Loading rates

Loading rates are calculated to determine the amount of pollutant coming from a specific sampling location based on the concentration of a given parameter and the flow discharge at that site. During storm events, loads are higher than during base flow conditions almost regardless of concentrations because of the large disparity in flows. For example, if nitrogen is 1.5 mg/l during base flow and the flow is 10 cfs, the loading is much less (80.8 lbs/day) than at the same site during a storm, which may have nitrogen concentration of 1.5 mg/l but at a flow of 400 cfs (3,234 lbs/day). Loading rates were calculated for each site for four major parameters of concern in the watershed: total aluminum, total iron, total nitrogen, and total phosphorus. During base flow sampling, discharge measurements were taken instream where there were no USGS gages. For stormflows, USGS gage flows were used to estimate flows based on drainage area for those sites that did not have gages. No loadings were calculated for tributaries since all three sites were sampled at locations where stream access was impossible during storm events and no instream flows could be measured.

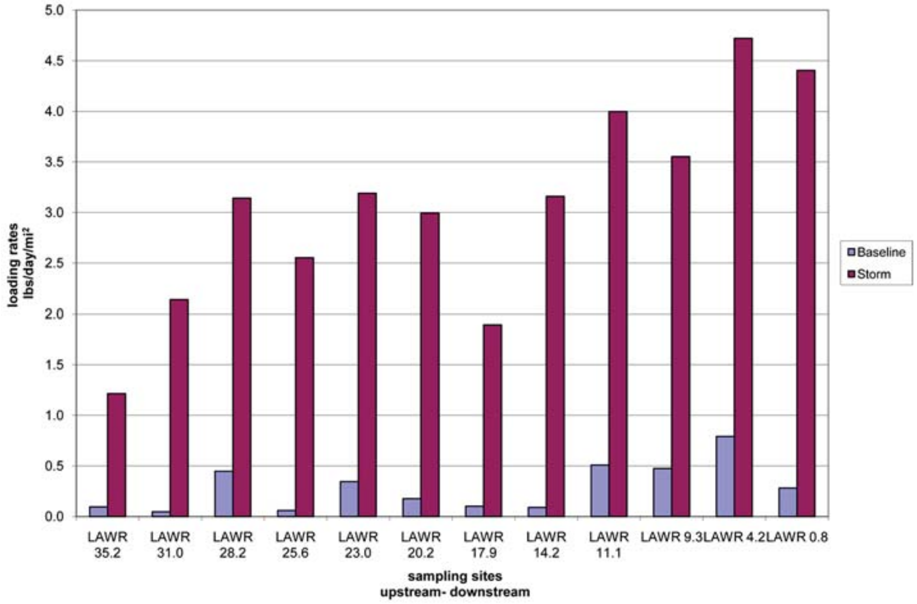


Figure 3. Total Phosphorus Loadings

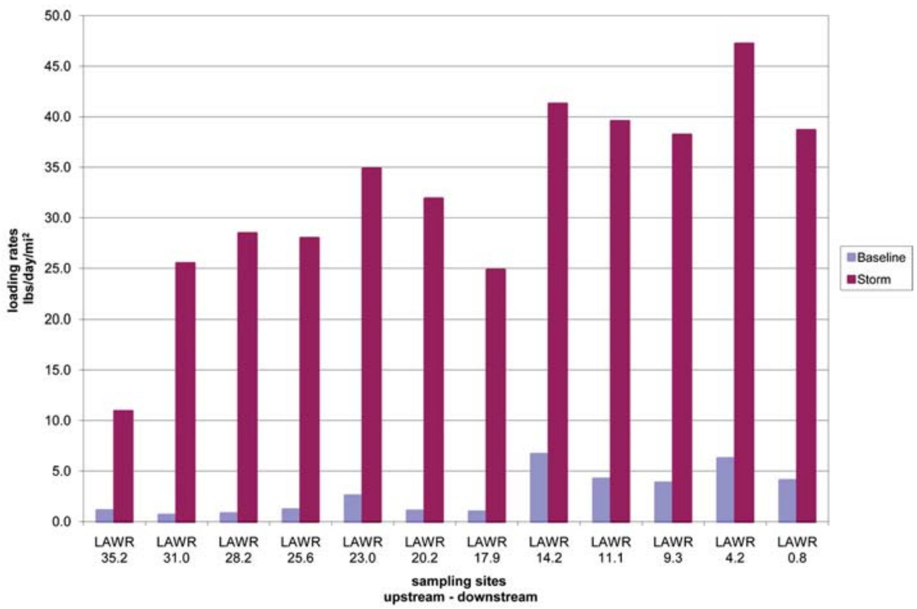


Figure 4. Total Nitrogen Loadings

During base flow, some parameters (primarily total aluminum) were reported by the lab to be below the detection limit. In situations where this occurred, the detection limit was used in the calculation to provide an estimate of loading rate for that parameter even though it likely resulted in high estimates for loadings during base flow. Loading rates are represented as pounds of the pollutant per day per square mile (lbs/day/mi_2) of drainage area at a specific site. This way, loading rates can be compared across sites, regardless of drainage size. These loading calculations only take into account one base flow sample and a maximum of three storm samples, so the results are admittedly based on a small sample size but still show the increased loading of pollutants during high flows in the Lackawanna River Watershed. This is not uncommon for urban areas but underscores the importance of stormwater management solutions, including CSO retrofitting.

Loading rates were calculated for each site for four major parameters of concern in the watershed: total aluminum, total iron, total nitrogen, and total phosphorus.

Along the mainstem Lackawanna River, the loading rates greatly increased during storms. As expected, the reference site (LAWR 35.2) showed the least amount of increase in loading rates for aluminum, iron, nitrogen, and phosphorus. This is expected because the site is located upstream of the urban development and CSOs and is located in a largely forested area. Figures 3-6 depict loading rates for these four parameters at each sampling site along the mainstem Lackawanna River for both base flow and stormflow. For phosphorus, loading rates were under 1.0 lbs/day/mi_2 for all sites during base flow. However, during stormflows, many of these loading rates increased by a factor of three to four. It also appears that there

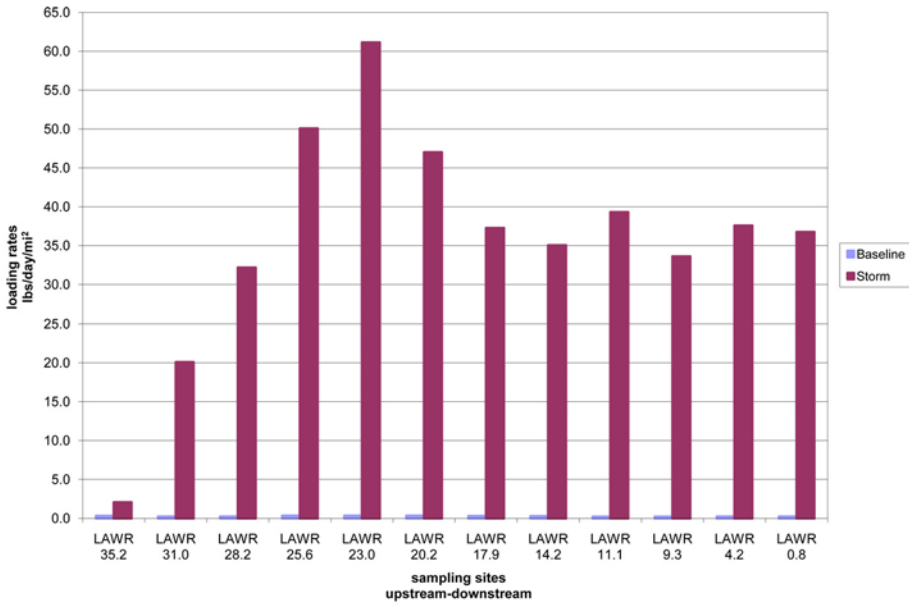


Figure 5. Total Aluminum Loadings

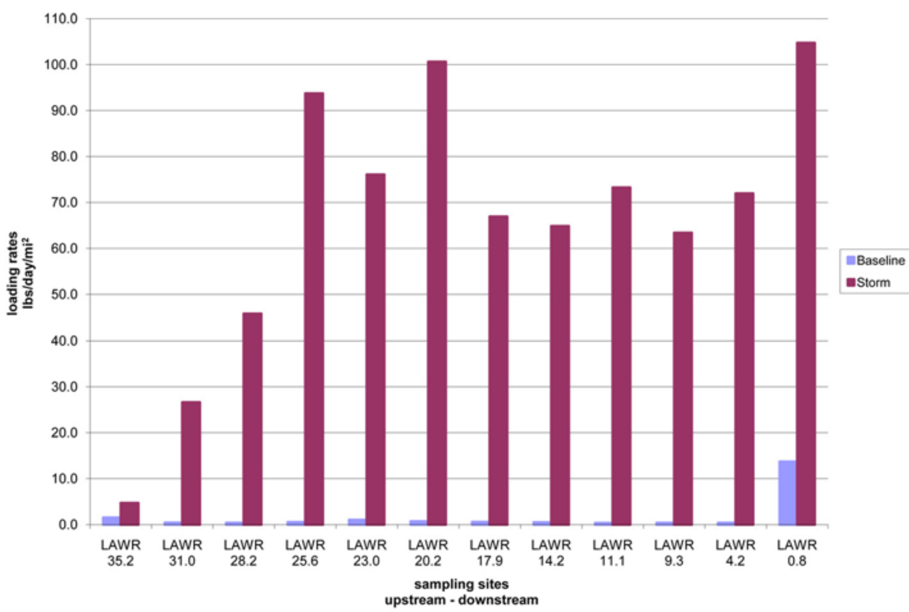


Figure 6. Total Iron Loadings

is more phosphorus addition per square mile in the lower end of the watershed, from the confluence of Leggetts Creek and downstream.

For nitrogen, a similar but larger trend prevails, with loading rates seven and eight times greater during stormflows and the higher loading rates per square mile occurring in the lower section of the watershed. Aluminum, however, had a very different pattern. Loading rates during base flow were very low with concentration values at most sites below the detection limit. During storms, the upper portion of the watershed, including those sites from Carbondale to Olyphant, had the highest increase in aluminum loading; in some cases, aluminum values were up to 60 times greater than in base flow conditions. Iron loadings were low as well during base flow, with the obvious exception of the lowest site (LAWR 0.8), which is downstream of the Old Forge borehole. Iron had a similar pattern as aluminum, with the same sites showing up to 100 times greater loading during stormflows.

YSI Continuous Data

Dataloggers were deployed for two weeks in April 2009 in Roaring Brook at Ash Street and in the Lackawanna River (LAWR 7.0) near Taylor to gather background information. This instrumentation collected a data reading every fifteen minutes for pH, temperature, dissolved oxygen, conductivity, and turbidity. During that time, a small storm event occurred and those data were useful in documenting continuous and instantaneous changes in field chemistry parameters. For the most part, results were expected at both these sites. At LAWR 7.0, dissolved oxygen concentrations followed a typical diurnal pattern, although during and directly following the rain event, the dissolved oxygen concentration was about 2 mg/l lower than during normal flows. This may be a result of the influx of organic wastes from CSOs and other stormwater conduits or a function of the higher water temperatures. Conductivity and pH were fairly constant throughout the two-week period, with both showing a slight decrease during the storm event. Temperature increased by 4 degrees Celsius (ºC) during the storm event, with the temperature staying between 11-13ºC during the storm. The average temperature for the rest of the two weeks was 7.5ºC. Turbidity was less than 10 NTU for a majority of the two-week period, but peaked at more than 1000 NTU during the storm event.

In Roaring Brook, results were similar. Dissolved oxygen showed less of a diurnal pattern but during the storm, there was an almost 2 mg/l drop in oxygen levels. Conductivity peaked during the storm and then went back to pre-storm levels, while pH remained between 7 and 7.5 during the entire two-week period. Water temperature during the storm was between 9-11ºC but averaged just 7ºC for the other non-storm days. Turbidity spiked during the storm, but Roaring Brook was much less turbid than the Lackawanna, as the highest turbidity measurement was recorded at just 27 NTU.

(continued on page 12)

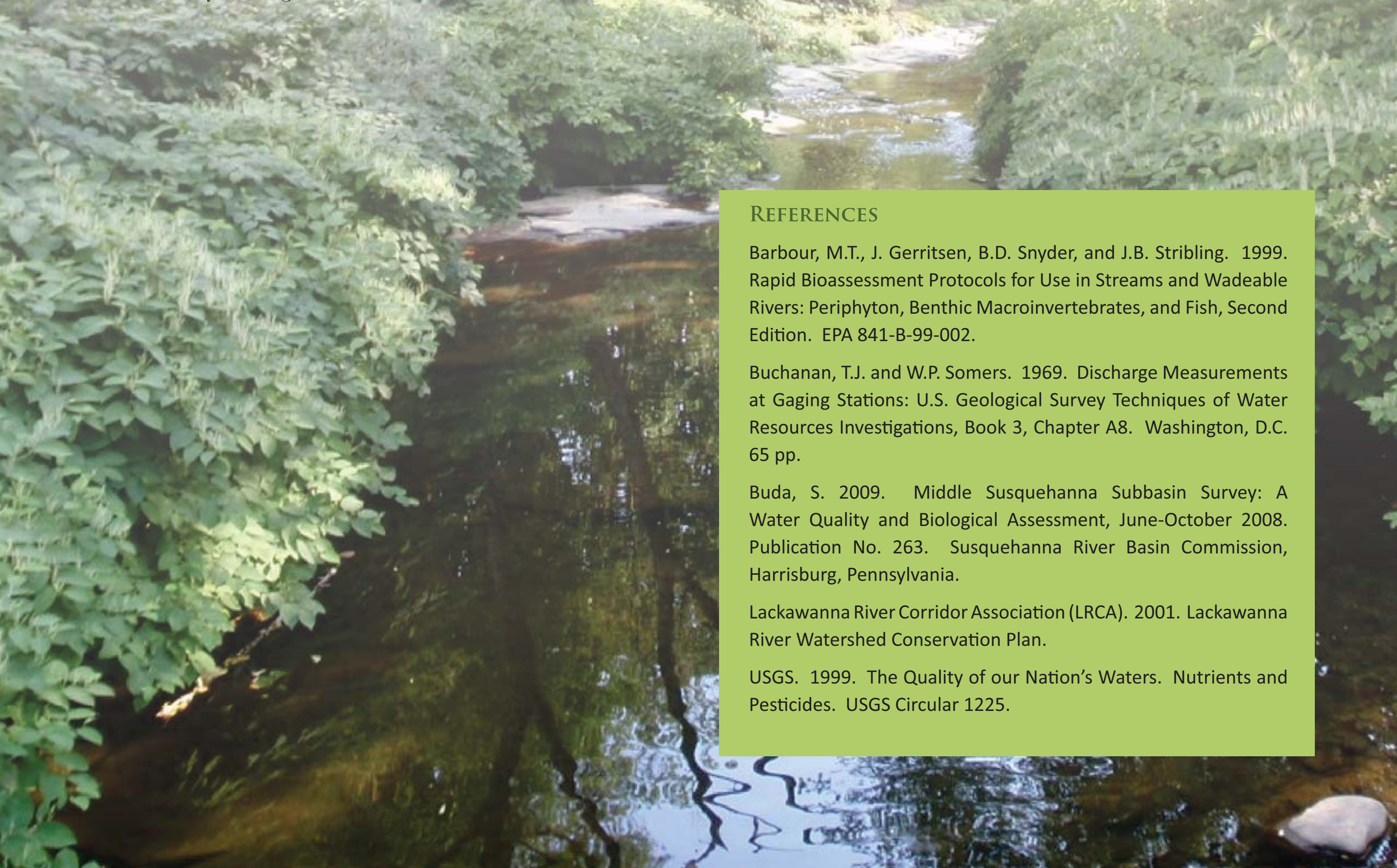
Dataloggers also were deployed at LAWR 7.0 prior to the December 2009 storm sampling. Data were logged every fifteen minutes from December 2-4, 2009. Water temperatures rose three degrees during the duration of the storm and turbidity increased more than a thousand fold. Using the USGS gage about three miles downstream as a guide, turbidity peaked just after the peak of the flow passed. Dissolved oxygen decreased by more than 2 mg/l during the peak of the stormflow. Conductivity peaked early in the storm but declined as flow increased, and pH remained constant throughout.

Additional SRBC Involvement in the Lackawanna River Watershed

Besides the Subbasin Survey program, SRBC also is involved in numerous other projects that include areas of the Lackawanna River Watershed. As part of SRBC's Remote Water Quality Monitoring Network (RWQMN), a continuous monitoring station was installed in the headwaters of the Lackawanna River near Forest City in 2010. The RWQMN was formed in response to the rise of Marcellus Shale natural gas drilling in the Susquehanna River Basin with the intention of developing baseline data and providing early and quick detection of any water quality threats stemming from the natural gas industry and other activities with the potential to cause adverse impacts to water quality. All remote stations record continuous data for pH, dissolved oxygen, conductance, temperature, and turbidity and upload the data directly to a web page. This web page can be accessed by clicking a link on SRBC's web site (www.srbc.net).

SRBC staff is also, under contract with PADEP, collecting water quality samples at select water supply intake locations throughout the Susquehanna basin to assist with determining if waterbodies are meeting the public water supply designated use. Within the Lackawanna River Watershed, eight samples are being collected from November 2009 through October 2010, just upstream of PA American's drinking water intake on the Lackawanna River near Forest City. The target parameters included color, nitrogen, chloride, sulfate, fluoride, arsenic, iron, and manganese.

One of the other prominent issues often associated with the Lackawanna River Watershed is AMD from past mining of the Anthracite Coal Region. Currently, SRBC staff is involved in numerous projects involving AMD monitoring and remediation. SRBC is working on the Anthracite AMD Remediation Strategy, which will allow staff to compile all water quality data from the past 20 years into one database and use it to prioritize AMD treatment projects. Of the top ten highest discharges, three are in the Lackawanna River Watershed. Moving forward, SRBC is coordinating with local agencies and groups, including the LRCA, to address these issues and begin restoration and remediation work.



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