

Report for 2002WV6B: WRI47-Establishing Biological and Water Quality Criteria for Water Resource Management in Mining Impacted Watersheds

There are no reported publications resulting from this project.

Report Follows:

WRI47

**ESTABLISHING BIOLOGICAL AND WATER QUALITY CRITERIA IN THE CHEAT
RIVER WATERSHED**

ANNUAL REPORT
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1. SYNOPSIS OF RESEARCH COMPLETED TO DATE

Introduction:

The overriding objective of this research is to develop an empirical model that can be used to predict stream biological condition as a function of specific water chemistry characteristics. The basic structure of the model is as follows:

$$\text{Stream Condition} = f(\text{interaction of a suite of water chemistry constituents}) + f(\text{temporal variability of the constituents})$$

This research focuses on developing a model for the lower Cheat River basin, and as such, focuses on chemical constituents associated with acid mine drainage (AMD). Our hope is that such a model can be used to predict changes in the overall ecological condition of the watershed as a function of changes in water quality resulting from AMD remediation efforts. Furthermore, we expect that such a model can be used to assess the relative ecological benefits of specific trades under a pollutant-trading framework.

Research Tasks:

The overall research design is divided into three separate research tasks.

Task 1: Water Quality Sampling and Analysis

Task 2: Benthic Invertebrate Sampling and Analysis

Task 3: Statistical Analysis of Data and Model Development

Over the past year we have completed Task 1 and initiated Tasks 2 and 3. The second year of this project will be devoted towards completing Tasks 2 and 3 and integrating results from all three tasks. Because Task 3 was the only task completed this year, I will discuss the results of this task in detail.

Results of Task 1 – Water Quality Sampling and Analysis:

Task 1 can be divided into two subtasks. Subtask 1.1 represented the regular, periodic sampling of 35 different stream reaches distributed throughout the lower Cheat River basin. Regular sampling of surface water chemistry and discharge at these locations in the lower Cheat River basin was initiated June 1, 2002. Water samples were obtained over a 3-day period every 3 weeks (total of 3 samples at each station have been taken to date). Water samples were taken to Black Rock labs in Sabraton, WV for analysis. The following parameters were determined: pH, conductivity, dissolved oxygen, alkalinity, hardness, total dissolved Al, total dissolved Fe, Mn, Cd, Cr, Ni, acidity, and sulfate. Water sampling was completed the week of May 21, 2003 giving a full year of regular water chemistry sampling (15 separate samples taken at each of the 35 locations). The water quality lab is still generating data from these samples. Table 1 gives mean values of each measured parameter from samples taken up through April 1, 2003.

Subtask 1.2 represented a more comprehensive sweep of surface water samples taken at a total of 80 stream reaches (35 of which were the reaches described above). Samples from these stations were obtained on each of two separate dates (late August 2002 and early April 2003). These samples were taken to represent low baseflow and moderate to high baseflow conditions). The same water chemistry parameters listed above were estimated for each stream reach on each date. In addition to the above parameters, we measured Selenium concentrations at each site on these two dates.

The primary objective of Task 1.1 was to quantify temporal variability in water quality conditions in stream reaches throughout the lower Cheat River basin. We were especially interested in temporal changes in trace metal concentrations in “moderately impaired” stream segments. Moderately impaired streams are those with pH ranging from 4.5 to 6.5 and manganese concentrations ranging from 0.2 to 4 mg/L. The primary objective of Task 1.2 was to quantify stream-to-stream variability in water quality conditions, again with an emphasis on variation in trace metal concentrations among moderately impaired streams. Combined, results from these subtasks will be used to relate spatio-temporal variability in water quality to specific levels of biological degradation.

Progress on Task 2 – Benthic Invertebrate Sampling and Analysis:

Benthic invertebrate sampling was completed May 24, 2003. Samples were obtained following West Virginia Department of Environmental Protection Standard Operating Procedures at each of the 80 study reaches (35 regularly sampled reaches plus 45 additional sites visited on two separate occasions). WV DEP procedures also will be used to analyze the samples in the lab over the next 3-4 months.

2. PUBLICATIONS DURING THE REPORTING PERIOD

None

3. INFORMATION TRANSFER ACTIVITIES DURING THE REPORTING PERIOD

Three separate seminars were given on the topic of water quality trading and how biological communities can be used to quantify trades at the scale of an entire watershed. All of these seminars were presented to participants in the Cheat Water Quality Trading Stakeholder Group.

4. SUMMARY OF THE NUMBER OF STUDENTS SUPPORTED

Category	USGS WRI Award	NIWR-USGS Internship	Supplemental Awards	Total
Undergrad	2	0	3	5
M.S.	0	0	1	1
Ph.D.	1	0	1	2
Post Doc	0	0	0	0
Total	4	0	5	9

5. NIWR-USGS STUDENT INTERNS

None

6. ACHIEVEMENTS AND AWARDS DURING THE REPORTING PERIOD

The Principal Investigator (JTP) received additional supplemental funding from Allegheny Energy and the Electrical Power Research Institute to conduct research that will allow us to quantify the overall degree of ecological impairment that can be attributed to different stressors in the Cheat River watershed. This information complements the research funded through the WRI and will make it possible to use the model being developed under the current WRI project to guide a pollutant trading program in the Cheat River watershed.

Table 1. Mean water quality values for the 35 regularly sampled stream reaches in the lower Cheat River watershed. Data used to calculate the means are from 14 separate sampling events that occurred approximately every three weeks from June 1, 2002 until April 1, 2003. Sample from three additional dates have not yet been analyzed.

Site Name	pH	Temp (°C)	Sp_Cond (uS cm-1)	DO (mg/L)	TDS	Q (m ³ /s)	Alkalinity (mg/L CaCo3 equiv.)	Acidity	SO ₄ (mg/l)	Al (mg/l)	Cd (mg/l)	Cr (mg/l)	Fe (mg/l)	Mn (mg/l)	Ni (mg/l)	Ca* (mg/L as CaCo3)	Hardness* (mg/L as CaCo3)	TSS**
Unimpaired																		
Daugherty Run 1	7.08	12.72	73	10.55	0.047	0.18	16.49	7.72	10.0	0.17	0.0015	0.0012	0.16	0.013	0.011	13.1	20.3	1.2
Muddy Creek 1	7.41	13.16	120	10.53	0.078	0.22	38.10	4.04	9.6	0.17	0.0014	0.0007	0.30	0.027	0.008	31.2	34.0	4.0
Muddy Creek 2	7.16	11.93	93	10.65	0.061	0.35	25.36	7.54	8.8	0.17	0.0012	0.0010	0.17	0.034	0.010	24.3	30.0	2.8
Roaring Creek 1	7.24	10.83	89	10.72	0.090	0.22	23.55	11.41	9.6	0.17	0.0017	0.0020	0.22	0.035	0.011	22.0	27.6	2.8
Moderately Impaired																		
Beaver Creek 1	5.76	10.90	33	11.11	0.023	0.27	2.82	24.39	14.6	0.23	0.0014	0.0012	0.17	0.076	0.010	8.8	11.4	1.2
Beaver Creek 2	6.57	11.15	45	11.30	0.030	0.24	4.27	26.86	11.2	0.16	0.0013	0.0013	0.18	0.041	0.009	10.4	14.5	0.8
Beaver Creek 3	6.35	11.43	150	11.40	0.098	0.60	5.78	28.36	54.2	0.24	0.0040	0.0015	0.24	0.398	0.021	24.1	43.9	0.2
Beaver Creek 4	6.62	11.35	177	11.36	0.115	0.57	7.81	23.40	63.9	0.17	0.0019	0.0072	0.24	0.341	0.022	27.0	51.3	0.2
Big Sandy Creek 1	5.95	13.12	200	10.64	0.130	7.02	10.07	23.20	58.4	0.53	0.0016	0.0008	0.16	0.382	0.019	28.8	48.0	6.8
Big Sandy Creek 2	6.95	14.77	189	10.53	0.123	.	16.78	14.11	46.1	0.14	0.0018	0.0006	0.13	0.078	0.015	28.3	46.3	1.6
Cheat DS Lick Run	3.75	6.14	320	12.80	0.203	.	0.00	103.38	141.6	4.70	0.0015	0.0037	9.33	0.346	0.064	24.3	45.3	27.4
Daugherty Run 2	7.05	10.65	158	11.37	0.103	0.38	25.75	5.96	42.6	0.12	0.0014	0.0009	0.12	0.023	0.009	32.7	46.2	3.4
Elk Run	6.67	11.27	121	11.30	0.078	0.24	9.80	17.87	37.6	0.13	0.0010	0.0012	0.22	0.126	0.017	21.0	35.2	0.2
Little Laurel Run	6.43	10.80	184	11.08	0.120	0.44	5.77	28.18	43.2	0.77	0.0012	0.0015	0.64	0.429	0.023	22.9	48.3	1.6
Lick Run of Roaring	6.07	11.24	61	10.76	0.040	0.27	2.53	25.80	16.1	0.30	0.0013	0.0008	0.21	0.169	0.011	11.4	16.6	2.8
Little Sandy 1	7.08	10.64	286	11.22	0.186	1.17	27.18	15.49	78.6	0.12	0.0013	0.0013	0.25	0.249	0.013	35.3	68.0	1.2
Little Sandy 2	7.05	10.40	290	11.21	0.189	1.20	22.42	14.25	80.4	0.19	0.0011	0.0030	0.29	0.353	0.027	34.8	65.1	1.0
Little Sandy 3	6.97	10.62	252	11.33	0.164	2.15	17.11	13.01	76.3	0.12	0.0023	0.0014	0.20	0.176	0.014	33.3	61.5	0.2
Little Sandy 4	6.87	10.09	253	10.69	0.178	2.28	16.74	13.87	72.1	0.14	0.0012	0.0015	0.23	0.225	0.019	32.4	58.8	6.0
Muddy Creek 3	6.72	10.72	149	11.24	0.097	0.99	12.92	17.36	50.6	0.20	0.0015	0.0026	0.30	0.321	0.018	26.4	43.4	1.2
Muddy Creek 4	7.00	10.53	205	11.30	0.133	1.25	17.59	17.95	69.1	0.16	0.0014	0.0020	0.29	0.249	0.017	31.8	57.2	4.0
Muddy Creek 5	6.93	10.81	269	11.38	0.175	1.40	24.56	9.25	89.8	0.22	0.0059	0.0009	0.24	0.142	0.015	43.1	78.6	5.0
Muddy Creek 6	5.25	10.43	333	11.44	0.216	1.38	4.23	39.24	134.1	1.96	0.0017	0.0016	0.49	0.380	0.045	38.9	78.7	12.0
NF Green's Run 1	4.09	10.13	163	11.52	0.107	0.14	0.00	46.16	57.0	2.87	0.0014	0.0013	0.27	1.013	0.033	15.8	25.9	0.2
NF Green's Run 2	4.66	10.25	139	11.63	0.090	0.21	0.00	37.44	49.3	1.97	0.0015	0.0015	0.24	1.198	0.029	16.8	26.5	2.2
NF Green's Run 3	6.26	11.93	259	11.64	0.168	0.26	18.33	14.91	92.1	0.51	0.0017	0.0012	0.18	0.515	0.023	29.6	62.0	10.2
NF Green's Run 4	6.47	10.98	214	11.13	0.140	0.38	14.71	11.41	76.8	0.31	0.0017	0.0015	0.17	0.335	0.022	31.1	59.3	8.2
Roaring Creek 2	7.05	10.85	79	11.13	0.051	0.67	16.48	16.57	11.4	0.14	0.0044	0.0011	0.09	0.087	0.014	18.0	23.8	2.6
Roaring Creek 3	6.88	11.45	218	11.26	0.142	0.61	16.94	12.06	71.3	0.15	0.0039	0.0038	0.15	0.124	0.015	40.4	62.7	2.2
Sovern Run	4.77	11.36	320	10.69	0.209	0.33	0.18	40.75	126.2	2.84	0.0037	0.0020	0.32	1.803	0.089	23.0	56.9	4.6
Webster Run	6.80	26.43	547	11.24	0.357	0.19	19.41	10.05	245.2	0.19	0.0020	0.0032	0.40	0.468	0.049	58.9	128.7	1.2
Severely Impaired																		
Lick Run of Cheat	2.71	7.35	1529	12.35	0.993	0.70	0.00	498.22	822.6	34.00	0.0031	0.0156	62.89	1.750	0.300	37.8	112.5	66.0
Martin Run	2.99	10.58	1811	11.46	1.177	0.46	0.00	382.24	941.8	19.78	0.0040	0.0071	27.08	8.264	0.400	91.9	281.9	0.4
Muddy Creek 7	3.57	10.40	777	11.57	0.551	1.85	0.00	146.88	381.9	9.28	0.0025	0.0037	7.38	3.033	0.155	50.6	140.2	14.2
Muddy Creek 8	3.82	10.32	973	11.53	0.633	2.13	0.00	137.32	443.7	8.76	0.0031	0.0041	4.99	2.555	0.154	58.9	151.1	16.2

Selenium was measured 9-Sep-02 (1 sample), not yet analyzed