

**COMMUNITY-BASED WATER QUALITY MONITORING  
PROJECTS IN MARCELLUS SHALE GAS  
DRILLING REGIONS IN CENTRE, CLEARFIELD, AND  
CLINTON COUNTIES, PA**

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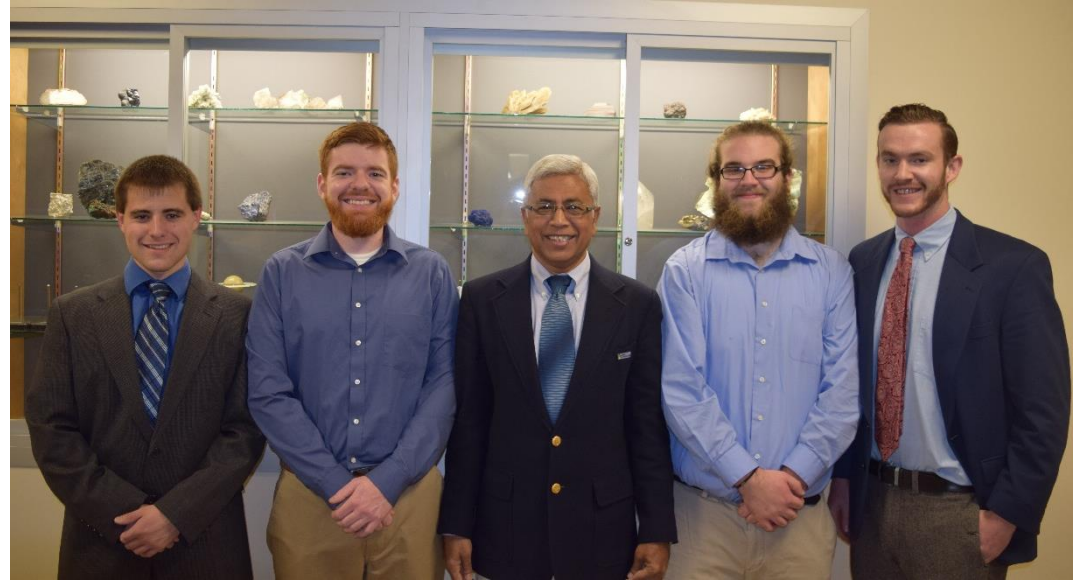


# Purpose and Scope

- In the wake of Marcellus Shale gas-well drilling in central Pennsylvania, Lock Haven University Geology program forged partnerships with several community-based organizations since 2010 to establish baseline data for quality of surface water in the vicinity of drilling sites.
- The organizations included the Clearfield and Centre County chapters of the Pennsylvania Senior Environmental Corps, Beech Creek Watershed Association, and the South Renovo Borough Water Supply System.

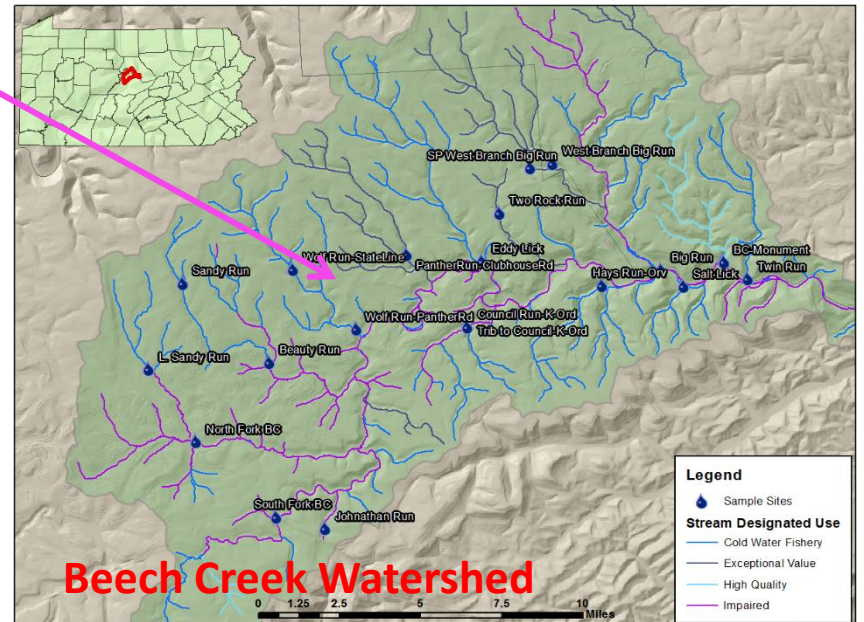
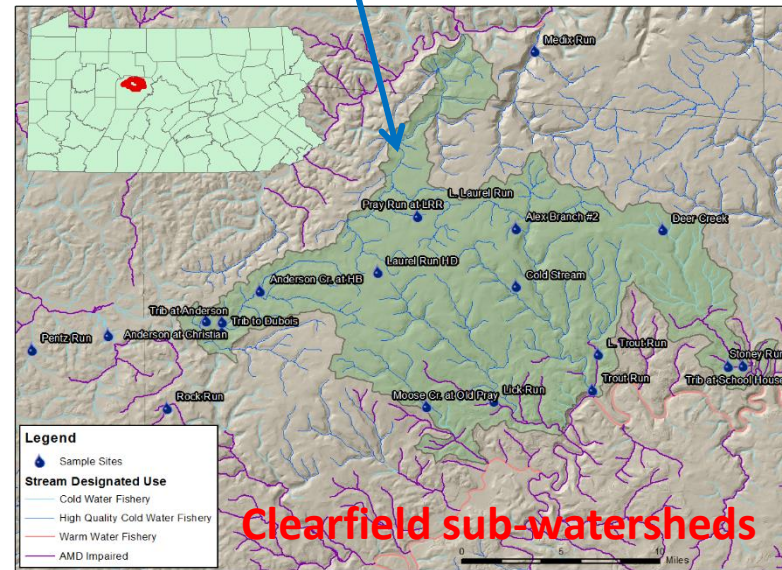
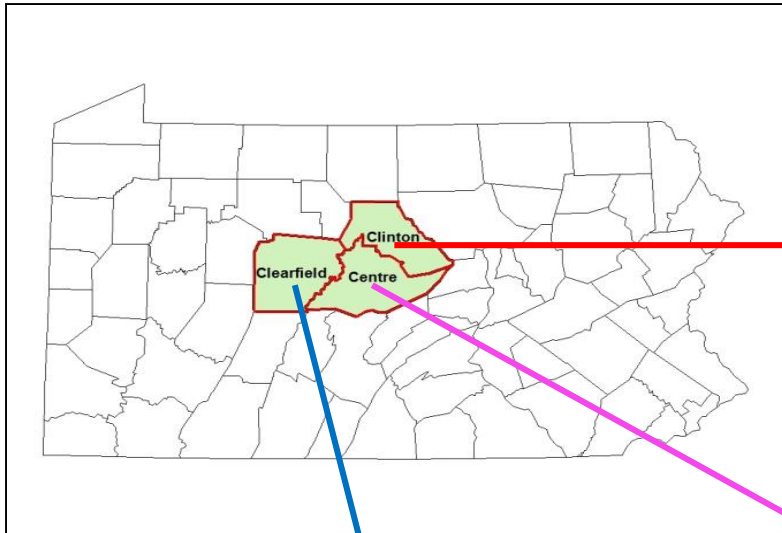


# The Water Team



Lock Haven University

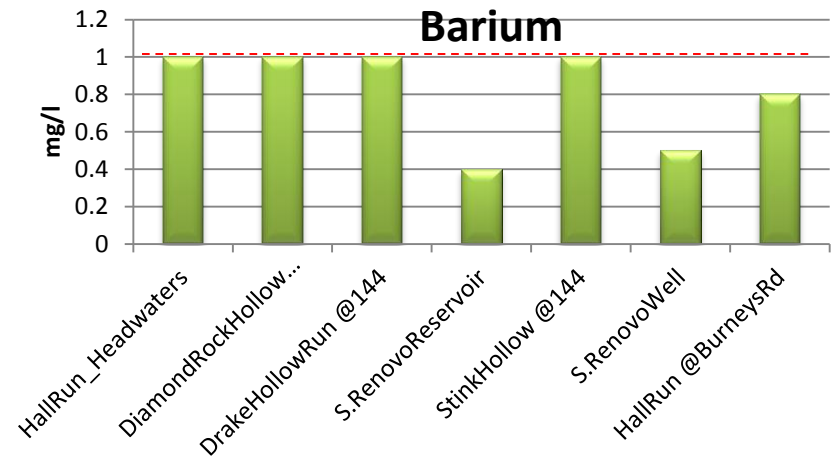
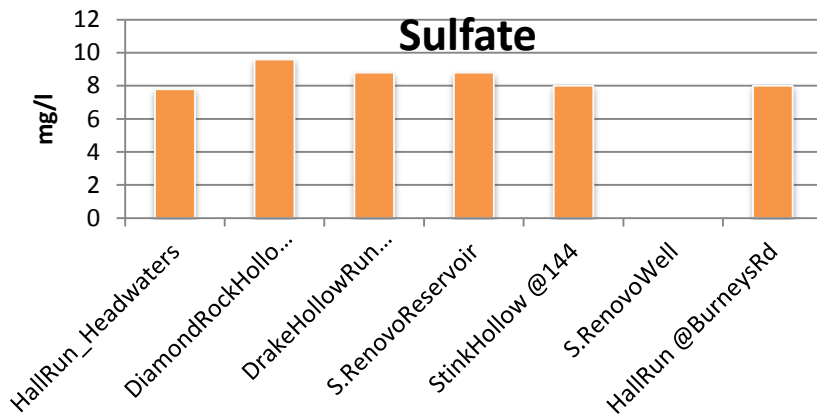
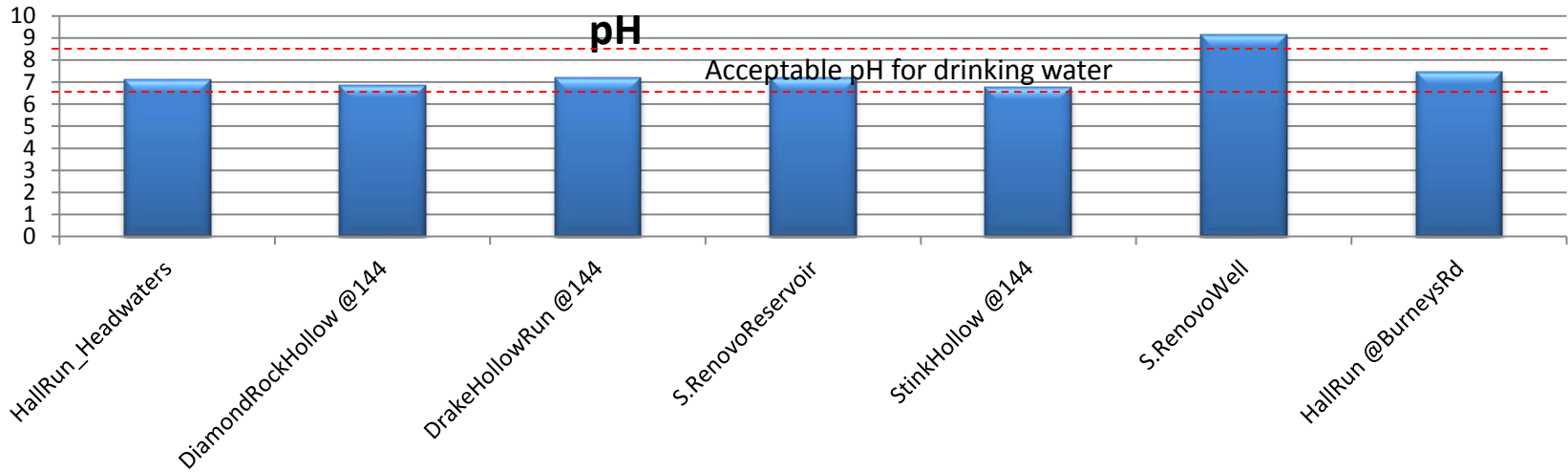
# The Study Locations



# The Hall Run Project



# The Results : Hall Run

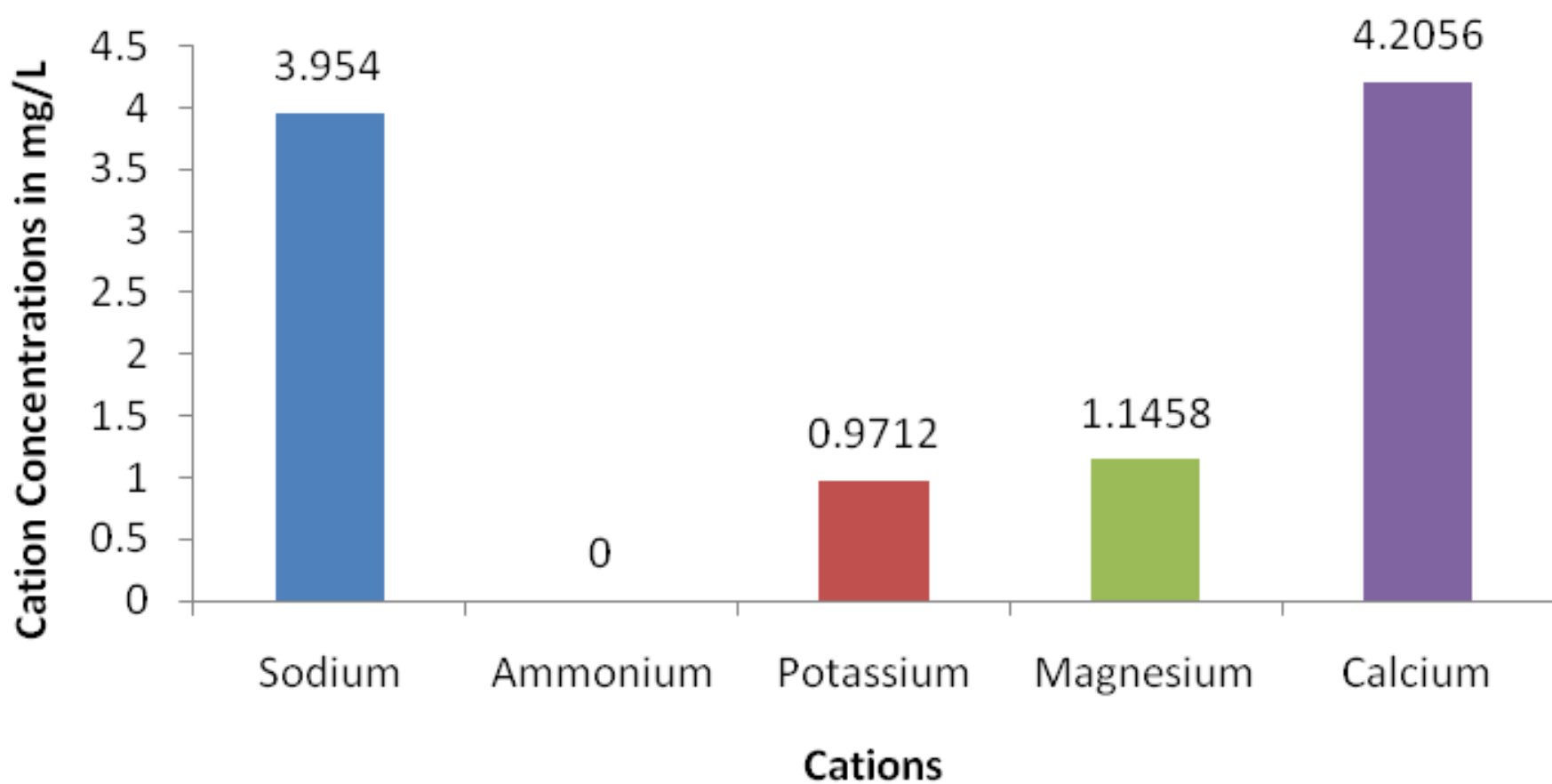


MCL for drinking water = 250 mg/L

MCL for drinking water = 2mg/L



# Hall Run Reservoir Site





# Conclusions : Hall Run

- Based on the field and lab analyses, we concluded that the water quality parameters in the Hall Run Watershed met drinking water standards.
- All efforts should be directed to preserve the pristine nature of this drinking water source.



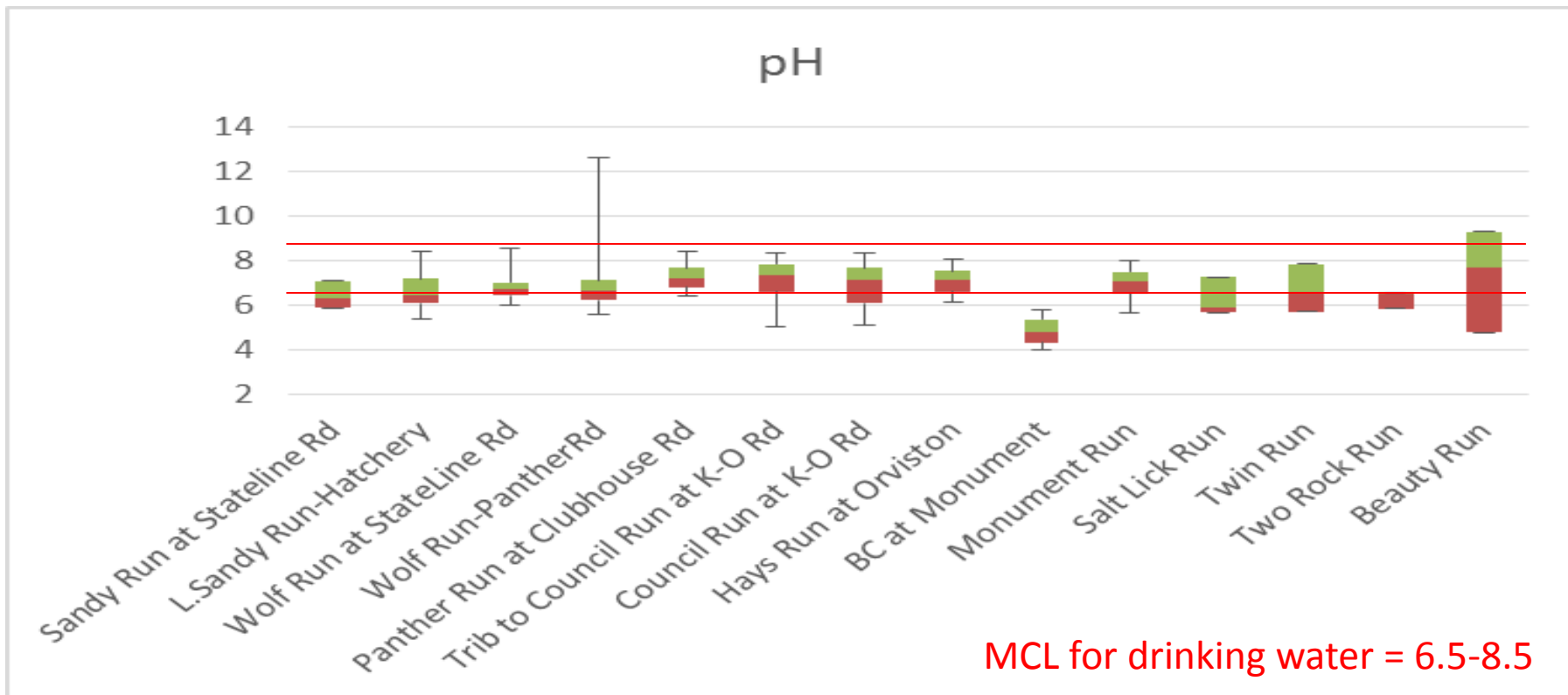
# The BCW Project



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# The Results : BCW



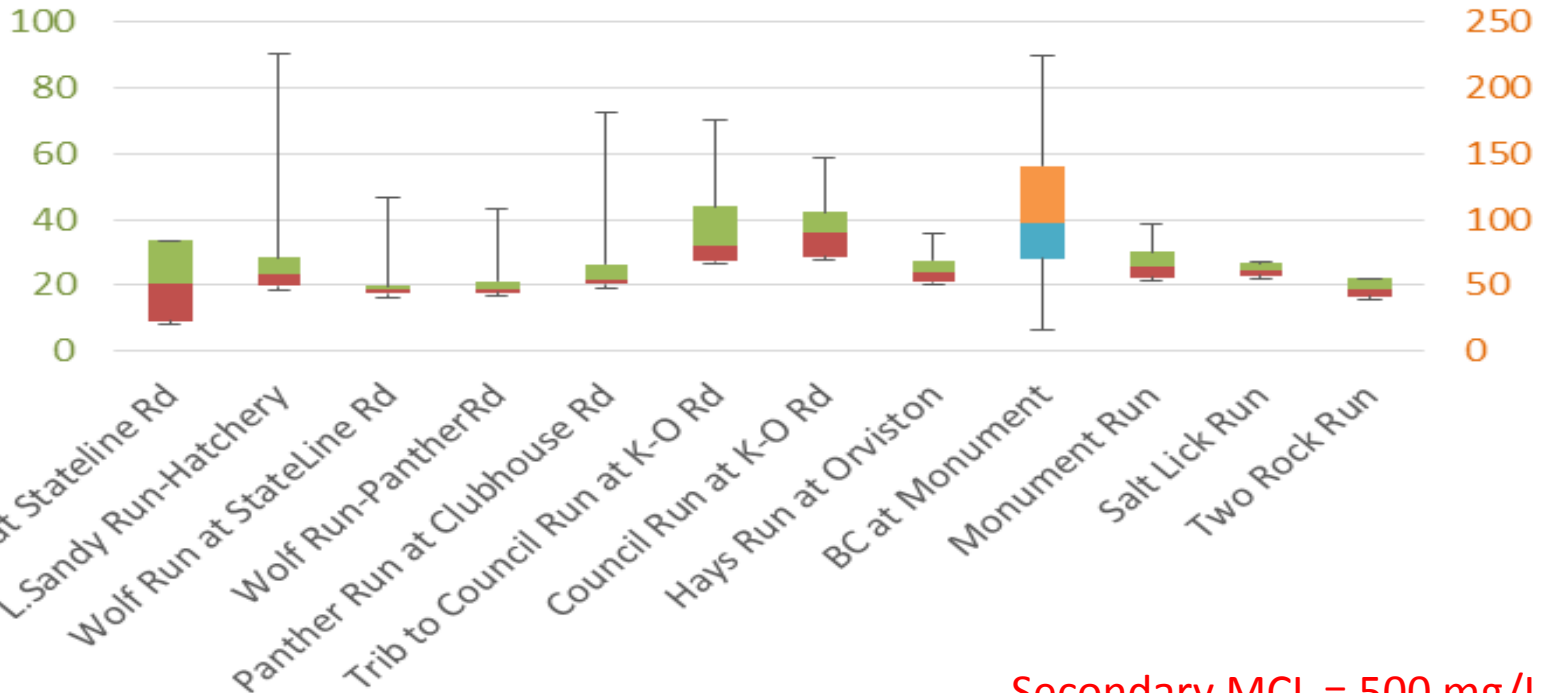
MCL for drinking water = 6.5-8.5



# The Results : BCW



TDS

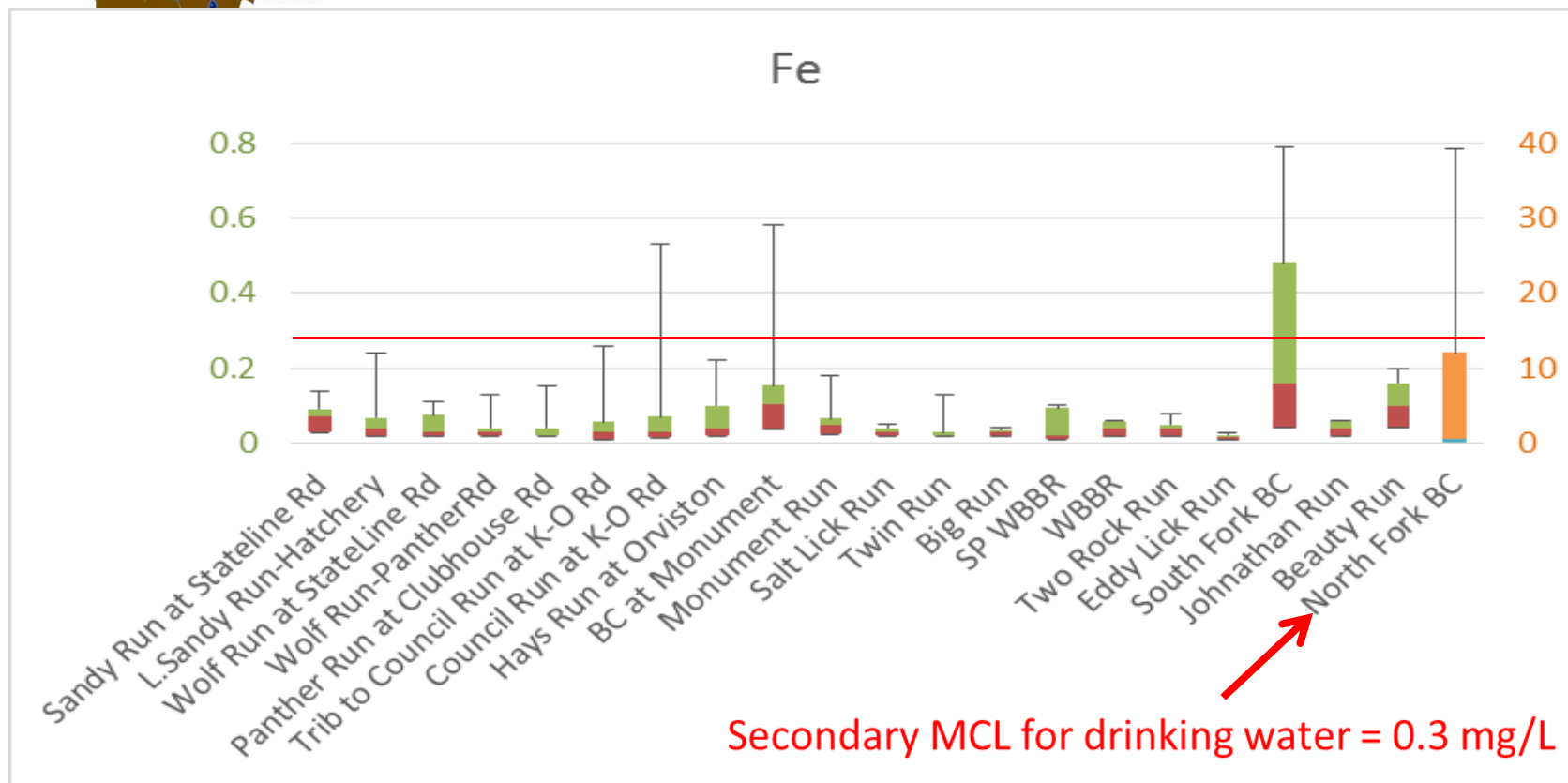


Secondary MCL = 500 mg/L



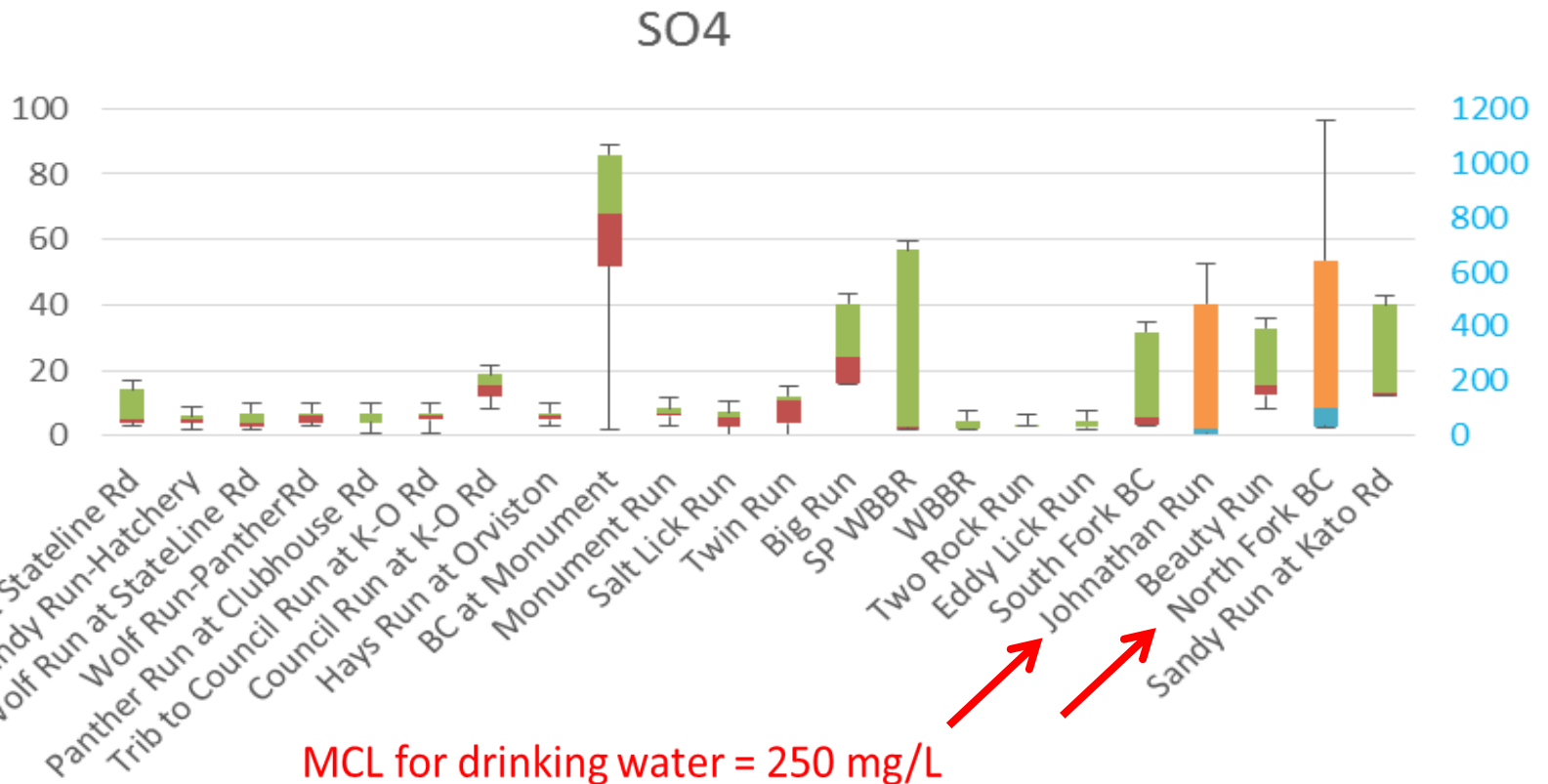


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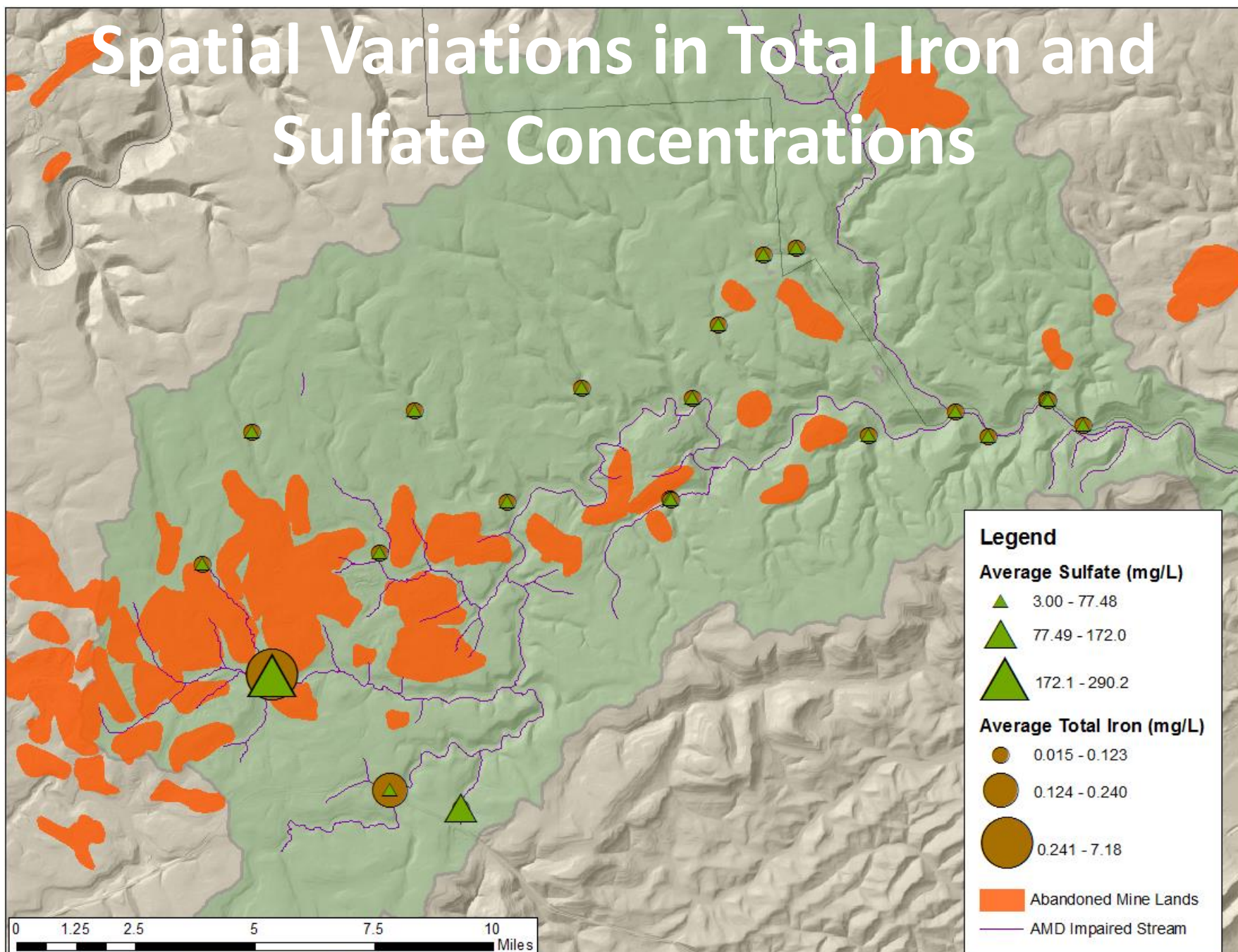




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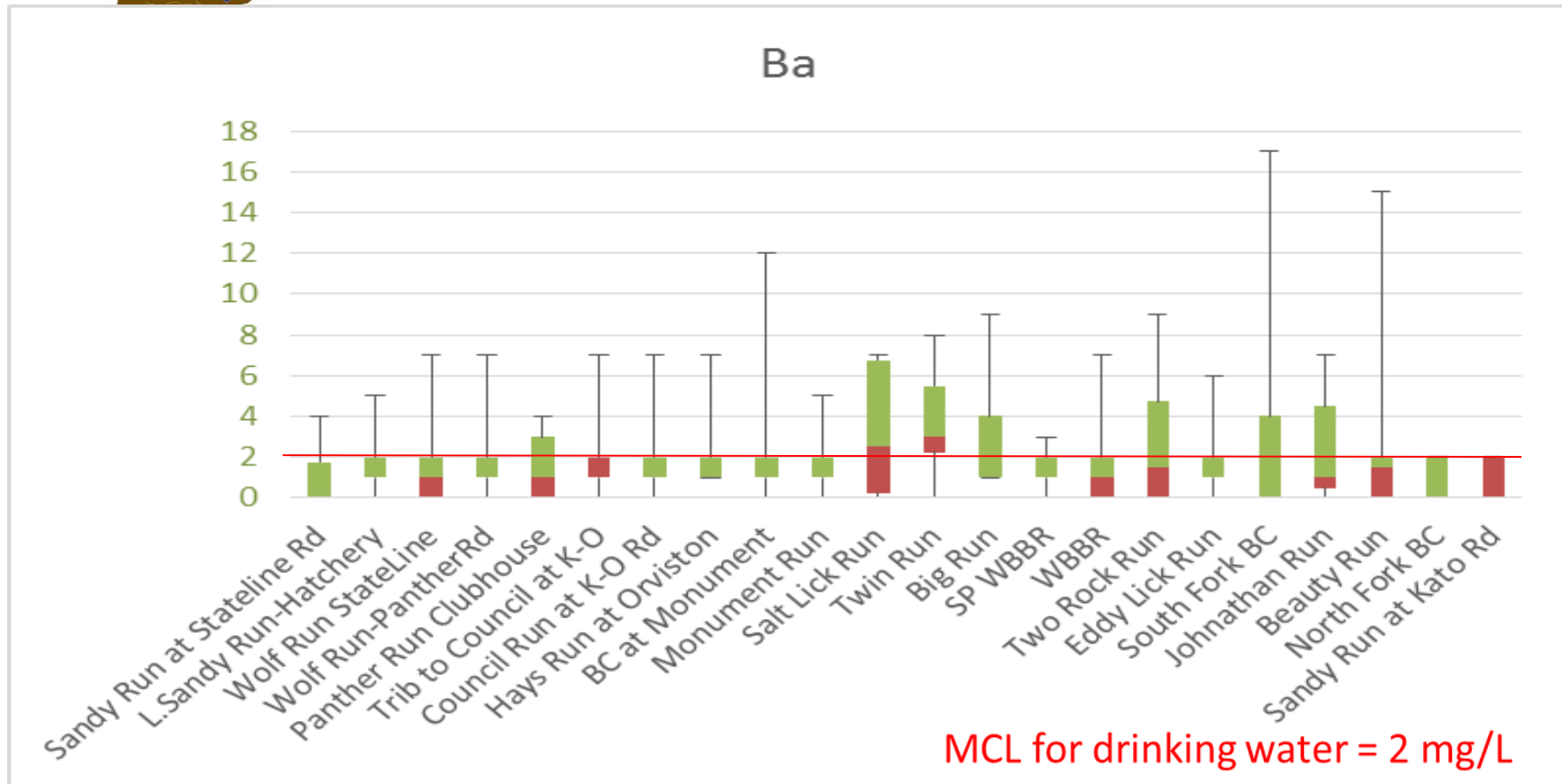


# Spatial Variations in Total Iron and Sulfate Concentrations

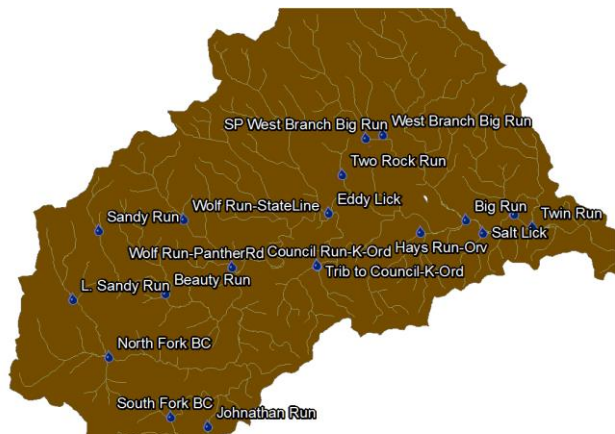




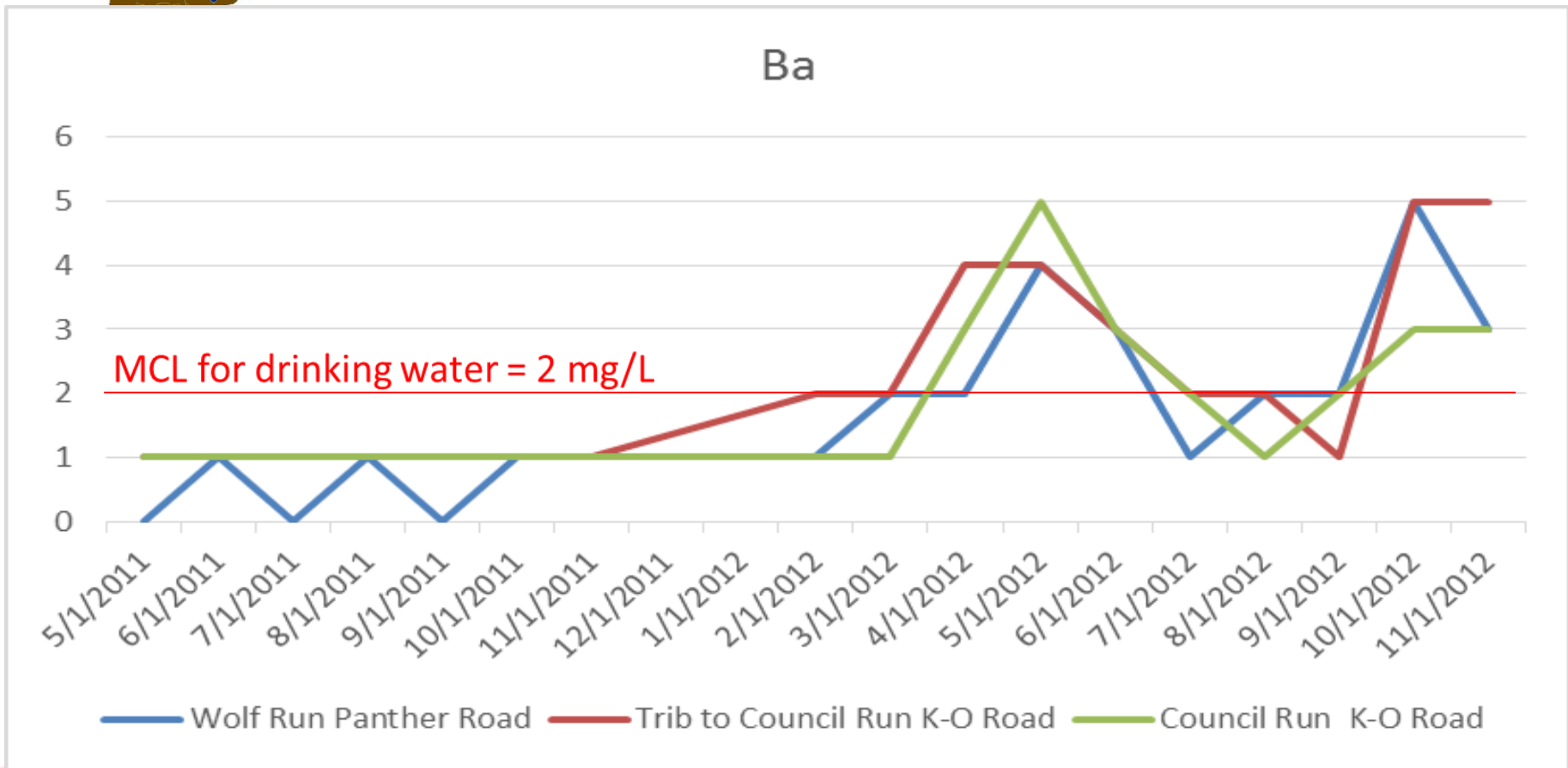
# The Results : BCW







# The Results : BCW



# Conclusions : BCW

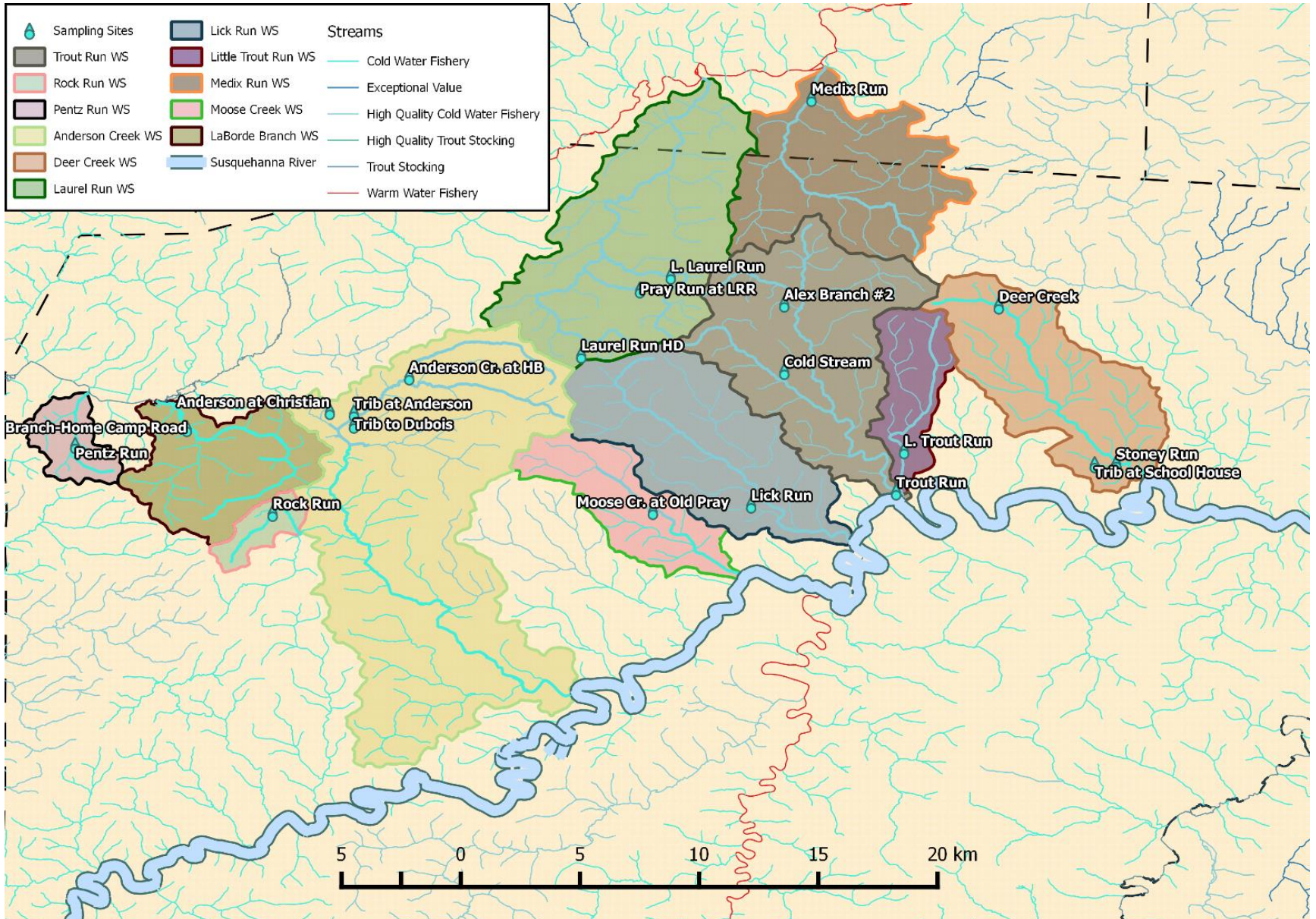
- Samples collected from the Beech Creek watershed generally exhibit low concentrations of Barium and Bromine, however several study locations (e.g. Council Run) occasionally exhibited concentrations outside of the range for natural fresh waters. Sources for these anomalies remain unidentified and warrant further investigation.
- Parameters related to Acid Mine Drainage (pH, Total Iron, Aluminum, Manganese, Sulfate) remain dominant and pervasive in the Beech Creek Watershed



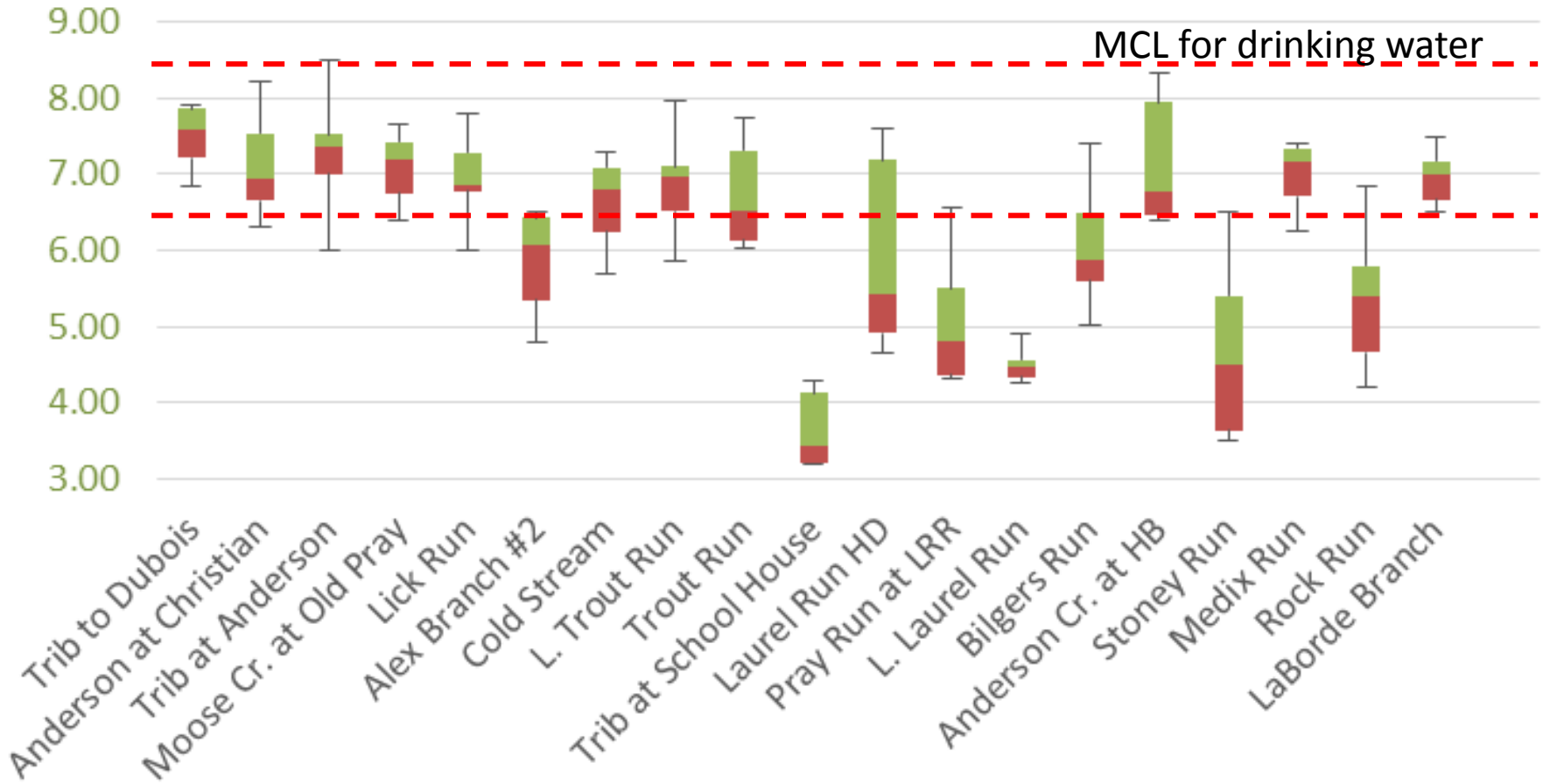
# The Clearfield Project



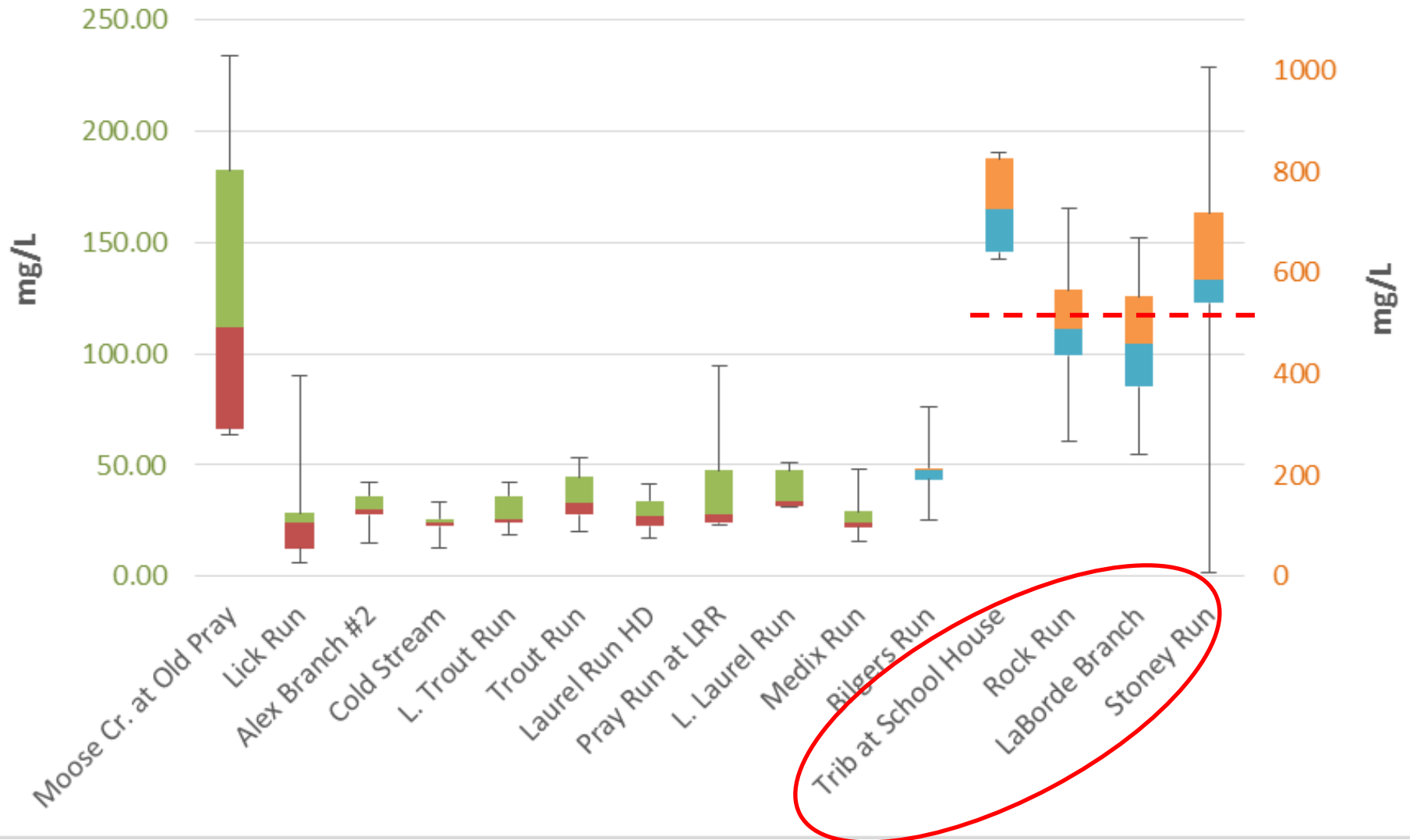
# Sub-watersheds in the Study Area



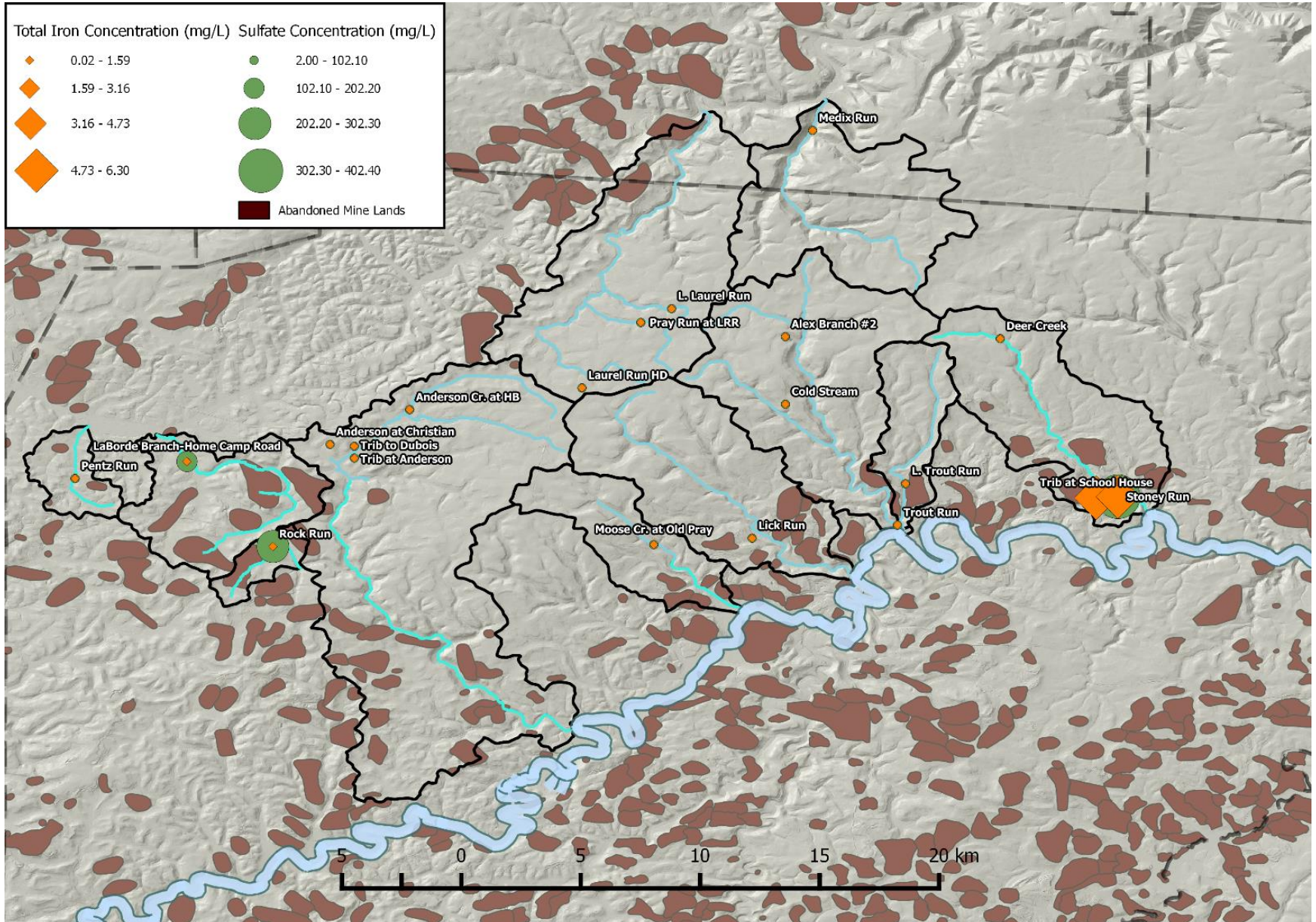
# pH



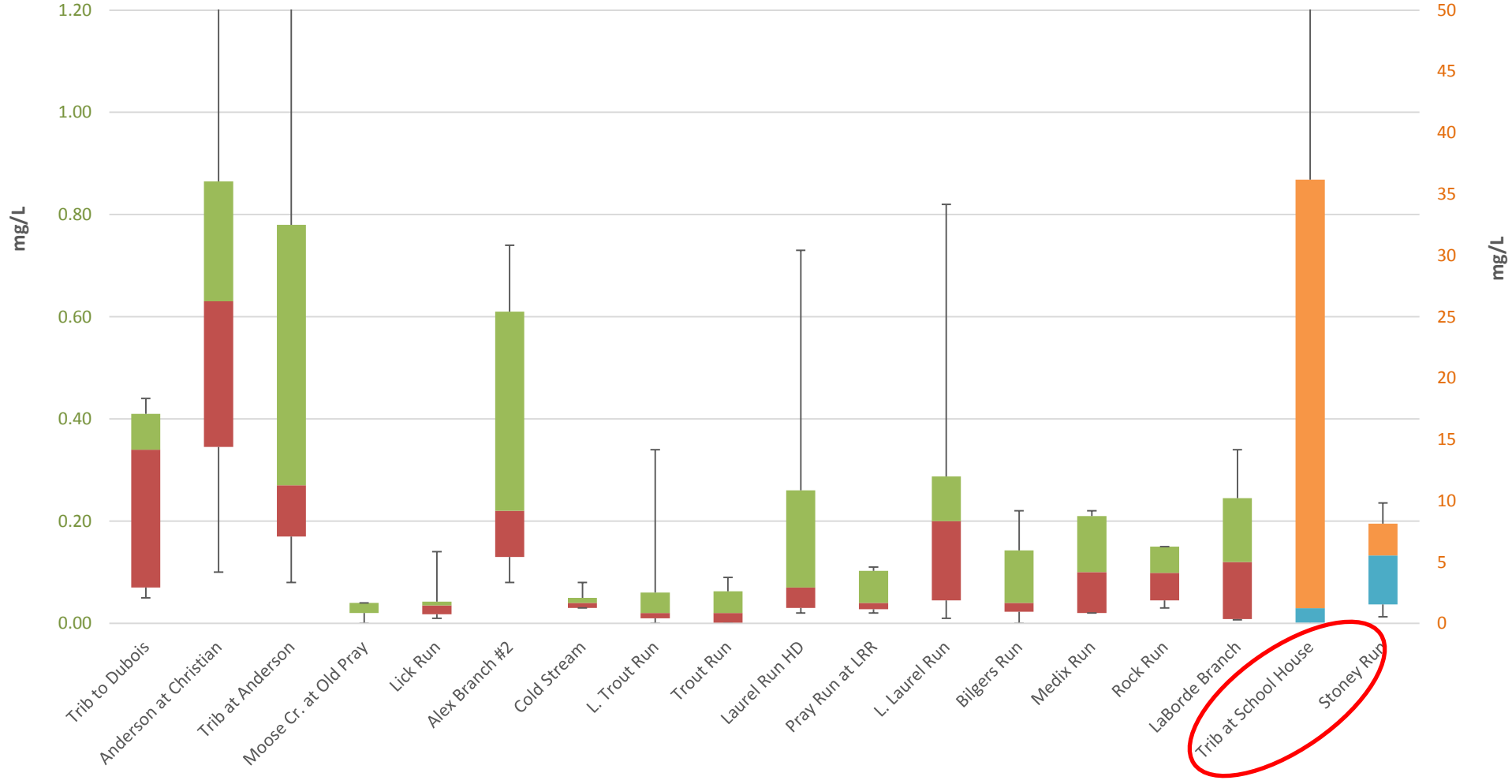
# Total Dissolved Solids



# Total Iron and Sulfate

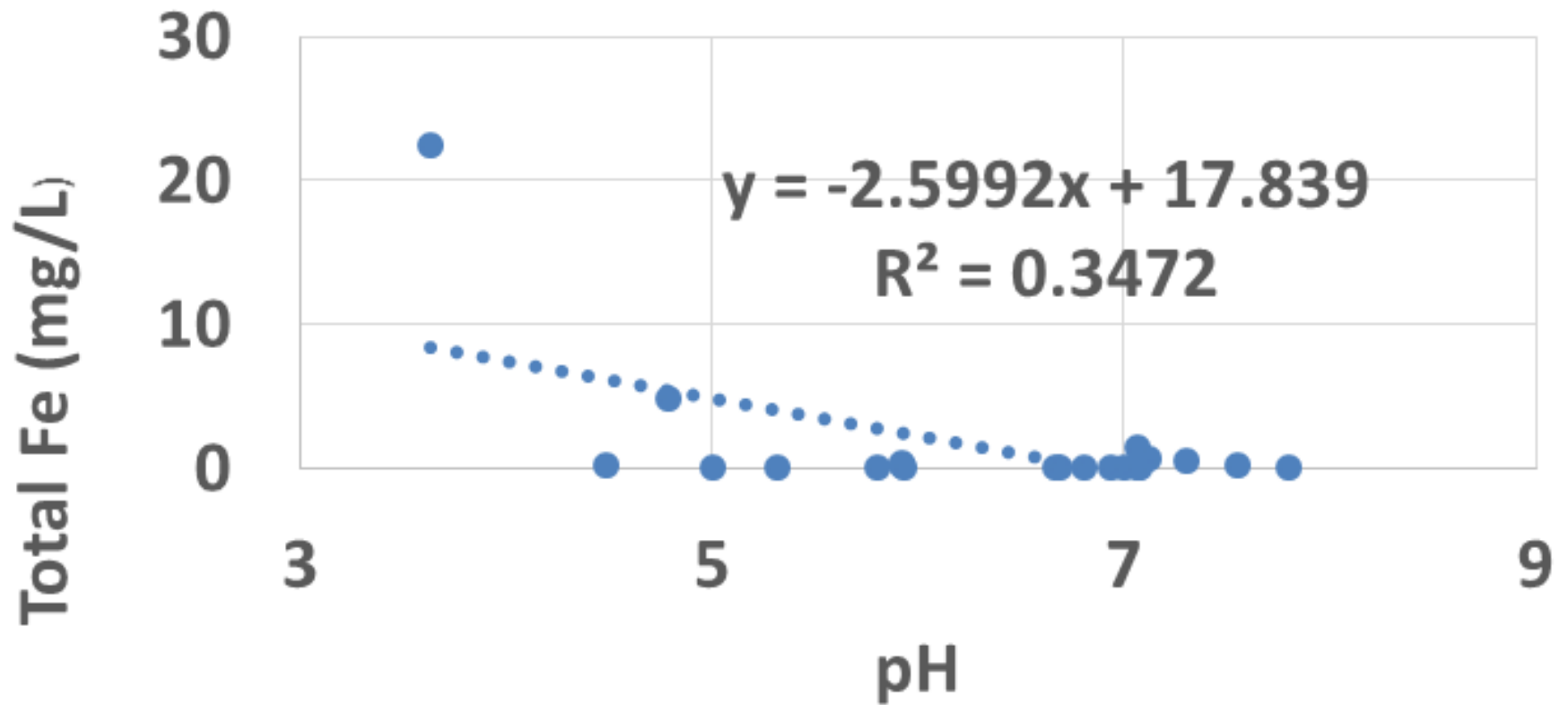


### Total Iron

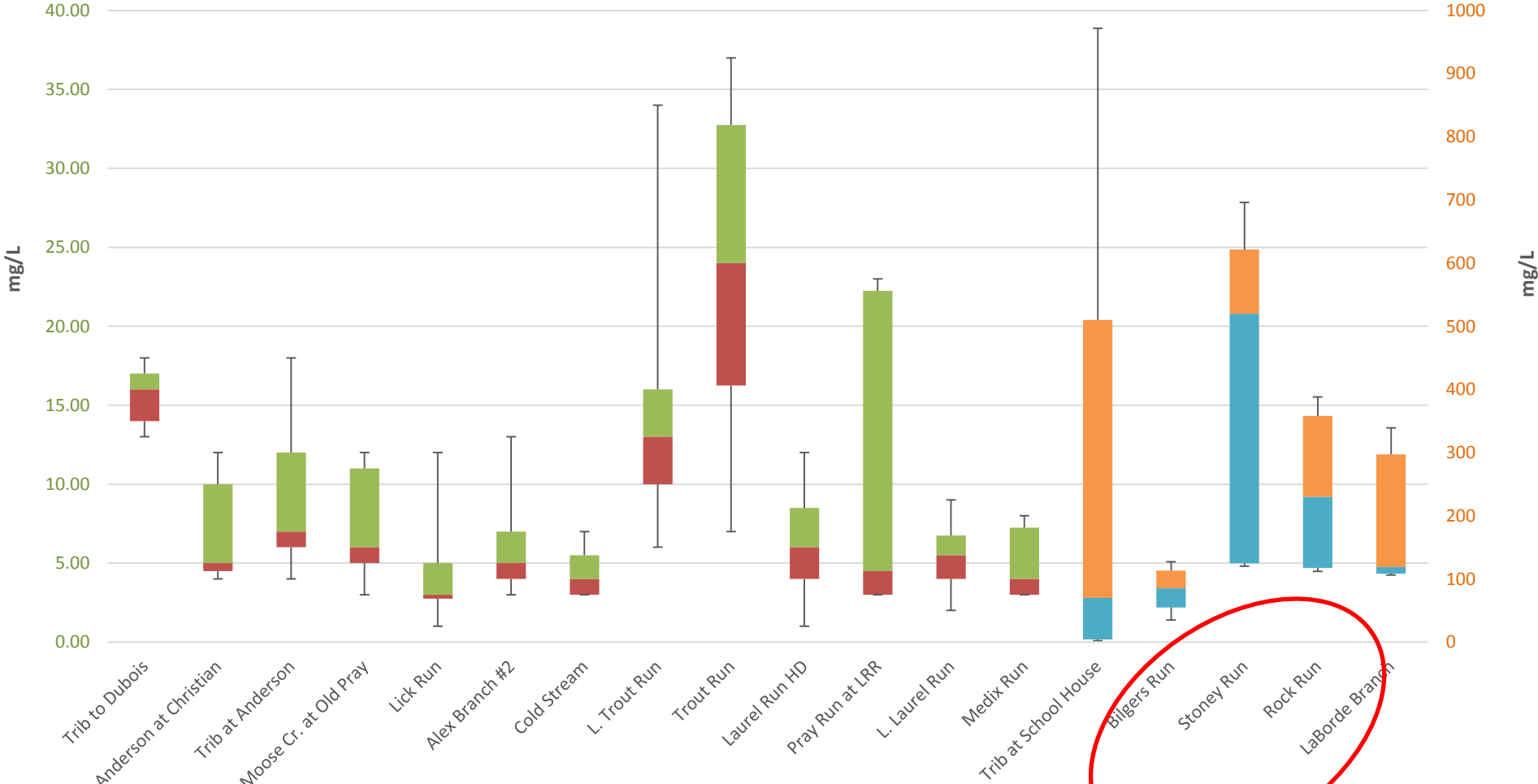




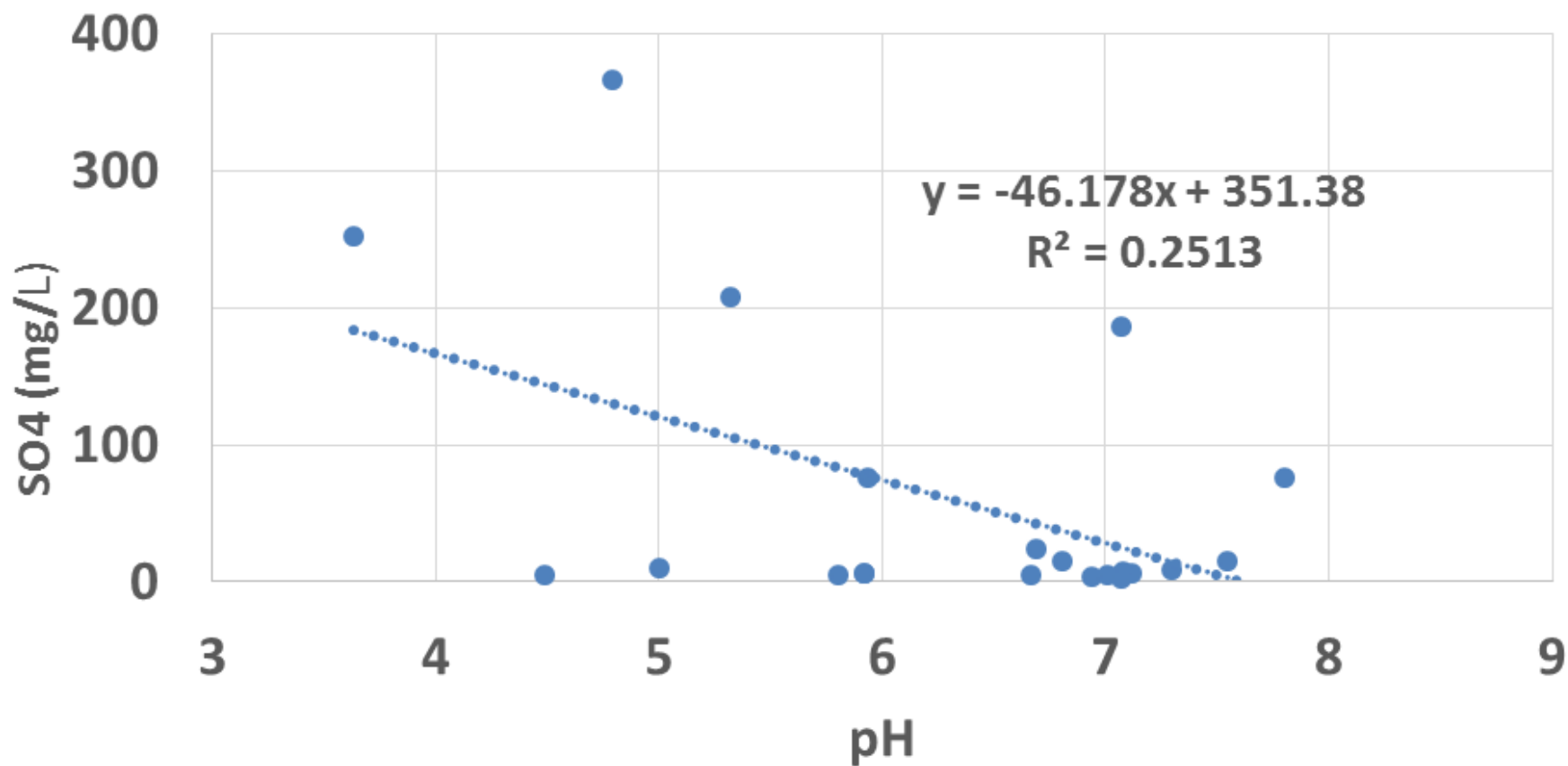
# pH vs. Total Iron



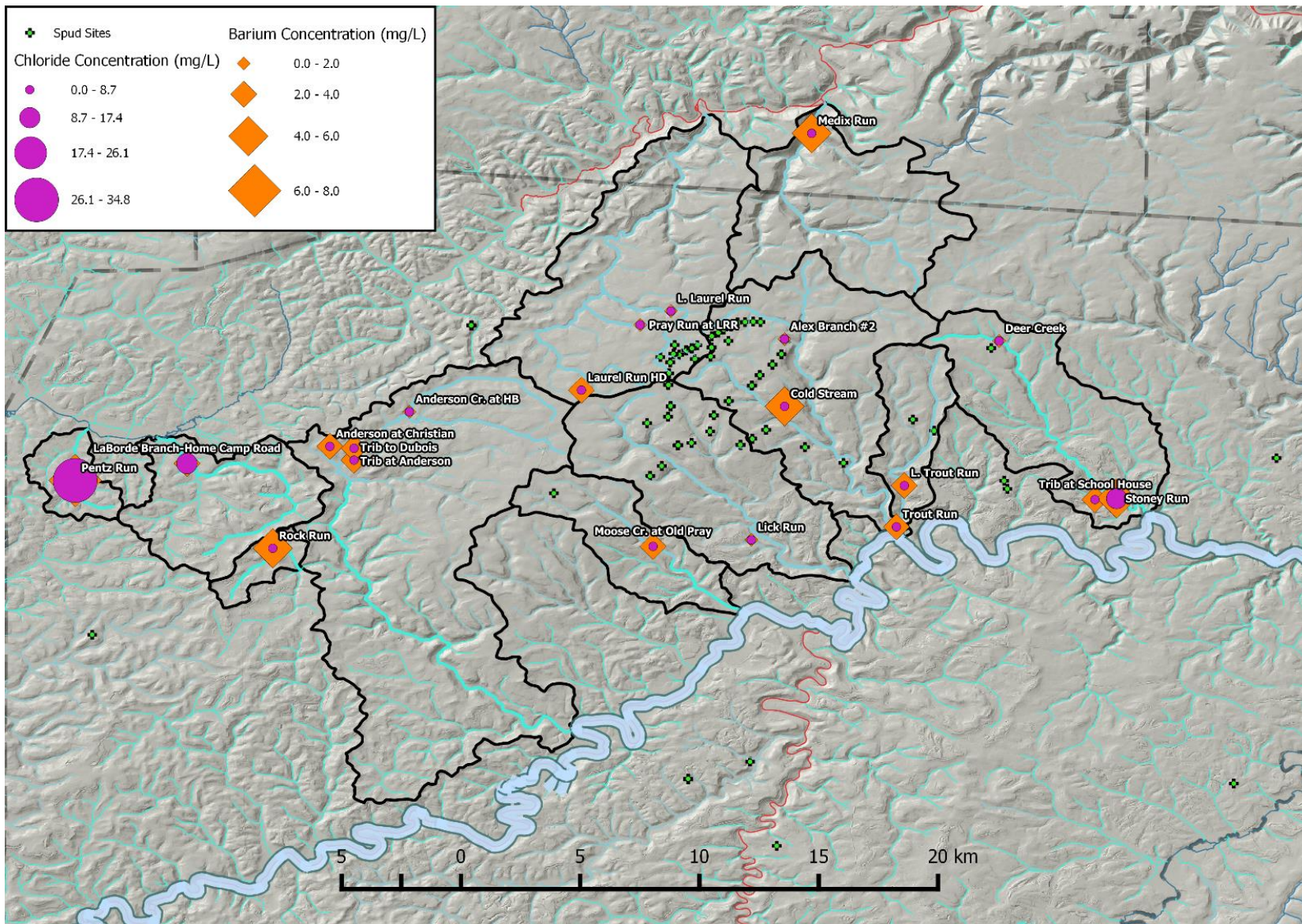
# Sulfate



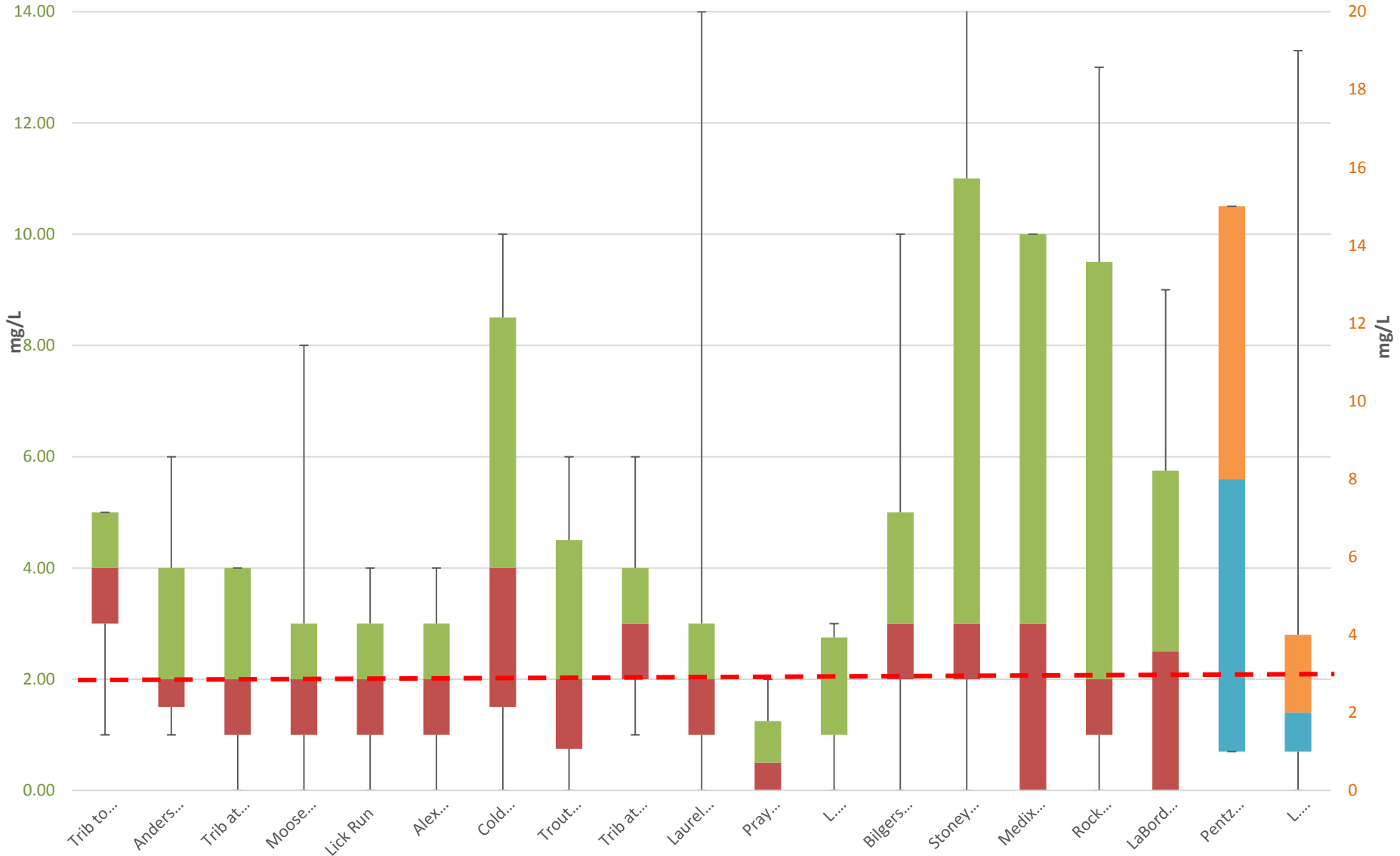
# pH vs. Sulfate



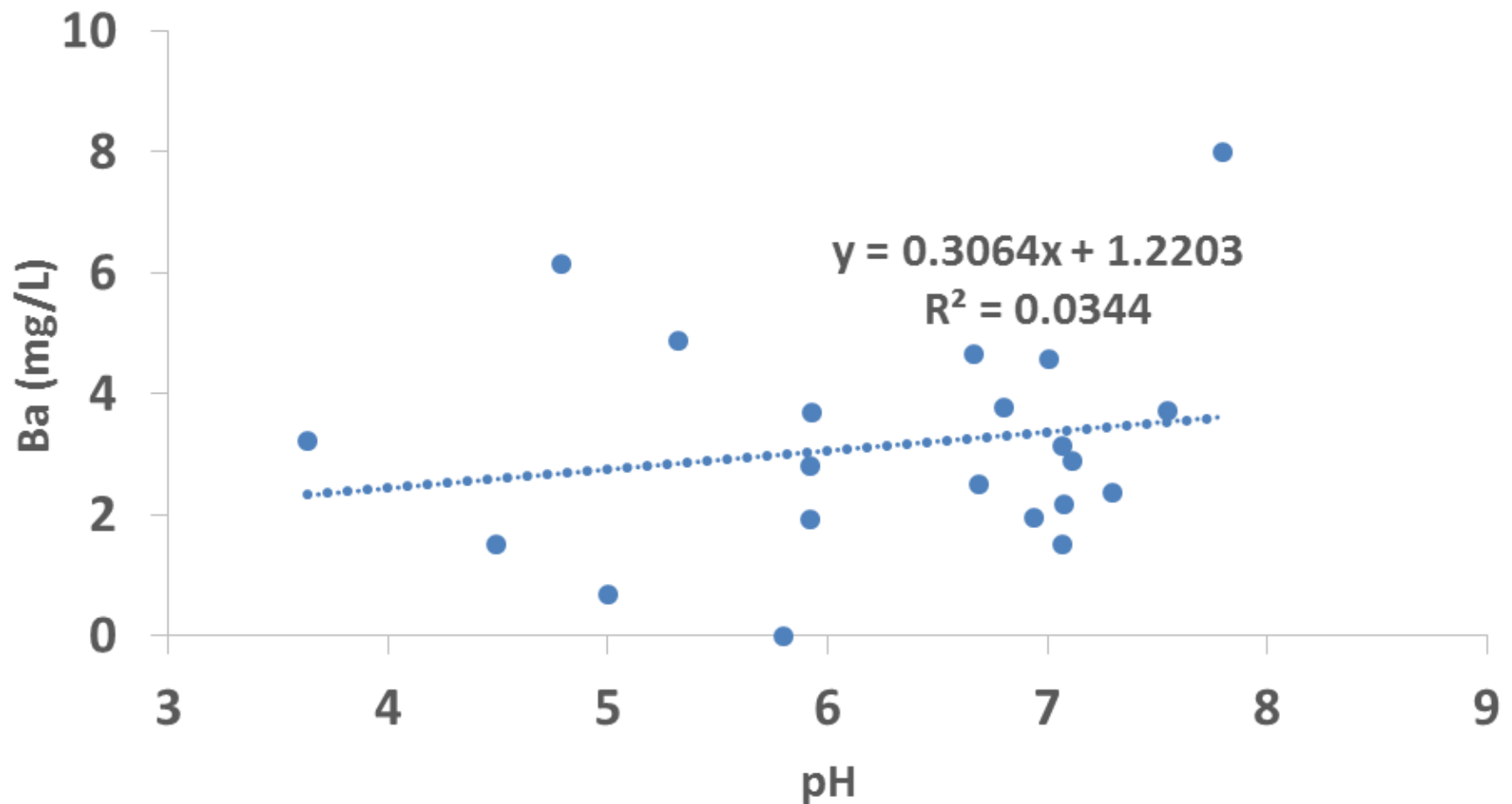
# Barium and Chloride



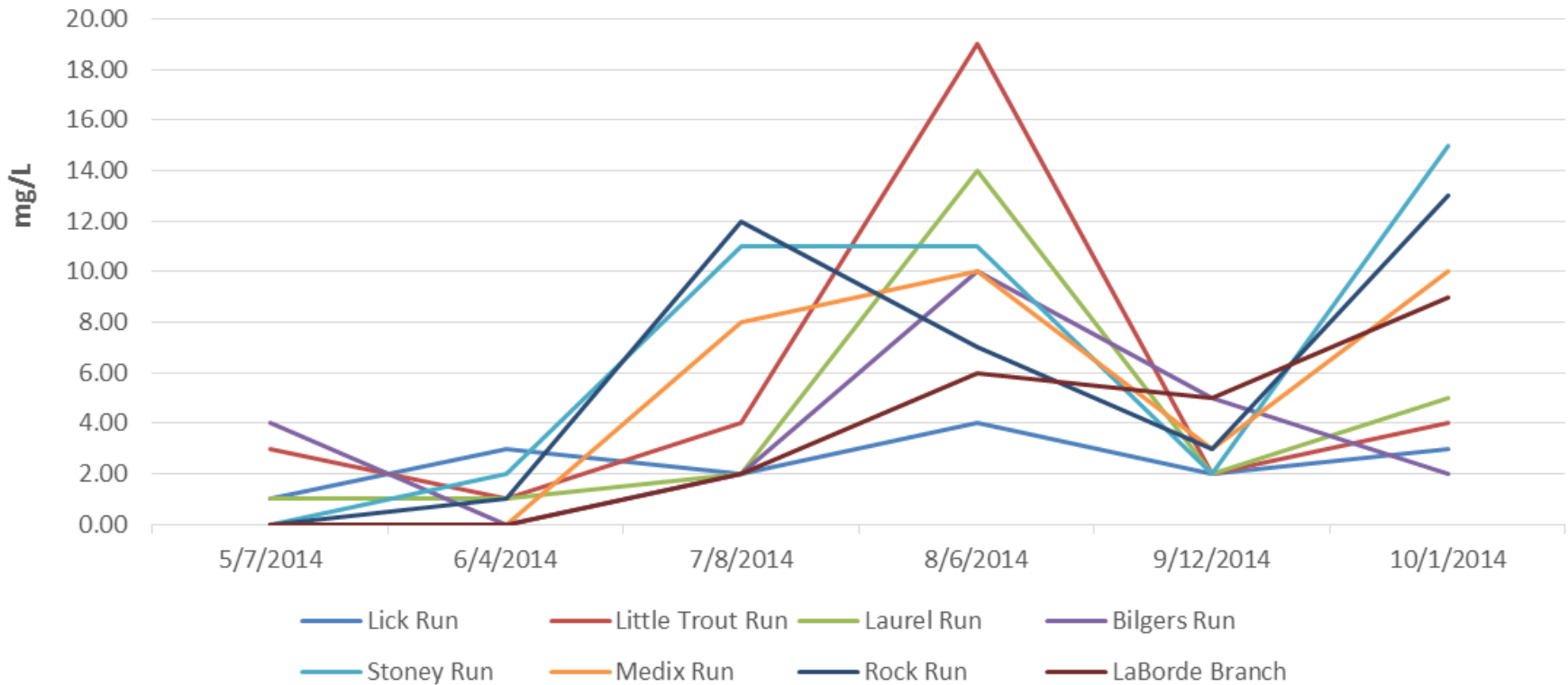
# Barium



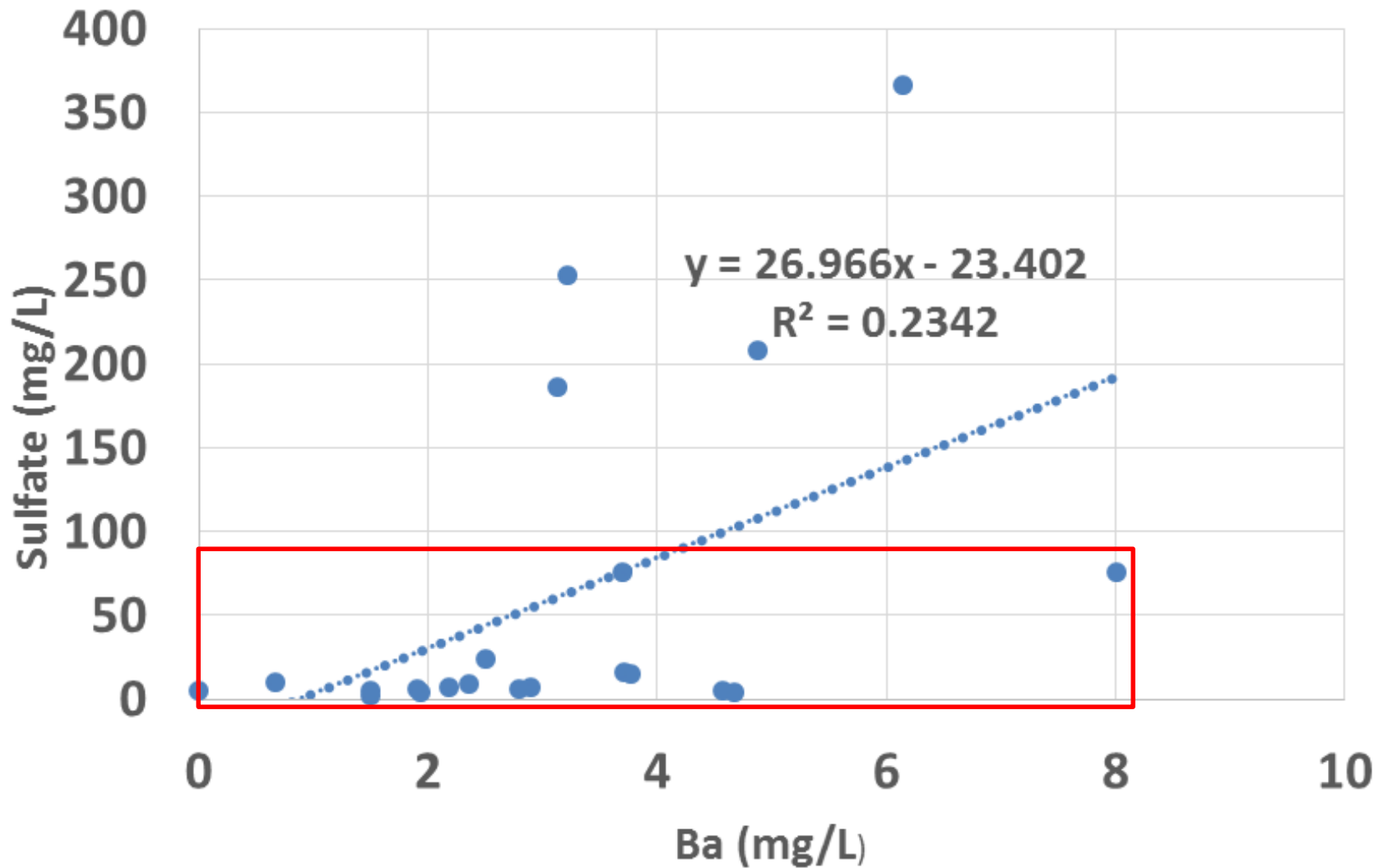
# pH vs Barium



### Barium Time Series

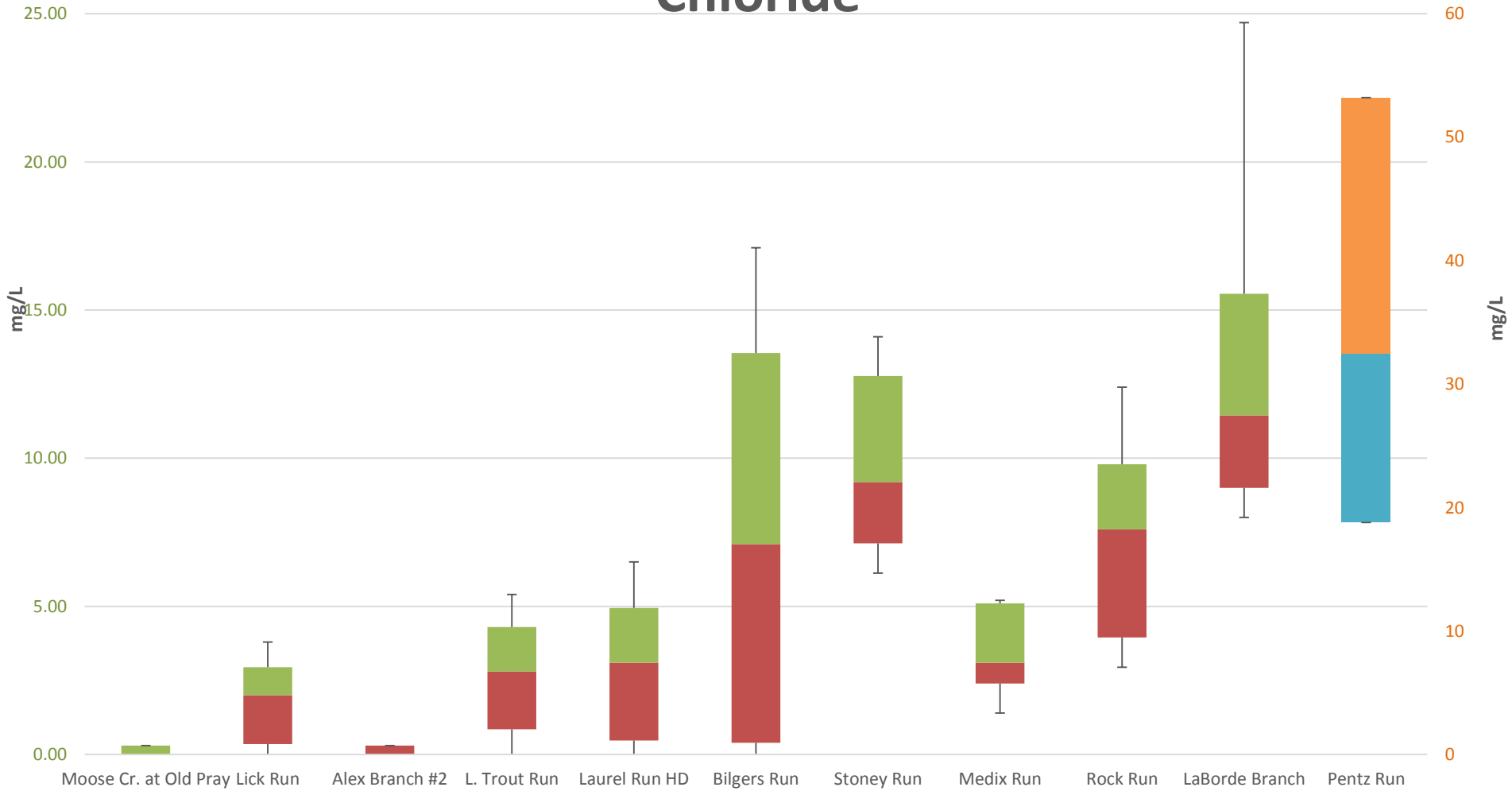


# Barium vs. Sulfate

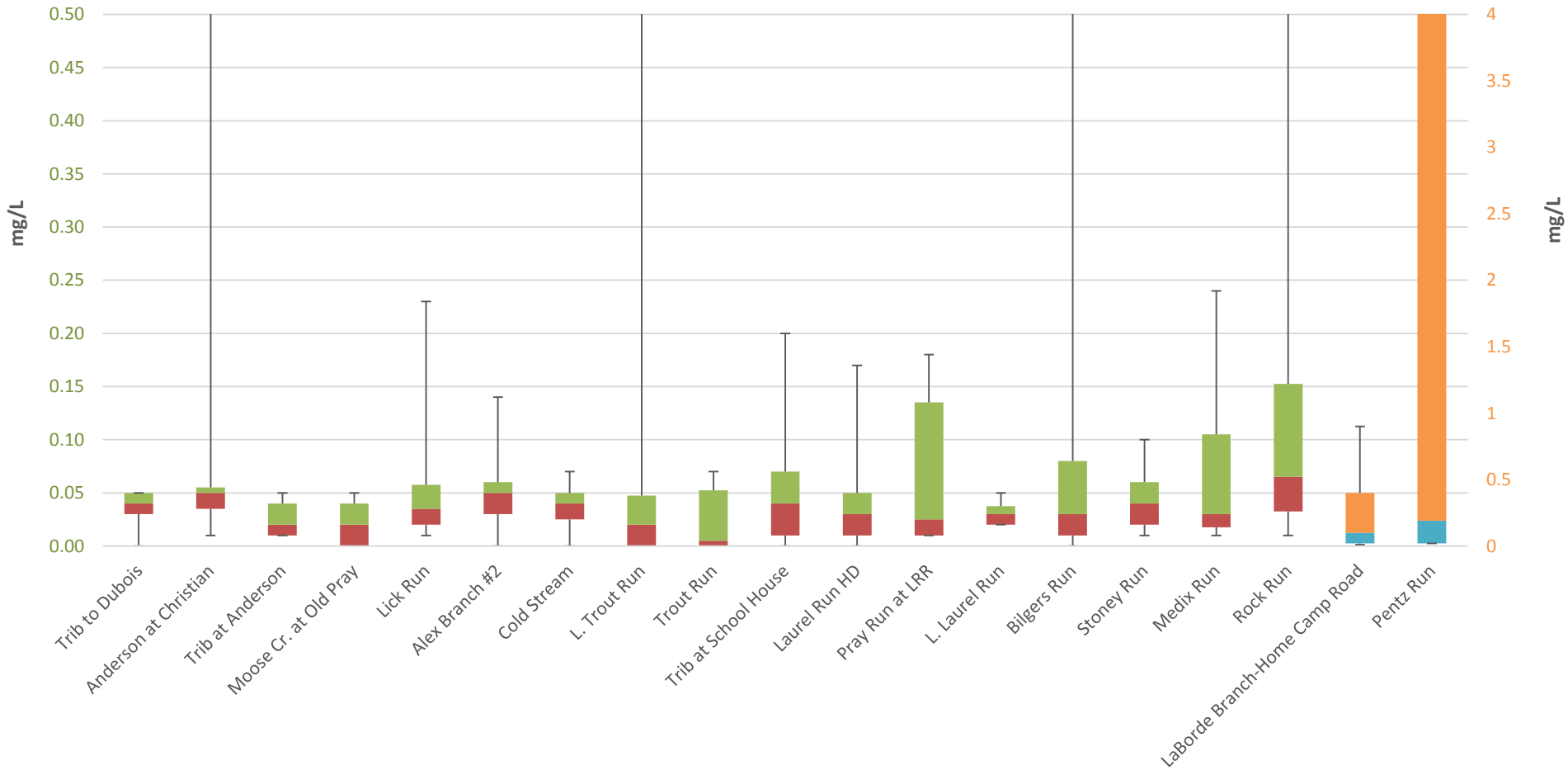




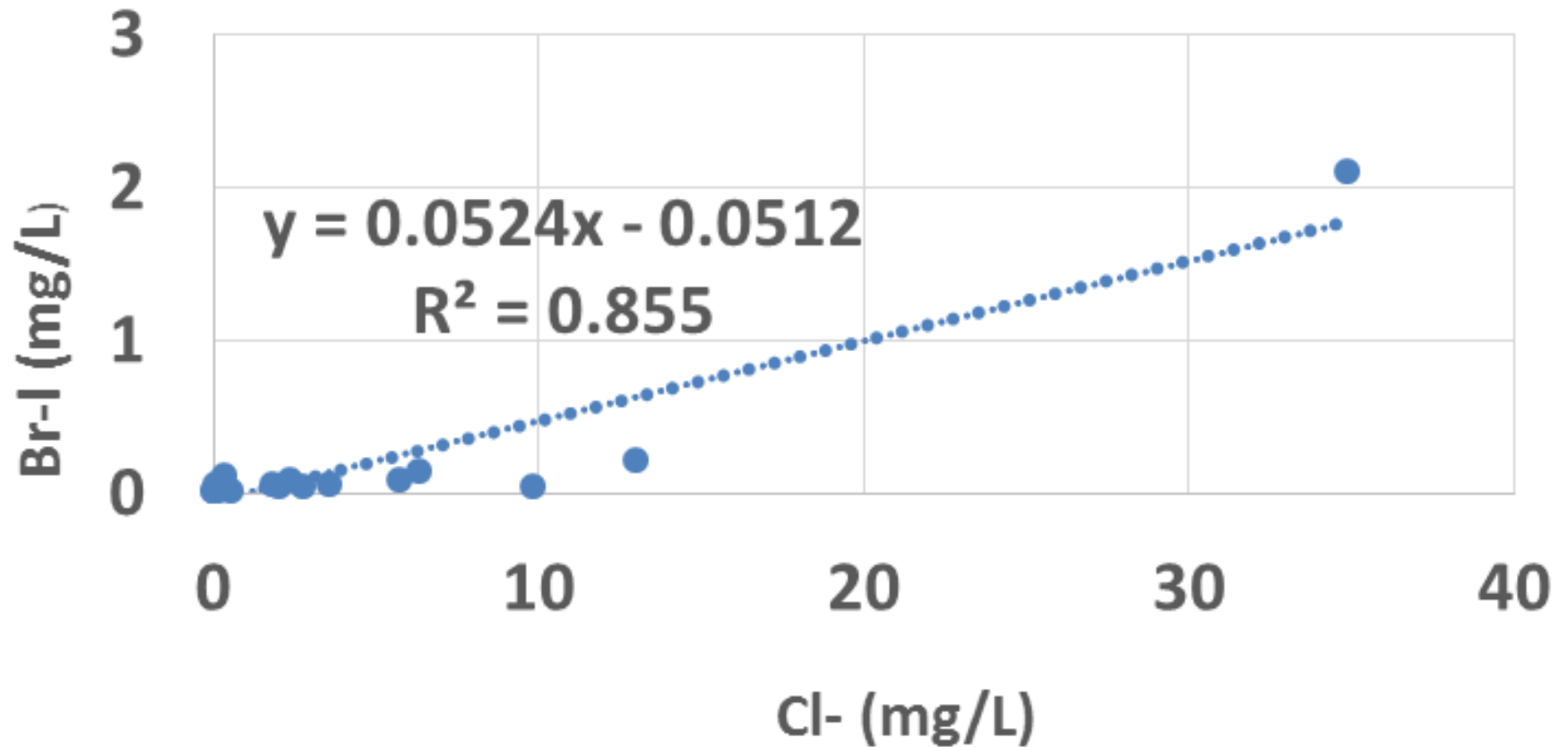
# Chloride



# Bromide



# Chloride vs. Bromide



# Average Concentrations

Location	Temp (°C)	pH	Conductivity (µS/cm)	TDS	Total Hardness	Calcium Hardness	Magnesium Hardness	Barium	Total Iron	Bromine	Sulfate	Copper	Chloride
Trib to Dubois	8.96	7.55	460.0	360.0	129.80	82.68	30.73	3.71	0.28	0.03	15.71	0.02	0.02
Anderson at Christian	12.00	7.12	192.8	60.8	40.21	23.34	17.10	2.89	0.77	0.12	6.78	0.08	0.30
Trib at Anderson	13.24	7.30	261.8	78.6	58.80	36.16	19.86	2.36	0.51	0.03	9.00	0.04	0.25
Moose Cr. at Old Pray	11.26	7.08	193.2	125.8	33.23	17.34	14.59	2.18	0.02	0.02	7.00	0.03	0.11
Lick Run	11.56	6.96	41.6	25.6	12.22	7.06	5.14	1.94	0.04	0.05	4.14	0.05	1.83
Alex Branch #2	11.48	5.92	45.6	31.0	10.44	6.21	4.21	1.91	0.35	0.05	5.73	0.03	0.20
Cold Stream	10.94	6.66	35.5	24.0	14.53	9.21	6.66	4.67	0.04	0.04	4.44	0.02	0.03
L. Trout Run	11.82	6.83	49.6	29.9	22.86	12.08	9.72	3.78	0.05	0.09	14.60	0.07	2.69
Trout Run	14.05	6.69	53.8	35.5	25.41	12.19	14.07	2.50	0.03	0.02	23.60	0.03	0.00
Trib at School House	14.47	3.63	1105.7	731.1	124.67	87.17	37.50	3.22	6.30	0.05	252.44	1.46	2.00
Laurel Run HD	13.63	5.96	44.7	28.2	20.31	9.22	10.98	2.81	0.20	0.04	6.23	0.07	2.97
Pray Run at LRR	12.78	5.00	53.9	38.3	22.92	11.90	11.18	0.67	0.06	0.06	10.00	0.12	0.07
L. Laurel Run	15.75	4.49	54.1	38.2	14.93	5.09	10.85	1.50	0.24	0.03	5.38	0.04	0.11
Bilgers Run	10.78	6.02	290.8	201.0	60.93	32.33	28.60	3.50	0.07	0.11	82.50	0.04	6.68
Anderson Cr. at HB	17.45	7.07	91.0	41.6	29.00	20.50	8.50	1.50	1.51	0.02	2.00	0.04	0.55
Deer Creek	13.50	5.80	30.0	20.0	4.80	2.40	2.40	0.00	0.02	0.02	5.00	0.01	0.02
Stoney Run	11.39	4.57	1200.2	590.4	534.25	330.20	204.05	5.88	4.97	0.04	402.40	0.63	9.78
Medix Run	12.49	7.04	45.2	26.6	20.20	9.65	10.55	4.57	0.11	0.07	4.75	0.10	3.56
Rock Run	12.01	5.33	738.4	494.7	274.45	140.25	134.35	4.56	0.10	0.14	237.83	0.09	6.97
LaBorde Branch-Home Camp Road	12.77	6.97	686.8	460.1	260.85	160.10	100.50	3.13	0.13	0.22	185.80	0.10	12.95
Pentz Run	19.10	7.63	358.3	240.1	90.00	74.50	15.50	8.00	0.05	1.41	76.10	0.05	34.83

Average concentrations of tested parameters for each sampling site. Reported in mg/L unless otherwise noted. Red and bolded indicate above the MCL for drinking.



# Conclusions : Clearfield

- Samples collected from sub-watersheds in Clearfield County generally exhibit low concentrations of Barium and Bromine
- Anomalous results observed at several sampling locations (e.g. Pentz Run, Tributary to DuBois Reservoir, Rock Run, Stoney Run, LaBorde Branch, Cold Stream, Bilger's Run, and Tributary at Schoolhouse Road) warrant focused study of water/sediment samples in the future.
- Parameters related to Acid Mine Drainage (pH, Total Iron, Aluminum, Manganese, Sulfate) remain dominant and pervasive in several sub-watersheds, including Stoney Run, Tributary at Schoolhouse Road, LaBorde Branch, and Rock Run.



# Conclusions: Overall

- The findings of this project provided community partners with the opportunity to act as citizen-naturalists in an effort to safeguard their environment through vigilance and monitoring.
- This ongoing community-based water quality monitoring project provided students a hands-on experience with field/lab methods and equipment in a real-world application, while involving and benefiting the greater community.



# Future Directions

- Develop a research project to analyze sediments, soils, and rocks to determine the potential sources of elevated Barium in water samples in various sub-watersheds, including the Medix Run, Pentz Run, Stoney Run, Trout Run, and LaBorde Branch.
- Investigate gas drilling activities and other activities for the time period of our study to examine potential “cause and effect” relationship between elevated levels of barium and those factors.
- Impact of fragmentation of forest through gas drilling activities and other land disturbances on ecosystems, erosion and sedimentation on gravel roads in and around drill sites.
- Expand sampling to include new locations and private drinking water wells and springs.
- Modeling of potential vulnerability of surface and groundwater pollution due to gas drilling activities and other landuse changes in the study area.



# Thank You!



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