Chapter 3: Subwatershed Conditions

Introduction

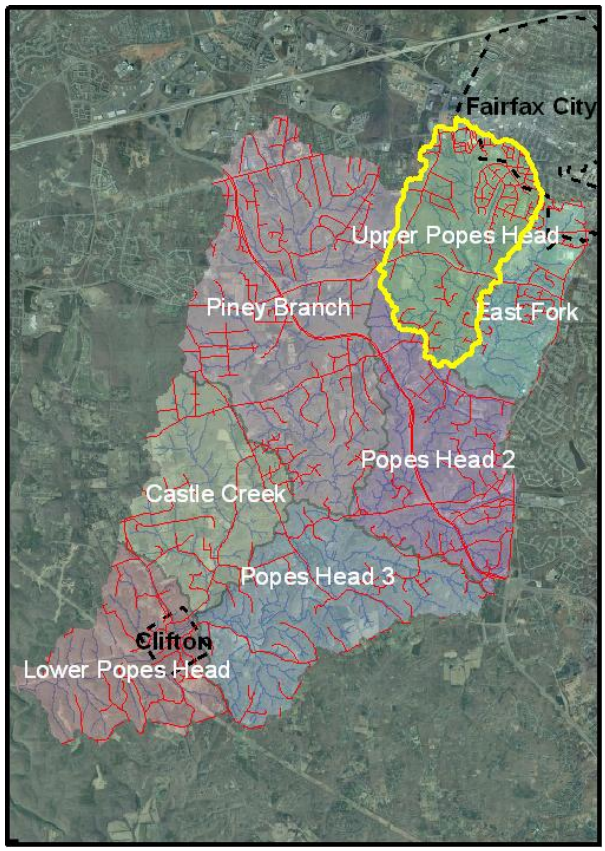
The data used to write this chapter was generated using the Fairfax County GIS layers, specifically the 2002 Stream Physical Assessment GIS layers, along with field assessments by the project team, input from citizens, and hydrologic, hydraulic, and water quality modeling. The Stream Physical Assessment data includes a stream habitat assessment, infrastructure inventory, and stream geomorphologic assessment for each stream in the entire County. The data for the Popes Head Creek watershed was subdivided, or spatially "clipped", to the Subwatershed level, and then recorded in each chapter section.

3.1 Upper Popes Head Subwatershed

The Upper Popes Head Subwatershed has an area of approximately 1,430 acres and contains the north portion of the Popes Head Creek main stem. It is bounded to the north by Lee Highway, Oakwood Drive and Crest Street; to the east by Lamarre Street and Prestwick Drive; to the south by Popes Head Road and Meath Drive; and to the west by Shirley Gate Road and Mattie Moore Court.

This subwatershed contains a portion of the City of Fairfax and George Mason University. Braddock Road and Lee Highway are both major thoroughfares which support low-intensity commercial uses. The Upper Popes Head Creek Subwatershed is shown on Map 3.1 and its condition is summarized below.

Map 3.1: Location of Upper Popes Head



3.1.1 Subwatershed Characteristics

The stormwater runoff from this subwatershed drains into the northernmost portion of Popes Head Creek, which has its headwaters near Lee Highway and the Waples Mobile Home Park. The stream flows in a southward direction for a distance of approximately 1.53 miles before it reaches the Popes Head 2 Subwatershed. Numerous small tributaries flow into Upper Popes Head Creek, ranging from 1,000 to over 5,000 feet in length.

Upper Popes Head Subwatershed Condition Summary

- Current Imperviousness = 15.7% with majority of land use Open Space
- Future Imperviousness = 17.6%
- Area of 1,430 acres
- 66.0% of the subwatershed is in the Rezoned area. Major land uses that are not in the rezoned area include George Mason University, the Fairfax Centre Shopping Center, Fairfax Villa Elementary School, the southern boundary of the City of Fairfax, and the Fairfax Villa neighborhood
- Eight stormwater management facilities currently exist.
- The stream exhibits fair habitat quality.
- Three head cuts were observed.
- Two trash dumps were observed.
- Eight obstructions were observed.
- Four out of seven crossings have minor to severe impacts.

The existing imperviousness in this subwatershed is 15.7% and expected to increase to 17.6% in the future, based upon the planned or zoned land uses in the Fairfax County Comprehensive Plan. Approximately 66% of the subwatershed lies in the area rezoned in 1982 by the Fairfax County Board of Supervisors in order to protect the Occoquan Reservoir. Building density within the rezoned area is reduced, and therefore imperviousness is decreased, reducing the amount of stormwater runoff that is generated. Land use in the subwatershed is predominantly open space, which comprises 33.3% of the area. Estate residential comprises 23.6% of the total subwatershed area. In the future, estate residential is expected to replace open space as the predominant land use, comprising 51% of the total subwatershed area. Roads and sidewalks are not included in the land use data. The existing and future land uses in the Upper Popes Head Subwatershed are described in Table 3.1.

Table 3.1 Upper Popes Head Land Use

Land Use Description	Existing		Future	
	Acres	%	Acres	%
Estate residential	287.5	23.6%	622.2	51.0%
Low-density residential	220.2	18.0%	206.1	16.9%
Medium-density residential	178.2	14.6%	225.2	18.5%
High-density residential	28.7	2.4%	29.8	2.4%
Low-intensity commercial	80.6	6.6%	84.7	6.9%
High-intensity commercial	17.0	1.4%	17.0	1.4%
Industrial	2.1	0.2%	0.4	0.0%
Open Space	406	33.3%	34.9	2.9%
Unknown	0.2	0.0%	0.2	0.0%
TOTAL	1220.5	100.0%	1220.5	100.0%

The subwatershed contains 1,157 parcels, with an average size of 1.05 acres per parcel. Upper Popes Head has the smallest average parcel size of all of the subwatersheds.

There are 22 neighborhoods fully within or apportioned within the subwatershed, as listed below:

- Brecon Ridge
- Cloisters of Fairfax
- Fairfax Woods
- Joyce Heights
- La Bellmont
- Shirley Gate Estates
- Warren Woods
- Brecon Ridge Woods
- Deerfield Forest
- George Mason Woods
- Kiels Gardens
- Popes Head View
- Shirley Gate Park
- Waples Mobile Home Park
- Westmore
- Cavalier Woods
- Fairfax Villa
- Huntwood Manor
- Lake Fairfax Estates
- Ridges of Glendilough
- University Square
- West Hill

The County's list of master plan drainage projects shows that three of the four identified projects in this subwatershed have been completed. Table 3.2 summarizes the type of master plan drainage project, project name/location, and current status. No cost estimates were available for these projects.

Table 3.2 Upper Popes Head Master Plan Drainage Projects

Type of Work	Project Name/Location
Completed Projects	
Raise Road and Replace Culvert	Popes Head Creek at Braddock Rd
Raise Road and Replace Culvert	Popes Head Tributary 1 at Braddock Rd
Raise Road and Replace Culvert	Unnamed Tributary at Braddock Rd
Inactive Project	
Stream Restoration and Stabilization	Popes Head Creek at Byrd Drive

One complaint regarding problems with a drainage swale was processed by the County and included in the database files for this subwatershed.

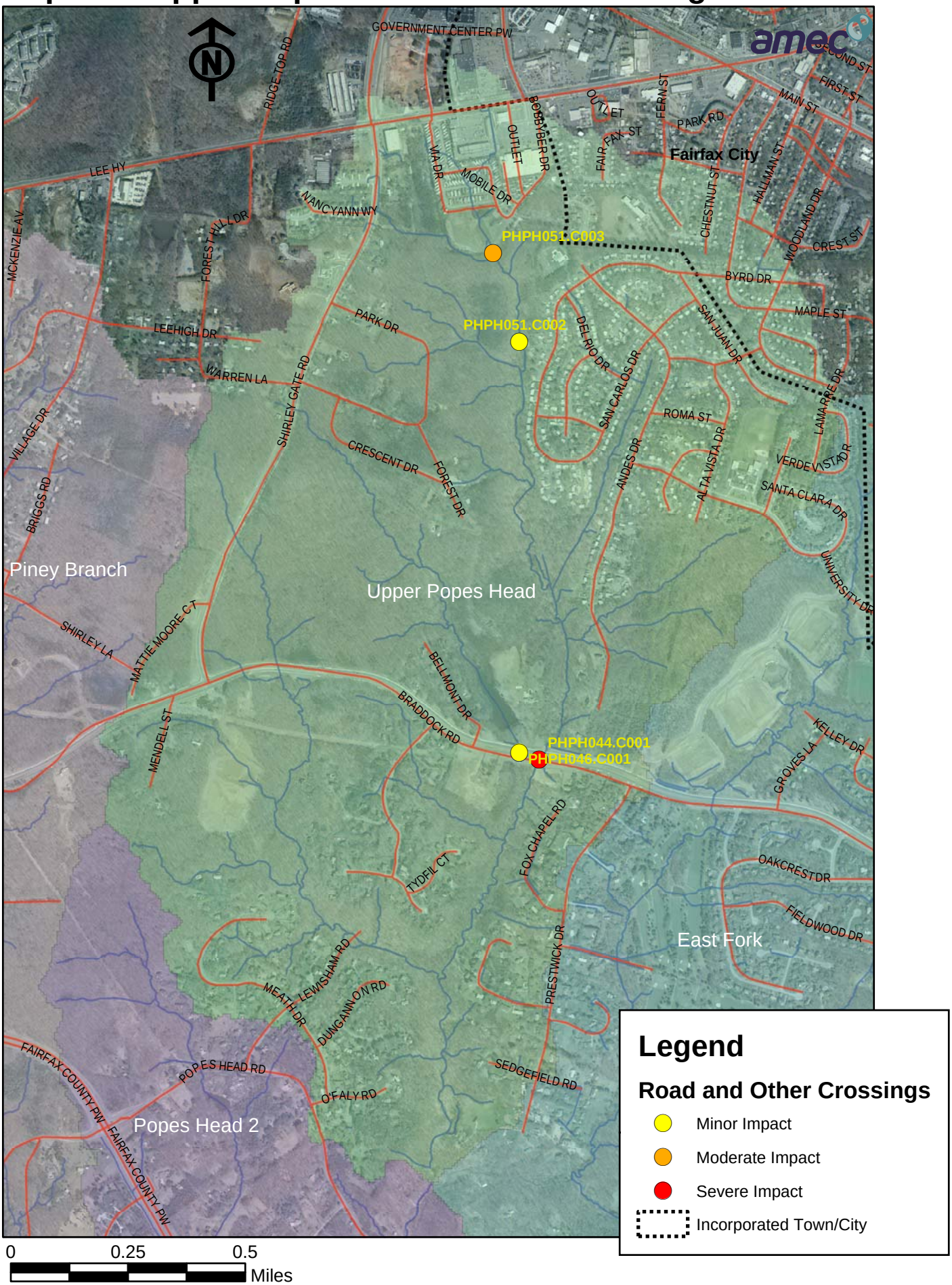
3.1.2 Storm Drain System Infrastructure

The northwestern part of the subwatershed along Lee Highway and the northeastern part of the subwatershed in the Fairfax Villa subdivision are drained through a network of storm drain pipes. The storm sewers outfall into tributaries of Popes Head Creek. In Fairfax Villa, most of the storm sewers drain to an engineered channel that runs to the west and parallel of Andes Drive. These outfalls vary in size, from 27 to 60 inches in diameter.

Map 3.2 shows the location of the four stream crossings that have an impact on the stream. Crossings that do not have an impact on the stream are not listed. The major crossings in this subwatershed, starting from the upstream end of Upper Popes Head, are described as follows:

- Via Drive: A four-foot diameter circular concrete culvert (PHPH051.C003) has a moderate impact on the main stem.
- West of Byrd Road: A five-foot wooden footbridge (PHPH051.C002) has a minor impact on the main stem.
- Braddock Road: A two-foot diameter circular concrete culvert (PHPH046.C001) has a minor impact on the main stem. To the east, a three foot by five foot, triple box

Map 3.2: Upper Popes Head Stream Crossings



concrete culvert (PHPH044.C001) has a severe impact on the main stem, as shown in Photo 3.1.

Two storm drain outfall pipes discharge into Upper Popes Head. Both pipes are composed of Reinforced Concrete Pipe (RCP), are 8 and 16 inches in diameter, respectively, and have no visible impact on the stream.

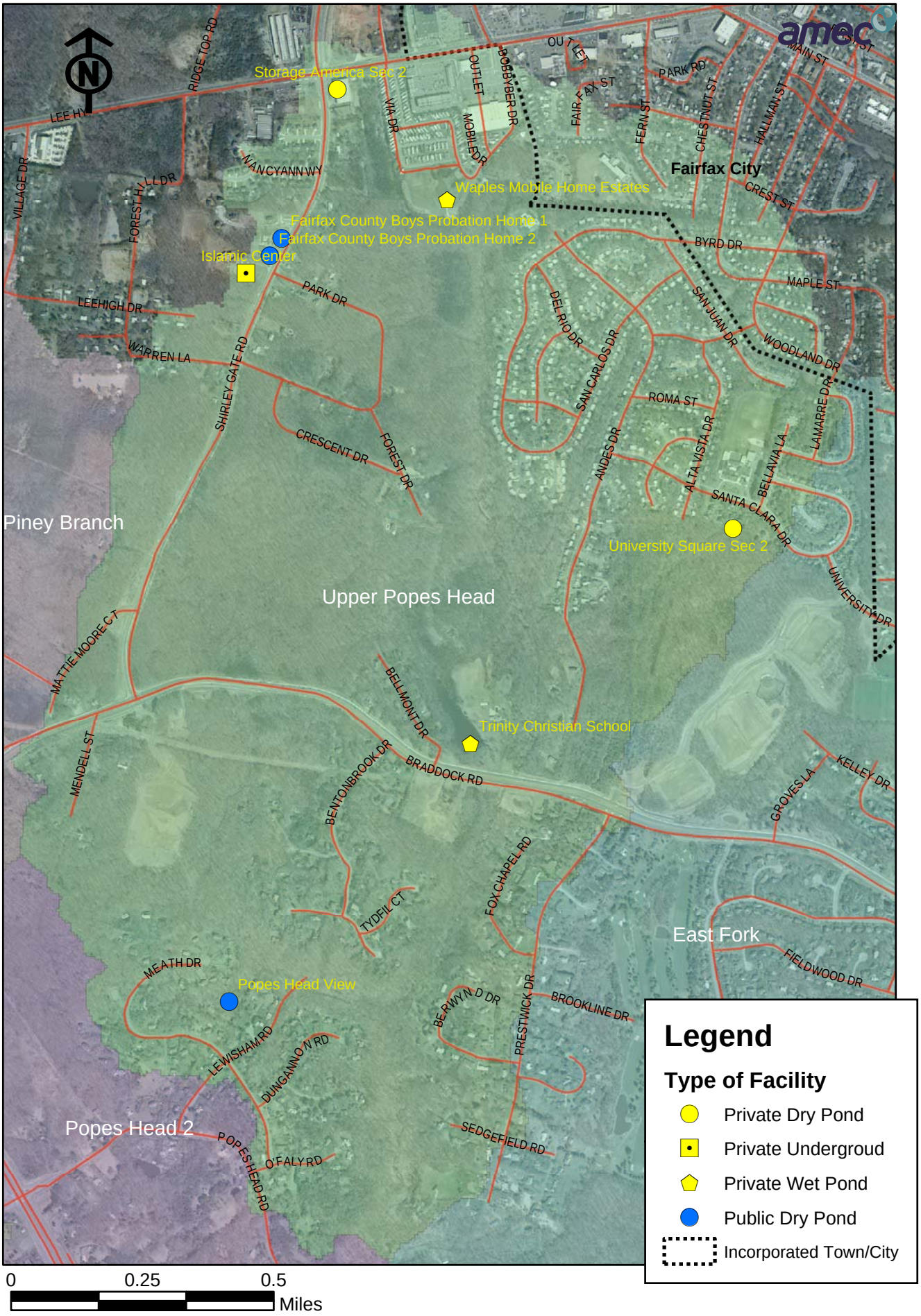
Photo 3.1 A triple box culvert (PHPH044.C001) has at Braddock Road has a severe impact on the stream

Table 3.3 shows the locations of known stormwater management facilities in the subwatershed, as depicted on Map 3.3.

Table 3.3 Upper Popes Head Stormwater Management Facilities

Name	Location	Type of Facility
Privately Owned		
Waples Mobile Home Estates	South of Via Drive and Mobile Dr	Wet Pond
Trinity Christian School	North of Braddock Road at Trinity Christian School	Wet Pond
Islamic Center	Park Drive and Shirley Gate Road	Underground
Storage America	Lee Highway and Waples Mill	Dry Pond
Publicly Owned		
Fairfax Co Boys Probation Home 1	Intersection of Shirley Gate Rd and Park Dr	Dry Pond
Fairfax Co Boys Probation Home 2	Intersection of Shirley Gate Rd and Park Dr	Dry Pond
Popes Head View	East of Popes Head View Lane and Meath Dr	Dry Pond
University Square Sec. 2	South of Fairfax Villa Elementary School	Dry Pond

Map 3.3: Upper Popes Head Stormwater Management Facilities



3.1.3 Stream Geomorphology

The geomorphology of the stream segments of Upper Popes Head can be summarized as follows:

- The dominant substrate in all stream segments is bedrock. Cobble is also present in the majority of the stream segments.
- The majority of the stream reaches are of Channel Evolution Model (CEM) type 4, referring to stabilizing stream banks and channel development as the stream returns to equilibrium.
- Several upstream reaches are of CEM type 2, referring to a deeply incised channel. This is a result of head cutting of the stream bed due to excessive flow.
- Three head cuts and one erosional area were observed.
- Two trash dumps were observed.
- Eight obstructions were observed.

3.1.4 Stream Quality

The stream reaches of Upper Popes Head are classified as riffle/run stream type. Riffles are a source of high-quality habitat and diverse fauna; therefore, an increased frequency of occurrence greatly increases the diversity of the stream community.
The habitat assessment for Upper Popes Head can be summarized as follows:

- Overall, the stream exhibits fair habitat quality.
- In most of the stream reaches, at least four habitat types were common for more than 50% of the reach; in some cases, up to seven different habitats were common.
- The stream reaches have riffles as wide as the stream, and the epifaunal substrate is composed of a mixture of softball sized cobble stones and gravel stones.
- The majority of the stream reaches have 40% - 50% embeddedness by sediment and silt.
- Only 20% - 40% of the stream reaches have disturbed or altered channels or banks.
- The stream reaches contain moderately frequent riffles with adequate depth in pools and riffles.
- The headwaters of the main stem are 35% - 40% full of water during normal flow conditions. The rest of the main stem is 60% - 85% full of water during normal flow conditions.
- The majority of the left banks exhibited 70% vegetation cover, typically of shrubs, grasses and forbes. The right banks exhibited 60% - 70% vegetation cover, with a few barren or thin areas that have fewer plant species.
- The headwaters of the stream banks featured moderately stable banks, with 15% - 30% erosional areas. The remaining stream reaches were moderately unstable, with 40% - 70% erosional areas. In general, the left banks were more stable than the right banks, as nearly all of right banks were moderately unstable.
- Nearly half of the stream reaches exhibited a left bank with a forested vegetated buffer greater than 100 feet wide that included some paths, utility lines, or other minor disturbances. The remaining stream reaches exhibited 25 to 50 feet wide forested buffers, or planted lawn grass yards. The majority of the right banks have a forested vegetated buffer with a minimum of 50 feet wide and often extending beyond 100 feet wide.

The general characteristics of the stream water quality were assessed as follows:

- The water had a clear appearance and no odor was detected at any of the assessed stream reaches.
- Medium fishes of three to six inches in length were observed in several reaches. Attached aquatic plants were not observed.
- Several stream reaches had green algae of heavy density and a slime coating; green algae of light density and a slime coating were also present.

3.1.5 Stream Ecology

The 2001 *Stream Protection Strategy (SPS) Baseline Study* did not include a sampling site in the Upper Popes Head Subwatershed. Therefore, there is no current information available about the condition of the aquatic ecological community in this subwatershed.

3.1.6 Problem Areas from Public Forum

There were no problem areas identified in this subwatershed at the March 27, 2004 Community Watershed Forum.

3.1.7 Modeling Results

The hydrology for Upper Popes Head Creek produced stormwater runoff that is relatively high due to dense development in the upper portions of this subwatershed. A reduction of discharges occurs downstream of Braddock Road due to storage occurring upstream of the Braddock Road culvert. The increase in discharges due to future development is average compared to the other subwatersheds. See Table 3.4 for a comparison of the existing and future 2- and 10-year peak discharges in the subwatershed.

Table 3.4 Upper Popes Head Creek Peak Runoff Flows

Upper Popes Head Discharge Table		Two-Year Rainfall Event			10-Year Rainfall Event		
Location	**Drainage Area**	**Existing Peak Flow (cfs)**	**Future Peak Flow (cfs)**	**% Peak Flow Increase**	**Existing Peak Flow (cfs)**	**Future Peak Flow (cfs)**	**% Peak Flow Increase**
Approximately 1,950 ft upstream of Braddock Road	0.86	1180	1300	10%	2280	2480	9%
Approximately 300 ft downstream of Braddock Road	1.33	890	1010	13%	1690	1870	11%
Just downstream of Berwynd Court	2.00	1200	1270	6%	2280	2380	4%

Velocities produced by the 2-year rainfall event in Upper Popes Head Creek were relatively high, averaging 6.7 feet per second. This would correspond with the stream physical assessment results that show that the majority of the stream bank of Popes Head Creek in this subwatershed has 40-70% erosional areas. The average velocity increases slightly, by approximately 2% in the future conditions.

Both the 2- and 10-year peak discharges overtop the channel banks on Upper Popes Head Creek and Popes Head Tributary 1 throughout the Upper Popes Head subwatershed. The model shows one structure greater than 500 square feet located in the 10-year floodplain near Sedgefield Road. Table 3.5 shows a summary of the flooded structures in the subwatershed for different recurrence intervals.

Table 3.5 Upper Popes Head Creek Flooded Structures

Recurrence Interval	Upper Popes Head	
	Existing	Future
2	1	1
5	1	1
10	1	1
25	1	1
50	1	1
100	1	1

The Upper Popes Head Creek subwatershed has the highest sediment loading rate of the seven subwatersheds due to the commercial area along Lee Highway. The predicted sediment load exceeds the target Tributary Strategy level. For future land use conditions, the average sediment loading rate is predicted to increase by 2% if not controlled by BMPs.

The Upper Popes Head Creek subwatershed has the greatest annual pollutant loading for total phosphorus of the seven subwatersheds. This can be attributed to the relatively high percentage of developed land in the watershed. For total phosphorus, the greater the proportion of medium- and high- density residential area compared to other land uses, the greater the phosphorus loading for the watershed. This subwatershed contains the greatest proportion of high density residential development since it contains the Fairfax Villa subdivision and a portion of the City of Fairfax. The predicted phosphorus load exceeds the target Tributary Strategy level. For future land use conditions, the phosphorus loading rate is predicted to increase by 3%.

This subwatershed also has the greatest annual pollutant loading for total nitrogen of the seven subwatersheds. Large areas of commercial development cause higher nitrogen pollutant loading rates. The predicted nitrogen load is just below the target Tributary Strategy level. For future land use conditions, the nitrogen loading rate is predicted to increase by 3%.

3.1.8 Summary

The Upper Popes Head Subwatershed exhibits fair stream habitat quality and stabilizing, unaltered stream channels. It has large riparian buffers beside the stream banks, despite the large areas of development and imperviousness.

Velocities produced by the 2-year rainfall event in Upper Popes Head Creek were relatively high, averaging 6.7 feet per second. Both the 2- and 10-year peak discharges overtop the channel banks on Upper Popes Head Creek and Popes Head Tributary 1 throughout the Upper Popes Head subwatershed.

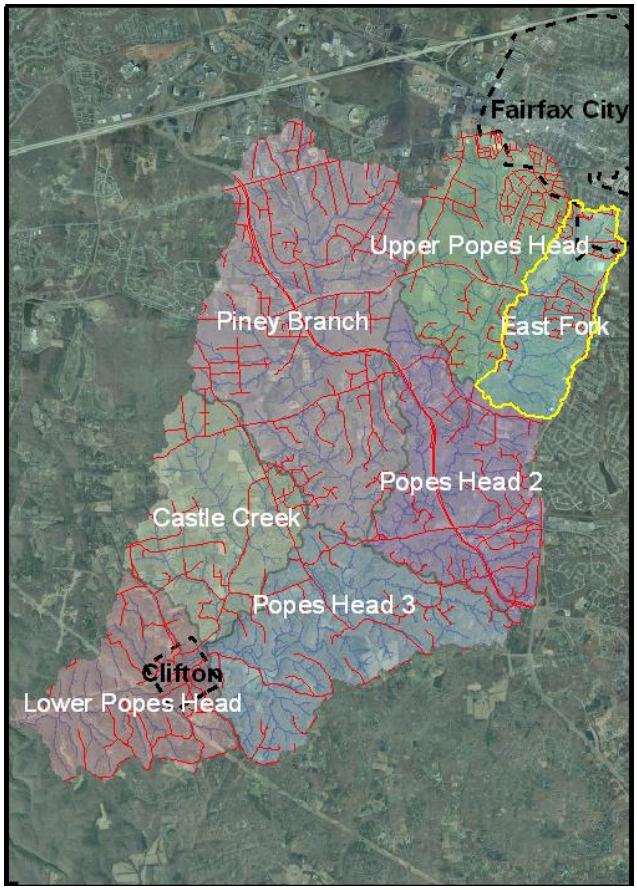
The Upper Popes Head Creek subwatershed has the greatest annual pollutant loading for total phosphorus and total nitrogen of the seven subwatersheds. This can be attributed to the relatively high percentage of developed land in the watershed.

3.2 East Fork Subwatershed

The East Fork Subwatershed has an area of approximately 847 acres and contains the East Fork of Popes Head Creek. It is bounded to the north by West Drive; to the east by Ox Road; to the south by Popes Head Road; and to the west by Lamarre Drive and Prestwick Drive.

This subwatershed contains a portion of the City of Fairfax, George Mason University and the Country Club of Fairfax. Braddock Road is the major east-west thoroughfare. The East Fork Subwatershed is shown on Map 3.4 and its condition is summarized below:

Map 3.4: Location of East Fork



3.2.1 Subwatershed Characteristics

The stormwater runoff from this subwatershed drains into East Fork Popes Head Creek, which has its headwaters inside the City of Fairfax and near the George Mason University campus. It has numerous small tributaries that range from 500 feet long to 2,500 feet long. The stream flows southward for 1.87 miles until it reaches Upper Popes Head Creek at the Popes Head 2 Subwatershed boundary.

East Fork Subwatershed Condition Summary

- Current Imperviousness = 14.7% with majority of land use Open Space
- Future Imperviousness = 23.4%
- Area of 847 acres
- 43.8% of the subwatershed is in the rezoned area. Major land uses that are not in the rezoned area include George Mason University, the southern boundary of the City of Fairfax, the Country Club of Fairfax, and the North Hill neighborhood.
- Eleven stormwater management facilities currently exist.
- The stream exhibits poor habitat quality.
- No dumps were observed.
- No head cuts were observed.
- Six obstructions were observed.
- Two out of 24 crossings have minor impacts.

The existing imperviousness of this subwatershed is 14.7% and expected to increase to 23.4% in the future, based upon the planned or zoned land uses in the Fairfax County Comprehensive Plan. The existing imperviousness is based on actual impervious cover in the watershed. The future impervious cover reflects imperviousness associated with the future land use condition. The significant increase in imperviousness is due to the future development possible on the George Mason University property. Currently, the George Mason University property within the watershed is primarily athletic fields and open space that do not contribute significant impervious areas. However this impervious difference is not shown on the land use maps because the property was designated low-intensity commercial for both conditions.

43.8% of the subwatershed is in the rezoned area; the rezoned area was established in 1982 by the Fairfax County Board of Supervisors in order to protect the Occoquan Reservoir. Building density within the rezoned area is reduced, and therefore imperviousness is decreased, reducing the amount of stormwater runoff that is generated. Land use in the subwatershed is predominantly open space, comprising 31.2% of the total area. Low-intensity commercial is the next highest land use by area, comprising 26.2% of the subwatershed. Estate residential use is expected to increase to 19% in the future, becoming the third highest land use in the subwatershed. Roads and sidewalks are not included in the land use data. Existing and future land uses in the subwatershed are described in Table 3.6 below.

Table 3.6 East Fork Land Use

Land Use Description	Existing		Future	
	Acres	%	Acres	%
Estate residential	85.1	12.5%	129.5	19.0%
Low-density residential	118.1	17.3%	124.7	18.3%
Medium-density residential	77.8	11.4%	90.5	13.3%
High-density residential	6.2	0.9%	6.2	0.9%
Low-intensity commercial	178.9	26.2%	178.9	26.2%
High-intensity commercial	3.8	0.6%	3.8	0.6%
Industrial	0	0.0%	0	0.0%
Open Space	212.8	31.2%	148.9	21.8%
Unknown	0	0.0%	0.2	0.0%
TOTAL	682.7	100.0%	682.7	100.0%

The subwatershed contains 476 parcels, with an average parcel size of 1.47 acres. There are 9 neighborhoods fully within or apportioned within the subwatershed, as listed below:

- Bell
- Brecon Ridge
- North Hill
- Braddock Forest
- Chancery Square
- University Square
- Braddox Alpine
- Michelson
- West Hill

The County's list of master plan drainage projects shows that one of the three identified projects in this subwatershed has been completed; one project is currently active with full funding, and the remaining project is active with partial funding. Table 3.7 summarizes the type of master plan drainage project, project name/location, and current status. No cost estimates were available for these projects.

Table 3.7 East Fork Master Plan Drainage Projects

Type of Work	Project Name/Location
Completed Project	
Regional Stormwater Pond	George Mason Pond
Active Project, partially funded	
Bank Protection near Brookline Drive	Brecon Ridge Subdivision
Active Project, fully funded	
Floodproof House on Groves Lane	Groves Lane

Four complaints regarding stream bank erosion, flooding, and stream blockages were registered with the County and included in the database files for this subwatershed. The County processed these complaints.

3.2.2 Storm Drain System Infrastructure

The mid-northern part of this subwatershed is drained by a network of storm drain pipes. The storm sewers outfall into tributaries of East Fork, and range in size from 18 inches to 48 inches. A drain pipe on Western Street discharges water into a dry pond. In North Hill, most of the storm sewers drain into a dry pond located west of Oakcrest drive.

Map 3.5 shows the location of two stream crossings that have an impact on the stream. Crossings that do not have an impact on the stream are not listed. The major crossings in this subwatershed, starting from the upstream end of East Fork, are described as follows:

- South of University Drive: A six-foot diameter circular concrete culvert (PHEF011.C001) has a minor impact on the main stem.
- Braddock Road: An eight-foot by six-foot, two-box concrete culvert (PHEF005.C010) has a minor impact on the main stem.

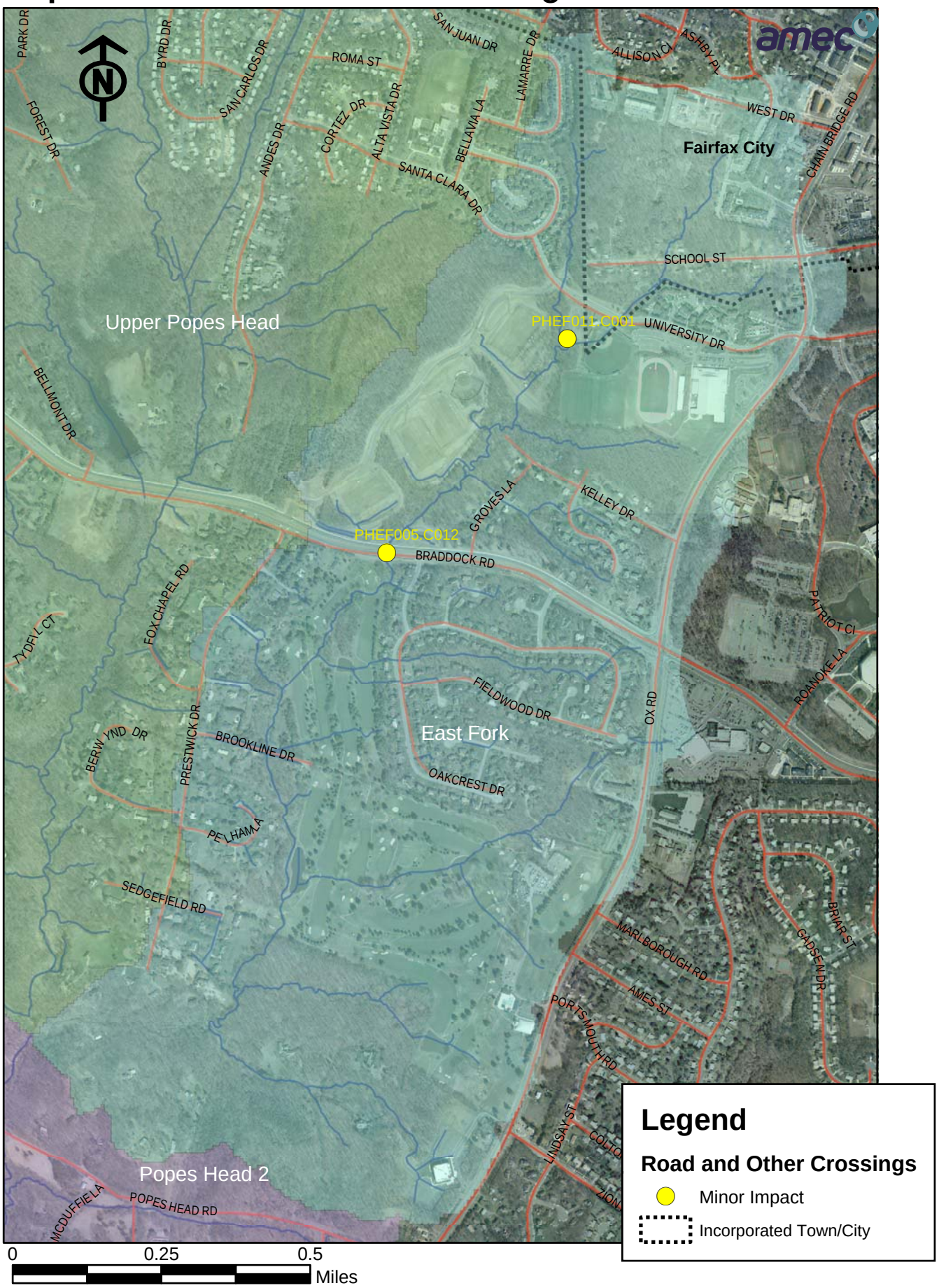
Four storm drain outfall pipes discharge into East Fork. Two of the pipes discharge stormwater from Fairfax City and George Mason University; they are 36-inches in diameter, composed of RCP, and have no impact on the stream. The other two pipes are located downstream; they are each six-inches in diameter, composed of High Density Polyethylene (HDPE), and have no impact on the stream.

Table 3.8 shows the locations of known stormwater management facilities in the subwatershed, as depicted on Map 3.6.

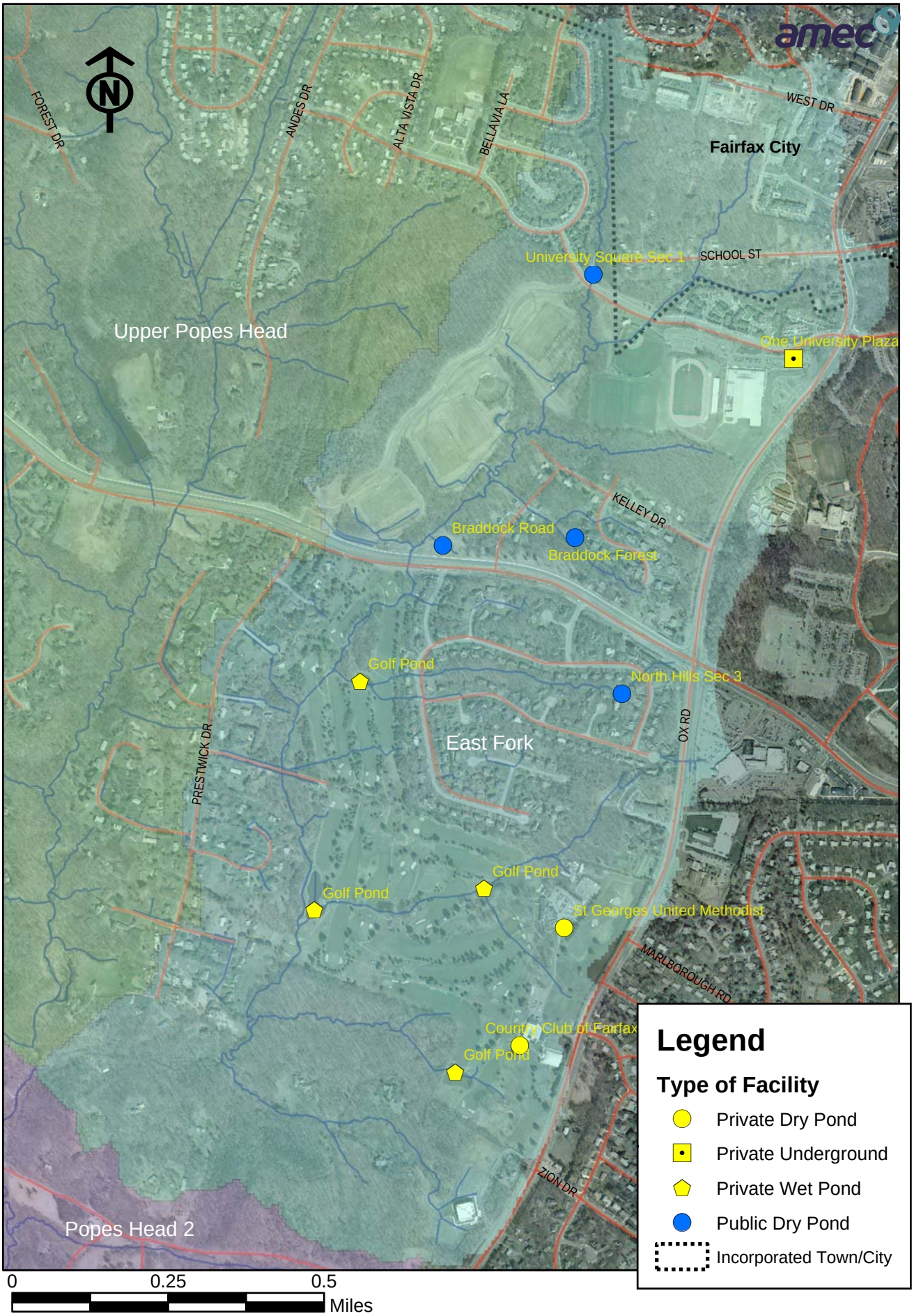
Table 3.8 East Fork Stormwater Management Facilities

Name	Location	Type of Facility
Privately Owned		
St. Georges United Methodist	Ox Road near Glenmont Lane	Dry Pond
One University Plaza	Ox Road and University Drive	Underground
Country Club of Fairfax	Ox Road and Portsmouth Road	Dry Pond
Golf Pond	Country Club of Fairfax	Wet Pond
Golf Pond	Country Club of Fairfax	Wet Pond
Golf Pond	Country Club of Fairfax	Wet Pond
Golf Pond	Country Club of Fairfax	Wet Pond
Publicly Owned		
University Square Sec. 1	West of Clara Dr on University	Dry Pond
Braddock Forest	West of Western St	Dry Pond
Braddock Road	North of Braddock Road and West of Groves Lane	Dry Pond
North Hills Sec 3	West of Oakcrest Dr	Dry Pond

Map 3.5: East Fork Stream Crossings



Map 3.6: East Fork Stream Stormwater Management Facilities



3.2.3 Stream Geomorphology

The geomorphology of the stream segments of East Fork can be summarized as follows:

- The stream reaches exhibit an evenly distributed substrate composed of clay, cobble, gravel, and sand.
- The stream reaches upstream of Braddock Road are of CEM type 3, referring to unstable stream banks and an actively widening channel.
- The stream reaches downstream of Braddock Road are of CEM type 4, referring to stabilizing stream banks and channel development as the stream returns to equilibrium.
- No dumps were observed.
- One erosional area was observed.
- No Head cuts were observed.
- Six obstructions were observed.

3.2.4 Stream Quality

The stream reaches of East Fork are classified as riffle/run stream type. Riffles can be a source of high-quality habitat and diverse fauna; therefore, an increased frequency of occurrence greatly increases the diversity of the stream community. The habitat assessment for East Fork can be summarized as follows:

- Overall, the stream exhibits poor habitat quality.
- The stream reaches upstream of Braddock Road contain two to seven habitat types common in less than 50% of the reach. The stream reaches downstream of Braddock Road contain four different habitat types in more than 50% of the reach.
- The epifaunal substrate of the stream reaches upstream of Braddock Road are composed primarily of a mixture of boulders/bedrock, gravel stones, and/or stable woody debris. Some reaches are composed of rock and sand, with no riffles present. In the stream reaches downstream of Braddock Road, the epifaunal substrate is composed of softball size cobble stones, gravel stones, boulders greater than 10 inches in diameter, and/or stable woody debris.
- The stream reaches upstream of Braddock Road have 60% - 80% embeddedness by sediment and silt. The headwaters have 50% embeddedness by sediment. The stream reaches downstream of Braddock Road have 40% - 50% embeddedness by sediment.
- More than half of the stream reaches have 80% - 90% channel disturbance or stream bank alteration. The remaining stream reaches show 50% - 60% channel disturbance.
- The stream reaches upstream of Braddock Road contain generally flat water or shallow riffles that are not deep enough to allow for fish passage. The stream reaches downstream of Braddock Road contain infrequent riffles or bends with a variable contoured bottom that provide some habitat for aquatic life.
- Water fills 75% of the main stem during normal flow conditions. The remaining stream reaches are 35% - 50% full of water during normal flow conditions.
- The left bank has 50% - 70% vegetation cover composed of shrubs, grasses and forbes. Between 50% - 80% of the right bank has vegetation cover composed of shrubs, grasses and forbes, with a few barren or thin areas present.
- The left banks are moderately unstable and have 40% - 60% erosional areas. The right banks are moderately stable and have 30% - 50% erosional areas.

- The majority of the left and right stream banks have no forested buffer, and are composed primarily of planted lawn grass yards and shrubs.

The general characteristics of the stream water quality were assessed as follows:

- The water had a clear appearance and no odor was detected at any of the assessed stream reaches.
- No fishes or aquatic plants were observed.
- Fertilizer from the Country Club of Fairfax may be washing into the stream.

3.2.5 Stream Ecology

The 2001 *Stream Protection Strategy (SPS) Baseline Study* did not include a sampling site in the East Fork Subwatershed. Therefore, there is no current information available about the condition of the aquatic ecological community in this subwatershed.

3.2.6 Problem Areas from Public Forum

There were no problem areas identified in this subwatershed at the March 27, 2004 Community Watershed Forum.

3.2.7 Modeling Results

The hydrology for East Fork produced stormwater runoff that is relatively high due to dense development in the upper portions of the subwatershed. The increase in discharges due to future development is the highest compared to the other subwatersheds. This is due to the amount of vacant and underdeveloped parcels in the subwatershed. See Table 3.9 for a comparison of the existing and future 2- and 10-year peak discharges in the subwatershed.

Table 3.9 East Fork Peak Runoff Flows

East Fork Discharge Table		Two-Year Rainfall Event			10-Year Rainfall Event		
Location	**Drainage Area**	**Existing Peak Flow (cfs)**	**Future Peak Flow (cfs)**	**% Peak Flow Increase**	**Existing Peak Flow (cfs)**	**Future Peak Flow (cfs)**	**% Peak Flow Increase**
Approximately 900 ft upstream of Braddock Road	0.49	440	530	20%	860	1030	20%
Just downstream of Braddock Road	0.54	570	660	16%	1120	1730	54%
Approximately 1,300 ft downstream of Brookline Drive	1.02	560	660	18%	1180	1790	52%

Velocities produced by the 2-year rainfall event in East Fork were usually below those in the other subwatersheds, averaging 4.8 feet per second. The average velocity is predicted to increase by approximately 28% in the future conditions.

Both the 2- and 10-year peak discharges overtop the channel banks for a majority of the cross sections in the East Fork model. The 2-year is confined to the channel bank in the lower reaches of East Fork. The model shows no structures greater than 500 square feet located in the 10-year floodplain.

While the East Fork subwatershed has the lowest sediment loading rate out of the seven subwatersheds, the predicted sediment load exceeds the target Tributary Strategy level. For future land use conditions, the average sediment loading rate is predicted to increase by 5%.

The East Fork subwatershed has a lower annual pollutant loading for total phosphorus and total nitrogen than five of the seven subwatersheds. This can be attributed to the relatively low percentage of residential development in the watershed. The total phosphorus load exceeds the target Tributary Strategy level and the total nitrogen load is just below the target Tributary Strategy level. For future land use conditions, the loading rate is predicted to increase by 6% for total phosphorus and 7% for total nitrogen.

3.2.8 Summary

The East Fork Subwatershed exhibits poor stream habitat quality throughout the subwatershed. This is likely due to the fact that less than half of the subwatershed is in the rezoned area. Approximately 80% - 90% of the stream channels have been altered, and they have very little vegetated protection to keep the stream banks from eroding. Imperviousness is expected to nearly double, increasing from 14.7% to 27.8%; therefore, stream habitat quality can be expected to continually degrade in the future.

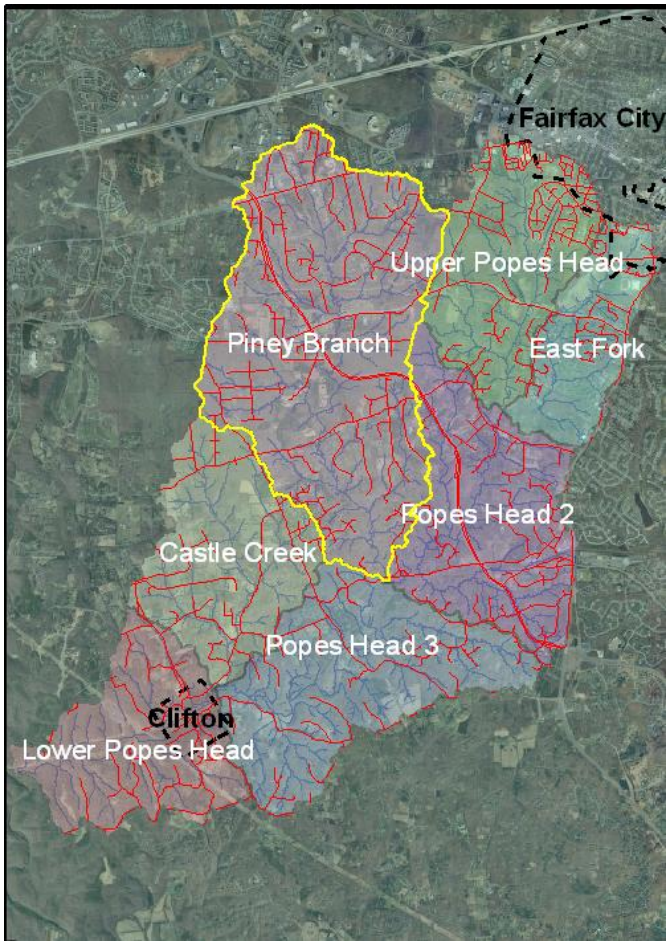
Braddock Road plays an important role in this watershed; in general, the stream reaches upstream of Braddock Road display poorer habitat quality than the stream reaches downstream of Braddock Road. This roughly coincides with the boundaries of the rezoned area in the subwatershed.

3.3 Piney Branch Subwatershed

The Piney Branch Subwatershed is approximately 3,389 acres in area. It is bounded to the northwest by West Ox Road; to the north by Ruffin Drive; to the northeast by the intersection of Lehigh Drive and Village Drive; to the east by Mattie Moore Court, Fairfax County Parkway and Innisvale Drive; to the south by Fairfax Station Road; to the southwest at the intersection of Saddle Horn Drive and Fairfax Hunt Road; and by Colchester Road to the west.

This subwatershed contains several portions of the Piney Branch Stream Valley Park. Braddock Road, Fairfax County Parkway, and Lee Highway are all major thoroughfares in the subwatershed. The Piney Branch Subwatershed is shown on Map 3.7 and its condition is summarized below:

Map 3.7: Location of Piney Branch



3.3.1 Subwatershed Characteristics

The stormwater runoff from this subwatershed drains into Piney Branch, which has its headwaters near the Costco Plaza, located at the intersection of West Ox Road and Lee Highway. Runoff from the Plaza flows southward through the Piney Branch Stream Valley Park and eventually into the Popes Head 3 Subwatershed. Piney Branch is 3.98 miles long, and has many significant tributaries. The existing impervious area of the subwatershed is 10.5% of the total area. Imperviousness is expected to increase to 13.2% in the future, based upon the planned or zoned land uses in the Fairfax County Comprehensive Plan. 83% of the subwatershed is in the rezoned area; the rezoned area was established in 1982 by the Fairfax County Board of Supervisors in order to protect the Occoquan Reservoir. Building density within the rezoned area is reduced, and therefore imperviousness is decreased, reducing the amount of stormwater runoff that is generated. Estate residential is the predominant land use, comprising 35.7% of the total area. Open space is expected to decrease dramatically in the future, providing more space for residential development. Roads and sidewalks are not included in the land use data. Existing and future land uses in the subwatershed are shown in Table 3.10 below.

Piney Branch Subwatershed Condition Summary

- Current Imperviousness = 10.5% with majority of land use Estate Residential
- Future Imperviousness = 13.2%
- Area of 3,389 acres
- 83.0% of the subwatershed is in the rezoned area. Major land uses that are not in the rezoned area include the Costco Plaza and the Piney Branch Stream Valley Park.
- 16 stormwater management facilities currently exist.
- The stream exhibits good to very poor habitat quality
- Active widening and downcutting was observed in the majority of the stream reaches.
- One dump was observed.
- Two head cuts were observed.
- Four obstructions were observed.
- Three out of 47 crossings have minor to severe impacts.

Table 3.10 Piney Branch Land Use

Land Use Description	Existing		Future	
	Acres	%	Acres	%
Estate residential	1104.5	35.7%	1707.9	55.1%
Low-density residential	684.1	22.1%	799.9	25.8%
Medium-density residential	87.2	2.8%	128.8	4.2%
High-density residential	10.7	0.3%	10.6	0.3%
Low-intensity commercial	120.8	3.9%	140.5	4.5%
High-intensity commercial	67.3	2.2%	67.3	2.2%
Industrial	3.8	0.1%	3.8	0.1%
Open Space	1007.3	32.5%	226.7	7.3%
Unknown	11.4	0.4%	11.4	0.4%
TOTAL	3097.1	100.0%	3096.9	100.0%

The subwatershed contains 1,864 parcels, with an average parcel size of 1.66 acres. There are 48 neighborhoods fully within or apportioned within the subwatershed, as listed below:

- Beaumont
- Braddock Farms
- Buckner Forest
- Centennial Hills
- Colchester Heights
- DeBosk
- Fairfax Hunt
- Glen Alden
- Hunt Woods Estates
- Lee Pines
- Legato Acres
- Birchtree
- Braddock Woods
- Cambryar
- Cobbs Corner
- Colchester Hunt
- Decour Estates
- Fairfax Ridge
- Hampton Forest
- Innisvale
- Leehigh Village
- Lincoln Park
- Blevinstown
- Brentwood
- Cannon Ridge
- Colchester Acres
- Colchester Meadow
- Dixie Hill
- Fairfax Woods
- Huntwood Manor
- Lake Fairfax Estates
- Leehigh Woods
- Lewis Park

- Marymead
- Piney Branch
- Robertson Farm
- Station Crossing
- Vannoy Park
- McKay
- Popes Head Estates
- Robeys Meadow
- Ten Penny Woods
- Windsor Gate
- Novak
- Quiet Brook
- Robeys Mill
- Vannoy Acres
- Windsor News

The County's list of master plan drainage projects shows that two of the nine identified projects in this subwatershed has been completed. Table 3.11 summarizes the type of master plan drainage project, project name/location, and current status. No cost estimates were available for these projects.

Table 3.11 Piney Branch Master Plan Drainage Projects

Type of Work	Project Name/Location
Completed Projects	
Raise Road and Replace Culvert	Piney Branch at Braddock Rd
Lower Invert and Replace Culvert	Piney Branch at Lee Highway
Inactive Projects	
Stream Restoration and Stabilization	Near Spruce Avenue
Lower Invert and Replace Culvert	Rochester Drive
Lower Invert and Replace Culvert	Tributary at Braddock Rd
Lower Invert and Replace Culvert	Tributary at Popes Head Rd
Raise Road and Replace Culvert	Piney Branch at Fairfax Station Rd

Three complaints regarding flooding, erosion, and stream channel blockage were registered with the County and included in the database files for this subwatershed. The county addressed two of the complaints by removing the blockages from the drainage system and by preventing erosion.

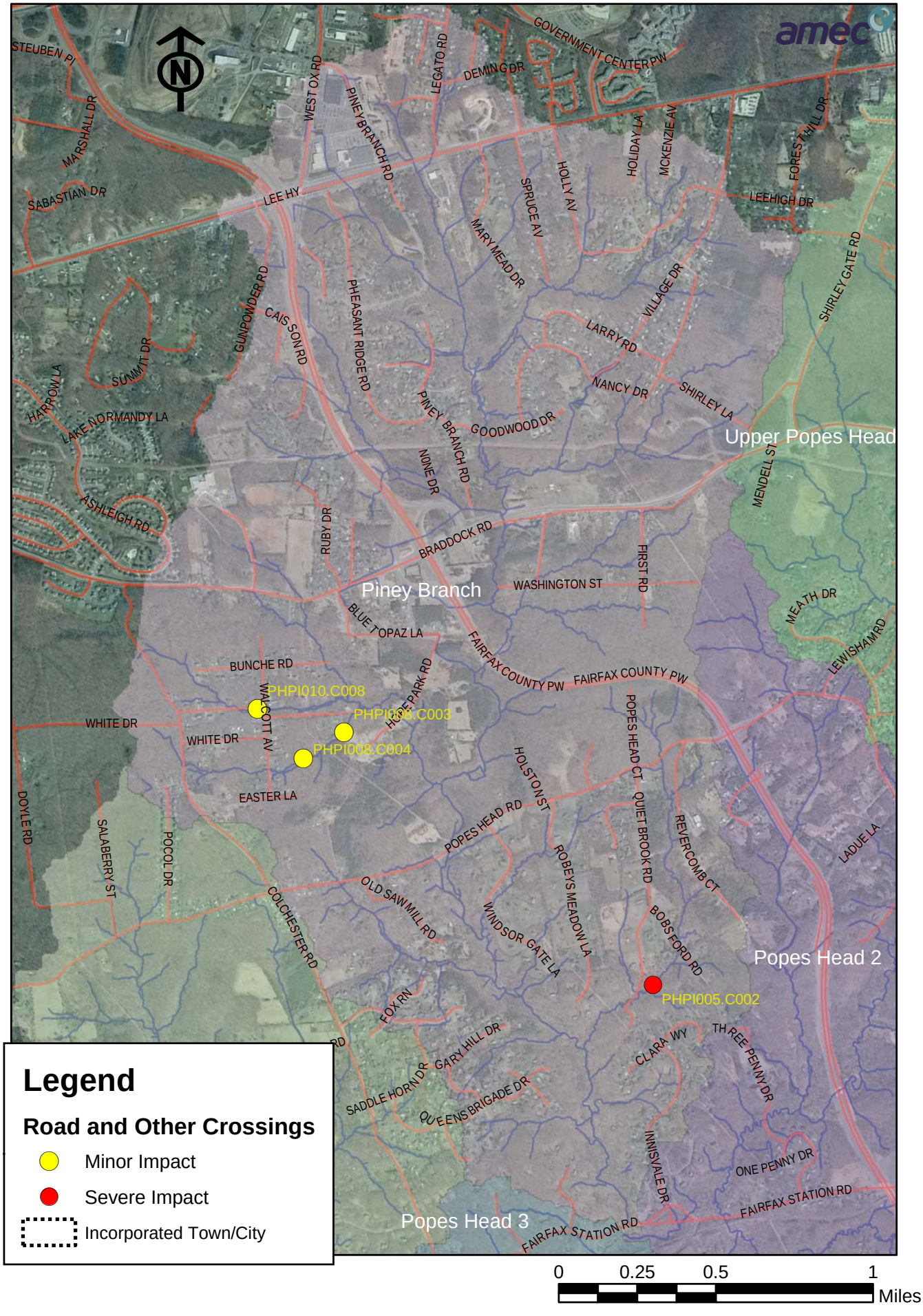
3.3.2 Storm Drain System Infrastructure

Piney Branch does not have a large network of storm drain pipes. Novak contains a small series of storm sewer pipes that discharge into Piney Branch. Colchester Hunt also contains a small network of storm sewer pipes that discharge into three dry ponds. The outfalls vary in size, ranging from 18 inches to 42 inches.

Map 3.8 shows the location of three stream crossings that have an impact on the stream. Crossings that do not have an impact on the stream are not listed. The major crossings in this subwatershed, starting from the upstream end of Piney Branch, are described as follows:

- Rochester Drive: A one-foot diameter, two barrel CMP culvert (PHPI008.C003) has a minor impact on a western tributary.
- Walcott Avenue: A 12-foot natural ford (PHPI008.C004) has a minor impact on the stream, as shown in Photo 3.2
- Quiet Brook Road: A three-foot diameter circular CMP culvert (PBPI005.C001) has no impact on an eastern tributary. To the northeast, a two-foot diameter circular concrete culvert (PHPI005.C002) has a severe impact on the same tributary, as shown in Photo 3.3

Map 3.8: Piney Branch Stream Crossings



Three storm drain outfall pipes discharge into Piney Branch. They range from 24 to 60 inches in diameter, and have no impact on the stream. All of the pipes are made of RCP and discharge from stormwater management ponds.

Photo 3.2 A natural ford (PHPI008.C004) near Walcott Avenue has a minor impact on the stream

Photo 3.3 A concrete culvert (PHPI005.C002) near Quiet Brook Road has a severe impact on the stream

Table 3.12 shows the locations of known stormwater management facilities in the subwatershed, as depicted on Map 3.9.

Table 3.12 Piney Branch Stormwater Management Facilities

Name	Location	Type of Facility
Privately Owned		
St. Mark Coptic Orthodox Church	Braddock Road and 2nd Road	Underground
Sports Authority	North of Lee Hwy and Pheasant Ridge Rd	Wet Pond
Piney Branch Rd Ext.	Lee Hwy and Piney Branch Rd	Dry Pond
Merrifield Garden Ctr.	West of Marymead Rd	Wet Pond
Publicly Owned		
Fairfax Ridge	Lee Hwy and Dixie Branch Rd	Dry Pond
Lee Pines	Pheasant Ridge Rd and Tall Pines Ct	Dry Pond
Marymead	East of Marymead Rd	Dry Pond
Novak	East end of Goodwood Dr	Dry Pond
Brentwood, Sec. 2	Hollow Tree Ln and Piney Branch Rd	Dry Pond
Birchtree Sec. 2	Leehigh Dr and Leehigh Ct	Dry Pond
Braddock Comm. Ctr.	West of 2nd Rd and Washington St (Mott Comm Ctr?)	Dry Pond
Decour Estates Sec. 1	DeCour Court	Dry Pond
Fairfax Hunt Pd 2	West of Fox Run	Dry Pond
Colchester Hunt Sec 2	Kings Color Dr and Brigade Dr	Dry Pond
Fairfax Hunt Pd 3	North end of Fox Run	Dry Pond
Fairfax Hunt Pd 4	North end of Fox Run	Dry Pond

3.3.3 Stream Geomorphology

The geomorphology of the stream segments of Piney Branch can be summarized as follows:

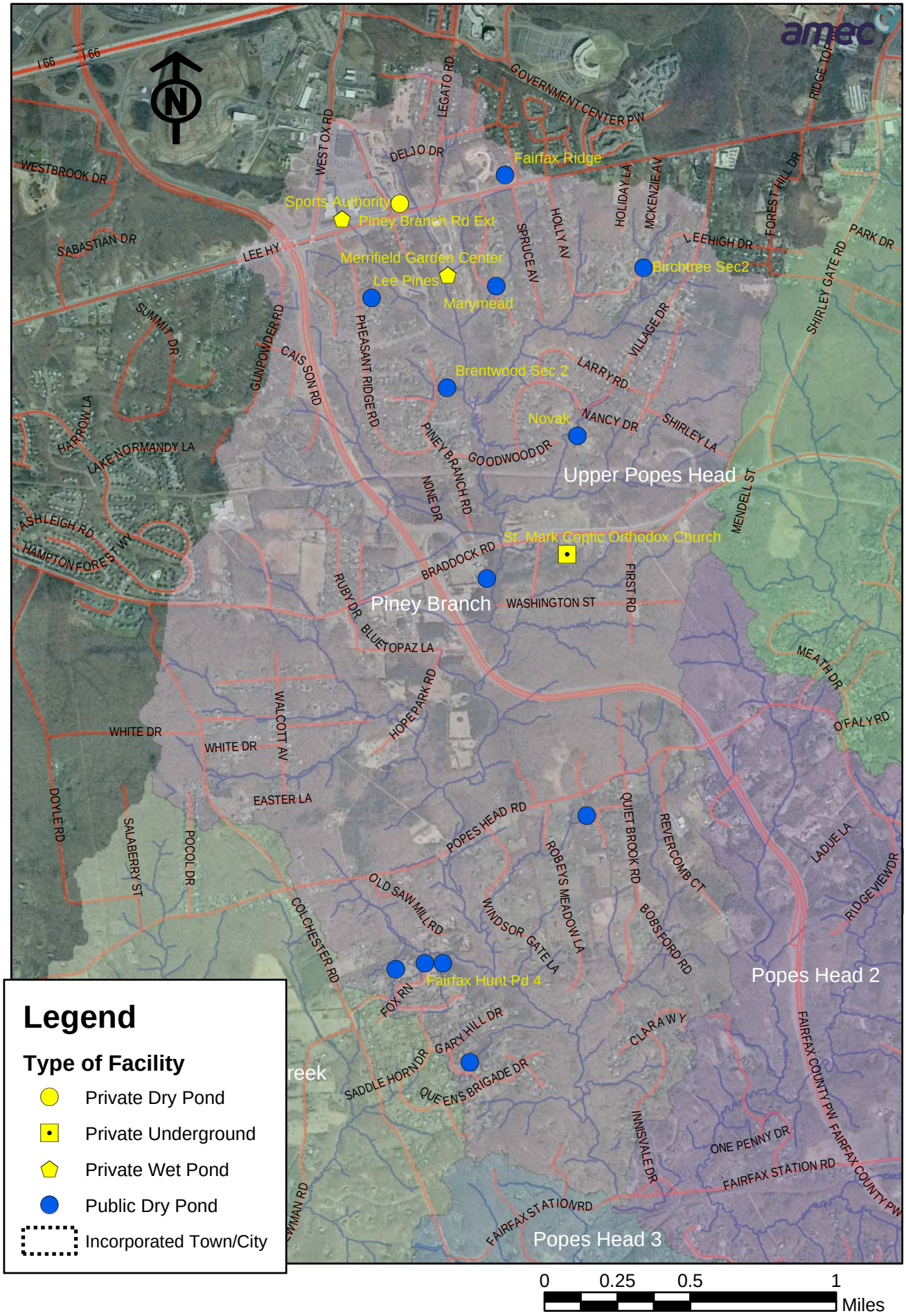
- The dominant substrate of the stream reaches upstream of the Fairfax County Parkway is sand. The dominant substrate of the stream reaches downstream of the Fairfax County Parkway is gravel.
- The majority of the stream reaches are of CEM type 3, referring to unstable stream banks and an actively widening channel. Active widening and downcutting was observed in the majority of the stream reaches.
- The reaches that are downstream of Popes Head Road are of CEM type 4, referring to stabilizing stream banks and channel development. These reaches contain stabilizing point bars that are creating internal meanders.
- One dump was observed.
- No erosional areas were observed.
- Two head cuts were observed.
- Four obstructions were observed.

3.3.4 Stream Quality

The stream reaches of Piney Branch are classified as riffle/run stream type. Riffles are a source of high-quality habitat and diverse fauna; therefore, an increased frequency of occurrence greatly increases the diversity of the stream community. The habitat assessment for Piney Branch can be summarized as follows:

- The stream habitat quality ranges from good to very poor.
- The main stem of Piney Branch downstream of Popes Head Road has four habitat types common in more than 70% of the reach, and seven habitat types common in more than 50% of the reach. The main stem of Piney Branch upstream of Fairfax County Parkway has five habitat types common in more than 50% of the reach. The remaining stream reaches have between two and seven habitat types common in less than 50% of the reach.
- The epifaunal substrate of the main stem of Piney Branch downstream of Popes Head Road is dominated by softball size cobble stones. The main stem upstream of Fairfax County Parkway is composed of a mixture of cobble and gravel stones and/or stable woody debris. The portion of the main stem between Fairfax County Parkway and Popes Head Road contains a well developed riffle run complex composed of gravel stones and boulders/bedrock and/or woody debris. The tributaries of the main stem have smaller riffles that are composed of bedrock and/or gravel stones and/or woody debris, cobble, and boulder stones greater than 10 inches in diameter.
- The stream reaches upstream of Popes Head Road have 60% - 70% embeddedness by sediment and silt. The stream reaches downstream of Popes Head Road have 30% - 50% embeddedness by sediments and silt.
- The stream reaches downstream of Popes Head Road have no evidence of disturbance; the stream follows a normal and natural meandering pattern. The stream reaches between Fairfax County Parkway and Popes Head Road have 5% of

Map 3.9: Piney Branch Stormwater Management Facilities



the channel disturbed or altered. The main stem of Piney Branch upstream of Fairfax County Parkway has between 40% - 70% of the channel disturbed, indicating channelization. The remaining tributaries have 30% - 40% of the channel disturbed, indicating artificial embankments and minor alterations.

- The main stem of Piney Branch downstream of Popes Head Road and portions of the upstream stem have infrequent riffles with variable bottom contours that may provide some habitat for aquatic life. The main stem between Goodwood Road and Popes Head Road has moderately frequent riffles which have adequate depth in the pool and riffle system. The remaining tributaries have infrequent riffles, or flat water and shallow riffles which do not provide an adequate passage for fishes.
- Water fills in 35% - 85% of the channel during normal flow conditions.
- The majority of the left and right stream banks for all reaches have 50% - 70% vegetation cover, consisting of shrubs, grasses, and forbes. The remaining reaches have 70% - 80% plant cover, with some areas thin or barren.
- The main stem of Piney Branch has moderately stable left stream banks, with only 30% erosional areas. The tributaries have moderately unstable banks, with 40% - 60% erosional areas. The right banks are also moderately stable, with only 5% - 30% erosional areas. Several of the tributaries are moderately unstable, with 40% - 50% bank erosional areas.
- The main stem of Piney Branch downstream of the Fairfax County Parkway has forested vegetated buffers greater than 100 feet wide on both the left and right banks. The stream reaches upstream of the Fairfax County Parkway have a forested vegetated buffer of 50 – 100 feet wide, a majority of which is composed of shrubs and a few trees, or planted lawn grass yards.

The general characteristics of the stream water quality were assessed as follows:

- Most of the stream reaches contained water with a clear appearance. The main stem had a turbid appearance between Goodwood Drive and Popes Head Road.
- No odor was detected at any of the assessed stream reaches.
- Small fishes of one to two inches in length were observed throughout the main stem.
- Attached aquatic plants were observed in the stream margin and near riffles in less than 10% of the entire stream bank area.
- Green and brown algae of light density and slime coating were observed throughout the main stem of Piney Branch.

3.3.5 Stream Ecology

The 2001 *Fairfax County Stream Protection Strategy (SPS) Baseline Study* sampled fish and aquatic macroinvertebrates in two different locations in the Piney Branch Subwatershed. The first sampling site (PHPI01), as shown on Map 2.11, is located downstream of Braddock Road and exhibited a poor macroinvertebrate community, which is indicative of degraded water quality. A high number of fish species was observed at this site, which is indicative of a strong community structure and good water quality. The second site (PHPI02), as shown on Map 2.11, is located downstream of Popes Head Road, and exhibited the same conditions as the first site. The disparity in water quality indicators is likely due to the degree of embeddedness found throughout Piney Branch, which primarily affects the benthic community.

3.3.6 Problem Areas from Public Forum

Attendees at the March 27, 2004 Community Watershed Forum noted that unauthorized fill was occurring in the floodplain of Piney Branch near 2nd Street, south of Braddock Road. The Fairfax County Department of Public Works and Environmental Services is aware of the illegal fill and is going through legal proceedings to resolve the issue. The majority of the fill site is in the County's Chesapeake Bay Act Resources Protection Area.

A participant at the January 13, 2004 Issues Scoping Forum noted that erosion is occurring adjacent to 12129 Queens Brigade Drive in the Colchester Hunt Subdivision.

3.3.7 Modeling Results

The hydrology for Piney Branch produced stormwater runoff that is average compared to the other subwatersheds. The increase in discharges due to future development is also average compared to the other subwatersheds. See Table 3.13 for a comparison of the existing and future 2- and 10-year peak discharges in the subwatershed.

Table 3.13 Piney Branch Peak Runoff Flows

Piney Branch Discharge Table		Two-Year Rainfall Event			10-Year Rainfall Event		
Location	**Drainage Area**	**Existing Peak Flow (cfs)**	**Future Peak Flow (cfs)**	**% Peak Flow Increase**	**Existing Peak Flow (cfs)**	**Future Peak Flow (cfs)**	**% Peak Flow Increase**
Approximately 0.44 mi upstream of Goodwood Drive	0.69	860	1000	16%	1670	1900	14%
Just upstream of Braddock Road	2.18	770	800	4%	1550	1560	1%
Approximately 2,000 ft downstream of Popes Head Road	4.04	1070	1130	6%	2190	2210	1%

Velocities produced by the 2-year rainfall event in Piney Branch were average compared to those in the other subwatersheds, averaging 5.7 feet per second. The average velocity is predicted to increase by approximately 4% in the future conditions.

Both the 2- and 10-year peak discharges overtop the channel banks for a majority of the cross sections in the Piney Branch model. The model shows three buildings greater than 500 square feet located in the 10-year floodplain, just upstream of Popes Head Road. Table 3.14 shows a summary of the flooded structures in the subwatershed for different recurrence intervals.

Table 3.14 Piney Branch Flooded Structures

Recurrence Interval	Piney Branch	
	Existing	Future
2	1	1
5	1	2
10	3	3
25	3	3
50	4	4
100	4	4

The Piney Branch subwatershed has an average sediment loading rate compared to the other subwatersheds. The predicted sediment load exceeds the target Tributary Strategy level. For future land use conditions, the average sediment loading rate is predicted to increase by 1%.

The Piney Branch subwatershed has an average pollutant loading for total phosphorus and total nitrogen as compared to the other subwatersheds. The total phosphorus load exceeds the target Tributary Strategy level and the total nitrogen load is just below the target Tributary Strategy level. For future land use conditions, the loading rate is predicted to increase by 2% for both total phosphorus and total nitrogen.

3.3.8 Summary

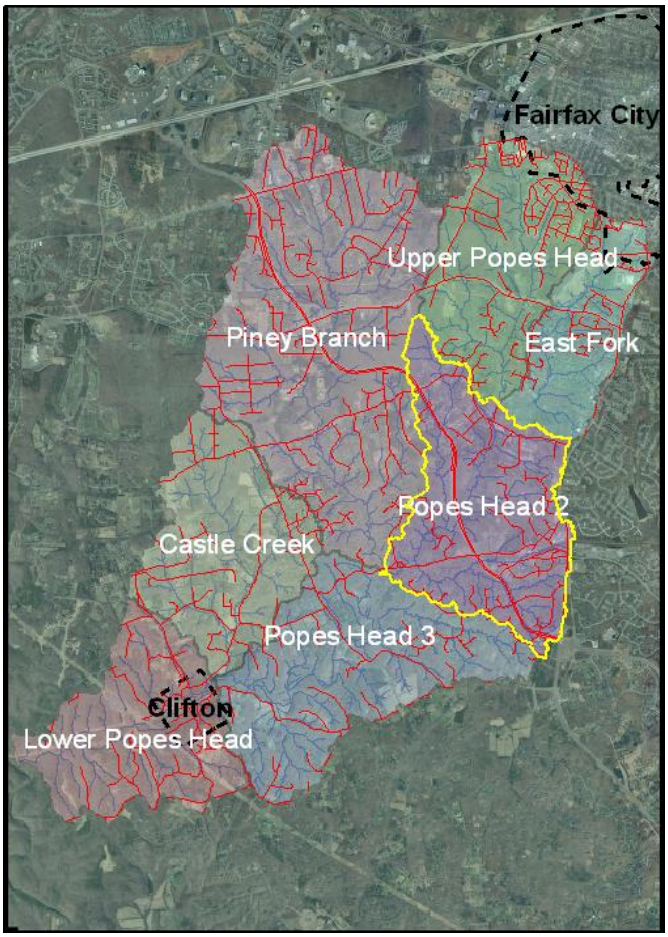
The stream habitat quality in the Piney Branch Subwatershed ranges from good to very poor. In general, the stream reaches upstream of the Fairfax County Parkway are in poorer condition than the stream reaches downstream. The entire main stem exhibited green and brown algae; this might be indicative of excessive nutrients running off from land.

Both the 2- and 10-year peak discharges overtop the channel banks for a majority of the cross sections in the Piney Branch model. The Piney Branch subwatershed has average sediment, phosphorus, and nitrogen loading rate compared to the other subwatersheds. For future land use conditions, the average sediment loading rate is predicted to increase by 1%, and the loading rate is predicted to increase by 2% for both total phosphorus and total nitrogen.

3.4 Popes Head 2 Subwatershed

The Popes Head 2 Subwatershed has an area of approximately 1,732 acres and contains the eastern portion of the Popes Head Creek main stem. It is bounded to the north by Popes Head Road and Meath Drive; to the east by Ox Road; to the south by Robert Carter Road and Clara Barton Road; to the southwest by Innisvale Road, and to the northwest by the Fairfax County Parkway.

Map 3.10: Location of Popes Head 2



The Fairfax County Parkway, Popes Head Road, and Fairfax Station Road are all major thoroughfares in the subwatershed. The Popes Head 2 Subwatershed is shown on Map 3.10 and its conditions are summarized below.

3.4.1 Subwatershed Characteristics

The stormwater runoff from this subwatershed drains into Popes Head Creek, which has its headwaters at the confluence of the Upper Popes Head and East Fork Subwatersheds. It flows southwestward for a distance of 2.61 miles before it reaches the Popes Head 3 subwatershed. There are several small tributaries that are over 1,000 feet long, and one long tributary that is over 8,000 feet long.

The existing imperviousness of this subwatershed is 12% of the total area. Imperviousness is expected to increase to 15.4% in the future, based upon the planned and zoned land uses in the Fairfax County Comprehensive Plan. 97.8% of the subwatershed is in the rezoned area; the rezoned area was established in 1982 by the Fairfax County Board of Supervisors in order to protect the Occoquan Reservoir. Building density within the rezoned area is reduced, and therefore imperviousness is decreased, reducing the amount of stormwater runoff that is generated. Land use in the subwatershed is predominantly estate residential, which comprises 50% of the area. Low-density residential also comprises a significant portion of the watershed area, totaling 24.2% of the total area. Estate residential and low-density residential are expected to total approximately 87.3% of the subwatershed area in the future, while open space area will decrease to 1.5%. Roads and sidewalks are not included in the land use data. The existing and future land uses in the Popes Head 2 Subwatershed are described in Table 3.15.

Popes Head 2 Subwatershed Condition Summary

- Current Imperviousness = 12.0% with majority of land use Estate Residential
- Future Imperviousness = 15.4%
- Area of 1,732 acres.
- 97.8% of the subwatershed is in the rezoned area.
- Six stormwater management facilities currently exist.
- The stream exhibits fair to poor habitat quality.
- Three dumps were observed.
- No head cuts were observed.
- Five obstructions were observed.
- Ten out of 26 crossings have minor impacts.

Table 3.15 Popes Head 2 Land Use

Land Use Description	Existing		Future	
	Acres	%	Acres	%
Estate residential	791.2	50.0%	999.5	63.2%
Low-density residential	383.6	24.2%	381.9	24.1%
Medium-density residential	22.7	1.4%	23.4	1.5%
High-density residential	0.1	0.0%	0.1	0.0%
Low-intensity commercial	103.4	6.5%	136.3	8.6%
High-intensity commercial	7.7	0.5%	9	0.6%
Industrial	35.6	2.2%	9.2	0.6%
Open Space	238.1	15.0%	23	1.5%
Unknown	0	0.0%	0	0.0%
TOTAL	1582.4	100.0%	1582.4	100.0%

The subwatershed consists of 910 parcels, with an average size of 1.74 acres per parcel. There are 20 neighborhoods fully within or apportioned within the subwatershed, as listed below:

- Barton Place
- Chilton Wood
- Fairview Woods
- Oak Brook
- Popes Head Mill Estates
- Smoke Rise
- Ten Penny Woods
- Beaumont
- Colchester Meadow
- Innisvale
- The Patterns
- Popes Head View
- Station Crossing
- West Ridge Estates
- Beech Ridge Estates
- Fairfax Station
- Lincoln Park
- Pickwick Woods
- Ridges of Glendilough
- Station Hills

The County's list of master plan drainage projects shows the one identified project in this subwatershed is inactive. Table 3.16 summarizes the type of master plan drainage project, project name/location, and current status. No cost estimates were available for these projects.

Table 3.16 Popes Head 2 Master Plan Drainage Projects

Type of Work	Project Name/Location
Inactive Project	
Raise Road and Replace Culvert	Popes Head Tributary 3 at Fairfax Station Rd

Twelve complaints regarding erosion, channel blockage, and flooding were registered with the County and included in the database files for this subwatershed. The County addressed six of the complaints by removing the blockages from the drainage system.

3.4.2 Existing Stormwater Management Facilities

Popes Head 2 does not have an extensive network of storm drain pipes; however, it does have several small networks that service the neighborhoods. The outfalls vary in size, ranging from 15 inches to 47 inches. Most of the outfalls discharge into Popes Head Creek. Barton Place is serviced by a small network of storm drain pipes which discharge into an underground storage facility. The Fairfax Station Shopping Center also has a network of storm drain pipes that discharge into an underground storage facility.

Map 3.11 shows the location of 10 stream crossings that have an impact on the stream. Crossings that do not have an impact on the stream are not listed. The major crossings in this subwatershed, starting from the upstream end of Popes Head 2, are described as follows:

- Popes Head Road: A two-foot diameter, circular CMP culvert (PHPH036.C002) has a minor impact on a western tributary, as shown in Photo 3.4. Immediately adjacent to it, a one-foot diameter circular concrete culvert (PHPH036.C001) has a minor impact on the same tributary. To the south, a two-foot diameter circular concrete culvert (PHPH035.C001) has a minor impact on the same tributary.
- Fairfax County Parkway: A three-foot diameter circular CMP culvert (PHPH033.C006) and a three-foot diameter circular CMP culvert (PHPH033.C007) both have minor impacts on the same tributary.
- McDuffie Lane: A two-foot diameter circular CMP culvert (PHPH039.C002) has a minor impact on an eastern tributary, as shown in Photo 3.5.
- Beech Ridge Drive: A three-foot diameter circular CMP culvert (PHPH039.C003) has a minor impact on an eastern tributary.
- Smoke Rise Lane: A six-foot diameter circular CMP culvert (PHPH038.C002) has a minor impact on an eastern tributary.
- Fairfax Station Road: A four-foot diameter elliptical concrete culvert (PHPH028.C002) has a minor impact on the main stem, as shown in Photo 3.6.
- Fairfax County Parkway: A six-foot by six-foot box concrete culvert (PHPH028.C003) has a minor impact on an eastern tributary, as shown in Picture 3.7.

Map 3.11: Popes Head 2 Stream Crossings

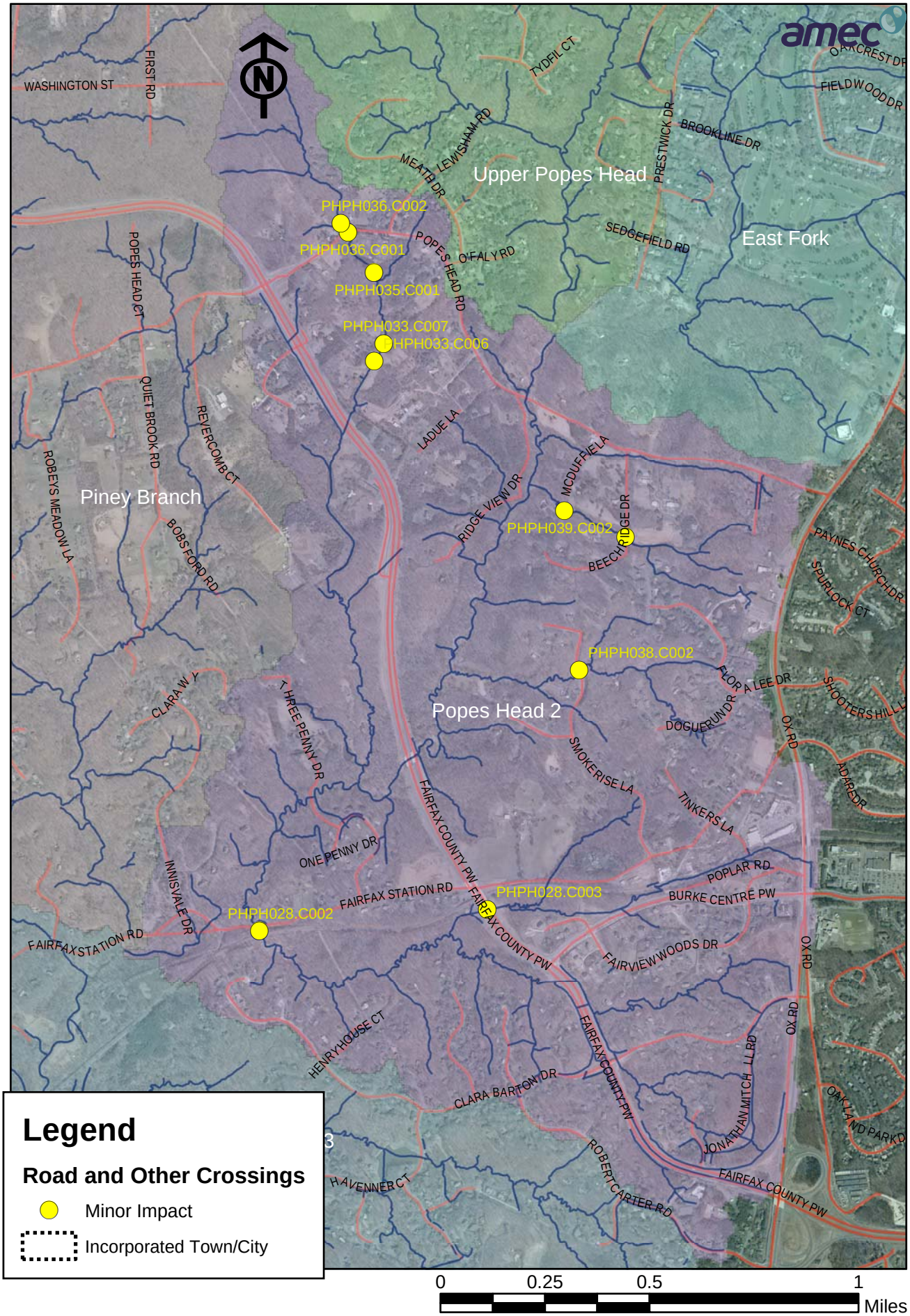


Photo 3.4 A culvert (PHPH036.C002) at Popes Head Road has a minor impact on the stream

Photo 3.5 A culvert (PHPH039.C002) at McDuffie Lane has a minor impact on the stream

Photo 3.6 A culvert (PHPH028.C002) at Fairfax Station Road has a minor impact on the stream

Photo 3.7 A box culvert (PHPH028.C003) near Fairfax County Parkway has a minor impact on the stream

Nine storm drain outfall pipes discharge into Popes Head 2. The pipes are made of PVC, iron, RCP, CMP, and HDPE. The two northernmost pipes have a minor impact on the stream. The remaining pipes have no impact on the stream.

Table 3.17 shows the locations of known stormwater management facilities in the subwatershed, as depicted on Map 3.12.

Map 3.12: Popes Head 2 Stormwater Management Facilities

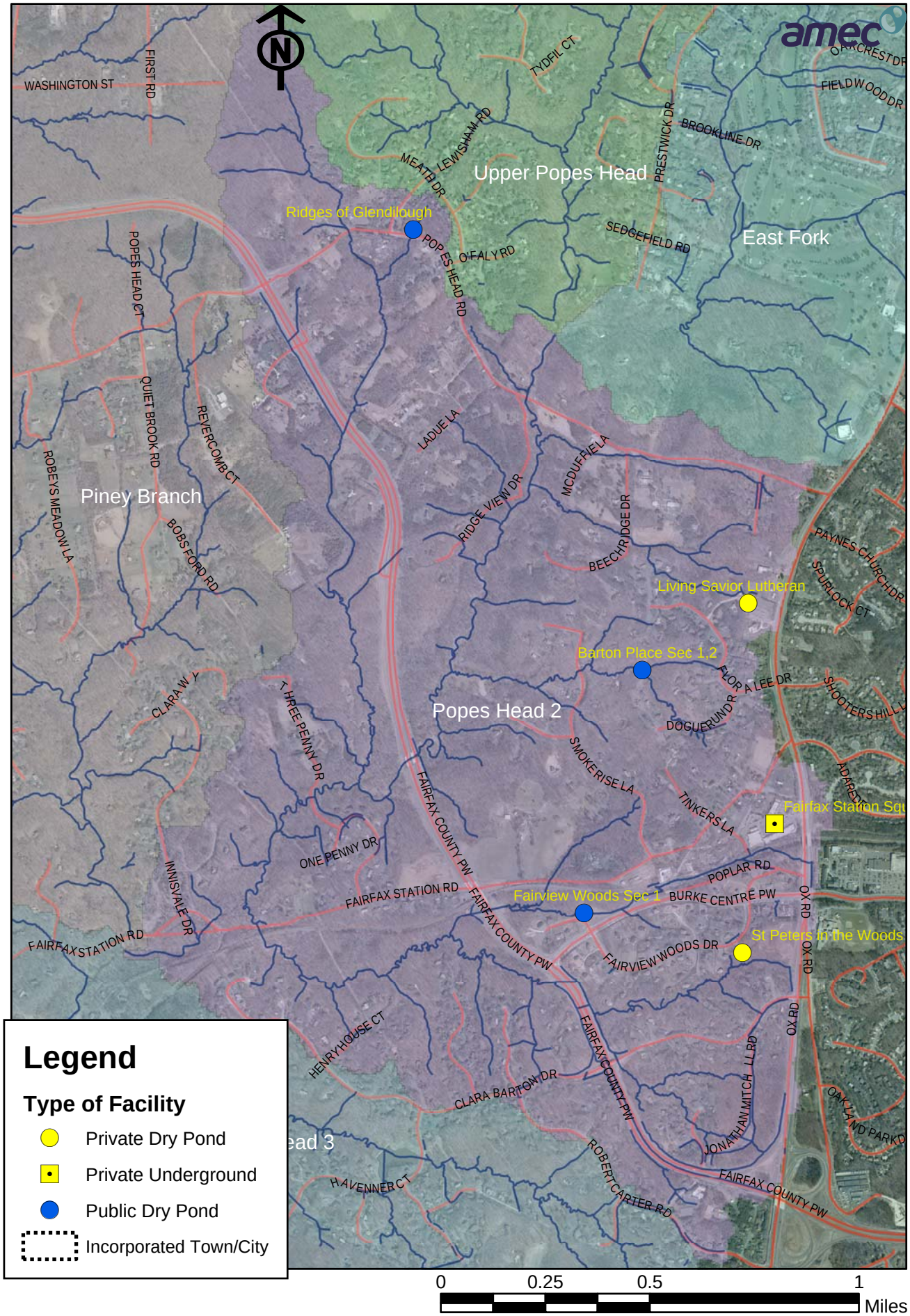


Table 3.17 Popes Head 2 Stormwater Management Facilities

Name	Location	Type of Facility
Privately Owned		
Living Savior Lutheran	North end of Four Stairs Ct	Dry Pond
Fairfax Station Square Shopping Center	Ox Road and CSX Railroad	Underground
St Peters in the Woods	Southeast Fairview Woods Dr	Dry Pond
Publicly Owned		
Fairview Woods Sec. 1	Fairview Woods Dr and North of Burke Center PW	Dry Pond
Ridges of Glendilough	East of Lewisham Rd and Popes Head Rd	Dry Pond
Barton Place Secs 1,2	West of Mary Fairfax Ct	Dry Pond

3.4.3 Stream Geomorphology

The geomorphology of the stream segments of Popes Head 2 can be summarized as follows:

- The dominant substrate throughout the main stem is cobble and cobble/bedrock, with gravel and sand being present in the tributaries.
- The main stem of Popes Head 2 upstream of the Fairfax County Parkway are of CEM type 4, referring to stream bank stabilization and channel deepening.
- The majority of the other stream reaches are of CEM type 3, referring to unstable stream banks and an actively widening channel.
- Three dumps were observed.
- No head cuts or erosion was observed.
- Five obstructions were observed.

3.4.4 Stream Quality

The stream reaches of Popes Head 2 are classified as riffle/run stream type. Riffles are a source of high-quality habitat and diverse fauna; therefore, an increased frequency of occurrence greatly increases the diversity of the stream community. The habitat assessment for Popes Head 2 can be summarized as follows:

- The stream exhibits fair to poor habitat quality.
- The main stem upstream of the Fairfax County Parkway contains between four to seven habitats in greater than 50% of the reach; the tributaries contain three to seven habitats in less than 50% of the reach.
- The majority of the stream reaches has a riffle as wide as the stream, and an epifaunal substrate composed of a mixture of gravel stones and boulders/bedrock and/or stable woody debris, cobble and boulder stones, and softball size cobble stones.
- The main stem has 40% - 50% embeddedness by sediment and silt. The tributaries have 50% - 70% embeddedness by sediment and silt.
- Only 5% - 30% of the stream reaches in the main stem have channel alteration or disturbance; artificial embankments are present but there is no evidence of recent

alteration. The tributary banks are 40% - 70% altered, showing channelization and dredging.

- The main stem contains frequent riffles with adequate depth in pools and riffles; the tributaries have infrequent riffles with variable bottom contours that provide some habitat.
- The main stem upstream of the Fairfax County Parkway is 80% - 85% full of water during normal flow conditions. The remaining stream reaches are 25% - 75% full of water during normal flow conditions.
- The main stem upstream of the Fairfax County Parkway exhibited 70% vegetation cover, typically of shrubs, grasses and forbes on the left and right banks. The remaining stream reaches exhibited 60% vegetation cover on both banks.
- The majority of the stream reaches exhibited moderately unstable banks, with 40% - 70% erosional areas on both the left and right banks.
- The majority of the stream reaches have a forested vegetated buffer zone 50 – 100 feet wide consisting of shrubs, trees, old fields, and planted lawn grass yards. This was observed on both the left and right banks.

The general characteristics of the stream water quality were assessed as follows:

- The water had a clear appearance and no odor was detected.
- Small fishes of one to two inches in length were observed in the southern reaches of the main stem and the connecting western tributary.
- Free floating vegetation in more than 50% of the entire stream bank area was found in an upstream stream segment; this vegetation was accompanied by green algae of heavy density and a slime coating.
- At the southernmost stream reach, attached vegetation was observed in the stream margin in less than 10% of the entire stream bank area; this vegetation was accompanied by brown algae of light density and a slime coating.

3.4.5 Stream Ecology

The 2001 *Fairfax County Stream Protection Strategy (SPS) Baseline Study* sampled fish and aquatic macroinvertebrates in two different locations in the Popes Head 2 Subwatershed. The first sampling site (PHPH01), as shown on Map 2.11, is located downstream of Popes Head Road and exhibited a poor macroinvertebrate community, which is indicative of degraded water quality. A high number of fish species was observed at this site, which is indicative of a strong community structure and good water quality. The second site (PHPH02), as shown on Map 2.11, is located downstream of Fairfax Station Road, and exhibited a fair macroinvertebrate community and a moderate number of fish species present; this is indicative of fair water quality.

3.4.6 Problems from Public Forum

There were no problem areas identified in this subwatershed at the March 27, 2004 Community Watershed Forum.

3.4.7 Modeling Results

The hydrology for the Popes Head 2 subwatershed produced stormwater runoff that is high compared to the other subwatersheds. This is due to a greater percentage of developed areas and commercial areas located along Ox Road. The increase in

discharges due to future development is also slightly higher when compared to the other subwatersheds. See Table 3.18 for a comparison of the existing and future 2- and 10-year peak discharges in the subwatershed.

Table 3.18 Popes Head 2 Peak Runoff Flows

Popes Head 2 Discharge Table		Two-Year Rainfall Event			10-Year Rainfall Event		
Location	**Drainage Area**	**Existing Peak Flow (cfs)**	**Future Peak Flow (cfs)**	**% Peak Flow Increase**	**Existing Peak Flow (cfs)**	**Future Peak Flow (cfs)**	**% Peak Flow Increase**
Just downstream of the confluence with East Fork River	3.56	1460	1680	15%	2700	3200	19%
Approximately 1,850 ft downstream of Popes Head Road	3.98	1500	1710	14%	2810	3240	15%
Approximately 1,500 ft upstream of Fairfax County Parkway	4.38	1730	1990	15%	3420	3800	11%

Velocities produced by the 2-year rainfall event in Popes Head 2 were lower than average when compared to those in the other subwatersheds, averaging 5.2 feet per second. Velocities on Tributaries 2 and 3 were the highest, averaging 7.2 feet per second. The average velocity is predicted to increase by approximately 12% in the future conditions.

Both the 2- and 10-year peak discharges overtop the channel banks along Popes Head Creek and its tributaries in the Popes Head 2 subwatershed. The model shows one building greater than 500 square feet located in the 10-year floodplain, on Sally Ford Court. Table 3.19 shows a summary of the flooded structures in the subwatershed for different recurrence intervals.

Table 3.19 Popes Head 2 Flooded Structures

Recurrence Interval	Popes Head 2	
	Existing	Future
2	0	0
5	1	1
10	1	1
25	1	1
50	1	1
100	1	1

The Popes Head 2 subwatershed has a sediment loading rate higher than five of the seven subwatersheds. This is due to a greater percentage of residential and commercial development than several of the other watersheds. The predicted sediment load exceeds the target Tributary Strategy level. For future land use conditions, the average sediment loading rate is predicted to increase by 3%.

The Popes Head 2 subwatershed has a higher pollutant loading rate for total phosphorus and total nitrogen than five of the seven other subwatersheds. The total phosphorus load exceeds the target Tributary Strategy level and the total nitrogen load is just below the target Tributary Strategy level. For future land use conditions, the loading rate is predicted to increase by 5% for both total phosphorus and total nitrogen.

3.4.8 Summary

The Popes Head 2 Subwatershed exhibits fair to poor stream habitat quality. It is in unexpectedly poor condition considering that it has nearly 98% of its area within the rezoned area. In general, the stream reaches upstream of the Fairfax County Parkway exhibit better stream habitat quality than the other reaches in this subwatershed.

Velocities produced by the 2-year rainfall event in Popes Head 2 were lower than average when compared to those in the other subwatersheds, averaging 5.2 feet per second. Both the 2- and 10-year peak discharges overtop the channel banks along Popes Head Creek and its tributaries in the Popes Head 2 subwatershed.

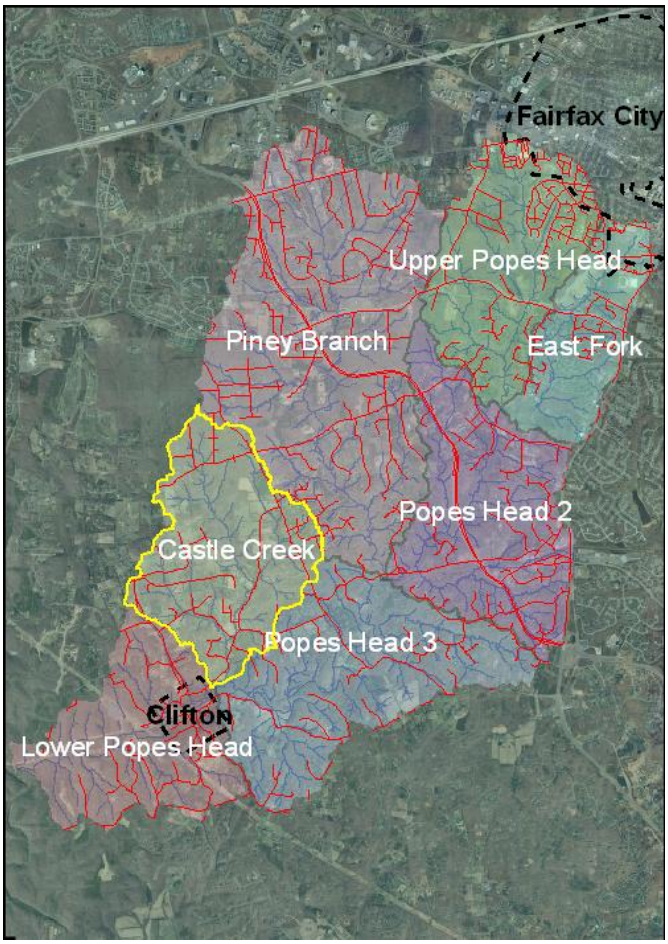
The Popes Head 2 subwatershed has a sediment loading rate higher than five of the seven subwatersheds. This is due to a greater percentage of residential and commercial development than several of the other watersheds. It has a higher pollutant loading rate for total phosphorus and total nitrogen than five of the seven other subwatersheds. The total phosphorus load exceeds the target Tributary Strategy level and the total nitrogen load is just below the target Tributary Strategy level.

3.5 Castle Creek Subwatershed

The Castle Creek Subwatershed has an area of approximately 1,477 acres and contains the main stem of Castle Creek, which is a western tributary of Popes Head Creek. It is bounded on the north and east by Colchester Road; to the south by Clifton Road and Newman Road; and to the west by Stallion Road.

The Castle Creek Subwatershed is shown on Map 3.13 and its condition is summarized below.

Map 3.13: Location of Castle Creek



3.5.1 Subwatershed Characteristics

The stormwater runoff from this subwatershed drains into Castle Creek, which has its headwaters at Popes Head Road. It flows southward for a length of 2.22 miles before reaching the Popes Head 3 Subwatershed.

The existing imperviousness in the subwatershed is 5.6% of the total area. Imperviousness is expected to increase to 8.2% in the future, based upon the planned or zoned land uses in the Fairfax County Comprehensive Plan. All the land in this subwatershed is in the rezoned area; the rezoned area was established in 1982 by the Fairfax County Board of Supervisors in order to protect the Occoquan Reservoir. Building density within the rezoned area is reduced, and therefore imperviousness is decreased, reducing the amount of stormwater runoff that is generated. Land use in the subwatershed is predominantly estate residential, which comprises 71.3% of the area. Open space comprises 20.6% of the total subwatershed area. Estate residential area is expected to increase to 91.6% of the total area, while open space will be consumed, leaving only 0.3% remaining. Roads and sidewalks are not included in the land use data. The existing and future land uses in the Castle Creek Subwatershed are described in Table 3.20.

Castle Creek Subwatershed Condition Summary

- Current Imperviousness = 5.6% with majority of land use Estate Residential.
- Future Imperviousness = 8.2%
- Area of 1,477.0 acres.
- 100.0% of the subwatershed is in the rezoned area.
- Three stormwater management facilities currently exist.
- The stream exhibits poor habitat quality.
- The majority of the stream reaches exhibited active downcutting and channel widening.
- One head cut was observed.
- Three obstructions were observed.
- Four out of 24 crossings have minor to moderate impacts.
- Stream reaches that intersect residential lots are in very poor condition
- A goat pasture near Newman Road might be affecting water quality.
- Waterfowl in a Wycklow Road residential pond may be affecting water quality.

Table 3.20 Castle Creek Land Use

Land Use Description	Existing		Future	
	Acres	%	Acres	%
Estate residential	1029	71.3%	1321.7	91.6%
Low-density residential	107.2	7.4%	107.2	7.4%
Medium-density residential	6.2	0.4%	6.2	0.4%
High-density residential	0	0.0%	0	0.0%
Low-intensity commercial	4.2	0.3%	4.2	0.3%
High-intensity commercial	0	0.0%	0	0.0%
Industrial	0	0.0%	0	0.0%
Open Space	296.8	20.6%	4.1	0.3%
Unknown	0	0.0%	0	0.0%
TOTAL	1443.4	100.0%	1443.4	100.0%

The subwatershed consists of 470 parcels, with an average size of 3.07 acres per parcel. Castle Creek has the largest average parcel size of all of the subwatersheds, due to prevalence of Estate Residential land use. There are 25 neighborhoods fully within or apportioned within the subwatershed, as listed below:

- Braddock Woods
- Chequers of Clifton
- Cloverleaf Farm Estates
- Colchester Hunt
- Debusk
- Lewis Park
- The Patterns
- Ten Penny Woods
- Burwyck
- Clifton Green
- Colchester Acres
- Colewood Estates
- Fairfax Hunt
- MeGills Crossing
- Southern Pines
- Vannoy Park
- Wonderland
- Chadwicke
- Clifton Overlook
- Colchester Hills
- Cranston
- Ferguson Knolls
- Paradise Spring
- Swayze
- Wilguson Hills

The County's list of master plan drainage projects shows that the two identified projects in this subwatershed are inactive. Table 3.21 summarizes the type of master plan drainage project, project name/location, and current status. No cost estimates were available for these projects.

Table 3.21 Castle Creek Master Plan Drainage Projects

Type of Work	Project Name/Location
Inactive Projects	
Raise Road and Replace Culvert	Castle Creek at Newman Rd
Raise Road	Tributary at Newman Rd
Lower Invert and Replace Culvert	Tributary at Colchester Rd
Lower Invert and Replace Culvert	Tributary at Newman Rd

Only one complaint regarding a clogged culvert was processed by the County and included in the database files for this subwatershed.

3.5.2 Existing Stormwater Management Facilities

Castle Creek does not have an extensive network of storm drain pipes; however, it does have a small network that services one of the neighborhoods. Colchester Hunt is serviced by a series of storm drain pipes, ranging from 18 inches to 42 inches in diameter, which discharge into two different dry ponds and Castle Creek.

Map 3.14 shows the location of four stream crossings that have an impact on the stream. Crossings that do not have an impact on the stream are not listed. The major crossings in this subwatershed, starting from the upstream end of Castle Creek, are described as follows:

- Knollbrook Drive: A three-foot diameter circular concrete culvert (PHCC004.C008) has a moderate impact on a western tributary, as shown in Photo 3.8.
- Knollbrook Drive: A two-foot diameter circular CMP culvert (PHCC005.C002) has a minor impact on a western tributary, as shown in Photo 3.9.
- Newman Road: A two-foot diameter, circular CMP culvert (PHCC006.C001) has a minor impact on the main stem, as shown in Photo 3.10.
- Wandering Lane: A two-foot diameter circular concrete culvert (PHCC004.C002) has a moderate impact on the main stem, as shown in Picture 3.11.

Map 3.14: Castle Creek Stream Crossings

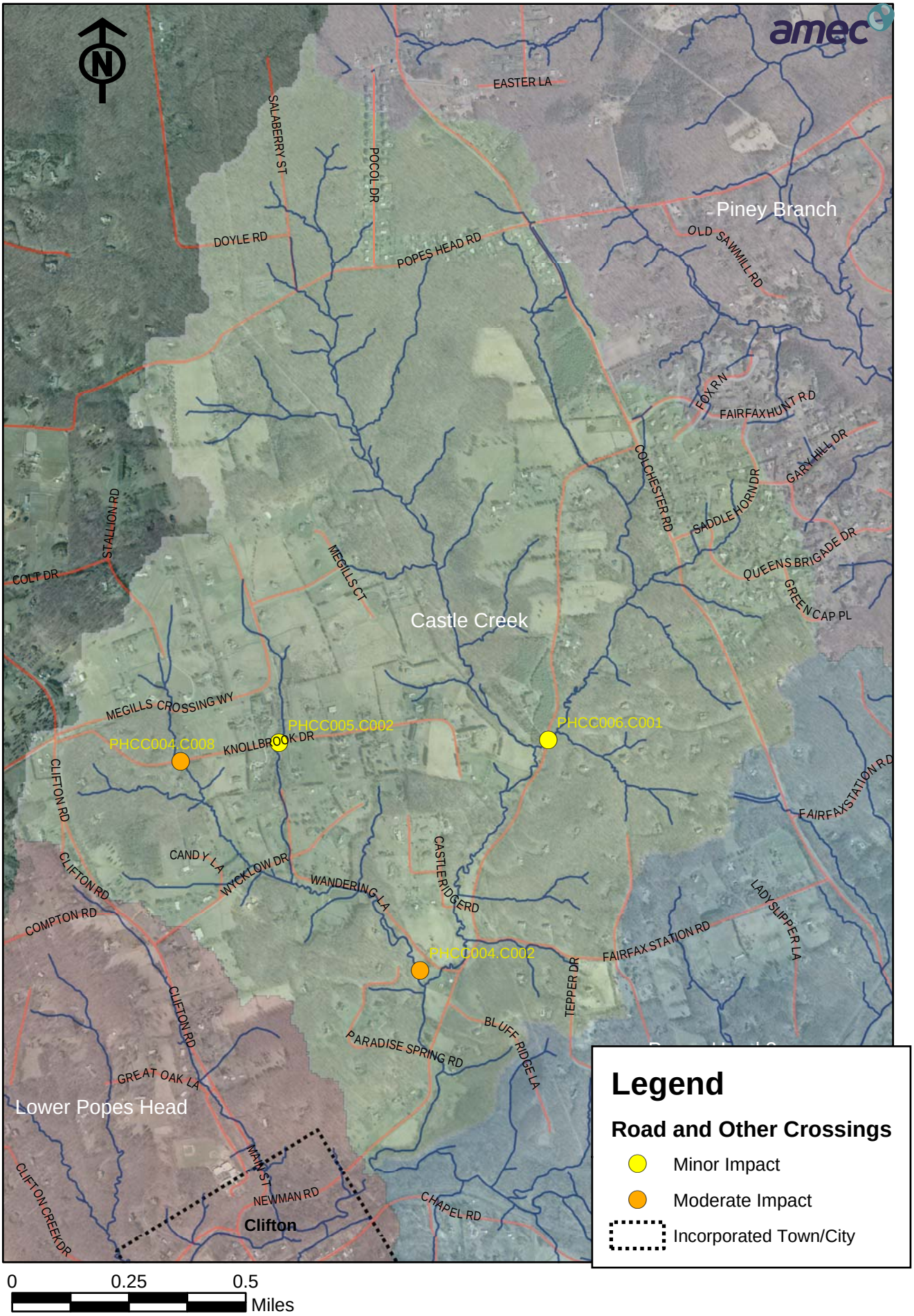


Photo 3.8 A culvert (PHCC004.C008) at Knollbrook Drive has a moderate impact on the stream

Photo 3.9 A culvert (PHCC005.C002) at Knollbrook Drive has a minor impact on the stream

Photo 3.10 A double culvert (PHCC006.C001) at Newman Road has a minor impact on the stream

Photo 3.11 A culvert (PHCC004.C002) at Wandering Lane has a moderate impact on the stream

Five storm drain outfall pipes discharge into Castle Creek. One pipe causes moderate erosion, as shown in Photo 3.12.

Photo 3.12 A storm drain outfall pipe near Wandering Lane has a moderate impact on the stream

Table 3.22 shows the locations of known stormwater management facilities in the subwatershed, as depicted on Map 3.15.

Table 3.22 Castle Creek Stormwater Management Facilities

Name	Location	Type of Facility
Publicly Owned		
Fairfax Hunt Pd 1	Colchester Rd and Newman Rd	Dry Pond
Colchester Hunt Section 4, Pond 1	South of Saddlehorn Dr and Colchester Dr	Dry Pond
Colchester Hunt Section 4, Pond 2	South of Saddlehorn Dr and Colchester Dr	Dry Pond

3.5.3 Stream Geomorphology

The geomorphology of the stream segments of Castle Creek can be summarized as follows:

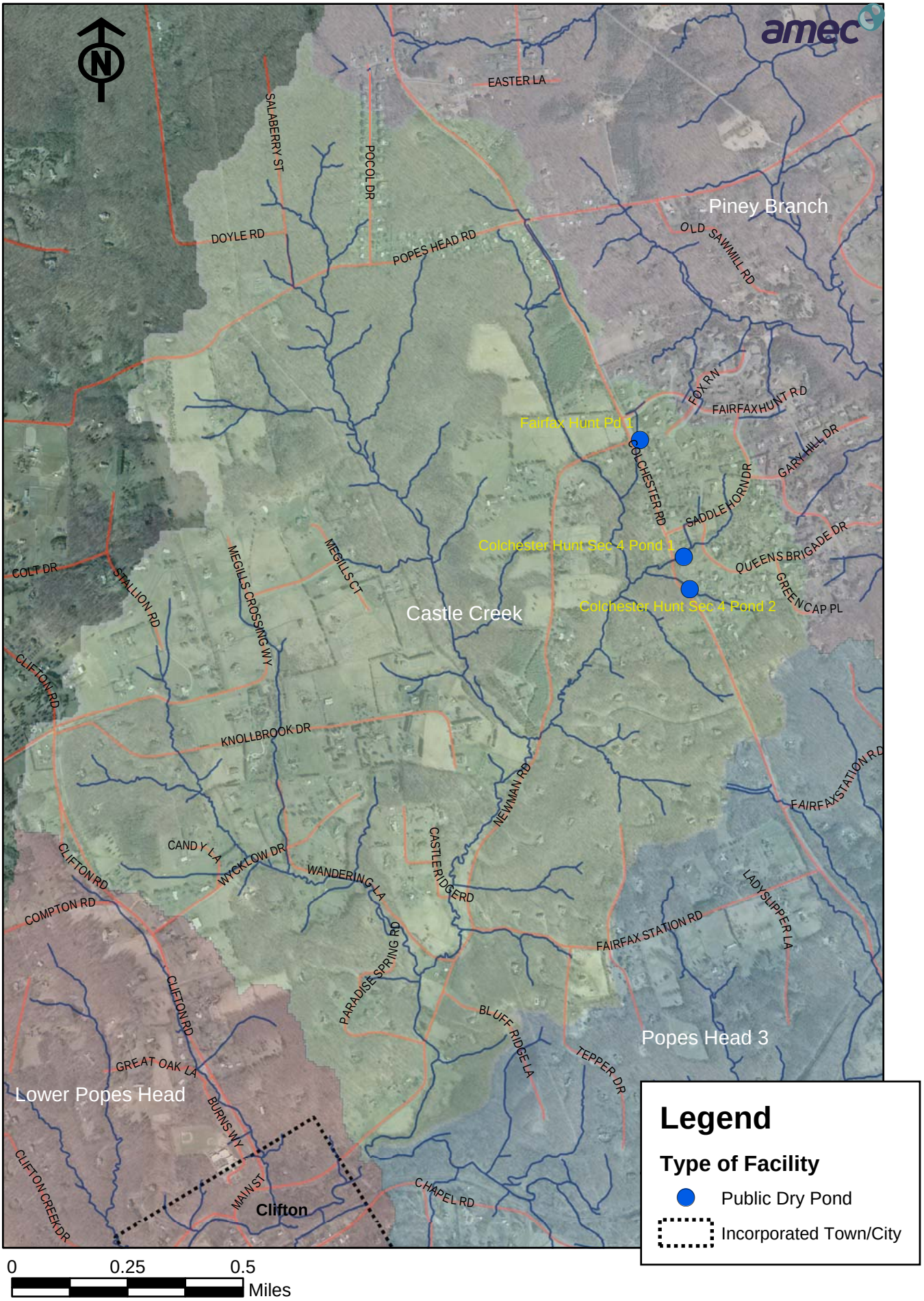
- The dominant substrate throughout the main stem is gravel. The tributaries are predominantly composed of a sand substrate.
- The majority of the stream reaches are of CEM type 3, referring to unstable stream banks and an actively widening channel. The main stem is of CEM type 4, referring to stream bank stabilization and channel development. These stream reaches are found downstream of Popes Head Road, and upstream of Knollbrook Road.
- The majority of the stream reaches exhibited active downcutting and channel widening. Several reaches were observed to have nearly vertical stream banks. A new floodplain is being developed on the main stem downstream of Popes Head Road and upstream of Knollbrook Road.
- One head cut was observed
- Three obstructions were observed

3.5.4 Stream Quality

The stream reaches of Castle Creek are classified as riffle/run stream type. Riffles are a source of high-quality habitat and diverse fauna; therefore, an increased frequency of occurrence greatly increases the diversity of the stream community. The habitat assessment for Castle Creek can be summarized as follows:

- Overall, the stream exhibits poor habitat quality.
- The southern stream reaches exhibited three to seven habitats in less than 50% of the reach. The northeastern stream reaches exhibited only one or two habitats in less than 50% of the reach. The northern stream reaches exhibited less than four to seven habitats in greater than 50% of the reach.
- The majority of the stream reaches contain riffles that are not as wide as the stream, and contain an epifaunal substrate composed of cobble, boulder stones greater than 10 inches wide, and a mixture of bedrock and/or gravel stones and/or woody debris. The main stem upstream of Knollbrook Road contains riffles that are wide as the stream, and a mixture of cobble, gravel stones and/or stable woody debris.
- The eastern tributary has 80% - 90% embeddedness by sediment and silt. The remaining stream reaches have 60% - 70% embeddedness by sediment and silt. Several reaches in the headwaters have 30% - 40% embeddedness by sediment and silt.

Map 3.15: Castle Creek Stormwater Management Facilities



- The majority of the stream reaches have 5% - 30% channel disturbance, indicating minor alterations, dredging, or artificial embankments. The remaining stream reaches exhibit 40% channel disturbance and channelization.
- The main stem of Castle Creek features frequent riffles with adequate depth in pools and riffles. The remaining stream reaches feature infrequent riffles with variable bottom contours which provide some habitat.
- Water fills between 50% - 80% of the channels during normal flow conditions.
- The stream banks exhibit 50% - 70% vegetation cover throughout the subwatershed. The vegetation cover is typically composed of shrubs, grasses and forbes, with thin or bare spots visible.
- The majority of the stream reaches have moderately unstable stream banks, with 40% - 60% erosional areas. The headwaters have moderately stable banks, with only 5% - 30% erosional areas. In general, the right banks are more stable than the left banks throughout the main stem.
- The majority of the stream reaches have a forested vegetated buffer zone that is 5 – 25 feet wide, composed of pasture/agricultural land and old fields. The main branch downstream of Popes Head Road and upstream of Knollbrook Road has a forested vegetated buffer zone that is 50 – 100 feet wide, and composed of shrubs and a few trees. In this stretch, the right bank is in poor condition, with a 5 – 25 foot wide buffer. The headwaters feature forested vegetated buffers that are greater than 100 feet wide and very few disturbances.

The general characteristics of the stream water quality were assessed as follows:

- The water had a clear appearance and no odor was detected.
- Attached aquatic plants were observed near riffles in less than 10% of the entire stream bank area in most of the stream reaches.
- Green algae of light density and a slime coating were observed in the headwaters; brown algae of light density and a slime coating were observed in the southernmost tributary. Green filamentous algae were also observed throughout the subwatershed.
- Many portions of the stream that intersect residential lots are very degraded in stream quality.
- A goat pasture near Newman Road might be affecting water quality.
- Waterfowl in a Wycklow Road residential pond may be affecting water quality.

3.5.5 Stream Ecology

The 2001 *Fairfax County Stream Protection Strategy (SPS) Baseline Study* sampled fish and aquatic macroinvertebrates at one location in the Castle Creek Subwatershed. The sampling site (PHCC01), as shown on Map 2.11, is located downstream of Newman Road and exhibited a fair macroinvertebrate community, which is indicative of fair water quality. A high number of fish species was observed at this site, which is indicative of a strong community structure and good water quality.

3.5.6 Problem Areas from Public Forum

There were no problem areas identified in this subwatershed at the March 27, 2004 Community Watershed Forum.

3.5.7 Modeling Results

The hydrology for the Castle Creek subwatershed produced stormwater runoff that is low compared to the other subwatersheds. This is due to a lower percentage of developed areas in the subwatershed. The increase in discharges due to future development is average when compared to the other subwatersheds. See Table 3.23 for a comparison of the existing and future 2- and 10-year peak discharges in the subwatershed.

Table 3.23 Castle Creek Peak Runoff Flows

Castle Creek Discharge Table		Two-Year Rainfall Event			10-Year Rainfall Event		
Location	**Drainage Area**	**Existing Peak Flow (cfs)**	**Future Peak Flow (cfs)**	**% Peak Flow Increase**	**Existing Peak Flow (cfs)**	**Future Peak Flow (cfs)**	**% Peak Flow Increase**
Approximately 0.83 mi upstream of confluence with Castle Creek Tributary No. 1	0.43	340	420	24%	850	990	16%
Approximately 1,000 ft upstream of Fairfax Station Road	1.36	810	910	12%	2000	2160	8%
Just downstream of Wandering Lane	2.20	710	750	6%	1690	1760	4%

Velocities produced by the 2-year rainfall event in Castle Creek were average when compared to those in the other subwatersheds, averaging 5.8 feet per second. The average velocity is predicted to increase by approximately 6% in the future conditions.

Both the 2- and 10-year peak discharges overtop the channel banks along the central portion of Castle Creek, while the 2 year stays within the channel banks in the upper and lower portions of the stream. Both the 2- and 10-year are confined to the channel banks in the upper portion of Castle Creek Tributary 1 and most of Tributary 2. The model shows two structures greater than 500 square feet located in the 10-year floodplain, on Newman Road south of the confluence with Tributary 2. Table 3.24 shows a summary of the flooded structures in the subwatershed for different recurrence intervals.

Table 3.24 Castle Creek Flooded Structures

Recurrence Interval	Castle Creek	
	Existing	Future
2	2	2
5	2	2
10	2	2
25	2	2
50	3	3
100	3	3

The Castle Creek subwatershed has a sediment loading rate lower than five of the seven subwatersheds. This is due to a lower percentage of development than several of the other watersheds. The predicted sediment load exceeds the target Tributary Strategy level. For future land use conditions, the average sediment loading rate is predicted to increase by 2%.

The Castle Creek subwatershed has a lower pollutant loading rate for total phosphorus and than five of the seven other subwatersheds and the lowest pollutant loading rate for total nitrogen. The total phosphorus load exceeds the target Tributary Strategy level and the total nitrogen load is below the target Tributary Strategy level. For future land use conditions, the loading rate is predicted to increase by 6% for total phosphorus and 3% for total nitrogen.

3.5.8 Summary

The Castle Creek Subwatershed exhibits poor habitat quality, which is unexpected because it has 100% of its area within the rezoned area. There are many residential lots that intersect the stream reaches; this may be the cause of habitat degradation, especially in lots with small or no riparian buffers. Castle Creek also exhibits very high embeddedness values, resulting in impaired benthic macroinvertebrate communities.

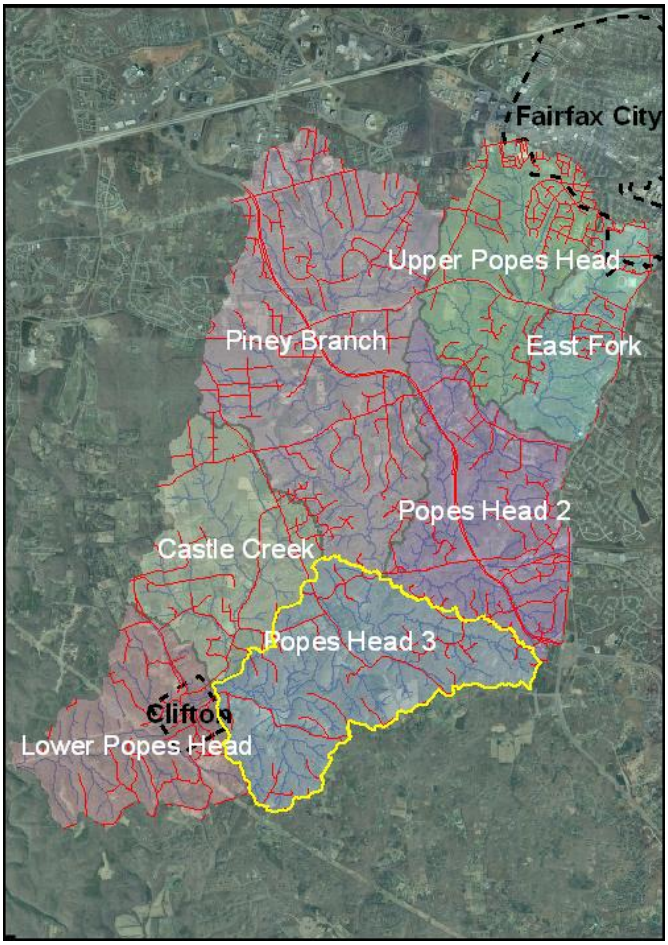
Velocities produced by the 2-year rainfall event in Castle Creek were average when compared to those in the other subwatersheds, averaging 5.8 feet per second. Both the 2- and 10-year peak discharges overtop the channel banks along the central portion of Castle Creek, while the 2 year stays within the channel banks in the upper and lower portions of the stream. The Castle Creek subwatershed has a sediment loading rate lower than five of the seven subwatersheds. This is due to a lower percentage of development than several of the other watersheds. It has a lower pollutant loading rate for total phosphorus and than five of the seven other subwatersheds and the lowest pollutant loading rate for total nitrogen. The total phosphorus load exceeds the target Tributary Strategy level and the total nitrogen load is below the target Tributary Strategy level.

Popes Head 3 Subwatershed

The Popes Head 3 Subwatershed has an area of approximately 1,870 acres and contains the southeast portion of the Popes Head Creek. It is bounded to the north by Fairfax Station Road, Clara Barton Road, and Robert Carter Road; to the southeast by Chapel Road; to the south by Clifton Road; and to the west by Cold Point Road, Colewood Estates Road, and Hanover Heights Trail.

This subwatershed contains a small portion of the Town of Clifton. The subwatershed is shown on Map 3.16, and its condition is summarized below.

Map 3.16: Location of Popes Head 3



3.6.1 Subwatershed Characteristics

The stormwater runoff from this subwatershed drains into Popes Head Creek, which has its headwaters at the confluence of the Piney Branch and Popes Head 2 Subwatersheds. Popes Head 3 flows to the southwest, and has a length of 3.06 miles. It has several tributaries that are longer than 3,000 feet each.

The existing imperviousness in this subwatershed is 6.4% and expected to increase to 7.5% in the future, based upon the planned or zoned land uses in the Fairfax County Comprehensive Plan. Approximately 99.7% of the subwatershed is in the rezoned area; the rezoned area was established in 1982 by the Fairfax County Board of Supervisors in order to protect the Occoquan Reservoir. Building density within the rezoned area is reduced, and therefore imperviousness is decreased, reducing the amount of stormwater runoff that is generated. Land use in the subwatershed is predominantly estate residential, which comprises 73% of the area. Estate residential is expected to increase to 80.5% in the future, while open space will decrease to 3.3% of the total subwatershed area. Roads and sidewalks are not included in the land use data. The existing and future land uses of the Popes Head 3 Subwatershed are described in Table 3.25.

Popes Head 3 Subwatershed Condition Summary

- Current Imperviousness = 6.4% with majority of land use Estate Residential.
- Future Imperviousness = 7.5%
- Area of 1,870.4 acres.
- 99.7% of the watershed is in the rezoned area.
- The stream exhibits fair habitat quality.
- Two stormwater management facilities currently exist.
- One ditch was observed.
- One dump was observed.
- Three head cuts were observed.
- 11 out of 23 crossings have minor impacts.

Table 3.25 Popes Head 3 Land Use

Land Use Description	Existing		Future	
	Acres	%	Acres	%
Estate residential	1335.2	73.0%	1471.8	80.5%
Low-density residential	256.1	14.0%	256.1	14.0%
Medium-density residential	13.1	0.7%	13.1	0.7%
High-density residential	0.5	0.0%	0.5	0.0%
Low-intensity commercial	0.3	0.0%	26.6	1.5%
High-intensity commercial	0	0.0%	0.0	0.0%
Industrial	26.4	1.4%	0.0	0.0%
Open Space	197.6	10.8%	60.9	3.3%
Unknown	0	0.0%	0.0	0.0%
TOTAL	1829.2	100.0%	1829.2	100.0%

The subwatershed consists of 731 parcels, with an average size of 2.5 acres per parcel. There are 24 neighborhoods fully within or apportioned within the subwatershed as listed below:

- Auburn Estates
- Chapel View Estates
- Clifton Overlook
- Colewood Estates
- Fairfax Station
- Haley and Lady
- Popes Head Valley of Clifton
- Southern Pines
- Chadwick
- Clifton Green
- Clifton Trails
- Elgin Corner
- Frog Hill
- The Patterns
- Redlac Forest
- Stonecrest
- Chapel Trails
- Clifton Oaks
- Colchester Hills
- Elistakes Estates
- Frosty Meadows
- Popes Head Mill Estates
- Sangsters Station
- Surrey Acres

The County's list of master plan drainage projects shows the one identified project is this subwatershed is inactive Table 3.26 summarizes the type of master plan drainage project, project name/location, and current status. No cost estimates were available for these projects.

Table 3.26 Popes Head 3 Master Plan Drainage Projects

Type of Work	Project Name/Location
Inactive Project	
Raise Road and Replace Bridge	Popes Head Creek at Colchester Rd

Four complaints regarding channel blockages and alignment were processed by the County and included in the database files for this subwatershed.

3.6.2 Existing Stormwater Management Facilities

Popes Head 3 has a large network of storm drain pipes on the eastern side of the subwatershed, to the east of Colchester Road, and to the south of the CSX Railroad. The Fairfax Station area is serviced by large network of storm drain pipes that discharge into a wet pond. The outfalls vary in size, ranging from 18 inches to 30 inches. To the west, Colchester Hills is serviced by a small series of 18 inch pipes that drain into a rip rap-lined dry pond.

Map 3.17 shows the location of 11 stream crossings that have an impact on the stream. Crossings that do not have an impact on the stream are not listed. The major crossings in this subwatershed, starting from the upstream end of Popes Head 3, are described as follows:

- Havenner Court: A three-foot diameter, two barrel concrete culvert (PHPH025.C002) has a minor impact on an eastern tributary, as shown in Photo 3.13.
- Havenner Court and Blackburn Ford Drive: A 15-foot wooden footbridge (PHPH024.C002) has a minor impact on the same tributary.
- Colchester Road: A 1.5-foot, two barrel CMP culvert (PHPH020.C001) has a minor impact on the main stem, as shown in Photo 3.14. To the south, an 18-foot diameter circular CMP culvert (PHPH020.C002) has a minor impact on the main stem.
- Stonecrest Lane: A three-foot by four-foot diameter, two barrel elliptical CMP culvert (PHPH054.C002) has a minor impact on the main stem.
- Chapel Road: A 75-foot iron bridge (PHPH014.C001) has a minor impact on the main stem, as show in Photo 3.15. To the southeast, a 50-foot iron bridge (PHPHC014.C002) has a minor impact on the main stem. To the south, a two-foot diameter circular CMP culvert (PHPH015.C002) has a minor impact on the main stem. To the south, three circular CMP culverts (PHPH017.C001, PHPH017.C002, PHPH017.C003) have minor impacts on the main stem. Two of the culverts are four-feet in diameter, and the remaining culvert is three-feet in diameter.

Map 3.17: Popes Head 3 Stream Crossings

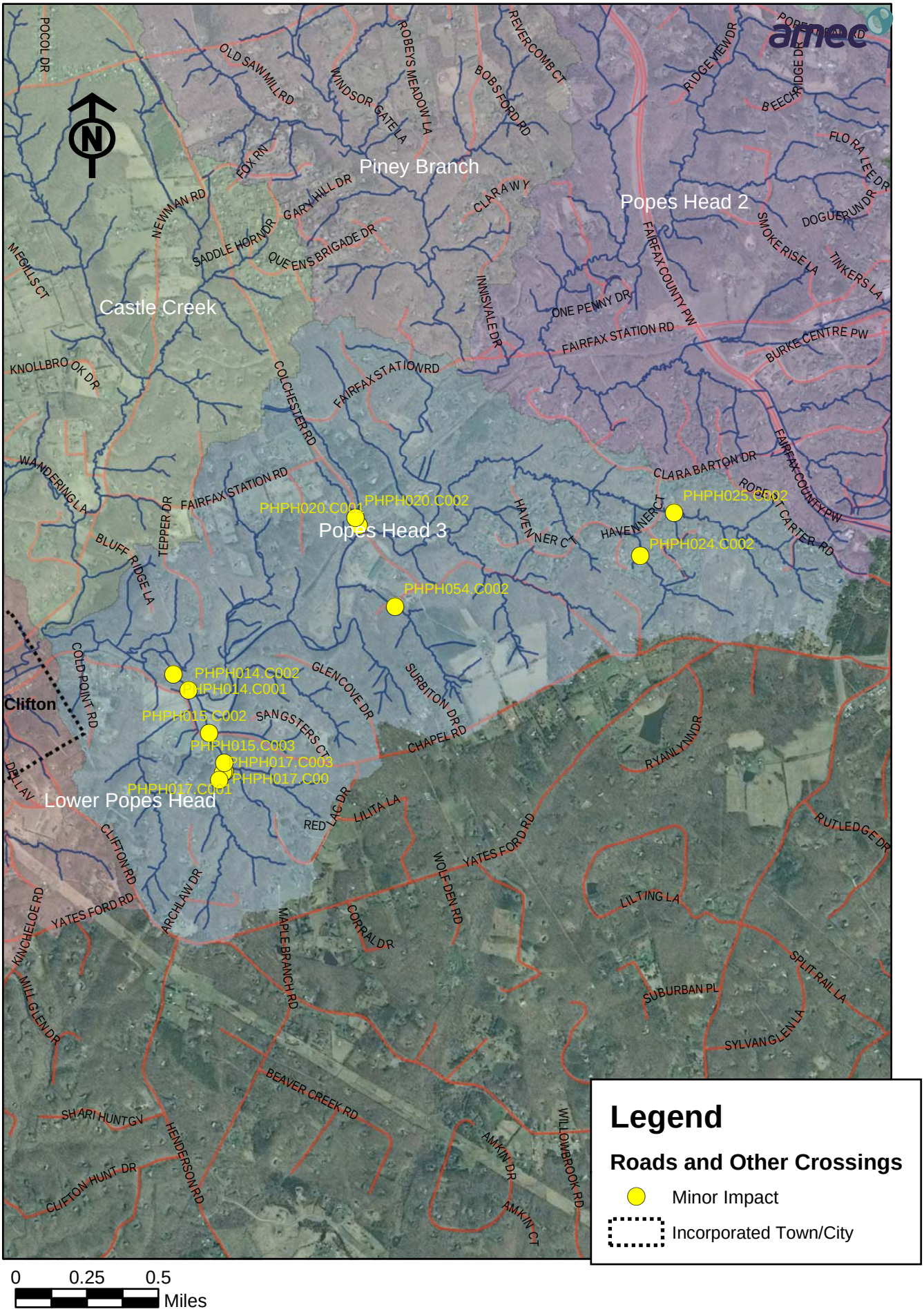


Photo 3.13 A double barrel culvert (PHPH025.C002) near Havenner Court has a minor impact on the stream

Photo 3.14 A double barrel culvert (PHPH020.C001) near Colchester Road has a minor impact on the stream

Photo 3.15 An iron bridge(PHPH014.C001) at Chapel Road has a minor impact on the stream

Photo 3.16 A storm drain pipe outfall is causing moderate erosion

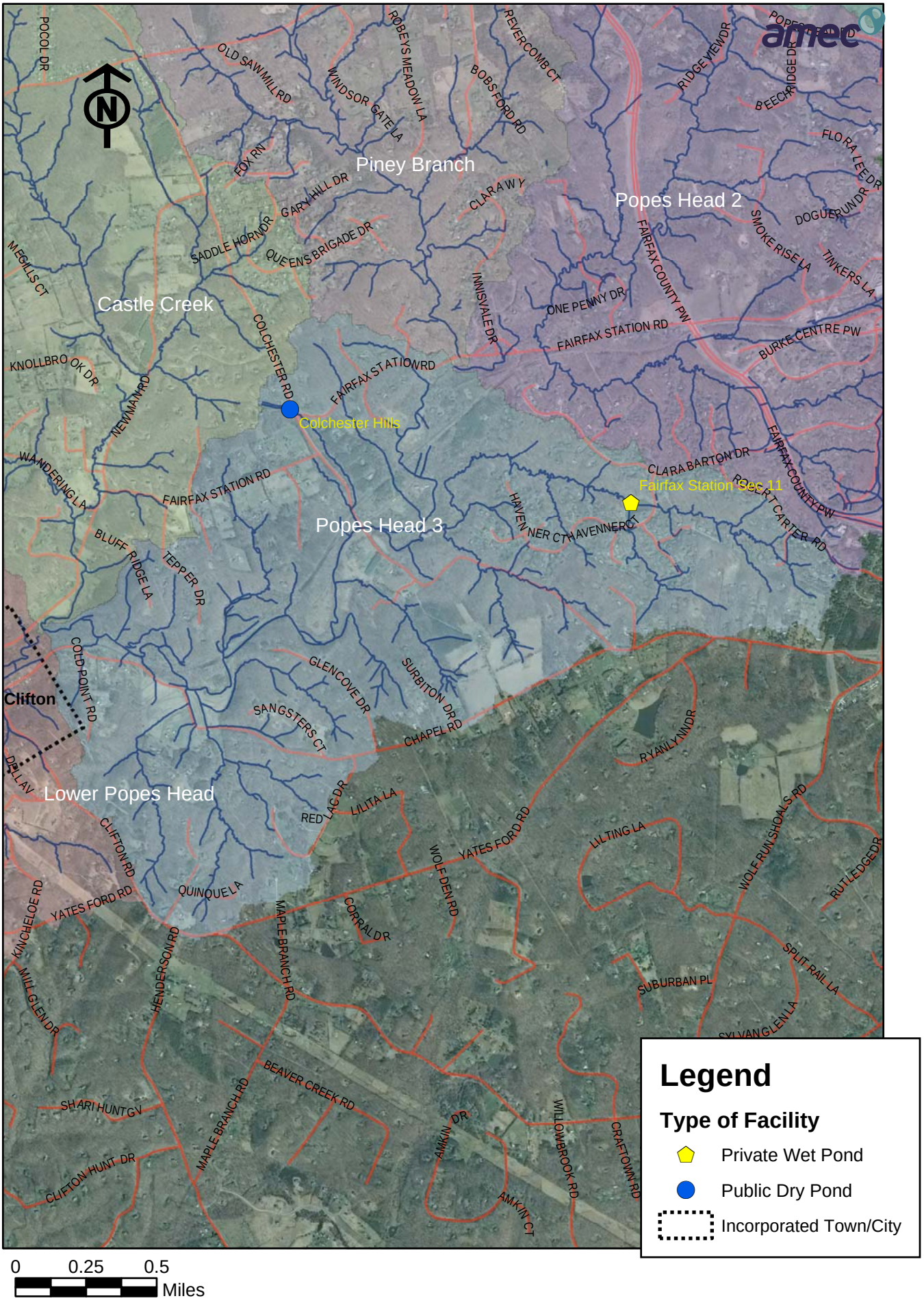
Five storm drain outfall pipes discharge into Popes Head 3. One five-inch diameter PVC pipe outfall is causing moderate erosion, as shown in Photo 3.16. The remaining four pipes are not causing erosion problems.

Table 3.27 shows the locations of known stormwater management facilities in the subwatershed, as depicted on Map 3.18.

Table 3.27 Popes Head 3 Stormwater Management Facilities

Name	Location	Type of Facility
Privately Owned		
Fairfax Station Sec. 11	North of Havenner Rd and East of Sudley Church CT	Wet Pond
Publicly Owned		
Colchester Hills	Fairfax Station Rd and Colchester Rd	Dry Pond

Map 3.18: Popes Head 3 Stormwater Management Facilities



3.6.3 Stream Geomorphology

The geomorphology of the stream segments of Popes Head 3 can be summarized as follows:

- The main stem of this subwatershed has a predominantly cobble and bedrock substrate. The eastern tributaries are characterized by gravel and cobble substrate. The remaining stream reaches are predominantly composed of sand and gravel substrate.
- The majority of the stream reaches are of CEM type 3, referring to unstable stream banks and an actively widening channel. The main stem upstream of Colchester Road and the bottom waters south of Tepper Drive are of CEM type 4, referring to stable stream banks and channel development. Several stream reaches are of CEM type 2, referring to a deeply incised channel.
- One ditch was observed.
- One dump was observed.
- One erosional area was observed.
- Three head cuts were observed.

3.6.4 Stream Quality

The stream reaches of Popes Head 3 are classified as riffle/run stream type. Riffles are a source of high-quality habitat and diverse fauna; therefore, an increased frequency of occurrence greatly increases the diversity of the stream community. The habitat assessment for Popes Head 3 can be summarized as follows:

- The stream exhibits fair habitat quality.
- The main stem upstream of Colchester Road has less than four habitat types present for more than 70% of the reach. The majority of the stream reaches contain four to seven habitat types in more than 50% of the reach.
- The epifaunal substrate of the main stem is composed of boulder stones, cobble, gravel stones, and/or stable woody debris. The riffles are as wide as the stream. The tributaries have riffles that are not as wide as the stream, and are composed of softball size cobble stone, boulder stones greater than 10 inches wide, and a mixture of bedrock and gravel stones, and/or woody debris.
- The main stem has 30% - 50% embeddedness by sediment and silt. The tributaries are 50% - 70% embeddedness by sediment and silt.
- The majority of the stream reaches exhibit 5% - 40% channel disturbance, indicating minor alterations, dredging, or artificial embankments. The remaining stream reaches are 40% - 80% channel disturbance, the result of channelization or dredging.
- The main stem upstream of Colchester Road and the bottom waters south of Tepper Drive feature frequent riffles, with abundant depth in pools and riffles. Several of the stream reaches are generally all flat water or shallow riffles that are not deep enough to allow for free passage of fish. The remaining reaches have infrequent riffles and variable bottom contours that provide habitat for aquatic life.
- The main stem downstream of Colchester Road and its eastern upstream tributary are 80% - 90% full of water during normal flow conditions. All other stream reaches have 25% - 75% full channels during normal flow conditions.
- The majority of the stream reaches have 50% - 70% vegetation cover on the left and right banks, typically composed of shrubs, grasses and forbes. The bottom waters

south of Tepper Drive and several tributaries exhibit 70% plant cover, with a few barren or thin areas with fewer plant species present.

- The stream reaches upstream of Colchester Road have moderately unstable banks, with 40% - 70% erosional areas. The reaches downstream of Colchester Road have moderately stable banks, with 30% erosional areas. In some reaches, the right side banks exhibit less than 5% erosional areas and little bank failure.
- The majority of the stream reaches, including the entire main stem upstream of Chapel Road, contain a forested vegetated buffer zone of 25 – 50 feet wide consisting of shrubs and a few trees. The upstream tributaries have forested vegetated buffers that are 50 – 100 feet wide, consisting of shrubs and a few trees. The bottom waters exhibit 5 – 25 foot buffers, consisting of shrubs and plants lawn grass yards.

The general characteristics of the stream water quality were assessed as follows:

- The water had a clear appearance and no odor was detected. The bottom waters south of Tepper Drive had a turbid appearance.
- Small fishes of one to two inches in length were observed in the bottom waters south of Tepper Drive and in the easternmost tributary.
- Attached aquatic vegetation was observed in pools and near riffles in less than 10% of the entire stream bank area in several stream reaches upstream of Colchester Road.
- Green filamentous algae was found in one stream reach.

3.6.5 Stream Ecology

The 2001 *Stream Protection Strategy (SPS) Baseline Study* did not include a sampling site in the East Fork Subwatershed. Therefore, there is no current information available about the condition of the aquatic ecological community in this subwatershed.

3.6.6 Problem Areas from Public Forum

Citizen attendees at the March 27, 2004 Community Watershed Forum identified three different problem areas in the Popes Head 3 subwatershed:

- Horses are contributing to stream bank erosion in Popes Head Creek, downstream of Colchester Road to Sangsters Court.
- Illegal dumping is common near Bunnyman tunnel (Colchester Road and CSX Railroad), causing culverts to clog, flooding the road. Dumping of Christmas trees is common at this area; it is also a known teen hangout.
- The grass is mown short near Popes Head Creek at Chapel Park Road; this area is used for parking on Clifton Day.

3.6.7 Modeling Results

The hydrology for the Popes Head 3 subwatershed produced stormwater runoff that is low compared to the other subwatersheds. This is due to a lower percentage of residential development in the subwatershed. The increase in discharges due to future development is average when compared to the other subwatersheds. See Table 3.28 for a comparison of the existing and future 2- and 10-year peak discharges in the subwatershed.

Table 3.28 Popes Head 3 Peak Runoff Flows

Popes Head 3 Discharge Table		Two-Year Rainfall Event			10-Year Rainfall Event		
Location	**Drainage Area**	**Existing Peak Flow (cfs)**	**Future Peak Flow (cfs)**	**% Peak Flow Increase**	**Existing Peak Flow (cfs)**	**Future Peak Flow (cfs)**	**% Peak Flow Increase**
Approximately 150 ft downstream of the confluence with Piney Branch	11.56	2930	3130	7%	6100	6370	4%
Just upstream of Colchester Road	12.77	3110	4220	36%	6560	7040	7%
Approximately 1 mi downstream of Colchester Road	13.32	3950	6380	62%	6770	7270	7%

Velocities produced by the 2-year rainfall event in Popes Head 3 were higher than average when compared to those in the other subwatersheds, averaging 6.6 feet per second. Velocities on Tributary 4 were the lowest, averaging 4.0 feet per second. The average velocity is predicted to increase by approximately 5% in the future conditions.

Both the 2- and 10-year peak discharges overtop the channel banks along Popes Head Creek and its tributary in the Popes Head 3 subwatershed. The model shows no structures greater than 500 square feet located in the 10-year floodplain. Table 3.29 shows a summary of the flooded structures in the subwatershed for different recurrence intervals.

Table 3.29 Popes Head 3 Flooded Structures

Recurrence Interval	Popes Head 3	
	Existing	Future
2	0	0
5	0	0
10	0	0
25	1	1
50	2	2
100	2	2

The Popes Head 3 subwatershed has an average sediment loading rate when compared to the other subwatersheds. The predicted sediment load exceeds the target Tributary Strategy level. For future land use conditions, the average sediment loading rate is predicted to increase by 2%.

The Popes Head 3 subwatershed has an average pollutant loading rate for total phosphorus and total nitrogen when compared to the other subwatersheds. The total phosphorus load exceeds the target Tributary Strategy level and the total nitrogen load is just below the target Tributary Strategy level. For future land use conditions, the loading rate is predicted to increase by 7% for total phosphorus and 4% for total nitrogen.

3.6.8 Summary

The Popes Head 3 Subwatershed exhibits fair habitat quality. It has medium sized riparian buffers, with the majority being 25 – 50 feet wide. Most of the stream reaches exhibit unstable stream banks and an actively widening channel.

Velocities produced by the 2-year rainfall event in Popes Head 3 were higher than average when compared to those in the other subwatersheds, averaging 6.6 feet per second. Both the 2- and 10-year peak discharges overtop the channel banks along Popes Head Creek and its tributary in the Popes Head 3 subwatershed.

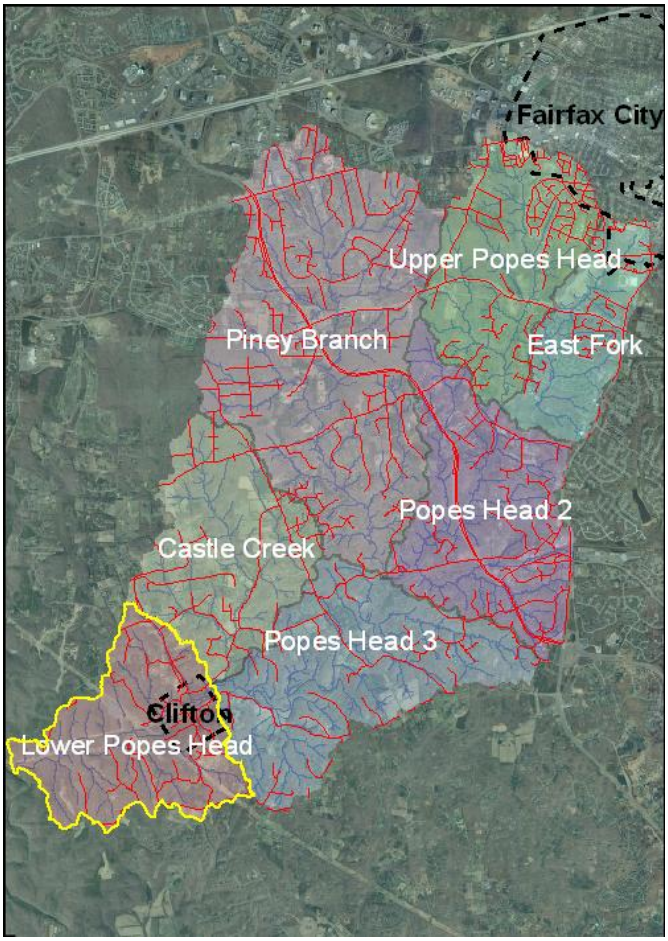
The Popes Head 3 subwatershed has an average sediment loading rate when compared to the other subwatersheds. The predicted sediment load exceeds the target Tributary Strategy level. It has an average pollutant loading rate for total phosphorus and total nitrogen when compared to the other subwatersheds. The total phosphorus load exceeds the target Tributary Strategy level and the total nitrogen load is just below the target Tributary Strategy level.

3.7 Lower Popes Head Subwatershed

The Lower Popes Head Subwatershed has an area of approximately 1,392 acres and contains the southernmost portion of Popes Head Creek. It is bounded to the north by Compton Road; to the east by Clifton Road; to the south by Yates Ford Road; and to the west by Balmoral Forest Road and Ivakota Road.

This subwatershed contains a portion of the Hemlock Overlook Regional Park and the majority of the Town of Clifton. The Lower Popes Head Subwatershed is shown on Map 3.19 and its condition is summarized below.

Map 3.19: Location of Lower Popes Head



3.7.1 Subwatershed Characteristics

The stormwater runoff from this subwatershed drains into Popes Head Creek, which has its headwaters at the confluence of Castle Creek and Popes Head 3. It has a length of 2.46 miles, and flows southwestward to the Hemlock Overlook Regional Park, and eventually discharges into Bull Run, a tributary of the Occoquan River.

The existing imperviousness in this subwatershed is 5.6% and expected to increase to 7.9% in the future, based upon the planned or zoned land uses in the Fairfax County Comprehensive Plan. The existing imperviousness is based on actual impervious cover in the watershed. The future impervious cover reflects imperviousness associated with the future land use condition. The significant increase in imperviousness is due to the future development possible on the Dominion power substation property. Currently, the Dominion power substation property within the watershed is only partially developed. However this impervious difference is not shown on the land use maps because the property was designated industrial in the existing condition and low-intensity commercial in the future.

88.6% of the subwatershed is in the rezoned area; the rezoned area was established in 1982 by the Fairfax County Board of Supervisors in order to protect the Occoquan Reservoir. Building density within the rezoned area is reduced, and therefore imperviousness is decreased, reducing the amount of stormwater runoff that is generated. Land use in this subwatershed is predominantly estate residential, which comprises 58.7% of the total subwatershed area. Open space is another significant land

use, totaling 24% of the subwatershed area. Estate residential is expected to increase to 66.1% in the future, while open space will decrease to 10.5% of the total subwatershed area. Roads and sidewalks are not included in the land use data. The existing and future land uses in the Lower Popes Head Watershed are described in Table 3.30.

Lower Popes Head Subwatershed Condition Summary

- Current Imperviousness = 5.6% with majority of land use Estate Residential.
- Future Imperviousness = 7.9%
- Area of 1,392.4 acres.
- 88.6% of the subwatershed is in the rezoned area. Major land uses that are not in the rezoned area include the Town of Clifton.
- Two stormwater management facilities currently exist.
- The stream exhibits fair habitat quality.
- One dump was observed.
- Four head cuts were observed.
- Three obstructions were observed.
- 11 out of 22 crossings have minor impacts and one crossing has a severe impact.

Table 3.30 Lower Popes Head Land Use

Land Use Description	Existing		Future	
	Acres	%	Acres	%
Estate residential	798.7	58.7%	899.4	66.1%
Low-density residential	68.6	5.0%	152	11.2%
Medium-density residential	11.2	0.8%	11.2	0.8%
High-density residential	0.5	0.0%	0.5	0.0%
Low-intensity commercial	29.3	2.2%	126.6	9.3%
High-intensity commercial	1.7	0.1%	1.7	0.1%
Industrial	123.5	9.1%	26.1	1.9%
Open Space	326.1	24.0%	142.1	10.5%
Unknown	0.0	0.0%	0.2	0.0%
TOTAL	1359.6	100.0%	1359.6	100.0%

The subwatershed consists of 450 parcels, with an average size of 3.02 acres per parcel. Lower Popes Head has the second largest average parcel size of all subwatersheds, while Castle Creek has the largest average parcel size. There are 15 neighborhoods fully within or apportioned within the subwatershed, not including the Town of Clifton. The neighborhoods are listed below:

- Balmoral Greens
- Clifton Forest
- Burwyck
- Clifton Heights
- Clifton Creek Ridge
- Clifton North

- Clifton Ridge
- Lee Mill
- Frog Hill
- Noble Estates
- Wyckland
- Glencairn
- Wiltonshire

The County's list of master plan drainage projects shows the two identified projects in this subwatershed are inactive. Table 3.31 summarizes the type of master plan drainage project, project name/location, and current status. No cost estimates were available for these projects.

Table 3.31 Lower Popes Head Master Plan Drainage Projects

Type of Work	Project Name/Location
Inactive Projects	
Replace Culvert and Channel Improvement Downstream	Tributary at Clifton Rd
Replace Culvert	Tributary at Clifton Rd

3.7.2 Existing Stormwater Management Facilities

Lower Popes Head does not have an extensive network of storm drain pipes. There are several pipes located within the Town of Clifton that discharge into Popes Head Creek.

Map 3.20 shows the location of stream crossings that have an impact on the stream. Crossings that do not have an impact on the stream are not listed. The major crossings in this subwatershed, starting from the upstream end of Lower Popes Head, are described as follows:

- Great Oak Lane: A five-foot diameter circular CMP culvert (PHPH011.C001) has a minor impact on a northern tributary, as shown in Photo 3.17.
- Clifton Road: A five-foot diameter circular CMP culvert (PHPH012.C003) has a minor impact on the main stem.
- Newman Road: A five-foot diameter circular CMP culvert (PHPH012.C002) has a minor impact on the main stem.
- Clifton Creek Drive: A 2.5-foot diameter circular CMP culvert (PHPH009.C001) has a minor impact on the main stem, as shown in Photo 3.18.
- Chapel Road: A two-foot diameter circular CMP culvert (PHPH013.C001) has a minor impact on a southern tributary.
- Dunquin Court: A two-foot diameter circular clay culvert (PHPH005.C001) has a minor impact on a southern tributary, as shown in Photo 3.19. To the southeast, a three-foot by two-foot elliptical concrete culvert (PHPH005.C002) has a minor impact on the same tributary. To the southeast, a two-foot diameter circular concrete culvert (PHPH006.C002) has a minor impact on the same tributary. Adjacent, a two-foot diameter circular concrete culvert (PHPH006.C001) has a severe impact on the same tributary, as shown in Photo 3.20.
- Dunvegan Drive: A four-foot diameter circular CMP culvert (PHPH007.C001) has a minor impact on a southern tributary.
- Kincheloe Road: A three-foot diameter circular CMP culvert (PHPH006.C003) has a minor impact on the southeastern tributary. To the southeast, a two-foot diameter circular CMP culvert (PHPH006.C004) has a minor impact on the same tributary.

Map 3.20: Lower Popes Head Stream Crossings

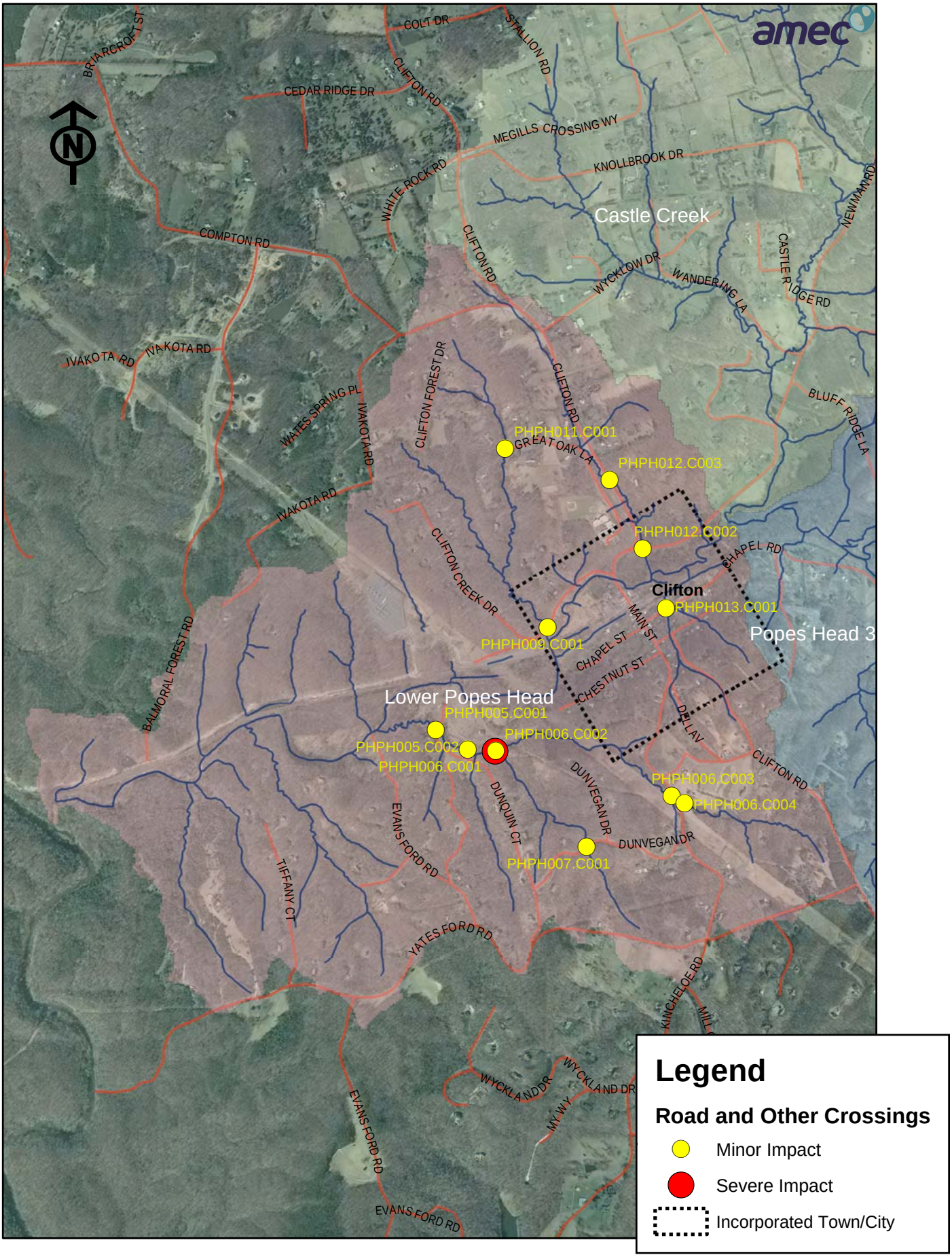


Photo 3.17 A culvert (PHPH014.C001) at Great Oak Lane has a minor impact on the stream

Photo 3.18 A culvert (PHPH009.C001) at Clifton Creek Drive has a minor impact on the stream

Photo 3.19 A culvert at (PHPH005.C001) Dunquin Court has a minor impact on the stream

Photo 3.20 A culvert (PHPH006.C001) at Dunquin Court has a severe impact on the stream

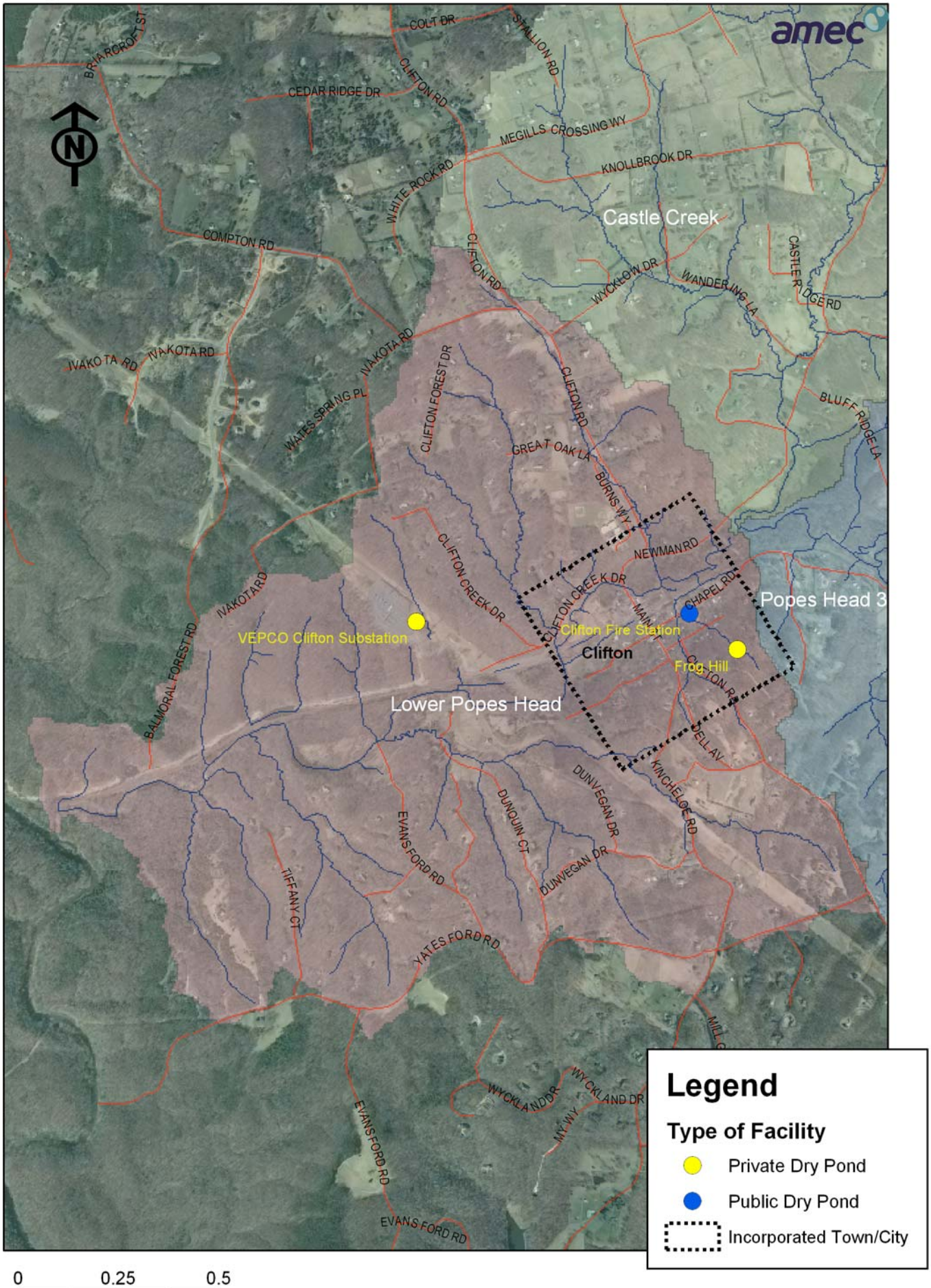
Seven storm drain pipes discharge into Lower Popes Head. They range from four to 36-inches in diameter; none of the which appear to be causing erosion.

Table 3.32 shows the locations of known stormwater management facilities in the subwatershed, as shown on Map 3.21.

Table 3.32 Lower Popes Head Stormwater Management Facilities

Name	Location	Type of Facility
Privately Owned		
VEPCO Clifton Substation	Near Clifton Creek Drive	Dry Pond
Frog Hill Subdivision	Water Street	Dry Pond
Publicly Owned		
Clifton Fire Station	Chapel Rd, East of Main St	Dry Pond

Map 3.21: Lower Popes Head Stormwater Management Facilities



3.7.3 Stream Geomorphology

The geomorphology of the stream segments of Lower Popes Head can be summarized as follows:

- The dominant substrate for the majority of the stream reaches is cobble.
- The main stem is of CEM type 4, referring to stream bank stabilization and channel development. The tributaries are of CEM type 3, referring to unstable stream banks and an actively widening channel. Several reaches are of CEM type 2, referring to a deep incised channel.
- One dump was observed.
- Four head cuts were observed.
- Three obstructions were observed.

3.7.4 Stream Quality

The stream reaches of Lower Popes Head are classified as riffle/run stream type. Riffles are a source of high-quality habitat and diverse fauna; therefore, an increased frequency of occurrence greatly increases the diversity of the stream community. The habitat assessment for Lower Popes Head can be summarized as follows:

- Overall, the stream exhibits fair habitat quality.
- The majority of the stream reaches contain four to seven habitat types in more than 50% of the reach. The tributaries contain two to seven habitat types in less than 50% of the reach.
- The main stem contains riffles that are as wide as the stream, and have epifaunal substrates composed of boulder stones, cobble, softball size cobble stones, and a mixture of gravel stones and boulders/bedrock and/or stable woody debris. The tributaries contain riffles that are not as wide as the stream, and have epifaunal substrates composed of softball size cobble stones, boulder stones, and a mixture of boulders/bedrock, gravel stones, and/or stable woody debris.
- The majority of the stream reaches have 30% - 40% embeddedness by sediment and silt.
- The majority of the stream reaches, including the entire main stem, have 5% - 40% channel disturbance, indicating minor alterations, dredging, or artificial embankments. The channel is mostly recovered and somewhat stable.
- The main stem contains frequent riffles with adequate depth in pools and riffles. The remaining stream reaches contain infrequent riffles with variable bottom contours which provide some habitat.
- The main stem channels are 80% - 90% full during normal flow conditions. The tributary channels are 20% - 75% full during normal flow conditions.
- The main stem has 70% - 80% vegetation cover, typically of shrubs, grasses and forbes, with a few thin or barren areas. The tributaries have 50% - 60% vegetation cover, typically of shrubs, grasses and forbes. In general, the right stream banks have more dense vegetation cover than the left banks.
- The downstream portion of the main stem has moderately stable banks with 30% erosional areas. The upstream portion of the main stem has moderately unstable banks with 40 – 70% erosional areas. In general, the left banks are more stable than the right banks, as the entire right side of the main stem is moderately unstable with 40% - 50% erosional areas.
- The main stem has forested vegetated buffer zones that are 50 – 100 feet wide, consisting of shrubs and a few trees, old fields, and planted lawn grass yards.

Several of the tributaries have buffers that are greater than 100 feet wide. In general, the left stream bank has wider buffer zones than the right side.

The general characteristics of the stream water quality were assessed as follows:

- The water was clear, except for stream reaches inside the Town of Clifton; here the water was turbid and light brown (other than tannin). No odors were detected.
- Small fishes one to two inches in length were observed at the headwaters and in one of the southern tributaries. Medium fishes three to six inches in length were observed in the downstream portion of the main stem.
- Attached aquatic vegetation was observed in pools in 10% - 30% of the entire stream bank area in one stream reach.
- No algae were observed in any of the stream reaches.

3.7.5 Stream Ecology

The 2001 *Fairfax County Stream Protection Strategy (SPS) Baseline Study* sampled fish and aquatic macroinvertebrates at one location in the Lower Popes Head Subwatershed. The sampling site (PHPH03), as shown on Map 2.11, is located downstream of Evans Ford Road and exhibited a poor macroinvertebrate community, which is indicative of degraded water quality. A moderate number of fish species was observed at this site, which is indicative of a strong community structure and good water quality.

3.7.6 Problem Areas from Public Forum

Citizen attendees at the March 27, 2004 Community Watershed Forum identified the following problem areas in the Lower Popes Head Subwatershed:

- Severe erosion along Popes Head Creek occurs downstream of Clifton Road and Eight Acre Park.
- Erosion occurs at two dirt road crossings within the electrical power line right-of-way on Popes Head Creek, downstream of Clifton.
- Runoff and sediment from the construction of six new houses uphill from Clifton Elementary School is flowing into Popes Head Creek.
- The Town of Clifton contains leaking fuel tanks.
- Clifton Road was overtopped by water during Hurricane Isabel.

3.7.7 Modeling Results

The hydrology for the Lower Popes Head subwatershed produced stormwater runoff that is low compared to the other subwatersheds. This is due to a lower percentage of residential development in the subwatershed. The increase in discharges due to future development is average when compared to the other subwatersheds. See Table 3.33 for a comparison of the existing and future 2- and 10-year peak discharges in the subwatershed.

Table 3.33 Lower Popes Head Peak Runoff Flows

Lower Popes Head Discharge Table		Two-Year Rainfall Event			10-Year Rainfall Event		
Location	**Drainage Area**	**Existing Peak Flow (cfs)**	**Future Peak Flow (cfs)**	**% Peak Flow Increase**	**Existing Peak Flow (cfs)**	**Future Peak Flow (cfs)**	**% Peak Flow Increase**
Just downstream of the confluence with Castle Creek	16.79	4440	5240	18%	7730	8000	3%
Approximately 1,500 ft downstream of Main Street	17.50	4580	5790	26%	7930	8330	5%
Approximately 200 ft downstream of Evans Ford Road	18.31	4450	5470	23%	7570	7820	3%

Velocities produced by the 2-year rainfall event in Lower Popes Head were higher than average when compared to those in the other subwatersheds, averaging 6.9 feet per second. Velocities on Tributary 4 were comparable to other tributaries, averaging 4.6 feet per second. The average velocity is predicted to increase by approximately 8% in the future conditions.

Both the 2- and 10-year peak discharges overtop the channel banks along Popes Head Creek and the 2-year is confined to the channel in the upper reaches of Popes Head Tributary 5. The model shows eight structures greater than 500 square feet located in the 10-year floodplain: 6 upstream of Main Street in Clifton, 1 downstream of Main Street in Clifton and 1 off of Tributary 5 near Dunquin Court. Table 3.34 shows a summary of the flooded structures in the subwatershed for different recurrence intervals.

Table 3.34 Lower Popes Head Flooded Structures

Recurrence Interval	Popes Head 3	
	Existing	Future
2	4	8
5	6	8
10	8	8
25	10	10
50	12	12
100	13	16

The Lower Popes Head subwatershed has an average sediment loading rate when compared to the other subwatersheds. The predicted sediment load exceeds the target Tributary Strategy level. For future land use conditions, the average sediment loading rate is predicted to increase by 6%.

The Lower Popes Head subwatershed has an average pollutant loading rate for total phosphorus and total nitrogen when compared to the other subwatersheds. The total phosphorus load exceeds the target Tributary Strategy level and the total nitrogen load is just below the target Tributary Strategy level. For future land use conditions, the loading rate is predicted to increase by 1% for both total phosphorus and total nitrogen.

3.7.8 Summary

The Lower Popes Head Subwatershed exhibits fair stream habitat quality. In general, the main stem of the stream has stable stream banks and a large riparian buffer, ranging 50 feet to greater than 100 feet wide. Several areas of significant erosion are observed around the Town of Clifton, and the stream reaches that flow through Clifton are turbid and brown in color.

Velocities produced by the 2-year rainfall event in Lower Popes Head were higher than average when compared to those in the other subwatersheds, averaging 6.9 feet per second. Both the 2- and 10-year peak discharges overtop the channel banks along Popes Head Creek and the 2-year is confined to the channel in the upper reaches of Popes Head Tributary 5.

The Lower Popes Head subwatershed has an average sediment loading rate when compared to the other subwatersheds. The predicted sediment load exceeds the target Tributary Strategy level. It has an average pollutant loading rate for total phosphorus and total nitrogen when compared to the other subwatersheds. The total phosphorus load exceeds the target Tributary Strategy level and the total nitrogen load is just below the target Tributary Strategy level.