Targeted longitudinal monitoring of a small watershed in West Chester, PA to describe patterns in freshwater salinization as indicated by elevated conductivity and chloride

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Personal Background

Shadowed Patty Haug (Penn State Master Watershed Steward and former West Chester University graduate student) at EnviroDIY continuous monitoring station on E Br Plum Run for 3 months

Worked with the Stroud Center to develop my real-world science skills – they provided the study design template

Now a Sophomore at Princeton studying economics, data science, and environmental studies!

Study Background

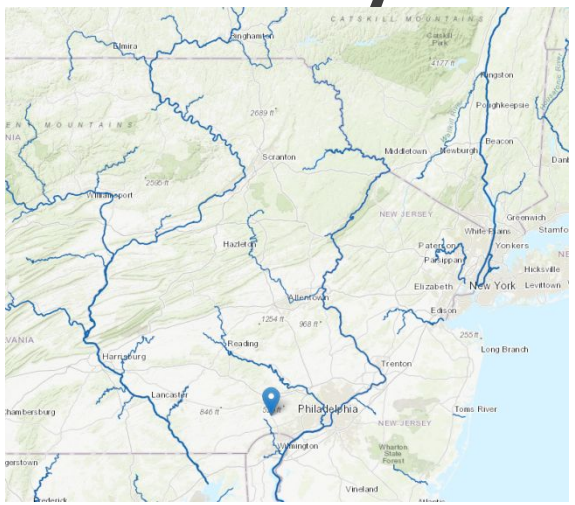
Patty Haug did her masters research on five streams in West Chester
- I continued that work by studying one of her streams in more detail

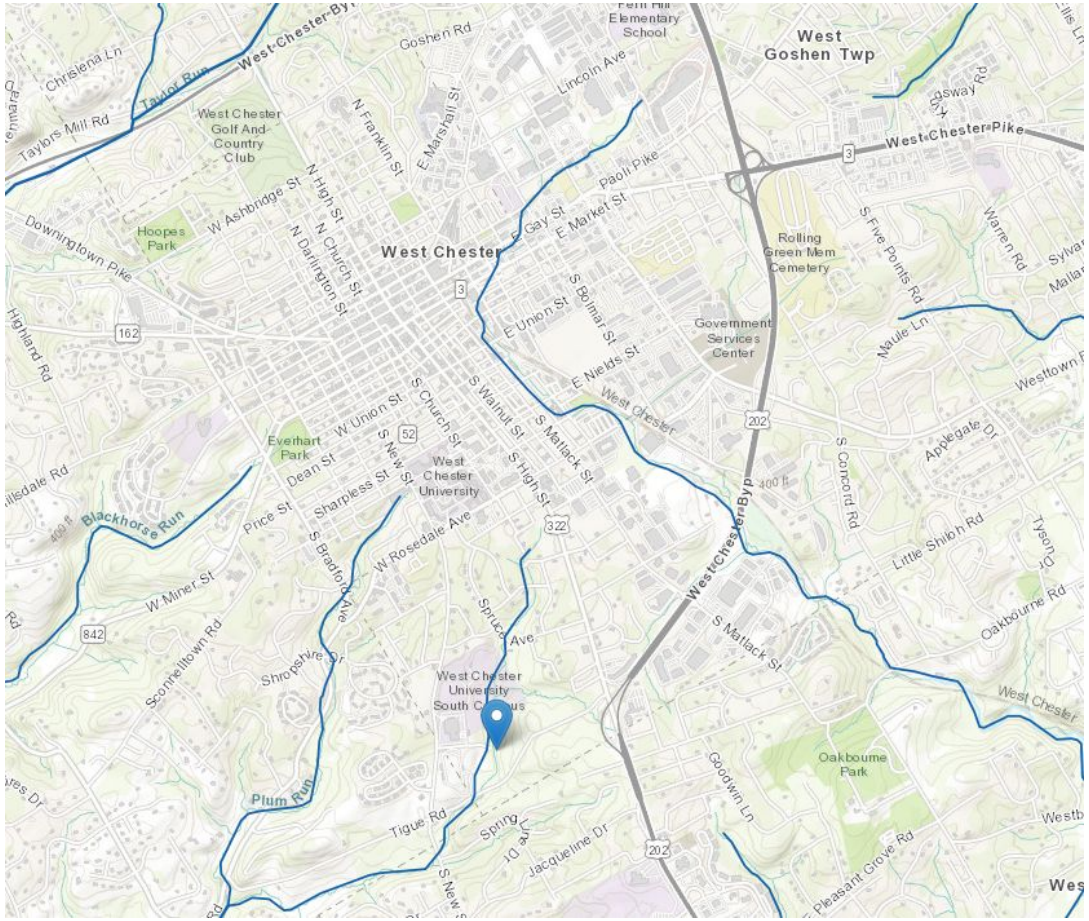
East Branch Plum Run in Gordon Natural Area – elevated conductivity levels (median ~620 uS/cm; mean ~690 uS/cm) as shown by the EnviroDIY continuous monitoring station (~2yrs of data)
- Olson and Cormier (2019) predicted a natural stream conductivity of 78.6 µS/cm

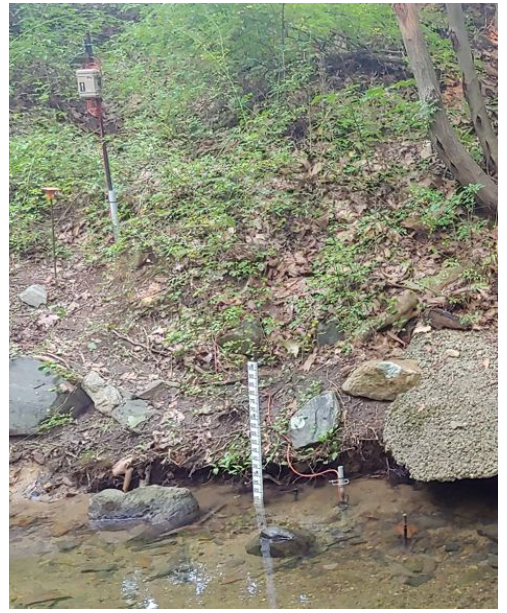
Longitudinal sampling to dive deeper into explaining high conductivity from the continuous monitoring station

Olson JR, Cormier SM. Modeling Spatial and Temporal Variation in Natural Background Specific Conductivity. *Environ Sci Technol*. 2019;53(8):4316-4325. doi:10.1021/acs.est.8b06777

Study Background

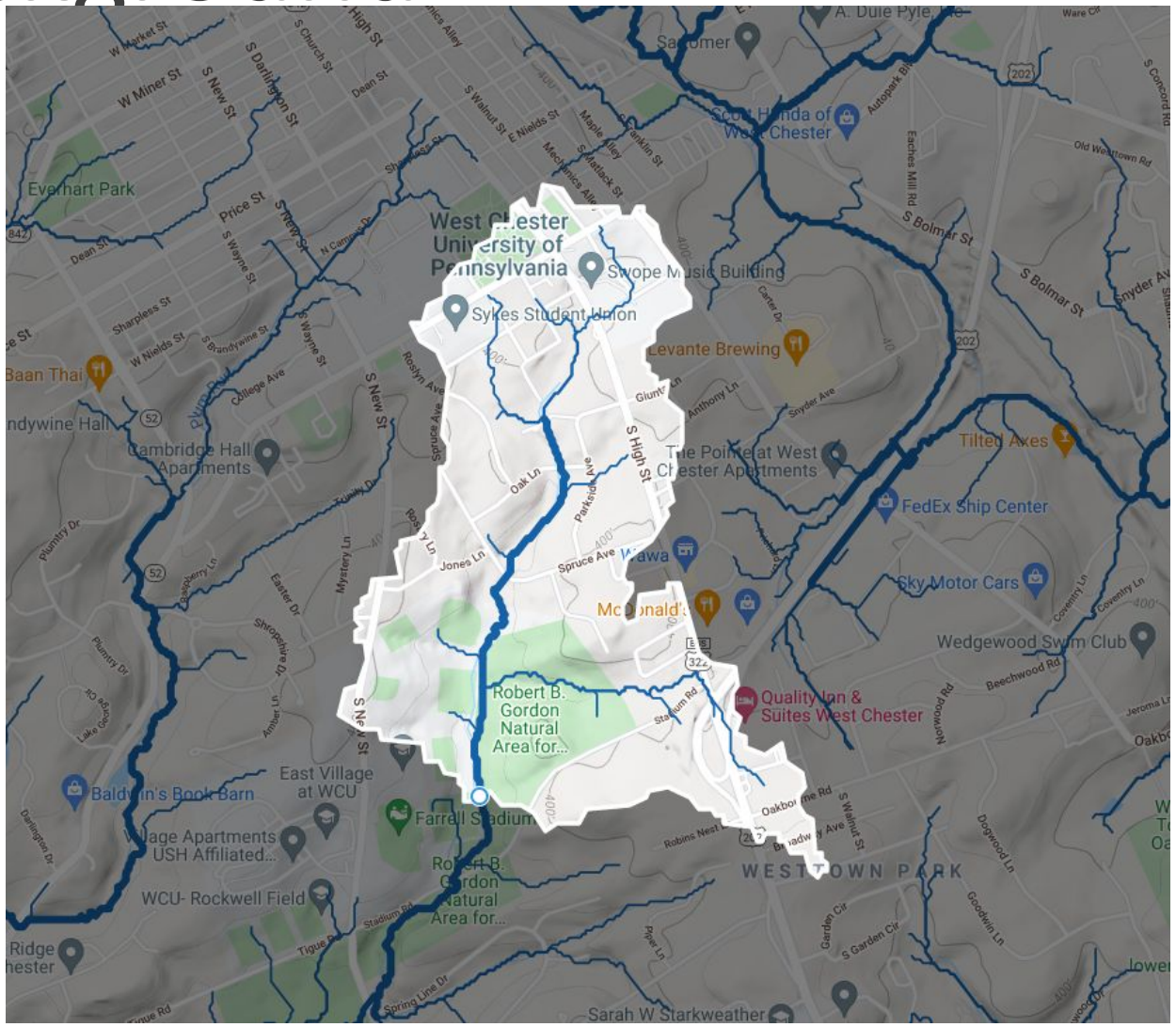






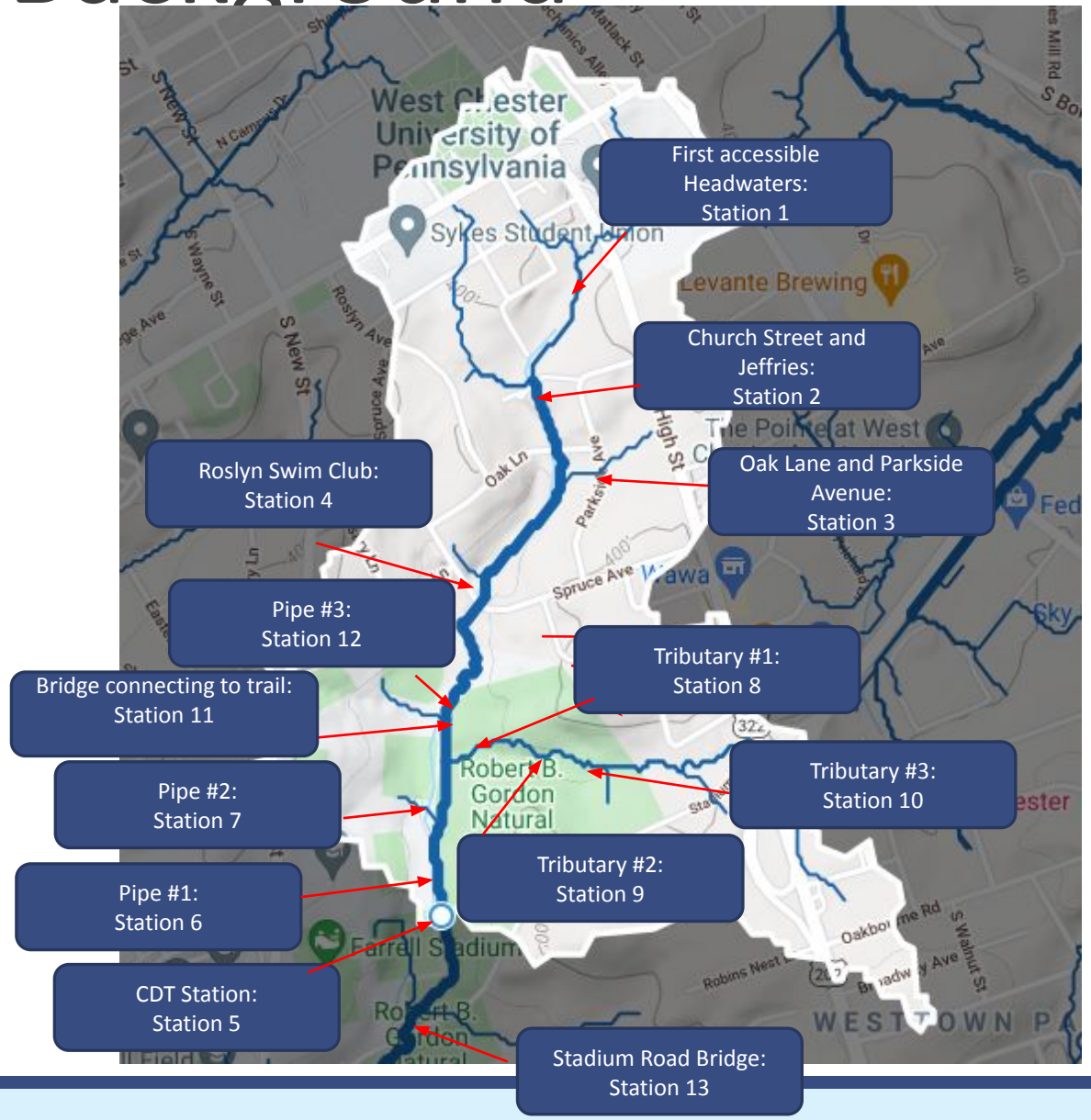
Study Background

Watershed upstream of continuous monitoring station



Study Background

Approximate Site Locations



Objective

Measure chloride and conductivity at road/pedestrian crossings, tributaries, and other junctions along the stream.

Measure at baseflow (non-storm conditions) to assess groundwater contamination.

Analyze data, explain patterns in relation to the watershed landscape, and consider implications for watershed management.

Materials and Methods

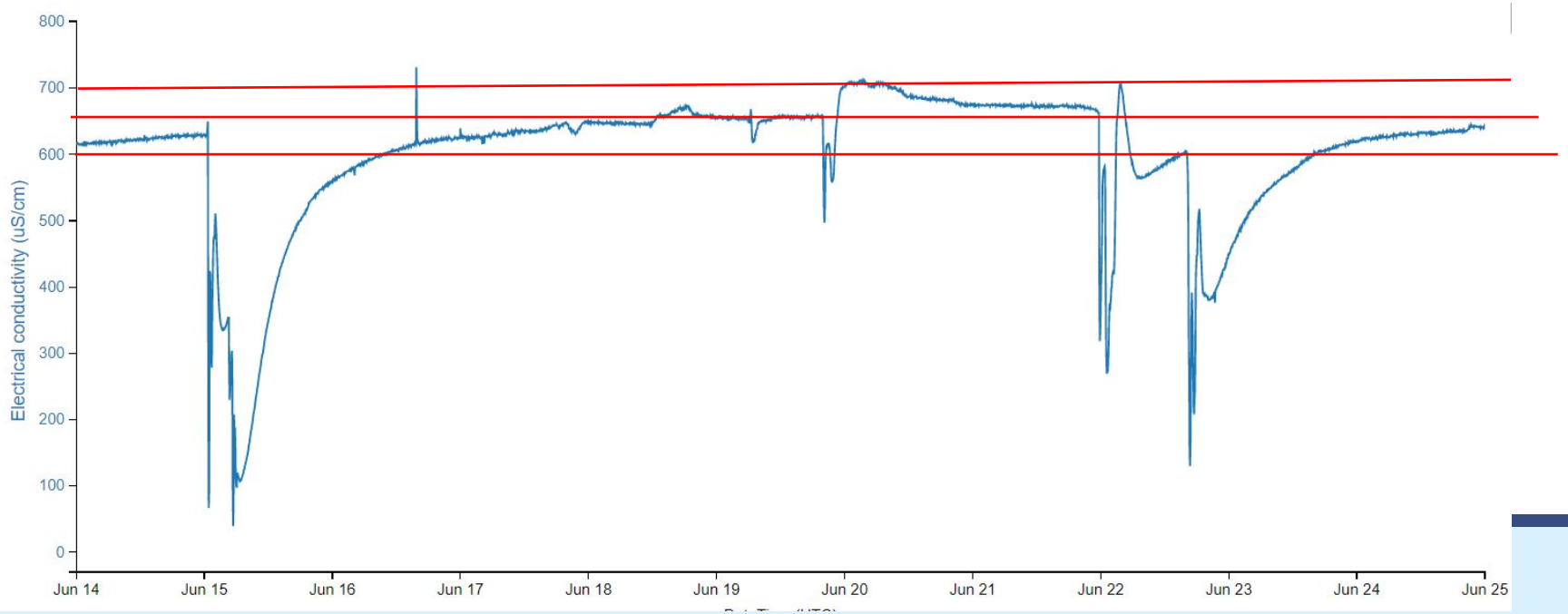
Measured conductivity and chloride on 9 different days (June 14- June 25) at 13 sites

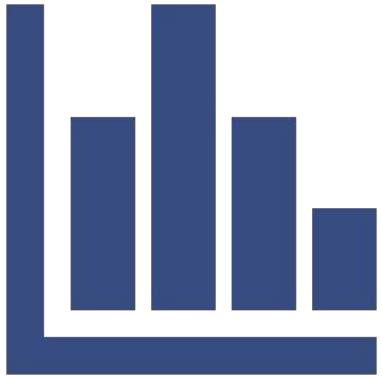
- Hach Quantab titrators measured chloride in mg/L
- Calibrated Hannah Dist 3 measured conductivity µS/cm and temperature ℃

Sampling Components

Baseline conditions of 650 +/- 50 µS/cm specific conductivity were set using the continuous monitoring station – to ensure all measurements were done at stable stream baseflow conditions

On June 15 and 20, samples were not taken due to rain disrupting the conditions.



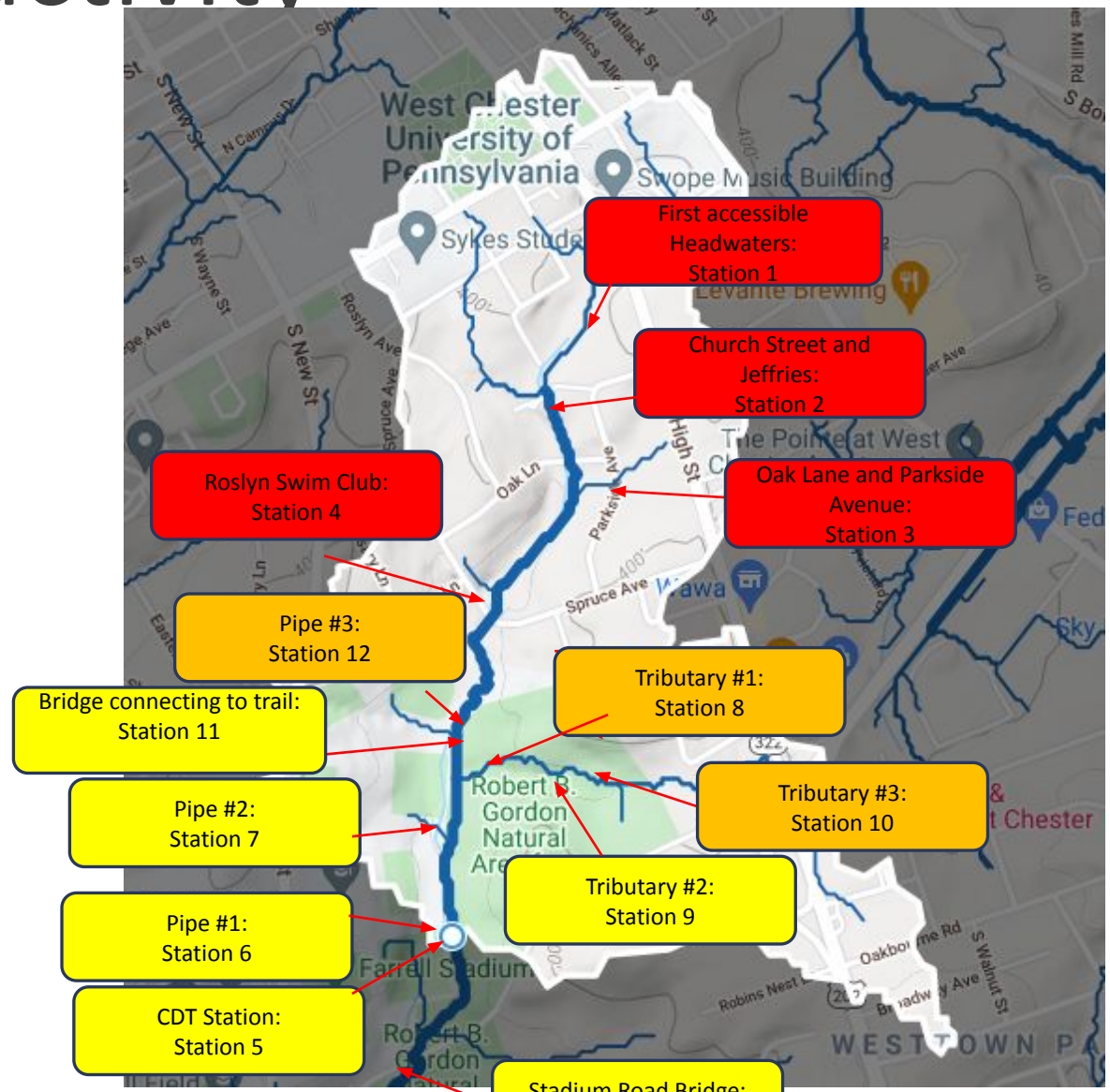


Results

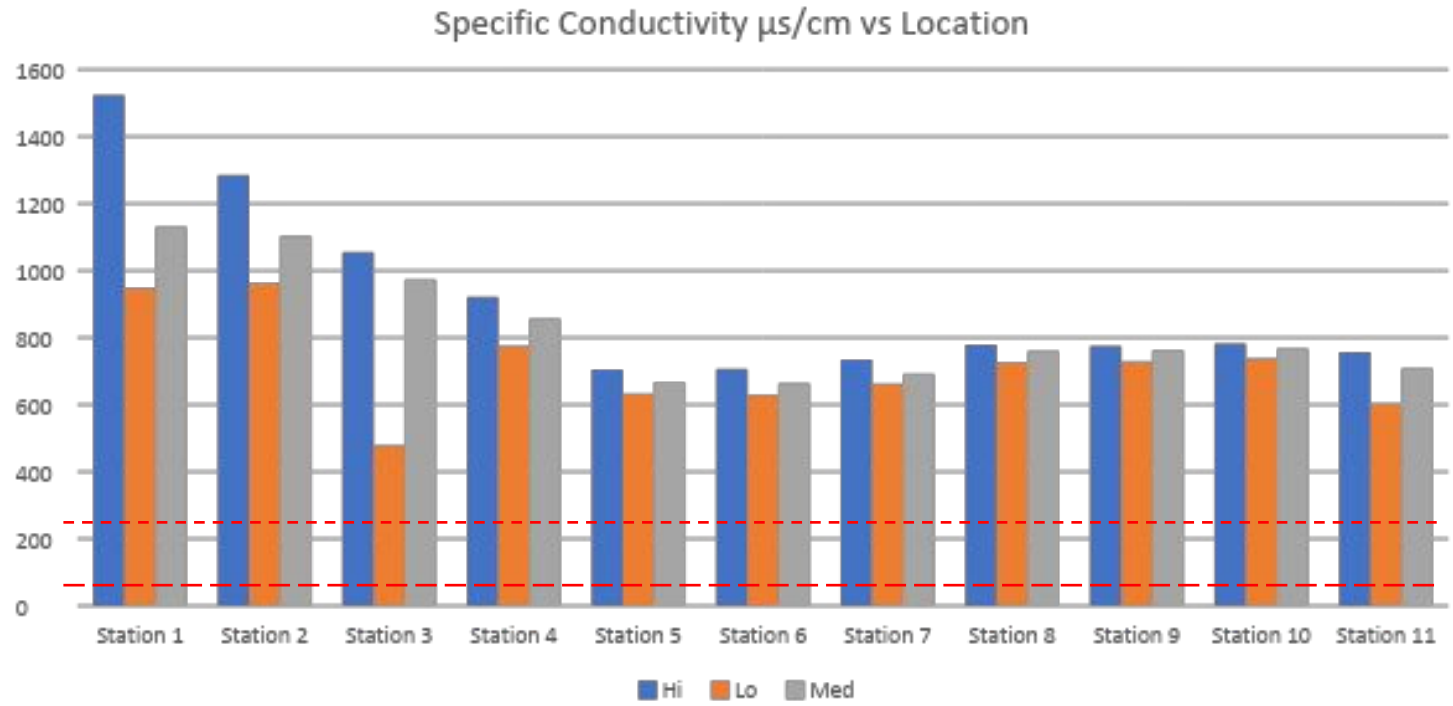
Key Conclusions

- Conductivity and chloride decreased from upstream to downstream
- Urbanization (and associated use of road salt/de-icer) is directly correlated to freshwater salinization
- Freshwater salinization is occurring at an alarming rate (when compared to 15 yrs ago)
- Multiple sites exceed EPA chloride criteria and other important thresholds

Conductivity



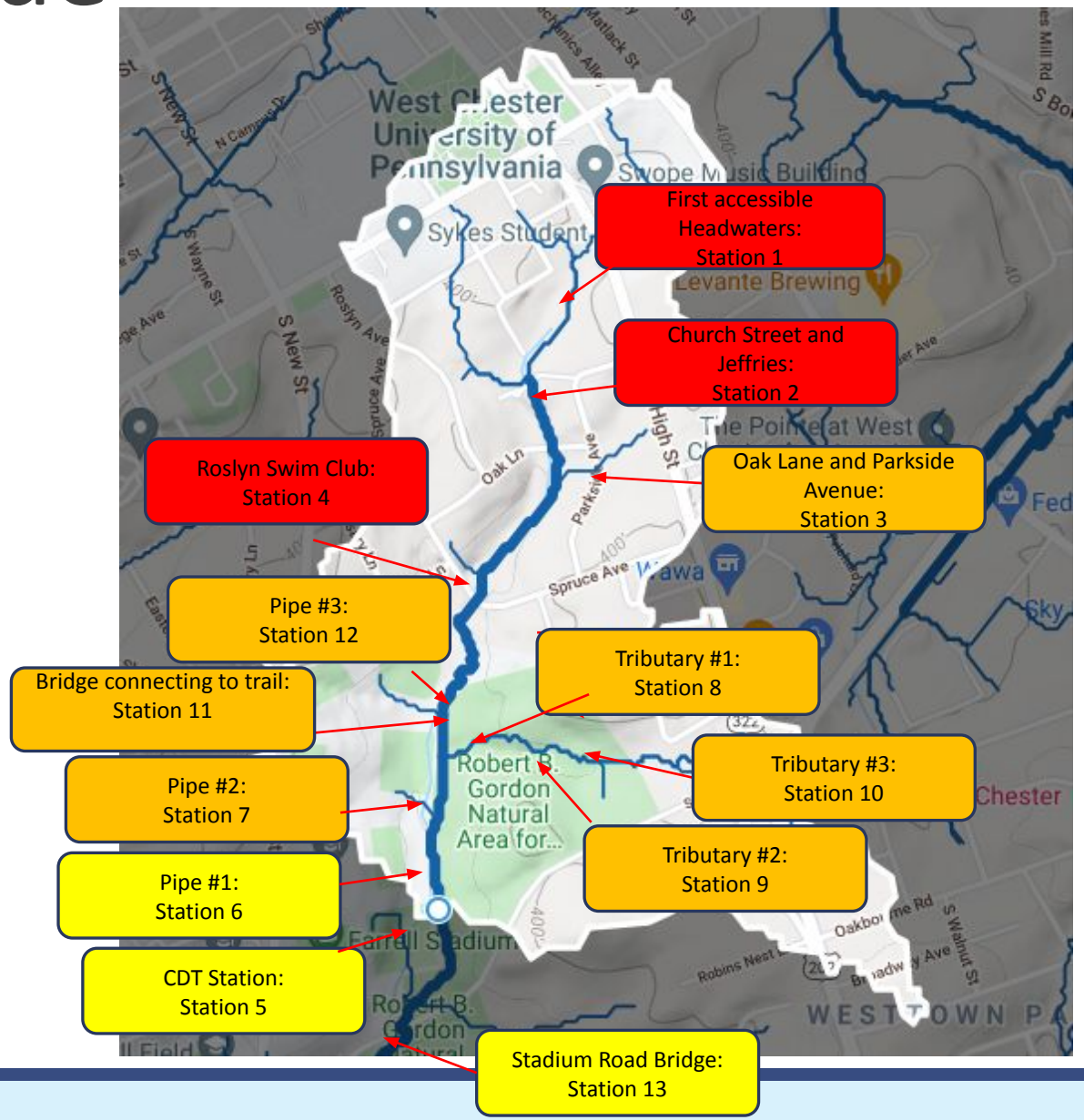
Conductivity- a closer look



– – = prediction of Olson and Cormier 2019

- - - = EPA conductivity natural reference sites, 75th percentile = 297.8

Chloride



Pennsylvania Drinking Water Chloride criterion = 250 mg/l (red >230)

EPA Chronic Chloride criterion = 230 mg/l (red >230)

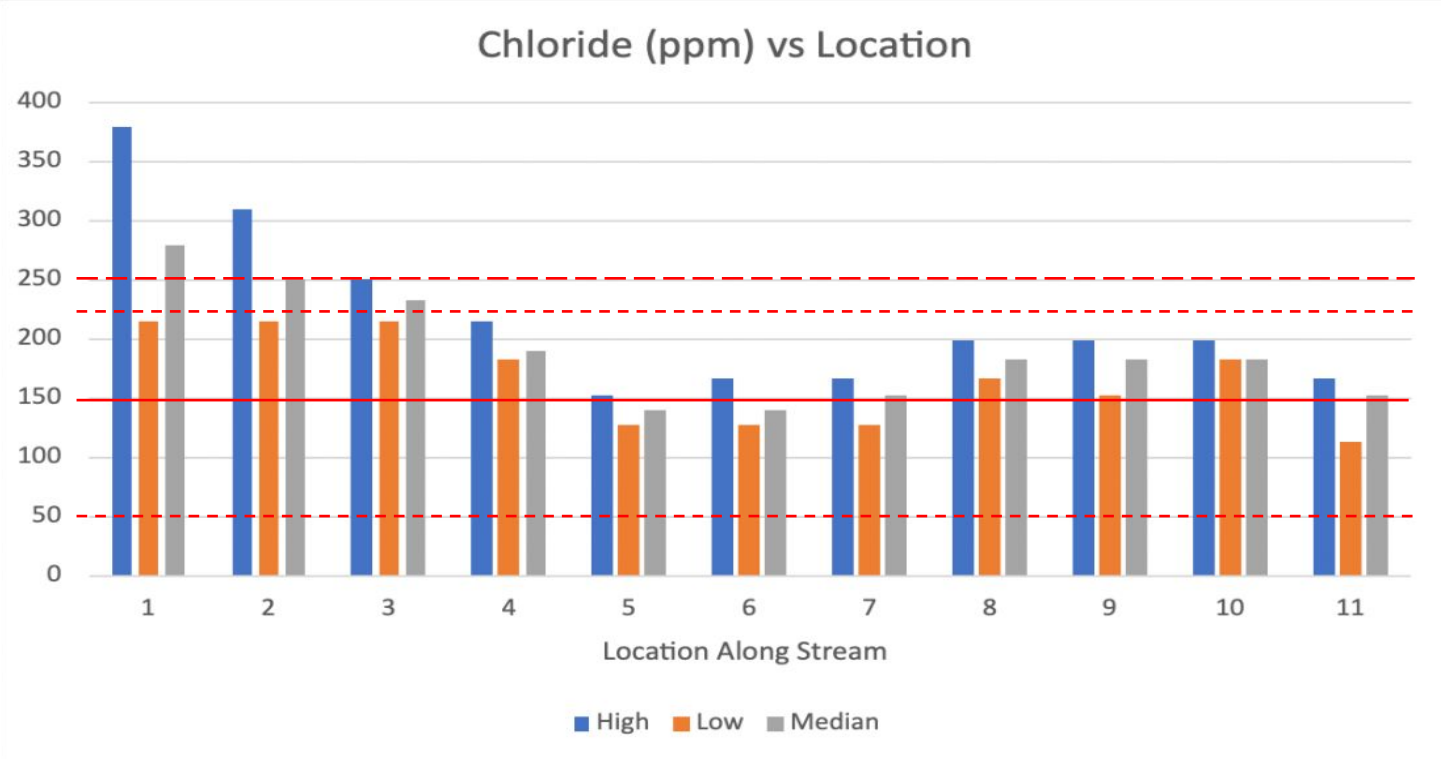
Michigan Chronic Chloride = 150 mg/l (orange 150-230)

Maryland DNR = 50 mg/l (yellow 50-150)

Green<50 mg/L

- = 230+ mg/L Cl
- =150-230 mg/L Cl
- =50-150 mg/L Cl
- = < 50 mg/L Cl

Chloride- a closer look

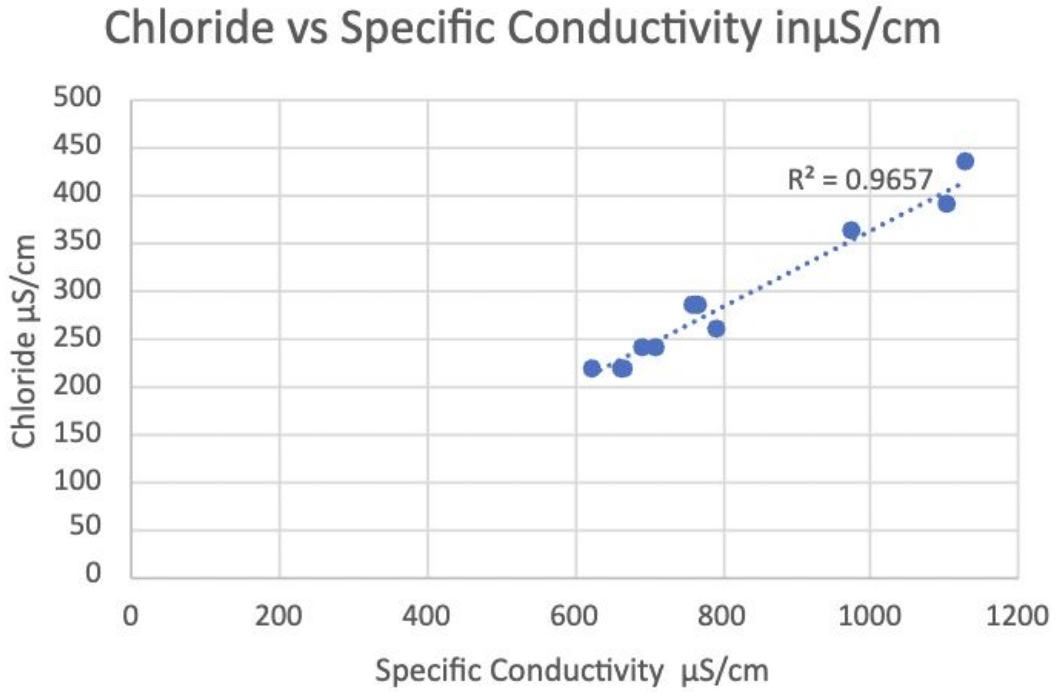


= recommended 50 mg/L of Maryland DNR

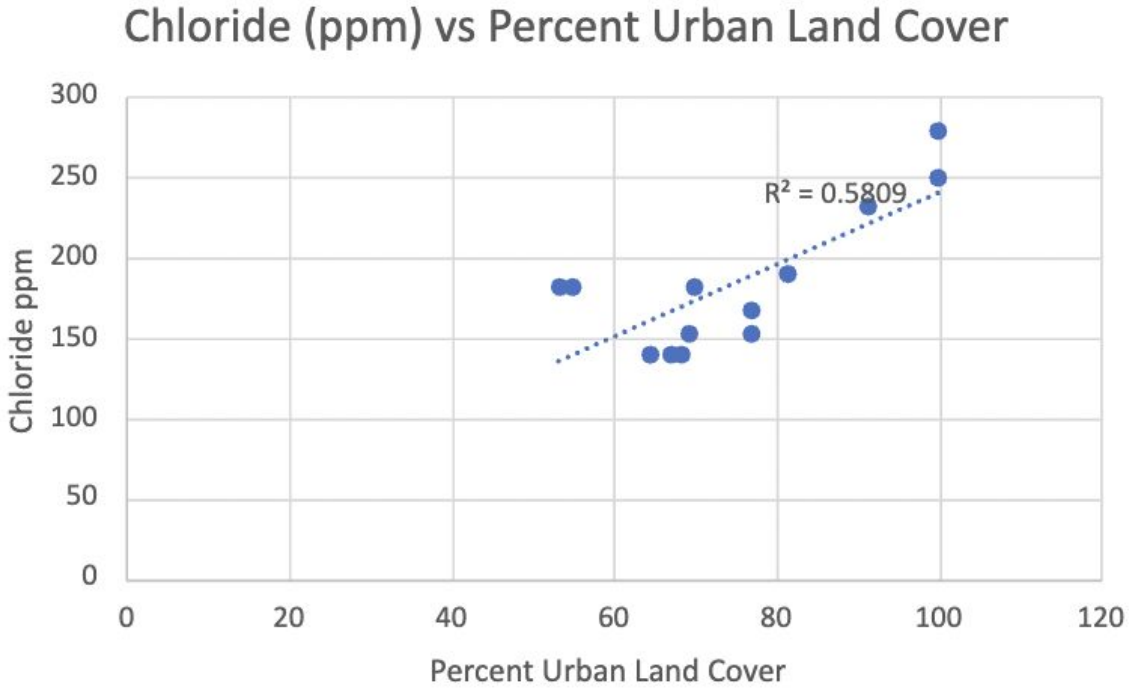
= recommended 230 mg/L of the EPA

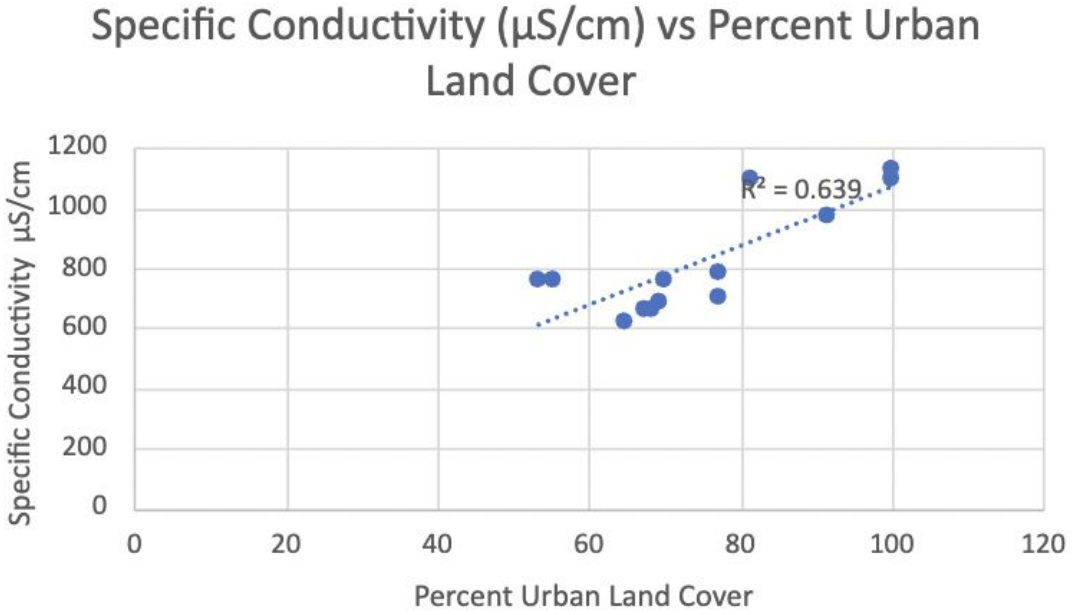
= PA drinking water chloride criterion

= Michigan Chronic Chloride recommendation



Likely Cause - Urbanization and associated road salt/de-icer (NaCl) application





*for stations 1-11, median chloride and conductivity values are used.
*for the follow up measurements of station 12 and 13, their exact values are used

Defrederico 2005

This graduate study measured 4 sites along the East Branch of Plum Run and its tributary in the Gordon Natural Area

	My Station 1	My Station 8
Defrederico, 2005	522 µs/cm	324 µs/cm
Now, median, 2021	**1130** µs/cm	**760** µs/cm
Percent Increase	116%	134%

Tributary in Gordon Natural Area seems to be significantly impacted by urbanization outside the preserved forested area

- This is reflected its higher than anticipated chloride and SC (based on the conductivity and chloride to urban plots)
- Even though it is situated in a mostly forested area, the upper watershed apparently has contaminated ground water with salt

Further Research

- pH, hardness, and sulfate
- Cation type (ie Ca^{+2}, Mg^{+2}, and Na^{+1})
- Downstream
- Chloride in soil.

What Can We Do?

https://www.sustainablebusiness.com/2014/10/university-celebrates-shut-down-of-coal-plant-transitions-to-geothermal-52589/

Where I am now!!

Numerous sustainability efforts on campus

- Geothermal energy and Bioplastic remediation development

nd news

Geo-Exchange on Princeton's Campus: Exchanging Antiquity with Sustainability

May 17, 2023

Three Princeton students presented their Geo-Exchange video during *Princeton Research Day* on May 4, 2023. Facilities Energy Plant Director, Ted Borer, is featured in the video and the students gave Facilities permission to share their work. Well done Angelica, Elisabeth, and Luke!

Thank you! Questions?

Further inquiries you can contact David Bressler- dbressler@stroudcenter.org