Ayers Brook Watershed Stormwater Management Plan

Towns of Randolph, Braintree, Brookfield

Completed by Two Rivers-Ottauquechee Regional Commission

February 2016

TRORC
Two Rivers-Ottauquechee
REGIONAL COMMISSION

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Acknowledgements

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Introduction

Water does not abide by political boundaries, but instead adheres to the watershed concept, in which all water in a specific area drains to a specific point in an ecosystem. This Stormwater Management Plan intends to provide opportunities to preserve and remediate the integrity of clean water in Ayers Brook and the land that contributes to its watershed.

This Stormwater Management Plan for the Ayers Brook Watershed was prepared for the Towns of Braintree, Randolph, and Brookfield as a Supplemental Environmental Project. The town of Roxbury contains a small portion of the Ayers Brook headwaters but was not included in this assessment.

Goals

This Stormwater Management Plan aims to:

- Reduce the impacts of stormwater runoff in the Ayers Brook watershed;
- Reduce flooding damage to communities in the Ayers Brook watershed;
- Identify problem areas that are contributing to stormwater runoff; and
- Identify and prioritize projects to actively restore the Ayers Brook river corridor, including culvert upgrades, riparian buffers, and other project types.

Vermont's River Management Program also establishes the following management goal that intersects with this project:

- Manage toward, protect, and restore the equilibrium conditions of Vermont's rivers by resolving conflicts between human investments and river dynamics in the most economically and ecologically sustainable manner.

The Randolph, Braintree, and Brookfield Town Plans also state their desires to protect water resources in their towns. The Randolph Town Plan states its intention to conserve "natural beauty and the environment" and includes a goal in its plan to "Encourage the conservation of essential natural resources (agricultural soils, healthy forests, and clean water) and discourage uses that diminish or threaten their future viability."

The Brookfield Town Plan states that "The maintenance of high water quality is important for public health, fisheries, ecosystem health, and water based recreation," that "nonpoint pollution from… runoff from roads [is] a problem," and that the "Town should take advantage of state programs to control nonpoint pollution. "The Braintree Town Plan likewise aims "to protect existing and future high quality water resources," "to consider surface water and groundwater impacts and the effects related to proposed or existing uses of land," and "to maintain or improve surface water quality and quantity."

Stormwater Background

Stormwater is any form of precipitation, including rain and snow, which runs off the land. Usually this water either infiltrates the soil, where it is absorbed as groundwater, or becomes part of evapotranspiration, the combination of water that evaporates into the air and water that transpires from plants. Much of Vermont's land is forested, where stormwater runoff is not a concern because it is naturally managed in the ecosystem that has developed to handle precipitation events. However, stormwater runoff results and increases from all land clearing and land conversion activities.

Human beings live in landscapes that have been altered in many ways. Human development has significantly changed the hydrologic cycle. Human development, more specifically the construction of impervious surfaces, prevents stormwater runoff from effectively infiltrating the ground. Examples of impervious surfaces include paved surfaces, concrete, buildings, rooftops, and gravel roads. Because stormwater and the pollutants that accompany runoff cannot infiltrate the ground, they flow at rapid velocities and with high volumes during precipitation events. Impervious surfaces also prevent the natural purification of pollutants such as phosphorous, nitrogen, and sediment. Gravel road management concerns, such as improper ditching and improper maintenance of roads in deteriorating quality, also lead to stormwater impacts. Road failures in heavy storms are a significant contributor of sediment. Gravel roads are of particular concern in Orange County, Vermont where they make up the majority of roads in the region.

High impervious surface area and unmanaged stormwater runoff cause many detrimental effects. They lead to flow alterations in river bodies, such as channel erosion, channel instability, restriction of stream access to floodplains, and channel incision. These river corridor alterations result in increased flooding, which threatens houses and roads, and jeopardizes the resiliency of communities. Unmanaged stormwater runoff leads to pollutant runoff and concentration in water bodies, causes sediment plumes in surface water, and negatively impacts flora and fauna. Concentrated pollutants and sediment also detract from recreational activities around the state and property values of homes near these surface waters. Water quality is a highly valued natural resource in Vermont, and this value is reflected by many towns and their desire to protect the natural resources around them.

Stormwater runoff is interconnected throughout a watershed. A watershed is an area of land off of which all water that drains collects in the same place. If one section of a watershed, especially a section that is higher in that watershed, is poorly managed, it will affect other parts of the watershed. Because of the importance of water quality throughout a watershed, this management plan addresses stormwater concerns on the scale of the Ayers Brook Watershed.

Stormwater Management Plan Development Process

In order to complete this project the Two Rivers-Ottauquechee Regional Commission (TRORC) compiled information from existing reports, analyzed existing data, and made site specific assessments. Specifically TRORC staff:

- Analyzed culvert inventories, completed by TRORC in Braintree in 2014, Randolph in 2013, and Brookfield in 2004 to determine culverts in poor and critical conditions;
- Analyzed road erosion risk ratings for Braintree, Randolph, and Brookfield to determine contentious sites;
- Overlaid road erosion risk data and culvert inventory data to determine potential stormwater problem areas to field visit;
- Met with Jeff Masterson, road foreman in Braintree on December 9, 2015 and asked about repeatedly damaged structures, culverts in poor condition, asked about roads that present problems, and asked if Jeff had completed any work since last culvert inventory;
- Met with Robert Reynolds, road foreman in Randolph and travelled in the field with him to visit spots in Randolph and Braintree on December 9, 2015;
- Site visited areas of concern in Randolph, Braintree, and Brookfield on December 16, 2015;
- Reached out Mary Russ of the White River Partnership and Mary Nealon of Bear Creek Environmental to determine the status of predetermined projects and conservation developments along Ayers Brook.
- Reached out to James Pease in the Vermont Clean Water Initiative Program to obtain current water quality reports and records.
- Met with Robert Reynolds, Ray Peck, and Jeff Masterson, of Randolph, Brookfield, and Braintree, on February 19, 2016 to review priority projects in this plan.

Summary and Recommendations

Summary of Current Conditions

Ayers Brook

Ayers Brook is currently an impaired waterway, as identified by the 2014 Vermont Stressed Waters List. Current pollutants include sediment, Nickel, Chromium, and E Coli, which have been caused by streambank erosion, loss of riparian vegetation, and habitat alteration from agricultural activities throughout the Brook's watershed in Randolph, Braintree, and Brookfield.

Data Gaps

Existing reports indicate that Chromium and Nickel are pollutants in Ayers Brook; however, sources of these metals are not identified by either the Tactical Basin Plan or the Stressed Waters List. Possible sources include closed landfills in Brookfield and Randolph.

The water quality data for Ayers Brook was last collected in 2006. Although biological monitoring and sediment data are reliable long-term indicators of water quality, they should be updated when possible. Current water quality data would complement this stormwater plan to give a more accurate and complete picture of the current condition in the Ayers Brook Watershed.

Existing Stormwater Ordinance in Randolph

The Town of Randolph currently has several stormwater provisions, as part of their Zoning Regulations which were last adopted in 2009. Much of this stormwater ordinance applies only to the established Interchange (INT) Districts surrounding the intersection of Interstate-89 and Vermont Route 66. These current stormwater management standards aim to protect surface waters and wetlands, by requiring a vegetated buffer to be maintained from the top of streambanks on perennial streams and Class I and II wetlands to all structures. The ordinance prohibits any clearing, excavation, filling, grading, or development to occur within the buffer strip except for activities such as road crossings, streambank stabilizations and restorations, and stormwater management facilities.

Development projects in Randolph's Interchange (INT) Districts equal to or greater than .5 acre of earth disturbance must physically mark the limits of disturbance that will occur during construction and must follow Best Management Practices that include the installation and maintenance of a stabilized construction entrance, the installation and maintenance of silt fencing, the stabilization of soils within 28 days of disturbance, and the winter stabilization of exposed soils. Development projects that result in .5 acre of new impervious surface will require a stormwater management plan certified by an engineer in compliance with a Vermont operational stormwater permit. All developments in the Interchange (INT) Districts that have long-term operational stormwater systems must identify maintenance and management requirements and shall be designed to maximize sheet flow of runoff. If possible, stormwater control systems shall be incorporated into features of the existing landscape.

No structures, paving, or filling is allowed in the Conservation Zone of Randolph's zoning regulation, which applies to land that is 200 feet from the village reservoir and 50 feet on each side of the Second and Third Branches of the White River. In all of Randolph's zoning districts, site plan review is required for the development of tracts for uses other than one or two family dwellings, whether or not such development includes a subdivision of the site.

Recommendations

- The process of developing the statewide Municipal Roads General Permit (MRGP) is a multi-year effort that aims to reduce road erosion, decrease sedimentation, and, improve water quality in surface waters. Road erosion risk maps for areas within the Ayers Brook Watershed for Braintree, Randolph, and Brookfield were included in this document. However, an important component of the development of this permit is that towns verify road erosion risk hot spots as identified as high and medium risk (red and yellow) on these maps. Towns should meet draft and final requirements of Municipal Roads General Permit as they progress.

- Continue to abide by adopted 2013 Road and Bridge Standards. The Towns of Braintree, Brookfield, and Randolph adopted these standards in 2013. Towns should adopt new Road and Bridge Standards as they are developed.

- Protect riparian buffer zones on rivers and streams, especially Ayers Brook and its tributaries, in Brookfield, Braintree, and Randolph. All streams, rivers, and wetlands outside of core developed areas should have an undisturbed vegetated buffer strip that extends 50 feet from the top of all streambanks and wetlands. These riparian buffers should exclude clearing, excavation, filling, grading or development, with the exceptions of streambank stabilization and restoration, and crossings for roads.

- The Town of Randolph includes provisions for stormwater management in their 2009 zoning regulations above and beyond state standards, however these provisions should be applied in districts beyond only the Interchange (INT) Districts. This more widespread application of stormwater management and the required use of best management practices for development projects would benefit water quality in Ayers Brook and the White River.

- Capitalize on grant opportunities, such as Vermont Agency of Transportation's Better Roads grants and Vermont Watershed Management Division's Ecosystem Restoration grants, to improve priority projects listed in this document.

- Adopt site plan green infrastructure/low impact development requirements in existing zoning in the Town of Randolph, especially surrounding Route 66 and Adams Brook.

- In order to maintain stream stability, the Towns of Randolph, Braintree, and Brookfield should limit all new development and construction projects to contain no greater than 10% impervious surface. If projects contain greater than 10% impervious surface they should be required to conserve or protect vegetated and forested land elsewhere in order to achieve this ratio.

Existing Reports

There are three existing reports that were referenced extensively in the development of this Ayers Brook Stormwater Management Plan.

- *Ayers Brook River Corridor Management Plan: Brookfield, Braintree, and Randolph, Vermont* completed June 22, 2007
    - Bear Creek Environmental completed this stream geomorphic assessment and was retained by the White River Partnership. The project includes information from a Phase 1 and Phase 2 geomorphic assessment of Ayers Brook, it assesses specific reaches and how they have been modified by human activity and natural channel movement, and it identifies river corridor restoration projects.
- *Town of Randolph Stormwater Infrastructure Mapping Report* completed in March 2015 by the VTDEC Ecosystem Restoration Section, Watershed Management Division
    - This project mapped hard infrastructure, developed municipal drainage maps, and established potential location for Best Management Practices for stormwater retrofit sites in the town of Randolph.
- *White River Tactical Basin Plan* completed in July 2013 by the Watershed Management Division of the Vermont Agency of Natural Resources
    - This project included projects that had already been identified in the Ayers Brook Watershed and provided background information on Ayers Brook.

These reports made individual recommendations and aided the development of priority projects included in this plan.

Background

Ayers Brook

The Ayers Brook watershed, which resides within the larger White River Watershed, is 37 square miles, and includes the towns of Brookfield, Randolph, Braintree, and Roxbury, Vermont. The headwaters of the brook originate in the towns of Roxbury and Brookfield, subsequently flow into the Town of Braintree, and enter the Third Branch of the White River in the Town of Randolph. Approximately two-thirds of the Ayers Brook watershed resides in Braintree, Brookfield, and Roxbury, while the Town of Randolph encompasses one-third of the watershed. Major brooks that feed into Ayers Brook include Adams Brook which runs alongside Vermont Route 66 in Randolph, Spear Brook which runs along Peth Road in Braintree, Cold and Open Meadow Brooks in Brookfield, and several other unnamed tributaries.

The Ayers Brook is a major tributary to the Third Branch of the White River, which drains into the larger Connecticut River. The Connecticut River forms the border between New Hampshire and Vermont, crosses Connecticut and Massachusetts, and empties into the Long Island Sound. Ayers Brook and the White River are part of Basin 9 in the state of Vermont's Tactical Basin Planning process. Figure 1 shows the Ayers Brook Watershed, surface water, and the towns that comprise its land area.

Existing Water Quality

The State of Vermont includes Ayers Brook in its 2014 Stressed Waters List. The White River Tactical Basin Plan identifies sediment, Chromium (Cr), Nickel (Ni), and E. coli as pollutants with elevated levels in Ayers Brook. The 2014 Stressed Waters List includes loss of riparian vegetation, habitat alteration from agricultural activities, and former gravel mining as activities that have negatively affected water quality in Ayers Brook. High levels of E. Coli are the result of failed septic and sewage systems by the Town of Randolph. Many of Ayers Brook's streambanks exhibit widespread erosion which has caused high sediment levels and turbidity. Possible sources of the metals Cr and Ni include closed landfills in Brookfield and Randolph.

Vermont Route 12 parallels Ayers Brook through Randolph, Braintree, and Brookfield, and is the most significant lateral constraint to the brook. There are several armored sections of streambank along Ayers Brook that have been established to protect road infrastructure. However, these armaments have led to loss of floodplain area, increased energy in the stream channel, high rates of bank erosion, channel widening, mass failures, and morphological instability. This widespread erosion has caused high levels of sediment and turbidity in Ayers Brook and subsequently the Third Branch of the White River.

Existing water quality monitoring data is from 2006 and should be updated.

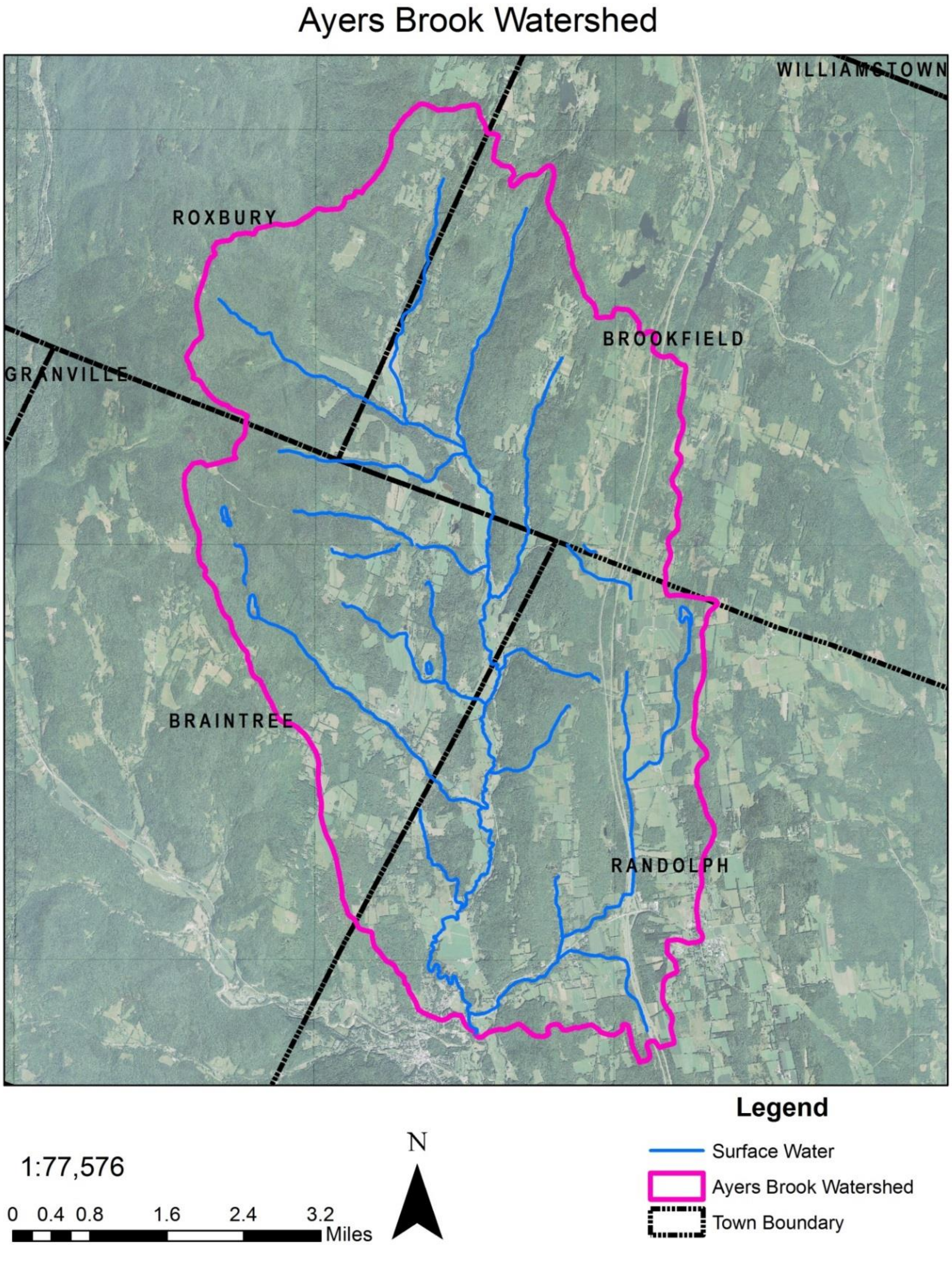


Figure 1 The Ayers Brook Watershed and Surface Water

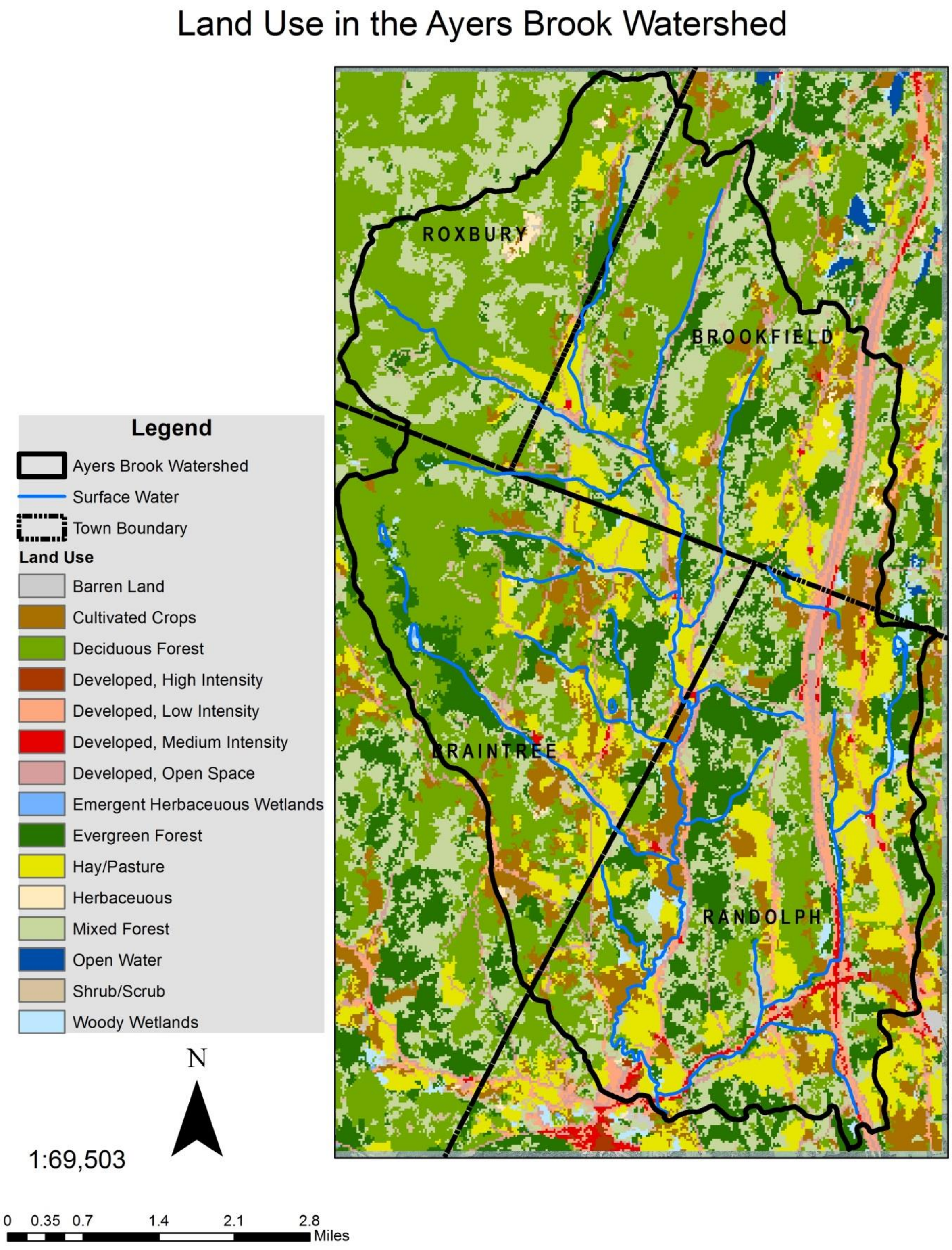


Figure 2 Land Cover Types in the Ayers Brook Watershed

The Ayers Brook Watershed consists of a variety of land uses that were mapped using the National Land Cover Database (NLCD). The most frequent land uses consist of deciduous, coniferous, and mixed forests, cultivated crops, hay or pasture, and developed land. Figure 2 shows that much of the land bordering Ayers Brook is cultivated crops, hay or pasture, and forest. Figure 2 also shows a long strip of developed, low intensity land next to Ayers Brook, which represents Vermont Route 12.

Figure 3 shows the most prominent land cover types by square miles. It indicates that forested land, consisting of deciduous, coniferous, and mixed forest types, constitute the highest land cover type with nearly 25 square miles, or 67.5% of the Ayers Brook Watershed.

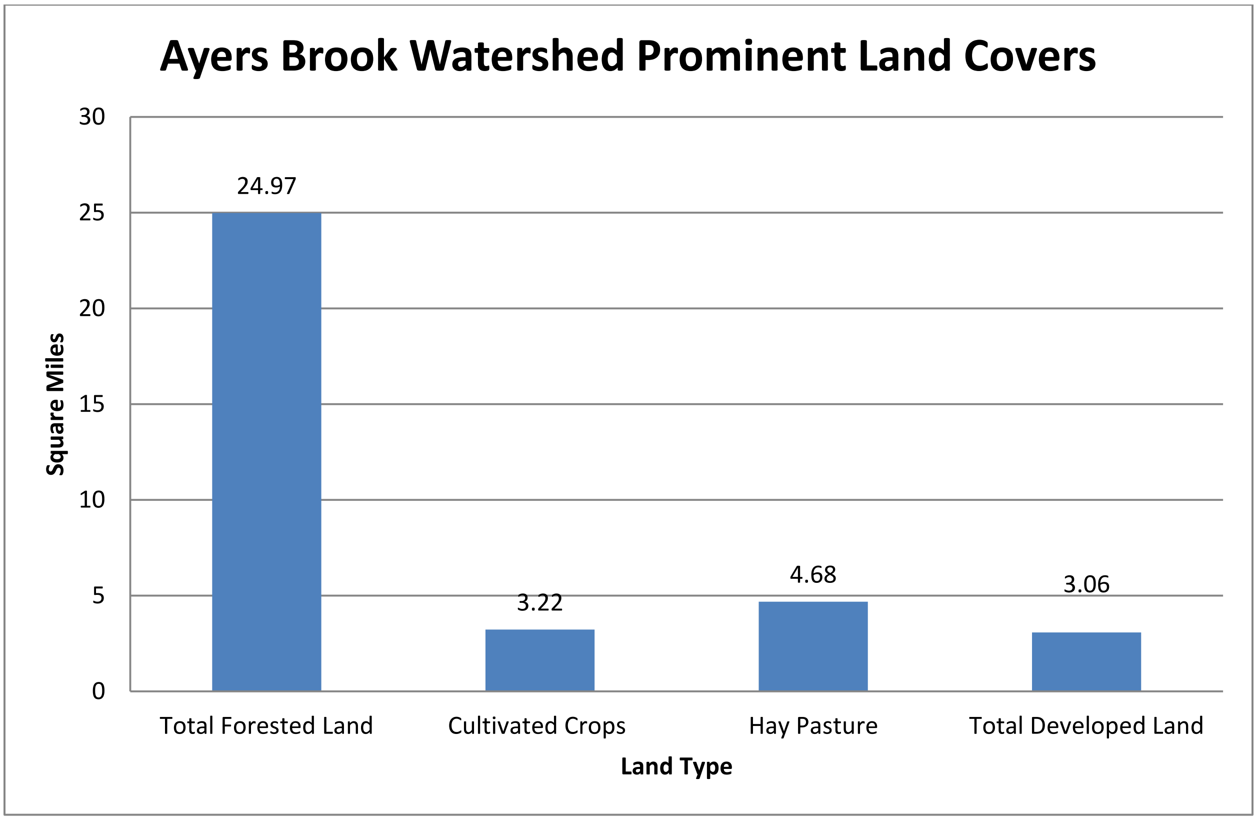


Figure 3 Prominent Land Cover Types in the Ayers Brook Watershed

NLCD also defines and classifies four types of development. Developed, open space consists of a mixture of constructed materials and vegetation, and 20% of this land is covered in impervious surfaces. Low intensity developed land is 20% to 49% covered in impervious surfaces, medium density developed land consists of 50% to 79% impervious surface coverage, and high intensity developed land consists of area that are 90-100% impervious surface.

Altogether, developed land of all four classifications consists of 3.06 square miles or 8.27% of the Ayers Brook Watershed. Most of the development in the Ayers Brook Watershed is either classified as Developed, Open Space with 1.63 square miles or Low Intensity, with 1.14 square miles. Figure 2 shows large sections of low and medium density developed land along Interstate 89 and near exit 4 where Vermont Route 66 intersects with Interstate 89. There are only a few sections of high intensity development in the Ayers Brook Watershed, and these are mostly located in the soutwestern portion of the watershed in Randolph.

Land Type	Square Miles	Percentage
Deciduous Forest	11.74	31.73%
Coniferous Forest	5.61	15.16%
Mixed Forest	7.63	20.61%
Total Forested Land	**24.98**	**67.50%**
Cultivated Crops	3.22	8.70%
Hay Pasture	4.68	12.65%
Shrub/Scrub	0.72	1.95%
Developed, Open Space	1.63	4.39%
Developed, Low Intensity	1.14	3.08%
Developed, Medium Intensity	0.28	0.75%
Developed, High Intensity	0.02	0.05%
Total Developed Land	**3.06**	**8.27%**
Emergent Wetlands	0.01	0.05%
Woody Wetlands	0.33	0.89%
Total Wetlands	**0.35**	**0.94%**
Barren	0.01	0.02%
Open Water	0.002	0.01%
Total	**37**	**100%**

Table 1 Land Use Cover in the Ayers Brook Watershed

The 2007 Ayers Brook Corridor Management Plan indicates that, according to stream geomorphic assessments, the waterbody is in a state of “active adjustment” to historic land use, channel modifications, and floodplain modifications (Nealon & Blazewicz, page i). The historic management activities in the watershed have created a stream that has become incised, leaving the floodplain inaccessible during normal high water events. Incised channels cannot alleviate erosive force through flooding and instead erode in order to reestablish a lower floodplain. Consequently, high water events lead to extreme bank erosion, channel widening, lateral migration, loss of aquatic habitat and channel instability (page ii). Erosion leads to sedimentation, turbidity and excess nutrients. There are many armored banks of Ayers Brook that have caused the brook’s erosive energy to go elsewhere along the river corridor. These banks have been lined with rip rap in order to protect road infrastructure, but have caused intense erosion along other streambanks.

Historic management and current issues combine to contribute to the overall health and condition of the Ayers Brook watershed. According to the Corridor Management Plan, one of the main hydrologic stressors in the Ayers Brook watershed is urbanization and the resulting increase in stormwater (Nealon and Blazewicz, page 24). Urbanization, the conversion of land that was once forested, and the creation of impervious surfaces has led to higher volumes and velocities of stormwater runoff and consequently erosive waterbodies.

When a watershed reaches 5-10% impervious surface, stormwater runoff impacts are considered to be a significant stressor on the overall health of the watershed. In addition, erosion in a stream channel also leads to increased sediment loading, which leads to increased turbidity and water quality issues. Therefore, new impervious surface creation in the Towns of Randolph, Braintree, and Brookfield should be minimized. Even in areas with little impervious cover, roadways, and improper ditching and access management lead to stormwater impacts. In addition, road failures in heavy storms are a significant contributor of sediment.

Conserved Land

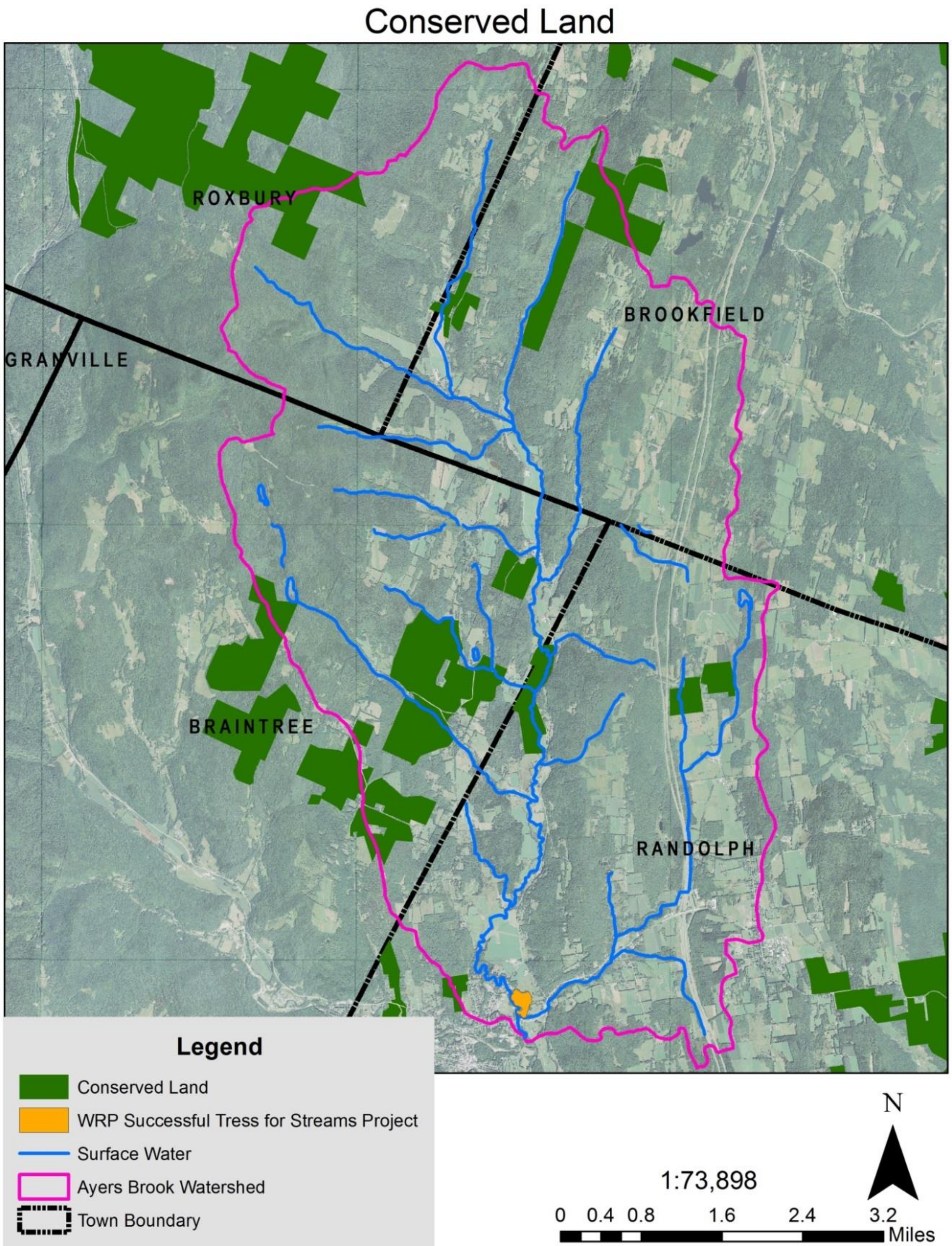


Figure 4 Conserved Land in the Ayers Brook Watershed and Surrounding Towns

Figure 4 on page 18 shows conserved parcels in the Ayers Brook Watershed. This includes land owned outright by private organizations, town forests, publicly conserved land, and conservation easements by the Vermont Land Trust, the Vermont River Conservancy, and The Nature Conservancy, which prevent further development.

Although, much of the Ayers Brook Watershed is forested, land use in river corridors close to the Ayers Brook and its tributaries is important to the health of surface waters in the watershed. River corridor easements and other conservation measures are crucial tools to the protection of these surface waters. Conserved land along river corridors consists of land conserved by Vermont Land Trust easements, Vermont River Conservancy easements, and the Allis State Park in Brookfield.

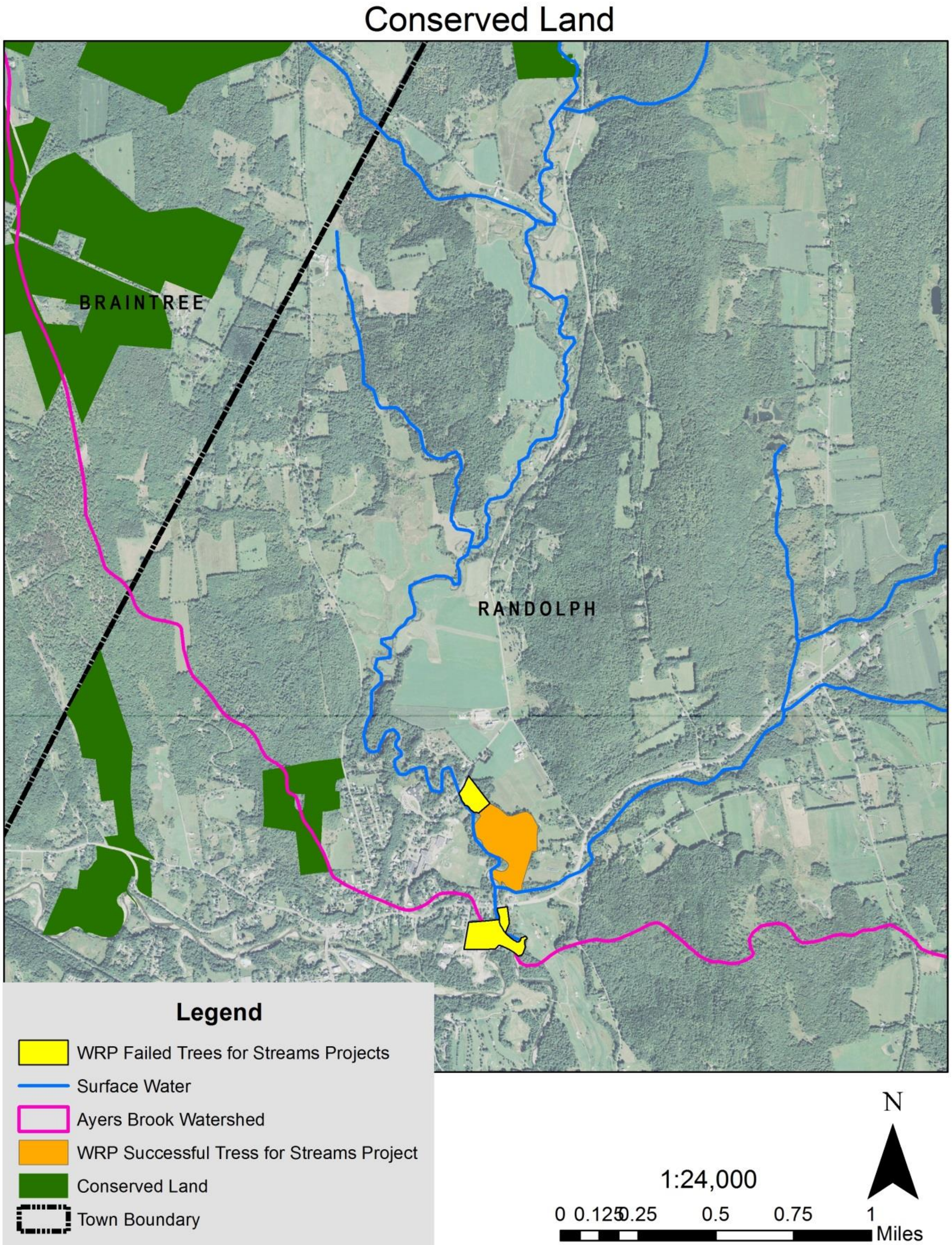


Figure 5 White River Partnership Trees for Streams Projects

In the southern portion of the watershed in Randolph, the White River Partnership, through their Trees for Streams program, has worked to plant tree and shrub riparian buffers in a site that has been marked with orange on Figure 5. Riparian buffers contribute ecological and social benefits to the watershed including providing ecological habitat, reducing stormwater runoff, preventing streambank erosion, filtering pollutants from runoff, and protecting against flood damage. The successful White River Partnership Trees for Streams project began with the planting of 142 trees in 2010, and continued with the planting of 300 trees in 2015.

Trees for Streams projects were completed in 2007 and 2008 at three other parcels in Randolph, but these plantings did not survive. These parcels are marked in yellow on Figure 5.

Randolph, Brookfield, Braintree, Vermont

Randolph, Braintree, and Brookfield are towns in Orange County. According to the U.S. Census, the population of Randolph was 4,778 people in 2010. This is a 1.55% decrease in population from the 2000 Randolph population of 4,853. Similarly, Randolph's population has increased by only .3% since 1990. In 2010, there were 2,076 total housing units in Randolph. This is nearly a 9% increase in houses since 2000, and a 13.4% increase over two decades. Although Randolph's population has slightly decreased over two decades, more housing units have been built during that period. About 13 square miles in Randolph reside in the Ayers Brook watershed, and it is here that Ayers Brook joins the Third Branch of the White River.

In 2010, the Town of Braintree contained 1,246 people, which represents a 4.4% increase from 2000. In 2010, there were 567 total housing units, which increased by 13.8% from 2000. Braintree contains 9.5 square miles that reside in the Ayers Brook watershed.

In 2010, the population of Brookfield was 1,292 people, which grew by 5.7% from 2000. In 2000 there were 702 total housing units, a number that increased by 16.6% from 2000. Brookfield contains 9.1 square miles that reside in the Ayers Brook watershed.

Despite moderate rates of growth in Braintree and Brookfield and an only slight population increase in Randolph, there were very high increases in the development of housing structures in all three towns in the lower Ayers Brook watershed. This development indicates an increase in land conversion and alteration from once forested areas to more developed ones. These activities increase stormwater runoff in the Ayers Brook watershed.

Road Systems and Erosion

Roads are a significant source of stormwater runoff. Both unpaved and paved roads are considered impervious surfaces. Figure 6 illustrates the types of roads in the towns of Randolph, Brookfield, and Braintree. Altogether, there are 64.75 miles of paved roads in the three towns, which consist of Interstate 89, state highways, and the small portion of class 1 roads in Randolph. Interstate and State Highways are maintained by the State of Vermont. The most prominent state highway in the Ayers Brook Watershed is Vermont Route 12, which parallels Ayers Brook for about 8.5 miles.

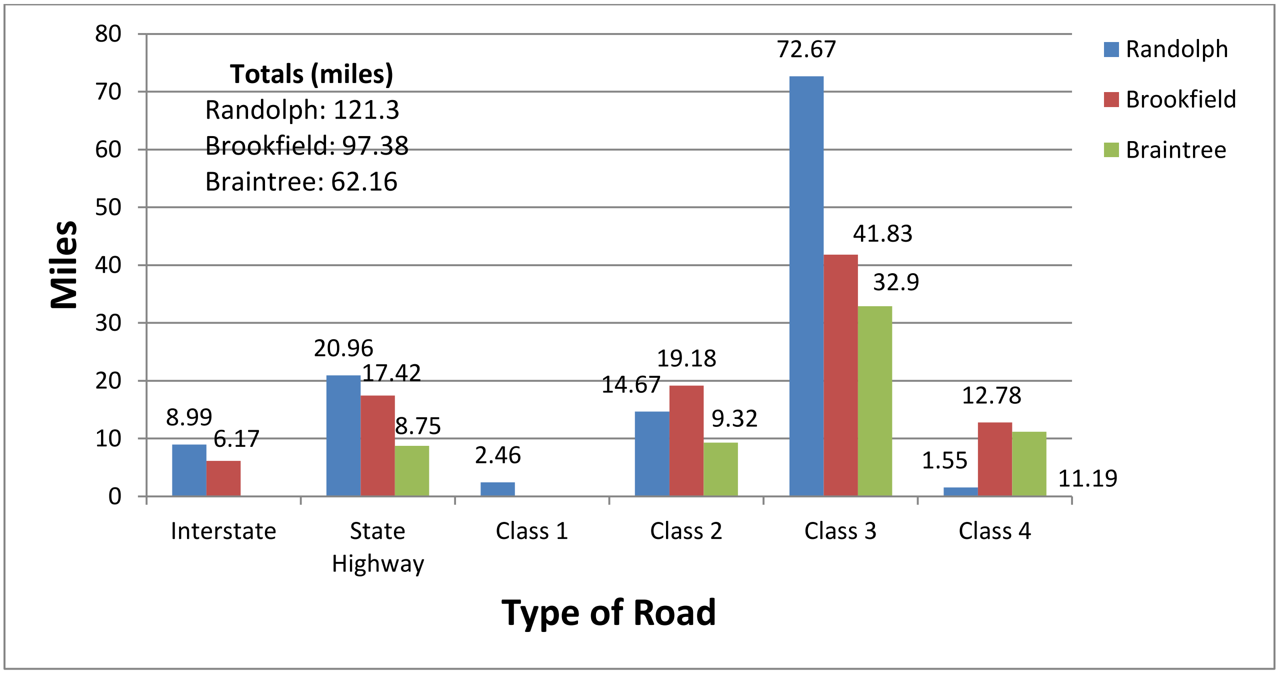


Figure 6 Road Classification and Mileage in Randolph, Brookfield, and Braintree

Altogether, unpaved roads, consisting of gravel and dirt, make up the vast majority of roads in the Ayers Brook watershed. These roads are also considered impervious surfaces and are a major source of sedimentation in surface waters. There are 216.09 miles of unpaved roads in the three towns. Randolph has 88.89 miles, Brookfield has 73.19 miles, and Braintree has 53.41 miles. Gravel and dirt roads vary widely in condition. The Vermont Agency of Natural Resources has compiled a road erosion risk rating for unpaved class 2-4 roads in the state, and several sections of high and medium risk erosion ratings occur in the Ayers Brook watershed. Within the Ayers Brook watershed there are 99 miles of improved roads. This number does not include Class 4 roads and legal trails.

Randolph Roads

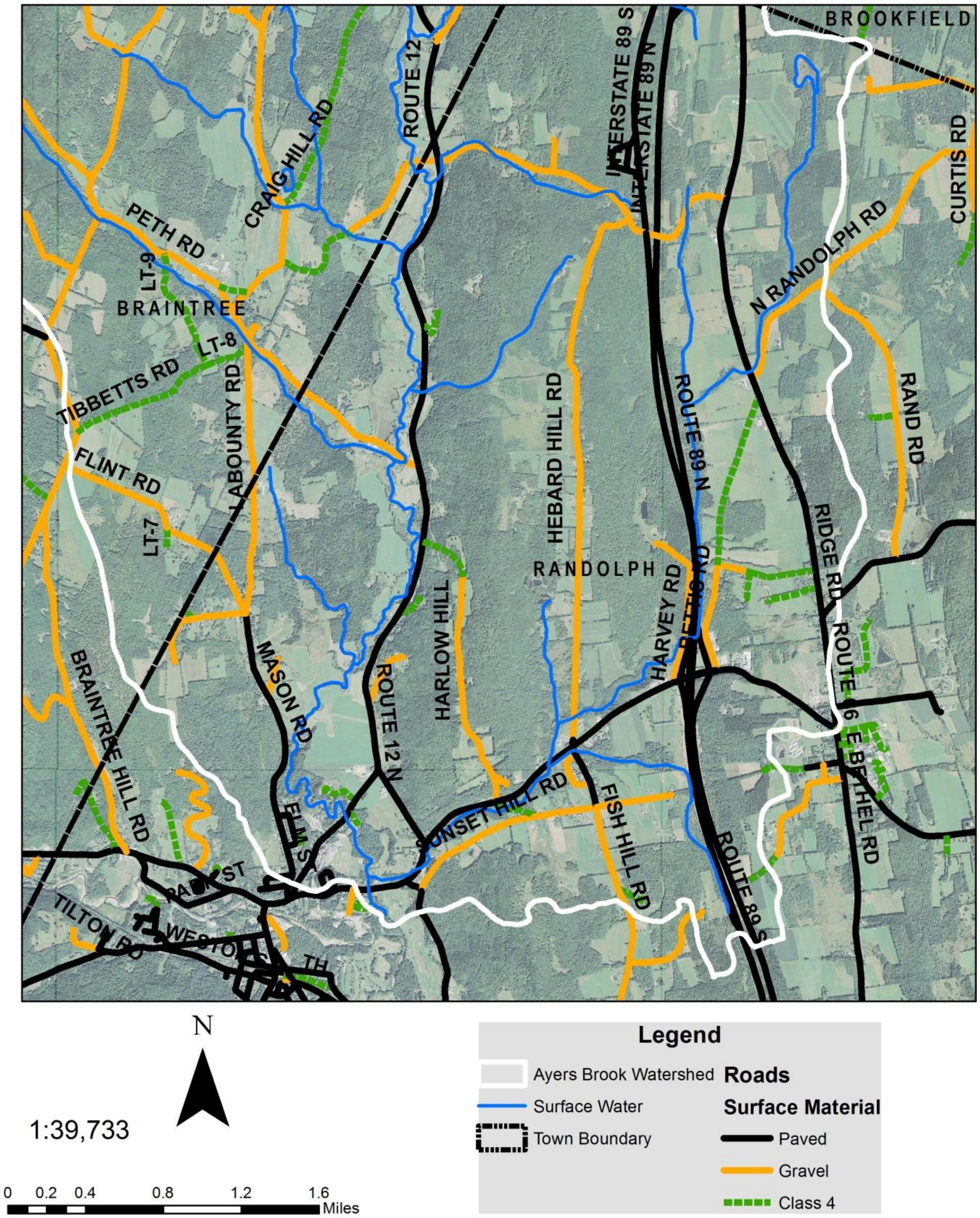


Figure 7 Roads by Material in Randolph

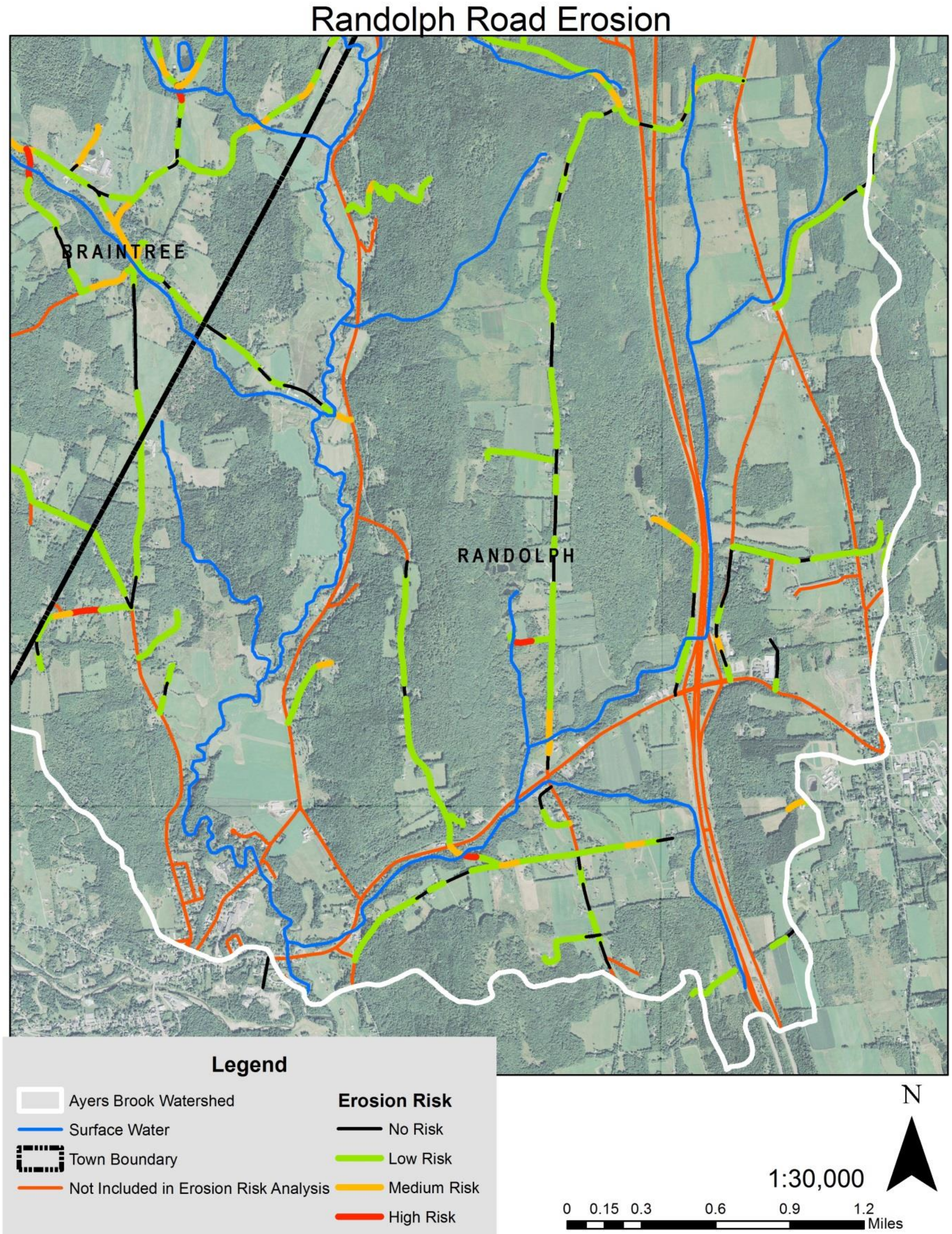


Figure 8 Road Erosion Risk for Roads in Randolph

There are only a few sections of high and medium risk road erosion in Randolph. One section is Hollyhock Hill in the southwestern part of town on the Braintree border. Another highly erosive section of road is Howard Hill Road. This section of road is steep and contains a major stream crossing. Surface water borders both sides of the gravel road in sections, and the steep section of the road empties onto Route 12 and Ayers Brook. There is a retention pond at the bottom of the road to help retain some of the sediment that washes down the hill and to treat stormwater runoff before it enters Ayers Brook.

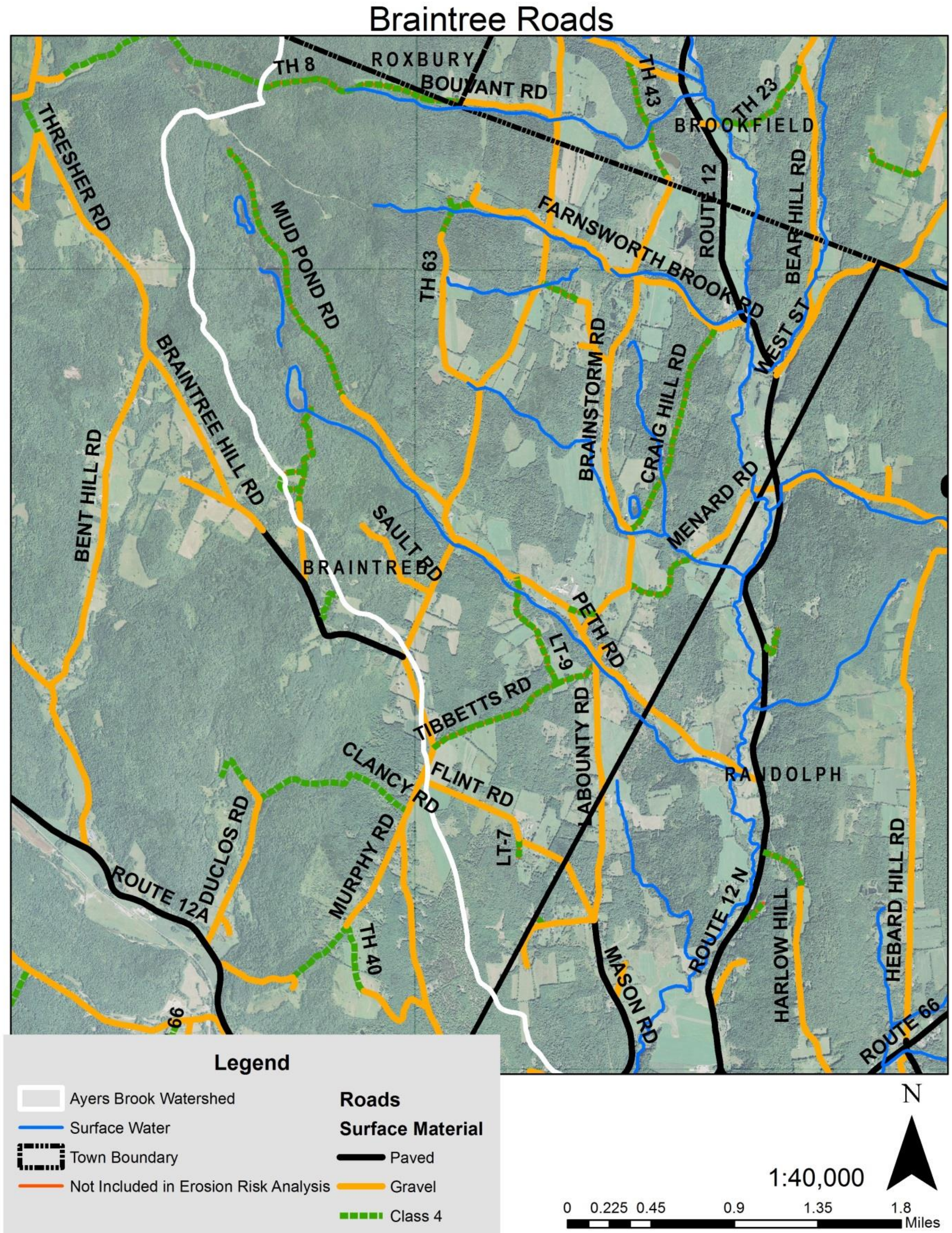


Figure 9 Roads by Material in Braintree

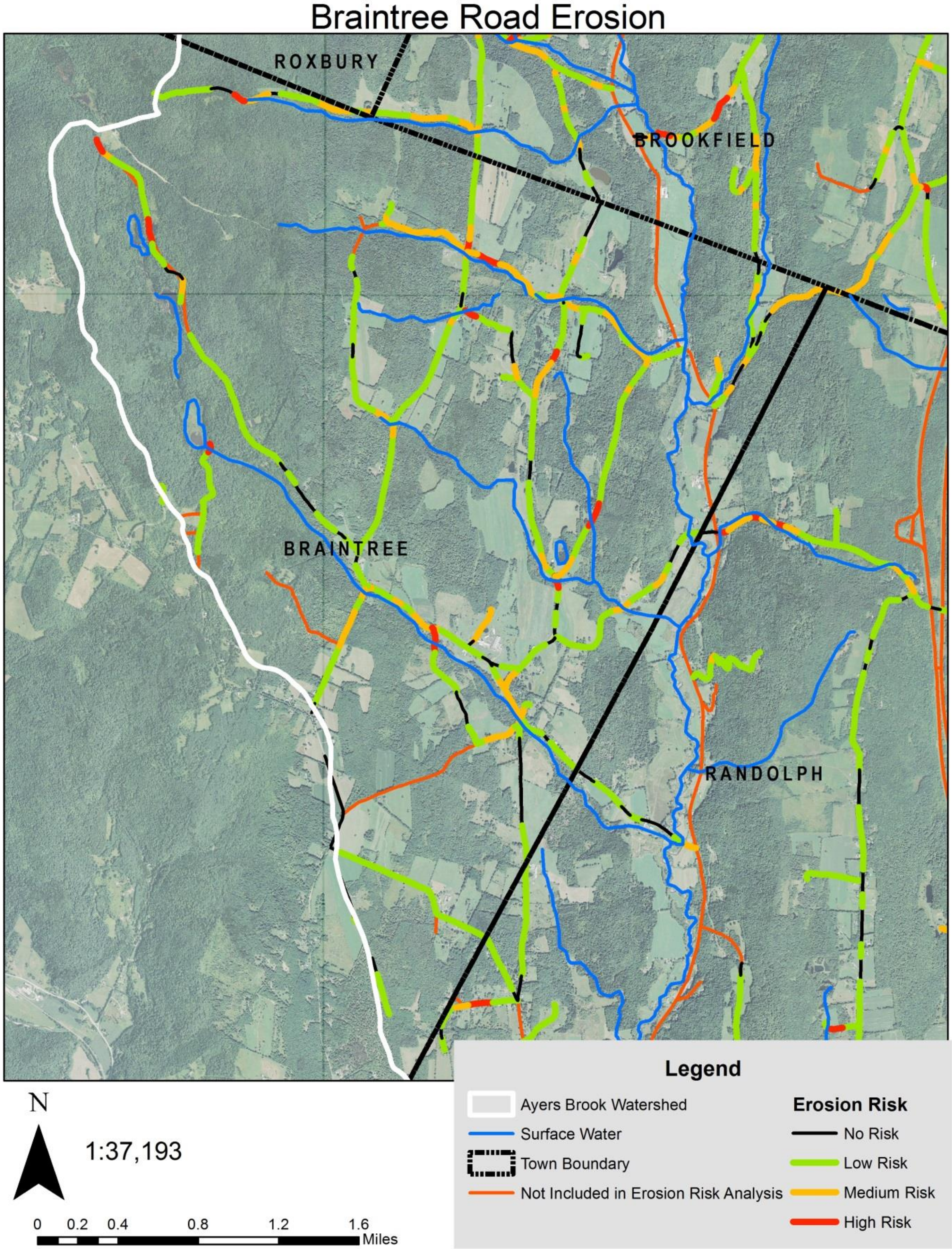


Figure 10 Road Erosion Risk for Roads in Braintree

In Braintree there are several road sections that have medium and high erosion risks. Peth Road contains several sections of medium risk erosion because it borders surface waters. Brainstorm Road contains a high risk erosion at a large stream crossing. Two sections of high risk erosion depart from Peth Road and Brainstorm Road due to stream crossings on Class 4 roads. Farnsworth Road also contains medium and high erosion risk for almost its entire length due to large stream crossings and surface water connection.

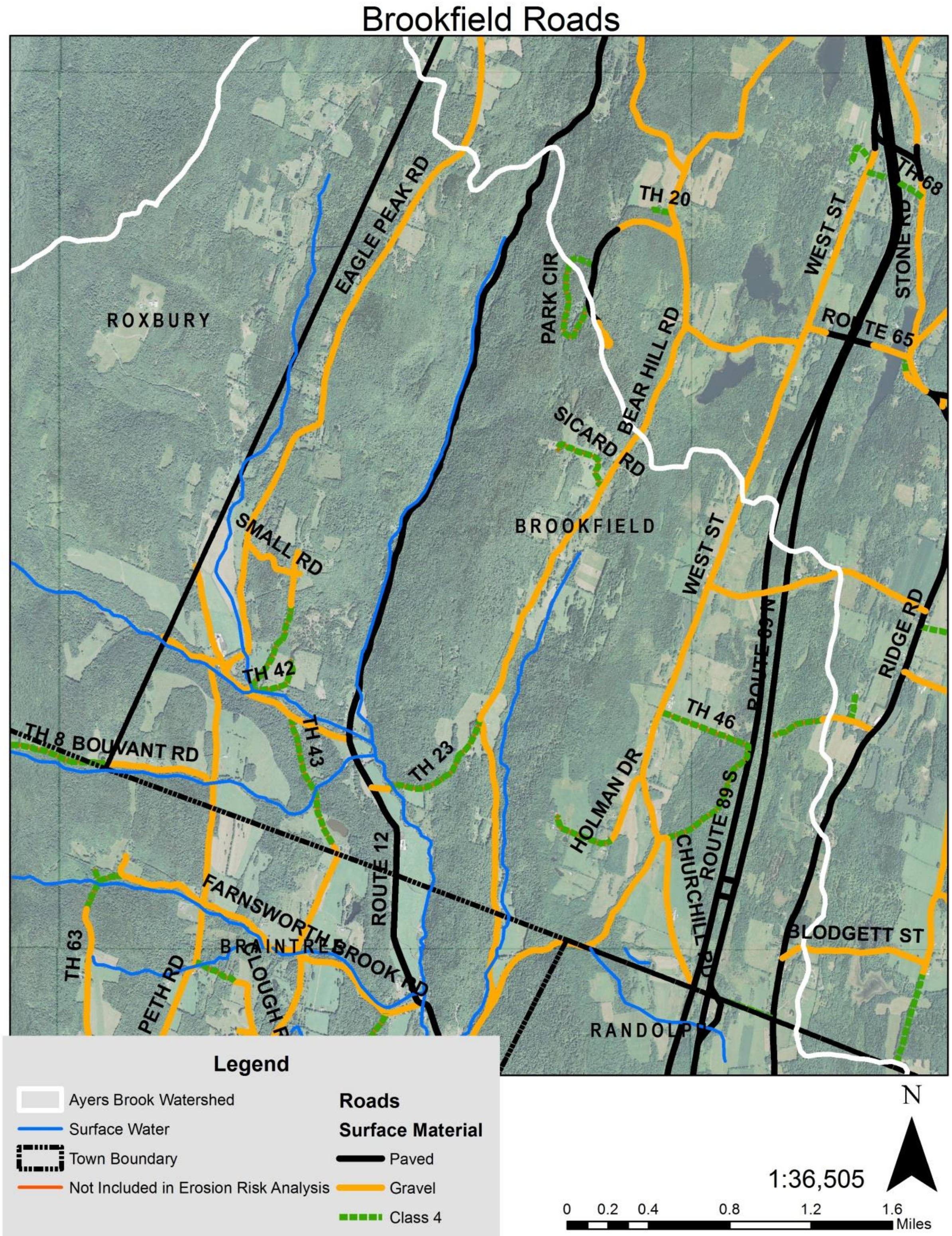


Figure 11 Roads by Material in Brookfield

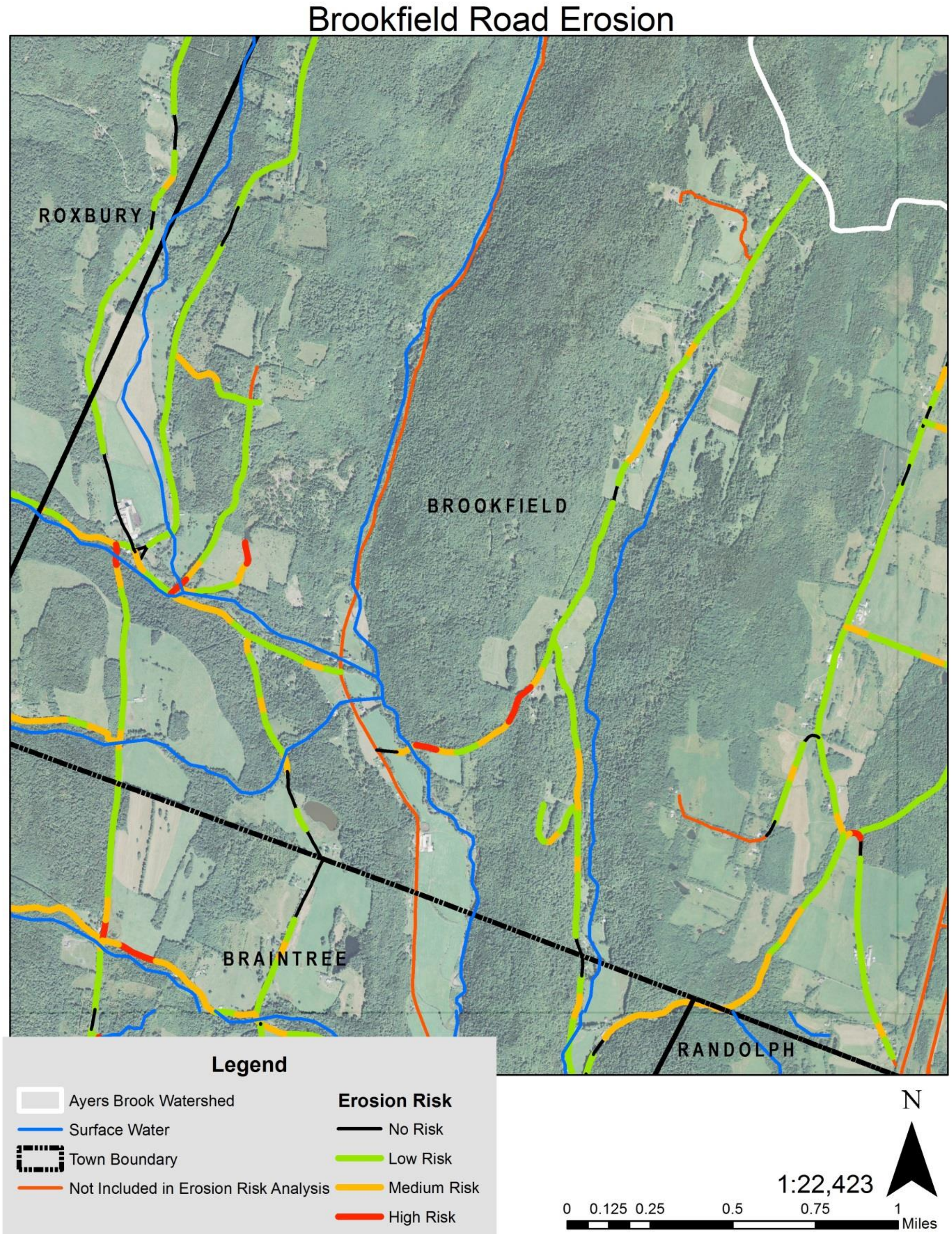


Figure 12 Erosion Risk of Roads in Brookfield

In Brookfield, Ayers Brook follows Route 12 north until the upper reaches of its watershed. The road is connected to surface water in many parts, as it along Bear Hill Road. The maps on the previous pages indicate that high erosion risk roads in Brookfield are Class 4 roads, TH-23, TH-42, Witts Bridge Road, as well as where Davis Acre Road crosses a stream.

ACT 64 and Vermont Water Quality

New legislation passed in spring of 2015 by the Vermont Legislature has altered policy within the state related to development and water quality.

New development projects equal to or greater than 1 acre of impervious surface will require a new general permit. The Vermont Department of Environmental Conservation may lower this threshold to .5 acres. The schedule for this permit has not yet been established. A new Developed Lands permit will be required for existing projects equal to or greater than 3 acres of impervious surface. This permit for existing surfaces will be adopted by 2018, and entities identified for compliance will need to do so by 2028, with an exception for those entities within the Lake Champlain Basin, which will need to comply by 2023.

A new Municipal Roads General Permit will be required for priority segments of municipal roads to reduce erosion and improve quality in Vermont waterways. Priority road segments include those that are high erosion risk and roads that are connected to waterways. For these priority road segments, municipalities will need to integrate Best Management Practices, such as stone lining ditches with slopes greater than 5%, road crowning, stabilizing exposed soils, installing culvert headers, stabilizing culvert outlets, making U-shaped ditches, and establishing turnouts, in order to reduce erosion on municipal roads. Once priority road segments and priority projects have been established, Towns will develop a maintenance schedule to address these problems over 20 years.

The Municipal Roads General Permit Draft Permit will be formulated by the end of 2016, the Final Permit will be established by end of 2017 where it will need to be approved the Vermont Legislature, and permit coverage will be phased in from 2018 through 20121 for all towns in Vermont.

Stormwater Areas of Concern and Problem Areas

The next section describes and illustrates areas of concern that are causing stormwater impacts in the Ayers Brook watershed. These areas of concern were discovered using existing data collected by TRORC, previously completed reports, conversations with road foreman in specific towns, and field visits.

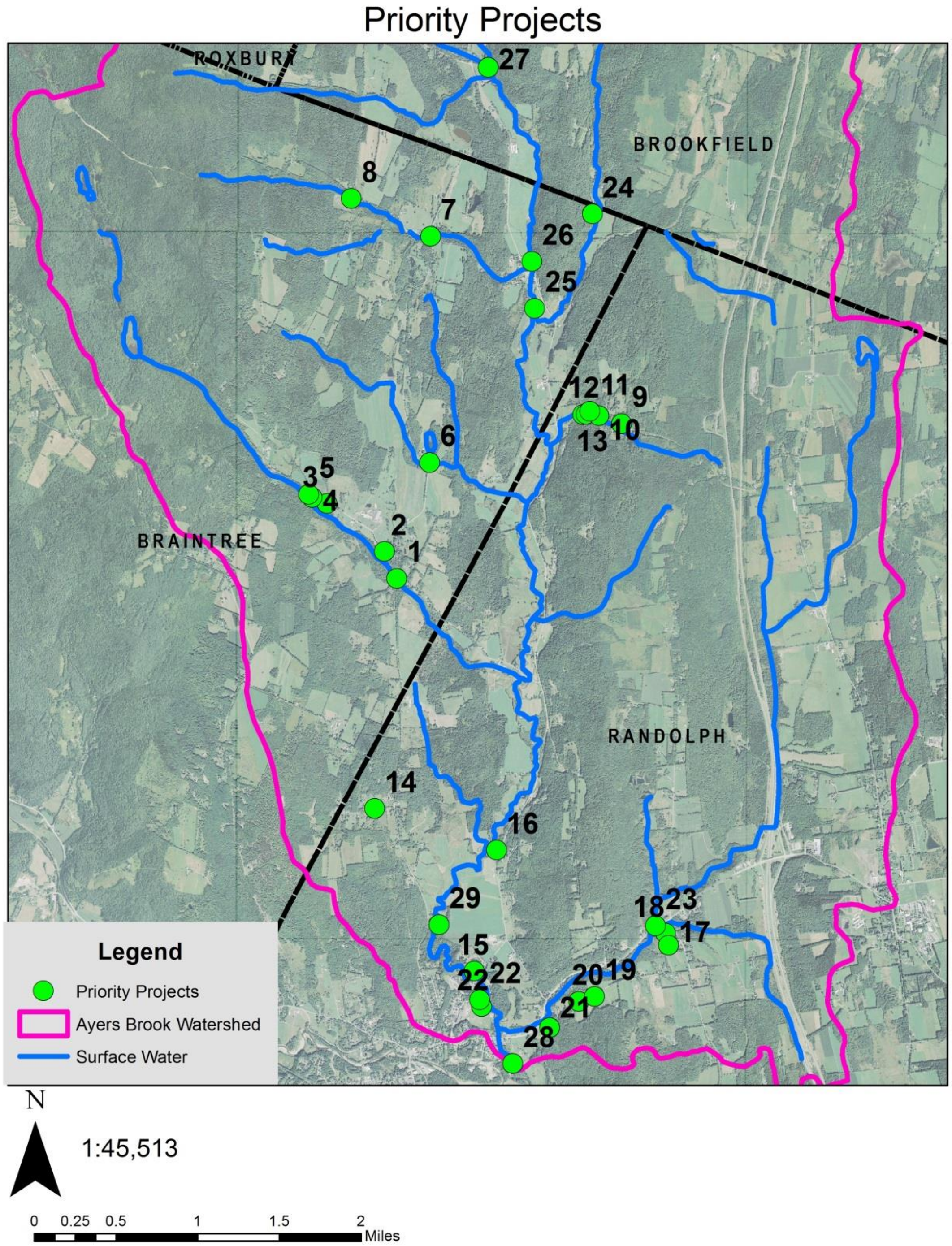


Figure 13 Priority Projects in the Ayers Brook Watershed

Braintree

Peth Road

Peth Road is a gravel road in Braintree that resides west of the main stem of Ayers Brook. It parallels the second and third order stream, Spear Brook, in Braintree, and continues into Randolph where it eventually joins Vermont Route 12. Spear Brook originates at the Mud Pond in Braintree, follows Mud Pond Road to its intersection with Peth Road, and continues until it joins Ayers Brook. There are several undersized culverts on Peth Road that pose stormwater problems and hamper the hydrologic functionality of Ayers Brook and its tributaries. Peth Road contains several major stream crossings, and much drainage passes under the road by means of culverts.

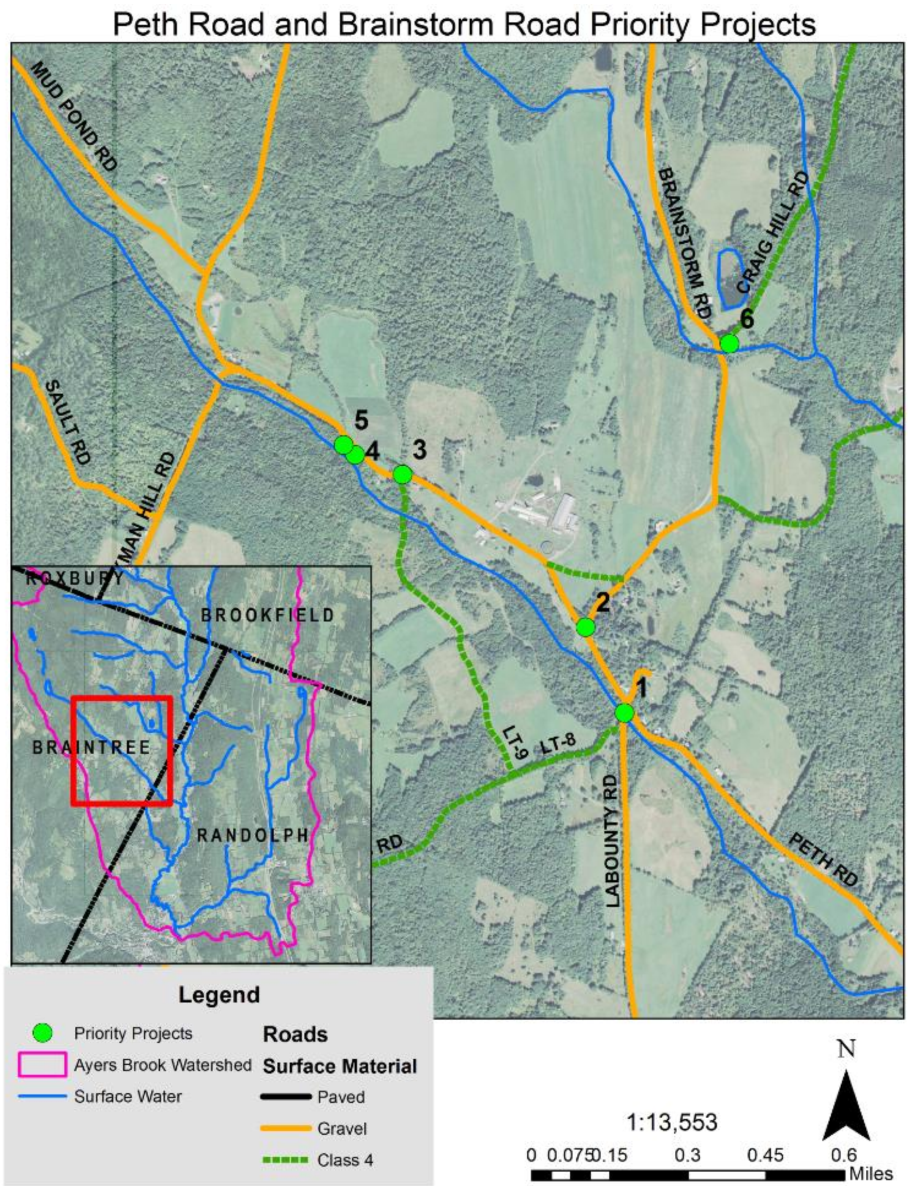


Figure 14 Priority Project on Peth Road and Brainstorm Road

Map ID: 1
Latitude and Longitude: (43.969374, -72.667852)
Priority: Low
Location and Description: There is an undersized culvert at the junction of Peth Road and Labounty Road. The culvert is 9 feet high, 9 feet wide, and 52 feet long. The existing squashed culvert cannot appropriately handle the level of water that it currently experiences. It should be replaced with a bridge or arch to handle the hydraulic capacity of Spear Brook, a third order stream in the Ayers Brook Watershed. The outlet of this culvert is also perched, which prevents aquatic organism passage and leads to streambank and streambed scouring downstream.
Recommended Treatment: Upgrade this culvert to a bridge or arch. The width or span of this structure should be close to 22.16 feet according to bankfull width. Specific hydrologic studies may indicate that structure width may be bigger or smaller.

Culvert at Junction of Peth and Labounty Roads: Inlet

Culvert at Junction of Peth and Labounty Roads: Outlet

Map Id: 2
Latitude and Longitude: (43.971749, -72.669363)
Priority: Low
Location and Description: The junction of Peth Road and Brainstorm contains two culverts. One was recently upgraded by Jeff Masterson, the Braintree road foreman. The other, more westerly culvert is undersized culvert. This culvert is 4 feet wide, 4 feet high, and 40 feet long. It experiences a constantly flowing stream.
Recommended Treatment: Stone line inlet and outlet ditches. Upsize existing undersized culvert.

Culvert at the Junction of Peth and Brainstorm Roads: Inlet

Culvert at the Junction of Peth and Brainstorm Roads: Inlet Stream

.


Culvert at the Junction of Peth and Brainstorm Roads: Outlet

Map Id: 3
Latitude and Longitude: (43.975979, -72.676428)
Priority: High
Location and Description: The 15 inch high, 15 inch wide, and 40 foot long culvert at this location is significantly undersized for the amount of water it witnesses. A rock wall at the outlet of this culvert poses a structural threat to the road if it were to collapse or fail. Sediment has accumulated at the inlet of this culvert. The outlet of this culvert is also perched, which prevents aquatic organism passage and leads to streambank and streambed scouring downstream.
Recommended Treatment: Upsize the culvert and stone-line the inlet and outlet ditches. The width or span of this structure should be close to 3.56 feet according to bankfull width. Specific hydrologic studies may indicate that structure width may be bigger or smaller.

Peth Road: Culvert Outlet Stream

Peth Road: Culvert Outlet and Rock Wall

Peth Road: Inlet

\

Peth Road: Sediment Buildup at Inlet

Peth Road: Inlet Stream

Map Id: 4
Latitude and Longitude: (43.976526, -72.678247)
Priority: High
Location and Description: This 15 inch high, 15 inch wide, and 30 foot long steel culvert on Peth Road is in significant disrepair. The inlet has been damaged and is not properly ditched. The perched outlet has led to a severely eroded gulley. Perched outlets also impede aquatic organism passage.
Recommended Treatment: Stone-line the ditch inlet and outlet. Upsize the culvert to appropriately handle current levels of water. Repair eroded gully by fixing outlet bed with placed rock material.

Peth Road: Culvert Inlet

Peth Road: Culvert Outlet

Peth Road: Culvert Outlet

Peth Road: Culvert Outlet

Map Id: 5
Latitude and Longitude: (43.976801, -72.67869)
Priority: Medium
Location and Description: The 36 inch high, 36 inch wide and 35 foot long steel culvert is undersized. It experiences a constantly flowing stream. The outlet of this culvert is also perched, which prevents aquatic organism passage and leads to streambank and streambed scouring downstream.
Recommended Treatment: Upsize culvert to appropriately handle current levels of water. Stone line inlet and outlet ditches. .

Peth Road: Culvert Outlet

Peth Road: Culvert Inlet

Peth Road: Culvert Inlet Stream

Brainstorm Road

Map Id: 6
Latitude and Longitude: (43.979636, -72.663843)
Priority: Medium
Location and Description: At the junction of Brainstorm Road and Craighill Road, there is a significant second order stream crossing through a 4 foot high, 4 foot wide, and 50 foot long aluminum culvert with concrete blocks. The outlet of this culvert is perched, which prevents aquatic organism passage and leads to streambank and streambed scouring downstream.
Recommended Treatment: Upgrade to a large pipe-arch or multi-plate pipe-arch. The width or span of this structure should be close to 11.5 feet according to bankfull width. Specific hydrologic studies may indicate that structure width may be bigger or smaller.

Brainstorm Road: Culvert Inlet

Brainstorm Road: Culvert Outflow

Brainstorm Road: Culvert Outlet

Brainstorm Road: Outlet Pool

Farnsworth Brook Road

Farnsworth Brook is a gravel road in Braintree that resides west of the main stem of Ayers Brook. It parallels a second and third order stream for its duration until it intersects with Vermont Route 12. The streams along this road flow directly into Ayers Brook. There are several undersized culverts on Farnsworth Brook Road that pose stormwater problems and hamper the hydrologic functionality of Ayers Brook and its tributaries. Farnsworth Brook Road contains several major stream crossings, and much drainage passes under the road by means of culverts. Several culverts on this road have been recently upgraded

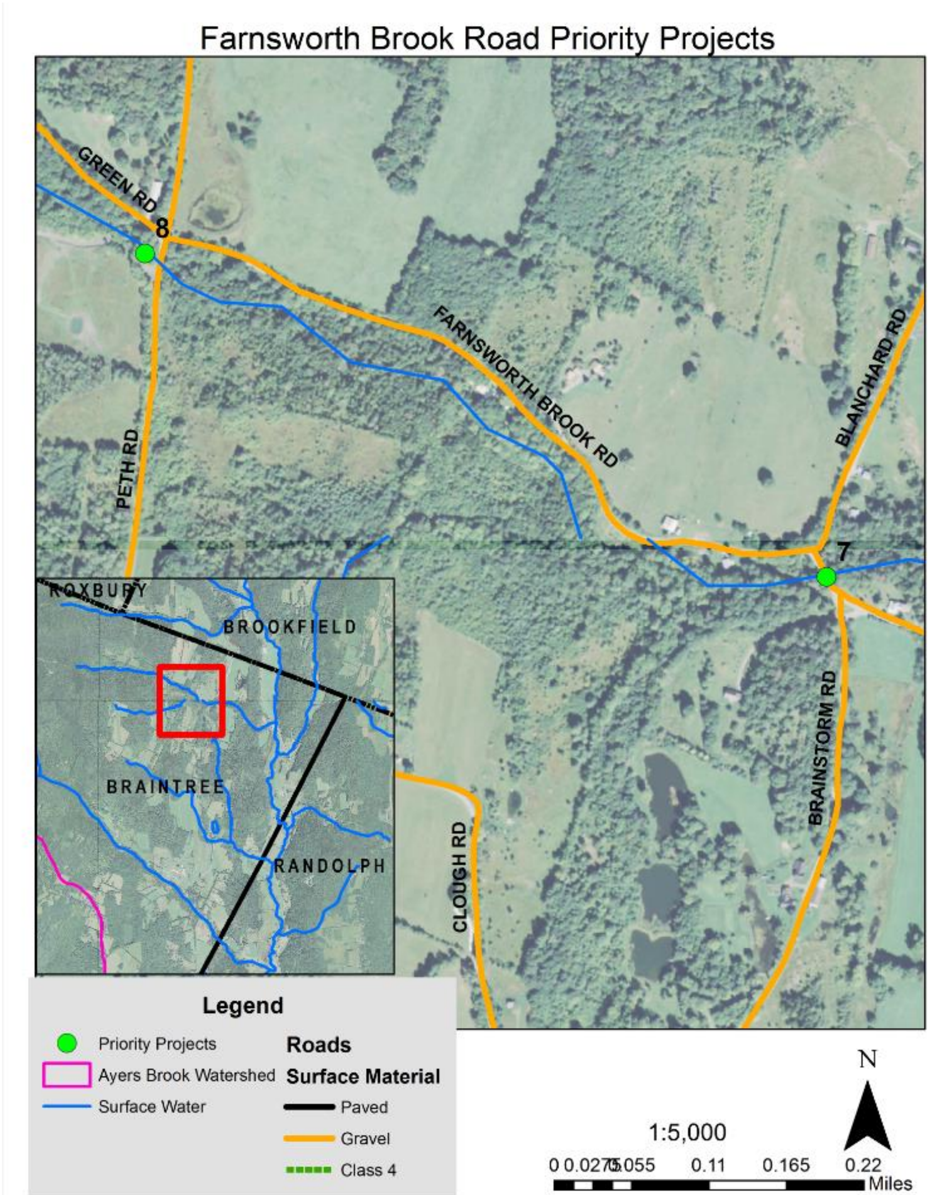


Figure 15 Priority Projects on Farnsworth Brook Road

Map Id: 7
Latitude and Longitude: (43.999691, -72.663742):
Priority: Medium
Location and Description: This upgrade occurs at the intersection of Farnsworth Brook Road and Blanchard Road. This undersized squashed aluminum culvert is 72 inches high, 96 inches wide and 50 feet long and has been previously identified as a priority project in a 2014 Better Backroad grant application. The outlet of this culvert is also perched, which prevents aquatic organism passage and leads to streambank and streambed scouring downstream.
Recommended Treatment: Justin Hadley's Hydraulic Report from 6/18/2015 concluded:

1. A bridge with a 14' wide by 6' high minimum waterway opening, providing 84 sq. ft. of waterway area. This structure will result in a headwater depth at Q25 = 3.7' and at Q100 = 4.6'. If a new bridge is installed, the bottom of abutment footings should be at least six feet below the channel bottom, or to ledge, to prevent undermining. Abutments on piles should be designed to be free standing for a scour depth at least 6' below channel bottom.
2. An open bottom arch with a 14' minimum clear span and 5.6' minimum clear height, providing at least 58 sq. ft. of waterway area. This structure will result in a headwater depth at Q25 = 4.2' and at Q100 = 5.5'. If the open bottom arch option is installed, we recommend full height concrete headwalls be constructed at the inlet and outlet. The bottom of abutment footings under the arch should be at least six feet below the channel bottom, or to ledge, to prevent undermining. We recommend a minimum cover of 3' over all metal arch structures. Pipe manufacturers can provide specific recommendations for minimum and maximum fill heights and required pipe thickness.
3. A concrete box with a 14' wide by 9' high inside opening, with 12" high bed retention sills (baffles) in the bottom. The box invert should be buried 36", so the top of the sills will be buried 24" and not be visible. That will result in a 14' wide by 6' high waterway opening above streambed, providing 84-sq. ft. of waterway area. The sills should be spaced no more than 8'-0" apart throughout the structure with one sill placed at the inlet and one at the outlet. The sills can be cast flat. The box should be filled up to the stream bed level with stone graded to match the natural stream bed material that will keep flow above the surface. This structure will result in a headwater depth at Q25 = 4.4' and at Q100 = 5.5', with no roadway overtopping up to Q100. If a new box is installed, we recommend it have full headwalls at the inlet and outlet. The headwalls should extend at least four feet below the channel bottom, or to ledge, to act as cutoff walls and prevent undermining.

It is always desirable for a new structure of this size to have flared wingwalls at the inlet and outlet, to smoothly transition flow through the structure, and to protect the structure and roadway approaches from erosion. The wingwalls should match into the channel banks. Any new structure should be properly aligned with the channel, and constructed on a grade that matches the channel. A new structure should span the natural channel width.

Stone Fill, Type III should be used to protect any disturbed channel banks or roadway slopes at the structure's inlet and outlet, up to a height of at least one-foot above the top of the opening. The stone fill should not constrict the channel or structure opening.

This bridge would cost around $100,000 based on previous town estimates. While these costs seem high, repairing and replacing large culverts after every large event can cost tens of thousands of dollars per site. This bridge will be large enough to pass flood waters, debris, and sediment and will need minimal maintenance over its 50 to 100 year life span.

Farnsworth Brook Road Inlet Flow

Farnsworth Brook Road: Culvert Inlet

Farnsworth Brook Road Outlet Flow

Farnsworth Brook Road Culvert Outlet

Map Id: 8
Latitude and Longitude: (44.00298, -72.67352)
Priority: High
Location and Description: This project occurs at the intersections of Farnsworth Brook Road, Green Road, and Peth Road. This squashed aluminum culvert is 48 inches tall, 98 inches wide, and 35 feet long. The culvert is bent and experiences very high flows of water. Due to its location high in the watershed, this culvert should be properly maintained. The outlet of this culvert is also perched, which prevents aquatic organism passage and leads to streambank and streambed scouring downstream.
Recommended Treatment: Upgrade to a bridge or arch. The width or span of this structure should be close to 11.42 feet according to bankfull width. Specific hydrologic studies may indicate that structure width may be bigger or smaller.

Culvert Inlet

Culvert Outlet

Ayers Brook Main Stem

Ayers Brook passes through East Braintree Village. There are two major stream crossings in this section, the first where Farnsworth Brook crosses Route 12 and the second where Ayers Brook crosses Route 12. Priority projects 25 and 26 are River Reach points identified the 2007 Ayers Brook River Corridor Management Plan.

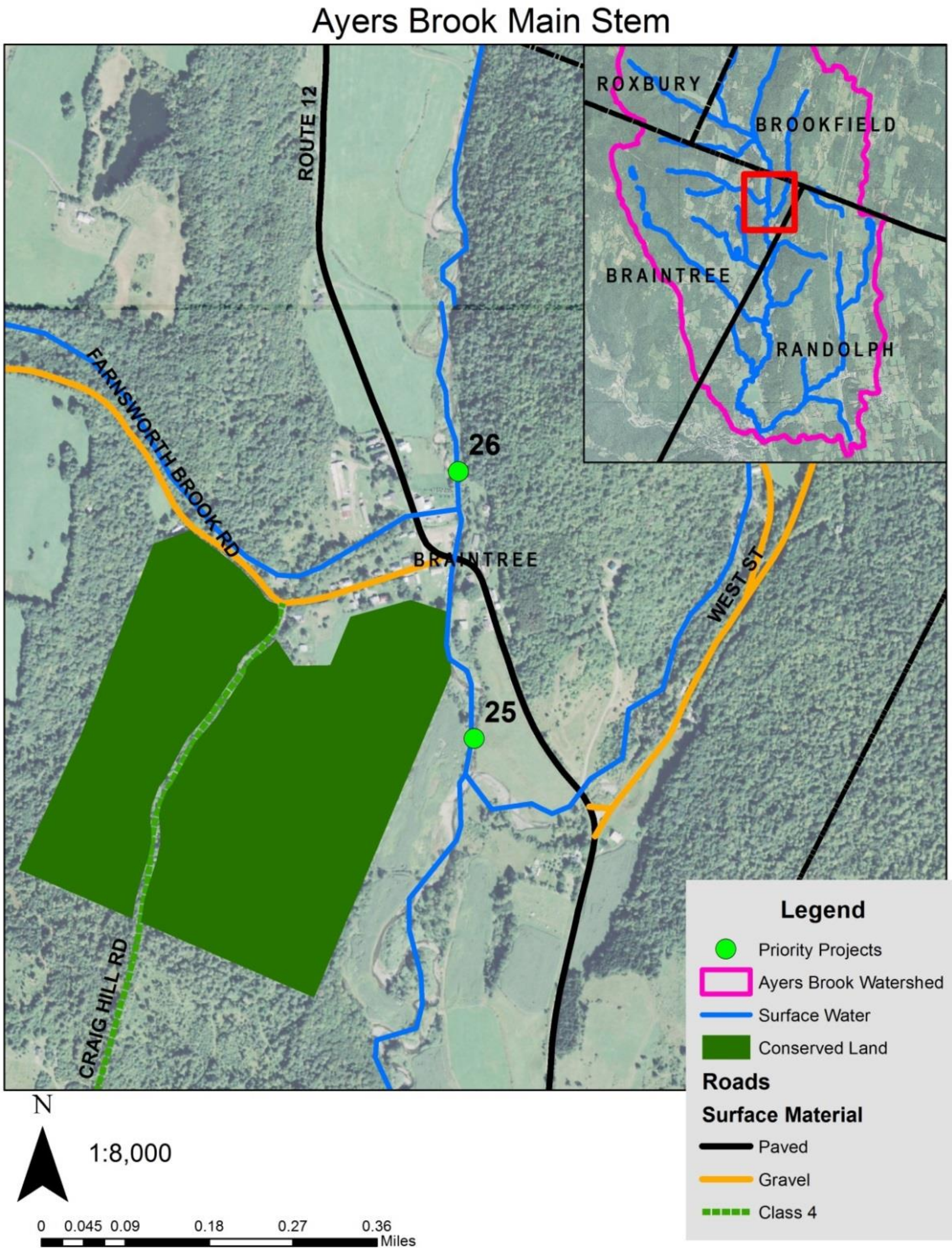


Figure 16 Priority Projects on the Main Stem of Ayers Brook Main Stem in Braintree

Map Id: 25
Latitude and Longitude: (43.9933, -72.651): Reach T2.04-A
Priority: Medium
Location and Description: This river reach, previously identified by Bear Creek Environmental runs through East Braintree Village. It is the site of historical bank armaments which have caused the channel to straighten. There are two major stream crossings on Route 12 near this river reach that contain undersized structures. There is also a farm that borders Ayers Brook. New Required Agricultural Practices would mandate livestock exclusion from surface waters with fencing. To the east of Ayers Brook, two Vermont Land Trust easements totaling 71.7 acres surround Craig Hill Road, a class 4 road south of Farnsworth Brook.
Recommended Treatment: The two bridges at this reach should be upsized. The width or span of the structure in East Braintree Village should be close to 17.3 feet according to bankfull width. Hydrologic studies may indicate that it needs to be larger or smaller. The second bridge on Route 12, which is about .07 miles south of the bridge in East Braintree Village, has a larger sub-watershed, and should be close to 40.5 feet according to bankfull width. This site is also a strong candidate for riparian buffers that would help strengthen banks and stabilize the stream. Livestock should be prevented from coming into contact with the surface water on this reach, and fencing should be installed.

Map Id: 26
Latitude and Longitude: (43.9975, -72.6514) Reach T2.04-B
Priority: Medium
Location and Description: Channel straightening in East Braintree Village, at ID #25 and River Reach T2.04-A, has increased energy in Ayers Brook which subsequently causes higher levels of erosion downstream. The location of this reach, identified by Bear Creek in 2007, is currently exhibiting channel adjustment. Because it does not contain significant infrastructure that could be damaged, this reach should be naturally maintained for Ayers Brook to meander and to store sediment and floodwaters.
Recommended Treatment: The river corridor along this reach is a priority for conservation and riparian buffer plantings.

Randolph

Howard Hill Road

Howard Hill Road is a steep gravel road in the northwest portion of Randolph that continues east of Vermont Route 12 and Ayers Brook. This steep road contains medium and high erosion risk for .43 miles, and borders surface water on both sides during these steep, erosion-prone sections before the surface water crosses underneath the road at one significant point. The surface water then continues north of the road until its confluence with Ayers Brook. These second and third order streams enter Ayers Brook at the bottom of Howard Hill. Currently, there is a stormwater retention pond that helps to alleviate sediment accumulation at the bottom of Howard Hill Road before it enters Ayers Brook.

Robert Reynolds, the Randolph Road Foreman, said that Howard Hill Road degrades quickly during rain events due to large volumes of water flowing on the sides of and down portions of the road. He stated that it is particularly difficult to maintain in the spring. Howard Hill Road has a long history of damage including those incurred in 2011 during Tropical Storm Irene, during DR-4140 in 2013, during DR-1715 in 2007, and during DR-1228 in 1998.

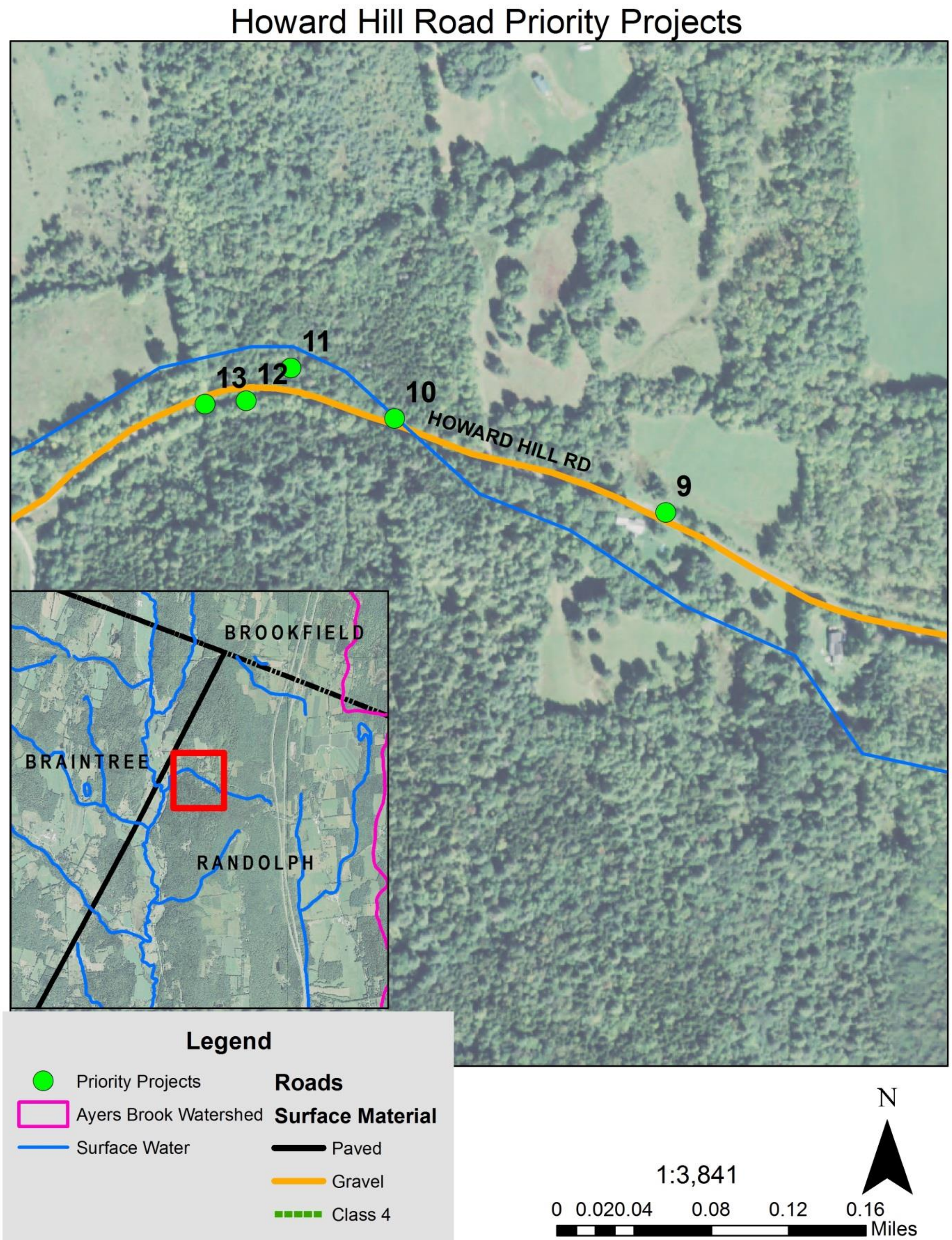


Figure 17 Priority Projects on Howard Hill Road

Map Id: 9
Latitude and Longitude: (43.983103, -72.640308)
Priority: Low
Location and Description: Near the flatter portion of the road, about .4 miles east of Route 12, there is an eroded ditch leading to a large washout on the side of the road. This washout has high sediment accumulation.
Recommended Treatment: Stone line ditch terminus and install check dams

Eroded ditch

Road Washout from
Stormwater Runoff

Map Id: 10
Latitude and Longitude: (43.983805, -72.643129)
Priority: Medium
Location and Description: Where the stream crosses Howard Hill Road, there are two large steel culverts structurally intact. However, both of these culverts discharge directly into the surface water to the north of Howard Hill Road. The more western culvert, lower on Howard Hill is a 48 inch high, 48 inch wide, and 40 foot long steel culvert. The outlet of this culvert is perched, which prevents aquatic organism passage and leads to streambank and streambed scouring downstream.
Recommended Treatment: Stone-line the inlet and outlet for silt retention. Install check dams. Also, a stone header should be installed at the outlet to prevent erosion from the road entering the surface water connected to this culvert.


Culvert Inlet Ditch


Culvert Outlet

Map Id: 11
Latitude and Longitude: (43.984184, -72.644207)
Priority: Medium
Location and Description: Further west along Howard Hill Road, when the road gets steep and has high erosion risk, there is a 24 inch high, 24 inch wide, and 40 foot long plastic culvert with concrete blocks that is being overrun by the amount of water it currently experiences. High erosion has occurred surrounding the inlet of the culvert, as well as past the inlet along the side of the road. Erosion has also occurred surrounding the outlet.
Recommended Treatment: Stone-line ditches along the inlet and outlet to prevent further erosion. Install check dams. Upsize culvert to appropriately handle current water levels. Stabilize the eroded banks with mulching.

Erosion at inlet

Erosion downhill of culvert inlet

Erosion at culvert outlet

Culvert outlet

Map Id: 12
Latitude and Longitude: (43.983937, -72.644671)
Priority: Medium
Location and Description: Close to Project #11, and similar in nature, is a 24 inch high, 24 inch wide, and 40 foot long plastic culvert with concrete blocks that has been overrun by the amount of water it experiences. High erosion has occurred surrounding the inlet of the culvert, as well as past the inlet along the side of the road. The culvert's outlet does not exhibit proper ditching and could experience erosion in the future. The culvert outlet discharges into the surface water that parallels the road and empties into Ayers Brook.
Recommended Treatment: Stone-line ditches along the inlet and outlet to prevent further erosion. Install check dams. Stabilize the eroded banks with mulching. Upsize culvert to appropriately handle current and future water levels.

Erosion at culvert inlet

Outlet discharge to surface waters

Map Id: 13
Latitude and Longitude: (43.98391, -72.645098)
Priority: Medium
Location and Description: Project #13 is very close to #11 and #12. This 24 inch high, 24 inch wide, and 40 foot long plastic culvert has been overrun by the amount of water it experiences. High levels of erosion have occurred near the culvert inlet, including bedrock exposure. The culvert outlet discharges to the surface water that parallels the road and empties into Ayers Brook.
Recommended Treatment: Stone-line ditches along the inlet and outlet to prevent further erosion. Stabilize the eroded banks with mulching. Upsize culvert to appropriately handle the current level of water.

Erosion at culvert inlet

Culvert discharges to surface

Holyhock Hill

Hollyhock Hill is a short, .56 mile town-maintained road near the Braintree town line. The road is in the southwestern portion of the Ayers Brook watershed.

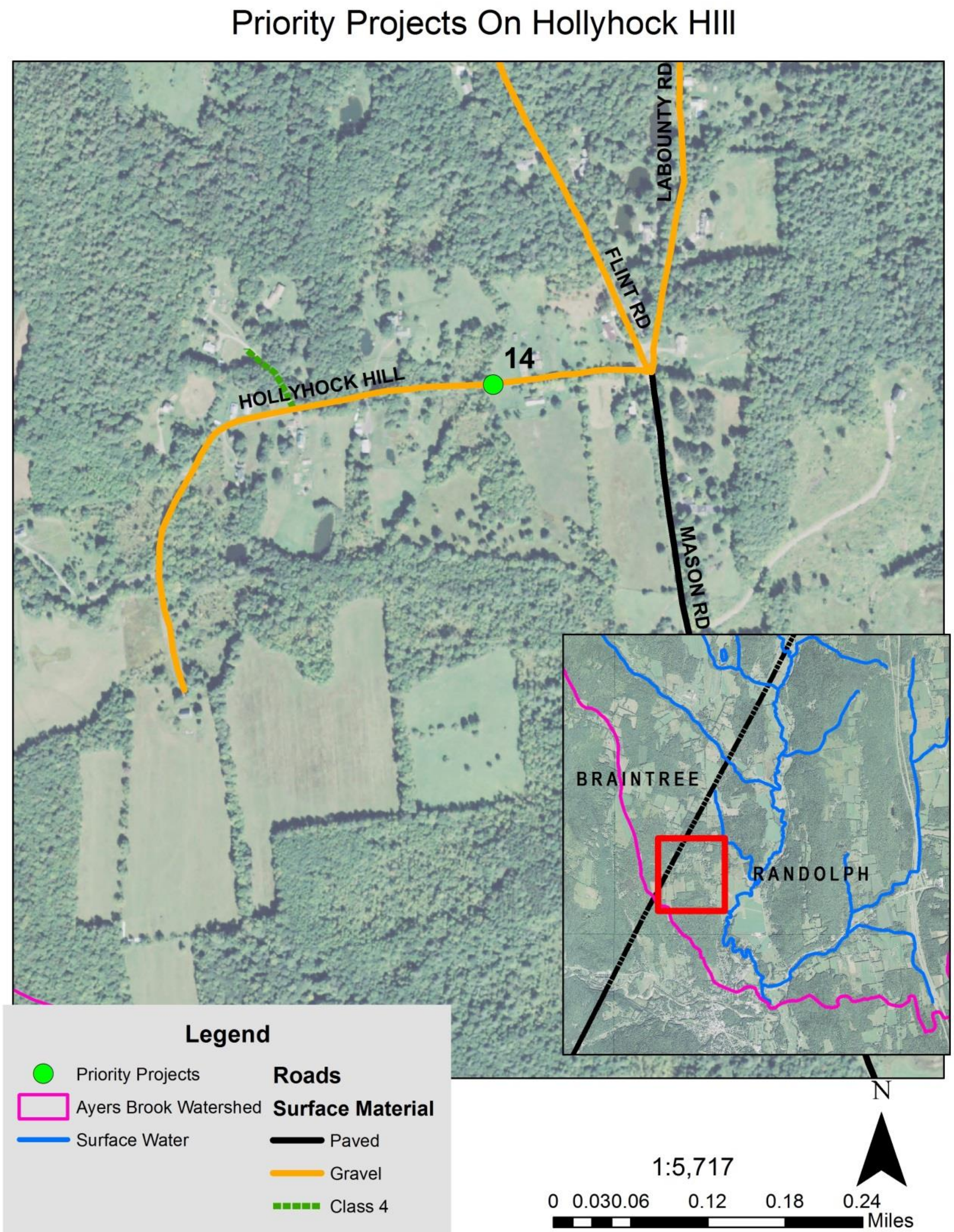


Figure 18 Priority Project on Hollyhock Hill

Map Id: 15
Latitude and Longitude: (43.948995, -72.670497)
Priority: Medium
Location and Description: The road currently contains one undersized and closed stone culvert in need of upsizing. Both the inlet and the outlet contain significant pooling of water and sediment accumulation, and are subject to overflowing of water during large rain events.
Recommended Treatment: Upsize culvert to appropriately handle the level of water. The width or span of this structure should be approximately 3 feet according to bankfull width. Specific hydrologic studies may indicate that structure width may be bigger or smaller.

Hollyhock Culvert: Inlet

Hollyhock Culvert: Outlet

Route 12 and Ayers Brook Main Stem

Vermont Route 12 parallels Ayers Brook in Randolph, Braintree, and Brookfield. There are many sections of streambank rip-rap armaments that have been installed in order to protect the road from the effects of fluvial erosion of Ayers Brook. However, these bank armaments build up hydrologic energy, which cause more erosive tendencies in other areas downstream.

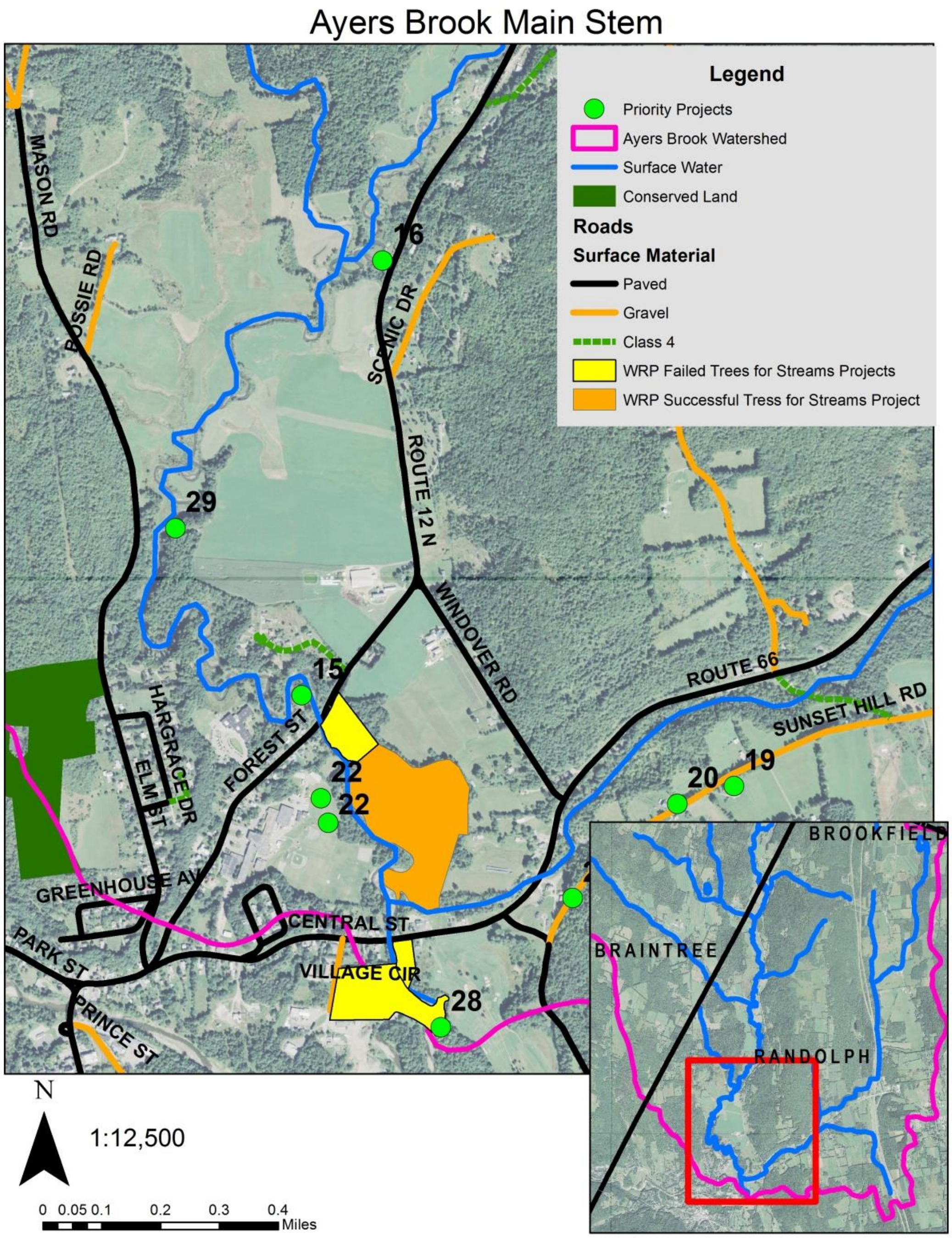


Figure 19 Priority Projects on the Main Stem of Ayers Brook in Randolph

Map Id: 15
Latitude and Longitude: (43.934628, -72.658282) Reach T2.01-B
Priority: Medium
Location and Description: West of Vermont Route 12 and south of Sugar Plum Court, a private road, there is a large washout on the western bank of Ayers Brook that will likely result in widespread bank failure. Some of the houses on the south side of Sugar Plum Court are jeopardized by this unstable bank. This river reach is the site of a USGS stream gauge. East of Route 12, the White River Partnership led a Trees for Streams riparian planting in 2008; however the 410 planted trees and willow stakes did not survive.

Recommended Treatment: Monitor top of streambank for fissures. The base of bank provides the potential for a root wad soft-armoring project.

Ayers Brook Bank Washout

Map Id: 16
Latitude and Longitude: (43.945343, -72.655555) Reach T2.02
Priority: Medium
Location and Description:
Farther north along Ayers Brook, north of Scenic Road on Route 12, is another section of extremely eroded and exposed streambank that is undergoing channel adjustment. A section of rip-rapped bank armament near this bank failure has pushed the erosive energy of Ayers Brook farther along in its stream channel path. Future encroachment of the river's flood hazard area should be avoided in order to allow the brook to meander and reestablish its flood storage capacity.
Recommended Treatment: Plant riparian buffers to help stabilize the bank. Plantings should occur away from the near bank and outside bends where future erosion from lateral movement from Ayers Brook will continue. The Ayers Brook River Corridor Management Plan also identifies this area for a river corridor protection under CREP (Conservation Reserve Enhancement Program) or a similar conservation strategy.

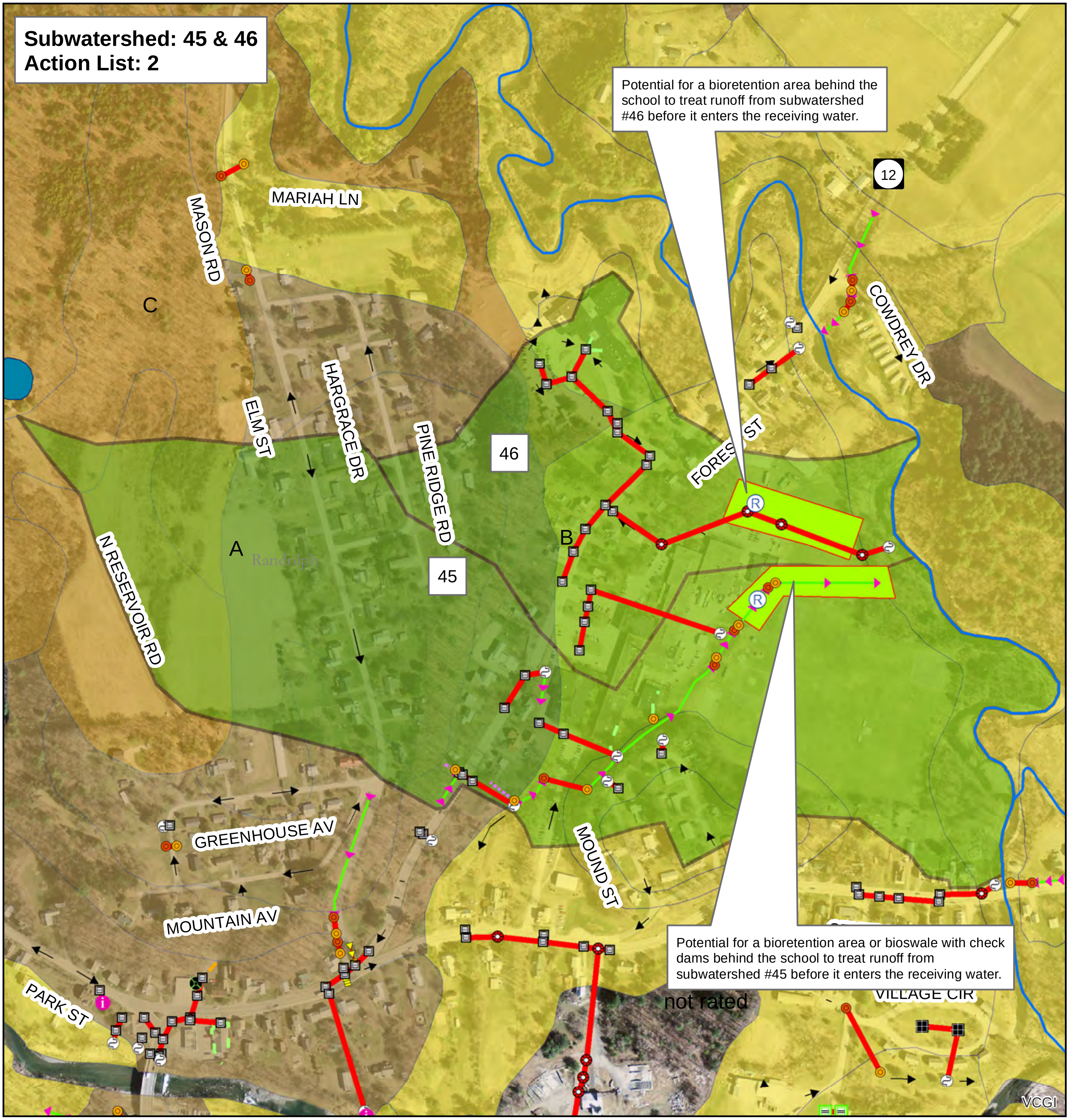
Rip-Rap Bank Armoring

Map Id: 22
Latitude and Longitude: (43.932386, -72.657238 and 43.932162, -72.657125)
Priority: High
Location and Description: The map on page 76 outlines a previously identified project by the VT DEC Ecosystem Restoration Program's Stormwater Mapping and Illicit Discharge Detection and Elimination Program for the Town of Randolph. The project area is west of Ayers Brook, southeast of Forest Street, and behind the Randolph Union High School. East of Ayers Brook, on the opposite side of the bank as this proposed project, the White River Partnership led a successful Trees for Streams project in which 142 trees were planted in 2010 and 300 trees were planted in 2015.

Recommended Treatment:
The project defines the potential for two bioretention areas behind the school. The northernmost project would be a bioretention area over an existing storm line. The southernmost one is south of an old sanitary line and has the potential to be either a bioretention area or a bioswale with check dams.

The proximity of these stormwater retrofits to the Ayers Brook surface water provides the opportunity to treat and retain stormwater before it enters the brook near its confluence with the Third Branch of the White River.

The project would reduce the current sediment load from 8,889 pounds to 1,778 pounds and the nitrogen load from 74.1 pounds to 44.4 pounds. That marks an 80% sediment load decrease and a 40.1% nitrogen load decrease.



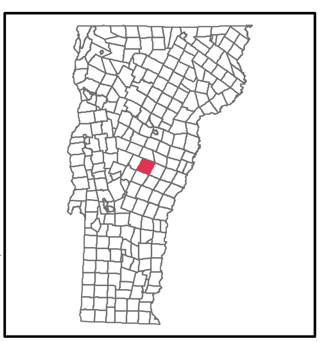
Randolph, VT

DEC Stormwater Infrastructure Mapping Project

This map shows high priority subwatersheds which are ranked by connectedness, percent of impervious cover, field observations, and potential retrofit measures and locations.

The data shown on this map is only as accurate as the available sources and field observations allowed and should be used as a basic planning level tool only.

VERMONT



Stormwater points

- Pipe Cross (not connected)
- Catchbasin
- Dry Well
- Drop Inlet
- Grate/Curb Inlet
- Yard drain
- CB tied to sanitary sewer
- Junction Box
- Stormwater Manhole
- Outfall
- Culvert inlet
- Culvert outlet
- Pond outlet structure
- Treatment feature (see notes)
- Retrofit
- Unknown Point
- Information Point

Stormwater line

- Storm line
- Storm line (old Sanitary line)
- Tunnel (storm)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Infiltration pipe
- French drain
- Trench drain
- Emergency spillway
- Stream
- Overland flow

NRCS - Soils

- A
- B
- C
- D

SubwatershedID

- Priority Subwatershed
- Stormwater Treatment Area
- Potential Stormwater Treatment Area

Creator: Jim Pease, David Ainley
DEC - WSMD - Ecosystem Restoration Program
Plotted Date: 2/18/2015
Data Sources: VTRANS Roads data, VT Hydrography data set, DEC Stormwater database, NRCS soils survery
Imagery Source: VCGI 2012 .5m

Map Id: 28
Latitude and Longitude: (43.9266, -72.6537) Reach T2.01-A
Priority: Low
Location and Description: This river reach is at the confluence of Ayers Brook and the Third Branch of the White River. This previously identified project by Bear Creek Environmental advocates the protection of this dynamic portion of Ayers Brooks through conservation and riparian buffers. This site is directly downstream of two unsuccessful Trees for Streams Projects. The first was a planting in 2007 of 64 trees, and the second was a planting in 2008 of 39 trees and willow stakes. Some trees survived in the 2007 planting; however the actively eroding high bank has provided challenges to the longevity of these plantings. The 2008 planting did not survive because of an infestation of Japanese knotweed, an invasive species. The owner decided to mow the planting in order to stem the spread of Japanese knotweed.
Recommended Treatment:
Conservation measures should be adopted in the form of river corridor easements in order to prevent further river corridor encroachment.

Map Id: 29
Latitude and Longitude: (43.9389, -72.6629) Reach T2.01-C
Priority: Medium
Location and Description:
This reach, also identified by Bear Creek Environmental in 2007, is undergoing active channel adjustment, so future floodplain encroachments should be avoided in order to allow the river to naturally meander and reestablish flood storage capacity. Riparian buffer plantings on outside bends should be avoided, because the brook will continue to erode laterally.
Recommended Treatment:
Riparian buffer plantings and conservation measures should be implemented to prevent future river corridor encroachment.

Radio Drive

Radio Drive is short residential gravel street that begins and ends on Fish Hill Road and is located south of Vermont Route 66. The road is short, but is located close to Adams Brook that drains into Ayers Brook near its confluence with the Third Branch of the White River. There are two culverts on this road that require attention.

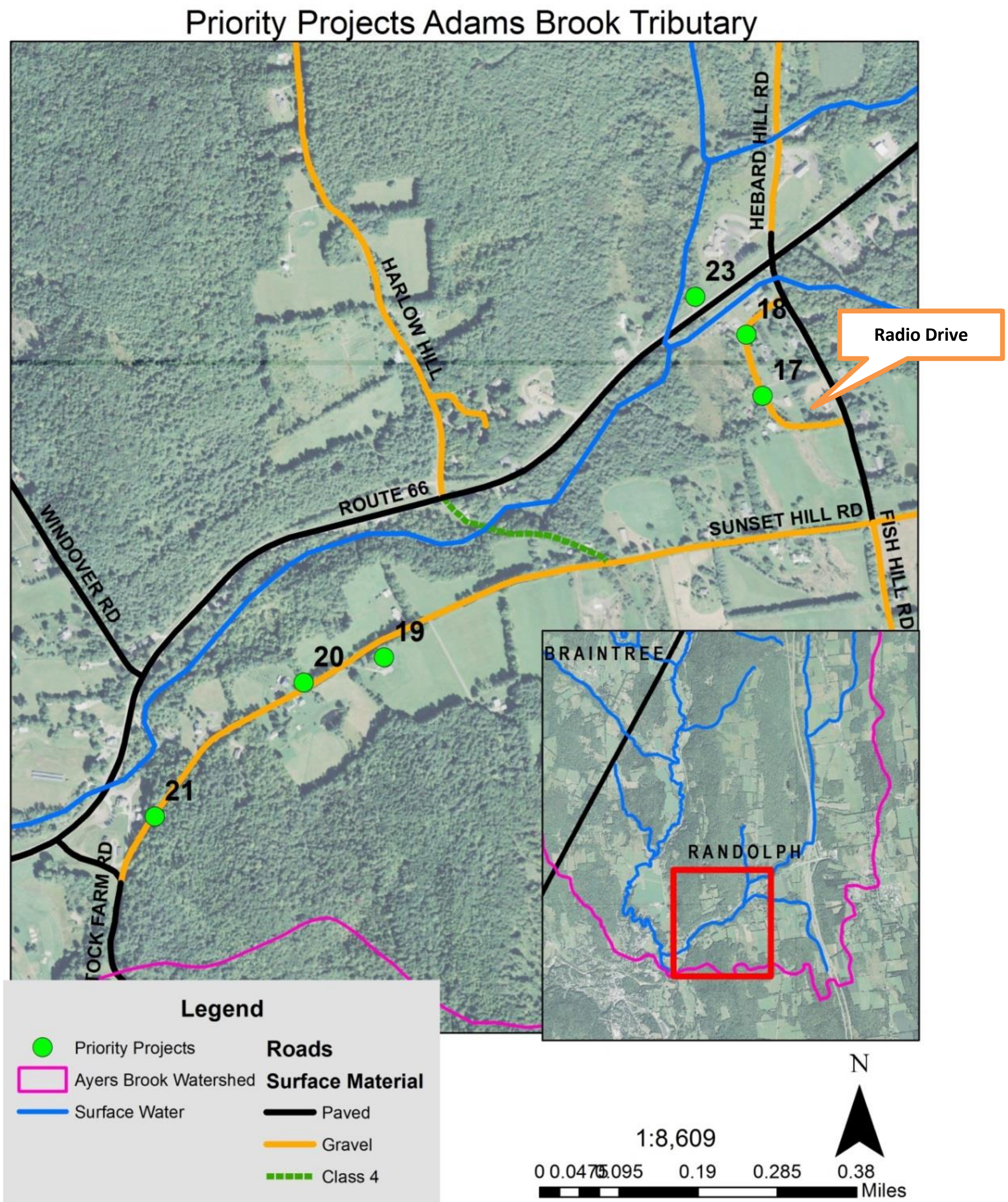


Figure 20 Priority Projects near Route 66

Map Id: 17
Latitude and Longitude: (43.936953, -72.634456)
Priority: Low
Location and Description:
A 24 inch high, 24 inch wide, and 40 foot long steel culvert on Radio Drive receives high volumes of water. The culvert is currently in fair condition. A secondary small plastic driveway culvert is contributing water to the outflow of this culvert.
Recommended Treatment: Stone-line inlet and outlet ditches. Upsize culvert to appropriately handle current water levels. The width or span of this upsized culvert should be close to 3.32 feet according to bankfull width. Specific hydrologic studies may indicate that structure width may be bigger or smaller.


Culvert Inlet


High Water Outflow


Culvert Outlet

Map Id: 18
Latitude and Longitude: (43.938014, -72.634847).
Priority: Low
Location and Description:
The second culvert is a 15 inch high, 15 inch wide, and 40 foot long steel culvert. Sediment is currently accumulating near the culvert inlet due to improper ditching.
Recommended Treatment: Properly ditch leading to the inlet of this culver, and stone-line the inlet ditch.

Sediment Buildup near Inlet


Buried Inlet


Buried outlet

Sunset Hill Drive

Sunset Hill Drive is gravel road south of Adams Brook in the southern portion of the Ayers Brook watershed. It is flat for most of its duration, but becomes steeper on its western end.

Map Id: 19
Latitude and Longitude: (43.932403, -72.643528)
Priority: Medium
Location and Description:
The plastic culvert at this location is 36 inches high, 36 inches wide, and 65 feet long. This site contains significant trash debris, including multiple tires in gullies along the side of the road. Significant water has caused a high level of erosion at the inlet, which has been increased by small drainage pipes contributing water at eroded sections. There is significant pooling of water at this culvert's outlet.
Recommended Treatment: Stone-line inlet and outlet ditches. Install check dams. Remove trash from inlet and outlet ditches.

High Water Levels near Inlet

Eroded Section along Inlet

Small drainage sources causing erosion

High Water Levels near Outlet

Tires in Inlet Ditch

Map Id: 20
Latitude and Longitude: (43.931963, -72.645458)
Priority: Medium
Location and Description:
This 24 inch high, 24 inch wide, and 35 foot long steel culvert requires upgrading to appropriately handle the amount of water flow that it currently experiences. A high volume of water has pooled at the outlet. The top part outlet of the culvert is damaged, and the culvert outlet is perched, which prevents aquatic organism passage.
Recommended Treatment: Upsize culvert, including repairing broken portion of outlet. Stone-line outlet ditch. The width or span of this upsized culvert should be close to 3.82 feet according to bankfull width. Specific hydrologic studies may indicate that structure width may be bigger or smaller.

Perched Culvert Outlet

Outlet Flow

Broken Part of Outlet

Map Id: 21
Latitude and Longitude: (43.929637, -72.649023)
Priority: Medium
Location and Description: The most western priority project on Sunset Hill Road involves improvements to a 15 inch high, 15 inch wide, and 45 foot steel culvert. The culvert's inlet ditch could potentially erode with high levels of water. The outlet of this culvert is perched, which has eroded the steep slope surrounding it. Perched culverts also inhibit aquatic organism passage.

Recommended Treatment: Upsize culvert. Stone-line inlet and outlet ditches. Repair eroded gully by fixing outlet bed with placed rock material.


Steep Slope at outlet

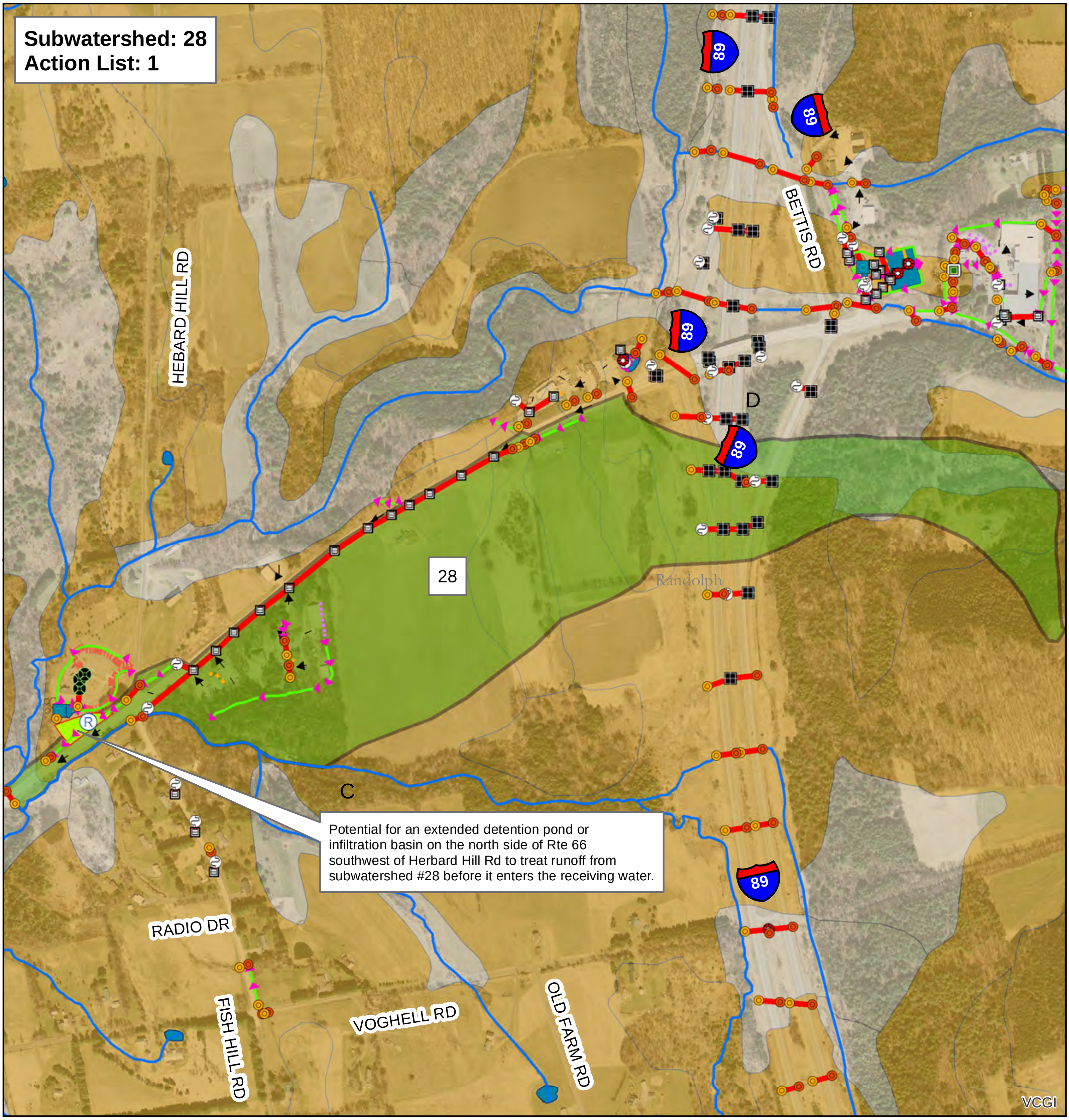

Perched Outlet

Ditch at Inlet

Map Id: 23
Latitude and Longitude: (43.938257, -72.636547)
Priority: High
Location and Description:
The map on page 91 outlines a previously identified project by the VT DEC Ecosystem Restoration Program's Stormwater Mapping and Illicit Discharge Detection and Elimination Program for the Town of Randolph. The project defines the potential for an extended detention pond or infiltration basin southwest of Hebard Hill Road.

This would aid in the treatment of runoff from Vermont Route 66, a paved road, and Hebard Hill Road, a gravel road with some moderately steep sections. According to this report, the priority project would reduce the current sediment load from 9,090 pounds to 1,818 pounds and would reduce current nitrogen loads from 75.8 pounds to 45.5 pounds. This marks an 80% sediment load reduction and a 40% nitrogen load reduction.

Recommended Treatment: Install an extended detention pond or infiltration basin.



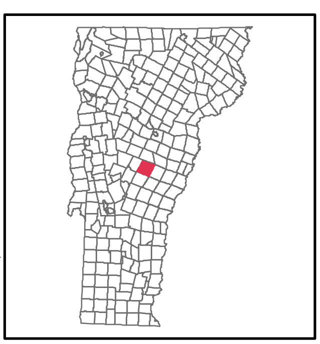
Randolph, VT

DEC Stormwater Infrastructure
Mapping Project

This map shows high priority subwatersheds which are ranked by connectedness, percent of impervious cover, field observations, and potential retrofit measures and locations.

The data shown on this map is only as accurate as the available sources and field observations allowed and should be used as a basic planning level tool only.

VERMONT



Stormwater points

- Pipe Cross (not connected)
- Catchbasin
- Dry Well
- Drop Inlet
- Grate/Curb Inlet
- Yard drain
- CB tied to sanitary sewer
- Junction Box
- Stormwater Manhole
- Outfall
- Culvert inlet
- Culvert outlet
- Pond outlet structure
- Treatment feature (see notes)
- Retrofit
- Unknown Point
- Information Point

Stormwater line

- Storm line
- Storm line (old Sanitary line)
- Tunnel (storm)
- Combined sewer
- Sanitary line
- Swale
- Footing drain
- Under drain
- Roof drain
- Infiltration pipe
- French drain
- Trench drain
- Emergency spillway
- Stream
- Overland flow

NRCS - Soils

- A
- B
- C
- D

SubwatershedID

- Priority Subwatershed
- Stormwater Treatment Area
- Potential Stormwater Treatment Area

Creator: Jim Pease, David Ainley
DEC - WSMD - Ecosystem Restoration Program
Plotted Date: 2/18/2015
Data Sources: VTRANS Roads data, VT Hydrography data set, DEC Stormwater database, NRCS soils survery
Imagery Source: VCGI 2012 .5m

Brookfield

The town of Brookfield contains much of the Ayers Brook headwaters. Large stretches of the surface water in these headwaters border roads, mainly Route 12, Bear Hill Road, West Brookfield Road, and Eagle Peak Road.

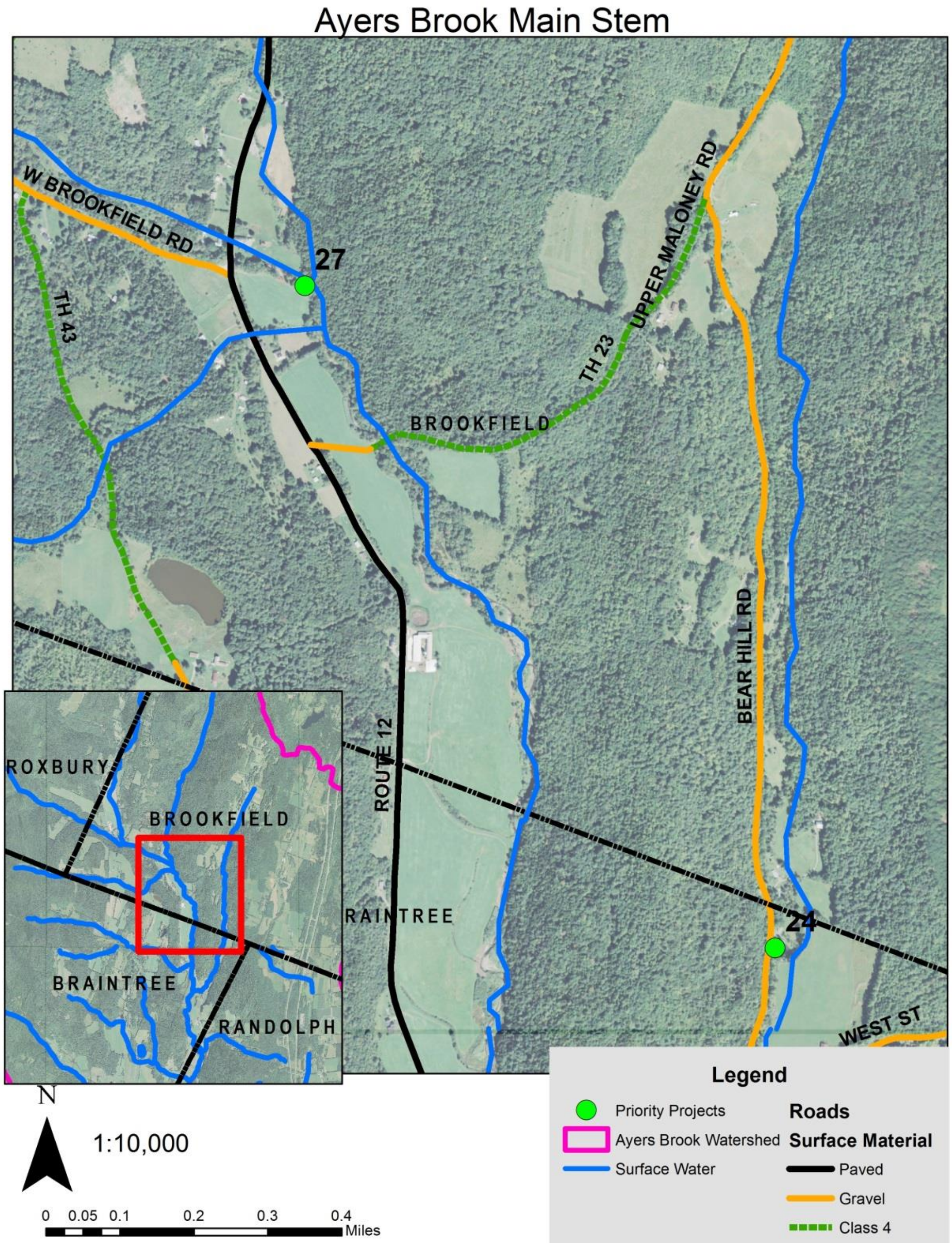


Figure 21 Priority Project Areas on the Main Stem of Ayers Brook in Brookfield

Map Id: 24
Latitude and Longitude: (44.001661, -72.643952)
Priority: Low
Location and Description: Near the Braintree, Brookfield town boundary, along Bear Hill Road there are large sections of road that border and are connected to surface water. Also, large sections of Route 12 in southwest Brookfield border Ayers Brook and are bordered by steep slopes. Runoff flows from these steep slopes, continues across the road, and deposits into the surface water. Additionally, in fall of 2015, Green Mountain Power and several private landowners cut down a large number of trees leaving only stumps in a 1.5-2 mile section along Bear Hill Road. These stumps currently stabilize the bank, however they present a hazard to machinery owned by the Town of Brookfield and operated by the Brookfield road crew. Removal of the stumps would result in bank destabilization along Bear Hill Road and the stream.
Recommended Treatment: Plant riparian buffers surrounding streams to help stabilize banks.

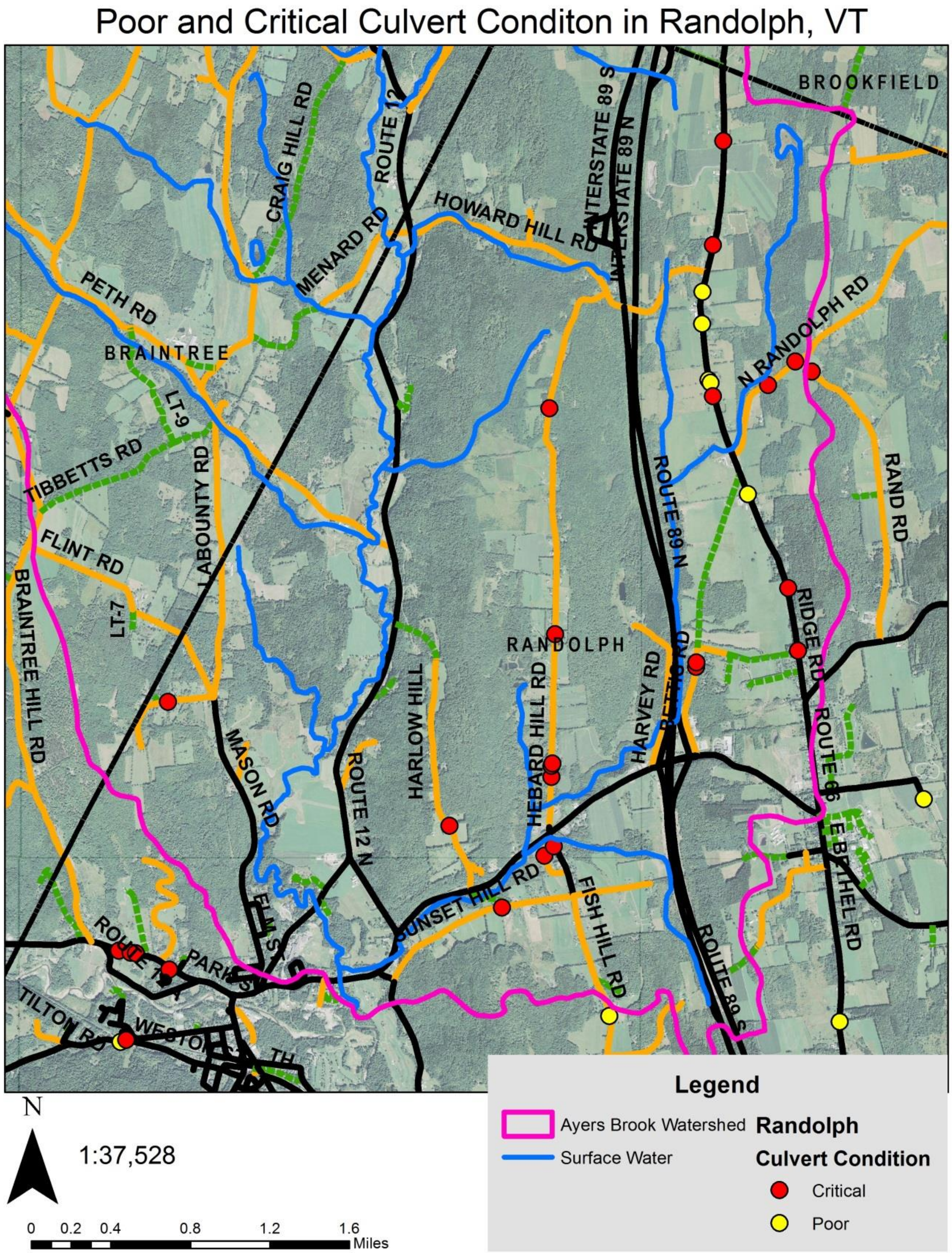
Map Id: 27
Latitude and Longitude: (44.0146, -72.6566): Reach T2:04-C
Priority: Low
Location and Description: This river reach, which was identified by Bear Creek in 2007, is near the headwaters of Ayers Brook. Steep valley walls occupy each side of the stream. Much riparian buffer has been removed from the river corridor of this portion of Ayers Brook, which has caused portions of the riverbed to become incised. There is an 18 inch wide, 18 inch high, and 25 foot long steel culvert in poor condition on West Brookfield Road which should be upsized.
Recommended Treatment: River corridor conservation should be considered here, and riparian buffer plantings would help stabilize river banks. Upsize the culvert in poor condition on West Brookfield Road.

Project Prioritization

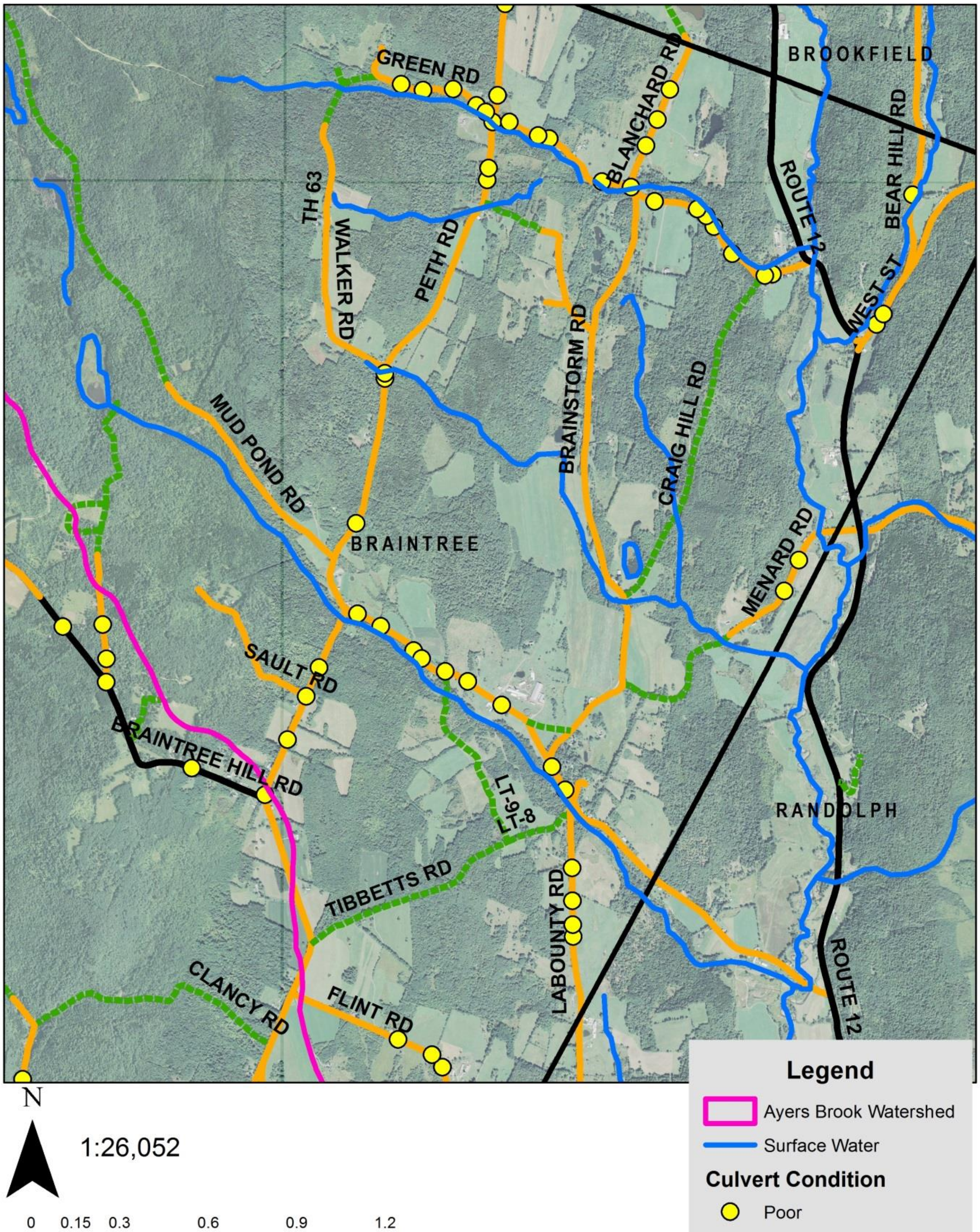
ID	Street Name	Project Description and Recommended Treatment	Town	Latitude	Longitude	Priority
3	Peth Road	Culvert Upsize, Stone-Line Ditches	Braintree	43.975979	-72.676428	High
4	Peth Road	Culvert Upsize, Stone-Line Ditches	Braintree	43.976526	-72.678247	High
8	Farnsworth Brook Road	Bridge or Arch	Braintree	44.00298	-72.67352	High
22	Forest Road/Route 12	Biorention Area	Randolph	43.932386	-72.657238	High
22	Forest Road/Route 12	Biorention Area	Randolph	43.932162	-72.657125	High
23	Route 66	Detention Pond	Randolph	43.938257	-72.636547	High
5	Peth Road	Culvert Upsize, Stone-Line Ditches	Braintree	43.976801	-72.67869	Medium
6	Brainstorm Road and Craighill Road	Bridge or Arch	Braintree	43.979636	-72.663843	Medium
7	Farnsworth Brook Road	Bridge or Arch	Braintree	43.999691	-72.663742	Medium
10	Howard Hill Road	Stone-Line Ditches, Install Outlet Header	Randolph	43.983805	-72.643129	Medium
11	Howard Hill Road	Culvert Upsize, Stone-Line Ditches, Check Dams, Bank Stabilization	Randolph	43.984184	-72.644207	Medium
12	Howard Hill Road	Culvert Upsize, Stone-Line Ditches, Check Dams, Bank Stabilization	Randolph	43.983937	-72.644671	Medium
13	Howard Hill Road	Culvert Upsize, Stone-Line Ditches, Check Dams, Bank Stabilization	Randolph	43.98391	-72.645098	Medium
14	Hollyhock Hill	Culvert Upsize	Randolph	43.948995	-72.670497	Medium
15	Ayers Brook Reach T2.01-B	Bank Stabilization	Randolph	43.934628	-72.658283	Medium
16	Ayers Brook Reach T2.02	Riparian Buffers	Randolph	43.945343	-72.655555	Medium
19	Sunset Hill Drive	Stone-Line Ditches, Check Dams	Randolph	43.932403	-72.643528	Medium
20	Sunset Hill Drive	Culvert Upsize, Stone-Line Ditches	Randolph	43.931963	-72.645458	Medium
21	Sunset Hill Drive	Culvert Upsize, Stone-Line Ditches	Randolph	43.929637	-72.649023	Medium
1	Peth Road and Labounty Road	Bridge or Arch	Braintree	43.969374	-72.667852	Medium
2	Peth Road and Brainstorm Road	Stone-Line Ditches	Braintree	43.971749	-72.669363	Medium
9	Howard Hill Road	Stone-Line Ditches, Check Dams	Randolph	43.983103	-72.640308	Medium
25	Ayers Brook Reach T2.04-A	Bridge or Arch, Riparian Buffer, Livestock Fencing	Braintree	43.9933	-72.651	Medium

29	Ayers Brook Reach T2.01-C	Conservation Measures, Riparian Buffers	Randolph	44.9389	-72.6629	Medium
17	Radio Drive	Culvert Upsize, Stone-Line Ditches	Randolph	43.936953	-72.634456	Low
18	Radio Drive	Culvert Upsize, Stone-Line Ditches	Randolph	43.938014	-72.634847	Low
24	Bear Hill Road and Route 12	Hydrologically Connected Roads, Riparian Buffers	Brookfield/Braintree	44.001661	-72.643952	Low
26	Ayers Brook Reach T2.04-B	Conservation Measures, Riparian Buffers	Braintree	43.9975	-72.6514	Low
27	Ayers Brook Reach T2.04-C	Conservation Measures, Riparian Buffers	Brookfield	44.1046	-72.6566	Low
28	Ayers Brook Reach T2.01-A	Conservation Measures	Randolph	43.9266	-72.6537	Low

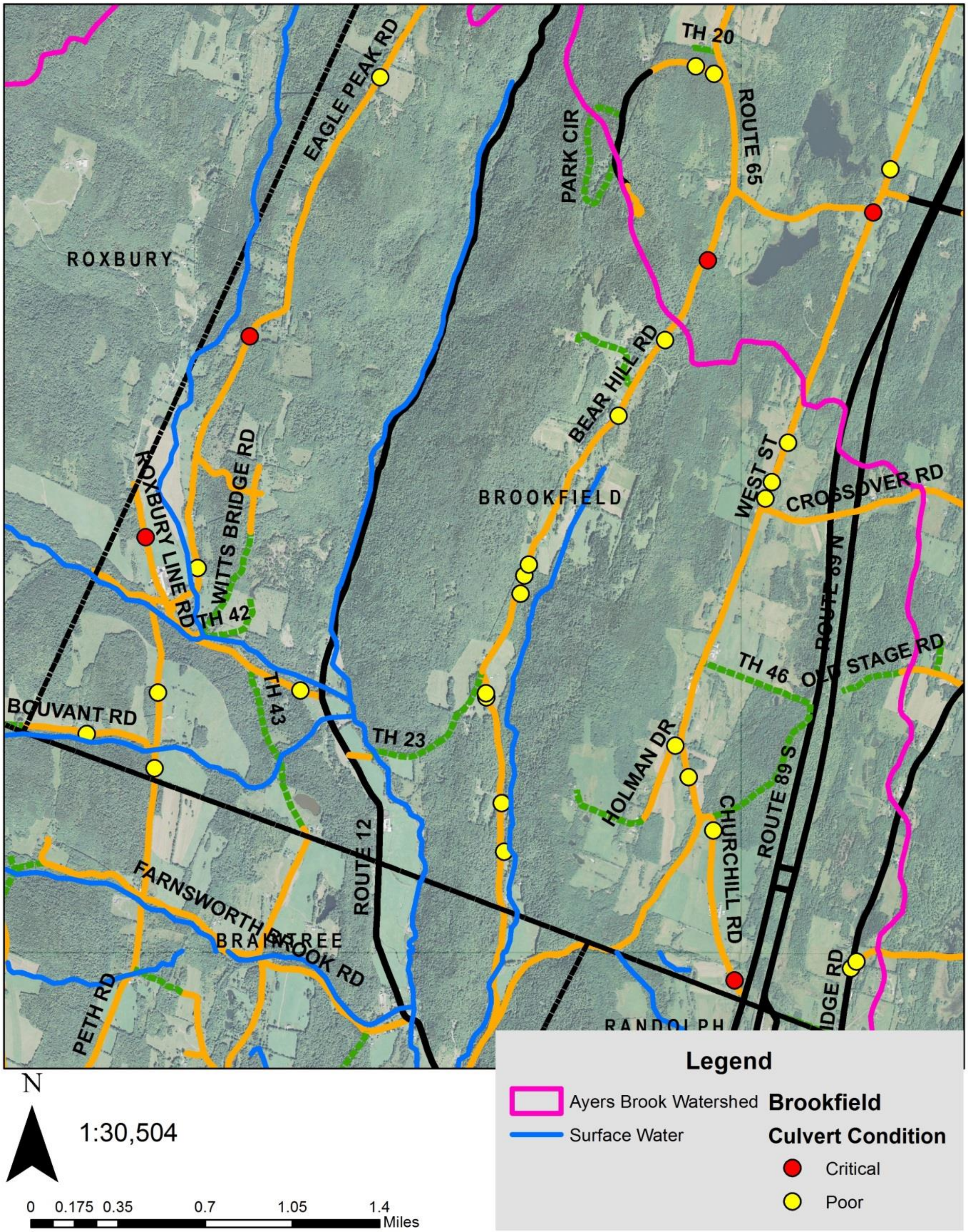
Appendix 1: Inventory of Poor/Critical culverts



Poor Culvert Conditon in Braintree, VT



Poor and Critical Culvert Conditon in Brookfield, VT



Appendix 2. List of High and Medium Erosion Risk Road Segments

Braintree

Segment #	Road	Risk Level	Erosion Factors
5	Bear Hill Rd	Medium	close to stream, close to medium steep slope
7	Blanchard Rd	Medium	close to steep slope, close to stream, steep road
1	Bouvant Rd	Medium	close to wetland, close to stream, close to steep slope, steep road
1	Brainstorm Rd	Medium	erodible soil, close to slope, steep road, close to stream
3	Brainstorm Rd	High	borders surface water, close to steep slope
4	Brainstorm Rd	Medium	erodible soil, close to slope, close to stream
5	Brainstorm Rd	Medium	erodible soil, close to wetland, close to waterbody
6	Brainstorm Rd	Medium	close to wetland, close to steep slope
20	Brainstorm Rd	Medium	erodible soil, close to steep slope, close to stream
22	Brainstorm Rd	High	severely undersized culvert, borders stream, close to steep slope, steep road
31	Brainstorm Rd	Medium	erodible soil, close to steep slope, close to stream
1	Clough Rd	Medium	close to steep slope, borders stream, steep road
1	Craig Hill Rd	Medium	erodible soils, close to steep slope, close to stream
2	Craig Hill Rd	Medium	close to steep slope, close to stream
5	Craig Hill Rd	Medium	erodible soils, close to steep slope
15	Craig Hill Rd	High	close to wetland, close to steep slope, close to stream, erodible soil
16	Craig Hill Rd	High	close to wetland, close to steep slope, borders stream, erodible soil
20	Craig Hill Rd	Medium	close wetland, erodible soil, borders stream
1	Davis Acres Rd	High	steep road, close to surace water, close to steep slope, erodible soil
8	Davis Acres Rd	Medium	erodible soils, close to steep slope, close to stream
2	Farnsworth Brook Rd	Medium	close to medium slope, close to stream
3	Farnsworth Brook Rd	Medium	close to medium slope, close to stream
6	Farnsworth Brook Rd	Medium	close to surface water, close to medium slope
7	Farnsworth Brook Rd	High	close to wetlands, erodible soils, close to medium slope, borders stream
8	Farnsworth Brook Rd	High	close to wetlands, erodible soils, close to steep slope, close to stream
9	Farnsworth Brook Rd	Medium	erodible soil, close to steep slope, close to stream
10	Farnsworth	Medium	close to steep slope, close to stream

	Brook Rd		
11	Farnsworth Brook Rd	Medium	close to steep slope, close to stream, steep road
12	Farnsworth Brook Rd	Medium	close to medium slope, close to stream, erodible soil
14	Farnsworth Brook Rd	Medium	severely undersized culvert, close to medium slope, close to stream
15	Farnsworth Brook Rd	Medium	severely undersized culvert, borders stream, close to medium slope
16	Farnsworth Brook Rd	Medium	close to steep slope, borders stream
19	Farnsworth Brook Rd	Medium	erodible soil, close to steep slope, close to stream, steep road
20	Farnsworth Brook Rd	Medium	erodible soil, close to steep slope, close to stream
1	Green Rd	Medium	close to stream; medium steep road
3	Green Rd	Medium	steep road
4	Green Rd	Medium	close to stream; medium steep road
5	Green Rd	Medium	close to stream; medium steep road
6	Green Rd	Medium	close to stream; medium steep road
7	Green Rd	Medium	close to stream; medium steep road
8	Green Rd	Medium	close to stream
9	Green Rd	Medium	close to stream; medium steep road
2	Hockman Hill Rd	Medium	close to stream; medium steep road
3	Hockman Hill Rd	Medium	close to stream; medium steep road
5	Hockman Hill Rd	Medium	close to stream; steep road
6	Hockman Hill Rd	Medium	close to stream; steep road
7	Hockman Hill Rd	Medium	close to stream; steep road
2	Labounty Rd	Medium	close to stream; medium steep road
5	Mendard Rd	Medium	close to stream
1	Old Bass Rd	Medium	close to stream; steep road
10	Peth Rd	Medium	close to stream
26	Peth Rd	Medium	close to stream
28	Peth Rd	Medium	close to stream
29	Peth Rd	Medium	close to stream
30	Peth Rd	Medium	close to stream
37	Peth Rd	Medium	close to stream
38	Peth Rd	Medium	close to stream
39	Peth Rd	Medium	close to stream
40	Peth Rd	Medium	close to stream
46	Peth Rd	Medium	close to stream; steep road
52	Peth Rd	Medium	close to stream; medium steep road
1	TH 8	Medium	close to wetlands

2	TH 8	Medium	close to wetlands
7	TH 8	Medium	close to stream; steep road
8	TH 8	Medium	close to stream; steep road
9	TH 8	High	close to stream; steep road
1	Walker Rd	Medium	close to stream; steep road
9	Walker Rd	Medium	close to stream; steep road
4	West St	Medium	close to stream; close to steep slope
7	West St	Medium	close to stream; close to steep slope
8	West St	Medium	close to stream; close to steep slope; medium steep road
9	West St	Medium	close to stream; close to steep slope
10	West St	Medium	close to stream; close to steep slope
11	West St	Medium	close to stream; close to steep slope
12	West St	Medium	close to stream; close to steep slope

Randolph

Segment #	Road	Risk Level	Erosion Factors
8	Bettis Road	Medium	close to stream
2	Harvey Road	Medium	close to wetland
3	Harvey Road	Medium	close to wetland
5	Harvey Road	Medium	close to wetland
3	Hebard Hill Road	Medium	close to steep slope, close to stream
52	Hebard Hill Road	Medium	close to steep slope, steep road, close to stream
53	Hebard Hill Road	Medium	close to steep slope, steep road, close to stream
54	Hebard Hill Road	Medium	close to steep slope, steep road, close to stream
6	Hollyhock Hill	Medium	very steep road, close to steep slope
7	Hollyhock Hill	High	very steep road, close to steep slope, close to wetland
8	Hollyhock Hill	High	steep road, close to steep slope, close to wetland
1	Howard Hill Road	High	close to stream, close to steep slope
3	Howard Hill Road	Medium	close to wetland, close to steep slope, steep road
5	Howard Hill Road	Medium	steep road, close to stream, close to steep slope
14	Howard Hill Road	Medium	steep road, close to stream, close to steep slope
15	Howard Hill Road	High	steep road, close to stream, close to steep slope
16	Howard Hill Road	Medium	steep road, close to stream, close to steep slope
17	Howard Hill Road	High	steep road, close to stream, close to steep slope
18	Howard Hill Road	Medium	steep road, close to stream, close to steep slope
19	Howard Hill Road	Medium	steep road, close to stream, close to steep slope
1	Peth Road	Medium	steep road, close to stream, close to steep slope
2	Radio Drive	Medium	close to steep slope, steep road
2	Scenic Drive	Medium	close to steep slope, steep road
3	Scenic Drive	Medium	close to steep slope, steep road
14	Sunset Hill Road	Medium	close to stream, close to steep slope
6	Voghell Road	Medium	close to stream, close to steep slope
1	Water Street	Medium	steep road, close to steep slope
1	West Street	Medium	close to steep slope, close to stream
2	West Street	Medium	close to steep slope, close to stream

Brookfield

Segment #	Road	Risk Level	Erosion Factors
22	Bear Hill Road	Medium	close to wetland, close to steep slope, steep road
25	Bear Hill Road	Medium	steep road, close to steep slope, close to stream
26	Bear Hill Road	Medium	close to slope, close to stream
27	Bear Hill Road	Medium	close to wetland, close to stream, close to steep slope
28	Bear Hill Road	Medium	close to wetland, close to stream, close to steep slope
44	Bear Hill Road	Medium	close to steep slope, close to stream
45	Bear Hill Road	Medium	close to steep slope, close to stream
46	Bear Hill Road	Medium	close to steep slope, close to stream
49	Bear Hill Road	Medium	close to steep slope, close to stream
1	Bouvant Road	Medium	close to steep slope, close to stream, steep road
5	Bouvant Road	Medium	close to steep slope, close to stream, steep road
6	Bouvant Road	Medium	close to steep slope, close to stream, steep road
7	Bouvant Road	Medium	close to stream, close to steep slope
9	Bouvant Road	Medium	close to stream, close to steep slope
1	Churchill Road	High	very steep road, close to very steep slopes
3	Churchill Road	Medium	steep road, close to steep slope, close to stream
2	Cram Hill Road	Medium	steep road, close to steep slope, close to stream
4	Cram Hill Road	Medium	close to stream, close to steep slope
5	Cram Hill Road	Medium	close to stream, close to steep slope
6	Cram Hill Road	Medium	close to stream, close to steep slope
3	Crossover Road	Medium	close to stream, close to steep slope
5	Crossover	Medium	close to stream, close to steep slope

	Road		
6	Crossover Road	Medium	close to stream, close to steep slope
11	Crossover Road	Medium	close to steep slope, close to wetland
12	Crossover Road	Medium	close to steep slope, close to wetland
1	Davis Acres Road	High	steep road, close to steep slope, close to stream
4	Davis Acre Road	Medium	close to steep slope, close to stream
12	Davis Acre Road	Medium	steep road, close to steep slope
19	Eagle Peak Road	Medium	steep road, close to steep slope
20	Eagle Peak Road	Medium	steep road, close to steep slope, close to wetland
21	Eagle Peak Road	Medium	close to wetland, close to stream
5	Holman Drive	Medium	close to steep slope, close to stream
2	Lower Maloney Drive	High	very steep road, close to very steep slopes, close to wetland
3	Lower Maloney Drive	Medium	close to wetland, close to stream
1	Small Road	Medium	very steep road, close to steep slopes
4	Small Road	Medium	very steep road, close to steep slopes
5	Small Road	Medium	very steep road, close to steep slopes
1	TH 23	High	very steep road, close to wetlands, close to steep slopes
2	TH 23	High	very steep road, close to stream, close to steep slopes
3	TH 23	High	very steep road, close to stream, close to steep slopes
4	TH 23	Medium	steep road, close to stream, close to steep slopes
5	TH 23	Medium	very steep road, close to steep slopes
7	TH 23	Medium	very steep road, close to steep slopes
1	TH 42	Medium	medim steep road, close to steep slopes, close to stream
2	TH 42	High	close to stream, close to wetland, close to steep slopes
3	TH 42	High	close to stream, close to wetland, close to steep slopes, medium steep road
4	TH 42	Medium	medium steep road, close stream, close to steep slope
1	TH 43	Medium	very steep road, close to steep slope
7	TH 43	Medium	close to stream, close to steep slope
10	TH 43	Medium	very steep road, close to steep slopes
1	TH 46	Medium	steep road, close to stream, close to steep slopes

10	TH 46	Medium	close to stream, close to steep slope
18	TH 46	Medium	steep road, close to steep slope
1	TH 47	Medium	steep road, close to steep slope, close to stream
1	Upper Maloney Road	High	very steep road, close to steep slopes, close to stream
4	Upper Maloney Road	Medium	steep road, close to steep slope, close to stream
3	West Brookfield Road	Medium	close to stream, close to steep slope
6	West Brookfield Road	Medium	close to stream, close to steep slope
7	West Brookfield Road	Medium	close to stream, close to steep slope
8	West Brookfield Road	Medium	steep road, close to steep slope
13	West Brookfield Road	Medium	steep road, close to steep slopes, close to stream
2	West Street	Medium	close to stream, close to steep slope
3	West Street	Medium	close to stream, close to steep slope
4	West Street	Medium	close to stream, close to steep slope
5	West Street	Medium	close to stream, close to steep slope
7	West Street	Medium	close to stream, close to steep slope
8	West Street	Medium	close to stream, close to steep slope
13	West Street	Medium	close to stream, close to steep slope, steep road
36	West Street	Medium	close to stream, close to steep slope
1	Witts Bridge Road	High	steep road, close to steep slope, close to stream
11	Witts Bridge Road	Medium	steep road, close to steep slope

References

U.S. Census Bureau. (2012). *Vermont: 2010 Population and Housing Unit Costs: 2010 Census of Population and Housing*. Retrieved from https://www.census.gov/prod/cen2010/cph-2-47.pdf

Blazewicz, M., and Nealon M. (2007). *Ayers Brook River Corridor Management Plan: Brookfied, Braintree, and Randolph, Vermont*. Bear Creek Environmental. Retrieved from http://whiteriverpartnership.org/wp-content/uploads/2014/02/Ayers-Brook-River-Corridor-Plan-2007.pdf

Vermont Agency of Natural Resources Watershed Management Division. (2013). *White River Tactical Basin Plan*. Retrieved from http://www.watershedmanagement.vt.gov/planning/docs/pl_WhiteRiverTacticalPlan.pdf