The Potomac Highlands School of Water Resources
Lesson Plan for Pollution Cleanup Module
February 14, 2005

Purpose:

This module was designed to teach students about the tools available and costs associated with reducing pollution in our waterways. Stream Cleaner's issues are shared by people throughout the Chesapeake Bay region who are currently working to help clean up both WV rivers and the Chesapeake Bay. Because it can be used to lead into discussions about pollution science, land management decisions, economic decisions, community decision making and citizenship, and the role of government, **Stream Cleaner** would be appropriate for general science, biology, environmental science, social science, and vocational-agriculture courses. **Middle and High School.**

Web Based Tools:

✍ **Interactive Learning Activities: Stream Cleaner**

Stream Cleaner is a game of strategy, where the player tries to clean up a polluted stream by applying the best combination of land management practices from the "Stream Cleaner Toolbox" before they run out of money. While playing the game, the user explores the relationship between people's actions and their impact on the environment. In Stream Cleaner, a stream is polluted with excess nutrients and sediment. (These are common pollutants in West Virginia's waters, and particularly important in the Potomac region due to pollution problems in the Chesapeake Bay.)

The pollution in Stream Cleaner is coming from various farm activities (pastures, corn fields, a barnyard) and a small town - in other words, a typical WV landscape. The student learns about the problem, about how much of the pollution is coming from each land use, and then about a "tool kit" with five Best Management Practices to help them reduce pollution. Each tool has a cost associated with its use, and an "efficiency" at reducing pollution flowing from the land to the water. Finally, the student has $10,000 to spend to clean up the water. Their challenge is to get the biggest bang for the buck by applying the best mixture of tools to the parts of the landscape where the problems are greatest. They simply drag tools from the BMP toolkit and drop them on the land areas they choose to clean up - until they run out of money.

It is a bit deceiving to say that they "simply" play the game, because there are a number of concepts to balance. Part of the learning here will be based on repetition: i.e. playing the game a number of times will reinforce the lessons to be learned. The degree to which learning has occurred can be measured by improvements in the student's final scores over time.

Instructional Procedure:

It is suggested that this module begin with very little introductory material. Background information is available, but it is not necessary to have the students read this material before playing Stream Cleaner.

We suggest that Stream Cleaner always be played alone the first time through so students get the feel of the game. Expect a few questions at this point. These questions will provide the opportunity for a class discussion on developing a logical strategy to succeed, where success is measured by how well the stream is cleaned. Without giving away all the answers, the students may be led into thinking about which parts of the landscape contribute the most to the problem,

and which tools have the best combination of low cost and pollution reduction. Following this discussion, several tracks are possible:

? Students can be asked to write their strategy on paper, and then try their strategy in the game. This process could be carried out several times, with students refining their written strategy, and their logic al process, before proceeding.

? Teams of students can be formed, and the game can be turned into a competition. Each team would work together to optimize a strategy and then play the game to see how it worked out. Low score wins.

? Just play the game again, and see how the students develop on their own without prompting.

All of the game text is available online in the Pollution section of the bookshelf, as well as an overview of the game and important background information. This allows the instructor to cover other topics such as those suggested below in the Follow Up sections.

? Links

A list of water pollution curriculum links has been provided within the student classrooms, available by clicking on the pollution section of the bookshelf. The link pages contain both the relevant student links and links to other material and references complimentary to the topic. Instructors can guide their students to links through the classroom.

Follow Up:

The information provided here is just a suggestion for follow up. More ideas can be found within the student and teacher links. Once the students have completed the web based activities additional information can be discussed in the classroom. The students can also explore issues concerning water pollution through at-home activities, and internet and library research

Classroom Activities:

? *The cost of pollution.* – A teacher led discussion that explores why it is important to reduce pollution in our State waters, and why it is important for West Virginia to also prevent pollution from flowing from West Virginia to downstream states. Before beginning this discussion, the students should go the e-classroom bookshelf and read about the WV Potomac Tributary Strategy.

? *The personal side of pollution.* My role in the watershed. – A teacher lead discussion/lesson informing students about the role and impacts people have on watersheds. Topics covered could include pollution from humans (it is suggested to discuss locally relevant pollution sources), impacts humans have on ground water (see links page), and what people can do to help protect and improve the health of their watershed (information can be found at many of the links).

? *The Socio-Economics of Pollution.* If it were easy to clean up non point source pollution, it would already be done. Success will require changes of ingrained societal behaviors. And, perhaps, success is something less than perfectly clean streams. How do we balance the values and benefits of clean water with the real costs involved in changing how the land is used? Perhaps the best sector to focus on here would be farming, not because farmers create all the pollution, but because there is a considerable history of government programs and farmer participation to draw upon. Land management changes on farms effects how farming is done, and can affect how much land is available for

farming. For example, installing forested or vegetative buffers along streams will reduce the flow of pollution from farmland, but will also remove some of the farmland from production. What are the pros and cons for the farmer?

- ✍ *How accurate is the game*? If you really want to dig deeply into the nuts and bolts of assessing pollution, this would be an excellent topic for discussion - perhaps a topic that would need some outside help. Cacapon Institute, or a number of state agencies, could arrange to help in this discussion.

At Home Activities:

The links provided for this module contain various at home activities for students to complete, such as learning about water use in their home and what types of impacts a student's home is having on their watershed. It is easy to locate these activities when surfing through the websites.

Stream Cleaner CSOs

This activity is suitable for both the middle and high school levels. *Stream Cleaner* explores the relationship between people's actions and their impact on the environment. The issues raised by **Stream Cleaner** are the same issues that people throughout the Chesapeake Bay region are currently working on to help clean up both WV rivers and the Chesapeake Bay. Also, because it can be used to lead into discussions about pollution science, land management decisions, economic decisions, community decision making and citizenship, and the role of government, **Stream Cleaner** would be appropriate for general science, biology, environmental science, social science, and vocational-agriculture courses. This activity is also intended to help teachers "provide opportunities for students to use education technology interwoven with relevant curricular content," as required by the WV Content Standards and Objectives (CSO).

Social Studies. The issues raised by **Stream Cleaner** are the same issues that people in the Potomac region are working on to help clean up both WV rivers and the Chesapeake Bay. The continuing process of developing the WV Potomac Tributary Strategy has been very public; it included a stakeholder process at the outset, and an implementation workgroup with public interaction today. It has not always been pretty, but it has been an example of trying to work issues out in a public forum. The activity can readily be used to lead into regionally relevant discussions on citizen involvement in decision making, weighing cost and benefits of a proposed action, the role of government in setting priorities, and complicated decisions related to balancing individual liberties with the common good.

Standard 1: Citizenship (SS.S.1)
Students will:
- ? develop and employ the civic skills necessary for effective citizenship by using criteria to make judgments, arrive at and defend positions and evaluate the validity of the positions or data (Evaluation Skills);
- ? demonstrate and employ the participatory skills of interacting, monitoring and influencing that are essential for informed, effective and responsible citizenship, including participation in civic life to shape public policy (Participatory Skills);

SS.5.1.1 describe how groups and institutions work to meet the individual needs and promote the common good (e.g., Red Cross, laws).
SS.5.1.2 explain the political process and describe its importance in decision-making.
SS.5.1.3 explain the consent of the governed as the source of authority of government
SS.6.1.1 describe ways in which nations interact with one another and try to resolve problems.
SS.6.1.2 evaluate, take and defend positions on the purposes that government should serve (e.g., debates, essays).
SS.7.1.2 explain actions citizens take to influence public policy decisions.

SS.7.1.4 locate, access and organize information about an issue of public concern from multiple points of view.

SS.8.1.1 evaluate how citizens can participate in government at the local, state and national levels (e.g., voting, community service, letter writing).

SS.8.1.2 identify and practice forms of civic discussion and participation consistent with the ideals of citizens in a democratic republic.

SS.8.1.5 explain the political process and the opportunities for citizens to influence government.

SS.8.1.6 locate, access, analyze, organize and apply information about selected public issues, recognizing and explaining multiple points of view.

SS.8.1.7 explain and analyze various forms of citizen action that influence public policy (e.g., how groups can work with governmental agencies to impact the development of tourism).

SS.8.1.8 analyze the influence of diverse forms of public opinion on the development of public policy and decision making.

SS.8.1.9 examine the strategies designed to strengthen the common good, which consider a range of options for citizen action.

SS.8.1.10 identify, analyze, evaluate and interpret sources and examples of the responsibilities, privileges and rights of citizens.

SS.9.1.1 compare and contrast various citizens' responses to controversial government actions.

SS.9.1.3 make informed decisions as to what government should and should not do.

SS.9.1.4 explain how the interactions of citizens with one another monitor and influence the government.

SS.9.1.5 evaluate ways conflicts can be resolved in a cooperative, peaceful manner that respects individual rights and promotes the common good.

SS.11.1.1 discuss ways citizens can work cooperatively to resolve personal, local, regional, and world conflicts peacefully.

SS.11.1.2 analyze and evaluate the influence of citizen action on public policy and law making.

SS.11.1.3 analyze the changing nature of civic responsibility.

SS.11.1.4 develop positions and formulate actions on the problems of today and predict challenges of the future (e.g., terrorism, religious conflict, weapons of mass destruction, population growth).

SS.12.1.2 explain that one of the primary purposes of American government is the protection of personal, political, and economic rights of citizens, examine the characteristics of these rights and analyze how they reinforce or conflict with each other necessitating reasonable limitations.

SS.12.1.3 describe and analyze the personal and civic responsibilities of U.S. citizens.

SS.12.1.6 explain how public policy is formed and carried out at the local, state and national levels and what roles citizens can play in the process.

Standard 2: Civics/Government (SS.S.2)

Students will:

✎ identify, examine and explain the structure, function and responsibilities of governments and the allocation of power at the local, state and national levels (United States Government and Politics); and

SS.9.2.3 explain the purpose of the United States government and analyze how its powers are acquired, used and justified.

SS.9.2.11 evaluate the degree to which public policies and citizen behaviors reflect or foster the stated ideals of a democratic republican form of government.

SS.12.2.9 explain the importance of law in the American constitutional system and examine the importance of the rule of law for the protection of individual rights and the common good.

Standard 3: Economics (SS.S.3)

Students will:

? analyze the role of economic choices in scarcity, supply and demand, resource allocation, decision-making, voluntary exchange and trade-offs (Choices);

? research, critique and evaluate the roles of private and public institutions in the economy (Institutions);

SS.8.3.7 describe and analyze the effects of national and state governmental actions on West Virginia's economy.

SS.11.3.1 evaluate the lifestyle changes brought on by industrialization, technology and transportation (e.g., debate industrialization vs. maintaining natural environment and the implications for tourism).

Standard 4: Geography (SS.S.4). Stream Cleaner would be most applicable to CSOs which concern analysis of include the interaction of society with the environment (Environment and Society);

SS.5.4.11 describe how people have changed the environment of the United States.
SS.9.4.14 analyze and explain the human impact on the environment throughout the American experience.
SS.11.4.6 analyze and assess the impact of human decision-making and technology on the environment.

Science Standard 6: Science in Personal and Social Perspectives
Applying science and technological innovations to personal and social issues such as health, populations, resources and environment helps students to develop decision-making skills. As students expand their conceptual horizons, they should recognize that collective individual actions manifest as societal issues. Students must recognize that society cannot afford to deal only with symptoms; personal and societal actions must be focused on elimination of the causes of problems. Students should recognize that unless imposed by legislation social change involves negotiation among different interest groups. Students must be allowed to encounter and examine social change in a variety of current and historical contexts.

Standard 6: Science in Personal and Social Perspectives (SC.S.6)
Students will:
? demonstrate the ability to evaluate personal and societal benefits when examining health, population, resource and environmental issues;
? demonstrate the ability to evaluate the impact of different points of view on health, population, resource and environmental practices;
? predict the long-term societal impact of specific health, population, resource and environmental practices; and
? demonstrate an understanding of public policy decisions as related to health, population, resource and environmental issues.

SC.5.6.3 - critically analyze the effects and impacts of science and technology on global and local problems (e.g., mining, manufacturing, recycling, farming, water quality).
SC.6.6.1 use scientific reasoning and the knowledge of science and technology to make informed personal decisions at the local and global levels.
SC.6.6.3 - critically analyze the effects and impacts of science and technology on global and local problems (e.g., mining, manufacturing, recycling, farming, water quality).
SC.6.6.5 analyze the positive and negative effects of technology on society and the influence of societal pressures on the direction of technological advances.
SC.7.6.1 use scientific reasoning and the knowledge of science and technology to make informed personal decisions at the local and global levels.
SC.7.6.3 - critically analyze the effects and impacts of science and technology on global and local problems (e.g., mining, manufacturing, recycling, farming, water quality).
SC.7.6.5 analyze the positive and negative effects of technology on society and the influence of societal pressures on the direction of technological advances.
SC.8.6.1 use scientific reasoning and the knowledge of science and technology to make informed personal decisions at the local and global levels.
SC.8.6.2 evaluate and critically analyze mass media reports of scientific developments and events.
SC.8.6.3 - critically analyze the effects and impacts of science and technology on global and local problems (e.g., mining, manufacturing, recycling, farming, water quality).
SC.8.6.5 analyze the positive and negative effects of technology on society and the influence of societal pressures on the direction of technological advances.
SC.9.6.1 - research uses and values of natural resources.
SC.9.6.2 - research current environmental issues (e.g., effects of pollution, solid waste management, local, national, and global issues).
SC.9.6.5 engage in decision making activities and actions to resolve science-technology-society issues.
SC.10.6.2 - research current environmental issues (e.g., depletion of fossil fuels, global warming, destruction of rainforest pollution).
SC.10.6.3 - describe the impact of cultural, technological, and economic influences on the evolving nature of scientific thought and knowledge.
SC.10.6.5 engage in decision making activities and actions to resolve science-technology-society issues.

AB.6.1 investigate and discuss the impact that humans may have on the quality of the biosphere such as depletion of the rainforest, pollution of estuaries, strip mining, depletion of fossil fuels and deterioration of ozone layer.

AB.6.2   investigate the effects of natural phenomena on the environment (e.g., oceanographic, meteorologic).

AB.6.3 research current environmental issues (e.g., depletion of fossil fuels, global warming, destruction of rainforest pollution).

AB.6.4 describe the impact of cultural, technological, and economic influences on the evolving nature of scientific thought and knowledge.

AB.6.5 explore occupational opportunities in science and technology including the academic preparation necessary.

AB.6.6 engage in decision making activities and actions to resolve science-technology-society issues.

BTC.6.2 - describe the impact of cultural, technological and economic influences on the evolving nature of scientific thought and knowledge.

BTC.6.4 engage in decision making activities and actions to resolve science-technology-society issues.

AES.4.30 explore the relationships between human consumption of natural resources and the stewardship responsibility for reclamations including disposal of hazardous and non-hazardous waste.

AES.4.32 - explain common problems related to the conservation, use, supply and the quality of water.

AES.4.36 research and explain how the political system influences environmental decisions.

AES.4.37 investigate which federal and state agencies have responsibility for environmental monitoring and actions.

AES.4.38 develop decision-making skills with respect to addressing environmental problems.

AES.6.1 research and explain how the political system influences environmental decisions.

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