

# Metal Analysis as a Tool for Understanding Headwater Health and Stream Processes in the Southern Appalachian Coal Region

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## Introduction

Headwater streams play an important role in hydrological and biological cycles, yet the processes governing headwater streams are not well understood. These processes are particularly important because of the impact of mountaintop mining on water quality and sediment yield in the Southern Appalachian coal region. In order to better understand these headwater systems, this study investigated the role of metals in four watersheds located in the coal mining region of Southeastern Kentucky.

## Sample Sites

All sites are located in Letcher County, Kentucky and are headwater tributaries to the Line Fork of the Kentucky River. Sites chosen included a forested control, a site established prior to the Surface Mine Control and Reclamation Act of 1977 (SMCRA), a post-SMCRA site, and an active mining site.

## Major Comparisons

Water and sediment samples were drawn from the source, middle, and outlet of the stream. Organic carbon and nitrogen levels were observed in filterable solids and dissolved metals. Conductivity, pH, dissolved oxygen, and temperature were measured with a YSI 556 water probe.



## Methods

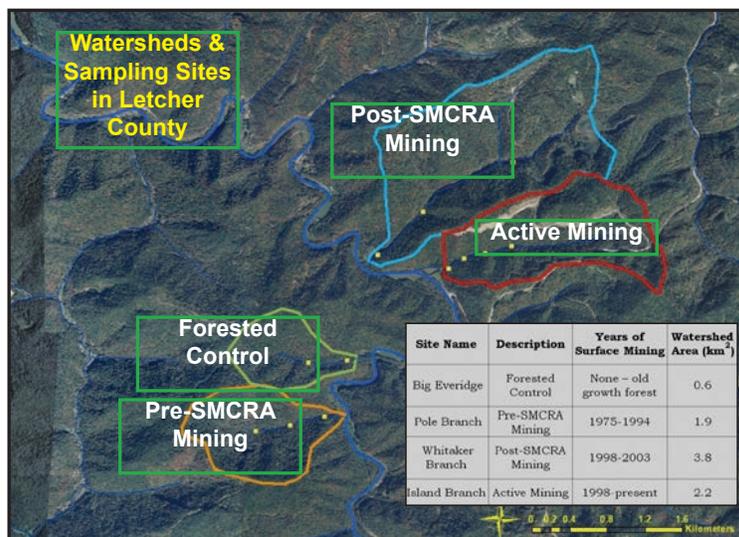
Sampling methods followed standards set by USEPA Method 1669. In low flow conditions, remobilization of the uppermost bed sediment was required. Bed sediment would be suspended in the next event. Samples were analyzed with inductively coupled plasma optical emission spectrometry (ICP-OES), according to standard procedures.

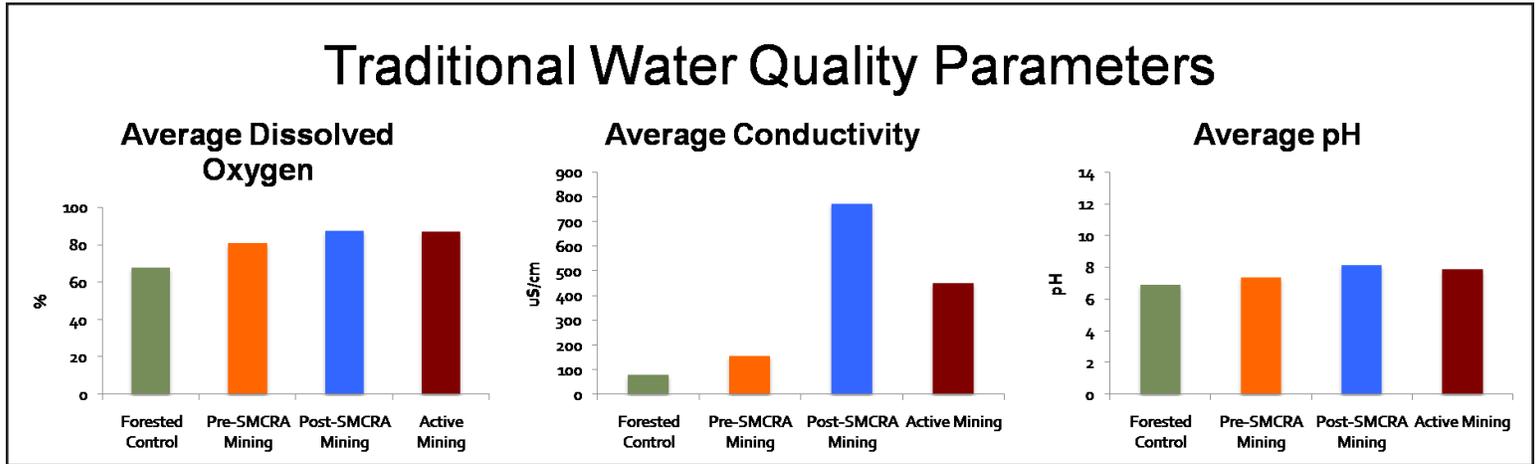
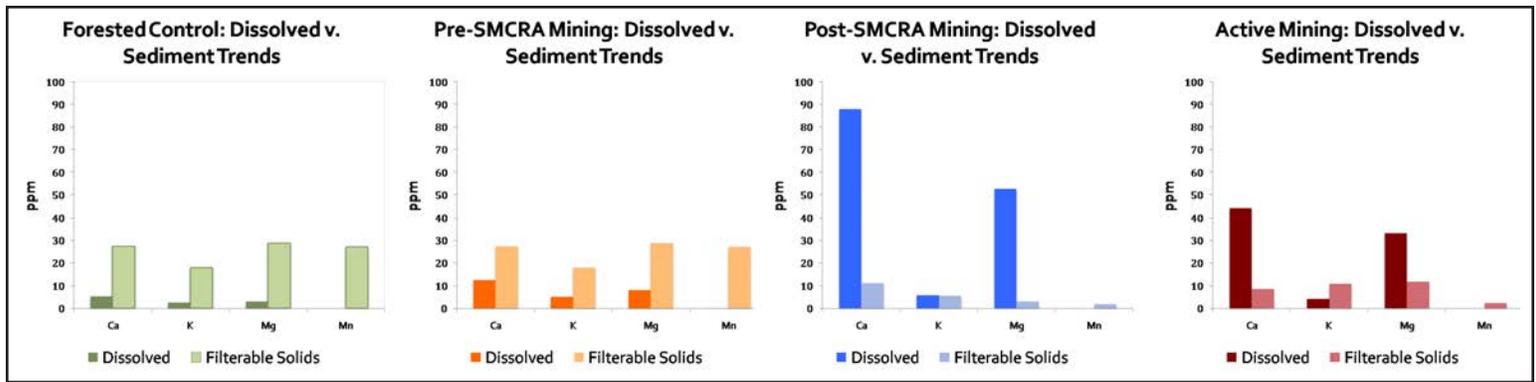
## Dissolved Metals

All sites passed USEPA drinking water quality standards and USEPA warm water aquatic life standards, although some maximum contaminant levels were below the instrument's detection limits.

## Filterable Solids

Sediment samples often had statistically different concentrations than filtered water, especially in the mining related watersheds.





Levels of Calcium (Ca), Potassium (K), Magnesium (Mg), and Manganese (Mn) in dissolved and filterable samples

## Conclusions

Both dissolved metals concentrations and sediment metals concentrations were high in the post-SMCRA and actively mined watersheds. The highest concentrations in water were in the post-SMCRA watershed, which was also the only watershed with significant residential activity. The control and pre-SMCRA watersheds both had low dissolved metals concentrations in the water, but the sediment concentrations remained high in the pre-SMCRA site. This suggests that some metals may flush out of the water column, but may remain in sediments at high levels for many years after reclamation.

A discriminant analysis was applied to a subset of elements in order to determine if there was a statistical difference between the four watersheds. When classifying the watersheds based on water and sediment samples, the program classified 77.3% correctly and determined the post-SMCRA to be the most different. With sediment samples alone, the program correctly classified 100% of the samples to the correct watershed. The pre-SMCRA site was identified as the most different while the active mining

and post-SMCRA sites were the most similar. With water samples alone, the program correctly classified 100% of the samples to the correct watershed. The control and the pre-SMCRA sites were found to be the most similar, and the active mining site to be the most different.

It appears mining related land use does impact headwater streams with respect to metals, but further study is necessary to determine if the differences may be correlated to time or land use.

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