2020 NMWRRI STUDENT WATER RESEARCH GRANT
FINAL REPORT
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Title of Project: Water Quality Monitoring of the Upper Pecos River; Protecting the Pecos with Baseline Data

Problem Statement and Objectives:
The Upper Pecos watershed, part of the larger Rio Grande Basin, extends from the headwaters of the Pecos River in the Sangre de Cristo Mountains to the point where Interstate Highway 25 crosses the Pecos, below its confluences with Cow Creek and El Rito. The Upper Pecos River supports recreation, agriculture, cattle grazing, tourism, and other uses. It is hypothesized that increased usage of public and private lands is degrading the quality of the Upper Pecos River. Water quality data are not collected regularly throughout the watershed to gage the river's health nor to assess changes in quality over time. Baseline levels and trends for water quality of the Upper Pecos River must be established in order to assess the health of the Upper Pecos River and land use impacts.

This project established 5 monitoring sites at approximately equal distances along a 25 km stretch of the Upper Pecos River. Sites were selected to capture conditions above an historic mine site (Willow Creek), at the confluence of two tributaries from a proposed exploratory hard rock drilling site on Jones Hill (Indian Creek and Macho Creek), and at several high-use recreation areas (Terrero Village, Dalton Canyon, and Pecos Village). The project is collecting bi-weekly in-the-field physical-chemical data measurements, determining bi-weekly averages, and assessing trends over time to test the hypothesis that land usage is degrading Upper Pecos River quality. Knowing if and how land use is impacting water quality of the Upper Pecos River is imperative, as the quality of water in a system sets the basis for the rest of the ecosystem health. The data and interpretations will be shared with the Upper Pecos Watershed Association to inform their restoration activities. This study will enable the NMHU student researcher to obtain the relevant data required to assess overall conditions of the Upper Pecos River over the 2020-2021 study year. The project aims to be an impactful and meaningful learning experience for the student and important and necessary water management tool for the Pecos community.

Methods

The physical attributes that are being collected include: temperature, dissolved oxygen specific conductance, pH, and turbidity. Temperature impacts both the chemical and biological characteristics of surface water. It affects the dissolved oxygen level in the water, photosynthesis of aquatic plants, metabolic rates of aquatic organisms, and the sensitivity of these organisms to perturbations in the system. Dissolved oxygen is essential for aquatic organisms and is limited by physical conditions, such as temperature. Assuming a constant atmospheric pressure, cooler waters hold more dissolved oxygen than warmer waters. Specific conductance is the ability of water to carry an electrical current. It is an indirect measure of the presence of dissolved chemicals in the water. A measure of dissolved H^+ ions is the pH value, which is defined as the negative $\log_{10}$ of the hydrogen ion concentration. How much a water's pH value deviates from 7 can tell you how acidic (< 7) or basic (>7) the water solution is. Some streams are naturally acidic or basic, depending on the geology and vegetation cover. However, a change in stream water pH can indicate point source pollution. Turbidity is a measure of water clarity. The higher the turbidity, the higher the degree of light scattering by suspended solids like mud, algae, and detritus. Factors that influence turbidity include soil erosion, algal blooms, and stirred sediments. The higher the turbidity, the lower the penetration of sunlight, amount of photosynthesis, and oxygen availability.

These parameters are being measured in the field using a Multiparameter Water Meter. Data are gathered three times during each monitoring visit and averages calculated. Two water samples are also being collected per site during each monitoring visit for measuring turbidity using a Hach TL2300 turbidimeter purchased in Fall 2019 through New Mexico Water Resources Research Institute funds (awarded to Johnson Adio). Turbidity is particularly important, as local streams have been found to be impaired for turbidity. Data are being tabulated, averaged, and graphed. Amounts and trends over the project period will be used to establish baseline conditions and assess whether the Upper Pecos River is meeting the water quality standards for its designated uses – domestic water supply, fish culture, high-quality cold-water aquatic life, irrigation, livestock watering, wildlife habitat and primary contact, and public water supply.

Monitoring sites include:
UPR1: Upper Pecos River at the Village of Pecos;
UPR2: Upper Pecos River at the Upper Dalton Fishing Access Fishing Site;
UPR3: Upper Pecos River at El Macho bridge;
UPR4: Upper Pecos River at Holy Ghost Creek confluence; and
UPR5: Upper Pecos River above the Willow Creek mine reclamation site.

Results

The data collected during this on-going 16+ month water quality monitoring from the end of February 2020 to the beginning of July 2021 suggest that the Upper Pecos River is in good health and that the measured parameters are mostly within range for its domestic water supply, fish culture, high-quality cold-water aquatic life, and other designated uses.

Turbidity, a measure of the relative clarity of a water sample, "shall not exceed 10 NTU over background turbidity" (New Mexico Administrative Code 20.6.4.900). Turbidity is measured in NTU: Nephelometric Turbidity Units by a turbidimeter or nephelometer, which measures the intensity of light scattered at 90 degrees as a beam of light passes through a water sample.

Figure 1 is a composite of turbidity data collected biweekly at sites 1-5 throughout this NMWRRI project period (June 2020 through July 2021) and includes sampling dates prior to the project initiation (February 28, 2020, through May 21, 2020). Site UPR 5 (above Willow Creek) is the furthest upstream and highest elevation site whereas UPR 1 (Pecos Village) is the furthest downstream and lowest elevation site.

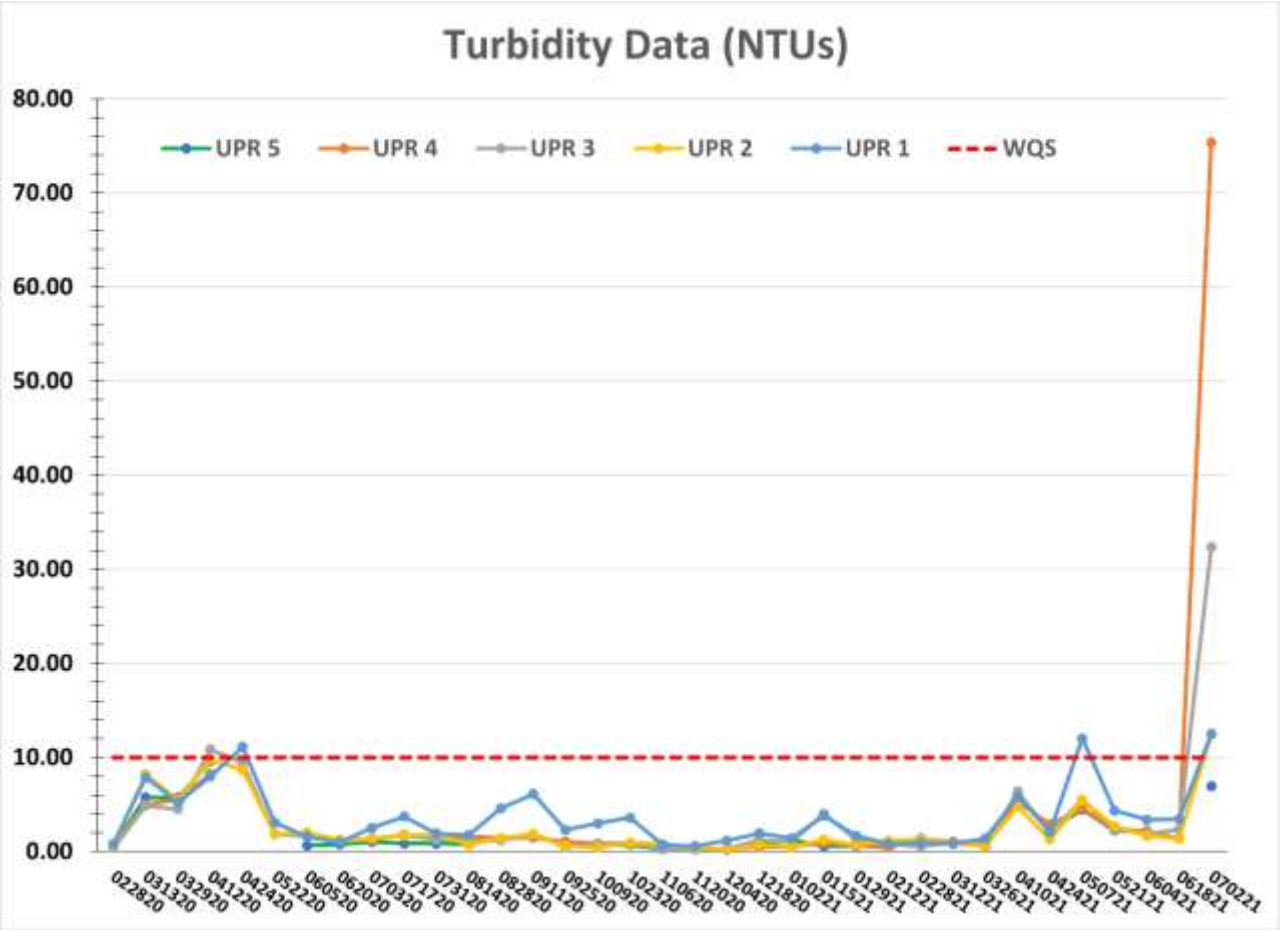

Figure 1: Turbidity data for the Upper Pecos River; February 2020 through July 2021. Red dash line indicates New Mexico Administrative Code 20.6.4.900 water quality threshold.

Out of one hundred and seventy-five reported turbidity values only seven were above the 10 NTU threshold. Within the year of 2020, site UPR3 had a turbidity value of 10.85 NTU on 04/12/20 and site UPR1 had a turbidity value of 11.10 NTU on 04/24/20. Both "exceedances" were only slightly above the 10 NTU water quality threshold and correspond with spring runoff and high discharge.

The following year of 2021, site UPR 1 had a turbidity value of 12.0 NTU on 05/07/21 marking the first exceedance of the 2021 year being sampled and measured. On 07/02/21, sites UPR 1-4 ranged from 12 NTU at site 1 to the highest turbidity value of 75.35 NTU at Site UPR 4. The high turbidity values on 07/02/21 are likely the result of high discharge in the Upper Pecos River (>190 cfs relative to the historic average of 90 cfs at USGS gauging station 08378500 on the Pecos River

near Pecos Village. UPR 4, in particular, is at the confluence of Holy Ghost Creek with the Upper Pecos River and saw high discharge and associated high sediment runoff.

Temperature, that impacts both the chemical and biological characteristics of surface water, "shall not exceed temperature of 68°F, or with an absolute maximum temperature of 73°F for four or more consecutive hours in a 24-hour period on more than three consecutive days" (New Mexico Administrative Code 20.6.4.900).

Figure 2 is a composite of temperature data collected biweekly at sites 1-5 throughout this NMWRRI project period (June 2020 through July 2021) and includes sampling dates prior to the project initiation (February 28, 2020, through May 21, 2020).

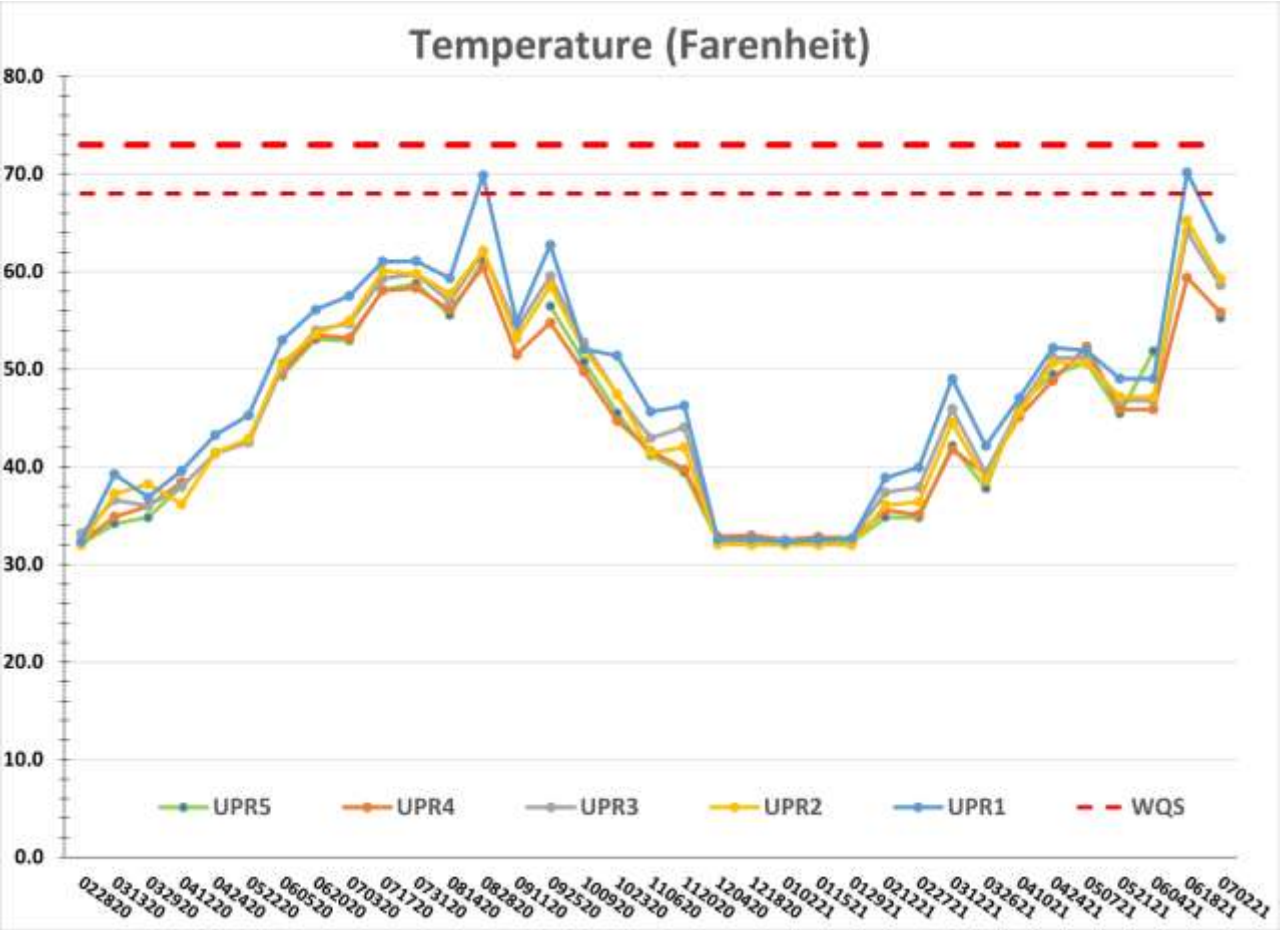

Figure 2: Temperature data for the Upper Pecos River; February 2020 through July 2021. Red dash line indicates temperature threshold.

Generally, for the year of 2020, the recorded temperature increased from upstream (site UPR 5) to downstream sites (UPR 1). The Upper Pecos River saw temperature highs during the during the summer months with a high at the end of August and drop in early September during an early snowfall. During the winter months, the river temperature was at or below freezing of 32°F where temperature increased with spring 2021 temperatures. Site UPR 1 was the only site with two

temperature exceedances on 08/28/20 and 06/18/21 with a temperature slightly above the threshold of 70°F.

Dissolved Oxygen, an essential component for aquatic organisms "shall be ≥6.0 mg/L" (New Mexico Administrative Code 20.6.4.900).

Figure 3 is a composite of dissolved oxygen data collected biweekly at sites 1-5 throughout this NMWRRI project period (June 2020 through July 2021) and includes sampling dates prior to the project initiation (February 28, 2020, through May 21, 2020).

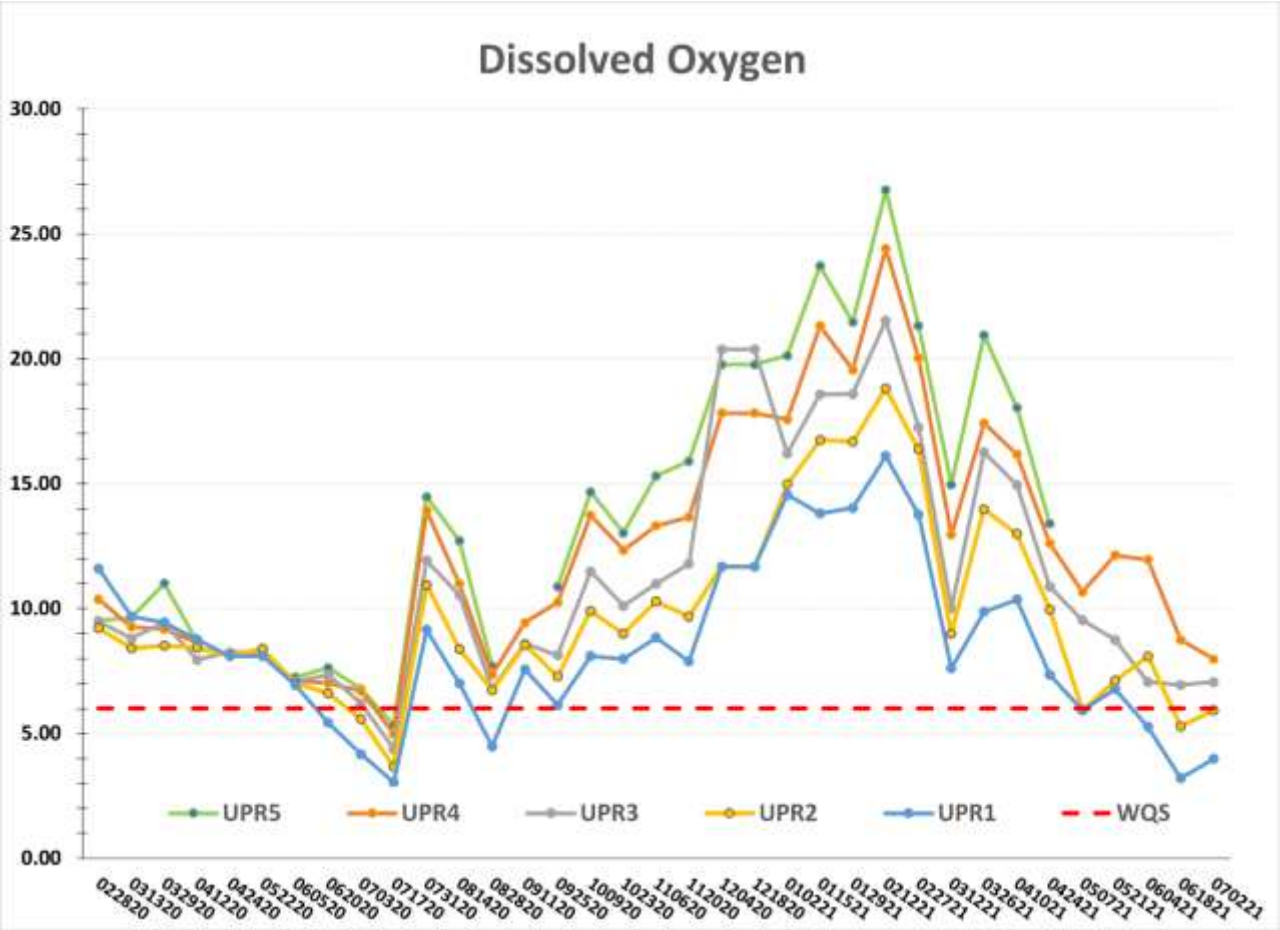

Figure 3: Dissolved oxygen data for the Upper Pecos River; February 2020 through July 2021. Red dash line indicates dissolve oxygen threshold be ≥6.0 mg/L.

The recorded dissolved oxygen values generally decreased downstream from site UPR 5 to site UPR 1 from February 2020 through July 2020 , mimicking warm trends. Levels steadily increased during fall and winter months. On February 12, 2021 levels dropped due to a change of increased temperature for the beginning of the 2021 year. Overall, dissolved oxygen exhibits a correlation with temperature where cooler waters hold more dissolved oxygen than warmer waters.

From June 20, 2020-July 17, 2020 site UPR 1 was below the dissolved oxygen water quality standard (WQS) with a range of 3.0-5.42 mg/L. On July 3, 2020, site UPR 2 was below the WQS

at 5.58 mg/L. Then on July 17, 2020, all UPR Sites were below the water quality threshold with a range upstream at site UPR 5 of 5.34 mg/L downstream to site UPR 1 of 3.04mg/L. Lastly, on August 28, 2020 site UPR 1 was below the threshold at 4.48 mg/L.

For the year of 2021, site UPR 1 was slightly below the threshold of 6.0 mg/L. Then from 06/04/21 through July 02, 2021, site UPR 1 was consistently below the WQS ranging from 3.21- 5.26 mg/L.

Electrical conductivity, an indirect measure of the presence of dissolved chemicals in the water, "shall not exceed 300µS/cm" (New Mexico Administrative Code 20.6.4.900).

Figure 4 is a composite of electrical conductivity data collected biweekly at sites 1-5 throughout this NMWRRI project period (June 2020 through July 2021) and includes sampling dates prior to the project initiation (February 28, 2020, through May 21, 2020).

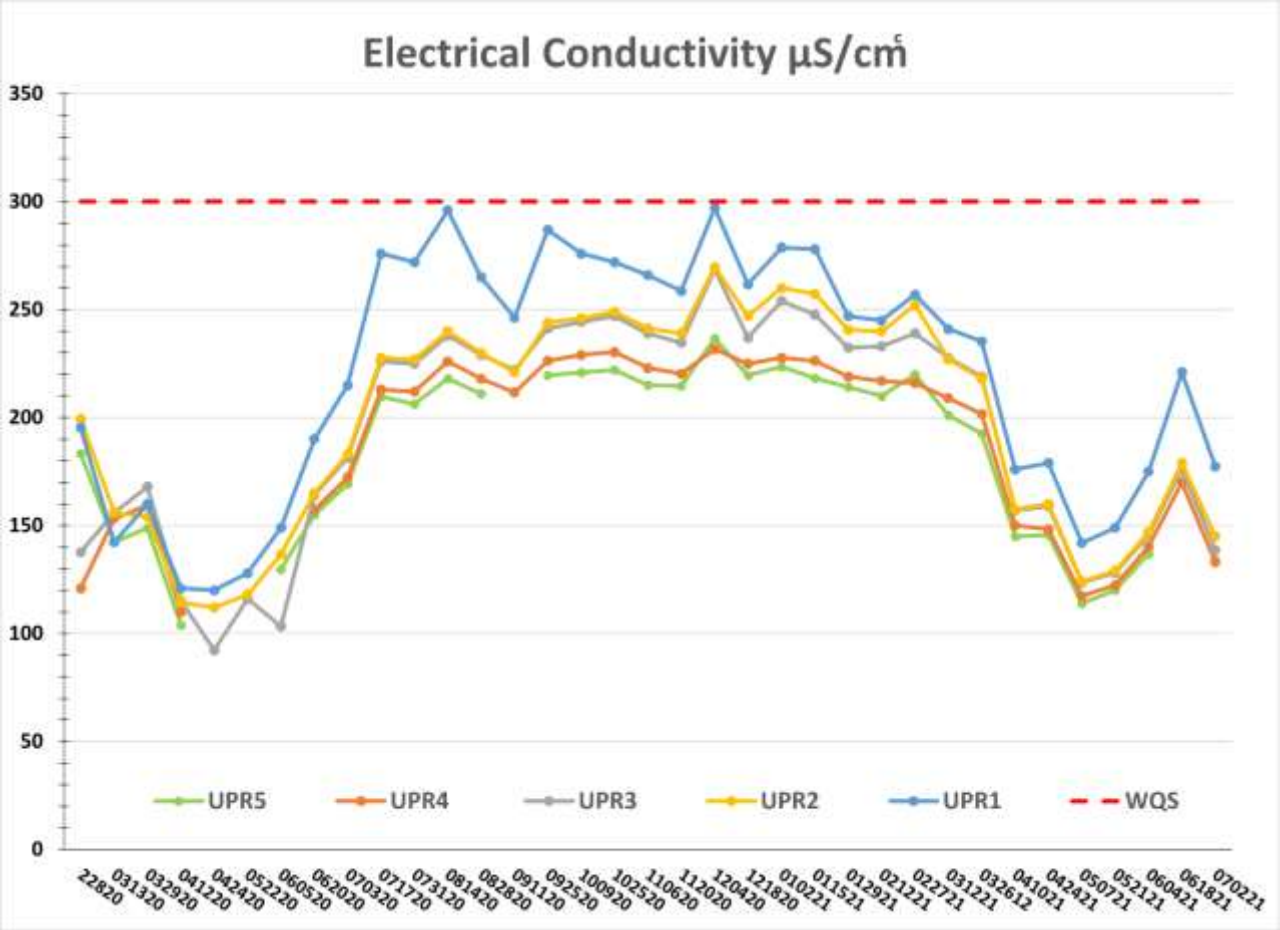

Figure 4: Electrical conductivity data for the Upper Pecos River; February 2020 through July 2021. Red dash line indicates electrical conductivity not to exceed 300µS/cm.

All electrical conductivity values for the project period fell below the 300 µS/cm water quality standard throughout the monitoring period. Electrical conductivity values were relatively low (<150 µS/cm) during the spring runoff (April-May 2020) and relatively high (>200 µS/cm)) during low flows.

pH, a measure of dissolved H^+ ions is the pH value which can tell you how acidic (< 7) or basic (>7) a water solution must be "within range of 6.6 to 8.8," (New Mexico Administrative Code 20.6.4.900).

Figure 5 is a composite of pH data collected biweekly at sites 1-5 throughout this NMWRRI project period (June 2020 through July 2021) and includes sampling dates prior to the project initiation (February 28, 2020, through May 21, 2020).

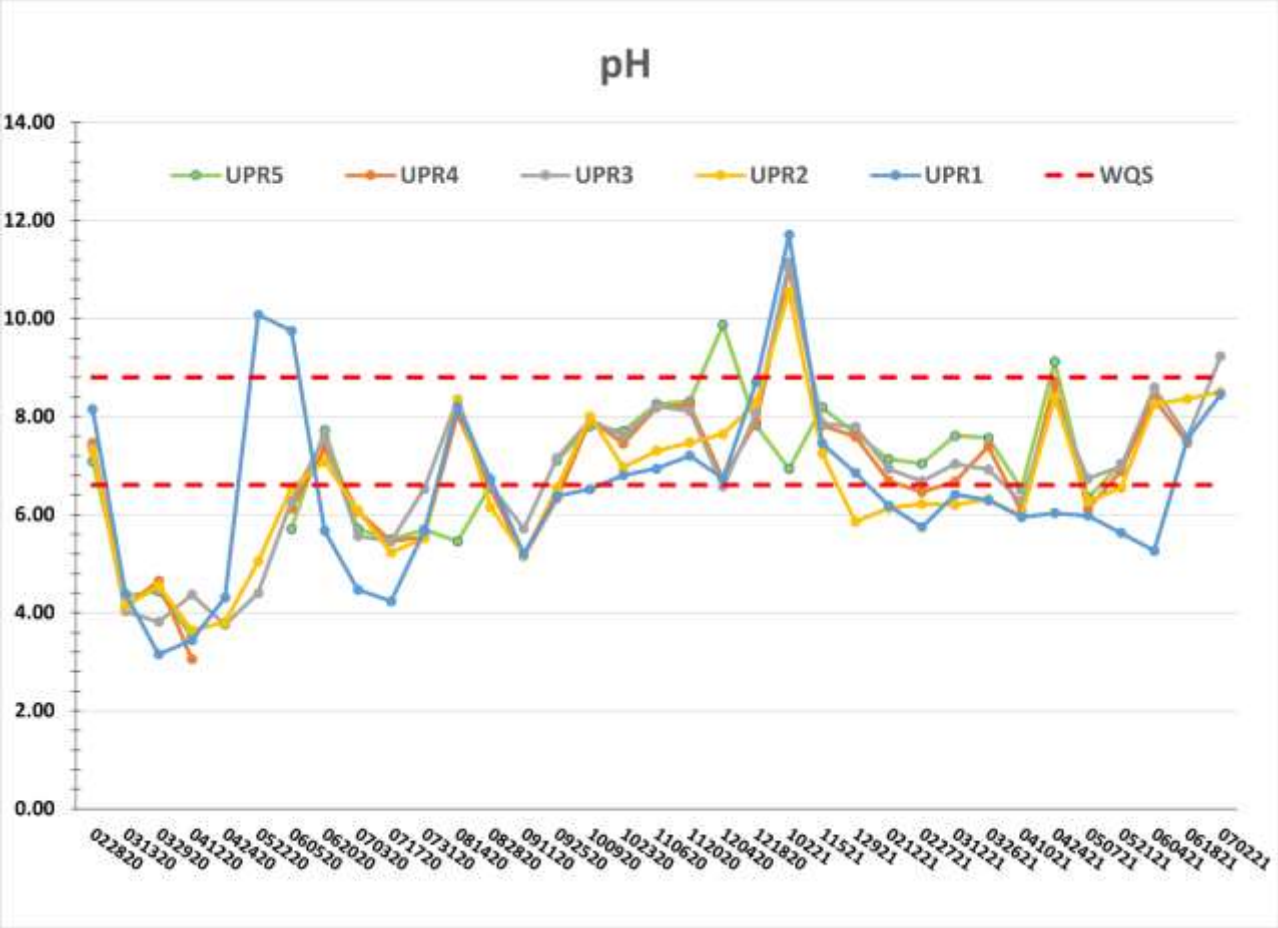

Figure 5: pH data for the Upper Pecos River; February 2020 through July 2021. Red dash line indicates pH must be within range of 6.6 to 8.8.

Measured pH values were highly variable during the monitoring period and often out of the 6.6-8.8 WQS range. These pH variations do not directly correlate with location or season. On most days, pH increased downstream from site UPR 5 to site UPR1 possibly reflecting input from the natural sulfide-bearing bedrock and historic mine workings.

Future work includes downloading discharge data from USGS gauging station 08378500 on the Pecos River near Pecos for the project period. The project data (turbidity, temperature, dissolved oxygen, electrical conductivity, and pH) will then be compared to discharge data to test whether a correlation exists between the water quality and stream flow.

Project Beneficiaries

The Upper Pecos Watershed Association (UPWA) is the main group to whom the results will be provided. These data will assist UPWA on their efforts to identify point and non-point source pollution and to protect, restore, and maintain the health of the Upper Pecos Watershed.

Grant Funds

All grant funds have been encumbered or expended. The project supported the purchase of a multiparameter water meter as well as field travel for the student in accordance with budget award.

Presentations

- Presented virtually for the 2021 New Mexico Geological Society spring meeting on April 15, 2021.
- Presented virtually with for the Upper Pecos Watershed Association Board Meeting on February 11th, 2021.
- Presented virtually for the Pecos Hydrology Workgroup on January 28th, 2021.
- Presented an ePoster virtually with at the NM WRRI Conference on October 29, 2020
- An abstract of the research was published in the 17th Annual New Mexico Highlands University Faculty and Student Research and Creative Showcase Day Programs.

Publications

No publications or reports are being prepared at the moment.

Participants

The names listed below are students and faculty who have contributed and assisted to the research project:

- Jennifer Lindline, Ph.D. (NMHU Faculty Sponsor)
- Letisha Mailboy (NMHU Undergraduate Student Project Investigator)
- Daryl Williams (NMHU Waters Resources Laboratory Manager)
- Kate Diem (NMHU Undergraduate Student Project Investigator)
- Ezekial Tapia (NMHU Undergraduate Student Project Investigator)

Awards or Notable Achievements

Special recognition for this grant award was given by:
New Mexico Highlands University; July 22, 2020
Geology Students Win Grants for Pecos River Water Quality Research
https://www.nmhu.edu/geology-students-win-grants-for-pecos-river-water-quality-research/

The Albuquerque Journal; August 2, 2020
NMHU students win grants for water research
https://www.abqjournal.com/1481598/nmhu-students-win-grants-for-water-research-ex-navajo-heritage-inspired-them-to-pursue-the-project.html

The SIPI Board of Regents Blog; September 22, 2020
SIPI Grads Doing Great Things
https://sipibor.com/blog/article/sipi-grads-doing-great-things-at-nmhu

Information on Degree Completion and Future Career Plans

The student researcher will graduate in in December 2021 with a B.S in Environmental Geology. Future career plans consist of working with the Navajo Nation in their Water Resources Department or continuing education at the University of New Mexico in water studies for Master of Science degree.