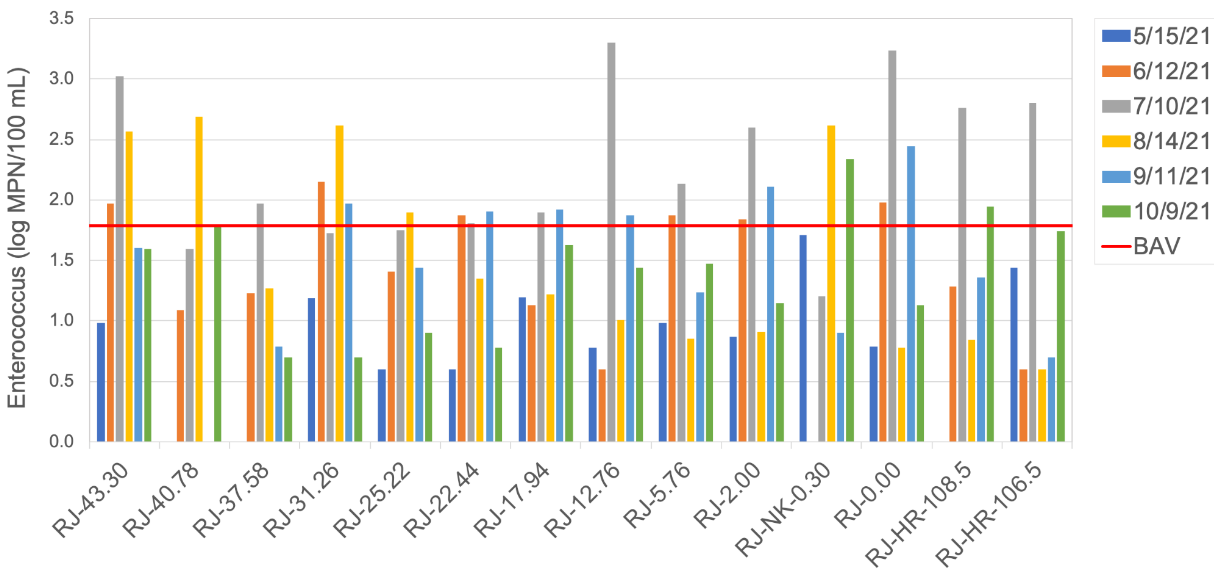
RJWC Water Quality Monitoring - 2021 Data Summary

A total of 84 samples were analyzed during the 2021 field season. Samples were collected monthly from May to October, by Roe Jan Watershed Community volunteers, at 14 sites. Conductivity and water temperature were measured at the time of sample collection. Staff and students in the Bard Community Science Lab (formerly known as the Bard Water Lab) determined Enterococcus counts (IDEXX Enterolert test) and turbidity in collected samples. Rainfall data was obtained from Weather Underground.

Enterococci

Enterococci are fecal indicator bacteria that indicate the possible contamination of waters by fecal waste. While enterococci are not harmful to humans, they indicate the possible presence of pathogenic bacteria, viruses, and protozoa. Of the 83 samples for which enterococcus counts were determined (Figure 1), 29 (i.e., 35%) were found to exceed the single sample threshold action value for bathing beaches (> 60 MPN/100 mL). Of these, 12 occurred during wet weather, identified as when total prior 4 day rainfall was greater than 0.25 inches. A significant rain event occurred prior to the July 10 sampling, during which 10 exceedances were observed. Based on personal weather station data, available at wunderground.com, approximately 4.5 to 6 inches of rain occurred from July 7-9 due to tropical storm Elsa. The most downstream sites also received significant rain (approximately 1.4 inches) of rain prior to the September 11 sampling (September 8-9).

Figure 1. Enterococcus counts in units of most probable number (MPN) per 100 mL (on a logarithmic scale) grouped by site and sampling date. The horizontal red line corresponds to the “beach action value” (on a log scale), based on a single sample threshold of > 60 MPN/100 mL.



Turbidity

Turbidity is an optical measurement of water clarity that reflects how much light is scattered due to the presence of suspended material. Sources of suspended particles can include soil erosion, runoff, effluent discharge, suspended sediments, or algal blooms. While some streams have naturally high levels of suspended solids, clear water is usually considered an indicator of healthy water. High levels of suspended solids will increase water temperatures and decrease dissolved oxygen levels(because warmer water cannot hold as much dissolved oxygen as colder water). High turbidity also reduces the amount of light that can reach aquatic plants, inhibiting photosynthesis.

Turbidity was higher during wet weather (when 19 samples were collected), ranging from 4.5 to 98.6 NTU across all sites. The average was 37.5 NTU during wet conditions compared to 5.6 NTU during dry weather (when the range was 1.8 to 23.1 NTU for 65 samples). Elevated turbidity levels were observed following the July storm, due to inputs of suspended material from stormwater runoff (Figure 2). Fecal indicator bacteria are often positively correlated with turbidity due to the association of bacteria with suspended sediments. While there is much scatter in the data (particularly at low turbidity), there is some evidence that enterococci are associated with the suspended material observed in the July samples with high turbidity (Figure 3).

Figure 2. Turbidity in nephelometric turbidity units (NTU) grouped by site and sampling date.

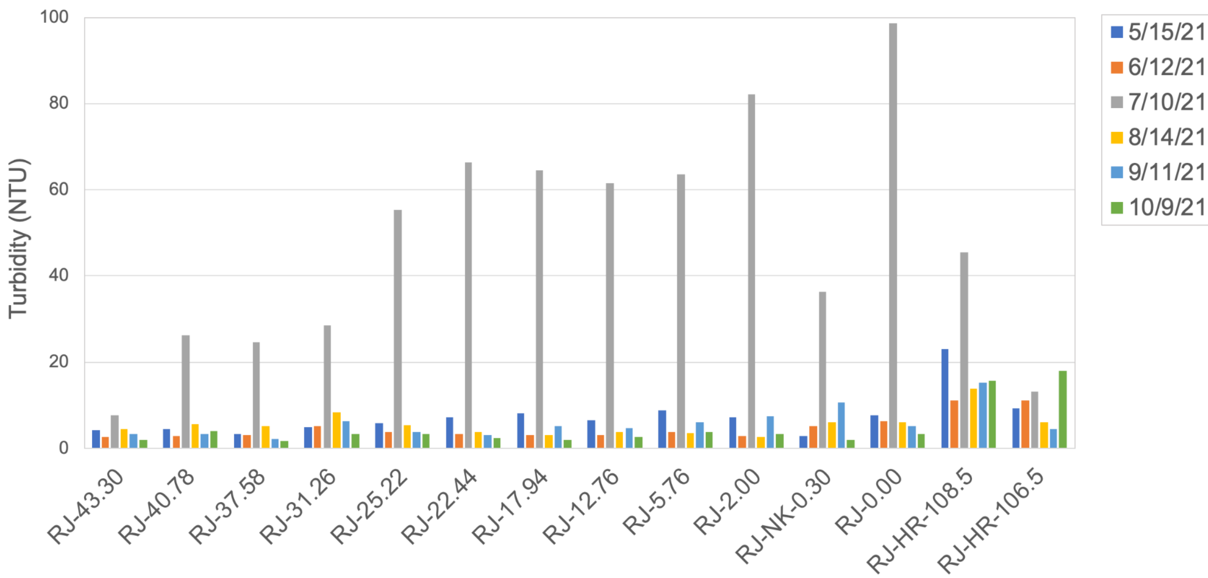
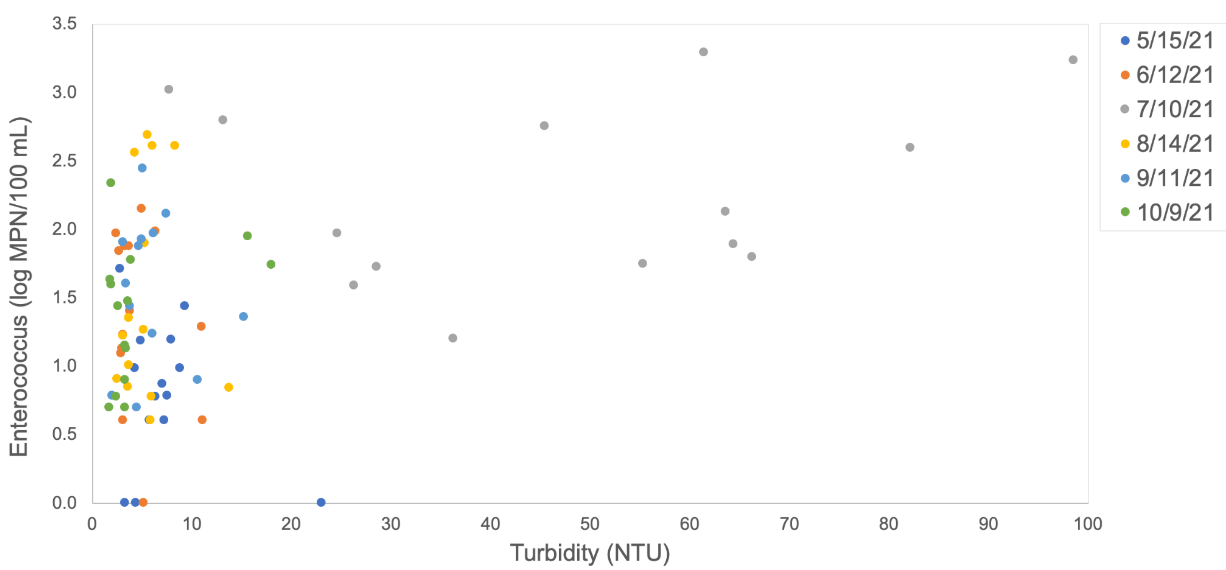


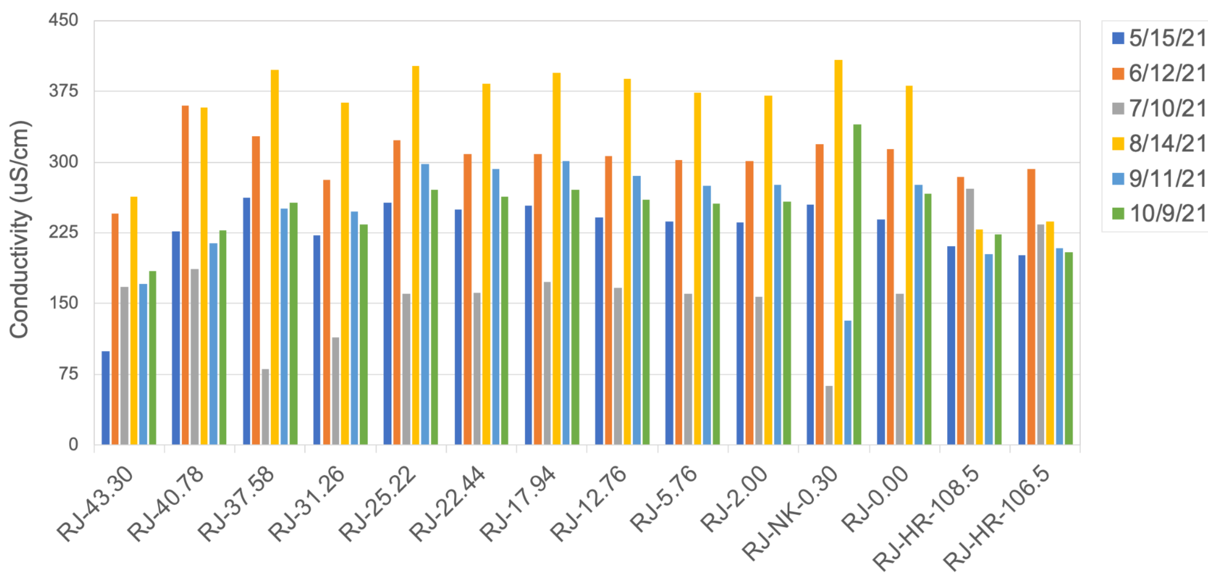
Figure 3. Enterococcus counts on a logarithmic scale as a function of turbidity.



<u>Conductivity</u>
Conductivity is a measure of the ability of water to pass an electrical current and is directly related to the concentration of inorganic ions (e.g., bicarbonate, sulfate, chloride, calcium, magnesium, sodium, potassium) dissolved in the water. Conductivity and the ionic composition of streams and rivers is affected primarily by the geology of the area through which the water flows. Conductivity is also influenced by streamflow and water temperature. As a result, each stream tends to have a relatively constant range of conductivity that, once established, can be used as a baseline against which changes due to a pollution source (e.g., leaking septic system, road salt) can be identified. There is no water quality standard for conductivity, but the concentration of total dissolved solids (standard is < 500 mg/L) can be estimated from measured conductivity using a conversion factor.

Conductivity (Figure 4) and total dissolved solids were lower during wet weather (ranging from 63 to 276 µS/cm; 50 to 214 mg/L) than when weather was dry (100 to 408 µS/cm; 89 to 295 mg/L). The average was 184 µS/cm (135 mg/L) during wet conditions compared to 279 µS/cm (210 mg/L) when there was no rain. Although streamflow was not measured, the decrease in conductivity observed following the July storm was likely largely due to dilution of the stream by rainwater. The ionic composition of water collected from four Roe Jan sites (RJ-40.78, RJ-37.58, RJ-17.94, and RJ-2.00) in May, July, and October was variable, with differences observed in the concentrations of the major cations (calcium, magnesium, sodium, and potassium) and anions (bicarbonate, sulfate, and chloride).

Figure 4. Conductivity in units of microsiemens per centimeter (µS/cm) grouped by site and sampling date.



In agreement with the conductivity data, concentrations of all major ions were lowest in July due to dilution by rainwater. However, when expressed as charge equivalents, the relative amounts of the ions are consistent for all the Roe Jan samples (Table 1). As expected due to the local geology, calcium is the dominant cation (53%) and bicarbonate is the dominant anion (76%). The Noster Kill shows the same dominant ions but the relative amounts were found to differ during dry and wet conditions. In July, following a major rain event, the relative amounts of sodium, chloride, and sulfate were higher than in October. This may reflect differences in the source water and/or other possible inputs to the tributary.

Table 1. Ion balances for the Roe Jan sites (average of data from sites RJ-40.78, RJ-37.58, RJ-17.94, RJ-2.00 sampled on 7/10/21 and 10/9/21) and the Noster Kill tributary site (RJ-NK-0.30) sampled 7/10/21 (wet conditions) and 10/9/21 (dry conditions). The sum of the charge of the negative anions balances the sum of the charge of the positive cations, resulting in an ion balance. The major ions are present at parts per million (ppm) levels.

Anions	**Percent**			**Cations**	**Percent**		
	RJ AVG	NK JULY	NK OCT		RJ AVG	NK JULY	NK OCT
Bicarbonate	76%	60%	83%	Calcium	53%	50%	53%
Sulfate	6%	14%	5%	Magnesium	26%	21%	34%
Chloride	18%	26%	12%	Sodium	20%	28%	12%
				Potassium	1%	1%	1%

Water quality standards[1] for the major ions (i.e., 250 ppm chloride, 250 ppm sulfate, 35 ppm magnesium, 1.5 ppm fluoride, and 2 ppm bromide) are health based and apply to drinking water sources (i.e., Class A waters). All analyzed samples met these standards. There are no standards for calcium, sodium, potassium, or bicarbonate.

Nutrients

Nitrogen and phosphorus are essential nutrients for aquatic organisms (e.g., plants, algae, fish, invertebrates). Water quality problems such as eutrophication, oxygen depletion, and (under certain conditions) harmful algal blooms can occur when nutrients are present in excess. Potential sources of nutrients include wastewater treatment effluent, leaking septic systems, and agricultural runoff (fertilizer and animal manure). Phosphorus is naturally present in rocks and soils.

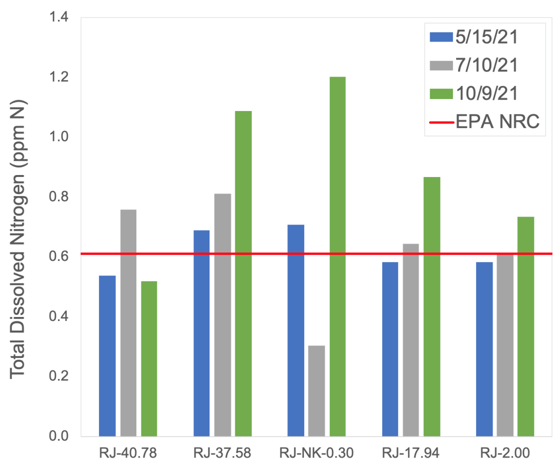
Total dissolved nitrogen (N) concentrations ranged from 0.3 to 1.2 ppm N (Figure 5). During dry conditions (5/10/21 and 10/9/21) the majority of nitrogen was present as nitrate. With the exception of site RJ-40.78, nitrogen concentrations were lower in July (following the storm) and nitrate accounted for roughly only half of the total nitrogen, with organic nitrogen associated with suspended sediments likely accounting for the rest. Nitrite concentrations ranged from 0.002 to 0.009 ppm nitrite as nitrogen (NO2-N) in all but one sample (RJ-37.58 collected on 10/9/21), in which 0.058 NO2-N was measured. The health-based nitrogen standards for drinking water sources[1] are 10 ppm nitrate as nitrogen (NO3-N), 1 ppm NO2-N, and 2 ppm ammonia as nitrogen (NH3-N). Generally, waters with less than 1 ppm NO3-N are considered to be unpolluted. The standard[1] to protect aquatic life is 0.02 ppm NO2-N for trout waters and 0.1 ppm NO2-N for warm water fishery waters. The EPA recommendation for ambient water quality nutrient criteria[2], which are ecoregion specific, is 0.61 ppm N for total nitrogen. With the exception of the October RJ-37.58 sample, observed nitrite levels meet the standard to protect trout waters. Based on total nitrogen, 9 of the 15 samples analyzed were found to exceed the recommended EPA criteria.

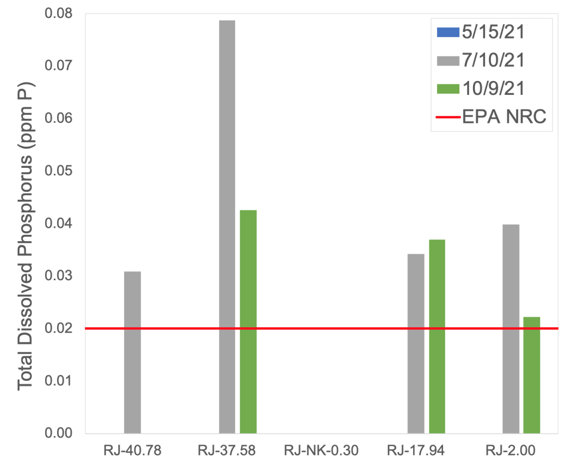
Total dissolved phosphorus (P) concentrations were found to range from < 0.02 (i.e., below detection) to 0.08 ppm P (Figure 5). The EPA recommendation[2] for total phosphorus in ambient waters is 0.02 ppm P and this level was exceeded in 7 of the 15 samples analyzed. Phosphate was only present in detectable levels at site RJ-37.58 on 7/10/21 and 10/9/21 (i.e., 0.05 and 0.03 ppm phosphate as P

[1] 6 CRR-NY 703.5
[2] https://www.epa.gov/sites/default/files/documents/rivers14.pdf

(PO4-P), respectively). Generally, waters with less than 0.01 ppm PO4-P are considered to be unpolluted and levels above 0.03 ppm PO4-P indicate pollution.

Figure 5. Nitrogen and phosphorus concentrations (in units of parts per million) grouped by site and sampling date. The horizontal red lines indicate the EPA nutrient criteria recommendation[2] for level III ecoregion 59 streams.





Trace Metals

Water quality standards[1] for most trace metals (i.e., 50 ppb arsenic, 5 ppb cadmium, 50 ppb chromium, 200 ppb copper, 200 ppb nickel, 50 ppb lead, 0.7 ppb mercury, 10 ppb selenium, 300 ppb iron, and 300 ppb manganese) are health based and apply to drinking water sources (i.e., Class A waters). The standards for aluminum (100 ppm) and zinc (variable) are based on aquatic life criteria. Levels of arsenic, mercury, lead, selenium, cadmium, aluminum, nickel, and zinc were below detection limits, typically < 2.5 ppb (but < 15 ppb in some cases due to instrument performance). One sample, RJ-40.78 contained 3.7 ppb copper. Iron and manganese were found at concentrations as high as 134 and 60 ppb, respectively (Figure 5).

Figure 5. Iron and manganese concentrations (in units of parts per billion) grouped by site and sampling date. These concentrations are well below the standards for drinking water sources (i.e., 300 ppb).