Dams, Bridges and Culverts Assessment Technical Memorandum

Wood-Pawcatuck Watershed Flood Resiliency Management Plan

Wood-Pawcatuck Watershed Association

October 2016

FUSS & O'NEILL

Project No. 20111470.B10

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1 Introduction

Fuss & O'Neill, Inc. was retained by the Wood-Pawcatuck Watershed Association (WPWA) to develop a flood resiliency management plan for the Wood-Pawcatuck watershed. Funding for the project was provided by a National Fish and Wildlife Foundation Hurricane Sandy Coastal Resiliency Competitive Grant awarded to WPWA. The project's overall objectives are to (1) assess the vulnerability of the watershed to the growing risks from flooding, erosion, and associated storm-related threats and (2) develop a watershed-based management plan that will protect and enhance the resiliency of the watershed communities to future flood damages and improve river and stream ecosystems.

An assessment of the hydraulic structures (i.e., dams, bridges, and culverts) in the Wood-Pawcatuck watershed was conducted to evaluate the associated flood risk and identify prioritized recommendations to increase flood resiliency and enhance aquatic habitat and water quality. The assessment of the watershed dams, bridges, and culverts will support the development of the flood resiliency management plan, along with a number of other technical evaluations including a stream geomorphic assessment, wetlands assessment, green infrastructure assessment, and land use regulatory review. This technical memorandum presents the methodology (field work, data collection, and analysis), results, and recommendations of the hydraulic structures assessment.

1.1 Background

The Pawcatuck River and its major tributary, the Wood River, are located in southwestern Rhode Island. The lower Pawcatuck River forms the border between Rhode Island and Connecticut and flows into the eastern end of Long Island Sound at Little Narragansett Bay. The area of land that drains to the Pawcatuck and Wood Rivers – commonly referred to as the "Wood-Pawcatuck watershed" – is approximately 300 square miles and includes several major tributaries (Queen River, Usquepaug River, Chickasheen Brook, Chipuxet River, Ashaway River, Beaver River, Shunock River, and Green Falls Rivers) and portions of 14 communities in Rhode Island and Connecticut (*Figure 1-1*).

The Wood-Pawcatuck watershed, like other areas of the region, has experienced extensive flooding and flood-related damages, with the most recent occurring in the March and April floods of 2010. Communities that were most severely affected by the 2010 flooding include Westerly, Stonington, Charlestown, Hopkinton, Richmond, and Exeter. Flood damages included flooding and washout of roadways, damages to bridges and culverts, damages to and failure of dams, flooding of properties and structures, erosion and sediment deposition in watercourses and wetlands, and transport of sediment and other pollutants downstream to Little Narragansett Bay. Riverine flooding – which occurs when persistent moderate to heavy rain falls over a period of time causing rivers and streams to overflow their banks and flow into the adjacent floodplain – is the most common type of flooding in the Wood-Pawcatuck watershed. Urban drainage flooding is also common in the more urbanized areas of the watershed as a result of outdated and undersized storm drainage systems.

New England is experiencing an unprecedented increase in the frequency of extreme rainfall events compared to other parts of the United States, consistent with climate change projections (Melillo, Richmond, & Yohe, 2014). Extreme rainfall in New England is expected to continue to increase with climate change. The frequencies of peak flows – both extreme events observed above the 90th percentile and lower frequency floods – are likely to increase across the Northeast (Armstrong, Collins, & Snyder, 2012) (Demaria, Palmer, & Roundy, 2016). Given this trend, the communities in the Wood-Pawcatuck watershed face an increasing risk of flooding and storm-related damages as large storms and floods become more common. In addition to climate change, some parts of the watershed are susceptible to future development pressure that, if not appropriately controlled, could increase floodplain encroachments, reduce the natural water-absorbing capacity of the land, increase impervious surfaces and stormwater runoff, and worsen flooding impacts.

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Figure 1-1. Overview map of the Wood-Pawcatuck watershed

Several factors contribute to flooding in the watershed, including a history of development that has reduced natural flood storage and placed populations and infrastructure in flood-prone areas. Undersized stream crossings can also contribute to flooding by restricting flood flows, causing backwater, sediment deposition, bifurcating flow, and sudden formation of new channels upstream of the crossing as well as scour downstream of the crossing. Undersized crossings increase the risk of floods inundating the associated road or railroad and can potentially cause floods to breach through a section of road fill adjacent to the existing channel. Culverts can also serve as barriers to the passage of fish and other aquatic organisms along a river system, altering aquatic habitat and disrupting river and stream continuity.

Dams are artificial barriers designed to impound or retain water for a variety of purposes, including water supply, irrigation, power generation, flood control, recreation and pollution control. Many of the approximately 150 known dams in the Wood-Pawcatuck watershed are relatively small dams built to power small industry mills of the 17th and 18th centuries and are no longer used for their original purpose. Many of the remaining dams in the watershed provide recreational opportunities, aquatic and wildlife habitat, and water supply. None of the dams in the watershed were originally constructed for flood control purposes; the dams therefore provide limited, if any, flood control benefit. The dams in the Wood-Pawcatuck watershed pose upstream flood hazards by backing up water during floods and present a hazard to downstream areas in the event of a breach or failure, potentially releasing large quantities of flow, sediment, and debris. Similar to undersized culverts, dams also restrict the passage of fish and other aquatic organisms. The lower Pawcatuck River has been the focus of dam removal efforts aimed at improving aquatic habitat, river continuity, and fish passage.

1.2 Assessment Objectives

The specific objectives of the bridge, culvert and dam assessment are to (1) assess flood risk associated with hydraulic structures in the watershed, and (2) identify prioritized recommendations to increase flood resiliency and enhance aquatic organism passage and aquatic habitat. Culverts and bridges were assessed relative to hydraulic capacity under current and future (i.e., climate change) conditions, flooding impact potential, geomorphic vulnerability, and aquatic organism passage. Dams were evaluated for failure potential based on existing condition, hazard classification, and a number of other considerations. The assessment includes recommendations for upgrade, repair, or removal of specific hydraulic structures to accomplish these objectives, including relative priorities for implementing the project recommendations.

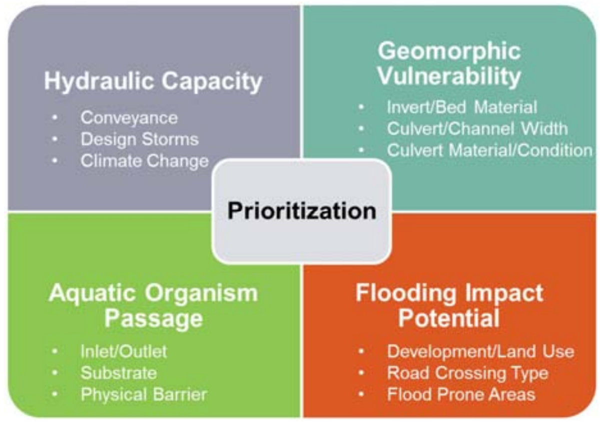
This technical memorandum is organized as follows:

- Section 1 contains an introduction and project background, including a brief description of the flooding issues in the watershed and the assessment objectives.
- Section 2 describes the methods, results and findings/recommendations for the bridges and culverts assessment.
- Section 3 describes the methods, results and findings/recommendations for the dams assessment.

Watershed-wide maps of the assessment results are provided as report figures. More detailed maps of the assessment results for each subwatershed are provided in the appendices. Field data, information obtained from file reviews, and hydrologic and hydraulic analysis documentation (model input and output) are provided in digital format (i.e., databases).

2 Bridges and Culverts Assessment

2.1 Assessment Methods



Bridges and culverts assessment framework.

Bridges and culverts in the Wood-Pawcatuck watershed were initially identified using publically-available GIS mapping. Field inspections and data collection (site characteristics, structure dimensions, upstream and downstream geomorphic conditions, and structure conditions) were conducted at the identified structures following procedures adapted from Vermont's Stream Geomorphic Assessment protocols. Using the information obtained from the field inspections, each structure was then assessed based on four separate but related criteria – hydraulic capacity, geomorphic vulnerability, flooding impact potential, and aquatic organism passage (see graphic at right). An overall rating and priority ranking (high, medium, and low) was assigned to each structure based on the combined assessment results associated with these four criteria. The priority rankings can be used by decision-makers to prioritize the repair and replacement of stream crossing infrastructure to increase flood resiliency and enhance aquatic organism passage.

2.2 Data Collection

2.2.1 Structure Selection

The locations of bridges and culverts in the watershed were initially identified by intersecting roads, rail lines, and developed bike/hiking trails with mapped streams using publically-available geospatial data obtained from the State of Rhode Island Geographic Information System (RIGIS), the Connecticut Department of Energy and Environmental Protection (CTDEEP) Environmental GIS Data Set, and the University of Connecticut Map and Geographic Information Center (MAGIC). The initial set of located structures was augmented by other existing data including structures previously evaluated as part of the Rhode Island Stream Continuity Project and review of aerial imagery of the watershed. Approximately 550 structures were initially identified.

The project Steering Committee requested that the project team inspect 6 driveway culverts in the Chickasheen Brook subwatershed due to known flooding issues. In the field, 20 additional structures were found and inspected. A few additional, previously unmapped culverts were observed at the time of the field inspections, most of which were drainage ditch culverts or structures on small unmapped streams. Evaluation of these smaller structures was beyond the scope of this study.

The final database of bridges and culverts in the watershed consisted of 573 structures (including the 20 structures that were found and inspected in the field). Of the 573 structures, 152 were not inspected for one of the following reasons:

- Location of crossing on a walking trail that could not be found — 38 structures
- No road/stream intersection at mapped location — 18 structures
- Structure not found at mapped location — 16 structures
- No access to private property — 32 structures
- No access to gated areas — 6 structures
- No access to railroad stream crossings — 11 structures
- No access/unsafe site conditions on highways — 18 structures

- No access due to dense thicket/vegetation or other barrier 13 structures

Most of the walking trail stream crossings that could not be field-located are in Voluntown and North Stonington, Connecticut. Many of the private road stream crossings that could not be found are also in the Connecticut portion of the watershed. Structures that could not be inspected due to safety concerns or no physical access are primarily associated with Interstate 95, other major limited-access state routes, and railroads.

The locations of the stream crossing structures are shown in *Figure 2-1.* More detailed subwatershed maps and a table summarizing information on the stream crossing structures are provided in *Appendix A*.

2.2.2 Structure Naming

Each structure was assigned a unique identifier based on its location within the watershed. The structures were named with a three-letter subwatershed code, a three-letter stream code, a one- or two-digit tributary number, and a one- or two-digit structure number. If a structure was located on a tributary of a tributary to a named structure, an additional tributary number was included in its name. Tributary numbers were generally assigned in a clockwise direction from the north. For example, structure LWR-BRU-2-1 is the first structure on the second tributary to Brushy Brook in the Lower Pawcatuck River subwatershed. Structure CPR-CHP-2-1-2 is the second structure on the first tributary to the second tributary to the Chipuxet River in the Chipuxet River subwatershed. Structure BVR-BEA-0-3 is the third structure on the main stem of the Beaver River in the Beaver River subwatershed. The three-letter subwatershed codes and stream codes are provided in *Table 2-1* and *Table 2-2* below.

The 20 found structures were labeled with their watershed code, the word "FOUND," and the date the structure was inspected. For example, structure QUR-FOUND-20150810 was found on August 10, 2015 in the Queen Usquepaug subwatershed.

Table 2-1. Subwatershed codes

Subwatershed	Code
Shunock River	SNR
Wayassup Brook	WPB
Ashaway River	AWR
Lower Wood River	LWR
Upper Wood River	UWR
Beaver River	BVR
Queen Usquepaug River	QUR
Chickasheen Brook	CKR
Chipuxet River	CPR
Upper Pawcatuck River	UPR
Middle Pawcatuck River	MPR
Lower Pawcatuck River	LPR

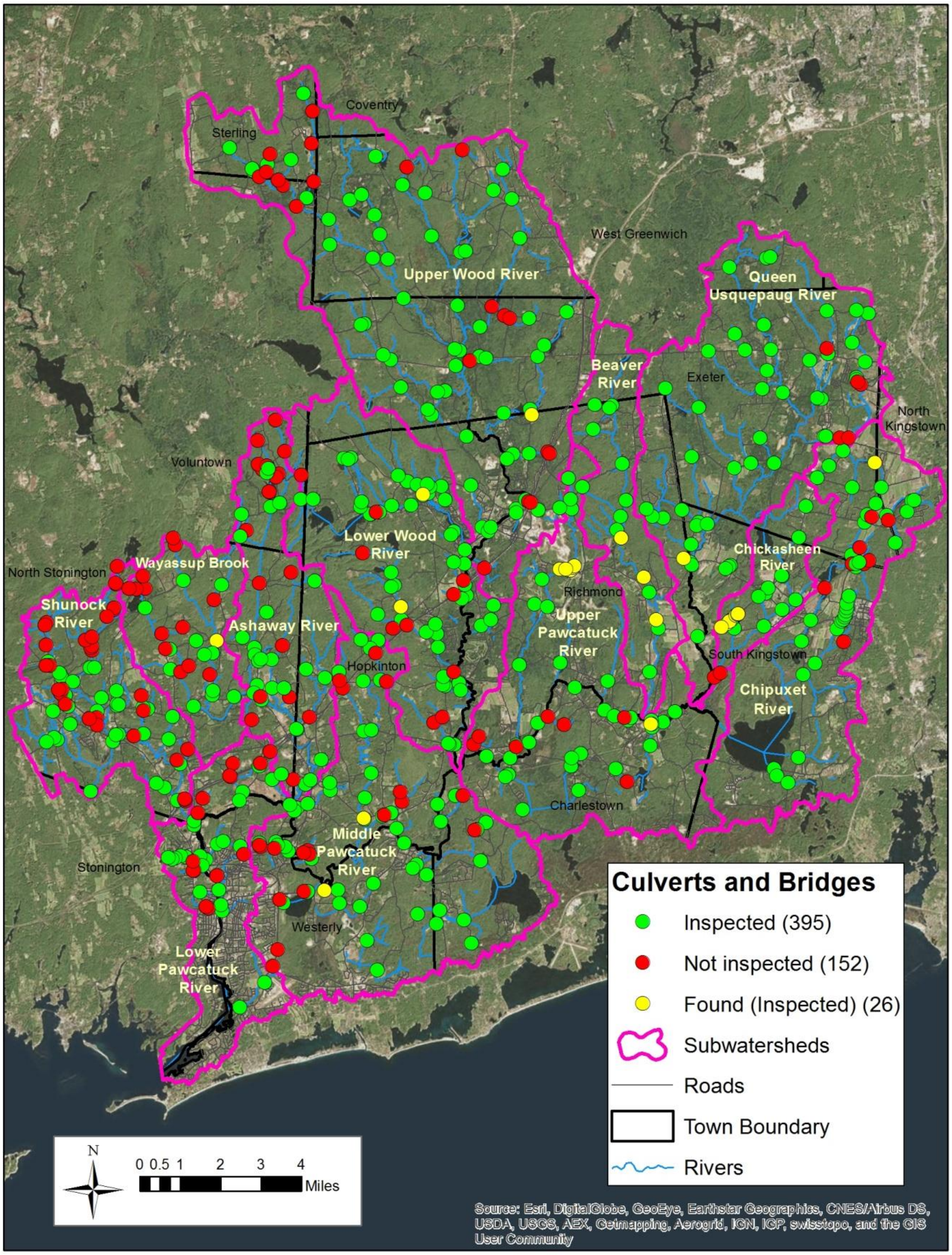


Figure 2-1. Selected culvert and bridge locations in the Wood-Pawcatuck watershed

Table 2-2. Stream codes

Stream Name	Code	Stream Name	Code	Stream Name	Code
Alewife Brook	ALE	Green Fall River	GRE	Poquaint Brook	POQ
Ashaway River	ASH	Hetchel Swamp Brook	HET	Queen River	QUR
Assekonk Brook	ASS	Kelley Brook	KEL	Queens Fort Brook	QFB
Baker Brook	BAK	Locke Brook	LOC	Rake Factory Brook	RAK
Beaver River	BEA	Log House Brook	LOG	Ruben Brown Brook	RUB
Breakheart Brook	BRE	Mastuxet Brook	MAS	Roaring Brook	ROA
Brushy Brook	BRU	McGowan Brook	MCG	Sherman Brook	SHE
Canonchet Brook	CAN	Meadow Brook	MEA	Shunock River	SHU
Carson Brook	CAR	Mile Brook	MIL	Sodom Brook	SOD
Cedar Swamp Brook	CED	Mink Brook	MIN	Taney Brook	TNY
Chickasheen Brook	CHK	Moscow Brook	MOS	Tanyard Brook	TYD
Chipuxet River	CHP	Mud Brook	MUD	Tomaquag Brook	TOM
Coney Brook	CON	Parmenter Brook	PAR	Usquepaug River	USQ
Diamond Brook	DIA	Pasquiset Brook	PAS	White Brook	WEB
Dutemple Brook	DUT	Pawcatuck River	PAW	White Horn Brook	WHB
Factory Brook	FAC	Peg Mill Brook	PEG	Wine Brook	WIN
Fisherville Brook	FIS	Pendleton Hill Brook	PHB	Wood River	WOR
Flat River	FLA	Pendock Brook	PDB	Woody Hill Brook	WHB
Genesee Brook	GEN	Perry Healy Brook	PER	Wyassup Brook	WAY
Glade Brook	GLA	Phelps Brook	PHE	Yawbucs Brook	YAW
Glen Rock Brook	GLE	Phillips Brook	PHI		

2.2.3 Field Inspections

Field inspections of the identified structures were conducted from May to September 2015 using procedures and field data collection forms adapted from Vermont's Stream Geomorphic Assessment handbook and similar standardized road-stream crossing assessment protocols used in Rhode Island, Massachusetts, and Connecticut. Field personnel were trained in the use of the culvert assessment protocol prior to conducting the assessments. During the field inspections, information was collected for evaluating culvert capacity, geomorphic vulnerability, flooding impact potential, and aquatic organism passage for each structure.

Field information collected for this assessment included:

- Site characteristics (e.g. aerial sketch, photos, street name, stream name, etc.)
- Structure dimensions necessary to assess hydraulic capacity (e.g. cross sectional area, slope, allowable head, etc.)
- Upstream and downstream geomorphic conditions (approximate channel slope/configuration, perched culvert discharge, sedimentation, evidence of erosion/scour/overtopping, bankfull width, etc.)
- Deficiencies and condition of the structure.

Field measurements were made using standard topographic surveying techniques, a laser rangefinder, and other field equipment. Blank field data forms are provided in digital format in *Database A.* The completed forms and site photographs are also provided in digital format in *Database A.* Field Geology Services staff completed inspections of bridges and culverts within the Phase 2 geomorphic assessment reaches as part of the related fluvial geomorphic assessment of the Wood-Pawcatuck watershed. Culvert and bridge inspection forms completed by Field Geology Services are also provided in *Database A*.

2.3 Data Analysis and Results

2.3.1 Hydraulic Capacity

Culverts and bridges are designed to convey flowing water through manmade infrastructure such as roads or railroad embankments. The hydraulic capacity of a road-stream crossing is a measure of its ability to safely convey the maximum or peak discharge (flow) from a specified design storm and is therefore an important factor in evaluating the flooding potential posed by the structure. The culverts and bridges identified in the Wood-Pawcatuck watershed were evaluated for their adequacy to convey peak flows associated with various design storms under current and potential future conditions, accounting for the effects of climate change and urbanization.

Structure Flow Capacity

The adequacy of a stream crossing structure is dictated by its flow capacity and a number of other common design criteria including allowable headwater, freeboard, maximum outlet velocity, backwater, and scour, as well as various flood frequencies. In Rhode Island and Connecticut, culverts are generally designed to convey the 25- or 50-year frequency peak discharge, while larger structures including bridges are often designed for larger events such as the 100-year or 500-year peak discharge.

For this assessment, the flow capacity of each structure was assumed to be the capacity of the structure at the point of overtopping of the associated roadway.[1] Flow capacity was estimated using the following methods:

- Existing HEC-RAS Models: The capacities of structures on larger rivers were estimated using draft HEC-RAS hydraulic models developed by the U.S. Geological Survey as part of the ongoing Risk Mapping, Assessment and Planning (Risk MAP) program to update FEMA flood maps for the Wood-Pawcatuck watershed. Flows at a specific bridge/culvert location were entered into the HEC-RAS hydraulic model (on a trial-and-error basis) until the flow that resulted in overtopping of the structure was determined. This flow rate was considered to be the full capacity flow of the structure. The use of the HEC-RAS models allows flow capacities to be computed that account for tailwater elevations based on actual river geometry and downstream hydraulics. Where structure sizes were not excessively large, the HEC-RAS computed flow capacities were confirmed using the Bentley CulvertMaster hydraulic analysis software using tailwater elevations obtained from HEC-RAS.

- Bentley CulvertMaster: For all structures on rivers and streams for which HEC-RAS models are not available, the maximum flow capacity was estimated using Bentley CulvertMaster software, which uses standard Federal Highway Administration (FHWA) culvert analysis methods. Input parameters were selected based on field measurements, with a headwater elevation set to the crest (top) of the roadway (i.e., at the point of overtopping of the structure). Inlet and outlet control was determined by the model, which used the appropriate hydraulic calculations for each structure. It should be noted that the results from this model are only estimates of flow capacity due to limitations of the software. The software uses standard culvert dimensions available; therefore for structures with non-standard dimensions, inputs were selected to most accurately match the field conditions. Additionally, CulvertMaster is designed to only model the capacity of culverts (not bridges). While the same equations used in CulvertMaster can be applied to bridges, the input parameters available typically do not match. Therefore, for bridges for which existing HEC-RAS models were not available, the CulvertMaster input parameters were selected to match the cross-sectional opening and other structure dimensions as closely as possible. The CulvertMaster model output is provided in digital format in *Database C*.

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[1] This approach assumes that flooding may occur at the point of overtopping, at which the structure is considered hydraulically undersized. It does not consider ponding and greater headwater-to-depth ratios, which are engineering design considerations that are more appropriate for detailed design and beyond the scope of this planning-level assessment.

Modeled flow capacities for each structure, listed by subwatershed and by town, are provided in *Appendix B*.

Existing Peak Discharge Estimates

The hydraulic capacity assessment also requires estimates of peak discharge at the location of the identified structures. Peak discharge for each structure was estimated for the 10-, 25-, 50- and 100-year recurrence intervals, which generally correspond to the range of design flows for the stream crossing structures in the watershed. The following hydrologic methods were used to estimate peak discharge for this assessment:

- USGS Regional Regression Equations: The United States Geological Survey has developed regional regression equations for estimating natural streamflow for ungaged stream sites based on streamflow statistics at stream gages in southeastern New England and basin characteristics (Zarriello, Ahearn, & Levin, 2012) (Bent, Steeves, & Waite, 2014). These regional regression equations have been incorporated into StreamStats (Version 3), which is a web-based GIS software available nationally, including Rhode Island and Connecticut. The regional regression equations in StreamStats were used to develop estimates of peak discharge at locations in the Wood-Pawcatuck watershed where the site input variables are within the range of parameter values for which the equations were developed and where streamflow has not been significantly altered. StreamStats also uses the drainage area ratio method (Zarriello, Ahearn, & Levin, 2012) to estimate flows at ungaged locations when the drainage area is outside the recommended range for which the regression equations were developed (approximately 0.5 to 300 square miles). The drainage area ratio method is based on the assumption that the streamflow at a site along a stream is the same per unit drainage-basin area as that at a nearby hydrologically similar site.

  Several of the watersheds corresponding to the structures for this project had one or more parameters (i.e., drainage area, stream density, percent slope, and mean basin elevation) outside of the suggested range for which the regional regression equations are valid. In these cases, the accuracy of the discharge estimate is unknown. To reduce the error in the peak discharge estimates, the SCS Unit Hydrograph Method (TR-20) was used, as described below.

- SCS Unit Hydrograph Method (TR-20): Hydraflow software, which uses the SCS Unit Hydrograph Method (TR-20), was used to estimate peak discharge at locations where (1) StreamStats did not provide a flow estimate due to input parameters being too far outside the acceptable range of values for regional regression equations or the drainage area ratio method, or (2) where the discharge estimates from StreamStats did not appear to be reasonable in comparison to discharge estimates and drainage areas associated with nearby structures or in relation to the drainage area/catchment characteristics.

  Drainage area was determined using StreamStats or delineated based on 2-foot topographic contours; hydrologic soil groups were assigned based on the average soil types within the watershed from review of the NRCS Soil Surveys for Rhode Island and Connecticut; curve numbers were assigned based on soil type and land cover within the watershed based on current aerial imagery; flow paths were delineated using 2-foot topographic contours to develop times of concentration; and updated precipitation frequency estimates were obtained from the on-line version of NOAA Atlas 14 (U.S. Department of Commerce, National Oceanic and Atmospheric Administraton, National Weather Service, 2015) using the Westerly, Rhode Island precipitation gage.

StreamStats reports and output files and TR-20 calculations, including Hydraflow output, are provided in digital format in *Database D*. Peak discharge estimates[2] for the 10-, 25-, 50- and 100-year recurrence intervals are provided in *Appendix B*.

[2] Peak discharge estimates for structure LWR-WOR-2-1 were set to a nominal value of 1 cfs since this structure is not required to pass flow. This structure is located adjacent to Alton Pond Dam and flood flows in this location are routed over the dam. However, flooding could occur at this culvert under extreme flows.

Overall, approximately 83% of the peak discharge estimates were obtained using StreamStats (regional regression equations or drainage area ratio method), while TR-20 was used to estimate peak discharge for the remaining 17% of stream crossing locations assessed in this study.

Future Peak Discharge Estimates

An increasing trend has been observed in annual peak discharge at stream locations in New England for both urbanizing basins and basins minimally affected by urbanization (Walter & Vogel, 2010) (Vogel, Yaindl, & Walter, June 2011) (Collins, 2009) (Hodgkins & Dudley, 2005). Vogel and others (2011) developed magnification factors to examine how a linear trend would affect flood magnitudes at a future time. The method assumes that the linear trend persists at the same rate over the projected time period and can be used to calculate the amount by which a given flood flow must be multiplied to represent a flood of the same exceedance probability over that time interval (Zarriello, Ahearn, & Levin, 2012). The USGS has used these flood magnification factors to estimate future peak discharge for various locations and exceedance probabilities.

The flood magnification factors developed by Vogel and others (2011) for 10-, 20-, and 30-year projections were extrapolated linearly to estimate a 50-year flood magnification factor of 1.51, which reflects a 50-year planning horizon (2070). Essentially, if the linear trend in annual peak flows persists, the flood with a given exceedance probability will, on average, be 51 percent greater in magnitude in 50 years. The 10-, 25-, 50- and 100-year peak discharge estimates for the structures assessed in this study were multiplied by 1.51 to estimate the anticipated future peak discharge due to the combined effects of climate change and urbanization, as flood magnification factors can be applied to floods of any exceedance probability (Vogel, Yaindl, & Walter, June 2011).

Hydraulic Capacity Ratio and Rating

A "capacity ratio" was calculated for each structure for the 10-, 25-, 50-, and 100-year flood frequencies under both existing and future condition scenarios. The capacity ratio is a simple indicator of whether a structure can safely pass flows of various recurrence intervals and the degree to which a structure may be vulnerable to flooding. For this assessment, the capacity ratio for a given structure and recurrence interval is a dimensionless parameter defined as the estimated flow capacity of the structure (in cubic feet per second or cfs), divided by the estimated peak discharge (in cfs). A capacity ratio greater than 1 indicates that the culvert or bridge has sufficient flow capacity to pass the peak discharge without overtopping the associated structure (road, railroad, trail, etc.). A capacity ratio less than 1 indicates that the culvert or bridge cannot pass the peak discharge without overtopping. The degree to which a capacity ratio is less than or greater than 1 provides information on the degree of vulnerability of the structure to flooding. Current design standards generally require culverts to safely pass the 25- or 50-year peak discharge. For the purposes of this analysis, the 25-year peak discharge is used as the design flow for determining if a structure is hydraulically undersized. A capacity ratio of less than 1 for the 25-year peak discharge indicates that a structure is undersized. Existing and future capacity ratios for the 25-year peak discharge are provided in the tables in *Appendix B*, with the information presented by subwatershed and by town.

Table 2-3 provides a breakdown of hydraulic capacity ratio values corresponding to the 25-year peak discharge for all of the assessed structures in the Wood-Pawcatuck watershed. The shaded cells reflect those structures with capacity ratios less than 1, indicating that the structures are undersized for the 25-year peak discharge. As shown in *Table 2-3*, an estimated 37% of the assessed structures in the watershed (primarily culverts) are hydraulically undersized. Under a potential future scenario (Year 2070) that considers the influence of climate change and future watershed urbanization, the percentage of undersized structures is anticipated to increase to approximately 50%, suggesting that roughly half of the assessed structures in the watershed would be hydraulically undersized relative to current design standards under this future conditions scenario. Approximately 50 structures that can currently convey the 25-year peak discharge are vulnerable to becoming undersized (i.e., unable to pass the 25-year peak discharge) in the future conditions scenario (refer to the second to last column in the tables in *Appendix B* for specific structures).

Table 2-3. Percentages of assessed structures in the Wood-Pawcatuck watershed and associated hydraulic capacity ratios for the 25-year peak discharge under existing and future conditions

Hydraulic Capacity Ratio[1]	Percentage of Structures	
	Existing	Future
0 to 0.1	3%	5%
0.1 to 0.5	15%	23%
0.5 to 1.0	19%	22%
1.0 to 2.0	21%	24%
2.0 to 10.0	34%	21%
Greater than 10.0	8%	6%

[1]Hydraulic capacity ratio is defined as the estimated flow capacity of the structure (cfs) divided by the estimated peak discharge (cfs). Shaded cells reflect structures that are undersized for the 25-year peak discharge (hydraulic capacity ratio less than 1).

A "capacity rating" was also assigned to each structure based on the largest recurrence interval flood that the structure is able to pass without overtopping. The five capacity rating categories used in this assessment are <10-year, 10-year, 25-year, 50-year, and 100-year. Structures with capacity ratings of <10-year or 10-year are considered to be hydraulically undersized.

Existing and future capacity ratings are also provided in the tables in *Appendix B*. The final column in the tables indicates a change in capacity ratings between existing and future conditions. For structures whose capacity ratings are predicted to decrease, cells are highlighted either yellow or red. Yellow indicates that the capacity rating is predicted to drop by one rating category (i.e., from 100-year to 50-year, for example). Red indicates that the capacity rating is predicted to drop by more than one rating category (i.e., from 100-year to 25-year or 10-year). A drop in capacity rating is an indicator of potential vulnerability to increased flooding resulting from climate change and future urbanization of the watershed.

Figure 2-2 shows existing and future hydraulic capacity ratings of the assessed structures in the Wood-Pawcatuck watershed. More detailed subwatershed maps showing existing and future hydraulic capacity ratings are also provided in *Appendix B*.

Table 2-4 and the bar chart in *Figure 2-3* summarize the percentage of structures in each hydraulic capacity rating category. The results indicate that approximately one-half of the structures assessed can currently convey the 100-year peak discharge without overtopping and about a quarter of the structures can convey less than the 10-year peak discharge. Similar to the capacity ratio findings, these results suggest that approximately 38% of the assessed structures in the watershed are hydraulically undersized, while 63% of the structures assessed are capable of safely conveying the 25-year peak discharge or larger flows. Under a potential future scenario, nearly 50% of the assessed structures in the watershed would be undersized. Approximately 51% of the structures would be capable of safely conveying the 25-year peak discharge or larger flows, or a 12% decrease compared to existing conditions.

The bar charts in *Figures 2-4, 2-5, and 2-6* illustrate existing capacity ratings by crossing type, structure type, and subwatershed, respectively. The gray shaded bars correspond to structures that are undersized for the 25-year peak discharge.

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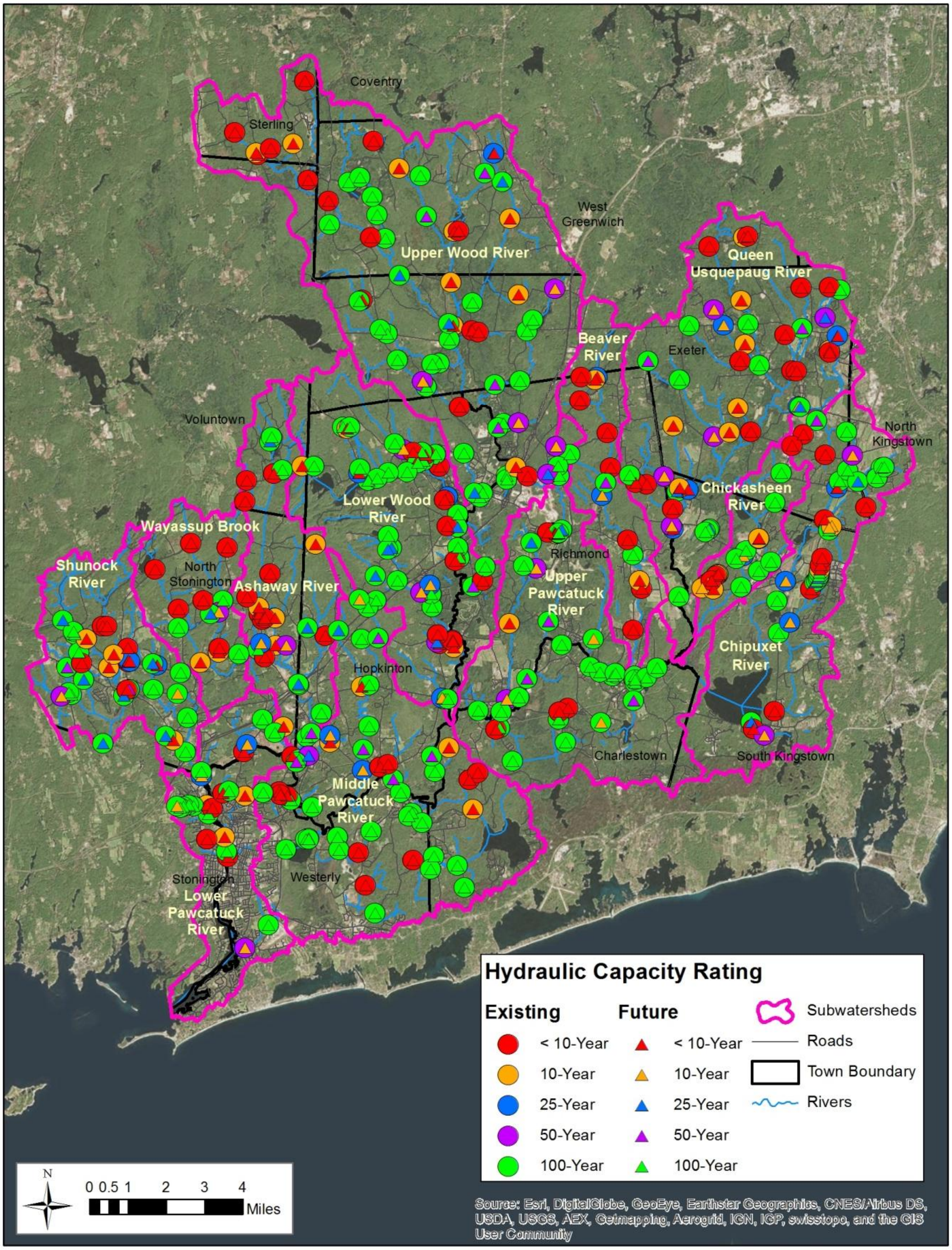


Figure 2-2. Culvert and bridge hydraulic capacity ratings

Table 2-4. Percentages of assessed structures in the Wood-Pawcatuck watershed and associated hydraulic capacity ratings under existing and future conditions

Hydraulic Capacity Rating[1]	Percentage of Structures	
	Existing	Future
<10-Year	25%	39%
10-Year	13%	10%
25-Year	6%	8%
50-Year	6%	5%
100-Year	51%	38%

[1]Hydraulic capacity rating reflects the largest recurrence interval peak discharge that a structure can convey without overtopping. Shaded cells reflect structures that are undersized for the 25-year peak discharge.

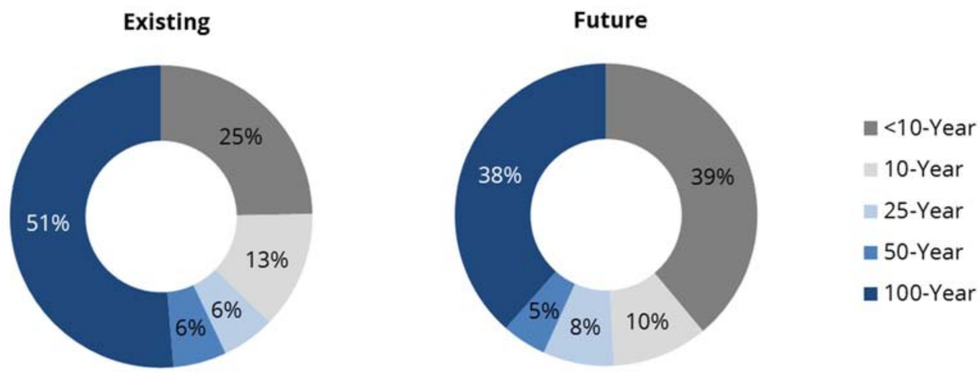


Figure 2-3. Existing and future hydraulic capacity ratings

In general, the assessed trails, driveways and local roads have the highest percentage of undersized crossing structures (*Figure 2-4*). Between 25% and 30% of these structures have hydraulic capacities less than the 10-year peak discharge. Approximately 38% of the trail crossings are undersized, most of which consist of small culverts, while most of the other trail crossings that were assessed are capable of conveying the 100-year peak discharge or larger. All of the assessed driveway crossings are small diameter culverts and are undersized relative to the 25-year peak discharge. In terms of local roads, an estimated 45% of the crossings are hydraulically undersized, while approximately 22% of state road crossings are undersized. Many of the local (44%) and state (64%) roads have significantly larger crossings capable of conveying the 100-year peak discharge or larger flows. Nearly all of the railroad and highway crossings that were assessed can safely convey the 100-year peak discharge, with a few of the railroad crossings having a 50-year capacity rating, which is consistent with the design of these larger structures.

Circular conduits (pipes) and box culverts make up the vast majority of the hydraulically undersized crossings in the watershed (*Figure 2-5*). Approximately 53% of the circular culverts are undersized, with 36% having hydraulic capacities less than the 10-year peak discharge. Roughly 27% of the assessed box culverts are also undersized. However, 35% of circular culverts and 59% of box culverts have a 100-year capacity rating. Most bridges and arched conduits can convey the 100-year peak discharge, although 18% of bridges and 13% of arched conduits cannot safely pass the 25-year peak discharge.

Some notable differences in hydraulic capacity ratings are apparent across the watershed (*Figure 2-6*). The highest percentages of undersized structures are located within the Beaver River, Wyassup Brook, Ashaway River, and Chickasheen Brook subwatersheds. The Upper and Middle Pawcatuck River and Lower Wood River subwatersheds have the lowest percentage of undersized structures, which likely reflects the relatively higher number of larger structures on the larger main-stem rivers. These subwatersheds, along with the Upper Wood River, Lower Pawcatuck, Chipuxet, and Shunock River subwatersheds, also have the highest percentages of crossings that can safely convey the 100-year peak discharge or larger flows.

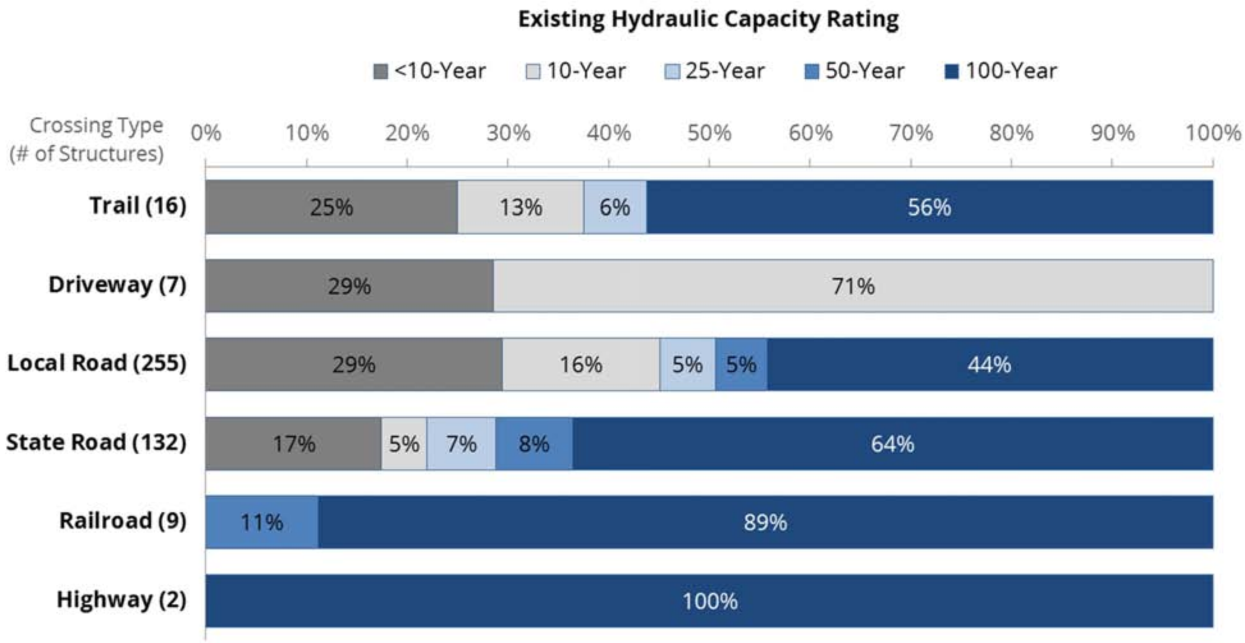


Figure 2-4. Culvert and bridge hydraulic capacity ratings by crossing type

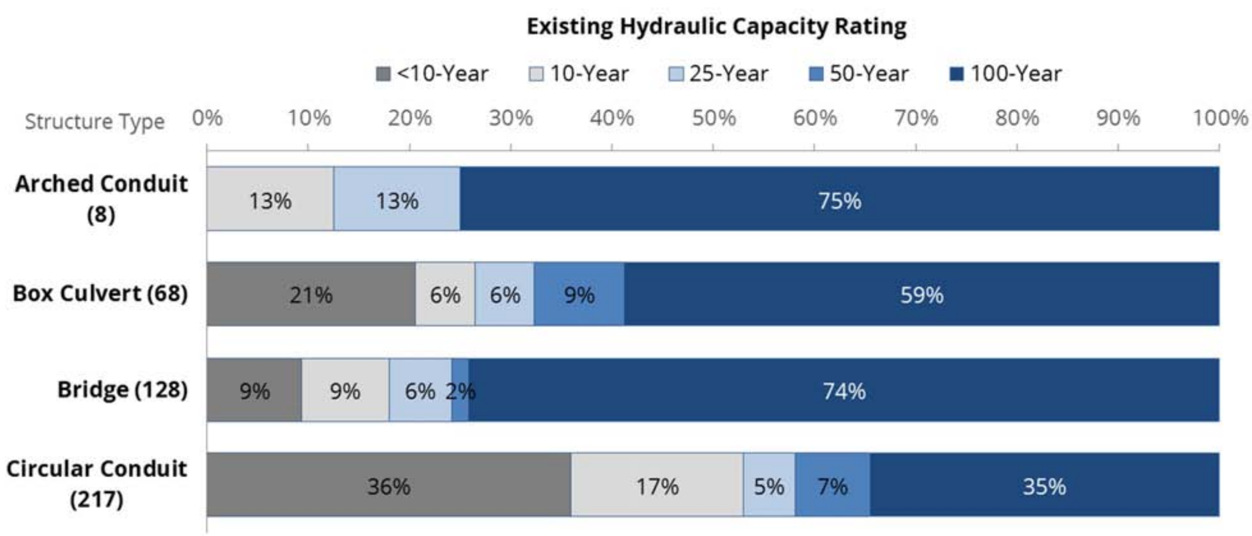


Figure 2-5. Culvert and bridge hydraulic capacity ratings by structure type

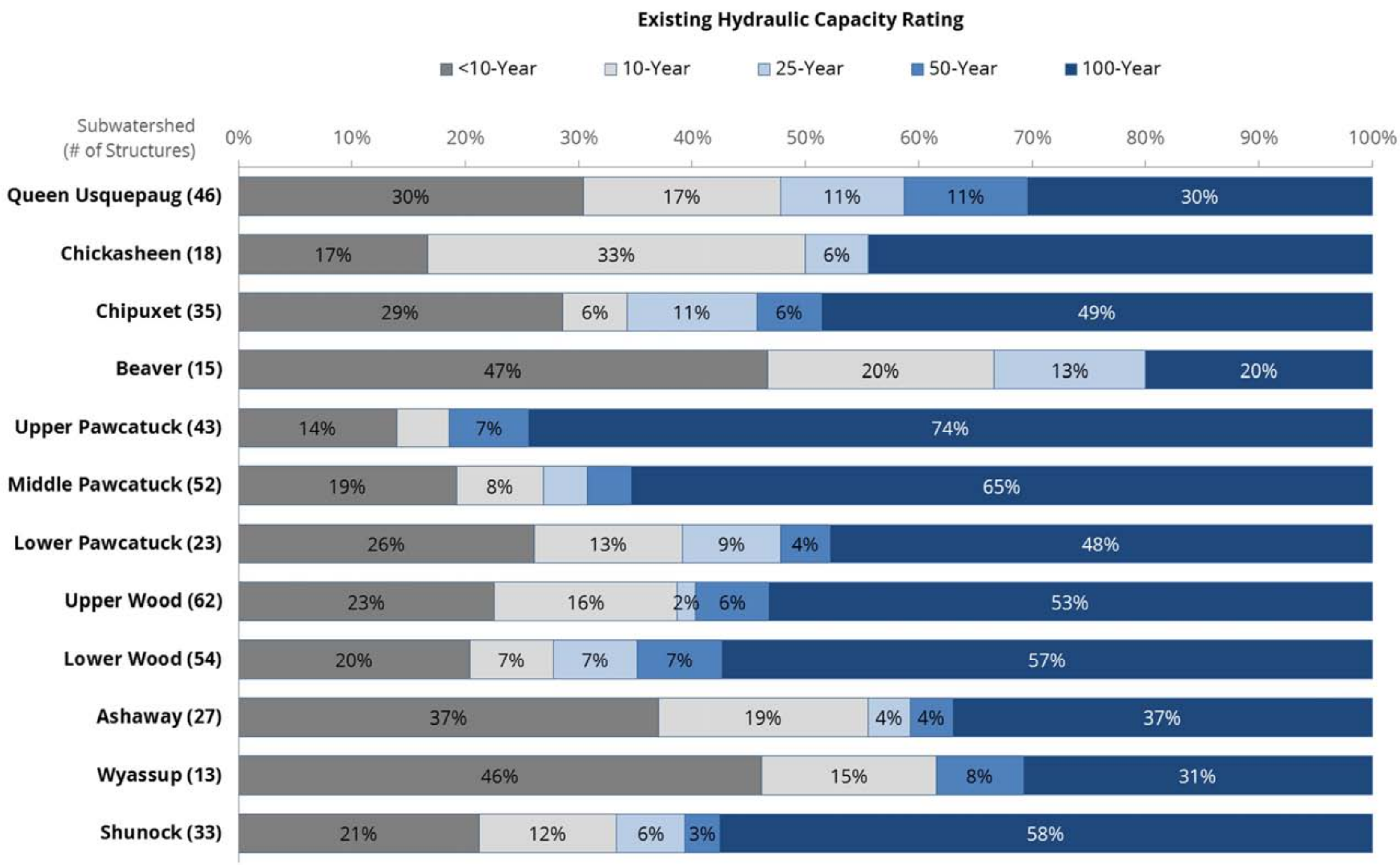


Figure 2-6. Culvert and bridge hydraulic capacity ratings by subwatershed

2.3.2 Flooding Impact Potential

Assessment of flood risk and vulnerability also requires consideration of the potential impact that flooding of a structure would cause. A flood hazard poses little risk to infrastructure, property or lives if there is limited exposure to the hazard. For example, an undersized culvert under a walking trail in a remote area with little upstream or downstream development poses less risk than an undersized culvert under a major road with significant development in the adjacent floodplain.

Three criteria were evaluated to assess the flooding impact potential of each structure – the type and intensity of development and land use upstream and downstream of the structure, whether the structure is located in a mapped flood zone, and the type of crossing (trail, driveway, town road state road, highway, or railroad). The National Land Cover Data Set and aerial imagery were used to evaluate development and land use adjacent to the stream approximately one mile upstream and one mile downstream of the structure. FEMA Flood Insurance Rate Maps (FIRMs) were used to determine if the structure is located in a flood hazard zone. Road type was determined from RIGIS data and information obtained during the field inspections.

Numeric flooding impact potential ratings, with values ranging from 1 (lower impact) to 5 (higher impact), were developed for each of the three criteria (*Table 2-5*). An overall impact rating was calculated as the average of the numeric ratings for each of the three criteria. Structures with an average impact rating of less than 2.33 (lower third of range) were considered to have a “Low” impact potential, whereas structures with an average impact rating greater than 3.66 (upper third of range) were considered to have a “High” impact potential. Structures with an average impact rating between these two values (middle third of range) were considered to have a “Medium” impact potential.

Table 2-5. Flooding impact potential ratings

Impact Rating	Flooding Impact Potential Criteria		
	Development in Surrounding Area	Structure Located In FEMA Food Zone?	Type of Crossing
1	Little to no development, mostly forested land	No	Trail
2	Mostly open farm land, very low density residential area	--	Driveway
3	Low to moderate density residential area, little commercial/industrial development	--	Town Road
4	Moderate to high density residential area, some commercial/industrial development	--	State Road
5	High density residential area, significant commercial/industrial development	Yes	Highway or Railroad

The flooding impact potential ratings and raw data for this assessment are provided in *Appendix C*, sorted by subwatershed and town. The map in *Figure 2-7* shows flooding impact potential ratings for the assessed structures in the Wood-Pawcatuck watershed. More detailed subwatershed maps showing flooding impact potential ratings are also provided in *Appendix C*.

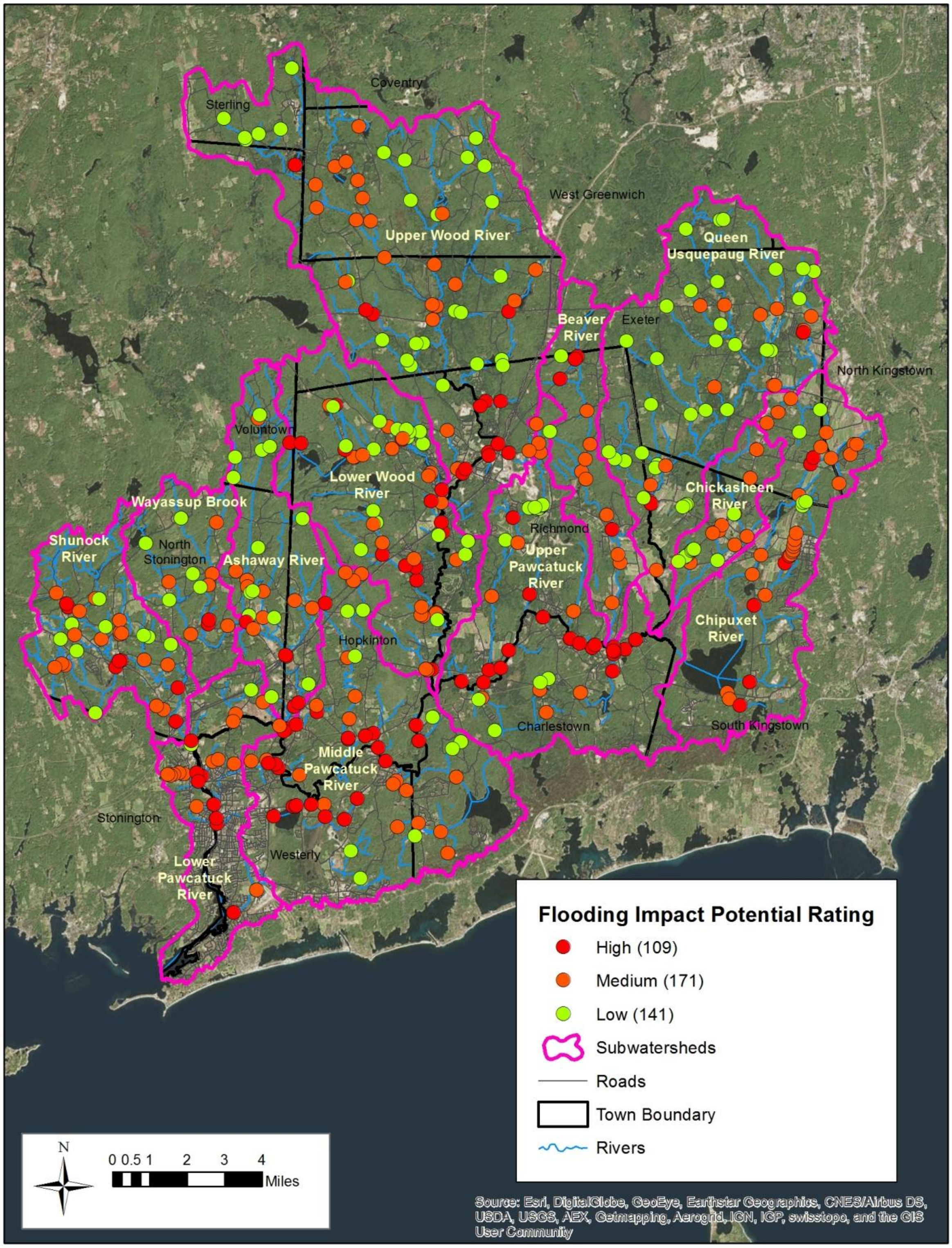


Figure 2-7. Culvert and bridge flooding impact potential ratings

The percentages of assessed structures are fairly evenly distributed between the High (26%), Medium (41%), and Low (33%) flooding impact potential rating categories. The bar charts in *Figures 2-8, 2-9, and 2-10* illustrate the percentage of structures in each impact potential rating category by crossing type, structure type, and subwatershed, respectively.

Structures associated with trails, driveways and local roads generally have lower flooding impact potential ratings, while structures associated with state roads, railroads and highways have higher flooding impact potential ratings (*Figure 2-8*). This result is not surprising since crossing type is one of the three criteria used to determine the impact potential ratings.

In terms of structure type, circular conduits and box culverts generally have lower impact potential ratings than arched conduits and bridges (*Figure 2-9*). Circular conduits and box culverts are typically used on smaller roads and stream crossings, whereas bridges and arched conduits are typically used for more significant crossings.

The map in *Figure 2-7* and the chart in *Figure 2-10* show the geographic distribution of flooding impact potential ratings throughout the Wood-Pawcatuck watershed. Stream crossing structures with high flooding impact potential are generally more prevalent along the main-stem Upper and Middle Pawcatuck River and along the Lower Wood River. The Chickasheen Brook, Chipuxet River, Beaver River, and Lower Pawcatuck River subwatersheds have the highest percentages of structures rated as medium flooding impact potential. The highest percentages of structures having low flooding impact potential are located in less developed watersheds including the Queen-Usquepaug, Upper Wood, and Ashaway River subwatersheds.

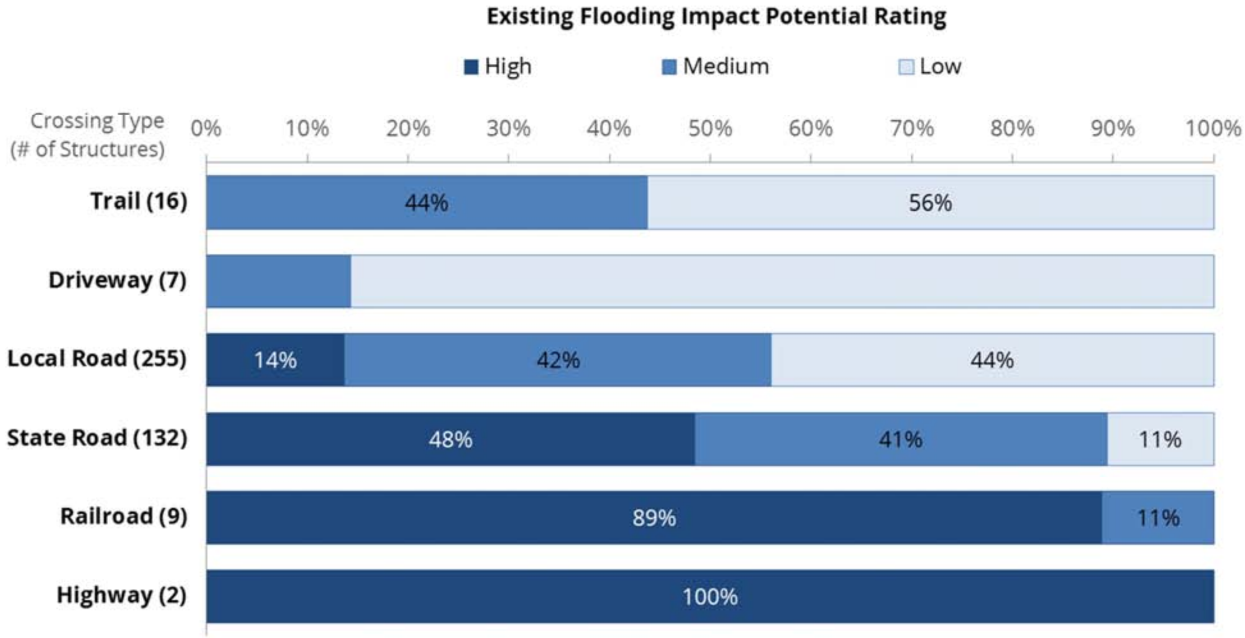


Figure 2-8. Culvert and bridge flooding impact potential ratings by crossing type

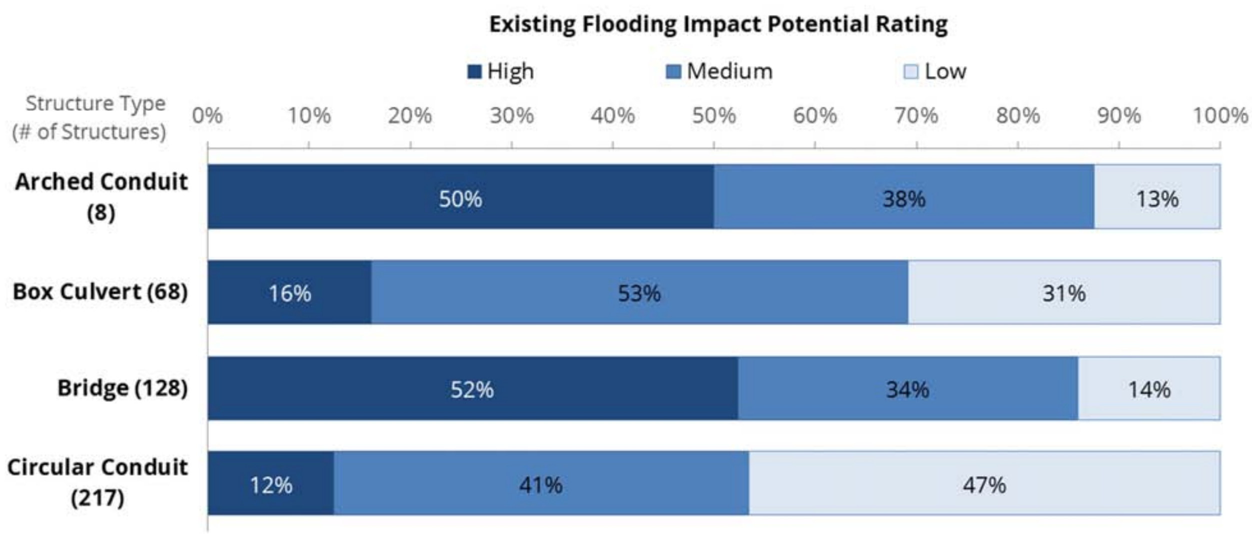


Figure 2-9. Culvert and bridge flooding impact potential ratings by structure type

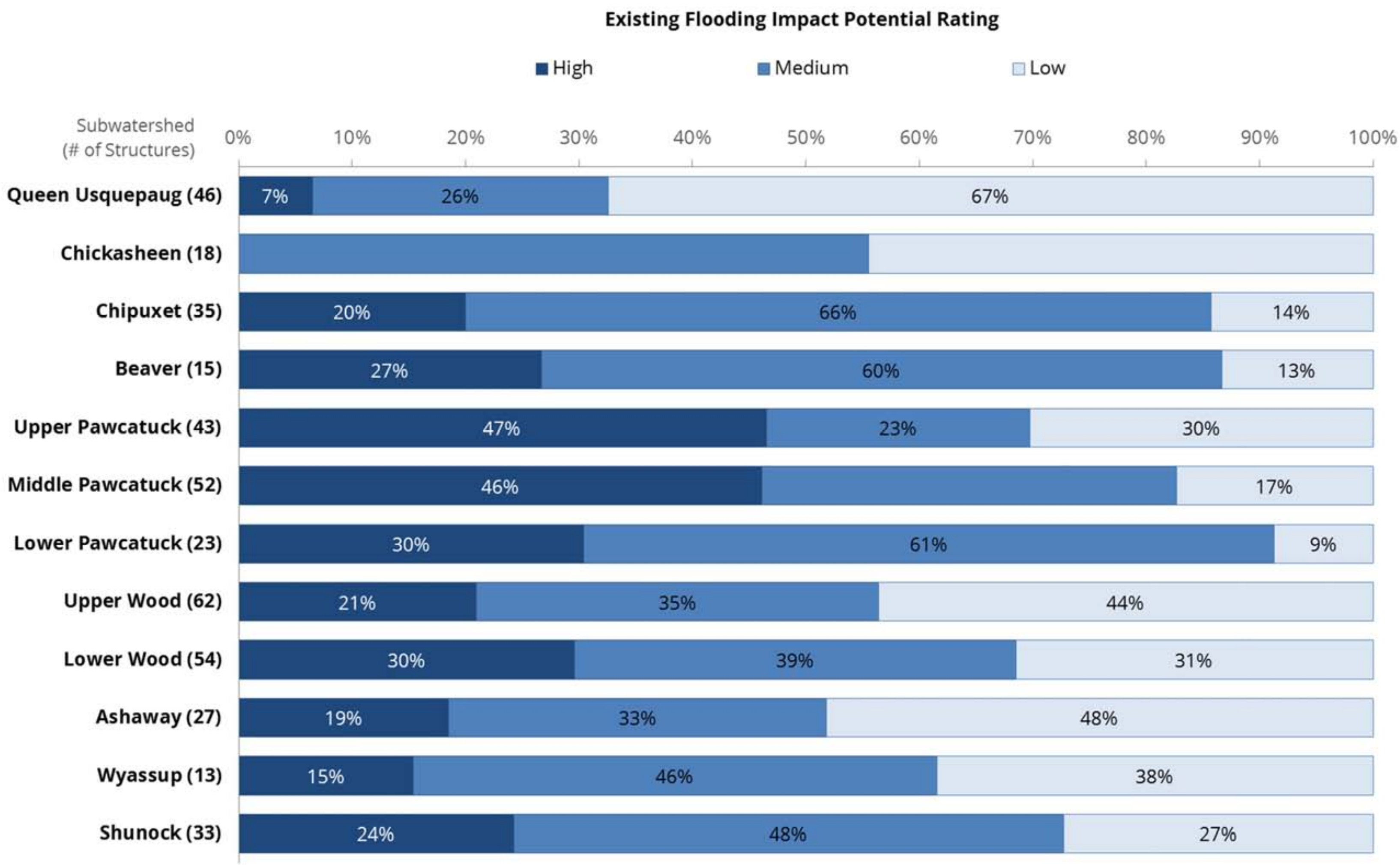


Figure 2-10. Culvert and bridge flooding impact potential ratings by subwatershed

2.3.3 Geomorphic Vulnerability

Geomorphic vulnerability of a culvert or bridge refers to the likelihood of potential impacts of the structure on channel stability based on consideration of the physical characteristics of the structure and stream channel. The geomorphic vulnerability of each structure was assessed using information collected during the field inspections and criteria and metrics adapted from a similar geomorphic vulnerability assessment of stream crossings in the Deerfield River watershed in Massachusetts by the Massachusetts Department of Transportation, the University of Massachusetts, USGS, and other project partners (Katherin McArthur, 2014). The criteria used for the Wood-Pawcatuck assessment are provided in *Table 2-6*.

Table 2-6. Culvert/bridge geomorphic vulnerability criteria

Characteristic	Low	Medium	High
Stream Bed Material	Bedrock	Cobbles/Riprap	Silt/Sand/Gravel
Culvert Invert (Bottom)	Structural	Cobbles/Riprap	Soil/Sediment
Culvert Flow Capacity	>50 Year	10-50 Year	<10 Year
Culvert Width/Channel Bankfull Width	>1.2	0.75-1.2	<0.75
Culvert Material	Concrete	Corrugated Steel[1]	Masonry[2]
Culvert Condition	Good	Fair	Poor

[1]Structures consisting of High Density Polyethylene (HDPE) or other plastic material were assigned a Culvert Material Rating of "Medium."
[2]Structures consisting of timber were assigned a Culvert Material Rating of "High."

Assumptions that were made in evaluating structures relative to the geomorphic vulnerability criteria are as follows:

- If a structure was composed of two or more materials, the most prevalent material was used
- If a structure was composed of two or more materials equally present throughout the structure, the higher rating (more vulnerable) material was used
- When multiple bed materials were present, the most prevalent material was used
- Where any characteristic was unclear, conservative assumptions were made.

To determine an overall geomorphic vulnerability rating, a value of 0 (Low), 0.5 (Medium), or 1 (High) was assigned for each of the characteristics/criteria. The values for each characteristic/criteria were then totaled to derive an overall geomorphic vulnerability score. Structures with a geomorphic vulnerability score of less than or equal to 2.5, between 2.5 and 3.5, and greater than or equal to 3.5 were given a geomorphic vulnerability rating of "Low," "Medium," and "High," respectively. Information on the geomorphic vulnerability characteristics/criteria for each structure, as well as the ratings, is provided in *Appendix D*, tabulated by subwatershed and town.

The map in *Figure 2-11* shows geomorphic vulnerability ratings for the assessed structures in the Wood-Pawcatuck watershed. More detailed subwatershed maps are also provided in *Appendix D*.

Overall, 47% of the assessed structures in the watershed have a high geomorphic vulnerability rating, 23% are rated as having medium geomorphic vulnerability, and 30% have a low geomorphic vulnerability rating. The bar charts in *Figures 2-12, 2-13, and 2-14* show the percentages of the assessed structures in each geomorphic vulnerability rating category by crossing type, structure type, and subwatershed, respectively.

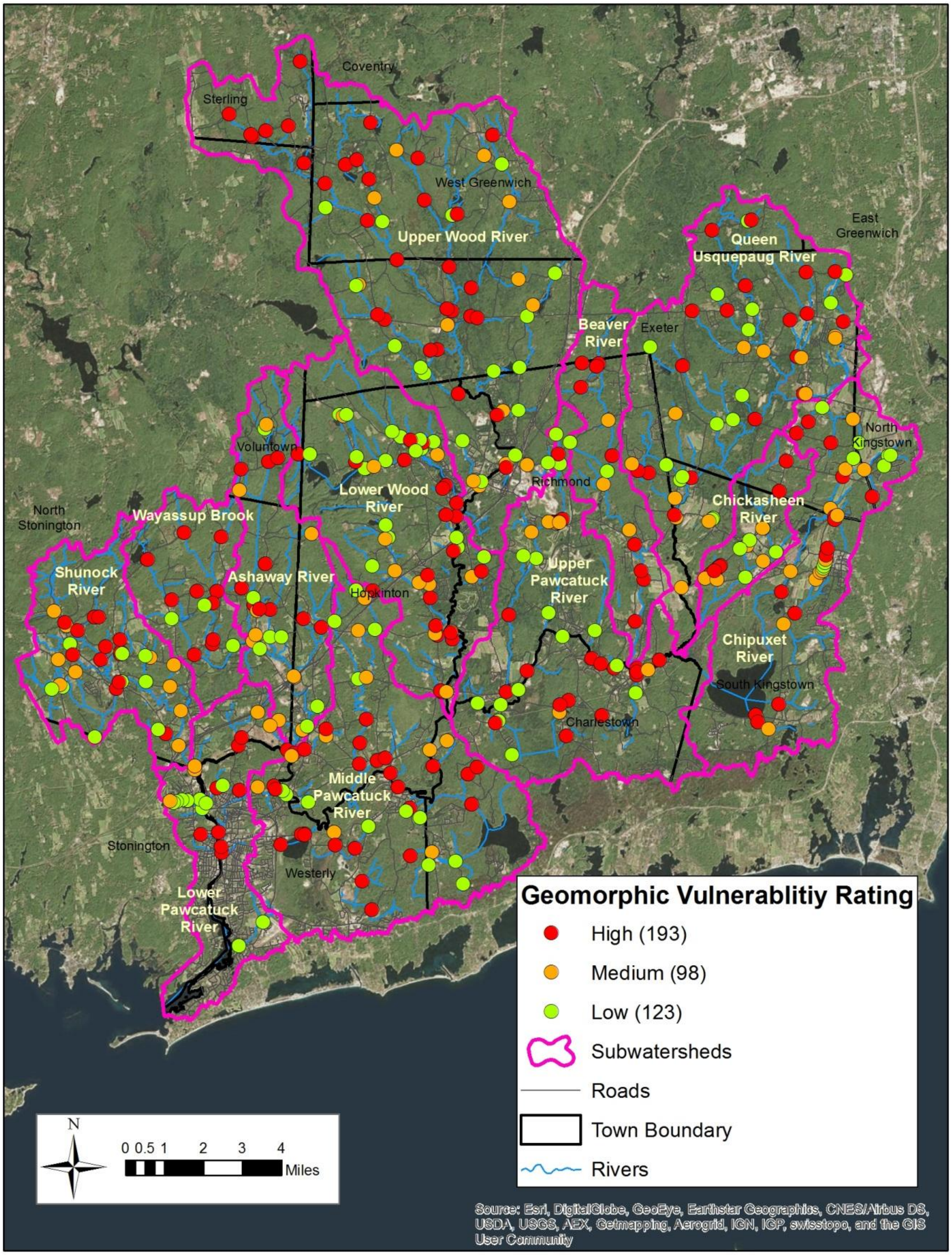


Figure 2-11. Culvert and bridge geomorphic vulnerability ratings

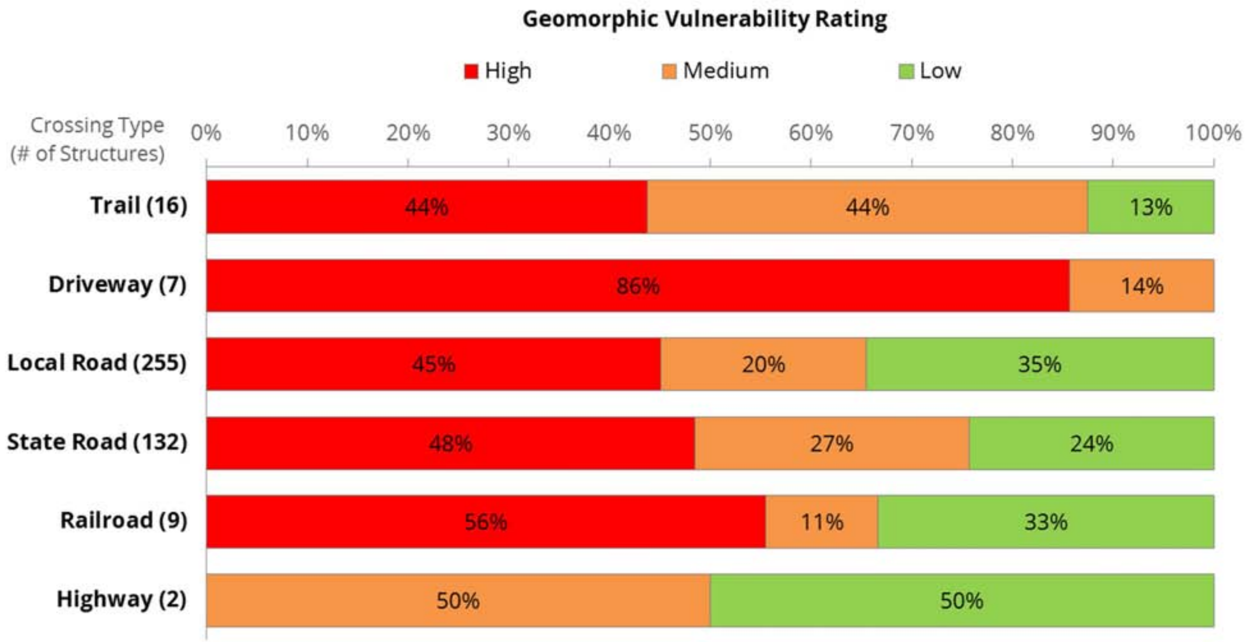


Figure 2-12. Culvert and bridge geomorphic vulnerability ratings by crossing type

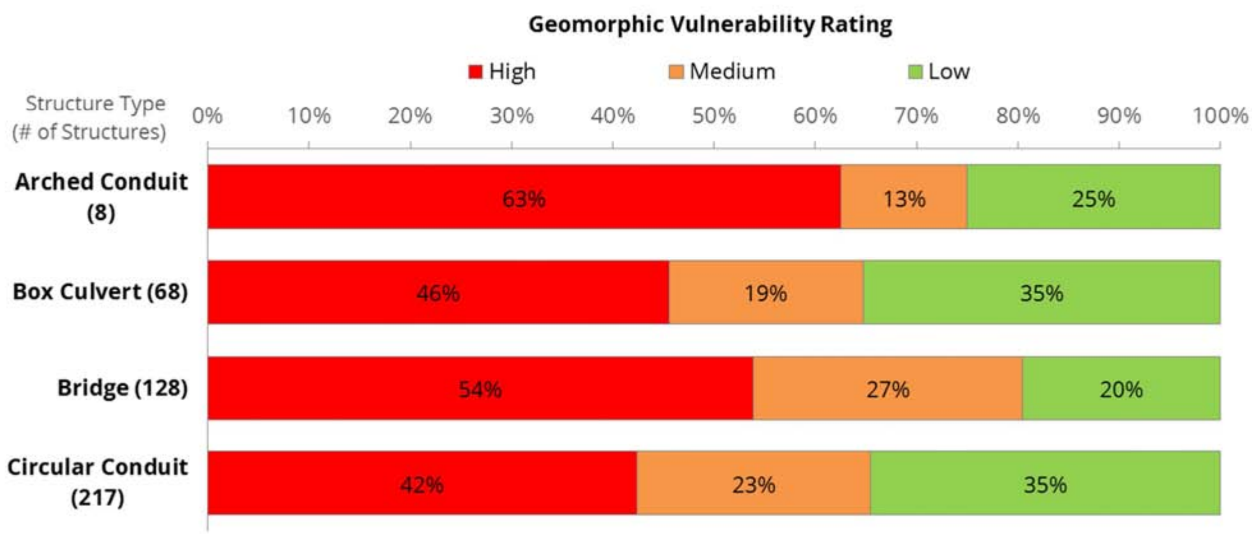


Figure 2-13. Culvert and bridge geomorphic vulnerability ratings by structure type

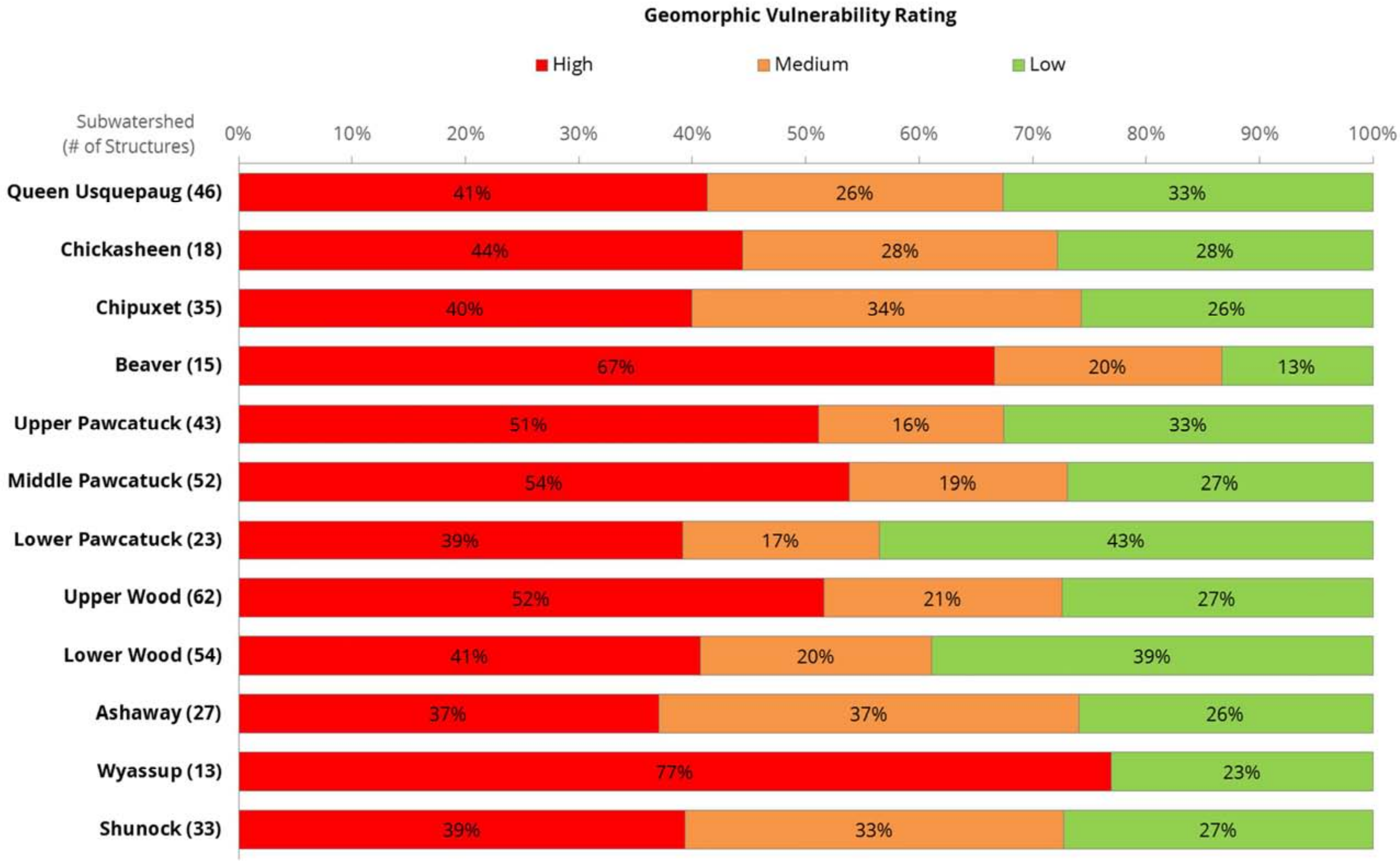


Figure 2-14. Culvert and bridge geomorphic vulnerability ratings by subwatershed

The assessed driveways and trails have a greater percentage of structures with high geomorphic vulnerability ratings (*Figure 2-12*). Local roads, state roads, and railroad crossings have comparable percentages of structures with high, medium, and low geomorphic vulnerability ratings. Geomorphic vulnerability also does not vary significantly with structure type (*Figure 2-13*). Arched conduits and bridges have a slightly higher percentage of high and medium geomorphic vulnerability ratings than box culverts and circular conduits.

The Wyassup Brook (77%) and Beaver River (67%) subwatersheds have the highest percentage of assessed structures with high geomorphic vulnerability ratings, while the Lower Pawcatuck River (43%) subwatershed has the highest percentage of assessed structures with low geomorphic vulnerability (*Figure 2-14*). The distribution of geomorphic vulnerability ratings is relatively consistent across the other subwatersheds.

2.3.4 Aquatic Organism Passage

Culverts and bridges in the watershed were also evaluated for the degree to which they impede or restrict the passage of fish and other aquatic organisms, thereby disrupting river and stream continuity. Structures that act as barriers to or severely limit aquatic organism passage (AOP) are potential candidates for upgrades or replacement, which can have both ecological and flood resiliency benefits.

Using data collected from the field inspections, an AOP rating was assigned to each structure following the North Atlantic Aquatic Connectivity Collaborative (NAACC) AOP Classification System, which is summarized in *Figure 2-15*. The NAACC is a semi-quantitative rating system, where stream crossings are assigned to one of three broad categories based on the degree of AOP provided by the crossing – "Full AOP", "Reduced AOP", and "No AOP" – as measured by a number of criteria related to the structure inlet, outlet, and substrate.

Metric	Flow Condition	Crossing Classification		
		Full AOP	**Reduced AOP**	**No AOP**
		If all are true	*If any are true*	*If any are true*
Inlet Grade		At Stream Grade	Inlet Drop or Perched	
Outlet Grade		At Stream Grade		Cascade, Free Fall onto Cascade
Outlet Drop to Water Surface		= 0		≥ 1 ft
Outlet Drop to Water Surface/ Outlet Drop toStream Bottom				> 0.5
Inlet or Outlet Water Depth	Typical-Low	> 0.3 ft		< 0.3 ft
	Moderate	> 0.4 ft		< 0.4 ft
Structure Substrate Matches Stream		Comparable or Contrasting		
Structure Substrate Coverage		100%	< 100%	
Physical Barrier Severity		None	Minor or Moderate	Severe

Figure 2-15. North Atlantic Aquatic Connectivity Collaborative (NAACC) Aquatic Organism Passage Classification System

For this assessment, a structure had to meet all of the individual criteria for "Full AOP" to be classified as "Full AOP." If a structure met one or more criteria for "Reduced AOP," it was classified as "Reduced AOP." If a structure met one or more criteria for "No AOP," it was assigned a rating of "No AOP." A "Full AOP" rating was assigned for the structure substrate criterion if the substrate inside the structure was similar in size to the substrate in the natural stream ("comparable"). "Reduced AOP" or "No AOP" were assigned for the structure substrate criterion if the substrate inside the structure was different in size from the substrate in the natural channel ("contrasting").

Field inspections were completed primarily during the summer and fall, which is typically a low-flow period. The summer and fall of 2015 was also below normal in terms of precipitation and streamflow, and several of the streams were dry (i.e., no flow) during the inspections. Structures that would have been classified as "No AOP" because there was less than 0.3 feet of water in the culvert but met all other criteria for either "Full AOP" or "Reduced AOP," were assigned classifications of "Dry (Full AOP)" or "Dry (Reduced AOP)," respectively.

It should be noted that the field inspections occurred during the dense foliage season, so in some cases visibility of the upstream and downstream channel was limited. Therefore, there may have been physical barriers in the stream channel upstream or downstream of the structure that could not be observed. If a physical barrier related to the structure was observed upstream or downstream of the structure (e.g., a beaver dam immediately upstream of a culvert, or deposited debris immediately upstream of the culvert) then the structure was considered a physical barrier to passage.

Several groups in Rhode Island and Connecticut, including the Rhode Island River and Stream Continuity Project led by the Rhode Island Resource Conservation & Development Council, WPWA, and other project partners, have conducted stream crossing assessments in the Wood-Pawcatuck watershed. Some of these assessments were completed prior to the development of the NAACC assessment protocols. The data from these previous assessments is available in the on-line NAACC Database.[3]

The AOP classifications resulting from the current Wood-Pawcatuck assessment were compared to the previous assessment results contained in the NAACC Database, where available. NAACC Database information was only available for some of the inspected structures in the Connecticut portion of the watershed. In general, the AOP classifications from the current assessment are consistent with the AOP classifications from previous stream crossing assessments contained in the NAACC Database. It should be noted that the assessment data in the NAACC Database includes physical barriers in the stream channel that were not associated with the assessed structures and has partial or incomplete data for some structures.

The AOP assessment data and associated classifications for each structure are provided in the tables in *Appendix E*, listed by subwatershed and by town. *Figure 2-16* shows the percentage of assessed structures in the Wood-Pawcatuck watershed within each of the AOP classification categories. Overall, 43% of the assessed structures in the watershed are classified as Full AOP or Dry (Full AOP). Another 30% are classified as Reduced AOP or Dry (Reduced AOP), and 27% are classified as No AOP. The percentage of assessed structures in the Wood-Pawcatuck watershed that were identified as moderate to severe barriers (57%) to aquatic organism passage is consistent with other regional stream crossing assessments in New England. The actual percentages of structures with Reduced AOP or No AOP may be somewhat higher than the values shown in *Figure 2-16*, depending on the amount of flow in the streams under "normal" (i.e., non-drought) flow conditions.

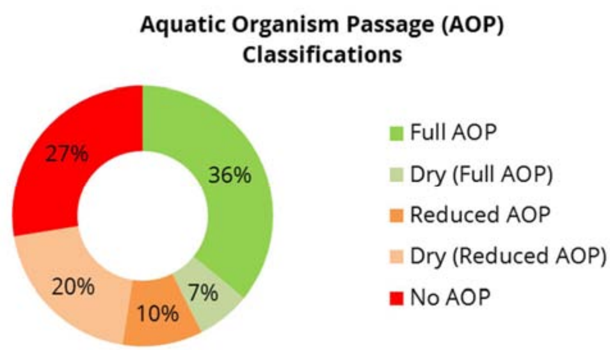


Figure 2-16. Percentage of stream crossing structures in the Wood-Pawcatuck watershed by aquatic organism passage (AOP) classification

The map in *Figure 2-17* shows AOP classifications for the assessed structures in the Wood-Pawcatuck watershed. More detailed subwatershed maps are provided in *Appendix E*. The bar charts in *Figures 2-18, 2-19, and 2-20* illustrate the percentage of the assessed structures in each AOP category by crossing type, structure type, and subwatershed, respectively.

Stream crossings associated with trails and local roads are more significant barriers to aquatic organism passage than crossings associated with state roads, railroads, and highways (*Figure 2-18*). Approximately 68% of local roads and 40% of state roads serve as some form of barrier to aquatic passage. Bridges (89% Full AOP) and arched conduits (75% Full

[3] NAACC (2016). *North Atlantic Aquatic Connectivity Collaborative* Database. North Atlantic Aquatic Connectivity Collaborative. Retrieved online in January 2016 from https://www.streamcontinuity.org/cdb2/naacc_search_crossing.cfm.

AOP) generally have the largest openings and provide the greatest continuity, while box culverts (41% Full AOP) and circular conduits (14% Full AOP) are the greatest barriers to aquatic organism passage in the watershed.

The Beaver River, Lower Wood River, and Shunock River subwatersheds have the greatest percentage of full barriers (No AOP) to aquatic organism passage. Many of the assessed structures in the Queen-Usquepaug River, Chickasheen Brook, Wyassup Brook, and Ashaway River subwatersheds, particularly smaller headwater streams, were dry at the time of the field inspections but exhibited one or more characteristics of reduced passage, resulting in relatively large numbers of structures classified as Dry (Reduced AOP) in these areas.

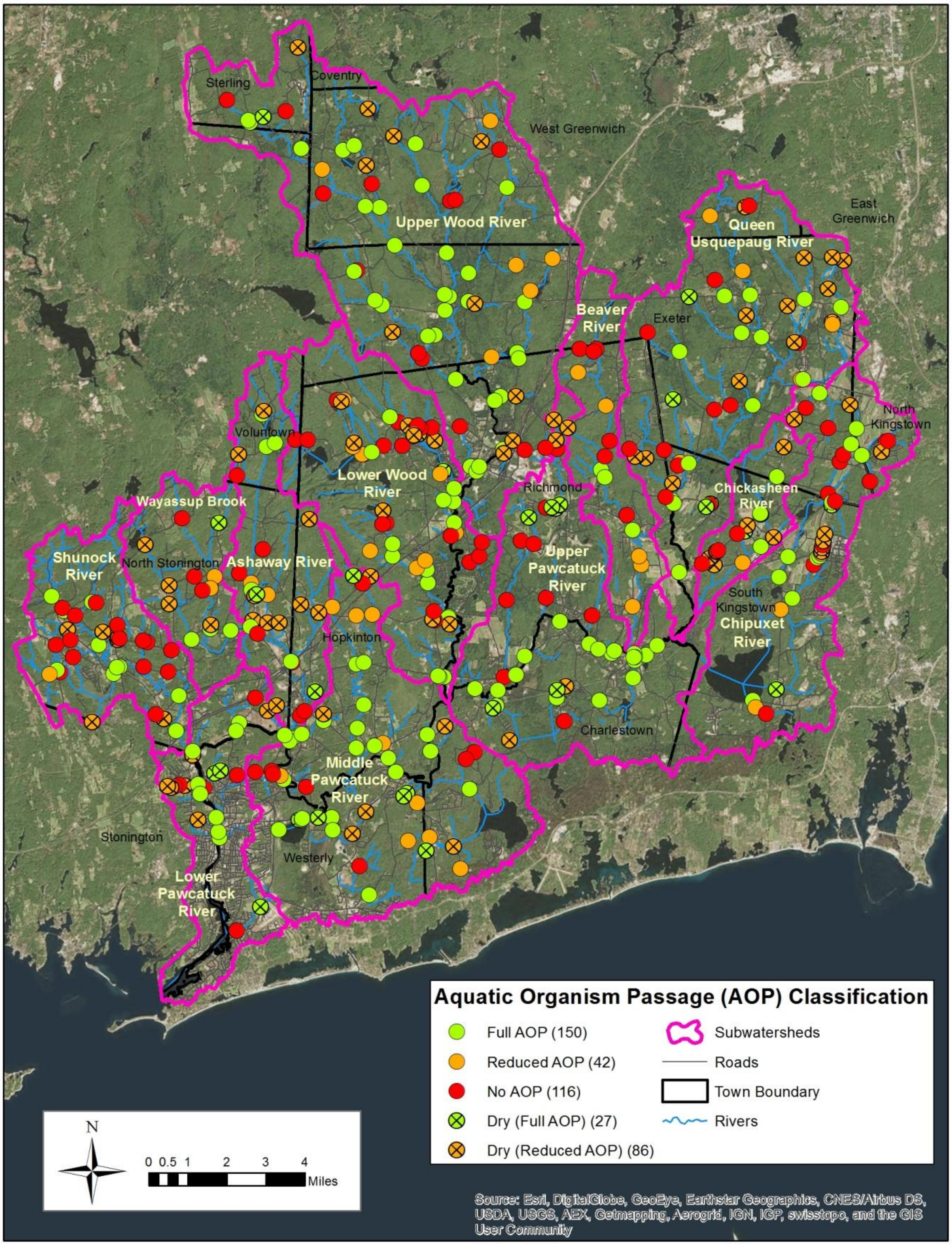


Figure 2-17. Culvert and bridge aquatic organism passage classifications

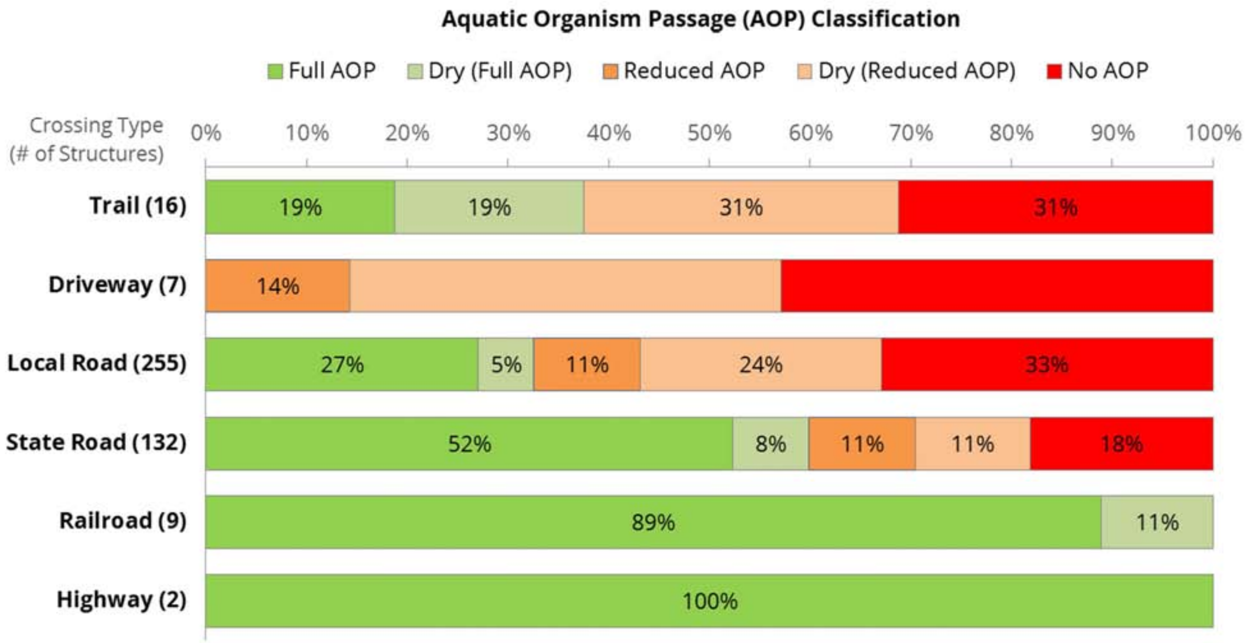


Figure 2-18. Culvert and bridge aquatic organism passage classifications by crossing type.

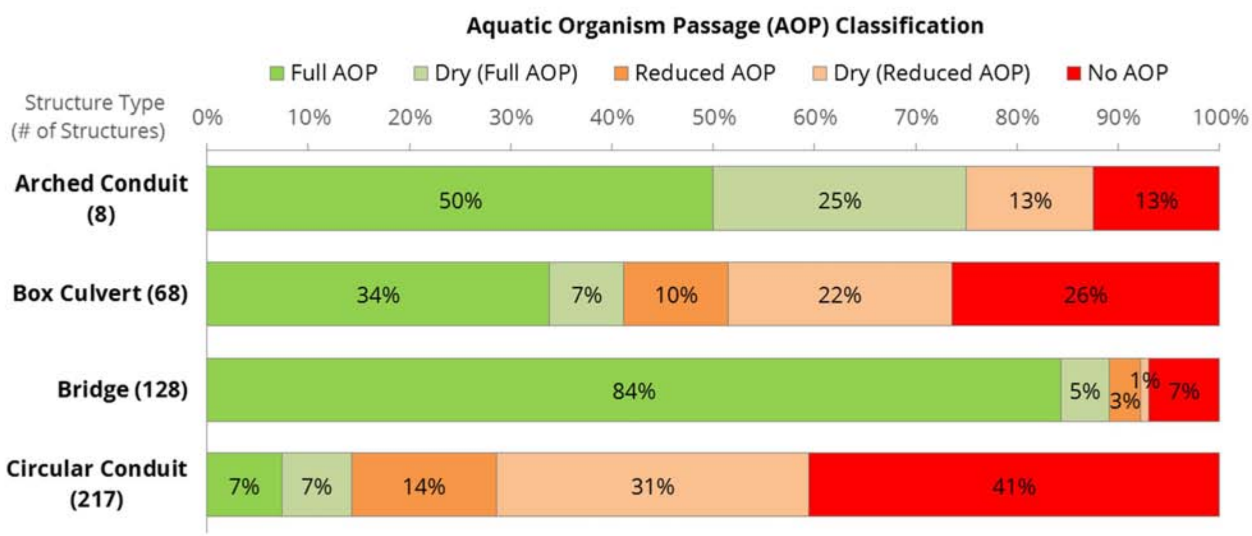


Figure 2-19. Culvert and bridge aquatic organism passage classifications by structure type.

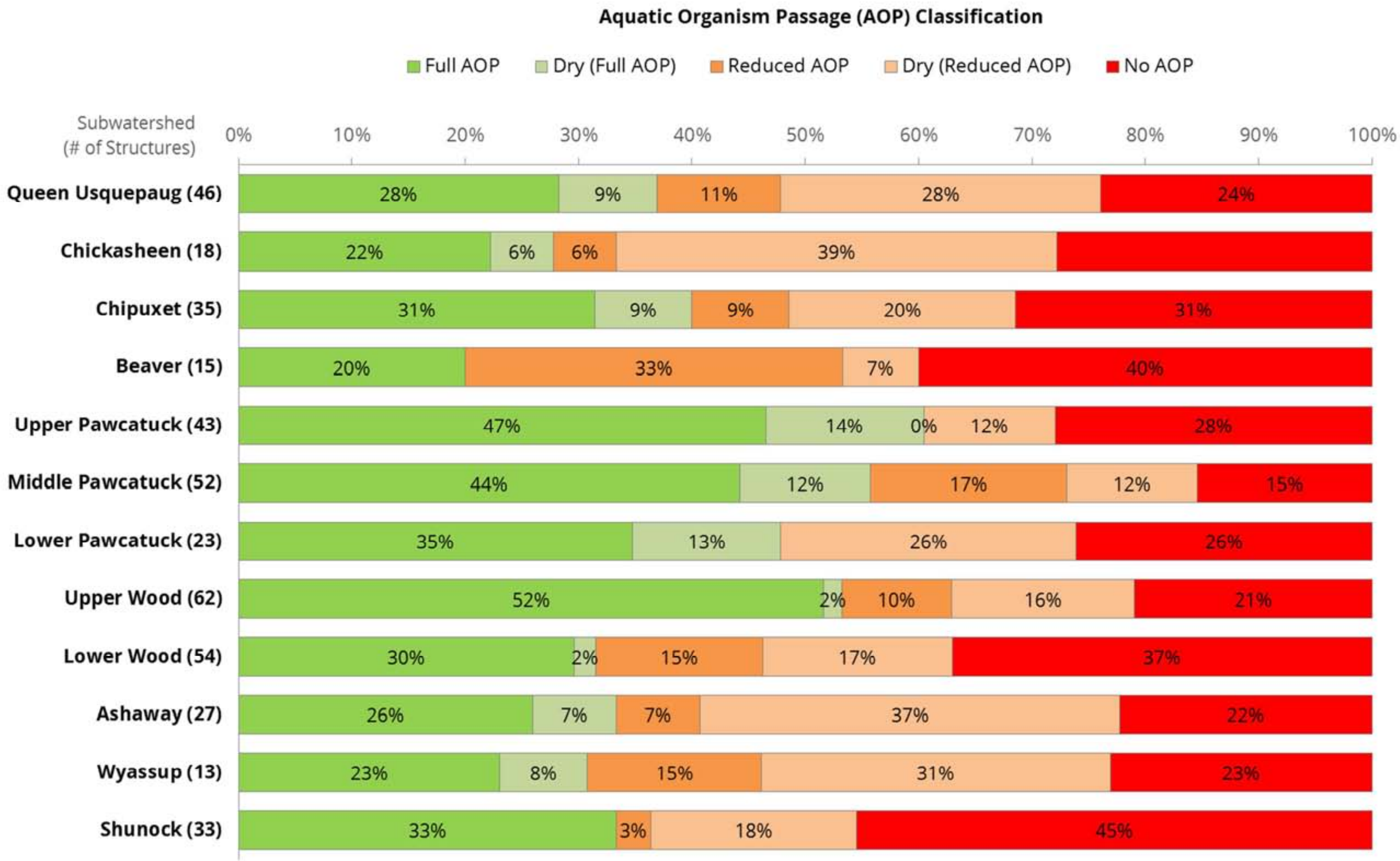


Figure 2-20. Culvert and bridge aquatic organism passage classifications by subwatershed.

2.4 Structure Prioritization

The results of all four culvert and bridge assessments – hydraulic capacity, flooding impact potential, geomorphic vulnerability, and aquatic organism passage (AOP) – were used to determine an overall priority for each structure for potential upgrade or replacement. Hydraulic capacity ratings, flooding impact potential ratings, geomorphic vulnerability ratings, and AOP classifications were converted to numerical scores between 1-5, with 1 reflecting the lowest flood hazard potential and 5 reflecting highest flood hazard potential. The scores for each assessment were weighted (*Table 2-7*), consistent with the goals of this study, and the weighted scores were then added to calculate an overall score.

Table 2-7. Weighting factors for priority ratings of culverts and bridges

Assessment Rating	Scoring Range	Weighting Factor
Hydraulic Capacity	1-5	43%
Flooding Impact Potential	1-5	29%
Geomorphic Vulnerability	1-5	14%
Aquatic Organism Passage	1-5	14%

The structures were then assigned a priority of "Low" (1-2), "Intermediate" (2-3), or "High" (3-5) based on their overall scores. The map in *Figure 2-21* shows priority ratings for the assessed structures in the Wood-Pawcatuck watershed. More detailed subwatershed maps are also provided in *Appendix F*. The overall scores and priority ratings for each structure are provided in *Appendix F*, tabulated by subwatershed and town.

Overall, 37% of the assessed structures in the watershed are rated as high priority, 43% are rated as intermediate priority, and 20% are low priority. The bar charts in *Figures 2-22, 2-23, and 2-24* show the percentages of the assessed structures in each priority rating category by crossing type, structure type, and subwatershed, respectively.

The high-priority stream crossings are associated with local roads (103), state roads (41), driveways (7) and trails (6), with a slightly higher percentage of local road stream crossings (40%) rated as high priority compared with high-priority stream crossings of state roads (31%) (*Figure 2-22*). Circular conduits and box culverts comprise the highest percentage of high-priority stream crossings in the watershed (*Figure 2-23*). Approximately 80% of the high-priority stream crossings are circular conduits or box culverts. 30 bridges and 1 arched conduit are also considered high priority.

The largest numbers of high-priority structures are located in the Queen-Usquepaug River, Upper Wood River, and Lower Wood River subwatersheds (*Figure 2-24*), although the Beaver River, Wyassup Brook, and Ashaway River subwatersheds have the highest percentage of high-priority structures. The high-priority stream crossings are summarized by town in *Table 2-8.*

The culvert and bridge priority ratings developed through this analysis help to identify overall priorities for stream crossing upgrade or replacement, given the large number of structures that exist in the watershed. The priority ratings are relative – upgrade or replacement of higher-rated or higher-priority structures generally provides greater potential benefits relative to flood resiliency and stream continuity based on a number of factors. The priorities are not meant as definitive recommendations (e.g., not all high-priority structures should necessarily be replaced or repaired, and not all low-priority structures are adequate "as-is") since the ratings do not account for the costs and other site-specific factors. The individual assessment ratings (i.e., hydraulic capacity, flooding impact potential, geomorphic vulnerability, and AOP) should also be considered individually and on a case-by-case basis when evaluating upgrades or replacement of specific stream crossing structures. Stream crossing recommendations should consider other upstream and downstream crossings and dams on the same river system. A full hydrologic and/or hydraulic analysis is beyond the scope of this planning-level assessment. Hydraulic modeling would be required during future design to quantitatively assess potential upstream and downstream impacts of stream crossing modifications on flow velocities and water surface profiles. Other potential impacts and constraints would also need to be considered during design and permitting.

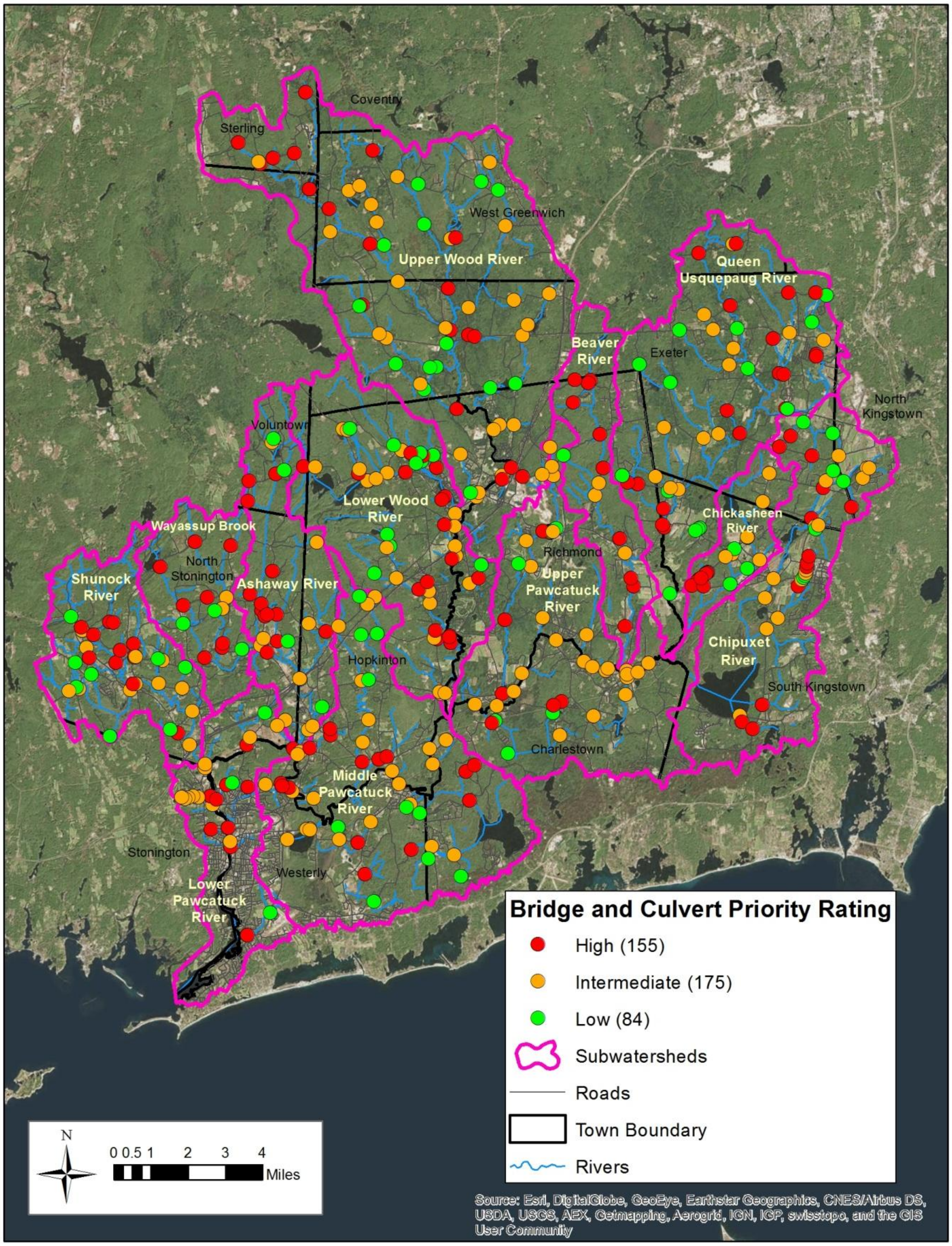


Figure 2-21. Culvert and bridge priority ratings

Figure 2-22. Culvert and bridge priority ratings by crossing type.

Figure 2-23. Culvert and bridge priority ratings by structure type.

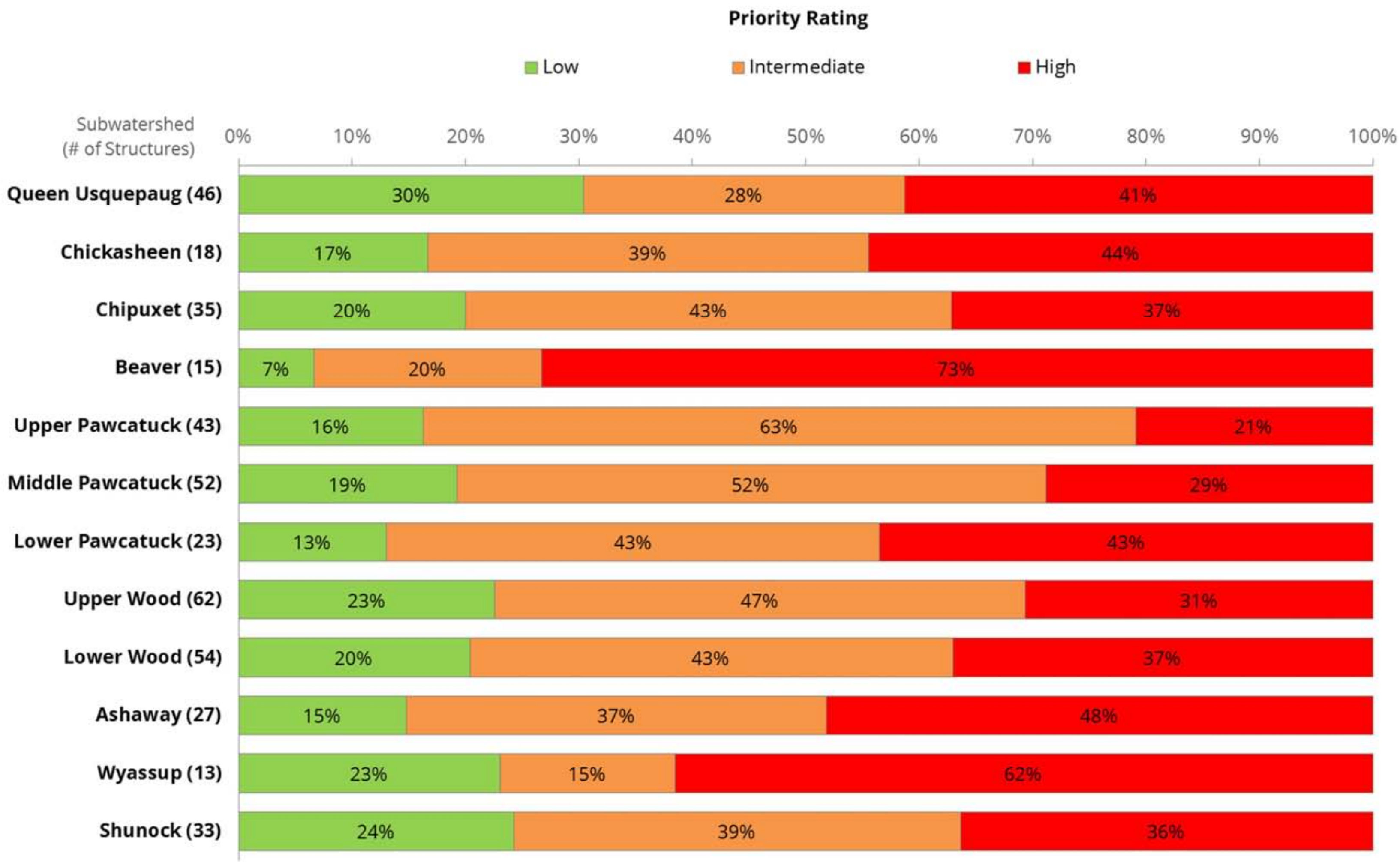


Figure 2-24. Culvert and bridge priority ratings by subwatershed.

Table 2-8. High priority culverts and bridges

Town	Structure Name/ Subwatershed	Road Name	Road Type	Structure Type	Hydraulic Capacity Rating	Flooding Impact Potential Rating	Geomorphic Vulnerability Rating	Aquatic Organism Passage Classification
Charlestown	MPR-POQ-0-1	Buckeye Brook Road	Local	circular conduit	10-Year	Medium	High	Full AOP
Charlestown	MPR-POQ-1-2	Burlingame State Park - Mgmt Area	State	circular conduit	< 10-Year	Low	High	No AOP
Charlestown	MPR-POQ-1-3	Burlingame State Park - Mgmt Area	State	circular conduit	< 10-Year	Low	High	No AOP
Charlestown	UPR-CED-1-1	Shumankanuac Hill Road	Local	circular conduit	< 10-Year	Low	High	Dry (Full AOP)
Charlestown	UPR-CED-7-1	Narragansett Trail	Local	circular conduit	< 10-Year	Low	High	Dry (Reduced AOP)
Charlestown	UPR-CED-8-1	Saw Mill Road	Local	circular conduit	< 10-Year	Low	High	Dry (Full AOP)
Exeter	CPR-CHP-0-4	Wolf Rocks Road	Local	box culvert	< 10-Year	Medium	Medium	No AOP
Exeter	CPR-CHP-0-5	Yawgoo Valley Road	Local	circular conduit	25-Year	High	High	No AOP
Exeter	CPR-CHP-6-1	Liberty Road	Local	circular conduit	< 10-Year	Low	High	No AOP
Exeter	CPR-CHP-7-2	Deer Brook Lane	Local	circular conduit	< 10-Year	Medium	High	No AOP
Exeter	CPR-CHP-7-3	Mail Road	Local	circular conduit	< 10-Year	Medium	High	Dry (Reduced AOP)
Exeter	QUR-FIS-0-2	Pardon Joslin Road	Local	circular conduit	10-Year	Low	High	Reduced AOP
Exeter	QUR-FOUND-20150810	Punchbowl Road	Local	circular conduit	< 10-Year	Low	High	No AOP
Exeter	QUR-QFB-0-1	Ladd Drive	Local	bridge	25-Year	Medium	High	Reduced AOP
Exeter	QUR-QFB-0-10	Pinoak Drive	Local	circular conduit	10-Year	Medium	Medium	Dry (Reduced AOP)
Exeter	QUR-QFB-0-9	Tarbox Drive	Local	circular conduit	< 10-Year	High	Medium	Reduced AOP
Exeter	QUR-QFB-2-2	Stony Lane	Local	circular conduit	< 10-Year	Low	High	Dry (Reduced AOP)
Exeter	QUR-QUR-0-6	Mail Road	Local	bridge	< 10-Year	Low	High	Full AOP
Exeter	QUR-QUR-0-7	William Reynolds Road	Local	box culvert	< 10-Year	Low	High	Dry (Reduced AOP)
Exeter	QUR-QUR-0-9	Stony Lane	Local	circular conduit	< 10-Year	Low	High	Dry (Reduced AOP)
Exeter	QUR-QUR-10-1	William Reynolds Road	Local	circular conduit	< 10-Year	Medium	Medium	Dry (Reduced AOP)
Exeter	QUR-QUR-11-1	Purgatory Road	Local	circular conduit	< 10-Year	Medium	High	Dry (Reduced AOP)
Exeter	QUR-QUR-7-1	Liberty Church Road	Local	circular conduit	10-Year	Medium	Low	Dry (Reduced AOP)
Exeter	UWR-FLA-0-1	Midway Rail Road	Local	bridge	10-Year	Medium	High	Full AOP
Exeter	UWR-FLA-0-2	Flat River Road	Local	bridge	10-Year	Medium	High	Full AOP
Exeter	UWR-WOR-18-4-1	Old Voluntown Road	Local	circular conduit	< 10-Year	Low	Medium	No AOP
Exeter	UWR-WOR-19-2	Arcadia Management Area	State	circular conduit	< 10-Year	Low	High	Full AOP
Exeter	UWR-WOR-19-3	Ten Rod Road	State	circular conduit	< 10-Year	Low	High	Dry (Reduced AOP)
Hopkinton	AWR-PAR-0-2	Clarks Falls Road	State	circular conduit	< 10-Year	Medium	High	Dry (Reduced AOP)
Hopkinton	LWR-BRU-0-2	Sawmill Road	Local	circular conduit	10-Year	Medium	High	No AOP
Hopkinton	LWR-BRU-2-1	Harningstuns Crossing	Local	bridge	25-Year	Medium	High	Dry (Full AOP)
Hopkinton	LWR-BRU-2-2	Harningstuns Crossing	State	circular conduit	< 10-Year	Medium	High	Reduced AOP
Hopkinton	LWR-BRU-3-1	Fairview Avenue	Local	circular conduit	< 10-Year	Low	Medium	Dry (Reduced AOP)
Hopkinton	LWR-BRU-5-2	Dye Hill Road	Local	circular conduit	< 10-Year	Low	High	No AOP
Hopkinton	LWR-BRU-6-1	Dye Hill Road	Local	circular conduit	< 10-Year	Low	High	Dry (Reduced AOP)
Hopkinton	LWR-CAN-0-3	Woodlawn Drive	Local	circular conduit	50-Year	High	Medium	Reduced AOP
Hopkinton	LWR-CAN-1-1	Palmer Circle	Local	circular conduit	25-Year	Medium	High	Reduced AOP
Hopkinton	LWR-MOS-0-2	Woody Hill Road	Local	bridge	100-Year	High	High	No AOP
Hopkinton	LWR-MOS-0-7	Camp Yawgoog Road	State	circular conduit	25-Year	Medium	High	Reduced AOP
Hopkinton	LWR-MOS-4-1	Camp Yawgoog Road	Local	bridge	10-Year	Low	High	No AOP
Hopkinton	LWR-WOR-0-1	Alton Bradford Road	State	bridge	50-Year	High	High	No AOP
Hopkinton	LWR-WOR-0-2	Woodville Road	State	bridge	< 10-Year	High	Medium	Full AOP
Hopkinton	LWR-WOR-4-1	Crowthor Road	Local	circular conduit	10-Year	Low	High	Dry (Reduced AOP)
Hopkinton	LWR-WOR-4-2	Woodville Road	State	circular conduit	< 10-Year	Medium	High	No AOP

Table 2-8. High priority culverts and bridges

Town	Structure Name/ Subwatershed	Road Name	Road Type	Structure Type	Hydraulic Capacity Rating	Flooding Impact Potential Rating	Geomorphic Vulnerability Rating	Aquatic Organism Passage Classification
Hopkinton	LWR-WOR-5-1	Woodville Road	State	bridge	< 10-Year	Medium	High	Full AOP
Hopkinton	LWR-WOR-6-1-1	Woodville Alton Road	Local	circular conduit	< 10-Year	Medium	High	No AOP
Hopkinton	LWR-WOR-8-1	Graniteville Road	Local	circular conduit	< 10-Year	Low	High	No AOP
Hopkinton	LWR-WOR-9-2	Noseneek Hill Road	State	box culvert	< 10-Year	High	High	Full AOP
Hopkinton	MPR-MIL-0-2	Main Street	State	box culvert	50-Year	High	High	Full AOP
Hopkinton	MPR-MIL-0-3	Ashaway Road	State	circular conduit	10-Year	High	Medium	Full AOP
Hopkinton	MPR-MIL-1-2	Ashaway Road	State	box culvert	25-Year	Medium	High	Dry (Reduced AOP)
Hopkinton	MPR-TOM-0-1	Chase Hill Road	State	bridge	25-Year	High	High	Full AOP
Hopkinton	MPR-TOM-1-1	Tomaquag Road	Local	box culvert	< 10-Year	High	High	Full AOP
Hopkinton	MPR-TOM-1-3	Vuono Road	Local	circular conduit	< 10-Year	High	High	Reduced AOP
Hopkinton	UWR-WOR-17-1	Blitzkrieg Trail	Local	box culvert	< 10-Year	Low	High	Full AOP
North Kingstown	CPR-CHP-5-1-2-1	Kayka Ricci Way	State	circular conduit	< 10-Year	Medium	High	No AOP
North Stonington	AWR-GLA-0-1	East Clarks Falls Road	Local	circular conduit	10-Year	Medium	Low	Dry (Reduced AOP)
North Stonington	AWR-GLA-0-2	Pine Woods Road	Local	circular conduit	10-Year	Medium	High	Reduced AOP
North Stonington	AWR-GRE-0-3	Denison Hill Road	Local	bridge	< 10-Year	Medium	High	Full AOP
North Stonington	AWR-GRE-0-4	Puttker Road	Local	box culvert	10-Year	Medium	Low	Reduced AOP
North Stonington	AWR-GRE-3-1	Clarks Falls Road	State	circular conduit	< 10-Year	Medium	Low	No AOP
North Stonington	AWR-GRE-5-1	Denison Hill Road	Local	circular conduit	< 10-Year	Low	Medium	Dry (Reduced AOP)
North Stonington	AWR-GRE-5-2	Denison Hill Road	Local	circular conduit	< 10-Year	Low	High	Dry (Full AOP)
North Stonington	AWR-GRE-6-1	Loin Hill Road	Local	circular conduit	< 10-Year	Medium	High	No AOP
North Stonington	AWR-GRE-7-1	Denison Hill Road	Local	circular conduit	< 10-Year	Low	High	No AOP
North Stonington	SNR-SHU-0-11	Bicentennial Trail	Local	bridge	10-Year	Medium	High	Full AOP
North Stonington	SNR-SHU-0-13	Norwich-Westerly Road	State	bridge	100-Year	High	High	No AOP
North Stonington	SNR-SHU-0-9	Main Street	Local	bridge	< 10-Year	High	High	Full AOP
North Stonington	SNR-SHU-1-1	Norwich-Westerly Road	State	circular conduit	10-Year	Medium	High	No AOP
North Stonington	SNR-SHU-6-3	Mains Crossing	Local	circular conduit	< 10-Year	Medium	High	No AOP
North Stonington	SNR-SHU-7-1	Wyassup Road	Local	circular conduit	< 10-Year	Medium	High	Dry (Reduced AOP)
North Stonington	SNR-SHU-7-1-1	Wyassup Road	Local	circular conduit	< 10-Year	Medium	High	Dry (Reduced AOP)
North Stonington	SNR-SHU-7-1-2	Chester Main Road	Local	circular conduit	< 10-Year	Medium	High	No AOP
North Stonington	SNR-SHU-8-1	Ryder Road	Local	circular conduit	10-Year	Low	High	Dry (Reduced AOP)
North Stonington	SNR-YAW-0-1	Ryder Road	Local	circular conduit	10-Year	Medium	High	No AOP
North Stonington	SNR-YAW-0-2	Yawbux Valley Road	Local	circular conduit	< 10-Year	Medium	High	Full AOP
North Stonington	SNR-YAW-1-1	Yawbux Valley Road	Local	circular conduit	< 10-Year	Low	High	No AOP
North Stonington	WPB-HET-0-2	Wyassup Road	Local	circular conduit	< 10-Year	Low	High	No AOP
North Stonington	WPB-PHB-0-1	State Highway 49	State	bridge	10-Year	High	High	Full AOP
North Stonington	WPB-PHB-0-5	State Highway 49	State	box culvert	< 10-Year	Medium	High	Dry (Full AOP)
North Stonington	WPB-PHB-1-1	State Highway 49	State	circular conduit	< 10-Year	High	High	Dry (Reduced AOP)
North Stonington	WPB-PHB-3-2	Grindstone Hill Road	Local	circular conduit	< 10-Year	Low	High	No AOP
North Stonington	WPB-WAY-0-2	State Highway 49	State	bridge	10-Year	Medium	High	Full AOP
North Stonington	WPB-WAY-0-4	Grindstone Hill Road	Local	circular conduit	< 10-Year	Medium	High	Dry (Reduced AOP)
North Stonington	WPB-WAY-0-6	Wyassup Road	Local	circular conduit	< 10-Year	Low	High	Dry (Reduced AOP)
Richmond	BVR-BEA-0-1	Shannock Hill Road	Local	bridge	< 10-Year	Medium	High	Reduced AOP
Richmond	BVR-BEA-0-2	Schoolhouse Road	Local	box culvert	< 10-Year	Medium	High	Reduced AOP
Richmond	BVR-BEA-0-4	Hillsdale Road	Local	circular conduit	< 10-Year	Medium	High	No AOP

Table 2-8. High priority culverts and bridges

Town	Structure Name/ Subwatershed	Road Name	Road Type	Structure Type	Hydraulic Capacity Rating	Flooding Impact Potential Rating	Geomorphic Vulnerability Rating	Aquatic Organism Passage Classification
Richmond	BVR-BEA-0-5	Old Mountain Road	Local	circular conduit	< 10-Year	Medium	Medium	Reduced AOP
Richmond	BVR-BEA-0-6	New London Turnpike	State	circular conduit	25-Year	High	High	No AOP
Richmond	BVR-BEA-5-1	New London Turnpike	State	circular conduit	< 10-Year	High	High	Reduced AOP
Richmond	BVR-BEA-6-1	New London Turnpike	State	circular conduit	10-Year	High	High	No AOP
Richmond	BVR-BEA-6-2	Dawley Park Road	Local	box culvert	< 10-Year	Low	High	No AOP
Richmond	BVR-FOUND-20150630	Punchbowl Road	Local	bridge	10-Year	Medium	High	Full AOP
Richmond	BVR-FOUND-20150817	Unnamed	Trail	bridge	< 10-Year	Medium	Medium	No AOP
Richmond	BVR-FOUND-20151015	Unnamed	Driveway	bridge	10-Year	Medium	High	Reduced AOP
Richmond	LWR-DIA-0-2	Shippee Trail Road	Local	circular conduit	< 10-Year	Low	High	No AOP
Richmond	QUR-GLE-2-1-1	James Trail	Local	circular conduit	< 10-Year	Low	High	Dry (Reduced AOP)
Richmond	QUR-GLE-2-2-1	James Trail	Local	circular conduit	< 10-Year	Low	High	Dry (Reduced AOP)
Richmond	QUR-QUR-0-3	Old Usquepaug Road	State	bridge	25-Year	High	Medium	Full AOP
Richmond	QUR-QUR-0-4	Old Usquepaug Road	State	bridge	50-Year	High	High	Full AOP
Richmond	UPR-FOUND-20151014-2	Unnamed	Trail	circular conduit	< 10-Year	Low	High	Dry (Reduced AOP)
Richmond	UPR-FOUND-20151014-3	Unnamed	Trail	circular conduit	< 10-Year	Low	High	Dry (Reduced AOP)
Richmond	UPR-FOUND-20151014-4	Unnamed	Trail	circular conduit	10-Year	Low	Medium	No AOP
Richmond	UPR-FOUND-20151015-1	Unnamed	Trail	circular conduit	< 10-Year	Low	Medium	No AOP
Richmond	UPR-MEA-0-2	Church Street	State	box culvert	50-Year	High	High	No AOP
Richmond	UPR-MEA-0-3	Pine Hill Road	Local	box culvert	10-Year	Medium	High	No AOP
Richmond	UWR-WOR-13-1	Noonseck Hill Road	State	box culvert	100-Year	High	High	Dry (Reduced AOP)
Richmond	UWR-WOR-14-1	K and G Ranch Road	Local	circular conduit	10-Year	High	Low	Dry (Reduced AOP)
Richmond	UWR-WOR-14-4	Buttonwood Road	Local	circular conduit	< 10-Year	High	Medium	No AOP
South Kingstown	CKR-3047	South County Trail Driveway	Driveway	circular conduit	10-Year	Low	High	No AOP
South Kingstown	CKR-3049	South County Trail Driveway	Driveway	circular conduit	10-Year	Low	High	Dry (Reduced AOP)
South Kingstown	CKR-3071	South County Trail Driveway	Driveway	circular conduit	< 10-Year	Low	High	No AOP
South Kingstown	CKR-3192	South County Trail Driveway	Driveway	circular conduit	10-Year	Low	High	Dry (Reduced AOP)
South Kingstown	CKR-3243	South County Trail Driveway	Driveway	circular conduit	< 10-Year	Low	High	Dry (Reduced AOP)
South Kingstown	CKR-3351	South County Trail Driveway	Driveway	circular conduit	10-Year	Low	Medium	No AOP
South Kingstown	CKR-CHK-1-1	Liberty Road	Local	circular conduit	10-Year	Medium	Medium	Dry (Reduced AOP)
South Kingstown	CKR-CHK-1-2	South County Trail	State	circular conduit	< 10-Year	Medium	High	No AOP
South Kingstown	CPR-ALE-0-2	Worden Pond Family Campground	Local	circular conduit	< 10-Year	Medium	High	Reduced AOP
South Kingstown	CPR-ALE-0-3	Ministerial Road	State	circular conduit	50-Year	High	Medium	No AOP
South Kingstown	CPR-MIN-0-1	Ministerial Road	State	circular conduit	< 10-Year	High	High	Dry (Full AOP)
South Kingstown	CPR-WHB-2-1	Peckham Farm Road	Local	circular conduit	< 10-Year	High	Medium	No AOP
South Kingstown	CPR-WHB-2-7	Walking Path	Trail	box culvert	10-Year	Medium	Medium	No AOP
South Kingstown	CPR-WHB-2-8	Plains Road	Local	circular conduit	< 10-Year	Medium	High	Dry (Reduced AOP)
South Kingstown	CPR-WHB-2-9	Flagg Road	Local	circular conduit	< 10-Year	Medium	High	Dry (Reduced AOP)
South Kingstown	QUR-QUR-1-1	Glen Rock Road	Local	circular conduit	< 10-Year	Low	Medium	No AOP
Sterling	UWR-CAR-0-5	Newport Road	Local	box culvert	< 10-Year	Low	High	Dry (Reduced AOP)
Sterling	UWR-WOR-0-18	Pachaug Trail	State	bridge	< 10-Year	Low	High	Full AOP
Sterling	UWR-WOR-0-20	Cedar Swamp Road	Local	box culvert	< 10-Year	Low	High	No AOP
Sterling	UWR-WOR-24-2	Gallup Homestead Road	Local	circular conduit	10-Year	Low	High	No AOP
Sterling	UWR-WOR-25-2	Gallup Homestead Road	Local	circular conduit	< 10-Year	Low	High	Dry (Full AOP)
Voluntown	AWR-GRE-0-6	Sand Hill Road	Local	box culvert	< 10-Year	Low	High	Full AOP

Table 2-8. High priority culverts and bridges

Town	Structure Name/ Subwatershed	Road Name	Road Type	Structure Type	Hydraulic Capacity Rating	Flooding Impact Potential Rating	Geomorphic Vulnerability Rating	Aquatic Organism Passage Classification
Voluntown	AWR-GRE-8-2-1	Tom Wheeler Road	Local	circular conduit	< 10-Year	Low	Medium	No AOP
Voluntown	AWR-GRE-8-2-2	Sand Hill Road	Local	circular conduit	< 10-Year	Low	High	Dry (Reduced AOP)
Voluntown	UWR-CAR-0-1	Bailey Pond Road	State	circular conduit	< 10-Year	High	High	Full AOP
West Greenwich	QUR-FIS-0-3	Henry Brown Road	Local	circular conduit	< 10-Year	Low	High	Reduced AOP
West Greenwich	QUR-FIS-3-2	Shetucket Turnpike	Local	circular conduit	< 10-Year	Low	High	No AOP
West Greenwich	UWR-CON-0-2	Tillinghast Pond Road	Local	box culvert	< 10-Year	Medium	High	Dry (Reduced AOP)
West Greenwich	UWR-FAC-1-1	Shetucket Turnpike	Local	circular conduit	< 10-Year	Medium	High	No AOP
West Greenwich	UWR-WOR-0-13	Falls River Road	Local	bridge	< 10-Year	Medium	High	Full AOP
West Greenwich	UWR-WOR-0-14	Hazard Road	Local	circular conduit	< 10-Year	Medium	High	Reduced AOP
Westerly	LPR-MAS-0-1	Watch Hill Road	State	circular conduit	50-Year	High	Low	No AOP
Westerly	LPR-PAW-0-1	Broad Street	State	bridge	< 10-Year	High	High	Full AOP
Westerly	LPR-PAW-0-3	Stillman Avenue	Local	bridge	10-Year	High	High	Full AOP
Westerly	LPR-PAW-0-5	White Rock Road	Local	bridge	10-Year	High	Low	Full AOP
Westerly	LPR-PAW-0-6	Boom Bridge Road	Local	bridge	< 10-Year	Medium	High	Full AOP
Westerly	LPR-PAW-0-7	Post Office Lane	Local	bridge	< 10-Year	Medium	High	Full AOP
Westerly	LPR-PAW-5-1	West Arch Street	Local	circular conduit	< 10-Year	Medium	High	Dry (Reduced AOP)
Westerly	LPR-PAW-7-1	White Rock Road	Local	circular conduit	< 10-Year	High	Low	No AOP
Westerly	LPR-PAW-7-1-1	Spring Brook Road	Local	box culvert	< 10-Year	Medium	High	Dry (Full AOP)
Westerly	LPR-PAW-7-2	Boom Bridge Road	Local	arched conduit	10-Year	Medium	High	No AOP
Westerly	MPR-ISO-NE	Moorehouse Road	Local	box culvert	< 10-Year	Low	High	No AOP
Westerly	MPR-MCG-1-1	Westerly-Bradford Road	State	circular conduit	< 10-Year	High	High	Dry (Reduced AOP)
Westerly	MPR-PAW-16-1	Hiscox Road	Local	circular conduit	< 10-Year	High	Low	Reduced AOP
Westerly	MPR-PAW-16-1-1	Potter Hill Road	State	circular conduit	< 10-Year	Medium	High	No AOP
Westerly	MPR-PAW-16-2	Forrestal Drive	Local	circular conduit	< 10-Year	High	High	No AOP
Westerly	MPR-PER-0-3	Ross Hill Road	State	circular conduit	< 10-Year	Medium	High	Reduced AOP

3 Dams Assessment

Dams in the Wood-Pawcatuck were initially identified through file reviews and then prioritized based on flood risk potential. Limited visual condition assessments were performed of the highest-priority dams, and recommendations were developed for each dam to help decision-makers prioritize the removal, repair or modification of dams to increase flood resiliency as well as improve aquatic habitat, river continuity, and fish passage.

3.1 Structure Selection

Files maintained by the Rhode Island Department of Environmental Management (RIDEM) and Connecticut Department of Energy and Environmental Protection (CTDEEP) dam safety programs were reviewed to develop an initial list of dams in the watershed and to gather available information on the dams. Approximately 150 dams were identified during this initial review.

The scope of this assessment included limited dam condition visual assessments of 70 dams. The 150 known dams were therefore screened to identify the 70 highest-priority dams for assessment (i.e., those with the greatest potential flood risk associated with upstream backwater flooding or downstream flooding in the event of failure). The dams were prioritized based on hazard classification, upstream and downstream development and infrastructure, and current condition identified from previous dam inspection reports available from RIDEM and CTDEEP. The initial list of dams for assessment was reviewed by the Project Steering Committee, and one additional dam was added (Decappet Pond Dam). Bradford Dam was excluded from the evaluation since The Nature Conservancy is already pursuing restoration either through removal or construction of a rock ramp fish passage structure.[4] The final list of dams selected for assessment is provided in *Appendix G*. The locations of these dams are shown in *Figure 3-1*. More detailed subwatershed maps showing the names and locations of the dams are provided in *Appendix G*.

3.2 Field Inspection and Data Collection

Limited visual condition assessments of the selected dams were conducted from May to September 2015. Assessments were conducted following standardized dam safety inspection protocols using a form adapted from the Massachusetts Office of Dam Safety Phase 1 Formal Dam Safety Inspection Checklist. The inspection form includes the following information:

- Classification information (current size, hazard classification, condition, name, location, purpose, etc.)
- Deficiencies and condition of each part of the structure (embankment, dikes, upstream face, downstream face, appurtenances, walls, concrete structures, masonry structures, spillways, etc.)

A blank copy of the inspection form, completed inspection forms, and relevant file review information for each dam assessed is provided in *Database B*.

[4] The Bradford Dam is a low hazard, run-of-the river type dam that spans the Pawcatuck River from Hopkinton to Westerly, Rhode Island. The Nature Conservancy of Rhode Island recently received funding from the U.S. Fish & Wildlife Service to undertake fish passage and flood mitigation projects along the Lower Pawcatuck River including at the Bradford Dam. In 2015, part of the funding was used to successfully remove the White Rock Dam which is located 7 miles downstream. Because restoration projects at Bradford Dam were under review at the time of this study, Bradford Dam was not included for prioritization. The Nature Conservancy is pursuing restoration with a rock ramp or by removal.

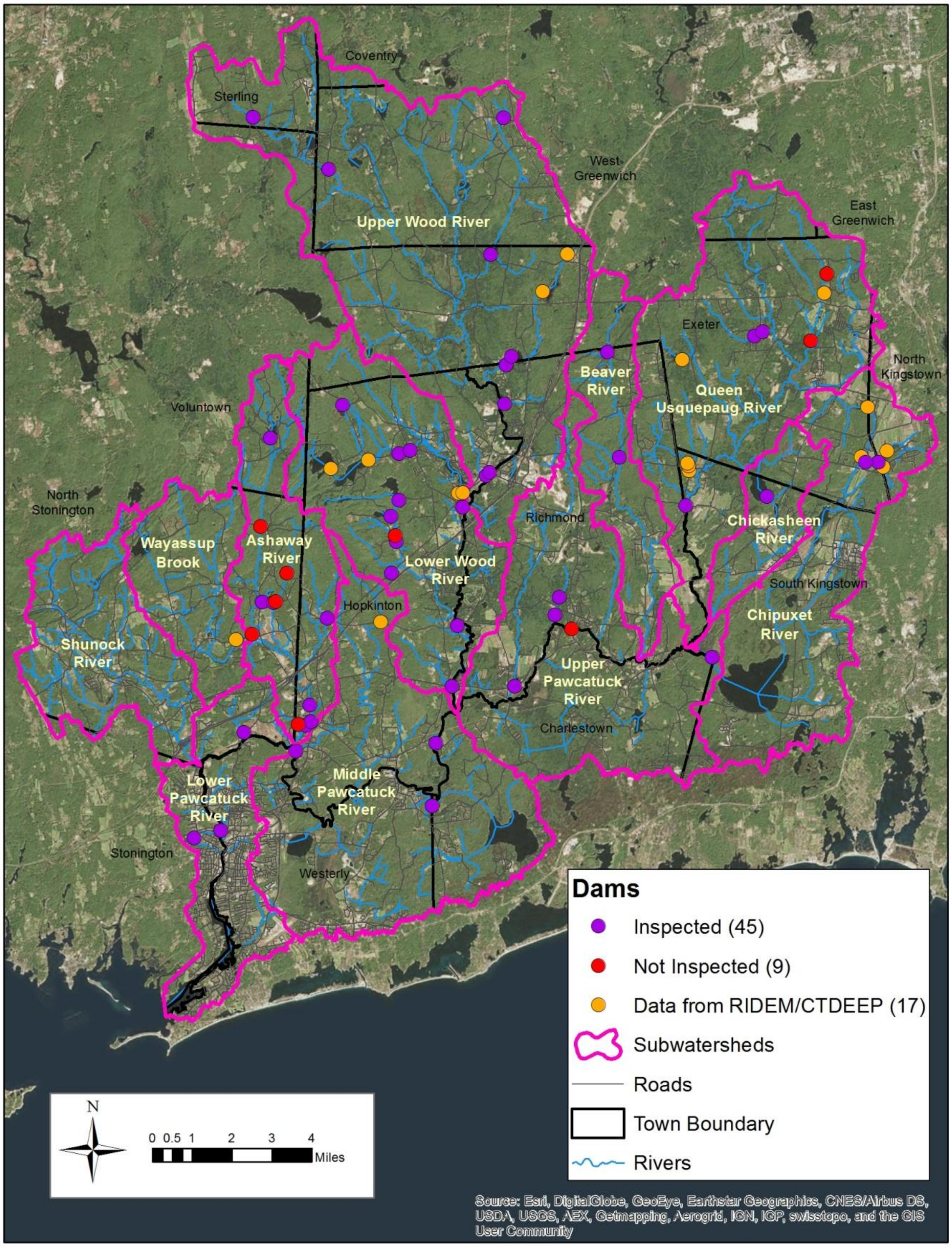
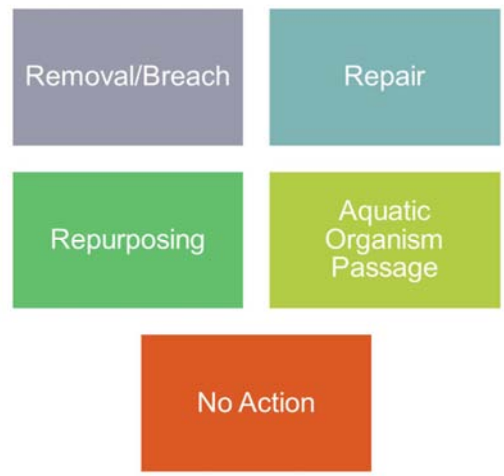


Figure 3-1. Locations of dams in the Wood-Pawcatuck watershed selected for limited visual condition assessment

Two dams in the RIDEM database had the same geographic coordinates (Arcadia Mill Lower Dam and Browning Mill Bypass Dam), but only one dam could be located during the inspection. Of the 70 dams selected for limited visual condition assessment, visual inspections were conducted of 43 dams. Access to 27 dams was either unavailable or denied by the land owner. Of the 27 dams that were not inspected, 16 had sufficient information in the RIDEM or CTDEEP files such that the file review information was used to assess and make recommendations for those dams.

3.3 Initial Screening of Management Alternatives

An initial screening-level assessment was conducted to evaluate and guide the development of management recommendations for each dam, with the goal of improving flood resiliency and aquatic habitat, river continuity, and fish passage. The following dam management alternatives were initially evaluated (see graphic at right):



Management alternatives evaluated for dams in the Wood-Pawcatuck watershed.

- Removal/Breach: this alternative consists of full removal or partial breach of a dam, thereby eliminating or lowering the impoundment, reducing the risk of failure or breach, and restoring free-flowing conditions to the river system. Dam removal eliminates flood risk due to failure or breach, potentially reduces flood risk in upstream areas, and meets aquatic organism passage objectives. However, the feasibility of removing a dam is also dictated by many other factors including current uses of the impoundment, cooperation of the owner, potential impacts to existing wetlands and habitat, and management of potentially contaminated sediments.

- Repair: the repair alternative includes repair of structural components of a dam to address existing deficiencies that threaten the structural integrity of the dam, thereby reducing the potential for failure or breach during a large storm event. The dam repair alternative alone does not eliminate the risk of failure nor does it improve aquatic organism passage. In some cases, the repair option, potentially combined with provision of aquatic organism passage, may be the only viable alternative if removal is not feasible. The dam repair alternative involves the up-front cost of the repairs and a long-term financial commitment to inspect and maintain the dam following the initial repairs. It also assumes that the current owner has the willingness, ability, and financial resources to adequately maintain the dam.

- Repurposing: this alternative includes modification of an existing dam to provide increased storage during floods. For example, repurposing could include modification of the low-level outlet structure to significantly reduce the impoundment size and normal pool elevation, allowing the river or stream to flow freely, under normal conditions (i.e., a dry impoundment), but allowing the impoundment to fill up and store floodwaters during larger storms. Given the low-gradient nature of the Wood-Pawcatuck system, none of the dams were originally constructed for flood control purposes and most of the existing impoundments provide limited flood storage. Repurposing also assumes that the current owner has the willingness, ability, and financial resources to adequately maintain the dam.

- Aquatic Organism Passage Structure: this alternative involves construction of an engineered structure at a dam to provide for Aquatic Organism Passage (AOP), including fishways such as fish ladders and rock ramps and bypass channels. This option is designed to provide enhanced stream continuity if dam removal is not feasible.

- No Action/Maintain: the No Action alternative is to essentially maintain the dam in its current condition.

For each dam, the above alternatives were evaluated based on a combination of the following factors, providing a standardized set of criteria against which all of the dams were initially assessed. A numerical score ranging from 1 to 5 was assigned for each of the criteria, with a 1 indicating lower flood risk and 5 indicating higher flood risk.

- Hazard Classification: Hazard classification or "hazard class" is a rating assigned to a dam by state dam safety officials (RIDEM and CTDEEP) that relates to the probable consequences of failure of the dam. It is based on dam height, potential hazard to downstream infrastructure, potential loss of human life, and potential property damage in the event of failure. Hazard class does not relate to the current condition of the dam or the probability that the dam might fail.

  In Rhode Island, RIDEM classifies dams as High Hazard, Significant Hazard, or Low Hazard. High Hazard dams are dams where failure or misoperation will result in a probable loss of human life. Significant Hazard dams are those dams where failure or misoperation results in no probable loss of human life but can cause major economic loss, disruption of lifeline facilities or impact to other concerns detrimental to the public's health, safety or welfare. Low Hazard refers to a dam where failure or misoperation results in no probable loss of human life and low economic losses. Connecticut uses a similar classification system, but with five categories – High Hazard, Significant Hazard, Moderate Hazard, Low Hazard, and Negligible Hazard.

  For this assessment, dam hazard classifications were lumped into four classes – High, Significant, Moderate, and Low – and assigned relative numerical scores of 5, 3, 3, and 1, respectively, as a measure of overall hazard potential. Connecticut's Moderate hazard class would likely be considered a Significant hazard class in Rhode Island, thus the equivalent scores.

- Overall Condition: The overall condition of the dam is based on observations made during the limited dam condition visual inspections, as well as recent inspections and photographs from file reviews. Dams were assigned a score of 1-5, with 1 being better condition and 5 being poorer condition.

- Watershed Ratio: The watershed ratio is the ratio of the watershed area to the impoundment area. The watershed ratio provides a rough quantitative measure of an impoundment's flood storage potential. A higher ratio reflects an impoundment that is small in relation to the size of the watershed, and thus is less likely to provide significant flood protection benefit to downstream properties and infrastructure. Conversely, a lower watershed ratio indicates that the impoundment may provide some level of flood mitigation, assuming adequate freeboard is available above the normal pool elevation. For each dam, the watershed area was obtained from the USGS StreamStats program, and the impoundment area was obtained from Rhode Island Dam Hazard reports, information from the CTDEEP file reviews, or estimated from aerial imagery (i.e., GoogleEarth).

  For this assessment, dams were assigned the following scores based on their watershed ratio:

Watershed Ratio greater than or equal to 75	5
Watershed ratio between 75 and 15	3
Watershed ratio less than or equal to 15	1

- Capacity Ratio: The capacity ratio is the ratio of the estimated dam hydraulic capacity to the estimated 100-year flood flow. The capacity ratio provides a rough quantitative measure of a dam's ability to safely pass flood flows. A higher ratio means that a dam is less likely to fail during a flood as a result of inadequate conveyance capacity. It should be noted that all dams should be able to pass their spillway design flood, which is typically greater than the 100-year flood flow. However, the 100-year flood flow was used in the analysis as data was available for this parameter for all dams, which allowed a relative comparison.

The hydraulic capacity of each dam was estimated using the weir flow equation for overflow spillways and drop inlets, and CulvertMaster software (i.e., culvert hydraulic equations) was used for low-level or conduit spillways. Low-level outlets or structures that require manual operation to increase the flow capacity were not considered in this analysis. The 100-year flood flow was estimated using regional regression equations (USGS StreamStats) and TR-20 (SCS unit hydrograph method) for one dam (Great Swamp Goose Marsh Dam) where regional regression equations could not be used to estimate flood flows. Similar to the culvert/bridge hydraulic capacity analyses, some of the dams had input parameters outside of the range for which the regional regression equations were developed. StreamStats output and TR-20 results are provided in *Database D*.

For this assessment, dams were assigned the following scores based on their capacity ratio:

Capacity Ratio greater than or equal to 5	1
Capacity Ratio between 5 and 2	2
Capacity Ratio between 2 and 1	3
Capacity Ratio between 1 and 0.75	4
Capacity Ratio less than 0.75	5

- Other Factors: Several other subjective factors were considered for some of the alternatives, including the current uses of the impoundments and associated benefits/values, existing downstream stream continuity, cost-effectiveness, ease of permitting, the owner's ability to maintain the dam, and land area available for aquatic organism passage structures. These considerations were worded as questions. If the answer to a question was 'Yes,' that consideration was assigned a score of 5; if the answer was 'No,' it was assigned a score of 1. Intermediate answers were assigned a score of 2 to 4, accordingly.

Table 3-1 lists the evaluation factors that were considered for each alternative. A 1-5 score was assigned to each factor, as described above. An average score (across all of the factors evaluated) was then calculated for each alternative. The evaluation matrix and associated scores are provided in *Appendix G*.

Table 3-1. Dam management alternatives evaluation factors

Dam Removal/Breach	Dam Repair	Dam Repurposing	Aquatic Organism Passage Structure	No Action/ Maintain
Hazard Classification	Dam Condition	Inverse of Watershed Ratio	Current AOP Prevention	Inverse of Dam Condition
Dam Condition	Inverse of Capacity Ratio	Owner's Ability to Maintain Dam	Available Land Area for an AOP Structure	Inverse of Hazard Classification
Watershed Ratio	Reduction in Likelihood of Failure/Cost-Effectiveness	Repurposing Feasibility	Owner's Ability to Maintain Dam	Inverse of Watershed Ratio
Capacity Ratio	Owner's Ability to Maintain Dam		Downstream Stream Continuity	Inverse of Capacity Ratio
Benefits vs. Loss of Current Uses	Existing Uses/Values of the Impoundment			Owner's Ability to Maintain Dam
Downstream Stream Continuity				Anticipated Impact on Flood Risk
Cost-effectiveness				Existing Uses/Values of the Impoundment
Ease of Permitting				

3.4 Development of Final Recommendations

This initial screening-level assessment was used to help identify the highest scoring management alternatives for each dam (i.e., relative management priorities for each dam). Due to the site-specific nature of the alternatives considered, the highest scoring alternatives were further evaluated for feasibility based on information specific to each dam. Planned and ongoing dam removal and repair projects, owner opinions, relationships/proximity with upstream and downstream dams, habitat conditions, recreational value, and other potential benefits and impacts were considered. For example, multiple dams on the same river or tributary, and even within the same subwatershed, were considered collectively when making final recommendations since they are hydrologically connected. Recommendations related to dam removal and aquatic organism passage structures were also considered jointly since it does not make sense, for example, to recommend an AOP structure upstream of a dam that is recommended to be maintained, unless an AOP structure is also recommended for the downstream structure. Input regarding management alternatives for individual dams was also sought from key project partners including WPWA, the Project Steering Committee, RIDEM Office of Dam Safety, and the CTDEEP Dam Safety Program in developing final recommendations for each dam.

In general, dam removal was given priority over other alternatives since dam removal best meets the goals of increased flood resiliency and improved stream continuity. While dam removal is not always the best alternative, where feasible, dam removal has the greatest potential to restore the natural floodplain, reduce upstream flood hazards, eliminate downstream flood risk associated with dam failure, and provide full aquatic organism passage. Removal was therefore recommended as the preferred alternative where it was determined to be a viable option and where dam removal would not cause long-term harm to the ecosystem.

The feasibility of dam removal is commonly dictated by environmental, economic, and social factors including current uses of the impoundment, cooperation of the owner, and public acceptance. Although dam removal is the best long-term solution for increasing flood resiliency, removing public safety hazards, and restoration of fish and wildlife habitat, local communities with strong attachments to a dam and its impoundment and a strong preference for the status quo can be a significant impediment to removal of a dam where the public safety risk and life-cycle costs are not well understood. Changes in public attitudes and social norms related to dams and healthy and naturally functioning river systems are needed for dam removal to be considered and then accepted or rejected on its merits (Johnson & Graber, 2002).

While each dam was evaluated on a case-by-case basis, the following general guidelines were used in developing final recommendations:

- Removal is considered a viable alternative where a dam is currently used solely for recreational purposes unless (1) it is determined that dam removal is not a high priority due to its location, hazard class, condition or maintenance history; (2) if a private owner is actively maintaining the dam; or (3) if the impoundment is a key resource in a dedicated recreational area.

- If current operations or other uses rely on the existing impoundment or dam (i.e., wildlife habitat preservation, agriculture, fish hatchery production, historic structure preservation, etc.), the preferred alternatives generally include repair of the dam, maintaining the dam in its existing condition with no further action, or construction of an aquatic organism passage structure depending on the current condition of the dam and its location.

- Rock ramps or similar nature-like fish passage structures are recommended, where feasible, where removal is not a viable option due to the need to maintain the impoundment for recreational or other purposes. Rock ramps can also be used in conjunction with phased removal of a dam if it is determined that the hydrologic or environmental impacts resulting from a full dam removal are unacceptable.

- Maintenance, rather than removal, is considered a potentially feasible option if the owner of a privately-owned dam is not interested in dam removal and has demonstrated a record of maintaining the dam in good condition consistent with RIDEM or CTDEEP dam safety standards. Removal is preferred for privately-owned dams where consistent and adequate maintenance has not been performed.

- If a dam is already breached, formalizing the breach or completely removing the remaining embankment to eliminate the remaining dam safety risk and restore stream connectivity is the recommended approach.

The table in *Appendix H* summarizes the highest-scoring management alternatives from the initial screening, the recommended alternative based on consideration of other site-specific factors, and comments related to the recommendations for each dam. *Figure 3-2* shows management recommendations for the assessed dams in the Wood-Pawcatuck watershed, grouped into High, Intermediate, and Low priority. More detailed maps showing management recommendations for each subwatershed are provided in *Appendix H*.

High-, intermediate-, and low-priority dam recommendations are presented in *Tables 3-2, 3-3, and 3-4*. Recommendations of “No Action” or “Maintain” are considered low-priority. All other dam recommendations are classified as medium- or high-priority. The priorities are based on current conditions and could change over time as management recommendations are completed. For example, removal of an upstream dam could become a higher priority after a downstream dam is removed on the same river or stream.

Of the approximately 60 dams in the watershed that had sufficient information to be assessed, 34 are recommended to be considered for removal or breach, 7 are recommended for repair, consideration for construction of rock ramps or other AOP structures are recommended at 6 dams, and another 13 dams are recommended to be maintained as-is.

The recommendations provided in this report (i.e., dam removal, repair, AOP structures, etc.) are preliminary in nature and require more detailed, site-specific evaluation to adequately assess various management alternatives, potential flood resiliency and ecological benefits, and potential impacts. Detailed feasibility studies are required to support future planning, design, permitting, and funding requests for implementation of specific dam management recommendations.

The dam management recommendations presented in this report may also be modified based on the findings of the separate Watershed-Scale Wetlands Assessment, which is being conducted as part of the Wood-Pawcatuck Watershed Flood Resiliency planning effort. Final recommendations will be presented in the watershed management plan.

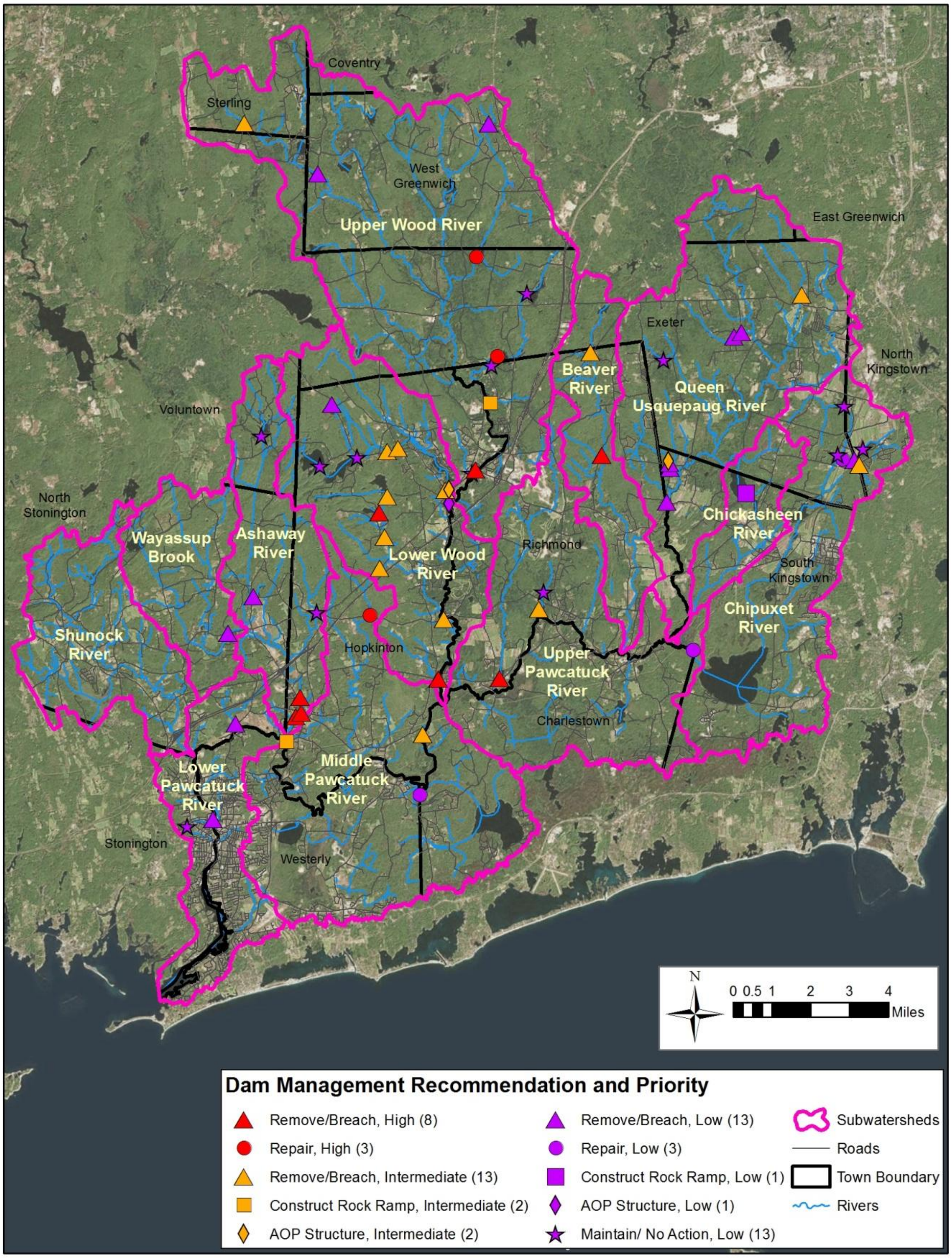


Figure 3-2. Management recommendations for the assessed dams in the Wood-Pawcatuck watershed

Table 3-2. High-priority dam recommendations

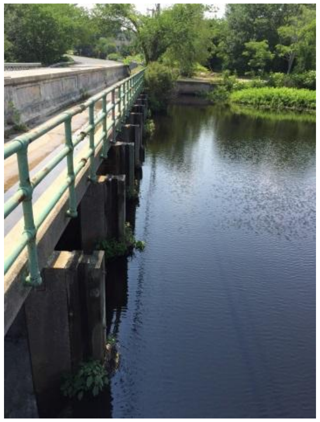
Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
Alton Pond Dam	247	Hopkinton / Richmond	Wood River	Remove	Alton Pond Dam is the downstream-most dam on the Wood River, restricting aquatic passage to the river. Removal should be considered. Replacement or reconfiguration of the Church Street bridge would be required to accommodate dam removal.	
Ashaway Line Pond Dam	266	Hopkinton	Ashaway River	Remove	The impoundment is currently used for fire suppression, although the owner is not opposed to removal. The downstream watercourse is open to fish passage, and the dam is deteriorating. Removal should be considered.	
Ashaway Mill Pond Dam	265	Hopkinton	Ashaway River	Remove	This dam is part of the RIDOT bridge supporting High Street (Route 216). The impoundment does not appear to support any active uses. The dam is deteriorating. Removal is recommended in conjunction with Ashaway Line Pond Dam removal.	

Table 3-2. High-priority dam recommendations

Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
Ashville Pond Dam	227	Hopkinton	Blue Pond Brook	Remove (Replace culvert to maintain roadway)	The dam is not being maintained, is deteriorating, and supports a public road. Dam could be decommissioned by replacing the culvert with a larger structure and draining the impoundment over time. Repurposing was evaluated and determined not to be a priority based on location, lack of downstream hazards and hydrology.	
Bethel Pond Dam	264	Hopkinton	Ashaway River	Remove	The impoundment does not appear to support any active uses and the dam is not being maintained. Removal should be considered in conjunction with the removal of Ashaway Line Pond Dam and Ashaway Mill Pond Dam to increase stream continuity.	

Table 3-2. High-priority dam recommendations

Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
Breakheart Pond Dam	214	Exeter	Breakheart Brook	Repair	This dam is located within the Arcadia Management Area, which has significant recreational value. The downstream watercourse has obstructions to fish passage, and the dam is in poor condition.	
Browning Mill Pond Dam	221	Exeter	Roaring Brook	Repair	RIDEM owns the dam and operates a hatchery downstream. Browning Mill Pond has significant public recreational value. The dam is deteriorating.	

Table 3-2. High-priority dam recommendations

Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
Decappett Pond Dam	230	Richmond	Beaver River	Remove	The dam is located on the Beaver River, which is one of the most valued cold water streams in the State and has a known population of Brook Trout. The impoundment does not appear to support any active uses and the dam is deteriorating. Removal should be considered.	
Potter Hill Dam	254	Hopkinton	Pawcatuck River	Remove	Although the dam has a fish ladder, removal of the dam should be considered to enhance AOP and flood resiliency. Concerns exist about impacts to upstream wetland habitats based on previous evaluations by the U.S. Fish and Wildlife Service.	

Table 3-2. High-priority dam recommendations

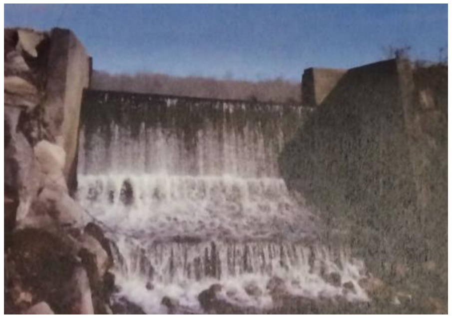
Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
Harris Pond Dam	274	Hopkinton	Tomaquag Brook Tributary	Repair	The owner wants to maintain the dam to provide a wildlife refuge and has completed repairs in the past. A 2013 inspection report indicates that the embankment was in fair to poor condition and was in need of repair (vegetation removal and establishment of grass cover).	
Wood River Junction Dam	273	Richmond	Meadow Brook	Remove	According to RIDEM Dam Safety, the dam is owned by RIDOT, but there is no official owner designation. Dam is in generally poor condition and is not being maintained although the impoundment has high recreational value. Removal should be considered.	

Table 3-2. High-priority dam recommendations

Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
Wyoming Upper Dam	216	Hopkinton/Richmond	Wood River	Removal or Repair (see description)	RIDEM (owner) plans to repair the dam. Dam removal would reduce flood risk to adjacent and upstream properties, improve stream connectivity and water quality. Significant public opposition to dam removal has been expressed by some Hopkinton residents and Town Council. The Richmond Town Council has expressed support for further evaluating the dam removal and other alternatives and requested that RIDEM publicly conduct such an evaluation prior to moving forward with the planned repairs.	

Table 3-3. Intermediate-priority dam recommendations

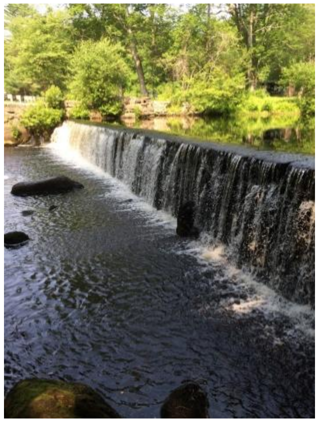
Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
Barberville Pond Dam	215	Hopkinton / Richmond	Wood River	Construct Rock Ramp	Removal of the dam is not recommended due to the impoundment's recreational value. A fish passage structure is recommended as an intermediate priority given the downstream obstructions to fish passage.	
Blue Pond Dam	229	Hopkinton	Blue Pond Brook	Formalize Breach	The dam is partially breached, currently supporting a reduced impoundment. Further erosion and embankment failure could occur during high flows. Formalizing the partial breach is recommended. RIDEM has considered managing the impoundment as a waterfowl management area, which could also be reconsidered.	

Table 3-3. Intermediate-priority dam recommendations

Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
Burdickville Dam	251	Charlestown/ Hopkinton	Pawcatuck River	Remove/Formalize Breach	The impoundment does not appear to support any active uses. The dam is partially breached but may currently prevent passage of some fish species such as shad.	
Centerville Pond Dam	223	Hopkinton	Moscow Brook	Remove (Re-evaluate hazard class)	The dam is deteriorating and not being maintained. The only current known use of the impoundment is private recreation. Removal should be considered. The hazard classification of the dam should be re-evaluated given the downstream infrastructure.	
Edward's Pond Dam	238	Exeter	Queen River	Remove	The impoundment does not appear to support any active uses. A NOV was issued in 2015 for vegetation on the embankment. The dam is classified as a significant hazard. Removal should be considered.	

Table 3-3. Intermediate-priority dam recommendations

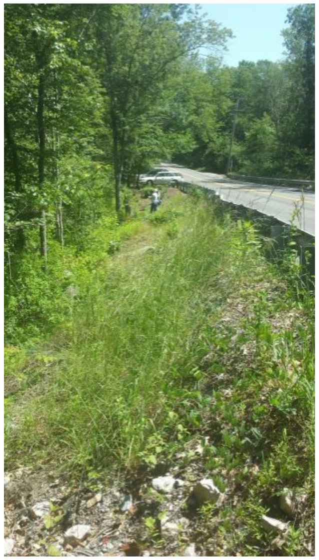
Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
Glen Rock Reservoir Dam	236	South Kingstown	Usquepaug River	Repair and AOP Structure	It is understood that the owner wants to maintain this dam and the impoundment is frequently used for recreation. However, the dam is deteriorating and needs repair. The dam is the downstream-most structure on the Usquepaug River, preventing fish passage to the Usquepaug.	
Hoxie Farm Pond Dam	440	Hopkinton	Canonchet Brook Tributary	Remove (Replace culvert to maintain roadway)	Replace culvert with larger structure and lower invert to drain impoundment and decommission dam. Repurposing was evaluated and determined not to be a priority based on location, lack of downstream hazards and hydrology.	

Table 3-3. Intermediate-priority dam recommendations

Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
Langworthy Pond Dam	285	Hopkinton	Brushy Brook Tributary	Remove	The impoundment is used for private recreation, and the owner has maintained the dam. Removal should be considered given its location and hazard classification. The dam is a significant hazard dam.	
Locustville Pond Dam	262	Hopkinton	Brushy Brook	Maintain/ AOP Structure	The dam is a hydropower dam and powers the commercial buildings downstream of the dam. Owners recently repaired but did not apply to RIDEM for permits for repairs. Repairs have not been inspected by RIDEM and current status is unknown. The dam should be maintained. An AOP structure should be considered once the downstream obstructions are removed.	

Table 3-3. Intermediate-priority dam recommendations

Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
Moscow Pond Dam	222	Hopkinton	Moscow Brook	Remove (Re-evaluate hazard class)	Impoundment is used for fishing. Although the dam is deteriorating, a public road traverses the dam crest and there appears to be a house downstream of the dam. Removal should be considered, and the hazard classification should be re-evaluated.	
Porter Pond Dam	13602	Sterling	Wood River	Remove	The impoundment supports limited recreation uses. The owner of the dam could not be identified. The dam is not being maintained and is in disrepair. Removal should be considered.	

Table 3-3. Intermediate-priority dam recommendations

Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
Slocum Road Upper Dam	710	North Kingstown	Chipuxet River - Tributary	Remove	NOVs were issued in 2011 and 2012 by RIDEM. The owner indicated that repairs were made but RIDEM has not confirmed. The impoundment supports limited recreational use. The dam should be removed if the owner is amenable.	
Tanner Pond Dam	280	Richmond	White Brook	Remove	The hatchery is no longer in operation and the dam is in very poor condition. The dam and hatchery facilities should be removed.	

Table 3-3. Intermediate-priority dam recommendations

Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
Tug Hollow Pond Dam	232	Richmond	Beaver River	Remove	The impoundment does not appear to support any active uses. Removal would improve water quality and connectivity on the Beaver River, which is one of the most valued cold water streams in the State. Removal could require replacement of the downstream culvert.	
Union Pond Dam	288	Hopkinton	Blue Pond Brook	Remove	The impoundment supports private recreational uses. Owner lives out of state and does not actively maintain the dam. Secondary spillway was reportedly breached in 2010 when Blue Pond Dam breached, but has since been dammed by beavers. Dam removal should be considered.	

Table 3-3. Intermediate-priority dam recommendations

Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
Woodville Pond Dam	246	Hopkinton / Richmond	Wood River	Remove (Re-evaluate hazard class)	The impoundment supports no significant active uses and is in disrepair. Removal of the dam could promote connectivity and allow fish passage from the main stem of the Pawcatuck up Meadow Brook. Removal should be considered. Challenges to removal include owner support, use of the impoundment for fire suppression, impacts to upstream wetlands, scour on the downstream bridge, and potential impacts on adjacent dry wells.	

Table 3-3. Intermediate-priority dam recommendations

Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
USGS Stream Gage Weir (USGS Station Number 01117500)	N/A	Richmond	Pawcatuck River	Retrofit (allow gaging to continue while increasing Aquatic Organism Passage)	The weir is a 4-foot high, concrete and stone masonry structure traversing the width of the river. This continuous record stream gage has been in operation since 1940. The weir has significant impacts on stream morphology, sediment transport and AOP (Field, 2016). Given the historical and ongoing data collected by the USGS at this site and the overall importance of this stream gage to the Wood-Pawcatuck and statewide streamflow data collection program, the stream gage weir should not be removed. Retrofitting the site may allow gaging to continue while increasing AOP along the Pawcatuck River. The potential impacts to streamflow measurements resulting from structural modifications at this location, such as the addition of an AOP structure, would need to be evaluated.	

Table 3-4. Low-priority dam recommendations

Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
Arcadia Mill Lower Dam (Browning Mill Bypass Pond Dam)	402	Hopkinton	Roaring Brook	Maintain	This impoundment is part of the RIDEM-owned Arcadia Warm Water Hatchery, which is still in partial operation and is also used for fire suppression.	
Boone Lake Dam	219	Exeter	Roaring Brook	Maintain	The owner's association is very active and maintains the dam. It is understood that the owners would not be supportive of removal.	
Dolly Pond Dam	243	Exeter	Sodom Brook	Remove	The dam is not being maintained and the owner is unknown. The impoundment supports private recreational uses. Removal should be considered, although it is understood that adjacent land owners may not be in favor of dam removal.	

Table 3-4. Low-priority dam recommendations

Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
Glen Rock Lower Pond Dam	233	South Kingstown	Glen Rock Brook	Remove	The impoundment does not support any known uses. The dam is not being maintained. Removal is recommended if supported by the owner.	No Recent Photographs Available
Glen Rock Middle Pond Dam	234	South Kingstown	Glen Rock Brook	Remove	The impoundment does not support any known uses. The dam is not being maintained. Removal is recommended if supported by the owner.	No Recent Photographs Available
Glen Rock Upper Pond Dam	235	South Kingstown	Glen Rock Brook	Remove	The impoundment does not support any known uses. The dam is not being maintained. Removal is recommended if supported by the owner.	No Recent Photographs Available
Grassy Pond Dam	289	Hopkinton	Wincheck Pond Tributary	Remove (Replace culvert to maintain roadway)	Dam was decommissioned by RIDEM (no longer on current dam list). The culvert could be replaced with a larger structure and lower invert to drain the impoundment. Repurposing was evaluated and determined not to be a priority based on location, lack of downstream hazards and hydrology.	

Table 3-4. Low-priority dam recommendations

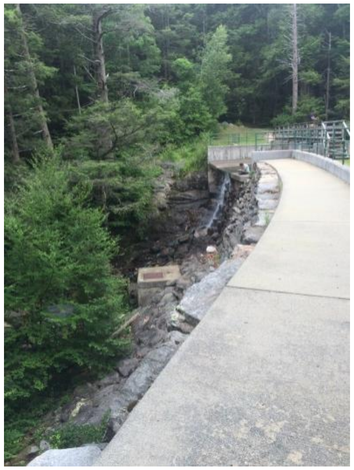
Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
Great Swamp Goose Marsh Dam	531	South Kingstown	Pawcatuck River	Repair	Dam was constructed by RIDEM to create bird habitat. Dam is a low hazard dam in disrepair.	
Green Falls Reservoir Dam	14701	Voluntown	Green Fall River	Maintain	Impoundment is located in the Pachaug State Forest and has significant public recreational value. Dam is in fair condition.	

Table 3-4. Low-priority dam recommendations

Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
Green River Pond Dam	10220	North Stonington	Green Fall River Tributary	Formalize breach, replace downstream culvert	Current uses are unknown. The dam has not been maintained and is partially breached. The culvert downstream of this impoundment (AWR-GRE-5-2) is likely undersized and contributing to backwater flooding.	
Hallville Pond Dam	571	Exeter	Sodom Brook	Remove	The dam is in poor condition and is not being maintained. The impoundment does not appear to support any active uses. Removal should be considered.	

Table 3-4. Low-priority dam recommendations

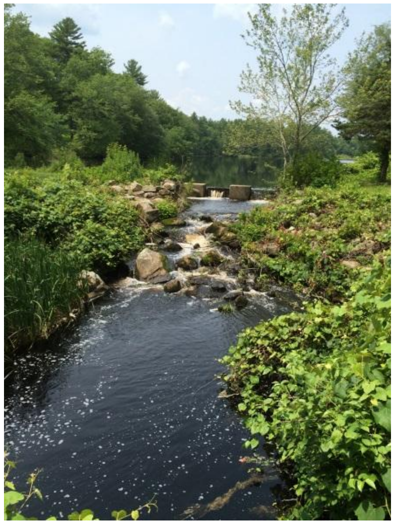
Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
Hazard Pond Dam	200	West Greenwich	Falls River	Remove	Dam is on the main stem of the Wood River. The downstream watercourse is unobstructed for 5+ miles until Barberville Pond, which is recommended for construction of a rock ramp or other fish passage structure. The impoundment does not appear to support any active uses.	
Hope Valley Mill Pond Dam	245	Hopkinton / Richmond	Wood River	AOP Structure	Dam is a historic structure and has been maintained as such. Fish were observed attempting to jump over the dam during the 2015 field assessment. Obstructions to fish passage exist downstream of the dam. Installation of an AOP structure is a low priority until the downstream obstructions are removed.	

Table 3-4. Low-priority dam recommendations

Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
Kasella Farm Pond Dam	468	West Greenwich	Breakheart Brook	Remove	The current uses of the dam are unknown. The dam was recently reconstructed when a road was built across the crest, but the dam requires further repair. Removal should be considered. Roadway could be maintained and culverts constructed to sufficiently drain the impoundment.	
Lewis Pond Dam	10217	North Stonington	Pawcatuck River Tributary	Remove	While current uses are unknown, it appears that the owner may use the impoundment as a watering hole for cattle. Removal should be considered.	
Liepold Pond Dam	13713	Stonington	Pawcatuck River	Maintain	The dam is being maintained, and the owner has indicated a desire to maintain the impoundment for private uses.	

Table 3-4. Low-priority dam recommendations

Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
Metcalf Wildlife Marsh Dam	527	Exeter	Locke Brook	Maintain	The dam and impoundment support wildlife habitat associated with the Metcalf Wildlife Marsh. The owner is actively maintaining the dam, and repairs were completed in 2013.	
Olaf Farm Pond Dam	493	Westerly	Cedar Swamp Brook	Repair	The owner is currently maintaining this low hazard dam, but further repairs are needed (dense vegetation on slopes and erosion at informal secondary spillway). The owner is currently opposed to removal.	

Table 3-4. Low-priority dam recommendations

Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
Slocum Reservoir Dam	239	Exeter	Chipuxet River	Maintain (Confirm repairs were made)	Dam is owned and maintained by a church. The impoundment provides an environmental resource and recreational facility for the church camp. Owner indicated recent repairs were made to the dam.	
Slocum Road Lower Dam	711	Exeter	Chipuxet River Tributary	Remove	Dam is in disrepair and the impoundment provides private recreational uses. The owner lives out of state and does not actively maintain the dam. Removal should be considered.	
Slocum Woods Dam	693	North Kingstown	Chipuxet River Tributary	Maintain	Dam was in good condition in 2013 (last documented inspection) and is being maintained. It is owned by the Slocum Woods Homeowner's Association and is used for recreational purposes. The impoundment also appears to be used for irrigation for turf farming operations (Sodco).	

Table 3-4. Low-priority dam recommendations

Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
Smith's Ice Pond Dam	272	Hopkinton	Parmenter Brook	No Action	Owner uses the impoundment for agricultural purposes and is not anticipated to be supportive of removal. The dam is a very low head dam and, although it is in poor condition, is not believed to pose significant flood risk.	
Sodco Dam	767	Exeter	Chipuxet River Tributary	Repair	The dam is owned by Sodco, and the impoundment supports turf farming operations. The dam is in disrepair, but the owner has been working with NRCS on the design of repairs to the dam and to allow the dam to overtop.	

Table 3-4. Low-priority dam recommendations

Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
Spaulding Pond Dam	10208	North Stonington	Wyassup Brook	Remove	The impoundment supports recreational uses. Repairs were recommended in 2013 (last documentation of correspondence in CTDEEP file). Once the dams on the Ashaway River are removed, removal of this dam would become a higher priority.	
Stillmanville Dam	256	Westerly / CT	Pawcatuck River	Remove	This concrete structure does not prevent fish passage or have a significant impact on the flow regime. However, removal could provide other river restoration benefits.	
White's Pond Dam	261	Richmond	White Brook	Maintain	This impoundment is part of the RIDEM-owned Carolina Trout Hatchery, which is still in operation. RIDEM has been maintaining the dam.	

Table 3-4. Low-priority dam recommendations

Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
Wincheck Pond Dam	225	Hopkinton	Moscow Brook	Maintain	The dam is owned and operated by the Narragansett Council Boy Scouts of America. The impoundment is used for recreational purposes during Boy Scout Camp. The owner maintains the dam and completed repairs in 2013 to address an NOV.	
Wyoming Pond Lower Dam	217	Hopkinton	Wood River	No Action	The remaining structure is not preventing fish passage, is not significantly impacting the flow regime, and is only on one of several braided stream channels. The dam does not pose significant flood risk.	

Table 3-4. Low-priority dam recommendations

Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
Yawgoo Pond Dam	290	South Kingstown	Chickasheen Brook	Construct Rock Ramp	The dam is a low head dam (hydraulic height of less than 1 foot) with a natural wetland downstream. The dam does not pose significant flood risk. The impoundment provides public recreational uses, but is not being maintained. Construction of a small rock ramp up to the spillway could allow for fish passage.	
Yawgoog Pond Dam	226	Hopkinton	Wincheck Brook	Maintain	The dam is owned and operated by The Boy Scouts of Rhode Island, Narragansett Council. The impoundment is used for recreational purposes for a boy scout camp. The owner maintains the dam and completed repairs to the embankment in 2014 and low level outlet repairs in 2015.	No Photographs are Available After the 2015 Repairs

Table 3-4. Low-priority dam recommendations

Dam Name	Dam ID	Town	River/Stream	Recommendation	Description	Photograph
Yorker Mill Pond Dam	240	Exeter	Chipuxet River	Maintain (Confirm repairs were made)	The current owner actively maintains the dam and wants to keep it although current uses of the impoundment are unknown. The owner planned to make repairs to the dam in 2014.	

3.5 Preliminary Hydraulic Assessment

An objective of dam removal is to eliminate downstream flood risk associated with dam failure. Dam removal can also impact river and floodplain hydraulics, including water surface elevations, upstream and downstream of the dam. Potential hydraulic impacts were qualitatively evaluated for each dam for which removal is recommended. Aerial imagery, Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) flood profiles (where available), and FEMA Flood Insurance Rate Maps (FIRMS) were reviewed to assess potential hydraulic impacts upstream and downstream of dams recommended for removal. *Table 3-5* summarizes the findings of this preliminary hydraulic assessment for each dam where adequate flood-related information is available. A full hydrologic and/or hydraulic analysis is beyond the scope of this planning-level assessment. Hydraulic modeling would be required in support of future design to quantitatively assess potential upstream and downstream impacts on flow velocities and water surface profiles. Other potential impacts and constraints would also need to be considered during design and permitting.

3.6 Preliminary Wetland Habitat Assessment

A preliminary, screening-level ecological function evaluation was also conducted for each of the priority dams in the Wood-Pawcatuck watershed. Impoundment reaches (segments of streams) were initially identified for each dam and then intersected with state-mapped wetlands, including the impoundment and any wetlands adjacent to or contiguous with the impoundment. The U.S. Fish and Wildlife Service National Wetlands Inventory (NWI+) wetland data were used to evaluate the ecological functions of the wetlands. NWI+ or Landscape, Landform, Water Flow and Waterbody (LLWW) wetlands were intersected with state-mapped wetlands to identify NWI+ wetlands (and associated wetland acreage) for each impoundment. Each NWI+ wetland was then assessed based on four LLWW classes indicative of potential ecological functions:[5]

- Fish/Aquatic Invertebrate Habitat (FAIH)
- Waterfowl and Waterbird Habitat (WBIRD)
- Other Wildlife Habitat (OWH)
- Unique, Uncommon or Highly Diverse Wetland Plant Communities (UWPC)

For each LLWW class, a numerical rating or weight was assigned to each wetland:

- FAIH
  - High = 1.0
  - Moderate = 0.5
- WBIRD
  - High = 1.0
  - Moderate = 0.5
  - Wood Duck = 0.25
- OWH
  - High = 1.0
  - Moderate = 0.5
- UWPC
  - Regionally Significant = 1.0
  - Locally Significant = 0.5

Each of the four classes was combined and an average Habitat Rating was assigned to each NWI+ wetland. Habitat Rating was multiplied by the Total Area of NWI+ wetlands associated with each dam, resulting in a Weighted Habitat Rating. *Table 3-6* sorts the dams first based on management recommendation priority (i.e., high, intermediated, low) then based on Weighted Habitat Rating.

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5 Rhode Island Wetlands: Updated Inventory, Characterization, and Landscape‐level Functional Assessment. 2014. USFWS. Available Online: http://www.aswm.org/wetlandsonestop/rhode_island%20wetlands_llww_2014.pdf

State-listed species were also considered based on approximate locations of endangered, threatened and special concern species in Rhode Island and Connecticut. This was accomplished by identifying state-mapped wetlands associated with each impoundment that intersect mapped areas of state-listed species. *Table 3-6* lists those dams and associated wetlands that have the potential to support state-listed species.

As stated previously, this assessment is a preliminary screening-level evaluation of potential ecological functions. As such there are certain limitations to the analysis:

- Mapping of natural resource areas, (i.e., the NWI+ and state-mapped wetlands data) was created based on remotely-sensed data. The actual location and extent of wetlands and waterbodies may be substantially different than what is depicted by the available geospatial data.

- The analysis identified ecological functions that could be potentially impacted, but does not account for site-specific impacts of the proposed management recommendations, such as the extent of the drawdown of an impoundment and associated acreage of actual wetland impacts resulting from dam removal.

- State-mapped wetlands were not wholly coincidental with NWI+ wetlands. Therefore, the ecological functions from the NWI+ data set were used as a proxy for the state-listed wetlands. Similarly, the calculation of a Weighted Habitat Rating was based on the NWI+ data only. It was assumed that the ecological functions identified in the NWI+ data extend to the state-mapped wetlands and that the Weighted Habitat Rating is a reasonable approximation for state-mapped wetlands.

- The analysis does not differentiate between NWI+ wetland types (e.g., lacustrine, riverine, palustrine, etc.). Rather, the analysis considers all wetland types the same.

Further site-specific evaluation is necessary to adequately assess the ecological effects of dam removal or other management recommendations for individual dams and associated impoundments. Such evaluations are required to support future planning, design, permitting, and funding requests for implementation of specific dam management recommendations.

A more detailed assessment of wetlands within the Wood-Pawcatuck watershed was conducted to identify and prioritize wetland conservation and restoration opportunities that may enhance flood resiliency in the watershed. The watershed-scale assessment is described in a separate technical memorandum.

Table 3-5. Preliminary hydraulic assessment of dams recommended for removal

Dam Name	Potential Hydraulic Impacts
Alton Pond Dam	• There is no FIS flood profile for this dam. • The dam is believed to have several vertical feet of flood storage capacity; therefore removal could impact the downstream floodplain. Based on aerial imagery, it appears that other than the former mill complex, no other significant infrastructure is located within the downstream floodplain. • Based on the FIRM it appears that there are not any homes or buildings located within the 100-year floodplain; however, there are several homes adjacent to the impoundment, just beyond the limit of the 100-year floodplain. Removal of the dam may require replacement of some private shallow wells. • Replacement/reconfiguration of the Church Street bridge would be required to accommodate dam removal.
Ashaway Line Pond Dam	• It is assumed that minimal flood storage capacity is currently provided by the impoundment. • Removal would likely only impact water surface elevations immediately upstream of the dam. • There is a 1.8-foot difference in base flood elevations upstream and downstream of the dam. • To remove the dam, the High Street Bridge would likely have to be replaced (new footings would need to be evaluated for potential scour).
Ashaway Mill Pond Dam	• The impoundment is believed to provide minimal flood storage capacity. • Removal would likely only impact water surface elevations upstream of the dam, between the dam and Bethel Pond Dam (which is recommended for removal). Should Bethel Pond Dam be removed, the hydraulic influence of removing Ashaway Mill Pond Dam could extend further upstream (the FIS only extends approximately 200 feet upstream of the dam so the extent of the impact is unknown). • Based on the FIRM, it appears that there are no homes within the 100-year floodplain; however, there are several homes/businesses adjacent to the 100-year floodplain. • There is a 6.1-foot difference in base flood elevations upstream and downstream of the dam. • Flow velocities upstream of the dam would be expected to increase if the dam were removed. The bridge footings at Laurel Street and High Street would need to be evaluated for scour potential.
Bethel Pond Dam	• The impoundment is believed to provide minimal flood storage capacity. • There is no FIS flood profile for this dam. • Based on the FIRM, it appears that there is no infrastructure within the 100-year floodplain. • Based on the FIRM it appears as if the impoundment may cause backwatering beyond the I-95 bridge. The bridge footings at Wellstown Road and I-95 would need to be evaluated for scour potential due to a potential increase in flow velocity at these locations.
Centerville Pond Dam	• The impoundment is believed to provide minimal flood storage capacity. • There is no FIS flood profile for this dam. • Based on the FIRM, there is no significant infrastructure within the 100-year floodplain, but there are several homes directly adjacent to the 100-year floodplain. Shallow wells associated with nearby residences may need to be replaced. • Flow velocities upstream of the dam would be expected to increase if the dam were removed. The bridge footings at Dye Hill Road and Spring Street would need to be evaluated for scour potential.

Table 3-5. Preliminary hydraulic assessment of dams recommended for removal

Dam Name	Potential Hydraulic Impacts
	• The downstream dam (Moscow Pond Dam) is also recommended for removal.
Decappett Pond Dam	• The impoundment is believed to provide minimal flood storage capacity. • There is no FIS flood profile for this dam. • Based on the FIRM, it appears that the dam does not have a significant impact on upstream hydraulics. Other than the Hillsdale Road bridge, there is no infrastructure in or adjacent to the 100-year floodplain for several thousand feet upstream of this dam.
Dolly Pond Dam	• The impoundment is believed to provide minimal flood storage capacity. • There is no FIS flood profile for this dam. • The FIRM does not show the 100-year floodplain associated with this dam/stream. Only limited infrastructure or development is located around or upstream of the dam. • Several homes adjacent to the impoundment may be affected by flooding as a result of the dam. • The downstream dam (Hallville Pond Dam) is also recommended for removal.
Edward's Pond Dam	• The impoundment is believed to provide minimal flood storage capacity. • There is no FIS flood profile for this dam. • The FIRM does not show the 100-year floodplain associated with this dam/stream; however, it appears that there are farms adjacent to the impoundment (potentially in the floodplain) that could benefit from dam removal.
Glen Rock Lower Pond Dam	• The impoundment is believed to provide minimal flood storage capacity. • There is no FIS flood profile for this dam. • The FIRM does not show the 100-year floodplain associated with this dam/stream; however, it appears that no significant infrastructure exists upstream of this dam that would be impacted by removal. • This dam is the downstream-most of three dams within close proximity, all of which are recommended for removal.
Glen Rock Middle Pond Dam	• The impoundment is believed to provide minimal flood storage capacity. • There is no FIS flood profile for this dam. • The FIRM does not show the 100-year floodplain associated with this dam/stream; however, it appears that no significant infrastructure exists upstream of this dam that would be impacted by removal. • This dam is the middle of three dams within close proximity, all of which are recommended for removal.
Glen Rock Upper Pond Dam	• The impoundment is believed to provide minimal flood storage capacity. • There is no FIS flood profile for this dam. • The FIRM does not show the 100-year floodplain associated with this dam/stream; however, it appears that no significant infrastructure exists upstream of this dam that would be impacted by removal. • This dam is the upstream-most of three dams within close proximity, all of which are recommended for removal.
Hallville Pond Dam	• The impoundment is believed to provide minimal flood storage capacity. • There is no FIS flood profile for this dam. • The FIRM does not show the 100-year floodplain associated with this dam/stream; however, it appears that there is no significant infrastructure around or upstream of the dam.

Table 3-5. Preliminary hydraulic assessment of dams recommended for removal

Dam Name	Potential Hydraulic Impacts
	• Flow velocities upstream of the dam would be expected to increase if the dam were removed. The bridge footings at Hallville Road would need to be evaluated for scour potential. • The upstream dam (Dolly Pond Dam) is also recommended for removal.
Hazard Pond Dam	• The impoundment is believed to provide minimal flood storage capacity. • There is no FIS flood profile for this dam. • Based on the FIRM, there is no infrastructure upstream of this dam within the 100-year floodplain.
Kasella Farm Pond Dam	• A bridge and several homes are located downstream of the dam. The dam may provide some flood storage; therefore, removal could affect downstream hydraulics and flooding. A hydraulic analysis is recommended to assess the significance of potential downstream impacts. • There is no FIS flood profile for this dam. • The FIRM does not show the 100-year floodplain associated with this dam/stream; however, it appears that there are several homes adjacent to the impoundment (potentially in the floodplain) that could benefit from dam removal.
Langworthy Pond Dam	• The impoundment is believed to provide minimal flood storage capacity. • There is no FIS flood profile for this dam. • The FIRM does not show the 100-year floodplain associated with this dam/stream; however, it appears that there are several homes adjacent to the impoundment (potentially in the floodplain) that could benefit from dam removal.
Moscow Pond Dam	• The dam may provide some flood storage; therefore, removal could affect downstream hydraulics and flooding. A hydraulic analysis is recommended to assess the significance of potential impacts on the homes located downstream of the dam. • There is no FIS flood profile for this dam. • Based on the FIRM, there is no infrastructure within the 100-year floodplain upstream or downstream of this dam. There are several homes directly adjacent to the dam. Shallow wells associated with nearby residences may need to be replaced. • The upstream dam (Centerville Pond Dam) is also recommended for removal. Based on the FIRM, it appears that the hydraulic influence of Moscow Pond Dam does not extend upstream to Centerville Pond Dam. • Replacement/reconstruction of the Woody Hill Road bridge (above the dam) would be required for dam removal.
Slocum Road Lower Dam	• The impoundment is believed to provide minimal flood storage capacity. • There is no FIS flood profile for this dam. • The FIRM does not show the 100-year floodplain associated with this dam and does not show a hydraulic connection between the upstream and downstream dams (Slocum Road Upper Dam and Sodco Dam, respectively). • Both Slocum Road Upper Dam and Sodco Dam are recommended to be maintained. Therefore, the hydraulic impact of removing Slocum Road Lower dam would be limited to the reach of river between the dam and Slocum Road Upper Dam. Several homes are located between these two dams. Removal of Slocum Road Lower dam would likely reduce flood risk for these homes, but may require replacement of any shallow wells at these residences.
Tanner Pond Dam	• The flood storage capacities of this dam and the downstream fish hatchery are unknown and should be evaluated. • There is no FIS flood profile for this dam.

Table 3-5. Preliminary hydraulic assessment of dams recommended for removal

Dam Name	Potential Hydraulic Impacts
	• This dam is associated with a decommissioned fish hatchery. Discharge from the hatchery flows directly into the Pawcatuck River. • Based on the FIRM, there isn't any infrastructure in the 100-year floodplain upstream of the dam other than a bridge at Pine Hill Road and the fish hatchery (which is still in operation) associated with White's Pond Dam. Removal of Tanner Pond Dam and the associated fish hatchery infrastructure is not expected to have a negative impact on the White's Pond Dam fish hatchery. • Flow velocities upstream of the dam would be expected to increase if the dam were removed. The bridge footings at Pine Hill Road would need to be evaluated for scour potential.
Union Pond Dam	• The impoundment is believed to provide minimal flood storage capacity. • There is no FIS flood profile for this dam. • Based on the FIRM, there is no infrastructure within the 100-year floodplain, but there are several farms directly adjacent to the 100-year floodplain. Shallow wells associated with the farms may need to be replaced if the dam is removed. • The upstream dam (Lower Mill Pond Dam) could not be inspected. Therefore, there is no recommendation for that dam at this time.
Woodville Pond Dam	• The impoundment is believed to provide minimal flood storage capacity. • Removal will likely only impact water surface elevations upstream of the dam, between the dam and Hope Valley Mill Pond Dam (an historic structure for which the recommendation is to add an AOP structure.) • Based on the FIRM, it appears that there are no homes within the 100-year floodplain, but there are several homes directly adjacent to the 100-year floodplain. • The hydraulic influence (backwater) of the dam appears to extend upstream along the main stem of the Wood River and in Canonchet Brook, which enters the Wood River approximately 1,500 feet upstream of the dam. • There appears to be a wetland along the Wood River that could be impacted by removal of the dam. • There is a 5.4-foot difference in base flood elevations upstream and downstream of the dam. • Flow velocities upstream of the dam would be expected to increase if the dam were removed. The bridge footings at Switch Road and I-95 would need to be evaluated for scour potential.
Wyoming Upper Dam	• The impoundment is believed to provide minimal flood storage capacity. • Removal would likely only impact water surface elevations upstream of the dam, between the dam and Barberville Pond Dam (which is recommended to be replaced with a rock ramp to maintain the current impoundment). • Based on the FIRM, there appear to be approximately 10 homes located in the 100-year floodplain that would likely be removed from the special flood hazard area if the dam were removed. If these homes have shallow wells, they may have to be replaced. • There is an 11.9-foot difference in base flood elevations upstream and downstream of the dam. However, it appears that there is a natural bedrock outcrop under the dam, which would likely limit the change in base flood elevation at that location. • Flow velocities upstream of the dam would be expected to increase if the dam were removed. The bridge footings at Skunk Hill Road and Arcadia Road would need to be evaluated for scour potential. • Removing this dam could significantly decrease flooding along the Wood River in the Valley Lodge Estates (Wood River Drive) neighborhood.

Table 3-6. Screening-level assessment of ecological functions for priority dams in the Wood-Pawcatuck watershed

Dam ID	Dam Name	# of Associated NWI+ Wetlands	Average Habitat Rating	Total Area of Associated NWI+ Wetlands (acres)	Weighted Habitat Rating (Habitat Rating * Total Area)	Overall Rank	Presence of State-Listed Species	Management Recommendation	Recommendation Priority
230	Decappet Pond Dam	1	0.13	0.4	0.1	59		Remove/Breach	High
266	Ashaway Line Pond Dam	1	0.31	0.3	0.1	58		Remove/Breach	High
265	Ashaway Mill Pond Dam	3	0.33	7.4	2.5	38		Remove/Breach	High
264	Bethel Pond Dam	8	0.23	23.4	5.5	32		Remove/Breach	High
273	Wood River Junction Dam	3	0.25	22.3	5.6	31	Yes	Remove/Breach	High
274	Harris Pond Dam	5	0.15	39.8	6.0	30		Repair	High
216	Wyoming Upper Dam	4	0.19	45.9	8.6	26		Remove/Breach	High
227	Ashville Pond Dam	1	0.38	32.1	12.1	22		Remove/Breach	High
214	Breakheart Pond Dam	2	0.28	47.0	13.2	21		Repair	High
247	Alton Pond Dam	10	0.29	57.7	16.6	17	Yes	Remove/Breach	High
221	Browning Mill Pond Dam	1	0.38	50.8	19.1	15	Yes	Repair	High
254	Potter Hill Dam	15	0.30	87.7	26.3	10	Yes	Remove/Breach	High
285	Langworthy Pond Dam	1	0.13	1.0	0.1	55		Remove/Breach	Intermediate
440	Hoxie Farm Pond Dam	2	0.13	2.3	0.3	52		Remove/Breach	Intermediate
288	Union Pond Dam	2	0.13	3.8	0.5	50		Remove/Breach	Intermediate
223	Centerville Pond Dam	2	0.13	6.2	0.8	49	Yes	Remove/Breach	Intermediate
280	Tanner Pond Dam	1	0.13	7.4	0.9	48	Yes	Remove/Breach	Intermediate
238	Edward's Pond Dam	3	0.19	6.4	1.2	44		Remove/Breach	Intermediate
222	Moscow Pond Dam	2	0.13	11.6	1.5	42	Yes	Remove/Breach	Intermediate
710	Slocum Road Upper Dam	4	0.19	8.1	1.5	41		Remove/Breach	Intermediate
235	Glen Rock Upper Pond Dam	2	0.31	24.7	7.7	27		AOP Structure	Intermediate
13602	Porter Pond Dam	7	0.41	21.0	8.6	25	Yes	Remove/Breach	Intermediate
232	Tug Hollow Pond Dam	8	0.22	61.2	13.4	20	Yes	Remove/Breach	Intermediate
262	Locustville Pond Dam	5	0.15	98.9	14.8	18		AOP Structure	Intermediate

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Table 3-6. Screening-level assessment of ecological functions for priority dams in the Wood-Pawcatuck watershed

Dam ID	Dam Name	# of Associated NWI+ Wetlands	Average Habitat Rating	Total Area of Associated NWI+ Wetlands (acres)	Weighted Habitat Rating (Habitat Rating * Total Area)	Overall Rank	Presence of State-Listed Species	Management Recommendation	Recommendation Priority
229	Blue Pond Dam	1	0.25	98.9	24.7	12	Yes	Remove/Breach	Intermediate
246	Woodville Pond Dam	31	0.18	182.3	32.3	7	Yes	Remove/Breach	Intermediate
215	Barberville Pond Dam	14	0.30	119.6	36.3	6		Construct Rock Ramp	Intermediate
251	Burdickville Dam	28	0.28	239.0	67.2	4	Yes	Remove/Breach	Intermediate
233	Glen Rock Lower Pond Dam	1	0.13	0.8	0.1	57		Remove/Breach	Low
711	Slocum Road Lower Dam	1	0.13	0.9	0.1	56		Remove/Breach	Low
234	Glen Rock Middle Pond Dam	1	0.13	1.0	0.1	54		Remove/Breach	Low
402	Arcadia Mill Lower Dam	1	0.13	1.5	0.2	53		Maintain/ No Action	Low
10220	Green River Pond Dam	2	0.63	0.6	0.4	51		Remove/Breach	Low
10217	Lewis Pond Dam	2	0.44	2.2	1.0	47	Yes	Remove/Breach	Low
217	Wyoming Pond Lower Dam	3	0.27	3.7	1.0	46	Yes	Maintain/ No Action	Low
261	White's Pond Dam	1	0.31	3.3	1.0	45	Yes	Maintain/ No Action	Low
493	Olaf Farm Pond Dam	3	0.19	6.8	1.3	43	Yes	Repair	Low
256	Stillmanville Dam	6	0.25	6.7	1.7	40	Yes	Remove/Breach	Low
240	Yorker Mill Pond Dam	2	0.13	19.1	2.4	39		Maintain/ No Action	Low
571	Hallville Pond Dam	4	0.13	20.7	2.6	37		Remove/Breach	Low
13713	Liepold Pond Dam	3	0.42	6.6	2.7	36		Maintain/ No Action	Low
272	Smith's Ice Pond Dam	5	0.21	14.9	3.2	35		Maintain/ No Action	Low
693	Slocum Woods Dam	4	0.19	18.0	3.4	34		Maintain/ No Action	Low
767	Sodco Dam	2	0.25	14.6	3.6	33		Repair	Low
468	Kasella Farm Pond Dam	3	0.25	25.4	6.3	29		Remove/Breach	Low
245	Hope Valley Mill Pond Dam	10	0.19	37.2	7.0	28	Yes	AOP Structure	Low
243	Dolly Pond Dam	5	0.20	50.3	10.1	24		Remove/Breach	Low
236	Glen Rock Reservoir Dam	10	0.23	46.4	10.4	23		Remove/Breach	Low

Table 3-6. Screening-level assessment of ecological functions for priority dams in the Wood-Pawcatuck watershed

Dam ID	Dam Name	# of Associated NWI+ Wetlands	Average Habitat Rating	Total Area of Associated NWI+ Wetlands (acres)	Weighted Habitat Rating (Habitat Rating * Total Area)	Overall Rank	Presence of State-Listed Species	Management Recommendation	Recommendation Priority
239	Slocum Reservoir Dam	11	0.18	77.9	14.2	19	Yes	Maintain/ No Action	Low
531	Great Swamp Goose Marsh Dam	27	0.13	138.4	18.6	16	Yes	Repair	Low
527	Metcalf Wildlife Marsh Dam	9	0.24	95.6	22.6	14		Maintain/ No Action	Low
219	Boone Lake Dam	3	0.38	60.9	22.8	13		Maintain/ No Action	Low
289	Grassy Pond Dam	5	0.28	92.2	25.3	11	Yes	Remove/Breach	Low
290	Yawgoo Pond Dam	3	0.19	159.5	29.9	9	Yes	Construct Rock Ramp	Low
14701	Green Falls Reservoir Dam	3	0.54	57.7	31.3	8	Yes	Maintain/ No Action	Low
225	Wincheck Pond Dam	2	0.25	151.3	37.8	5		Maintain/ No Action	Low
226	Yawgoog Pond Dam	6	0.40	177.2	70.1	3	Yes	Maintain/ No Action	Low
200	Hazard Pond Dam	26	0.43	262.2	112.2	2		Remove/Breach	Low
10208	Spaulding Pond Dam	17	0.45	265.2	119.0	1	Yes	Remove/Breach	Low

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Appendix A

Culverts/Bridges - Subwatershed Location Maps and Summary Tables

Appendix B

Culverts/Bridges - Subwatershed Hydraulic Capacity Rating Maps and Summary Tables

Appendix C

Culverts/Bridges - Subwatershed Flooding Impact Potential Rating Maps and Summary Tables

Appendix D

Culverts/Bridges - Subwatershed Geomorphic Vulnerability Rating Maps and Summary Tables

Appendix E

Culverts/Bridges - Subwatershed AOP Classification Maps and Summary Tables

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Appendix F

Culverts/Bridges - Subwatershed Priority Rating Maps and Summary Tables

Appendix G

Dams – Subwatershed Location Maps, Summary Table, and Assessment Matrix

Appendix H

Dams – Subwatershed Recommendations Maps

Database A

Culverts and Bridges

Blank Culvert and Bridge Inspection Form
Completed Culvert and Bridge Inspection Forms and Photographs

Database B

Dams

Blank Dam Inspection Form
File Review Data from CTDEEP and RIDEM
Completed Dam Inspection Forms and Photographs

Database C

Culverts and Bridges Hydraulic Calculations (CulvertMaster)

Database D

Culverts, Bridges and Dams Hydrologic Calculations

StreamStats Output Files
TR-20 Spreadsheet and Hydraflow Files