St. Mary's River Stream Corridor Assessment and Tidal Shoreline Survey

Robert W. Paul, Ph.D.
Department of Biology
St. Mary's College of Maryland
St. Mary's City, MD 20686
In Partnership with
St. Mary's River Watershed Association, Inc.
PO Box 94, St. Mary's City, MD 20686

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Summary

A stream corridor assessment (SCA) was conducted for the 70.62 square mile (45,198 acre) St. Mary's River (St. Mary's County, Maryland) watershed from April 1 to September 30, 2008. The watershed is the largest in St. Mary's County, is part of the lower Potomac River drainage, has 174.9 miles of streams, and nearly 85 miles of tidal shoreline. With support from the Maryland Department of Natural Resources (DNR) Watershed Services Unit, St. Mary's College of Maryland performed the SCA using DNR protocols. The results of the survey will be used by state and local governments to determine problem sites that can be addressed through restoration projects.

Prior to the start of field work, St. Mary's County's Department of Land Use and Growth Management (LUGM) in cooperation with the St. Mary's River Watershed Association (SMRWA) sent out letters to all property owners with lands adjacent to watershed water bodies and asked them to contact the project director if they objected to the survey crew entering their property. A total of 54.6 stream miles were denied access by property owners and this was 31.6% of the watershed miles. Therefore, the survey crew walked a total of 118.4 stream miles during the survey period. Also prior to field studies, Ken Yetman, from DNR's Watershed Services, trained the field survey crew in SCA protocols and survey techniques.

The St. Mary's River watershed is subdivided into 12-digit subwatersheds by DNR, and these subwatersheds were the units of study. They were identified on maps, and the streams within the subwatersheds classified on the basis of their stream orders. Therefore, each stream segment within a subwatershed had a unique identifying numerical code that allowed the field crew to assemble and compile information based on specific location. The survey crew identified 119 potential problem sites and recorded basic habitat information at 98 representative sites. The most frequently observed environmental problem was erosion (29), followed by channel alteration (22). In addition, there were 19 fish barriers, 14 inadequate stream buffers, 13 trash dumping sites, 8 pipe outfalls, 8 unusual conditions, 4 exposed pipes, and 2 construction sites.

Site documentation included a photograph and a GPS location. All environmental problems were also ranked on a scale from one to five for severity compared to other sites of the same type, correctability of the problem, and how easily the problem site could be accessed. Representative sites were recorded at about one mile intervals along the stream and these were included because of their potential value in future preservation initiatives.

We analyzed the 119 problem sites by their locations within subwatersheds and found that the problems were clumped in large subwatersheds, along the main stem of the river, and in the more urbanized parts of the watershed. Subwatersheds 714 and 719 had significantly more problems than any other watershed followed by subwatersheds 717, 718, and 710 with an intermediate number. Subwatersheds 709, 711, 712, 713, 715, and 716 had very few problems.

Environmental problems were also analyzed by type of problem and severity to determine if certain problems with the St. Mary's River watershed were more severe than others. Of the 119 problems, only 10 were classified as being severe, and these included 3 unusual conditions that had no real standard for evaluating severity, 3 fish migration barriers, and one each from the erosion, exposed pipe, channel alteration, and inadequate buffer categories. Overall, considering the size of the watershed, we felt that the number of severe problems was quite small.

This Stream Corridor Assessment survey was able to assess the conditions in almost 70% of the watershed's streams. The number of representative sites (98) gave some indication of stream health since representative sites were taken at mile intervals when no problems were encountered, and these sites are included because they indicate areas worthy of protection. The fact that the number of problem sites (119) was about the same as representative sites, was encouraging and gave us the strong impression that the St. Mary's River watershed streams were in relatively good shape. A further indication that the streams were relatively healthy was that problem severity was rated as moderate in 30, low in 32, and minor in 27 of the 119 cases. These three classifications total to be 76.5% of the total problems.

These results lead us to believe that the problems in the St. Mary's watershed are localized, mostly in the watershed's urban areas, are possibly exacerbated by impervious surface development, and that vigilance is required to protect these streams from further degradation.

Introduction

A stream corridor assessment (SCA) is a watershed management tool. A SCA survey using specific protocols in itself is not a detailed scientific evaluation, but a tool to provide a rapid overview of the condition of the entire watershed. It is used to locate specific environmental problems and to collect basic habitat information on stream corridors in a watershed. The strengths of the survey lie in the ability to put individual problems in context of the entire watershed and to use these to prioritize restoration work. All of the problems noted in a survey can be used by state and local governments in their future restoration efforts. The survey is also a requirement of the Clean Water Act. A compilation of these sites can be used to form an effective plan of action (Yetman, 2001).

Developed by the Maryland Department of Natural Resources (DNR)'s Watershed Restoration Division, the SCA survey utilizes a small survey team to record observable problems and prioritize restoration opportunities. The Stream Corridor Assessment (SCA) survey is designed to provide a method which can be used to both rapidly assess the general physical condition of a stream system and identify the location of a variety of common environmental problems within the stream's corridors. It is intended to be a tool that can help resource managers identify not only the location of environmental problems but also restoration opportunities that exist within a drainage network. Potential environmental problems identified as part of the SCA survey include: erosion sites, inadequate stream buffers, fish migration blockages, exposed or discharging pipes, channelized stream sections, trash dumping sites, in- or near-stream construction, or unusual conditions. In addition, the survey also collects information on potential wetlands creation/water quality retrofit sites, as well as data on the general condition of both in-stream and riparian corridor habitats. The survey can also be used to assist in the identification of healthy stream sections that may be in need of environmental protection (Yetman, 2001).

One of the key commitments made by the Chesapeake Bay Program (CBP) partners in the Chesapeake 2000 agreement is: "by 2010, work with local governments, community groups and watershed organizations to develop and implement locally supported watershed management plans in two-thirds of the Bay watershed covered by this Agreement. These plans would address the protection, conservation and restoration of stream corridors, riparian forest buffers and wetlands for the purposes of improving habitat and water quality, with collateral benefits for optimizing stream flow and water supply." (Chesapeake Bay Program, 2008). Watershed management plans address the protection, conservation and restoration of stream corridors, riparian forest buffers, wetlands, parklands and other open space for the purposes of preserving watershed health while enhancing the quality of life in local communities. By the end of 2007, watershed management plans were in place for 13 million acres of the Bay watershed, approximately 57% of the two-thirds goal (Chesapeake Bay Program, 2008). Because St. Mary's County has only completed a single watershed management plan (Breton Bay in 2005) it is necessary for St. Mary's County to complete an additional watershed management plans. Watershed Restoration Action Strategies include watershed characterizations, synoptic surveys, and stream corridor assessment surveys as the first steps in a watershed planning effort.

Methods

The St. Mary's River watershed is located entirely in St. Mary's County, Maryland, and is a part of the lower Potomac tributary basin. This eight-digit watershed (02140103) is the largest in St. Mary's County and is the second county watershed to be evaluated by a SCA, with Breton Bay being first in 2002. The SCA will be used along with a synoptic stream survey and a watershed characterization study to formulate a restoration plan for the St. Mary's River watershed problem areas.

This SCA survey began on April 1 and was concluded on September 30, 2008, with the submission of the final report to DNR. A survey team of five St. Mary's College of Maryland students was assembled by the Project Director, Dr. Robert W. Paul, working with Ms. Amy Drohan, the project's field coordinator. It was originally envisioned that a survey team leader who was a college graduate would be recruited, but it was decided that the 5 students that made up the field team could easily be directed by the field coordinator and the project director. All students were hired as contract employees of the College, and they started work on May 12, 2008, the day of the project's first public meeting. Field sampling materials were assembled and tested from May 12 through May 23, and Kenneth Yetman from DNR provided training during this time frame at St. Mary's College using the SCA Survey Protocol manual (Yetman, 2001). Two specific tasks were required in the SCA, the field assessment and characterization of non-tidal streams by walking the stream channels and documenting the condition of the tidal St. Mary's River shoreline by photography.

Prior to the start of field work, St. Mary's County's Department of Land Use and Growth Management (LUGM) in cooperation with the St. Mary's River Watershed Association (SMRWA) sent out letters to all property owners with lands adjacent to watershed water bodies and asked them to contact the project director if they objected to the survey crew entering their property. A total of 1263 letters were mailed, and responses denying access to properties were received from 242 property owners. These properties were identified as polygons on a GIS representative map for the watershed, and the stream segments within these polygons were marked as "No Walk" zones. Other property owners responded to the letter requesting that that survey team notify them when they were to be on the property.

A base map for the St. Mary's River watershed streams was supplied by LUGM as an ArcMap® shapefile and this map layer was modified using a 2003 orthophotograph of the county to verify stream channels. Once modified this map was used as the representative stream map. The St. Mary's River watershed is subdivided into 12-digit subwatersheds by DNR, and these subwatersheds were used as the study units. They were identified on the base stream map, and the streams within the subwatersheds were then classified on the basis of their stream orders and numbered. Therefore, each stream segment within a subwatershed had a unique identifying numerical code that allowed the field crew to assemble and compile information based on specific location. For example, the code 0717-302, indicated the 12-digit subwatershed number (717) and then the stream order

(3) and finally the number of the third order stream (02). All stream segments in the watershed were numbered in this way.

Site documentation included a photograph and a GPS location. All environmental problems were also ranked on a scale from one to five for severity compared to other sites of the same type, correctability of the problem, and how easily the problem site could be accessed. These rankings are subjective, but they offer a solid starting point in determining what problem sites need to become a priority for restoration. The following is a general description of the rankings that the survey teams used, and more detailed information on all procedures can be found in Stream Corridor Assessment Survey – Survey Protocols (Yetman, 2001).

At representative sites, the field crew ranked the condition of attachment sites for macroinvertebrates, embeddedness, shelter for fish, channel alteration, sediment deposition, velocity and depth, channel flow status, bank vegetation protection, condition of banks, and riparian vegetation zone width as optimal, suboptimal, marginal, or poor. These rankings made up representative sites that were taken at approximately one mile intervals along the stream corridor. These sites serve to compare health of the streams across the St. Mary's River watershed and to highlight areas that might be suitable for preservation.

At each of these representative and problem sites the survey team took a picture of the stream that includes a six digit number. The first three digits of this number identified the subwatershed in which the stream is located. The fourth number identified the team (either 1 or 2) that surveyed that stream segment, and the last two digits were the site number of the stream in that subwatershed. These numbers were combined to give each site a unique identification number. For example, site 709108 would be the eighth site surveyed in subwatershed 709 by team one.

Severity rankings told how good or bad a specific problem site was relative to others. Severity rankings were only used to compare problems of the same type. It was not possible, for example, to compare rankings between an in stream construction site and a fish barrier. In most cases the negative influence of construction on the stream ecosystem was inherently much larger than the impact of a single fish barrier. We used the following severity rankings in accordance with the SCA protocols (Yetman, 2001).

Very severe ratings (1) were used to identify problems that have a direct and wide reaching impact on the stream's aquatic resources. Within a specific problem category, a very severe rating indicated that the problem was among the worst that the field teams have seen or would expect to see. Examples would included a discharge from a pipe that was discoloring the water over a long stream reach (greater than 1000 feet) or a long section of stream (greater than 1000 feet) with high raw vertical banks that are unstable and eroding at a rapid rate.

Moderate severity ratings (3) identified problems that have some adverse environmental impacts but the severity and/or length of affected stream was fairly limited. While a moderate severity rating would indicate that field crews believed it was a significant problem, it also indicated that they have seen or would expect to see worse problems in the specific problem category. Examples include: a small fish blockage that is passable by strong swimming fish like trout, but a barrier to resident species such as sculpins or a site where several hundred feet of stream has an inadequate forest buffer.

Minor severity ratings (5) identified problems that do not have a significant impact on stream and aquatic resources. A minor rating indicated that a problem is present, but compared to other problems in the same category it was considered minor. One example of a site with a minor rating would be a pipe outfall from a storm water management structure that is not discharging during dry weather and does not have an erosion problem at the outfall or immediately downstream. Another example might be a section of stream with stable banks that has a partial forest buffer less than 50 feet wide along both banks.

Correctability ratings were a reflection of how easily the survey team thought that the problem could be fixed. These ratings will be used to determine which problems can be addressed with a fixed amount of funding. Restoration funding should be directed at the most severe projects that can be most easily corrected. In some cases, problems with minor correctability could be fixed by a team of volunteers while problems with very difficult correctability will require engineers. The following guidelines were used in this study and were taken directly from the SCA survey manual (Yetman, 2001).

Minor correctibility ratings (1) indicated problems that can be corrected quickly and easily using hand labor, with a minimal amount of planning. These types of projects would usually not need any Federal, State or local government permits. These would be jobs that a small group of volunteers (10 people or less) could fix in a day or two without using heavy equipment. Examples would include removing debris from a blocked culvert pipe, removing less than two pickup truck loads of trash from an easily accessible area or planting trees along a short stretch of stream.

Moderate correctibility ratings (3) may require a small piece of equipment, such as a backhoe, and some planning to correct the problem. These would not be the type of project that volunteers would usually do alone, although volunteers could assist in some aspects of the project, such as final landscaping. This type of project would usually require a week or more to complete. The project may require some local, State or Federal government notification or permits. However, environmental disturbance would be small and approval should be easy to obtain.

Very difficult correctibility ratings (5) indicated problems that require a large, expensive effort to correct. These projects would usually require heavy equipment, significant amount of funding ($100,000 or more), and construction could take a month or more. The amount of disturbance would be large and the project would need to obtain a variety of Federal, State and/or local permits. Examples might include a potential restoration area where the stream has deeply incised several feet over a long distance (i.e., several thousand feet) or a fish blockage at a large dam.

The accessibility ratings also reflected how easy it was to reach a problem site. In many cases, streams located in a remote wooded area or sometimes on private land that would require permission from the property owner received higher accessibility ratings. We used the following guidelines from the SCA survey manual (Yetman, 2001) in evaluating accessibility.

Very easy accessibility ratings (1) indicated sites that are readily accessible both by car and on foot. Examples included a problem in an open area inside a public park where there is sufficient room to park safely near the site.

Moderate accessibility ratings (3) indicated sites that are easily accessible by foot but not easily accessible by a vehicle. Examples would included a stream section that can be reached by crossing a large field or a site that was accessible only by a 4-wheel drive vehicle.

Very difficult accessibility ratings (5) were assigned to sites that would be difficult to reach both on foot and by a vehicle. To reach the site it would be necessary to hike at least a mile, and if equipment were needed to do the restoration work, an access road would need to be built through rough terrain. Examples would include a site where there are no roads or trails nearby.

The survey team recorded geographic locations and the location of photographs to the nearest 0.001 decimal degree of latitude and longitude at problem and representative sites with Garmin Etrex® GPS receiver. Results from problem and representative sites were recorded on the appropriate data sheets taken from the SCA Protocol manual (Yetman, 2001). Photographs were taken with either a Nikon Cool-pic or a Kodak digital camera and the images downloaded onto a computer as jpeg files. All stream survey data were transferred from field data sheets and entered into Excel files stored on a St. Mary's College of Maryland Panasonic CF-19 Toughbook computer. All data and photographs were also converted to ArcMap shape files to show their geographical location on ArcMap 9.2 maps.

The tidal shoreline survey was begun in June 2008. A shakedown cruise and 17 cruises to collect data were used to photograph the entire length of the St. Mary's River tidal shoreline. A 24-foot Grady-White boat with a 200 HP Yamaha outboard engine was leased from St. Mary's College to move along a specific route approximately 75 meters from shore. A Ricoh Caplio 500SE GPS camera (Ricoh Company Ltd., Tokyo, Japan) was mounted on a tripod on and programmed to take shoreline pictures automatically every thirty seconds.

After programming the camera, we proceeded along the shoreline at approximately 5 nautical miles per hour. This combination of speed and distance was ideal for capturing a complete image of the shoreline. These photographs were stored on the Panasonic CF-19 Toughbook computer and then saved on St. Mary's College of Maryland desktop computers. Images obtained with the Ricoh camera were converted to ArcMap shapefiles with Geospatial Experts' GPS-Photo Link- Ricoh Edition software.

Photographic images, once converted to shape files (ArcMap 9.2, ESRI, Redlands, CA, USA), were plotted on GIS maps of the tidal St. Mary's River. These images were initially screened to determine if there was sufficient overlap in the frames to provide a continuous record of the shoreline. If photographs were not sufficiently close to provide overlap, and then the shoreline segment was targeted for additional photographs in subsequent cruises. In some cases, shoaling did not allow the Grady-White boat to approach close enough to the shore for photographs. In these cases, we brought a shallow-draft skiff so we could get closer to shore, anchored the larger boat, and then photographed the shore from the skiff. To photograph the shoreline of NESEA (Naval Air Station- Patuxent River, Webster Field Annex) it was necessary to secure special permission from their security office, and they also screen photographs removing those which showed sensitive buildings.

Once all photographs were linked to their GPS locations and mapped, we reviewed the images to find those which showed sufficient shoreline erosion or inadequate shoreline buffers so they could be considered for restoration. These shoreline segments were then transfer to a map that highlighted the shoreline where possible restoration efforts could be focused.

Results

STREAM CORRIDOR ASSESSMENT

General Results

The St. Mary's River watershed has 174.9 miles of stream on 45,198 acres (70.62 square miles) of land. Of these acres, 6,012 are urban and include impervious surfaces that make up 5.3% of the watershed. Most of St. Mary's County is forested (27,364 acres) and the county has 11,269 acres of agriculture. There are also 358 acres of wetlands which make up a small part of the total 17% of land that is classified as non-forested stream buffer (MDE, 2008).

Land owners were contacted by mail telling the purpose of the study and asking them to respond to the project director if permission to access their land was denied. We received a total of 242 contacts (letters, e-mails, phone calls) from property owners denying access to their properties. We determined that a total of 54.6 stream miles could not be surveyed, and this was 31.6% of the watershed miles. These stream segments were not even distributed throughout the watershed, but were clustered (Figure 1, Table 1). For example, Fisherman's Creek subwatershed (712) had several large farms where access was denied, so 69% of the total stream miles in this subwatershed could not be surveyed. By contrast, two small subwatersheds, Craney Creek (713) and Hilton Run (715) had no denials, so all the streams in the watershed were surveyed.

The survey crew identified 119 potential problem sites and recorded basic habitat information at 98 representative sites. The most frequently observed environmental problem was erosion (29 sites), followed by channel alteration (22 sites). In addition, there were 19 fish barriers, 14 inadequate stream buffers, 13 trash dumping sites, 8 pipe outfalls, 8 unusual conditions, 4 exposed pipes, and 2 construction sites. Most problems were classified as moderate or minor severity. A detailed description of the sites grouped by problem type and subwatershed can be found in Appendix tables. In the following section, the results are summarized first by subwatershed and then by problem type.

We also found that of the 174.9 stream miles in the watershed, a small number (23) of streams were perennial or seasonal and only had water when sufficient precipitation provided enough surface run off for stream flow (Table 1). The Western Branch of the St. Mary's River contained the largest number (10) of seasonal streams.

Watershed streams were separated into individual stream segments whenever a stream junction occurred and these segments were classified by stream order (Horton, 1945) and numbered. There were a total of 498 individual stream segments identified in the St. Mary's River watershed (Table 2). By far, the most numerous were first order, headwater streams (75.5 %) and these dominated all subwatersheds. Subwatershed 710, the Middle St. Mary's River, has total of 109 first order streams with more than twice as many as the next subwatershed, and this subwatershed also has the largest number of second order streams. Only 4 subwatersheds have fourth order streams, and two of these (717 and 718) are the two major non-tidal, East and West Branches, respectively, of the non-tidal St. River. Once these two major branches join, the St. Mary's River becomes a fifth order stream and runs for 3.4 miles before becoming tidal. A USGS stream gage is located in this segment of the river.

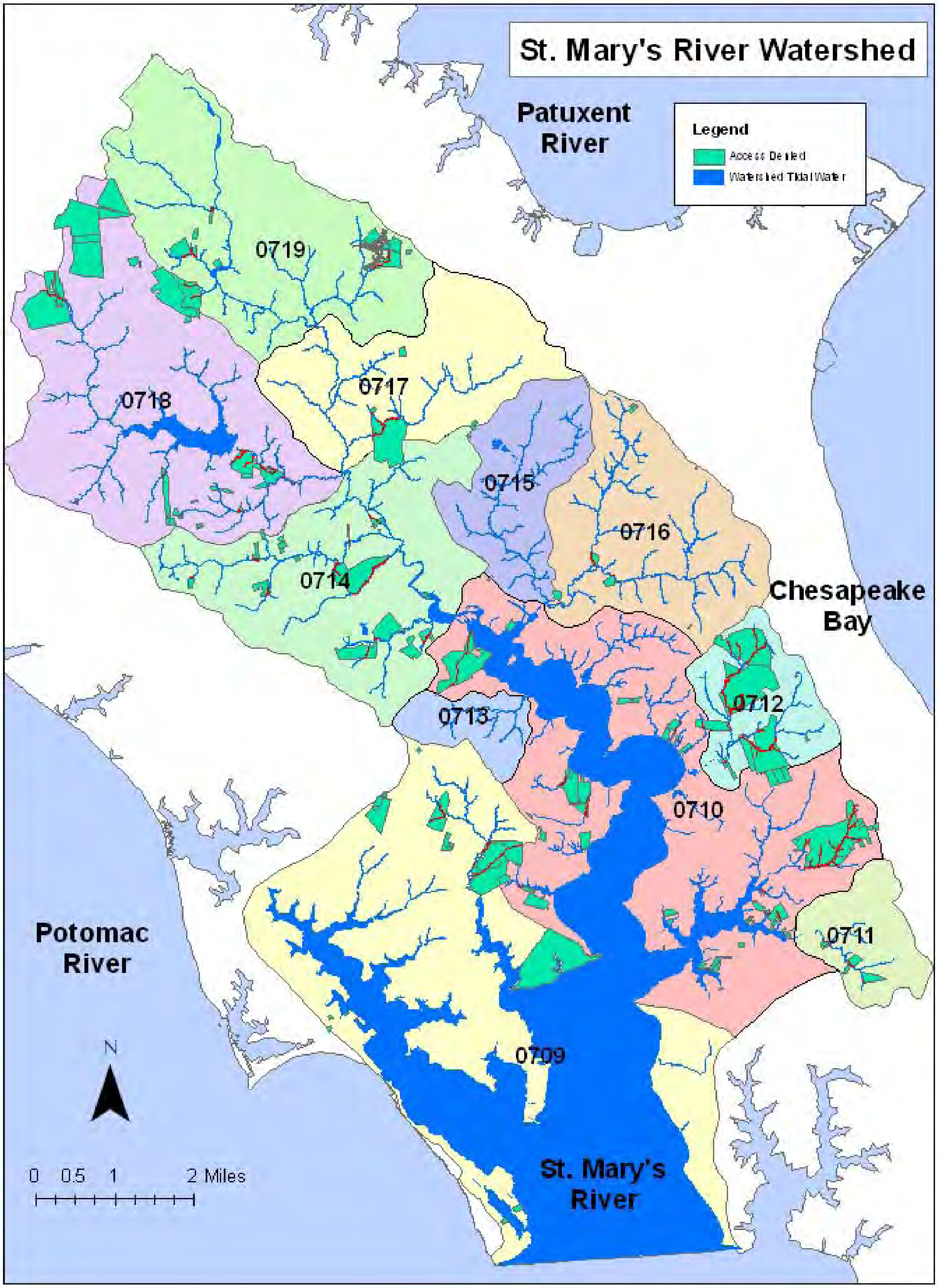

Figure 1. St. Mary's River watershed and 12 digit subwatersheds with properties and stream segments where access was denied by property owners.

Table 1. General characteristics of St. Mary's River watershed non-tidal streams by subwatershed.

12 digit watershed code	Subwatershed name	Seasonal Stream Count	Total Length (mi)	Percent of watershed miles (%)	Denied Access (mi)	Denied Access (%)
709	Lower St. Mary's River	4	10.9	6.3	3.6	33.0
710	Middle St. Mary's River	4	31.8	18.4	6.3	19.8
711	Church Creek	0	3.2	1.8	1.4	43.9
712	Fishermans Creek	0	10.6	6.1	7.3	69.0
713	Craney Creek	0	4.4	2.6	0	0
714	Johns Creek	0	22.6	13.1	15.2	67.3
715	Hilton Run	0	12.7	7.3	0	0
716	Pembrooke Run	2	22.5	13.0	5.5	24.4
717	Eastern Branch	2	13.2	7.6	3.2	24.3
718	Western Branch	10	23.3	12.4	5.4	25.2
719	Upper St. Mary's River	1	19.7	11.4	6.7	34.0
Totals:		23	174.9	100.0	54.6	31.6

SCA Results by Subwatershed

When all the 217 problem and representative sites were plotted on the master watershed map (Figure 2) it was difficult to see the individual locations and the type of problem associated with each site, and representative sites were also obscured because they tended to be spatially clustered. Therefore, we decided to do map analyses on a subwatershed basis, working sequentially through the 12 digit subwatershed numbers beginning with the southernmost subwatershed, 0709.

All of the identified problems were not spread evenly between the subwatersheds (Figure 2). Subwatersheds 714 and 719 had significantly more problems than any other watershed followed by subwatersheds 717, 718, and 710 with an intermediate number. Subwatersheds 709, 711, 712, 713, 715, and 716 had very few problems. The overall frequencies of problems by subwatershed are shown in Figure 3.

Table 2. St. Mary's River watershed streams classified according to their stream order by subwatershed.

12 digit code	Name	1st Order Number	1st Order Length (miles)	2nd Order Number	2nd Order Length (miles)	3rd Order Number	3rd Order Length (miles)	4th Order Number	4th Order Length (miles)	5th Order Number	5th Order Length (miles)	Total Length (miles)
709	Lower St. Mary's River	19	7.2	6	2.4	1	1.2					10.9
710	Middle St. Mary's River	109	23.5	25	7.5	4	0.8					31.8
711	Church Creek	5	1.7	2	1.1	1	0.4					3.2
712	Fishermans Creek	23	7.6	9	1.4	2	0.6	1	1.0			10.6
713	New Creek	9	3.4	4	0.7	1	0.2					4.4
714	Johns Creek	32	10.3	8	4.9	2	4.0			1	3.4	22.6
715	Hilton Run	36	6.4	8	3.8	1	2.6					12.7
716	Pembrooke Run	49	18.4	13	2.2	2	0.7	1	1.2			22.5
717	Eastern Branch	18	6.5	3	3.1	1	1.0	1	2.6			13.2
718	Western Branch	46	12.3	13	5.9	3	3.2	1	1.9			23.3
719	Upper St. Mary's River	30	11.7	6	5.8	2	2.2					19.7
	TOTALS	376	109.1	97	38.6	20	16.9	4	6.8	1	3.4	174.9

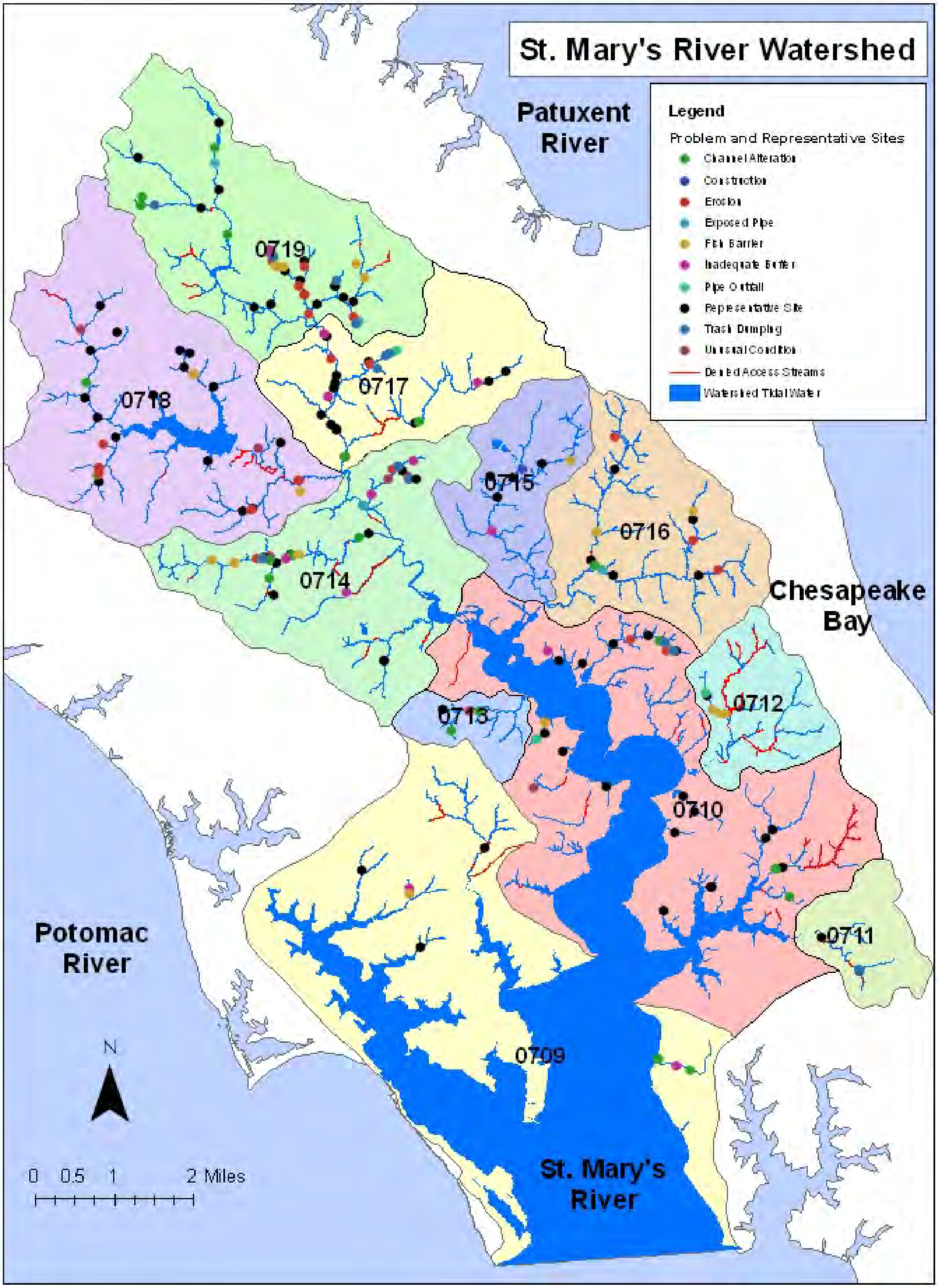

Figure 2. St. Mary's River watershed and 12 digit subwatersheds with problem and representative sites identified.

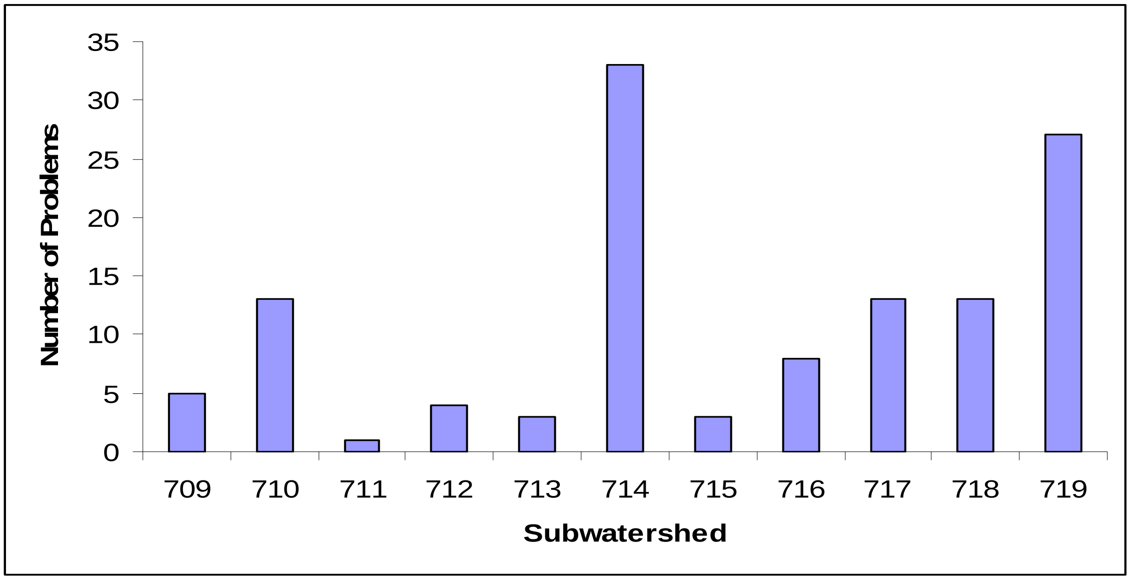

Figure 3. The number of problems identified in each subwatershed.

Analysis of problem types by subwatershed (Table 3, Figure 3) showed, not surprisingly, that the larger watersheds (those with more than 10% of the total stream miles in the subwatershed) also had the greatest number of representative and problem sites. However, some problem sites may have been under estimated in subwatersheds such as 712, Fishermans Creek, where such a large proportion of the streams could not be accessed. A quarter of the pipe outfalls were found in Subwatersheds 710 and 717.

Table 3. Number of stream miles, problem types and representative sites by subwatersheds in the St. Mary's River watershed.

	Subwatershed number										
Problem Type	709	710	711	712	713	714	715	716	717	718	719
Percent of total watershed streams	6.3	18.4	1.8	6.1	2.6	13.1	7.3	13.0	7.6	12.4	11.4
Exposed Pipe	0	0	0	0	0	1	0	1	0	0	2
Pipe Outfall	0	2	0	1	0	3	0	0	2	0	0
Construction Site	0	0	0	0	0	0	1	1	0	0	0
Channel Alteration	2	3	0	0	2	6	0	1	2	2	4
Erosion	0	3	0	0	1	7	0	3	3	6	7
Inadequate Buffer	2	1	0	0	0	5	1	0	3	0	2
Fish Barrier	1	1	0	3	0	2	1	2	0	3	6
Trash Dumping	0	2	1	0	0	5	0	0	2	0	5
Unusual Condition	0	1	0	0	0	4	0	0	1	2	1
Total Problems	5	13	1	4	3	33	3	8	13	13	27
Representative Sites	4	20	2	1	1	12	4	5	15	18	16

Subwatershed 714 had the highest proportion of these outfalls with 38%. In the case of exposed pipes, half were in subwatershed 719. Subwatershed 714 had the most channel alterations with 27% of the total. Additionally, the greatest concentration of erosion sites was in subwatershed 714 and 719, with 25%, each. Inadequate buffers were mostly found in subwatershed 714 which contained 36% of the total. Fish barriers were found primarily (32%) in subwatershed 719, and 39% of the total trash dumping was found in subwatersheds 714 and 719. Subwatershed 714 also contained the highest concentration of unusual conditions.

Subwatershed 709- Lower St. Mary's River

While the lower St. Mary's River contains only 6.3% of the total watershed stream miles, the subwatershed has a large land area (Figure 4). Most of the streams in this subwatershed are short, low elevation gradient streams that discharge directly into the St. Mary's River. The subwatershed has 19 first order streams, 6 second order streams, and 1 third order stream. The topography is flat and low elevation gradients do not create erosion problems, so subwatershed 709 is one of 4 subwatersheds without erosion problems. Relative to its large land area, it has few problems: 2 each channel alterations and inadequate buffers, plus one fish blockage.

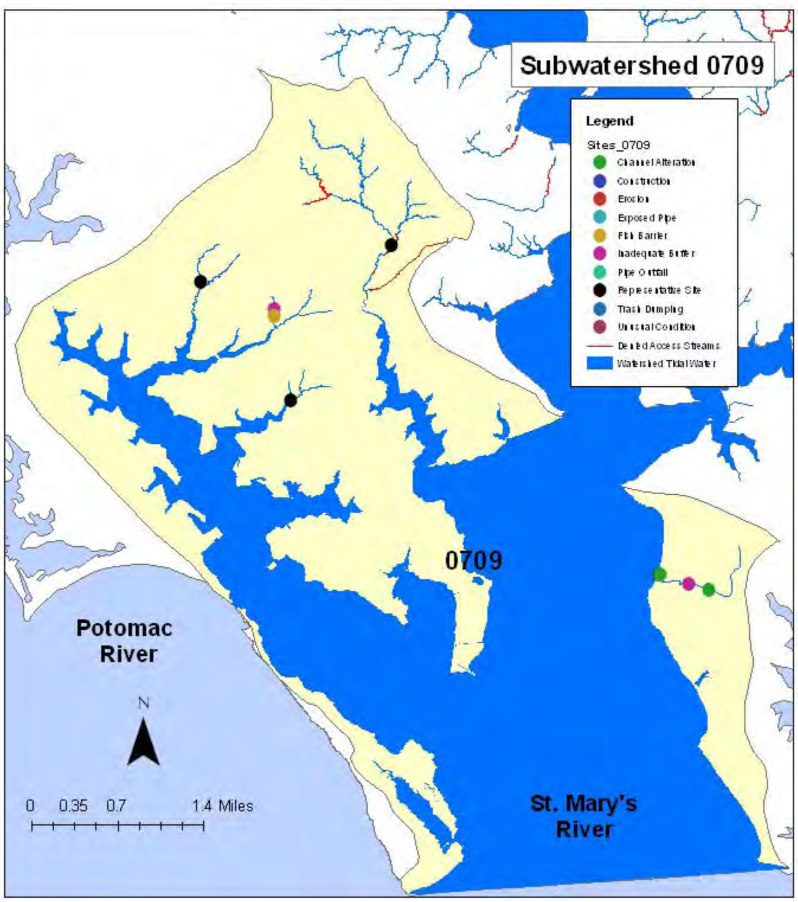

Figure 4. Problem and representative sites in subwatershed 709- the Lower St. Mary's River.

Subwatershed 710- Middle St. Mary's River

The Middle St. Mary's River is a large and complicated subwatershed that straddles both sides of the St. Mary's River (Figure 5). The subwatershed boundaries in the north extend nearly to the non-tidal portion of the river and south to the southern most extent of St. Inigoes Creek. Within this subwatershed are 31.8 miles of stream and about half of these stream miles are associated with tidal St. Inigoes Creek. The balance is represented by mostly first and second order streams that discharge directly into the tidal St. Mary's River. Because nearly 20% of the total stream miles are contained in this subwatershed (Table 1) and because only 20% of these stream miles had access denied, the assessment of the subwatershed and its stream conditions was fairly complete.

There were 13 problem sites and 20 representative sites in subwatershed 710. The problems were clustered primarily in a small unnamed stream that flows into Martin Cove in the northern part of the subwatershed. The problem sites there were mostly channel alteration (1), erosion (3) and trash dumping (2). The fact that most of these problems are concentrated leads us to the conclusion that they may be readily correctable.

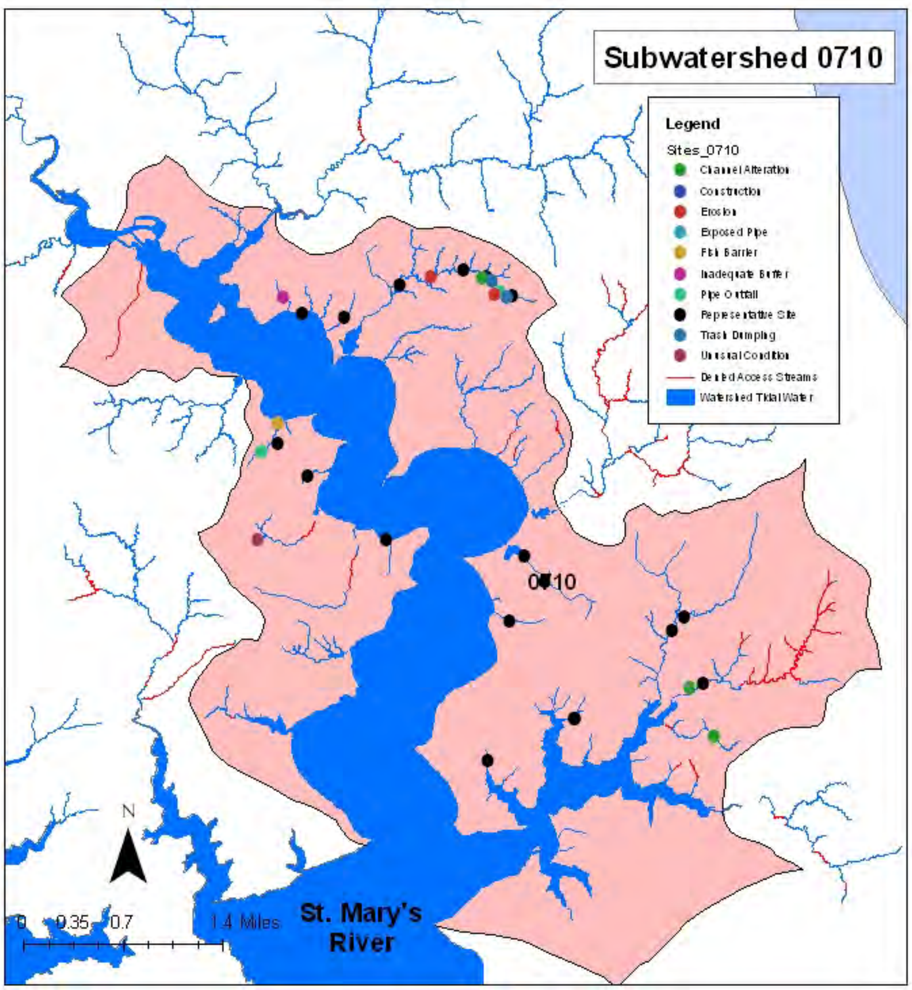

Figure 5. Problem and representative sites in the Middle St. Mary's River (710).

Subwatershed 711- Church Creek

Church Creek is a very small (1330 acre) subwatershed with only 3.2 miles of streams Figure 6). These streams combine to form a small, third order stream that discharges into tidal St. Inigoes Creek. The lower part of Church Creek is occasionally tidal. Historically, a stormwater pipe and outfall from the north-bound lane of State Route 5 has caused serious erosion problems, but the state highway administration has constructed a catchment basin at the problem location, and this has seemingly mitigated the erosion problem.

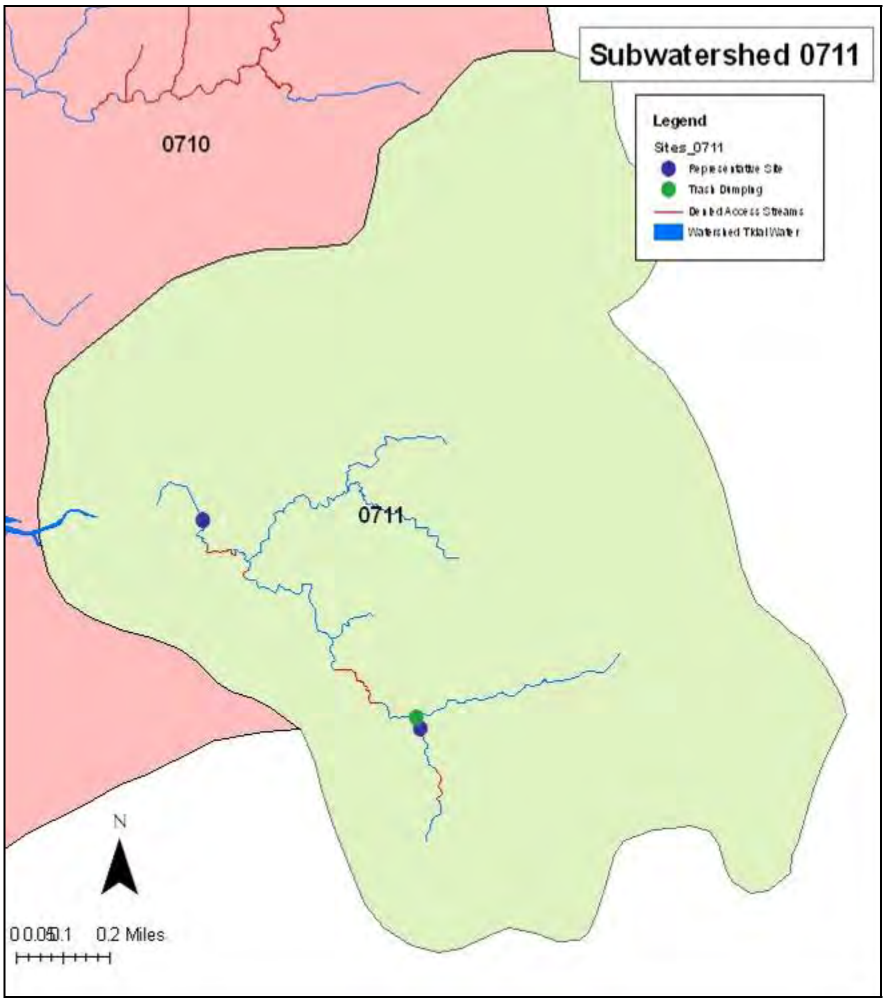

Figure 6. Problem and representative sites in subwatershed 711- Church Creek.

There were only one trash dumping site in this subwatershed and two representative sites were noted. Of all the subwatersheds, Church Creek seemed to have the fewest problems, but it is a very small watershed.

Subwatershed 712- Fishermans Creek

Fishermans Creek subwatershed is located near St. Mary's College and is almost entirely surrounded by the middle St. Mary's River subwatershed (Figure 7). The lower reaches of the stream are tidal and this estuary connects with the tidal St. Mary's River. This watershed has several very large farms near its headwaters and access was denied to almost 70% of the stream miles. Therefore, stream characterization in this SCA was limited. However, we know much about this subwatershed from our St. Mary's River Project sampling over the last ten years. It can be seen in Figure 7 that Fishermans Creek has two major tributaries. The northwest branch is heavily forested with little housing development. Yet slopes in this portion of the subwatershed are quite steep and soils are easily erodible. This leads to sedimentation problems in this tributary during heavy rains, but erosion channels were not readily apparent. Much of the denied areas in this part of the subwatershed are marshy areas with substantial beaver activity, and this may have led to 3 fish migration barriers being noted. Access to the other stream segments was so

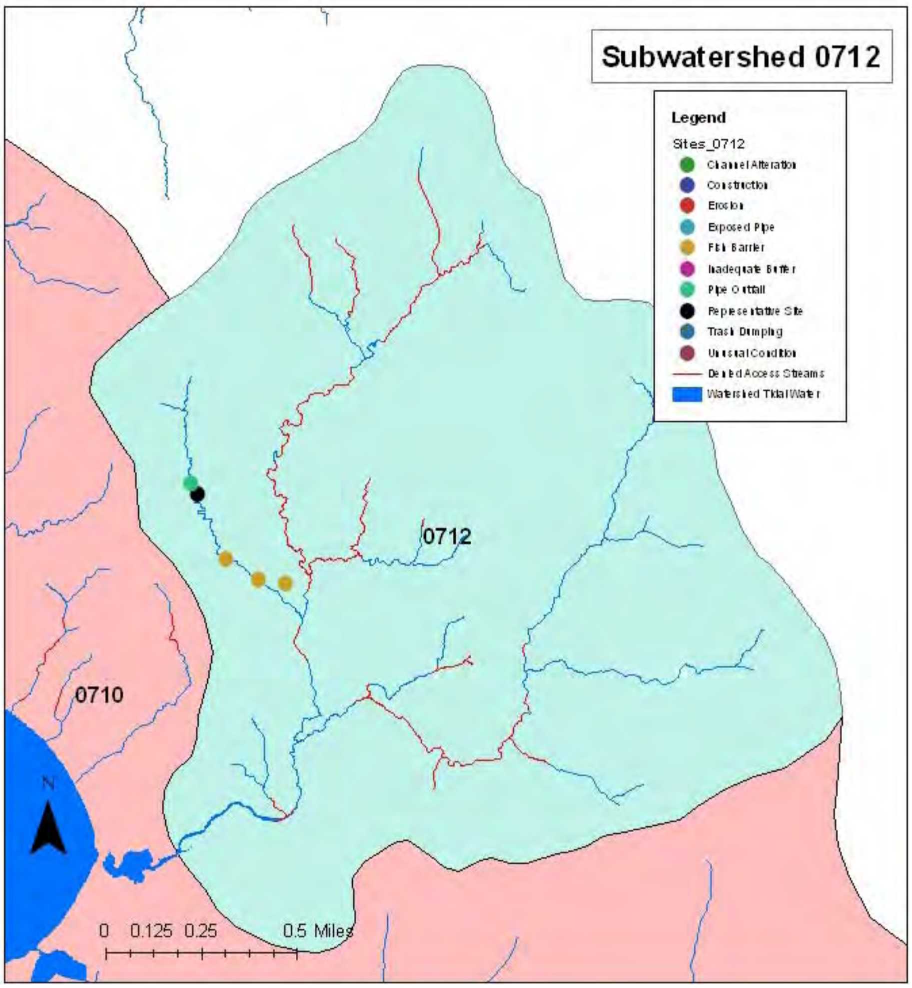

Figure 7. Problem and representative sites in subwatershed 712- Fishermans Creek.

limited, either by land owner denial or by posting, that it is difficult to draw conclusions about this subwatershed. We know that the streams that enter Fishermans Creek and discharge into the St. Mary's River carry very heavy sediment loads, as the tidal river is extremely murky following heavy precipitation events and spates.

Subwatershed 713- Craney Creek

Craney Creek watershed (Figure 8) is quite small, has less than 3% of the total stream miles in the entire watershed, and until recently was a large tract of undeveloped farmland. But within the last 10 years, rapid development of large single family housing area has taken place in the subwatershed, and this development included stream crossings by roads. While there are fairly wide buffers between the development and Craney Creek, slopes are steep, and there was some visual evidence of storm water wash into the stream and rather severe erosion in some of the stream's seasonal channels.

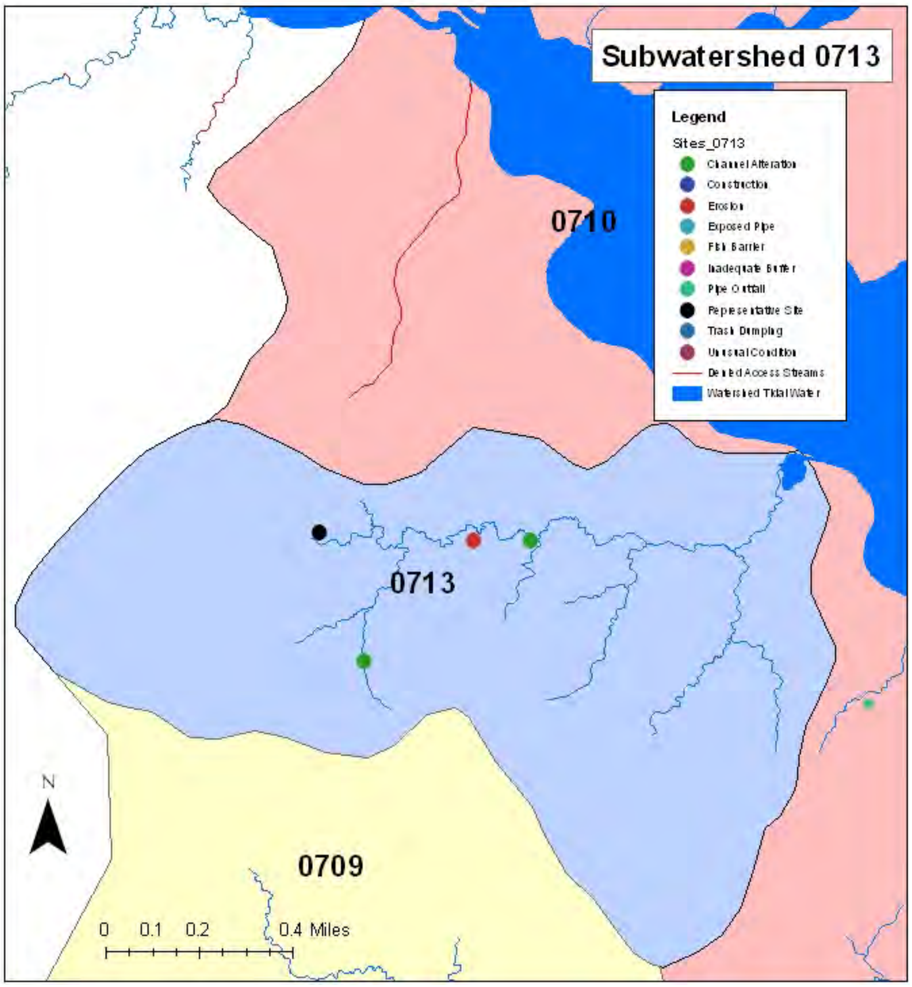

Figure 8. Problem and representative sites in subwatershed 713- Craney Creek

Yet, Craney Creek has only 3 problem sites (2 channel alterations and 1 erosion site) and we included a single representative site. For the most part the subwatershed's streams are in relatively good condition, but additional build out in the development may further impact Craney Creek.

Subwatershed 714- Johns Creek

Johns Creek subwatershed is a narrow piece of land that runs a considerable distance next to State Route 5. Johns Creek itself runs west to East before reaching the St. Mary's River and has a substantial number of problems clustered around the mid point of it's course (Figure 9). In addition, another unnamed tributary in the northeastern corner of the subwatershed had a good number of problems. In total Johns Creek watershed had 33 problem sites, the most of any subwatershed in the study. This is particularly alarming because this subwatershed accounts for 13% of the total river miles in the watershed.

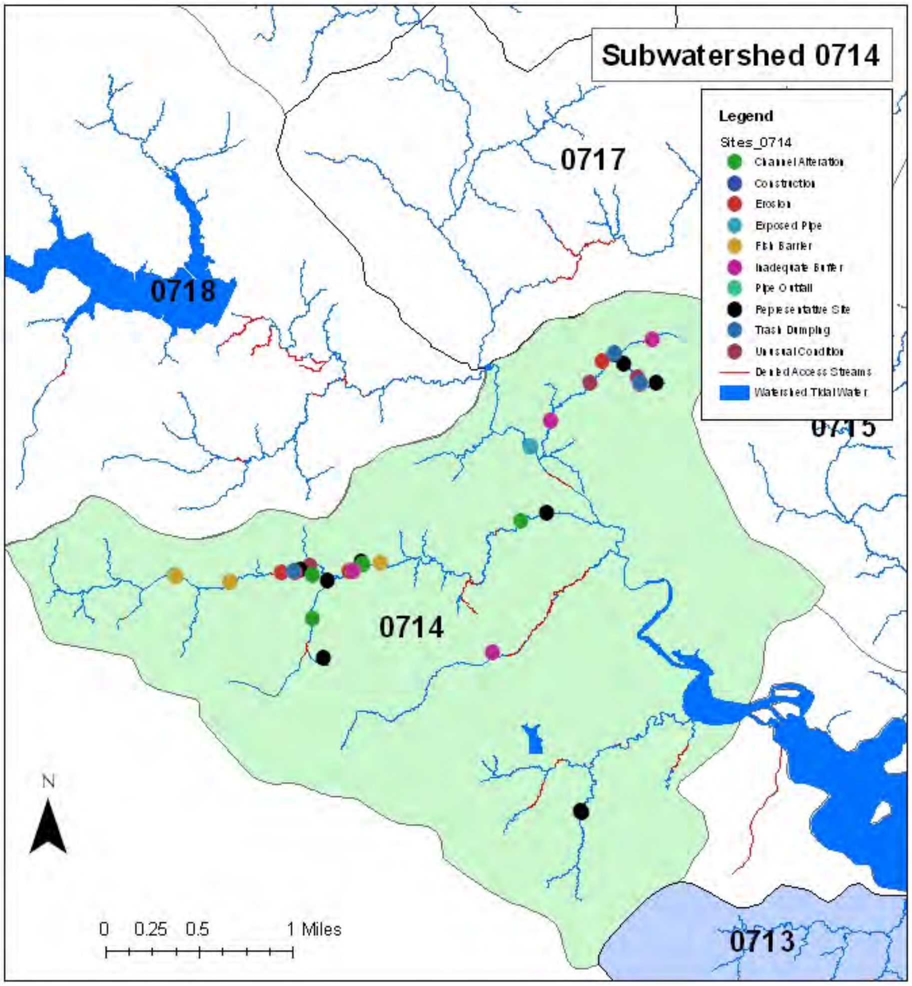

Figure 9. Problem and representative sites in subwatershed 714 - Johns Creek.

Yet, other subwatersheds with equivalent percentages of river miles (subwatersheds 710 and 716) had substantially fewer problems compared to Johns Creek. Channel alterations (6 sites) and erosion (7 sites) predominated, but there were also strong instances of trash dumping and inadequate buffers (5 sites each). Johns Creek had the most unusual conditions (4 sites) and instances of trash dumping of any subwatershed. It is fairly clear that this subwatershed is the most impacted of all those studied, and that it might be the most likely candidate for restoration actions.

Subwatershed 715- Hilton Run

Of all the subwatersheds in the St. Mary's River watershed, Hilton Run is the best studied. It has been the source of several extensive studies by St. Mary's College students, fish surveys by DNR personnel, and it has been a representative site for the St. Mary's River Project's water quality monitoring for nearly 10 years. In addition, Hilton Run was the subject of a subwatershed management plan written in 2002 and revised in 2005 by the St. Mary's River Watershed Association (SMRWA). In short, we know quite a bit about Hilton Run.

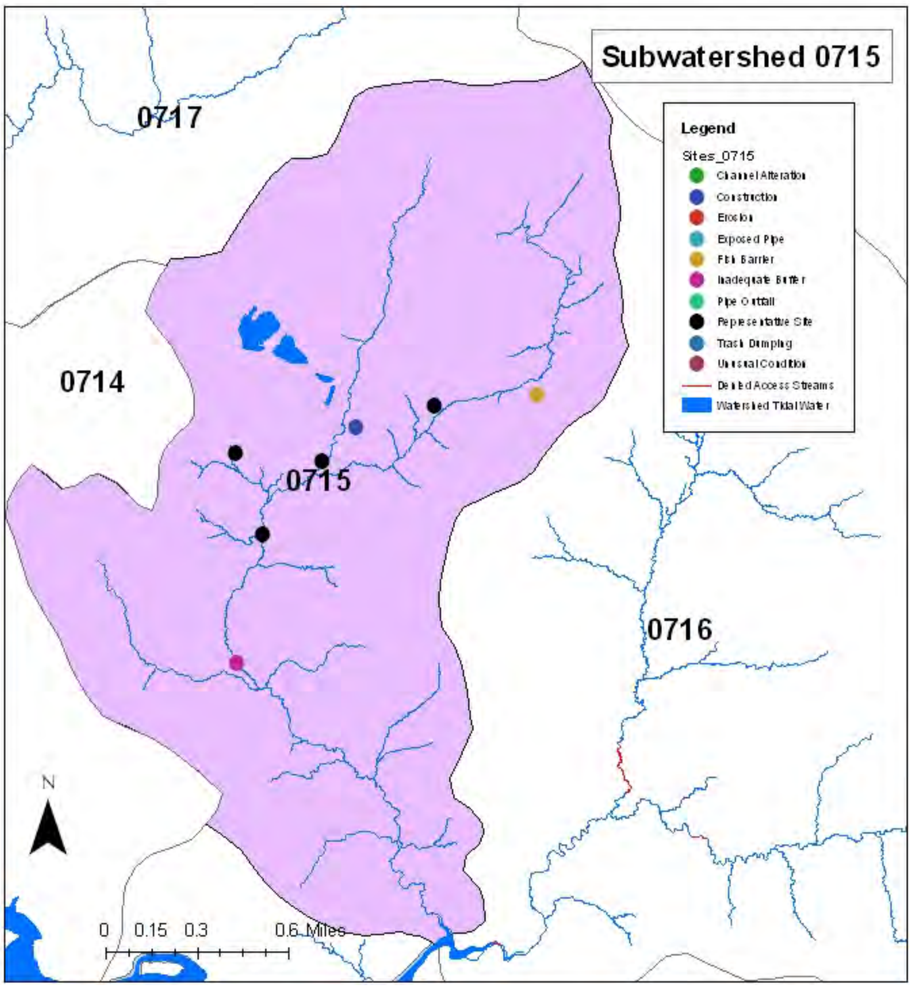

Figure 10. Problem and representative sites in subwatershed 715 – Hilton Run.

The subwatershed is relatively small with only 7.3% of the total watershed stream miles (Figure 10). Its headwaters are located in the Lexington Park Development District, but we found no major problems there during our stream characterization. Only 3 problems were noted, one construction site, one inadequate buffer, and one fish barrier. Here is substantial beaver activity in the central part of the subwatershed.

Subwatershed 716- Pembrooke Run

Like Hilton Run, Pembrooke Run has its headwaters in the Lexington Park Development District; however, the impacts not seen as a consequence of imperviousness in Hilton Run were readily apparent in Pembrooke Run. This could be due to multifamily dwellings, and intense single family development near the stream channels. In addition, a small business park with a substantial amount of impervious surface is located near the first and second order streams of this subwatershed.

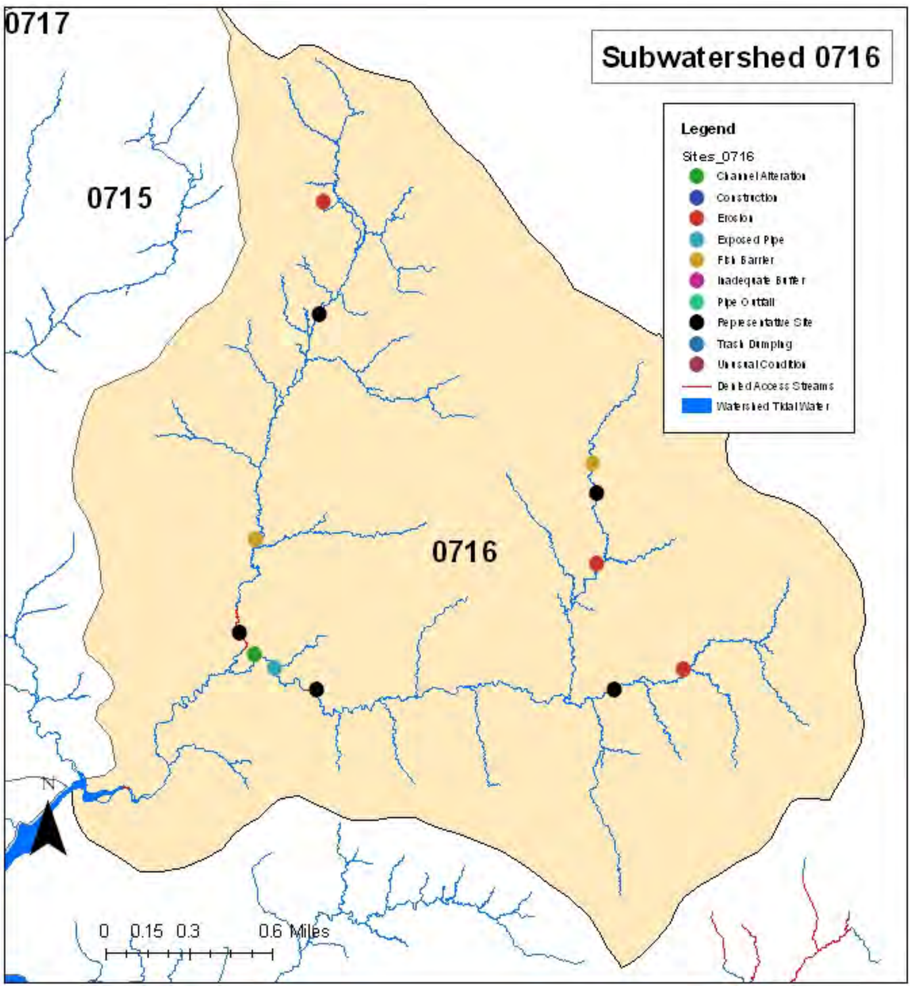

Figure 11. Problem and representative sites in subwatershed 716 – Pembrooke Run

Pembrooke Run has two major branches (Figure 11). The northern branch flows from the development district while the eastern branch flows through a mix of land uses, but primarily single family dwellings of moderate density. The primary problem in the subwatershed is erosion with 3 problem sites, followed by fish barriers (2) and one each of channel alteration, exposed pipe, and a construction site.

Subwatershed 717- Eastern Branch

The Eastern Branch of the St. Mary's River lies directly to the east of Western Branch subwatershed (718) and has its headwaters in the Lexington Park Development district. In general its topography is gently rolling and has land uses which are primarily farming and low density residential. The watershed is also characterized by large wood lots and rather extensive forest tracts that are associated with St. Mary's River State Park. Within the Eastern Branch subwatershed, the survey teams took a fairly large number (13) of representative sites compared to the 15 problem sites that they found (Figure 12). The problem sites were spread along the two branches of the subwatersheds stream. The northern branch had the most representative (11) and problem (11) sites compared to the eastern branch and main stem (3 representative and problem sites). The primary

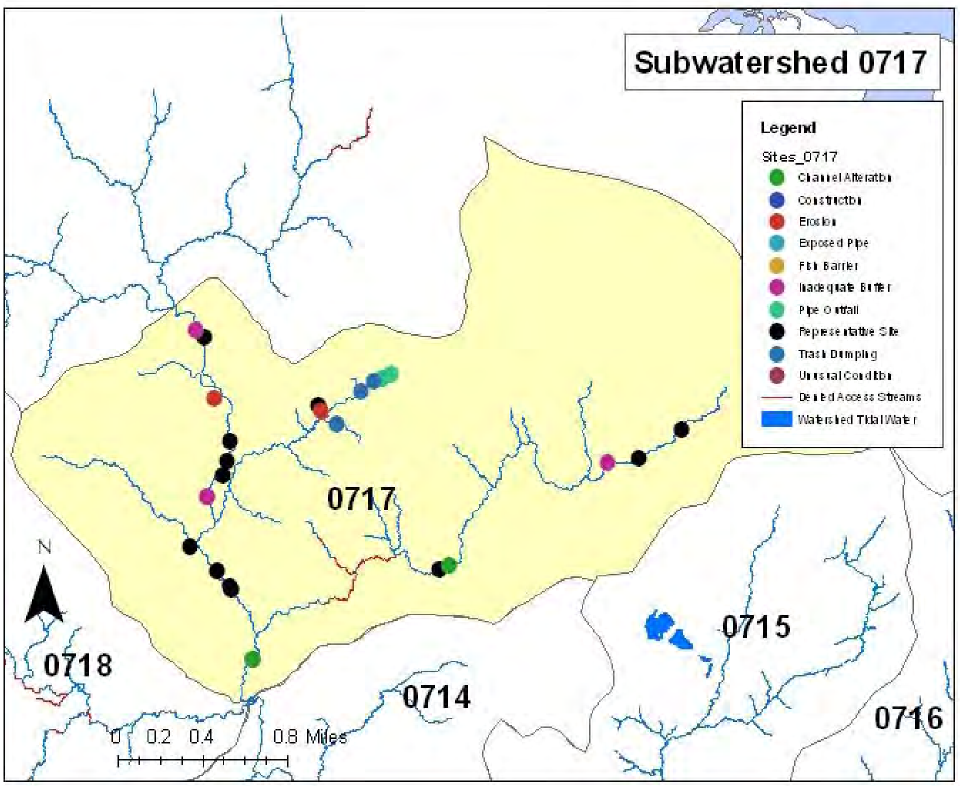

Figure 12. Problem and representative sites in subwatershed 717 – Eastern Branch.

problems found in the Eastern branch were 3 erosion sites and 3 inadequate buffers. There were also 2 each pipe outfalls, channel alteration, and trash dumping sites. Most of these were isolated in a small first order tributary in the northern tributary of Eastern Branch.

Subwatershed 718- Western Branch

The Western Branch (subwatershed 718) was quite similar to subwatershed 717 (Eastern Branch) in terms of representative and problem sites, yet the Western Branch has almost

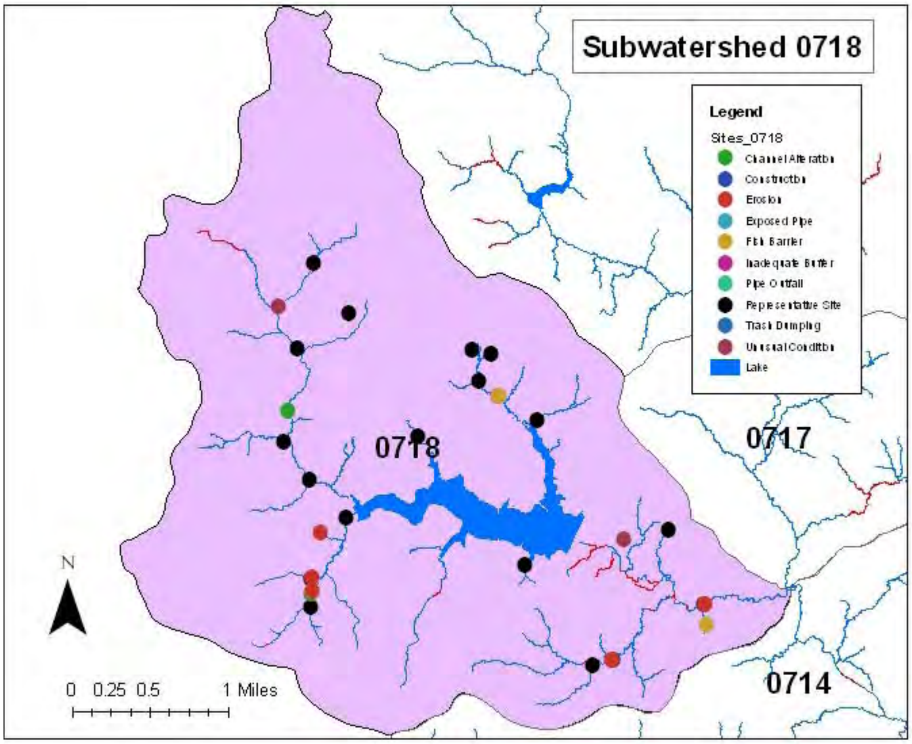

Figure 13. Problem and representative sites in subwatershed 718 – Western Branch.

5 miles more stream miles than the Eastern Branch. This is interesting because both of these subwatersheds have wooded tracts that are a part of the St. Mary's River State Park. The Western Branch subwatershed is in the western most extent of the St. Mary's River watershed, and it unique in that it contains St. Mary's Lake within the state park. Much of the land to the west and north of the lake is within the state park, is difficult to access, and is extensively wooded. In terms of disturbance, this area is perhaps the least disturbed portion of the entire St. Mary's watershed.

There were slightly more representative sites (18) than problem sites (13) in this subwatershed, and this indicated to us that the Western Branch was relatively undisturbed. Both representative and problem sites were dispersed across the subwatershed (Figure 13). Erosion (6 sites) and fish passage barriers (3 sites) were the primary problems noted by the field teams. But there were also 2 channel alterations and 2 unusual conditions noted in this subwatershed.

Because both Eastern and Western Branches are of similar size and because they contain a similar number of representative and problem sites, they seem to clump together as large subwatersheds with moderate numbers of problems. They also seem to be the most similar of all the watersheds in the St. Mary's River watershed, with the possible exceptions of the very small subwatersheds (711, and 713), and those that are slightly larger (712, 715, and 716).

Subwatershed 719- Upper St. Mary's River

The Upper St. Mary's River subwatershed is an interesting and diverse subwatershed. Its headwaters contain the St. Mary's County airport, commercial development, high and medium density housing developments, as well as parts of the St. Mary's River State Park in the south. A substantial part of the subwatershed is located in the Lexington Park Development District as the northern boundary of the subwatershed is bounded by State Route 235, the major, 6-lane traffic artery in the county.

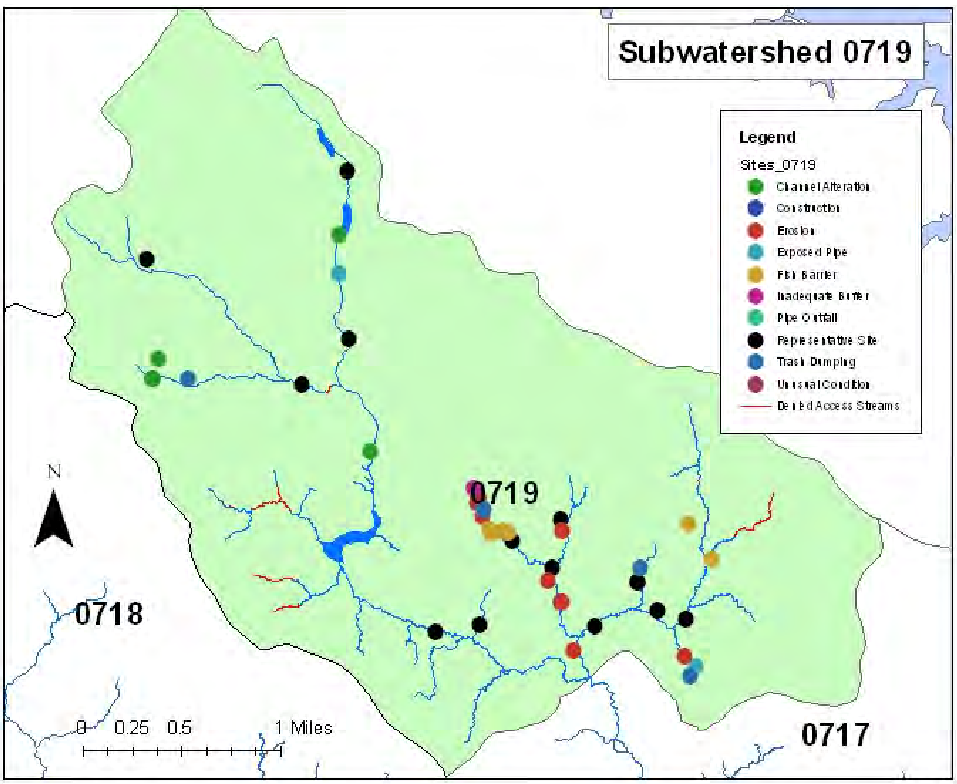

Figure 14. Problem and representative sites in subwatershed 719 – Upper St. Mary's River.

The Upper St. Mary's River has many (27) problems and was second only to subwatershed 714, Johns Creek. This was anticipated as this is by far the fastest urbanizing area in the watershed and the county. Commercial and many types of housing density are leading the development and impervious surface development is increasing a very fast rate in this subwatershed. Problems were concentrated in the southeastern portion of the subwatershed, and others (mostly stream channel alterations and exposed pipes) were located in the northwestern part of the subwatershed (Figure 14). There were many (7) erosion sites and fish migration barriers (6) and well as trash dumping (5 sites) all within 1 mile of each other. Clearly, this was the largest concentration of diverse problem sites of any encountered in this survey. These occurrences also indicate that these problems may be localized and addressed through a localized restoration effort.

SCA Results by Problem Type

Table 4. Summary of problem and representative sites in the St. Mary's River watershed by problem type.

Identified Problem	Number of Sites	Very Severe	Severe	Moderate	Low Severity	Minor	Unknown
Unusual Conditions	8	3	0	1	0	3	1
Exposed Pipe	4	1	0	2	0	0	1
Pipe Outfall	8	0	1	0	2	2	3
Construction Site	2	0	1	0	0	1	0
Channel Alteration	22	1	4	3	8	6	0
Erosion	29	1	4	11	11	2	0
Inadequate Buffer	14	1	1	4	3	5	0
Fish Barrier	19	3	4	7	3	2	0
Trash Dumping	13	0	0	2	5	6	0
Representative Sites	98						
Total	217	10	15	30	32	27	5

We also analyzed our stream characterization results by their type and their severity (Table 4). Of all the problems (119 total), the unusual conditions category had the most serve occurrences (3 sites out of 8 total sites), but these rankings could be misleading and arbitrary as there were no standards specified in the SCA protocols for unusual conditions. While erosion was the most frequently encountered problem type, most of these problems had a moderate to low severity ranking, and a similar trend was noted for the second-ranking channel alterations. Fish barriers seemed to be the second most severe problem in the watershed after unusual conditions.

Unusual Conditions

The survey teams recorded unusual conditions when a problem that did not fit into any other categories was identified. In the St. Mary’s River watershed there were a total of eight unusual conditions. This included two man made ponds, two power lines in the stream, one ATV track, one beaver dam, an underground tributary, and a road that was built right through a stream. The severity rankings for these sites were relatively arbitrary and are pending further investigation (Figure 15).

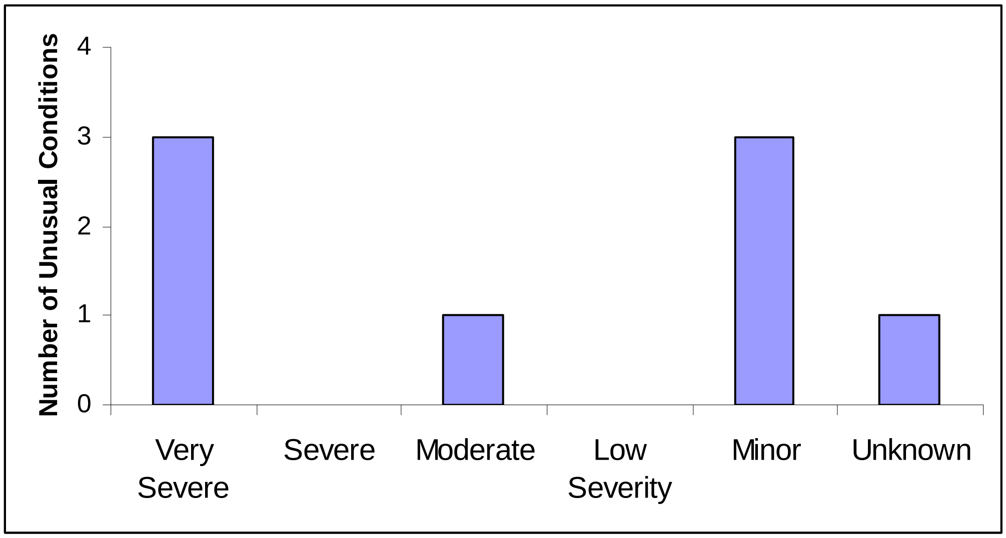

Figure 15. The frequency of unusual conditions with each severity ranking.

Exposed Pipe

Exposed pipes are any pipes in the stream or along the banks that could be damaged by a high flow event. This includes manhole stacks in or along the edge of the stream channel, pipes that are exposed along the stream banks, pipes that run under the stream's bed and have been exposed by stream down-cutting, and pipes that are built of a stream but are low enough that they could be affected by occasional high storm flows (Yetman, 2000).

Gravity sewer lines that depend on the downward slope of the pipeline to move refuse are commonly found by streams as they are located at the lowest topographic point. Engineers also build lines parallel to stream to collect the refuse from adjacent neighborhoods. This can result in problems as the pipelines are stationary, but the streams move. Over time, pipes can become exposed or be punctured by debris in the stream. They can also discharge their contents into the stream creating a water quality problem.

In this survey of the St. Mary's River watershed we discovered only 4 exposed pipes because there are relatively few urban areas immediately adjacent to watershed streams. The pipes that were discovered did not have any discharge with strange colors or odors. Two of the pipes were exposed along the stream bottom, while the other two were exposed along the stream bank. The severity ranking of these pipes reflects their exposed lengths. Two were moderate with 8 and 30 feet exposed, and the other two were minor with only 2 and 3 feet exposed.

Pipe Outfall

Pipe outfalls include any pipes or small manmade channels that discharge into the stream. This is different from an exposed pipe in that the end of the pipe directly empties into the stream. It also includes pipes with openings outside of the immediate stream corridor, but which discharge into a channel which enters the stream eventually. These pipes are a potential environmental problem because they can introduce pollutants such as oil, heavy metals, and nutrients into the stream corridor (Yetman, 2000). They can also carry uncontrolled runoff. The Clean Water Act requires state and local governments to address these non-point pollution sources.

In the St. Mary's River survey, special attention was paid to pipes that had discharges. Half of the eight discovered pipe outfalls had discharges. One of the pipes had a brown discharge was also accompanied by a musky odor. It was assumed that most of these pipes were part of a storm water system, but further scrutiny by a professional is required to determine their real origins. Figure 16 shows the severity distribution of all the pipe outfalls. The unknown severities were a result of the survey team not knowing if the discharge was a significant problem.

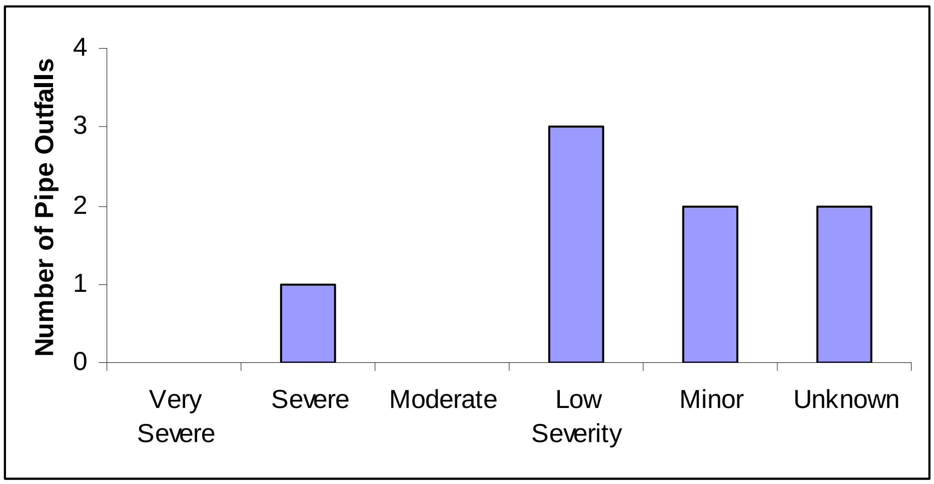

Figure 16. The frequency of pipes with each severity ranking.

Construction Site

In or near stream construction was only found two times in the SCA survey of the St. Mary's River watershed. One of these sites was ranked a two (severe) and the other was ranked as a five (minor). The first of these sites was a residential development with absolutely no sediment control. This resulted in excessive sediment being deposited downstream.

In contrast, the second site was a residential development with adequate sediment control. There was a black staked fence surrounding the construction site in an effort to minimize the impact on the stream. While the construction company seemed to be doing all it could to contain sediment, there was still sediment deposition up to 500 feet downstream. As these construction sites are temporary, it is highly unlikely that they will still be in progress when their impact can be addressed. New construction sites in the watershed will have to be monitored as they arise.

Channel Alteration

Channelization refers to the practice of dredging, straightening, or widening stream channels in an attempt to lower the ground water table or reduce flooding (Yetman, 2000). It was initially thought to be a benefit to the stream because it would increase hydraulic capacity during floods by increasing the slope of the water to move it faster. Channelization would also reduce the roughness of the stream channel for the same purpose. In the case of adjacent wetlands or croplands, it could be used to drain these areas when the water table was lowered.

All of these potential benefits are outweighed by the destruction that channelization has on the ecosystem. These streams have an incredibly poor in-stream habitat for aquatic organisms due to their lack of vegetation and hiding places. Channels can also be a barrier to fish migration when they are too shallow, they are raised too high, or when they sun heats the stream so much during the day reducing it oxygen holding capacity.

In the context of the SCA survey, a channelized stream is one that has been altered for at a least a continuous fifty foot stretch. This could have been accomplished by building a traditional concrete channel or by creating a steep straight slope. The strongest indicator of channel alteration is when the meandering pattern is broken. Channel alteration does not include a road crossing unless a significant amount of stream channelization has occurred either up or down stream of the crossing (Yetman, 2000). The channel alteration category does not include recent stream restoration projects.

The survey teams found a total of 22 channel alteration sites in the St. Mary's River watershed. Most of these alterations manifested themselves as concrete, but there was also rip-rap, metal pipes, plastic, steel pipes, and PVC pipes. All but one of these exhibited perennial flow and most had sediment deposition. In only four cases was there vegetation in the channel. The vast majority of channelizations were found below road crossings, and there was a wide range of severity throughout the watershed (Figure 17).

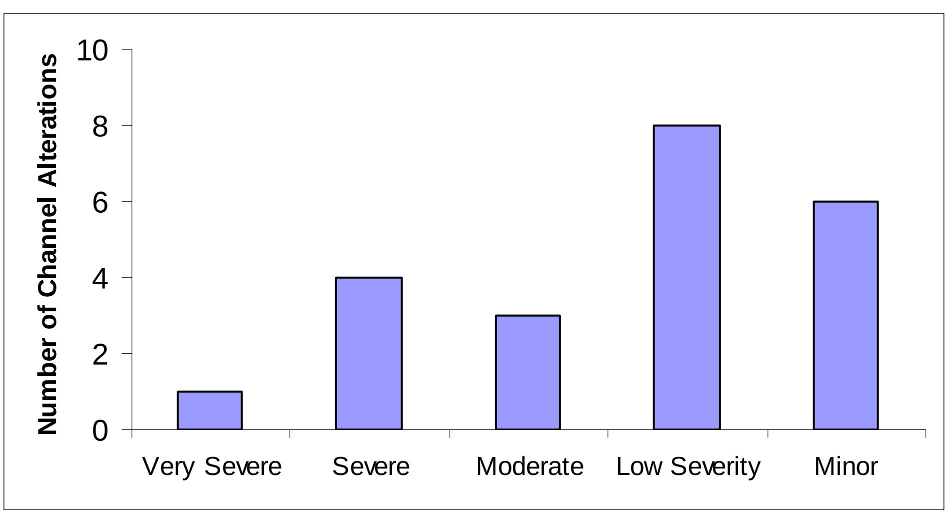

Figure 17. The frequency of channelization with each severity ranking.

Erosion

Erosion is a natural process necessary for streams and their biota, but too much erosion can have a negative effects. Excess erosion can destabilize stream banks and destroy in-stream habitat causing significant sediment pollution problems downstream. Severe problems occur when a stream's hydrology or sediment supply have been altered. This often occurs when land use in a watershed changes. Urbanization calls for the construction of many impervious surfaces which increases runoff to the stream. The stream channel with adjust over time to new flows by eroding the stream bed further and increasing channel size. Over many years, erosion will cause huge quantities of sediment deposition and deplete aquatic resources.

Since erosion is a natural process, it is also incredibly common. This is reflected in the 29 erosion sites that were found in the survey, and these outnumber all other problem types (Figure 18). In reality, almost every foot of stream exhibited signs of erosion, but in many cases the erosion was very minor and not worth mention. Almost all of these problems were caused by a bend in the course of the stream at a steep slope. There were also four erosion sites caused by a fragile bank, one caused by channelization, and one where the cause was unknown. The land use on all but two banks was forests with the two exceptions being a lawn. None of the erosion sites were a threat to any infrastructures.

Figure 18. The frequency of erosion sites with each severity ranking.

Inadequate Buffer

Forested buffers are important to maintain a healthy stream environment. They contribute to good water quality, counteract eutrophication, and intercept sediment and nutrients (Yetman, 2000). When buffers are located by croplands, they can prevent the bioaccumulation of pesticides in organisms. Buffers can also provide habitat and, subsequently, increase biodiversity.

The roots of trees can stabilize stream banks and prevent erosion while the leaves shade the stream decreasing water temperature. Cooler water holds more dissolved oxygen and is crucial for many species. Riparian buffers and their shady leaves also play a critical role each autumn as the deciduous leaves fall into the stream and enter the benthic cycle. They become a food source for macroinvertebrates.

This survey identified 14 sites that had inadequate buffers. None of these were recently established, and only one had livestock present. In most instances the streams lacked a buffer on both the left and right banks. The land use was variable and included forests, pastures, power lines, small trees, lawns, wetlands, and crop fields. As with the other problem types, most of the inadequate buffer sites were of minor or moderate severity (Figure 19).

Figure 19. The frequency of inadequate buffers with each severity ranking.

Fish Barrier

A fish barrier is any blockage that prevents fish from migrating upstream. These barriers are harmful to anadromous fish that must return to non-tidal streams to spawn. Some of these fish species native to Maryland include white perch, blueback herring, American shad, and yellow perch (Yetman, 2000). Blockages are also important for fish that spend their entire lives in the stream but need to move up and down stream throughout their life cycle.

If a fish blockage is present in a tributary and a particular fish species dies out in that tributary, then it is impossible for other members of that species to repopulate the affected area. Some severe blockages can also create large areas of marshland behind them when the water backs up. These blockages may include beaver dams, man-made dams, road crossings, channelized regions or waterfalls.

Each of these types can be a blockage for different reasons. There could be a high vertical drop that the fish can not swim up or the water is too shallow so they cannot swim through it. In this survey nine were too high, five were too fast, and five were too shallow. Additionally, if the water is moving too fast the fish may not be able to build up enough power to make it upstream. The severity of these blockages created a bell curve with most sites of moderate severity and few very severe or minor (Figure 20).

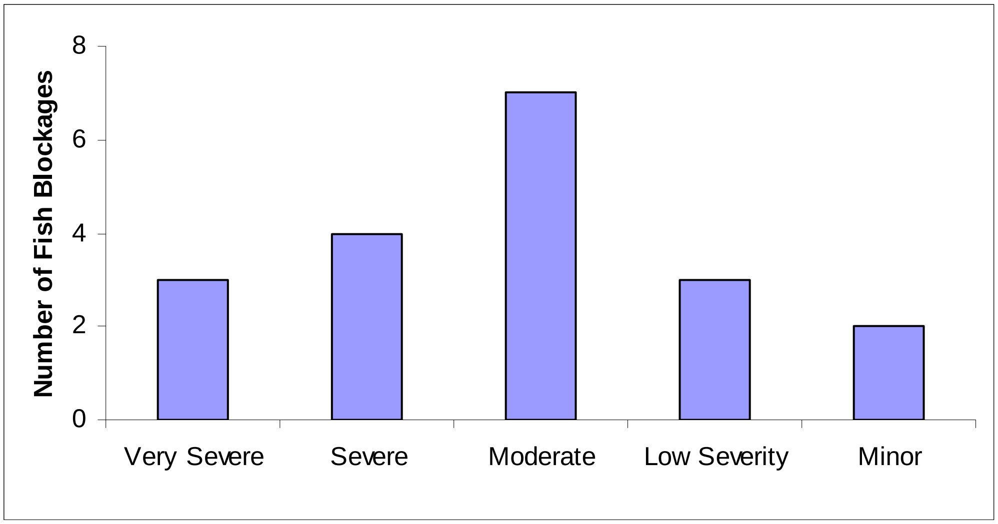

Figure 20. The frequency of fish blockages with each severity ranking.

Trash Dumping

Trash dumping sites include both sites where there is a considerable amount of trash and sites that have the potential to collect a large amount of trash. This accumulation can either be due to nearby residential areas or storm drainage. In the SCA survey of the St. Mary's River watershed there were only moderate and minor trash dumping sites which made the severity rankings skewed to the right (Figure 21).

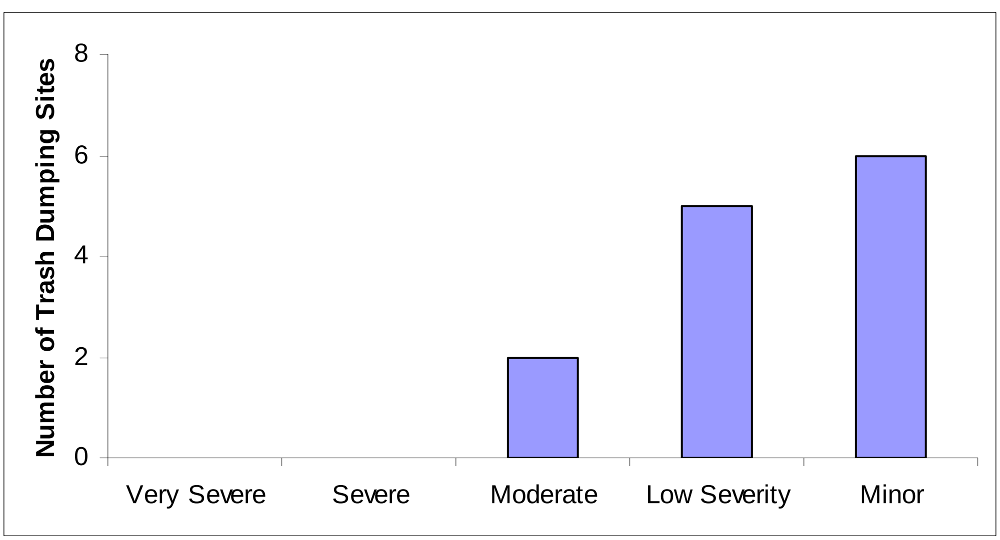

Figure 21. The frequency of trash dumping sites with each severity ranking.

Representative Sites

The SCA survey crew recorded representative sites at approximately one mile intervals to document the general condition of the streams. This was predominantly done in areas where few problem sites were identified for a total of 98 sites. At each site, ten categories were ranked as optimal, suboptimal, marginal, or poor. These categories were:

- attachment sites for macroinvertebrates
- embeddedness
- shelter for fish
- channel alteration
- sediment deposition
- velocity and depth
- channel flow status
- bank vegetation protection
- condition of banks
- riparian vegetation zone width

In addition to each of these habitat rankings the wetted width and depth was recorded for riffles, runs, and pools. The type of bottom sediment is also noted as silt, sand, gravel, cobble, boulder, or bedrock.

Unlike all of the other problem types, representative sites have no severity ranking. They provide an overall assessment of general watershed condition and can be used to identify potential restoration sites. They can also identify areas that are in pristine condition and can be targeted for preservation. Each of the 98 sites was variable and unique, but the sites throughout the entire watershed did exhibit some general trends. At almost every site, both bank vegetation and riparian vegetation were optimal. Channel alteration and channel flow were also frequently optimal. At the other end of the spectrum, embeddedness was often substandard due to the high frequency of silt bottoms in the watershed.

Results- TIDAL SHORELINE ASSESSMENT

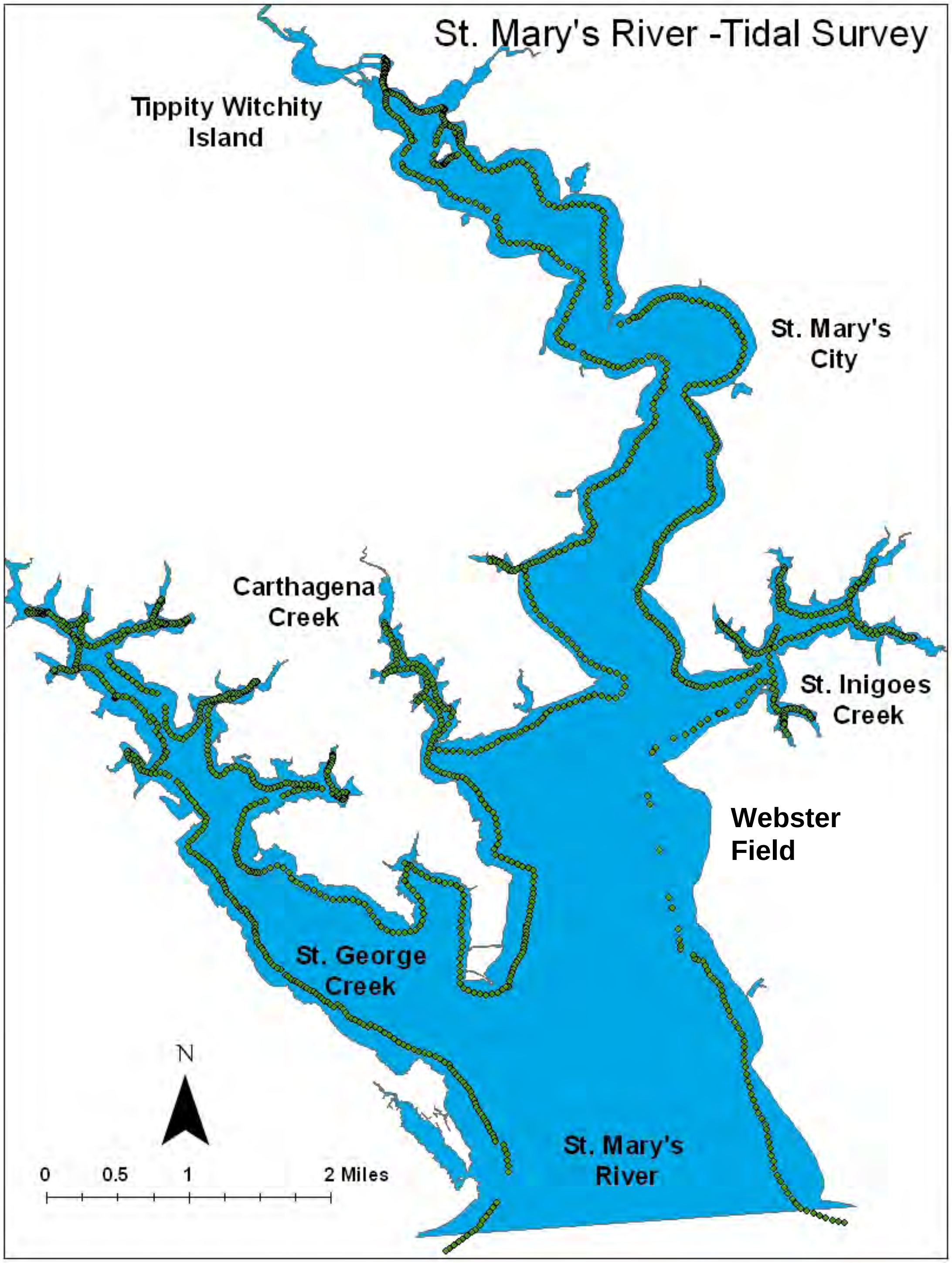

Figure 22. Tidal shoreline of the St. Mary's River with the track of the survey vessel indicated by the green markers. These green markers correspond to GPS-referenced, edited photographs of the shoreline.

We were able to obtain 1596 geo-referenced photographs of approximately 85 miles of the tidal St. Mary's River's shoreline (Figure 22). Photographs were organized and numbered by the date of the cruise in which they were obtained. Some photographs taken on the 17 cruises were redundant, some were edited by security personnel at Webster Field (Naval Air Station Patuxent River's Annex), and others were replaced because of clarity. We are including these photographs and their shapefile translations, along with their projections in ArcMap 9.2 maps on a compact disk submitted with this final report.

The shoreline of the tidal portion of the St. Mary's River is mainly comprised of private, residential lands. Also along the River are some areas of farmland, small commercial ventures such as marinas, Webster Field, and St. Mary's College of Maryland. The most densely populated section of the river is St. Inigoes Creek, closely followed by the south side of St. George's Creek. The principle problems on the River appear to be inadequate buffering, and erosion (Figure 23).

Inadequate buffering is principally a problem on a very small scale at residential sites where natural vegetation has been removed for habitations and to improve water views from buildings. On a larger scale the same problem is present at farm sites on St. George's Creek (Images 866-886) and on the eastern shore of the river just south of Tippity Witchity Island (Images 159-160), as well as along the College's waterfront property (Images 216-227) and along the shoreline of Webster Field (Images 1773-1789), for example. The most serious residential example of inadequate buffering occurs at the property on Portobello Point (Images 583-590).

Overall, the majority of erosion problems on the River have been neutralized by corrective action such as bulk heading or revetment with rip rap. For example, south of St. Mary's College's dock, a wooden bulkhead has been used to retain a steep bank, and strategic placing of rip rap on the shoreline between Historic St. Mary's City and Chancellor's Point has created small artificial wetlands, and this has stopped the erosion of banks several meters high. In some places, erosion is still an issue. Along the St. Mary's College waterfront, sand bags and black plastic sheeting are being used to retain an eroding bank close to one meter high (Image 223). A similar bank was seen and photographed with both serious erosion and an inadequate buffer on the north shore of St. George's Creek, where no control structures are in place (Images 866-886).

Another erosion site exists on the up-river side of Tippity Witchity Island (Images 1,4,6,48-52). While fairly sheltered, and, by the appearance of flora on the bank, not eroding rapidly, this bank is approximately two meters high. A similar erosion site appears on the southern shoreline in the bend above Pagan Point. Here, a long lawn down to the river ends in a bank several meters high which appears to be actively eroding into the river (Images 658-661).

The most severe erosion site on the river is located on the western shore across from Chancellor's Point. At this site, an inadequate buffer has resulted in the erosion of a bank

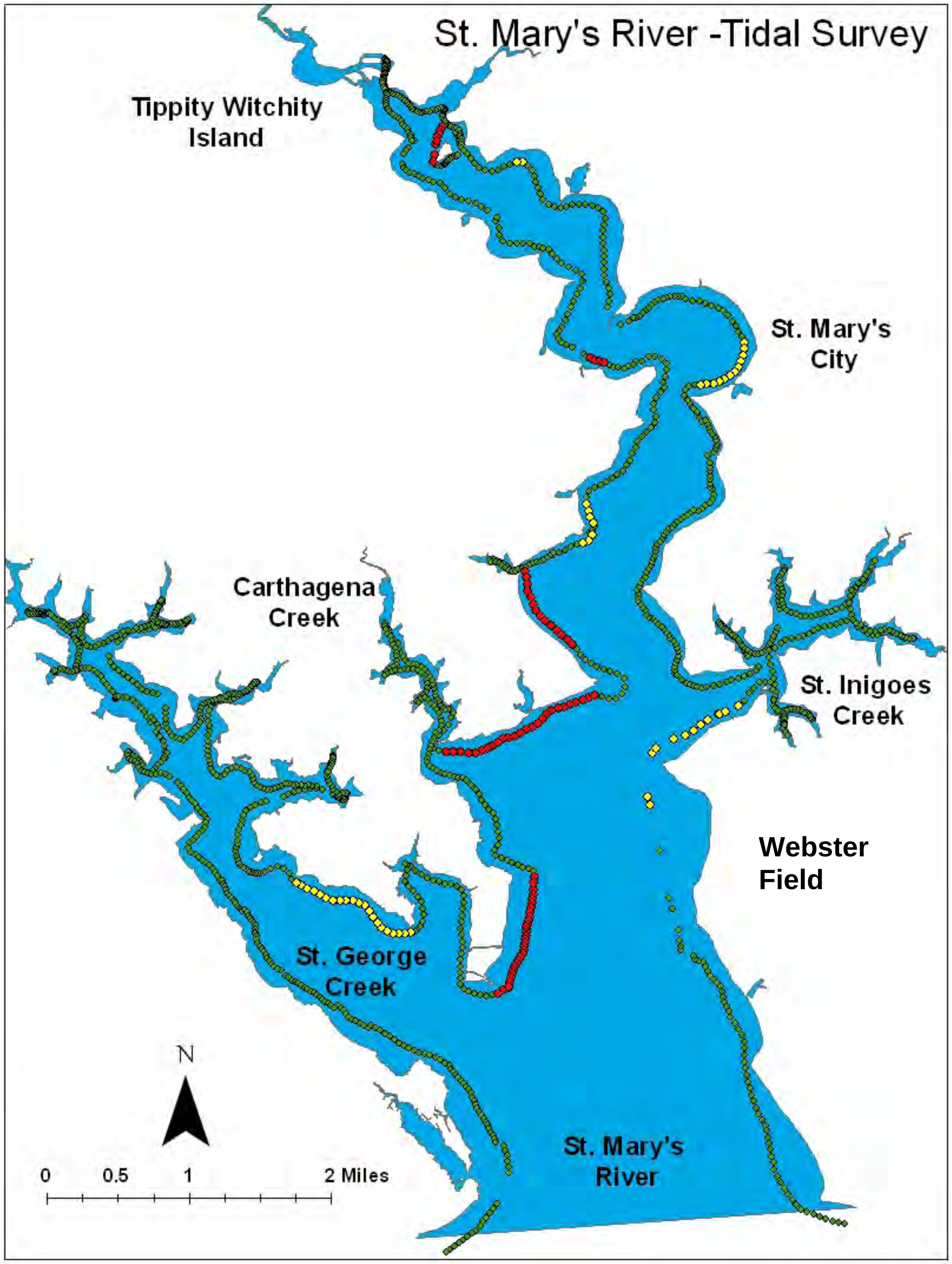

Figure 23. Tidal shoreline of the St. Mary's River with an assessment of shoreline stability. Green markers indicate stable shoreline, red markers show shoreline erosion sites, and yellow markers show shoreline segments without correspond to geo-referenced photographs of the shoreline.

approximately 4 meters high and several hundred meters long (Images 623-636). A similar problem may be seen around the point to the south, where a bank approximately 2 meters high and several hundred long is eroding between the green number 3 channel marker and Carthagena Creek (Images 651-676).

Just north of St. George's Creek on the western shore is a long low peninsula of undisturbed land. While no obvious eroding bank exists here, a number of fallen trees along the shoreline indicate a consistent pattern of erosion. The fallen trees are acting to some degree as a barrier for the shoreline, helping to slow the erosion (Images 799-820 & 1413-1441).

While much of the St. Mary's River shoreline is protected and is not in danger of drastic erosion, the problems sites noted in this survey might be addressed by the WRAS Steering Committee. These restoration projects might use the model of the rip rap - living shoreline used on the public lands (Historic St. Mary's City) in the middle portion of the tidal reach of the river.

Discussion

The results of the St. Mary's River SCA survey pinpoint the observable environmental problems in the watershed and summarize them according to relative severity, correctibility, and access. The problem sites offer targeted areas for restoration, while the representative sites highlight potential preservation area.

In this survey the most commonly reported problems were erosion sites and channel alterations. Most of the streams in this county were incredibly healthy as most of the land area is protected by forest. These healthy streams have natural meanders which caused most of the reported erosion sites because 80% of these problems were due to a river bends at steep slopes. The commonality of channel alterations was due to the fact that many of the road crossings that we encountered have channel alteration either below or above them.

The other potential problems included 4 exposed pipes, 8 pipe outfalls, 2 construction sites, 14 inadequate buffers, 19 fish barriers, 13 trash dumping, and 8 unusual conditions. Most of these were of minor severity except for a few fish barriers and unusual conditions. Three of the fish barriers were so severe that the stream was dammed and had turned into a marshland upstream. The most severe of the unusual conditions included two sites where power lines were in the stream and a site where a road had been built directly through a stream.

The most notable of the trash dumping sites was a sealed industrial drum in the stream. The exposed pipes and pipe outfalls that had discharge were the most noteworthy of their kind and occurred at three sites. Both of the construction sites exhibited major sediment deposition, but the construction firms have probably finished their work a long time ago. There were very few and these were minor sites with inadequate buffer because most of the watershed is heavily forested.

The 98 representative sites reflected the general healthy condition of the watershed. Most of the land is either undeveloped or in agriculture, so there has been a relatively low human impact on the entire ecosystem. In looking over the entire watershed, problem areas are clustered in specific regions such as in subwatershed 714. When a single problem was found by the survey team, it was likely that others frequently followed.

Overall, the tidal shoreline of the St. Mary's River appears to be in reasonably good shape, yet erosion problems linger and inadequate buffers, to a lesser extent, seem to exacerbate the erosion problems. Our objective was to document potential shoreline restoration sites, to chronicle their severity, and to provide a level of prioritization of these sites.

The SCA survey report is a tool for watershed management. This SCA survey will allow the Watershed Restoration Action Strategy Steering Committee to formulate a strategy that will improve the St. Mary's River and its watershed. With the cooperation of legislators in state and local government, these changes can be implemented.

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Appendix

Table 5. Distribution of problem types between the subwatersheds (S=Severity C=Correctability A=Access).

Site Code	Catchment	Latitude (N)	Longitude (W)	Problem Type	S	C	A
709103	201	38.1590	-76.4960	Representative Site			
709201	301	38.1792	-76.4758	Representative Site			
709202	118	38.1609	-76.4909	Representative Site			
709203	1077	38.1402	-76.4361	Representative Site			
709204	1077	38.1402	-76.4360	Channel Alt	4	3	1
709205	1078	38.1383	-76.4287	Channel Alt	4	4	1
709102	113	38.1717	-76.4933	Inadequate Buffer	1	3	1
709206	1077	38.1400	-76.4320	Inadequate Buffer	3	1	1
709101	113/114	38.1708	-76.4933	Fish Barrier	5	4	1
710214	1091	38.1901	-76.4643	Unusual Condition	-1	-1	2
710101	209	38.1883	-76.4298	Representative Site			
710102	209	38.1856	-76.4272	Representative Site			
710103	1049	38.1716	-76.4235	Representative Site			
710104	1046	38.1800	-76.4217	Representative Site			
710105	212	38.1808	-76.4225	Representative Site			
710106	1108	38.1670	-76.4346	Representative Site			
710107	1029	38.2149	-76.4311	Representative Site			
710110	203	38.2168	-76.4345	Representative Site			
710112	304	38.1752	-76.4068	Representative Site			
710116	203	38.2183	-76.4375	Representative Site			
710201	1041	38.1817	-76.4317	Representative Site			
710202	1084	38.2000	-76.4617	Representative Site			
710205	213	38.1806	-76.4107	Representative Site			
710206	1051	38.1820	-76.4091	Representative Site			
710207	1091	38.1901	-76.4476	Representative Site			
710209	1084	38.1990	-76.4640	Representative Site			
710210	1086	38.1942	-76.4583	Representative Site			
710211	301	38.2160	-76.4460	Representative Site			
710216	301	38.2180	-76.4380	Representative Site			
710217	1105	38.2130	-76.4530	Representative Site			
710109	1029	38.2153	-76.4327	Pipe Outfall	4	-1	1
710208	1086	38.1938	-76.4564	Pipe Outfall	-1	4	1
710111	304	38.1748	-76.4084	Channel Alt	5	5	1
710115	203	38.2167	-76.4350	Channel Alt	3	2	2
710212	1074	38.1698	-76.4054	Channel Alt	4	5	1
710203	1084	38.2021	-76.4617	Erosion	4	3	2
710113	203	38.2150	-76.4335	Erosion	4	3	3
710213	301	38.2170	-76.4417	Erosion	4	5	3
710215	1102	38.2150	-76.4617	Inadequate Buffer	2	2	1
710204	1082	38.2021	-76.4617	Fish Barrier	4	3	2
710108	1029	38.2148	-76.4319	Trash Dumping	4	1	1

Table 5. (continued)

710114	203	38.2164	-76.4337	Trash Dumping	4	2	2
711201	301	38.1620	-76.3980	Representative Site			
711202	101	38.1562	-76.3897	Representative Site			
711203	101	38.1564	-76.3894	Trash Dumping	3	2	3
712202	203	38.2067	-76.4242	Representative Site			
712201	203	38.2071	-76.4245	Pipe Outfall	2	4	1
712203	203	38.2050	-76.4217	Fish Barrier	2	2	2
712204	203	38.2050	-76.4217	Fish Barrier	2	4	1
712205	203	38.2033	-76.4200	Fish Barrier	3	2	3
713202	301	38.2045	-76.4853	Representative Site			
713201	109	38.2010	-76.4840	Channel Alt	5	3	1
713204	301	38.2042	-76.4770	Channel Alt	4	4	1
713203	301	38.2042	-76.4792	Erosion	5	3	3
714111	117	38.2327	-76.5255	Unusual Condition	5	-1	2
714117	302	38.2314	-76.5334	Unusual Condition	3	3	2
714124	101	38.2471	-76.4932	Unusual Condition	1	5	2
714130	201	38.2467	-76.4978	Unusual Condition	1	5	3
714102	302	38.2328	-76.5203	Representative Site			
714109	206	38.2315	-76.5238	Representative Site			
714112	302	38.2324	-76.5265	Representative Site			
714125	101	38.2482	-76.4945	Representative Site			
714128	102	38.2489	-76.4954	Representative Site			
714134	501	38.2418	-76.5037	Representative Site			
714135	301	38.2556	-76.5096	Representative Site			
714201	206	38.2330	-76.5204	Representative Site			
714204	126	38.2255	-76.5243	Representative Site			
714205	209	38.2134	-76.4989	Representative Site			
714206	1001	38.2135	-76.4990	Representative Site			
714207	501	38.2370	-76.5020	Representative Site			
714133	501	38.2418	-76.5037	Exposed Pipe	5	-1	1
714105	302	38.2322	-76.5213	Pipe Outfall	5	4	1
714104	302	38.2322	-76.5213	Pipe Outfall	5	4	1
714119	302	38.2320	-76.5388	Pipe Outfall	-1	-1	2
714107	302	38.2322	-76.5216	Erosion	3	4	1
714113	302	38.2321	-76.5270	Erosion	3	3	2
714115	302	38.2321	-76.5283	Erosion	4	4	4
714122	101	38.2466	-76.4929	Erosion	3	3	1
714129	201	38.2484	-76.4966	Erosion	2	4	3
714131	201	38.2438	-76.5017	Erosion	2	3	1
714110	302	38.2319	-76.5252	Channel Alt	5	4	1
714108	206	38.2290	-76.5250	Channel Alt	4	5	1
714103	302	38.2322	-76.5213	Channel Alt	5	2	1
714101	302	38.2328	-76.5203	Channel Alt	1	5	1
714120	101	38.2467	-76.4929	Channel Alt	4	4	1
714202	123	38.2360	-76.5050	Channel Alt	4	1	1
714106	302	38.2322	-76.5213	Inadequate Buffer	5	3	1
714123	101	38.2467	-76.4929	Inadequate Buffer	5	1	1

Table 5. (continued)

714126	101	38.2500	-76.4920	Inadequate Buffer	5	2	1
714132	201	38.2438	-76.5017	Inadequate Buffer	4	2	1
714203	129	38.2330	-76.5190	Inadequate Buffer	4	1	1
714116	302	38.2314	-76.5334	Fish Barrier	3	3	1
714118	302	38.2319	-76.5387	Fish Barrier	3	3	4
714114	302	38.2322	-76.5271	Trash Dumping	3	4	3
714121	101	38.2467	-76.4929	Trash Dumping	4	1	1
714127	102	38.2490	-76.4954	Trash Dumping	4	1	3
715202	135	38.2493	-76.4619	Representative Site			
715203	135	38.2467	-76.4687	Representative Site			
715101	301	38.2432	-76.4723	Representative Site			
715103	208	38.2470	-76.4740	Representative Site			
715204	135	38.2483	-76.4667	Construction	2		
715102	301	38.2371	-76.4739	Inadequate Buffer	3	4	1
715201	114	38.2498	-76.4557	Fish Barrier	1	2	3
716201	302	38.2317	-76.4507	Representative Site			
716101	203	38.2483	-76.4453	Representative Site			
716204	109	38.2390	-76.4270	Representative Site			
716105	301	38.2287	-76.4456	Representative Site			
716208	212	38.2286	-76.4259	Representative Site			
716104	301	38.2299	-76.4484	Exposed Pipe	3	1	2
716202	302	38.2366	-76.4496	Construction	5		
716103	302	38.2306	-76.4497	Channel Alt	5	4	1
716102	146	38.2542	-76.4450	Erosion	4	5	4
716206	109	38.2352	-76.4270	Erosion	3	5	4
716207	212	38.2297	-76.4213	Erosion	4	4	3
716203	302	38.2366	-76.4496	Fish Barrier	1	4	2
716205	109	38.2400	-76.4270	Fish Barrier	2	4	3
717110	401	38.2568	-76.5108	Unusual condition	5	1	5
717101	401	38.2787	-76.5139	Representative Site			
717104	401	38.2728	-76.5118	Representative Site			
717106	401	38.2634	-76.5103	Representative Site			
717107	401	38.2568	-76.5108	Representative Site			
717108	102	38.2585	-76.5131	Representative Site			
717109	101	38.2657	-76.5096	Representative Site			
717116	201	38.2680	-76.5020	Representative Site			
717117	201	38.2558	-76.5097	Representative Site			
717119	301	38.2508	-76.5077	Representative Site			
717201	401	38.2643	-76.5099	Representative Site			
717202	401	38.2619	-76.5116	Representative Site			
717204	111	38.2663	-76.4704	Representative Site			
717206	111	38.2640	-76.4740	Representative Site			
717208	202	38.2575	-76.4915	Representative Site			
717209	114	38.2467	-76.4913	Representative Site			
717111	104	38.2702	-76.4956	Pipe Outfall	4	3	1
717113	104	38.2699	-76.4964	Pipe Outfall	4	3	1
717118	301	38.2508	-76.5077	Channel Alt	3	4	1
717207	202	38.2575	-76.4915	Channel Alt	2	4	1
717102	302	38.2769	-76.5159	Erosion	3	3	4
717105	201	38.2686	-76.5109	Erosion	5	2	4

Table 5. (continued)

717115	201	38.2680	-76.5020	Erosion	2	5	2
717103	401	38.2733	-76.5125	Inadequate Buffer	5	4	1
717203	401	38.2619	-76.5116	Inadequate Buffer	4	5	4
717205	111	38.2641	-76.4769	Inadequate Buffer	3	2	1
717112	104	38.2691	-76.4964	Trash Dumping	5	3	1
717114	201	38.2708	-76.4967	Trash Dumping	5	1	2
					-	-	-
718109	135	38.2525	-76.5278	Unusual Condition	1	1	1
718102	201	38.2744	-76.5687	Unusual Condition	1	4	1
718101	201	38.2785	-76.5644	Representative Site			
718103	201	38.2700	-76.5692	Representative Site			
718105	210	38.2533	-76.5225	Representative Site			
718107	401	38.2464	-76.5185	Representative Site			
718201	207	38.2501	-76.5396	Representative Site			
718202	140	38.2700	-76.5430	Representative Site			
718204	127	38.2408	-76.5316	Representative Site			
718206	128	38.2413	-76.5293	Representative Site			
718207	123	38.2620	-76.5527	Representative Site			
718208	212	38.2703	-76.5457	Representative Site			
718209	213	38.2673	-76.5450	Representative Site			
718212	213	38.2660	-76.5430	Representative Site			
718213	204	38.2463	-76.5649	Representative Site			
718216	205	38.2490	-76.5649	Representative Site			
718218	113	38.2546	-76.5607	Representative Site			
718219	301	38.2582	-76.5651	Representative Site			
718220	202	38.2617	-76.5681	Representative Site			
718222	105	38.2737	-76.5603	Representative Site			
718214	205	38.2476	-76.5650	Channel Alt	4	2	1
718221	201	38.2647	-76.5676	Channel Alt	2	1	1
718205	303	38.2412	-76.5294	Erosion	2	5	4
718211	212	38.2683	-76.5383	Erosion	3	5	4
718215	205	38.2479	-76.5648	Erosion	3	5	2
718217	205	38.2491	-76.5648	Erosion	3	4	3
718104	210	38.2533	-76.5638	Erosion	4	5	2
718108	210	38.2464	-76.5183	Erosion	3	5	3
718203	127	38.2386	-76.5185	Fish Barrier	3	4	1
718210	212	38.2665	-76.5430	Fish Barrier	1	3	2
718106	142	38.2440	-76.5180	Fish Barrier	3	4	3
719103	122	38.2878	-76.5248	Unusual Condition	5	3	3
719104	122	38.2881	-76.5246	Representative Site			
719111	122	38.2849	-76.5215	Representative Site			
719112	102	38.3057	-76.5554	Representative Site			
719201	104	38.2819	-76.5099	Representative Site			
719202	123	38.2865	-76.5170	Representative Site			
719204	123	38.2830	-76.5178	Representative Site			
719207	205	38.2804	-76.5170	Representative Site			
719208	124	38.2819	-76.5099	Representative Site			
719210	206	38.2783	-76.5033	Representative Site			
719215	128	38.2798	-76.5080	Representative Site			
719218	301	38.2780	-76.5290	Representative Site			

Table 5. (continued)

719220	120	38.2790	-76.5240	Representative Site			
719222	106	38.3121	-76.5366	Representative Site			
719225	105	38.2998	-76.5366	Representative Site			
719227	103	38.2970	-76.5410	Representative Site			
719229	103	38.2970	-76.5549	Representative Site			
719213	128	38.2742	-76.5033	Exposed Pipe	3	5	3
719224	105	38.3046	-76.5375	Exposed Pipe	5	2	3
719223	108	38.3074	-76.5375	Channel Alt	2	3	1
719226	201	38.2916	-76.5347	Channel Alt	2	3	1
719231	103	38.2984	-76.5544	Channel Alt	5	3	1
719230	103	38.2970	-76.5549	Channel Alt	3	3	1
719102	122	38.2881	-76.5246	Erosion	4	4	4
719106	122	38.2867	-76.5242	Erosion	4	4	4
719203	123	38.2857	-76.5168	Erosion	3	5	5
719205	123	38.2820	-76.5182	Erosion	3	5	5
719206	205	38.2804	-76.5169	Erosion	4	5	4
719216	128	38.2767	-76.5033	Erosion	4	5	4
719221	206	38.2881	-76.5246	Erosion	1	4	4
719101	122	38.2888	-76.5250	Inadequate Buffer	5	4	1
719219	302	38.2888	-76.5250	Inadequate Buffer	3	3	3
719109	122	38.2857	-76.5224	Fish Barrier	3	4	4
719110	122	38.2856	-76.5219	Fish Barrier	4	3	4
719107	122	38.2858	-76.5236	Fish Barrier	4	3	4
719108	122	38.2855	-76.5234	Fish Barrier	5	3	4
719212	104	38.2861	-76.5050	Fish Barrier	3	4	5
719217	104	38.2835	-76.5030	Fish Barrier	2	5	3
719105	122	38.2873	-76.5241	Trash Dumping	5	1	3
719209	104	38.2829	-76.5096	Trash Dumping	5	1	2
719211	124	38.2750	-76.5050	Trash Dumping	5	1	2
719214	124	38.2668	-76.5003	Trash Dumping	4	1	1
719228	103	38.2970	-76.5516	Trash Dumping	5	1	1

Table 6**.** Unusual conditions found throughout entire watershed and ranked by decreasing severity (S=Severity C=Correctability A=Access).

Site Code	Catchment	Latitude (N)	Longitude (W)	Description	Cause	S	C	A
710214	1091	38.1901	-76.4643	Large dam w/ pumping system.Water derived from river with a pipe outfall.	Man	-1	-1	2
714124	101	38.2471	-76.4932	Power lines in stream.	Unknown	1	5	2
714130	201	38.2467	-76.4978	Power lines in stream.	Unknown	1	5	3
718102	201	38.2744	-76.5687	Stream is marsh on one side which crosses a road and then flows again as a stream	New Road	1	4	1
714117	302	38.2314	-76.5334	Man made tributary and pond.	Home Owner	3	3	2
714111	117	38.2327	-76.5255	Underground tributary	Unknown	5	-1	2
717110	401	38.2568	-76.5108	Beaver dam	Beavers	5	1	5
719103	122	38.2878	-76.5248	ATV Track	ATV usage	5	3	3

Table 7. Exposed pipes found throughout entire watershed and ranked by decreasing severity (S=Severity C=Correctability A=Access).

Site Code	Catchment	Latitude (N)	Longitude (W)	Pipe is	Made of	Pipe Diameter (in)	Length Exposed (ft)	Purpose of Pipe	Discharge	Color	Odor	S	C	A
716104	301	38.2299	-76.4484	Exposed along stream bank	Corrugated Metal	24	30	Unknown	No	NA	NA	3	1	2
719213	128	38.2742	-76.5033	Exposed Across Bottom of Stream	Smooth metal	12	8	Unknown	No	NA	NA	3	5	3
714133	501	38.2418	-76.5037	Exposed along stream bank	Smooth metal	4	2	Unknown	No	NA	NA	5	-1	1
719224	105	38.3046	-76.5375	Exposed Across Bottom of Stream	Smooth metal	4	3	Unknown	No	NA	NA	5	2	3

Table 8. Pipe outfalls in the watershed and ranked by decreasing severity (S=Severity C=Correctability A=Access).

Site Code	Catchment	Latitude (N)	Longitude (W)	Pipe is	Made of	Pipe Dia. (in)	Length Exposed (ft)	Purpose of Pipe	Discharge	Color	Odor	S	C	A
716104	301	38.2299	-76.4484	Exposed along stream bank	Corrugated Metal	24	30	Unknown	No	NA	NA	3	1	2
719213	128	38.2742	-76.5033	Exposed Across Bottom of Stream	Smooth metal	12	8	Unknown	No	NA	NA	3	5	3
714133	501	38.2418	-76.5037	Exposed along stream bank	Smooth metal	4	2	Unknown	No	NA	NA	5	-1	1
719224	105	38.3046	-76.5375	Exposed Across Bottom of Stream	Smooth metal	4	3	Unknown	No	NA	NA	5	2	3
717111	104	38.2702	-76.4956	Stormwater	Concrete	18	3	Unknown	No	NA	NA	4	3	1
717113	104	38.2699	-76.4964	Stormwater	Plastic	4		Unknown	No	NA	NA	4	3	1
714105	302	38.2322	-76.5213	Unknown	Plastic	4	3	Unknown	No	NA	NA	5	4	1
714104	302	38.2322	-76.5213	Stormwater	Plastic	4	3	Unknown	Yes	Clear	None	5	4	1

Table 9. In stream construction found throughout entire watershed and ranked by decreasing severity (S=Severity).

Site Code	Catchment	Latitude (N)	Longitude (W)	Type of Activity	Sediment Control	If Inadequate, Why?	Excess Sediment Downstream	Length of Stream Affected (Ft)	Construction Company	Location	S	Contact Office
715204	135	38.2483	-76.4667	Residential Development	Inadequate	No attempt to contain	Yes	200	Unknown	Unknown	2	Yes
716202	302	38.2366	-76.4496	Residential Development	Adequate		Yes	500	Unknown	Abberly Crest	5	No

Table 10. Channel alteration found throughout entire watershed and ranked by decreasing severity (S=Severity C=Correctability A=Access).

Site Code	Catchment	Latitude (N)	Longitude (W)	Type	Bottom Width (in)	Length	Perennial Flow	Sediment Deposition	Vegetation	Road Crossing	Channelized length above road crossing (ft)	Channelized length below road crossing (ft)	S	C	A
714101	302	38.2328	-76.5203	Concrete	120	50	Yes	Yes	No	Below			1	5	1
717207	202	38.2575	-76.4915	Metal	24	50	Yes	Yes	No	Below	5	10	2	4	1
718221	201	38.2647	-76.5676	Plastic	12	12	Yes	Yes	No	Below	100	120	2	1	1
719223	108	38.3074	-76.5375	Concrete	72	200	Yes	Yes	No	Below	65	12	2	3	1
719226	201	38.2916	-76.5347	Metal	24	50	Yes	No	No	Below	60	12	2	3	1
710115	203	38.2167	-76.4350	PVC Pipe	4	15	Yes	Yes	No	Path			3	2	2
717118	301	38.2508	-76.5077	Concrete	30	20	Yes	Yes	No	Below			3	4	1
719230	103	38.2970	-76.5549	Metal Pipe	40	10	Yes	No	No	Below			3	3	1
709204	1077	38.1402	-76.4360	Concrete	24	30	Yes	Yes	No	Below			4	3	1
709205	1078	38.1383	-76.4287	Concrete	12	26	Yes	Yes	No	Below			4	4	1
710212	1074	38.1698	-76.4054	Concrete	24	300	Yes	No	No	No		25	4	5	1
713204	301	38.2042	-76.4770	concrete	40	25	Below	Yes	Yes	No			4	4	1
714108	206	38.2290	-76.5250	Concrete	72	12	Yes	No	No	Below			4	5	1
714120	101	38.2467	-76.4929	Metal	6	30	Yes	No	No	Below			4	4	1
714202	123	38.2158	-76.5133	Rip-Rap	36	22	Yes	Yes	Yes	Below	6	4	4	1	1
718214	205	38.2476	-76.5650	Concrete	6	20	No	No	No	Below	6	8	4	2	1
710111	304	38.1748	-76.4084	Steel Pipe	8	20	Yes	Yes	No	Below			5	5	1
713201	109	38.2010	-76.4840	Concrete	32	20	Below	Yes	Yes	No			5	3	1
714103	302	38.2322	-76.5213	Rip-Rap	36	15	Yes	Yes	No	No			5	2	1
714110	302	38.2319	-76.5252	Metal pipe	72	10	Yes	No	No	Below			5	4	1
716103	302	38.2306	-76.4497	Concrete	70	20	Below	Yes	Yes	No			5	4	1
719231	103	38.2984	-76.5544	Rip-Rap	10	6	Yes	No	No	No			5	3	1

Table 11**.** Erosion sites found throughout entire watershed and ranked by decreasing severity (S=Severity C=Correctability A=Access).

Site Code	Catch ment	Latitude (N)	Longitude (W)	Type	Cause	Length (ft)	Av. Bank Height (ft)	Land Use Left	Land Use Right	Threat to Infrastructure	S	C	A
719221	206	38.2881	-76.5246	Widening	Fragile bank	90	2.5	Forest	Forest	No	1	4	4
714129	201	38.2484	-76.4966	Widening	Bend at steep slope	50	15	Forest	Forest	No	2	4	3
714131	201	38.2438	-76.5017	Widening	Bend at steep slope	90	8	Lawn	Forest	No	2	3	1
717115	201	38.2680	-76.5020	Widening	Fragile Bank	800	6	Forest	Forest	No	2	5	2
718205	303	38.2412	-76.5294	Widening	Bend at steep slope	200	2	Forest	Forest	No	2	5	4
714107	302	38.2322	-76.5216	Widening	Bend at steep slope	100	8	Forest	Forest	No	3	4	1
714113	302	38.2321	-76.5270	Widening	Bend at steep slope	120	5	Forest	Forest	No	3	3	2
714122	101	38.2466	-76.4929	Widening	Bend at steep slope	50	7	Forest	Lawn	No	3	3	1
716206	109	38.2352	-76.4270	Widening	Bend at steep slope	600	4	Forest	Forest	No	3	5	4
717102	302	38.2769	-76.5159	Widening	Bend at steep slope	45	10	Forest	Forest	No	3	3	4
718108	210	38.2464	-76.5183	Widening	Bend at steep slope	80	4	Forest	Forest	No	3	5	3
718211	212	38.2683	-76.5383	Widening	Bend at steep slope	60	3	Forest	Forest	No	3	5	4
718215	205	38.2683	-76.5383	Downcutting	Channelization	75	3	Forest	Forest	No	3	5	2
718217	205	38.2479	-76.5648	Widening	Bend at steep slope	100	3	Forest	Forest	No	3	4	3
719203	123	38.2491	-76.5648	Widening	Bend at steep slope	70	5	Forest	Forest	No	3	5	5
719205	123	38.2820	-76.5182	Widening	Bend at steep slope	200	5	Forest	Forest	No	3	5	5
710113	203	38.2150	-76.4335	Downcutting	Bend at steep slope	70	3.5	Forest	Forest	No	4	3	3
710203	1084	38.2021	-76.4617	Widening	Bend at steep slope	70	4	Forest	Forest	No	4	3	2
710213	301	38.2170	-76.4420	Widening	Bend at steep slope	600	14	Forest	Forest	No	4	5	3
714115	302	38.2321	-76.5283	Widening	Bend at steep slope	50	3	Forest	Forest	No	4	4	4
716102	146	38.2542	-76.4450	Widening	Fragile bank	500	1	Forest	Forest	No	4	5	4
716207	212	38.2297	-76.4213	Widening	Bend at steep slope	400	3	Forest	Forest	No	4	4	3
718104	210	38.2533	-76.5638	Widening	Fragile bank	500	1.5	Forest	Forest	No	4	5	2
719102	122	38.2881	-76.5246	Widening	Bend at steep slope	300	3	Forest	Forest	No	4	4	4
719106	122	38.2867	-76.5242	Widening	Bend at steep slope	50	6	Forest	Forest	No	4	4	4
719206	205	38.2804	-76.5169	Widening	Bend at steep slope	80	4	Forest	Forest	No	4	5	4
719216	128	38.2767	-76.5033	Widening	Bend at steep slope	70	4	Forest	Forest	No	4	5	4
713203	301	38.2042	-76.4792	Widening	Bend at steep slope	60	2	Forest	Forest	No	5	3	3
717105	201	38.2686	-76.5109	Headcutting	Unknown	1	1	Forest	Forest	No	5	2	4

Table 12. Inadequate buffer sites found throughout entire watershed and ranked by decreasing severity (S=Severity C=Correctability A=Access).

Site Code	Catch.	Latitude (N)	Longitude (W)	Side of Stream	Unshaded	Buffer Width Left (ft)	Buffer Length Left (ft)	Present Land Use Left	Buffer Width Right (ft)	Buffer Length Right (ft)	Present Land Use Right	Recently Estab-lish.	Livestock Present	S	C	A	Wetland Potential
709102	113	38.1717	-76.4933	Both	Both	0	2100	Pasture	0	2100	Crop Field	No	No	1	3	1	4
710215	1102	38.2142	-76.4617	Both	Both	0	700	Pasture	0	700	Pasture	No	Yes-horses	2	2	1	4
717205	111	38.2641	-76.4769	Both	Both	0	60	Power Lines	0	60	Power Lines	No	No	3	2	1	4
719219	302	38.2888	-76.5250	Both	Both	0	500	Power Lines	0	500	Power Lines	No	No	3	3	3	1
709206	1077	38.1708	-76.4361	Both	Both	0	500	Wetland	0	500	Wetland	No	No	3	1	1	1
715102	301	38.2371	-76.4739	Both	Both	0	500	Forest	0	80	Forest	No	No	3	5	1	1
714132	201	38.2438	-76.5017	Left	Left	0	50	Lawn	>50	NA	Forest	No	No	4	2	1	5
714203	129	38.2330	-76.5190	Both	Both	0	25	Forest	0	75	Forest	No	No	4	1	1	3
717203	401	38.2619	-76.5116	Both	Both	0	80	Forest	0	70	Forest	No	No	4	5	4	5
714123	101	38.2467	-76.4929	Right	Right	>50	NA	Small Trees	0	50	Lawn	No	No	5	1	1	5
714126	101	38.2450	-76.4947	Right	Right	>50	NA	Forest	0	90	Lawn	No	No	5	2	1	5
714106	302	38.2322	-76.5213	Right	Right	>50	NA	Forest	0	80	Lawn	No	No	5	3	1	5
719101	122	38.2888	-76.5250	Both	Both	0	50	Pasture	0	20	Pasture	No	No	5	4	1	4
717103	401	38.2733	-76.5125	Right	Right	>50	NA	Pasture	0	50	Pasture	No	No	5	4	1	2

Table 13. Fish barriers found throughout entire watershed and ranked by decreasing severity (S=Severity C=Correctability A=Access).

Site Code	Catchment	Latitude (N)	Longitude (W)	Fish Blockage	Type of Barrier	Blockage Cause	Water Drop (in)	Water Depth (in)	S	C	A
715201	114	38.2498	-76.4557	Partial	Beaver Dam	Too High	40		1	2	3
716203	302	38.2366	-76.4496	Total	Debris Dam	Too High	40		1	4	2
718210	212	38.2665	-76.5948	Total	Beaver Dam	Too High	53		1	3	2
712203	203	38.2050	-76.4217	Total	Debris Dam	Too Shallow		4	2	2	2
712204	203	38.2050	-76.4217	Unknown	Pipe Crossing	Too Shallow	8	4	2	4	1
716205	109	38.2400	-76.4270	Total	Pipe Crossing	Too High/Shallow	8	1	2	4	3
719217	104	38.2835	-76.5030	Partial	Chanalized	Too High	30		2	5	3
712205	203	38.2033	-76.4200	Total	Debris Dam	Too Shallow		0	3	2	3
714116	302	38.2314	-76.5334	Total	Natrual Falls	Too Fast			3	3	1
714118	302	38.2319	-76.5387	Total	Natural Falls	Too high	8		3	3	4
718106	142	38.2440	-76.5180	Total	Natural Falls	Too High	8		3	4	3
718203	127	38.2386	-76.5185	Partial	Road Crossing	Too Shallow		<1	3	4	1
719109	122	38.2857	-76.5224	Partial	Debris Dam	Too Fast			3	4	4
719212	104	38.2861	-76.5050	Total	Debris Dam	Too High			3	4	5
710204	1082	38.2021	-76.4617	Total	Natural Falls	Too High	36		4	3	2
719107	122	38.2858	-76.5236	Partial	Debris Dam	Too Fast			4	3	4
719110	122	38.2856	-76.5219	Partial	Debris Dam	Too Fast			4	3	4
709101	113/114	38.1708	-76.4933	Total	Road Crossing	Too High	24		5	4	1
719108	122	38.2855	-76.5234	Partial	Debris Dam	Too Fast			5	3	4

Table 14. Trash dumping sites found throughout entire watershed and ranked by decreasing severity (S=Severity C=Correctability A=Access).

Site Code	Catchment	Latitude (N)	Longitude (W)	Type of Trash	Amount of Trash (truck loads)	Trash Confined To	Volunteer Cleanup	Land Ownership	If Public, Name	S	C	A
714114	302	38.2322	-76.5271	Construction	3	Single site	No	Unknown		3	4	3
711203	101	38.1564	-76.3894	Industrial	<1	Single site	No	Private		3	2	3
710108	1029	38.2148	-76.4319	Construction/Residential	2	Large area	Yes	Private		4	1	1
710114	203	38.2164	-76.4337	Resodential	1	Large area	Yes	Private		4	2	2
714127	102	38.2490	-76.4954	Residential	1	Large area	Yes	Unknown		4	1	3
719214	124	38.2668	-76.5003	Residential	<1	Single Site	Yes	Public	St. Mary's State Park	4	1	1
714121	101	38.2467	-76.4929	Residential	2	Large area	Yes	Private		4	1	1
717112	104	38.2691	-76.4964	Residential	<1	Single Site	Yes	Public		5	3	1
717114	201	38.2708	-76.4967	Residential	<1	Single Site	Yes	Public		5	1	2
719105	122	38.2873	-76.5241	Residential	<1	Large Area	Yes	Public	St. Mary's State Park	5	1	3
719209	104	38.2829	-76.5096	Residential	<1	Single Site	Yes	Public	St. Mary's State Park	5	1	2
719211	124	38.2750	-76.5050	Residential	<1	Single Site	Yes	Public	St. Mary's State Park	5	1	2
719228	103	38.2970	-76.5516	Residential	<1	Single Site	Yes	Private		5	1	1

Table 15. Representative sites recorded throughout entire watershed and ranked by decreasing severity. S=Severity. C=Correctability. A=Access.

Site Code	Catchment	Latitude (N)	Longitude (W)	Macroinvertebrate Substrata	Embeddedness	Shelter for Fish	Channel Alteration	Sediment Deposition	Velocity and Depth	Channel Flow	Bank Vegetation
709103	201	38.1590	-76.4960	Suboptimal	Poor	Suboptimal	Optimal	Suboptimal	Suboptimal	Suboptimal	Suboptimal
709201	301	38.1792	-76.4758	Optimal	Marginal	Suboptimal	Optimal	Optimal	Optimal	Optimal	Optimal
709202	118	38.1609	-76.4909	Suboptimal	Poor	Suboptimal	Optimal	Suboptimal	Suboptimal	Marginal	Optimal
709203	1077	38.1402	-76.4361	Optimal	Poor	Suboptimal	Marginal	Suboptimal	Suboptimal	Optimal	Marginal
710101	209	38.1883	-76.4298	Poor	Optimal	Suboptimal	Optimal	Optimal	Marginal	Optimal	Optimal
710102	209	38.1856	-76.4272	Optimal	Optimal	Optimal	Optimal	Suboptimal	Suboptimal	Optimal	Optimal
710103	1049	38.1716	-76.4235	Suboptimal	Optimal	Marginal	Optimal	Optimal	Suboptimal	Optimal	Optimal
710104	1046	38.1716	-76.4235	Suboptimal	Marginal	Poor	Optimal	Marginal	Marginal	Suboptimal	Optimal
710105	212	38.1716	-76.4235	Suboptimal	Suboptimal	Poor	Suboptimal	Optimal	Marginal	Optimal	Optimal
710106	1108	38.1670	-76.4346	Suboptimal	Optimal	Optimal	Optimal	Suboptimal	Marginal	suboptimal	Optimal
710107	1029	38.2149	-76.4311	Optimal	Suboptimal	Poor	Optimal	Optimal	Poor	Optimal	Optimal
710110	203	38.2168	-76.4345	Optimal	Optimal	Optimal	Optimal	Suboptimal	Suboptimal	Optimal	Optimal
710112	304	38.1752	-76.4068	marginal	Optimal	Suboptimal	Optimal	Optimal	Marginal	Optimal	Optimal
710116	203	38.2183	-76.4375	Suboptimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
710201	1041	38.1817	-76.4317	Suboptimal	Marginal	Suboptimal	Optimal	Optimal	Marginal	Optimal	Optimal
710202	1084	38.2000	-76.4617	Optimal	Suboptimal	Optimal	Optimal	Suboptimal	Optimal	Optimal	Optimal
710205	213	38.1806	-76.4107	Optimal	Suboptimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
710206	1051	38.1820	-76.4091	marginal	Suboptimal	Optimal	Optimal	Suboptimal	Suboptimal	Optimal	Optimal
710207	1091	38.1901	-76.4476	Optimal	Suboptimal	Optimal	Optimal	Suboptimal	Suboptimal	Optimal	Optimal
710209	1084	38.1990	-76.4640	Suboptimal	Marginal	Optimal	Suboptimal	Suboptimal	Suboptimal	Optimal	Optimal
710210	1086	38.1942	-76.4583	Suboptimal	Marginal	Suboptimal	Optimal	Suboptimal	Suboptimal	Suboptimal	Suboptimal
710211	301	38.2160	-76.4460	Optimal	Suboptimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
710216	301	38.2180	-76.4380	Optimal	Marginal	Marginal	Optimal	Optimal	Marginal	Optimal	Optimal
710217	1105	38.2130	-76.4530	Optimal	Suboptimal	Optimal	Optimal	Suboptimal	Optimal	Optimal	Optimal
711201	301	38.1620	-76.3980	Suboptimal	Optimal	Optimal	Optimal	Optimal	Suboptimal	Optimal	Optimal
711202	101	38.1562	-76.3897	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
712202	203	38.2067	-76.4242	Optimal	Suboptimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
713202	301	38.2045	-76.4853	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
714102	302	38.2328	-76.5203	Optimal	Optimal	Suboptimal	Suboptimal	Suboptimal	Optimal	Optimal	Optimal
714109	206	38.2315	-76.5238	Optimal	Suboptimal	Optimal	Suboptimal	Suboptimal	Optimal	Optimal	Optimal

Table 15 (continued)

Site Code	Catchment	Latitude (N)	Longitude (W)	Macroinvertebrate Substrata	Embeddedness	Shelter for Fish	Channel Alteration	Sediment Deposition	Velocity and Depth	Channel Flow	Bank Vegetation
714128	102	38.2489	-76.4954	Optimal	Optimal	Optimal	Optimal	Suboptimal	Optimal	Optimal	Optimal
714135	301	38.2418	-76.5037	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
714134	501	38.2556	-76.5096	Suboptimal	Suboptimal	Optimal	Suboptimal	Suboptimal	Optimal	Optimal	Optimal
714201	206	38.2330	-76.5204	Optimal	Suboptimal	Optimal	Suboptimal	Marginal	Optimal	Optimal	Optimal
714204	126	38.2255	-76.5243	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
714205	209	38.2134	-76.4989	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
714206	1001	38.2135	-76.4990	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
714207	501	38.2370	-76.5020	Optimal	Suboptimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
715101	301	38.2493	-76.4619	Optimal	Suboptimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
715103	208	38.2470	-76.4740	Suboptimal	Marginal	Optimal	Marginal	Suboptimal	Suboptimal	Optimal	Optimal
715202	135	38.2432	-76.4723	Optimal	Optimal	Optimal	Optimal	Suboptimal	Suboptimal	Optimal	Optimal
715203	135	38.2258	-76.4600	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
716101	203	38.2317	-76.4507	Optimal	Marginal	Optimal	Optimal	Suboptimal	Suboptimal	Optimal	Optimal
716105	301	38.2483	-76.4453	Optimal	Optimal	Optimal	Optimal	Suboptimal	Optimal	Optimal	Optimal
716201	302	38.2388	-76.4437	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
716204	109	38.2390	-76.4270	Optimal	Suboptimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
716208	212	38.2286	-76.4259	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
717101	401	38.2787	-76.5139	Suboptimal	Marginal	Optimal	Optimal	Marginal	Optimal	Marginal	Optimal
717104	401	38.2728	-76.5118	Poor	Poor	Optimal	Optimal	Optimal	Suboptimal	Optimal	Optimal
717106	401	38.2634	-76.5103	Marginal	Optimal	Optimal	Optimal	Suboptimal	Supoptimal	Optimal	Optimal
717107	401	38.2568	-76.5108	Suboptimal	Marginal	Optimal	Optimal	Suboptimal	Optimal	Optimal	Optimal
717108	102	38.2585	-76.5131	Optimal	Suboptimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
717109	101	38.2657	-76.5096	Poor	Optimal	Poor	Optimal	Optimal	Marginal	Optimal	Optimal
717116	201	38.2680	-76.5020	Optimal	Suboptimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
717117	201	38.2558	-76.5097	Suboptimal	Marginal	Optimal	Optimal	Optimal	Suboptimal	Optimal	Optimal
717119	301	38.2508	-76.5077	Marginal	Optimal	Optimal	Optimal	Suboptimal	Suboptimal	Optimal	Optimal
717201	401	38.2643	-76.5099	Optimal	Marginal	Optimal	Optimal	Optimal	Marginal	Optimal	Optimal
717202	401	38.2619	-76.5116	Poor	Suboptimal	Optimal	Optimal	Optimal	Suboptimal	Optimal	Suboptimal
717204	111	38.2663	-76.4704	Optimal	Optimal	Optimal	Optimal	Marginal	Optimal	Optimal	Optimal

Table 15 (continued)

Site Code	Catchment	Latitude (N)	Longitude (W)	Macroinvertebrate Substrata	Embeddedness	Shelter for Fish	Channel Alteration	Sediment Deposition	Velocity and Depth	Channel Flow	Bank Vegetation
717209	114	38.2467	-76.4913	Optimal	Optimal	Optimal	Optimal	Optimal	Suboptimal	Optimal	Optimal
718101	201	38.2785	-76.5644	Suboptimal	Poor	Suboptimal	Optimal	Suboptimal	Marginal	Suboptimal	Optimal
718103	201	38.2700	-76.5692	Suboptimal	Poor	Optimal	Optimal	Marginal	Suboptimal	Optimal	Optimal
718105	210	38.2533	-76.5225	Optimal	Optimal	Optimal	Optimal	Suboptimal	Suboptimal	Optimal	Optimal
718107	401	38.2464	-76.5185	Optimal	Suboptimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
718201	207	38.2501	-76.5396	Suboptimal	Poor	Suboptimal	Optimal	Suboptimal	Marginal	Optimal	Optimal
718202	140	38.2700	-76.5430	Suboptimal	Marginal	Optimal	Optimal	Suboptimal	Suboptimal	Optimal	Optimal
718204	127	38.2408	-76.5316	Optimal	Suboptimal	Optimal	Optimal	Suboptimal	Optimal	Optimal	Optimal
718206	128	38.2413	-76.5293	Optimal	Marginal	Optimal	Optimal	Optimal	Suboptimal	Optimal	Optimal
718207	123	38.2620	-76.5520	Suboptimal	Poor	Suboptimal	Optimal	Suboptimal	Marginal	Suboptimal	Optimal
718208	212	38.2703	-76.5457	Optimal	Suboptimal	Optimal	Optimal	Suboptimal	Optimal	Optimal	Optimal
718209	213	38.2673	-76.5450	Suboptimal	Poor	Optimal	Optimal	Optimal	Suboptimal	Optimal	Optimal
718212	213	38.2660	-76.5430	Optimal	Optimal	Optimal	Optimal	Suboptimal	Optimal	Optimal	Optimal
718213	204	38.2463	-76.5649	Suboptimal	Suboptimal	Optimal	Suboptimal	Suboptimal	Optimal	Marginal	Optimal
718216	205	38.2490	-76.5649	Suboptimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
718218	113	38.2546	-76.5607	Optimal	Optimal	Marginal	Optimal	Suboptimal	Optimal	Marginal	Optimal
718219	301	38.2582	-76.5651	Optimal	Suboptimal	Optimal	Optimal	Suboptimal	Optimal	Optimal	Optimal
718220	202	38.2617	-76.5681	Optimal	Optimal	Optimal	Optimal	Suboptimal	Optimal	Optimal	Optimal
718222	105	38.2737	-76.5603	Optimal	Marginal	Suboptimal	Marginal	Poor	Marginal	Suboptimal	Suboptimal
719104	122	38.2881	-76.5246	Suboptimal	Marginal	Marginal	Optimal	Marginal	Optimal	Marginal	Optimal
719111	122	38.2849	-76.5215	Suboptimal	Suboptimal	Optimal	Optimal	Suboptimal	Optimal	Suboptimal	Optimal
719112	102	38.3057	-76.5554	Marginal	Poor	Marginal	Suboptimal	Suboptimal	Marginal	Suboptimal	Marginal
719201	104	38.2819	-76.5099	Marginal	Poor	Optimal	Optimal	Optimal	Suboptimal	Optimal	Optimal
719202	123	38.2865	-76.5170	Optimal	Suboptimal	Optimal	Optimal	Suboptimal	Optimal	Optimal	Optimal
719204	123	38.2830	-76.5178	Optimal	Marginal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
719207	205	38.2804	-76.5170	Suboptimal	Marginal	Optimal	Optimal	Suboptimal	Optimal	Optimal	Optimal
719208	124	38.2819	-76.5099	Marginal	Poor	Optimal	Optimal	Optimal	Suboptimal	Optimal	Optimal
719210	206	38.2783	-76.5033	Suboptimal	Marginal	Suboptimal	Optimal	Marginal	Optimal	Optimal	Optimal
719215	128	38.2798	-76.5080	Suboptimal	Marginal	Suboptimal	Optimal	Suboptimal	Optimal	Optimal	Optimal
719218	301	38.2780	-76.5290	Optimal	Poor	Optimal	Optimal	Marginal	Suboptimal	Optimal	Optimal
719220	120	38.2790	-76.5240	Optimal	Poor	Optimal	Optimal	Suboptimal	Optimal	Optimal	Optimal

Table 15 (continued)

Site Code	Catchment	Latitude (N)	Longitude (W)	Macroinvertebrate Substrata	Embeddedness	Shelter for Fish	Channel Alteration	Sediment Deposition	Velocity and Depth	Channel Flow	Bank Vegetation
719222	106	38.3121	-76.5366	Optimal	Poor	Optimal	Poor	Poor	Marginal	Marginal	Optimal
719225	105	38.2998	-76.5366	Optimal	Suboptimal	Poor	Optimal	Suboptimal	Marginal	Suboptimal	Optimal
719227	103	38.2970	-76.5410	Suboptimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
719229	103	38.2970	-76.5549	Optimal	Optimal	Suboptimal	Optimal	Optimal	Optimal	Optimal	Optimal

Table 5 (continued)

Site Code	Catchment	Bank Condition	Riparian Vegetation	Wetted Width: Riffles	Wetted Width: Runs	Wetted Width: Pools	Thalweg Depth: Riffles	Thalweg Depth: Runs	Thalweg Depth: Pools	Bottom Type
709103	201	Suboptimal	Optimal	0	160	0	0	3	0	Silt
709201	301	Suboptimal	Optimal	12	8	16	1	3	3	Sand
709202	118	Optimal	Optimal	0	48	0	0	4	0	Silt
709203	1077	Suboptimal	Suboptimal	144	144	144	12	24	40	Silt
710101	209	Optimal	Marginal	0	48	48	0	12	12	Silt
710102	209	Optimal	Optimal	36	36	36	1	3	6	Gravel
710103	1049	Optimal	Optimal	0	0	0	0	0	0	Silt
710104	1046	Optimal	Optimal	48	48	48	3	3	3	Sand
710105	212	Optimal	Optimal	12	12	12	3	3	3	Silt
710106	1108	Optimal	Optimal	48	72	72	12	48	60	Silt
710107	1029	Optimal	Optimal	12	12	12	3	3	3	Silt
710110	203	Optimal	Optimal	12	24	24	3	6	12	Gravel
710112	304	Optimal	Optimal	0	69	0	0	40	0	Silt
710116	203	Optimal	Optimal	26	48	66	3	5	24	Gravel
710201	1041	Optimal	Optimal	4	6	18	1	1	2	Gravel/Sand
710202	1084	Suboptimal	Optimal	10	24	32	2	6	16	Gravel
710205	213	Suboptimal	Optimal	20	25	36	2	4	18	Gravel
710206	1051	Optimal	Optimal	0	25	25	0	3	8	Silt
710207	1091	Suboptimal	Optimal	24	36	48	3	6	15	Gravel
710209	1084	Suboptimal	Optimal	0	150	0	0	48	0	Silt
710210	1086	Marginal	Optimal	0	60	0	0	30	0	Silt
710211	301	Optimal	Optimal	36	90	120	2	12	18	Silt
710216	301	Suboptimal	Optimal	24	36	40	2	3	8	Silt
710217	1105	Optimal	Optimal	12	24	36	2	4	12	Silt
711201	301	Optimal	Optimal	30	30	36	4	8	16	Gravel
711202	101	Optimal	Optimal	30	36	50	2	3	8	Gravel
712202	203	Suboptimal	Optimal	36	30	45	2	5	8	Gravel
713202	301	Suboptimal	Optimal	36	36	48	2	5	9	Gravel

Table 5 (continued)

Site Code	Catchment	Bank Condition	Riparian Vegetation	Wetted Width: Riffles	Wetted Width: Runs	Wetted Width: Pools	Thalweg Depth: Riffles	Thalweg Depth: Runs	Thalweg Depth: Pools	Bottom Type
714102	302	Optimal	Optimal	48	60	60	5	5	18	Silt
714109	206	Marginal	Optimal	18	36	48	3	5	6	Gravel
714112	302	Suboptimal	Optimal	48	48	48	6	12	24	Silt
714125	101	Suboptimal	Optimal	60	72	72	3	12	18	Gravel
714128	102	Optimal	Optimal	48	60	72	3	5	8	Gravel
714135	301	Suboptimal	Optimal	40	60	60	12	36	48	Sand
714134	501	Optimal	Optimal	240	240	240	24	36	48	Gravel
714201	206	Optimal	Optimal	36	40	48	12	16	28	Sand
714204	126	Optimal	Optimal	30	36	40	3	6	10	Cobble
714205	209	Optimal	Optimal	24	40	52	4	12	18	Gravel/Cobble
714206	1001	Suboptimal	Optimal	6	12	50	1	2.5	5	Gravel
714207	501	Optimal	Optimal	60	100	120	4	30	48	Silt
715101	301	Optimal	Optimal	96	80	112	1	4	18	Cobble
715103	208	Optimal	Optimal	0	180	0	0	48	0	Silt
715202	135	Optimal	Optimal	2	35	42	2	5	6	Gravel
715203	135	Optimal	Optimal	24	40	48	3	12	16	Gravel/Sand
716101	203	Suboptimal	Optimal	0	80	96	0	12	36	Silt
716105	301	Optimal	Optimal	70	90	120	4	12	24	Gravel
716201	302	Optimal	Optimal	30	40	50	2	4	12	Gravel
716204	109	Optimal	Optimal	36	24	48	1	5	12	Cobble
716208	212	Suboptimal	Optimal	30	36	42	2	4	8	Gravel
717101	401	Suboptimal	Optimal	54	72	72	4	6	36	Gravel
717104	401	Suboptimal	Optimal	0	144	144	0	24	40	Silt
717106	401	Optimal	Optimal	0	240	300	0	12	42	Silt
717107	401	Suboptimal	Optimal	170	170	170	6	30	46	Sand
717108	102	Suboptimal	Optimal	24	24	24	5	5	5	Sand
717109	101	Optimal	Optimal	0	36	36	0	5	5	Silt
717116	201	Optimal	Optimal	18	36	40	1	4	10	Sand/Cobble
717117	201	Optimal	Optimal	0	144	180	0	36	50	Silt
717119	301	Optimal	Optimal	240	240	240	30	30	15	Silt

Table 5 (continued)

Site Code	Catchment	Bank Condition	Riparian Vegetation	Wetted Width: Riffles	Wetted Width: Runs	Wetted Width: Pools	Thalweg Depth: Riffles	Thalweg Depth: Runs	Thalweg Depth: Pools	Bottom Type
717201	401	Optimal	Optimal	121	180	200	8	12	40	Silt
717202	401	Optimal	Optimal	108	170	240	5	50	60	Silt
717204	111	Optimal	Optimal	36	40	52	6	8	20	Sand
717206	111	Optimal	Optimal	24	36	49	8	12	20	Sand
717208	202	Optimal	Optimal	38	40	52	8	10	22	Sand
717209	114	Optimal	Optimal	12	16	20	2	4	6	Gravel
718101	201	Suboptimal	Optimal	0	80	96	0	30	45	Silt
718103	201	Optimal	Optimal	24	40	50	4	10	18	Silt
718105	210	Optimal	Optimal	0	60	48	0	7	12	Silt
718107	401	Optimal	Optimal	60	108	120	4	24	48	Silt/Gravel
718201	207	Optimal	Optimal	6	12	18	1	2	4	Silt
718202	140	Optimal	Optimal	6	8	18	2	2	4	Sand
718204	127	Optimal	Optimal	12	15	36	2	3	12	Cobble
718206	128	Optimal	Optimal	6	18	36	2	5	18	Silt
718207	123	Optimal	Optimal	16	24	0	1	1	0	Silt
718208	212	Optimal	Optimal	30	36	36	1	2	5	Cobble
718209	213	Optimal	Optimal	0	36	40	0	8	12	Silt
718212	213	Optimal	Optimal	18	36	45	1	8	12	Silt/Cobble
718213	204	Optimal	Optimal	24	30	38	5	6	18	Silt
718216	205	Optimal	Optimal	24	12	48	1	4	8	Sand/Gravel
718218	113	Optimal	Optimal	0	12	18	0	2	4	Silt
718219	301	Optimal	Optimal	36	50	120	4	6	24	Sand
718220	202	Suboptimal	Optimal	24	30	36	1	2	8	Sand
718222	105	Optimal	Optimal	0	60	0	0	24	0	Silt
719104	122	Marginal	Optimal	50	144	169	2.5	7	11	Gravel
719111	122	Marginal	Optimal	72	78	70	2	4	18	Gravel
719112	102	Suboptimal	Suboptimal	0	0	264	0	0	60	Silt
719201	104	Marginal	Optimal	18	24	48	2	4	18	Silt
719202	123	Optimal	Optimal	24	36	72	1	2	18	Cobble

Table 5 (continued)

Site Code	Catchment	Bank Condition	Riparian Vegetation	Wetted Width: Riffles	Wetted Width: Runs	Wetted Width: Pools	Thalweg Depth: Riffles	Thalweg Depth: Runs	Thalweg Depth: Pools	Bottom Type
719204	123	Suboptimal	Optimal	96	84	65	2	12	14	Cobble
719207	205	Suboptimal	Optimal	118	136	98	2	4	36	Silt
719208	124	Marginal	Optimal	18	24	48	2	4	18	Silt
719215	128	Suboptimal	Optimal	36	60	48	2	4	7	Silt
719218	301	Suboptimal	Optimal	96	76	120	2	8	36	Silt
719220	120	Optimal	Optimal	96	120	60	4	8	36	Silt
719222	106	Optimal	Optimal	0	0	200	0	0	12	Silt
719225	105	Optimal	Optimal	12	18	26	<1	<1	<1	Silt
719227	103	Optimal	Optimal	12	16	20	48	60	60	Silt
719229	103	Optimal	Optimal	36	48	48	12	12	12	Silt