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Heads Up on Headwaters

How Surface Coal Mining Threatens Small Streams, Creeks, Springs and Seeps

Strip-mine Issues Committee

SOCM

Credits

This paper is a collaborative project of the Strip-mine Issues Committee of Statewide Organizing for Community eMpowerment—SOCM (formerly, Save Our Cumberland Mountains):

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Cover: Severe sedimentation of Dan Branch, a headwater stream of the Cumberland River, occurred following a haul road slide at the Zeb Mountain Mine in Campbell County, TN. *(Photo by Cathie Bird)*

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Executive Summary

"More than food, guns, or energy the control of water has defined the structure of civilizations."

—Thirst: Fighting the Corporate Theft of Our Water (p.3)

Many agree that adequate supplies of clean water—available to all citizens of Earth in ways that are socially just—will be the primary resource challenge of our immediate future. Here in Tennessee, we already feel the squeeze. In the summer of 2007, Orme, a town of 145 people near the Georgia border, ran out of water. A recent article in the *Christian Science Monitor* describes revival of an old border feud between Tennessee and Georgia, involving the Tennessee River and stirred up this time by severe drought. Tennessee complains that Virginia sends pollutants downstream through the Upper Tennessee River Basin[1], while recent EPA and USGS[2] studies show that upstream nutrient loading from Tennessee and other states contributes to the Gulf's "dead zone."

As citizens and their governments attempt to come to grips with these problems, water has become a commodity—now with a number of Stock Exchange indices just for water trade—and big corporations have fast-tracked a multi-billion dollar industry founded on a basic human need for clean water. Yet bottled water, desalinization and reuse technology is not the only way big business co-opts control of freshwater resources from citizens. Coal companies have buried hundreds of miles of small streams in Appalachia under valley fills, and polluted many more surface and groundwater supplies. Construction companies bury urban headwaters to grow cities instead of food, and many corporate farms contribute pesticides and other pollutants to rural streams. Mass removal of trees and plants to make way for mines, highways and buildings disrupts life processes at critical edges between land and water resources. Private landowners who ignore proven conservation practices on their property also contribute to destruction of the watersheds that must sustain us all.

Such activities securely embed human relationships to water in the fields of social, economic and environmental justice as well as aquatic ecology. Unfortunately, these concerns have only more recently begun to be acknowledged as critical elements of sound water policy, regulation and management.

Water quality regulation in the United States sprang from a desire to protect shipping lanes and harbors from pollution that threatened to disrupt commerce. Today we have evidence that even the smallest headwaters play a significant role in the functioning of entire river systems, from uplands to the sea. We also know that human activity has altered aquatic ecosystems such that old assumptions about "natural" streams must now be questioned. We know that huge amounts of money are required to clean up dirty water, and that no amount of money or human engineering has yet been able to restore the natural function of a headwater stream.

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[1] http://yosemite.epa.gov/opa/admpress.nsf/a883dc3da7094f97852572a00065d7d8/8385c43abde66786852573b800649694!OpenDocument

[2] http://water.usgs.gov/nawqa/sparrow/nutrient_yields/index.html

Watershed health is tied to human health. Three- to four-million American children live within one mile of at least one toxic waste site; of the 9-million citizens who live within 1.8 miles of waste facilities, 75% of them are people of color. Heavy metals from disturbed soil have polluted groundwater and forced coalfield residents across Appalachia to install water purification systems or pay for city water. Yet even city waters must now be suspect due to the growing problem of emergent contaminants—antidepressants, antibiotics, steroids, and by-products of water chlorination, for example—that have been linked to weird mutations in fish and frogs, as well as to human cancers and neurological disorders.

It is through society's institutions that the dreams and desires of its citizens are either oppressed or allowed to play out. Citizens, then, are the key to fundamental change in corporate and government structures that perpetuate unsustainable relationships with nature. As more people experience consequences of the collective human impact on the world's waters, grassroots groups that have been on the frontlines for many years will find new allies in efforts to redirect governmental and corporate behavior and hold leaders accountable.

With so much water in such bad shape around the world, where do concerned citizens start to make a difference? We start where we are—in our home watersheds, on the streams where we live. For the past 37 years, SOCM members have organized for social and environmetal justice issues, including those arising from surface mining activities in Appalachia. The organization has been involved with four *Lands Unsuitable for Mining* designations in Tennessee. Our members monitor activity at mines and initiate citizen complaints when violations are noted. We review mining permit applications and often testify at public hearings. We also track federal environmental laws, rule changes and environmental impact statements to offer input based on experience in our communities.

Unfortunately, our political and regulatory systems don't yet get the significance of headwaters. We have laws that clearly protect "wetlands" and streams that have reached a certain size, structure or function ("waters of the U.S." and "waters of the state"). But there are also uplands with very small streams, springs, seeps and stream-dependent communities (riparian areas) that slip through the cracks of protection and regulation. This is unfortunate because watersheds are *systems*, not collections of parts, and the ecological services of headwaters to large river ecosystems are now known to be of critical importance.

No one knows the frustration of this better than citizens of Appalachia with concerns about how mountaintop removal and other surface mining methods have impacted the headwater areas where they live. Citizens are forced to argue in terms of engineering practice or water quality laws and regulations, with protection of small streams and riparian areas too often lacking a real place in the regulatory and operational systems they must confront. Many feel they have only to watch in frustration as their mountain home environment is rendered insecure.

This paper focuses on the smallest flowing elements of the watershed: headwaters, a key to watershed and whole river system health. We looked at aquatic science and considered social, legal and economic dimensions with which we must interact in our work toward clean, available water for ourselves, and people who come after us. Based on this information, we came up with a list of guiding questions and principles that we can use to develop, refine or advocate strategies for sustainable water resources and best management practices in headwater areas.

Many of these ideas reflect experiences of SOCM members, and the challenges we have already taken on in our own communities. They represent larger problems we must continue to confront on the scales at which we have influence, be it in Appalachia, Tennessee, our home watershed or the stream closest to where we live.

1: Appalachian Headwaters: An Endangered Resource?

"The increasing human population and degradation of biological integrity has been expressed, to a great extent, as a decline in water resources, the most critical factor to achieve sustainable development."

(Zalewski 2002)

Human beings need water in adequate amounts to survive. It should not surprise us then to find the homes, settlements and industries of our ancestors close to a surface water source. The ability to tap ground water sources, to engineer water transfer systems and to navigate waterways allowed for tremendous expansion of human habitation into broader reaches of this huge watery planet Earth.

However, to sustain human communities, we need *clean* water. In the 21st Century we will continue to face tremendous challenges of water quality and distribution. In addition to the legal, ecological and engineering issues that now make headlines, concerns of national security and social justice will more fully emerge as people and nations negotiate for clean water. In recognition of these challenges, the United Nations declared 2005 to 2015 as the decade of Water for Life: one of its core concepts is that all human beings have a right to clean water. [3]

Unfortunately, citizens in Appalachia share concerns about clean water with many in developing nations around the world. When you turn on your faucet and get black sludge, it doesn't much matter that you have a house with plumbing. With the arrival of mountaintop mining, historic assaults to Appalachian homelands from surface mining have been compounded with larger scale desecration of mountain headwaters.

Watersheds are *systems*, not collections of parts. The ecological services of headwaters to large river ecosystems are now known to be of critical importance. We have laws that clearly protect wetlands and streams that have reached a certain size, structure or function ("waters of the U.S." and "waters of the state"). But there are also uplands with very small streams, springs, seeps and stream-dependent communities (riparian areas) that may slip through the cracks of protection and regulation.

Coalfield residents worry about how mountaintop removal and other surface mining methods impact headwater areas where they live. Because regulatory agencies, politicians and mining companies tend to dictate the language of mine operations, citizens must argue their concerns in terms of engineering practice or water quality laws and regulations. Protection of the smallest streams and riparian areas too often lack a real place in the regulatory and operational systems citizens must confront. Many find this situation extremely frustrating.

The Strip-mine Issues Committee has been dealing with mining impacts on coalfield communities since 1972. SOCM has a nationally known history of addressing water quality issues surrounding surface mining activities in Appalachia. Our members monitor activity at mines and initiate citizen complaints when violations are noted. We review SMCRA, NPDES and ARAP applications and often testify at public hearings. We also track federal environmental laws, rule changes and environmental impact

[3] http://www.un.org/waterforlifedecade/

statements to offer input based on our experience in the coalfields. When necessary, SOCM members have organized to protect vulnerable coalfield landscapes through LUMP designations.

In years past, we have encountered a number of surface mining violations and other problems that impact watershed health:

- Inappropriate location of sediment basins in streams (including some designated perennial) in initial drainage control designs.
- Inadequate capacity of proposed sediment basins.
- Inaccurate classification of waters of the U.S. and state of Tennessee.
- Errors in initial stream condition and quality assessments.[i]
- Incomplete environmental assessment of the cumulative impact of disturbing and burying more headwater streams.[ii]
- Cracks in old sediment basins.
- AMD from sediment basins.
- AMD from highly toxic coal seams.[iii]
- Violations for exceeding wastewater limitations.
- Overtopping of sediment basins due to severe thunderstorms.[iv]
- Haul road slides due to inappropriate placement and compaction of fill material.[v]
- Slides at old reclaimed surface mines.[vi]
- Delays in remediation due to ownership or operator transfers.[vii]
- Mining through streams without a permit.[viii]
- Failure of wells in previously mined areas, and problems with water contamination.[ix]

In addition to these situations, many new blips pepper the Strip-mine Committee's mining radar screen:

- Natural recovery of previously mined but unreclaimed watersheds in the Tennessee coalfields has not been adequately studied. Current remining policies do not make sense in Tennessee due to the climate and regenerative capacities of these wet temperate forest conditions. Does remining-as-reclamation in Tennessee represent unnecessary human disturbance to recovering mined lands? Such information may be critical to decisions relating to the impacts of remining on water quality and flow, and to the practice of remining as a watershed reclamation strategy.

- Unregulated or inadequately regulated activities such as oil and gas extraction and creek rock or field rock mining have impacts on watersheds that can be as severe as those from surface mining.

- Inconsistent terminology among agencies about classification of headwater streams complicates citizens' analysis and response to permit applications.[x]

- The EPA and USGS are involved in the issue of emergent contaminants. Polyacrylic flocculants have been used at Tennessee mine sites. There is some concern about degradation of polyacrylics over time and the possibility that they might enter ground or surface water systems. These substances are hazardous to human health and may represent an example of emergent contaminants.

- Proposed rule changes regarding burial of coal combustion residues (CCR) at AML and operational mine sites is of great concern in terms of potential water contamination. The National Resource Council committee that supplied OSM and Congress with a technical and scientific study of CCR disposal says that "comparatively little is known about the potential for minefilling to degrade the quality of groundwater and/or surface waters particularly over longer time periods." (NRC 2006)

- How will future climate conditions affect hydrology, geomorphology, and all of the ecological services provided by watershed ecosystems? Considering all of the consequences of coal extraction, power generation and coal combustion waste disposal, should this trigger a hard look at the use of coal for energy?

- Environmental justice rarely gets adequate analysis or integration into policy-making, environmental assessment and actual operations. The purpose of water quality law is to make sure that people, livestock and wildlife have adequate supplies of clean water to support life and good health. A SOCM member from Fentress County reports that citizens in Jamestown have been warned not to drink city water. Three- to four-million children now live within one mile of at least one toxic waste site.[4] More than 9 million people live within 1.8 miles of the nation's 413 commercial waste facilities; of those, more than 5.1 million are people of color (Bullard, et. al. 2007). How many other water quality times bombs—the "unknown unknowns" of science and technology—are set to go off in Tennessee?

In the Tennessee Water Quality Control Act of 1977, the "declaration of policy and purpose" in Section 69-3-102 reflects the core concept that the UN's Water and Life decade hopes to address (emphasis added):

> *Recognizing that the waters of Tennessee are the property of the state and are held in public trust for the use of the people of the state, it is declared to be the public policy of Tennessee that the people of Tennessee, as beneficiaries of this trust,* ***have a right to unpolluted waters****. In the exercise of its public trust over the waters of the state,* ***the government of Tennessee has an obligation to take all prudent steps to secure, protect, and preserve this right****.*

Coalfield citizens take their rights to clean water very seriously. We appreciate the efforts of Governor Bredesen and the Tennessee Department of Environment and Conservation (TDEC) over the past few years to hear our concerns over the past few years that mountaintop removal and cross-ridge mining pose a significant threat to that right. We also understand that some stakeholders operating in our home watersheds do not share our concerns, and that many of them will not share the long-term consequences of the alteration of headwater areas. We will support policy and legislative proposals that strengthen protection of headwater areas, and oppose those that take us in the wrong direction.

Section 2 of this paper will summarize past and present scientific thinking about headwater area streams and their interdependence with adjacent communities of plants, animals and other life forms. Section 3 will discuss mountaintop removal mining and its impact on headwater areas. Approaches to protection of headwater streams and riparian zones will be connected in Section 4 to recent court cases, existing Tennessee water quality laws and permitting, and the consequences of changes in the language of laws and regulations at both state and federal levels of government. Section 5 will look at some economic issues of small stream protection, and Section 6 will discuss the Strip-mine Issues Committee's recommendations to maintain or strengthen protection of headwater streams.

[4] ATSDR Children's Health web page at http://www.atsdr.cdc.gov/child/ochchildhlth.html

Box 1-A: The Zeb Mountain Mine, Campbell County, Tennessee

Problems at the Zeb Mountain Mine illustrate numerous negative consequences that can unfold in watersheds where surface mining operations exist. Like many watersheds in the Cumberland Mountains, the ones around Zeb Mountain had suffered impacts from early, unregulated mining, but in the absence of widespread mining for several decades, natural processes had effected a fair amount of repair and regeneration.

In 2002, Robert Clear Coal Corporation (RCCC) applied for a SMCRA permit to open a 2,000+-acre "cross-ridge mine" on Zeb Mountain's three peaks. Fearing that such a large mountaintop mining operation in this steep and complex mountain environment would threaten water quality and other community resources, SOCM members in the Elk Valley community of Campbell County decided to organize opposition to the permit. Grassroots citizens countered coal company claims that some of the streams did not support wildlife or recreation uses for which they were classified. Further, they challenged the notion that "remining" the area would leave the streams in better shape because reclamation would be required under SMCRA. Citizens also objected to inadequate drainage control plans, and argued that some of the headwaters to be mined through were, in fact, waters of the state. Many who testified at public hearings warned that the destructive practices and inadequate controls proposed for this mine could lead to significant adverse impacts.

After delays due to lack of data from the coal company, and strenuous opposition from citizens and environmental justice organizations, the application was determined to be technically complete. OSMRE issued a Finding of No Significant Impact, and a permit was granted on July 1, 2003. By the end of December 2003, the operator had been cited for water quality violations, the Army Corps of Engineers had validated citizen concerns that "waters of the state" boundaries had been miscalculated, and independent aquatic surveys verified degradation of water quality in Dan Branch, a headwater stream. In January 2004, the Tennessee Department of Environment and Conservation (TDEC) issued a Director's Order to RCCC for damages caused to waters of the state. (Required remediation was not actually completed until 2007!)

Just a year after mining began, the Zeb permit was transferred to National Coal Corporation (NCC). Violations continued. On 10 April 2006, OSM issued a "pattern of violations" notice to NCC for 7 hydrologic balance regulation violations in the preceding 12 months. In August 2006, after NCC mined through two headwater streams without a permit, TDEC issued a Stop Work Order that mandated restoration of the streams.

SOCM, the Sierra Club, Tennessee Clean Water Network and others organized opposition to renewal of the Zeb Mountain permit for a second five-year period, a process required under SMCRA. In advance of the public hearing, a water sample collected on a site visit was shown to contain excess amounts of selenium. While many life forms, including humans, needs small amounts of selenium for healthy functioning, larger amounts are known to cause kidney and liver damage and damage to the nervous and circulatory systems. Bioaccumulations of selenium in fish can cause reproductive failure, birth defects and damage to gills and internal organs. Mining-related selenium pollution has become a hotter issue in Appalachia since publication of the MTR-VF draft programmatic EIS (EPA 2003) that included results of studies of selenium pollution downstream of valley fills.

Subsequent samples, as well as samples taken as far back as December 2007 confirmed excess selenium at several monitoring sites at Zeb Mountain Mine. Based on this data, the Sierra Club, SOCM and TCWN filed a law suit against NCC for violations of CWA and SMCRA.

2: The Science of Headwater Streams

The number of headwater streams, the complexity of their interactions with aquatic and terrestrial species, and their contribution to integrity of downstream portions of networks in which they flow has long been unappreciated. Aquatic specialists increasingly recommend that the data from new headwater research be brought into discussions of water policy and water quality protection.

> "There is no ecologically sound, nationally consistent definition or accounting of intermittent and ephemeral stream channels. Society considers them of such little value that they are ignored."
>
> —*Rediscovering Small Streams*, Meyer & Wallace (2001)

Character and Distribution of Headwater Streams

Headwater streams, defined here as first and second order streams[5], represent 95% of all stream channels and about 73% of the total stream length in the United States. (Meyer & Wallace 2001) Many aquatic scientists consider these estimates to be conservative based on well-documented studies of the relation of map scale to the numbers of small streams represented. (Leopold 1994; Meyer & Wallace 2001; Meyer 2003) Headwaters may also be classified in terms of flow as perennial, intermittent and ephemeral.[6] Beyond that, there are many ways of classifying and characterizing headwaters[7], and there is still no "ecologically sound, nationally consistent definition or accounting of intermittent and ephemeral stream channels." (Meyer & Wallace 2001, 302)

At local, watershed and regional scales, stream system classification may incorporate climate, geology, channel shape, streambed features, nutrient concentrations, algal biomass, turbidity, or social factors such as human disturbance and designated stream uses. At larger scales—for example, Omernik's *national ecoregions*—factors such as climate, topography, biogeography, regional geology and soils, and broad land use patterns determine classification of the system (Feldman 2000).

Beginning in 1993, Omernik assisted Tennessee's water pollution control division to update ecoregion designations and locate reference streams[8] for each subregion. As a result of this project, the classification of Tennessee streams was reconfigured to include 14 different ecoregions defined by similarities of climate, landform, soil, potential natural vegetation, hydrology, and other ecologically relevant variables (Feldman 2000).

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[5] Stream order classifies streams based on their position in the hierarchy of basin tributaries. First order streams have no upstream branches; second order streams are those with tributaries comprised only of first order streams (Leopold 1994). Generally in this paper we use *headwaters* to include small streams, creeks, springs and seeps in the upland reaches of watersheds.

[6] *Perennial streams* generally flow year round except for occasional drying in extended droughts; *intermittent streams* have seasonal dry periods in which ground water levels may drop below the streambed; *ephemeral streams* have distinct channels that are above groundwater levels and only flow for a few hours or days in response to surface runoff and shallow flowthrough (Meyer & Wallace 2001; Fritz 2006).

[7] For example, see USEPA 2003. The table in Appendix B lists the definitions of these flow categories adopted by various Appalachian coal mining states (including TN) and regulatory agencies.

[8] A reference stream is a least impacted waterbody within an ecoregion that can be monitored to establish a baseline to which other waters can be compared. Reference streams are not necessarily pristine or undisturbed by humans (Feldman 2000).

Stream system classification is only the beginning of a long process to construct useful, accurate characterizations of small streams. Site-specific variations can be numerous and, as the USGS instructed its mapmakers long ago, the most useful supporting data may come from people who live near the streams (Leopold 1994).

Box 2-A: Ecosystem Alteration by Beavers (Naiman, et. al. 1986, 1988)

Beavers live and work primarily in 2nd, 3rd and 4th order stream environments, which make them an interesting species for study in the larger picture of headwater ecohydrology. When beavers move into an area, their dam-building activity alters stream structure and the flow of water through the system. Over time these changes can have profound influence on sediment storage, nutrient cycling, land-water boundary structure and dynamics, downstream water characteristics and even the composition and diversity of entire plant and animal communities in stream networks.

Naiman's studies of beaver-generated alterations of drainage networks suggest that animal and plant populations as well as geochemical dynamics in systems with beavers are substantially different than those without. Modern attempts to characterize unaltered streams have not always appreciated that what we see in a landscape today may reflect beaver activity there hundreds of years ago, long before this species was nearly terminated by human exploitation.

An accurate characterization of natural headwaters may be critical as we seek to successfully restore streams damaged by mining, construction or corporate agriculture. Historically, the re-introduction of beaver has been a strategic element of erosion control and stream restoration. Today, beaver again are being drafted for crucial roles in headwater stream restoration. (See Box 3-A and 5-A)

Ecological Services of Headwater Streams

Research continues to reveal how headwaters and associated aquatic and riparian communities contribute to the function and integrity of entire river ecosystems. Meyer (2003) outlines three broad areas of ecosystem function, or services, those headwaters provide to the whole network:

Contributes to physical integrity of river networks

By recharging groundwater stores, headwaters help maintain downstream base flows and reduce flooding. Sediment that is washed off steep upland hillslopes is retained in small channels that release these particles more slowly into downstream transport. This helps the whole river system maintain its productivity, and protects food and habitat for fish and insects from sedimentation damage. Because headwater streams are cooler in the summer and warmer in the winter than downstream waters, they help regulate water temperature for the whole system.

Maintains chemical integrity of river networks

Headwaters are largely responsible for the basic chemical signature of stream networks. The interface between water in these channels and other headwater ecosystem components is larger, closer and lasts longer than similar interconnections downstream. Small shallow streams take up, transform and retain nutrients to a greater degree than larger downstream channels. When these upland channels are obliterated, more nutrients are carried downstream and the buffering effect is lost. Ephemeral and intermittent channels flow more heavily when it rains, so their nutrient-removal function kicks in at the same time nonpoint source nutrient contamination of the river system is highest.

Supports biotic integrity of river networks

Physical and biological processes transform organic matter that falls into headwater channels before it moves on as useable energy for organisms downstream. Upstream, diverse populations of organisms that shred and process this material are themselves a food source for aquatic and terrestrial species, as are insects that live and reproduce in headwaters. Many species spend critical stages of their life cycle in headwater areas, and the streams there serve as thermal refuges from summer heat and winter freezes. Headwater environments also provide breeding and spawning habitat for fish that live much of their lives downstream. A fair number of endangered or threatened fish, amphibians and invertebrates fill specialized niches that depend on the presence of unique headwater environments. Many of these species, for example, are tightly linked to unique features of intermittent and ephemeral streams such as springs and seeps, or *hyporheic zones* that are charged by groundwater that flows even under seasonally dry sections of the channel.

Connectivity and Scale

The term "connectivity" in relation to aquatic ecosystems has different scales of meaning. It can refer to linkages between land and water elements of the system, or, in a more global sense, to interconnections of these systems with the hydrologic cycle.

Aquatic-Terrestrial Linkages

Stream processes, aquatic life, and adjacent riparian communities are inextricably linked. Exchanges between land and stream components take place across upstream-downstream dimensions, between the stream and adjacent riparian or floodplain systems, between surface water with groundwater, and over time, for example, the time required for changes in a stream to elicit a response from aquatic or riparian species, or vice versa. (Ward 1989)

Hydrologic Connectivity

Water-mediated transfer of energy, material or organisms within or between elements of the hydrologic cycle is essential to keep ecosystem functioning intact, but these processes also contribute to circulation of human-derived nutrients and toxic waste as well as colonization of exotic species that compete with native plants and animals (Pringle 2003). Human activity that disrupts hydrologic connectivity in watersheds has consequences far beyond local boundaries insofar as it adds to cumulative impacts from many alterations. These impacts now endanger ecosystem integrity worldwide (Pringle 2003; Freeman 2007).

Intrinsic vs. Extrinsic Values of Headwater Streams

The value of headwater streams is often determined by how badly people want the resources under or around them. Bioethical, social and environmental justice forums and faith-based stewardship initiatives expand our view of links between human rights and environmental protection. (See Weiskel 1997; Barry 1996; Innes 2007; Snell, 2007) Not only do all people have basic rights to a clean, safe environment, but natural landscapes and the species that inhabit them have a right to exist beyond utilitarian values of the ecological services they provide. In the long history of this planet, exploitation of resources usually implies simultaneous exploitation of people, and vice versa.

Integrating Aquatic Science, Water Policy and Water Quality Regulation

Citizens, engineers, ecologists and policy-makers bring very different worldviews to bear on resource production and protection. Following mid-20th century concerns about water pollution from wastewater treatment and coal-fired power plants, there was a boom in ecological research characterized by increasing importance of interdisciplinary studies. This research took scientists beyond species inventories to questions such as how energy flows through natural systems and how all living and non-living components of ecosystems are linked. We can appreciate these developments in science and technology as we apply them to water problems in the 21st Century, but for a number of reasons we must use them with caution. Despite tremendous expansion of knowledge through research, there remains a great deal of uncertainty about the precise workings of nature. The task of modern ecological science is an ongoing effort to discover the range of natural processes, how they operate and how they interact. (Talbot 1996)

Influence of River Engineering on Theories about Streams

Humans built dams, aqueducts and sewer systems long before they could predict how their alteration of multiple headwater streams impacted whole drainage basins, or changed channel dynamics downstream. These early engineers developed skills based on observation of the flow of water in natural channels. This practical, problem-solving approach to human needs for water became the basis for modern engineering hydrology, which in turn profoundly informs our modern view of rivers and their tributaries (Dunne 1998; McKnight 1997). Hydrology today is a distinct earth science that requires us to draw upon oceanic, atmospheric and solid-Earth sciences to understand how water creates channels, moves through them, and transports dissolved elements and suspended material within it. (Dunne 1998)

Another contribution of engineering hydrology has been the development of models that allow us to make objective and quantitative decisions about environmental alterations. Though models serve predictive needs well, Dunne (1998) suggests that their use tends to de-emphasize what we don't know as well as to divert our investigations from a deeper understanding of processes that operate in nature. He sees a more useful model as one in which we operate in a "web" of information arising both from nature and from society's interests. We can generate new ideas and experiments that contribute to human welfare, says Dunne, if we analyze hydrologic processes in ways that are not usually considered in most engineering applications.

Despite unquestionable contributions, an engineering hydrology approach tends to define both boundaries and solutions to problems that arise when humans log, mine or build highways and houses in headwater areas. Mining in particular is an engineering-based activity. For example, choosing to define streams as perennial, intermittent or ephemeral for regulatory purposes has limited considerations of the stream's importance to a single hydrologic parameter: flow. This ignores other physical, chemical and biological factors that contribute to the value of a stream. As demand for resources from an exploding human population creates desires both for satisfaction of material needs and assurance of sustainable resource supply, policy-makers and regulatory agencies will need to go beyond the narrow problem definitions of engineering hydrology. (Dunne 1998)

Role of human impacts

If humans truly valued headwater ecosystems and understood how they function, we would not see such widespread alteration and wholesale destruction that we do today. Early ideas about aquatic ecosystems arose from studies conducted in regions of the world heavily altered by human activity. This led to assumptions that research results accurately describe how nature functions in an undisturbed state, leaving significant gaps in 20th Century conceptions of small streams. (Meyer & Wallace 2001; Ward 2002)

Recognition of the magnitude of human impacts on natural landscapes is even more recent. Hooke (1999) suggested that role of humans in shaping Earth's landscapes is now greater than that of any other geomorphic agent. On a global scale, humans displace about 35 gigatons of soil and rock annually, while rivers account for approximately 24 gigatons.

Flowing water systems in particular are considered to be human-dominated, and their sustainability requires us to understand the link between ecological processes and human attitudes, institutions and policies. (Meyer & Wallace 2001) An emerging consensus among aquatic scientists advocates that human impacts upon hydrologic connectivity become part of the dialogue on land use policy and regulation. (Pringle 2003; Nadeau 2007; Meyer & Wallace 2001)

Concepts of dimension and scale

When we set out to study an "ecosystem" we must first define its boundaries. A drop of water on a flower petal, or the entire Mississippi River drainage basin can be viewed as an ecosystem. The difference is the scale of the landscape involved. Considerations of scale were not important in older ecological paradigms, but it is now known to be of critical importance. Some theories imply one or more scales, thus, to extrapolate ideas from theory to policy and practice successfully, the limitations of one scale or another must be understood (Minshall 1988; Ward 2002; Sivapalan 2005).

For example, the various dimensions[9] in which river systems operate must be considered when using science to inform policy-making. The river continuum concept[10] (Vannote 1980) primarily concerns processes over the length of a river. Though this idea is considered a significant contribution to aquatic science, it may more accurately reflect the situation for rivers that are highly impacted and managed by humans, and not that of pristine streams and rivers (Ward 2002). On the other hand, the hyporheic corridor theory considers patterns and processes along the whole length of a river. In addition to the upstream-downstream dimension, this concept considers lateral connections between the channel and its riparian areas, and exchanges between surface and ground water, including zones of activity under dry segments of intermittent streams (Stanford & Ward 1993).

The "scale" typically considered as the area of impact for a mountaintop removal mine is the area designated as the boundaries of a permit. But natural processes do not fall under manmade regulation, thus limitations of the regulatory scale may hinder realistic assessment of environmental, social and economic impacts to the rest of the watershed. Existing legal mandates to assess cumulative impacts should address this to some extent, but—as evidenced by testimony at public hearings on mine permits—it is rarely done so to the satisfaction of citizens and scientists.

Complexity of Ecosystems

It might be argued, as does Julien (2002), that early river engineers needed only know that water ran downhill. Resource policy and management in the 21st Century needs to go beyond narrowly focused viewpoints to include multidisciplinary analyses. Ecosystem function involves multiple patterns and processes linking living and non-living components across multiple dimensions and scales. (Lowe 2006; Sivapalan 2005; Ward 2002) In addition to various disciplines of physical and biological science, ecosystem research must now include social, political, economic and legal analysis. (Meyer & Wallace 2001; Benda 2002)

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[9] i.e., longitudinal, vertical, lateral and temporal (Ward 1989).
[10] An idea that there is a continuous gradient of physical variables that elicits a continuum of responses from organisms as well as consistent patterns of handling organic matter from headwaters to the mouth of a river.

Conclusion

Headwater streams and the stream-dependent communities in and around them respond as an integrated system to human activity. The complexity of aquatic ecosystem processes across a wide spectrum of natural landscapes requires that management and regulatory agencies must have the flexibility to address site-specific needs and projected outcomes. It is thus imperative that policy-makers and legislators seek input from aquatic and terrestrial hydroecologists so that land use policies and regulations reflect a scientific understanding of potential consequences to rural and urban watershed communities.

3: Surface Coal Mining and Other Human Impacts to Headwaters

> "Animals suffer and their screams fill the air. Forests are being destroyed. Mountains are ripped open for the metals streaming in their veins. And man cherishes and celebrates those who do the greatest of damage to nature and humanity."
>
> —Leonardo Da Vinci (1500)

Natural disturbances have a huge role in maintenance of ecosystem function and biodiversity. But there is a huge difference between natural disruptions and the human alterations that now threaten lives and landscapes worldwide. In the eastern United States, for example, humans now move more soil than all of the rivers in the western half of the country (Hooke 1999).

Over the past 150 years of coal mining in Appalachia there have been dramatic changes in the scale and method of extraction. Changes in federal regulations, the market value of coal, and technology at coal fired power plants—in addition to concerns about future access to foreign oil—signal a potential for increased mining in coalfields of the United States. Much of this mining may take the form of mountaintop removal, a highly destructive practice in which whole mountaintops are blasted apart and removed in order to extract an entire coal seam. Mountaintop removal mining forever changes the landscape, and has disrupted many watershed communities in West Virginia, Kentucky and Virginia.

After a coal company clear-cuts trees, strips away topsoil and blasts apart the mountain, it is almost impossible for native forests to regenerate. The Environmental Impact Statement on Mountaintop Mining and Valley Fills (MTR-VF EIS) (EPA 2006) found that at the current rate of destruction, 2,200 square miles of Appalachian hardwood forest would be lost to mountaintop removal in the next eight years.

Mountaintop removal mining also causes a character shift from *interior forest* to forest *edge*. Wickham (2006) used Landsat imagery to identify changes in areas of interior forest at multiple scales across time on land-cover maps of the Southern Appalachians. Their analyses showed that mountaintop removal mining has significantly reduced the area that can be classified as interior forest. Such a shift changes forest structure, function and the ecological processes that operate within it. This fragmentation of Southern Appalachian interior forest is of global significance, they say, because large intact expanses of similar forest types are rare worldwide.

In addition to these worrisome changes in streamside habitats, the headwater streams, creeks, bogs, springs and seeps that drain mountaintops and ridgelines are directly destroyed with draglines, bulldozers and explosives.

Cross Ridge Mining versus Mountaintop Removal

In Tennessee, most of the mountaintop seam extraction involves cross ridge mining. This term is often used to evoke images of a friendlier, less destructive method of mining. However, as used in the MTR-VF EIS (USEPA 2006), cross ridge mining refers to a method of mountaintop removal. In the 1985 Programmatic EIS for mining in Tennessee it is referred to as “cross ridge mountaintop removal.”

In traditional mountaintop removal mining, the coal operator applies for a variance from the federal rule requiring that a mined area be put back to *approximate original contour* (AOC). This variance allows the mine operator to store the tops of mountain in huge valley fills and to leave the mined area at a "gently rolling contour." In cross ridge mining there is no AOC variance and companies are required to comply with the approximate original contour rule. Returning the mountain to AOC decreases the amount of spoil that ends up as fill, but, because of the swell that occurs when the solid rock that makes up a mountaintop is blasted apart, does not eliminate it entirely.

It's true that cross ridge mining operations rely on fewer and smaller fills. But the consequence of depositing whole mountaintop loads of spoil to restore AOC brings a whole new set of concerns, such as erosion, risk of slope failure, and alterations of hydrology in streams and aquifers. Neither does cross ridge mountaintop removal mining restore the mountain to its original elevation or shape. In steeper terrain, federal guidelines allow for 20' wide terraces every 50', leaving a distinct mark of human engineering in place of nature's own.

In this document, the term mountaintop removal mining will be used to refer to all mountaintop mining (i.e. mining operations in a steep slope area where an entire coal seam is removed) including cross ridge mining.

Impacts on Headwater Streams

Mountaintop removal mining has a profound impact on streams and water quality. The MTR-VF EIS studied 8 impacts that mountaintop removal and valley fills can have on headwater streams:

- Loss of linear stream length.
- Loss of biota under fill foot print or from mined stream areas.
- Loss of upstream energy from buried stream reaches.
- Changes in downstream thermal regime.
- Changes in downstream flow regime.
- Changes in downstream chemistry.
- Changes in downstream sedimentation (bed characteristics).
- Effects to Downstream Biota.

The MTR-VF EIS found that more than 700 miles of streams in Central Appalachian had been buried by mountaintop removal mining operations since 1985 and an additional 1,200 miles of streams had been negatively impacted.[11] The removal of a mountaintop essentially destroys the upper reaches of watersheds. The coal operator mines through the top of a watershed destroying the small streams where lakes and rivers begin. In order to store mine spoil and other waste generated by the mining operation, the coal company builds fills and impoundments in the upper reaches of streams.

During mountaintop removal mining operations, watercourses are filled and rerouted, creating man-made storm water channels and huge sediment control ponds in the place of mountain streams. The disturbance of large amounts of land in steep slope areas makes it inevitable that storm water will wash mine spoil down the mountain. In order to keep storm water from carrying sediment into streams, surface mining operations usually construct sediment basins. But with mountaintop removal mining there is no safe place to construct these basins. Basins on the mining bench are prone to failure and can slide down steep slopes. Some operations are proposing "in stream" sediment basins, where an operator would impound a stream and allow sediment to collect behind the impoundment. Instead of protecting streams from sediment pollution these basins actually fill streams with sediment.

[11] These numbers, of course, are higher now in 2009 and are expected to increase until destructive mining practices cease, or regulation and enforcement of laws actually achieve adequate protection of headwaters.

A study of stream chemistry changes below valley fills showed significant increases in conductivity, hardness, sulfate, and selenium concentrations downstream of mountaintop removal operations (Bryant 2002). Selenium, in particular, is highly toxic to aquatic life at relatively low concentrations. Living Waters for the World, an organization that helps people primarily in third world countries to set up water purification programs, has brought their expertise to 27 projects in the Buffalo Creek and Viking Mountain areas of Tennessee, where water has been polluted by toxic metals from surface mining.[12]

For many years people have assumed that headwaters—small intermittent and ephemeral streams, spring-brooks and seeps—did not support aquatic life and thus were expendable. In fact headwaters support rich assemblages of living organisms, some of which are exquisitely adapted to life in temporary flow conditions. Scientific evidence available today exposes mining and other human alterations of these waters as harmful. (See Williams 1996; Dieterich 1999; Meyer 2007.)

Permit requirements and best management practices, if enforced and utilized, can protect many small streams not only from mining, but also from other activities such as forestry and construction. Prior to 2008, a federal 100' stream buffer zone rule required that regulatory authorities only authorize operations within that zone when such activity would not cause or contribute to the violation of applicable State or Federal water quality standards and would not adversely impact the water quantity or quality or any other environmental resources of the stream. Channel diversions were only permitted when they were designed and placed to maximize stability and minimize hydrologic impacts inside and outside the mined area. Many aquatic scientists as well as coalfield citizens considered stream buffer zones as the best way to protect headwaters (short of elimination of mining near streams entirely). TDEC currently does not permit mining through streams unless the stream is in an area that has been previously mined and the activity would result in improvement of the stream's condition. Stream alterations require an ARAP.[13, 14]

Other Human Alterations of Headwaters

Hard work by SOCM and other environmental justice organizations in the 1970's brought many destructive surface mining operations under state and federal regulation. But mining is not the only human activity that wrecks headwater streams. Many impacts to streams are generated in the legislative chambers of local, state and federal government, far from the watersheds through which they flow. Politically motivated changes in the language of the Clean Water Act in 2002 by the Army Corps of Engineers allowed mine waste to be dumped into streams—at the direction of the Bush Administration and without Congressional approval. This gift to coal companies came at the expense of small stream protection, as it accelerated mountaintop removal operations in Appalachia. In five consecutive legislative sessions since 2006, bills introduced in the Tennessee legislature have proposed to alter the definition of waters of the state under the Tennessee Water Quality Control Act, and define them in a way that essentially removed some headwater streams from protection under this law. [See Box 4-A]

SOCM is concerned that federal and state proposals like these place headwater streams at risk, and could open the door for more mountaintop removal mining in Tennessee. In addition, human activity in agriculture, forestry, real estate development and urban sprawl compounds the man-made assault on headwaters by surface mining. A distinction between "point source" pollution that is regulated, and "non-

[12] http://www.livingwatersfortheworld.org/Page3-Installations.php
[13] Aquatic Resource Alteration Permit. See Chapter 1200-4-7 of the Rules of the Tennessee Department of Environment and Conservation, Water Quality Control Board, Division of Water Pollution Control.
[14] Letter dated January 13, 2006 from Paul Schmierbach, TDEC Water Pollution Control Division, to Tim Dieringer, Director, Knoxville Field Office of OSMRE.

point source" pollution that is not, creates loopholes that allow these impacts to continue.[15] The cumulative impacts of all these activities may represent a threat to waters of the state and the nation that we ignore at our own peril.

Box 3-A: The Impact of Milldams on Characterization and Restoration of Streams (Walter & Merritt, 2008)

At the same time beaver dam builders were being wiped out by trapping, human dam builders were busy impounding streams to power forges, furnaces, mines and mills. Impacts of both species on hydrologic balance and stream geomorphology are profound, and challenge long-held assumptions about headwater streams.

By 1840 there were more than 65,000 water-powered mills distributed across 872 counties in the eastern United States. Mill density in the Appalachian coalfields was low—between 0 and 0.05 mills per square kilometer—with much higher densities in the Mid-Atlantic Piedmont region. While in operation, ponds behind milldams on hundreds of miles of small streams collected massive amounts of sediment generated by deforestation and agricultural activity. Walter and Merritt hypothesize that subsequent abandonment and failure of milldam structures created the meandering channels with alternating pools and riffles, deeply cut through fine-grained floodplain sediments commonly thought to be the natural form of pre-settlement headwater streams. Their study revealed evidence that pre-settlement valley bottoms are better characterized as wide, forested wetlands with sheet-like flows from shallow branching headwater networks and vegetated islands in the floodplains. Such a description mirrors Naiman's work on ecosystem alteration by beavers.

If we map early stream research hubs as an overlay of mill site maps, we might see how scientists lacking more recent data on mill and beaver dam impacts could have mischaracterized pre-settlement headwater streams in the east. Taken together, Naiman's studies of beaver -altered environments, and the milldam studies of Walter and Merritt illustrate how difficult it is to accurately interpret complex ecosystems. Both studies discuss the relationship of accurate ecosystem interpretations to success or failure of stream restoration efforts. (See Box 5-A for discussion of stream restoration.)

No Good News in Recent Scientific Studies of Mountaintop Removal Mining Impacts

Since the Committee's first release of this paper early in 2009, some significant scientific studies related to mountaintop removal and surface mining have been published.

In May of 2009, many mountain communities across Kentucky and West Virginia experienced substantial flooding. A month later—after Governor Joe Manchin, Congressman Nick Rahall and industry spokesmen had declared these floods "an act of God"—Jack Spadaro, former director of the National Mine Health and Safety Academy, said in an interview that studies by the EPA, the Corps of Engineers and the State of West Virginia all show a link between mountaintop-removal mining and flooding.[16]

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[15] Rebecca Hanmer, USEPA, discussant at a workshop, *The Value of Headwater Streams*, State College, PA, April 13, 1999. Proceedings published as Appendix D of the MTR-VF DEIS (USEPA, 2006).

[16] Heyman, D. (June 8, 2009). "Expert says mountaintop removal causes flooding." *Public News Service* online: http://www.publicnewsservice.org/index.php?/content/article/9231-1 (accessed May 12, 2010)

Soon after that, Hendryx and Ahearn (2009) followed earlier hospitalization and mortality research in Appalachian coalfields (Hendryx 2007, 2008, 2009) with a study that estimated the corresponding value of statistical life (VSL) lost relative to the economic benefits of the coal mining industry. In April of 2010, yet another study (Hitt and Hendryx) tested the prediction that the ecological integrity of streams would provide an indicator of human cancer mortality rates in West Virginia. The authors found that:

> *Coal mining was significantly associated with ecological disintegrity and higher cancer mortality. Spatial analyses also revealed cancer clusters that corresponded to areas of high coal mining intensity.*

These studies lend much evidence to notions that living near surface mining operations can be hazardous to your health, and that these externalized costs outweigh any benefits of coal mining.

In December 2009, the Government Accountability Office (GAO) released its study of coal mining in mountainous areas of Kentucky and West Virginia. The report to Congress documents that, over nearly two decades, the number of acres being mined in these areas has increased and is being concentrated such that a relatively small number of counties is bearing a huge share of the destruction of forested mountain landscapes.

Finally, in January of 2010, the journal *Science* published a significant analysis of peer-reviewed studies on the consequences of mountaintop removal and valley fill operations. According to the paper (Palmer 2010), mountaintop mining and valley-fills continue to cause significant damage despite requirements to minimize them:

> Clearly, current attempts to regulate MTM/VF practices are inadequate. Mining permits are being issued despite the preponderance of scientific evidence that impacts are pervasive and irreversible and that mitigation cannot compensate for losses. Considering environmental impacts of MTM/VF, in combination with evidence that the health of people living in surface-mining regions of the central Appalachians is compromised by mining activities, we conclude that MTM/VF permits should not be granted unless new methods can be subjected to rigorous peer review and shown to remedy these problems. Regulators should no longer ignore rigorous science. The United States should take leadership on these issues, particularly since surface mining in many developing countries is expected to grow extensively. (p.149)

The Strip-mine-Issues Committee continues to follow new research on the impact of mountaintop removal coal mining on the health of Appalachian headwaters and the communities they support.

4: CWA, TWQCA and Protection of Headwater Streams

> Morality cannot be legislated but behavior can be regulated. Judicial decrees may not change the heart, but they can restrain the heartless.
>
> — Martin Luther King, Jr.

The legal link between waters of the United States and the waters of Tennessee is the Federal Water Pollution Control Act of 1972, commonly known as the Clean Water Act (CWA).[17] Protection of U.S. waters from pollution is not a new idea, having its lineage even as far back as the River and Harbor Act of 1899 that prohibited discharge of refuse into navigable waters. The federal government became more directly involved in regulating water quality with passage of the Federal Water Pollution Control Act (FWPCA) in 1948. Since then federal water quality regulation has evolved through a series of laws[18] of which the CWA is only the most recent. (Craig 2004)

To enter a discussion of the current situation in Tennessee (and the U.S.), it's important to note three facts about the evolution of the Clean Water Act:

- The effort of Congress to protect waters of the U.S. was motivated not from progressive, proactive stewardship of water resources but from a reaction to observable deterioration of water quality, particularly in navigable waters.
- An underlying assumption of the navigable waters focus in early water quality laws is that the role of headwater streams in the larger river system is negligible, a misperception that has proved hard to overcome in the 21st Century.[19]
- The CWA's predecessors trace an evolving relationship between the states and the federal government in their roles as regulators of water quality.

The CWA aimed to continue restoration of the nation's ailing waters and then to maintain the natural structure and function of America's aquatic ecosystems, protecting them henceforth from the discharge of pollutants that had degraded them in the first place. The CWA affirmed several rights and responsibilities of the states to "prevent, reduce and eliminate pollution" and to develop, restore, preserve or enhance land and water resources within state boundaries. Among other assignments, states were to manage CWA construction grants and to implement permit programs relating to discharge of pollutants as well as dredge and fill operations in waters of the U.S. In this partnership to restore and protect national water resources, states were also to receive federal funding.

Tennessee's intentions to participate are clear in its own Water Quality Control Act of 1977. Section 69-3-102 of this law declares that Tennesseans have the right to unpolluted waters, and that the State intends to "abate existing pollution of the waters of Tennessee, to reclaim polluted waters, to prevent the future pollution of the waters, and to plan for the future use of the waters so that the water resources of Tennessee might be used and enjoyed to the fullest extent consistent with the maintenance of unpolluted

[17] http://www.epa.gov/watertrain/cwa/
[18] The Federal Water Pollution Control Act of 1948; the Water Pollution Control Act Extension of 1952; the Water Pollution Control Act Amendments of 1956; the FWPCA Amendments of 1961; the Water Quality Act of 1965; the Clean Water Restoration Act of 1966; and the Water and Environmental Quality Improvement Act of 1970.
[19] See discussion of the importance of headwaters in the MTR-VF EIS, Appendix D at page 53.

waters." Paragraph (c) of this section names an additional purpose "to enable the state to qualify for full participation in the national pollutant discharge elimination system established under § 402 of the Federal Water Pollution Control Act, Public Law 92-500."

Box 4-A: The Scale of the Law in Headwater Protection

What people do in headwater areas can generate legal questions the whole length of the river system. In its 2008 water quality report required under the Clean Water Act, the Tennessee Department of Environment and Conservation declared that two rivers—the Powell and the Clinch—were at risk over their entire length and needed all the protection they could get.

It is of some significance to claim that a river is polluted from its point of entry from another state. Based on information in an EPA watershed risk assessment, TDEC attributes significant loss of aquatic species in the Clinch and the Powell rivers to pollution from mining and agriculture near their southwestern Virginia headwaters. TDEC said the effects of this pollution extend into Tennessee, and requested that Virginia also list the Clinch and the Powell as threatened and impaired, respectively. In addition, Tennessee has requested assistance from the EPA to develop recovery plans for these river systems. The Southern Environmental Law Center (SELC) agreed with TDEC's listing. Long active in support Appalachian coalfield citizens whose communities bear the consequences of destructive surface mining practices, SELC announced their intention to ask that Virginia honor TDEC's requests to list the Clinch and Powell as Tennessee did. SELC also plans to urge Virginia to clean up their reaches of these two rivers to protect endangered mollusks and other aquatic species.

At the western boundary of Tennessee, the reach of accountability across state lines has a different twist. On July 30, 2008, environmental groups from nine states whose waters empty into the Mississippi filed a petition asking that the EPA set limits on nitrogen and phosphorus discharged into the river. These pollutants from agriculture and other human activities upstream contributed, they say, to a "dead zone" in the Gulf of Mexico that has health and economic consequences for people on the Gulf Coast.

Does Virginia's pollution of the Clinch and the Powell make it harder for Tennessee to stay within discharge limits into the Mississippi? If so, by how much? As we begin to play with possible questions, the challenge becomes clear. Rivers function as systems without respect to legal and political boundaries. At some point we will have to stop pointing fingers at neighbors and accept, as a system of people, our mandates as stewards in relation to our living waters.

The CWA proposed to protect navigable waters, defined in the Act as "waters of the United States." Practical determination of the reach of the CWA was eventually specified in regulations drafted by the Corps of Engineers, approved by Congress for inclusion in the 1977 Code of Federal Regulations.[20] The regulatory interpretation extended protection to wetlands and small streams adjacent to waters considered navigable in a traditional sense, a decision that went unchallenged for nearly twenty years. Since 1985

[20] 33 CFR §323.2(a)(5) (1978): defined "waters of the United States" to include "isolated wetlands and lakes, intermittent streams, prairie potholes, and other waters that are not part of a tributary system to interstate waters or to navigable waters of the United States, the degradation or destruction of which could affect interstate commerce."

there have been three notable challenges, at the level of the U.S. Supreme Court, to CWA jurisdiction. Decisions in these cases—*Riverside Bayview*, *SWANCC* and *Rapanos*—anchor our current understanding of protective limits for wetlands and small streams in the CWA (ELI 2007).

Riverside Bayview (1985)
In this first challenge to the Corps' interpretation of regulatory reach, the Supreme Court held in a unanimous decision that it was reasonable for the Corps to require a real estate developer to have a 404 permit to discharge fill material into wetland areas that were adjacent to traditional navigable waters of the U.S. In its decision, the Court acknowledged the inherent difficulties in determining boundaries along nature's continuum of dry land to open waters in a way that would protect waters of the U.S. from pollution as the Act intended. By defining navigable waters as waters of the United States, said the Court, Congress clearly had intended to regulate at least some waters that were not navigable and that "navigable" was "of limited import" as used in the Act.[21]

SWANCC (2001)
In 2001, the U.S. Supreme Court in *SWANCC v U.S.* ruled on two issues relative to jurisdiction of the Army Corps of Engineers under section 404 of the Clean Water Act: does the Corps' jurisdiction extend to isolated, non-navigable intrastate waters based solely on use of these waters by migratory birds, and, does the Corps have authority under the Commerce Clause of the U.S Constitution to include such isolated, non-navigable waters as waters of the U.S. protected by the Act. In a 5-4 decision, the Court ruled that use of isolated wetlands by migratory birds as a sole condition is not sufficient to require a 404 permit. [22] The Court did not rule, however, on the issue of the Corps' authority to regulate isolated, non-navigable waters.

Rapanos (2006)
In *Rapanos v. United States* (heard together with *Carabel v. USACE*)[23] the petitioners essentially argued that the CWA can't be invoked to protect any waters other than those that support commercial shipping, and those streams or wetlands directly touching such navigable waters (Earthjustice 2006). In a widely analyzed Supreme Court decision issued in June, 2006 these two cases were remanded to the lower courts in a 4-1-4 decision that failed to reach consensus on the reach of waters of the U.S. and the jurisdictional boundaries of the Clean Water Act. Despite this fact, and based on opinions of Justices Scalia and Kennedy, waters may be protected if 1) they are a wetland that has a continuous surface connection to a relatively permanent body of water that in turn is connected to traditional interstate navigable waters; or, 2) they have a "significant nexus"[24] to traditional navigable waters (Thomas 2007).

In the wake of these decisions, various analysts, pundits and stakeholders agree only on two things: the future of the Clean Water Act is uncertain, and it's going to take a long time to clear the muddy waters of small stream protection. Craig (2004) sees continuing challenges to the reach of federal jurisdiction until

[21] *United States v. Riverside Bayview Homes, Inc.*, 474 U.S.121, 133 (1985). Held:
1. The Court of Appeals erred in concluding that a narrow reading of the Corps' regulatory jurisdiction over wetlands was necessary to avoid a taking problem. Neither the imposition of the permit requirement [474 U.S.121, 122] itself nor the denial of a permit necessarily constitutes a taking. And the Tucker Act is available to provide compensation for takings that may result from the Corps' exercise of jurisdiction over wetlands. Pp. 126-129.
2. The District Court's findings are not clearly erroneous and plainly bring respondent's property within the category of wetlands and thus of the "waters of the United States" as defined by the regulation in question. Pp.129-131.
3. The language, policies, and history of the Clean Water Act compel a finding that the Corps has acted reasonably in interpreting the Act to require permits for the discharge of material into wetlands adjacent to other "waters of the United States." Pp. 131-139.
[22] *Solid Waste Agency of Northern Cook County v. United States. Army Corps of Engineers, 531 U.S. 159 (2001) ("SWANCC ")*
[23] *Rapanos v. United States*, 126 S.Ct. 2208, 2248 (2006)
[24] Significant nexus may be argued on the basis of textbooks and treatises, delineation manuals for wetlands or streams, scientific journals, assessment methodologies for wetlands or streams, technical reports issued by federal and state agencies, watershed plans and assessments, wetland and stream databases, for example. (See Thomas 2007)

citizen's rights to a clean and healthy environment are amended to the U.S. Constitution. Until that happens, she says, scientific, economic and social justice will likely fail to receive due consideration. Meyer (2003, 7) notes that any change to federal definitions of "waters of the U.S" that isolates navigable rivers from their headwaters is a "direct contradiction to long-standing and robust scientific evidence." Because these streams represent such a huge percentage of all stream networks, she says, eliminating them from protections of the CWA "would profoundly alter the physical, chemical, and biotic integrity of that network."

Recent court decisions protective of headwater streams

Destruction of headwater streams from mountaintop removal mining came under scrutiny in *Bragg v Robertson.*[25] A court decision in this case led to a multi-agency programmatic EIS on mountaintop removal mining and valley fills. While thousands of comments by a concerned public did not appear to change the alternative action selected, the document still reflects the fact that mountaintop removal and valley fills cause loss of ephemeral and intermittent streams in headwater areas and that such activity has many negative impacts on watershed function. Once destroyed, headwater streams cannot be replaced, and their functions have yet to be duplicated by engineered channels. (USEPA 2006)

Recent court activity continues to illuminate concerns about the ongoing loss of headwater streams in Appalachia. In *OVEC et al. v USACE*, for example, plaintiffs asked U.S. District Court Judge Robert Chambers for a declaratory judgment that "the stream segments located between the toes of the valley fills and the sediment pond embankments are "waters of the United States"; that the Corps lacks authority to permit discharge from the valley fills into the stream segments as "secondary impacts"; and that the discharge of pollutants into the stream segments below the valley fills is impermissible unless in compliance with CWA § 402. In his June, 2007 decision,[26] Judge Chambers granted the motion.

In the same case the plaintiffs also sought declaratory relief on CWA and NEPA violations in conjunction with four permits granted by USACE to Massey Energy. On these issues, Judge Chambers cited the Corps of Engineers for failure to take a "hard look" at the destruction of headwater streams and failure "to evaluate their destruction as an adverse impact on aquatic resources in conformity with its own regulations and policies (p.46)." In particular, Judge Chambers criticized the Corps' finding that sediment ditches constructed on mine sites can be engineered to replace headwaters that are buried by mining. "The scientific community is skeptical of the likelihood that important headwater stream functions will actually be achieved in manmade streams (p.61)," Chambers wrote. "The court finds that the corps has too little experience to support its faith in stream creation as an acceptable means of compensatory mitigation (p.63). As a result of his ruling, four mining permits issued to Massey Energy by the Corps were revoked, and a full assessment of the streams was ordered.[27]

Following this decision, Boone County, WV residents filed suit to stop a valley fill at Massey's Calisto mine (Earthjustice 2007a). In a ruling on October 11, 2007, Judge Chambers issued a temporary restraining order and preliminary injunction against Massey's operations at Calisto. Chambers stated that the environmental groups "made a strong showing that the permits issued by the Corps are arbitrary and capricious, contrary to law, and contrary to the economic and environmental balance struck by Congress in the passage of the relevant environmental statutes." (Earthjustice 2007b)

Unfortunately, on Friday the 13th of February in 2009, the 4th U.S. Circuit Court of Appeals overturned Judge Chamber's decision.[28] A few weeks later, new EPA Administrator Lisa Jackson announced a

[25] *Bragg v Robertson,* 190 F.R.D. 194, 196 (S.D. W. Va. 1999)
[26] *OVEC v USACE*, Civ. No. 3:05-0784 (S.D. W. Va. June 2007)
[27] *OVEC v USACE*, Civ. No. 3:05-0784 (S.D. W. Va. March 2007)
[28] 4th U.S. Circuit Court of Appeals Decision: http://www.epa.gov/owow/wetlands/pdf/OVECdecision2-13-09.pdf

decision for close review of at least 48 mountaintop removal mining permits. According to Jackson, this move reflected EPA's "serious concerns about the need to reduce the potential harmful impacts on water quality."

The 4th Circuit Court decision did not end the discussion on the threat of mountaintop removal mining to aquatic (and human!) communities. Grassroots activists continue to press the EPA and the Obama Administration for adequate protection of headwaters in the wake of the 4th Circuit Court's decision.

TDEC and the Clean Water Act in Tennessee

For some years now, the SOCM Strip-mine Issues Committee has argued that, when adequately enforced, the Tennessee Water Quality Control Act of 1977 (and its amendments) gives a fair amount of protection to headwater streams in surface mining operations. While the federal government through the Office of Surface Mining (OSM) has primary regulatory responsibility for coal mining, the state, under the Tennessee water quality law, has responsibility for regulating the impacts of mining on state waters. Two permits are needed to operate a coalmine in Tennessee: a SMCRA[29] permit that is issued by OSM and a NPDES permit, which is issued by the state through TDEC.

The SMCRA permit deals with the mining operation and reclamation plans and includes the company's plans for controlling water pollution. This permit governs what happens on the mine site. In the latter days of the Bush Administration in 2008, a new stream buffer zone rule that is much less protective of headwaters went into effect.[30] The new rule prohibits "surface mining activities that would disturb the surface of land within 100 feet, measured horizontally, of waters of the United States." However, four activities—all within "waters of the United States"[31]—are exempt from this prohibition:

- mining through;
- placement of bridge abutments, culverts, or other structures;
- construction of sediment pond embankments;
- construction of excess spoil fills and coal mine waste disposal facilities.

The NPDES (or National Pollution Discharge Elimination System) permit deals primarily with point source discharges from a mine site into waters of the state. It governs how the mining company deals with the water that will leave the mining site. Essentially, the NPDES is the state's permit for coal mining. TDEC also folds general storm water permitting of mining operations into the NPDES permit. With non-mining operations, such as construction, storm water permitting is covered with a separate general storm water permit. The NPDES permitting process is the main mechanism that the State has for assessing the potential for damage to and regulating the impact on waters of the state by mining operations. It takes action by *both* OSM and the State of Tennessee for a mining operation to be permitted. Thus the State has the ability to prevent initiation of mining operations that will have a negative impact on the state's water resources by not issuing a NPDES permit.

Mine operators may also need other permits to fill or alter streams. The U.S. Army Corps of Engineers (USACE) issues a 404[32] permit for filling of waters of the U.S. In some situations, a permittee may need only the nation-wide permit 21 (NWP21), which is a general 404 permit for mining activity in streams, including mountaintop removal and valley fills. However, before the Corps can issue a 404 permit, they

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[29] Surface Mining Control and Reclamation Act

[30] This rule is being challenged and many grassroots and national environmental groups are advocating reversal of the stream buffer zone rule decision with the Obama Administration.

[31] RIN1029-AC04: Excess Spoil, Coal Mine Waste, and Buffers for Waters of the United States. *Federal Register* 72(164): 48924

[32] Authorized by Section 404 of the CWA.

must obtain 401-certification from the State of Tennessee declaring that the federal 404 permit will not violate state water quality law.[33]

TDEC also requires an Aquatic Resource Alteration Permit (ARAP) if a coal company proposes to fill or alter waters of the state of Tennessee. TDEC enforces a 100' stream buffer zone, a distance they consider necessary to protect streams in mining operations, and does not permit mining through previously undisturbed streams.[34] TDEC will consider an ARAP for "only those streams previously disturbed by past mining and where there is environmental benefit to restoring altered drainage patterns."[35] In view of likely changes to SMCRA regulations, protection of headwaters from destructive mining practices in Tennessee clearly rests with the state through TDEC permitting.

Assumptions in permitting

Resource and regulatory agencies, legislators and many citizens often assume that if a mine site has an NPDES permit in place the waters of the state will be protected from pollution. Experience of coalfield residents over many decades demonstrates that this is simply not the case. Their proof is a virtual laundry list of violations of water quality law by coal companies operating with NPDES permits. The notices of violation issued to operators at the Glady Fork, Big Brush Mines 1 & 2; Cumberland Coal Company at the Turner 1 Mine and Robert Clear Coal Company at the Zeb Mountain Mine are just a few examples.

SOCM maintains that the removal of a mountaintop, by design, destroys the upper reaches of watersheds. SOCM suggests that instead of working with the assumption that issuing a NPDES permit will prevent pollution, the State of Tennessee must work with the presumption that a coal mining operation that removes an entire seam in a steep slope area cannot help but cause pollution. SOCM continues to challenge both OSM and TDEC on this point for all mountaintop removal/cross ridge mining applications.

The Obama Administration and Recent Changes at EPA and OSMRE

Signs that science had returned to the White House took form in March of 2009 when EPA announced that it had sent two letters to the U.S. Army Corps of Engineers expressing serious concerns about the need to reduce the potential harmful impacts on water quality caused by certain types of coal mining practices, such as mountaintop mining. EPA said they planned to review a number of permit applications, and also sent letters to operators at two large mountaintop removal operations in West Virginia and Kentucky.[36]

After this review process was underway, the federal government also announced, on June 11, 2009, that three agencies had signed a Memorandum of Understanding implementing the Interagency Action Plan on Appalachian Surface Coal Mining.[37] In a press release, the agencies said that they were "taking unprecedented steps to reduce the environmental impacts of mountaintop coal mining in the six Appalachian states of Kentucky, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia through a coordinated approach between the Environmental Protection Agency (EPA), Department of the Interior

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[33] The USACE

[34] Letter dated January 16, 2006 from Paul Schmierbach, TDEC Division of Water Pollution Control, to Tim Dieringer, Director of OSM's Knoxville Field Office.

[35] Letter dated January 18, 2006 from Paul Schmierbach, TDEC Division of Water Pollution Control, to Tim Dieringer, Director of OSM's Knoxville Field Office.

[36] http://www.epa.gov/Wetlands/guidance/mining-letters.html

[37] http://www.epa.gov/owow/wetlands/pdf/Final_MTM_MOU_6-11-09.pdf

(DOI) [which includes the Office of Surface Mining, Reclamation and Enforcement] and Army Corps of Engineers."[38] This plan had both short and long term elements:

- Minimize the adverse environmental consequences of mountaintop coal mining through short-term actions to be completed in 2009;
- Undertake longer-term actions to tighten the regulation of mountaintop coal mining;
- Ensure coordinated and stringent environmental reviews of permit applications under the Clean Water Act (CWA) and Surface Mining Control and Reclamation Act of 1997 (SMCRA);
- Engage the public through outreach events in the Appalachian region to help inform the development of Federal policy; and
- Federal Agencies will work in coordination with appropriate regional, state, and local entities to help diversify and strengthen the Appalachian regional economy and promote the health and welfare of Appalachian communities.

By September 11, 2009, EPA had completed its initial review of hundreds of permits, and announced that it would send 79 of those permits back for extended review.[39] Environmental justice activists stayed busy through October of 2009 with USACE's public hearings on a proposal to suspend the Nationwide Permit 21 in Appalachia.[40] By that time, tensions had risen substantially in mountain communities, and encounters between miners and activists came dangerously close to violence at some of these hearings. In some cases, activists were unable to give testimony.[41]

The most recent activity by EPA in the process conceived in the interagency MOU came on April 1, 2010, with the release of a detailed guidance to protect Appalachian communities from harmful environmental impacts of mountaintop mining. The memo was followed by release of two draft technical documents on impacts of mountaintop removal mining and valley fills. [42]

Also during April of 2010, OSMRE held outreach meeting for stakeholders in Appalachia. The meetings introduced OSMRE's current thinking on strengthening stream protection, and solicited input and questions from stakeholder groups. Following these meetings, OSMRE officially published a notice of intent to prepare an environmental impact statement to analyze potential revisions of the Surface Mining Control, Regulation and Enforcement Act (SMCRA) to improve protection of streams from the adverse impacts of surface coal mining operations.[43]

The Strip-mine Issues Committee sees these developments as positive steps toward stronger protection of Appalachian headwater areas against the destructive practice of mountaintop removal mining.

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[38] More details and links are provided at the end of section 3 of this paper, under the heading "2010 Update"
[39] Document available online at: http://yosemite.epa.gov/opa/admpress.nsf/3881d73f4d4aaa0b85257359003f5348/b746876025d4d9a38525762e0056be1b!OpenDocument
[40] http://edocket.access.gpo.gov/2009/pdf/E9-16803.pdf
[41] http://www.youtube.com/watch?v=EtwceseZz4w
[42] *The Effects of Mountaintop Mines and Valley Fills on Aquatic Ecosystems of the Central Appalachian Coalfields*, and *A Field-Based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams*. Both documents can be accessed at EPA's webpage: Surface Coal Mining Activities under Clean Water Act Section 404 at http://www.epa.gov/owow/wetlands/guidance/mining.html#memo20100401
[43] **Federal Register** /Vol. 75, No. 83 / Friday, April 30, 2010 / Proposed Rules, page 22723: http://edocket.access.gpo.gov/2010/pdf/2010-10091.pdf

Box 4-A: Post-Rapanos Legislation in Tennessee?

Following the Rapanos decision, the US Army Corps of Engineers and EPA issued a joint guidance document to specify how they intended to respond to the outcome of this case. A number of subsequent cases have also cited Rapanos. In 2007 and 2008, the Tennessee legislature entertained the "narrow ditch" and "limited resource waters" bills that sought to change the definition of "waters" of the state in the Tennessee Code.** The Strip-mine Committee views these bills as attempts by industry lobbies to eliminate restrictions of their activities in headwater streams—in other words, they represented attempts at post-Rapanos legislation that would remove some of these streams from the regulatory purview of the Tennessee Water Quality Control Act (TWQCA).

Section 69-3-103 (33) of the Tennessee Code defines "waters" of the state as "*any and all water, public or private, on or beneath the surface of the ground, which are contained within, flow through, or border upon Tennessee or any portion thereof except those bodies of water confined to and retained within the limits of private property in single ownership which do not combine or effect a junction with natural surface or underground waters*."

The narrow ditch bill would have retained this definition but added an exemption for "*narrow run-off ditches that are dry a majority of the year and that contain water only following heavy rains due to being fed by small wet springs or other run-off following such rains.*" Failure of this bill in 2007 led to a proposal in 2008 to add a new subdivision of waters defined as "Limited Resource Waters" meaning "*ephemeral bodies of water that flow primarily in response to rainfall, for which groundwater is not a significant source, and that do not support a significant indigenous population of native fish or aquatic life*" and excepting such waters from the definition of waters of the state.

Scientific evidence (see Section 2 of this paper) suggests that such language could have had significant environmental consequences for headwater streams. The 2008 language reflects an attempt to address at least some objections to the "narrow ditch" exclusion. The effect, however, would have been the same. We'd still have a definition of "waters" based only on flow and not on the whole range of physical, chemical and biological processes operating in whole watersheds, and state agencies would have been stuck with interpreting such ambiguous concepts as "significant ground water source" and "significant aquatic life" for regulatory purposes. More fundamentally, many of the state's headwaters would remain at risk for degradation or permanent loss.

The language of legislation is often about compromise. As illustrated by support of these bills, the industry lobbies are eager to exclude as many of their activities in headwater streams as possible from regulation. The compromise language offered by some of our Tennessee legislators indicates that that are either unable or unwilling to embrace broader views of aquatic resources, including those of science, social justice, economics and faith-based stewardship.

Fortunately, neither bill made it out of committee. Until the issues left unclear or unresolved by the Rapanos decision are addressed, the Strip-mine Issues Committee predicts ongoing legislative attempts to remove small streams from regulation.

**The “limited resource waters” bill and 13 others, many of which had post-Rapanos agendas, were introduced into the 2008-2009 Tennessee legislative session. In the first session of 2009, it became clear that the coal industry itself had hand-crafted some of these bills.

5: The Economics of Headwater Stream Protection

There appears to be consensus across a broad spectrum of regulatory agencies and special interest groups that implementation of the Clean Water Act, at least in its first decades, improved the health of the nation's waters. Inevitably—in America's mixed institutional cultures of politics, business and environmental concerns—questions about the costs and benefits of environmental regulation continue to be raised.

> Ecological restoration and stewardship offers a high growth job sector for our national economy with a payback in ecological benefits that provide billions of dollars in economic value far beyond jobs such as supplying clean water, clean air, renewable energy and climate change mitigation.
>
> — Rural Green Economy Initiative, sustainablenorthwest.org

The Clean Water Action Plan (USEPA 1998) notes that improvements in water quality not only create aesthetically pleasing landscapes but also generate jobs and economic growth. In 1998 the recreation and tourism industry was the second largest employer in the U.S., and a large portion of recreational spending came from fishing, swimming and boating—all of which depend on clean water.

Clean water for crop irrigation and fisheries is a foundation for success of these industries that contribute billions of dollars a year to the nation's economy. Water quality regulation under various programs of the Clean Water Act is largely responsible for restoring and maintaining national and state waters to a level that supports all of these activities.

In recent years, the federal Office of Management and Budget (OMB) has issued annual analyses of the costs and benefits of various federal regulatory programs. The 2006 report looked at 9 EPA water regulations and estimated benefits at 1.4 to 10.1 billion dollars, and costs of 3.2 to 3.5 billion dollars in the 10-year period from 1995 to 2005. These figures might seem to be great fodder for environmental debates, but the OMB warns that much more information is needed for an accurate cost-benefit accounting. Agencies used different models to generate statistics for the report, and many of the costs and benefits of major regulations have not been quantified. OMB estimates that it will take some time to refine the process of such analyses to produce more accurate comparisons. In the meantime, many analysts concede that water quality regulations have reduced industrial pollution, cut the loss of wetlands, funded the construction grants program and otherwise improved the quality of U.S. waters without significant negative impacts to employment, economic growth or investment (Andreen 2004).

It is not yet known what impact recent court decisions may have on loss of resources or water quality and what that will cost the nation in the long run. There are also several Clean Water Act bills making their way through Congress that could shift cost-benefit ratios one way or the other.[44]

Protection of watersheds is a fundamental piece of water quality restoration and maintenance. Activities in small streams potentially impact the loss of watershed resources and threaten public health and general welfare through:

- water quality degradation;
- increased risk of flooding;

[44] Clean Water Protection Act (H.R.2169) and the Appalachia Restoration Act(S.696); Clean Water Restoration Act(H.R.2421).

- failure of wells and septic systems;
- disruption of water supply;
- loss of open space real estate value;
- competition among water supply interests in rural areas;
- loss of riparian forest and other vegetation;
- loss of medicinal plant habitat (e.g., ginseng);
- loss of natural habitat and habitat corridors for game and non-game species of fish, birds and mammals;
- increased risk to endangered species;
- permanent loss of natural headwater streams and the ecological services they provide to human communities.

Box 5-A: The Costs of River Restoration

Under Clean Water Act protection in 1972, thousands of miles of damaged rivers and streams began to recover, and for many years showed improvement. However, in 2004 the EPA reported that some 30 years' progress had reversed course and our river systems were once again in deep trouble. Human life is inextricably linked to clean water so we have little choice but to restore rivers and streams that have been ruined.

Despite the fact that river restoration has become a $1 billion per year industry, leading aquatic scientists say that we don't really know what works and what doesn't. A landmark study of 37,099 river restoration projects (Bernhardt, 2005) revealed that only 10% of the project records included assessment or monitoring data, and most of those ~3,700 projects were not designed to evaluate effectiveness of the restoration effort. Thus, without data on successes and failures, many opportunities to study what works have been lost. Unfortunately, failed projects diminish public desire for governments to invest in restoration, creating a potential feedback loop that further threatens clean water goals.

The final EIS on Mountaintop Removal and Valley Fills (EPA 2006) reports a sobering fact: once we destroy a headwater stream, no amount of money, technology or engineering savvy has yet been able to recreate natural stream processes. Failure to restore landscapes to pre-mining function is the source of much disappointment and suffering for people who live in coalfield regions. For those who live near them, loss of headwater stream length, riparian vegetation, and natural filtration means increased risks for floods and water contamination water that destroys homes and makes people sick. The money required to restore property and health is not usually paid by coal companies, but is externalized to citizens and governments.

The studies of Naiman (Box 2-A), Walter & Merritt (Box 3-A) and others have added to the body of knowledge needed to make progress in restorative efforts. We will all in some way pay the price for our failure as a society to hold our leaders and ourselves accountable for

An Important Link: Economics and Sustainable Resources

Humans need clean water in adequate amounts to sustain life and livelihood, but human activity has had huge negative impacts to the very resources on which we depend. The domination of water resource science and management by engineering paradigms in the United States and other developed countries has failed to achieve universal long-term mitigation of human impacts on watersheds. An engineering response to water problems creates more impoundments, more canals, and more piped streams that further prevent ecological processes from moderating the hydrologic cycle. In turn, this further degrades water quality and amplifies nutrient pollution. Reliance on mechanical fixes that don't work anyway can quickly become cost-prohibitive. Cost-benefit and investment analyses represent newer approaches based on decision-making theory that have been brought to bear on these problems, but with no better integration of ecohydrologic processes that must inform the work of managing water. (Zalewski 2002)

A recent case study of coupled human and natural systems in six different locations around the world revealed the tremendous complexity of reciprocal effects and feedback loops in nature-human interactions (Liu et.al. 2007). Smelt, introduced as a prey species for walleye and other game fish in Wisconsin, ate juvenile walleyes causing a decline in the walleye population. Growth management policy in Puget Sound unintentionally fostered unwanted urban sprawl outside the management boundaries. In Sweden, a wetland became choked with grass after grazing was eliminated under an international treaty for the conservation and sustainable use of wetlands.

When functioning of linked human-nature systems is not understood, any political, social, legal and economic decisions made from a distance can have unintended negative consequences. In this light, how critical is it that we understand ecohydrologic process? Water can be viewed as a resource around which ecosystems—and the humans within them—organize (USFS 2000). As such, effective management of water is a key to sustainability of other resources as well as human life and livelihood. Effective water resource management in the 21st Century will require us to integrate our evolving understanding of ecohydrology in the context of coupled human and natural systems.

As more people become educated to these connections and the role that headwaters play in them, we will likely see the value that society places on small stream protection expand and strengthen. What begins as a growing public desire will mature to a strong political mandate, as we are seeing now with global warming. If predictions are correct, conflicts of the future will not be about enough clean energy, but enough clean water.[45]

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[45] See, for example, Danaher 2007; Castelein & Otte 2001; Lohan, 2007.

6: Strengthening Protection of Headwater Streams

> "The care of rivers is not a question of the rivers but of the human heart."
>
> —Tanaka Shozo

In 37 years of experience with strip mining in our communities, the Strip-mine Issues Committee has come to appreciate the seriousness of negative impacts on surface and ground waters by coal mining, not only in Tennessee but also in Appalachia and other coal-producing regions of the United States. Though most of our work takes place at smaller scales of space and time, we know that it would be foolish to ground that work in anything less than a desire for sustainable resource use. We support the idea that there should be enough clean water "for the future use of the waters so that the water resources of Tennessee might be used and enjoyed to the fullest extent consistent with the maintenance of unpolluted waters."[46] We will continue to insist that state water laws and regulations ensure that any use will only proceed while "minimizing adverse economic, social and ecological impacts and maintaining the structure and function of natural systems."[47]

As the Strip-mine Issues Committee continues to advocate for elimination of mountaintop removal and cross ridge mining from Tennessee's permissable coal mining practices, we intend to anchor specific local and regional strategies in larger principles of sustainable energy and water resource use. We support such an approach as the most reliable way to strengthen protection for headwaters and the watersheds through which they flow.

The Big Picture: Management of Watersheds for People and Nature

Starting from the idea that pollution and depletion of global water resources threatens both sustainable levels development and the health of humans and the environment, Wagner (2002) looked in detail at four dysfunctional watersheds around the world. Based on these case studies, they hoped to identify the most relevant threats to freshwater sustainability, and ways that management would most likely move freshwater use and development toward sustainable levels.

Their final report lists five situations in which sustainable use may be undermined—

- Water withdrawal and redistribution,
- Health risks associated with water treatment and reuse,
- Non-point source groundwater and surface water contamination,
- Discharge of industrial waste to river and watershed,
- Loss of riparian and in-stream ecological habitat.

The study also lists five interventions that foster sustainability—

- Minimization of changes in the natural water cycle,
- Increase of the potential to sustain/restore natural biodiversity,
- Reduction of point-source pollution,
- Reduction of non-point source pollution,
- Increases in community involvement and social participation.

The study noted that in the U.S. watershed,[48] managers typically relied on finance- and energy-intensive technologies to restore or prevent further degradation of their water resources. The researchers suggest

[46] TNWQCA §69-3-102(b)

[47] See definition of "sustainability" in Wagner (2002, 2)

that such strategies may look good in the short term, but often fall short in terms of sustainability due to high demand for fossil energy sources, lack of consideration for natural biotic resources, or the potential for creating new human health risks. Coalfield residents observe this, for example, when mine operators divert natural streams or attempt to replace natural headwaters with engineered ones.

Many of the themes extracted by Wagner (2002) are reflected in other studies as well. Naiman (1995) identifies three consequences of freshwater resource degradation that currently challenge mankind at the global scale:

- biological impoverishment that results from alteration of the physical, chemical, and biological integrity of aquatic ecosystems;
- alteration of hydrological regimes, which ultimately modulate the availability of water for people; and
- risk to human and environmental health.

Meyer & Wallace (2001) advocate linking science not only to people, but also to the institutions that generate resource policy, regulatory and management practices. Strengthening interactions of scientists with economists, anthropologists, political scientists, policy analysts and lawyers is essential. They also remind us of substantial cumulative impacts to small streams created by individual decision makers such as developers and property owners. At this level of decision-making, they say, ecological science has not been well integrated.

In a similar vein, Angermeier (2007) advocates "better societal literacy" of sustainable use that reflects an understanding of how humans affect biota. We need to counter the myth that quality of life depends on consumption, and cultivate appreciation of "how intact ecosystems contribute to aesthetic, emotional, physical, social, intellectual, and spiritual dimensions of human life." (p.9)

A watershed can be thought of as a "superorganism" that can both resist stress and recover, within limits, from human assaults. If the goal of management is sustainability, people need to find better ways to co-exist with nature. We can look at the function of natural processes under the influence of scale, dynamics, and hierarchy that determine the limits of natural capacity to absorb human impacts. Management for optimal resistance and resilience requires a holistic approach that is guided by ecological realities of the watershed rather than engineering principles and practices. (Zalewski 2002)

A key to watershed sustainability is the creation, management and restoration of buffering zones in transitional spaces between ecosystems, such as those of land and water (Zalewski 1997; Naiman & Decamps 1990). For many years, the Strip-mine Issues Committee has testified on mine applications, environmental impact statements, and rule changes that mining regulations and their enforcement—particularly with respect to mountaintop removal—need to go much further to protect these zones. The best strategies are those that are based on a profound understanding of hydrology, biotic mechanisms, and the economics of the whole catchment (Zalewski 1997, 7).

Science & Policy, Nature & People

With the eruption of large-scale destructive mining practices in recent years, it is not uncommon to find both professional scientists and grassroots citizen scientists confronting policy-makers and regulatory agencies with similar concerns. Though they may hold the same ground together, it is not always easy ground to hold.

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[48] Also in the watersheds of other developed countries in the study, i.e., Japan and Switzerland.

Box 6-A: SUSTAINABLE WATERSHED MANAGEMENT (Zalewski 1997, p.8)

An ecohydrology approach fulfills two fundamental conditions of successful strategy according to decision-making theory:

Amplify chances (zone of success)

- Use biotechnologies to transform and control matter circulating at ecosystem and landscape scale towards sustainable use of resources:
    a. Monitor and control of hydrological processes toward enhancement of resistance and resilience of aquatic ecosystems
    b. Enhance aquatic ecosystem resistance to human stress by restoring homeostasis, emphasizing hydrology as a regulatory tool
    c. Mitigate nonpoint source pollution via restoration of river valley and catchment ecotones

Eliminate threats (zone of failure)

- eliminate catastrophic floods and droughts;
- reduce point source pollution

Historically, the scientific community has been reluctant to bring their work to the political arena where science and social responsibility more clearly mix. For citizens on the frontlines, science brings welcome validation of concerns that don't always appear to be taken seriously by politicians and regulators. On the other hand, different players in the political process operate at different levels of confidence in relation to risk and uncertainty (Carolan 2006). Professional regulators may use a particular research finding as a basis to allow a particular mining practice, for example, while grassroots citizens read the same studies and say, "Not in my (or anybody's) backyard!"

The nature of science is such that it can help reduce uncertainty, but not eliminate it. Ultimately, scientific knowledge is a blend of facts and values, and does not represent objective truth or proof (Carolan 2006). Coupled human-nature systems are complex. The forces that drive such a system come from within it, and we may not see the results of our interactions with nature for many years—thus our ability to predict how even the smallest changes in policy or regulation policy will affect the people-nature system is limited. For this reason, the policy experiments of those who came before us must be taken into account. If we are unable to detect and interpret signals from the past, we will not be able to quickly adapt policies to limit negative outcomes. (Newell & Wasson 2001, p.3)

Many of these ideas will resonate with the experiences of SOCM members, and the challenges we have already taken on in our own communities. We can use them as a blueprint, based on the expertise of aquatic scientists, around which we can organize ongoing grassroots advocacy for sustainable water resources. They represent larger problems we must continue to confront on the scales at which we have influence, be it in Appalachia, Tennessee, our home watershed or the stream closest to where we live.

Bringing People & Science into Water Policy: Bullet Points

In summary, larger questions and viewpoints can be used to develop, refine or advocate strategies for sustainable water resources and best management practices in headwater areas:

- Holistic watershed approach—does ecological reality of the watershed trump engineering?
- Are all the players at the table and, if not, who's missing and why?

- Does it reflect multidisciplinary input?
- How does it relate to consensus, uncertainty?
- Do predictive models that are used adequately address risk and uncertainty?
- Does it address both point- and nonpoint-source pollution?
- Will it sustain or restore natural biodiversity?
- Does it protect transitional zones between land and water?
- Does it minimize changes in the hydraulic cycle?
- Has all human activity in the watershed been adequately factored in?
- Is there a risk of biological impoverishment that results from alteration of the physical, chemical, and biological integrity of aquatic ecosystems?
- Does it alter hydrological regimes, which ultimately modulate the availability of water for people?
- Have risks to human and environmental health been considered?

Box 6-B: NYC Unfiltered—Clean Water for the Big Apple

How do you provide safe drinking water for 5-million people? This was a big question for the Big Apple. The Safe Drinking Water Act (SDWA) of 1986 required filtration of public surface water supplies, unless entities that supplied drinking water could demonstrate a watershed control program that minimized the potential for water-borne disease organisms, such as Giardia and viruses, in source waters. Though the EPA advocates a watershed management approach to water quality, SDWA regulations are the only ones to require it.

New York City has two sources of surface water supply. The Croton River system drains 300 square miles and accounts for 10-12% of NYC's water. Constructed in the 1840's, the Croton System requires filtration by order of the EPA. The remaining 90% of NYC's water comes from the Catskill Mountains and headwaters of the Delaware River.

The first challenge NYC faced in this 1,600 square-mile watershed was to reach all the stakeholders and secure a buy-in to the project. Science has long supported the watershed as a fundamental management unit for all resources, but the huge scale of Catskill-Delaware system required a long, multi-faceted process that resulted in a monumentally complex Memorandum of Agreement (MOA) between NYC, state and local governments, the EPA, and several environmental groups.

Behind NYC's naturally filtered drinking water is a host of policies, programs, and best management practices that integrate scientific, technical, social and economic principles and practices that matter to people upstream and downstream. As more U.S. cities and counties face the consequences of our collective, long standing lack of stewardship for water resources, NYC's successful experience may serve as inspiration that a watershed management approach works, and that a multitude of stakeholders with disparate interests can come together and make it happen on huge scales.[1]

Source: Watershed Management for Potable Water Supply: Assessing the New York City Strategy. This publication can be read online free at: http://www.nap.edu/catalog/9677.html.

1Update: New York watersheds may face new challenges with natural gas drilling and hydrofracking in the Marcellus shale. See Abraham Lustgarten's investigative reports at ProPublica: http://www.propublica.org/series/buried-secrets-gas-drillings-environmental-threat

Specific Strategies in Tennessee and Appalachia

With these questions in mind, the Strip-mine Issues Committee proposes the following as specific strategies:

<u>SOCM will continue to advocate for the following conditions in the ongoing dialogue with TDEC.</u>

- No permits for any surface mine operation that doesn't provide for 100' buffer around streams.
- No NPDES for proposed head of hollow/valley fills.
- No NPDES for proposed fills in springs (including ephemeral springs) or streams.
- No NPDES for MTR mining.
- No NPDES for water pollution control or toxic materials handling plans not proven effective.
- Independent analysis by TDEC of water pollution control and toxic materials handling plans.
- No ARAPs for in stream sediment basins.
- No ARAPs for MTR mining.
- No compensatory mitigation allowed for filling or alteration of streams.
- No 401 for MTR mining.
- No permit of any kind for mining operations proposing to use water pollution control and toxic materials handling plans that are unproven in situations similar to the one proposed.
- Require storm water permit for any mine operation over 5 acres, any haul road, and any mine site facilities.
- Identify streams with parameters that are not limited to definitions of flow (i.e., perennial, intermittent, ephemeral, wet weather conveyance).
- Advocate a clear and consistent approach to determination of waters of the state that includes onsite observation in all 4 seasons; consultation with local residents on stream conditions; opportunities for citizens to challenge the determination; careful record keeping on how the determination was made; protection of streams, creeks, springs and seeps as "waters of the state."
- Recommend review of current compensatory mitigation rules and policy, because headwaters that are destroyed can't be replaced.
- No advocacy for permittees or their plans in the permitting process.
- Deny permits with inadequate plans.
- Treat reapplications of previously inadequate plans as a new permit.
- Determine cumulative impact based on all human activity in the whole watershed.

- Seek input from other state departments and state universities.
- Publicize permit applications in a newspaper circulated in the areas nearest the permit.
- Raise the permit fee to fund more comprehensive research, inspection, enforcement.
- Renegotiate MOU with OSM.

<u>SOCM intends to monitor other state issues related to water and mining and organize if needed.</u>

- TVA - Royal Blue/Koppers DEIS.
- Push OSM to update 1985 PEIS.
- Monitor legislative activity for bills related to water and support or oppose based on principles identified in this paper. (Examples from 2007 and 2008 sessions are the narrow ditch bill, limited resource waters bill, and the scenic vistas bill.)
- Support efforts for the Big South Fork LUMP.
- Closely monitor exploration permits or any other threats in existing LUMPs.
- Identify, monitor or consider actions regarding the consequences of headwater and downstream water pollution for people of color.
- Stay aware of non-mining/non-forestry assaults on headwaters (construction, agriculture, real estate development, urban sprawl, private landowners).
- Support or draft sound legislation for field & creek rock mining regulation.

<u>SOCM intends to be involved with several Regional or National Issues</u>

- The Alliance for Appalachia and the Alliance's work to stop mountaintop mining & its assaults on headwaters
- HR 2169 - Clean Water Protection Act
- HR 2421 - Clean Water Restoration Act
- S 696– Appalachia Restoration Act
- Climate change - coal - hydrologic cycle issue
- EPA coal combustion residue disposal rule & DEIS
- SMCRA reform - re-evaluation of BMPs, etc

- Any proposed rule changes relating to AML, other SMCRA regulations, CWA, NEPA that impact surface mining and water protection.

Obviously, there are different lenses through which we can view and analyze widespread destruction of headwater streams and possible consequences to the natural, social, and economic environments of Tennessee. As our society matures, we need to look beyond limited approaches to headwater protection strategies that are located solely with politicians and managers, operators and regulators, judges and attorneys.

What works well now must be energetically augmented by better integration of natural and social sciences, as well as ancient knowledge held by the world's Indigenous peoples.[49] Citizens must be educated and willing to be more conservative in use and consumption of resources. The political processes through which resource decisions are made must become more transparent and more inclusive, with citizens becoming more involved in policy-making alongside elected leaders and stewardship alongside professional managers and regulators to ensure clean and plentiful water supplies for themselves and future generations.

If Tennessee is serious about the rights of its people to adequate amounts of clean water—now, and for future generations—its leaders, resource managers, regulators and citizens need to sustain positive changes already in motion toward that goal. We can't afford any steps backward. Scientific research continues to validate the vital role of headwater areas in the health of watersheds. The value that Tennesseans place on clean water will continue to rise as the consequences of resource degradation to human health and security become more obvious. At the federal level, legal challenges to the Clean Water Act, regulatory follies such as the stream buffer zone rule change—as well as concurrent legislative attempts to strengthen CWA—make it imperative that Tennessee stay focused on its own priorities as world and national situations unfold.

[49] For example, see the website of the Indigenous Peoples restoration Network at http://www.ser.org/iprn/default.asp

REFERENCES:

Alexander, R. 2007. Importance of headwaters in urban watersheds. *Urban Watersheds Perspectives.* http://urbanwatersheds.typepad.com/urban_watersheds_perspect/2007/02/index.html (accessed November 10, 2007)

Andreen, W. L. 2004. Water Quality Today - Has the Clean Water Act Been a Success? *Alabama Law Review* 55:537-593. http://ssrn.com/abstract=554803 (accessed July 10, 2007)

Barlow, M. 2007. *Blue covenant: The global water crisis and the coming battle for the right to water*. NY: The New Press.

Barry, T. 1996. Ethics and ecology. *Harvard Seminar on Environmental Values*. Harvard University. http://ecoethics.net/ops/eth&ecol.htm (accessed September 6, 2007)

Benda, L.E., N.L. Poff, C. Tague, M.A. Palmer, J. Pizzuto, S. Cooper, E. Stanley, G. Moglen. 2002. How to avoid train wrecks when using science in environmental problem solving. *BioScience* 52(12):1127-1136 http://www.palmerlab.umd.edu/docs/Benda_et_al_2002_BioScience.pdf (accessed June 20, 2007)

Bryant, G., S. McPhilliamy, H. Childers. 2002. A Survey of the Water Quality of Streams in the Primary Region of Mountaintop / Valley Fill Coal Mining, October 1999 to January 2001. In *Mountaintop Mining/Valley Fills in Appalachia Programmatic EIS*: Appendix D. USEPA 2006.

Bullard, R.D., P. Mohai, R. Saha, B. Wright. 2007. *Toxic waste and race at twenty: 1987 - 2007.* Cleveland, OH: United Church of Christ.

Carolan, M.S. 2006. Scientific knowledge and environmental policy: why science needs values. *Environmental Sciences* 3(4): 229-237.

Castelein, S., A. Otte. 2001. *Conflict and cooperation related to international water resources: historical perspectives*. IHP-VI, Technical Documents in Hydrology No. 62. UNESCO, Paris, 2002. http://unesdoc.unesco.org/images/0012/001280/128073e.pdf (Accessed July 7, 2007.)

Craig, R. K. 2004. *The Clean Water Act and the Constitution: Legal structure and the public's right to a clean and healthy environment.* Washington, D.C.: The Environmental Law Institute.

Committee on Riparian Zone Functioning and Strategies for Management, Water Science and Technology Board, National Research Council. 2002. *Riparian areas: Functions and strategies for management.* National Academy of Sciences. http://www.nap.edu/openbook.php?isbn=0309082951 (accessed June 10, 2007).

Committee on Mine Placement of Coal Combustion Wastes, National Research Council, 2007. *Managing Coal Combustion Wastes in Mines*. National Academy of Sciences. http://www.nap.edu/catalog.php?record_id=11592

Danaher, K., S. Biggs, J. Mark. (September 25, 2007). World's water supply at risk. *AlterNet,* http://www.alternet.org/story/62950. (Accessed October 1, 2007).

Dieterich, M., and N. H. Anderson.2000.The invertebrate fauna of summer-dry streams in western Oregon." *Arch. Hydrobiologie* 147:273-295.

Dunne, T., 1998. Wolman Lecture: Hydrologic Science…In Landscapes…on a Planet…in the Future. In *Hydrologic Sciences: Taking Stock, Looking Ahead. Proceedings of the 1997 Abel Wolman Distinguished Lecture and Symposium on the Hydrologic Sciences, Water Science and Technology Board, National Research Council.* http://www.nap.edu/catalog/6107.html

Earthjustice. 2006. *Fact sheet on Rapanos v. United States and United States v. Carabel, two monumental Clean Water Act cases before the U.S. Supreme Court*. http://www.earthjustice.org/news/press/006/fact-sheet-on-rapanos-v-united-states-and-united-states-v-carabel-two-monumental-clean-water-act-cases-before-the-us-supreme-court.html (accessed June 27, 2007).

Earthjustice. 2007a. (September 26, 2007) *Residents Fight in Court to Protect Their Homes and the Streams of Appalachia from Mountaintop Removal Coal Mining.* http://www.earthjustice.org/news/press/007/residents-fight-in-court-to-protect-their-homes-and-the-streams-of-appalachia-from-mountaintop-removal-coal-mining.html (Accessed June 21, 2009.)

Earthjustice. 2007b. *Judge Tells Big Coal: Stop Burying Appalachian Streams*. http://www.earthjustice.org/news/press/007/judge-tells-big-coal-stop-burying-appalachian-streams-2.html (Accessed October 11, 2007.)

Feldman, D.L., J.O. Elmendorf. 2000. *Water Supply Challenges Facing Tennessee: Case Study Analyses and the Need for Long-Term Planning.* Energy, Environment and Resources Center, University of Tennessee-Knoxville. http://eerc.ra.utk.edu/divisions/wrrc/water_supply/Report.PDF (Accessed June 10, 2007)

Freeman, M. C., C. M. Pringle and C. R. Jackson. 2007. Hydrologic connectivity and the contribution of stream headwaters to ecological integrity at regional scales. *Journal of the American Water Resources Association* 43:5-14.

Fritz, K.M., B.R. Johnson, D.M. Walters. 2006. *Field Operations Manual for Assessing the Hydrologic Permanence and Ecological Condition of Headwater Streams*. EPA/600/ R-06/126. U.S. Environmental Protection Agency, Office of Research and Development, Washington DC. http://www.epa.gov/eerd/manual/headwater.htm (accessed May 6, 2007).

Harrington, W. 2006. "Grading Estimates of the Benefits and Costs of Federal Regulation," Discussion Papers dp-06-39, Resources for the Future. http://ideas.repec.org/p/rff/dpaper/dp-06-39.html

Hendryx, M., M.M. Ahern, T.R. Nurkiewicz. 2007. Hospitalization patterns associated with Appalachian coal mining. *J Toxicol Environ Health A*, 70:2064-70.

Hendryx M., K. O'Donnell, K. Horn. 2008. Lung cancer mortality is elevated in coal-mining areas of Appalachia. *Lung Cancer*, 62:1-7.

Hendryx, M. 2009. Mortality from heart, respiratory, and kidney disease in coal mining areas of Appalachia. *Int Arch Occup Environ Health*, 82:243-9.

Hendryx, M., M.M. Ahern. 2009. Mortality in Appalachian coal mining regions: the value of statistical life lost. *Public Health Reports*, 124: 541-550.

Hitt, N., M. Hendryx. 2010. Ecological integrity of streams related to human cancer mortality rates. *EcoHealth*: Apr.2 (Published online ahead of print at http://www.springerlink.com/content/lu7wgk595v1hhm64/)

Hooke, R. LeB. 1999. Spatial distribution of human geomorphic activity in the United States: comparison with rivers. *Earth Surface Processes and Landforms* 24(8): 687-692.

Innes, S. 2007. Faith goes green. *Arizona Daily Star*, September 3, 2007. http://www.azstarnet.com/dailystar/199458 (accessed September 6, 2007).

Jonsson, Patrik, "Drought-stricken Georgia, eyeing Tennessee River, Revives Old Border Feud," *Christian Science Monitor*, February 15, 2008. (Accessed at http://www.csmonitor.com/2008/0215/p02s02-usgn.html on June 20, 2009.)

Julien, P.Y. 2002. *River Mechanics*. Cambridge, UK: Cambridge University Press.

Krajick, K. 2001. Acid rain: Long-term data show lingering effects from acid rain. *Science* 292:195-196 http://www.sciencemag.org/cgi/content/full/292/5515/195 (accessed June 7, 2007).

Lohan, T. (October 11, 2007). Our drinkable water supply is vanishing. *AlterNet*. http://www.alternet.org/story/64948 (accessed October 11, 2007.)

Lohan, T. (February 14, 2008). Maude Barlow: The growing battle for the right to water. *AlterNet*. http://www.alternet.org/story/76819/ (Accessed on 14 February 2008.)

Leopold, L., 1962. *A national network of hydrologic bench marks*, U.S. Geological Survey Circular 460-B. http://eps.berkeley.edu/people/lunaleopold/(077 Images) A National Network of Hydrologic Bench Marks.pdf (accessed July 2, 2007).

Leopold, L. 1994. *A view of the river.* Cambridge, MA: Harvard University Press.

Leopold, L.B., M.G. Wolman, J.P. Miller.1964 *Fluvial processes in geomorphology*. New York: Dover.

Liu, J., T. Dietz, S. R. Carpenter, M. Alberti, C. Folke, E. Moran, A.N. Pell, P. Deadman, T. Kratz, J. Lubchenco, E. Ostrum, Z. Ouyang, W. Provencher, C.L. Redman, S.H. Schneider, W.W. Taylor. 2007. Complexity of coupled human and natural systems. *Science* 317: 1513-1516. http://www.sciencemag.org/ (Accessed on September 15, 2007.)

Lowe, W.H., G.E Likens, M.E. Power. 2006. Linking scales in stream ecology. *BioScience* 56(7): 591-597.

McKnight, D.M., 1997. Aquatic Ecosystems: Defined by hydrology, holistic approaches required for understanding, utilizing and protecting freshwater resources. In: *Hydrologic Sciences: Taking stock and looking ahead*. *Proceedings of the 1997 Abel Wolman Distinguished Lecture and Symposium on the Hydrologic Sciences, Water Science and Technology Board, National Research Council,* Washington, D.C.: National Academy Press, 1998. http://books.nap.edu/catalog.php?record_id=6107 - toc (accessed May 7, 2007).

Meyer, J.L., 2003. Small streams are indispensable waters. *National Wetlands Newsletter* 25(4):7-8, 25. Washington, D.C.: Environmental Law Institute.

Meyer, J.L. 2007. *Where rivers are born*. http://www.sierraclub.org/healthycommunities/rivers/

Meyer, J.L., J.B. Wallace. 2001. Lost linkages and lotic ecology: Rediscovering small streams. In *Ecology: Achievement and Challenge.* M.C. Press, N.J. Huntly, S. Levin (Eds.). Boston: Blackwell Science. Also available at http://www.uga.edu/ecology/people/faculty/Journal_Articles/Meyer/Meyer&Wallace2001.pdf (Accessed June 1, 2007).

Meyer, J.L., G.C. Poole, K.L. Jones. 2005. Buried alive: Potential consequences of burying headwater streams in drainage pipes. *Proceedings of the 2005 Georgia Water Resources Conference*, held April 25-27, 2005, at the University of Georgia. Kathryn J. Hatcher, editor, Institute of Ecology, The University of Georgia, Athens Georgia.

Meyer, J. L., D.L. Strayer, J.B. Wallace, S.L. Eggert, G.S. Helfman, N.E. Leonard. 2007. The contribution of headwater streams to biodiversity in river network. *Journal of the American Water Resources Association (JAWRA)* 43(1):86-103. Also available online at http://www.ecostudies.org/reprints/Meyer_et_al_JAWRA_2007.pdf (accessed November 5, 2007).

Minshall, G. W. 1988. Stream ecosystem theory: a global perspective. *J.N. Am. Bentol. Soc*., 7(4): 263-288.

Moore, A.A., M.A. Palmer. 2004. Invertebrate biodiversity in agricultural and urban headwater streams. *Ecological Applications* 15:1169–1177. http://www.palmerlab.umd.edu/docs/Moore & Palmer_Ecol Applications.pdf (accessed July 8, 2007)

Nadeau, T-L., M. Rains. 2007. Hydrological connectivity between headwater streams and downstream waters: How science can inform policy. *Journal of the American Water Resources Association* 43(1):118-133.

Naiman, R.J., J.M. Mellilo, J.E. Hobbie. 1986. Ecosystem alteration of boreal forest streams by beaver (Castor canadensis). *Ecology* 67(5): 1254-1269.

Naiman, R.J., C.A. Johnston, J.C. Kelley. 1988. Alteration of North American streams by beaver. *BioScience* 38(11): 753-762.

Naiman, R.J., H. Décamps, eds. 1990. *The ecology and management of aquatic-terrestrial ecotones*. Man and the Biosphere Series no. 4. Paris: UNESCO; Carnforth, England: Parthenon.

Naiman, R.J., J.J. Magnuson, D.M. McKnight, J.A. Sanford. 1995. *The freshwater imperative*. Washington, D.C.: Island Press.

Newell, B., R. Wasson. 2001. Social system versus solar system: Why policy makers need history. In: *Conflict and cooperation related to international water resources: Historical perspectives.* S. Castelein & A. Otte (Eds): 3-17. IHP Technical Documents in Hydrology, No. 62. http://unesdoc.unesco.org/images/0012/001280/128073e.pdf (accessed May 4, 2007).

Oppenheimer, M., B. O'Neill, M. Webster, S. Agrawala. 2007. The limits of consensus. *Science*, 317:1505-1506. http://www.sciencemag.org/ (downloaded September 15, 2007).

Oreskes, N. 2004. The scientific consensus on climate change. *Science*, 306:1686-1702. http://www.sciencemag.org/(downloaded June 23, 2007).

Palmer, M.A., E. S. Bernhardt, W. H. Schlesinger, K. N. Eshleman, E. Foufoula-Georgiou, M. S. Hendryx, A. D. Lemly, G. E. Likens, O. L. Loucks, M. E. Power, P. S. White, P. R. Wilcock. 2010. Mountaintop Mining Consequences. *Science,* 327: 147-148. http://sciencemag.org/ (downloaded January 7, 2010)

Paul, M.J., J.L. Meyer. 2001. Streams in the urban landscape. *Annu. Rev. Ecol. Syst*. 2001. 32:333-65 http://www.ecology.uga.edu/people/faculty/Journal Articles/Meyer/Paul&Meyer2001.pdf (accessed September 5, 2007)

Pringle, K. 2003. The need for a more predictive understanding of hydrologic connectivity. *Aquatic Conserv: Mar. Freshw. Ecosyst.* 13: 467-471 http://cpringle.myweb.uga.edu/Pringle 2003 editorial.pdf accessed May 4, 2007)

Safe Drinking Water Committee of the National Research Council, 1977. *Drinking Water and Health*. Washington, D.C.: National Academy Press. http://books.nap.edu/catalog.php?record_id=1780 - toc (accessed May 17, 2007).

Sivapalan, M. 2005. Pattern, Process and Function: Elements of a unified theory of hydrology at the catchment scale. In: *Encyclopedia of Hydrological Sciences*. Edited by M G Anderson. John Wiley & Sons, Ltd.

Snell, M.B., September 5, 2007, Bulldozers and blasphemy. Sierra Magazine, September-October, 2007. http://www.truthout.org/issues_06/090507EC.shtml (accessed September 7, 2007).

Stanford, J.A., J.V. Ward. 1993. An ecosystem perspective of alluvial rivers: Connectivity and the hyporheic corridor. *J. N. Am. Benthol. Soc.* 12(1): 48-60.

Starnes, L.B., D.C. Gasper. 1995. Effects of surface mining on aquatic resources of North America. *Fisheries*, 20(5): 20-23.

Talbot (1996). The linkage between ecology and conservation policy. In: *The Ecological Basis of Conservation*. S.T.A. Pickett, R.S. Ostfield, M. Shachak and G.E. Likens, eds.: 368-378. New York: Chapman & Hall.

Tennessee Water Quality Control Act of 1977. TENN. CODE ANN. §69-3-101 (2008). http://www.michie.com/tennessee/lpext.dll?f=templates&fn=main-h.htm&cp=

Tennessee Department of Agriculture. 2003. Guide to forestry best management practices in Tennessee. http://www.state.tn.us/agriculture/forestry/BMPs.pdf (accessed July 17, 2007).

Tennessee Valley Authority. 2004. Reservoir Operations Study—Final Programmatic EIS. http://www.tva.gov/environment/reports/ros_eis/ (accessed May 4, 2007).

Thomas, R., B. Myers, J. McElfish. 2007. *The clean water act jurisdiction handbook*. Washington, D.C.: Environmental Law Institute. Register to access free download at: http://www.elistore.org/reports_popup.asp?file=/Data/products/d17_08.pdf (accessed July 7, 2007).

U.S. Department of Agriculture, Forest Service. 2000. Water and the forest service. FS-660. http://www.fs.fed.us/publications/policy-analysis/water.pdf(accessed July 7, 2007.)

U.S. Environmental Protection Agency. (1998) *Clean Water Action Plan: Restoring and protecting America's waters*. EPA-840-R-98-001.

U.S. Environmental Protection Agency. 2003. *Mountaintop Mining/Valley Fills in Appalachia: Draft Programmatic Environmental Impact Statement*. EPA Region 3, Philadelphia, PA. EPA 9-03-R-00013.

U.S. Environmental Protection Agency. 2006. *Mountaintop Mining/Valley Fills in Appalachia: Final Programmatic Environmental Impact Statement*. EPA Region 3, Philadelphia, PA. EPA 9-03-R-00013.

U.S. Geological Survey. 1998. Basin Description: Lower Tennessee River Basin. National Water Quality Assessment Program. http://tn.water.usgs.gov/lten/basin_description.html (accessed September 13, 2007).

U.S. Government Accountability Office. Surface Coal Mining: Characteristics of mining in mountainous areas of Kentucky and Virginia. Report to Congressional Requesters. GAO-10-21. http://www.gao.gov/new.items/d1021.pdf (Accessed May 12, 2010)

Vannote, R.L., G.W. Minshall, K.W. Cummings, J.R. Sedell, and C.E. Cushing. 1980. The River Continuum Concept. Can. J. Fish. Aquat. Sci. 37:130-137.

Wagner, W., J. Gawel, H. Furomai, M. De Souza, D. Teixeira, L. Rios, S. Ohgaki, A. Zehnder, H. Hemond. 2002. Sustainable Watershed Management: An International Multi-Watershed Case Study. *AMBIO*: 31(1):2-13. 2002
doi: 10.1579/0044-7447-31.1.2

Ward, J. V. 1989. The four-dimensional nature of the lotic ecosystem. *Journal of the North American Benthological Society* 8:2-8.

Ward, J.V., C.T. Robinson, K. Tockner. 2002. Applicability of ecological theory to riverine ecosystems. *Verh.Internat.Verein.Limnol*. 28: 443-450. http://www.internal.eawag.ch/~tockner/publications/Ward-SIL-2002.pdf (accessed June 26, 2007).

Ward, K. 2007. U.S. judge cites 'alarming cumulative stream loss' in decision. *The Charleston Gazette,* March 24, 2007. http://www.wvgazette.com/webtools/print/News/2007032329 (accessed March 25, 2007).

Weiskel, T.C. 1997. Selling pigeons in the temple: The danger of marketplace metaphors in an ecosystem. *Harvard Seminar on Environmental Values, July 6, 1997.* Harvard Divinity School. http://ecoethics.net/ops/tsp.htm (accessed September 17, 2007).

Wickham, J.D.; Riitters, Kurt H.; Wade, T.G.; Coan, M.; Homer, C., 2006. The effect of Appalachian mountaintop mining on interior forest. *Landscape Ecol*. 22: 179-187 Available free online at: http://www.srs.fs.usda.gov/pubs/26001 (accessed September 14, 2007).

Wilkinson, B. 2005. Humans as geologic agents: A deep-time perspective. *Geology* 33(3):161-164.

Wilkinson, B., B. McElroy. 2007. The impact of humans on continental erosion and sedimentation. *GSA Bulletin* 119(1-2):140-156.

Williams, D. D.1996. Environmental constraints in temporary waters and their consequences for insect fauna. *J. N. Amer. Benthol. Soc*. 15:634-650, 1996.

Zalewski, M. 2002. Ecohydrology—the use of ecological and hydrological processes for sustainable management of water resources. *Hydrological Sciences* 47(5): 823-832. http://www.cig.ensmp.fr/~iahs/hsj/470/hysj_47_05_0823.pdf (accessed November 25, 2007)

Zalewski, M., G.A. Janauer, G. Jolanki. 1997. Ecohydrology: a new paradigm for the sustainable use of aquatic resources. UNESCO IHP Tech. Document in Hydrology: 7, IHP-V Projects 2.3/2.4, UNESCO, Paris, France. http://unesdoc.unesco.org/images/0010/001062/106296e.pdf (accessed December 6, 2007)

Zalewski, M. 2002. Ecohydrology - the use of ecological and hydrological processes for sustainable management of water resources. Hydrological sciences Journal. 47, 825-834

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[i] At the Zeb Mountain mine, a supporting stream was classified as "non-supporting" of designated uses; assessors missed the presence of a federally listed species in waters immediately downstream of the permit area.

[ii] The Tennessee coalfields also represent areas of timber harvest, farming and other land uses that impact watershed ecosystems. Environmental impact assessments should--but rarely do--adequately address the consequences of cumulative multiple uses of land.

[iii] The Sewanee coal seam in Tennessee is highly toxic, and there is no known technology that adequately deals with AMD from this seam.

[iv] At the Zeb Mountain mine, sediment basin (DNB3) washes out and the operator rebuilds it, but without revising the permit. TDEC issues a violation.

[v] In the Dan Branch watershed (Zeb Mountain mine) sediment from a haul road slide contaminated the stream with sediment. Violations were issued. A second slide occurs. TDEC conducts biological survey of Dan Branch and concludes that "the overall index score indicates degradation." TDEC issued a Director's Order for damages caused to Waters of the State. The Order required restoration of the biological integrity of Dan Branch within 5 months and confined the operator to mining in that watershed until damage was remediated. The remediation plan took TDEC, OSM and mine engineers much time to devise, and called drastic engineering in the watershed: placing huge rock buttresses for the slide areas, moving the natural stream channel further from the slide area and engineering a new channel that included use of piping.

[vi] A large slide occurred in the New River watershed on previously mined and *reclaimed* land. The slide occurred during a period of heavy rainfall in which a lot of the steep slopes were saturated with water. Do we know enough about the effects of warming or cooling trends on hydrologic processes in the steep slopes of the Tennessee coalfields to predict similar problems?

[vii] At Zeb Mountain mine, a new owner claims they are not responsible for remediation of a problem created by the previous operator and appeals to the state water board. This delays remediation and contributes to ongoing pollution.

[viii] At the Zeb Mountain mine, the operator mined through streams without a permit and caused degradation of waters of the state; TDEC commissioner issued a stop work order (September 2006).

[ix] We have confidential reports that people living near Zeb Mountain are now having problems with well water and are drinking only commercial bottled water because they are afraid of the water in their wells. Several residents who bought property in a gated community on a previously mined area are having trouble with their wells. Well yield is sometimes unreliable and one couple is on their 4th well.

[x] For example, get rid of the "wet weather conveyance" or "ditch" terminology in any rule or law having to do with natural resource harvest or extraction, unless they refer only to man-made structures. There are other terms that more adequately reflect the nature of these waters and are more consistent with usage by other people/agencies: scientists, EPA, OSM, USACE, USGS etc. For example: perennial, intermittent, ephemeral (best choices?); or 0-, 1st-, 2nd-order streams (not used as much -- yet -- but seems to be coming into more use).