

# A School, a Stream and a Teacher's Dream

Testing in Fairfax County Public Schools for  
Urban Stream Water Quality

George Kralovec

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Scientist and Engineer (SSE) Classroom Volunteer*

*Rotary Club of Tysons Corner  
August 17 & 24, 2017*

So since some of you asked...

*“How an Astronautical Engineer and fighter pilot ended up in rubber boots counting bugs in the bottom of urban creeks in Northern Virginia.”*

# The Winding Route

- **Retired in 2010 from 46 year career in Aerospace Defense (26 years flying Marine jets, 20 years with industry)**
- **Spotted small AAAS Ad in Metro section of WashPost for retired Scientist and Engineers to volunteer to help science teachers in the National Capital Region.**

# Next Seven Years in the Schools

**Bull Run Elementary , 5 years, 16 teachers!**

*Grades K-5<sup>th</sup>, Community and advanced academic levels. A range of science subjects.*

**Little Run Elementary, 2 years, one teacher.**

*Engineering lab weekly and development of a program for **Urban Stream Health testing in Long Branch Creek adjacent to the school property.***



# Bull Run E.S. (>850 students)



# Little Run E.S. (<400 students)



**Part I**  
**Urban Stream Health,  
the Clean Water Act, and  
“TMDLs”**

**Huh! What the heck is a “TMDL?”**



# What is a “TMDL?”

## Clean Waters Act of 1972

### Program Overview: 303(d) Listing of Impaired Waters

The term "303(d) list" or “list” is short for a state’s list of impaired and threatened waters (e.g. stream/river segments, lakes). States are required to submit their list for EPA approval every two years. For each water on the list, the state identifies the pollutant causing the impairment, when known. In addition, the state assigns a priority for development of Total Maximum Daily Loads (TMDL) based on the severity of the pollution and the sensitivity of the uses to be made of the waters, among other factors

In general, once a water body has been added to a state’s list of impaired waters it stays there until the state develops a TMDL and EPA approves it. EPA reporting guidance provides a way to keep track of a state’s water bodies, from listing as impaired to meeting water quality standards. This tracking system contains a running account of all of the state’s water bodies and categorizes each based on the attainment status. For example, once a TMDL is developed, a water body is no longer on the 303(d) list, but it is still tracked until the water is fully restored.

**Ack!** Isn’t there a shorter answer?

# TMDL (Short Answer)

*Total Maximum Daily Loads, or TMDLs, are pollution "budgets" developed to restore waters that are impaired.*

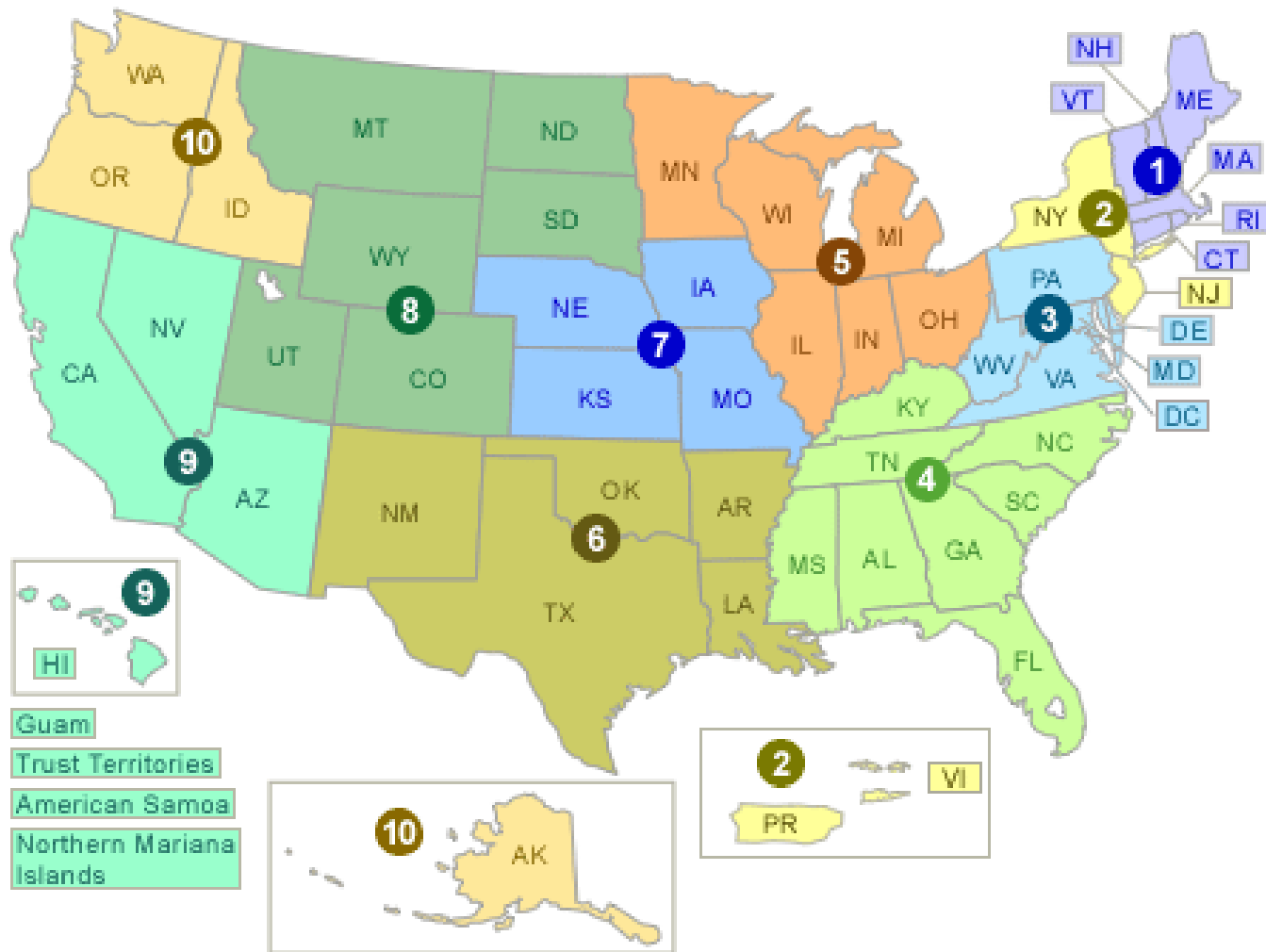
Okay, then what are the probable sources of pollution in assessed streams?

## Probable Sources of Impairments in Assessed Rivers and Streams

[Description of this table](#)

<a href="#">Probable Source Group</a>	<a href="#">Miles Threatened or Impaired</a>
<a href="#">Agriculture</a>	142,776
<a href="#">Unknown</a>	138,626
<a href="#">Atmospheric Deposition</a>	91,660
<a href="#">Hydromodification</a>	88,565
<a href="#">Habitat Alterations (Not Directly Related To Hydromodification)</a>	64,772
<a href="#">Urban-Related Runoff/Stormwater</a>	60,230
<a href="#">Municipal Discharges/Sewage</a>	58,821
<a href="#">Unspecified Nonpoint Source</a>	57,640
<a href="#">Natural/Wildlife</a>	49,760
<a href="#">Silviculture (Forestry)</a>	40,799
<a href="#">Resource Extraction</a>	33,097
<a href="#">Construction</a>	20,716

# Ten TMDL Regions



So, how many TMDLs are there nationwide since 1996 anyway?

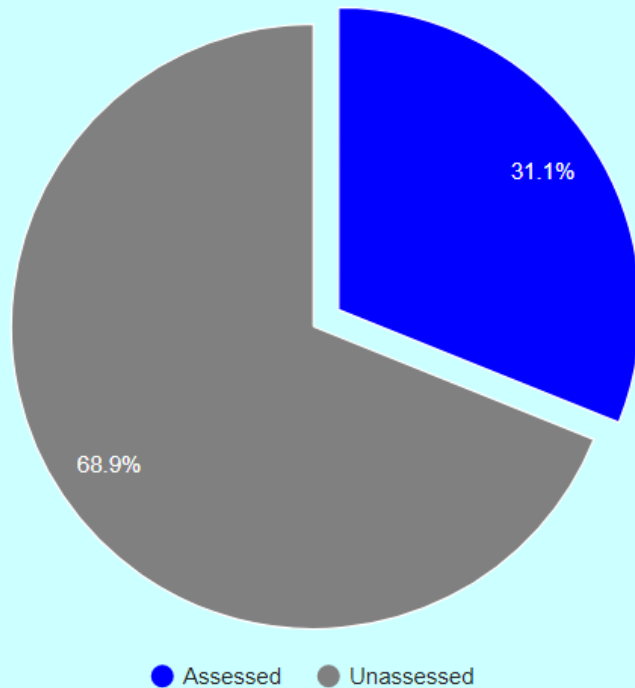
**Over 74,000!**

Okay, but how are the ones  
that apply to streams going?



# National Summary of Rivers and Streams

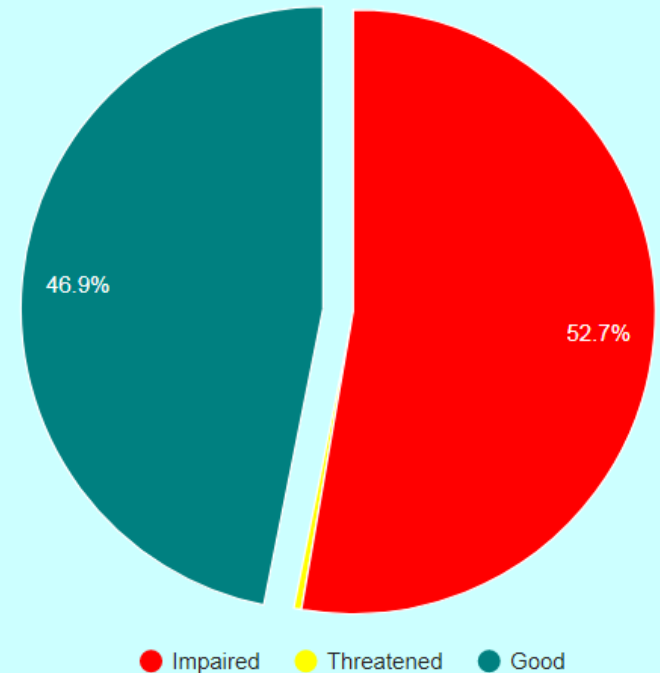
All Rivers and Streams



3 533 205 0 Miles of Rivers and Streams

arrow pointing right

Assessed Rivers and Streams



1 098 367 7 Miles of

Okay, but to put this in context, what are the other Categories of Assessed Waters besides Rivers and Streams?

# Categories of Assessed Waters

## Assessed Waters of United States

Incomplete state reported information may lead to discrepancies and/or missing information in these reports.

### Description of this table

	<u>Size of Water</u>							
	<u>Rivers and Streams (Miles)</u>	<u>Lakes, Reservoirs, and Ponds (Acres)</u>	<u>Bays and Estuaries (Square Miles)</u>	<u>Coastal Shoreline (Miles)</u>	<u>Ocean and Near Coastal (Square Miles)</u>	<u>Wetlands (Acres)</u>	<u>Great Lakes Shoreline (Miles)</u>	<u>Great Lakes Open Water (Square Miles)</u>
<u>Good Waters</u>	514,632	5,363,451	11,556	1,290	617	569,328	102	
<u>Threatened Waters</u>	4,495	30,309						
<u>Impaired Waters</u>	579,241	12,918,363	44,692	3,325	6,263	665,494	4,354	39,183
<u>Total Assessed Waters</u>	1,098,368	18,312,122	56,247	4,615	6,881	1,234,822	4,457	39,183
<u>Total Waters</u>	3,533,205	41,666,049	87,791	58,618	54,120	107,700,000	5,202	196,343
<u>Percent of Waters Assessed</u>	31.1	43.9	64.1	7.9	12.7	1.1	85.7	20.0

# Let's get Local

## The Accotink Creek TMDLs

**2013 EPA test case:** Using stormwater runoff as a surrogate for sediment, a stream pollutant under the CWA.

- *Contested by Commonwealth of Virginia and Fairfax County. Challenged science, economics, and legality.*
- *Shot down in Alexandria Federal District Court as illegal! Science and economics not considered.*

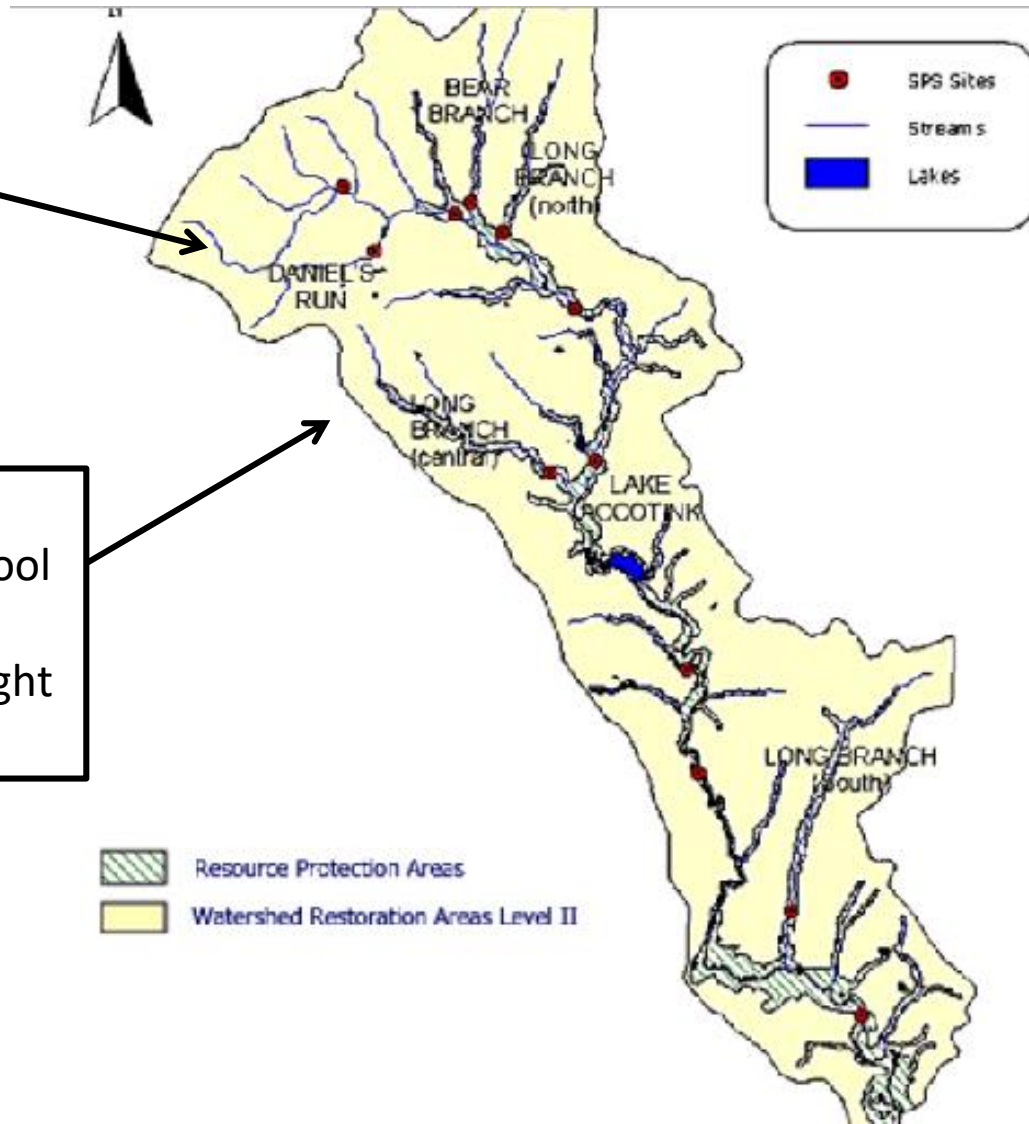
**Current EPA TMDL:** Testing for two pollutants

- *Sediment*
- *Chlorides*

# The Accotink Creek Watershead

Daniels Run ES  
(Trained here)

Little Run  
Elementary School  
and adjacent  
testing site is right  
about here



# An Unhealthy Stream





# Unhealthy Stream





# A Healthy Stream

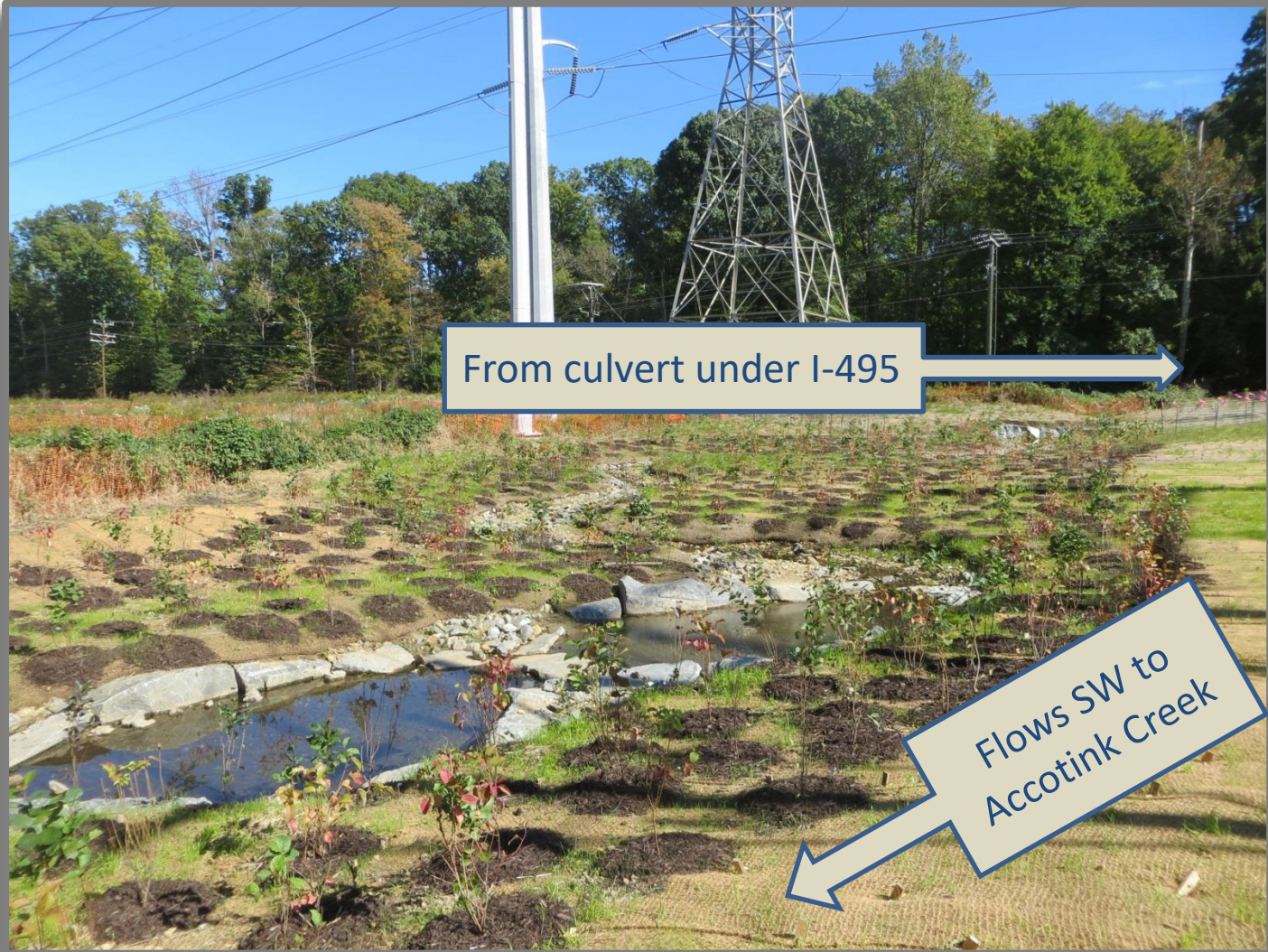


Nicer, huh?

**So, can you make an unhealthy stream healthy?**



Let's Look at a Newly Restored Section of a Local Stream  
Tributary of Accotink Creek crossing the Gerry Connolly Trail  
North of Audrey Meadows Rec Center





## Part II

# The School Testing Program

# The School Testing Program

-- Six lab classes --

-- Two types of tests --

- Classroom Lecture on Watersheds and Urban Streams
- Streamside **Macroinvertebrate** Data Collection
- Classroom **Macroinvertebrate** Analysis and Scoring
- Streamside **Chemical** analysis
- Classroom **Chemical** Analysis and Scoring
- Classroom Review

# Macroinvertebrate Testing





**OK, what the heck is a macroinvertebrate?**

# Three Levels of Benthic Pollution Tolerance

# Macroinvertebrate Identification Key

GROUP 1





















DO NOT TOLERATE POLLUTION

<p>Stonefly nymph</p>  <p>5-35mm</p>	<p>Caddisfly larva</p>  <p>2-40mm</p>	<p>Mayfly nymph</p>  <p>3-10mm</p>	<p>Alderfly nymph</p>  <p>10-25mm</p>	<p>Fishfly larva</p>  <p>5-16mm</p>
<p>Stonefly adult</p>  <p>10-40mm</p>	<p>Caddisfly adult</p>  <p>14-25mm</p>	<p>Mayfly adult</p>  <p>5-25mm</p>	<p>Alderfly adult</p>  <p>24-50mm</p>	<p>Water penny</p>  <p>4-6mm</p>
<p>Hellgrammite (dobsonfly larva)</p>  <p>25-90mm</p>	<p>Freshwater mussel</p>  <p>2-250mm</p>	<p>Pouch snail</p>  <p>2-70mm</p>	<p>Ramshorn snail</p>  <p>2-70mm</p>	<p>Snipe fly larva</p>  <p>12-18mm</p>

# Macroinvertebrate Identification Key

GROUP 2











TOLERATE SOME POLLUTION

<p>Dragonfly larva</p>  <p>15-50mm</p>	<p>Damselfly larva</p>  <p>10-50mm</p>	<p>Water beetle larva</p>  <p>2-6mm</p>	<p>Whirligig beetle</p>  <p>3-15mm</p>	<p>Riffle beetle adult</p>  <p>2-4mm</p>
<p>Dragonfly nymph</p>  <p>30-50mm</p>	<p>Damselfly nymph</p>  <p>10-50mm</p>	<p>Water beetle</p>  <p>3-40mm</p>	<p>Whirligig beetle larva</p>  <p>3-12mm</p>	<p>Water strider</p>  <p>10-25mm</p>
<p>Dragonfly adult</p>  <p>17-200mm</p>	<p>Damselfly adult</p>  <p>25-55mm</p>	<p>Backswimmer</p>  <p>5-16mm</p>	<p>Waterboatman</p>  <p>5-16mm</p>	<p>Cranefly larva</p>  <p>10-25mm</p>
<p>Scud (amphipod)</p>  <p>5-21mm</p>	<p>Crayfish</p>  <p>10-150mm</p>	<p>Water scorpion</p>  <p>20-43mm</p>	<p>Sowbug</p>  <p>5-22mm</p>	<p>Freshwater clam</p>  <p>30-270mm</p>

## Macroinvertebrate Identification Key

GROUP 3

TOLERATE POLLUTION

<p>Blackfly larvae</p>  <p>3-12mm</p>	<p>Midge larva</p>  <p>2-15mm</p>	<p>Mosquito larva</p>  <p>1-6mm</p>	<p>Flatworm (planaria)</p>  <p>1-6mm</p>	<p>Freshwater worm</p>  <p>1-30mm</p>
<p>Blackfly adult</p>  <p>2-5mm</p>	<p>Midge adult</p>  <p>3-4mm</p>	<p>Mosquito adult</p>  <p>6-13mm</p>	<p>Leech</p>  <p>5-40mm</p>	<p>Water snail</p>  <p>2-70mm</p>



# Collecting





# Finding, Sorting, Identifying, Recording



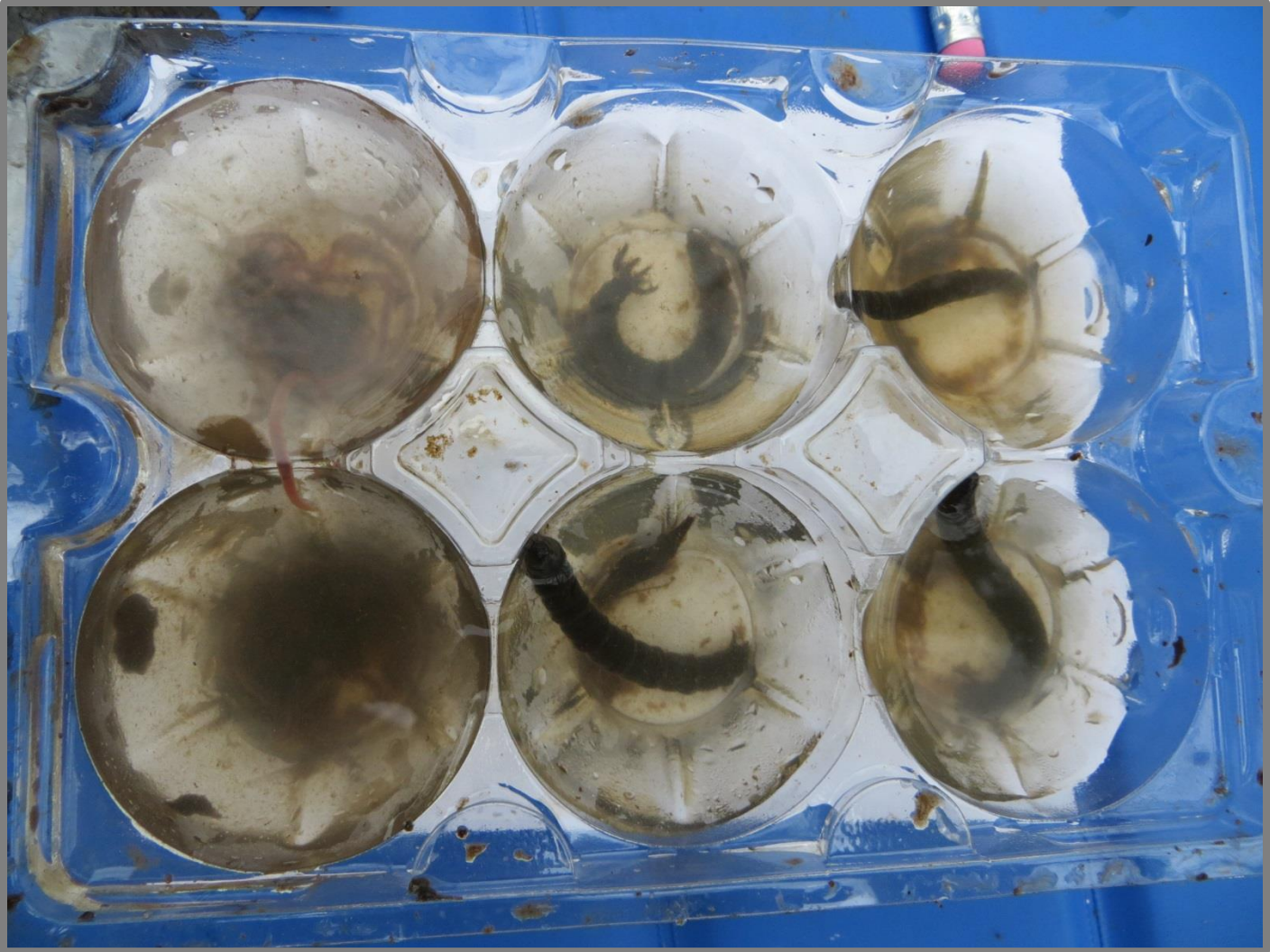


# Finding, Sorting, Identifying, Recording





# Finding, Sorting, Identifying, Recording



# Finding, Sorting, Identifying, Recording





# Finding, Sorting, Identifying, Recording



# Recording, Computing, and Analyzing

## **Students Record**

- Number of each type of macro
- Total found – all types
- Number of different types

## **Students Compute**

- use multi-stage scoring matrix to compute Stream Pollution Index (SPI)

## **Students Analyze**

- Compare to regional and national averages

# Chemical Testing

Normally done a week or two after macro testing and classroom analysis

Requires purchase of standard testing kits

- pH
- Oxygen
- Temperature
- Nitrogen
- Phosphorous
- Turbidity

# Little Run E.S. Stream Test “First Ever”

6<sup>th</sup> grade class

April 18, 2016

## **Volunteers**

**AAAS:** George Kralovec, Sally Berman

**FACC:** Kris Unger, Philip Latasa

**Lands and Waters:** Jeanette Stewart

## **Teacher:**

Misty Clatterbuck

Gifted Education Teacher

Little Run Elementary School









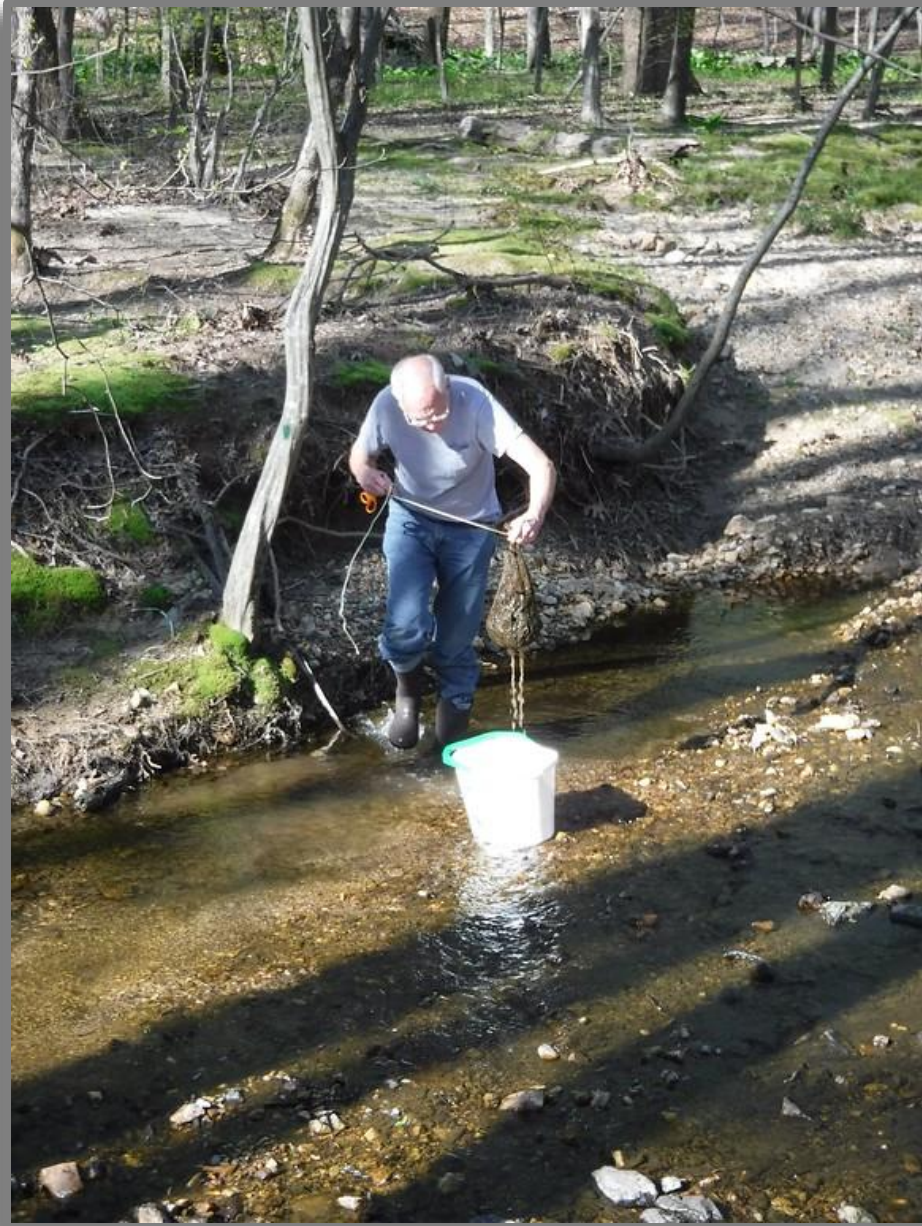


































Will we get  
to do this  
again?

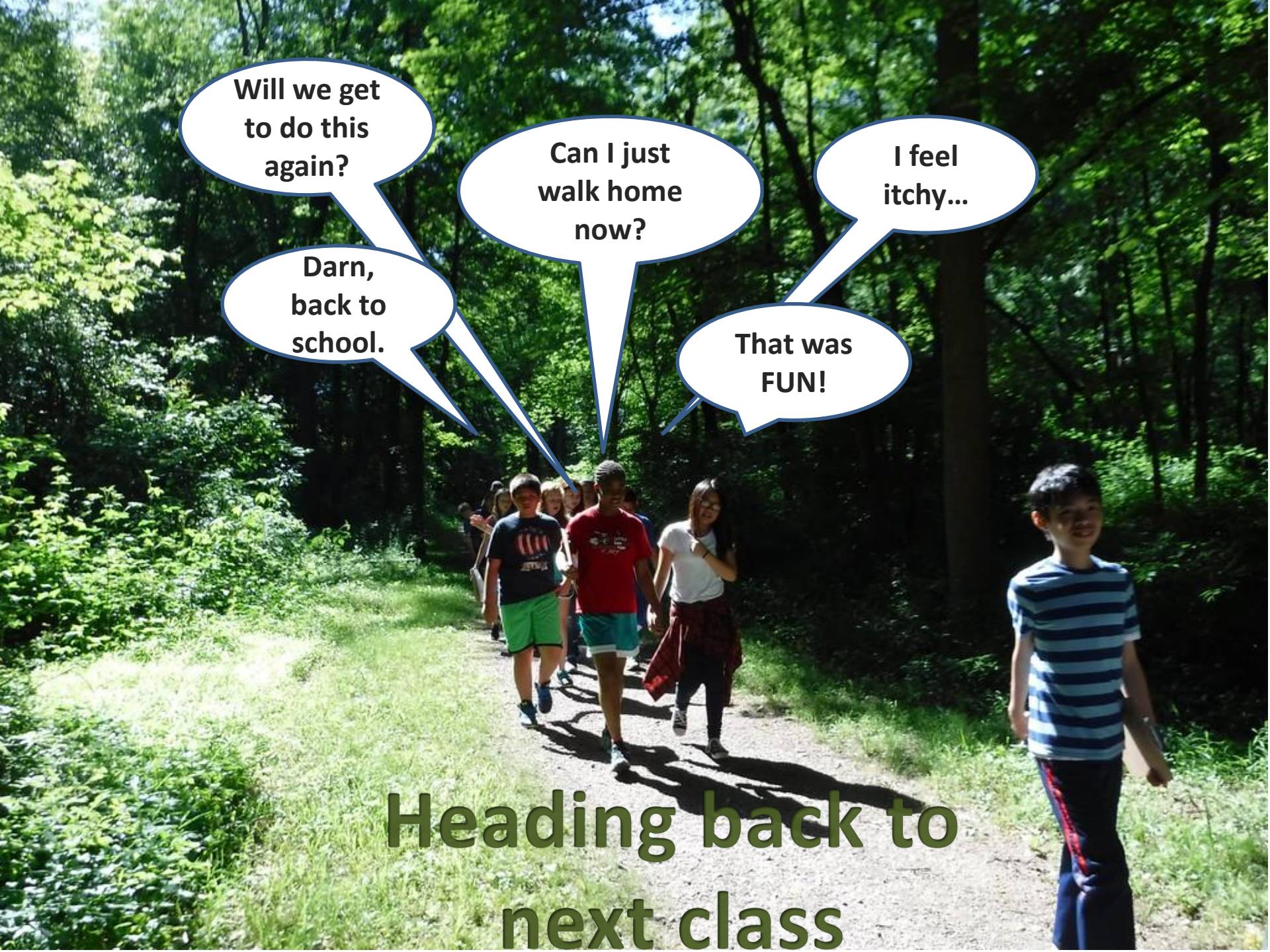
Can I just  
walk home  
now?

I feel  
itchy...

Darn,  
back to  
school.

That was  
FUN!

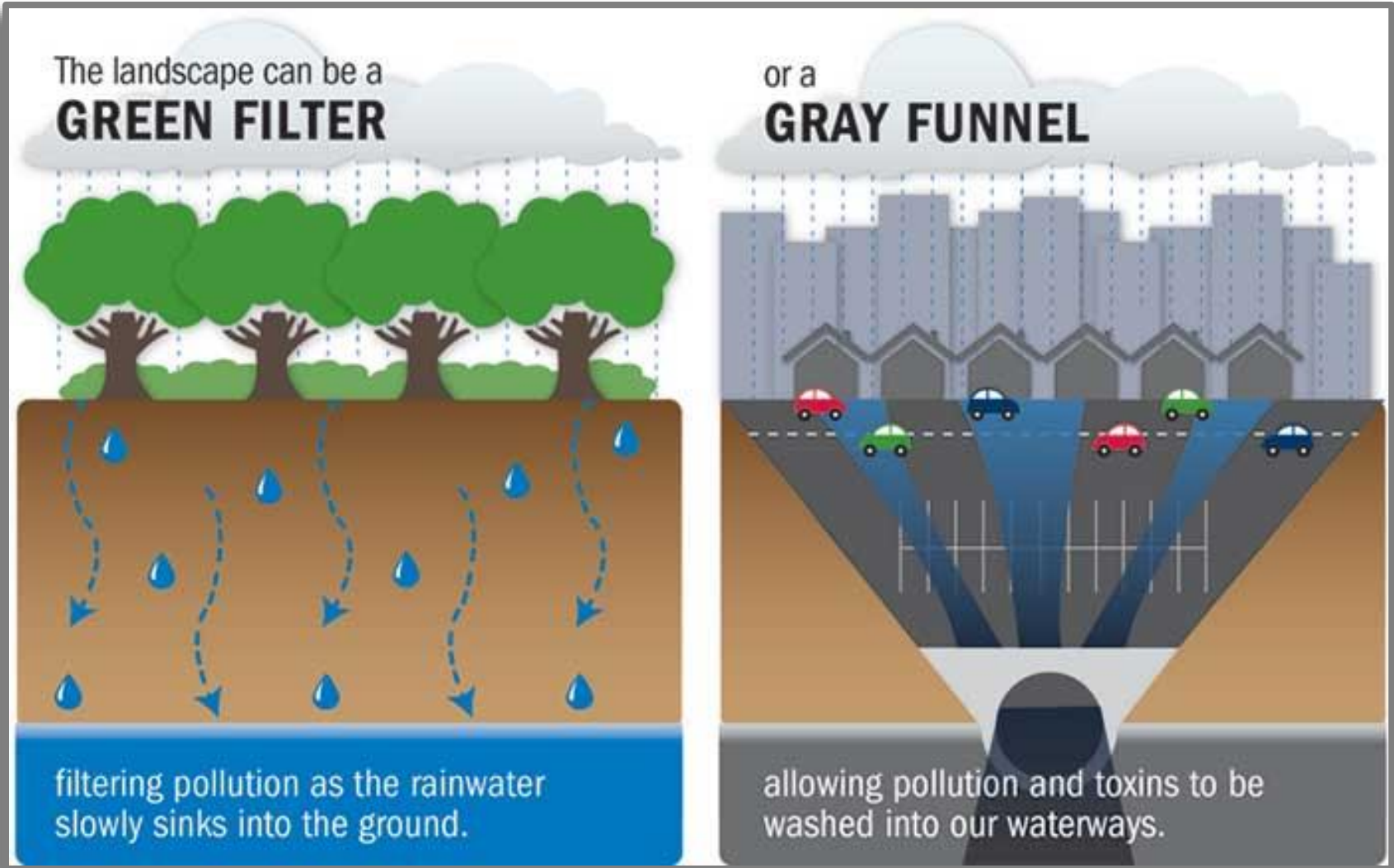
Heading back to  
next class



# Improving Urban Stream Health



# The Urban Situation -- In a Nutshell



# One of Many Actions to Help

Here how it works: It starts to rain. Rain water falls onto the native grass hillside. The tall grass catches the water, slows it down, and directs it down towards the root system where the water is absorbed. The rain stays in the best possible place - where it falls! There is less water runoff, less pollution, and less stream bank erosion.

**Big Blue Stem**  
Root system depth 12 feet

**Little Blue Stem**  
Root system depth 8 feet

**Switch Grass**  
Root system depth 10 feet

**Turf grass**  
Root system depth 2 to 4 inches

**Little Bluestem**  
3 to 4 feet

**Switch grass**  
4 to 8 feet

**Big Bluestem**  
6 to 8 feet

Replacing turf with native plants is a principle of **BayScaping**, landscaping for the health of the watershed.

the City of Fairfax,  
Northern Virginia.

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# The Water Cycle



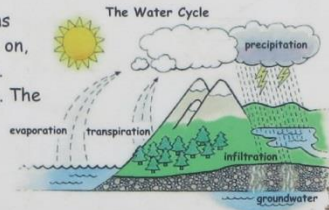
## Mini Marsh

### A Wetland Garden to Restore the Water Cycle



**Water keeps life going!** What happens to water after it rains? Where does it go? The water cycle gives us the answers.

The water cycle explains the movement of water on, in, and above the Earth. Water is always moving. The water cycle has been working for billions of years. Life depends on it continuing to work.



Hi, I'm a raindrop! I fell behind your school into the Daniels Run stream. I am on my way to Accotink Creek and then to the Chesapeake Bay. Part of my job is to help keep the streams and rivers flowing.



Now I'm floating in Lake Accotink, but not for long. I am about to **evaporate** into the atmosphere. I'll be back again as rain!



I caught a ride in some storm clouds and I rained down on the forest floor of your schoolyard. The forest soil soaked me right up. That's called **infiltration**. I provide water for the plants.



I was absorbed by the thirsty roots of a tree. From there, I traveled up to the leaves and **transpired** back into the atmosphere. There are more adventures to come because I'll return again as rain! Sound familiar?



This time I infiltrated into the soil, but I seeped way down and became **groundwater**. Groundwater helps keep our streams flowing and provides fresh water for living things. Having an abundant supply of groundwater is really a wonderful thing!



Good grief, this time I'm in a mess! I fell near the school's trailers but I haven't evaporated or infiltrated. I'm stuck on top of compacted clay. The teachers are unhappy since I'm getting their students muddy. **Help! Something needs to be done. I want to water the plants or become groundwater!**



In 2013, something was done! A mini marsh was created as a healthy and environmentally-friendly solution. Some of the compacted clay was removed, then mixed with compost and leaf mulch to create an absorbent soil. The new soil mix was spread over the muddy area. Now raindrops can easily infiltrate into the soil where they belong. Hooray, more adventures for me!

Finally, students, teachers, and volunteers helped plant the new garden with different kinds of native plants that like moist soil. The plants will provide food and shelter for wildlife, like hummingbirds and monarch butterflies.



Swamp Milkweed Monarch Caterpillar Monarch Butterfly Hummingbird

Funding provided by the National Fish and Wildlife Foundation, Lands and Waters, Fairfax County Department of Facilities and Transportation Services, and George Mason University. Educational sign designed by Lands and Waters.





# On Path to Canterbury Woods E.S.



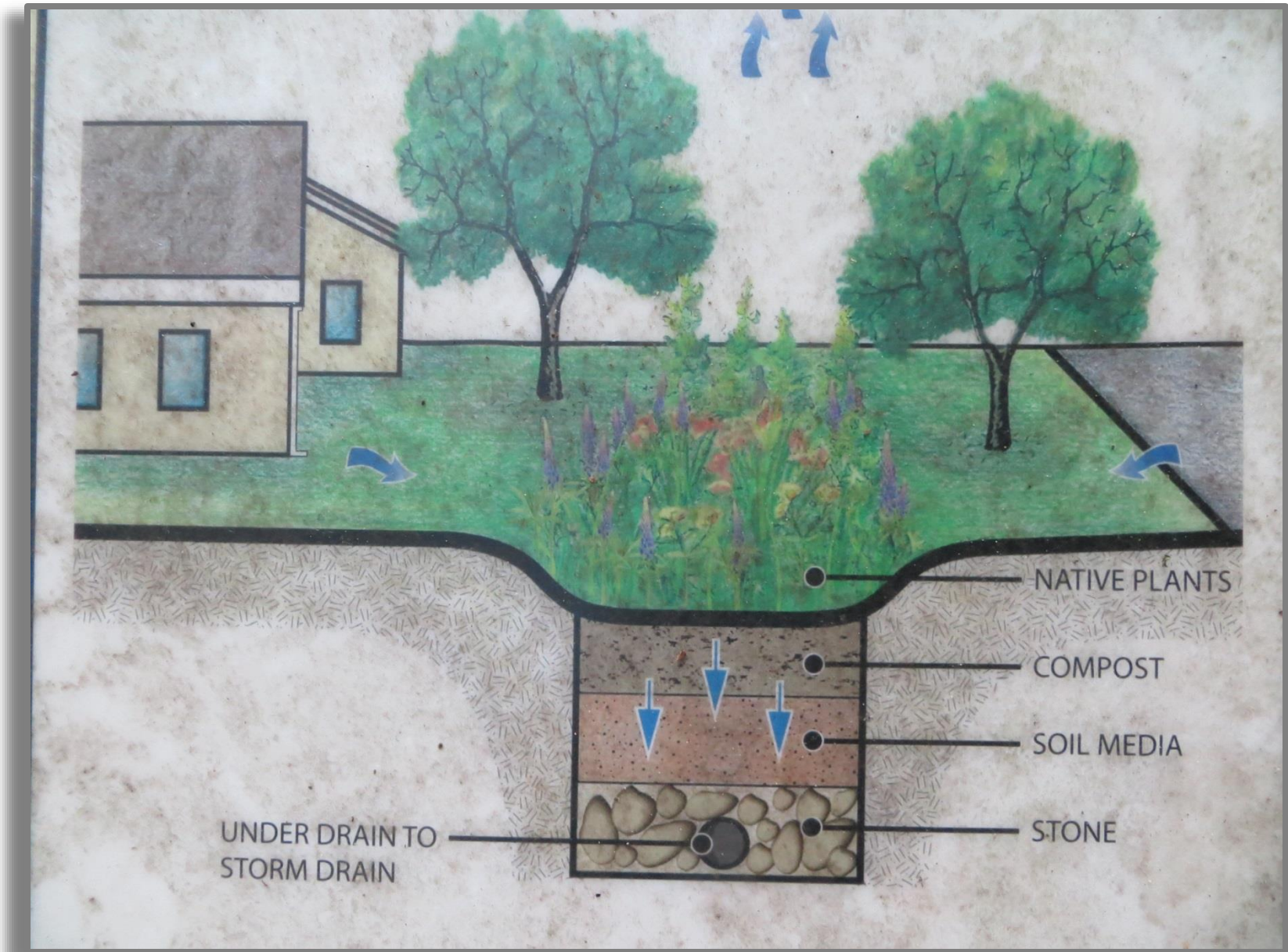


# On Path to Canterbury Woods E.S.

**A Rain Garden** is a planted depression that collects rainwater, promotes infiltration, and reduces erosion potential and pollutants, thus improving the water quality in nearby bodies of water.

As it rains on our yards

# On Path to Canterbury Woods E.S.





# On Path to Canterbury Woods E.S.

## Fun Facts:

This rain garden collects around 155,000 cubic feet of rain water every year. That's about the same as 65 school buses filled with clean water making its way towards the Chesapeake Bay!

There are about 980 miles of streams in Fairfax County. That's long enough to stretch a stream all the way from Fairfax County to the city of Jackson, the capital of Mississippi!

The root of butterfly milkweed is known to have medicinal uses.



# Neighborhood Values Sometimes Clash

## -- The Saga of John and Mary --

**John**

**Mary**

### John's 6 ft fence

- Applied to civic association for a variance so he would not have to look at Mary's "weeds."

### John's Perfect Lawn

- Sprinkler system
- Daily care
- Lots of Chemicals

### Mary's Natural Lawn

- No Sprinkler system
- Cutting only
- Minimum of Chemicals
- Rain and butterfly garden with native plantings





# Fairfax Water Competitive Grant Award

## First Project-

The “Little Watershed” at  
Little Run Elementary School

Rain Garden planted by two 1<sup>st</sup> grade and two  
6<sup>th</sup> grade classes

May 30<sup>th</sup>, 2017

# Welcome to the Little Watershed!



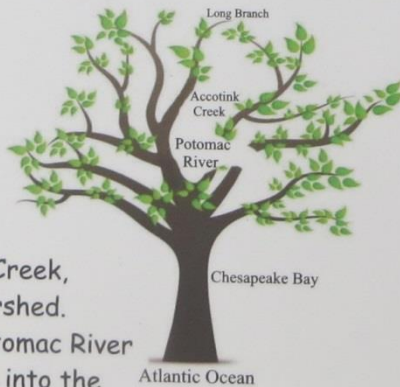
What is a watershed? A watershed is an area of land where all the rain that falls flows to one point. The area in front of you is a little watershed. The rain that flows over the land drains to one point, the storm drain.



The storm drain connects to a pipe that carries the water to Long Branch Stream. This Little Watershed is in the Long Branch watershed. All the rain that falls on your school campus flows into Long Branch. So your school is in the Long Branch Watershed.



Like branches on a tree, small streams in small watersheds join streams from other small watersheds to form larger streams and watersheds.



Long Branch flows into Accotink Creek, joining the Accotink Creek Watershed. Accotink Creek flows into the Potomac River (Potomac River Watershed), then into the Chesapeake Bay (Chesapeake Bay Watershed), and finally into the Atlantic Ocean.

What happens here affects everything downstream. Clean water from Long Branch would improve the water in the Accotink, Potomac, Chesapeake Bay, and Atlantic Ocean. But polluted water from Long Branch would degrade the water all the way to the Atlantic Ocean.

Funding by Fairfax County Public School Schoolyard Stewardship Mini Grant

What causes watersheds and streams to become unhealthy? Rain flowing off our lawns and impervious surfaces, such as driveways and rooftops, become polluted by eroded soil (sediment), motor oil, trash, pesticides, and fertilizers.




This unhealthy stormwater runoff travels over surfaces in our communities then into the storm drains and streams. This polluted water harms plants, animals, and degrades water quality.

When we develop land, we cover surfaces like forest and meadows that absorb and clean stormwater runoff. We replace these with impervious surfaces that do not absorb water. This increases stormwater runoff.



Water enters the stream at a faster rate eroding and damaging our streams even more.

 The best place for a raindrop is where it falls!

What can we do to help our watershed become healthier?

- ☺ Replace impervious with pervious surfaces whenever possible
- ☺ Replace lawn areas with native plant gardens to increase wildlife habitat
- ☺ Plant different kinds of native plants to increase biodiversity
- ☺ Get to know, love, and care for your watershed

Why did we plant Native Plants here?

- ☺ Support wildlife by providing food and shelter
- ☺ Attract pollinators and beneficial insects
- ☺ Reduce the need for water, fertilizers, and pesticides
- ☺ Well-adapted to local soils and climate

Partners:



**FRIENDS of  
LONG BRANCH  
STREAM VALLEY**











# Rewards of Volunteering

- The Kids are Great
- The Teachers are Awesome
- The Parent and Community Volunteers
- The Supporting Organizations (Lands and Waters, Friends of Accotink Creek, Friends of Long Branch Stream Valley Park, Fairfax Water)
- Recognition is always appreciated too

**American Association for the Advancement of Science  
Award for Best Teacher-Volunteer Partnership of the  
2016-2017 School Year –  
Misty Clatterbuck, George Kralovec**





# Could This School Be Next to Test?



Questions?  
Suggestions?





