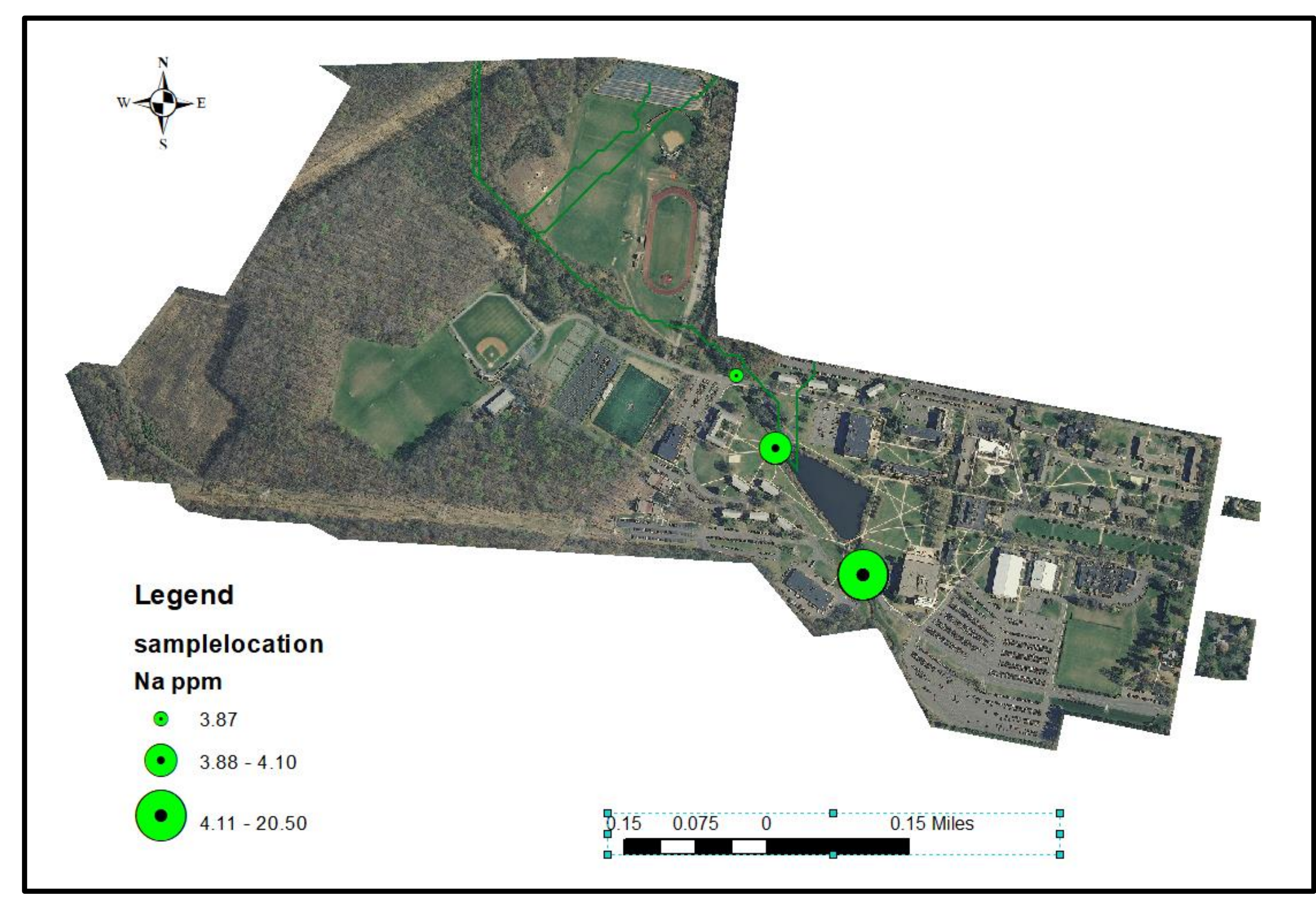


Abstract

Cold winters in the Northeast drive communities to apply winter de-icing salts to roads and walkways. While effective, the salt applications create long-term water quality and ecological issues on the local and regional water system. The purpose of this research was to understand the interaction of sodium with water and soil in the Centennial Lake Watershed, which is a part of the larger Delaware River Watershed that supplies potable water to Pennsylvania, North Jersey, and New York state. Our result indicates there are three components in the sodium source in water: road salt, mineral dissolution, and precipitation deposition. Sodium absorption can mobilize other metals in the soil through a cation exchange process, while complexes of the chloride can also help mobilize other metals, including mercury in the water. Compared to the sodium levels in stream water measured 10 years, its average concentration is more than 25% higher in the off snow season today.

Location of Sample Sites

Figure 1. Location map of the Centennial Lake Watershed and the three sampling locations showing increasing sodium concentration for water running through Rider



Sources of Na and rising Na concentration in Rider's water

Figure 2. a), Concentrations of sodium in the Centennial lake watershed are between the levels of runoff water from I-95 and soil solutions. B) Sodium level increases downstream, indicating Rider's salt contribution.

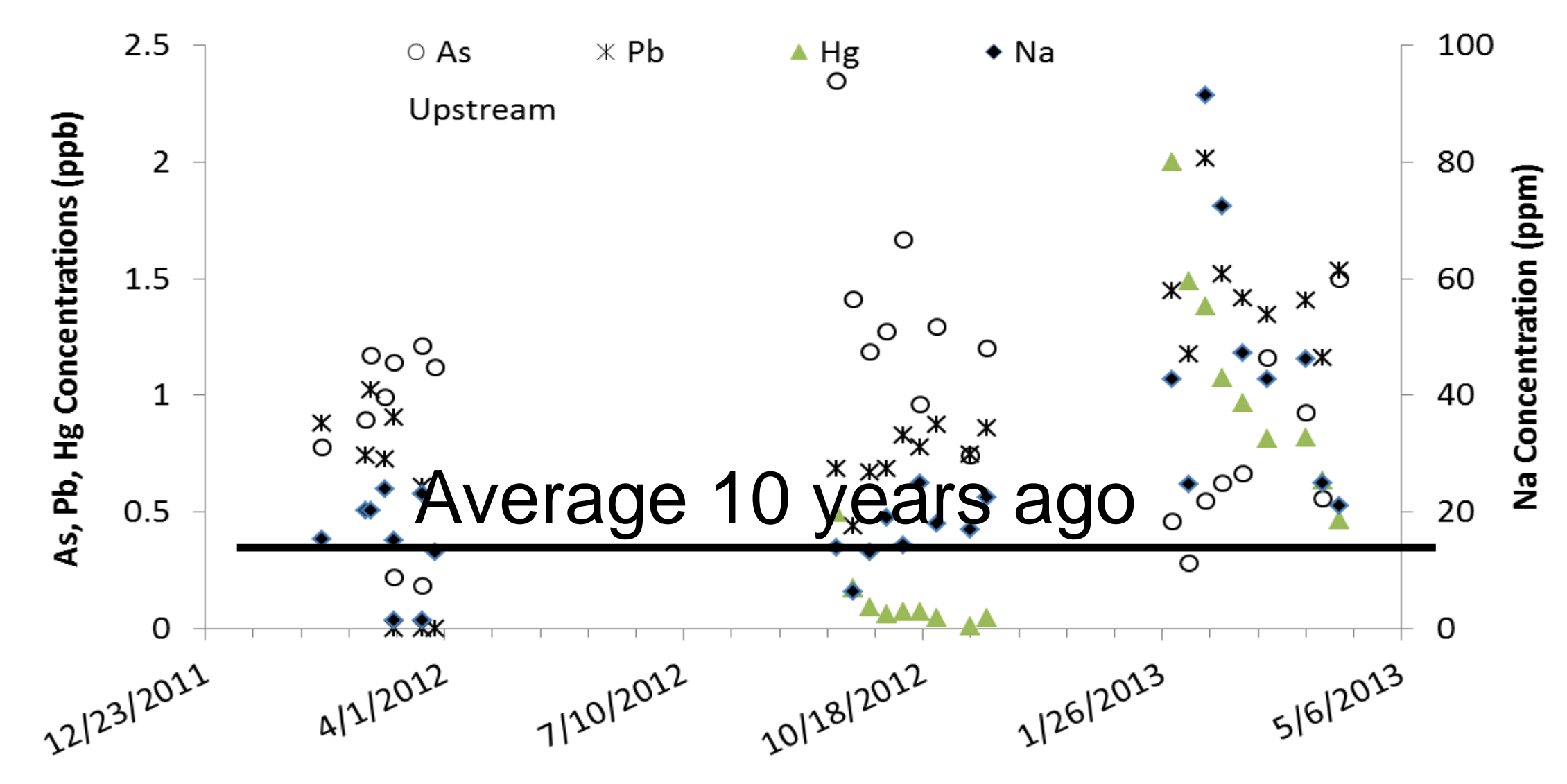
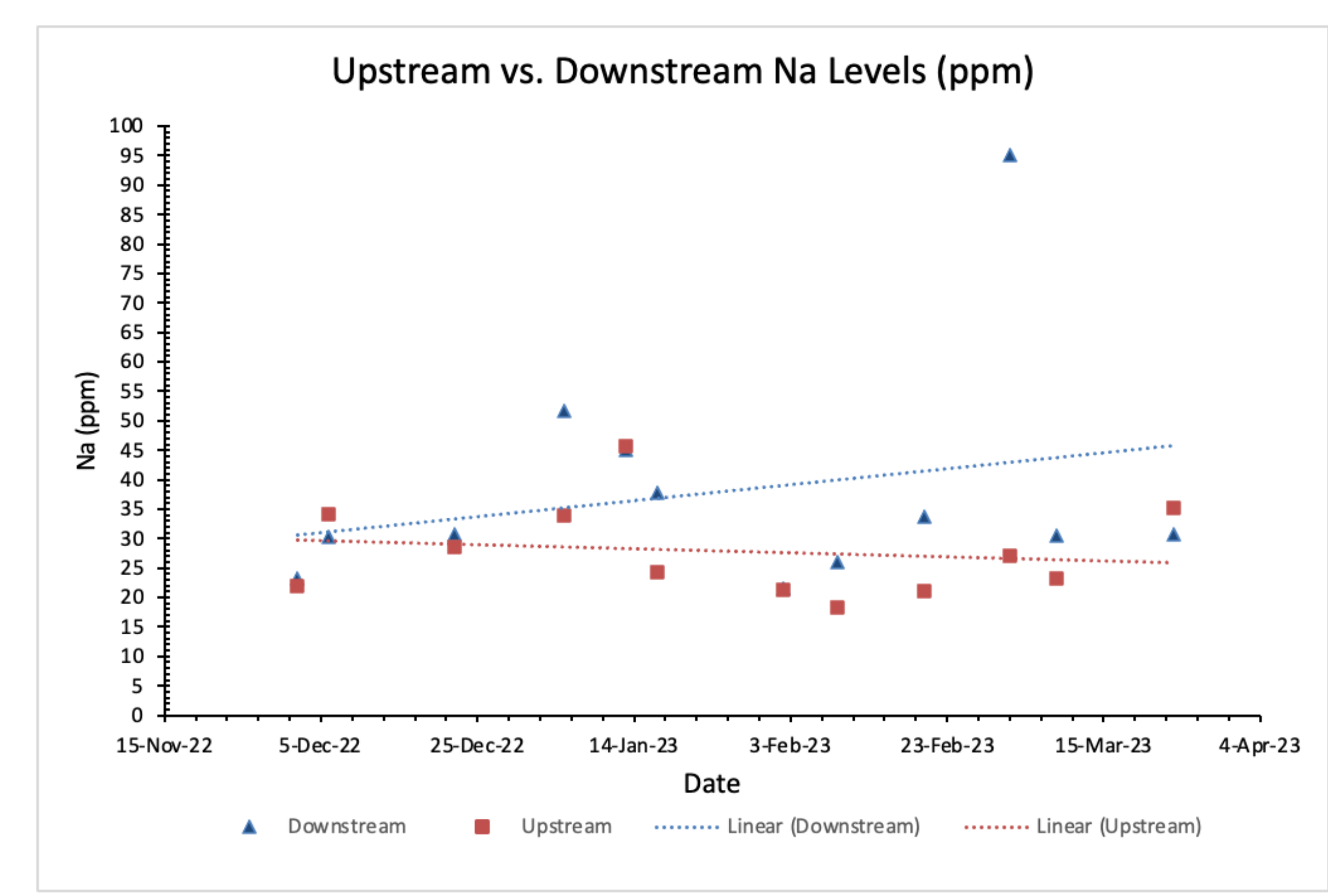
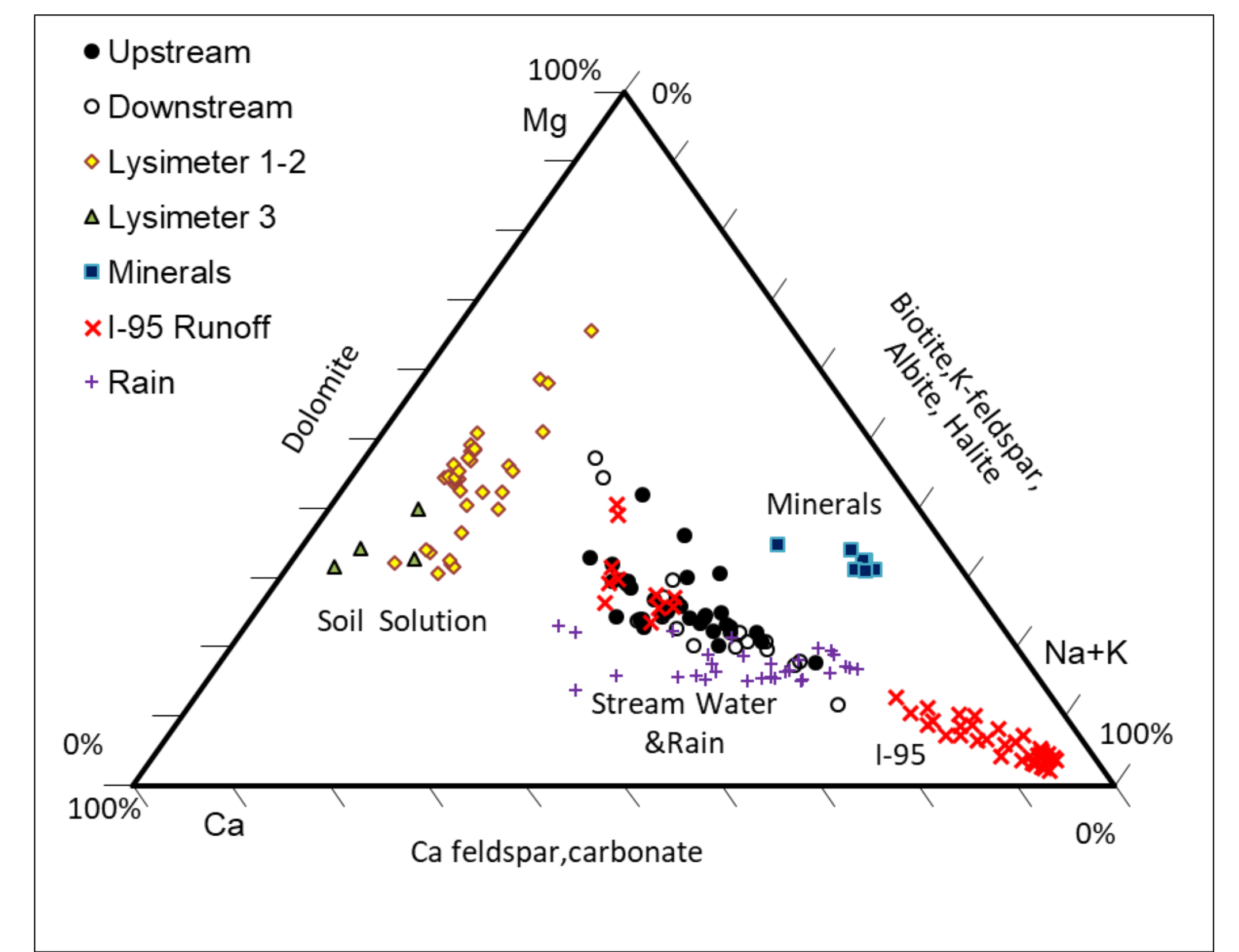


Figure 3. Average level of sodium concentrations is now is above 20 ppm (EPA's portable allowance level) the average sodium level 10 years ago in Rider's creek, indicating the soil retention sodium for road salt and slow release of the sodium into the water. They also affect the As, Pb and Hg concentration in the water.

Sample	Na	K	Mg	Ca
1/13/23down	45	64.7	8.8	20
1/13/23lake	53	50.6	9.1	23
1/13/23up	45.7	64.9	8.8	18
1/17/23down	37.8	53.3	12	23
1/17/23lake	29.1	46.9	12	17
1/17/23up	24.2	45.7	11	23
1/5/23down	51.7	56.6	10	24
1/5/23lake	35.7	51	11	25
1/5/23up	33.9	52.9	10	22
1/5/23down	23.3	63.7	3.3	14
12/2/22lake	38.5	62.6	11	19
12/2/22up	21.9	53.2	< 7.740	< 23.087
12/22/22down	30.8	57.7	8.5	19
12/22/22lake	38.6	51.4	12	27
12/22/22up	28.5	51.5	11	20
12/6/22down	30.3	60.6	9.6	25
12/6/22lake	37.6	98.5	12	28
12/6/22up	34.2	57	12	17
2/2/23down	21.4	41.3	0.8	20
2/2/23lake	23.9	43.3	2.7	22
2/2/23up	21.4	41.1	0.7	20
2/20/23down	33.7	45.6	9.1	21
2/20/23lake	24.9	42.3	11	31
2/20/23up	21.2	43.3	10	25
2/9/23down	26.1	46.6	11	26
2/9/23lake	34.6	46.2	11	19
2/9/23up	18.4	40.1	9.5	19
3/24/23down	30.7	44.9	15	25
3/24/23lake	35.8	48.6	10	24
3/24/23up	35.3	84.5	13	25
3/3/23down	95	77.3	11	26
3/3/23lake	30.3	116	12	27
3/3/23up	27	41.7	4.2	23
3/9/23down	30.5	45.1	9.7	23
3/9/23lake	24.8	43.4	10	19
3/9/23up	23.2	39.8	1.9	22

Table 1. Elemental Concentrations (ppm) of Na, K, Mg, and Ca

Sample	Plagioclase Albite var Cleavelandite
Site 2#1	6.59
Site 2#2	1.25
Site 2#3	1.82
Site 2#4	2.71
Site 2#5	1.58
Site 4#1	1.1
Site 4#2	1.65
Site 4#3	1.28
Site 4#4	3.3
Site 4#5	2.04
Site 4#6	1.49

Table 2. Normalized Mineral Weight Percentages of Plagioclase Albite for Sites 2 and 4 Soil Transects. Albite is the main mineral source of sodium in water

Salt and Sulfate in soil and runoff water control the general chemistry of Rider's water

Figure 4. Sulfate concentrations from three sample locations. Balance of salt (stabilizing the pH) and sulfate level (lowering the pH) in water controls the pH level in water and soil at Rider

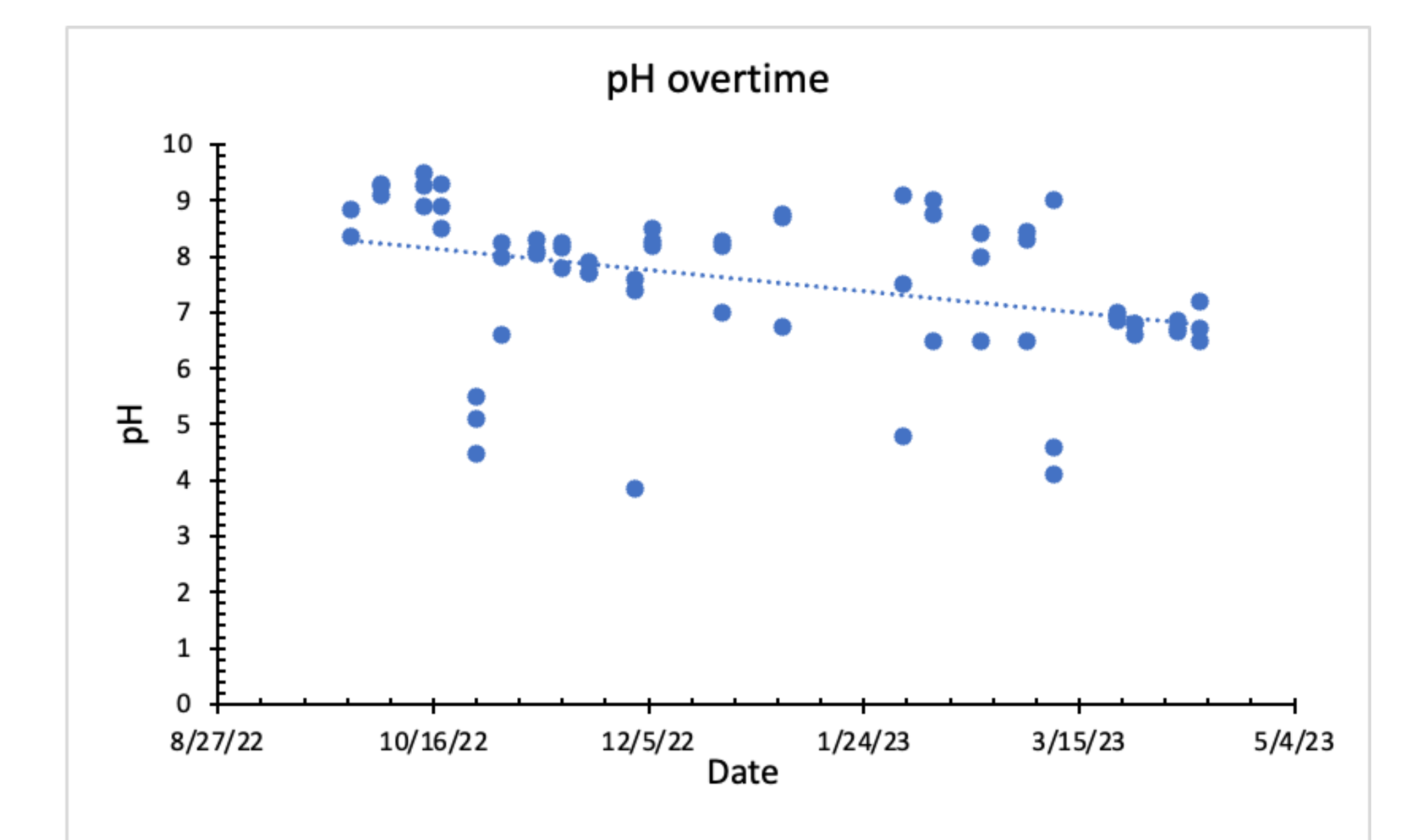
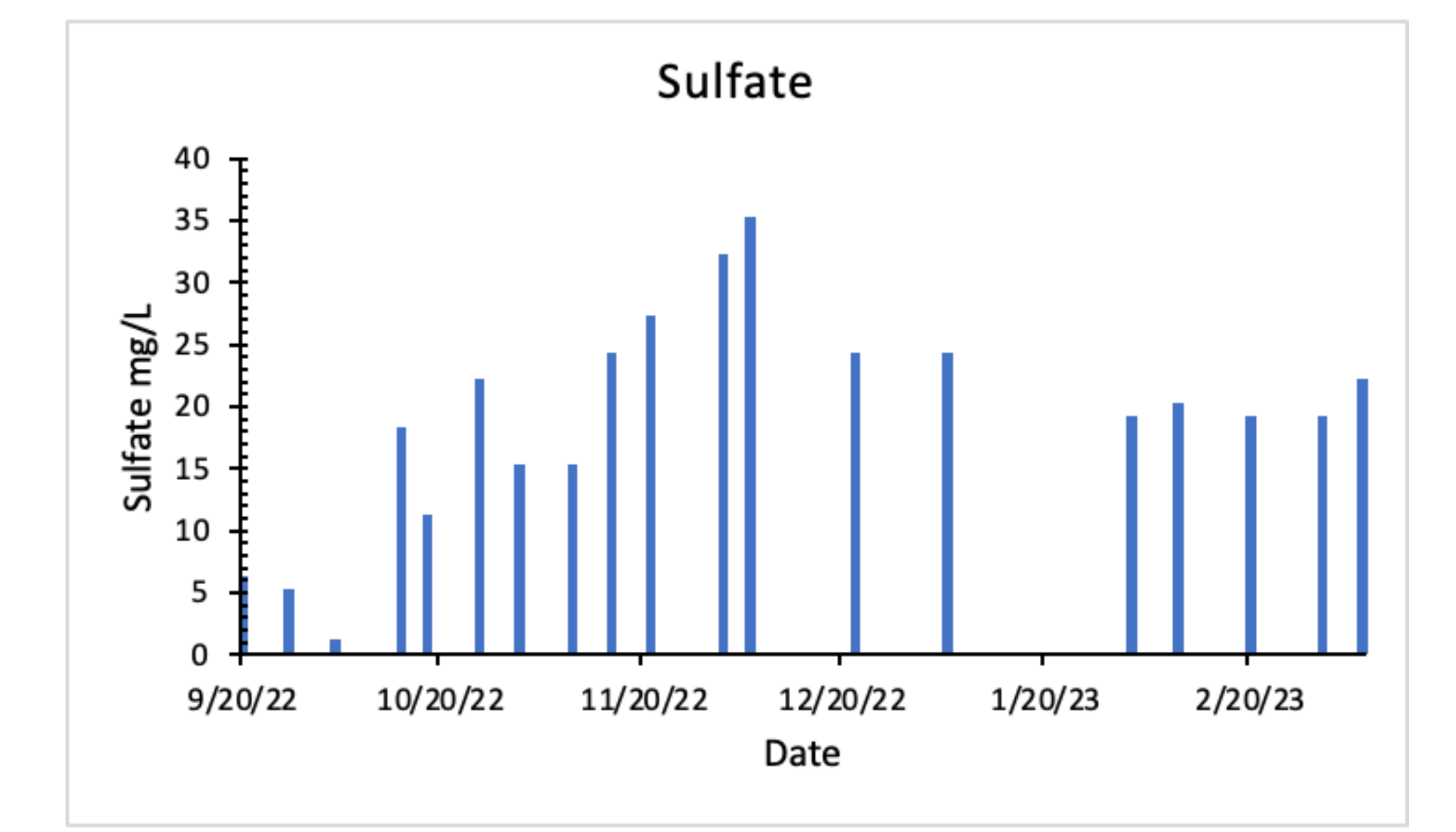
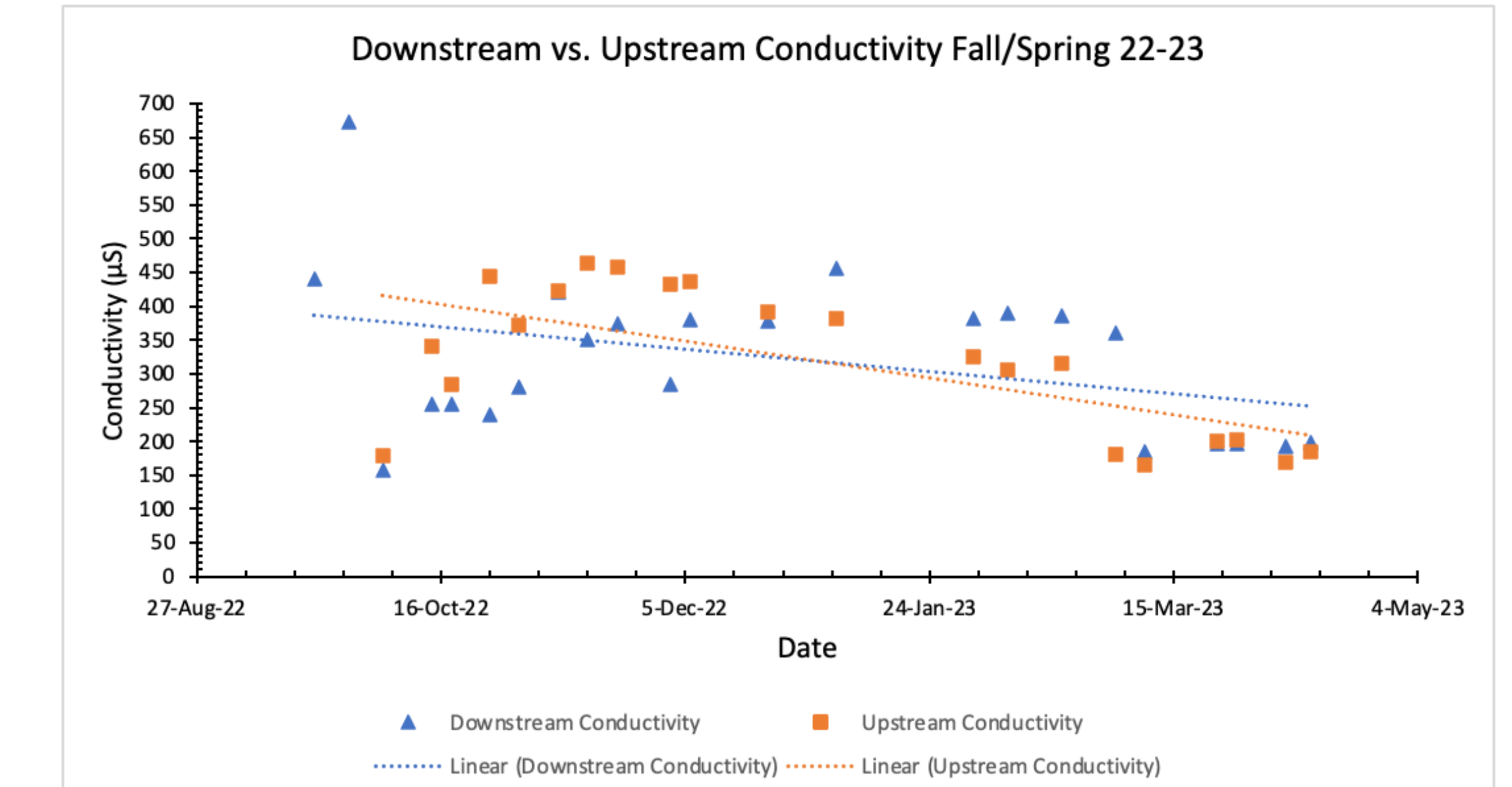


Figure 5 Conductivity levels from upstream and downstream locations Fall 2022 - Spring 2023. It correlates with the salt levels and rising of the concentrations of other cations (Ca, Mg).



Conclusions

1. Sodium level in streams of Rider is about 25% higher than that of 10-year ago in the off snow season.
2. Runoff from Rider's road salt application and mineral dissolution of plagioclase albites are the main sources of sodium in our water.
3. Increasing salt application and air deposition, including sulfate, soil dissolution of other minerals determines the overall water chemistry, and mobilization of As, Pb and Hg in Rider's stream water.