A Report on the Cumulative Off-Site Impacts from a Large Area Mine in Southeast Ohio

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Mining and Reclamation Activities in the ABig Muskie@ Pit Area

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Background Information:

The Central Ohio Coal Company (COCCO) has been mining coal since the 1950's on approximately 125,000 acres of land owned by the Ohio Power Company, a subsidiary of American Electric Power Company (AEP). The Meigs Creek #9 coal was the primary seam mined. Early mining was mostly done with small to medium sized shovels using contour strip mining methods. In the 1960's, draglines and larger shovels were added to the operation. The desire for larger equipment culminated with the construction of the ABig Muskie,@ the world=s largest dragline, with a bucket capacity of 220 cubic yards. The ABig Muskie@ was built in 1968, and was followed by the construction of two 110 cubic yard capacity draglines in the late 70's and mid 80's. With the advent of using larger equipment, COCCO was able to mine higher cover using area type strip mining methods. The ABig MuskieA was permanently shut down in the early 1990's and demolished in 1999. Today, only one 110 yard dragline remains in operation.

The large scale area mining done by COCCO started just north of the Village of Cumberland and moved in a southerly direction to where mining will end, approximately 12 miles to the south near the village of Unionville. All mining done after April of 1972 was reclaimed to approximate original contour, and seeded to hay and pasture crops. Prior to 1972, reclamation consisted of only rough grading, leaving water-filled pits, highwalls, and planting trees. Because of the alkalinity provided by the limestone overburden in this area, the water impoundments support good quality aquatic communities. Discharges to surrounding streams have a high pH and low metals. Also, due to the alkalinity and uncompacted nature of the pre-1972 overburden, trees survived and grew well.

In 1987, the Ohio Environmental Protection Agency (OEPA) began doing fish and macroinvertebrate studies on Buffalo Fork of Wills Creek and its various tributaries. These streams drain most of the northern part of COCCO=s mining area. Two of the tributary streams studied, Collins Fork and Rannells Creek, are made up by a preponderance of post-1972 mining and reclamation area. A third tributary, Miller=s Creek is made up of a combination of pre-and post-1972 mining and reclamation area. It is twice as large as the Collins Fork or Rannells Creek study areas. Because the mining was older in Miller=s Creek than in Collins Fork or Rannells Creek, mining maps and other records are unavailable. Therefore, Miller=s Creek will not be included in this review. OEPA did a follow-up study in 1999 at the same sampling points as the 1987 study.

Purpose of Review:

The purpose of this review is to organize the available information from all sources, to determine the cumulative off-site impacts from a large area mine over a 12-year period. The total cumulative impacts may be difficult to determine, because mining began in the 1950's, thus impacting the area to an unknown extent long before any data was gathered. However, the data that does exist may show the extent of recovery of these watersheds after reclamation under post-SMCRA standards.

Description of Study Areas: (See Appendix A for maps)

Collins Fork - Collins Fork has a watershed of six square miles, or 3840 acres, upstream of the fish sampling site, which is located 2.7 miles upstream from the mouth. Post-1972 mining began in this watershed in 1976 and was completed in 1992. Of the total watershed acreage, approximately 3484 acres, or 90.7 percent, have been mined and reclaimed to grassland. There were 19 water impoundments left as permanent ponds, with a total acreage of 121 acres. There are also 235 acres of second growth woods, scrub, and bottom land. Some of the wooded area may also be pre-1972 reclamation with trees. This area was not reaffected by the more recent mining operations. In addition to ponds, woods, and grasslands, there are approximately 17.5 miles of roads within the watershed. Of these, about 5.4 miles are designated state highways. The stream drops about 20.8 feet per mile in the study area. It is estimated that the mining operation has impacted about 5.5 miles of intermittent headwater streams. Many of these streams are now ephemeral channels in their upper reaches. There are also numerous oil and gas wells on this area.

Rannells Creek - Rannells Creek has a watershed of 5.5 square miles, or 3584 acres upstream of the sampling site, which is located one mile up from the mouth. Post-1972 mining began in the watershed in 1981 and was completed in 1987. Of the total watershed, approximately 3060 acres have been mined and reclaimed to grasslands, including a 40-acre experimental tree planting area. There were 28 water impoundments left as permanent ponds, with a total surface area of about 90 acres. In addition to these impoundments are many areas of wetlands created by pre-1972 mining. About 434 acres of woods also exist within the study area. There are about 25.9 miles of roads within the watershed. Of these, 2.7 miles is designated state highway. There is also 3.8 miles of railroad that was used for coal haulage from the Cumberland tipple.
This tipple site and the area associated with the demolition location of the ABig Muskie@ are currently being reclaimed. The gradient of the stream in the study area is 9.1 feet per mile. It is estimated that about 2.9 miles of intermittent headwater streams were impacted by mining. There are also numerous oil and gas wells on this area.

Grassland Reclamation with Haul Road

Typical Oil and Gas Well Site

and Permanent Impoundment

Methodology:

OSM obtained fish study results, macroinvertebrate study results, water quality analysis, and Quality Habitat Evaluation Indicators (QHEI) from the OEPA. Aerial photographs, water quality reports, and other mining information was obtained from the COCCO. We scanned the aerial photos into a computer program, and used autocad to calculate areas of the various features. A mapwheel was used to measure road lengths, and a ruler was used to measure stream impacts off USGS topographic maps. Only streams showing dashed blue lines were included in the stream impact estimates. This information was charted and analyzed for trends, in addition to making a site visit to the study areas on October 26, 1999.

Water Chemistry:

Collins Fork - Water quality sampling was done by the COCCO for a six-month period in 1980 at an elevation on Collins Fork that corresponds to the OEPA sampling location. OEPA sampled this location during the summer of 1987 for a four-month period, and again in 1999. All of the analysis shows highly alkaline mine drainage with high levels of hardness, sulfates, and conductivity. There was a slight increase in iron, sulfates, and conductivity from 1980 to 1987. This may be due to using two different labs to perform the analysis, or it could represent an actual increase. OEPA also did some additional metals, nutrient, and fecal coliform testing, which did not show any abnormal levels of these constituents. OEPA=s 1999 data showed similar results. However, the 1999 data also shows slightly higher concentrations of sulfates, alkalinity, and dissolved solids than in 1987. This may be attributable to the severe drought conditions of 1999.

Rannells Creek - COCCO sampled quarterly for a three-year period between February 1981, and December 1983, at the same location as OEPA=s sampling site. The analysis shows water quality similar to that of Collins Fork, which is to be expected because the two drainages are of the same geology, and abut one another. Two of the sampling dates (June 9,1981 and June 16,1982) showed high flows and high total suspended solids. The June 16,1982 sample also showed a high iron of 24.6 mg/l. This could be an error, or could be due to some unusual event at the time of sampling. Either way, this data is an anomaly. The OEPA sampled for a six-month period in the spring and summer of 1987, which again showed a slight increase in sulfates and conductivity, but was similar in all other parameters. Additional tests for metals, nutrients, and fecal coliform did not show anything unusual. OEPA=s 1999 data showed similar results. Again, sulfates, alkalinity, and dissolved solids were noticeably higher than in 1987.

It should be noted that the company=s hydrologic impact assessments, submitted with their permit applications, accurately predicted the water quality changes identified. In turn, the permitting agency, the Ohio Division of Reclamation, deemed the changes as insignificant because there would be no adverse impact on the proposed land use or aquatic life.

(See Appendix B for Water Quality Data)

Stream Habitat:

The OEPA evaluated the stream habitat at the sampling sites in 1987 and again in 1999. The evaluation was done using OEPA=s Qualitative Habitat Evaluation Index (QHEI) form, which takes into account different positive and negative attributes of the stream habitat. The evaluation is somewhat subjective, and results may vary slightly from one reviewer to another. However, the QHEI is still a good indicator of habitat quality. A typical warm water stream meeting its designated aquatic life use status has generally a QHEI rating of 60 or more. The 1987 index for Collins was 45.0, and for Rannells was 45.5. The main negative factors affecting both streams were heavy to moderate silt cover, and substrate embeddedness. The 1999 index for Collins was 60.5, and for Rannells was 55. This shows that the habitat for both streams had improved sufficiently to support warm water habitat aquatic biota.

One particular item of interest noted by OEPA during the summer of 1999 was that, in spite of being in the midst of a severe drought, both Collins Fork and Rannells Creek had good flows while other similar sized stream were dry. This was verified by the author on October 26, 1999, when Collins (six squares miles drainage) and Rannells (5.5 square miles drainage) were observed flowing substantially. On the same day, unmined subwatersheds were observed in the Buffalo Creek watershed. North Fork Buffalo Creek (6.95 squares miles drainage) and the South Fork of Buffalo Creek (eleven square miles drainage) had no decernable flow, including interstitial. The good flows from the mined areas are likely attributable to the porous spoil acting as a Asponge,@ storing water and discharging it evenly. There have also been numerous recharge zones created from the permanent water impoundments.

Rannells Creek 10-26-99

Collins Fork 10-26-99

South Fork Buffalo Creek 10-26-99

(See Appendix C for QHEI Reports)

Stream Biology:

OEPA conducts fish surveys using electroshocking to sample 150 to 200 meters of stream in the

sample area. An Index of Biological Integrity (IBI) is assigned based on the diversity of species encountered, the number of fish, the ratio of sensitive to tolerant species , and other factors. The lowest IBI possible is 12. An IBI of 44 is needed to attain warm water habitat status. Collins Fork had an IBI of 12 in 1982, with only three tolerant species of fish encountered. The Collins Fork site was surveyed again in 1987 and in 1999. In 1987, the IBI was 17 (average of two passes of 12 and 22) with eight species encountered. In 1999, this improved to an IBI of 32 with nine species encountered.

OEPA also conducted fish surveys on the Rannells Creek site in 1987 and 1999. The 1987 survey had an IBI of 27 (based on two passes of 28 and 26) with 13 species present, and in 1999 this improved to 32 with 12 species present. Even though there were more species in 1987, the majority were pollution tolerant species.

In addition to the fish surveys, OEPA performed surveys of macroinvertebrates (aquatic insects) on both streams in 1987 and 1999. The Invertebrate Community Index (ICI) is the value given based on the quality of the invertebrate community. The ICI may also be a better measurement of environmental health because airborne insects are more mobile than fish, and can repopulate at a faster rate, without being affected by such barriers as dams, culverts, and waterfalls. An ICI of 36 is needed to obtain warm water habitat status. In 1987 the ICI of Collins Fork was 30, and the ICI of Rannells was 36. The 1999 ICI for Collins was 30, showing no change over the 12-year period. An ICI score for Rannells Creek in 1999 was not possible due to vandalism of the artificial substrate samplers. However, qualitative sampling showed little change in macroinvertebrate quality compared to the results from 1987. It is particularly noteworthy that none of the macroinvertebrate samples in 1987 or 1999 showed any significant numbers or kinds of Mayflies. This has also been observed in recent surveys by the USEPA in West Virginia in mining areas with acceptable pH-s, but with high conductivites (Green 1999).

Because there was no data collection before the initial mining began in these two watersheds, it is impossible to determine what the quality of these two streams was prior to any mining. However, Yoker Creek, located three miles north of the Village of Cumberland can serve as a reference point. This stream, with a drainage area of 11.6 squares miles at the sampling point, also had a fish survey done in 1987. About 30 to 40 percent of this drainage was mined in the 60's to early 70's. The area was made up of small farms, woods, and reverting farmland, prior to mining, just as Collins Fork and Rannells were. The 1987 survey showed warm water habitat status was being attained with an IBI of 48. It is reasonable to estimate Collins and Rannells may have had similar or better IBI-s prior to mining. A macroinvertabtrate study also done by OEPA in 1987 on the same section of Yoker Creek, had an ICI of 34, which is essentially the same as the ICI of 36 for Rannells Creek for the same year. The fact that the ICI-s were at or near warm water status for the two streams studied, shows that the environmental conditions of the streams may be better than what is indicated by the IBI-s for fish. The IBI-s for fish may be limited by a lack of diverse species populations in the watershed below the study area that could repopulate the impacted streams. Physical isolation of the study sites by beaver dams, culverts, or other obstructions may also be limiting new fish species moving into the study areas.

(See Appendix D for IBI Data, and Appendix E for ICI Data)

Field Observations:

The reclaimed areas in both watersheds have good grassland cover established in most areas, with some limited hay cropping occurring. Trees have also been planted in many areas, but survival and growth are spotty at this time. Rock channel ditches are mostly stable, and many have volunteer trees such as sycamore and cottonwood established in the rock. There are many oil and gas wells, but most appear to be adequately stabilized to control any erosion or sediment connected with the well sites. Many of the roads in the area were built extra wide to accommodate large coal haulers. The size of these roads increases sheet run-off, and side ditch flows. These roads, where they intersect streams and drain ways, appear to be the last significant

Haul Road near Collins Fork Sampling Site

Haul Road Crossing above Rannells Creek Sampling Site

sources of sediment from the mining operation. The AMuskie@ pit has been backfilled and is in the process of being reclaimed, as is the Cumberland tipple. Both of these areas have adequate sediment control by ponds. Flows in both watersheds were very good considering the severe drought conditions. The Collins Fork sample site is at a haul road crossing that has culverts that drop several feet into a plunge-pool on the downstream side. This may be limiting fish movement from downstream areas. The Rannells Creek site has a beaver dam within the sampling segment, which could also limit fish movements.

Discussion:

The data reviewed shows that both of the streams studied were impacted prior to the study period. They appeared to recover significantly during the study period. However, we acknowledged that many fluctuations could have occurred in the twelve-year period between samplings.

Conclusions:

Water Quality - As increased area and overburden were mined, the sulfates and conductivity increased slightly. None of the samples showed toxic levels of any parameter sampled. However, the high levels of sulfates appear to be responsible for the absence of Mayfly taxa.

Stream Habitat - The habitat of the two streams in question has been impaired. But, it is showing signs of recovery and may be good enough to attain warm water fishery status.

Stream Biology - The IBI-s show that the streams have improved over time, but are still not attaining warm water fishery status. This recovery has occurred while the area was being mined and reclaimed to current standards. The ICI-s show that the macroinvertabrate community has remained stable and is at or near warm water aquatic life attainment.

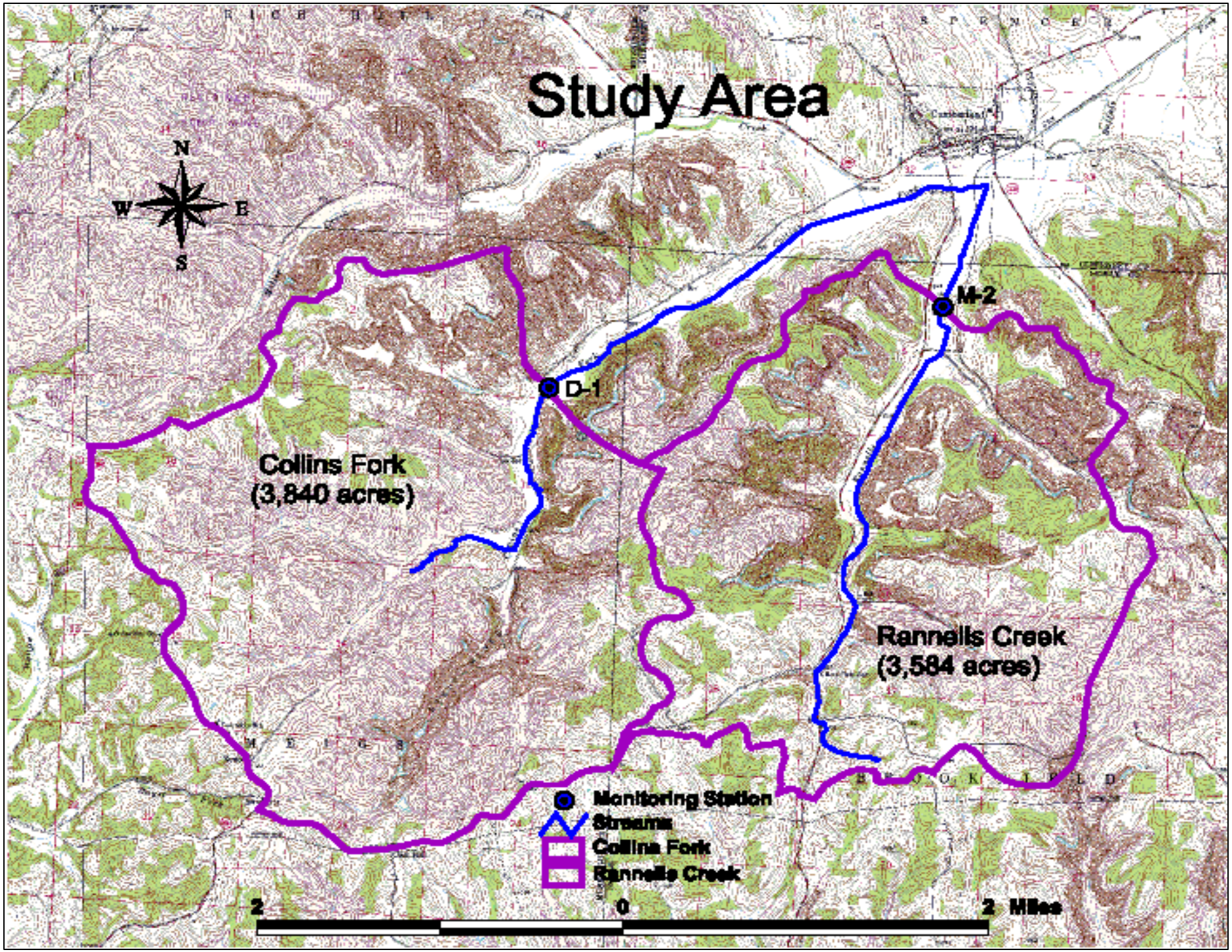
Summary:

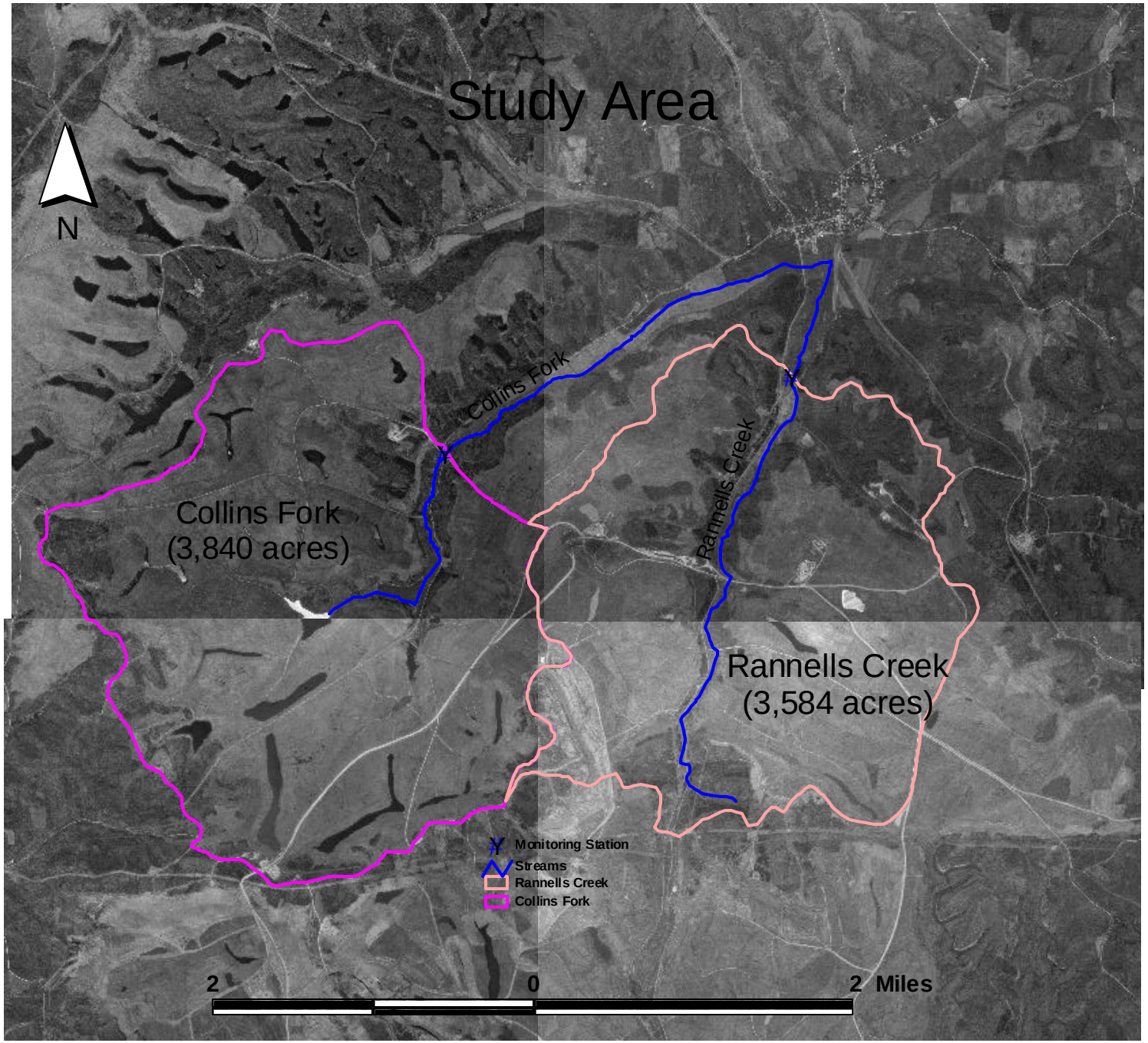
The cumulative off-site impacts from the post-SMCRA mining in the Collins Fork and Rannells Creek watersheds are increased levels of sulfates, and increased base flows in these two streams.
High levels of sulfates appear to have an adverse effect on mayfly taxa. However, it is not known at what level this begins to occur. Since the sulfate levels of these two watersheds were high to begin with, the post-SMCRA mining did not adversely effect Mayflies in this instance. The increased base flows have had a positive off-site impact by providing an aquatic environment during dry periods. Overall, biological integrity of the two streams has improved over time, but has still not reached warm water habitat status. If the watersheds revert to a more natural forested condition full warm water habitat status should be attainable.

Recommendations:

Measures should be taken to reduce any sedimentation from roads that have been left as permanent features. Any barriers to fish migration, such as road culverts with large dropoffs, should be removed. The culverts through the haul road fill at the Collins Fork sampling site are a good example of this. Reforestation efforts should be continued. OEPA should continue monitoring these points to further document conditions over time. If possible, the frequency of monitoring should be increased. Further changes in water quality or habitat conditions could serve as triggers for more intensive biological monitoring.

Appendix A: Maps

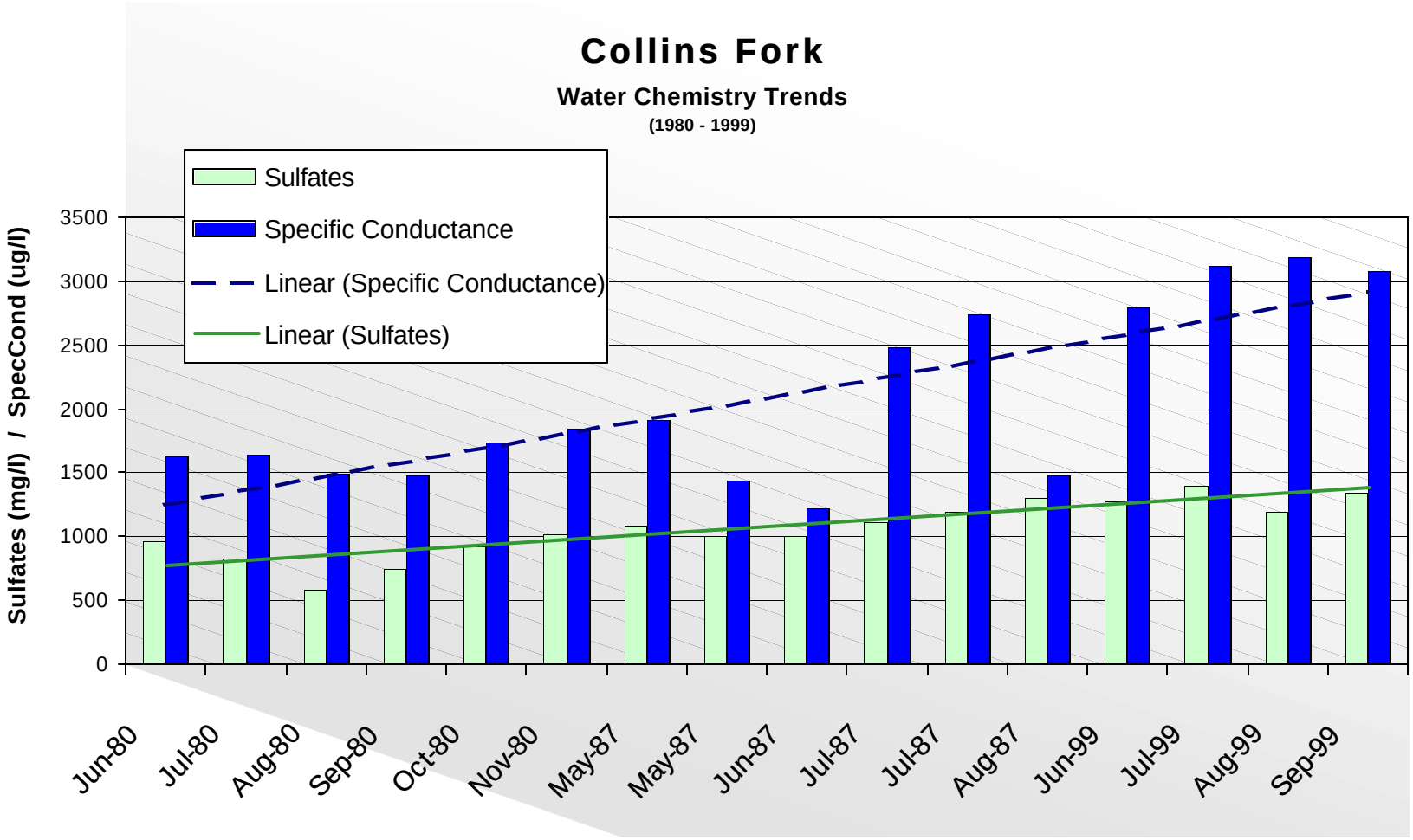

Study Area
N
W
E
S
M-2
D-1
Collins Fork
(3,840 acres)
Rannells Creek
(3,584 acres)
Monitoring Station
Streams
Collins Fork
Rannells Creek
2
0
2 Miles

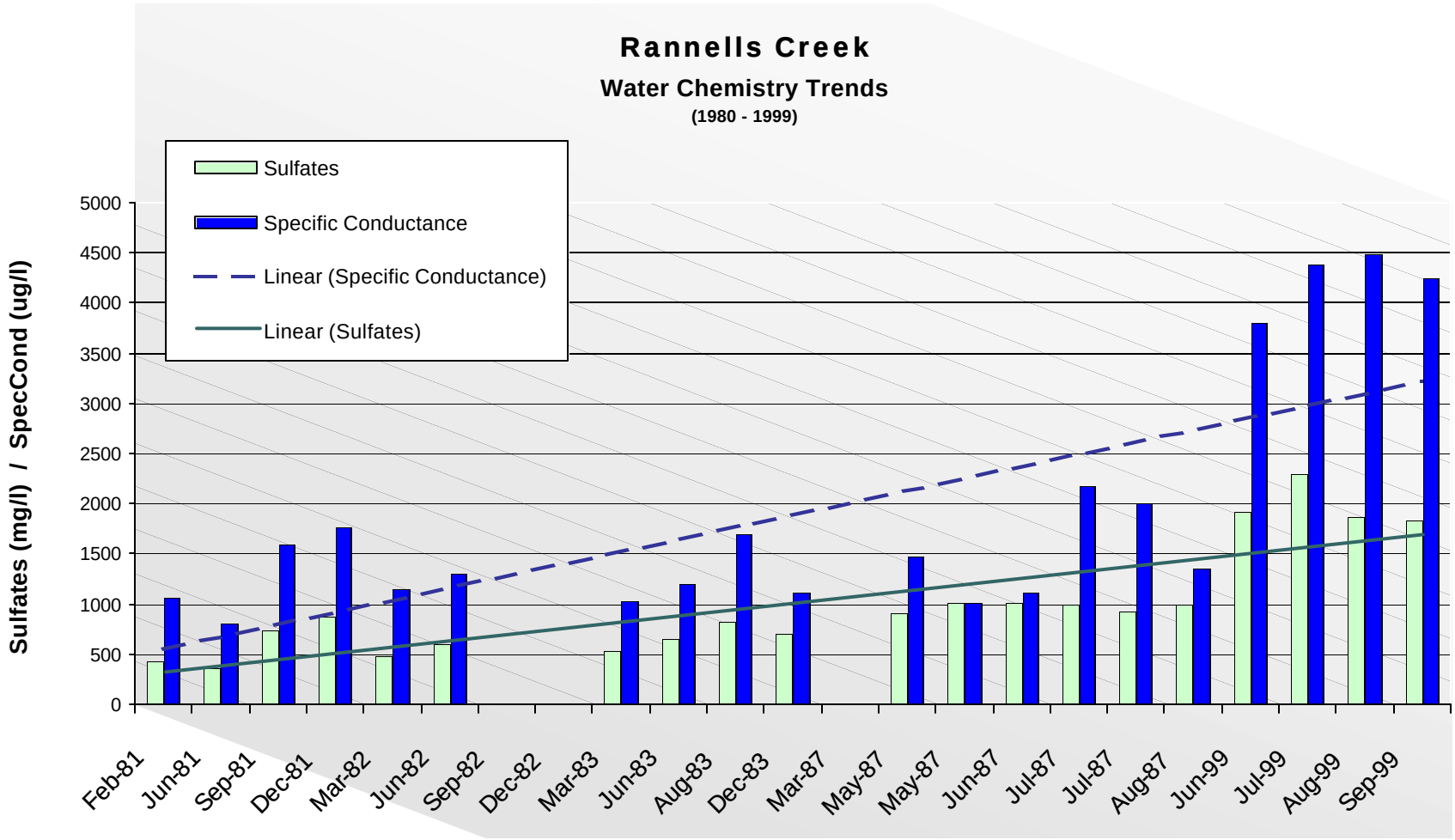

Study Area
N
Collins Fork
Rannells Creek
Collins Fork
(3,840 acres)
Rannells Creek
(3,584 acres)
Monitoring Station
Streams
Rannells Creek
Collins Fork
2
0
2 Miles

Appendix B: Water Chemistry

Water Quality Monitoring

Site Id	Date	Flow	pH	Acidity	Alk	Fe	Mn	TSS	Hard	SO4	Spc Cond	Dis Solids
D-1	6/23/1980	15000	7.7	11.8	147	0.28	1.21	48.8	1012	960	1632	2179
D-1	7/9/1980	5000	7.4	11.3	156	0.24	0.8	34.5	850	828	1647	
D-1	8/7/1980	30000	7.6	19.2	140	0.14	1.02	77.5	840	584	1496	
D-1	9/11/1980	8000	7.7	12.7	154	0.65	1.05	32.5	860	748	1472	
D-1	10/21/1980	6000	7.7	2.4	175	0.23	0.78	30.9	1070	920	1733	
D-1	11/14/1980	4000	7.6	16.6	178	0.29	1.29	17.1	1070	1017	1843	
D-1	5/13/1987		7.75		308	0.09	0.67		960	1090	1915	
D-1	5/28/1987		7.9		279		0.55			1000	1440	
D-1	6/25/1987		7.6		294	1.83	0.54		915	1002	1220	
D-1	7/15/1987		7.7		270	0.7	0.35		837	1110	2480	
D-1	7/28/1987		7.9		282		0.11			1200	2740	
D-1	8/11/1987		7.7		307	0.96	0.47		1040	1300	1480	
D-1	6/16/1999				403	0.43	0.29	15	1000	1270	2790	2500
D-1	7/21/1999				349	0.51	0.31	14	935	1400	3120	2530
D-1	8/11/1999				354	0.45	0.29	16.5	931	1190	3190	2570
D-1	9/2/1999				386	0.45	0.32	13.5	958	1340	3080	
M-12	2/3/1981	5000	7.6	8.7	123	1.11	0.65	22.5	584	436	1061	
M-12	6/9/1981	55750	7.5	19	130	2.4	0.87	175	452	362	810	
M-12	9/8/1981	1200	7.8	35	176	0.59		40	1172	743	1600	
M-12	12/15/1981	800	7.8	13.7	250	0.18	1.14	7.3	1180	875	1770	1663
M-12	3/17/1982	5000	7.8	6.2	134	0.71	0.47	30.7	607	473	1145	808
M-12	6/16/1982	30000	7.8	13.8	124	24.6	0.86	928	760	594	1296	1056
M-12	9/14/1982	2000	7.7	11.9	174	0.34	0.33	11.2	773			
M-12	12/8/1982	2500	7.7	17.4	134	0.63	0.64	4.7	2			
M-12	3/9/1983	1795	7.6	30	155	0.07	0.84	20	664	535	1030	
M-12	6/8/1983	2502	7.4	30	169	0.1	0.15	20	744	646	1200	
M-12	8/31/1983	75	7.6	30	204	0.22			1152	817	1690	
M-12	12/13/1983	7506	7.5	44	624				780	710	1120	
M-12	3/25/1987		7.8			0.79	0.56					
M-12	5/13/1987		7.65		214		0.72		904	911	1480	
M-12	5/28/1987		7.9		192		0.76			1010	1010	
M-12	6/25/1987		7.8		233	1.16	0.36		835	1002	1120	
M-12	7/15/1987		7.9		236	0.19	0.21		831	1000	2180	
M-12	7/28/1987		7.65		226		0.35			921	2010	
M-12	8/11/1987	9110	8.3		230				834	1000	1350	
M-12	6/16/1999				479	0.64	0.14	13.5	997	1920	3800	3300
M-12	7/21/1999				420	0.42	0.14	12	907	2290	4380	3470
M-12	8/11/1999				418	0.3	0.12	8	930	1870	4480	3500
M-12	9/2/1999				446	0.34	0.17	9	927	1840	4250	3330


Collins Fork
Water Chemistry Trends
(1980 - 1999)
Sulfates
Specific Conductance
Linear (Specific Conductance)
Linear (Sulfates)
Sulfates (mg/l) / SpecCond (ug/l)
3500
3000
2500
2000
1500
1000
500
0
Jun-80
Jul-80
Aug-80
Sep-80
Oct-80
Nov-80
May-87
May-87
Jun-87
Jul-87
Jul-87
Aug-87
Jun-99
Jul-99
Aug-99
Sep-99


Rannells Creek
Water Chemistry Trends
(1980 - 1999)
Sulfates
Specific Conductance
Linear (Specific Conductance)
Linear (Sulfates)
Sulfates (mg/l) / SpecCond (ug/l)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Feb-81
Jun-81
Sep-81
Dec-81
Mar-82
Jun-82
Sep-82
Dec-82
Mar-83
Jun-83
Aug-83
Dec-83
Mar-87
May-87
May-87
Jun-87
Jul-87
Jul-87
Aug-87
Jun-99
Jul-99
Aug-99
Sep-99

Appendix C: QHEI Reports

Appendix D: IBI Data

Appendix E: ICI Data