The Aquatic Bugs & Chemistry ABC's

of Stormwater & Stream Sampling

Dive Deeper
09/25/2025

Muhlenberg College

CITY OF ALLENTOWN PENNSYLVANIA

City of Allentown Stormwater Bureau

Mike Schmidt –
Environmental Compliance Specialist

Gabe Caprio –
Stormwater Education Manager

Muhlenberg College

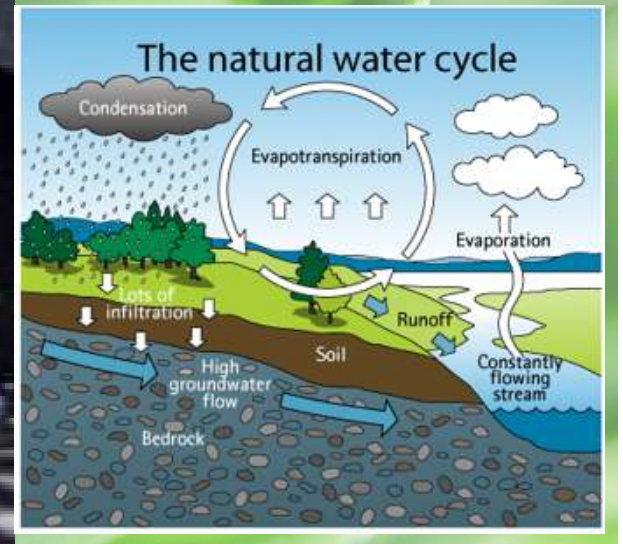
Prof. Karen Tuerk

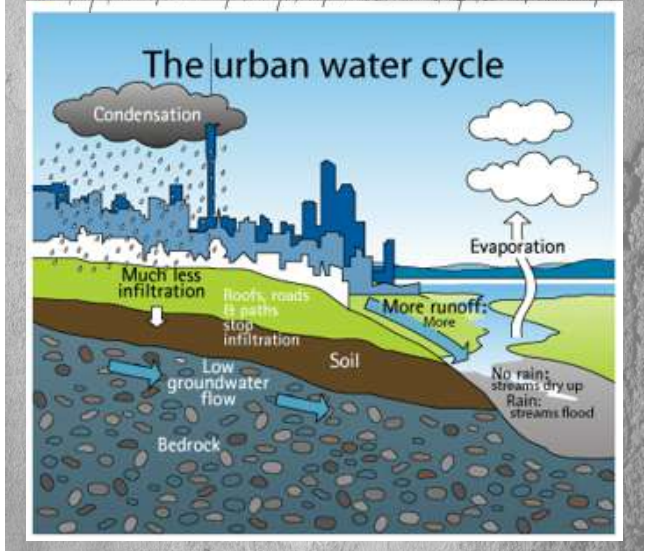
Dr. Erika Iyengar

Three summers working with a total of 33 Muhlenberg College student researchers and two professors

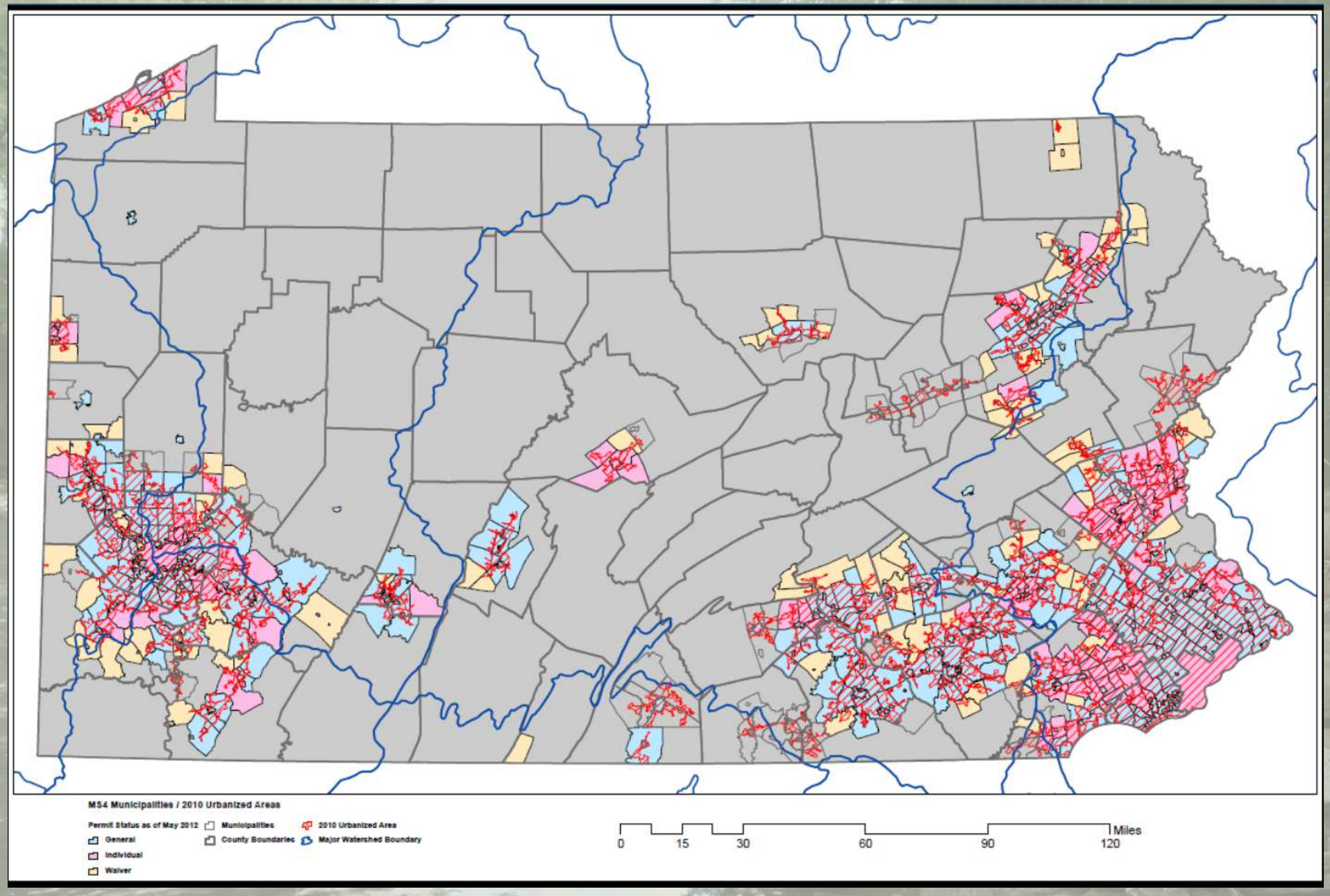
- Project Overview
- Site Selection
- Stream Characterizations
- Water Chemistry
- Collection Methods
- Macro Counts/Raw Data
- Data Interpretation
- Presentation Options For Study And Data

What is Stormwater?





Municipal Separate Storm Sewer System (MS4)



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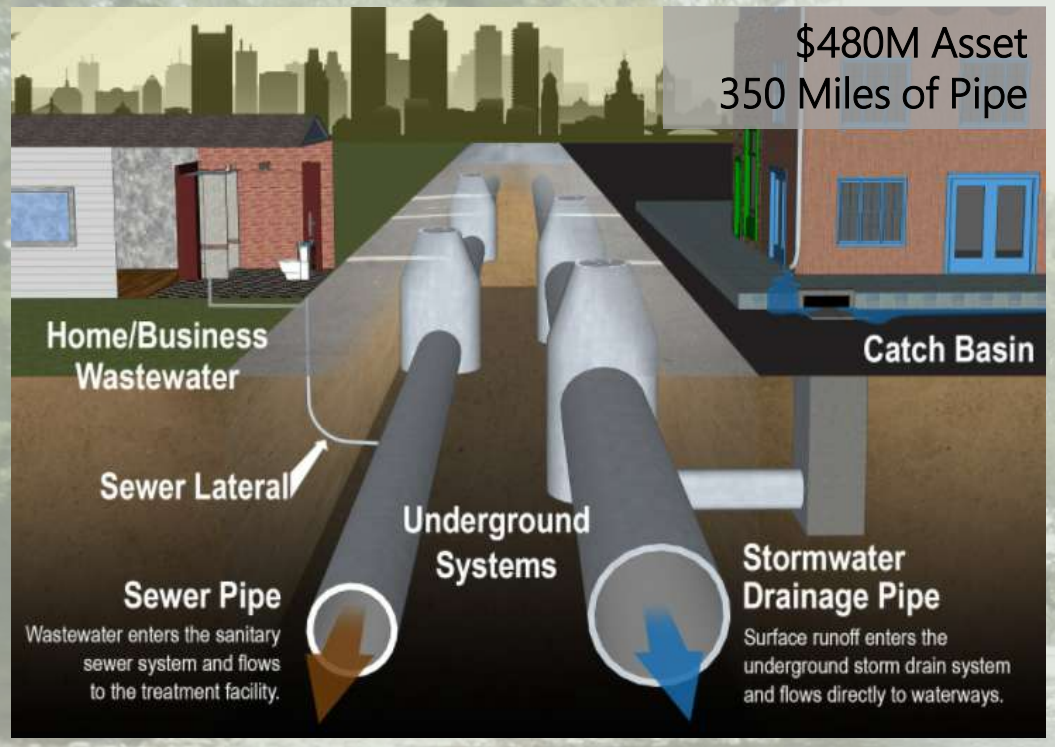
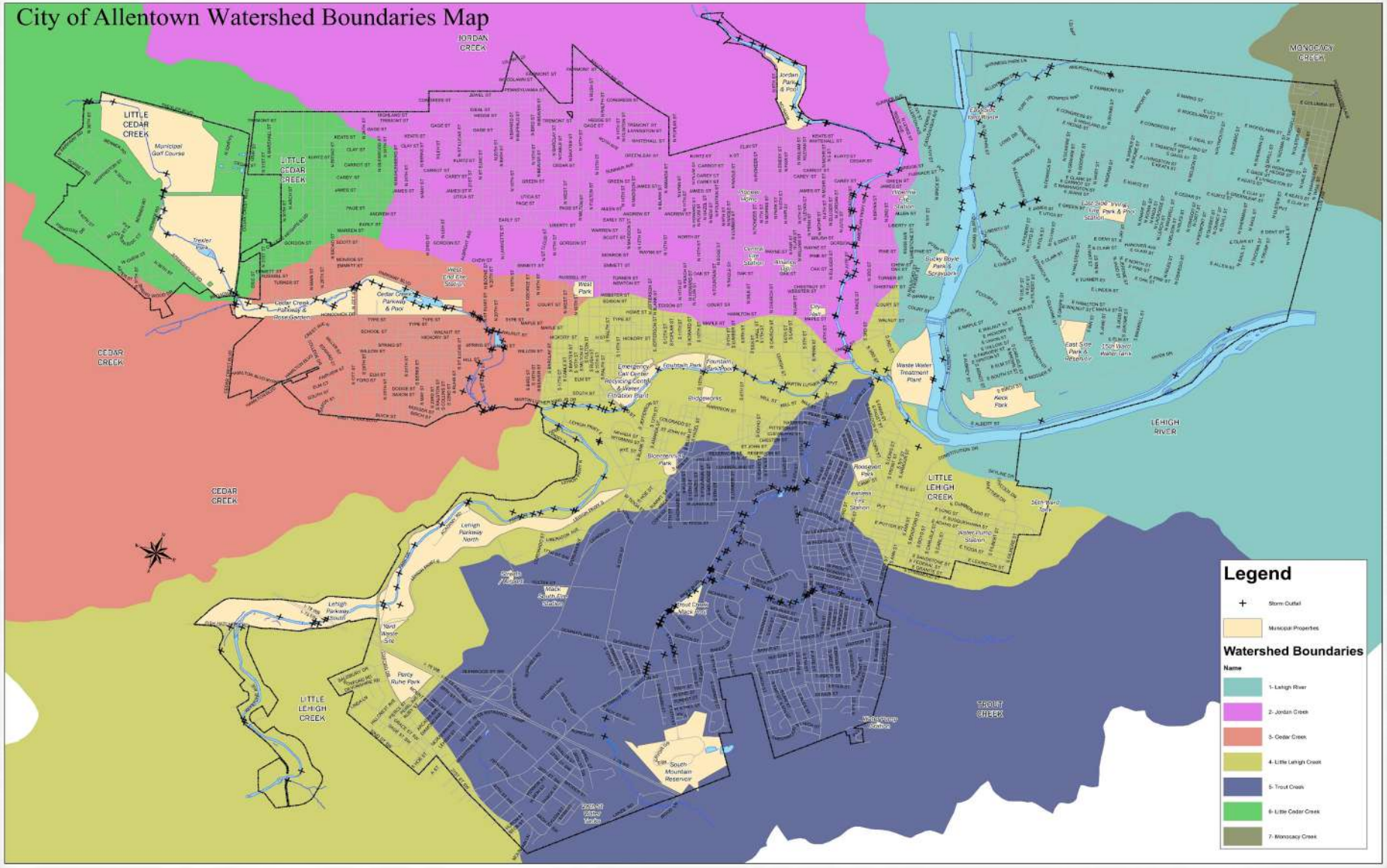
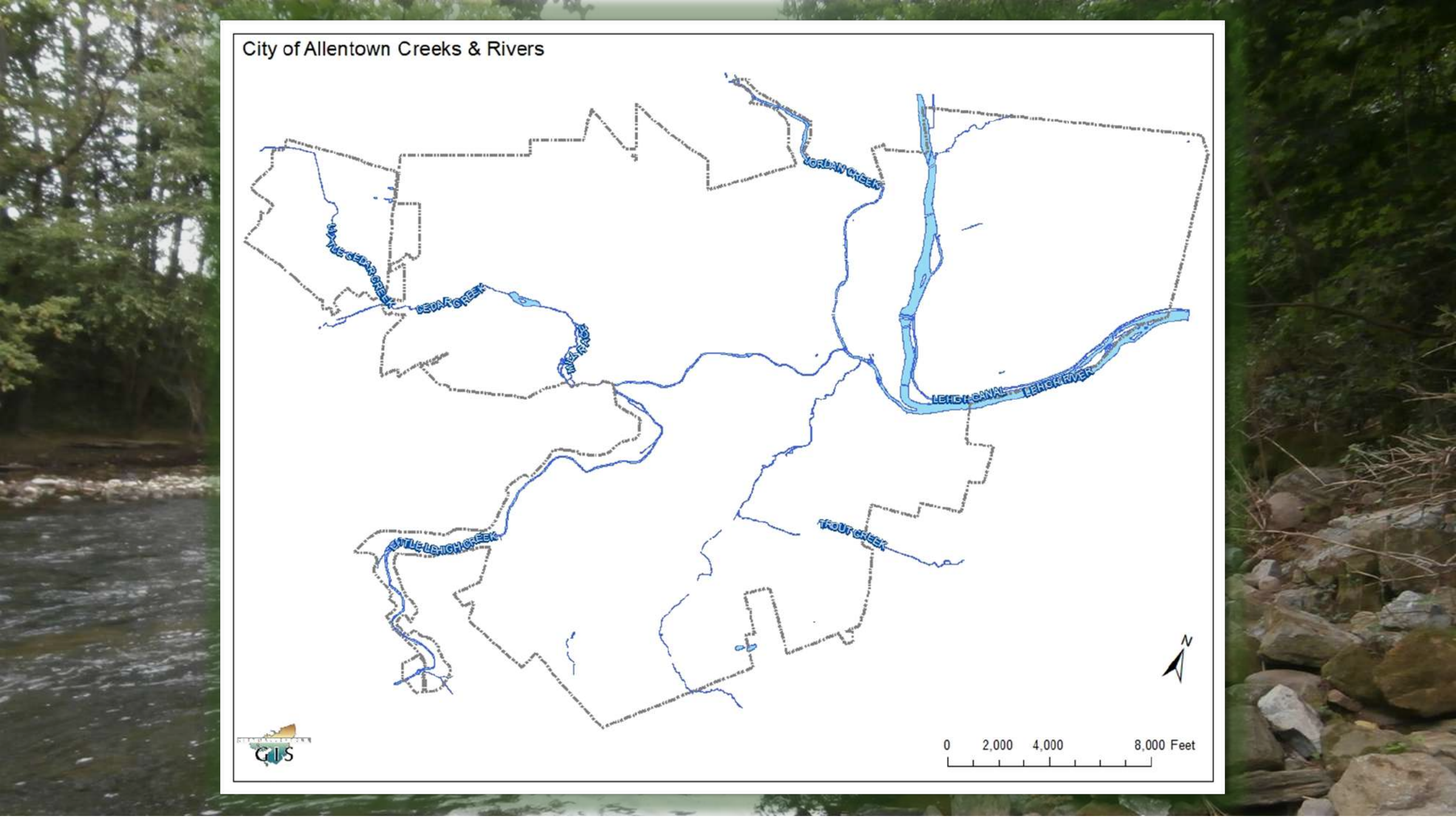


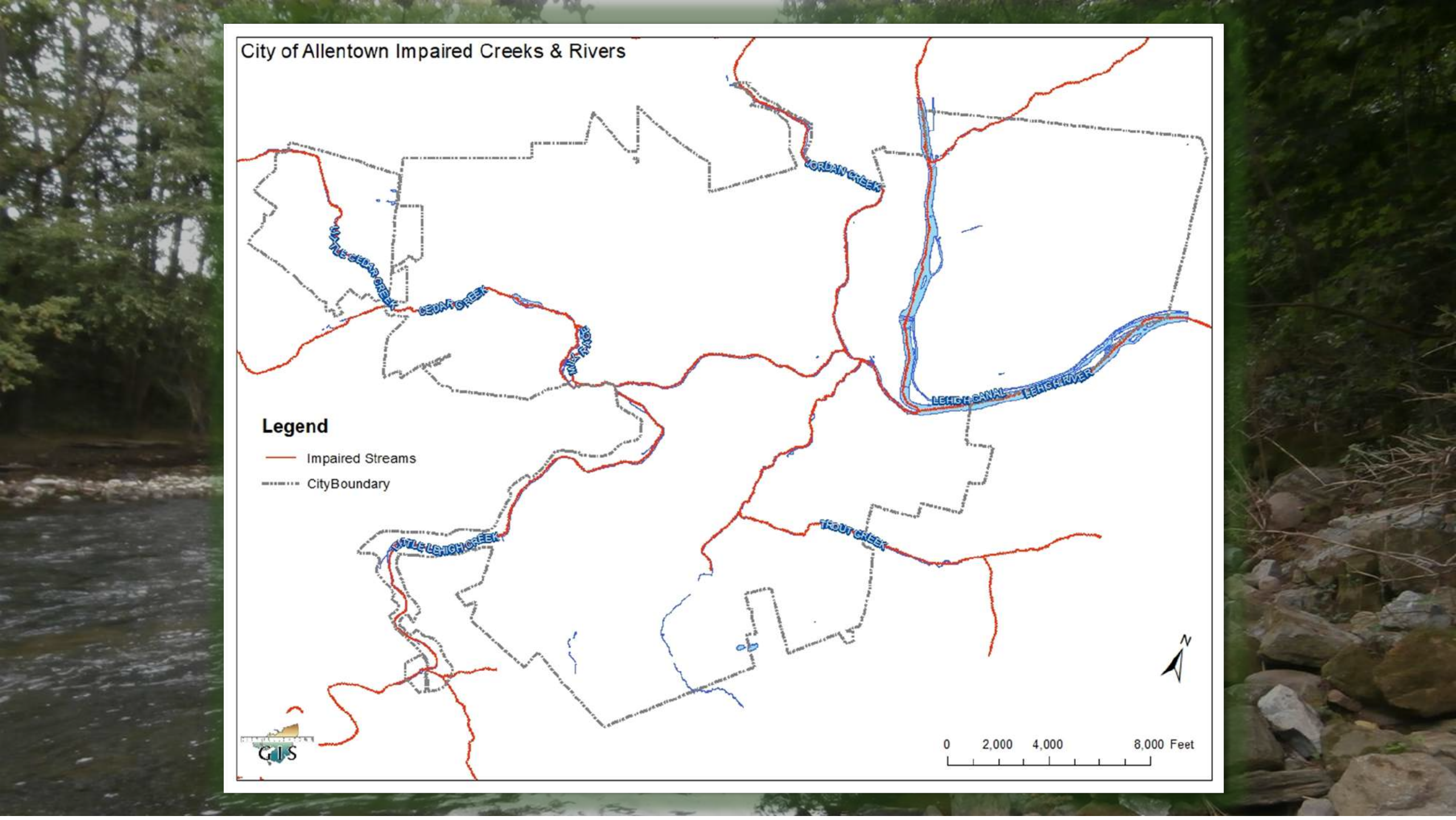
2024 Pennsylvania Integrated Water Quality Report

Integrated Report 2024



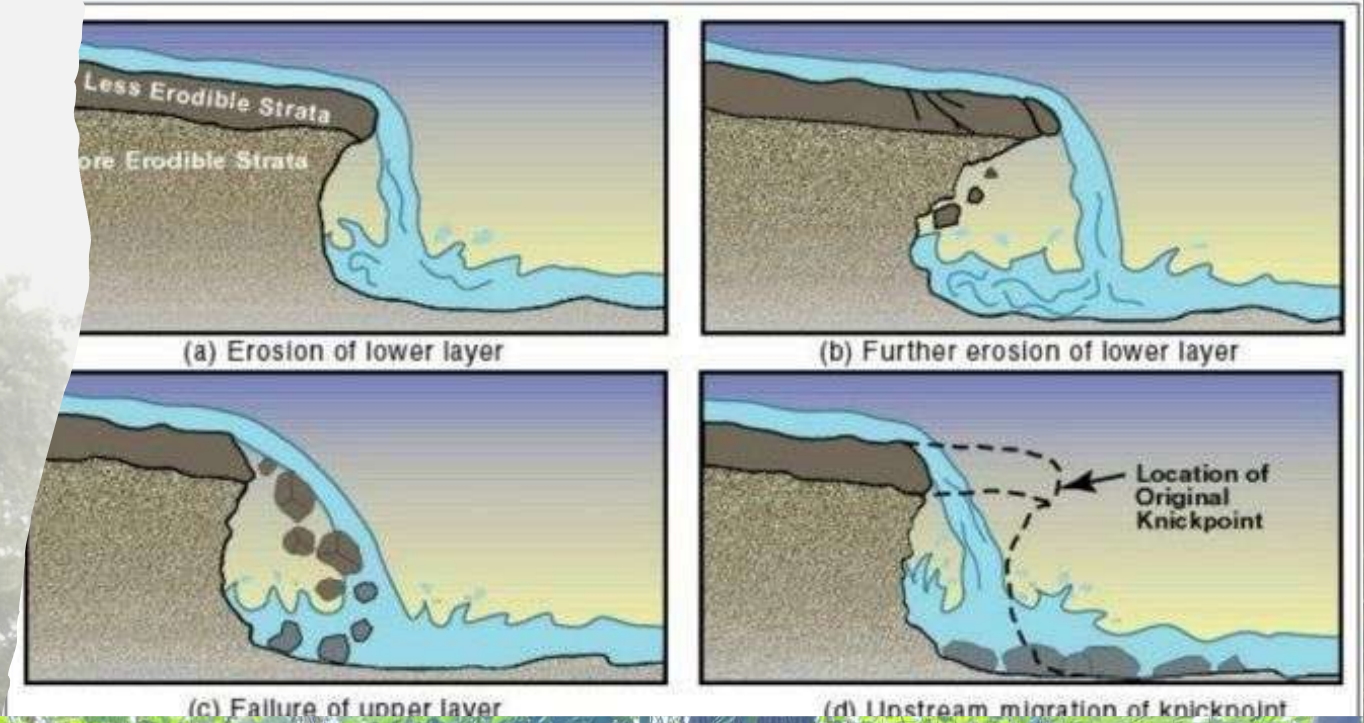
Allentown Storm Infrastructure Map

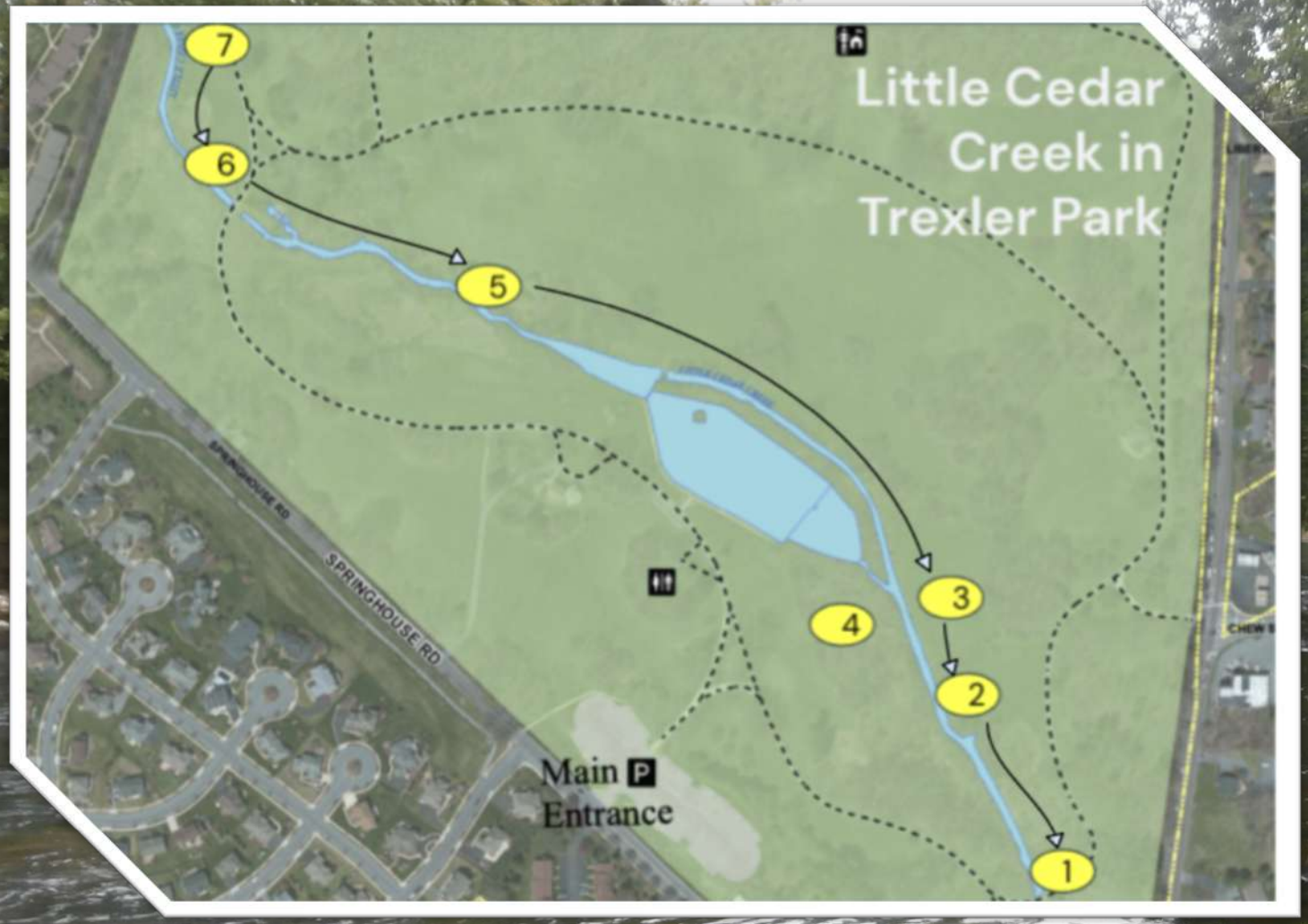

City of Allentown Creeks & Rivers
JORDAN CREEK
LITTLE CEDAR CREEK
CEDAR CREEK
LEHIGH CANAL
LEHIGH RIVER
TROUT CREEK
LITTLE LEHIGH CREEK
N
0
2,000
4,000
8,000 Feet
GIS


City of Allentown Impaired Creeks & Rivers
JORDAN CREEK
LITTLE CEDAR CREEK
CEDAR CREEK
MILL CREEK
LEHIGH CANAL
LEHIGH RIVER
TROUT CREEK
LITTLE LEHIGH CREEK
Legend
Impaired Streams
CityBoundary
N
0 2,000 4,000 8,000 Feet

Streambank Erosion

- Sediment depositing from flooding and stormwater can change the stream bottom composition.
- Changes to stream flow and course occur over time.

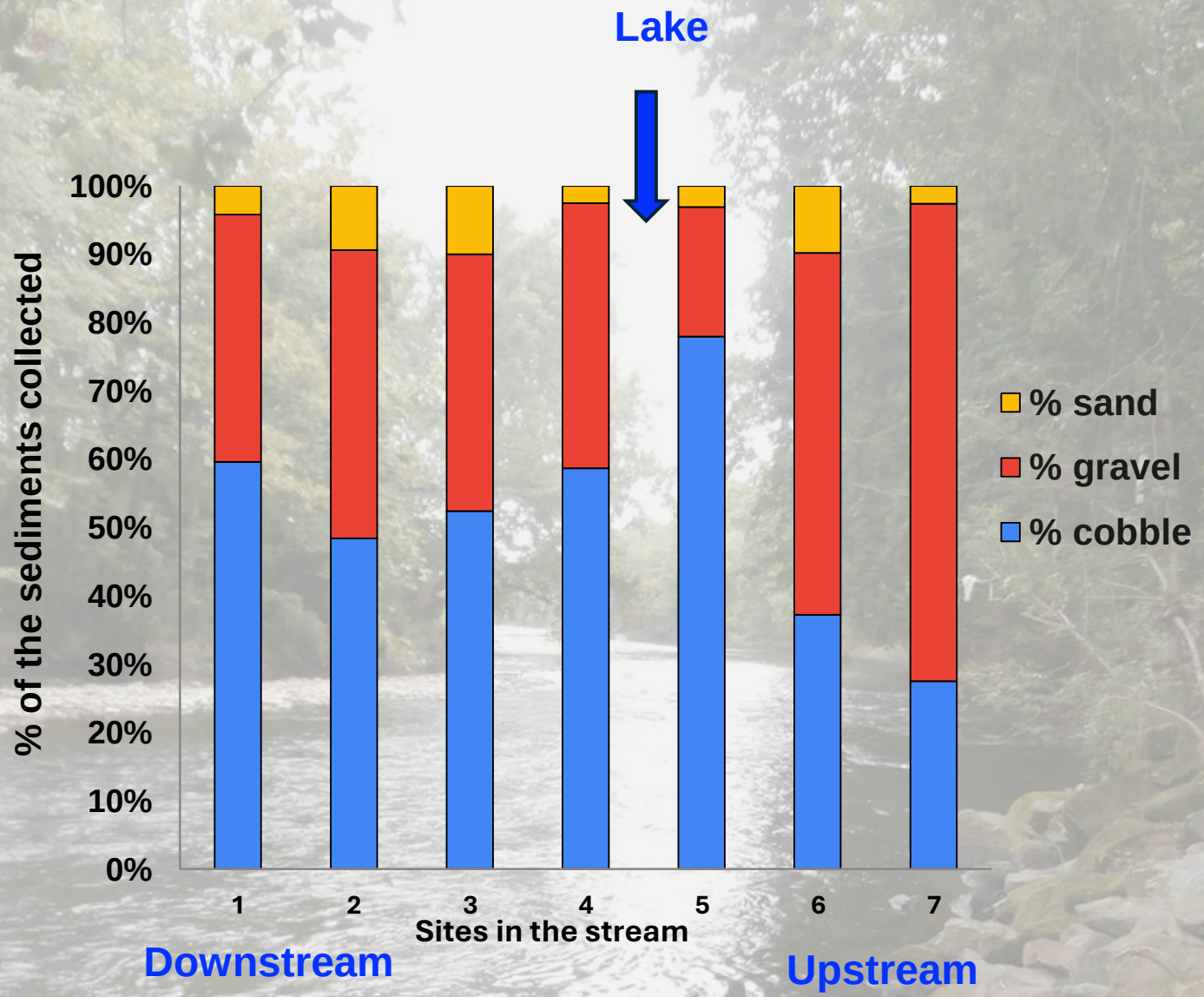




Seven sites along Little Cedar Creek, an urban stream

Description of particle size			$\phi = -\log_2$	mm	$\psi = \log_2$
			- 12.0	4096	12.0
	very large		- 11.5	2896	11.5
			- 11.0	2048	11.0
	large		- 10.5	1448	10.5
Boulder			- 10.0	1024	10.0
	Medium		- 9.5	724	9.5
			- 9.0	512	9.0
	small		- 8.5	362	8.5
			- 8.0	**256**	**8.0**
	large		- 7.5	181	7.5
Cobble			- 7.0	128	7.0
	Small		- 6.5	90.5	6.5
			- 6.0	**64**	**6.0**
	very coarse		- 5.5	45.3	5.5
			- 5.0	32	5.0
	coarse		- 4.5	22.6	4.5
		Pebble	- 4.0	16	4.0
Gravel	medium		- 3.5	11.3	3.5
			- 3.0	8	3.0
	fine		- 2.5	5.66	2.5
			- 2.0	4	2.0
	very fine	**Granule**	- 1.5	2.83	1.5
			- 1.0	**2**	**1.0**
	very coarse		- 0.5	1.41	0.5
			0	1	0
	coarse		+ 0.5	0.707	- 0.5
			+ 1.0	0.500	- 1.0
Sand	medium		+ 1.5	0.354	- 1.5
			+ 2.0	0.250	- 2.0
	fine		+ 2.5	0.177	- 1.5
			+ 3.0	0.125	- 3.0
	very fine		+ 3.5	0.088	- 3.5
			+ 4.0	**0.063**	**- 4.0**
Silt					
			+ 8.0	**0.0039**	**- 8.0**
Clay					
			+ 12.0	0.00024	- 12.0

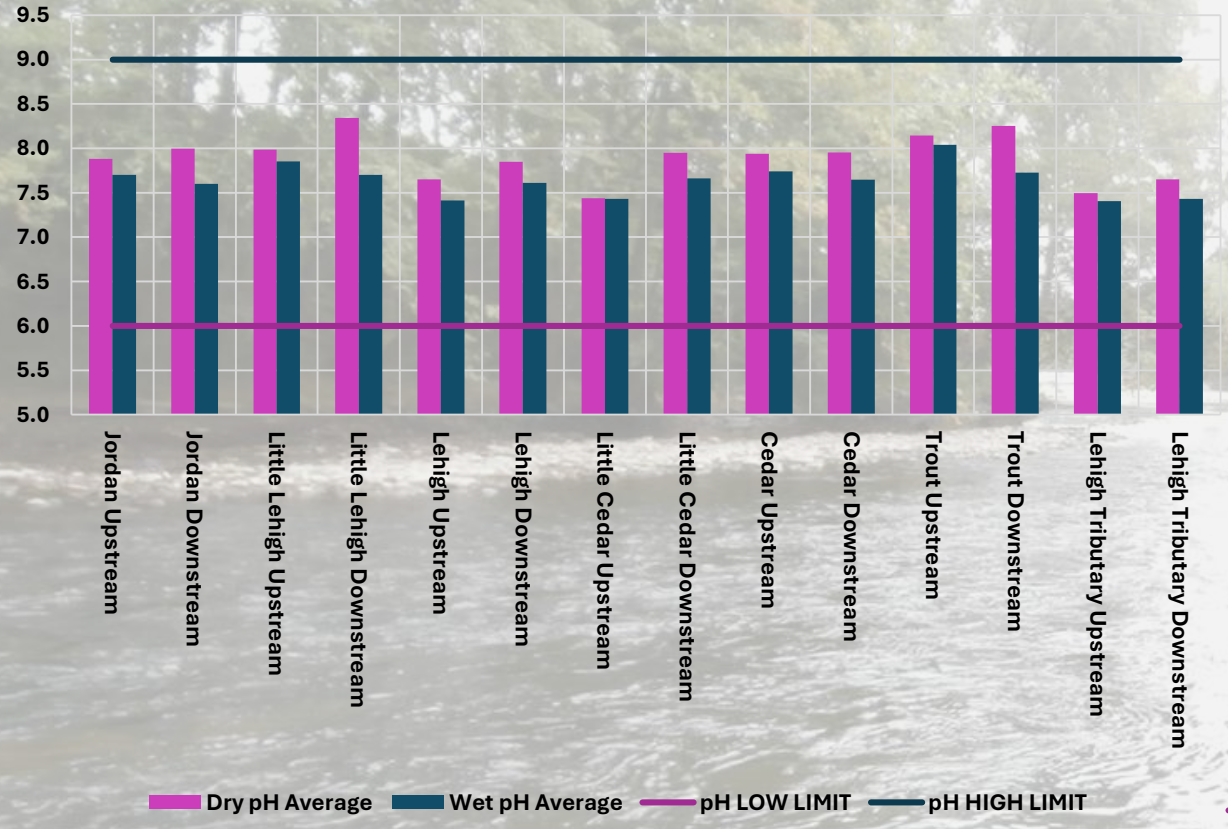
Collected, sorted, and weighed the various sediment size categories from each site



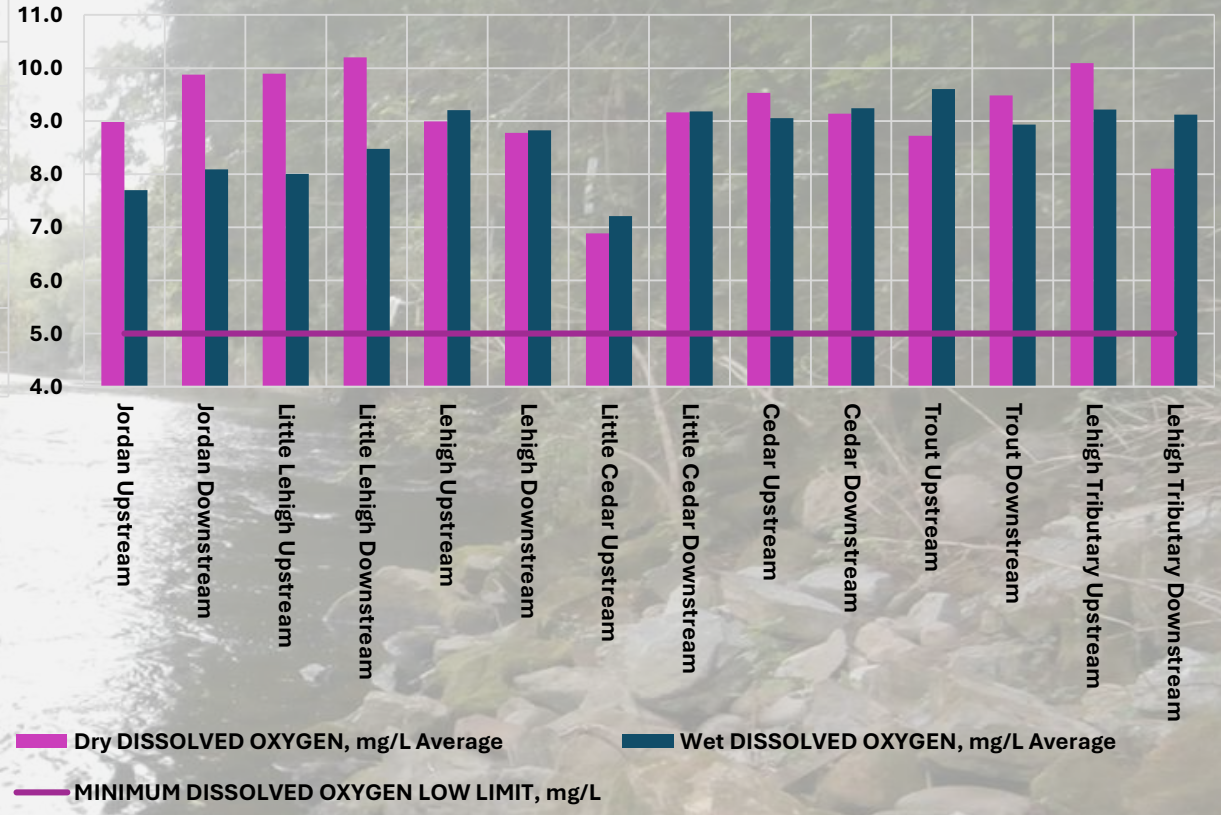
Proportions of variously sized sediments. More small-sized sediment far upstream of the lake (sites 6 & 7). Downstream of the lake (sites 1-4) were relatively similar.

Water Chemistry

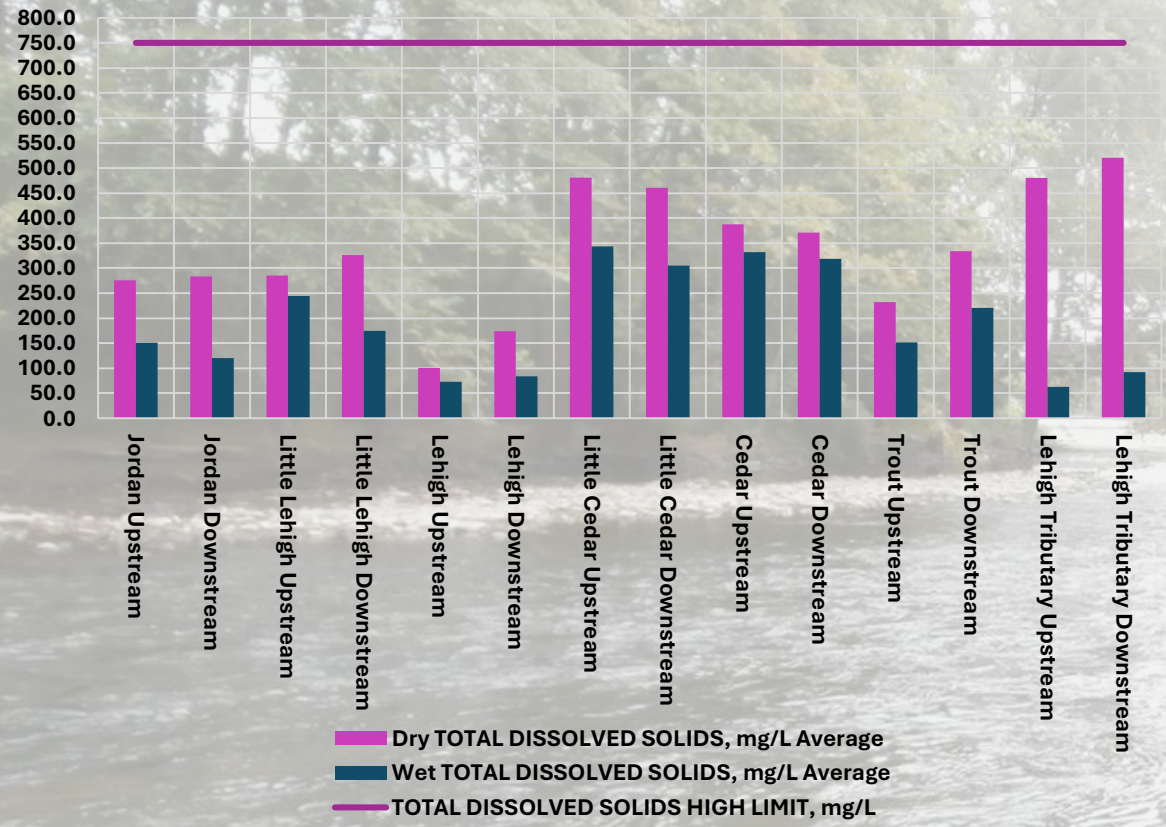
Average pH for Streams



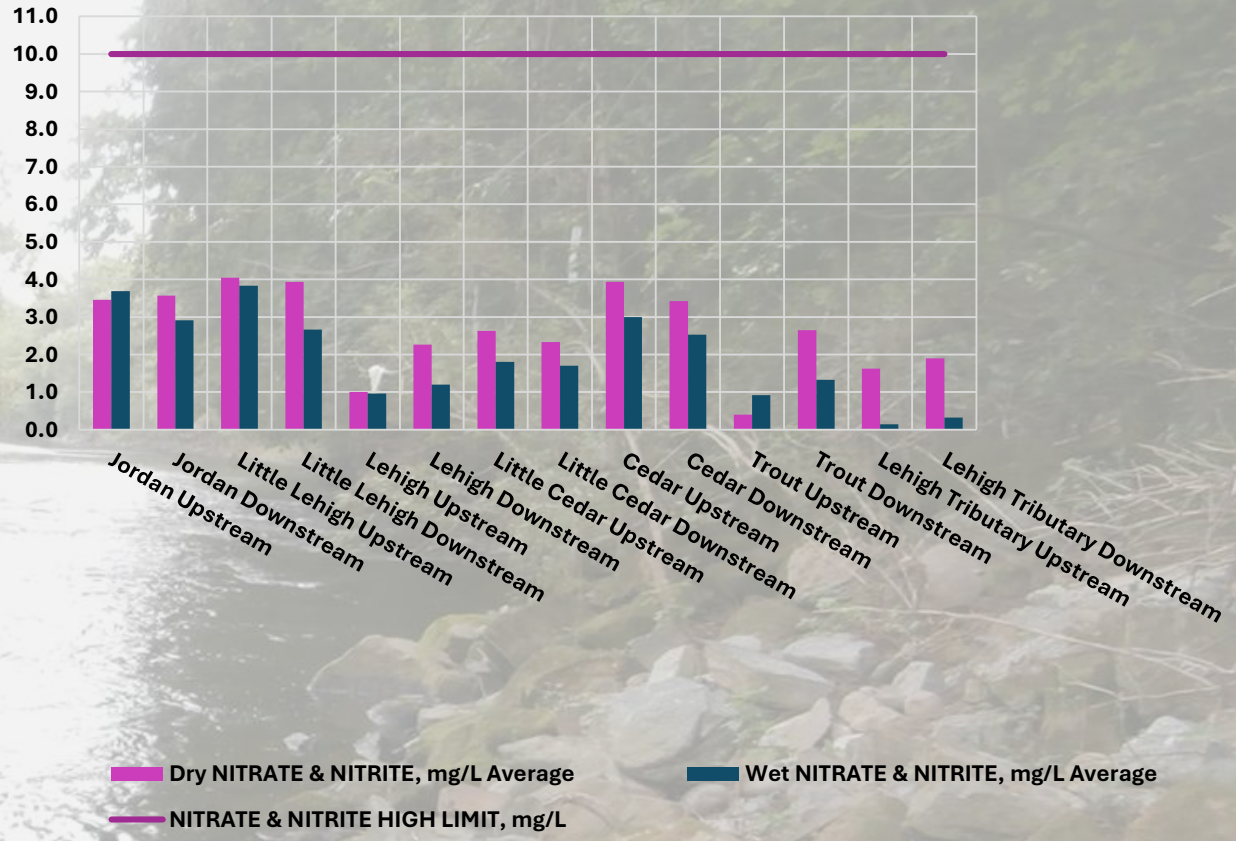
Average Dissolved Oxygen for Streams in the City



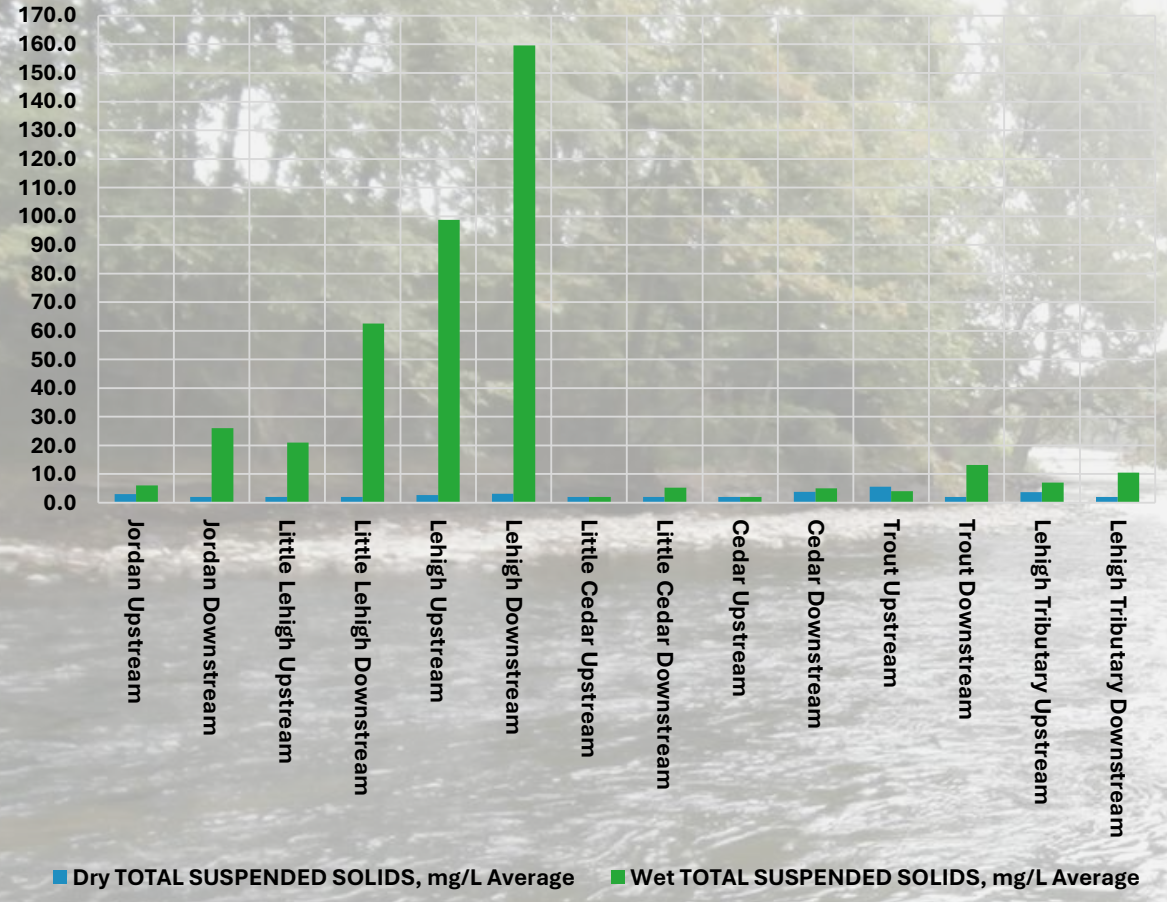
Average Total Dissolved Solids



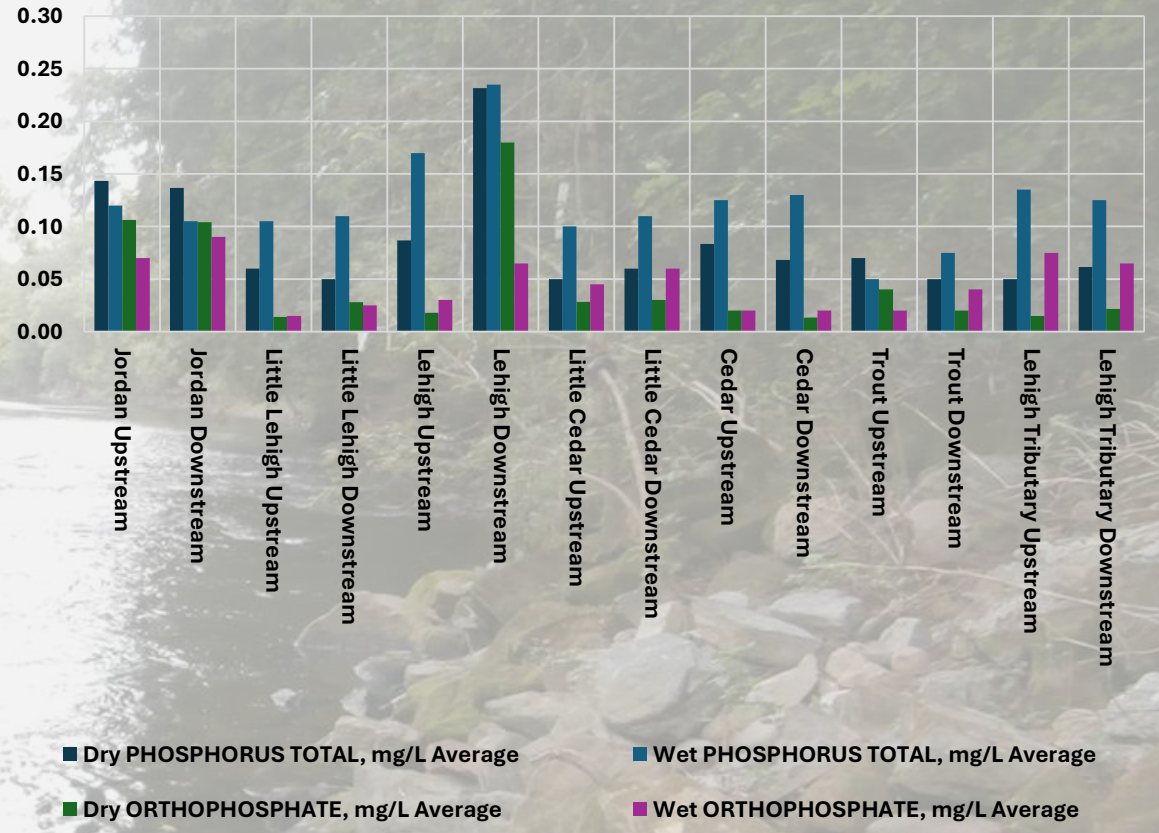
Average Nitrate and Nitrite for Streams



Average Total Suspended Solids for Streams



Average Total Phosphorous and Orthophosphate for Streams



How does pollution in stormwater affect macroinvertebrates?

- They are sensitive to changes in the ecosystem.
- Many live in an aquatic ecosystem over a year or more. Meaning that we can learn more about the waterway than from taking just chemical parameters.
- They do not easily escape changes to water quality.
- Collection methods are easy and inexpensive, unofficial counts can be done during water testing.

Group 1: Pollution Intolerant Species

Mayfly

Riffle Beetle

Caddisfly Larva

Stonefly

Right-Handed Snail

Group 2: Moderately Pollution Intolerant Species

Sowbug

Scud

Clam

Crayfish

Damselfly Larva

Group 3: Pollution Tolerant Species

Aquatic Worm

Midge Larva

Leech

Black Fly Larva

Left-Handed Snail

What are Macroinvertebrates?

Figure 4. Some common taxa in our samples. (A) ostracod*; B) Chironomids; (C) Isopods; (D) Mayflies, (E) The invasive New Zealand mud snail*

* photo (A) Piter Keo, earthlingnature.wordpress.com; (E) PA Fish and Boat Commission web site, www.fishandboat.com)


SAMPLE COLLECTION

STREAM QUALITY SAMPLING DATA SHEET

Watershed:
Site Location:

Monitoring Condition:	Sample Date:	Sample Time:
Weather:	Last Rain event date:	
Leaf Packet or In Stream Sampling:		
Leaf Packet placed today (Y/N):	Macroinvertebrates Collected (Y/N)	

Wet Chemistr

Parameter	Result
Water Temperature, °C	
pH, SU	
Conductivity, µS/cm²	
Dissolved Oxygen,%	
Chlorine, mg/L	
Ammonia, mg/L	
Surfactants, mg/L	
Turbidity, STU	

Macroinvertebrates (*Use this section only if Macros are collected*)

Organism	Tally	Total	Observations
Mayflies			
Stoneflies			
Caddisflies (Case Building)			
Caddisflies (Net Building)			
Watersnipe Flies			
Riffle Beetles			
Water Pennies			
Midge Flies			
Alderflies			
Damselflies			
Dragonflies			
Craneflies			
Hellgrammites/Dobsonflies			
Sowbugs			
Scuds			
Crayfish			
Clams/Mussels			
Blackflies			
Gilled Snails			
Lunged Snails			
Aquatic Worms			
Leeches			
White Midge Flies			
Red Midge Flies			
Flatworms/Planaria			
Crane Fly Larvae			
Unidentified/Other			
Total # of Organisms =			
EPT Index # =			

	Excellent	Good	Good-Fair	Fair	Poor
Rating	>27	21-27	14-20	7-13	0-6

Stream Conditions/Water Quality

Stream-flow rate ____High ____Normal ____Low
Stream ____Clear ____Cloudy _____Muddy ____Odor

Width	Height average	FPS	Q(Flow)

Circle All That Apply:

Stream Bottom (Sandy, Rocky, Large Stones, Leaf Debris/Vegetation, Algae, Other)

Odor(Sewage, Rancid/sour, Petroleum, Chemical, Sulfide, Other, Not Applicable)

Color(Clear, Brown, Gray, Yellow, Orange, Red, Green, Other, Not Applicable)

Turbidity(Clear, slight cloudiness, Cloudy, Opaque, Not Applicable)

Floatable (Sewage, Suds, Petroleum, Litter, Other, Not Applicable (NA)

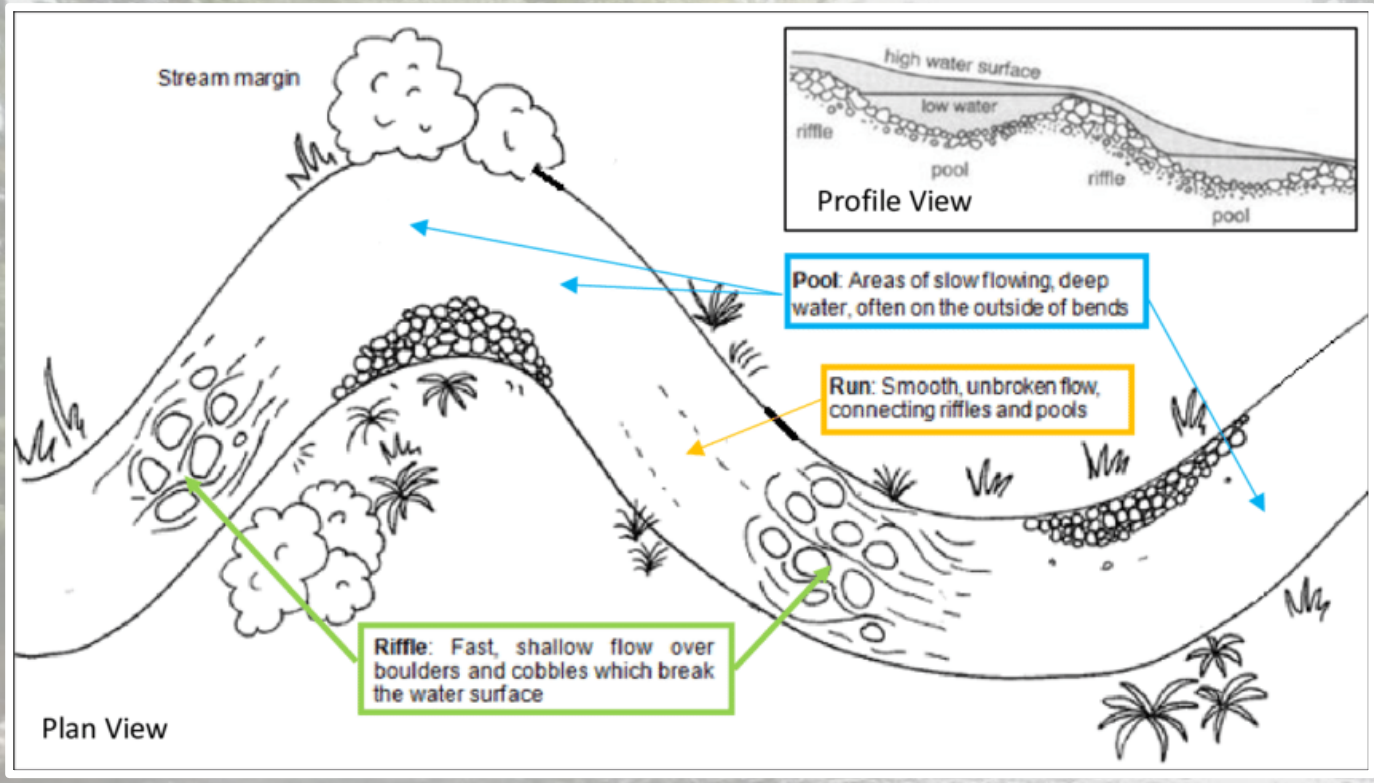
Deposits/Stains(Oily , Flow Line, Paint, Other, Not Applicable (NA)

Abnormal Vegetation(Excessive ,Partially/Totally Inhibited, Not Applicable (NA)

Algae Growth, Brown ,Orange, Green, Other, Not Applicable (NA)

OBSERVATIONS:

Collection Methods



Looking Below the Surface (pa.gov)

Measured stream parameters (width, depth) & water velocity (floating ping pong balls!)

MACROINVERTERATE RESULTS

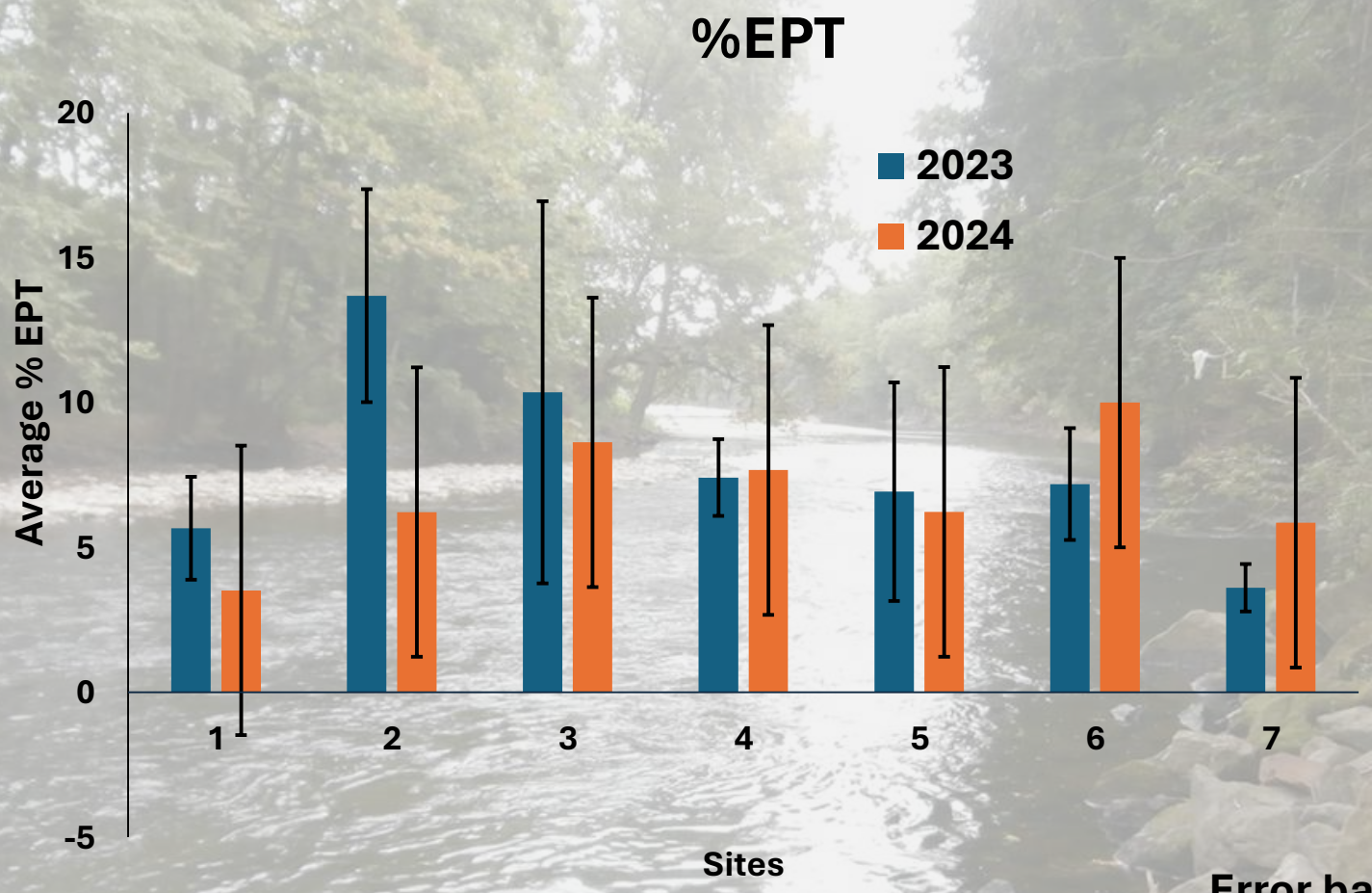
Select data from 2023; first summer of sampling

Average density of organisms within a quadrat
& Shannon Weiner Diversity Index (SW) per site,)

Site	Density Average	Density 1 SD	SW Average	SW 1 SD
1	143.0	125.2	1.9	0.3
2	297.0	421.0	1.8	0.4
3	126.5	59.9	2.0	0.2
4	229.2	47.7	1.7	0.4
5	283.8	311.2	1.6	0.3
6	569.2	256.7	1.3	0.3
7	1170.2	769.0	0.9	0.4

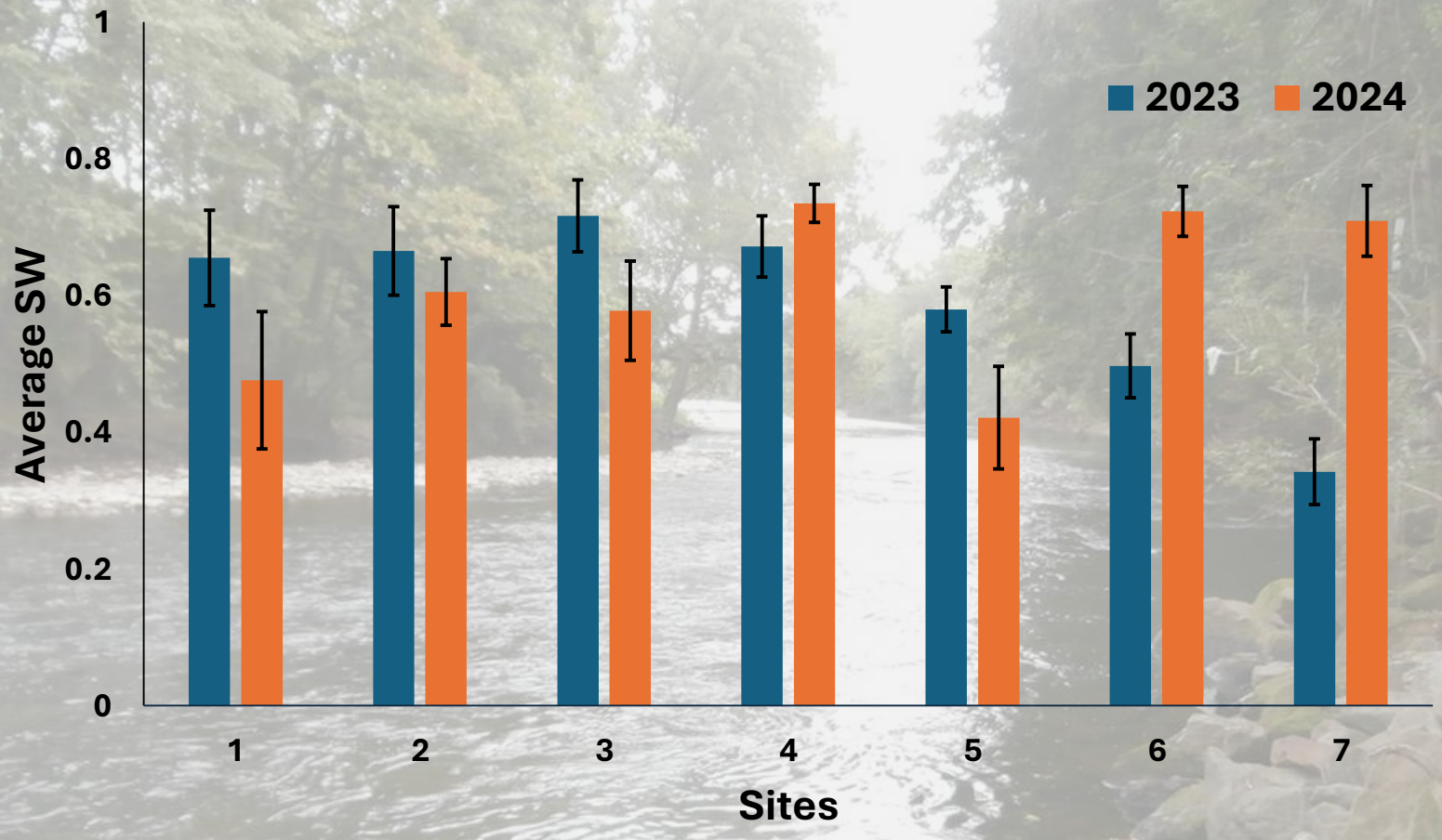
The extreme increase in sites 6 & 7 was largely due to ostracods.

Even large differences within quadrats at a site,
As evidenced by the large error bars.
Streams are patchy entities!



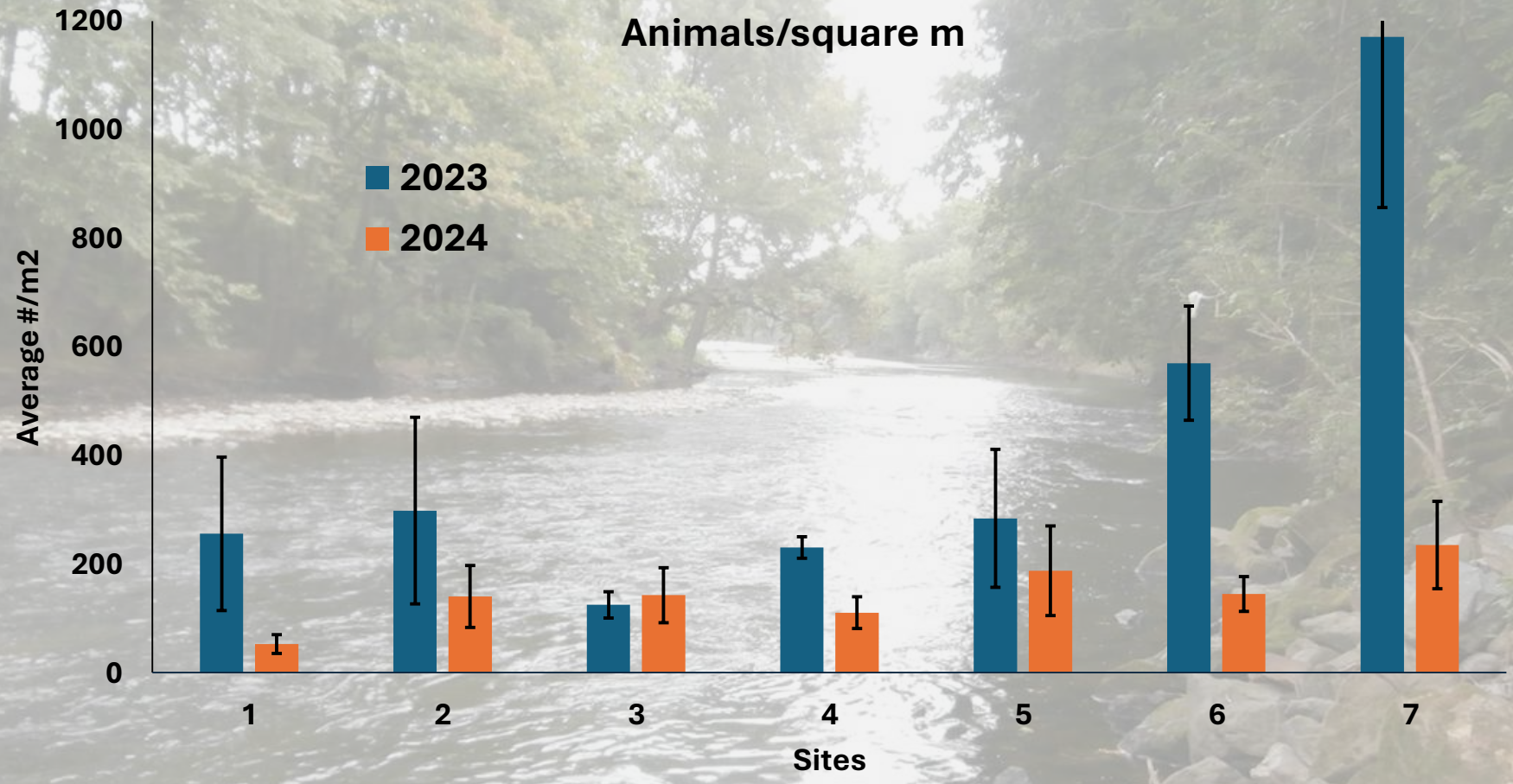
Error bars are +/-1SE
N = 6 per bar

Shannon-Weiner Diversity Index



Error bars are +/-1SE
N = 6 per bar

There can be very large differences among years, so best to sample more than one year



Error bars are +/-1SE
N = 6 per bar

Fun For All Ages

Undergrad

- Kick Nets
- Follow DEP parameters and procedures for sampling
- Identify ALL species
- Calculate Shannon-Weiner Index (or other index)
- Present finished data in poster form

High School

- Leaf packs or Kick Nets
- Follow specific sampling parameters and procedures
- Identify main species (Stoneflies, Mayflies, Caddisflies, Dobsonflies, Riffle Beetles, etc.)
- Calculate EPT Index

Fun For All Ages

Middle School

- Leaf packs or Kick Nets
- Sample at random
- Count total number of insects
- Identify main species (Stoneflies, Mayflies, Caddisflies, Dobsonflies, Riffle Beetles, etc.)

Elementary

- Leaf packs
- Count total number of insects
- Try to identify Stoneflies & Mayflies

List of the most key pieces of equipment – Kick Net

- **Fishing license and educator collection permit $27.97 (PA Fish & Boat)**
- Hip waders or water shoes (closed toes for kicking) $40ea. (Amazon)
- Quadrats (and white rocks for marking kick sites) Cost of PVC and Cost of Paint
- D-Nets $115 (www.LaMotte.com)
- Feather forceps or dissecting tweezers $10 for 5pk (Amazon)
- Plastic tubs for collecting and holding samples $1.25ea. (Dollar Tree)
- 1gal. Plastic bags (if taking samples back to classroom) $1.25ea. (Dollar Tree)
- Rite in the Rain paper $30 for 3pk (Amazon)
- Measuring tape, ping pong ball and timer (stream flow) ~$20 (Amazon)
- Yard stick (stream depth) $8 (Amazon)
- Habitat assessment forms No Cost
- Dissecting scopes $225ea.- AmScope (Amazon)
- Ice Cube Trays or Petrie Dishes $1.25ea. (Dollar Tree)

Total = ~$175.00

List of the most key pieces of equipment – Leaf Pack

- **Fishing license and educator collection permit $27.97 (PA Fish & Boat)**
- Hip waders or water shoes (closed toes for kicking) $40ea. (Amazon)
- Onion or Mesh Bags $8 for 90pk (Amazon)
- Scale $10 (Amazon)
- Anchor (rebar or twine to tie bag)$5.48 ½” x 2ft ea. (Home Depot)
- Sledgehammer or Mallet $40 (Home Depot)
- Tree Identification Guide $20 (Amazon)
- Feather Forceps or Dissecting Tweezers $10 for 5pk (Amazon)
- Plastic tubs for collecting and holding samples $1.25ea. (Dollar Tree)
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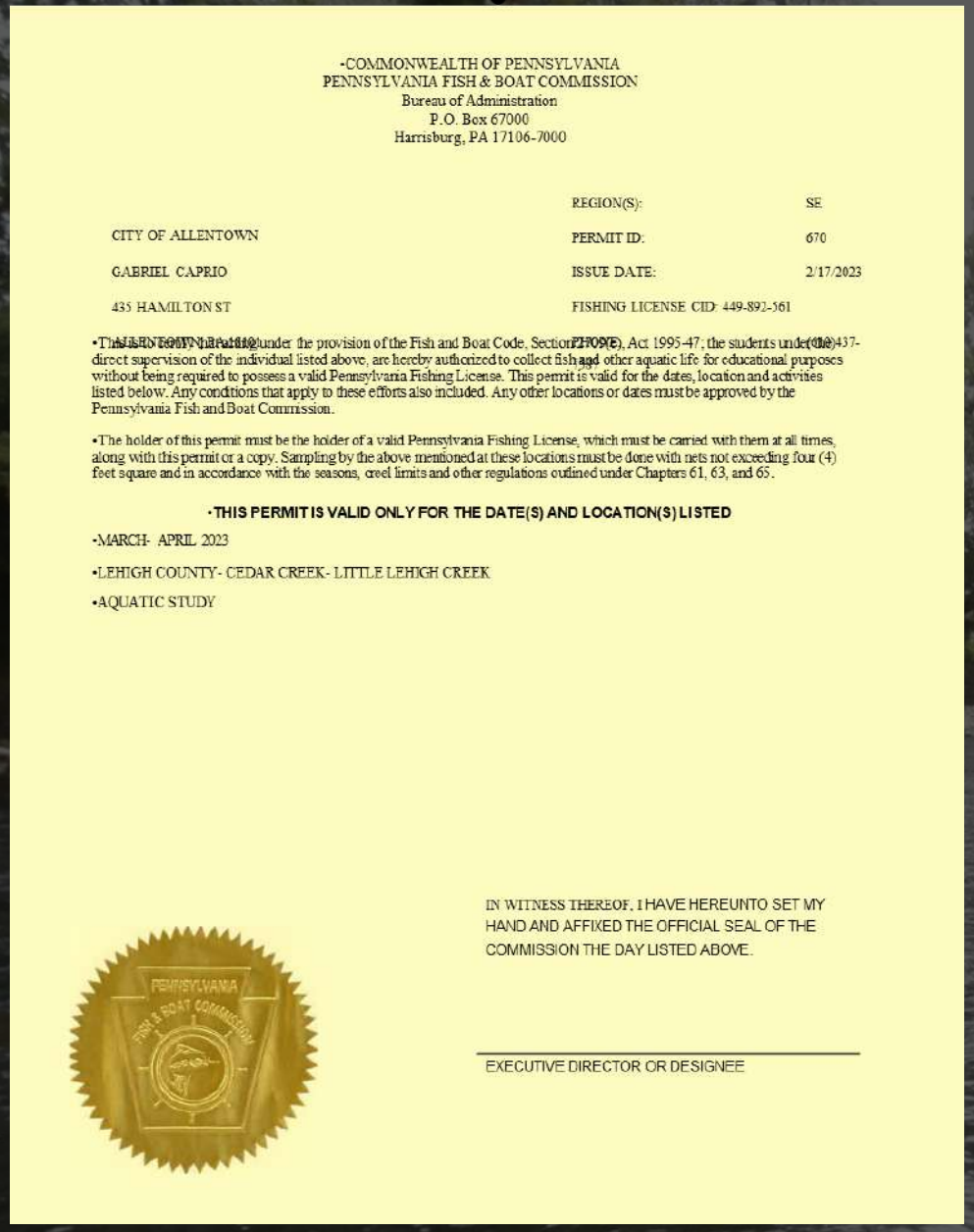
- Ice Cube Trays or Petrie Dishes $1.25ea. (Dollar Tree)

Total = ~$75.00

PA Fish & Boat Commission Collectors Permit



-COMMONWEALTH OF PENNSYLVANIA
PENNSYLVANIA FISH & BOAT COMMISSION
Bureau of Administration
P.O. Box 67000
Harrisburg, PA 17106-7000

	REGION(S):	SE
CITY OF ALLENTOWN	PERMIT ID:	670
GABRIEL CAPRIO	ISSUE DATE:	2/17/2023
435 HAMILTON ST	FISHING LICENSE CID: 449-892-561	

•This permit is issued under the provision of the Fish and Boat Code, Section 2709(e), Act 1995-47; the students under the direct supervision of the individual listed above, are hereby authorized to collect fish and other aquatic life for educational purposes without being required to possess a valid Pennsylvania Fishing License. This permit is valid for the dates, location and activities listed below. Any conditions that apply to these efforts also included. Any other locations or dates must be approved by the Pennsylvania Fish and Boat Commission.

•The holder of this permit must be the holder of a valid Pennsylvania Fishing License, which must be carried with them at all times, along with this permit or a copy. Sampling by the above mentioned at these locations must be done with nets not exceeding four (4) feet square and in accordance with the seasons, creel limits and other regulations outlined under Chapters 61, 63, and 65.

•THIS PERMIT IS VALID ONLY FOR THE DATE(S) AND LOCATION(S) LISTED

•MARCH- APRIL 2023

•LEHIGH COUNTY- CEDAR CREEK- LITTLE LEHIGH CREEK

•AQUATIC STUDY

IN WITNESS THEREOF, I HAVE HEREUNTO SET MY HAND AND AFFIXED THE OFFICIAL SEAL OF THE COMMISSION THE DAY LISTED ABOVE.

EXECUTIVE DIRECTOR OR DESIGNEE

https://www.pa.gov/content/dam/copapwp-pagov/en/fishandboat/documents/forms-permits/scicoll_interimsolution_application_form.pdf

QUESTION/COMMENTS?

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Michael.Schmidt@allentownpa.gov