Vine Brook and Willard's Brook Stream Shoreline Surveys

May 9, 2009
Lexington, Massachusetts

Conducted by the Watershed Stewardship Program,
a joint program of Lexington's Conservation Division,
Engineering Division, and citizen volunteers

Compiled by Emily Schadler and Tom Whelan
December 8, 2009

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We would like to offer a special thanks to the Directors of Lexington's Watershed Stewardship Program, who have generously contributed their time and effort to developing this program, and to the Watershed Stewards who volunteered to conduct the pilot round of stream surveys.

Abstract

Citizen volunteers conducted stream shoreline surveys on Vine Brook and Willard's Brook in Lexington, Massachusetts on May 9, 2009 to identify potential issues with stream health and function. The surveys were the pilot project of Lexington's new Watershed Stewardship Program, a citizen science-based project that aims to survey all of Lexington's 20 streams and follow-up with remediation efforts. Volunteer stewards collected observational data on general stream characteristics (i.e. water color, water odor, habitat features), potential problem areas (i.e. garbage, erosion, sedimentation), and outfalls. Photographs were used to document notable features. Results indicate no major crises on the stream at this time but a number of issues to be address in the near future. These include erosion and sedimentation issues (particularly around outfalls), stream blockages, and garbage in the stream. The preponderance of pavement, buildings, and lawn along Vine Brook suggests a need for outreach efforts to citizens about run-off as well as water quality testing to investigate nutrient and other pollutant levels in the water. Volunteers should use their experience from this survey to fine-tune methods for future stream shorelines surveys in Lexington, which will show larger trends across town.

Watershed Steward volunteers collect data on a section of Vine Brook during the May 9, 2009 survey.

Introduction

Lexington is home to 20 streams that drain into three major watersheds: the Charles River Watershed, the Mystic River Watershed, and the Shawsheen River Watershed. All of the streams in Lexington start within the town and flow outward to communities downstream (with the exception of part of Reeds Brook), making Lexington a unique headwaters-only community. As in many urbanized areas, these streams have faced increasing pressure over the years from stormwater run-off, alterations in surrounding land-use, and aging infrastructure.

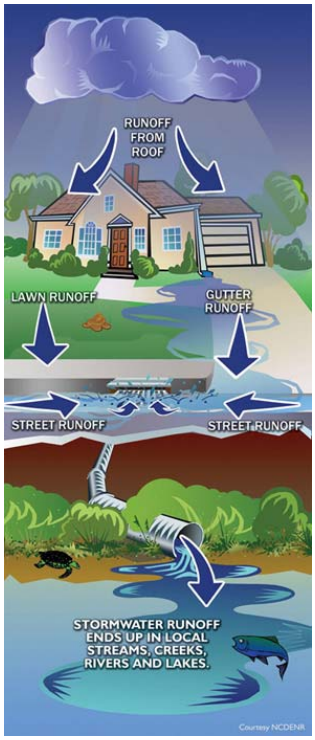
In response to concerns about issues with stream health and function, Lexington's Conservation Division, Engineering Division, and citizen volunteers recently collaborated on developing a Watershed Stewardship Program. This program engages citizen volunteers in observation-based stream shoreline surveys to gather data on characteristics and potential problems in and around the streams. Using trends identified through these surveys, volunteers will develop and implement strategies for addressing issues facing Lexington's streams. The survey is modeled after two successful programs with the same goal: the Charles River Watershed Association's Find It and Fix It program and the MassRiverways Stream Team program.

The Vine Brook (including the Vine Brook itself and an unnamed brook in the Vine Brook watershed) and Willard's Brook were selected as the study area for the pilot run of the stream shoreline surveys. This report describes the Vine Brook and Willard's Brook stream surveys conducted on May 9, 2009.

What is Stormwater Run-off?

Stormwater is water that flows over the ground when it rains or snows. When precipitation falls on vegetated areas, most of the water soaks into the ground. But when precipitation falls on impervious surfaces, such as driveways and streets, it **can't soak into the ground**, so it runs over the surface. This stormwater run-off either **flows directly into a stream** or into a storm drain that discharges into a stream. As stormwater runs over the ground, **it picks up pollutants**, such as oil, fertilizer, sand, and trash, and carries them with it as it flows into streams. These pollutants can contaminate drinking water supplies, fish and wildlife habitat, and swimming facilities. Stormwater can also cause erosion and flooding problems.

The stormwater run-off diagram to the right is courtesy of the North Carolina Department of Environment and Natural Resources.



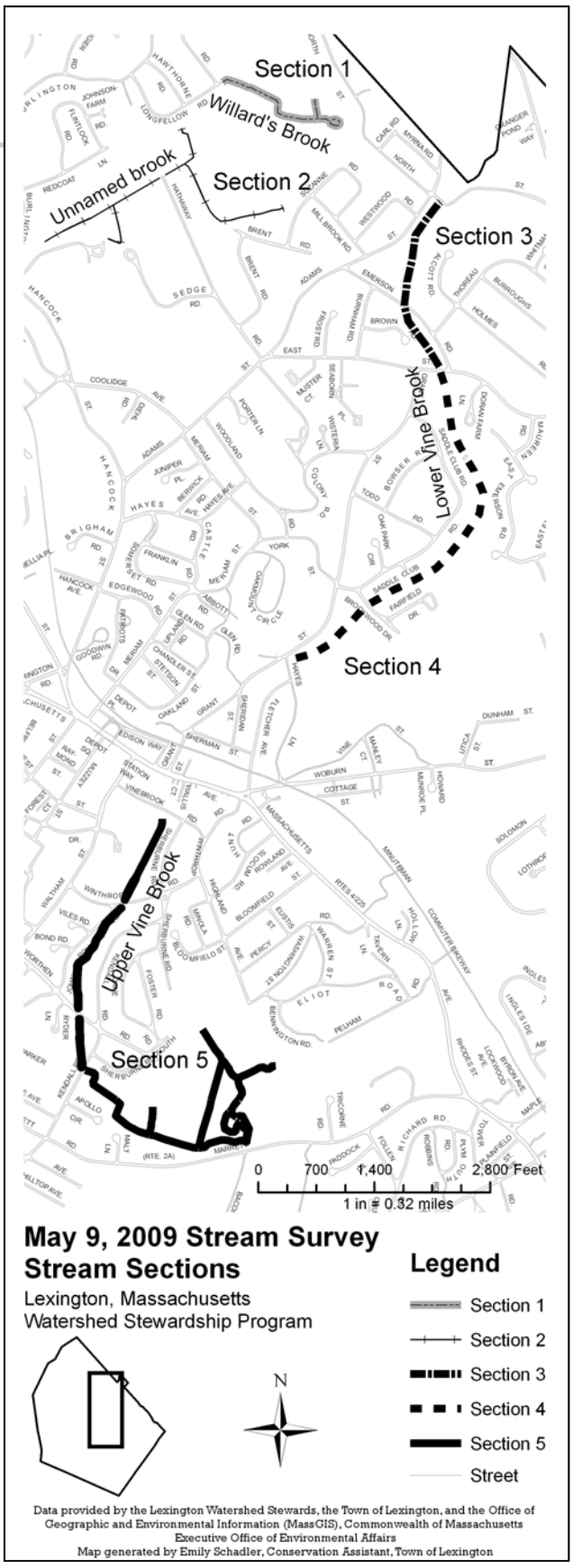
Study Area

Vine Brook, Lexington's largest stream, is centrally located, flowing from the Upper Vine Brook conservation area through residential areas and downtown Lexington to the Burlington line, past the Burlington Mall, and into Bedford where it joins the Shawsheen River. It runs underground through the center of Lexington, from Vine Brook Road to Hayes Lane, through a network of pipes. Vine Brook is classified by the Environmental Protection Agency as an impaired stream with a history of high bacteria counts.

Willard's Brook is a much smaller stream that joins Vine Brook across the Burlington line. Willard's Brook emerges from a culvert at the end of Longfellow Road, then runs primarily through Willard's Woods conservation land. It enters a small pond before being culverted under North Street.

Volunteers in 5 teams surveyed the following stream sections:

1. Willard's Brook, from Longfellow Rd. to North St.
2. An unnamed brook in the Willard's Woods conservation area in the Vine Brook watershed
3. Lower Vine Brook, from East St. to North St.
4. Lower Vine Brook, from Hayes Ln. to East St.
5. Upper Vine Brook, from the headwaters of the stream in the Upper Vine Brook conservation area to the town center at Vine Brook Road



Methods

25 citizen volunteers participated in the survey. Prior to the survey, volunteers attended two 1.5 hour training sessions. They learned how to make stream observations using the survey data categories. They also learned how to record observations using Trimble GeoExplorer 2008 GPS devices or by filling out paper survey forms and annotating maps.

For the survey, 4 teams used a Trimble GPS device for data collection and 1 team collected on paper. Teams also carried digital cameras to document outfalls and other points of interest. Each team worked from approximately 9 a.m. to 1 p.m. to complete the survey in the field, with additional time later to assemble the results and write the narratives. The objectives for the survey teams were to:

Characterize the stream itself

⇒ color, flow, depth, odor, sediment, in-stream vegetation, woody debris, habitat features

Characterize the stream banks, riparian area, and surrounding land use

⇒ bank slope, shade cover, habitat features, run-off from lawns and impervious surfaces

Collect specific location data

⇒ outfalls, debris, erosion, excess sediment, pollutants, in-stream vegetation, lawns

Characterize each outfall

⇒ material, size, flow level, condition, water color, odor, erosion

Photograph notable features

⇒ outfalls, blockages, the stream scene, other points of interest

Write a narrative describing each section

⇒ trends, unique features, priorities for action

Volunteers documented certain features with photographs, such as the duckweed and sediment above.

Results

Data collected on overall stream characteristics (Table 1) indicate that Vine Brook and Willard's Brook are generally slow-flowing, shallow streams with tea/red coloring and sandy/silty streambeds. Oily sheens, foam, algae, and dense in-stream vegetation were observed minimally. Woody debris was observed in all sections, and excess sediment was observed near 9 outfalls.

Data collected on the stream bank, riparian area, and surrounding areas (Table 2) show that while cover types vary throughout the stream sections, the most common stream bank cover observed was trees/shrubs, and the most common riparian area covers observed were forests/shrubs and lawns. The most common nearby land uses are residential and conservation areas. Severe erosion was observed in some locations. Overhanging vegetation was moderately abundant, while undercut banks were sparse. Frogs, snails, aquatic insects, and ducks/geese were observed using the streams, but fish were not observed in any location.

Specific locations were recorded for certain features, including outfalls, woody debris, garbage, other stream blockages (i.e. vegetation, sediment, organic material not classified as woody debris, unidentified blockages), and possible stream bank or riparian issues (i.e. erosion, exposed roots, rip-rap, lawns, buildings, pavement, invasive species). Counts of these locations by stream section are presented in Table 3.

Raw data is provided in Appendix 1 and Appendix 2.

Table 1: Summary of overall stream characteristics in Vine Brook watershed and Willard's Brook

Streambed material	Mainly sand and silt; some stones; no boulders
Streambed color	Mainly brown; sometimes orange/red
Water color	Tea/Red
Water depth	Variable, generally > 1 foot and < 5 feet
Water odor	Primarily none; mild odor in some areas
Stream flow rate	Primarily slow, but quick in some locations
Oily sheen	Minimal; observed in two sections
Foam	Observed in 3 sections; natural colored where observed
Woody Debris	Observed in all sections
Dense in-stream vegetation	Minimal; observed in two instances
Algae	Minimal; observed in one instance
Excess sediment	Observed near 9 outfalls

Results

Table 2. Overall stream bank and riparian area characteristics in Vine Brook watershed and Willard's Brook.

Stream bank cover	Variable; trees/shrubs most common
Stream bank slope	Variable
Stream bank erosion	Most often mild; severe in key locations
Riparian cover	Variable; forest/shrubs and lawn most common
Nearby land use	Variable; residential and conservation land most common
Undercut banks	Sparse
Overhanging vegetation	Moderate
Pools and riffles	Variable; none to moderate
Aquatic vegetation	Variable
Aquatic life	Frogs, snails, aquatic insects. No fish observed
Ducks/Geese	Identified in 3 sections

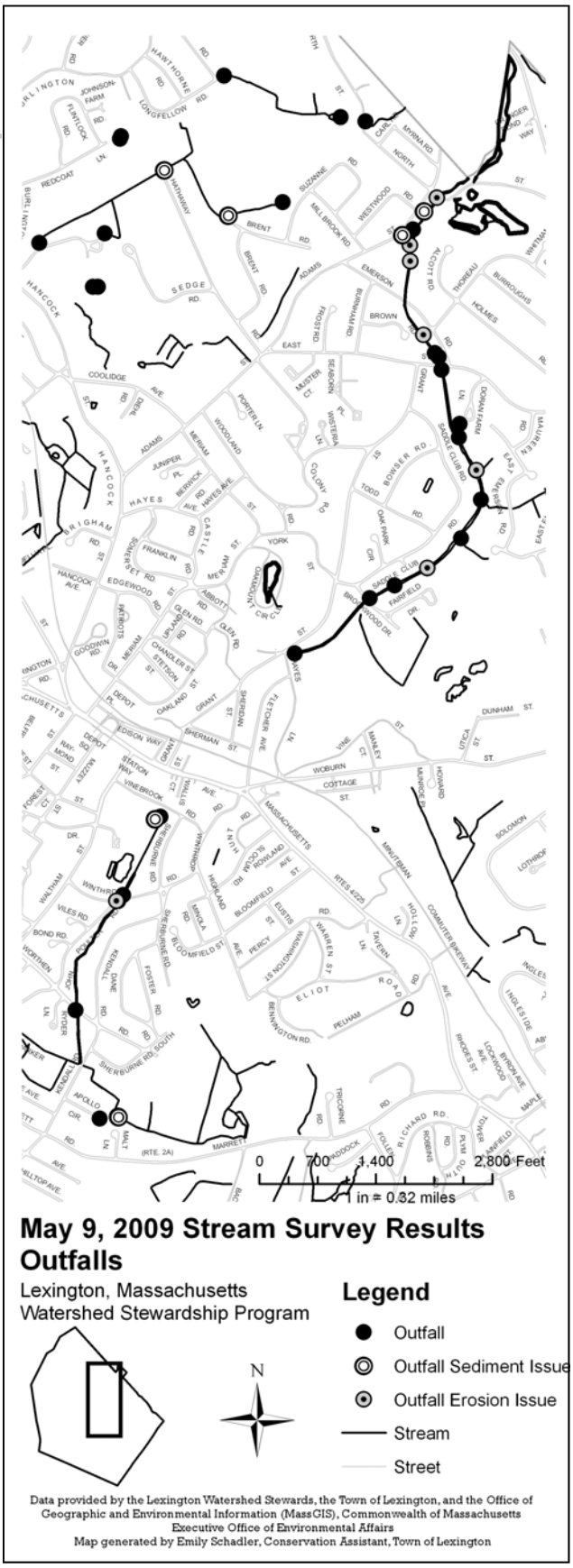
Table 3: Summary of key locations in Vine Brook watershed and Willard's Brook. Other stream blockages refers to vegetation, sediment, organic material not classified as woody debris, and unidentified blockages. Possible stream bank or riparian issues refers to erosion, exposed roots, riprap, lawns, buildings, pavement, and invasive species.

	Outfalls	**Outfalls w/ Erosion or Sediment Issues**	**Woody Debris**	**Garbage**	**Other Stream Blockage**	**Possible Stream Bank or Riparian Issue**
1. Willard's Brook	3	0	2	0	5	3
2. Unnamed brook in Vine Brook watershed	10	3	1	4	2	2
3. Lower Vine Brook (East St. to North St.)	10	6	5	1	1	1
4. Lower Vine Brook (Hayes Ln. to East St.)	10	3	2	1	3	5
5. Upper Vine Brook	10	4	1	2	3	7
Totals	43	16	11	8	14	18

Results

The **Outfalls map** to the right shows the locations of all outfalls identified in the survey. Volunteers were instructed to collect data on all pipes draining into the stream, so the map does not distinguish illicit connections. Outfalls with nearby excess sediment deposits and erosion issues are noted separately.

Outfall located on Vine Brook at Worthen Road.



Results

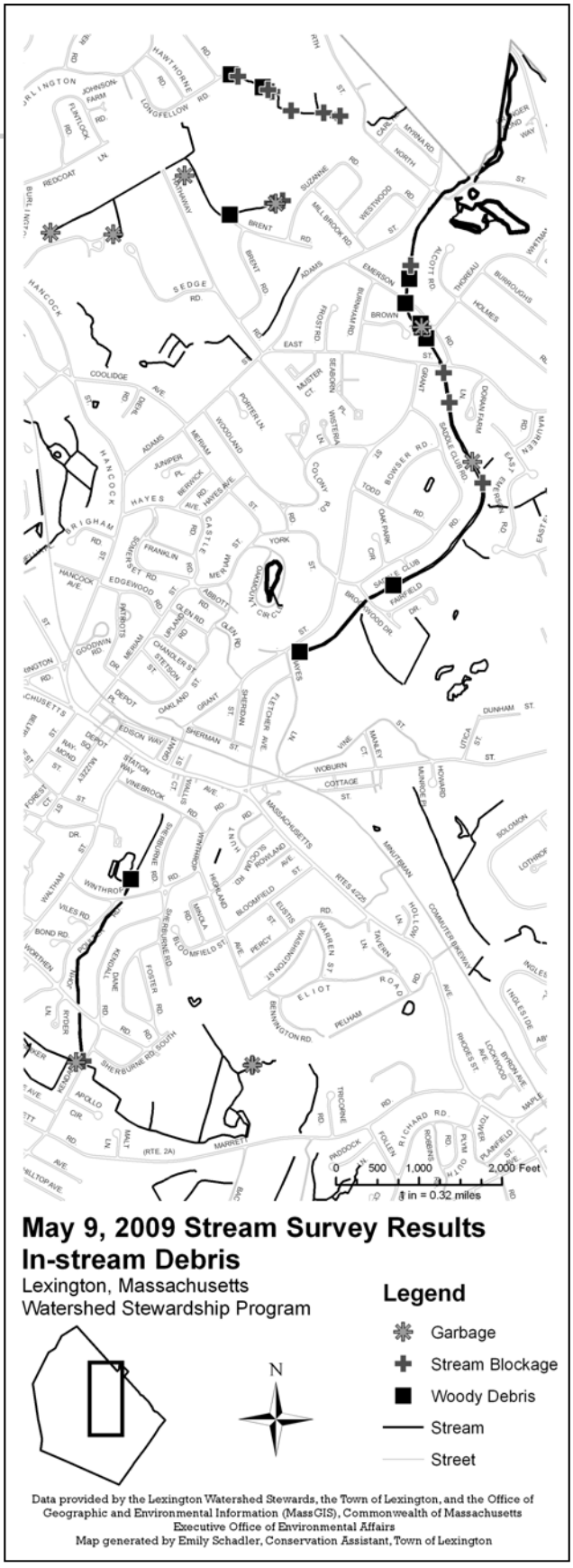
The **In-stream Debris** map to the right shows the location of 3 types of debris:

⇒ **Garbage**—includes any type of non-natural trash located in stream.

⇒ **Woody Debris**—large and small pieces of woody material (twigs, branches, trunks) spanning the width of the stream.

⇒ **Other Stream Blockage**—any stream flow blockage that doesn't fit into the categories above, including sediment, organic debris, in-stream vegetation, and unidentified stream blockages.

Woody debris and other organic matter spanning a stream bed.

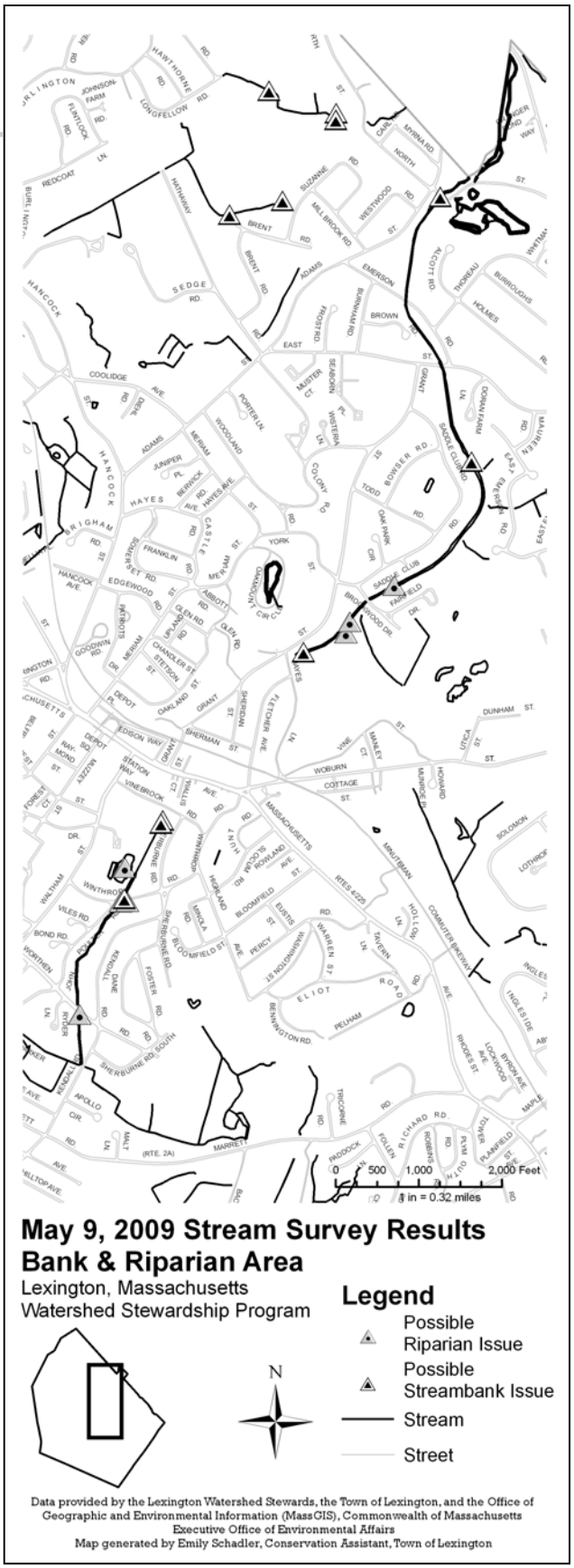


Results

The **Bank and Riparian Areas** map to the right shows the location of possible stream bank issues, including severe or moderate erosion, riprap, exposed roots, grass, and landscaping debris located in the bank area, and possible riparian issue, including lawns, buildings, pavement, and invasive species in the riparian area.

Photographs taken by the volunteers during the surveys and links to the locations where they were taken is available in the Lexington Community Development Office from Emily Schadler, Conservation Assistant.

Bank erosion on a stretch of Vine Brook.



Action items and observations

Volunteers were also asked to provide a narrative of their survey to describe trends that they observed as well as to outline what they saw as priorities for follow-up action. The full text of these narratives is provided in Appendix 1. A summary of these narratives is provided below.

Narrative Summary

In the headwaters of Vine Brook, a conservation area, there are relatively few issues. As the stream flows through residential areas, the numbers of outfalls, trash sightings, erosion issues, pollutant sightings, and invasive plants begin to mount.

There are profuse stands of Japanese knotweed (*Polygonum cuspidatum*), Oriental bittersweet (*Celastrus orbiculatus),* and Multiflora rose (*Rosa multiflora*) along the banks of the stream in certain areas. The numbers of lawns, other landscaping, and pavements near the stream increases in the residential areas as well. On Willard's Brook, which flows entirely through a conservation area (Willard's Woods), the major issues were erosion at stream crossings and invasive species in the riparian area.

The streams were relatively free of aquatic invasive species and algae growth at this time of year, although a few areas showed some algae growth or duckweed growth. (Duckweed is not invasive but can be indicative of excess nutrients.) Stream wildlife sighted included small numbers of frogs and other amphibians, but no fish. The teams saw a number of birds both in the stream (mainly mallards and one Upland sandpiper) and in areas immediately adjacent to the stream.

The most commonly mentioned team priorities for follow-up action items were:

- ⇒ Clearing trash and blockages from the stream and outfalls
- ⇒ Controlling invasive/nuisance species, especially Japanese knotweed (*Polygonum cuspidatum*), Oriental bittersweet (*Celastrus orbiculatus),* duckweed, and Multiflora rose (*Rosa multiflora*)
- ⇒ Relieving erosion of stream and pond banks.

*Red-winged black bird (*Agelaius phoeniceus*) in cattails in a wetland near the unnamed brook in Vine Brook watershed.*

Discussion

The surveys identified no areas of extreme immediate concern (such as oil spills or signs of raw sewage) but do indicate a number of areas of concern that should be investigated and addressed.

When considering the results from this study, it is important to remember these are urbanized stream. In areas, they have been culverted, diverted, rip-rapped, or surrounded by impervious surfaces that alter hydrology. Additionally, the surveys were conducted by volunteers who have varying levels of experience. While measures were taken to ensure consistency across the data, it is inevitable that there are inconsistencies.

It is also important to recognize that these surveys were conducted on one day in the spring; observations in different seasons and over longer time spans may reveal other trends. That said, a number of trends do emerge from the May 9th data that can help to guide the Watershed Stewards in remediation efforts.

Outfalls

Of the 43 outfalls identified, 16 show signs of sedimentation or erosion issues nearby. Sedimentation likely comes from road sand applied in the winter and from erosion on construction sites that makes its way to streams. Stream bank erosion can stem from a number of factors, including improper drainage and poor natural vegetation along banks. Follow-up communication with the Engineering Division of Lexington's DPW Department to take a closer look at the condition of these outfalls should be conducted. Additionally, some of the identified outfalls may be illicit connections rather than approved outfalls, particularly the PVC, metal, and small pipes. Illicit connections are illegal and can be sources of pollutants. Follow-up work should be conducted to identify which, if any, of these outfalls are actually illicit connections.

In-stream debris

Less garbage was identified in the streams than originally anticipated; for many stretches of Vine Brook and Willard's Brook, the water is trash-free. The most garbage-impacted area appears to be the area behind the Diamond School and adjacent to Willard's Woods conservation area. Garbage should be removed as soon as possible to avoid contamination, beautify the stream, and remove blockage sources.

Woody debris, both large and small, was identified in a number of areas on the stream, including at some culverts. While woody debris can pose stream blockage and flooding issues, it also performs a number of ecosystem functions for streams, including providing habitat features, promoting oxygenation, and reducing down-stream flooding and erosion issues. The Watershed Stewards should continue to work with Conservation and Engineering staff to develop a protocol that removes woody debris when it poses a threat to neighboring properties and culverts but leaves it in place where possible.

Discussion

In-stream vegetation

The lack of observed areas of dense in-stream vegetation and algae in this survey may be due to the time of year—early spring—that the survey was conducted. Informal observations from volunteers later in the year indicate that more areas of duckweed and algae appeared over the summer and fall. Follow-up work should be conducted to identify these areas to better understand the extent of in-stream vegetation growth. This growth can often be an indicator of excess nutrients and eutrophication, which is likely in the survey area given the amount of lawn and pavement nearby.

Invasive species

The abundance of non-aquatic invasive species observed along the stream banks and in the riparian areas is consistent with observations made throughout Lexington. Invasive species are detrimental in that they crowd out native species, but in terms of stream health, they can also provide shade cover and hold banks back from eroding. Therefore, any invasive species removal undertaken along stream banks should include plans to re-plant native species and obtain proper permits through the Conservation office. In general, invasive species management issues should be turned over to the Lexington Conservation Stewards or other groups who are working on land stewardship issue.

Japanese knotweed growing along the banks of Vine Brook.

Discussion

Volunteers use a Trimble GPS device to collect data on Upper Vine Brook. Loppers and a walking stick also came in handy.

Run-off water quality

While much of the survey area is bordered by conservation land, lawns and residential areas also occur frequently along the streams. Fertilizers from lawns and run-off from impervious surface can greatly affect water quality and stream health. Further, vegetating stream bank and riparian areas with lawn rather than forest can increase erosion and stream water temperatures, impacting the aquatic biota. Outreach efforts should be made to citizens and businesses regarding steps can be taken to reduce the run-off from their properties.

Previous water quality testing on the Vine Brook has shown it to be impaired with high bacteria counts; the Town is working to remediate this problem. In the future, Watershed Stewards may want to work with the Engineering Division to establish a volunteer-based water quality sampling program to further investigate the impacts of run-off on the town's streams. In the past, fish lived in Vine Brook, but no fish have been seen in the stream for many years.

Recommendations for methods in future surveys

An additional objective for the first survey is to form a core group to help lead others in later surveys. Feedback from the May 9th survey indicates that volunteers who participated:

⇒ Enjoyed doing the survey
⇒ Learned about stream health and function issues
⇒ Seem willing to participate in watershed stewardship in 2010

In preparation for the next survey, a few issues that arose in the May 9th survey should be

Discussion

addressed. First, each volunteer team should be responsible for checking that its data is complete before submitting it. (A team mistakenly didn't collect GPS locations with their data, and re-creating the results was troublesome).

Putting the data together was time consuming, mostly because of bottlenecking due to the GIS/ GPS technology used. Initially, only one person with access to ArcGIS was able to assemble the data, which greatly slowed progress. For future surveys, it would be more efficient for teams to collect their data on paper rather than on Trimble devices and immediately hand-enter it into a pre-fabricated spreadsheet at the end of the survey day. Teams that want to collect point locations that correspond with the paper data on their own GPS devices could do so provided that the device was set up to easily transfer data to ArcGIS (i.e. X/Y data provided in decimal degrees).

In some cases, matching photographs with locations and objects was difficult due to unclear labeling. In the future, volunteers should clearly link a photograph number to the point on the map where it was taken and provide a description of what the photo shows (i.e. "sediment in stream", "invasive species on stream bank").

Some survey questions may need to be revised for the next survey round. For instance, the questions about stream flow and depth caused some confusion. Providing a simple way to measure stream flow (i.e. floating a stick over 10 feet and timing it) and clarifying the depth question would improve the survey. Other questions should be reviewed for revisions as well.

Overall, however, the surveys were informative for the town and engaging for the citizens volunteers. The Watershed Stewardship Program should continue to conduct surveys 20 of Lexington's streams to provide guidance regarding how to best improve the health and function of our waterways.

Hairy woodpecker near the unnamed brook in Willard's Woods.

Appendix 1—Stream Survey Data

Section Name	Willard's Book: Longfellow Road to North Street	Unnamed stream (section near Long-fellow Road)	Unnamed stream (section from Burling-ton Road to-ward Brent Road)	East Street to North Street	Hayes Lane to East Street	UVB Conserva-tion Area to Vine Brook Road
Section Number	1	2	2	3	4	5 & 6
Streambed material	Organic	Organic	Organic	Gravel	Gravel	Sand
	Silt		Silt	Sand	Sand	Silt
	Sand			Silt	Silt	Organic
				Cobbles		Boulders
Streambed color	Black	Brown	Brown	Brown	Orange/Red	Orange/Red
	Sandy			Sandy	Brown	Black
	Grey			Grey		Brown
Water color	Tea/Red	Tea/Red	Tea/Read	Tea/Red	Tea/Red	Tea/Red
	Clear					Clear
Water odor	None	None	None	None	None	None
Water depth	> or = 1 foot	variable	< 1 foot	> or = 1 foot	> or = 3 feet	> or = 3 feet
Stream flow rate	quickly	Not at all	Slowly	Slow	Quickly	Quickly
					Slowly	Slowly
Stream flow blockages *	Yes	Yes	Yes	Yes	Yes	Yes
Dense vegetation *	Duck weed	Clogging pipe	No	No	Clogging stream	No
Invasive species present *	No	No	No	No	Yes	No
Algae presence *	No	No	No	Yes	No	No
Toxic garbage *	No	No	Low	No	No	No
Non-toxic garbage *	Very low	Low	No	Low	Moderate	Low
Lawns *	No			No	Green/lush	Mottled
Oily sheen or odor *	No	No	No	No	Yes	Yes
Sewage/ bacteria sources *	No	No	No	No	No	No
Foam or scum *	No	No	No	Natural colored	Natural colored	Natural colored
Excess sediment *	No	No	No	No	No	No
Run-off *	Roads	Driveway	No	Bridge	Lawn	No
		Parking lot		Road		
		Road		Lawn		

Appendix 1—Stream Survey Data

Section Name	Willard's Book: Longfellow Road to North Street	Unnamed stream (section near Long-fellow Road)	Unnamed stream (section from Burling-ton Road to-ward Brent Road)	East Street to North Street	Hayes Lane to East Street	UVB Conserva-tion Area to Vine Brook Road
Section Number	1	2	2	3	4	5 & 6
Left stream bank cover	Exposed roots/ erosion (where bridge crosses)	Wetlands	Trees	Trees	Riprap	Trees
	Trees	Brambles	Moss	Brambles	Shrubs	Shrubs
	Moss		Exposed roots/ erosion		Trees	Other
	Wetlands		Shrubs		Moss	
	Grasses/flower				Brambles	
	Brambles					
Left slope	Slight	Variable	Steep	Moderate	Moderate	Slight
						Moderate
						Steep
Left erosion *	Severe	None	Mild	Mild	Mild	None
	Mild					
Right stream bank cover	Exposed roots/ erosion	Wetlands	Trees	Trees	Riprap	Wetlands
	Shrubs	Brambles	Exposed roots/ erosion	Riprap	Shrubs	Shrubs
	Trees		Moss		Trees	Trees
	Grass/ flowers		Shrubs		Grass/flowers	Grass/Flowers
					Brambles	
Right slope	Slight	Variable	Steep	Mild	Moderate	Slight
	Severe				Steep	Moderate
						Steep
Right erosion *	Mild	None	Mild	Moderate	Mild	None
					Severe	
Left riparian cover	Forest/shrubs	Grass/ Flowers	Forest/shrubs	Forest/shrubs	Forest/shrubs	Forest/shrubs
	Trail	Parking Lot		Sidewalk		Lawn
		Lawn				Driveway
		Trail				House/building
		Wetland				
Right riparian cover	Pasture/ meadow	Grass/ Flowers	Forest/shrubs	Forest/shrubs	Forest/shrubs	Forest/shrubs
	Forest/shrubs	Parking Lot		Pasture/ meadow	Pasture/ meadow	Lawn
	Trail	Lawn				Grass/ flowers
	Wetland	Wetland				
	Conservation land					

Appendix 1—Stream Survey Data

Section Name	Willard's Book: Longfellow Road to North Street	Unnamed stream (section near Longfellow Road)	Unnamed stream (section from Burlington Road toward Brent Road)	East Street to North Street	Hayes Lane to East Street	UVB Conservation Area to Vine Brook Road
Section Number	1	2	2	3	4	5 & 6
Land use visible from stream	Residential	Residential	Residential	Pavement	Residential	Residential
	Forest	Conservation land	Conservation land	Conservation land		Conservation land
	Wetland	Pavement		Bike path		Forest
	Bike path	Forest		Wetland		
		Wetland		Residential		
		Park/ballfields		Forest		
Large woody material	Moderate	Abundant	Moderate	Sparse	None	Sparse
Small organic material	Moderate	Adundant	Abudant	Sparse	None	Moderate
Undercut banks	Sparse	None	None	Sparse	None	None
Overhanging vegetation	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
						Abundant
Aquatic vegetation	Sparse	Abundant	None	Moderate	None	None
						Abundant
Pools and riffles	Sparse	None	Sparse	Moderate	Sparse	None
						Moderate
Aquatic life evidence	No	Frogs	None	Snails	Frogs	None
		Snails		Aquatic insects	Aquatic insects	
		Snakes				
		Aquatic insects				
Vernal pools *	Sparse	None	None	None	None	Sparse
Fallen limbs and trunks	Moderate	Moderate	Moderate	Abundant	Abundant	Moderate
Mast plant species	Moderate	Abundant	Abundant	Abdundant	Moderate	Sparse
Scattered rocks and boulders	Moderate	Sparse	Sparse	Sparse	Sparse	Sparse
Stone walls	Sparse	Sparse	Sparse	Sparse	None	None
Standing dead trees	Sparse	Moderate	Sparse	Moderate	Moderate	Sparse
Animal evidence	Holes in trees	Holes in trees	Holes in trees	Holes in trees	Holes in trees	
	Tracks	Calls	Calls	Tracks	Dens/nests	
	Calls	Dens/nests		Calls	Teeth marks	
	Birds	Tracks			Calls	
	Deer					
	Cottontail					
	Owl pellet					
Signs of ducks or geese *	Yes	Yes	Yes	No		

* indicates data categories that may have associated GPS location points

Appendix 2—Outfall Data

	Outfall type	Headwall material	Headwall condition	Pipe size	Pipe material	Flow level	Erosion around outfall	Sed. Accumulation	Water color	Water odor
Section 1. Willard's Book: Longfellow Road to North Street										
1	Straight headwall	Fieldstone	Good	24"	Concrete	half	minor	minor	clear	none
2	Straight headwall	Fieldstone	Fair	28"	Concrete	three quarter	minor	minor	clear	none
Section 2. Unnamed Brook in Vine Brook watershed										
1	Headwall/ Straight	Concrete	Good	24"	Concrete	quarter	None	None	Colored	None
2	Headwall/ Straight	Fieldstone	Fair	36"	Concrete	three quarters	None	Impeding Flow	Colored	None
3	Headwall/ Straight	Fieldstone	Poor	36"	Concrete	under water		Impeding Flow	Colored	None
4	Pipe with Flared End	NA	NA	36"	Concrete	three quarters		Substantial	Colored	None
5	No Headwall				PVC	none	None	Minor		None
6	No Headwall			12"	PVC	none	None	Minor		None
7	Headwall/ Straight	Concrete	Good	24"	Concrete	half	None	Minor	Colored	None
Section 3. East Street to North Street										
1	Headwall/ Straight	Fieldstone	Good	24"	Concrete	quarter	None	None	Clear	None
2	Headwall/ Straight	Fieldstone	Fair	12"	Concrete	none	Minor	None		None
3	No Headwall	NA	NA	36"	Concrete	quarter	Collapsed Pipe	Minor	Foamy	None
4	No Headwall	NA	NA	18"	Concrete	half	None	None	Oily	None
5	No Headwall	NA	NA	12"	PVC	quarter	Substantial	Substantial	Clear	None

Appendix 2—Outfall Data

	Outfall type	Headwall material	Headwall condition	Pipe size	Pipe material	Flow level	Erosion around outfall	Sed. Accumulation	Water color	Water odor
Section 4. Hayes Lane to East Street										
1	No Headwall	NA	NA	18"		quarter	None	None	Clear	None
2	No Headwall	NA	NA	24"	Metal	quarter	None	None	Colored	None
3	No Headwall	NA	NA	18"	Metal	under water	None	None	Colored	Mild
4	No Headwall	NA	NA	18"	Metal	under water	None	None	Colored	Mild
5	No Headwall	NA	NA	18"	Metal	quarter	None	None	Clear	None
6	Headwall/ Straight	Concrete	Fair	12"	Clay	none	None	None		None
7	No Headwall	NA	NA	16"	Metal	quarter	Collapsed Pipe	None	Clear	None
8	No Headwall	NA	NA	18"	Metal	quarter	Collapsed Pipe	None	Clear	None
9	Headwall/ Straight	Concrete	Fair	24"	Concrete	quarter	None	None	Clear	None
10	Headwall/ Straight	Concrete	Fair	36"	Concrete	quarter	None	None	Clear	Mild
11	Headwall/ Straight	Concrete	Fair	24"	Concrete	none	None			
Section 5. UVB Conservation Area to Vine Brook Road										
1	No Headwall									
2	No Headwall	NA	Good	18"	Concrete					
3	No Headwall	NA	Poor	16"	Metal	under water	None	Minor		None
4					Concrete	none	None	Substantial		None
5	Headwall/ Straight	Concrete	Good	16"	Concrete	half	None	Impeding Flow	Clear	None
6	No Headwall	NA	NA	36"	Concrete	quarter	Minor	None	Clear	None

Appendix 3—Narrative & Priorities for Action Text

Section 1: Willard's Brook (Willard's Book watershed), Longfellow Road toward North Street

This section of the stream flows exclusively through Conservation area. The flow is quick with clear/tea colored water. The stream bottom alternates between sandy and thick organic mud/silt. Throughout the stream there are periodic blockages from dead wood/logs or vegetation. The stream banks are generally in good condition other than where the path crossed the stream. At the bridge and the pond each side had major erosion due to foot/dog traffic. The outflow from the pond was largely blocked with broken branches and small logs. The outflows on either end of this section were in good condition and not blocked. We encountered many people with dogs whenever we approached the path. Area around the stream was conservation land with presence of some invasive plant species, poison ivy, multiflora, bittersweet and garlic mustard.

Problems	The main problem in this section is periodic blockages and partial blockages from fallen branches/logs and vegetation. A second localized problem is major erosion in two places: the bridge and around the pond. This is due to foot/dog traffic. There is also an abundance of invasive species around the stream.
Assets	This is a very scenic area with an abundance of wildlife, including birds, deer, rabbits and one fish observed in the pond. There were also several valuable native species observed, such as lady slipper and partridge berry.
Priorities for action	Clear blockage throughout stream. Find a way to block access to the areas with major erosion so they can recover. Develop a plan to remove invasive species from Willard's Woods.

Section 2: Unnamed brooks in the Lower Vine Brook watershed from Longfellow Road toward Suzanne Road

Team 2 discovered today two distinct areas of note:

- Brook at Brent Street Entrance. R — flows well, minimum obstructions (one trash can). L — clogged, little/no flow, opens into marshy area, flowing into yards at #29-27 Hathaway Rd. (Relatively clean, no debris, lots of wildlife)
- Brook at Longfellow Rd. (# 15 + #17) at Hawthorne Rd. Water flowing into storm drain, couldn't see pipe — not drawing properly. Wire bale near origin of our route parallel to Diamond Driveway and Chabad Ctr. causing blockage

Problems, Assets, Priorities for action	No data submitted.

Section 3: Lower Vine Brook from East St. to North St.

The overall stream quality was good; the stream was consistent from one end to the other in terms of depth, flow, vegetation, and lack of litter and pollution. However, there were a few trees blocking the stream flow, the largest being at Emerson Street. There are also a few fast flow spots. Landscaping is also close to the stream, which should be noted.

Problems	Dam caused fallen trees and man-made rock dam. Broken pipes. Some invasive species.
Assets	A lot of native wetland plants. Scenic.
Priorities for action	Remove the large tree near Emerson Street. Repairing two or three of the pipes. Remove some invasive species.

Section 4: Lower Vine Brook from Hayes Lane to East St

The stream ran through residential areas except for a section bounded by a conservation area. The water was clear and tea-brown throughout. At the Hayes Lane end, the stream bed is rocky, but for the most part it is fine sand or silt. About 1/8th of the brook has some obstruction by fallen tree limbs and silting midstream. As the stream approaches East Street, it narrows, becomes swifter in places, and obstructions become an issue.

Appendix 3—Narrative & Priorities for Action Text

There were some areas of native species along the sides but the vast majority of the stream was surrounded by invasive plant species , including multiflora rose, Norway maple, honeysuckle, garlic mustard, with some significant stands of knotweed (see photo 7). We saw 2 pairs of mallards and an Upland Sandpiper in or by the stream. There is evidence of many birds nesting in the area.

There were several areas of significant trash, including tires on the stream bank. There was a curious large yellow tarp (address of neighbor on the GPS data collector, see photo 3) that the neighbors said started out as a floating barrier across the stream near the Hayes Lane end and then collapsed and migrated down the brook. It seems to have been part of a DPW project. An outfall near the Brookwood area seemed to contribute to the scum and oily surface of the downstream zone.

Problems	Trash, flow blockage by fallen limbs, shoreline invasive species. Also, many residents clearly use fertilizer and insecticide on lawns within 10-25 feet of the stream.
Assets	This is a very pretty stream and there is considerable interest by the neighbors we met to improve the quality of the stream. Easy access from the trail along the stream makes it an important asset for passive recreation.
Priorities for action	Removal of the yellow tarp, tires, and other trash (possibly as a Boy Scout or high school community service project). Clearing limbs, debris, and silt in narrow spots removal to improve flow. Invasive species management could start with the stands of multiflora rose. (Another possible Boy Scout or high school community service project). Community outreach to involve people in cleaning up their stream and in reducing the use of chemicals in their gardens.

Section 5: Upper Vine Brook Conservation Area to Vine Brook Road

Vine Brook rises in the wooded Upper Vine Brook conservation property. The stream descends through a series of lovely open wooded wet meadows to a point where it empties into a large red maple swamp. Along the south side of the swamp bordering Marrett Road there are extensive healthy cattail marshes with nary a clump of phragmites in sight. We did locate one extensive stand of Japanese Knotweed which we fixed through a Trimble entry. This is located along what appears to be a man-made berm that looked to be the spoils from a former stream channelization effort that was no doubt intended to improve farming opportunities along Marrett Road. We weren't able to determine if this swamp is infested with purple loosestrife but other than the JKW, the swamp looks surprisingly free of invasive species down to Apollo Circle.

Vine Brook exits the large red maple swamp opposite the Apollo Circle cul-de-sac, meanders through a residential development which was not surveyed and crosses under Kendall Road. This section looks to be heavily overgrown with a combination of invasive species including multi-flora rose and naturally occurring shrubby growth.

The section between Kendall Road and Worthen Road is a placid stretch with little gradient, a silty muddy stream bottom, low banks and traverses mature wet woodlands with an under story of invasive plant species (primarily multiflora rose and buckthorn).

The section between Worthen and Winthrop was not surveyed but looks equally placid but with significantly steeper banks overgrown with invasive plant species as above. This section is bordered on both sides by house lots down to Winthrop.

The section from Winthrop to the culvert conveying Vine Brook under the town center closely resembles the Worthen/Winthrop section, picking up gradient in the last 100' approaching the culvert. There is a large (48" +/-) outfall pipe just before said culvert that apparently drains from the Lincoln Park branch of the Vine Brook watershed. This had a steady flow of water. The left bank is bounded by house lots. The right bank is forested town land heavily invaded by garlic mustard, multi-flora rose, JKW and bittersweet. The extended riparian zone on the right bank becomes a flooded forest about 200' from the bank with significant standing water and widespread dead standing mature trees.

Also note the alteration of the stream bank through landscaping (mulch, lack of tree cover for shade) at Winthrop Road.

Problems	Sediment buildup on west side of Kendall Road culvert. Large downed tree across brook between Worthen Rd and Vine Brook Rd. Heavy infestation of invasive plant species between Worthen Rd and Vine Brook Rd.
Assets	Large red maple swamp with adjoining cattail margins that appear to be largely free of invasives opposite Marrett Road.
Priorities for action	Remove downed tree. Seasonal monitoring of culverts at Winthrop Road and Vine Brook Road for blockages.