20 inches] ranges from 10.0 micrometers per second (1.42 inches per hour) to 40.0 micrometers per second (5.67 inches per hour). The depth to any water impermeable layer is greater than 50 centimeters [20 inches]. The depth to the water table is greater than 60 centimeters [24 inches]. Soils that are deeper than 100 centimeters [40 inches] to a water impermeable layer or water table are in group B if the saturated hydraulic conductivity of all soil layers within 100 centimeters [40 inches] of the surface exceeds 4.0 micrometers per second (0.57 inches per hour) but is less than 10.0 micrometers per second (1.42 inches per hour).</td>
<td>B</td>
</tr>
<tr>
<td>Soils in this group have moderately high runoff potential when thoroughly wet. Water transmission through the soil is somewhat restricted. Group C soils typically have between 20 percent and 40 percent clay and less than 50 percent sand and have loam, silt loam, sandy clay loam, clay loam, and silty clay loam textures. Some soils having clay, silty clay, or sandy clay textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments. The limits on the diagnostic physical characteristics of group C are as follows. The saturated hydraulic conductivity in the least transmissive layer between the surface and 50 centimeters [20 inches] is less than 4.0 micrometers per second (0.57 inches per hour).</td>
<td>C</td>
</tr>
</tbody>
</table>
Surface and 50 centimeters [20 inches] is between 1.0 micrometers per second (0.14 inches per hour) and 10.0 micrometers per second (1.42 inches per hour). The depth to any water impermeable layer is greater than 50 centimeters [20 inches]. The depth to the water table is greater than 60 centimeters [24 inches]. Soils that are deeper than 100 centimeters [40 inches] to a restriction or water table are in group C if the saturated hydraulic conductivity of all soil layers within 100 centimeters [40 inches] of the surface exceeds 0.40 micrometers per second (0.06 inches per hour) but is less than 4.0 micrometers per second (0.57 inches per hour).

Dual hydrologic soil groups—Certain wet soils are placed in group D based solely on the presence of a water table within 60 centimeters [24 inches] of the surface even though the saturated hydraulic conductivity may be favorable for water transmission. If these soils can be adequately drained, then they are assigned to dual hydrologic soil groups (A/D, B/D, and C/D) based on their saturated hydraulic conductivity and the water table depth when drained. The first letter applies to the drained condition and the second to the undrained condition. For the purpose of hydrologic soil group, adequately drained means that the seasonal high water table is kept at least 60 centimeters [24 inches] below the surface in a soil where it would be higher in a natural state.

Soils in this group have high runoff potential when thoroughly wet. Water movement through the soil is restricted or very restricted. Group D soils typically have greater than 40 percent clay, less than 50 percent sand, and have clayey textures. In some areas, they also have high shrink-swell potential. All soils with a depth to a water impermeable layer less than 50 centimeters [20 inches] and all soils with a water table

Source: Natural Resources Conservation Service (NRCS) Part 630 Hydrology
Proposed Conditions

Description of Contributing Areas

The proposed redevelopment project provides minor adjustments to the horizontal alignment. The vertical alignment raises Barber Road Bridge approximately 1’. The roadway approaches match back to existing ground within 133’ on the west approach to Midway Bridge. The east approach to Midway Bridge is approximately 28’ from the Midway Trail intersection. The proposed Vertical alignment on Midway Trail will be raised approximately 2’ to match to the proposed bridge elevation on Barber Road.

The existing roadway approaches are widened to be 17ft wide with new gravel borrow wearing surface within the traveled ways. Barber Road approach typical section is a fill section, an additional 3.1’ wide panel width is added only where timber guardrail is proposed just off of the bridge. Midway Trial is a fill typical section. The proposed roadway layout closely matches the existing roadway width and overall layout. The only minor change is the intersection grading which results in approximately 700 sf of additional roadway impervious area runoff shedding to the Flat River watershed. There will be some minor re-grading and shaping of the existing parking area on Midway Trail. The elevation of the parking area will increase by approximately 1.7’ in elevation. This is due to the change in proposed vertical alignments on Barber Road and Midway Trail. All walking paths will match the existing layout.

The project area has been broken up into 6 catchments that drain the proposed impervious areas to Falls River and one (1) catchment that drains to Flat River. The catchment areas were determined based on the proposed bridge, roadway approach and parking area design and the topography shown on a USGS contour map of the area.

There are 0.11 acres of proposed impervious area that drain to Falls River in the proposed condition and 0.10 acres that drain to the Flat River watershed.
Methodology & Design Criteria

The following section summarizes the design parameters and constraints that were used during the storm water review.

Hydrologic Criteria

The proposed project’s stormwater runoff impacts were analyzed using the Rational Method. The project proposed impacts were analyzed by comparing the existing condition (pre) 2-year, 10-year, and 100-year storm events and proposed condition (post) 2-year, 10-year and 100 year storm events.

Design Storms

The proposed stormwater impacts for the 2yr, 10yr and 100-year design storm events were analyzed. These rainfall events are based on a 24hr-duration for Washington County, RI, see RI Stormwater Design and Installations Standards Manual (SM) Table 3-1 for rainfall intensities.

Runoff Coefficient

Runoff coefficients (c) for each roadway catchment were chosen based on the different land uses, hydrologic soil groups and terrain slopes found within each catchment area. The following (c) values were used for this storm water review.

- Bridge Deck Area: 0.95
- Gravel Borrow Roadway Approaches: 0.70
- Gravel Borrow Parking areas: 0.70

Time of Concentration / Duration

Times of concentrations / storm durations were based on a type III rainfall distribution. 24 hour rainfall amounts were based on Table 3-1 of the SM. The project is located within Washington County. The most distant point of the catchments is within 200’ of the Falls River.
5

Conclusion

The overall scope of work for the Midway Bridge replacement project is very limited. The project is limited to 481’ in horizontal alignment and 0.2 acres of impervious area. There is a decrease in impervious area draining to Falls River between the existing and proposed conditions. The resulting change in runoff of impervious area to Falls River is not measurable because the change in resulting pre and post areas is negligible.

There is a 700 SF increase in impervious area draining to the Flat River watershed. This results in an increase of 0.1cfs in the 100 year storm event. This minor increase in flow is negligible and has no impact on the surrounding area.

Given the rather small difference in impervious areas, the resulting increase in storm water runoff for the different storm events there is no measurable impact of storm water runoff.

Recharge and water quality volumes were computed for this bridge replacement project based on the roadway and bridge impervious areas. The project is located in a low traffic volume area on gravel borrow roads with minimal increase to existing gravel borrow travel ways and existing drainage patterns remaining intact. Given the rather minor impacts of this reconstruction project no structural BMP’s are proposed for this project. Two QPA’s (Qualifying Pervious Areas) have been located to the north side of Midway Trail Road. These areas are outside of the construction limits and the existing condition will not be impacted. These areas treat 52% of the proposed impervious area.
Appendix A
Hydrologic Calculations

- Hydrologic Calculations
## DRAINAGE CALCULATIONS

**Midway River Bridge / Barber Road / Midway Trail**

### Pre-Development - 2 Year Event

<table>
<thead>
<tr>
<th>Catchment</th>
<th>Runoff Coefficient</th>
<th>Intensity (in/hr)</th>
<th>Area (sf)</th>
<th>Area (acres)</th>
<th>Peak Rate Runoff (cfs)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Falls River</td>
<td>E-1</td>
<td>0.70</td>
<td>3.3</td>
<td>1218.71</td>
<td>0.028</td>
<td>0.06 Gravel Roadway</td>
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<tr>
<td>Falls River</td>
<td>E-2</td>
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<td>Falls River</td>
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<td>3.3</td>
<td>1230.08</td>
<td>0.028</td>
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<td>3.3</td>
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<td>3.3</td>
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<th>Area (acres)</th>
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<th>Area (sf)</th>
<th>Area (acres)</th>
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## DRAINAGE CALCULATIONS

### Title:
Pre & Post Development Peak Run-Off Comparison of Impervious Areas

<table>
<thead>
<tr>
<th>Midway River Bridge / Barber Road / Midway Trail</th>
<th>Runoff Coefficient</th>
<th>Intensity (in/hr)</th>
<th>Area (sf)</th>
<th>Area (acres)</th>
<th>Peak Rate Runoff (cfs)</th>
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Wood River Peak Runoff Delta 2-Year: 0.0 cfs
Wood River Peak Runoff Delta 10-Year: 0.0 cfs
Wood River Peak Runoff Delta 100-Year: 0.0 cfs
Flat River Peak Runoff Delta 2-Year: 0.0 cfs
Flat River Peak Runoff Delta 10-Year: 0.1 cfs
Flat River Peak Runoff Delta 100-Year: 0.1 cfs
Recharge

\[ R_{ew} = 1'' \frac{(F)(I)}{12} \]

\[ HSD = A + C \]

- \( F_a = 0.60 \) West Side of Bridge and Midway Trail
- \( F_c = 0.25 \) East Side of Bridge

\[ \text{West} = W \quad \text{East} = E \quad \text{Midway Trail/Flat River} = M \]

\[ I_w = 0.05 A = (P-1)(P-2) \]
\[ I_e = 0.06 A = (P-3)(P-4)(P-5)(P-6) \]
\[ I_m = 0.10 A = P-7 \]

\[ R_{ew} = 1'' \frac{(0.60)(0.05)}{12} = 0.0025 \text{ Ac-FT} = 169 \text{ CF} \]

\[ R_{e} = 1'' \frac{(0.25)(0.06)}{12} = 0.0013 \text{ Ac-FT} = 55 \text{ CF} \]

\[ R_{m} = 1'' \frac{(0.60)(0.10)}{12} = 0.0050 \text{ Ac-FT} = 210 \text{ CF} \]

Water Quality

\[ WQ = \frac{(1'')(I)}{12} \]

\[ WQ_w = \frac{(1'')(0.05)}{12} = 0.0042 \text{ Ac-FT} = 182 \text{ CF} \]
\[ WQ_e = \frac{(1'')(0.06)}{12} = 0.0050 \text{ Ac-FT} = 210 \text{ CF} \]
\[ WQ_m = \frac{(1'')(0.10)}{12} = 0.0083 \text{ Ac-FT} = 363 \text{ CF} \]
Midway Trail  Sta. 300+00 - 301+11.6 LT  HSG = A
- Proposed storm run-off sheets from center of Barber Rd + Midway Trail LT.
- QPA Length = (301+11.6) - (300+00) = 112' +
  QPA Width = 28' (width of parking area)

Sta. 301+11.6 - 302+15.9 LT
QPA Length = 105',
QPA Width = 28',

\[ Re_a = (F)/(I) \]
\[ I = I_w + I_F + I_a = 0.21A \]
\[ (F) = 0.60 \]
\[ Re_a = 0.126 A \]

\[ QPA = 1963.2 \text{ ft}^2 + 2556.6 \text{ ft}^2 = 4519.8 \text{ ft}^2 \]
\[ = 0.11' A \]

Redevelopment Area = 0.21A
QPA Area = 0.11

Recharge/Water Quality % Treated = 52%
\[ CN = \frac{1000}{\left[ 10 + 5P + 10Q - 10 (Q^2 + 1.25QP)^{\frac{1}{2}} \right]} \]

\[ P = 1.2 \text{ in} \]

\[ Q_{w} = \frac{0.0092 \text{ AC-FT}}{0.05 \text{ A} \times 12\text{"}} = 1" \]

\[ Q_{E} = \frac{0.0050 \text{ AC-FT}}{0.06 \text{ A} \times 12\text{"}} = 1" \]

\[ Q_{m} = \frac{0.0083 \text{ AC-FT}}{0.10 \text{ A} \times 12\text{"}} = 1" \]

\[ CN = 98.1 \]

\[ I_{q} = \frac{200}{98.1} - 2 = 0.04 \]

\[ I_{q}/P = 0.033 \]

\[ q_{u} = 5.75 \text{ cfs/ni}^{2\text{"}} \text{ in} \]

\[ WQ_{w} = (575) (0.0000785 \text{ in}) (1") = 0.05 \text{ cfs} \]

\[ WQ_{E} = (575) (0.000094 \text{ in}) (1") = 0.06 \text{ cfs} \]

\[ WQ_{m} = (575) (0.000156 \text{ in}) (1") = 0.09 \text{ cfs} \]
Appendix B
Stormwater Management Checklist

- Checklist RI Stormwater Design and Installations Standards Manual (Appendix A)
The first thing that applicants and designers must do before beginning a project is to make sure they are familiar with the 11 minimum standards listed in Manual Chapter Three, as projects must meet all 11 standards. Next, designers should review the available LID site planning and design strategies and BMPs in Manual Chapters Four through Seven to determine which would work best at their site. This checklist serves as a guide for engineers and designers to refer to during all stages of a project to ensure that they are meeting all applicable requirements. In addition, designers must include a completed checklist with their final stormwater management plan.

A.1 CHECKLIST FOR STORMWATER MANAGEMENT PLAN PREPARATION AND REVIEW

A.1.1 General Information

- [ ] Applicant name, mailing address, and telephone number
- [✓] Contact information for the licensed professional(s) responsible for site plans and stormwater management plan
- [ ] Common address and legal description of project site
- [✓] Vicinity map
- [✓] Existing zoning and land use at the project site
- [✓] Proposed land use – indicate if land use meets definition of a LUHPPL (see Manual Table 3-2)
- [✓] General Project Narrative
- [✓] Project type (new development or redevelopment)

A.1.2 Existing and Proposed Mapping and Plans

- [✓] Existing and proposed mapping and plans (scale not greater than 1” = 40’) with North arrow that illustrate at a minimum:
  - [✓] Existing and proposed site topography (2-foot contours required). 10-foot contours accepted for off-site areas.
  - [✓] Existing and proposed drainage area delineations and drainage flow paths, mapped according to the DEM Guidance for Preparation of Drainage Area Maps (included in Appendix K). Drainage area boundaries need to be complete; include off-site areas in both mapping and analyses, as applicable.
  - [✓] Perennial and intermittent streams, in addition to areas subject to storm flowage (ASSFs)
Mapping of predominant soils from USDA soil surveys, especially hydric soil groups as well as location of site-specific borings and/or test pits (on drainage area maps only – not site plans)

Boundaries of existing predominant vegetation and proposed limits of clearing

Location and field-verified boundaries of resource protection areas such as freshwater and coastal wetlands, lakes, ponds, coastal shoreline features and required setbacks (e.g., buffers, water supply wells, septic systems)

Location of floodplain and, if applicable, floodway limits and relationship of site to upstream and downstream properties and drainages

Location of existing and proposed roads, buildings, and other structures including limits of disturbance

Existing and proposed utilities (e.g., water, sewer, gas, electric) and easements

Location of existing and proposed conveyance systems such as grass channels, swales, and storm drains

Location and dimensions of channel modifications, such as bridge or culvert crossings

Location, size, and limits of proposed LID planning and site design techniques (type of practice, depth, area). LID techniques should be labeled clearly on the plan and a key should be provided that corresponds to a tabular description.

Location, size, and limits of disturbance of proposed stormwater treatment practices (type of practice, depth, area). Stormwater treatment practices (BMPs) should be labeled with numbers that correspond to the table in Section A.1.5.

Soils information from test pits or borings at the location of proposed stormwater management facilities, including but not limited to soil descriptions, depth to seasonal high groundwater, depth to bedrock, and estimated hydraulic conductivity. Soils information will be based on site test pits or borings logged by a DEM-licensed Class IV soil evaluator or RI-registered PE.

8.5 x 11 inch copy of site plan for public notice, as applicable.

A.1.3 Minimum Stormwater Management Standards

Minimum Standard 1: LID Site Planning and Design Strategies

Document specific LID site planning and design strategies and associated methods that were employed for the project in the following table:
# LID Site Planning and Design Checklist

The applicant must document specific LID site planning and design strategies applied for the project (see Manual Chapter Four and the *RI Community LID Guidance Manual* for more details regarding each strategy). If a particular strategy was not used, a justification and description of proposed alternatives must be provided. If a strategy is not applicable (N/A), applicants must describe why a certain method is not applicable at their site. For example, preserving wetland buffers may be not applicable for sites located outside any jurisdictional wetland buffers. In communities where conservation development or other low-impact development site planning and design processes exist, following the local community conservation development option may help a project achieve this standard.

## 1. Strategies to Avoid the Impacts

### A. Preservation of Undisturbed Areas

- [ ] Not Applied or N/A. *Use space below to explain why:*

  **Select from the following list:**
  - [x] Limits of disturbance clearly marked on all construction plans.
  - [x] Mapped soils by Hydrologic Soil Group (HSG).
  - [ ] Building envelopes avoid steep slopes, forest stands, riparian corridors, HSG D soils, and floodplains.
  - [x] New lots, to the extent practicable, have been kept out of freshwater and coastal wetland jurisdictional areas.
  - [x] Important natural areas (i.e., undisturbed forest, riparian corridors, and wetlands) identified and protected with permanent conservation easement.
  - [ ] Percent of natural open space calculation is provided.
  - [ ] Other (describe):

  **Explain constraints when a strategy is applied and/or proposed alternatives in space below:**

  Midway bridge is located within the floodplain and HSG A and C soils.

  Project is a reconstruction and does not impact open space.

### B. Preservation of Buffers and Floodplains

- [ ] Not Applied or N/A. *Use space below to explain why:*

  **Select from the following:**
  - [x] Applicable vegetated buffers of coastal and freshwater wetlands and perennial and intermittent streams have been preserved, where possible.
  - [x] Limits of disturbance included on all construction plans that protect applicable buffers
  - [ ] Other (describe):

  **Explain constraints and/or proposed alternatives in space below:**

  ______________________________________________________________
  ______________________________________________________________
  ______________________________________________________________
  ______________________________________________________________
## LID Site Planning and Design Checklist

### C. Minimized Clearing and Grading

- Not Applied or N/A. *Use space below to explain why:*

  **Select from the following list:**
  - Site fingerprinting to extent needed for building footprints, construction access and safety (i.e., clearing and grading limited to 15 feet beyond building pad or 5 feet beyond road bed/shoulder).
  - Other (describe):

  **Explain constraints and/or proposed alternatives in space below:**
  
  Proposed fill slopes shown on plan, along with ditch lines and roadway, bridge, parking layout and stone slopes under bridge.

  _______________________________________________________________________
  _______________________________________________________________________
  _______________________________________________________________________
  _______________________________________________________________________

### D. Locating Sites in Less Sensitive Areas

- Not Applied or N/A. *Use space below to explain why:*

  **Select from the following list:**
  - A site design process, such as conservation development, used to avoid or minimize impacts to sensitive resources such as floodplains, steep slopes, erodible soils, wetlands, hydric soils, surface waters, and their riparian buffers.
  - Development located in areas with least hydrologic value (e.g., soil groups A and B)
  - Development on steep slopes, grading and flattening of ridges has been avoided to the maximum extent practicable.
  - Other (describe):

  **Explain constraints and/or proposed alternatives in space below:**
  
  Bridge, Roadway and parking areas replace existing infrastructure.

  _______________________________________________________________________
  _______________________________________________________________________
  _______________________________________________________________________
  _______________________________________________________________________

### E. Compact Development

- Not Applied or N/A. *Use space below to explain why:*

  **Select from the following list:**
  - A site design technique (e.g., conservation development) used to concentrate development to preserve as much undisturbed open space as practicable and reduce impervious cover.
  - Reduced setbacks, frontages, and right-of-way widths have been used where practicable.
  - Other (describe):

  **Explain constraints and/or proposed alternatives in space below:**
  
  Reconstruction project, impact minimized as much as reasonably possible.

  _______________________________________________________________________
  _______________________________________________________________________
  _______________________________________________________________________
  _______________________________________________________________________

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**APPENDIX A  STORMWATER MANAGEMENT CHECKLIST**

A-4
# LID Site Planning and Design Checklist

## F. Work with the Natural Landscape Conditions, Hydrology, and Soils

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Not Applied or N/A. <strong>Use space below to explain why:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Select from the following list:</strong></td>
<td></td>
</tr>
<tr>
<td>☑ Stormwater management system mimics pre-development hydrology to retain and attenuate runoff in upland areas (e.g., cuts and fills limited and BMPs distributed throughout site; trees used for interception and uptake).</td>
<td></td>
</tr>
<tr>
<td>☑ The post-development time of concentration (t_c) should approximate pre-development t_c.</td>
<td></td>
</tr>
<tr>
<td>☑ Flow velocity in graded areas as low as practicable to avoid soil erosion (i.e., slope grade minimized). Velocities shall not exceed velocities in Appendix B, Table B-2.</td>
<td></td>
</tr>
<tr>
<td>☑ Plans show measures to prevent soil compaction in areas designated as Qualified Pervious Areas (QPAs) for better infiltration.</td>
<td></td>
</tr>
<tr>
<td>☑ Site designed to locate buildings, roadways and parking to minimize grading (cut and fill quantities)</td>
<td></td>
</tr>
<tr>
<td>☐ Other (describe):</td>
<td></td>
</tr>
</tbody>
</table>

**Explain constraints and/or proposed alternatives in space below:**

_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________

## 2. Strategies to Reduce the Impacts

### Reduce Impervious Cover

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Not Applied or N/A. <strong>Use space below to explain why:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Select from the following list:</strong></td>
<td></td>
</tr>
<tr>
<td>☑ Reduced roadway widths</td>
<td>☑ Reduce driveway areas</td>
</tr>
<tr>
<td>☐ Reduced sidewalk area</td>
<td>☑ Reduced cul-de-sacs</td>
</tr>
<tr>
<td>☐ Other (describe):</td>
<td></td>
</tr>
</tbody>
</table>

**Explain constraints and/or proposed alternatives in space below:**

_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________

## 3. Strategies to Manage the Impacts

### A. Disconnecting Impervious Area

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Not Applied or N/A. <strong>Use space below to explain why:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Select from the following list:</strong></td>
<td></td>
</tr>
<tr>
<td>☐ Impervious surfaces have been disconnected to QPAs to the extent possible.</td>
<td></td>
</tr>
<tr>
<td>☑ Other (describe):</td>
<td></td>
</tr>
</tbody>
</table>

**Explain constraints and/or proposed alternatives in space below:**

Gravel borrow roadway surface will sheet flow across grassed side slopes to existing drainage patterns. This matches the existing conditions.
### LID Site Planning and Design Checklist

#### B. Mitigation of Runoff at the point of generation

- Not Applied or N/A. Use space below to explain why:

Select from the following list:

- Roof runoff has been directed to a QPA, such as a yard or vegetated area.
- Roof runoff has been directed to a lower impact practice such as a rain barrel or cistern.
- A green roof has been designed to reduce runoff.
- Small-scale BMPs applied at source.
- Other (describe):

*Explain constraints and/or proposed alternatives in space below:*

- Project is a reconstruction with minimal impact.
- Wetlands are located within all four quadrants of construction.

#### C. Stream/Wetland Restoration

- Not Applied or N/A. Use space below to explain why:

Select from the following list:

- Historic drainage patterns have been restored by removing closed drainage systems and/or restoring degraded stream channels and/or wetlands.
- Removal of invasive species.
- Other (describe):

*Explain constraints and/or proposed alternatives in space below:*

- Existing stream patterns unchanged.

#### D. Reforestation

- Not Applied or N/A. Use space below to explain why:

Select from the following list:

- Low maintenance, native vegetation has been proposed.
- Trees are proposed to be planted or conserved to reduce runoff volume, increase nutrient uptake, and provide shading and habitat.
- Other (describe):

*Explain constraints and/or proposed alternatives in space below:*

- Reconstructing the existing bridge and roadway, minimal site clearing required.

#### E. Source Control

- Not Applied or N/A. Use space below to explain why:

Select from the following list:

- Source control techniques such as street sweeping or pet waste management have been proposed.
- Other (describe):

*Explain constraints and/or proposed alternatives in space below:*

- Gravel borrow roadway in a low volume recreational area.
- Minimal pollutants and there are no paved area or closed drainage systems in this location.
Minimum Standard 2: Groundwater Recharge

Demonstrate that groundwater recharge criteria for the site have been met. Include:

- The required recharge volume \((R_{e,v})\) in acre-feet (See Manual Section 3.3.2)
- LID Stormwater Credit from Checklist Section A.1.4 to be applied to recharge requirement, if applicable, with the following calculations (See Manual Section 4.6.1):
  - the recharge area \((R_{e,a})\) in acres for the site
  - the site impervious area draining to QPAs
  - the new \(R_{e,v}\) requirement
- Specific BMPs from Checklist Section A.1.5 that will be used to meet the recharge requirement. Note: Only BMPs listed in Manual Table 3-5, List of BMPs Acceptable for Recharge may be used to meet the recharge requirement.

Minimum Standard 3: Water Quality

Demonstrate that the water quality criteria for the site have been met. Include:

- Required water quality volume \((WQ_{v})\) in acre-feet or \(ft^3\) (see Manual Section 3.3.3).
- LID Stormwater Credit from Checklist Section A.1.4 to be applied to water quality requirement, if applicable, with the following calculations (see Manual Section 4.6.1):
  - the new impervious area (in acres) for the site
  - the new \(WQ_{v}\) in acre-feet or \(ft^3\)
- Specific BMPs from Checklist Section A.1.5 that will be used to meet water quality volume requirement. Note: Only BMPs listed in Manual Table 3-6, Acceptable BMPs for Water Quality Treatment may be used to meet the water quality requirement.
- Specify any additional pollutant-specific requirements and/or pollutant removal efficiencies applicable to the site as the result of SAMP, TMDL, or other watershed-specific requirements.

Minimum Standard 4: Conveyance and Natural Channel Protection

Demonstrate that the conveyance and natural channel protection criteria for the site have been met. Include:

- Justification for channel protection criterion waiver, if applicable (see Manual Section 3.3.4).
- Required channel protection volume \((CP_{v})\) (see Manual Section 3.3.4).
- Specific BMPs from Checklist Section A.1.5 that will be used to meet the channel protection requirement. Hydrologic and hydraulic site evaluation as described in Manual Section 3.3.4 should be included in Checklist Section A.1.5 for each channel protection BMP.
Minimum Standard 5: Overbank Flood Protection
Demonstrate that the overbank flood protection criteria for the site have been met. Include:

- Justification for overbank flood protection criterion waiver, if applicable (see Manual Section 3.3.5).
- Pre- and post-development peak discharge rates.
- Specific BMPs from Checklist Section A.1.5 that will be used to meet the overbank flood protection requirement. Hydrologic and hydraulic site evaluation as described in Manual Section 3.3.4 should be included in Checklist Section A.1.5 for each overbank flood protection BMP.

Minimum Standard 6: Redevelopment and Infill Projects
Demonstrate that criteria for redevelopment and/or infill projects have been met, if applicable. Include:

- Description of site that meets redevelopment/infill definition.
- Approved off-site location within watershed where stormwater management requirements will be met, if applicable (see Manual Section 3.2.6).

- Not Applicable.

Minimum Standard 7: Pollution Prevention
Demonstrate that the project meets the criteria for pollution prevention. Include:

- Stormwater pollution prevention plan

Minimum Standard 8: LUHPPLs
Demonstrate that the project meets the criteria for LUHPPLs, if applicable. Include:

- Description of any land use activities considered stormwater LUHPPL (see Manual Table 3-2).
- Specific BMPs listed in Checklist Section A.1.5 that receive stormwater from LUHPPL drainage areas. These BMP types must be listed in Manual Table 3-3, “Acceptable BMPs for Use at LUHPPLs.”
- Additional BMPs, if any, that meet RIPDES MSGP requirements.

- Not Applicable.

Minimum Standard 9: Illicit Discharges
Applicant asserts that no illicit discharges exist or are proposed to the stormwater management system in accordance with State regulations.
Minimum Standard 10: Construction Erosion and Sedimentation Control

Demonstrate that ESC practices will be used during the construction phase and land disturbing activities. Include:

- Description of temporary sediment trapping and conveyance practices, including sizing calculations and method of temporary and permanent stabilization (see Manual Section 3.2.9 and the Rhode Island Soil Erosion and Sediment Control Handbook).

- Description of sequence of construction. Activities should be phased to avoid compacting soil during construction, particularly in the location of infiltrating stormwater practices and qualifying pervious areas for stormwater credits.

- Location of construction staging and material stockpiling areas.

Minimum Standard 11: Stormwater Management System Operation and Maintenance

Provide a stormwater management system operation and maintenance plan that at a minimum includes:

- Name, address, and phone number of responsible parties for maintenance

- Description of annual maintenance tasks

- Description of applicable easements

- Description of funding source

- Minimum vegetative cover requirements

- Access and safety issues

A.1.4 LID Stormwater Credit

Description of stormwater credit, if applicable. Label qualifying pervious areas (QPAs) on the site map, and document that all stormwater credit requirements listed in Section 4.6 are met. For each QPA, note the impervious area (in acres) that drains to it, and place a check in the appropriate box to demonstrate that it meets the following criteria:

<table>
<thead>
<tr>
<th>QPA</th>
<th>QPA 1</th>
<th>QPA 2</th>
<th>QPA 3</th>
<th>QPA 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impervious Area Draining to QPA (acres)</td>
<td>0.045A</td>
<td>0.059A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>QPA Criteria</th>
<th>Criterion Met?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction vehicles shall not be allowed to drive over the QPA during construction. If the area becomes compacted, soil must be suitably amended, tilled, and revegetated once construction is complete to restore infiltration capacity.</td>
<td>X   X</td>
</tr>
<tr>
<td>QPA infiltration area is at least 10ft from building foundation.</td>
<td></td>
</tr>
<tr>
<td>QPA 1</td>
<td>QPA 2</td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>Contributing impervious area does not exceed 1,000 ft².</td>
<td></td>
</tr>
<tr>
<td>Length of QPA in feet is equal to or greater than the contributing rooftop area in ft² divided by 13.3. The maximum contributing flow path from non-rooftop impervious areas is 75ft.</td>
<td>X</td>
</tr>
<tr>
<td>QPA does not overlap any other QPA.</td>
<td></td>
</tr>
<tr>
<td>Lot is greater than 6,000 ft².</td>
<td></td>
</tr>
<tr>
<td>The slope of the QPA is less than or equal to 5.0%.</td>
<td>X</td>
</tr>
<tr>
<td>Disconnected downspouts draining to QPA are at least 10 feet away from the nearest impervious surface.</td>
<td></td>
</tr>
<tr>
<td>Runoff from rooftops without gutters / downspouts that drains to QPA flows away from the structure as low-velocity sheet flow.</td>
<td></td>
</tr>
<tr>
<td>QPA is located on Hydrologic Soil Group (HSG) A or B soils.</td>
<td>X</td>
</tr>
<tr>
<td>Depth to groundwater within QPA is 18 inches or greater (has been confirmed by evaluation by a DEM-licensed Class IV soil evaluator or RI-registered PE).</td>
<td></td>
</tr>
<tr>
<td>Runoff is directed over soft shoulders, through curb cuts or level spreaders to QPA.</td>
<td>X</td>
</tr>
<tr>
<td>Measures are employed at discharge point to prevent erosion and promote sheet flow.</td>
<td>X</td>
</tr>
<tr>
<td>The flow path through the QPA complies with the setback requirements for structural infiltration BMPs.</td>
<td>X</td>
</tr>
<tr>
<td>Rooftop runoff draining to QPA from LUHPPLs does not commingle with runoff from any paved surface or areas that may generate higher pollutant loads</td>
<td></td>
</tr>
<tr>
<td>Inspection and maintenance of the QPA is included in the site Operation and Maintenance Plan (Minimum Standard 11).</td>
<td>X</td>
</tr>
<tr>
<td>The QPA is owned or controlled by the property owner</td>
<td>X</td>
</tr>
<tr>
<td>There is no history of groundwater seepage and / or basement flooding on the property</td>
<td></td>
</tr>
</tbody>
</table>
A.1.5 Best Management Practices

Provide detailed information for all structural stormwater best management practices (BMPs) to be implemented. *Note: If a BMP cannot meet the required design criteria in Manual Chapters Five, Six, and Seven, a different BMP should be considered.*

Fill in the following table to document which proposed practices meet which requirement(s). Number each BMP and label them accordingly on the site map:

<table>
<thead>
<tr>
<th>BMP No.</th>
<th>Type of BMP</th>
<th>Check the function provided by the BMP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Pretreatment Re, WQ, CP, Qp</td>
</tr>
</tbody>
</table>

In addition, for all structural components of stormwater system (e.g., storm drains, open channels, swales, stormwater BMPs, etc.) provide the following, if applicable:

- Hydrologic and hydraulic analysis, including:
  - Study design/analysis points. The existing and proposed condition analyses need to compare the same overall area; thus, common study points are needed for both existing and proposed conditions.
Existing condition analysis for drainage area boundaries, curve numbers, times of concentration, runoff rates, volumes, velocities, and water surface elevations showing methodologies used and supporting calculations.

Proposed condition analysis for drainage area boundaries, curve numbers, times of concentration, runoff rates, volumes, velocities, water surface elevations, and routing showing the methodologies used and supporting calculations.

Downstream Analysis, where required (see Manual Section 3.3.6).

Final sizing calculations for structural stormwater BMPs including, contributing drainage area, storage, and outlet configuration.

Stage-discharge or outlet rating curves and inflow and outflow hydrographs for storage facilities (e.g., detention, retention, or infiltration facilities).

Dam breach analysis, where necessary, for earthen embankments over six (6) feet in height, or a capacity of 15 acre-feet or more, and that is a significant or high hazard dam.

Drainage Area Maps prepared in accordance with DEM’s Guidance for Preparation of Drainage Area Maps (included in Appendix K).

Representative cross-section and profile drawings, notes and details of structural stormwater management practices and conveyances (i.e., storm drains, open channels, swales, etc.), which include:

- Locations, cross sections, and profiles of all streams and drainage swales and their method of stabilization.

- Existing and proposed structural elevations (e.g., invert of pipes, manholes, etc.).

- Design water surface elevations.

- Structural details of outlet structures, embankments, spillways, stilling basins, grade control structures, conveyance channels, etc.

- Logs of borings and/or test pit investigations along with supporting soils/geotechnical report.

Planting plans for structural stormwater BMPs, including:

- Species, size, planting methods, and maintenance requirements of proposed planting.

Structural calculations, where necessary.

Applicable construction specifications.

Identification of all anticipated applicable local and State permits.

Identification of all anticipated legal agreements related to stormwater (e.g., off-site easements, deed restrictions, and covenants).
DEPARTMENT OF TRANSPORTATION
RHODE ISLAND
EXETER, RHODE ISLAND
REPLACEMENT OF DESIGN/BUILD SERVICES FOR MIDWAY BRIDGE EXISTING CONDITIONS

BEGIN PROJECT STA. 200+10.00
R.I. CONTRACT NO. 2011-DB-100
F.A.P. NO. BRD-0784(002)

HSG-A

END PROJECT STA. 2024+64.00
R.I. CONTRACT NO. BRO-DYER(002)
F.A.P. NO. 2011-08-100

HSG-A

GREAT PLANS
SCALE 1" = 100'

EXISITING CONDITIONS