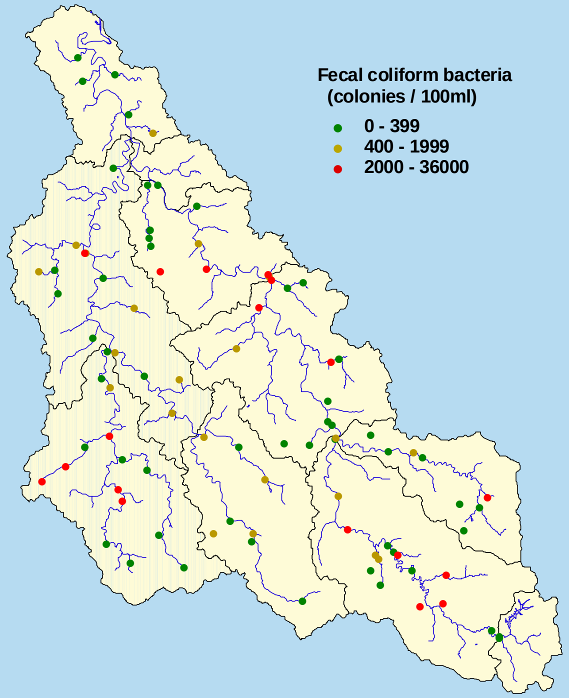
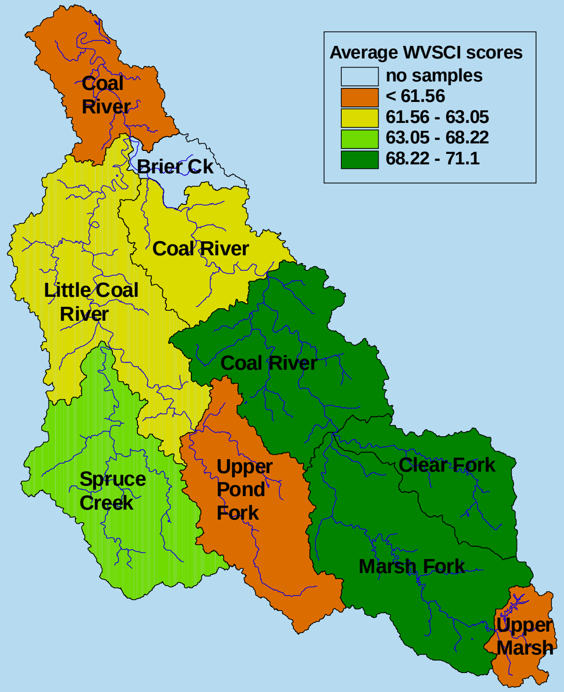
West Virginia
Department of Environmental Protection
Division of Water Resources

This report summarizes the data collected in the Coal River Watershed by the Watershed Assessment Program in 1997. It includes:

Water Quality Information from 151 sites;



Biological Health Information (Benthic macroinvertebrates) from 135 sites;



And physical habitat and landuse pattern information that help us identify and understand the impairments that are affecting the streams of West Virginia.

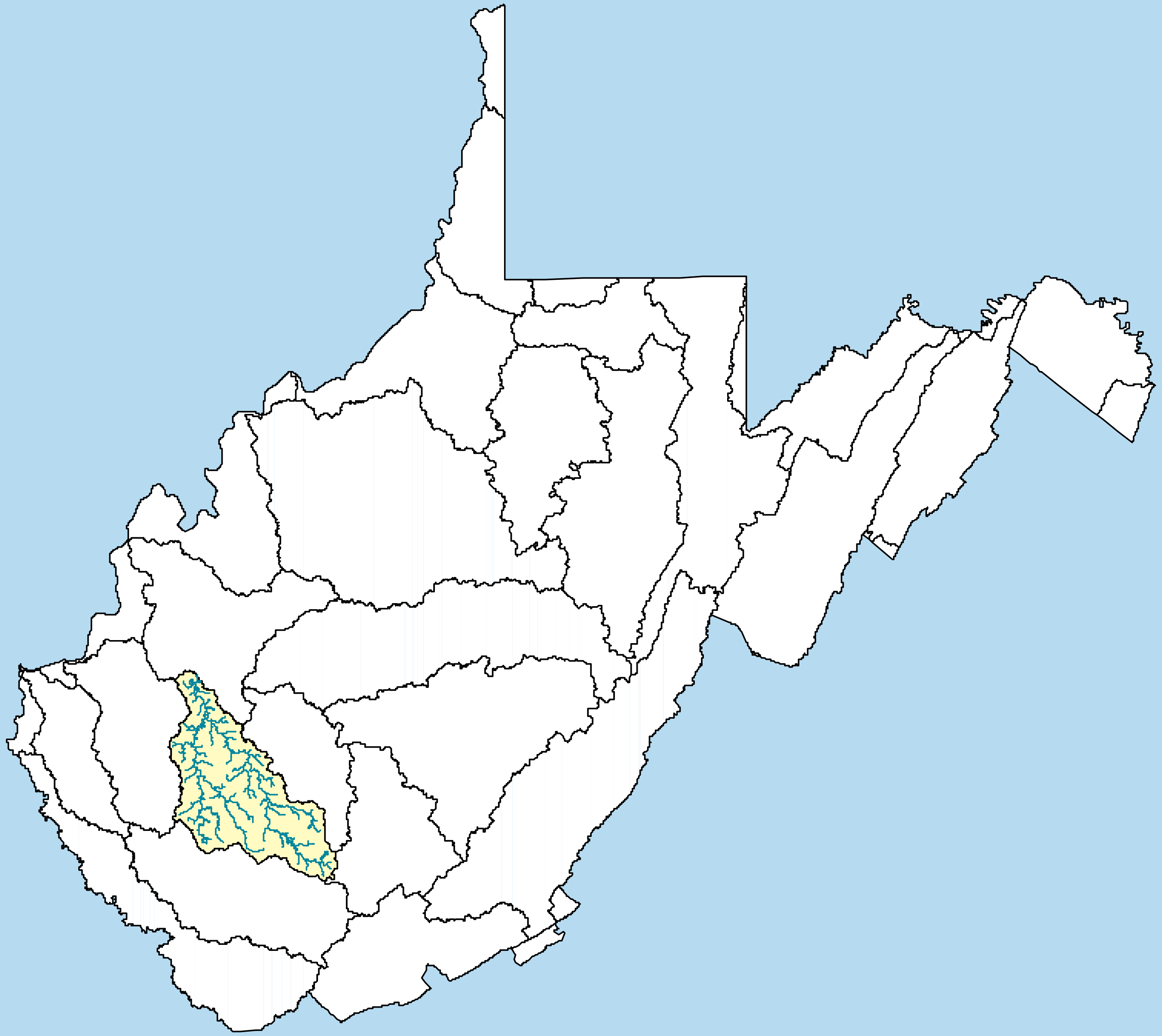
Watershed Assessment Program

WV Division of Water Resources

An Ecological Assessment of the Coal River Watershed

WEST VIRGINIA
Department of Environmental Protection

An Ecological Assessment of the
Coal River Watershed



Watershed Assessment Program

An Ecological Assessment
of the
Coal River Watershed

Report number - 05050009 - 1997

prepared by:

Watershed Assessment Program
Division of Water Resources
West Virginia Department of Environmental Protection

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Summary

The Coal River Watershed extends from the river's headwaters in Raleigh County to its confluence with Kanawha River at St. Albans in Kanawha County. On the way it drains parts of Raleigh, Logan, Boone, Lincoln, Kanawha and Putnam Counties. The majority of the Coal River Watershed is within Ecoregion 69. A small portion near the mouth is in Ecoregion 70.

Assessment teams visited 100 sites in the Coal River Watershed (HUC # 05050009) between September 15 and October 8, 1997. Of the 589 named streams in this watershed, 78 (approximately 13%) were visited. Only named tributaries were sampled as part of this assessment .

Assessments included measurements of physical attributes of the stream and riparian zone, observations of activities and disturbances in the surrounding area, water quality data, and benthic macroinvertebrate collections.

As expected, sediments, coal mining and inadequate sewage treatment were the major stressors on streams in this watershed. At least 103 National Pollutant Discharge Elimination System (NPDES) permits were in effect in this watershed. The majority of these permits were for coal mines and sewage treatment plants.

Approximately 32% of the sampled sites had impaired benthic macroinvertebrate communities, another 20 % had benthic communites with potential impairment. Approximately 42% had fecal coliform bacteria concentrations in violation of the criterion established by the Environmental Quality Board.

The top priority actions suggested by the DEP are:

- Continue restoration efforts on streams impaired by acid mine drainage
- Support the federal initiative to determine stream impacts of mountaintop removal/valley fill mining
- Develop an action plan for the prevention of erosion that includes protecting the natural vegetation along stream corridors and revegetating stream corridors where necessary

- Conduct an intensive study to determine the sources of high concentrations of fecal coliform bacteria in some streams in the watershed. This would include determining the adequacy of sewage treatment and developing an understanding of the contribution wildlife and livestock make to the problem.
- Locate and protect the few remaining high quality streams in the Coal River watershed

Acknowledgements

Funding for this watershed assessment was provided by the U.S. Environmental Protection Agency's 319 and 104(b)(3) programs and by the West Virginia Department of Environmental Protection.

Michael Arcuri, Jeffrey Bailey, Christina Moore, Perry Casto, Alvan Gale, John Wirts, Mike Puckett, Charles Surbaugh, Janice Smithson, Mike Whitman and Douglas Wood collected the samples and assessed the sites.

Marshall University Students, Eric Wilhelm and Andrea Henry, under the supervision of Dr. Donald Tarter and Jeffrey Bailey, processed the benthic samples. Jeffrey Bailey, Janice Smithson, John Wirts, Douglas Wood and Alvan Gale identified the benthic macroinvertebrates. Jeffrey Bailey and John Wirts created the tables and figures. James Hudson co-authored this report with Jeffrey Bailey, John Wirts and Douglas Wood. Patrick Campbell, Janice Smithson, Michael Arcuri and Jessica Welsh provided help in reviewing the various drafts of this report and bringing it to completion. John Wirts designed the layout and provided finishing touches to the report.

Watersheds and Their Assessment

In 1959, the West Virginia Legislature created the State Water Commission, predecessor of the Division of Water Resources (DWR). The DWR has since been charged with balancing the human needs of economic development and water consumption with the restoration and maintenance of water quality in the state's waters.

At the federal level, the U.S. Congress enacted the Clean Water Act of 1972 (the Act) plus its subsequent amendments to restore the quality of our nation's waters. For 25 years, the Act's National Pollutant Discharge Elimination System (NPDES) has caused reductions in pollutants piped to surface waters. There is broad consensus that because NPDES permits have reduced the amount of contaminants in point sources, the water quality of many of our nation's streams has improved significantly.

Under the federal law, each state was given the option of managing NPDES permits within its borders or leaving the federal government in that role. When West Virginia assumed primacy over NPDES permits in 1982, the state's Water Resources Board [renamed the Environmental Quality Board (EQB) in 1994] began developing water quality criteria for each kind of use designated for the state's waters (see box). In addition the WV Department of Environmental Protection's (DEP) water protection activities are guided by the EQB's anti-degradation policy, which charges the DWR with maintaining surface waters at sufficient quality to support existing uses, whether or not the uses are specifically designated by the EQB.

WATER QUALITY CRITERIA - The levels of water quality parameters or stream conditions that are required to be maintained by the Code of State Regulations, Title 46, Series 1 (Requirements Governing Water Quality Standards).

DESIGNATED USES - For each water body, those uses specified in the water quality standards, whether or not those uses are being attained. Unless otherwise designated by the rules, all waters of the state are designated for:

- the propagation and maintenance of fish and other aquatic life
- water contact recreation.

Other types of designated uses include:

- public water supply,
- agriculture and wildlife uses, and
- industrial uses.

Even with significant progress, by the early 1990s many streams still did not support their designated uses. Consequently, environmental managers began examining pollutants flushing off the landscape from a broad array of sources. Recognizing the negative impacts of these non-point sources (NPS) of pollution, was a conceptual step that served as a catalyst for today's holistic watershed approach to improving water quality. A nonpoint source is one that does not originate at clearly identifiable pipes or other outlets,

Several DEP units, including the Watershed Assessment Program (the Program) are currently implementing a variety of watershed projects. Located within the DWR, the Program's scientists are charged with evaluating the health of West Virginia's watersheds. The Program is guided, in part, by the Interagency Watershed Management Steering Committee (see box).

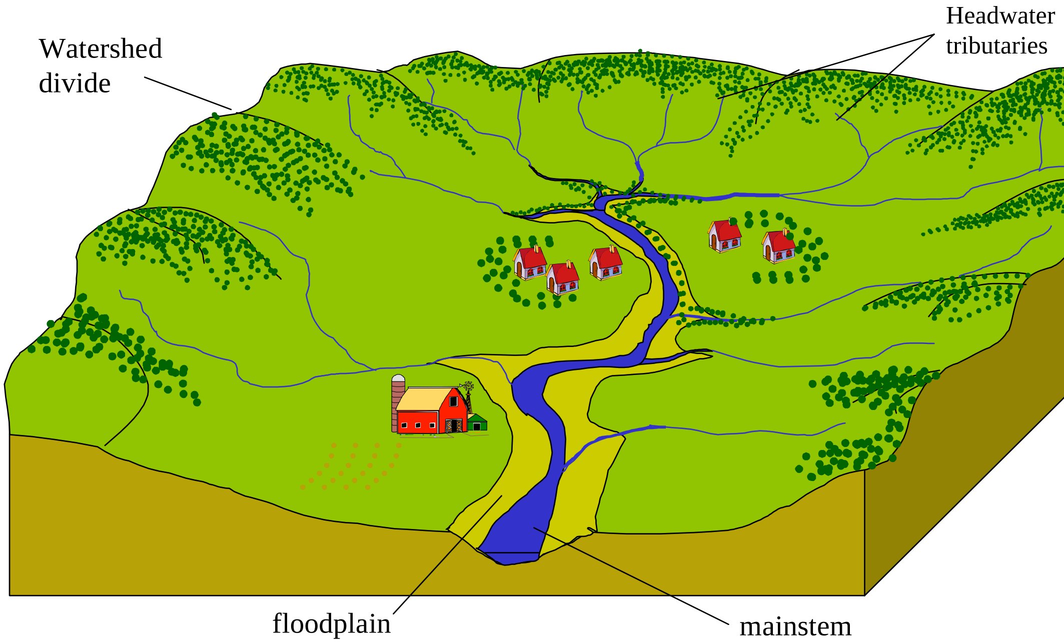
The Program uses the U.S. Geological Survey's (USGS) scheme of hydrologic units to divide the state into 32 watersheds. Some of these watershed units are entire stream basins with natural hydrologic boundaries (e.g., Gauley River Watershed). Three other types of watershed units were devised for manageability: (1) clusters of small tributaries that drain directly into a larger mainstem stream (e.g., Potomac River Direct Drains Watershed); (2) the West Virginia parts of interstate basins (e.g., Tug Fork Watershed); and (3) divisions of large watersheds (e.g., Upper and Lower Kanawha River Watersheds).

A goal of the Program is to assess each watershed unit every five years, an interval coinciding with the reissuance of NPDES permits.

THE INTERAGENCY WATERSHED MANAGEMENT STEERING COMMITTEE consists of representatives from each agency that participates in the Watershed Management Framework. Its function is to coordinate the operations of the existing water quality programs and activities within West Virginia to better achieve shared water resource management goals and objectives.

The Watershed Basin Coordinator serves as the day to day contact for the committee. The responsibilities of this position are to organize and facilitate the Steering Committee meetings, maintain the watershed management schedule, assist with public outreach, and to be the primary contact for watershed management related issues.

Figure 1. A Generalized Watershed



In this report, watershed refers to all of the land that drains to a certain point on a river. In the case of the Coal River Watershed, it includes all of the land (about 571,000 acres) that drains to the mouth of the Coal River in St. Albans.

General Watershed Assessment Strategy

A watershed can be envisioned as an aquatic tree, a system of upwardly branching, successively smaller streams. An ideal watershed assessment would document changes in the quantity and quality of water flowing down every stream, at all water levels, in all seasons, from headwater reaches to the exit point of the watershed. Land uses throughout the watershed would also be quantified. Obviously this approach requires more time and resources than are available.

The Program assesses the health of a watershed by evaluating the health of as many streams as possible, as close to their mouths as possible. An exception to this general strategy is the strategy developed to produce statistically valid summaries that allow the comparison of watersheds to one another. This strategy is detailed in the section titled "Probabalistic or Random Sampling." The general sampling strategy can be broken into several steps:

- The names of streams within the watershed are retrieved from the U. S. EPA's Water Body System database.

- A list of streams is developed that consists of several sub-lists, including:
  1. Severely impaired streams,
  2. Slightly or moderately impaired streams,
  3. Unimpaired streams,
  4. Unassessed streams, and
  5. Streams of particular concern to citizens.

- Assessment teams visit as many streams listed as possible and sample as close to the streams' mouths as allowed by road access and sample site suitability.

Longer streams may also be sampled at additional sites further upstream. In general, if a stream is 15 to 30 miles (25 to 50 km) long, two sites are sampled; 30 to 50 miles (50 to 89 km) long, three sites are sampled; 50 to 100 miles (80 to 160 km) long, four sites are sampled; longer than 100 miles (160 km), five sites are sampled. If inaccessible or unsuitable sites are dropped from the list, they are replaced with previously determined alternate sites.

The Program has scheduled the study of each watershed for a specific year of a five-year cycle. Advantages of this pre-set timetable include: a) synchronizing study dates with permit cycles, b) facilitating the addition of stakeholders to the information gathering process, c) insuring assessment of all watersheds, and d) improving the DWR's ability to plan.

In broad terms, DWR evaluates the streams and the Interagency Watershed Management Steering Committee sets priorities in each watershed in five phases:

Phase 1 - For an initial cursory view assessment teams measure or estimate about 50 indicator parameters in as many of each watershed's streams as possible.

Phase 2 - Combining pre-existing information, new Phase 1 data and stakeholders' reports, the Program produces a list of streams of concern.

Phase 3 - From the list of streams of concern, the Interagency Watershed Management Steering Committee (see sidebar) develops a smaller list of priority streams for more detailed study.

Phase 4 - Depending on the situation, Program teams or outside teams (e.g., USGS or consultants) intensively study the priority streams.

Phase 5 - The Division of Water Resources issues recommendations for improvement, develops total maximum daily loads, if applicable (see box on next page), and makes data available to any interested party such as local watershed associations, educators, consultants and citizen monitoring teams.

This document, which reports Phase 1 findings for the Coal River watershed in West Virginia, has been prepared for a wide variety of users, including elected officials, environmental consultants, educators and natural resources managers.

Probabalistic or Random Sampling

Beginning in 1997, the Program has included random sampling as part of the assessment process. The non-random component of the watershed assessments has potential bias because of the way that sites are selected. The non-random sites are generally sampled at locations that are most easily accessed, generally near the mouth of streams and at road crossings. An assessment of just these sites does not provide a valid evaluation of the entire watershed.

The random sites are computer chosen and assessments may occur at any point along the length of the stream. This should allow for valid statements to be made about the conditions of streams within each watershed. This also allows for comparisons between watersheds, which the non-random assessments do not.

U.S. EPA personnel provide locations for about 40 random sites within each watershed. Because there are many more miles of first and second order headwater streams than there are of higher ordered streams, sites are weighted so that an adequate number of larger streams are selected.

Program field crews visit the sites and verify their location with GPS units. If the site meets the criteria of being a wadeable stream with riffle / run habitat, it is assessed according to protocols which are the same as for the non-random sites with some additional water quality parameters .

TOTAL MAXIMUM DAILY LOAD AND THE 303(d) LIST - The term "total maximum daily load" (TMDL) originates in the federal Clean Water Act, which requires that degraded streams be restored to their designated uses.

Every four years, a list of water quality limited streams (called the 303(d) list after the Clean Water Act section number wherein the list is described) is prepared. Prior to adding a stream to the list, technology-based pollution controls must have been implemented or the conclusion must have been reached that even after implementing such controls the stream would not support its designated uses. West Virginia's 303(d) lists include streams affected by a number of stressors including mine drainage, acid deposition (rain), metals and siltation.

Mathematically, a TMDL is the sum of the allocations of a particular pollutant (from point and nonpoint sources) into a particular stream, plus a margin of safety. Restoration of a 303(d) listed stream begins by calculating a TMDL, which involves several steps:

- **Define when a water quality problem is occurring, the critical condition, (e.g., at base flow, during the hottest part of the day or throughout the winter ski season),**
- **Calculate how much of a particular contaminant must be reduced in a stream in order to meet the appropriate water quality criterion,**
- **Calculate the total maximum daily load from flow values during the problem period and the concentration allowed by the criterion,**
- **Divide the total load allocation between point and nonpoint sources (e.g., 70% point and 30% nonpoint); and**
- **Recommend pollution reduction controls to meet designated uses (e.g., install best management practices, reduce permit limits or prohibit discharges during problem periods). A TMDL cannot be approved unless the proposed controls are reasonable and implementable.**

The Program was designed in part to determine whether a stream belongs on the 303(d) list. In some cases this determination can be made readily (ie, a stream degraded by acid mine drainage). However, the determination is more difficult to make for most streams because the necessary data is missing, conflicting, of questionable quality or too old. Any stream which would not support its designated uses, even after technology based controls were applied, would be considered for listing.

The Coal River Watershed

The Coal River (HUC # 05050009) and many of its tributaries generally flow from southeast to northwest through the steep-sloped valleys of the southwestern portion of the state. The Coal River divides into two major branches about 19 miles from its confluence with the Kanawha River. These two, the Little Coal and the Big Coal Rivers, drain areas of approximately the same size. Spruce Fork and Pond Fork join at Madison to form the Little Coal. The Big Coal River is formed by the confluence of Marsh Fork and Clear Fork just south of Whitesville. The Coal River Watershed lies within the Western Allegheny Plateau (70) and the Central Appalachian (69) Ecoregions.

Only a small portion of this watershed, the area from the Coal River's mouth at St. Albans up to the confluence of the two main branches, is in the Western Allegheny Plateau Ecoregion (see Figure 3). Sandstone, siltstone, shale, limestone and coal underlie this ecoregion. The dominant forest types of this region are primarily Appalachian oak forest and mixed mesophytic forest. Urban, suburban and industrial developments dominate some locales, especially the narrow stream valleys that serve as major transportation corridors. Most of the acreage is too steep to be farmed by modern standards and many old farms are reverting to woodlands. Nevertheless, some operating farms grow corn and hay on rounded ridges and narrow bottomlands, and some pastures remain on the slopes. Grazing and cultivation have increased erosion, and upland soils on many farms are often thin or absent. Coal mining and oil and gas production occur within this ecoregion.

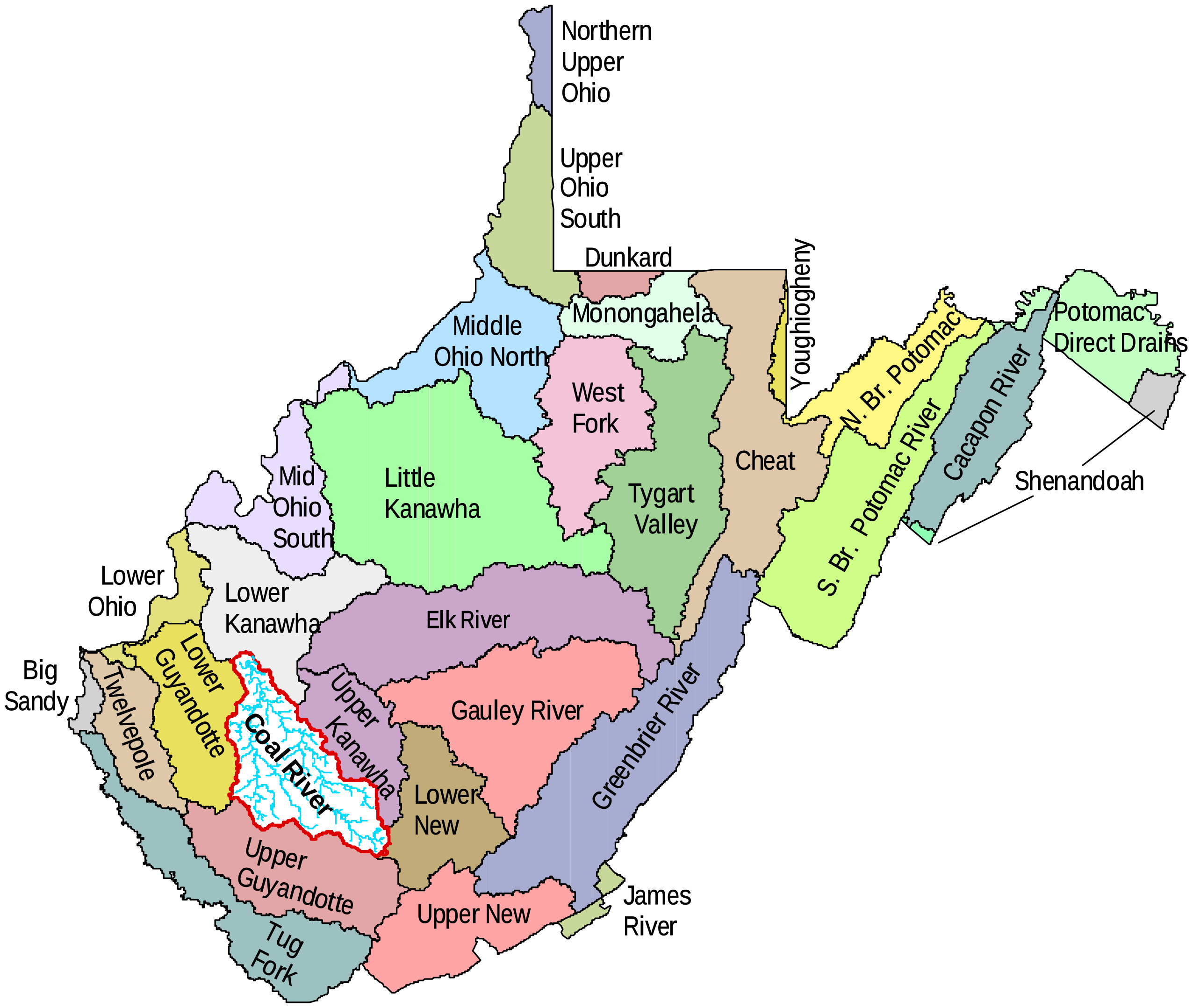
The Central Appalachian Ecoregion, which covers most of this watershed, is generally more rugged, more forested and cooler than the Western Allegheny Plateau Ecoregion. Typically, interbedded limestones, shales, sandstones and coals underlie this ecoregion. The limestones tend to be thin and infrequent. Some very thick sandstones are found here. Extraction of coal, oil and natural gas is common and has degraded stream habitat in much of this ecoregion. Ten streams in the Coal River watershed are listed on the 1998 303(d) list as impaired by mine drainage. All are in the Central Appalachian Ecoregion. These streams are:

- Shumate Creek (KC-46-D),
- Peachtree Creek (KC-46-G),
- Drews Creek (KC-46-G-1),
- Martin Fork of Peachtree Creek (KC-46-G-2),

- Jehu Branch (KC-46-Q-5),
- Clear Fork (KC-47),
- Long Fork of Clear Fork (KC-47-G),
- Dow Fork (KC-47-G-1),
- Toney Fork (KC-47-L), and
- Workman Creek of Clear Fork (KC-47-O).

All but two of the ten streams on the 1998 303(d) list were sampled thoroughly during this study. Jehu Branch (KC-46-Q-5) was sampled only for a few water quality constituents

Figure 2. West Virginia's Major Watersheds



because it had only standing pools with no discernible flow. Shumate Creek (KC-46-D) was not sampled due to an oversight.

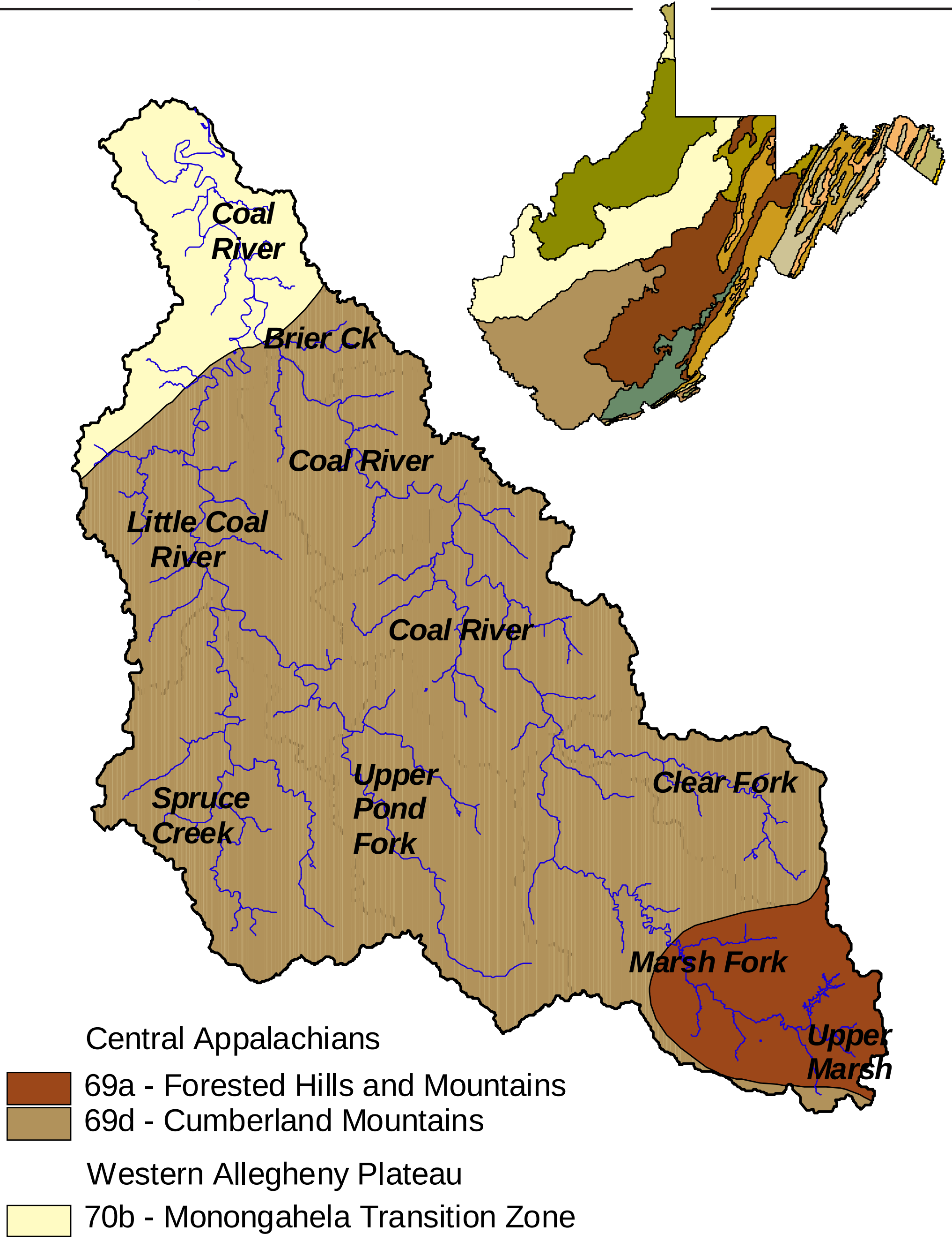
Climate within the watershed is considered mild. Generally, summers are warm and winters are moderately cold. Summer temperatures may reach the high 90's on occasion with winter lows near zero. Precipitation occurs on an average of 152 days a year. While 1996 set the record as the wettest year for West Virginia in more than a century of keeping records (Friedlander, Jr., Blaine P.), 1997 was much closer to the long-term average.

The elevation in the Coal River watershed ranges from 3,620 feet on Ivy Knob of Guyandotte Mountain near the headwaters of Pond Fork and Marsh Fork, to a low of approximately 566 feet at Coal River's confluence with Kanawha River. Several of the prominent ridges within the southern headwatershed have knobs over 3,000 feet above mean sea level. Cook, Cherrypond, Kayford, Coal River, Paint and Guyandotte Mountains are the loftiest within or bordering the watershed.

The Lower Coal River flows through the ancient Teays Lake bed. Consequently, its course is meandering and its banks are high as it cuts down into the lake bed sediment. This ditch-like appearance undoubtedly inspired the Delaware Indians to name it "Wal-hon-de-cepe." The historian, J.P. Hale or his informant, mistakenly translated this and the Miami name, "Wa-len-de-co-ni-cepe" as "Hill Creek" (Hale 1886:50). However, "Walhond" means "ditch" and "Walhondi" is the adjectival form. "Sipu/sipo/sipi" or, in Hale's version, "cepe" translates as "stream." A modern Delaware speaker would have no trouble recognizing "Walhondi Sipu" in Hale's word and would have no difficulty translating the word as "Ditch-like Stream." The Walhonding River in Ohio is named similarly, only the "ing" suffix translates as "locale/place." So "Walhonding" translates as "Ditch Place."

The first recorded European exploration into the watershed was made by a party headed by John Howard with John Peter Salley/Salling as their guide. Salley, a German pioneer, was captured by Cherokees in 1736 while he was hunting in the area of present-day Salem, VA. He escaped and in 1740 he moved his family to the frontier in the vicinity of Natural Bridge in the James River watershed. Howard hired Salley to guide his expedition of discovery in the winter of 1742. Salley recounted his route from memory in 1745 after returning from French captivity. His description seems to place his party in a buffalo-skin boat from the vicinity of Radford, Virginia to Kanawha Falls, West Virginia, thence overland to the headwaters of Coal River. Salley's account was recorded in William M. Darlington's book, *Christopher Gist's*

Figure 3. Ecoregions of the Coal River Watershed



Journals, published in 1893. In Salley's own words we read:

> "We went then a south west course by Land eighty five miles [Salley's memory of mileages was greatly inflated on every account or else his English-speaking recorder mistranslated his standard of length measurement], where we came to a small river and there we made a little Boat which carried only two men and our provisions. … Where we came to this river the country is mountainous, but the

> farther down the plainer, in those mountains we found great plenty of coals, for which we named it Coal river … ."

In the winter of 1755-56, Virginia Colonial Governor, Robert Dinwiddie (an Ohio Company official), ordered a military expedition against the Shawnees living at Lower Shawnee Town (near present-day Portsmouth, Ohio). The expedition nearly ended in total disaster and men made their ways back home as best they could in small foraging parties. One of these parties included Samuel Cole, who, along with his starving mates, steered an eastward course from Tug Fork through the Coal River watershed. They carved their names on a beech tree near the confluence of Marsh and Clear Forks. For 100+ years the beech tree and its signatures testified to the passage of the desperate Virginians. Their names were still visible when the tree was felled in 1882 or 1883 by someone intent on clearing his land. It was after the militiamen's journey that the stream became known by the moniker "Cole River." The spelling of this name was eventually changed to the one most familiar today, the same as that given it by John Salley as mentioned earlier (Hale, 1886:50).

Long before these early white explorers scrambled through the rugged fastness of the upper Coal River watershed, red folk called the land "home." The watershed had been continually occupied by Amerindians for at least 9,000 years. A few scattered earthworks, primarily in the valley of the lower Coal River mainstem, revealed the presence of Adena culture people in the watershed for several hundred years. Evidence from these sites as well as that from rock overhang shelters, show that the diets of ancient and historic Indians included a good deal of deer meat and freshwater mussels.

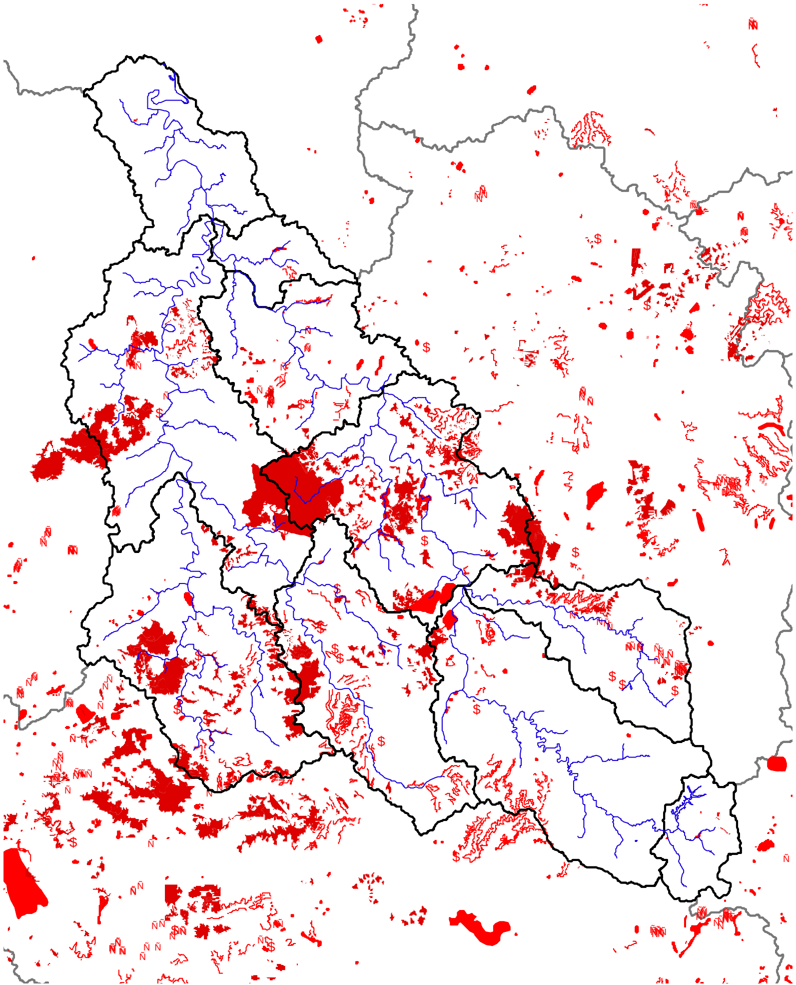
The native mussel assemblage of the watershed was adversely impacted by sediment runoff from agricultural development in the 19th and early 20th centuries. The rapid expansion of the coal industry in the latter half of this century, especially surface mining, has continued this harmful sedimentation process and prevented the native mollusks from repopulating.

In the 1800s , the lower Coal River was altered to support navigation by construction of eight locks and dams. These structures suffered from neglect during the Civil War to the point they were never again operable (Harris). Remnants of these locks and dams can still be seen along Coal River, especially just upstream from Lower Falls, some five miles from the mouth of the river.

As of January 1998, there were at least 103 NPDES discharge permits in effect within the Coal River watershed. Of these, 87 were coal companies, nine were sewage treatment plants and six were other discharges.

Coal mining continues to be the major industry in the basin. Large surface mines and mountaintop removal mining has increased dramatically in the last two decades. Boone County, which comprises about 56 % of the watershed, went from producing 4.2 million tons of coal via surface mining in 1982 to 8.4 million tons int 1998 . The increase in surface mining has followed the technological trend of increasing size and efficiency of earth moving equipment. Mountaintop / surface mining allows extraction of coal from seams that are too thin to be mined using underground methods. The excess rock material that is removed (overburden) is often placed in valley fills, burying an estimated 750 miles of streams to date.

Figure 4. Mining in the Coal River Watershed

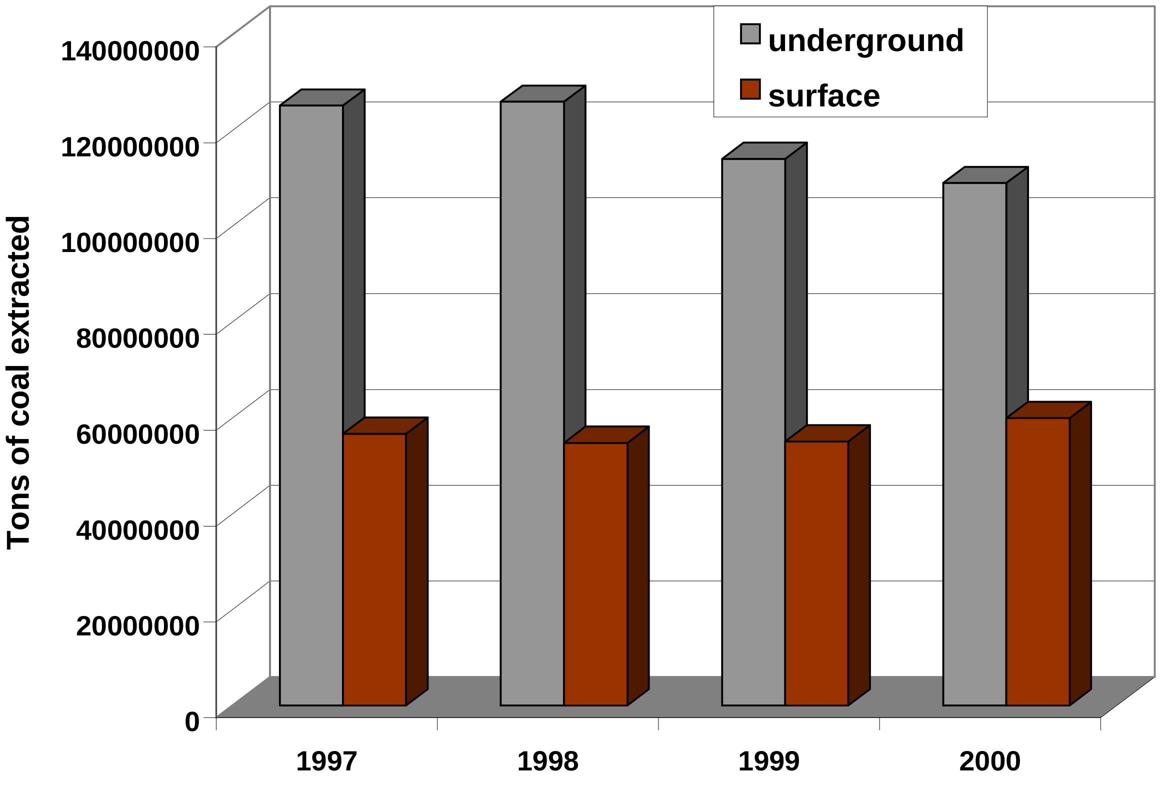


Map shows the extent of coal mining in the watershed, and includes several GIS layers that are available from the Division of Mining and Reclamation. Layers includes surface mining, valley fills, and bond forfeiture sites.

The amount of coal extracted from West Virginia has declined slightly in the past three years. The overall decline in the extraction of coal in the state is attributable to decreases in undergound mining, not surface mining. In fact, the amount of coal extracted from surface mining increased from 1997 to 2000 by 9.4 percent (see Figure 5). During this same time the amount of coal taken from underground mines decreased by 13.5 percent (from the WV Office of Miners Health and Safety and Training's web page)

The largest population centers in the Coal River Watershed are Madison (3,051) and Danville (595) in Boone County, and St. Albans (11,194) in Kanawha County. The latter city's population is split between the Coal River and Lower Kanawha River watersheds. Route 119 (Corridor G) runs parallel to Little Coal River from near the Forks of Coal upstream to Danville. Development along this four-lane highway has increased tremendously in the last few years, however, most of the development has been in the adjacent Lower Kanawha River watershed.

Figure 5. Trends in the coal mining industry



(from the WV Office of Miners Health and Safety and Training's web page)

Watershed Assessment Methods

In 1989, the U.S. EPA published a document entitled Rapid Bioassessment Protocols for Use in Streams and Rivers - Benthic Macroinvertebrates and Fish (Plafkin et al. 1989). This document was intended to provide water quality monitoring programs such as WVDEP-WAP with a practical technical reference for conducting cost-effective biological assessments of flowing waters.

Originally, the Rapid Bioassessment Protocols (RBP) were intended to be inexpensive screening tools to determine if a stream was supporting a designated aquatic life use. However, the current consensus is that the RBPs can also be applied to other program areas, such as:

- Characterizing the existence and severity of use impairment
- Helping to identify sources and causes of impairments in watershed studies
- Evaluating the effectiveness of control actions
- Supporting use attainability studies
- Characterizing regional biological components.

The diversity of applications provided by the RBPs was the primary reason the Program adopted one for use in assessing watersheds in West Virginia. The EPA published a second edition of the RBP manual in 1999 (Barbour, et. al.,1999). Our program adopted many of the recommended changes for the 1998 sampling season, a year ahead of the publication date, based on a draft version of the manual. The changes were minor, consisting mainly of a reconfiguration of the habitat assessment and a different way of categorizing levels of effort for the benthic collections. Because the vast majority of streams in the state have some riffle/ run habitat, the Single Habitat Approach was the benthic collection method adopted by the program.

Benthic communities from the Coal River Watershed were sampled according to our earlier protocols. These were basically the same as those used for the Single Habitat Approach, with accommodations for sampling slow moving streams that lack riffle/run habitat. These “MACS” sites (so-called because of the Mid-Atlantic Coastal Streams methodolgy employed) were difficult to interpret and the Program decided to not collect benthos at sites that lacked riffle / run habitat after the 1999 sampling season.

The following sections summarize the procedures used to assess the streams in this watershed. A more detailed description of the assessment procedures is in the Watershed Assessment Program's Standard Operating Procedures, available by contacting the Program.

Biological Monitoring — Benthic Macroinvertebrates

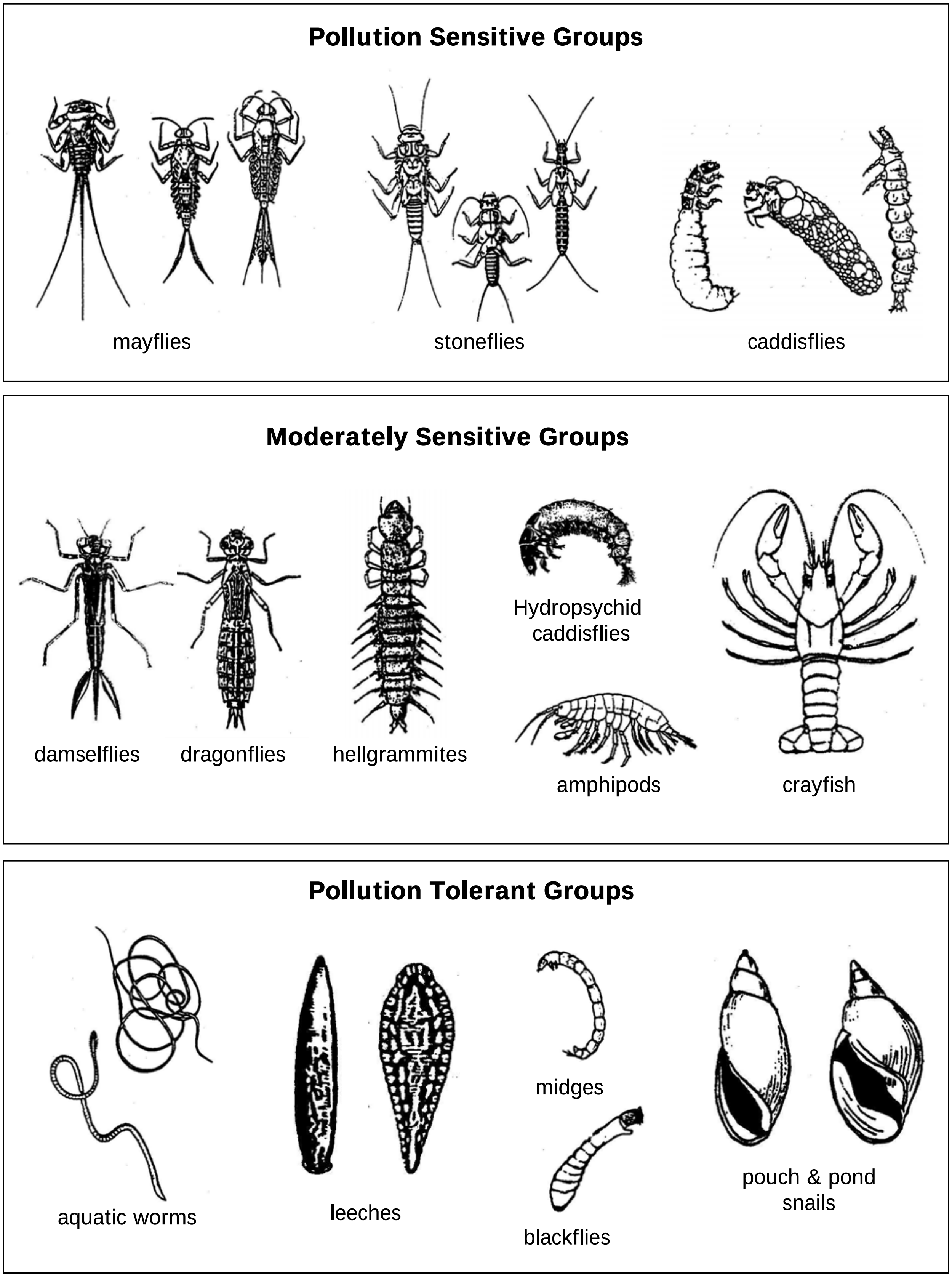
Benthic macroinvertebrates are small animals living on the bottom of streams, rivers, and lakes. Insects comprise the largest diversity of these animals and include mayflies, stoneflies, caddisflies, beetles, midges, crane flies, dragonflies, and others. Snails, mussels, aquatic worms and crayfish are also members of the benthic macroinvertebrate community. Benthic macroinvertebrates are important in the processing and cycling of nutrients, and are major food sources for fish and other aquatic animals.

In general, a clean stream has a diverse array of benthic organisms that occupy a variety of ecological niches. Polluted streams generally are low in diversity and often are devoid of pollution sensitive species.

Benthic macroinvertebrate data has been used for several decades as a tool for conducting ecological assessments of streams. Many federal, state and private organizations use this group of animals as part of their biological monitoring programs. The advantages are myriad. The most recognized benefit is that benthic macroinvertebrate communities reflect overall ecological integrity (i.e., chemical, physical, and biological integrity). They provide a holistic measure of environmental condition by integrating responses to stresses over time, and the public better understands them (as opposed to chemical conditions) as measures of environmental health (Plafkin et al. 1989). Figure 6 shows some of the more common macroinvertebrates collected from West Virginia streams.

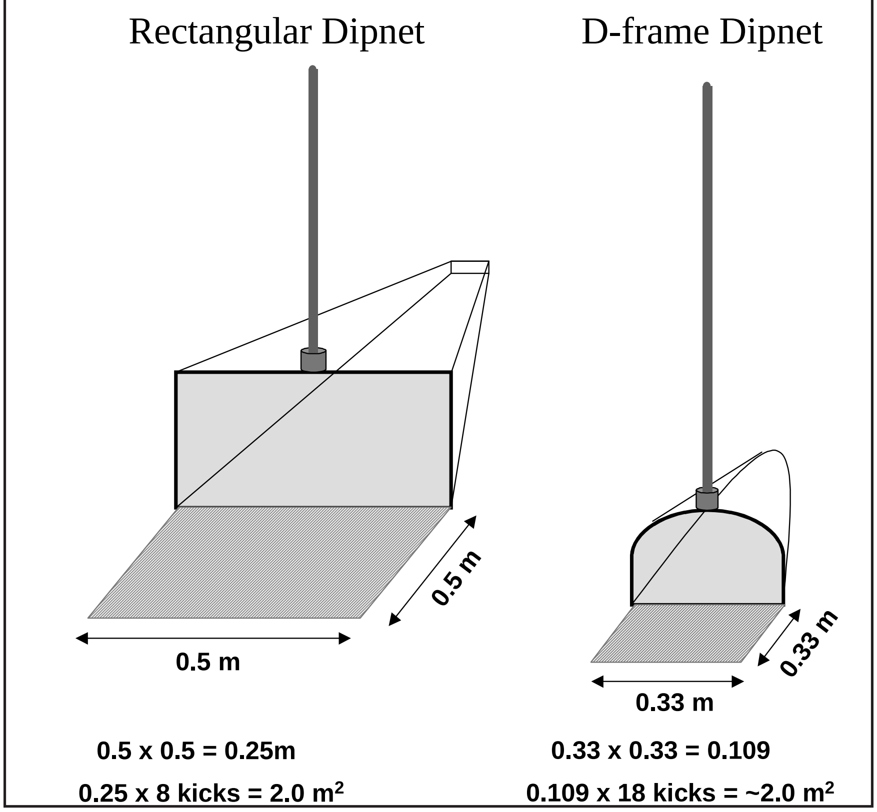
Benthic macroinvertebrates can be collected using several techniques. In 1997, the program used EPA's RBP II with some modifications. The two-man kick net of the original RBP was replaced with a kick net modified for use by one person. In streams having adequate riffle/run habitat, the Program used the rectangular kick net (Surber-on-a-stick) to capture organisms dislodged by kicking the stream bottom substrate and rubbing large rocks and sticks. In streams too small to accommodate the rectangular dipnet, a smaller net called a D-frame was used to collect dislodged organisms (See Figure 7). Riffle/run streams with low flow that did not have enough water to sample with either net were sampled using a procedure

Figure 6. Common Benthic Macroinvertebrates



called hand picking. This procedure involves picking and washing stream substrate materials in a bucket of water. Field crews attempted to sample two square meters of stream substrate (an area equal to eight kicks with a rectangular dipnet) regardless of the device or technique employed.

Figure 7. Benthic Collection Nets



The D-frame net was also used to collect macroinvertebrates in slow flowing (glide/pool) streams that did not have riffle/run habitat. Sampling of macroinvertebrates in glide/pool streams was accomplished using a procedure developed for use in sluggish coastal streams. The sampling procedure is called the Mid-Atlantic Coastal Streams technique (MACS) and consists of sampling a variety of habitats (aquatic plants, woody debris, undercut stream banks, etc) through sweeping and jabbing motions of the net (Maxted 1993).

Benthic macroinvertebrate samples were preserved and delivered to the Department of Biological Sciences at Marshall University for processing. Processing involved removing a 100-organism subsample from the composite sample following RBP II protocols. The subsample was returned to Program biologists who counted and identified the specimens to the family or the lowest level of classification possible. The samples were kept for future reference and for identification to lower taxonomic levels if necessary.

Fish specimens inadvertently collected during macroinvertebrate sampling were transferred to the DNR Office in Elkins, West Virginia, where they became part of the permanent fish collection. Salamanders inadvertently collected were donated to the Marshall

University Biological Museum in care of Dr. Tom Pauley.

The Program's primary goal in collecting macroinvertebrate data was to determine the biological condition of the selected stream assessment sites. Determining the biological condition of each site involved calculating and summarizing six-community metrics using the benthic macroinvertebrate data. The following benthic community metrics were used for each assessment site:

Richness Metrics

1. Total taxa - measures the total number of different macroinvertebrate taxa collected in the sample. In general, the total number of taxa increases with improving water quality.

2. EPT taxa - measures the total number of distinct taxa within the generally pollution sensitive groups Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies). In general, this value increases with improving water quality.

Community Composition Metrics

3. Percent Contribution of Two Dominant Taxa - measures the relative abundance of the two numerically dominant taxa to the total number of organisms in the sample. Generally this value decreases with improving water quality.

4. Percent EPT – measures the relative abundance of mayfly, stonefly, and caddisfly individuals to the total number of organisms in the sample. In general, this value increases with improving water quality.

Benthic Community Metrics

Metrics are calculations that numerically describe the benthic community of streams. Some metrics are simple summations such as taxa richness; a measure of the total number of different kinds of organisms in a sample.

Other metrics are more complex such as Hilsenhoff's Biotic Index, which incorporates pollution tolerance values of collected organisms to provide a number that assesses organic pollution in streams.

The Program currently uses six metrics to determine the health of benthic macroinvertebrate communities. The use of several metrics provides a greater assurance that a valid assesssment of health has been reached because several components of community structure are measured**.**

5. Percent Chironomidae – measures the relative abundance of chironomid (midges) individuals to the total number of individuals in the sample. Chironomids are considered to be tolerant to many pollutant sources. This metric generally decreases in value with improving water quality.

Tolerance/Intolerance Metric

6. HBI (Hilsenhoff's Biotic Index - modified) - summarizes tolerances of the benthic community to organic pollution. Tolerance values range from 0 to 10 and generally decrease with improving water quality.

These metrics were used because: 1) they provide the best discrimination between impaired and non-impaired or reference sites; 2) they represent different community attributes; and 3) they minimize redundancy.

Stream Condition Index

The six benthic community metrics were combined into a single index, The West Virginia Stream Condition Index (WVSCI). The WVSCI was developed by Tetra Tech Inc. (Gerritsen et al, 2000) using WVDEP-WAP and EPA's EMAP data collected from riffle habitats in wadeable streams from throughout West Virginia.

The WVSCI score is determined by averaging the standardized score of each metric. The standardized score for metrics is determined by comparing an individual metric value to the best standard value. This value is the 95th or 5th percentile (depending on whether the metric scores high or low for healthy streams) of all sites sampled with comparable methods. In general terms, all metrics values were converted to a standard 0 to 100 (worst to best) scale. The six standardized metric scores were then averaged for each benthic sample site to come up with a final index score that ranges from 0 to 100.

In order to be able to interpret the WVSCI score, the Program needed to establish a reference condition. In previous assessments, the Program used either a *single least impaired site* or a *set of sites* based on both stream width and ecoregion as the reference condition. As the Program progressed, it became clear that it was difficult to identify a single reference site that had both (1) minimal impairment and (2) the type of biological community that would provide defensible conclusions about the impairment of assessed sites.

As a result, the Program began using a collection of streams that met predetermined minimum impairment criteria to define the reference condition. Reference conditions were established by comparing the habitat and physico-chemical data of each assessment site to a list of minimum degradation criteria or reference site criteria. Assessment sites that met all of the minimum criteria were given reference site status. The Program developed the degradation criteria with the assumption that sites meeting these criteria would provide a reasonable approximation of the least disturbed conditions.

Originally, the Program was using a set of sites limited to the watershed being studied. Subsequent research showed that a single reference set for wadeable streams is sufficient for statewide assessments (Gerritson 2000). They found that partitioning streams into ecoregions does not significantly improve the accuracy of assessments. The Program currently has 107 reference sites it uses to describe the reference condition. The reference condition is then used to establish a threshold for biological impairment. This reference condition can be used statewide, in all wadeable streams, and throughout the established sampling period of April through October.

The reference sites are used to determine the score that represents the threshold between impaired and non-impaired sites. The 5th percentile of the WVSCI scores for all of the reference sites was selected as determining this impairment threshold. The 5th percentile for the 107 reference sites was 68. The 25th percentile of the reference sites was selected as a threshold to indentify the least impacted streams.

Initially, a site that received a WVSCI score equal to or less than 68 was considered impaired. However, the final WVSCI score can be affected by a number of factors (collector, micro-habitat variables, subsampling, etc.) and the Program decided it needed to assess this variability. Twenty six sites were sampled in duplicate to determine

Reference Condition

Reference conditions describe the characteristics of waterbody segments least impaired by human activities and are used to define attainable biological and habitat conditions. Final selection of reference sites depends on a determination of minimal disturbance, which is derived from physico-chemical and habitat data collected during the assessment of the stream sites.

A site must meet least disturbed criteria established by the Program before it is given reference site status. In general, the following parameters are examined: dissolved oxygen, pH, conductivity, fecal coliform bacteria, violations of water quality standards, non-point sources (NPS) of pollution, benthic substrate, channel alteration, sediment deposition, streambank vegetation, riparian vegetation, overall habitat condition, human disturbances, point sources of pollution, and land use.

The information from the sites that meet the defined criteria is used to establish a reference condition. Benthic macroinvertebrate data from each assessment site can then be compared to the reference condition to produce a WVSCI score for each site.

the precision of the scoring. Following an analysis of the duplicate data, the Program determined the precision estimate to be 7.4 WVSCI points. The Program then subtracted 7.4 points from the impaired threshold of 68 and generated what is termed the gray zone that ranges from 60.6 to 68.0. If a site had a WVSCI score within the gray zone, a single kick sample was considered insufficient for classifying it as impaired. If a site received a WVSCI score equal to or less than 60.6, the Program was confident that the site was truly biologically impaired based on a single benthic macroinvertebrate sample. Accordingly, sites recieving the lowest WVSCI scores are the most impaired.

The impairment threshold and impairment categories developed within the WVSCI are important tools the Program uses in making important management decisions and steering limited resources to the streams that need them most. For the purposes of this report, the Program considered all impaired sites and sites with WVSCI scores in the gray zone to be in need of further investigation and/or corrective action.

Fecal Coliform Bacteria

Numerous disease-causing organisms may accompany fecal coliform bacteria, which is released to the environment in feces. Thus, the presence of such bacteria in a water sample indicates the potential presence of human pathogens.

A fecal coliform bacteria sample was collected at each assessment site. U.S. EPA sampling guidelines limit the field holding time for such samples to six hours. Due to the distance to laboratories, personnel limitations and time constraints, 24 hours was the limit utilized during this sampling effort. All bacteria samples were packed in wet ice until delivered to the laboratory for analysis.

Physico-Chemical Sampling

Physico-chemical samples were collected at each site to help determine what types of stressors, if any, were negatively impacting the benthic macroinvertebrate community. They were also helpful in providing clues about the sources of stressors.

Field analyses for pH (standard units), temperature (°C), dissolved oxygen (mg/l) and

TABLE 1: WATER QUALITY PARAMETERS

All numbered references to analytical methods are from either EPA: Methods for Chemical Analysis of Water and Wastes; March 1983 unless otherwise noted.

Parameter	Minimum Detection Limit or Instrument Accuracy	Analytical Method	Maximum Holding Time
Acidity	5 mg/l	305.1	14 days
Alkalinity	5 mg/l	310.1	14 days
Sulfate	5 mg/l	375.4	28 days
Iron	200 µg/l	200.7	6 months
Aluminum	100 µg/l	200.7	6 months
Manganese	10 µg/l	200.7	6 months
Fecal Coliform Bacteria	Not Applicable	9222 D[1]	24 hours[2]
Conductance	1% of range[3]	Hydrolab™	Instant
pH	± 0.2 units[3]	Hydrolab™	Instant
Temperature	± 0.15 C[3]	Hydrolab™	Instant
Dissolved Oxygen	± 0.2 mg/l[3]	Hydrolab™	Instant
Total Phosphorus	0.02 mg/l	4500-PE[1]	28 days
Nitrite+Nitrate-N	0.5 mg/l	353.3	28 days
Ammonia-N	0.5 mg/l	350.2	28 days
Unionized Amm-N	0.5 mg/l	350.2	28 days
Suspended Solids	5 mg/l	160.2	28 days
Chloride	1 mg/l	325.2	28 days

[1] **Standard Methods For The Examination Of Water And Wastewater, 18th Edition, 1992.**

[2] **U. S. EPA guidelines limit the holding time for these samples to six hours. Due to laboratory location, personnel limitations and time constraints, 24 hours was the limit utilized during this sampling effort.**

[3] **Explanations of and variations in these accuracies are noted in Hydrolab Corporation's Reporter ™ Water Quality Multiprobe Operating Manual, May 1995, Application Note #109.**

conductivity (umhos/cm) were performed. The manufacturer's calibration guidelines were followed with minimal variation, except that the instruments were generally not calibrated at the end of each sampling day.

Samples were collected at many sites for analysis of specific water quality parameters. A list of these constituents, preservation procedures, and analytical methods is included in Table 1.

In areas where mine drainage was present, assessment teams collected water samples for the analyses of aluminum (Al), iron (Fe), and manganese (Mn). In a few cases, samples were analyzed for hot acidity (mg/l), alkalinity (mg/l), and sulfate (mg/l). Water samples were collected in conjunction with the habitat assessment and benthic macroinvertebrate sampling.

Assessment teams measured stream flow in cubic feet per second (cfs) when field readings indicated that there was mine drainage impacting the stream. A current meter was used across a stream transect and the discharge was calculated with the sum-of-partial-discharges method.

The collection, handling, and analysis of water samples generally followed procedures approved by the U.S. EPA. Field blanks for water sample constituents were prepared on a regular basis by each assessment team. The primary purpose of this procedure was to check for contamination of preservatives, containers, and sample water during sampling and transporting. A secondary purpose was to check the precision of analytical procedures.

Physical Habitat

An eight page Stream Assessment Form (Appendix B) was completed at each site. A 100 meter section of stream and the land in its immediate vicinity were qualitatively evaluated for instream and streamside habitat conditions. The assessment team recorded the location of each site, utilizing GPS (global positioning system) when possible, and provided detailed directions so future researchers may return to the same site. A map was sketched to aid in locating each site. The team recorded stream measurements, erosion potential, possible nonpoint source pollution, and any anthropogenic activities and disturbances. They also recorded observational data about the substrate, water, and riparian zone.

An important part of each assessment was the completion of a two page Rapid Habitat Assessment (from EPA's EMAP-SW, Klemm and Lazorchak, 1994), which provided a numerical score of the habitat conditions most likely to affect aquatic life. This information provided insight into what macroinvertebrate taxa may be present or expected to be present at the sample site. It also provided information on any physical impairments to the stream habitat that were encountered during the assessment. The following 12 parameters were evaluated:

- Instream cover (fish)
- Benthic substrate
- Embeddedness
- Velocity/depth regimes
- Channel alteration
- Sediment deposition
- Riffle frequency
- Channel flow status
- Bank condition
- Bank vegetative protection
- Bank disruptive pressure (grazing)
- Riparian vegetation zone width.

A Rapid Habitat Assessment data set is a valuable tool because it provides a means of comparing sites to one another. Each parameter was given a score ranging from 0 to 20. Table 2 describes the categories that are used to rate each parameter:

Table 2. Scoring for Rapid Habitat Assessment parameters

Optimal (score 16-20)	Habitat quality meets natural expectations.
Sub-optimal (score 11-15)	Habitat quality is less than desirable but satisfies expectations in most areas.
Marginal (score 6-10)	Habitat quality has a moderate level of degradation; severe degradation at frequent intervals.
Poor (score 0-5)	Habitat is substantially altered; severe degradation

The 12 individual scores for each parameter were summed (maximum possible = 240) and this number provided the final habitat condition score for each assessment site. The habitat condition score and WVSCI score for each site were plotted on an XY graph (see Figures 10a, 10b, and 10c).

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Assessment Results

General Overview

Assessment teams visited 100 sites in the Coal River Watershed between September 15 and October 8, 1997. Figure 8 shows the sample sites locations, and Table 4 in Appendix A contains additional locational data.

Seventy-eight (approximately 13% of the named streams in the watershed) were visited (see Table 3). Some of the longer streams were sampled more than once. A total of 100 sites were visited. Field teams (usually two persons) collected benthic macroinvertebrate samples at each site following Rapid Bioassessment Protocol II (RPB II) (Plafkin, et. al., 1989).

TABLE 3: SAMPLING SUMMARY

Named streams	**589**
Streams visited	**78**
Sites visited	**100**
Habitat assessed	**95**
Water quality sampled	**103**
Benthic macroinvertebrates collected	**91**

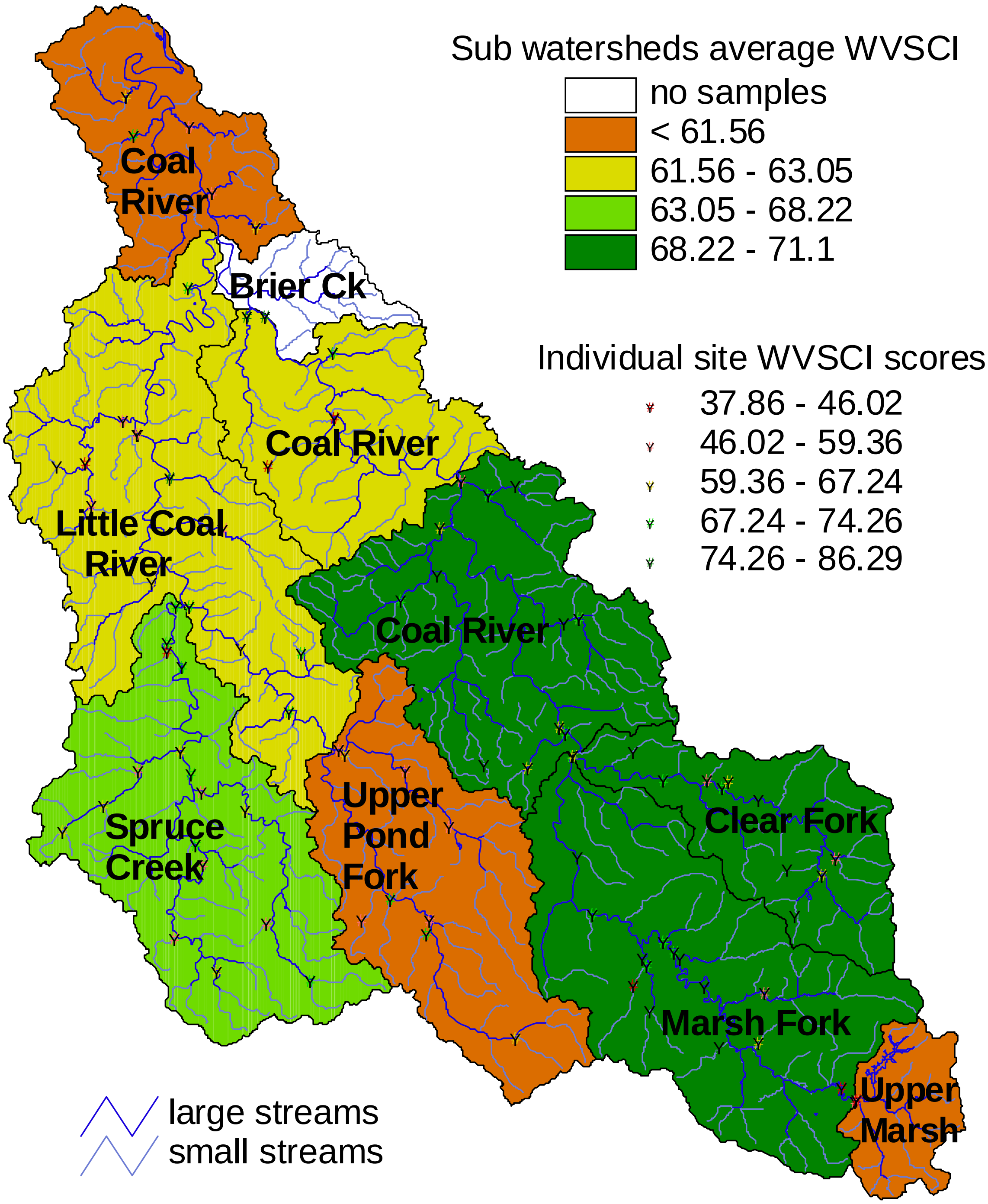
Benthic Macroinvertebrates

Benthic macroinvertebrate samples were collected at 91 of the 100 sites visited and three of the sites produced duplicate samples for a total of 94 samples collected. Ten samples were considered non-comparable because of variations in sampling techniques. For the purposes of this report, comparable means collected from similar habitat, from equal sampling area, and using the same sampling device and technique.

The number of distinct family level taxa identified from all samples in the watershed was 80. The most common taxa collected in the Coal Watershed are shown in Figure 11. A list of the benthic macroinvertebrates collected at each assessment site is presented in Table 10 of Appendix A.

Figure 8. Sample site locations

Figure 9. Average WVSCI scores by sub-watershed (11 digit HUC watersheds.



The West Virginia Stream Condition Index (WVSCI) score for each benthic sample is graphically presented in Figures 10a, 10b, and 10c. The Program utilized these XY graphs as a means of summarizing the relationship between biological condition and habitat condition. In order to reduce crowding on the graphs, the benthic sampling sites were divided and presented on three XY graphs. Figure 10a presents the data from Coal River mainstem and tributaries (excluding the Little Coal River subwatershed), and Big Coal River mainstem and tributaries (excluding the Marsh Fork and Clear Fork subwatersheds). Figure 10b presents the Little Coal River subwatershed data, and Figure 10c presents those of the Marsh Fork and Clear Fork subwatersheds.

A total of 84 comparable benthic samples are presented on the three graphs. Considering the entire watershed, a total of 26 (approximately 31%) comparable samples received a WVSCI value of less than 60.60 (Table 9 shows the metrics and final WVSCI score for each site). As mentioned previously, an assessment site receiving a SCI value of less than 60.60 was considered biologically impaired and in need of further investigation and/or corrective action. A site receiving a value greater than 68.00 was considered unimpaired.

An explanation of the findings for the biologically impaired streams is presented in the “Discussion of Impairments” section of this chapter. All the data referred to in the discussion (i.e., benthic metrics, physico-chemical data, and habitat data) can be found in Appendix A.

Of the 84 comparable samples, 41 received a WVSCI value greater than 68.00. In other words, approximately 49% of the samples were considered biologically unimpaired. The percentage found to be impaired or potentially impaired was 51% (43 of 84). The data can be clustered in numerous ways depending on what a researcher wishes to investigate. If the data are clustered according to subwatershed location, relative biological health of the subwatersheds can be investigated, at least minimally.

Overall, the Little Coal River subwatershed samples did not compare favorably to the rest of the watershed. The subwatershed had a majority of its samples (68% of 35 samples) fall below the “benthologically impaired” value (31% were unimpaired). Compare these figures to those of the rest of the watershed: approximately 61% unimpaired and 38% (11 of 49 samples) impaired. Since there were more than one methodology used to select sample sites, these percentages are not free from biases, but they should serve to interest future investigators in determining whether or not there are significant differences in biological health between the subwatersheds.

There appeared to be a weak, positive correlation between habitat scores and WVSCI values in the Coal River watershed exclusive of the Little Coal River subwatershed. No correlation was evident in the Little Coal River subwatershed. This is evidence, albeit weak, that in the Little Coal River subwatershed, something other than habitat quality is controlling the benthological health of some of its streams.

Ten samples scored above 78. This is the value above which samples are considered in very good condition. None of these were from sites in the Little Coal River subwatershed. From these 10 relatively high-scoring samples, no clear correlations were derived. The sites they were taken from ranged from less than one meter wide to slightly greater than 18 meters wide. Conductivities ranged from 217 to 836 mmhos/cm. Habitat scores varied, but a large majority fell within the suboptimal range.

There were 4 samples that produced WVSCI values below 45. None were from the Little Coal River subwatershed. Marsh Fork at mile point 32.8 (KC-46-{32.8}) and Millers Camp Branch (KC-46-Q) are located in the Marsh Fork subwatershed. Brush Creek (KC-21) drains directly into the Coal River mainstem and Ridgeview Hollow (KC-21-C) is a tributary of Brush Creek.

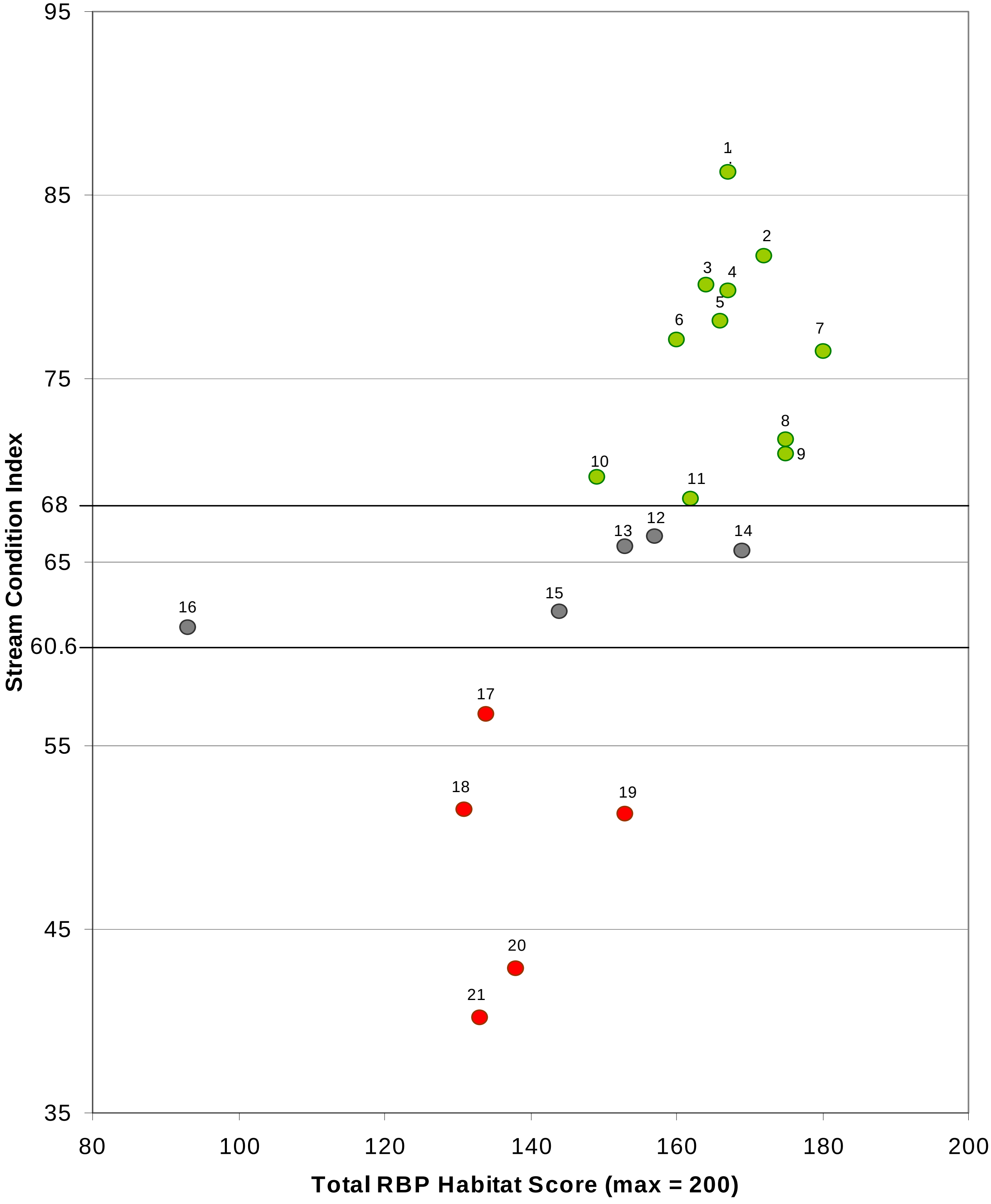
No samples produced WVSCI scores below 22, indeed, none scored below 40.00. Therefore, none were of a certainty in very poor condition.

Comparing benthic data that were obtained using different sampling techniques is not appropriate within the Program’s current analysis procedure. Therefore, sites with non-riffle/run (kick sampled) benthic data must be analyzed separately.

In general, the biological condition of non-comparable sites is determined using best professional judgement after carefully considering biological, physico-chemical and habitat data. Ten sites were sampled using non-comparable methods (see Table 4). Smith Creek (KC-4-{2.5}) and Falls Creek (KC-5) were sampled incompletely using the riffle/run D-net sampling technique. Only eight of the required 10 kicks were made at each. Smith Creek scored lower on both habitat (111) and WVSCI (49.89) categories than did Falls Creek (143 & 70.42, respectively). Water quality constituents were similar, so habitat may be implicated as one of the contributors to Smith Creek’s poorer showing compared to Falls Creek. Although the outcome of a full sampling procedure on Falls Creek cannot be predicted, it appears likely

(continued on page 41)

Figure 10a. Benthic health versus habitat condition. Sites from mouth to Whitesville (excluding Little Coal River).



Site information for Figure 10a.

Chart #	Stream Name	Stream Code	WVSCI	RBP Total
1	HOPKINS FORK	WVKC-31-B-{10.9}	86.29	167
2	COAL RIVER	WVK-34-{58.4}	81.70	172
3	BIG COAL RIVER	WVK-34-{23.8}	80.15	164
4	SPICELICK FORK	WVKC-29-A-3	79.78	167
5	FORK CREEK	WVKC-14	78.11	166
6	HOPKINS FORK	WVKC-31-B-{0.2}	77.16	160
7	COAL RIVER	WVK-34-{58.4}	76.46	180
8	COLD FORK	WVKC-31-C	71.71	175
9	LEFT FORK OF WHITE OAK CREEK	WVKC-35-F	70.92	175
10	LEFT FORK JOES CREEK	WVKC-29-A	69.64	149
11	LEFT FORK/BULL CREEK	WVKC-16-A	68.49	162
12	ELK RUN	WVKC-43-{0.0}	66.42	157
13	ELK RUN	WVKC-43-{2.8}	65.89	153
14	LAUREL CREEK	WVKC-31-{0.4}	65.63	169
15	ALUM CREEK	WVKC-11-{5.6}	62.30	144
16	BROWNS CREEK	WVKC-2-{2.0}	61.48	93
17	JOES CREEK	WVKC-29	56.73	134
18	CROOKED CREEK	WVKC-9	51.56	131
19	WHITE OAK CREEK	WVKC-35-{3.0}	51.34	153
20	BRUSH CREEK	WVKC-21-{0.0}	42.86	138
21	RIDGEVIEW HOLLOW	WVKC-21-C	40.21	133

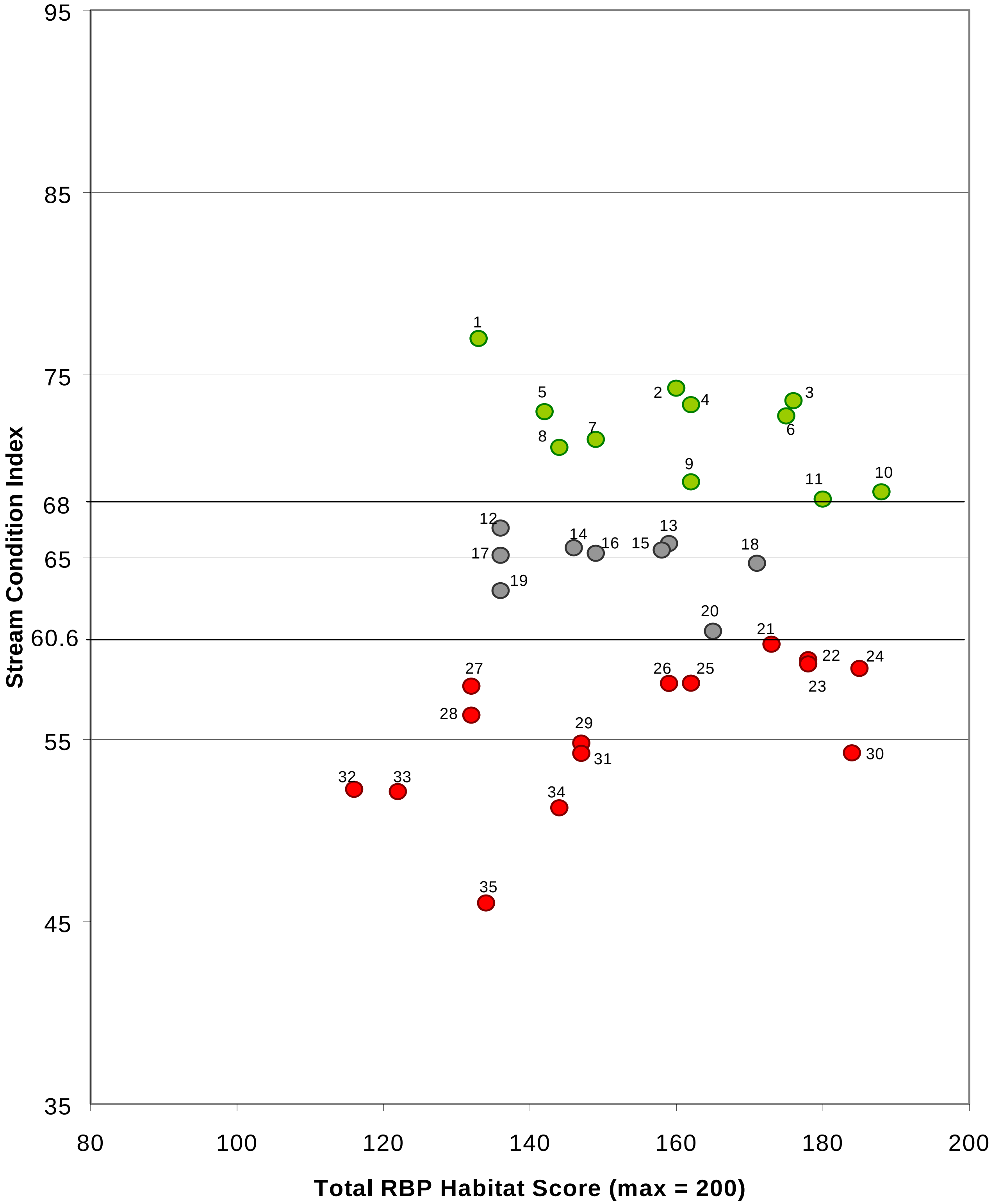
INTERPRETING X-Y GRAPHS

Habitat quality is an important measurement in biological surveys because aquatic animals often have specific habitat requirements independent of water quality.

A point on an XY Graph represents two numbers, one for the WV Stream Condition Index score on the Y axis (vertical axis), and one for the habitat condition score on the X axis (horizontal axis). The upper right-hand section of the graph is the ideal situation where optimal habitat quality and biological condition exist. The upper left-hand corner of the graph is where optimal biological condition is generally not possible due to severely degraded habitat.

The lower left-hand portion of the graph is where habitat quality is poor and further degradation may result in relatively little difference in biological condition. The lower right-hand corner of the graph is often considered the most important since this is where degraded biological condition can be attributed to something other than habitat quality (i.e., chemical pollutants). (Adopted from Barbour et al. 1996)

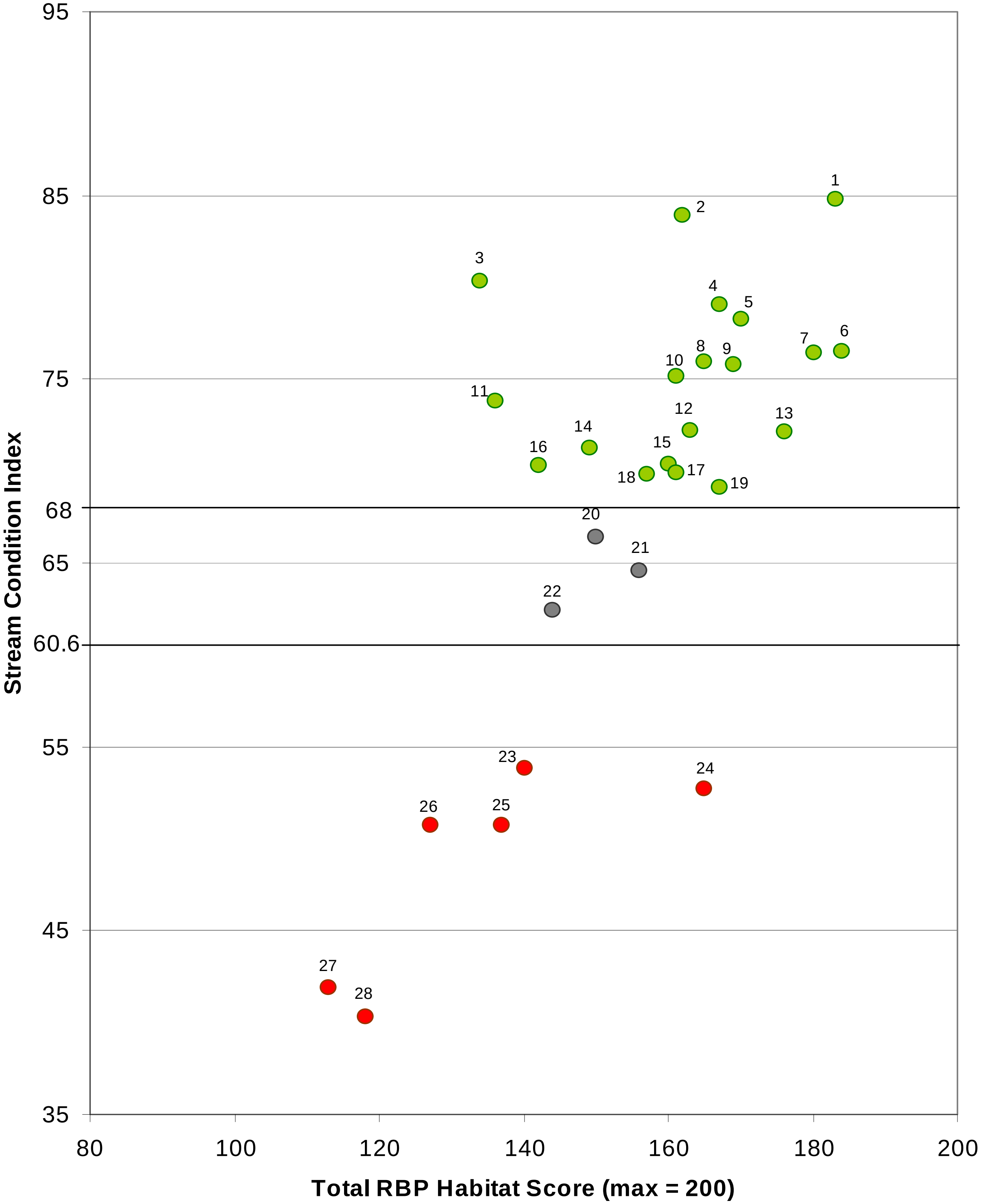
Figure 10b. Benthic health versus habitat condition. Sites in Little Coal River Watershed



Site information for Figure 10b.

Chart #	Stream Name	Stream Code	WVSCI	RBP Total
1	CAMP CREEK	WVKC-10-L	76.98	133
2	LITTLE COAL RIVER	WVKC-10-{03.6}	74.26	160
3	POND FORK	WVKC-10-U-{0.4}	73.57	176
4	BENNETT FORK	WVKC-10-U-3-B	73.35	162
5	SPRUCE FORK	WVKC-10-T-{4.6}	72.97	142
6	JASPER WORKMAN BRANCH	WVKC-10-U-17	72.75	175
7	SPRUCE FORK	WVKC-10-T-{0.3}	71.46	149
8	LAUREL BRANCH	WVKC-10-T-2	71.01	144
9	GRAPEVINE BRANCH	WVKC-10-U-13	69.12	162
10	SPRUCE LAUREL FORK	WVKC-10-T-11-{15.3}	68.58	188
11	SPRUCE FORK	WVKC-10-T-{17.4}	68.19	180
12	ISOM BRANCH	WVKC-10-T-9-B.5	66.59	136
13	ROACH BRANCH	WVKC-10-U-7-A	65.74	159
14	LITTLE COAL RIVER	WVKC-10-{17.0}	65.50	146
15	HEWITT CREEK	WVKC-10-T-9	65.38	158
16	HEWITT CREEK	WVKC-10-T-9	65.20	149
17	LONG BRANCH	WVKC-10-P-.5	65.10	136
18	POND FORK	WVKC-10-U-{4.9}	64.66	171
19	RATTLESNAKE HOLLOW	WVKC-10-I-6-C	63.16	136
20	LACEY BRANCH	WVKC-10-U-21	60.93	165
21	SPRUCE LAUREL FORK	WVKC-10-T-11-{4.1}	60.21	173
22	POND FORK	WVKC-10-U-{24.4}	59.36	178
23	TRACE FORK/COW CREEK	WVKC-10-U-12-A	59.13	178
24	ADKINS FORK	WVKC-10-T-21	58.89	185
25	SPRUCE LAUREL FORK	WVKC-10-T-11-{0.2}	58.08	162
26	WEST FORK	WVKC-10-U-7-{0.0}	58.07	159
27	ROCK CREEK	WVKC-10-N-{3.0}	57.91	132
28	MISSOURI FORK/HEWITT	WVKC-10-T-9-B	56.32	132
29	BIG HORSE CREEK	WVKC-10-I-{12.5}	54.79	147
30	SPRUCE FORK	WVKC-10-T-{18.5}	54.25	184
31	WEST FORK OF POND FORK	WVKC-10-U-7-{7.9}	54.22	147
32	LITTLE HORSE CREEK	WVKC-10-J	52.25	116
33	BIG HORSE CREEK	WVKC-10-I-{0.0}	52.12	122
34	WEST FORK OF POND FORK	WVKC-10-U-7-{4.3}	51.24	144
35	BIG HORSE CREEK	WVKC-10-I-{5.6}	46.02	134

Figure 10c. Benthic health versus habitat condition
Sites from Clear Fork and Marsh Fork watersheds



Site information for Figure 10c.

Chart #	Stream Name	Stream Code	WVSCI	RBP Total
1	ROCKHOUSE CREEK	WVKC-47-A-{1.3}	84.81	183
2	COVE CREEK	WVKC-46-K	83.90	162
3	ROCK CREEK	WVKC-46-I	80.36	134
4	MARTIN FORK	WVKC-46-G-2	79.07	167
5	MARSH FORK	WVKC-46-{5.8}	78.28	170
6	MCDOWELL BRANCH	WVKC-47-N-{1.4}	76.55	184
7	PEACHTREE CREEK	WVKC-46-G	76.45	180
8	WORKMAN CREEK	WVKC-47-O-{2.4}	75.95	165
9	MARE BRANCH	WVKC-47-H	75.86	169
10	MARSH FORK	WVKC-46-{20.2}	75.19	161
11	DREWS CREEK	WVKC-46-G-1	73.80	136
12	MARSH FORK	WVKC-46-{0.0}	72.28	163
13	MARSH FORK	WVKC-46-{15.3}	72.15	176
14	PANTHER BRANCH	WVKC-47-C	71.25	149
15	HAZY CREEK	WVKC-46-C	70.38	160
16	STINK RUN	WVKC-46-E	70.32	142
17	LONG FORK	WVKC-47-G	69.95	161
18	DRY CREEK	WVKC-46-H	69.88	157
19	CLEAR FORK	WVKC-47	69.13	167
20	CLEAR FORK	WVKC-47	66.46	150
21	WORKMAN CREEK	WVKC-47-O-{0.0}	64.61	156
22	DOW FORK	WVKC-47-G-1	62.48	144
23	SURVEYOR CREEK	WVKC-46-P	53.89	140
24	TONEY FORK	WVKC-47-L-{0.8}	52.73	165
25	BEE BRANCH	WVKC-46-J-2	50.76	137
26	STONECOAL BRANCH	WVKC-47-F	50.75	127
27	MARSH FORK	WVKC-46-{32.8}	41.90	113
28	MILLERS CAMP BRANCH	WVKC-46-Q	40.32	118

from the partial-sample WVSCI score that Falls Creek may actually have had a relatively diverse and healthy benthic community.

Figure 11. Frequency of occurrence of macrobenthic taxa in collections. Top 30 of 80 total family level taxa

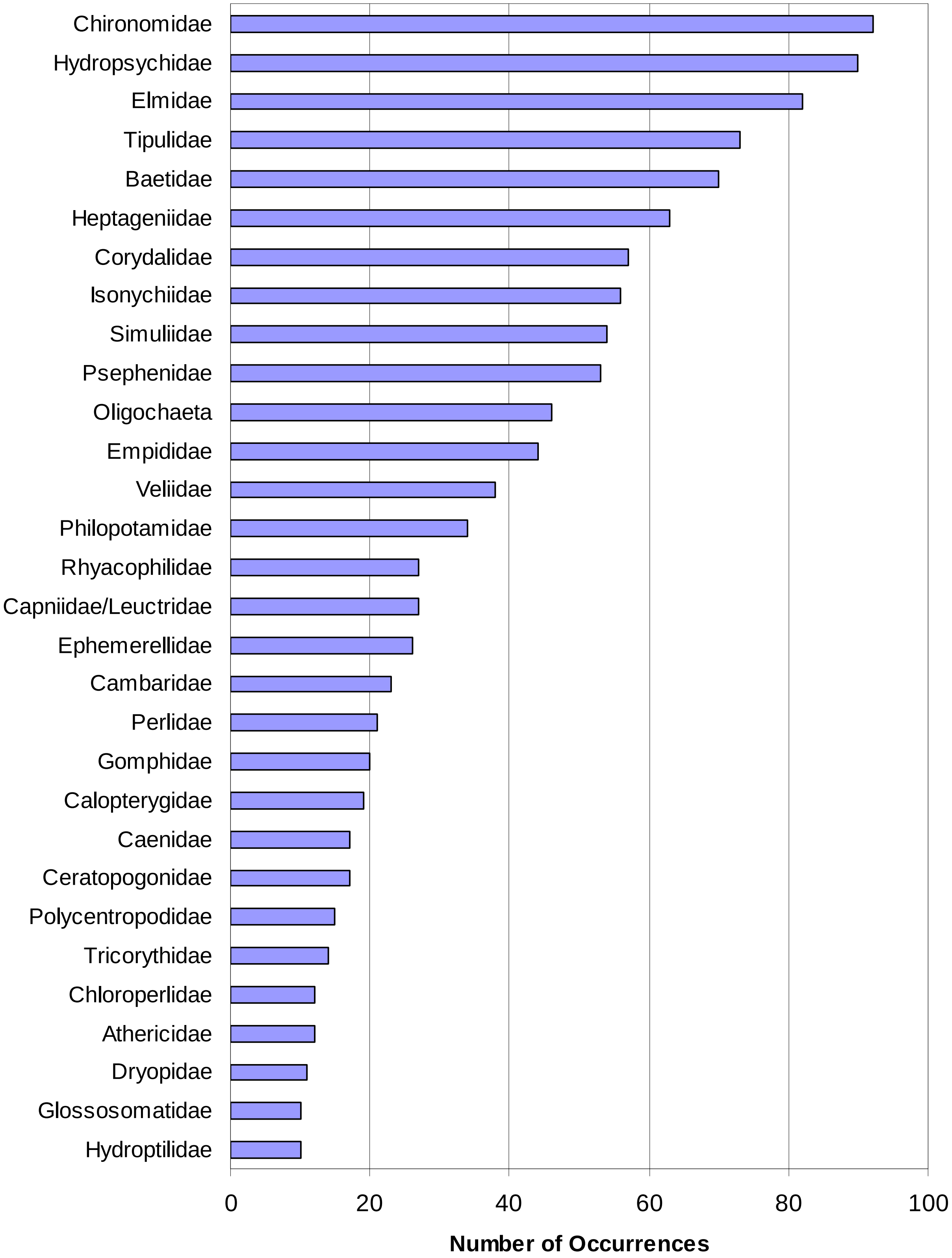


Table 4 . Sites with noncomparable benthic samples

Smith Creek	KC-4-{2.5}	Incomplete D-Net sample
Falls Creek	KC-5	Incomplete D-Net sample
Low Gap Creek	KC-10-T-3	Hand Pick
Sycamore Branch	KC-10-T-9-C-2	Hand Pick
Stollings Branch	KC-10-T-10	Hand Pick
Tickle Britches Fork	KC-10-T-11-H.5-{0.3}	Hand Pick
Brushy Fork	KC-10-T-24-{0.6}	Hand Pick
Pond Fork	KC-10-U-{9.0}	MACS Protocol
Canterbury Branch	KC-46-G-1-.5A	Hand Pick
Shiloh Fork	KC-46-L.5	MACS Protocol

Both MACS-sampled sites appeared to have conditions that could have contributed to degradation of their benthic communities. Water quality samples collected from each site were in violation of the fecal coliform bacteria criterion. The conductivity at Pond Fork (KC-10-U-{9.0}) was relatively high (1,037 mmhos/cm) while that at Shiloh Fork (KC-46-L.5) was relatively low (42 mmhos/cm). The glide/pool-dominated habitat at Pond Fork scored 170 while the Shiloh Fork site only scored 138. The sampled habitat at Shiloh Fork was overhanging vegetation, considerably less suitable for colonization than the woody snags and aquatic plants sampled at Pond Fork. The difference in habitat could account for the better WVSCI of Pond Fork (68.08) compared to that of Shiloh Fork (66.41), but the two scores are actually too similar to allow for confidence in their distinction.

The relative scores of the six hand-picked sites cannot be explained with confidence because the sampling procedure was not standardized. All the samples, except Stollings Branch (KC-T-10), seemingly reflected degraded conditions. However, the data are misleading. Illustrative of the inability of the hand-pick method to systematically sample in an unbiased manner is Tickle Britches Fork (KC-10-T-11-H.5-{0.3}). The sample from this site scored only 55.00 on the WVSCI while the habitat scored very high at 192. The sampling team is confident that had there been enough flow to collect a riffle/run kick sample, the WVSCI would have been much higher. A note on the assessment form indicated that the sampler saw numerous tiny mayflies and crayfish that were not collected.

Fecal Coliform Bacteria

The West Virginia water quality standards state that for primary contact recreation (e.g., swimming, boating, fishing), the fecal coliform bacteria content is not to exceed 400 colonies /100 ml in more than 10% of all samples taken during a month.

FECAL COLIFORM BACTERIA

Fecal coliform bacteria are organisms that naturally live in the intestines of birds and mammals, including man. Released to the environment in feces, disease-causing organisms may accompany these bacteria. Therefore, the presence of fecal coliform bacteria in a water sample indicates the potential presence of human pathogens.

A stream could have a high concentration of fecal bacteria due to a variety of sources, including failing septic systems, streamside wildlife, livestock herds with free stream access, and field-applied manure washing into the stream. Therefore, understanding local land uses is important for inferring the reasons for a high bacteria count at any particular site.

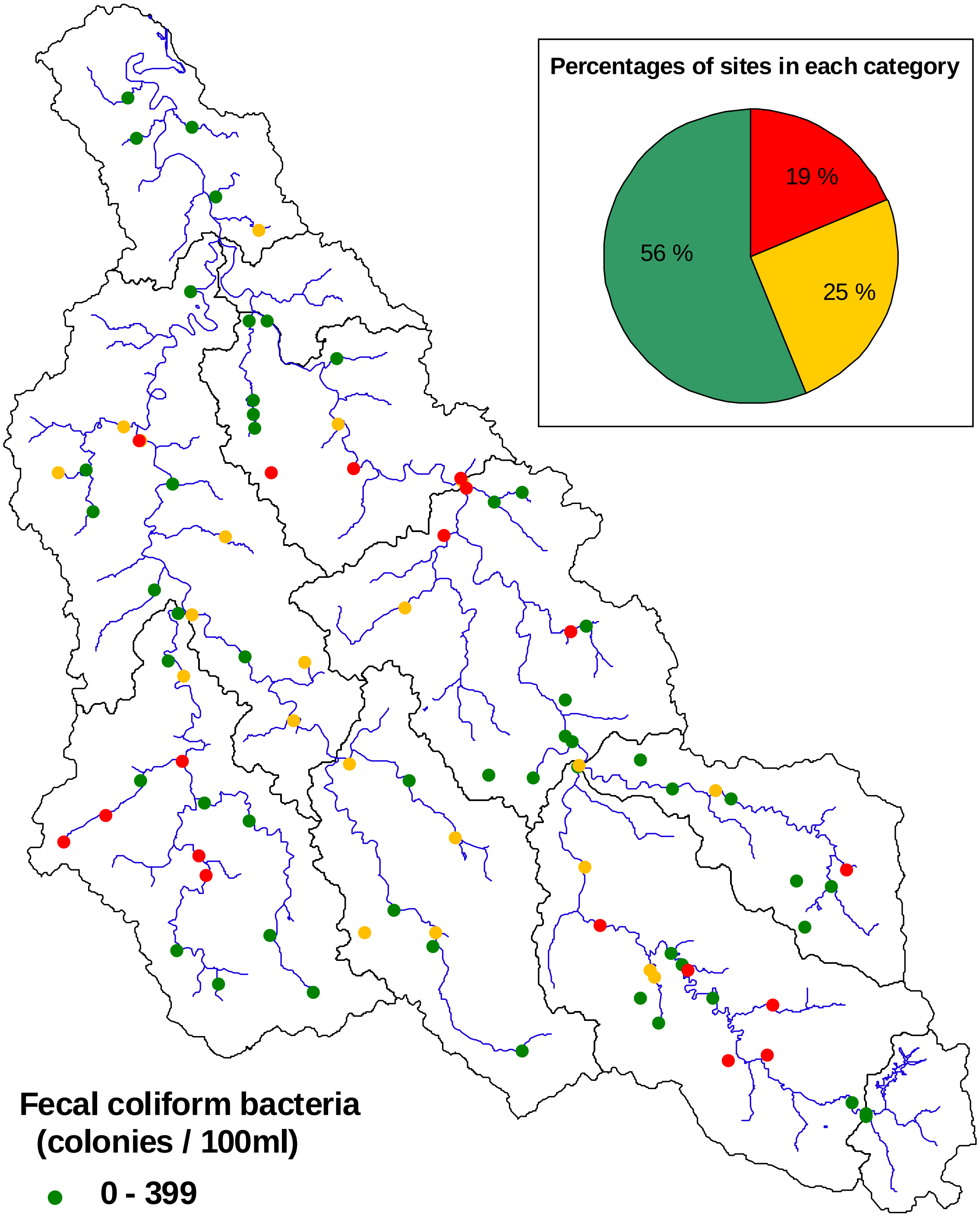
Results of fecal coliform bacteria sampling for all assessment sites are in Table 11 of Appendix A. Figure 12 presents a location map of sites exceeding the standard.

Of 100 samples collected for bacteria analysis, 42 (42%) exceeded the water quality standard. Three samples produced bacteria concentrations in excess of 6,000 colonies/100 ml (which was the contract lab's quantification limit based on their dilutions). These samples were from Hewitt Creek (KC-10-T-9 {Duplicate 1}), Isom Branch (KC-10-T-9-B.5) and Joes Branch (KC-28). Two other samples produced concentrations above 6,000, but they were analyzed with greater certainty, so their levels are known. These samples are Hewitt Creek (duplicate 2 with 6,200/100 ml) and Ridgeview Hollow (KC-21-C with 36,000/100 ml).

Physico-chemical Water Quality

The results of field readings for temperature, dissolved oxygen, pH and conductivity are presented in Table 11 of Appendix A. The results for other parameters are given in Table 12a and 12b of Appendix A.

Figure 12. Fecal coliform bacteria levels



**Fecal coliform bacteria
(colonies / 100ml)**

- 🟢 0 - 399
- 🟡 400 - 1999
- 🔴 2000 - 36000

The water quality standard for dissolved oxygen requires that streams maintain a concentration of at least 5.0 mg/L. Low Gap Creek (KC-10-T-03), Jimmy Fork (KC-14-C) and Dave Fork (KC-14-D-2) were the only sites violating the standard with values of 3.3, 4.4 and 0.8 mg/L, respectively. At all three sites, sampling personnel noted very low flow conditions contributing to the low dissolved oxygen. No riffles were seen, so only pooled water could be sampled.

The minimum water quality standard for pH is 6.0 standard units. Values below 6.0 are violations of the standard. Only two sites (2% of total) had pH values below 6.0. Stonecoal Branch (KC-47-F) and Dow Fork (KC-47-G-1) produced pH values of 4.5 and 3.9, respectively. No site exceeded the maximum standard of 9.0.

The Coal River watershed seemed to have higher conductivity readings overall than several watersheds sampled previously. Only 38% of sites produced conductivites below 500 mmhos/cm. Only 3% had conductivities below 100 mmhos/cm. The percentage of sites with conductivity readings above 1,000 mmhos/cm was 21%. Two sites on Big Horse Creek (one 5.6 mi. upstream of the mouth and one 12.5 mi. upstream) had conductivities above 2,000 mmhos/cm. In addition, the mouth of Big Horse Creek (KC-10-I-{0.0}) showed a relatively high conductivity of 1,650 mmhos/cm. Two sites on Spruce Laurel Fork (KC-10-T-11-{00.2} and {04.1}) also produced high conductivities (1,540 and 1,860 mmhos/cm).

Only 18% of the sites sampled for mine drainage water quality constituents produced violations of water quality standards for metals and two sites (Stonecoal Branch and Dow Fork) had net acidities at the time of sampling. Some sites had relatively high sulfate concentrations. Sites with sulfate greater than 500 mg/l were Big Horse Creek (5.6 and 12.5 miles from the mouth), Spruce Laurel Fork (4.1 miles from the mouth), Pond Fork (KC-10-U-{24.4}), Long Fork (KC-47-G), Dow Fork (KC-47-G-1), Toney Fork (KC-47-L-{0.8}) and Workman Creek (KC-O-{0.0}) at its mouth.

The water quality standard (acute) for aluminum is 0.750 mg/L. Of the 48 sites sampled for aluminum, nine (18%) produced results in violation of the standard. The chronic water quality standard for iron (1.5 mg/L) was not exceeded at any site. The water quality standard for manganese (1.0 mg/L) was exceeded at two sites, Stonecoal Branch and Dow Fork.

Physical Habitat

The eight-page stream assessment form detailed an evaluation of habitat within and around each 100 meter stream reach selected for study. Table 6 presents the physical measurements of each stream. The average stream width, riffle depth, run depth and pool depth are presented. Stream width ranged from 0.4 meters wide at Rattlesnake Hollow to an estimated 60 meters wide at Coal River near Comfort. The majority of the streams sampled were relatively small, with nearly 80% being less than or equal to 10 meters wide.

Human related activities and disturbances observed near the assessment sites were recorded. The most frequently encountered disturbances were roads, which were observed at 41% of the assessment sites in the watershed. Bridges/culverts were also commonly encountered (27% of sites). The frequency of these disturbances is a reflection of one assessment strategy used by the Program, which dictates that all streams be assessed as near the mouth as possible. These locations are often near a bridge or culvert, where access to the stream is generally less difficult. Other frequently encountered disturbances were residences, lawns, bank stabilization and channelization.

Information collected on sediment is found in Table 7. Table 8 summarizes substrate composition. Where sediment observations were made, sand and silt were most frequently mentioned. Sand was found at approx. 97% of the sites (91 of 94), while silt was documented at 90% (85 of 94) of the sites. Metal hydroxide deposits were found at approximately 15% of the sites. Coal was mentioned at nine sites and "red dog" at seven sites.

Assessment teams recorded observations on water odor, surface oils and turbidity at each site. Most sites (approx. 91% or 87 out of 95 where assessment forms were filled out in full) had normal or no water odor. Sewage and/or anaerobic odors were detected at six sites. Surface oil was detected at 14 sites. This is nearly 15% and seems a bit higher than would be expected.

Results of the Rapid Habitat Assessment for each site are presented in Table 13. The lowest individual score for a site was at Low Gap Creek (KC-10-T-3) with a score of 88. A site on Tickle Britches Fork (KC-10-T-11-H.5-{0.3}) received the highest score of 192. Both of these sites are within the Spruce Fork drainage of the Little Coal River subwatershed. Because of differences in sampling procedures, neither of the benthic macroinvertebrate samples collected from these two sites were considered comparable to the majority of samples collected during the study.

In general, the watershed as a whole exhibited better than marginal habitat with an average total score of approximately 152. This score is high enough to be in the lower sub-optimal category, which is defined as “less than desirable but satisfies expectations in most areas”. Although a sub-optimal rating is basically good, a comparison to the average total score of the reference sites (180 = optimal category) indicated a possibility for improvement.

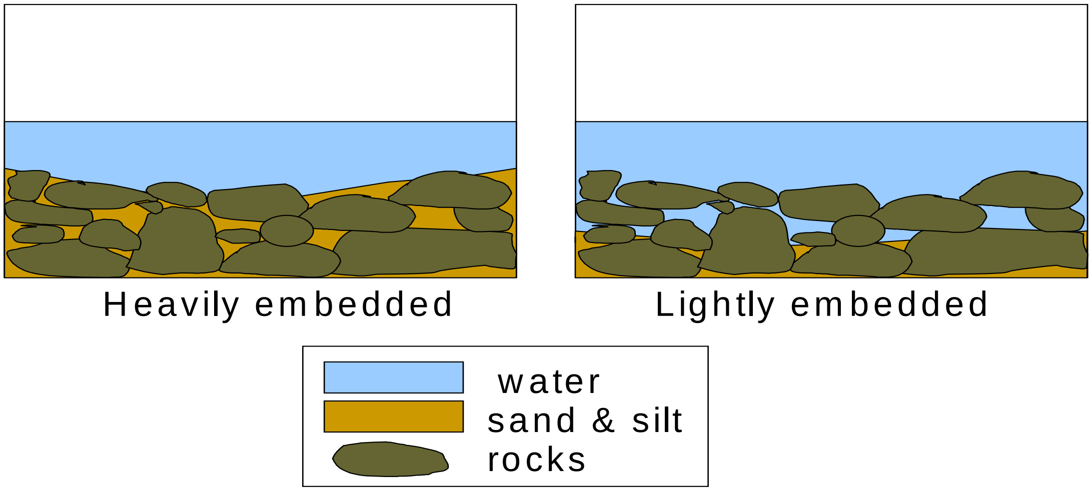
The habitat parameter that exhibited the most degradation was riparian vegetation zone width which had an average score of 7.7 out of a possible 20. Considering the entire watershed, 66 out of the 95 sites assessed (69%) received a marginal or poor score for riparian vegetation zone width. This parameter is a good indicator of human disturbance. In part, the low scores for this parameter reflect the easy access (e.g., near bridges, beside roads, etc.) sampling strategy employed by the Program. In other instances vegetation has been removed from the stream corridor to provide land for development activities such as residential areas, businesses, industry and agriculture. Additionally, riparian vegetation is often removed in misguided attempts to reduce flooding. Regardless, compared to a wide vegetated riparian zone, a narrow vegetated zone is less effective at buffering pollutants from runoff, less effective at controlling erosion, and does not provide optimal stream habitat and nutrient input. See Figure 13.

The less cobble and other stable habitat there is in a stream, the poorer the colonization potential is for benthic macroinvertebrates. Sampling teams recorded their observations of percent area covered by different substrate particle sizes in the two square meter benthic sampling zone . These observations were subjective, but useful nonetheless. Of the 16 comparable sites with cobble comprising 20% or less, only four (25%) produced WVSCI scores above 68.00.

While all of the parameters measure important aspects of stream habitat, some affect the benthic community at the specific location more than others. Embeddedness is the measurement of the amount of fine materials surrounding (or embedding) the larger substrate types – cobble and boulders. This embedding limits the interstitial space, (areas between and below rocks), which benthic organisms depend on for feeding and shelter. Figure 13 illustrates stream substrate embeddedness. High levels of sediment deposition can create an unstable and continually changing environment that becomes unsuitable for many benthic macroinvertebrates.

Figure 13. Illustration of embeddedness

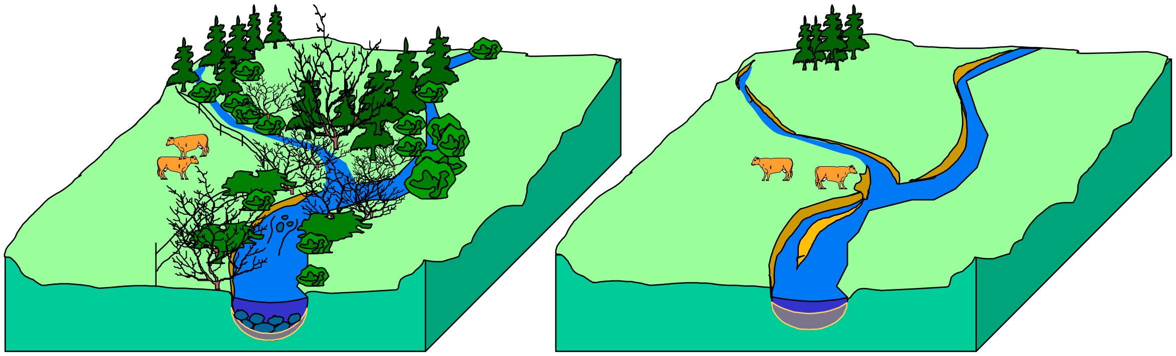
The view on the left is heavily embedded with sand and silt. Notice the different amounts of interstitial space (the space between the rocks and gravel).



Heavily embedded

Lightly embedded

Figure 14. Stream segment with and without intact riparian buffer zone



Discussion of Impairments

Several sites seem to have been negatively impacted by mine drainage. Only two [Stonecoal Branch (KC-47-F) and Dow Fork (KC-47-G-1)] showed severe impacts to their water quality, though less than severe impacts to their benthic biota. Other sites showed evidence of mine drainage, though not necessarily acidic. Toney Fork (KC-47-L-{0.8}) is a good example, with an aluminum concentration in violation of the water quality standard, a high sulfate concentration and high conductivity, but a pH reading of 8.2 and an alkalinity of 100 mg/l. The high total aluminum concentration could have been due to the presence of particulates in the turbid stream water. However, a note on the assessment form indicated that Costain Coal Company was pumping mud from a settling pond into Toney Fork at the time of sampling.

It is obvious Toney Fork was impaired by non-acidic mine drainage. Other streams that likely fell into this category are Big Horse Creek (KC-10-I), Little Horse Creek (KC-10-J), Spruce Fork (KC-10-T), Missouri Fork (KC-10-T-9-B), Spruce Laurel Fork (KC-10-T-11), Pond Fork (KC-10-U), West Fork of Pond Fork (KC-10-U-7), Adkins Fork (KC-10-T-21), Trace Fork of Cow Creek (KC-10-U-12-A), Road Fork (KC-35-G), Elk Run (KC-43-{2.8}), Marsh Fork (KC-46), Clear Fork (KC-47), Panther Branch (KC-47-C), Long Fork (KC-47-G), McDowell Branch (KC-47-N-{1.4}) and Workman Creek (KC-47-O). A few of these streams had sites that produced relatively high-scoring macroinvertebrate samples, but most sites scored below the 68.00, unimpaired flag value.

Clues to the sources of impairment to these streams were found in high conductivity readings or high sulfate concentrations and in assessment notes that indicated the presence of coal mining activities upstream or coal particles instream. For instance, the notes on Missouri Fork described an abundance of “white boy,” a metal-laden precipitate often associated with coal mine discharges. Further sampling is necessary to confirm or deny the suspected presence of elevated metals concentrations. Metal hydroxides like white boy (primarily aluminum precipitate) and yellow boy (primarily iron precipitate) contribute to the severe impairment of mine drainage streams in the coal mining regions of the nation.

Conversely, the presence of red dog, coal fines, small amounts of metal hydroxides, rock fill and other mining-related materials did not necessarily indicate the benthic community was severely impaired. Some coal refuse-laden streams had high-scoring benthic samples as well.

Some streams received alkaline discharges from deep mines, but the active mining had ceased and the physical disturbances associated with the mining had diminished significantly. This healing allowed recolonization of affected streams. The sites that may fit this description are Hopkins Fork (KC-31-B-{10.9}) and Rockhouse Creek (KC-47-A-{1.3}), both with WVSCI values above 80.00, and Marsh Fork (KC-46) at mile points 5.8 and 20, Camp Creek (KC-10-L), Fork Creek (KC-14), Spicelick Fork (KC-29-A-3), Mare Branch (KC-47-H), McDowell Branch (KC-47-N-{1.4}) and Workman Creek (KC-47-O-{2.4}), all with WVSCI values above 75.00.

The 1998 303(d) list of waterbodies impaired by metals from mine drainage includes 10 streams in the Coal River Watershed. A list on page 10 identifies those streams. During this survey, Shumate Creek (KC-56-D) was not visited and Jehu Branch (KC-46-Q-5) had no flow near its mouth, so it was not sampled for mine drainage constituents. Very few notes were recorded regarding Jehu Branch, so it cannot be determined from this survey whether or not the stream was still impacted by metals from mine drainage.

Toney Fork and Dow Fork have already been discussed. Long Fork (KC-47-G) is also on the 1998 303(d) list and its water quality reflected this during this study. The site sampled had a relatively high sulfate content, a high conductivity and a violation of the aluminum standard. Field notes indicated aluminum deposits, red dog and coal were found on the substrate. However, the WVSCI score (69.95) placed it in the benthologically unimpaired category.

The sampling sites on three other 303(d) list streams, Peachtree Creek (KC-46-G), Drews Creek (KC-46-G-1) and Martin Fork (KC-46-G-2), produced no violations of water quality standards for metals, nor were there any notes taken at these sites that indicated the presence of coal mining activities that could potentially impact these streams. Indeed, benthic macroinvertebrate samples from these three sites received WVSCI values above 68 (respectively, 76.45, 73.80 and 79.07). Notes from a tributary of Drews Creek, Canterbury Branch (KC-46-G-1-.5A), indicate there was mining in the Peachtree Creek watershed. These three streams should be investigated further to determine whether or not their status on the 303(d) list is appropriate.

The Clear Fork and Workman Creek sampling sites produced no metals violations, but notes regarding the presence of red dog on their substrates indicate that mining may have had an impact on them. However, the macroinvertebrate sample from the Workman Creek site at mile point 2.4 (KC-47-O-{2.4}) scored a 75.95 on the WVSCI. The other Workman Creek sample (at its mouth) received a WVSCI score of 64.61. It may be that only a portion of Workman Creek need be included on the 303(d) list.

Stonecoal Branch should be added to the 303(d) mine drainage impaired stream list. The poor water chemistry and the relatively low WVSCI value (50.75) support this suggestion.

Although Marsh Fork at mile point 32.8 was sampled using the riffle/run kick net protocol, its habitat was assessed using the glide/pool rapid habitat assessment form. The samplers recorded that 60% of the sampled substrate area was sand, 25% was silt, 10% was sticks and 5% was gravel. This is extremely poor habitat for most riffle-dwelling fauna. Even if other conditions were favorable to producing a diverse benthic community, the poor habitat found here could account for the relatively low WVSCI score (43.99) the sample received. A similar argument could be made for Millers Camp Branch (KC-46-Q), which had a riffle/run habitat score of only 118 and a WVSCI value of only 41.97. The sampler noted that 35% of the sampled substrate was logs, which are considered relatively poor habitat for riffle-dwelling macroinvertebrates. The habitat scores of these two sites were the lowest in the combined Marsh Fork & Clear Fork watersheds, and they both fell within the marginal category.

The other two sites that scored below 45 on the WVSCI are Brush Creek (KC-21, WVSCI=42.86) and Ridgeview Hollow (KC-21-C, WVSCI=40.21). Their habitat scores (respectively, 138 & 133) fell within the lower portion of the sub-optimal range, but other sites with better WVSCI scores had worse habitat scores. The reasons why these two sites fared so poorly on the WVSCI are not clear. The sampling team recorded cobble covering only 20% of the benthic sampling area of each of these sites. Brush Creek had 50% gravel while Ridgeview Hollow had 30% gravel and 30% silt, with the balance of 20% area coverage in sand. These were poor habitats for benthic colonization. Therefore, habitat condition probably played a role in suppressing the benthic community, but it is likely not the only factor. Ridgeview Hollow had one of the highest fecal coliform bacteria concentrations detected during the study (36,000 colonies/100ml).

Implications

The restoration of highly degraded streams and the preservation of high quality streams present great challenges to the Program and other concerned agencies, as well as to the citizens of West Virginia. The mission of the West Virginia Department of Environmental Protection's Division of Water Resources, is to address these challenges by enhancing and preserving the physical, chemical, and biological integrity of surface and ground waters, considering nature and the health, safety, recreational and economic needs of humanity. The following implications attempt to address the charges of restoration and preservation of streams assessed by the Program in the Coal River Watershed. Ideally, a discussion of the status of each stream would be presented. However, due to the extensive scope of the study, implications are given in generalities with citations of specific examples given for illustration.

Mine Drainage & Acid Mine Drainage (AMD) Impacted Streams

A few streams in the watershed were biologically impaired by AMD. Some of these are currently listed on the 1998 303(d) list. Several more were impaired by non-acidic mine drainage or treatment-neutralized mine drainage as evidenced by high sulfates, metals and conductivities combined with near neutral pH readings and low acidities. However, at many sites with impaired biota, there was no clear correlation with mine drainage. Some of the sites with the lowest WVSCI scores produced no evidence that mine drainage was the primary contributor to their degraded conditions. Although there are many treatment technologies available for treating AMD and non-acidic mine drainage, the cost of chemicals, equipment and continuous maintenance make the treatment of all affected streams improbable. Consequently, successful treatment of even one stream should be viewed as a tremendous accomplishment.

The watershed has been extensively mined in the latter half of the 20th century and it appears likely that such mining will continue until all minable coal is gone. Some streams have subsided due to underground mining and others have become degraded due to untreated and treated mine drainage. Many stream miles have become severely degraded physically by mining and road building activities. In the last few decades of the 20th century, mountaintop removal/valley fill mining has eliminated several headwater streams. There is no question what happens to the aquatic biota of streams completely covered by mine fill material, but there is some uncertainty about the effect on waterbodies downstream of the valley fills.

The U.S.EPA, with assistance from WV DEP's Division of Water Resources, conducted an intensive study of the benthological impacts downstream of mountain-top removal & valley fill mining. The EPA's study showed that mining impacts on aquatic biota range from minimal to severe, depending on a number of variables, some of which are more clear than others. The data generated during this watershed assessment study support this finding of variability in mine drainage impacts. Together, these two studies demonstrate the need to better understand the variables that effect water quality downstream of valley fills. We need to learn what it is about those valley fills that cause the least damage that makes them better. Is it material handling, the underlying geology, or simply the age of the fill?

As indicated previously, Peachtree Creek (KC-46-G), Drews Creek (KC-46-G-1) and Martin Fork (KC-46-G-2) should be investigated further to determine whether or not their status on the 303(d) list is appropriate. Workman Creek (KC-47-O) should also be checked to see if perhaps only a portion of its length need be on the 303(d) list. The WVSCI score at mile point 2.4 was much better than that at the stream's mouth.

Fecal Coliform Bacteria

As stated previously, 42% of all samples collected in the watershed had bacteria concentrations exceeding the 400/100 ml criterion. It is likely that many small towns and residential areas have inadequate sewage treatment or depend on septic tanks including a pump-and-dump management procedure. When properly installed and maintained, septic systems can provide adequate sewage treatment. However, neglected ones or those improperly sited can lead to malfunctioning systems that introduce fecal contamination into ground and surface waters. Agricultural activities that permit livestock to access streams for watering can be significant sources of fecal coliform bacteria. Also, feed lots and dog pens located too close to streams can contribute bacteria via runoff during precipitation events.

Given the variety of potential sources of fecal coliform bacteria, it is sometimes difficult to pinpoint the causes of high concentrations in streams. Notations by the watershed assessment teams lead to the conclusion that inadequate sewage treatment was likely the primary contributor to high bacteria concentrations within the Coal River watershed. An intensive study is needed to pinpoint sewage and other sources of fecal coliform bacteria in streams exceeding the standard. Such a study should include identifying the type and efficacy of sewage treatment in local communities and residences. Also, the study should include an understanding of the contribution that livestock make to the bacteria problem.

High Quality Streams

High quality streams with minimal human disturbances provide significant and even irreplaceable wildlife habitat. They also provide a tremendous recreational resource. No sites in the Coal River Watershed met the minimum criteria for reference site status. This is the first of 32 watersheds studied in West Virginia that produced no potential reference sites. Researchers conducting the EPA study on mountaintop mining, alluded to previously, have found a few small streams within the watershed that may meet the reference site criteria. The Program has since adopted one stream, White Oak Branch (KC-10-T-22), as a reference site. Since reference sites reflect least-degraded conditions, it is vital that the WVDEP do its part in fulfilling the mission of preserving the high quality of these rare and important streams. It is also important that the agency make a concerted effort to find the apparently few remaining streams within the watershed that have not been significantly impacted by human disturbances.

Additional Resources

The watershed movement in West Virginia includes a wide variety of federal, state and non-governmental organizations that are available to help improve the health of the streams in this watershed. Several agencies have established the West Virginia Watershed Management Framework. A Basin Coordinator has been employed to coordinate the activities of these agencies. The Basin Coordinator may be contacted at (304)-558-2108. In addition, the DEP’s Stream Partners Program coordinator, available at (800)-556-8181, serves as a clearinghouse for these and other resources.

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APPENDIX A. DATA TABLES

Table 5. Sites sampled

Stream Name	Stream Code	Date	Latitude			Longitude			County
BIG COAL RIVER	WVK-34-{23.8}	10/ 8/97	38	13	33	81	45	48	BOONE/KAN
BIG COAL RIVER	WVK-34-{35.0}	9/17/97	38	8	28.06	81	41	58.1	BOONE
COAL RIVER	WVK-34-{44.0}	9/17/97	38	8	1.44	81	37	8	BOONE
COAL RIVER	WVK-34-{58.4}	10/ 7/97	38	2	49.46	81	32	19.77	BOONE
BROWNS CREEK	WVKC-2-{2.0}	9/17/97	38	21	16.66	81	52	5.94	KANAWHA
SMITH CREEK	WVKC-4-{2.5}	9/17/97	38	20	16.74	81	49	13.59	KANAWHA
FALLS CREEK	WVKC-5	9/17/97	38	19	54.07	81	51	41.81	KANAWHA
CROOKED CREEK	WVKC-9	9/17/97	38	17	53.61	81	48	9.37	KANAWHA
LITTLE COAL RIVER	WVKC-10-{03.6}	9/23/97	38	14	33.02	81	49	14.26	KANAWHA
LITTLE COAL RIVER	WVKC-10-{17.0}	9/22/97	38	9	22.07	81	51	21.76	BOONE
BIG HORSE CREEK	WVKC-10-I-{0.0}	9/22/97	38	9	50.04	81	52	6.4	BOONE
BIG HORSE CREEK	WVKC-10-I-{12.5}	9/23/97	38	6	53	81	53	28	BOONE
BIG HORSE CREEK	WVKC-10-I-{5.6}	9/22/97	38	8	19.87	81	53	43.9	BOONE
RATTLESNAKE HOLLOW	WVKC-10-I-6-C	9/22/97	38	8	13.65	81	54	59.83	BOONE
LITTLE HORSE CREEK	WVKC-10-J	9/22/97	38	9	21.31	81	51	25.8	BOONE
CAMP CREEK	WVKC-10-L	9/23/97	38	7	51.89	81	49	58.29	BOONE
ROCK CREEK	WVKC-10-N-{3.0}	9/25/97	38	6	2.02	81	47	34.59	BOONE
LONG BRANCH	WVKC-10-P-.5	9/24/97	38	4	10.42	81	50	43.09	BOONE
SPRUCE FORK	WVKC-10-T-{0.3}	9/24/97	38	3	20.23	81	49	38.03	BOONE
SPRUCE FORK	WVKC-10-T-{17.4}	9/25/97	37	54	54.23	81	48	38.88	LOGAN
SPRUCE FORK	WVKC-10-T-{18.5}	9/25/97	37	54	13	81	48	21	LOGAN
SPRUCE FORK	WVKC-10-T-{4.6}	9/24/97	38	1	10.16	81	49	22.56	BOONE
LAUREL BRANCH	WVKC-10-T-2	9/24/97	38	2	1.88	81	50	1.22	BOONE
LOW GAP CREEK	WVKC-10-T-3	9/24/97	38	1	41.91	81	50	2.95	BOONE
HEWITT CREEK	WVKC-10-T-9	9/24/97	37	58	13	81	49	24	BOONE
MISSOURI FORK/HEWITT	WVKC-10-T-9-B	9/23/97	37	57	30.4	81	51	16	BOONE
ISOM BRANCH	WVKC-10-T-9-B.5	9/24/97	37	56	16	81	52	45.77	LOGAN
SYCAMORE BRANCH	WVKC-10-T-9-C-2	9/24/97	37	55	21	81	54	35	LOGAN
STOLLINGS BRANCH	WVKC-10-T-10	9/24/97	37	57	26	81	48	55	BOONE
SPRUCE LAUREL FORK	WVKC-10-T-11-{0.2}	9/25/97	37	56	45.64	81	48	24.95	BOONE
SPRUCE LAUREL FORK	WVKC-10-T-11-{15.3}	9/15/97	37	50	11	81	43	33	BOONE
SPRUCE LAUREL FORK	WVKC-10-T-11-{4.1}	9/25/97	37	56	8	81	46	28	BOONE
TICKLE BRITCHES FORK	WVKC-10-T-11-H.5-{0.3}	9/15/97	37	52	10	81	45	30	BOONE
ADKINS FORK	WVKC-10-T-21	9/25/97	37	51	37	81	49	34	LOGAN
BRUSHY FORK	WVKC-10-T-24-{0.6}	10/ 8/97	37	50	27	81	47	42	LOGAN
POND FORK	WVKC-10-U-{0.4}	9/23/97	38	3	18.8	81	49	0.9	BOONE
POND FORK	WVKC-10-U-{24.4}	9/22/97	37	52	18	81	38	13	BOONE
POND FORK	WVKC-10-U-{4.9}	9/23/97	38	1	51.88	81	46	41.98	BOONE
POND FORK	WVKC-10-U-{9.0}	9/23/97	37	59	39	81	44	32	BOONE
BENNETT FORK	WVKC-10-U-3-B	9/23/97	38	1	42	81	44	1	BOONE
WEST FORK	WVKC-10-U-7-{0.0}	9/22/97	37	58	19	81	42	20	BOONE
WEST FORK OF POND FORK	WVKC-10-U-7-{4.3}	9/18/97	37	57	35.2	81	39	23.2	BOONE
WEST FORK OF POND FORK	WVKC-10-U-7-{7.9}	9/18/97	37	55	36	81	37	22	BOONE
ROACH BRANCH	WVKC-10-U-7-A	9/22/97	37	58	10.3	81	42	4	BOONE
TRACE FORK/COW CREEK	WVKC-10-U-12-A	9/22/97	37	52	17.1	81	41	17.2	BOONE
GRAPEVINE BRANCH	WVKC-10-U-13	9/23/97	37	53	4	81	40	1	BOONE
JASPER WORKMAN BRANCH	WVKC-10-U-17	9/22/97	37	51	50	81	38	20.2	BOONE
LACEY BRANCH	WVKC-10-U-21	9/22/97	37	48	12	81	34	23	BOONE
ALUM CREEK	WVKC-11-{5.6}	9/18/97	38	16	42.3	81	46	12.89	KANAWHA
FORK CREEK	WVKC-14	10/ 6/97	38	13	34	81	46	37	BOONE
JIMMY FORK	WVKC-14-C	10/ 6/97	38	10	47	81	46	24	BOONE
WILDERNESS FORK	WVKC-14-D	10/ 6/97	38	10	19	81	46	25	BOONE

Table 5. Sites sampled (continued)

Stream Name	Stream Code	Date	Latitude			Longitude			County
DAVE FORK	WVKC-14-D-2	10/ 6/97	38	9	51.06	81	46	20.82	BOONE
LEFT FORK/BULL CREEK	WVKC-16-A	9/26/97	38	12	17.17	81	42	45.33	BOONE
BRUSH CREEK	WVKC-21-{0.0}	9/26/97	38	10	0.65	81	42	38.62	BOONE
RIDGEVIEW HOLLOW	WVKC-21-C	10/ 8/97	38	8	17.8	81	45	34.1	BOONE
JOES BRANCH	WVKC-28	9/17/97	38	8	7	81	37	12	BOONE
JOES CREEK	WVKC-29	9/17/97	38	7	48.81	81	36	57.1	BOONE
LEFT FORK JOES CREEK	WVKC-29-A	10/ 7/97	38	7	20.1	81	35	44.5	BOONE
SPICELICK FORK	WVKC-29-A-3	9/17/97	38	7	38.83	81	34	31	BOONE
LAUREL CREEK	WVKC-31-{0.4}	10/ 7/97	38	6	8.9	81	37	54.9	BOONE
HOPKINS FORK	WVKC-31-B-{0.2}	10/ 7/97	38	4	31.2	81	38	1.8	BOONE
HOPKINS FORK	WVKC-31-B-{10.9}	10/ 6/97	37	57	49	81	35	53	BOONE
COLD FORK	WVKC-31-C	10/ 7/97	38	3	35	81	39	38	BOONE
WHITE OAK CREEK	WVKC-35-{3.0}	10/ 8/97	38	3	0.6	81	31	40.68	BOONE
LEFT FORK OF WHITE OAK	WVKC-35-F	10/ 8/97	38	3	1.1	81	31	40.8	BOONE
ROAD FORK	WVKC-35-G	10/ 8/97	38	0	27	81	32	33	BOONE
ELK RUN	WVKC-43-{0.0}	10/ 7/97	37	59	10.87	81	32	31.86	BOONE
ELK RUN	WVKC-43-{2.8}	10/ 7/97	37	57	43	81	33	56	BOONE
MARSH FORK	WVKC-46-{0.0}	10/ 6/97	37	58	8	81	31	59	RALEIGH
MARSH FORK	WVKC-46-{5.8}	10/ 6/97	37	54	36	81	31	40	RALEIGH
MARSH FORK	WVKC-46-{15.3}	10/ 6/97	37	51	15	81	27	22	RALEIGH
MARSH FORK	WVKC-46-{20.2}	9/29/97	37	50	3.19	81	25	58.6	RALEIGH
MARSH FORK	WVKC-46-{32.8}	10/ 6/97	37	46	28.4	81	19	51.7	RALEIGH
HAZY CREEK	WVKC-46-C	10/ 6/97	37	58	57.99	81	32	14.34	RALEIGH
STINK RUN	WVKC-46-E	10/ 6/97	37	52	34.6	81	30	58.2	RALEIGH
PEACHTREE CREEK	WVKC-46-G	9/25/97	37	51	3	81	28	47	RALEIGH
DREWS CREEK	WVKC-46-G-1	9/25/97	37	50	46.9	81	28	33.66	RALEIGH
CANTERBURY BRANCH	WVKC-46-G-1-.5A	9/25/97	37	50	5	81	29	10	RALEIGH
MARTIN FORK	WVKC-46-G-2	9/25/97	37	49	11.27	81	28	23.47	RALEIGH
DRY CREEK	WVKC-46-H	10/ 6/97	37	51	36	81	27	51	RALEIGH
ROCK CREEK	WVKC-46-I	10/ 7/97	37	51	3	81	27	4.37	RALEIGH
BEE BRANCH	WVKC-46-J-2	9/29/97	37	49	49.9	81	23	19.95	RALEIGH
COVE CREEK	WVKC-46-K	9/29/97	37	47	54	81	25	20	RALEIGH
SHILOH FORK	WVKC-46-L.5	9/29/97	37	48	5.14	81	23	34.1	RALEIGH
SURVEYOR CREEK	WVKC-46-P	10/ 7/97	37	45	59.06	81	19	14.74	RALEIGH
MILLERS CAMP BRANCH	WVKC-46-Q	10/ 7/97	37	46	3.46	81	19	12.8	RALEIGH
JEHU BRANCH	WVKC-46-Q-5	10/ 7/97	37	46	16.17	81	16	2.49	RALEIGH
CLEAR FORK	WVKC-47	9/23/97	37	58	8.73	81	31	54.89	RALEIGH
ROCKHOUSE CREEK	WVKC-47-A-{1.3}	9/23/97	37	58	20.43	81	29	13.77	RALEIGH
PANTHER BRANCH	WVKC-47-C	9/24/97	37	57	20.22	81	27	50.61	RALEIGH
STONECOAL BRANCH	WVKC-47-F	9/24/97	37	57	19	81	25	54	RALEIGH
LONG FORK	WVKC-47-G	9/24/97	37	57	2.63	81	25	12.46	RALEIGH
DOW FORK	WVKC-47-G-1	9/24/97	37	57	18	81	24	57	RALEIGH
MARE BRANCH	WVKC-47-H	9/24/97	37	56	38	81	23	39	RALEIGH
TONEY FORK	WVKC-47-L-{0.8}	9/22/97	37	54	34.44	81	20	8.94	RALEIGH
MCDOWELL BRANCH	WVKC-47-N-{1.4}	9/22/97	37	54	11.26	81	22	18.99	RALEIGH
WORKMAN CREEK	WVKC-47-O-{0.0}	9/22/97	37	53	59.58	81	20	46.88	RALEIGH
WORKMAN CREEK	WVKC-47-O-{2.4}	9/22/97	37	52	33.2	81	21	58.57	RALEIGH

Table 6. Physical characteristics of 100 meter stream reach

Stream Code	Stream Width (m)	Riffle Depth (m)	Run Depth (m)	Pool Depth (m)
WVK-34-{23.8}	18	0.12	0.16	1
WVK-34-{35.0}	50			
WVK-34-{44.0}	60			
WVK-34-{58.4}	18.3	0.2	0.2	0.3
WVKC-2-{2.0}	1.8	0.05	0.1	1
WVKC-4-{2.5}	2.7	0.05	0.15	0.3
WVKC-5	3.3	0.01	0.02	0.5
WVKC-9	3.1	0.03	0.1	0.25
WVKC-10-{03.6}	17.3	0.25	0.3	1
WVKC-10-{17.0}	11.8		0.35	1
WVKC-10-I-{0.0}	7.2	0.1	0.25	0.3
WVKC-10-I-{12.5}	3.9	0.1	0.15	0.45
WVKC-10-I-{5.6}	5.8	0.1	0.25	0.3
WVKC-10-I-6-C	0.4	0.01	0.05	0.15
WVKC-10-J	0.6	0.1	0.15	0.25
WVKC-10-L	2.9	0.05	0.1	1
WVKC-10-N-{3.0}	3.6	0.12	0.13	0.2
WVKC-10-P-.5	1	0.01	0.05	0.3
WVKC-10-T-{0.3}	24.5	0.25	0.51	1
WVKC-10-T-{17.4}	7.5	0.1	0.25	1.1
WVKC-10-T-{18.5}	9.3	0.1	0.25	0.3
WVKC-10-T-{4.6}	15.5	0.3	0.6	1
WVKC-10-T-2	1.2	0.01	0.02	0.2
WVKC-10-T-3	1.2			0.3
WVKC-10-T-9	2.9	0.1	0.2	0.4
WVKC-10-T-9-B	1.8	0.02	0.1	0.2
WVKC-10-T-9-B.5	1.4	0.02	0.04	
WVKC-10-T-9-C-2	0.6	0.02	0.04	
WVKC-10-T-10	0.7	0.01	0.04	
WVKC-10-T-11-{0.2}	11.1	0.05	0.2	0.5
WVKC-10-T-11-{15.3}	2.2	0.1	0.15	0.15
WVKC-10-T-11-{4.1}	10	0.1	0.2	
WVKC-10-T-11-H.5-{0.3}	1	0.01	0.02	0.03
WVKC-10-T-21	3.1	0.15	0.3	0.4
WVKC-10-T-24-{0.6}	1			0.2
WVKC-10-U-{0.4}	25	0.1	0.2	0.5
WVKC-10-U-{24.4}	7.5	0.2	0.4	0.6
WVKC-10-U-{4.9}	28.3	0.1	0.4	1
WVKC-10-U-{9.0}	30		0.5	1
WVKC-10-U-3-B	2.1	0.03	0.1	0.3
WVKC-10-U-7-{0.0}	13.3	0.15	0.25	0.4
WVKC-10-U-7-{4.3}	7.6	0.16	0.28	
WVKC-10-U-7-{7.9}	6.6	0.15	0.3	0.5
WVKC-10-U-7-A	1.1	0.05	0.2	0.4
WVKC-10-U-12-A	0.9	0.02		0.2
WVKC-10-U-13	2	0.03	0.2	0.5
WVKC-10-U-17	2.7	0.05	0.1	0.35
WVKC-10-U-21	3.8	0.1	0.25	0.35
WVKC-11-{5.6}	1.4	0.02	0.04	0.3
WVKC-14	5.6	0.08	0.1	0.3
WVKC-14-C				
WVKC-14-D				
WVKC-14-D-2				
WVKC-16-A	1.2	0.01	0.08	0.1

Table 6. Physical characteristics of 100 meter stream reach (cont.)

Stream Code	Stream Width (m)	Riffle Depth (m)	Run Depth (m)	Pool Depth (m)
WVKC-21-{0.0}	2.6	0.05	0.25	0.7
WVKC-21-C	0.8	0.02	0.07	0.15
WVKC-28	1			
WVKC-29	6.4	0.08	0.13	0.4
WVKC-29-A	5.6	0.03	0.05	0.3
WVKC-29-A-3	0.9	0.05	0.08	0.1
WVKC-31-{0.4}	6.8	0.1	0.25	0.5
WVKC-31-B-{0.2}	6.2	0.2	0.35	0.6
WVKC-31-B-{10.9}	1.6	0.04	0.05	0.09
WVKC-31-C	1.6	0.1	0.2	0.3
WVKC-35-{3.0}	6.9	0.1	0.2	0.25
WVKC-35-F	3.3	0.1	0.2	
WVKC-35-G	2.2	0.05	0.1	
WVKC-43-{0.0}	3.2	0.1	0.2	0.3
WVKC-43-{2.8}	1.7	0.05	0.15	0.25
WVKC-46-{0.0}	13.7	0.1	0.4	1.2
WVKC-46-{5.8}	15.7	0.15	0.35	0.7
WVKC-46-{15.3}	15.6	0.14	0.25	0.5
WVKC-46-{20.2}	16.6	0.15	0.3	0.5
WVKC-46-{32.8}	5.2	0.29		0.6
WVKC-46-C	6.7	0.1	0.2	0.35
WVKC-46-E	0.7	0.02		0.2
WVKC-46-G	8.5	0.1	0.25	0.6
WVKC-46-G-1	3.6	0.1	0.15	0.23
WVKC-46-G-1-.5A	0.8	0.02		0.1
WVKC-46-G-2	2.1	0.08	0.1	0.2
WVKC-46-H	1.4	0.05		0.6
WVKC-46-I	1.9	0.03	0.1	0.2
WVKC-46-J-2	1.5	0.05	0.1	0.2
WVKC-46-K	4.8	0.1	0.15	0.5
WVKC-46-L.5	0.9			0.3
WVKC-46-P	4.9	0.1	0.2	0.5
WVKC-46-Q	6.5	0.15	0.25	0.6
WVKC-46-Q-5				
WVKC-47	13.6	0.16	0.25	0.3
WVKC-47-A-{1.3}	1.3	0.05	0.1	0.3
WVKC-47-C	1	0.03	0.08	0.15
WVKC-47-F	0.8	0.02	0.05	0.25
WVKC-47-G	2.3	0.1	0.14	0.3
WVKC-47-G-1	1.3	0.04	0.1	0.2
WVKC-47-H	1.2	0.01	0.02	0.18
WVKC-47-L-{0.8}	1.7	0.05	0.1	0.22
WVKC-47-N-{1.4}	1.3	0.01	0.02	0.2
WVKC-47-O-{0.0}	2	0.05	0.08	0.2
WVKC-47-O-{2.4}	2	0.03	0.1	0.2

Blanks indicate ‘not measured’ for stream width or ‘habitat type not present’ for depths

Table 7. Observed sediment characteristics

Stream Code	Sediment odors	Sediment oils	Sediment deposits
WVK-34-{23.8}	normal	absent	sand,silt
WVK-34-{44.0}	normal	absent	sand,silt,metal hydroxides
WVK-34-{58.4}	normal	absent	silt
WVKC-2-{2.0}	normal	slight	sand,silt,metal hydroxides
WVKC-4-{2.5}	normal	absent	sand,silt
WVKC-5	normal	absent	sand,silt
WVKC-9	normal	absent	sand,silt
WVKC-10-{03.6}	normal	absent	sand,silt
WVKC-10-{17.0}	sewage	absent	sand,silt,coal chunks
WVKC-10-I-{0.0}	normal	absent	sand,silt
WVKC-10-I-{12.5}	normal	absent	sand,silt,metal hydroxides
WVKC-10-I-{5.6}	slight sulfur	slight	sand,silt,metal hydroxides
WVKC-10-I-6-C	normal	slight	sand,silt
WVKC-10-J	normal	absent	sand,silt,coal
WVKC-10-L	none	absent	sand,silt,metal hydroxides
WVKC-10-N-{3.0}	sewage	moderate	sludge,sand,silt,metal hydroxides
WVKC-10-P-.5	normal	absent	sand,silt
WVKC-10-T-{0.3}	normal	absent	sand,silt,metal hydroxides,coal
WVKC-10-T-{17.4}	normal	slight	sand,silt,metal hydroxides
WVKC-10-T-{18.5}	normal	absent	sand,silt
WVKC-10-T-{4.6}	normal	absent	sand,silt
WVKC-10-T-2	normal	absent	sand,silt
WVKC-10-T-3	anaerobic	absent	sand,silt
WVKC-10-T-9	normal	absent	sand,silt,grayish ppt
WVKC-10-T-9-B	normal	slight	sand,silt,metal hydroxides
WVKC-10-T-9-B.5	normal	absent	sand,silt
WVKC-10-T-9-C-2	normal	absent	sand,silt
WVKC-10-T-10	normal	absent	sand,silt,clay
WVKC-10-T-11-{0.	normal	absent	sand
WVKC-10-T-11-{15	slight iron	absent	sand,silt
WVKC-10-T-11-{4.	normal	absent	sand,silt
WVKC-10-T-11-H.5	normal	absent	sand
WVKC-10-T-21	normal	absent	sand,silt
WVKC-10-T-24-{0.	normal	absent	sand,silt
WVKC-10-U-{0.4}	normal	absent	sand,silt
WVKC-10-U-{24.4}	normal	absent	sand,silt
WVKC-10-U-{4.9}	normal	absent	sand,silt
WVKC-10-U-{9.0}	normal	absent	sand,silt
WVKC-10-U-3-B	normal	absent	sand,silt,coal fines
WVKC-10-U-7-{0.0	normal	absent	sand,silt
WVKC-10-U-7-{4.3	normal	absent	sand,silt
WVKC-10-U-7-{7.9	normal	absent	sand
WVKC-10-U-7-A	normal	absent	sand,silt
WVKC-10-U-12-A	normal	absent	sand,silt
WVKC-10-U-13	normal	absent	sand,silt
WVKC-10-U-17	normal	absent	sand,silt,metal hydroxides
WVKC-10-U-21	normal	absent	sand,silt
WVKC-11-{5.6}	normal	absent	sand,silt
WVKC-14	none	absent	sand
WVKC-16-A	normal	absent	sand
WVKC-21-{0.0}	normal	absent	sand,silt,clay
WVKC-21-C	anaerobic	absent	sand,silt
WVKC-28	sewage	absent	sludge,sewage fungus
WVKC-29	normal	absent	sand,silt
WVKC-29-A	normal	absent	sand

Table 7. Observed sediment characteristics (continued)

Stream Code	Sediment odors	Sediment oils	Sediment deposits
WVKC-29-A-3	normal,slight iron	absent	sand,metal hydroxides
WVKC-31-{0.4}	normal	absent	sand
WVKC-31-B-{0.2}	normal	absent	sand
WVKC-31-B-{10.9}	none	absent	sand,silt
WVKC-31-C	normal	absent	sand
WVKC-35-{3.0}	normal	absent	paper fiber,silt
WVKC-35-F	normal	absent	sand,silt
WVKC-35-G	normal	absent	sand,silt,metal hydroxides
WVKC-43-{0.0}	normal	absent	sand,silt
WVKC-43-{2.8}	normal	absent	sand,silt,coal fines
WVKC-46-{0.0}	normal	absent	sand,silt
WVKC-46-{5.8}	normal	slight	sand,silt,metal hydroxides
WVKC-46-{15.3}	normal	absent	sand,silt
WVKC-46-{20.2}	normal	absent	sand,silt,red dog
WVKC-46-{32.8}	anaerobic	slight	sand,silt
WVKC-46-C	normal	absent	sand,silt
WVKC-46-E	normal	absent	sand,silt
WVKC-46-G	normal	absent	sand,silt
WVKC-46-G-1	normal	absent	sand,silt
WVKC-46-G-1-.5A	normal	absent	sand,silt
WVKC-46-G-2	normal	absent	sand,silt
WVKC-46-H	normal	absent	sand,silt
WVKC-46-I	normal	absent	sand,silt
WVKC-46-J-2	normal	absent	sand,silt
WVKC-46-K	normal	absent	sand,silt
WVKC-46-L.5	anaerobic	absent	sand,silt,clay
WVKC-46-P	normal	absent	sand,silt
WVKC-46-Q	normal	absent	sand,silt
WVKC-47	normal	absent	sand,silt,a little red dog
WVKC-47-A-{1.3}	normal	absent	sand,silt,coal pieces
WVKC-47-C	normal	absent	sand,silt
WVKC-47-F	normal	absent	sand,silt
WVKC-47-G	normal	absent	sand,silt,metal hydroxides,red dog,coal
WVKC-47-G-1	normal	absent	sand,silt,red dog,coal
WVKC-47-H	normal	absent	sand,silt,a little red dog
WVKC-47-L-{0.8}	normal	absent	sand,silt
WVKC-47-N-{1.4}	normal	absent	sand,silt,coal fines
WVKC-47-O-{0.0}	normal	absent	sand,silt,red dog
WVKC-47-O-{2.4}	normal	absent	sand,silt,red dog

Table 8. Substrate composition in area of macrobenthic collection

Stream Code	% bedrock	% boulder	% cobble	% gravel	% sand	% silt	% clay
WVK-34-{23.8}	0	20	35	15	25	5	0
WVK-34-{58.4}	0	0	60	30	10	0	0
WVKC-2-{2.0}	0	0	20	45	20	15	0
WVKC-4-{2.5}	0	0	20	50	20	10	0
WVKC-5	0	0	30	40	15	10	5
WVKC-9	15	0	15	60	10	0	0
WVKC-10-{03.6}	0	20	60	10	10	0	0
WVKC-10-{17.0}	0	0	20	40	30	10	0
WVKC-10-I-{0.0}	0	5	5	30	50	5	0
WVKC-10-I-{12.5}	0	0	30	50	20	0	0
WVKC-10-I-{5.6}	0	0	20	40	40	0	0
WVKC-10-I-6-C	0	5	50	15	20	10	0
WVKC-10-J	0	0	30	40	20	10	0
WVKC-10-L	0	0	20	60	10	10	0
WVKC-10-N-{3.0}	0	10	40	25	20	5	0
WVKC-10-P-.5	40	0	30	10	10	10	0
WVKC-10-T-{0.3}	0	5	45	25	20	5	0
WVKC-10-T-{17.4}	0	0	60	30	10	0	0
WVKC-10-T-{18.5}	5	0	50	30	15	0	0
WVKC-10-T-{4.6}	0	0	40	30	20	10	0
WVKC-10-T-2	0	5	60	10	15	10	0
WVKC-10-T-3	0	0	70	20	0	10	0
WVKC-10-T-9	0	0	50	30	20	0	0
WVKC-10-T-9-B	0	0	30	50	20	0	0
WVKC-10-T-9-B.5	0	0	30	55	15	0	0
WVKC-10-T-9-C-2	0	0	30	30	35	5	0
WVKC-10-T-10	0	0	20	50	15	10	5
WVKC-10-T-11-{0.2}	0	5	50	35	10	0	0
WVKC-10-T-11-{15.3}	0	0	50	20	30	0	0
WVKC-10-T-11-{4.1}	0	0	40	35	20	5	0
WVKC-10-T-11-H.5-{0.3}	1	9	30	40	20	0	0
WVKC-10-T-21	0	0	40	35	20	5	0
WVKC-10-T-24-{0.6}	20	0	80	0	0	0	0
WVKC-10-U-{0.4}	0	0	40	40	15	5	0
WVKC-10-U-{24.4}	0	10	45	25	20	0	0
WVKC-10-U-{4.9}	0	0	50	40	10	0	0
WVKC-10-U-{9.0}	0	0	20	10	50	20	0
WVKC-10-U-3-B	0	0	40	35	20	3	2
WVKC-10-U-7-{0.0}	0	5	50	30	10	5	0
WVKC-10-U-7-{4.3}	0	5	55	30	8	2	0
WVKC-10-U-7-{7.9}	0	0	50	35	10	5	0
WVKC-10-U-7-A	0	0	70	15	10	5	0
WVKC-10-U-12-A	0	0	50	10	30	10	0
WVKC-10-U-13	0	0	50	25	20	5	0
WVKC-10-U-17	0	0	60	30	10	0	0
WVKC-10-U-21	5	5	50	20	15	5	0
WVKC-11-{5.6}	0	0	20	40	30	10	0
WVKC-14	0	0	40	40	20	0	0
WVKC-16-A	0	0	15	60	20	5	0
WVKC-21-{0.0}	0	0	20	50	15	5	10
WVKC-21-C	0	0	20	30	20	30	0
WVKC-29	0	0	20	45	30	5	0
WVKC-29-A	0	0	40	50	10	0	0

Table 8. Substrate composition in area of macrobenthic collection (cont.)

Stream Code	% bedrock	% boulder	% cobble	% gravel	% sand	% silt	% clay
WVKC-29-A-3	0	5	25	40	30	0	0
WVKC-31-{0.4}	0	0	50	40	10	0	0
WVKC-31-B-{0.2}	0	0	30	50	20	0	0
WVKC-31-B-{10.9}	0	0	50	25	20	5	0
WVKC-31-C	0	0	50	40	10	0	0
WVKC-35-{3.0}	0	0	40	35	20	5	0
WVKC-35-F	0	0	40	40	15	5	0
WVKC-35-G	0	0	45	35	15	5	0
WVKC-43-{0.0}	0	0	30	30	20	20	0
WVKC-43-{2.8}	0	0	30	30	20	20	0
WVKC-46-{0.0}	0	0	70	20	10	0	0
WVKC-46-{5.8}	0	0	70	20	10	0	0
WVKC-46-{15.3}	0	10	50	30	10	0	0
WVKC-46-{20.2}	0	15	40	25	15	5	0
WVKC-46-{32.8}	0	0	0	5	65	30	0
WVKC-46-C	0	0	70	15	8	7	0
WVKC-46-E	0	0	30	50	15	5	0
WVKC-46-G	0	10	40	30	15	5	0
WVKC-46-G-1	0	10	35	30	20	5	0
WVKC-46-G-2	0	5	45	35	13	2	0
WVKC-46-H	0	10	35	25	20	10	0
WVKC-46-I	0	0	60	10	20	10	0
WVKC-46-J-2	0	0	40	40	10	10	0
WVKC-46-K	0	10	40	30	15	5	0
WVKC-46-P	0	0	10	20	25	20	0
WVKC-46-Q	0	10	10	10	30	5	0
WVKC-47	0	0	50	30	15	5	0
WVKC-47-A-{1.3}	0	5	20	50	25	0	0
WVKC-47-C	0	5	30	45	20	0	0
WVKC-47-F	0	5	30	40	15	10	0
WVKC-47-G	0	5	40	35	15	5	0
WVKC-47-G-1	0	15	30	40	15	0	0
WVKC-47-H	0	5	30	50	10	5	0
WVKC-47-L-{0.8}	0	5	40	40	10	5	0
WVKC-47-N-{1.4}	0	10	40	30	15	5	0
WVKC-47-O-{0.0}	5	5	30	40	20	0	0
WVKC-47-O-{2.4}	0	5	25	40	30	0	0

Table 9. Macrobenthic community metrics and WVSCI scores

Stream Code	Total Taxa	EPT taxa	% EPT	% 2 dom	% chiros	HBI	WVSCI
WVK-34-{23.8}	18	10	81.82	67.91	1.60	4.34	80.15
WVK-34-{58.4}	16	9	78.40	50.78	4.90	3.86	81.70
WVK-34-{58.4}	13	6	83.42	51.76	3.02	3.85	76.46
WVKC-2-{2.0}	17	7	40.88	63.54	38.12	5.02	61.48
WVKC-4-{2.5}	11	4	29.89	62.64	45.40	5.02	49.89
WVKC-5	19	8	37.55	47.65	29.24	4.57	70.42
WVKC-9	11	5	29.06	62.39	42.74	5.01	51.56
WVKC-10-{03.6}	16	6	82.19	63.47	6.39	4.17	74.26
WVKC-10-{17.0}	12	5	80.20	78.22	1.98	4.52	65.50
WVKC-10-I-{0.0}	14	3	23.53	65.44	27.94	4.99	52.12
WVKC-10-I-{12.5}	13	3	35.49	67.39	19.90	4.80	54.79
WVKC-10-I-{5.6}	9	4	19.70	76.35	30.05	4.78	46.02
WVKC-10-I-6-C	13	5	28.03	42.42	19.70	4.53	63.16
WVKC-10-J	13	2	21.62	50.45	30.63	5.37	52.25
WVKC-10-L	16	8	70.91	55.76	7.58	4.00	76.98
WVKC-10-N-{3.0}	16	6	25.49	64.71	32.35	4.75	57.91
WVKC-10-P-.5	16	5	26.79	45.54	16.96	4.47	65.10
WVKC-10-T-{0.3}	14	5	73.22	52.13	10.66	4.40	71.46
WVKC-10-T-{17.4}	12	5	52.02	45.16	10.08	4.29	68.19
WVKC-10-T-{18.5}	10	5	27.08	74.31	10.42	4.37	54.25
WVKC-10-T-{4.6}	16	7	50.91	49.09	7.88	4.33	72.97
WVKC-10-T-2	17	7	60.34	63.79	12.93	4.24	71.01
WVKC-10-T-3	7	1	3.51	80.70	8.77	5.74	37.86
WVKC-10-T-9	11	4	60.00	43.81	19.05	4.72	65.38
WVKC-10-T-9	11	4	72.32	61.61	10.71	4.38	65.20
WVKC-10-T-9-B	13	3	8.20	55.74	8.20	4.17	56.32
WVKC-10-T-9-B.5	15	4	47.50	47.50	12.50	4.66	66.59
WVKC-10-T-9-C-2	16	4	26.17	52.35	3.36	4.50	64.17
WVKC-10-T-10	15	6	59.66	47.06	11.76	4.19	72.68
WVKC-10-T-11-{0.2}	12	4	39.21	55.07	26.43	4.79	58.08
WVKC-10-T-11-{15.3}	12	7	88.28	79.08	4.18	4.68	68.58
WVKC-10-T-11-{4.1}	9	3	67.16	61.76	13.73	4.65	60.21
WVKC-10-T-11-H.5-{0.3}	6	5	35.56	75.56	0.00	3.89	55.00
WVKC-10-T-21	11	5	62.12	70.83	22.73	4.94	58.89
WVKC-10-T-24-{0.6}	13	6	56.80	64.00	7.20	4.06	67.24
WVKC-10-U-{0.4}	18	6	59.11	52.13	9.20	4.41	73.57
WVKC-10-U-{24.4}	10	4	62.14	70.87	10.92	4.70	59.36
WVKC-10-U-{4.9}	13	5	72.32	74.03	7.22	4.70	64.66
WVKC-10-U-{9.0}	19	6	47.32	49.11	17.86	5.89	68.08
WVKC-10-U-3-B	14	7	60.00	43.53	14.71	4.32	73.35
WVKC-10-U-7-{0.0}	10	4	72.81	77.42	15.67	5.00	58.07
WVKC-10-U-7-{4.3}	10	1	46.24	65.59	19.35	5.27	51.24
WVKC-10-U-7-{7.9}	10	3	61.45	76.51	18.67	5.11	54.22
WVKC-10-U-7-A	14	7	45.71	65.71	15.71	3.93	65.74
WVKC-10-U-12-A	16	6	44.48	69.33	33.44	5.11	59.13
WVKC-10-U-13	16	8	61.92	62.06	23.55	4.81	69.12
WVKC-10-U-17	18	9	64.69	63.99	17.83	4.90	72.75
WVKC-10-U-21	14	7	43.26	62.36	34.27	4.83	60.93
WVKC-11-{5.6}	16	6	31.15	50.16	31.48	4.99	62.30
WVKC-14	19	8	73.00	55.91	11.81	4.37	78.11
WVKC-16-A	11	4	84.29	63.57	3.57	4.19	68.49
WVKC-21-{0.0}	14	4	8.98	73.05	54.49	5.60	42.86
WVKC-21-C	14	3	2.82	66.90	57.75	6.16	40.21
WVKC-29	12	5	37.84	56.76	29.73	5.38	56.73
WVKC-29-A	16	7	55.80	59.12	12.15	4.71	69.64

Table 9. Macrobenthic community metrics and WVSCI scores (cont.)

Stream Code	Total Taxa	EPT taxa	% EPT	% 2 dom	% chiros	HBI	WVSCI
WVKC-29-A-3	22	8	49.79	41.70	9.79	4.27	79.78
WVKC-31-{0.4}	12	7	61.39	70.81	7.34	4.55	65.63
WVKC-31-B-{0.2}	14	6	72.06	40.65	4.16	4.16	77.16
WVKC-31-B-{10.9}	19	12	72.82	54.37	5.83	3.66	86.29
WVKC-31-C	14	9	85.09	78.95	9.21	4.52	71.71
WVKC-35-{3.0}	8	4	43.23	68.23	28.65	5.00	51.34
WVKC-35-F	16	8	67.37	62.70	18.88	4.73	70.92
WVKC-43-{0.0}	20	7	37.80	55.19	34.79	4.86	66.42
WVKC-43-{2.8}	19	9	40.68	65.35	34.12	4.98	65.89
WVKC-46-{0.0}	13	5	79.79	62.09	4.28	3.57	72.28
WVKC-46-{5.8}	15	6	80.25	47.10	4.71	3.90	78.28
WVKC-46-{15.3}	14	6	69.88	54.82	6.02	4.42	72.15
WVKC-46-{20.2}	15	6	71.08	52.41	3.61	4.00	75.19
WVKC-46-{32.8}	13	4	13.92	75.95	62.66	5.15	41.90
WVKC-46-C	14	7	84.52	73.12	9.16	4.60	70.38
WVKC-46-E	17	6	52.25	49.55	9.91	5.16	70.32
WVKC-46-G	17	8	79.11	66.22	5.04	4.22	76.45
WVKC-46-G-1	16	9	89.73	81.25	6.70	4.59	73.80
WVKC-46-G-1-.5A	2	1	50.00	100.00	0.00	3.00	45.04
WVKC-46-G-2	19	8	84.29	68.58	3.63	4.02	79.07
WVKC-46-H	13	7	66.05	61.73	6.79	4.48	69.88
WVKC-46-I	18	9	60.29	43.38	8.82	4.24	80.36
WVKC-46-J-2	8	3	23.96	63.54	20.83	4.29	50.76
WVKC-46-K	20	10	59.38	36.61	20.98	3.77	83.90
WVKC-46-L.5	10	4	80.85	74.47	7.45	2.99	66.41
WVKC-46-P	14	7	28.57	65.84	48.45	5.29	53.89
WVKC-46-Q	11	3	3.13	89.84	34.38	4.25	40.32
WVKC-47	8	5	86.86	60.32	5.63	3.87	69.13
WVKC-47	12	4	60.81	46.62	18.24	4.41	66.46
WVKC-47-A-{1.3}	20	11	66.15	51.28	1.54	4.22	84.81
WVKC-47-C	18	8	48.39	49.46	26.88	4.69	71.25
WVKC-47-F	6	2	48.89	66.67	20.00	4.71	50.75
WVKC-47-G	12	8	78.15	72.27	6.72	4.43	69.95
WVKC-47-G-1	13	5	66.36	72.73	12.73	4.92	62.48
WVKC-47-H	15	10	72.97	62.16	12.16	4.35	75.86
WVKC-47-L-{0.8}	13	6	47.95	82.50	37.73	5.32	52.73
WVKC-47-N-{1.4}	11	7	89.09	58.18	3.64	3.36	76.55
WVKC-47-O-{0.0}	14	6	51.92	53.46	27.31	4.87	64.61
WVKC-47-O-{2.4}	15	8	83.58	62.69	9.70	4.16	75.95

Table 10. Benthic macroinvertebrates indentified

Stream Code	Taxa	count
WVK-34-{23.8}	Corydalidae	7
WVK-34-{23.8}	Corbiculidae	9
WVK-34-{23.8}	Glossosomatidae	1
WVK-34-{23.8}	Chironomidae	6
WVK-34-{23.8}	Simuliidae	2
WVK-34-{23.8}	Tipulidae	5
WVK-34-{23.8}	Elmidae	37
WVK-34-{23.8}	Coenagrionidae	1
WVK-34-{23.8}	Limnephilidae	1
WVK-34-{23.8}	Heptageniidae	15
WVK-34-{23.8}	Empididae	1
WVK-34-{23.8}	Caenidae	1
WVK-34-{23.8}	Philopotamidae	2
WVK-34-{23.8}	Tricorythidae	125
WVK-34-{23.8}	Isonychiidae	30
WVK-34-{23.8}	Hydropsychidae	129
WVK-34-{23.8}	Hydroptilidae	1
WVK-34-{23.8}	Baetidae	1
WVK-34-{58.4}	Philopotamidae	1
WVK-34-{58.4}	Caenidae	2
WVK-34-{58.4}	Chironomidae	22
WVK-34-{58.4}	Simuliidae	2
WVK-34-{58.4}	Empididae	1
WVK-34-{58.4}	Psephenidae	5
WVK-34-{58.4}	Elmidae	64
WVK-34-{58.4}	Coenagrionidae	2
WVK-34-{58.4}	Baetidae	47
WVK-34-{58.4}	Tricorythidae	1
WVK-34-{58.4}	Physidae	1
WVK-34-{58.4}	Rhyacophilidae	1
WVK-34-{58.4}	Heptageniidae	128
WVK-34-{58.4}	Isonychiidae	100
WVK-34-{58.4}	Hydropsychidae	70
WVK-34-{58.4}	Hydroptilidae	2
WVKC-2-{2.0}	Elmidae	14
WVKC-2-{2.0}	Asellidae	1
WVKC-2-{2.0}	Simuliidae	4
WVKC-2-{2.0}	Ephydridae	1
WVKC-2-{2.0}	Tipulidae	12
WVKC-2-{2.0}	Veliidae	3
WVKC-2-{2.0}	Corydalidae	1
WVKC-2-{2.0}	Psephenidae	1
WVKC-2-{2.0}	Chironomidae	69
WVKC-2-{2.0}	Hydropsychidae	46
WVKC-2-{2.0}	Isonychiidae	6
WVKC-2-{2.0}	Leptophlebiidae	2
WVKC-2-{2.0}	Heptageniidae	6
WVKC-2-{2.0}	Ephemerellidae	1
WVKC-2-{2.0}	Baetidae	12
WVKC-2-{2.0}	Caenidae	1
WVKC-2-{2.0}	Coenagrionidae	1
WVKC-4-{2.5}	Psephenidae	7
WVKC-4-{2.5}	Chironomidae	79
WVKC-4-{2.5}	Simuliidae	6
WVKC-4-{2.5}	Tipulidae	5
WVKC-4-{2.5}	Corydalidae	2
WVKC-4-{2.5}	Elmidae	21
WVKC-4-{2.5}	Chloroperlidae	1
WVKC-4-{2.5}	Hydropsychidae	17
WVKC-4-{2.5}	Isonychiidae	4
WVKC-4-{2.5}	Baetidae	30
WVKC-4-{2.5}	Veliidae	2
WVKC-5	Dryopidae	1
WVKC-5	Calopterygidae	1
WVKC-5	Chironomidae	81
WVKC-5	Empididae	1
WVKC-5	Ceratopogonidae	1
WVKC-5	Tipulidae	16
WVKC-5	Veliidae	2
WVKC-5	Corydalidae	6
WVKC-5	Psephenidae	51
WVKC-5	Aeshnidae	2
WVKC-5	Baetidae	33
WVKC-5	Perlodidae	1
WVKC-5	Chloroperlidae	5
WVKC-5	Capniidae/Leuctridae	7
WVKC-5	Hydropsychidae	42
WVKC-5	Isonychiidae	2
WVKC-5	Heptageniidae	13
WVKC-5	Ephemerellidae	1
WVKC-5	Elmidae	11
WVKC-9	Philopotamidae	1
WVKC-9	Simuliidae	1
WVKC-9	Empididae	1
WVKC-9	Corydalidae	1
WVKC-9	Psephenidae	17
WVKC-9	Perlidae	3
WVKC-9	Chironomidae	50
WVKC-9	Hydropsychidae	23
WVKC-9	Heptageniidae	2
WVKC-9	Baetidae	5
WVKC-9	Elmidae	13
WVKC-10-{03.6}	Philopotamidae	1
WVKC-10-{03.6}	Simuliidae	1
WVKC-10-{03.6}	Tipulidae	9
WVKC-10-{03.6}	Veliidae	1
WVKC-10-{03.6}	Corydalidae	9
WVKC-10-{03.6}	Elmidae	24
WVKC-10-{03.6}	Gomphidae	1
WVKC-10-{03.6}	Hydropsychidae	91
WVKC-10-{03.6}	Isonychiidae	43
WVKC-10-{03.6}	Tricorythidae	187
WVKC-10-{03.6}	Heptageniidae	36
WVKC-10-{03.6}	Baetidae	2

Table 10. Benthic macroinvertebrates indentified (continued)

Stream Code	Taxa	count
WVKC-10-{03.6}	Pleuroceridae	3
WVKC-10-{03.6}	Oligochaeta	1
WVKC-10-{03.6}	Chironomidae	28
WVKC-10-{03.6}	Corbiculidae	1
WVKC-10-{17.0}	Polycentropodidae	1
WVKC-10-{17.0}	Chironomidae	4
WVKC-10-{17.0}	Ceratopogonidae	1
WVKC-10-{17.0}	Tipulidae	1
WVKC-10-{17.0}	Corydalidae	3
WVKC-10-{17.0}	Elmidae	27
WVKC-10-{17.0}	Isonychiidae	1
WVKC-10-{17.0}	Tricorythidae	82
WVKC-10-{17.0}	Heptageniidae	2
WVKC-10-{17.0}	Oligochaeta	1
WVKC-10-{17.0}	Corbiculidae	3
WVKC-10-{17.0}	Hydropsychidae	76
WVKC-10-I-{0.0}	Psephenidae	1
WVKC-10-I-{0.0}	Chironomidae	38
WVKC-10-I-{0.0}	Simuliidae	2
WVKC-10-I-{0.0}	Ceratopogonidae	1
WVKC-10-I-{0.0}	Corydalidae	3
WVKC-10-I-{0.0}	Elmidae	51
WVKC-10-I-{0.0}	Hydropsychidae	30
WVKC-10-I-{0.0}	Isonychiidae	1
WVKC-10-I-{0.0}	Tricorythidae	1
WVKC-10-I-{0.0}	Cambaridae	1
WVKC-10-I-{0.0}	Corbiculidae	4
WVKC-10-I-{0.0}	Oligochaeta	1
WVKC-10-I-{0.0}	Aeshnidae	1
WVKC-10-I-{0.0}	Tipulidae	1
WVKC-10-I-{12.5}	Philopotamidae	8
WVKC-10-I-{12.5}	Perlidae	1
WVKC-10-I-{12.5}	Gomphidae	1
WVKC-10-I-{12.5}	Elmidae	142
WVKC-10-I-{12.5}	Psephenidae	3
WVKC-10-I-{12.5}	Corydalidae	3
WVKC-10-I-{12.5}	Cossidae	1
WVKC-10-I-{12.5}	Tipulidae	12
WVKC-10-I-{12.5}	Chironomidae	83
WVKC-10-I-{12.5}	Simuliidae	20
WVKC-10-I-{12.5}	Empididae	3
WVKC-10-I-{12.5}	Oligochaeta	1
WVKC-10-I-{12.5}	Hydropsychidae	139
WVKC-10-I-{5.6}	Philopotamidae	1
WVKC-10-I-{5.6}	Heptageniidae	1
WVKC-10-I-{5.6}	Hydropsychidae	37
WVKC-10-I-{5.6}	Elmidae	94
WVKC-10-I-{5.6}	Psephenidae	3
WVKC-10-I-{5.6}	Corydalidae	3
WVKC-10-I-{5.6}	Tipulidae	2
WVKC-10-I-{5.6}	Chironomidae	61
WVKC-10-I-{5.6}	Baetidae	1
WVKC-10-I-6-C	Veliidae	9
WVKC-10-I-6-C	Calopterygidae	1
WVKC-10-I-6-C	Ceratopogonidae	6
WVKC-10-I-6-C	Psephenidae	19
WVKC-10-I-6-C	Elmidae	30
WVKC-10-I-6-C	Dryopidae	3
WVKC-10-I-6-C	Capniidae/Leuctridae	10
WVKC-10-I-6-C	Polycentropodidae	2
WVKC-10-I-6-C	Hydropsychidae	17
WVKC-10-I-6-C	Ephemerellidae	6
WVKC-10-I-6-C	Heptageniidae	2
WVKC-10-I-6-C	Chironomidae	26
WVKC-10-I-6-C	Gomphidae	1
WVKC-10-J	Psephenidae	3
WVKC-10-J	Chironomidae	34
WVKC-10-J	Simuliidae	7
WVKC-10-J	Empididae	1
WVKC-10-J	Tipulidae	18
WVKC-10-J	Gerridae	1
WVKC-10-J	Elmidae	10
WVKC-10-J	Calopterygidae	1
WVKC-10-J	Hydropsychidae	22
WVKC-10-J	Caenidae	2
WVKC-10-J	Cambaridae	3
WVKC-10-J	Oligochaeta	8
WVKC-10-J	Veliidae	1
WVKC-10-L	Dryopidae	1
WVKC-10-L	Oligochaeta	10
WVKC-10-L	Chironomidae	25
WVKC-10-L	Simuliidae	6
WVKC-10-L	Tipulidae	14
WVKC-10-L	Corydalidae	9
WVKC-10-L	Psephenidae	4
WVKC-10-L	Elmidae	27
WVKC-10-L	Baetidae	5
WVKC-10-L	Philopotamidae	13
WVKC-10-L	Hydropsychidae	28
WVKC-10-L	Isonychiidae	66
WVKC-10-L	Heptageniidae	118
WVKC-10-L	Ephemerellidae	2
WVKC-10-L	Capniidae/Leuctridae	1
WVKC-10-L	Caenidae	1
WVKC-10-N-{3.0}	Elmidae	66
WVKC-10-N-{3.0}	Psephenidae	7
WVKC-10-N-{3.0}	Veliidae	1
WVKC-10-N-{3.0}	Tipulidae	2
WVKC-10-N-{3.0}	Simuliidae	1
WVKC-10-N-{3.0}	Isonychiidae	6
WVKC-10-N-{3.0}	Chironomidae	66
WVKC-10-N-{3.0}	Ceratopogonidae	2
WVKC-10-N-{3.0}	Hydropsychidae	4
WVKC-10-N-{3.0}	Heptageniidae	32
WVKC-10-N-{3.0}	Ephemeridae	1

Table 10. Benthic macroinvertebrates indentified (continued)

Stream Code	Taxa	count
WVKC-10-N-{3.0}	Caenidae	5
WVKC-10-N-{3.0}	Baetidae	4
WVKC-10-N-{3.0}	Cambaridae	4
WVKC-10-N-{3.0}	Oligochaeta	1
WVKC-10-N-{3.0}	Gomphidae	2
WVKC-10-P-.5	Dryopidae	4
WVKC-10-P-.5	Ceratopogonidae	2
WVKC-10-P-.5	Tipulidae	32
WVKC-10-P-.5	Veliidae	8
WVKC-10-P-.5	Corydalidae	1
WVKC-10-P-.5	Psephenidae	6
WVKC-10-P-.5	Hydrophilidae	5
WVKC-10-P-.5	Gomphidae	1
WVKC-10-P-.5	Capniidae/Leuctridae	1
WVKC-10-P-.5	Philopotamidae	1
WVKC-10-P-.5	Hydropsychidae	15
WVKC-10-P-.5	Heptageniidae	11
WVKC-10-P-.5	Ephemerellidae	2
WVKC-10-P-.5	Oligochaeta	1
WVKC-10-P-.5	Calopterygidae	3
WVKC-10-P-.5	Chironomidae	19
WVKC-10-T-{0.3}	Psycomyiidae	1
WVKC-10-T-{0.3}	Chironomidae	45
WVKC-10-T-{0.3}	Simuliidae	10
WVKC-10-T-{0.3}	Tipulidae	1
WVKC-10-T-{0.3}	Athericidae	1
WVKC-10-T-{0.3}	Elmidae	50
WVKC-10-T-{0.3}	Isonychiidae	32
WVKC-10-T-{0.3}	Tricorythidae	108
WVKC-10-T-{0.3}	Heptageniidae	12
WVKC-10-T-{0.3}	Baetidae	45
WVKC-10-T-{0.3}	Ancylidae	3
WVKC-10-T-{0.3}	Hydropsychidae	112
WVKC-10-T-{0.3}	Psephenidae	1
WVKC-10-T-{0.3}	Oligochaeta	1
WVKC-10-T-{17.4}	Simuliidae	16
WVKC-10-T-{17.4}	Baetidae	38
WVKC-10-T-{17.4}	Heptageniidae	10
WVKC-10-T-{17.4}	Isonychiidae	34
WVKC-10-T-{17.4}	Hydropsychidae	46
WVKC-10-T-{17.4}	Chironomidae	25
WVKC-10-T-{17.4}	Elmidae	66
WVKC-10-T-{17.4}	Tipulidae	2
WVKC-10-T-{17.4}	Oligochaeta	2
WVKC-10-T-{17.4}	Capniidae/Leuctridae	1
WVKC-10-T-{17.4}	Athericidae	1
WVKC-10-T-{17.4}	Corydalidae	7
WVKC-10-T-{18.5}	Baetidae	1
WVKC-10-T-{18.5}	Chironomidae	15
WVKC-10-T-{18.5}	Simuliidae	4
WVKC-10-T-{18.5}	Corydalidae	2
WVKC-10-T-{18.5}	Psephenidae	4
WVKC-10-T-{18.5}	Elmidae	80
WVKC-10-T-{18.5}	Philopotamidae	2
WVKC-10-T-{18.5}	Hydropsychidae	27
WVKC-10-T-{18.5}	Heptageniidae	3
WVKC-10-T-{18.5}	Isonychiidae	6
WVKC-10-T-{4.6}	Gomphidae	1
WVKC-10-T-{4.6}	Psephenidae	1
WVKC-10-T-{4.6}	Elmidae	53
WVKC-10-T-{4.6}	Tipulidae	7
WVKC-10-T-{4.6}	Simuliidae	1
WVKC-10-T-{4.6}	Coenagrionidae	1
WVKC-10-T-{4.6}	Tricorythidae	25
WVKC-10-T-{4.6}	Polycentropodidae	1
WVKC-10-T-{4.6}	Hydropsychidae	28
WVKC-10-T-{4.6}	Ephemeridae	1
WVKC-10-T-{4.6}	Chironomidae	13
WVKC-10-T-{4.6}	Heptageniidae	5
WVKC-10-T-{4.6}	Baetidae	13
WVKC-10-T-{4.6}	Corbiculidae	1
WVKC-10-T-{4.6}	Oligochaeta	3
WVKC-10-T-{4.6}	Isonychiidae	11
WVKC-10-T-2	Chironomidae	15
WVKC-10-T-2	Calopterygidae	1
WVKC-10-T-2	Physidae	2
WVKC-10-T-2	Tipulidae	11
WVKC-10-T-2	Corydalidae	4
WVKC-10-T-2	Psephenidae	6
WVKC-10-T-2	Elmidae	4
WVKC-10-T-2	Dryopidae	1
WVKC-10-T-2	Ceratopogonidae	1
WVKC-10-T-2	Philopotamidae	1
WVKC-10-T-2	Isonychiidae	1
WVKC-10-T-2	Tricorythidae	1
WVKC-10-T-2	Heptageniidae	59
WVKC-10-T-2	Ephemerellidae	5
WVKC-10-T-2	Asellidae	1
WVKC-10-T-2	Perlidae	1
WVKC-10-T-2	Baetidae	2
WVKC-10-T-3	Hydropsychidae	2
WVKC-10-T-3	Chironomidae	5
WVKC-10-T-3	Veliidae	1
WVKC-10-T-3	Psephenidae	25
WVKC-10-T-3	Elmidae	2
WVKC-10-T-3	Physidae	21
WVKC-10-T-3	Hydrophilidae	1
WVKC-10-T-9	Elmidae	8
WVKC-10-T-9	Tipulidae	4
WVKC-10-T-9	Simuliidae	1
WVKC-10-T-9	Corydalidae	2
WVKC-10-T-9	Psephenidae	1
WVKC-10-T-9	Isonychiidae	13
WVKC-10-T-9	Heptageniidae	6

Table 10. Benthic macroinvertebrates indentified (continued)

Stream Code	Taxa	count
WVKC-10-T-9	Chironomidae	20
WVKC-10-T-9	Baetidae	18
WVKC-10-T-9	Oligochaeta	6
WVKC-10-T-9	Hydropsychidae	26
WVKC-10-T-9-B	Calopterygidae	1
WVKC-10-T-9-B	Chironomidae	5
WVKC-10-T-9-B	Tipulidae	9
WVKC-10-T-9-B	Corydalidae	3
WVKC-10-T-9-B	Lampyridae	1
WVKC-10-T-9-B	Coenagrionidae	1
WVKC-10-T-9-B	Gomphidae	12
WVKC-10-T-9-B	Phryganeidae	2
WVKC-10-T-9-B	Hydropsychidae	2
WVKC-10-T-9-B	Caenidae	1
WVKC-10-T-9-B	Cambaridae	1
WVKC-10-T-9-B	Oligochaeta	1
WVKC-10-T-9-B	Elmidae	22
WVKC-10-T-9-B.5	Physidae	3
WVKC-10-T-9-B.5	Psephenidae	7
WVKC-10-T-9-B.5	Chironomidae	15
WVKC-10-T-9-B.5	Empididae	1
WVKC-10-T-9-B.5	Ceratopogonidae	1
WVKC-10-T-9-B.5	Tipulidae	17
WVKC-10-T-9-B.5	Veliidae	3
WVKC-10-T-9-B.5	Corydalidae	8
WVKC-10-T-9-B.5	Elmidae	5
WVKC-10-T-9-B.5	Calopterygidae	2
WVKC-10-T-9-B.5	Aeshnidae	1
WVKC-10-T-9-B.5	Hydropsychidae	40
WVKC-10-T-9-B.5	Heptageniidae	10
WVKC-10-T-9-B.5	Baetidae	2
WVKC-10-T-9-B.5	Ephemerellidae	5
WVKC-10-T-9-C-2	Dryopidae	5
WVKC-10-T-9-C-2	Elmidae	16
WVKC-10-T-9-C-2	Chironomidae	5
WVKC-10-T-9-C-2	Tipulidae	3
WVKC-10-T-9-C-2	Veliidae	2
WVKC-10-T-9-C-2	Corydalidae	3
WVKC-10-T-9-C-2	Hydrophilidae	6
WVKC-10-T-9-C-2	Cambaridae	1
WVKC-10-T-9-C-2	Gomphidae	3
WVKC-10-T-9-C-2	Physidae	3
WVKC-10-T-9-C-2	Ephemerellidae	1
WVKC-10-T-9-C-2	Heptageniidae	16
WVKC-10-T-9-C-2	Psephenidae	59
WVKC-10-T-9-C-2	Hydropsychidae	19
WVKC-10-T-9-C-2	Oligochaeta	4
WVKC-10-T-9-C-2	Philopotamidae	3
WVKC-10-T-10	Ceratopogonidae	2
WVKC-10-T-10	Elmidae	5
WVKC-10-T-10	Tipulidae	16
WVKC-10-T-10	Lepidoptera	1
WVKC-10-T-10	Veliidae	2
WVKC-10-T-10	Psephenidae	5
WVKC-10-T-10	Chironomidae	14
WVKC-10-T-10	Chloroperlidae	4
WVKC-10-T-10	Capniidae/Leuctridae	1
WVKC-10-T-10	Hydropsychidae	21
WVKC-10-T-10	Heptageniidae	35
WVKC-10-T-10	Ephemerellidae	4
WVKC-10-T-10	Baetidae	6
WVKC-10-T-10	Cambaridae	2
WVKC-10-T-10	Gomphidae	1
WVKC-10-T-11-{0.2}	Elmidae	104
WVKC-10-T-11-{0.2}	Chironomidae	120
WVKC-10-T-11-{0.2}	Simuliidae	15
WVKC-10-T-11-{0.2}	Empididae	2
WVKC-10-T-11-{0.2}	Oligochaeta	2
WVKC-10-T-11-{0.2}	Corydalidae	21
WVKC-10-T-11-{0.2}	Hydropsychidae	130
WVKC-10-T-11-{0.2}	Isonychiidae	33
WVKC-10-T-11-{0.2}	Baetiscidae	1
WVKC-10-T-11-{0.2}	Baetidae	14
WVKC-10-T-11-{0.2}	Gomphidae	1
WVKC-10-T-11-{0.2}	Tipulidae	11
WVKC-10-T-11-{15.3}	Chironomidae	10
WVKC-10-T-11-{15.3}	Rhyacophilidae	5
WVKC-10-T-11-{15.3}	Philopotamidae	1
WVKC-10-T-11-{15.3}	Capniidae/Leuctridae	1
WVKC-10-T-11-{15.3}	Perlidae	1
WVKC-10-T-11-{15.3}	Gomphidae	1
WVKC-10-T-11-{15.3}	Elmidae	14
WVKC-10-T-11-{15.3}	Tipulidae	2
WVKC-10-T-11-{15.3}	Baetidae	17
WVKC-10-T-11-{15.3}	Hydropsychidae	172
WVKC-10-T-11-{15.3}	Psephenidae	1
WVKC-10-T-11-{15.3}	Heptageniidae	14
WVKC-10-T-11-{4.1}	Baetidae	40
WVKC-10-T-11-{4.1}	Oligochaeta	1
WVKC-10-T-11-{4.1}	Simuliidae	1
WVKC-10-T-11-{4.1}	Veliidae	1
WVKC-10-T-11-{4.1}	Corydalidae	2
WVKC-10-T-11-{4.1}	Elmidae	34
WVKC-10-T-11-{4.1}	Hydropsychidae	86
WVKC-10-T-11-{4.1}	Isonychiidae	11
WVKC-10-T-11-{4.1}	Chironomidae	28
WVKC-10-T-11-H.5-{0.3}	Psephenidae	29
WVKC-10-T-11-H.5-{0.3}	Perlidae	3
WVKC-10-T-11-H.5-{0.3}	Limnephilidae	3
WVKC-10-T-11-H.5-{0.3}	Hydropsychidae	4
WVKC-10-T-11-H.5-{0.3}	Ephemeridae	1
WVKC-10-T-11-H.5-{0.3}	Heptageniidae	5

Table 10. Benthic macroinvertebrates indentified (continued)

Stream Code	Taxa	count
WVKC-10-T-21	Perlidae	1
WVKC-10-T-21	Corydalidae	1
WVKC-10-T-21	Chironomidae	60
WVKC-10-T-21	Tipulidae	7
WVKC-10-T-21	Elmidae	19
WVKC-10-T-21	Isonychiidae	12
WVKC-10-T-21	Oligochaeta	2
WVKC-10-T-21	Heptageniidae	1
WVKC-10-T-21	Baetidae	23
WVKC-10-T-21	Simuliidae	11
WVKC-10-T-21	Hydropsychidae	127
WVKC-10-T-24-{0.6}	Pteronarcyidae	2
WVKC-10-T-24-{0.6}	Chironomidae	9
WVKC-10-T-24-{0.6}	Tipulidae	34
WVKC-10-T-24-{0.6}	Veliidae	1
WVKC-10-T-24-{0.6}	Elmidae	7
WVKC-10-T-24-{0.6}	Perlidae	4
WVKC-10-T-24-{0.6}	Philopotamidae	11
WVKC-10-T-24-{0.6}	Hydropsychidae	46
WVKC-10-T-24-{0.6}	Heptageniidae	7
WVKC-10-T-24-{0.6}	Planorbidae	1
WVKC-10-T-24-{0.6}	Oligochaeta	1
WVKC-10-T-24-{0.6}	Polycentropodidae	1
WVKC-10-T-24-{0.6}	Carabidae	1
WVKC-10-U-{0.4}	Chironomidae	54
WVKC-10-U-{0.4}	Gomphidae	1
WVKC-10-U-{0.4}	Elmidae	157
WVKC-10-U-{0.4}	Corydalidae	6
WVKC-10-U-{0.4}	Gerridae	1
WVKC-10-U-{0.4}	Ancylidae	4
WVKC-10-U-{0.4}	Simuliidae	8
WVKC-10-U-{0.4}	Hydroptilidae	2
WVKC-10-U-{0.4}	Tipulidae	1
WVKC-10-U-{0.4}	Isonychiidae	34
WVKC-10-U-{0.4}	Tricorythidae	129
WVKC-10-U-{0.4}	Heptageniidae	11
WVKC-10-U-{0.4}	Baetidae	22
WVKC-10-U-{0.4}	Cambaridae	2
WVKC-10-U-{0.4}	Lymnaeidae	3
WVKC-10-U-{0.4}	Planorbidae	2
WVKC-10-U-{0.4}	Nemertea	1
WVKC-10-U-{0.4}	Hydropsychidae	149
WVKC-10-U-{24.4}	Baetidae	59
WVKC-10-U-{24.4}	Empididae	2
WVKC-10-U-{24.4}	Chironomidae	45
WVKC-10-U-{24.4}	Tipulidae	2
WVKC-10-U-{24.4}	Corydalidae	3
WVKC-10-U-{24.4}	Elmidae	102
WVKC-10-U-{24.4}	Hydropsychidae	190
WVKC-10-U-{24.4}	Heptageniidae	2
WVKC-10-U-{24.4}	Oligochaeta	2
WVKC-10-U-{24.4}	Isonychiidae	5
WVKC-10-U-{4.9}	Chironomidae	89
WVKC-10-U-{4.9}	Corydalidae	18
WVKC-10-U-{4.9}	Simuliidae	6
WVKC-10-U-{4.9}	Tipulidae	1
WVKC-10-U-{4.9}	Elmidae	220
WVKC-10-U-{4.9}	Hydropsychidae	692
WVKC-10-U-{4.9}	Isonychiidae	34
WVKC-10-U-{4.9}	Tricorythidae	119
WVKC-10-U-{4.9}	Heptageniidae	22
WVKC-10-U-{4.9}	Baetidae	24
WVKC-10-U-{4.9}	Corbiculidae	2
WVKC-10-U-{4.9}	Oligochaeta	4
WVKC-10-U-{4.9}	Empididae	1
WVKC-10-U-{9.0}	Lepidoptera	1
WVKC-10-U-{9.0}	Chironomidae	20
WVKC-10-U-{9.0}	Empididae	1
WVKC-10-U-{9.0}	Culicidae	1
WVKC-10-U-{9.0}	Caenidae	4
WVKC-10-U-{9.0}	Mesoveliidae	1
WVKC-10-U-{9.0}	Lymnaeidae	14
WVKC-10-U-{9.0}	Corbiculidae	3
WVKC-10-U-{9.0}	Baetidae	1
WVKC-10-U-{9.0}	Tricorythidae	7
WVKC-10-U-{9.0}	Hydropsychidae	2
WVKC-10-U-{9.0}	Limnephilidae	4
WVKC-10-U-{9.0}	Polycentropodidae	35
WVKC-10-U-{9.0}	Aeshnidae	1
WVKC-10-U-{9.0}	Coenagrionidae	3
WVKC-10-U-{9.0}	Elmidae	11
WVKC-10-U-{9.0}	Gerridae	1
WVKC-10-U-{9.0}	Veliidae	1
WVKC-10-U-{9.0}	Physidae	1
WVKC-10-U-3-B	Philopotamidae	17
WVKC-10-U-3-B	Perlidae	3
WVKC-10-U-3-B	Chironomidae	25
WVKC-10-U-3-B	Simuliidae	2
WVKC-10-U-3-B	Empididae	1
WVKC-10-U-3-B	Tipulidae	2
WVKC-10-U-3-B	Veliidae	1
WVKC-10-U-3-B	Oligochaeta	1
WVKC-10-U-3-B	Hydropsychidae	38
WVKC-10-U-3-B	Isonychiidae	9
WVKC-10-U-3-B	Heptageniidae	26
WVKC-10-U-3-B	Baetiscidae	1
WVKC-10-U-3-B	Baetidae	8
WVKC-10-U-3-B	Elmidae	36
WVKC-10-U-7-{0.0}	Isonychiidae	1
WVKC-10-U-7-{0.0}	Chironomidae	34
WVKC-10-U-7-{0.0}	Empididae	2
WVKC-10-U-7-{0.0}	Corydalidae	8
WVKC-10-U-7-{0.0}	Psephenidae	1

Table 10. Benthic macroinvertebrates indentified (continued)

Stream Code	Taxa	count
WVKC-10-U-7-{0.0}	Hydropsychidae	134
WVKC-10-U-7-{0.0}	Heptageniidae	1
WVKC-10-U-7-{0.0}	Baetidae	22
WVKC-10-U-7-{0.0}	Oligochaeta	1
WVKC-10-U-7-{0.0}	Elmidae	13
WVKC-10-U-7-{4.3}	Nemertea	3
WVKC-10-U-7-{4.3}	Corydalidae	8
WVKC-10-U-7-{4.3}	Chironomidae	18
WVKC-10-U-7-{4.3}	Empididae	2
WVKC-10-U-7-{4.3}	Tipulidae	2
WVKC-10-U-7-{4.3}	Elmidae	11
WVKC-10-U-7-{4.3}	Aeshnidae	1
WVKC-10-U-7-{4.3}	Hydropsychidae	43
WVKC-10-U-7-{4.3}	Oligochaeta	4
WVKC-10-U-7-{4.3}	Psephenidae	1
WVKC-10-U-7-{7.9}	Elmidae	50
WVKC-10-U-7-{7.9}	Chironomidae	62
WVKC-10-U-7-{7.9}	Empididae	4
WVKC-10-U-7-{7.9}	Athericidae	1
WVKC-10-U-7-{7.9}	Rhyacophilidae	1
WVKC-10-U-7-{7.9}	Hydropsychidae	192
WVKC-10-U-7-{7.9}	Baetidae	11
WVKC-10-U-7-{7.9}	Lymnaeidae	1
WVKC-10-U-7-{7.9}	Oligochaeta	8
WVKC-10-U-7-{7.9}	Tipulidae	2
WVKC-10-U-7-A	Rhyacophilidae	1
WVKC-10-U-7-A	Elmidae	2
WVKC-10-U-7-A	Ceratopogonidae	1
WVKC-10-U-7-A	Tipulidae	47
WVKC-10-U-7-A	Pyralidae	1
WVKC-10-U-7-A	Chironomidae	22
WVKC-10-U-7-A	Corydalidae	1
WVKC-10-U-7-A	Dryopidae	2
WVKC-10-U-7-A	Perlidae	1
WVKC-10-U-7-A	Peltoperlidae	1
WVKC-10-U-7-A	Capniidae/Leuctridae	14
WVKC-10-U-7-A	Hydropsychidae	45
WVKC-10-U-7-A	Glossosomatidae	1
WVKC-10-U-7-A	Chloroperlidae	1
WVKC-10-U-12-A	Calopterygidae	3
WVKC-10-U-12-A	Simuliidae	16
WVKC-10-U-12-A	Chironomidae	109
WVKC-10-U-12-A	Empididae	1
WVKC-10-U-12-A	Tipulidae	7
WVKC-10-U-12-A	Veliidae	1
WVKC-10-U-12-A	Psephenidae	1
WVKC-10-U-12-A	Elmidae	38
WVKC-10-U-12-A	Philopotamidae	1
WVKC-10-U-12-A	Rhyacophilidae	1
WVKC-10-U-12-A	Hydropsychidae	117
WVKC-10-U-12-A	Glossosomatidae	3
WVKC-10-U-12-A	Isonychiidae	7
WVKC-10-U-12-A	Baetidae	16
WVKC-10-U-12-A	Oligochaeta	4
WVKC-10-U-12-A	Collembola	1
WVKC-10-U-13	Psephenidae	11
WVKC-10-U-13	Corydalidae	2
WVKC-10-U-13	Tipulidae	13
WVKC-10-U-13	Empididae	2
WVKC-10-U-13	Pteronarcyidae	1
WVKC-10-U-13	Chironomidae	167
WVKC-10-U-13	Perlidae	6
WVKC-10-U-13	Simuliidae	44
WVKC-10-U-13	Oligochaeta	2
WVKC-10-U-13	Nemouridae	1
WVKC-10-U-13	Philopotamidae	43
WVKC-10-U-13	Rhyacophilidae	15
WVKC-10-U-13	Hydropsychidae	273
WVKC-10-U-13	Heptageniidae	8
WVKC-10-U-13	Baetidae	92
WVKC-10-U-13	Elmidae	29
WVKC-10-U-17	Chironomidae	51
WVKC-10-U-17	Gomphidae	1
WVKC-10-U-17	Elmidae	27
WVKC-10-U-17	Hydrophilidae	1
WVKC-10-U-17	Psephenidae	1
WVKC-10-U-17	Tipulidae	7
WVKC-10-U-17	Simuliidae	1
WVKC-10-U-17	Capniidae/Leuctridae	1
WVKC-10-U-17	Empididae	2
WVKC-10-U-17	Oligochaeta	10
WVKC-10-U-17	Philopotamidae	8
WVKC-10-U-17	Rhyacophilidae	4
WVKC-10-U-17	Hydropsychidae	132
WVKC-10-U-17	Isonychiidae	2
WVKC-10-U-17	Heptageniidae	16
WVKC-10-U-17	Baetidae	19
WVKC-10-U-17	Perlodidae	1
WVKC-10-U-17	Peltoperlidae	2
WVKC-10-U-21	Peltoperlidae	1
WVKC-10-U-21	Lepidoptera	1
WVKC-10-U-21	Tipulidae	15
WVKC-10-U-21	Empididae	1
WVKC-10-U-21	Chironomidae	61
WVKC-10-U-21	Nemouridae	1
WVKC-10-U-21	Simuliidae	12
WVKC-10-U-21	Philopotamidae	2
WVKC-10-U-21	Rhyacophilidae	12
WVKC-10-U-21	Hydropsychidae	10
WVKC-10-U-21	Baetidae	50
WVKC-10-U-21	Oligochaeta	10
WVKC-10-U-21	Capniidae/Leuctridae	1
WVKC-10-U-21	Corydalidae	1

Table 10. Benthic macroinvertebrates indentified (continued)

Stream Code	Taxa	count
WVKC-11-{5.6}	Oligochaeta	3
WVKC-11-{5.6}	Hydropsychidae	57
WVKC-11-{5.6}	Isonychiidae	1
WVKC-11-{5.6}	Heptageniidae	3
WVKC-11-{5.6}	Ephemerellidae	1
WVKC-11-{5.6}	Caenidae	1
WVKC-11-{5.6}	Cambaridae	1
WVKC-11-{5.6}	Psephenidae	27
WVKC-11-{5.6}	Baetidae	32
WVKC-11-{5.6}	Elmidae	47
WVKC-11-{5.6}	Calopterygidae	2
WVKC-11-{5.6}	Corydalidae	5
WVKC-11-{5.6}	Veliidae	4
WVKC-11-{5.6}	Tipulidae	10
WVKC-11-{5.6}	Simuliidae	15
WVKC-11-{5.6}	Chironomidae	96
WVKC-14	Psephenidae	1
WVKC-14	Corydalidae	6
WVKC-14	Veliidae	1
WVKC-14	Athericidae	1
WVKC-14	Tipulidae	13
WVKC-14	Empididae	1
WVKC-14	Elmidae	35
WVKC-14	Chironomidae	56
WVKC-14	Chloroperlidae	2
WVKC-14	Simuliidae	12
WVKC-14	Nemouridae	1
WVKC-14	Capniidae/Leuctridae	2
WVKC-14	Psycomyiidae	1
WVKC-14	Philopotamidae	14
WVKC-14	Hydropsychidae	186
WVKC-14	Isonychiidae	56
WVKC-14	Heptageniidae	79
WVKC-14	Baetidae	6
WVKC-14	Gomphidae	1
WVKC-16-A	Elmidae	6
WVKC-16-A	Lepidoptera	1
WVKC-16-A	Tipulidae	7
WVKC-16-A	Veliidae	1
WVKC-16-A	Corydalidae	1
WVKC-16-A	Philopotamidae	20
WVKC-16-A	Hydropsychidae	60
WVKC-16-A	Heptageniidae	29
WVKC-16-A	Isonychiidae	9
WVKC-16-A	Chironomidae	5
WVKC-16-A	Aeshnidae	1
WVKC-21-{0.0}	Simuliidae	31
WVKC-21-{0.0}	Chironomidae	91
WVKC-21-{0.0}	Empididae	1
WVKC-21-{0.0}	Tipulidae	11
WVKC-21-{0.0}	Veliidae	1
WVKC-21-{0.0}	Corydalidae	1
WVKC-21-{0.0}	Elmidae	10
WVKC-21-{0.0}	Hydropsychidae	12
WVKC-21-{0.0}	Isonychiidae	1
WVKC-21-{0.0}	Caenidae	1
WVKC-21-{0.0}	Cambaridae	2
WVKC-21-{0.0}	Oligochaeta	3
WVKC-21-{0.0}	Turbellaria	1
WVKC-21-{0.0}	Capniidae/Leuctridae	1
WVKC-21-C	Tricorythidae	2
WVKC-21-C	Chironomidae	82
WVKC-21-C	Empididae	4
WVKC-21-C	Tipulidae	6
WVKC-21-C	Psephenidae	1
WVKC-21-C	Hydrophilidae	1
WVKC-21-C	Elmidae	13
WVKC-21-C	Oligochaeta	13
WVKC-21-C	Philopotamidae	1
WVKC-21-C	Baetidae	1
WVKC-21-C	Cambaridae	2
WVKC-21-C	Physidae	11
WVKC-21-C	Sphaeriidae	4
WVKC-21-C	Calopterygidae	1
WVKC-29	Gomphidae	1
WVKC-29	Tipulidae	1
WVKC-29	Empididae	1
WVKC-29	Veliidae	1
WVKC-29	Elmidae	22
WVKC-29	Hydropsychidae	30
WVKC-29	Isonychiidae	1
WVKC-29	Heptageniidae	5
WVKC-29	Oligochaeta	10
WVKC-29	Baetidae	5
WVKC-29	Capniidae/Leuctridae	1
WVKC-29	Chironomidae	33
WVKC-29-A	Elmidae	20
WVKC-29-A	Chironomidae	22
WVKC-29-A	Simuliidae	6
WVKC-29-A	Empididae	1
WVKC-29-A	Tipulidae	17
WVKC-29-A	Veliidae	6
WVKC-29-A	Psephenidae	1
WVKC-29-A	Caenidae	2
WVKC-29-A	Leptoceridae	5
WVKC-29-A	Hydropsychidae	85
WVKC-29-A	Isonychiidae	2
WVKC-29-A	Heptageniidae	1
WVKC-29-A	Ephemerellidae	1
WVKC-29-A	Gomphidae	6
WVKC-29-A	Corydalidae	1
WVKC-29-A	Baetiscidae	5
WVKC-29-A-3	Psephenidae	19
WVKC-29-A-3	Staphylinidae	1
WVKC-29-A-3	Hydraenidae	1

Table 10. Benthic macroinvertebrates indentified (continued)

Stream Code	Taxa	count
WVKC-29-A-3	Corydalidae	8
WVKC-29-A-3	Chironomidae	23
WVKC-29-A-3	Veliidae	1
WVKC-29-A-3	Ceratopogonidae	1
WVKC-29-A-3	Elmidae	29
WVKC-29-A-3	Gerridae	1
WVKC-29-A-3	Tipulidae	18
WVKC-29-A-3	Baetidae	3
WVKC-29-A-3	Gomphidae	9
WVKC-29-A-3	Pyralidae	2
WVKC-29-A-3	Cambaridae	4
WVKC-29-A-3	Baetiscidae	5
WVKC-29-A-3	Ephemeridae	1
WVKC-29-A-3	Heptageniidae	48
WVKC-29-A-3	Hydropsychidae	50
WVKC-29-A-3	Capniidae/Leuctridae	2
WVKC-29-A-3	Chloroperlidae	2
WVKC-29-A-3	Perlidae	6
WVKC-29-A-3	Oligochaeta	1
WVKC-31-{0.4}	Simuliidae	18
WVKC-31-{0.4}	Nemouridae	2
WVKC-31-{0.4}	Chironomidae	39
WVKC-31-{0.4}	Empididae	3
WVKC-31-{0.4}	Corydalidae	4
WVKC-31-{0.4}	Elmidae	141
WVKC-31-{0.4}	Hydropsychidae	235
WVKC-31-{0.4}	Isonychiidae	30
WVKC-31-{0.4}	Heptageniidae	42
WVKC-31-{0.4}	Baetiscidae	4
WVKC-31-{0.4}	Baetidae	12
WVKC-31-{0.4}	Hydroptilidae	1
WVKC-31-B-{0.2}	Coenagrionidae	2
WVKC-31-B-{0.2}	Chironomidae	18
WVKC-31-B-{0.2}	Simuliidae	21
WVKC-31-B-{0.2}	Empididae	3
WVKC-31-B-{0.2}	Athericidae	2
WVKC-31-B-{0.2}	Baetidae	69
WVKC-31-B-{0.2}	Elmidae	73
WVKC-31-B-{0.2}	Nemouridae	2
WVKC-31-B-{0.2}	Philopotamidae	25
WVKC-31-B-{0.2}	Hydropsychidae	103
WVKC-31-B-{0.2}	Isonychiidae	48
WVKC-31-B-{0.2}	Heptageniidae	65
WVKC-31-B-{0.2}	Calopterygidae	1
WVKC-31-B-{0.2}	Corydalidae	1
WVKC-31-B-{10.9}	Chironomidae	6
WVKC-31-B-{10.9}	Perlidae	2
WVKC-31-B-{10.9}	Pteronarcyidae	1
WVKC-31-B-{10.9}	Perlodidae	1
WVKC-31-B-{10.9}	Cordulegastridae	1
WVKC-31-B-{10.9}	Psephenidae	3
WVKC-31-B-{10.9}	Ceratopogonidae	1
WVKC-31-B-{10.9}	Capniidae/Leuctridae	19
WVKC-31-B-{10.9}	Elmidae	4
WVKC-31-B-{10.9}	Heptageniidae	1
WVKC-31-B-{10.9}	Tipulidae	12
WVKC-31-B-{10.9}	Baetidae	3
WVKC-31-B-{10.9}	Leptophlebiidae	1
WVKC-31-B-{10.9}	Polycentropodidae	2
WVKC-31-B-{10.9}	Hydropsychidae	37
WVKC-31-B-{10.9}	Rhyacophilidae	1
WVKC-31-B-{10.9}	Philopotamidae	3
WVKC-31-B-{10.9}	Limnephilidae	4
WVKC-31-B-{10.9}	Cambaridae	1
WVKC-31-C	Elmidae	5
WVKC-31-C	Taeniopterygidae	1
WVKC-31-C	Chironomidae	21
WVKC-31-C	Tabanidae	1
WVKC-31-C	Haliplidae	1
WVKC-31-C	Perlodidae	1
WVKC-31-C	Chloroperlidae	1
WVKC-31-C	Capniidae/Leuctridae	17
WVKC-31-C	Ephemerellidae	1
WVKC-31-C	Philopotamidae	11
WVKC-31-C	Rhyacophilidae	2
WVKC-31-C	Hydropsychidae	159
WVKC-31-C	Tipulidae	6
WVKC-31-C	Peltoperlidae	1
WVKC-35-{3.0}	Perlidae	1
WVKC-35-{3.0}	Chironomidae	55
WVKC-35-{3.0}	Corydalidae	6
WVKC-35-{3.0}	Elmidae	46
WVKC-35-{3.0}	Hydropsychidae	76
WVKC-35-{3.0}	Caenidae	1
WVKC-35-{3.0}	Baetidae	5
WVKC-35-{3.0}	Psephenidae	2
WVKC-35-F	Capniidae/Leuctridae	2
WVKC-35-F	Isonychiidae	18
WVKC-35-F	Chironomidae	81
WVKC-35-F	Simuliidae	8
WVKC-35-F	Empididae	19
WVKC-35-F	Ceratopogonidae	2
WVKC-35-F	Tipulidae	7
WVKC-35-F	Elmidae	21
WVKC-35-F	Cambaridae	1
WVKC-35-F	Glossosomatidae	1
WVKC-35-F	Heptageniidae	3
WVKC-35-F	Ephemerellidae	1
WVKC-35-F	Baetidae	33
WVKC-35-F	Gammaridae	1
WVKC-35-F	Hydropsychidae	188
WVKC-35-F	Philopotamidae	43
WVKC-43-{0.0}	Simuliidae	64
WVKC-43-{0.0}	Elmidae	119
WVKC-43-{0.0}	Psephenidae	5

Table 10. Benthic macroinvertebrates indentified (continued)

Stream Code	Taxa	count
WVKC-43-{0.0}	Sialidae	2
WVKC-43-{0.0}	Corixidae	2
WVKC-43-{0.0}	Veliidae	4
WVKC-43-{0.0}	Empididae	2
WVKC-43-{0.0}	Calopterygidae	3
WVKC-43-{0.0}	Chironomidae	278
WVKC-43-{0.0}	Tipulidae	13
WVKC-43-{0.0}	Nemertea	1
WVKC-43-{0.0}	Polycentropodidae	1
WVKC-43-{0.0}	Hydroptilidae	4
WVKC-43-{0.0}	Hydropsychidae	78
WVKC-43-{0.0}	Isonychiidae	41
WVKC-43-{0.0}	Heptageniidae	14
WVKC-43-{0.0}	Ephemerellidae	1
WVKC-43-{0.0}	Baetidae	163
WVKC-43-{0.0}	Gomphidae	3
WVKC-43-{0.0}	Hydrophilidae	1
WVKC-43-{2.8}	Perlidae	1
WVKC-43-{2.8}	Calopterygidae	1
WVKC-43-{2.8}	Chironomidae	130
WVKC-43-{2.8}	Psephenidae	5
WVKC-43-{2.8}	Rhyacophilidae	1
WVKC-43-{2.8}	Tipulidae	4
WVKC-43-{2.8}	Empididae	5
WVKC-43-{2.8}	Elmidae	75
WVKC-43-{2.8}	Simuliidae	1
WVKC-43-{2.8}	Oligochaeta	1
WVKC-43-{2.8}	Veliidae	2
WVKC-43-{2.8}	Nematoda	2
WVKC-43-{2.8}	Baetidae	19
WVKC-43-{2.8}	Caenidae	1
WVKC-43-{2.8}	Ephemerellidae	6
WVKC-43-{2.8}	Heptageniidae	3
WVKC-43-{2.8}	Isonychiidae	2
WVKC-43-{2.8}	Glossosomatidae	3
WVKC-43-{2.8}	Hydropsychidae	119
WVKC-46-{0.0}	Simuliidae	1
WVKC-46-{0.0}	Psephenidae	2
WVKC-46-{0.0}	Chironomidae	29
WVKC-46-{0.0}	Empididae	1
WVKC-46-{0.0}	Athericidae	1
WVKC-46-{0.0}	Corydalidae	3
WVKC-46-{0.0}	Hydroptilidae	11
WVKC-46-{0.0}	Hydropsychidae	152
WVKC-46-{0.0}	Isonychiidae	269
WVKC-46-{0.0}	Heptageniidae	99
WVKC-46-{0.0}	Baetidae	10
WVKC-46-{0.0}	Oligochaeta	5
WVKC-46-{0.0}	Elmidae	95
WVKC-46-{5.8}	Elmidae	64
WVKC-46-{5.8}	Stratiomyidae	1
WVKC-46-{5.8}	Chironomidae	26
WVKC-46-{5.8}	Simuliidae	9
WVKC-46-{5.8}	Empididae	1
WVKC-46-{5.8}	Tipulidae	2
WVKC-46-{5.8}	Athericidae	3
WVKC-46-{5.8}	Baetidae	64
WVKC-46-{5.8}	Psephenidae	2
WVKC-46-{5.8}	Hydroptilidae	10
WVKC-46-{5.8}	Hydropsychidae	130
WVKC-46-{5.8}	Isonychiidae	130
WVKC-46-{5.8}	Heptageniidae	107
WVKC-46-{5.8}	Caenidae	2
WVKC-46-{5.8}	Veliidae	1
WVKC-46-{15.3}	Glossosomatidae	2
WVKC-46-{15.3}	Simuliidae	12
WVKC-46-{15.3}	Empididae	1
WVKC-46-{15.3}	Corydalidae	6
WVKC-46-{15.3}	Psephenidae	3
WVKC-46-{15.3}	Chironomidae	10
WVKC-46-{15.3}	Elmidae	15
WVKC-46-{15.3}	Hydropsychidae	65
WVKC-46-{15.3}	Isonychiidae	26
WVKC-46-{15.3}	Heptageniidae	7
WVKC-46-{15.3}	Baetidae	15
WVKC-46-{15.3}	Oligochaeta	2
WVKC-46-{15.3}	Rhyacophilidae	1
WVKC-46-{15.3}	Coenagrionidae	1
WVKC-46-{20.2}	Athericidae	1
WVKC-46-{20.2}	Simuliidae	11
WVKC-46-{20.2}	Corydalidae	8
WVKC-46-{20.2}	Psephenidae	2
WVKC-46-{20.2}	Elmidae	16
WVKC-46-{20.2}	Pyralidae	2
WVKC-46-{20.2}	Polycentropodidae	1
WVKC-46-{20.2}	Rhyacophilidae	1
WVKC-46-{20.2}	Hydropsychidae	20
WVKC-46-{20.2}	Isonychiidae	32
WVKC-46-{20.2}	Heptageniidae	9
WVKC-46-{20.2}	Baetidae	55
WVKC-46-{20.2}	Corbiculidae	1
WVKC-46-{20.2}	Psycomyiidae	1
WVKC-46-{20.2}	Chironomidae	6
WVKC-46-{32.8}	Psycomyiidae	5
WVKC-46-{32.8}	Chironomidae	99
WVKC-46-{32.8}	Simuliidae	2
WVKC-46-{32.8}	Empididae	1
WVKC-46-{32.8}	Tipulidae	21
WVKC-46-{32.8}	Corydalidae	1
WVKC-46-{32.8}	Elmidae	4
WVKC-46-{32.8}	Calopterygidae	2
WVKC-46-{32.8}	Hydropsychidae	5
WVKC-46-{32.8}	Leptophlebiidae	2
WVKC-46-{32.8}	Ephemerellidae	10
WVKC-46-{32.8}	Baetidae	5
WVKC-46-{32.8}	Cordulegastridae	1

Table 10. Benthic macroinvertebrates indentified (continued)

Stream Code	Taxa	count
WVKC-46-C	Rhyacophilidae	2
WVKC-46-C	Simuliidae	8
WVKC-46-C	Empididae	3
WVKC-46-C	Corydalidae	1
WVKC-46-C	Chironomidae	45
WVKC-46-C	Perlidae	2
WVKC-46-C	Hydropsychidae	283
WVKC-46-C	Elmidae	13
WVKC-46-C	Nemertea	2
WVKC-46-C	Oligochaeta	4
WVKC-46-C	Baetidae	76
WVKC-46-C	Heptageniidae	1
WVKC-46-C	Isonychiidae	44
WVKC-46-C	Glossosomatidae	7
WVKC-46-E	Chloroperlidae	4
WVKC-46-E	Calopterygidae	1
WVKC-46-E	Tipulidae	4
WVKC-46-E	Veliidae	8
WVKC-46-E	Corydalidae	2
WVKC-46-E	Psephenidae	5
WVKC-46-E	Hydrophilidae	1
WVKC-46-E	Chironomidae	11
WVKC-46-E	Cambaridae	10
WVKC-46-E	Aeshnidae	1
WVKC-46-E	Physidae	1
WVKC-46-E	Nemouridae	1
WVKC-46-E	Ephemerellidae	6
WVKC-46-E	Hydropsychidae	44
WVKC-46-E	Rhyacophilidae	1
WVKC-46-E	Polycentropodidae	2
WVKC-46-E	Oligochaeta	9
WVKC-46-G	Perlidae	2
WVKC-46-G	Gomphidae	1
WVKC-46-G	Chironomidae	34
WVKC-46-G	Simuliidae	11
WVKC-46-G	Empididae	1
WVKC-46-G	Tipulidae	8
WVKC-46-G	Athericidae	1
WVKC-46-G	Psephenidae	5
WVKC-46-G	Baetiscidae	2
WVKC-46-G	Elmidae	79
WVKC-46-G	Baetidae	59
WVKC-46-G	Heptageniidae	18
WVKC-46-G	Isonychiidae	117
WVKC-46-G	Hydropsychidae	330
WVKC-46-G	Rhyacophilidae	5
WVKC-46-G	Nemertea	1
WVKC-46-G	Chloroperlidae	1
WVKC-46-G-1	Perlodidae	5
WVKC-46-G-1	Calopterygidae	1
WVKC-46-G-1	Simuliidae	4
WVKC-46-G-1	Empididae	1
WVKC-46-G-1	Tipulidae	3
WVKC-46-G-1	Corydalidae	1
WVKC-46-G-1	Chironomidae	30
WVKC-46-G-1	Elmidae	6
WVKC-46-G-1	Chloroperlidae	4
WVKC-46-G-1	Rhyacophilidae	24
WVKC-46-G-1	Hydropsychidae	320
WVKC-46-G-1	Isonychiidae	1
WVKC-46-G-1	Heptageniidae	1
WVKC-46-G-1	Ephemerellidae	2
WVKC-46-G-1	Baetidae	44
WVKC-46-G-1	Perlidae	1
WVKC-46-G-1-.5A	Philopotamidae	1
WVKC-46-G-1-.5A	Tipulidae	1
WVKC-46-G-2	Ceratopogonidae	2
WVKC-46-G-2	Chironomidae	12
WVKC-46-G-2	Tipulidae	13
WVKC-46-G-2	Athericidae	1
WVKC-46-G-2	Veliidae	2
WVKC-46-G-2	Corydalidae	1
WVKC-46-G-2	Psephenidae	4
WVKC-46-G-2	Elmidae	10
WVKC-46-G-2	Dryopidae	1
WVKC-46-G-2	Cambaridae	3
WVKC-46-G-2	Perlidae	33
WVKC-46-G-2	Baetidae	7
WVKC-46-G-2	Hydropsychidae	194
WVKC-46-G-2	Rhyacophilidae	3
WVKC-46-G-2	Philopotamidae	13
WVKC-46-G-2	Polycentropodidae	2
WVKC-46-G-2	Capniidae/Leuctridae	25
WVKC-46-G-2	Chloroperlidae	2
WVKC-46-G-2	Dixidae	3
WVKC-46-H	Tipulidae	5
WVKC-46-H	Elmidae	24
WVKC-46-H	Chironomidae	11
WVKC-46-H	Veliidae	1
WVKC-46-H	Corydalidae	4
WVKC-46-H	Psephenidae	10
WVKC-46-H	Polycentropodidae	1
WVKC-46-H	Philopotamidae	2
WVKC-46-H	Rhyacophilidae	1
WVKC-46-H	Hydropsychidae	66
WVKC-46-H	Heptageniidae	34
WVKC-46-H	Isonychiidae	2
WVKC-46-H	Chloroperlidae	1
WVKC-46-I	Chironomidae	12
WVKC-46-I	Psephenidae	14
WVKC-46-I	Corydalidae	5
WVKC-46-I	Veliidae	1
WVKC-46-I	Athericidae	2
WVKC-46-I	Elmidae	8
WVKC-46-I	Empididae	3

Table 10. Benthic macroinvertebrates indentified (continued)

Stream Code	Taxa	count
WVKC-46-I	Isonychiidae	15
WVKC-46-I	Tipulidae	6
WVKC-46-I	Capniidae/Leuctridae	2
WVKC-46-I	Oligochaeta	3
WVKC-46-I	Glossosomatidae	1
WVKC-46-I	Heptageniidae	32
WVKC-46-I	Ephemerellidae	1
WVKC-46-I	Caenidae	1
WVKC-46-I	Baetiscidae	1
WVKC-46-I	Baetidae	2
WVKC-46-I	Hydropsychidae	27
WVKC-46-J-2	Elmidae	1
WVKC-46-J-2	Cambaridae	10
WVKC-46-J-2	Tipulidae	40
WVKC-46-J-2	Chironomidae	20
WVKC-46-J-2	Rhyacophilidae	1
WVKC-46-J-2	Ephemerellidae	1
WVKC-46-J-2	Hydropsychidae	21
WVKC-46-J-2	Calopterygidae	2
WVKC-46-K	Gerridae	1
WVKC-46-K	Chironomidae	47
WVKC-46-K	Simuliidae	20
WVKC-46-K	Veliidae	1
WVKC-46-K	Sialidae	1
WVKC-46-K	Corydalidae	2
WVKC-46-K	Psephenidae	1
WVKC-46-K	Elmidae	13
WVKC-46-K	Dryopidae	1
WVKC-46-K	Heptageniidae	6
WVKC-46-K	Tipulidae	4
WVKC-46-K	Nemouridae	1
WVKC-46-K	Ephemerellidae	1
WVKC-46-K	Leptophlebiidae	1
WVKC-46-K	Isonychiidae	28
WVKC-46-K	Hydropsychidae	3
WVKC-46-K	Rhyacophilidae	20
WVKC-46-K	Philopotamidae	35
WVKC-46-K	Capniidae/Leuctridae	6
WVKC-46-K	Baetidae	32
WVKC-46-L.5	Cambaridae	4
WVKC-46-L.5	Dytiscidae	1
WVKC-46-L.5	Chironomidae	7
WVKC-46-L.5	Culicidae	1
WVKC-46-L.5	Elmidae	3
WVKC-46-L.5	Glossosomatidae	5
WVKC-46-L.5	Leptophlebiidae	40
WVKC-46-L.5	Baetidae	1
WVKC-46-L.5	Oligochaeta	2
WVKC-46-L.5	Ephemerellidae	30
WVKC-46-P	Rhyacophilidae	7
WVKC-46-P	Tipulidae	4
WVKC-46-P	Empididae	3
WVKC-46-P	Chironomidae	156
WVKC-46-P	Corydalidae	5
WVKC-46-P	Elmidae	20
WVKC-46-P	Glossosomatidae	3
WVKC-46-P	Isonychiidae	3
WVKC-46-P	Heptageniidae	3
WVKC-46-P	Ephemerellidae	1
WVKC-46-P	Baetidae	19
WVKC-46-P	Oligochaeta	1
WVKC-46-P	Simuliidae	41
WVKC-46-P	Hydropsychidae	56
WVKC-46-Q	Simuliidae	2
WVKC-46-Q	Chironomidae	44
WVKC-46-Q	Tipulidae	71
WVKC-46-Q	Veliidae	1
WVKC-46-Q	Psycomyiidae	2
WVKC-46-Q	Hydropsychidae	1
WVKC-46-Q	Tricorythidae	2
WVKC-46-Q	Ancylidae	1
WVKC-46-Q	Nemertea	2
WVKC-46-Q	Oligochaeta	1
WVKC-46-Q	Rhyacophilidae	1
WVKC-47	Hydropsychidae	32
WVKC-47	Chironomidae	21
WVKC-47	Baetidae	137
WVKC-47	Elmidae	24
WVKC-47	Isonychiidae	66
WVKC-47	Tricorythidae	1
WVKC-47	Heptageniidae	88
WVKC-47	Simuliidae	4
WVKC-47-A-{1.3}	Pteronarcyidae	1
WVKC-47-A-{1.3}	Perlidae	8
WVKC-47-A-{1.3}	Chironomidae	3
WVKC-47-A-{1.3}	Ceratopogonidae	1
WVKC-47-A-{1.3}	Tipulidae	9
WVKC-47-A-{1.3}	Veliidae	1
WVKC-47-A-{1.3}	Psephenidae	29
WVKC-47-A-{1.3}	Elmidae	19
WVKC-47-A-{1.3}	Dryopidae	1
WVKC-47-A-{1.3}	Ephemerellidae	1
WVKC-47-A-{1.3}	Gomphidae	1
WVKC-47-A-{1.3}	Capniidae/Leuctridae	1
WVKC-47-A-{1.3}	Baetidae	12
WVKC-47-A-{1.3}	Ephemeridae	4
WVKC-47-A-{1.3}	Heptageniidae	26
WVKC-47-A-{1.3}	Isonychiidae	1
WVKC-47-A-{1.3}	Hydropsychidae	71
WVKC-47-A-{1.3}	Philopotamidae	2
WVKC-47-A-{1.3}	Polycentropodidae	2
WVKC-47-A-{1.3}	Cambaridae	2
WVKC-47-C	Calopterygidae	3
WVKC-47-C	Muscidae	1

Table 10. Benthic macroinvertebrates indentified (continued)

Stream Code	Taxa	count
WVKC-47-C	Simuliidae	2
WVKC-47-C	Empididae	8
WVKC-47-C	Ceratopogonidae	1
WVKC-47-C	Tipulidae	15
WVKC-47-C	Veliidae	2
WVKC-47-C	Elmidae	3
WVKC-47-C	Chironomidae	50
WVKC-47-C	Capniidae/Leuctridae	1
WVKC-47-C	Philopotamidae	13
WVKC-47-C	Hydroptilidae	1
WVKC-47-C	Hydropsychidae	42
WVKC-47-C	Isonychiidae	5
WVKC-47-C	Heptageniidae	1
WVKC-47-C	Baetidae	25
WVKC-47-C	Perlidae	2
WVKC-47-C	Psephenidae	11
WVKC-47-F	Hydropsychidae	21
WVKC-47-F	Chironomidae	9
WVKC-47-F	Tipulidae	9
WVKC-47-F	Veliidae	1
WVKC-47-F	Rhyacophilidae	1
WVKC-47-F	Corydalidae	4
WVKC-47-G	Capniidae/Leuctridae	2
WVKC-47-G	Chironomidae	8
WVKC-47-G	Tipulidae	16
WVKC-47-G	Gerridae	1
WVKC-47-G	Peltoperlidae	1
WVKC-47-G	Nemouridae	4
WVKC-47-G	Leptoceridae	1
WVKC-47-G	Rhyacophilidae	2
WVKC-47-G	Hydropsychidae	70
WVKC-47-G	Baetidae	12
WVKC-47-G	Cambaridae	1
WVKC-47-G	Phryganeidae	1
WVKC-47-G-1	Perlodidae	1
WVKC-47-G-1	Oligochaeta	2
WVKC-47-G-1	Dolichopodidae	1
WVKC-47-G-1	Chironomidae	14
WVKC-47-G-1	Tipulidae	6
WVKC-47-G-1	Veliidae	1
WVKC-47-G-1	Hydrophilidae	1
WVKC-47-G-1	Peltoperlidae	3
WVKC-47-G-1	Polycentropodidae	1
WVKC-47-G-1	Rhyacophilidae	2
WVKC-47-G-1	Hydropsychidae	66
WVKC-47-G-1	Cambaridae	1
WVKC-47-G-1	Corydalidae	11
WVKC-47-H	Cambaridae	3
WVKC-47-H	Polycentropodidae	1
WVKC-47-H	Chironomidae	9
WVKC-47-H	Tipulidae	6
WVKC-47-H	Psephenidae	1
WVKC-47-H	Perlodidae	5
WVKC-47-H	Peltoperlidae	1
WVKC-47-H	Capniidae/Leuctridae	4
WVKC-47-H	Philopotamidae	1
WVKC-47-H	Hydropsychidae	37
WVKC-47-H	Leptophlebiidae	1
WVKC-47-H	Heptageniidae	1
WVKC-47-H	Ephemerellidae	1
WVKC-47-H	Gammaridae	1
WVKC-47-H	Baetidae	2
WVKC-47-L-{0.8}	Calopterygidae	1
WVKC-47-L-{0.8}	Simuliidae	32
WVKC-47-L-{0.8}	Psephenidae	6
WVKC-47-L-{0.8}	Tipulidae	3
WVKC-47-L-{0.8}	Chironomidae	166
WVKC-47-L-{0.8}	Elmidae	15
WVKC-47-L-{0.8}	Hydroptilidae	1
WVKC-47-L-{0.8}	Hydropsychidae	197
WVKC-47-L-{0.8}	Isonychiidae	9
WVKC-47-L-{0.8}	Ephemerellidae	1
WVKC-47-L-{0.8}	Baetidae	2
WVKC-47-L-{0.8}	Capniidae/Leuctridae	1
WVKC-47-L-{0.8}	Empididae	6
WVKC-47-N-{1.4}	Rhyacophilidae	1
WVKC-47-N-{1.4}	Dixidae	2
WVKC-47-N-{1.4}	Chironomidae	2
WVKC-47-N-{1.4}	Sialidae	1
WVKC-47-N-{1.4}	Perlodidae	7
WVKC-47-N-{1.4}	Capniidae/Leuctridae	8
WVKC-47-N-{1.4}	Hydropsychidae	24
WVKC-47-N-{1.4}	Leptophlebiidae	2
WVKC-47-N-{1.4}	Baetidae	1
WVKC-47-N-{1.4}	Cambaridae	1
WVKC-47-N-{1.4}	Peltoperlidae	6
WVKC-47-O-{0.0}	Isonychiidae	24
WVKC-47-O-{0.0}	Simuliidae	15
WVKC-47-O-{0.0}	Empididae	3
WVKC-47-O-{0.0}	Tipulidae	5
WVKC-47-O-{0.0}	Corydalidae	3
WVKC-47-O-{0.0}	Chironomidae	71
WVKC-47-O-{0.0}	Elmidae	22
WVKC-47-O-{0.0}	Hydropsychidae	68
WVKC-47-O-{0.0}	Heptageniidae	7
WVKC-47-O-{0.0}	Caenidae	1
WVKC-47-O-{0.0}	Baetidae	32
WVKC-47-O-{0.0}	Oligochaeta	5
WVKC-47-O-{0.0}	Dryopidae	1
WVKC-47-O-{0.0}	Philopotamidae	3
WVKC-47-O-{2.4}	Philopotamidae	2
WVKC-47-O-{2.4}	Chironomidae	13
WVKC-47-O-{2.4}	Simuliidae	2

Table 10. Benthic macroinvertebrates indentified (continued)

Stream Code	Taxa	count
WVKC-47-O-{2.4}	Ceratopogonidae	2
WVKC-47-O-{2.4}	Tipulidae	2
WVKC-47-O-{2.4}	Psephenidae	1
WVKC-47-O-{2.4}	Perlodidae	1
WVKC-47-O-{2.4}	Perlidae	1
WVKC-47-O-{2.4}	Nemouridae	1
WVKC-47-O-{2.4}	Polycentropodidae	2
WVKC-47-O-{2.4}	Hydropsychidae	60
WVKC-47-O-{2.4}	Baetidae	21
WVKC-47-O-{2.4}	Oligochaeta	1
WVKC-47-O-{2.4}	Lepidoptera	1
WVKC-47-O-{2.4}	Capniidae/Leuctridae	24

Table 11. Water quality - parameters measured in the field and fecal coliform bacteria

Stream Code	Temp (°C)	pH (S.U.)	DO (mg/l)	Conductivity (umhos)	Fecal coliform bacteria (colonies/ 100ml)
WVK-34-{23.8}	19.7	7.8	8.2	836	210
WVK-34-{35.0}	21	7.8	8.4	825	2200
WVK-34-{44.0}	21	7.9	8.1	852	1000
WVK-34-{58.4}	18.2	8.1	9.3	795	1200
WVKC-2-{2.0}	18.7	7.2	5.4	298	330
WVKC-4-{2.5}	18.5	7.5	7.1	333	120
WVKC-5	17.4	7.5	8.5	305	10
WVKC-9	19.2	7.7	8.3	269	10
WVKC-10-{03.6}	18.8	8.5	9.7	1030	44
WVKC-10-{17.0}	17.6	8.4	8.7	1111	960
WVKC-10-I-{0.0}	15.1	8	9.8	1650	520
WVKC-10-I-{12.5}	16.3	8.2	8.9	2410	35
WVKC-10-I-{5.6}	13.4	8.2	9.7	2170	27
WVKC-10-I-6-C	13.6	7	9.3	444	520
WVKC-10-J	16.4	7.9	9.5	1325	5300
WVKC-10-L	16.5	7.5	6.8	255	18
WVKC-10-N-{3.0}	14.6	7.9	8.9	409	1700
WVKC-10-P-.5	18.2	8	9.1	313	280
WVKC-10-T-{0.3}	17.3	8.6	10.1	1024	44
WVKC-10-T-{17.4}	15.5	8.5	9.7	883	3000
WVKC-10-T-{18.5}	15.1	8.5	9.6	913	2000
WVKC-10-T-{4.6}	16.5	8.5	7.9	1137	1900
WVKC-10-T-2	15.8	7.9	8.1	300	
WVKC-10-T-3	16.5	6.8	3	300	0
WVKC-10-T-9	16	7.7	8.6	603	6200
WVKC-10-T-9-B	18.1	7.1	6.6	851	24
WVKC-10-T-9-B.5	15.1	7.8	8.3	505	6000
WVKC-10-T-9-C-2	15.2	7.5	7	317	4000
WVKC-10-T-10	15.3	8.1	8.2	159	3200
WVKC-10-T-11-{0.2}	16.7	8.7	9.9	1540	220
WVKC-10-T-11-{15.3}	14.8	7.7	9.2	522	72
WVKC-10-T-11-{4.1}	17.2	8.7	11.2	1860	230
WVKC-10-T-11-H.5-{0.3}	15.3	7.2	8.4	90	120
WVKC-10-T-21	15.1	7.8	8.5	1054	30
WVKC-10-T-24-{0.6}	14.9	6.3	5.2	377	20
WVKC-10-U-{0.4}	18.6	8.5	9.4	1016	400
WVKC-10-U-{24.4}	18.6	8.5	9	1114	1400
WVKC-10-U-{4.9}	18.2	8.5	9.3	1028	320
WVKC-10-U-{9.0}	17.4	8.4	8.8	1037	1200
WVKC-10-U-3-B	17.5	8.2	8.5	432	700
WVKC-10-U-7-{0.0}	14.8	8.4	9.7	1139	1800
WVKC-10-U-7-{4.3}	23.6	8.5	7.9	1382	320
WVKC-10-U-7-{7.9}	20.1	8.6	9.3	1312	600
WVKC-10-U-7-A	12.7	7	9.4	248	400
WVKC-10-U-12-A	18.3	8.2	8.8	1225	900
WVKC-10-U-13	14.7	8.2	9.1	604	2
WVKC-10-U-17	15.4	7.5	9.1	450	170
WVKC-10-U-21	13.3	7.7	9.6	938	80
WVKC-11-{5.6}	18.9	7.7	6.3	377	520
WVKC-14	16.3	8.3	8.9	441	260
WVKC-14-C	15.8	6.9	4.4	124	24
WVKC-14-D	13.8	7.5	7.6	144	200

Table 11. Water quality - parameters measured in the field and fecal coliform bacteria (continued)

Stream Code	Temp (ºC)	pH (S.U.)	DO (mg/l)	Conductivity (umhos)	Fecal coliform bacteria (colonies/ 100 ml)
WVKC-14-D-2	15.6	6.7	0.8	178	120
WVKC-16-A	16.7	7.7	8.5	490	280
WVKC-21-{0.0}	14.9	7.6	8.3	667	1500
WVKC-21-C	16.7	7.4	5.3	478	36000
WVKC-28					6000
WVKC-29	17.7	7.4	8.6	724	4200
WVKC-29-A	18.6	8.2	8.2	442	320
WVKC-29-A-3	16.4	6.7	7.6	217	280
WVKC-31-{0.4}	19.2	7.9	9.3	813	5800
WVKC-31-B-{0.2}	17.5	7.9	8.7	475	
WVKC-31-B-{10.9}	15.7	7	8.1	248	52
WVKC-31-C	14.4	7.2	8.5	715	900
WVKC-35-{3.0}	15	7.8	9.2	661	180
WVKC-35-F	15.2	7.6	8.6	797	10
WVKC-35-G	16.2	7.8	9.1	766	320
WVKC-43-{0.0}	14.7	7.9	9.4	636	360
WVKC-43-{2.8}	14.2	7.7	9.1	582	60
WVKC-46-{0.0}	19.4	8	9.3	822	160
WVKC-46-{5.8}	17.4	7.9	9.8	651	420
WVKC-46-{15.3}	15.4	8.3	10	784	320
WVKC-46-{20.2}	17.4	8.5	9.2	771	150
WVKC-46-{32.8}	14.7	7.9	8.4	427	64
WVKC-46-C	14.6	7.6	9.1	622	160
WVKC-46-E	15.3	6.9	6.2	454	2200
WVKC-46-G	15.6	7.7	9.4	601	1600
WVKC-46-G-1	14.7	7.6	9.2	646	1800
WVKC-46-G-1-.5A	15.2	7	6.6	75	300
WVKC-46-G-2	13.4	7.3	9.1	346	160
WVKC-46-H	14.7	7.5	7.8	159	120
WVKC-46-I	23	8.1	9.7	619	4200
WVKC-46-J-2	16.9	7.2	8	353	3000
WVKC-46-K	13.4	7.5	8.8	553	2700
WVKC-46-L.5	14.8	7.1	6.4	42	4000
WVKC-46-P	12.5	8.2	9.5	502	140
WVKC-46-Q	13.3	7.5	7.5	353	160
WVKC-47	16.5	8.1	9.5	743	420
WVKC-47-A-{1.3}	16.2	7.9	8.9	507	12
WVKC-47-C	15.8	8.1	8.9	971	160
WVKC-47-F	14.6	4.5	9	592	700
WVKC-47-G	14.4	7.5	9.5	985	280
WVKC-47-G-1	14.3	4	8.7	998	2
WVKC-47-H	14.4	7.3	9	252	200
WVKC-47-L-{0.8}	14.2	8.3	10.5	1100	2800
WVKC-47-N-{1.4}	14.6	7.7	9	749	48
WVKC-47-O-{0.0}	19	8.1	8.6	1297	330
WVKC-47-O-{2.4}	13.8	7.8	9.8	931	72

Table 12a. Additional WQ parameters from random sites and sites with suspected WQ problems (values in mg/l)

Stream Code	Acidity	Alkalinity	Sulfate	Chloride	TSS	Tot. Phos.	NH_3-N	NO_2-NO_3-N
WVK-34-{35.0}	<1	120	490	17	19	<0.02	<0.5	0.54
WVK-34-{44.0}	<1	120	280	17	<5	<0.02	<0.5	0.47
WVKC-2-{2.0}	<1	112	25	13	5	0.08	<1	<0.05
WVKC-4-{2.5}	<1	124	20	22	<5	0.03	<1	<0.05
WVKC-10-{03.6}	<1	260	280	10	<5	<0.02	<1	0.81
WVKC-10-{17.0}	<1	228	280	11	5	<0.02	<1	0.07
WVKC-10-I-{12.5}	<1	220	1500	26	<5	<0.02	<1	1
WVKC-10-I-{5.6}	<1	168	1300	22	<5	<0.02	<1	0.88
WVKC-10-N-{3.0}	<1	110	120	22	<5	0.02	<0.5	0.27
WVKC-10-T-{0.3}	<1	260	280	11	<5	<0.02	<1	0.66
WVKC-10-T-{17.4}	<1	290	170	11	<5	<0.02	<0.5	0.51
WVKC-10-T-{18.5}	<1	300	170	13	<5	<0.02	<0.5	0.53
WVKC-10-T-{4.6}	<1	300	280	15	<5	<0.02	<1	0.38
WVKC-10-T-11-{4.1}	<1	500	620	30	<5	<0.02	<0.5	1.10
WVKC-10-T-24-{0.6}	<1	120	59	<1	15	<0.02	<0.5	<0.05
WVKC-10-U-{24.4}	<1	380	860	13	<5	<0.02	<0.5	0.44
WVKC-10-U-{4.9}	<1	300	260	20	<5	<0.02	<0.5	0.62
WVKC-10-U-{9.0}	<1	320	240	18	<5	<0.02	<0.5	1.30
WVKC-10-U-7-{4.3}	<1	500	160	28	<5	<0.02	<0.5	0.24
WVKC-10-U-7-{7.9}	<1	510	140	23	<5	<0.02	<0.5	0.22
WVKC-11-{5.6}	<1	130	45	19	5	<0.02	<0.5	0.08
WVKC-14	<1	240	31	4	<5	<0.02	<0.50	<0.05
WVKC-14-C					<5			
WVKC-14-D					<5			
WVKC-14-D-2					<5			
WVKC-21-{0.0}	<1	50	360	8	<5	<0.02	<0.5	0.57
WVKC-31-{0.4}	<1	56	490	7	<5	<0.02	<0.5	0.36
WVKC-31-B-{0.2}	<1	65	230	7	<5	<0.02	<0.5	0.15
WVKC-31-B-{10.9}	<1	12	120	<1	6	<0.02	<0.5	0.11
WVKC-31-C	<1	16	450	1	<5			
WVKC-35-{3.0}	<1	68	310	7	<5		<0.5	3.8
WVKC-43-{2.8}	<1	91	180	20	<5	<0.02	<0.5	0.46
WVKC-46-{5.8}	<1	160	160	22	<5	<0.02	<0.5	0.08
WVKC-46-{15.3}	<1	220	200	31	<5	<0.02	<0.5	0.06
WVKC-46-{20.2}	<1	220	170	35	<5	<0.02	<0.5	0.16
WVKC-46-{32.8}	<1	200	47	7	<5	0.06	<0.5	0.10
WVKC-46-H					<5			
WVKC-46-G	<1	34	220					
WVKC-46-G-1	<1	33	240					
WVKC-46-G-2	<1	20	94					
WVKC-47	<1	76	270					
WVKC-47	<1	74	290					
WVKC-47-A-{1.3}	<1	120	140	1	<5	<0.02	<0.5	1.80
WVKC-47-F	27	3	260					
WVKC-47-G	<1	53	560					
WVKC-47-G-1	74	<1	610					
WVKC-47-L-{0.8}	<1	100	530	3	63	<0.02	<0.5	0.22
WVKC-47-N-{1.4}	<1	56	310	2	7	<0.02	<0.5	0.55
WVKC-47-O-{0.0}	<1	59	860					
WVKC-47-O-{2.4}	<1	73	430	1	<5	<0.02	<0.5	0.18

Table 12b. Additional WQ parameters from random sites and sites with suspected WQ problems (values in mg/l)

Stream Code	Ca Tot.	Ca. Dis	Mg. Tot.	Al Tot.	Al Dis.	Fe Tot.	Mn Tot.	Zn Tot.	Cu Tot.
WVK-34-{35.0}	51.00	51.8	28.00	0.069	<0.05	0.200	0.100	0.031	0.0082
WVK-34-{44.0}	53.00	53.2	30.00	0.110	<0.05	0.200	0.110	0.020	0.0052
WVKC-2-{2.0}	37	35.4	8.000	0.540	<0.05	0.570	0.500	<0.01	<0.01
WVKC-4-{2.5}	38.00	38.1	8.600	0.500	<0.05	0.640	0.320	0.010	<0.01
WVKC-10-{3.6}	43	38.3	31	0.890	<0.05	0.24	0.049	0.022	<0.01
WVKC-10-{17.0}	220*	48.4	230*	0.930	<0.05	0.15	0.052	0.017	0.013
WVKC-10-I-{12.5}	230	193	240	0.960	<0.05	0.09	0.045	0.079	0.014
WVKC-10-I-{5.6}	190*	181	190*	0.770	<0.05	0.13	0.046	0.025	0.015
WVKC-10-I-6-C	41.5	40.5		<0.050	<0.05				
WVKC-10-N-{3.0}	38.00	37.8	11.00	<0.050	<0.05	0.290	0.044	0.052	0.0072
WVKC-10-T-{0.3}	49	47.2	25	0.930	<0.05	0.13	0.013	<0.01	<0.010
WVKC-10-T-{17.4}	23.00	21.9	11.00	<0.05	<0.05	0.210	0.022	0.058	0.01
WVKC-10-T-{18.5}	23.00	22.6	11.00	<0.050	<0.05	0.170	<0.020	0.088	0.007
WVKC-10-T-{4.6}	51	46.0	25	0.730	<0.05	0.16	0.015	0.01	<0.01
WVKC-10-T-11-{4.1}	27.00	25.3	14.00	<0.050	<0.05	0.230	<0.020	0.061	0.0093
WVKC-10-T-24-{0.6}	18.00	31.0	6.00	0.082	<0.05	0.069	<0.020	0.140	<0.0050
WVKC-10-U-{24.4}	41.00	46.2	23.00	0.052	<0.05	<0.050	0.033	0.021	<0.005
WVKC-10-U-{4.9}	33.00	33.0	22.00	0.051	0.05	0.056	<0.020	0.079	0.0063
WVKC-10-U-{9.0}	33.00	35.8	21.00	0.078	0.07	<0.050	<0.020	<0.02	0.0057
WVKC-10-U-7-{4.3}	22.00	19.3	12.00	0.380	0.30	0.093	0.022	<0.020	0.01
WVKC-10-U-7-{7.9}	26.00	23.4	11.00	0.110	0.07	0.150	0.074	<0.020	0.0092
WVKC-11-{5.6}	50.00	48.8	11.00	0.072	<0.05	0.120	0.043	0.032	0.0079
WVKC-14	9.9	8.18	4.4	0.074	<0.05	0.560	<0.020	0.15	<0.005
WVKC-14-C	8.6	8.27		<0.05	<0.05				
WVKC-14-D	12.1	11.7		<0.05	<0.05				
WVKC-14-D-2	18.6	17.4		<0.05	<0.05				
WVKC-21-{0.0}	63.00	66.6	35.00	0.250	<0.05	0.180	0.099	0.047	<0.005
WVKC-31-{0.4}	86.00	86.3	40.00	<0.050	<0.05	<0.050	0.027	0.021	0.0085
WVKC-31-B-{0.2}	54.00	49.1	27.00	0.130	<0.05	0.310	0.054	0.052	0.0072
WVKC-31-B-{10.9}	20.00	18.7	18.00	0.100	<0.05	0.150	0.032	0.059	<0.005
WVKC-31-C				<0.05		<0.050	<0.020		
WVKC-35-{3.0}	66.00	62.0	53.00	0.260	0.13	<0.050	0.350	0.130	<0.0050
WVKC-43-{2.8}	59.00	59.0	27.00	<0.050	<0.05	<0.050	0.053	0.061	0.0097
WVKC-46-{5.8}	33.00		14.00	<0.050		0.120	<0.020	0.086	0.0058
WVKC-46-{15.3}	26.00	24.3	8.700	<0.050	<0.05	0.096	<0.020	0.020	<0.0050
WVKC-46-{20.2}	22.00	20.1	7.00	0.360	<0.05	0.250	0.032	0.120	<0.0050
WVKC-46-{32.8}	15.00	12.9	5.900	0.051	<0.05	0.370	0.039	0.035	<0.0050
WVKC-46-G				<0.050		<0.050	<0.020		
WVKC-46-G-1				0.190		0.320	0.035		
WVKC-46-G-2				<0.050		<0.050	<0.020		
WVKC-46-H	14.0	13.2		0.074	<0.05				
WVKC-47				<0.050		<0.050	<0.050		
WVKC-47				<0.050		<0.050	<0.050		
WVKC-47-A-{1.3}	42.00	42.9	28.00	0.066	<0.05	<0.05	<0.02	0.026	0.0058
WVKC-47-F				3.400		<0.050	1.600		
WVKC-47-G				1.700		<0.050	0.320		
WVKC-47-G-1				11.00		<0.050	1.700		
WVKC-47-L-{0.8}	110.00	110.0	73.00	0.80	<0.05	1.300	0.29	0.021	0.0066
WVKC-47-N-{1.4}	70.00	75.0	36.00	0.085	<0.05	0.067	<0.02	0.040	0.0061
WVKC-47-O-{0.0}				<0.050		<0.050	0.031		
WVKC-47-O-{2.4}	93.00	95.9	56.00	<0.05	<0.05	<0.050	0.046	0.021	<0.005

Table 13. Rapid Habitat Assessment Scores

Stream Code	cover	substrate	embed	veloc	alteration	sediment	riffle freq.	flow	bank stab.	bank veg	grazing	rip veg	Total
WVK-34-{23.8}	17	17	14	16	12	11	17	18	9	10	11	12	164
WVK-34-{58.4}	17	17	11	14	18	9	17	14	16	17	13	9	172
WVKC-2-{2.0}	8	6	8	11	14	6	6	7	5	8	9	5	93
WVKC-4-{2.5}	15	10	10	12	13	9	8	10	7	8	6	3	111
WVKC-5	16	11	7	11	12	11	16	10	15	15	11	8	143
WVKC-9	7	6	11	9	12	16	5	13	17	17	12	6	131
WVKC-10-{03.6}	18	16	11	16	15	10	17	14	12	12	11	8	160
WVKC-10-{17.0}	12	13	10	18	18	7	16	13	11	12	10	6	146
WVKC-10-I-{0.0}	13	7	5	9	13	5	11	15	13	11	11	9	122
WVKC-10-I-{5.6}	7	11	10	8	14	12	16	12	14	14	11	5	134
WVKC-10-I-{12.5}	14	16	12	9	13	7	16	13	13	14	11	9	147
WVKC-10-I-6-C	9	10	10	9	12	10	17	14	16	16	10	3	136
WVKC-10-J	11	11	7	12	13	8	17	9	4	8	11	5	116
WVKC-10-L	12	11	8	12	13	8	16	10	8	7	17	11	133
WVKC-10-N-{3.0}	11	12	10	8	10	11	16	12	14	15	9	4	132
WVKC-10-P-.5	9	10	11	9	12	10	17	14	13	16	10	5	136
WVKC-10-T-{0.3}	10	12	10	16	13	10	16	18	15	14	10	5	149
WVKC-10-T-{4.6}	10	11	8	12	16	9	11	16	14	15	11	9	142
WVKC-10-T-{17.4}	16	17	15	15	18	14	17	9	13	11	17	18	180
WVKC-10-T-{18.5}	15	18	15	10	19	15	18	10	17	10	18	19	184
WVKC-10-T-2	9	14	12	9	14	15	17	10	16	16	9	3	144
WVKC-10-T-3	5	5	8	5	13	9	1	1	16	15	6	4	88
WVKC-10-T-9	14	16	12	10	15	12	16	7	13	13	18	12	158
WVKC-10-T-9-B	12	15	9	10	13	12	16	9	14	13	6	3	132
WVKC-10-T-9-B.5	11	16	10	8	11	11	16	8	16	16	8	5	136
WVKC-10-T-9-C-2	11	17	13	9	12	11	17	8	16	16	5	3	138
WVKC-10-T-10	11	16	7	8	11	7	18	9	6	7	6	2	108
WVKC-10-T-11-{0.2}	14	16	9	14	15	8	18	12	14	16	14	12	162
WVKC-10-T-11-{4.1}	14	18	11	10	14	14	18	10	19	18	17	10	173
WVKC-10-T-11-{15.3}	15	16	15	10	19	13	19	9	15	19	20	18	188
WVKC-10-T-11-H.5-{0.3}	13	18	19	10	20	15	18	7	16	19	20	17	192
WVKC-10-T-21	11	18	11	10	14	13	18	19	18	17	18	18	185
WVKC-10-T-24-{0.6}	12	8	10	7	12	9	7	5	9	9	10	2	100
WVKC-10-U-{0.4}	16	17	15	15	16	13	16	16	16	16	11	9	176
WVKC-10-U-{4.9}	16	18	16	15	16	10	17	17	12	15	13	6	171
WVKC-10-U-{9.0}	14	16	16	16	16	15	6	16	10	16	16	13	170
WVKC-10-U-{24.4}	17	17	16	18	13	14	17	10	16	14	17	9	178
WVKC-10-U-3-B	13	17	15	10	12	14	16	9	18	17	15	6	162
WVKC-10-U-7-{0.0}	16	17	16	10	12	16	16	10	16	17	9	4	159
WVKC-10-U-7-{4.3}	15	16	12	10	6	13	16	14	14	15	10	3	144
WVKC-10-U-7-{7.9}	15	16	11	15	7	12	17	16	16	16	3	3	147
WVKC-10-U-7-A	12	14	13	10	12	13	16	11	12	12	18	16	159
WVKC-10-U-12-A	14	17	14	9	13	14	17	12	17	17	18	16	178
WVKC-10-U-13	16	18	15	14	15	15	19	10	15	9	8	8	162
WVKC-10-U-17	15	17	15	10	13	14	18	9	15	17	18	14	175
WVKC-10-U-21	17	16	12	10	13	11	18	12	17	16	17	6	165
WVKC-11-{5.6}	15	13	14	10	12	14	16	8	13	16	8	5	144
WVKC-14	13	14	12	10	18	16	18	10	12	12	16	15	166
WVKC-16-A	16	16	14	8	7	14	16	14	18	18	16	5	162
WVKC-21-{0.0}	12	15	7	15	19	3	16	9	5	5	16	16	138
WVKC-21-C	10	12	8	10	11	7	16	15	15	16	11	2	133
WVKC-29	10	11	15	15	14	11	17	8	11	8	8	6	134

Table 13. Rapid Habitat Assessment Scores (continued)

Stream Code	cover	substrate	embed	veloc.	alteration	sediment	riffle freq.	flow	bank stab.	bank veg	grazing	rip veg	Total
WVKC-29-A	14	16	10	9	11	10	16	9	14	15	13	12	149
WVKC-29-A-3	16	16	15	10	15	16	18	8	16	18	14	5	167
WVKC-31-{0.4}	18	16	16	15	12	15	16	10	16	16	10	9	169
WVKC-31-B-{0.2}	17	18	15	14	16	15	16	9	14	15	6	5	160
WVKC-31-B-{10.9}	14	16	15	10	15	13	18	9	10	11	19	17	167
WVKC-31-C	16	18	16	9	16	15	19	7	14	15	16	14	175
WVKC-35-{3.0}	8	15	17	10	13	17	18	13	13	12	15	2	153
WVKC-35-F	14	18	19	10	17	16	18	15	12	14	16	6	175
WVKC-35-G	15	19	10	9	11	16	18	16	17	19	9	1	160
WVKC-43-{0.0}	17	16	13	10	14	14	19	9	13	12	13	7	157
WVKC-43-{2.8}	17	12	9	10	13	7	18	9	18	17	17	6	153
WVKC-46-{0.0}	16	17	13	15	15	12	15	7	14	12	13	14	163
WVKC-46-{5.8}	15	18	12	15	15	13	17	7	17	10	17	14	170
WVKC-46-{15.3}	8	13	16	13	19	17	18	15	17	13	14	13	176
WVKC-46-{20.2}	17	14	16	15	18	14	17	15	11	10	9	5	161
WVKC-46-{32.8}	12	8	16	7	15	8	7	13	10	15	1	1	113
WVKC-46-C	17	18	13	10	12	13	18	10	11	9	16	13	160
WVKC-46-E	14	13	14	9	12	13	17	7	11	12	13	7	142
WVKC-46-G	16	12	14	15	17	13	18	14	17	13	17	14	180
WVKC-46-G-1	11	17	11	10	14	13	15	13	11	11	8	2	136
WVKC-46-G-1-.5A	8	12	16	8	18	17	16	5	15	17	6	2	140
WVKC-46-G-2	11	19	16	10	15	14	19	16	17	16	10	4	167
WVKC-46-H	15	17	11	16	11	12	17	15	19	11	11	2	157
WVKC-46-I	16	17	13	8	17	12	16	8	11	11	4	1	134
WVKC-46-J-2	9	11	11	7	14	10	17	15	15	18	7	3	137
WVKC-46-K	12	15	13	15	15	13	18	14	12	15	14	6	162
WVKC-46-L.5	13	12	16	8	11	14	5	14	16	16	10	3	138
WVKC-46-P	11	16	16	11	16	12	13	14	9	9	9	4	140
WVKC-46-Q	9	9	11	11	12	8	12	11	8	9	10	8	118
WVKC-47	12	17	14	10	11	15	18	16	17	18	14	5	167
WVKC-47-A-{1.3}	15	19	16	10	19	14	17	10	14	15	18	16	183
WVKC-47-C	13	17	17	9	11	12	16	10	14	14	11	5	149
WVKC-47-F	9	15	11	8	14	11	16	12	11	15	4	1	127
WVKC-47-G	14	18	14	10	16	16	19	17	15	15	5	2	161
WVKC-47-G-1	14	14	13	10	14	11	16	10	9	10	13	10	144
WVKC-47-H	12	18	18	9	16	14	18	10	15	15	13	11	169
WVKC-47-L-{0.8}	13	18	18	10	11	16	19	18	16	16	9	1	165
WVKC-47-N-{1.4}	10	18	13	8	19	15	19	8	17	18	19	20	184
WVKC-47-O-{0.0}	15	17	17	10	13	16	17	15	14	15	4	3	156
WVKC-47-O-{2.4}	18	18	16	10	18	15	18	11	12	14	9	6	165

Categories scored 0-20, total possible score =

cover = instream cover
substrate = epifaunal substrate
embed = embeddedness
veloc = # of velocity/depth regimes (i.e. fast/shallow)
alteration = channel alteration
sediment = sediment deposition

riffle freq. = frequency of
flow = channel flow
bank stab = erosional condition of banks
bank veg = vegetative protection
grazing = grazing or other disruptive
rip veg = riparian vegetation zone width (least buffered side)

Appendix B. Glossary

303(d) list -a list of streams that are water quality limited and not expected to meet water quality criteria even after applying technology-based controls. Required by the Clean Water Act and named for the section of the Act in which it appears.

acidity -the capacity of water to donate protons. The abbreviation pH (see def.) refers to degree of acidity. Higher acidtites are more corrosive and harmful to aquatic life.

acid mine drainage (AMD) -acidic water discharged from an active or abandoned mine.

alkalinity -measures water's buffering capacity, or resistance to acidification; often expressed as the concentration of carbonate and bicarbonate.

aluminum -a potentially toxic metallic element often found in mine drainage; when oxidized forms a white precipitate called "white boy".

benthic macroinvertebrates - small animals without backbones yet still visible to the naked eye that live on the bottom (the substrate) of a water body, that are large enough to be collected with a 595 micron mesh screen. Examples include insects, snails, and worms.

benthic organisms, or benthos - organisms that live on or near the substrate (bottom) of a water body, e.g., algae, mayfly larvae, darters.

buffer -a dissolved substance that maintains a solution's original pH by neutralizing added acid.

canopy -The layer of vegetation that is more than 5 meters from the ground; see understory and ground cover.

citizens monitoring team -a group of people that periodically check the ecological health of their local streams.

conductivity (conductance) -the capacity of water to conduct an electrical current, higher conductivities indicate higher concentrations of ions.

designated uses -the uses specified in the state water quality standards for each water body or segment (e.g., fish propagation or industrial water supply).

discharge -liquid flowing from a point source, or the volume of water flowing down a stream per unit of time, typically recorded as cfs (cubic feet / second).

discharge permit -a legal document issued by a government regulatory agency specifying the kinds and amounts of pollutants a person or group may discharge into a water body; often called NPDES permit.

dissolved oxygen (DO) - the amount of molecular oxygen dissolved in water, normally expressed in mg/l.

Department of Environmental Protection (DEP) -a unit in the executive branch of West Virginia's state government charged with enforcing environmental laws and monitoring environmental quality.

ecoregion -a land area with relative homogeneity in ecosystems that, under nonimpaired conditions, contain habitats which should support similar communities of animals (specifically macrobenthos).

ecosystem -the complex of a community and its environment functioning as an ecological unit in nature. A not easily defined aggregation of biotic and abiotic components that are interconnected through various trophic pathways, and that interact systematically in the transfer of nutrients and energy.

effluent -liquid flowing from a point source (e.g., pipe or collection pond).

Environmental Quality Board (EQB) -a standing group, whose members are appointed by the governor, that promulgates water quality criteria and judges appeals for relief from water quality regulations.

Environmental Protection Agency (EPA) -a unit in the executive branch of the federal government charged with enforcing environmental laws.

ephemeral -a stream that carries surface water during only part of the year; a stream that occasionally dries up.

eutrophic -a condition of a lake or stream which has higher than normal levels of nutrients, contributing to excessive plant growth. Usually etropic waters are seasonally deficient in oxygen. Consequently more food and cover is provided to some macrobenthos than would be provided otherwise.

fecal coliform bacteria -a group of single-celled organisms common in the alimentary tracts of some birds and all mammals, including man; indicates fecal pollution and the potential presence of human pathogens.

ground cover -vegetation that forms the lowest layer in a plant community defined as less than 0.5 meters high for this assessment) .

impaired -(1) according to the water quality standards, a stream that does not fully support one or more of its designated uses; (2) as used in this assessment report, a benthic macroinvertebrate community with metric scores substantially worse than those of an appropriate reference site.

iron -a metallic element, often found in mine drainage, that is potentially harmful to aquatic life. When oxidized, it forms an orange precipitate called “yellow boy” that can clog fish and macroinvertebrate gills.

lacustrine - of or having to do with a lake or lakes.

MACS -Mid-Atlantic Coastal Streams -macrobenthic sampling methodology used in streams with very low gradient that lack riffle habitat suitable for The Program’s preferred procedure (see Appendix B).

manganese -a metallic element, often found in mine drainage, that is potentially harmful to aquatic life.

metrics -statistical tools used by ecologists to evaluate biological communities (i.e., number of total taxa)

National Pollutant Discharge Elimination System (NPDES) -a government permitting activity created by section 402 of the federal Clean Water Act of 1972 to control all discharges of pollutants from point sources. In West Virginia this activity is conducted by the Office of Water Resources.

nonimpaired -(1) according to the water quality standard, a stream that fully supports all of its designated uses: (2) as used in this assessment report, a benthic community with metric scores comparable to those of an appropriate reference site.

nonpoint source (NPS) pollution -contaminants that run off a broad landscape area (e.g., plowed field, parking lot, dirt road) and enter a receiving water body.

Division of Water Resources (DWR) -a unit within the DEP that manages a variety of regulatory and voluntary activities to enhance and protect West Virginia’s surface and ground waters.

oligotrophic - a stream, lake or pond which is poor in nutrients.

palustrine - of or having to do with a marsh, swamp or bog.

pH -indicates the concentration of hydrogen ions; a measure of the intensity of acidity of a liquid. Represented on a scale of 0-14, a pH of 1 describes the strongest acid, 14 represents the strongest base, and 7 is neutral. Aquatic life cannot tolerate either extreme.

point source -a specific, discernible site (e.g., pipe, ditch, container) locatable on a map as a point, from which pollution discharges into a water body.

red dog - material formed by the heat and pressure resulting from piling waste coal, carbonaceous shales and slate together. Often has a reddish orange color.

reference site -a stream reach that represents an area's least impacted condition; used for comparison with other sites within that area. Site must meet the agency's minimum degradation criteria.

SCA -Soil Conservation Agency

stakeholder -a person or group with a vested interest in a watershed, e.g., landowner, businessperson, angler.

STORET -STOrage and RETrieval of U.S. waterways parametric data -a system maintained by EPA and used by OWR to store and analyze water quality data.

total maximum daily load (TMDL) -the total amount of a particular pollutant that can enter a water body and not cause a water quality standards violation.

turbidity -the extent to which light passes through water, indicating its clarity; indirect measure of suspended sediment.

understory -the layer of vegetation that form a forest's middle layer (defined as 0.5 to 5 meters high for this assessment).

USGS -United States Geological Survey.

water-contact recreation -the type of designated use in which a person (e.g., angler, swimmer, boater) comes in contact with the stream's water.

watershed -a geographic area from which water drains to a particular point.

Watershed Approach Steering Committee -a task force of federal (e.g., U.S. Environmental Protection Agency, US Geological Survey) and state (e.g., Department of Environmental Protection, Soil Conservation Agency) officers that recommends streams for intense, detailed study.

Watershed Assessment Program (the Program) -a group of scientists within the OWR charged with evaluating and reporting on the ecological health of West Virginia's watersheds.

watershed association -a group of diverse stakeholders working via a consensus process to improve water quality in their local streams.

WVSCI - West Virginia Stream Condition Index, a multi-metric index developed for use in West Virginia to help evaluate the health of benthic macroinvertebrate communities in wadeable streams

Division Of Water Resources

MISSION STATEMENT

To enhance and preserve the physical, chemical and biological integrity of surface and ground waters, considering nature and health, safety, recreational and economic needs of humanity.

VISION STATEMENT

The Division of Water Resources provides leadership on all water issues through effective programs that improve water quality and public safety statewide.

STATEMENT OF POLICY REGARDING THE EQUAL OPPORTUNITY TO USE AND PARTICIPATE IN PROGRAMS

It is the policy or the West Virginia Department of Environmental Protection to provide its facilities, accommodations, services and programs to allpersons without regard to sex, race, color, age, religion, national origin or handicap. Proper licenses/ registration and compliance with official rules and regulations are the only sources of restrictions for facility use or program participation. Complaints should be directed to:

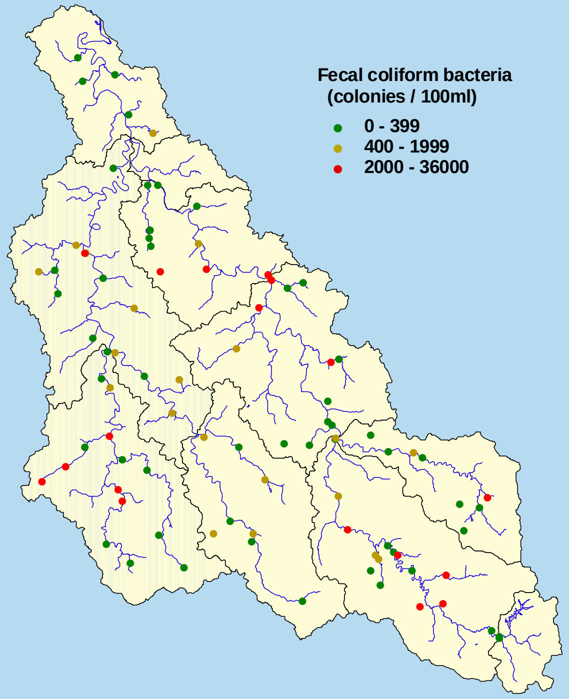
Secretary
WV Department of Environmental Protection
10 McJunkin Road
Nitro, WV 25143-2506

The Department of Environmental Protection is an equal opportunity employer.

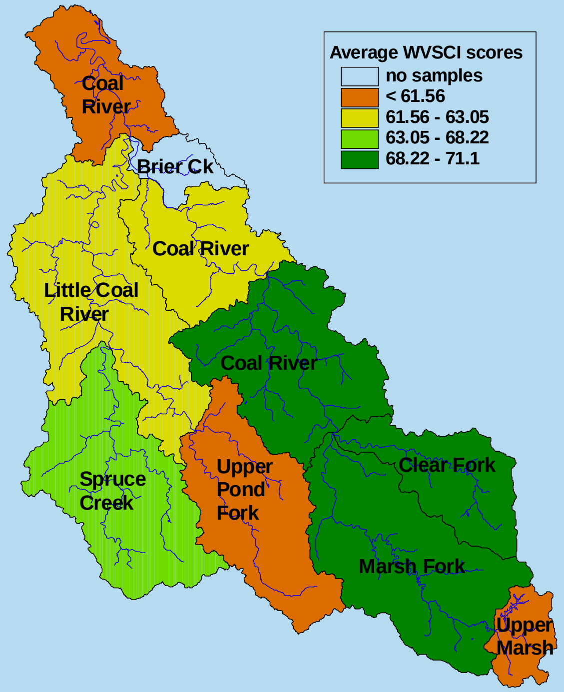
West Virginia
Department of Environmental Protection
Division of Water Resources

This report summarizes the data collected in the Coal River Watershed by the Watershed Assessment Program in 1997. It includes:

Water Quality Information from 151 sites;



Biological Health Information (Benthic macroinvertebrates) from 135 sites;



And physical habitat and landuse pattern information that help us identify and understand the impairments that are affecting the streams of West Virginia.

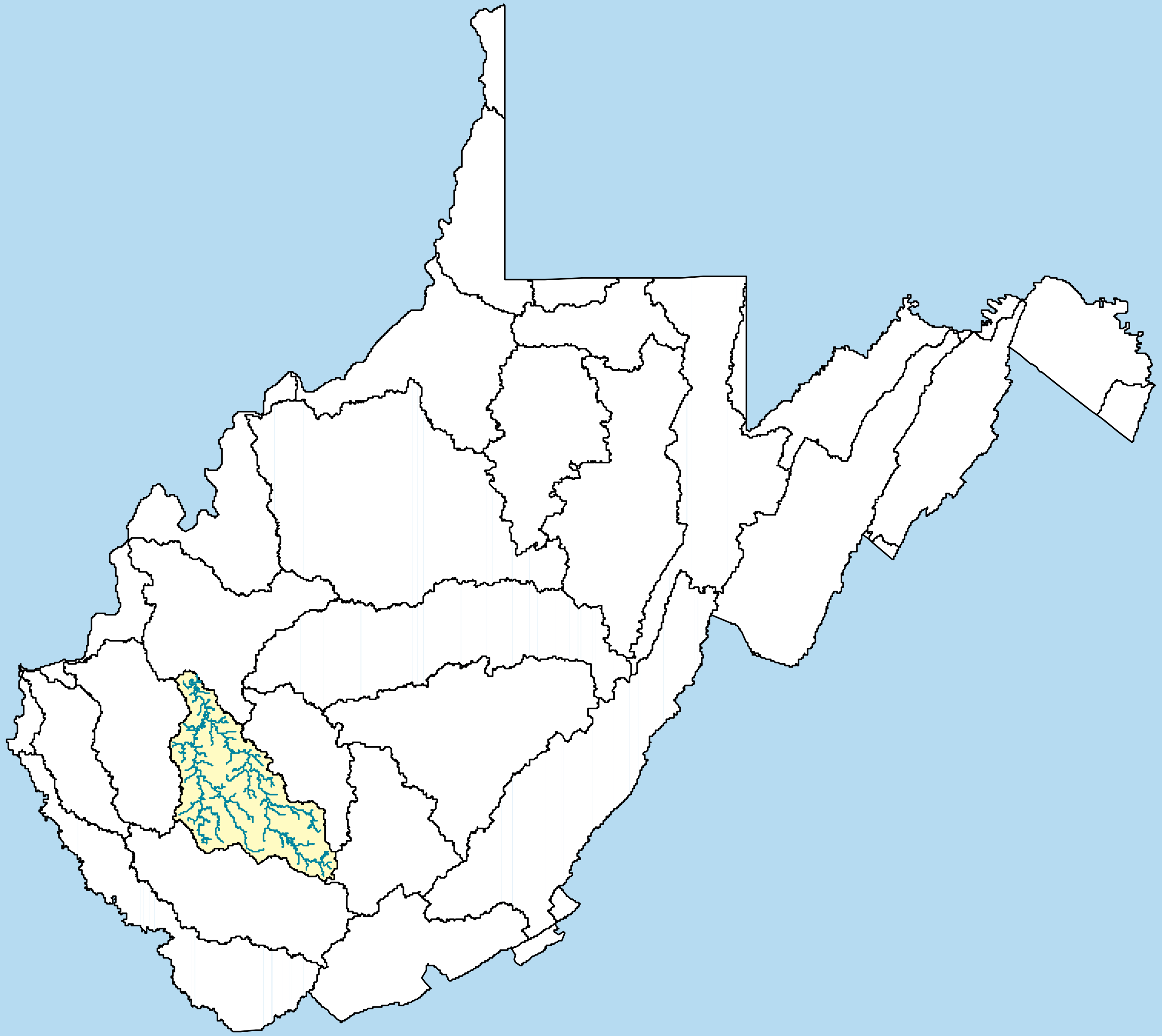
Watershed Assessment Program

WV Division of Water Resources

An Ecological Assessment of the Coal River Watershed

DEP **WEST VIRGINIA**
Department of Environmental Protection

An Ecological Assessment of the
Coal River Watershed



Watershed Assessment Program