LOCK HAVEN UNIVERSITY OF PENNSYLVANIA

Characterizing Sources of Turbidity in Stream Sediments in the Marcellus Shale Gas-Well Drilling Region in Central PA

Matt Bell, Rose Nash, and Md. Khalequzzaman
Department of Geology & Physics, Water and Soil Resources lab, Lock Haven University, Lock Haven PA 17745

Water and Soil Lab

ABSTRACT

Throughout the development of the Marcellus shale infrastructure and industry in Pennsylvania, the impacts and cost-benefit have been vigorously debated. It is important for the public, as well as the science community, to fully understand the impacts Marcellus activities have on the environment. One such concern is a possible increase in stream turbidity caused by an upswing in Marcellus shale infrastructures, including construction and modification of existing gravel roads (figure 4).

Sediments collected from streambeds, farmlands, stream banks, and gravel roads were analyzed using x-ray fluorescence (XRF) to determine elemental composition. Two watersheds were studied, each with varied intensities of Marcellus shale activity. Marsh Creek exhibits virgin territory in terms of Marcellus activity. Whereas Baker Run holds approximately 8 distinct drilling pads within its bounds, as well as miles of newly constructed gravel roads. The results were compared using a variety of graphical and statistical methods, such as ternary diagrams, XY scatter plots, and the student's t-test.

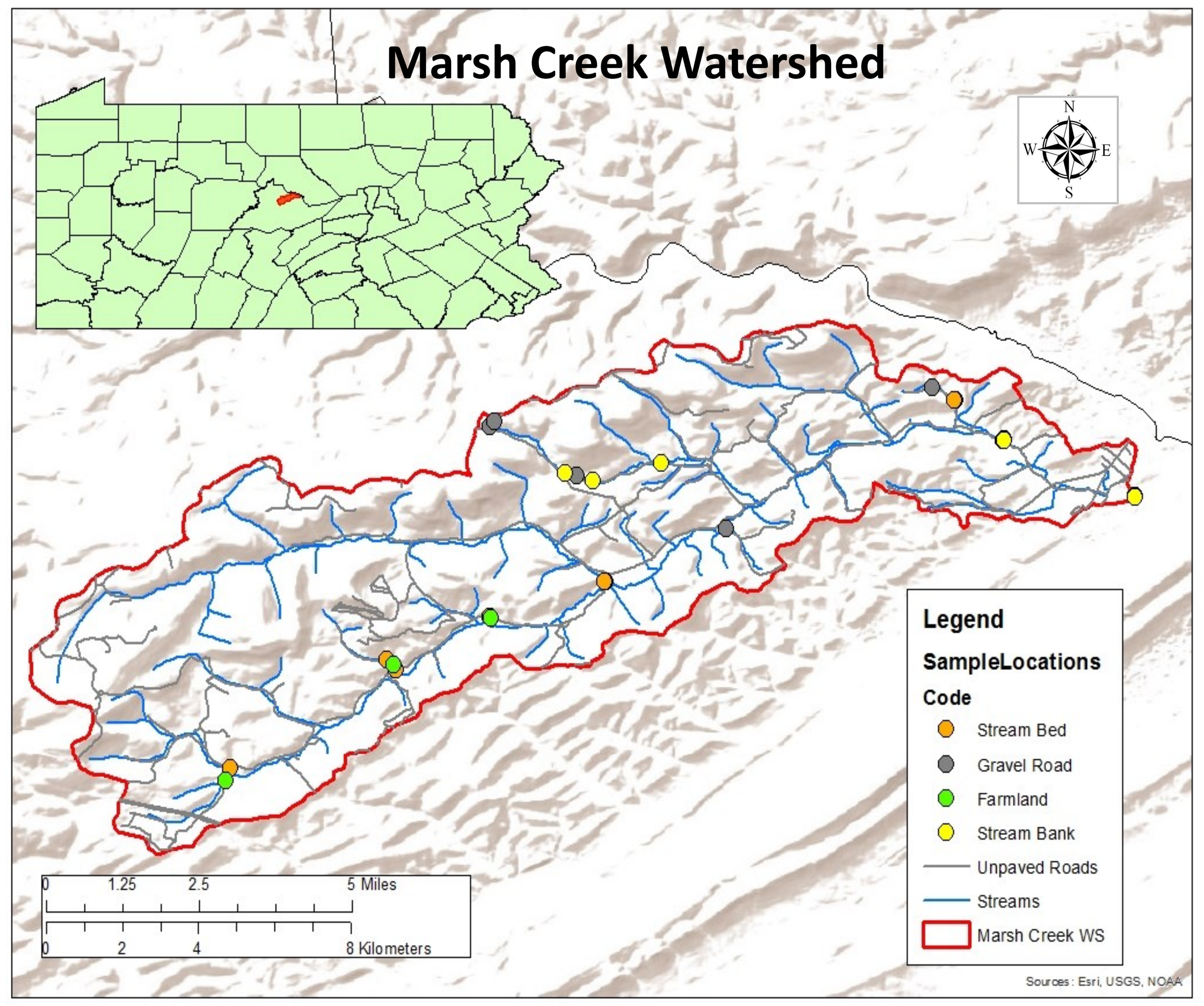


Figure 1 Olympus Professional handheld XRF analyzer. Used for analyzing elemental concentrations.

METHODS

Sediment samples were collected from three separate types of landuse (stream bed, adjacent stream bank, and surrounding countryside/farm soil), as well as gravel roads from two watersheds with varying levels of Marcellus activity. Samples were analyzed using x-ray fluorescence (XRF) to determine elemental concentrations within the sediment (figure 1). The concentrations were compared between the types of landuse and gravel roads using the student's t-test to demonstrate statistical differences within the data collected. The alpha value for the t-tests performed was 0.05, indicating a 95% certainty in obtained results. Concentrations were then symbolized using a series of ternary plots and XY plots for Al, Ca, K, Mn, Ni, Si, Sr, and Zn, to visually symbolize relationships and influence of surrounding sediments on stream turbidity.

In total, 25 samples were analyzed from Baker Run, and 27 from Marsh Creek.

Figure 2: Matt taking field notes of conditions during a day of sample collection.

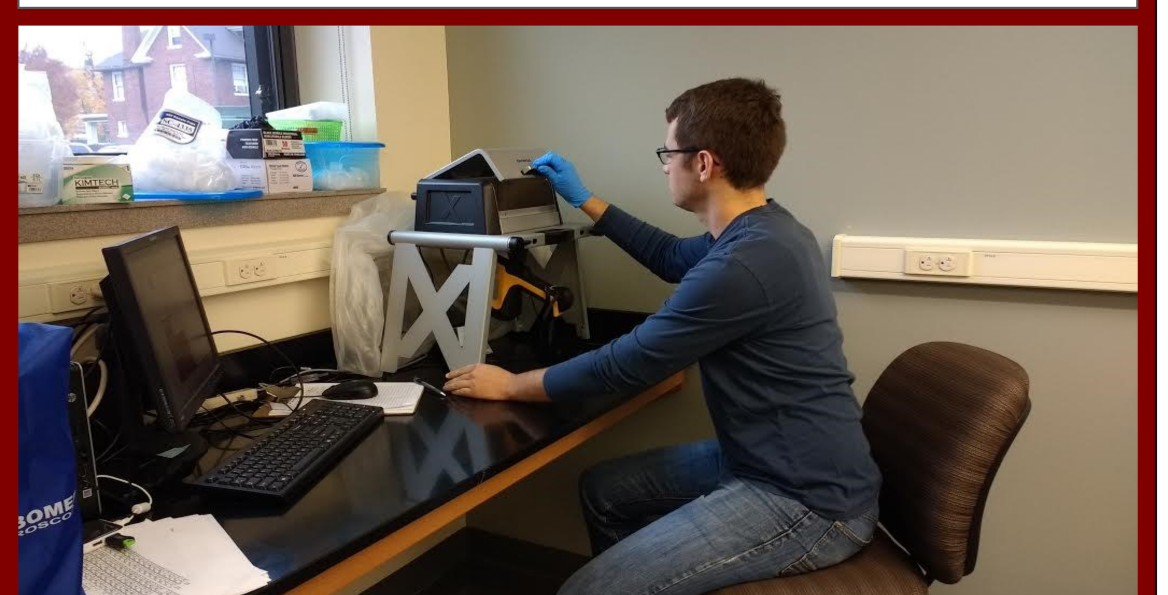
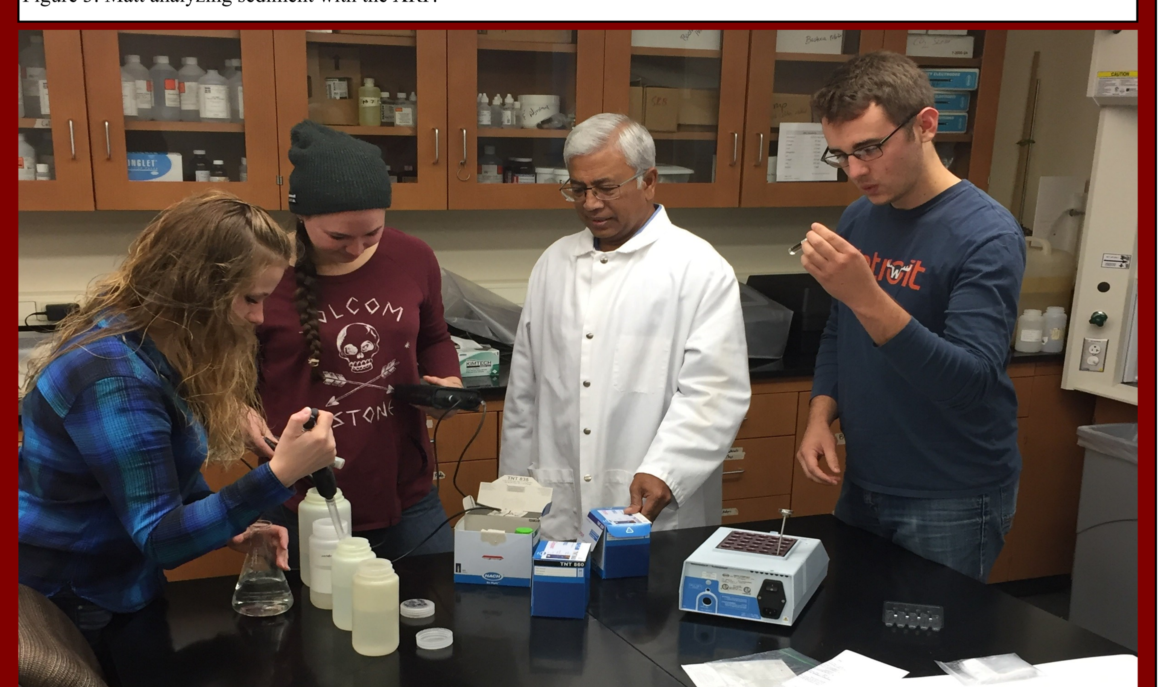


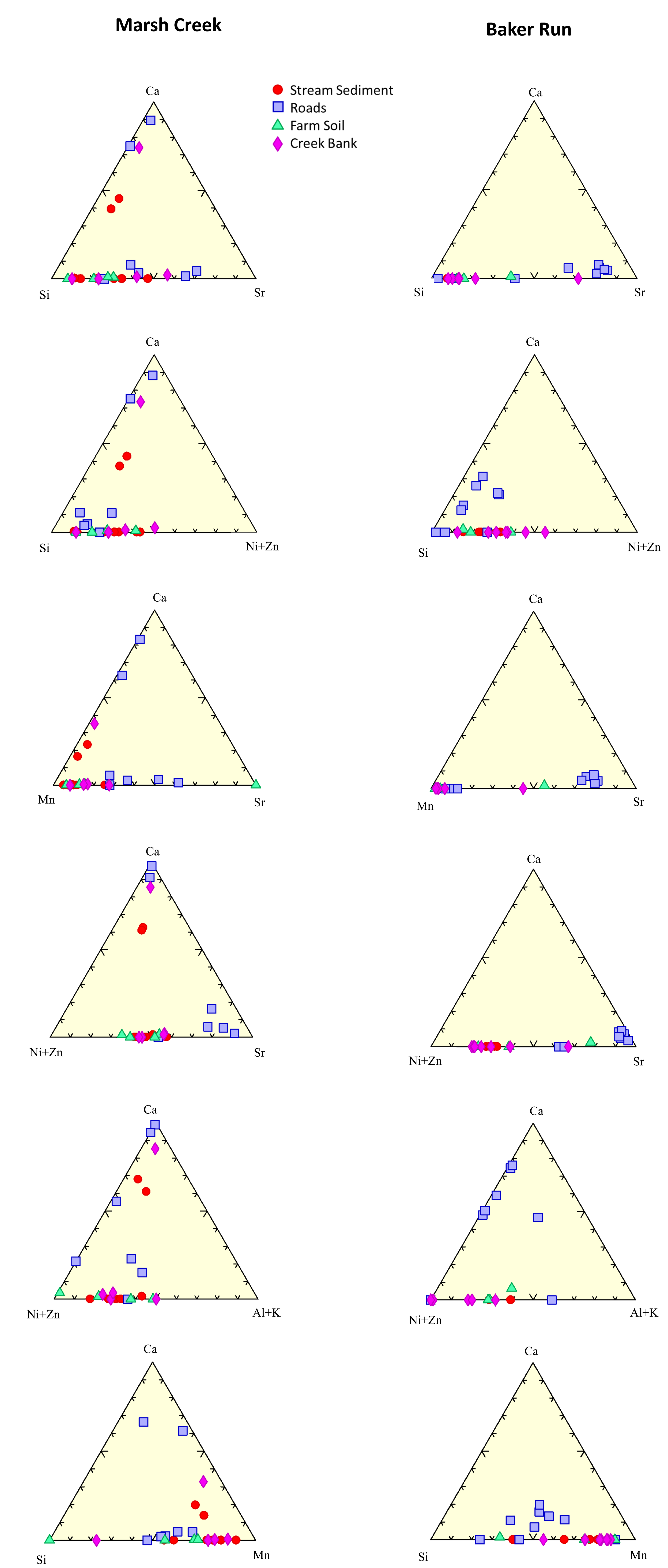
Figure 3: Matt analyzing sediment with the XRF.

GEISINGER
REDEFINING BOUNDARIES

SRHCES



The lab group, putting in work.



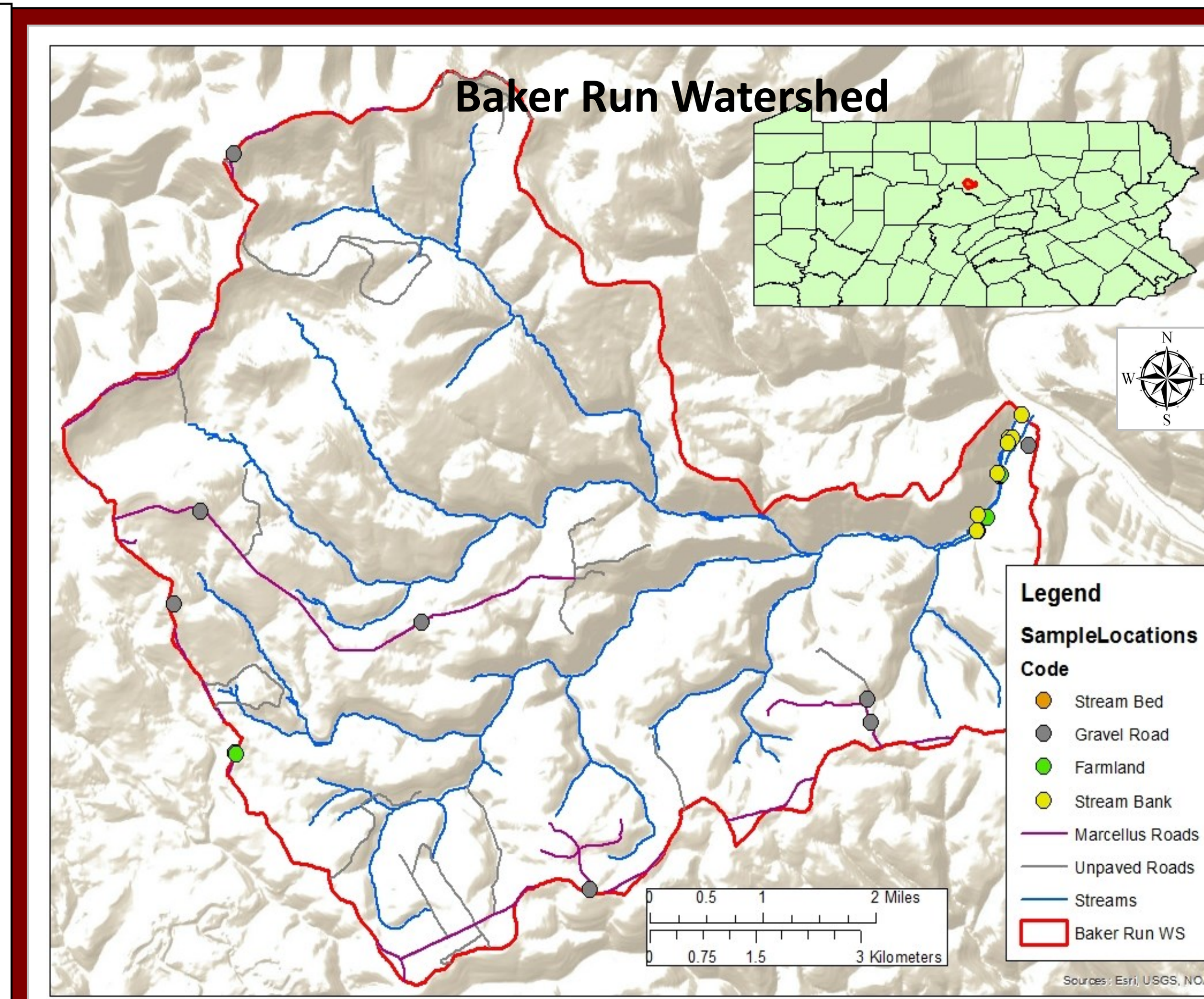


Figure 4: Samples ready for analysis

RESULTS & CONCLUSIONS

Results of the student's t-test on elemental concentrations of samples collected from various landuses demonstrate that there are some key differences between the groups. Within the Marsh Creek watershed, the only statistically significant difference was observed between gravel roads and stream sediment with regard to Mn concentration. Analytical results for Ca, Si, Sr, and Al+K concentrations showed no statistically significant difference between samples collected from different landuses and those collected from gravel roads. However, samples collected from farmland sediment, stream bank sediment, and stream bed sediment within the Baker Run watershed were statistically different from those collected from gravel roads in regard to Ca and Sr. Samples collected from stream bank and gravel roads were also statistically different in terms of Mn concentration. Comparing these results to the Marcellus Shale gas-well drilling activity in the watersheds, a correlation is evident. The Marsh Creek watershed has no Marcellus activity within its boundary, so it can be inferred that the gravel roads in this region have been in place long before the Marcellus Shale activity in the region. However, the Baker Run watershed has 8 Marcellus Shale gas-well drilling pads, as well as increased gravel road infrastructure connecting them. The gravel roads within Baker Run watershed are expanded and maintained for heavy traffic to support the extraction and exploration process. Elemental composition of gravel roads in Marsh Creek watershed are not statistically different from samples collected within other landuses; however, gravel road samples collected from Baker Run are statistically different from sediment collected within surrounding landuses.

The elemental composition of the gravel roads and other landuses from both watersheds were compared against the elemental composition of stream bed sediments to determine the relative contribution of these sediment sources to stream turbidity in receiving streams. Stream bed samples from Marsh Creek plot intermixed with stream bank, farmland sediment, and gravel road samples in various ternary diagrams, indicating that stream turbidity owes its origin to mixed sources, including contributions from gravel roads. In the Marsh Creek watershed, on average 28-78% of gravel road samples were characterized by similar elemental composition as stream bed sediments. In Baker Run watershed, depending on elemental compositions plotted in the ternary diagrams, on average 11-44% of gravel road samples were characterized by similar elemental composition as the stream bed sediments. When comparing these two watersheds, it can be concluded that gravel roads in Marsh Creek watershed contribute relatively more to stream turbidity as compared to Baker Run watershed.

SPECIAL THANKS

Kyle Rennell, Bethany Shaffer, Morgen Weiant, Dustin Ballat, Derrick Watkins, Geisinger Health Systems, Susquehanna River Heartland Coalition for Environmental Studies, Susquehanna River Basin Commission, Jeff Stover, "Skip" Wieder, and the Degenstein Foundation.

Figure 5: Typical Marcellus Shale gravel road. Some common practices observed in the areas

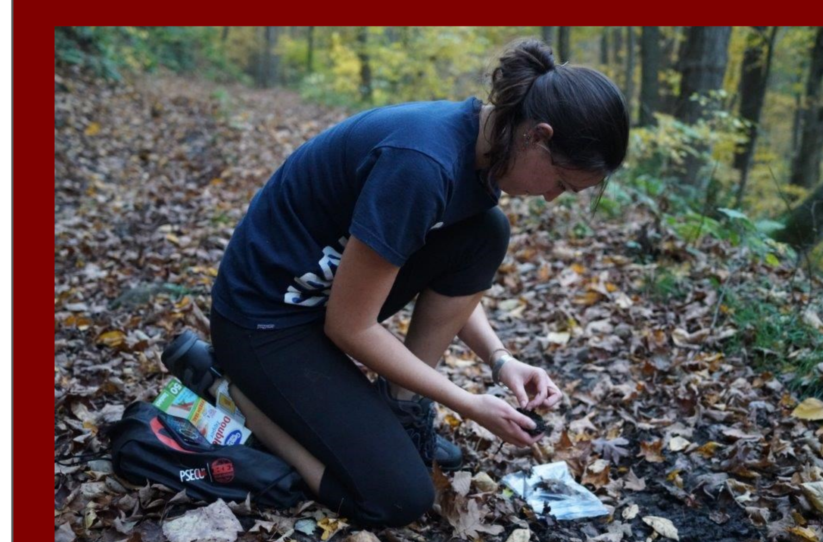


Figure 6: Rose collecting and documenting samples along Baker Run

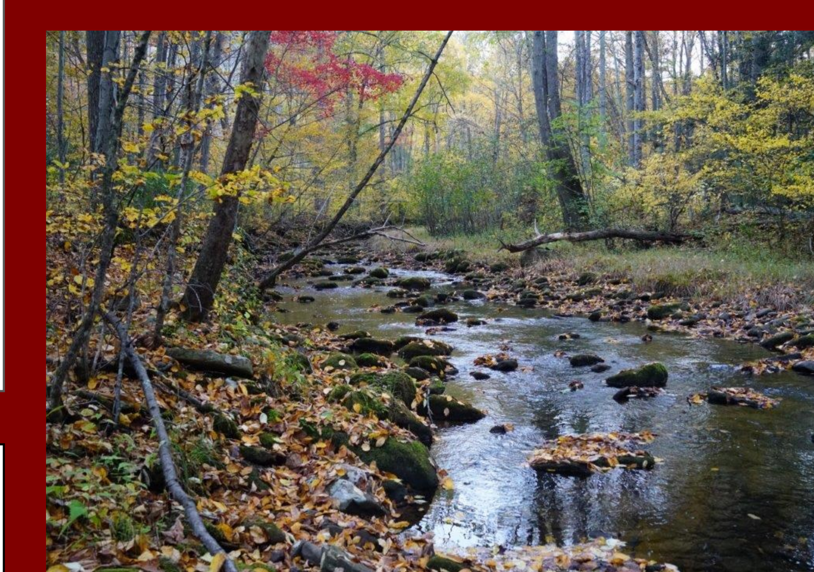


Figure 7: Baker Run Landscape