BUREAU OF THE ENVIRONMENT
ENVIRONMENTAL QUALITY BOARD
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MINUTES
WEST VIRGINIA ENVIRONMENTAL QUALITY BOARD
NOVEMBER 17, 2000

I. General

On November 17, 2000, a quorum of the members of the Environmental Quality Board (hereinafter referred to as the "Board") met at the offices of the Bureau for Public Health located at 815 Quarrier St., Charleston, West Virginia. Chairman Snyder called the meeting to order at 8:30 a.m.

Board members present were as follows:

Ed Snyder, Chair
Bob Jenkins
Betsy Dulin

Absent were Board members:

Cameron Hackney
Dave Samuel

Staff members present were as follows:

Libby Chatfield
Becky Charles
Melissa Carte

Whereupon, the Board addressed the issues set forth in the Agenda as follows:

II. Rulemaking

1. Presentation by the WV Bureau for Public Health regarding the development of the Zones of Critical Concern (ZCCs):

The Source Water Assessment and Protection Plan developed by the Bureau provides for delineating Zones of Critical Concern (ZCC) above all public drinking water intakes. Delineation of the ZCCs was completed by Spatial Analytics, Inc. under contract with the Bureau earlier this year.

The Board is considering revising the Public Drinking Water Supply Use Category (Category A) by limiting its application to the ZCCs and has sought input from the Bureau on this issue. Reuben Gillispie, geologist for the WV Bureau for Pubic Health, explained the scientific methodology used in delineating ZCCs. This information is summarized in the attached handouts labeled Exhibit "A".

2. Review and Discussion of USEPA letter to the Board dated October 25, 2000:

On October 31, 2000, the Environmental Quality Board received a letter from Bradley Campbell, Regional Administrator for the USEPA. In this letter Mr. Campbell expressed the USEPA's disappointment in the Board's proposed antidegradation implementation procedures that were submitted to the WV Legislature for promulgation. Mr. Campbell stated that the USEPA is immediately proceeding to prepare a draft proposal for Federal procedures that will applicable in lieu of state-promulgated procedures. (See Exhibit "B")

On October 27, 2000, Mike Castle, Commissioner of the Bureau of the Environment responded to this letter, voicing the DEP's commitment to working with the USEPA on the development of a final antidegradation document that both the WV DEP and the USEPA find to be fair and consistent with federal law and guidance. (See Exhibit "C")

During the November 17, 2000, Environmental Quality Board meeting, DEP Commissioner Castle appeared before the Board to discuss the role of that the Division of Environmental Protection is taking in the effort to develop an antidegradation implementation policy which will meet with the approval of the USEPA.

Mr. Castle explained that he met with Mr. Campbell to discuss the USEPA's position on the content of the proposed procedures. He stated that he is attempting to resolve the outstanding issues by soliciting informal comments from the members of the Board's antidegradation stakeholders group. He indicated that the DEP hopes to build on the Board's work in order to develop a product which all of

those involved, including the USEPA can agree to, but is unsure of the "vehicle" that will be used to implement any revisions to the proposed legislative rule.

The Board members encouraged Commissioner Castle to include the Board in the process and requested that they be updated on the document progress. The Board has not been included in the discussions between the USEPA, DEP and the Stakeholders.

The Board directed Ms. Chatfield to draft a response to the USEPA which emphasizes the Board's commitment to the development of antidegradation implementation procedures and which offers the Board's continuing assistance as proposed ongoing revision take place.

III. Administrative Matters

1. Review and approval of October 20, 2000, Environmental Quality Board meeting minutes:

Whereupon, the minutes of the October 20, 2000 Environmental Quality Board meeting were presented to the Board for consideration. Dr. Jenkins moved and Ms. Dulin seconded that the minutes of the October 20, 2000, Board meeting, as written, be approved and the motion passed unanimously 3 to 0.

2. Review and approval of October 20, 2000, Environmental Quality Board and Air Quality Board joint meeting minutes:

Whereupon, the minutes of the October 20, 2000, joint meeting of the Air Quality Board and the Environmental Quality Board were presented to the Board for consideration. Dr. Jenkins moved and Ms. Dulin seconded that the minutes of the October 20, 2000, joint Board meeting, as written, be approved and the motion passed unanimously 3 to 0.

3. Budget Matters:

The Board was informed that the Bureau of the Environment will be providing the Boards with a bridge loan within the next week. The money will be provided to the Boards in $10,000 increments as needed. The DEP is preparing a memorandum of understanding that will outline the terms of the loan agreement.

The Board decided to investigate the possibility of the Boards' obtaining grant monies or other source of additional funding by linking with colleges and universities on special projects such as the zones of critical concern. They will also investigate obtaining additional funding from the USEPA.

4. Technology Matters:

a.) Computer Hardware:

The Board members were informed that Ms. Coleman is currently preparing the bid packet for the purchase of a new computer server.

b.) Computer Software:

The Board was informed that the Adobe Acrobat software has been ordered.

Whereupon, the November 17, 2000, meeting recessed. At approximately **11:00 a.m.** the Environmental Quality Board reconvened in the **2nd floor conference room at the Board offices located at 1615 Washington Street E., Charleston, Kanawha County, West Virginia**.

IV. Appeals

1. 00-13-EQB (Fola Coal):

The Board members were informed that the Appellant in this appeal has withdrawn this appeal and were presented with an Order of Dismissal. Whereupon, Dr. Jenkins moved and Ms. Dulin seconded that appeal #00-13-EQB (Fola Coal) be dismissed and the motion passed unanimously 3 to 0.

2. 00-12-EQB (Mountain Valley):

The Board conducted a hearing on the Motion to Dismiss Appeal #00-12-EQB (Mountain Valley). This hearing was recorded and will be transcribed by a certified court reporter. Copies of the transcript will be made available to the parties of the appeal and also retained in the Board office.

II. Other Business

The Board may take up additional administrative matters and may also consider such business as it may deem timely and appropriate. Portions of this meeting may not be subject to the Open Governmental Proceedings Act. Also, portions of this meeting may occur in executive session.

I hereby certify that the forgoing is a true and correct record of the proceedings of the meeting held on November 17, 2000, by the West Virginia Environmental Quality Board. The minutes were approved by the Environmental Quality Board on Dec. 18th, 2000.

Melissa Carte

Melissa Carte, Clerk

Source Water Protection System Software

A surface watershed delineation tool

WV BPH ZCC methodology approved by EPA Region III for Source Water Protection Program.

In Region III, WV has the most scientific methodology for delineating the watersheds and Zones of Critical Concern for SWAP. WV had its SWAP plan chosen as the baseline to which all other Region III states were compared.

The SWPS model math has been reviewed by USGS and partly taken from USGS publications. The specific equation is given in the Final Technical Report.

The five hour time of travel is an accepted protocol for spill response times for intake shutdowns and testing to ensure no contamination of water already in the plant.

By design, the software model is supposed to calculate what distance a certain stream would transport a load during high flow. It is not designed to emulate perfectly the stream flow characteristics.

SWAP Design Criteria

Based on comments from the citizen and technical committees, BPH decided to adopt a dual delineation for streams with surface water intakes.

The watershed delineation would measure the entire basin upstream from the intake point.

The Zone of Critical Concern would calculate a distance that could be traveled by a spill in 5 hours downstream.

The committees stipulated that the buffer area calculation must reflect the stream velocity and travel time.

For all instate streams the equation for distance needed to be solved. Time was known and velocity had to be found in order to solve D=T*V.

The model used bankfull or 90% of maximum flow to determine the fastest velocity of a flowing river. Other states are using a bankfull stage curve to determine maximum velocity of streamflow for spill response purposes.

SWAP Criteria

Shortcuts and Assumptions

- If this were intended to be an accurate hydraulic flow model of real streams, there would be insufficient data to run statewide and not enough gauge data to fill in the particular variables. Assumptions would be used and a great deal of error introduced in the attempt to gain greater precision.
- Not every stream in WV has gauge data nor do all of the gauges have the full 30 years of flow measurements.
- Some or most of the data used in the USGS paper are from watersheds outside and not similar to WV.
- The math behind the model is simplistic and ignores many variables - this was intended to project a center of mass of a spill plume at maximum velocity/minimum travel time for the 5 hour criteria. The benefit of the math being simple is that the variables being ignored will only lend a small amount of precision to the velocity calculation. At the bankfull stage, many of the variables for natural streamflow become insignificantly small. Basically, velocity is derived from streamflow discharge and multiplied by 5 hours to get a distance.

A Computer Model for Stream Hydrology

Source Water Protection System (SWAP) software is vector-based Geographic Information using stream data tables of 30 meter grid cells of actual WV stream flow data.

- The watershed delineation portion (WSDA) was an existing model put together by Spatial Analytics as a tool to be included with the SWAP software. The watershed delineation model is driven by a hydrographically correct Digital Elevation Model coverage for WV. The watershed delineation is also used to clip any buffer which may extend over a ridge line.
- Every grid cell is queried for stream order attribute. All cells representing the main stem reach are buffered 1,000 feet on either side. Any tributary joining the main stem would be buffered 500 feet to either side.
- This method is used for any and all watersheds completely contained within the borders of the State of WV.

What are these?

Definitions and explanations

- Grids
- Are cell based, raster spatial data format especially suited to representing geographic phenomena that vary continuously over space, such as terrain.
- Grid Cells
- Are individual units that store data about each attribute recorded for that grid. Every Grid cell is unique and stores data about that cell and how it relates to the grid.

Citations for flow regression equations.

USGS Water Resources Investigations Report 96-4013

- Hobson, J.E., 1996, Prediction of Traveltime and Longitudinal Dispersion in Rivers and Streams.
- The model was written in Avenue script for ArcView GIS by Spatial Analytics. The code is open and can be revised by Spatial Analytics as necessary.

Stream Velocity (V)

From the USGS paper the peak velocity equation is:

- $V_p = 0.094 + 0.0143 \times (D'_a)^{0.919} \times (Q'_a)^{-0.469} \times S^{0.159} \times Q/D_a$.
- Drainage area would be calculated by the model for any given point for the entire basin upstream. (Da) is used to drive (Q).
- Stream slope would be calculated by the DEM to give gradient. This gives (S) slope.
- Bankfull flow conditions represent the maximum speed in a river by confining the most water in a channel. As flow drops, velocity drops. As a river floods over its banks, velocity drops because of increased drag. Mean annual river discharge was recorded by gauges. (Qa) is used to determine the 90th percentile. 30 years of gauge data were used for streams with permanent USGS gauges. Stage would be measured and the 90th percentile maximum discharge (Q) would be used to reflect bankfull flow.

Why choose the peak velocity equation?

- In the USGS paper there are several equations to describe when a slick or plume would reach a measuring point. There were three major equations considered for use as the formula inside the software to calculate velocity and the 5 hours time of travel distance.
- 1. There is a leading edge formula which considers the fastest movement of any detectable trace of chemical.
- 2. There is a maximum possible velocity formula which finds the highest theoretical value.
- 3. The peak velocity equation was the best fit line through a scatter of data points for over 900 real watersheds throughout the US.
- After discussion of safety factors and conservatism and realism, it was decided to use the peak velocity formula.

Calculations ArcView must perform

Statewide number crunching

- 5 different grids for the state were calculated:
  - Drainage area grid methodology is given on Pg 5.
  - Stream slope methodology is given on Pg 6.
  - Average annual flow method is also on pg 6.
  - Bankfull flow grid derivation is given on pages 7-9.
- Once these 4 grids were computed the velocity equation would be solved for every grid cell.
- Each grid cell which represented a stream in the coverage had those 4 variables stored as data. Every cell upstream from any stream leaving the state had successively smaller Q and A and increasing time (T) until the segment ended.
- Since all of the imputed values of the models fit so well to actual data (97% for annual average stream flow down to 92% bankfull flow down to 89.9% for streamflow runoff), the Bureau felt comfortable using the model statewide even in places without direct data. As models only mimic reality, this model has an acceptable accuracy with available datasets.

Limitation of the Program

- The software cannot accurately represent a ZCC of waters involving an impoundment.
- There is a method of drawing ZCCs around lakes as given in the SWAP but the software treats velocity as zero in lakes. The user must trick the program by moving the intake to the main river and generating the ZCC from that point.
- Alternately, the user will delineate the ZCC for a lake by hand.

Limitations of the Program

The software is not mature and the technique is brand new.

Error checking of the model must be done by hand where the map of the ZCC is printed overlying the topographic map.

Each ZCC may or may not accurately reflect the hydrology of the basin.

In order to revise the ZCC, intakes must be relocated on the screen or the stream coverage must be updated to represent the actual position.

DNR must be asked to create a highflow condition coverage instead of a low flow or normal flow stream coverage. Streams may appear as intermittent on the coverage yet seem sizeable on the map. During high flow conditions they would certainly run and may carry spills toward the intake, but because of the intermittent designation would not be considered as part of the basin hydrology.

Limitations of Datasets

- The model is based on GIS coverage of 1:100,000 scale for full statewide coverage, and utilized except where noted.
- Certain selected portions of the state are available with the hydrology shown at 1:24,000. Where 1:24,000 stream reaches were available, these were used.

Limitations of Datasets

Not every WV stream was digitized by DNR.

Not every stream has flow data recorded by gauge stations maintained by USGS.

There are a number of intermittent streams which have been omitted from DNR reach version 3 coverage of WV streams. When the map is viewed, ZCCs may not reach up the tributaries as intended because they are not part of the 30m grid cell coverage.

Limitations of Datasets

- There is a lack of data coverage for the surrounding states with the 30 meter grid cells.
- When the model is run for the rivers forming state boundaries, all water is assumed by the model to be contributed by WV streams only.
- The model must be rerun when the additional grid coverages are available.

Other Limitations

- Runoff from land to streams is an important potential pollution contributor. Nonpoint source pollution is not accommodated in the model.
- Turbidity and other contaminants move during rain events into the stream and toward intakes. The ZCC will only show the land use and not the potential pollution load.
- An actual effort to calculate the amount of nonpoint source pollution would require separate models for each individual stream and knowledge of specific land treatment practices. SWPS makes no effort to do that.

Limitation of the Program

By no means does the agency suggest that spills would not arrive sooner or that as long as a potential source was five hours or more away that it would pose no threat to the intake.

The Car Analogy

BPH bought a program to perform a specific task

- Our two door, emerald green 2000 model Volkswagen Beetle was bought with a certain set of factory options.
- The Board needs a RED full size, one ton, V-10 automatic, extended cab, 4x4 Dodge Ram TRUCK with the towing package.
- The Board should consider ZCCs as a theoretical construct and should be aware that further work is necessary to finish the implementation software.

two or more time-of-travel measurements are required to define the transport characteristics of the river reach. Geomorphic analyses by many investigators, however, suggest that the exponent in equation 8 typically has a value of about 0.34 (Jobson, 1989).

The velocity of the peak concentration and associated hydraulic data are compiled in Appendix A for more than 980 subreaches for about 90 different rivers in the United States representing a wide range of river sizes, slopes, and geomorphic types. Four variables were available in sufficient quantities for regression analysis. These included the drainage area (D_a), the reach slope (S), the mean annual river discharge (Q_a), and the discharge at the section at time of the measurement (Q). It was reasoned that these variables should be combined into the following dimensionless groups. The dimensionless peak velocity is defined as:

$$V'_p = \frac{V_p D_a}{Q}. \tag{9}$$

The dimensionless drainage area is defined as:

$$D'_a = \frac{D_a^{1.25} \times \sqrt{g}}{Q_a} \tag{10}$$

in which g is the acceleration of gravity. The dimensionless relative discharge is defined as:

$$Q'_a = \frac{Q}{Q_a}. \tag{11}$$

These equations are homogeneous, so any consistent system of units can be used in the dimensionless groups. The regression equations that follow, however, have a constant term that has specific units, meters per second. The most convenient set of units for use with the equations is, therefore, velocity in meters per second, discharge in cubic meters per second, drainage area in square meters, acceleration of gravity in m/s^2, and slope in meters per meter.

The most accurate prediction equation, based on 939 data points, for the peak velocity in meters per second was:

$$V_p = 0.094 + 0.0143 \times (D'_a)^{0.919} \times (Q'_a)^{-0.469} \times S^{0.159} \times \frac{Q}{D_a}. \tag{12}$$

The standard error of estimates of the constant and slope are 0.026 m/s and 0.0003, respectively. This prediction equation has an R^2 of 0.70 and an RMS error of 0.157 m/s. Figure 9 contains a plot of the observed velocities as a function of the variables on the right side of equation 12.

For responses to accidental spills, the highest probable velocity, which will result in the highest concentration, is usually a concern. On figure 9 an envelope line for which more than 99 percent of the observed velocities are smaller is also shown. The equation for this line, the maximum probable velocity, in meters per second (V_{mp}) is:

$$V_{mp} = 0.25 + 0.02 \times (D'_a)^{0.919} \times (Q'_a)^{-0.469} \times S^{0.159} \times \frac{Q}{D_a}. \tag{13}$$

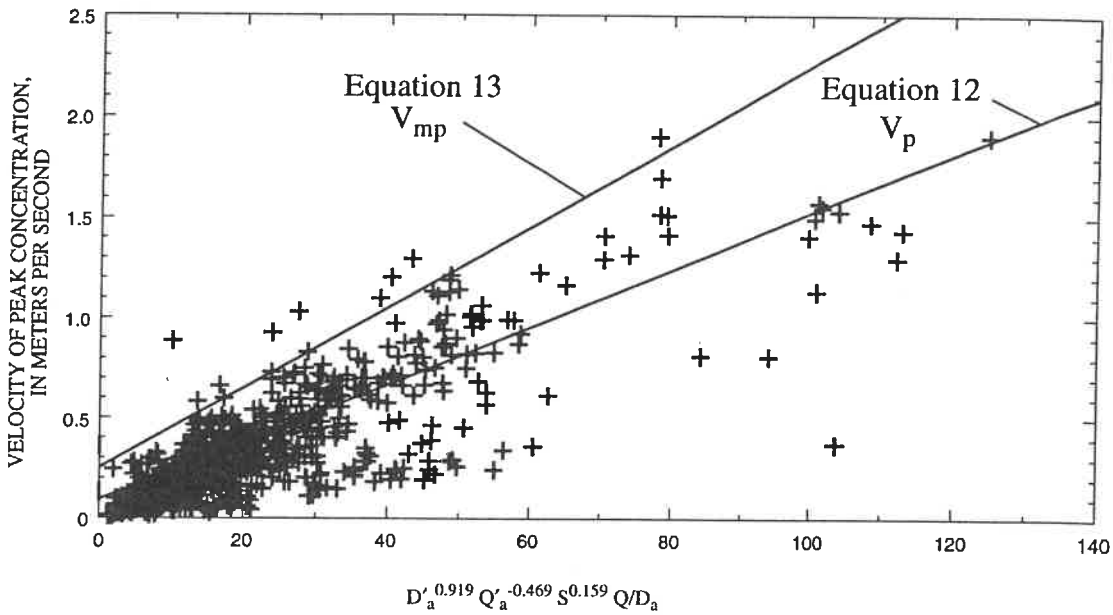


Figure 9. Plot of velocity of the peak concentration as a function of dimensionless drainage area, relative discharge, slope, local discharge, and drainage area.

The best equation for the velocity of the peak concentration, in meters per second, that did not include slope as a variable was:

$$V_p = 0.020 + 0.051 \times (D'_a)^{0.821} \times (Q'_a)^{-0.465} \times \frac{Q}{D_a}. \tag{14}$$

The standard error of estimates of the constant and slope are 0.009 m/s and 0.0013, respectively. The root-mean-square error of the prediction equation, based on 986 points, is 0.17 m/s with an R^2 of 0.62. Figure 10 presents a plot of the observed velocities as a function of the variables on the right side of equation 14. Also shown on the figure is a line for which 99 percent of the data points indicate a smaller velocity. The equation for this line, for the probable maximum velocity, in meters per second, is:

$$V_{mp} = 0.2 + 0.093 \times (D'_a)^{0.821} \times (Q'_a)^{-0.465} \times \frac{Q}{D_a}. \tag{15}$$

The best equation for the velocity of the peak concentration, in meters per second, using only drainage area was:

$$V_p = 0.152 + 8.1 \times (D''_a)^{0.595} \times \frac{Q}{D_a}. \tag{16}$$

provided in a pulldown text information box within the susceptibility ranking menu option.

Component 4. Watershed delineation and zone of critical concern delineation for surface water sites

The ability to interactively delineate watersheds and zones of critical concern is built into SWPS. In this section, we will first discuss the watershed delineation tool, followed by the zone of critical concern delineation tool.

Watershed Delineation

SWPS allows the user to delineate a watershed for any mapped stream location in the state. The watershed is delineated based on the user-clicked point and it is added to the current view's table of contents as a new theme or map layer labeled "Subwatershed." The drainage area is reported back to the user as well. If only drainage area is requested, a separate tool allows for quick query of stream drainage area in acres and square miles, without waiting for the watershed boundary to be calculated.

The watershed delineation is driven by a hydrologically correct digital elevation model (DEM). The DEM is corrected using stream centerlines for all 1:100,000-scale hydrology and many 1:24,000 streams. The stream centerlines are converted to raster cells and DEM values are calculated for each cell. All off-stream DEM cells are raised by a value of 20 meters to assure the DEM stream locations are the lowest cells in the DEM. This step is necessary to assure of more accurate watershed delineations especially at the mouth of the watersheds. After the DEM is filled of all spurious sinks, flow direction and flow accumulation grids are calculated. These grids help determine the direction of flow and the accumulated area for each cell in the landscape. These grids were necessary for watershed delineation to occur and are important inputs for finding the zones of critical concern for surface water intakes.

Surface Water Zones of Critical Concern

After much time and thought on the best way to determine a five-hour upstream delineation for each surface water intake in WV, it was decided to use an equation that included stream velocity as the driving factor. Only with stream velocity calculated could we include factors such as high bank-full flow, average flow, stream slope, and drainage area all at once. The velocity equation used in this study came from a report titled "Prediction of Travel Time and Longitudinal Dispersion in Rivers and Streams" (US Geological Survey, Water-Resources Investigations Report 96-4013, 1996). In this report, data were analyzed for over 980 subreaches or about 90 different rivers in the United States representing a wide range of river sizes, slopes, and geomorphic types. The authors found that four variables were available in sufficient quantities for a regression analysis. The variables included the drainage area (D_a), the reach slope (S), the mean annual river discharge (Q_a), and the discharge at the section at time of the measurement (Q). The report defines peak velocity as:

$V'_p = V_p D_a / Q$

The dimensionless drainage area as:

$D'_a = D_a^{1.25} * \text{sqrt}(g) / Q_a$

Where g is the acceleration of gravity. The dimensionless relative discharge is defined as:

$Q'a = Q/Q_a$

The equations are homogeneous, so any consistent system of units can be used in the dimensionless groups. The regression equation that follows has a constant term that has specific units, meters per second. The most convenient set of units for use with the equation are: velocity in meters per second, discharge in cubic meters per second, drainage area in square meters, acceleration of gravity in m/s2, and slope in meters per meter.

The equation derived in the report and the equation used in this study for peak velocity in meters per second was the following:

$Vp = 0.094 + 0.0143 * (D'_a)^{0.919} * (Q'_a)^{-0.469} * S^{0.159} * Q/D_a$

The standard error estimates of the constant and slope are 0.026 m/s and 0.0003, respectively. This prediction equation had an R^2 of 0.70 and a RMS error of 0.157 m/s.

Once a velocity grid was calculated as described above, we used its inverse as a weight grid in the flowlength GIS command. The flowlength command calculates a stream length in meters. If velocity is in meters per second, the inverse velocity as a weight grid will return seconds in our output grid. This calculation of seconds would track how long water takes to move from every cell in the state where a stream is located to where it leaves the state. The higher values will exist in the headwater sections of a watershed. By querying the grid, we could add the appropriate travel time to the cell value and this will be our time of travel for an intake. All cells above an intake by 18,000 seconds (5 hours) will be the locations in which water would take to reach the intake.

To use this methodology, we needed to calculate GIS data layers for drainage area, stream slope, annual average flow, and bank-full flow for all of WV. The sections below describe how each of these grids was created.

Drainage area

To obtain a drainage area calculation for every stream cell in the state required a hydrogically correct DEM. The process of creating a hydrologically correct DEM was covered in the watershed delineation component described earlier. Essentially, from the

DEM we calculate the flow direction and flow accumulation values for each stream cell. The output of the flow direction request is an integer grid whose values range from 1 to 255. The values for each direction from the center are:

32	64	128
16	X	1
8	4	2

For example, if the direction of steepest drop were to the left of the current processing cell, its flow direction would be coded as 16. If a cell is lower than its 8 neighbors, that cell is given the value of its lowest neighbor and flow is defined towards this cell.

The accumulated flow is based upon the number of cells flowing into each cell in the output grid. The current processing cell is not considered in this accumulation. Output cells with a high flow accumulation are areas of concentrated flow and may be used to identify stream channels. Output cells with a flow accumulation of zero are local topographic highs and may be used to identify ridges. The equation to calculate drainage area from a 20-meter cell sized flow accumulation grid was:

(cell value of flow accumulation grid + 1) * 400 = drainage area in meters squared

Stream slope

Stream slope was calculated for each stream reach in the state. A stream reach is not necessarily an entire stream but only the section of a stream between junctions. The GIS command streamlink was first used to find all unique streams between stream intersections or junctions. For each of these reaches, the length was calculated from the flowlength GIS command. Having the original DEM allowed us to find the maximum and minimum values for each of the stream reaches. The difference in the maximum and minimum elevations for the stream reach divided by the total reach length gave us our stream reach slope in meters per meter.

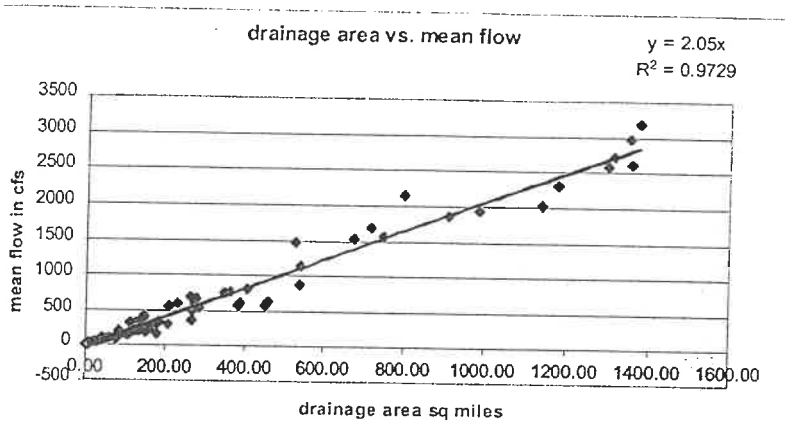
Annual average flow

Annual average flow for each stream cell location was found based on a relationship between drainage area and gauged stream flow. For 88 gauging stations in WV, covering many different rainfall, geological, and elevation regions, we assembled a table of drainage area for the gauges versus the historic annual stream flow for the gauge. After fitting a linear regression line for this data set, we found the following equation for annual stream flow setting the y intercept to zero.

Annual stream flow in cfs = 2.05 * drainage area in square miles

This equation had a corrected R^2 of .9729. The XY plot and equation are shown in Figure 1.

Figure 1. Annual stream flow from gauged stations and drainage area at the gauges



Since drainage area is already calculated for each stream cell location, we applied this equation with the drainage area grid to compute a separate grid layer of annual stream flow. This would be another input for the velocity calculation.

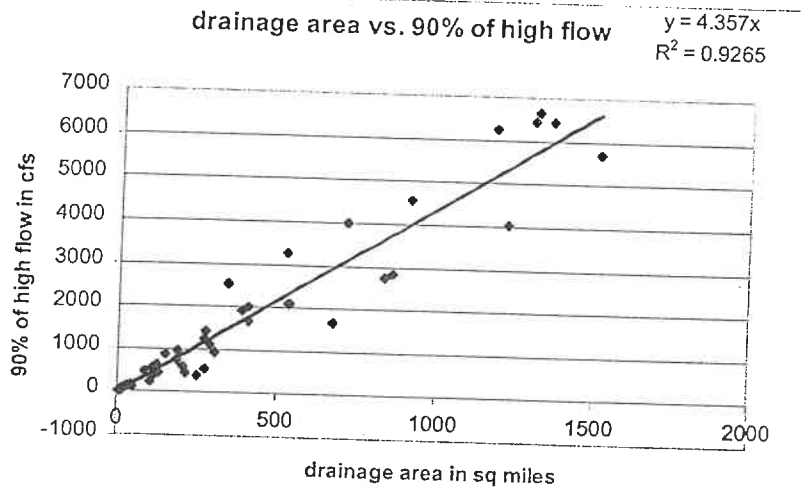
Bank-full flow

The last input for the velocity equation was the bank-full flow measure. Just like annual average flow, this required a modeled value for every raster stream cell in WV. Using the same approach to regressing drainage area to gauged stream flow as we did to find an annual average flow equation, we applied this to find a bank-full flow equation. Bank-full flow as defined by the Bureau of Public Health, is 90% of the annual high flow. To find the 90% of high flow for each gauging station, we first downloaded all historic daily stream flow data for each of the 88 gauging stations. This data was then sorted lowest to highest and then numbered lowest to highest after removing repeating values. The value of flow at the 90% of the data became the bank-full flow value for that gauge. These values were then regressed against drainage area at the gauge. After fitting a linear regression line for this data set, we found the following equation for bank-full stream flow setting the y intercept to zero.

Bank-full stream flow in cfs = 4.357 * drainage area in square miles

This equation had a corrected R^2 of .9265. The XY plot and equation are shown in Figure 2.

Figure 2. Bank-full stream flow from gauged stations and drainage area at the gauges



This equation could be applied to the drainage area grid to calculate the bank-full flow for any stream cell in the state. It was the final input needed in the velocity calculation.

The interactive zone of critical concern tool of SWPS delineates the upstream contributing area for a surface water intake in the following way. First, the user locates the surface water intake and makes sure the intake is on the raster stream cell. A button on the interface then initiates the model. The model will query the time of travel value for the intake and then add 18,000 seconds (5 hours) to the queried value upper range. All cells that fit this range are identified and the stream order attribute retrieved for those cells. All cells that are on the main stem stream where the intake existed are buffered 1000 feet on each side of the stream. All tributaries to the main stem are buffered 500 feet on each side of the stream. Next, a watershed boundary for the location of the intake is delineated and used to clip any areas of the buffer that may extend beyond ridgelines. And lastly, the surface water intake is buffered 1000 feet and combined with the clipped buffer to include areas 1000 feet downstream of the intake. This interactive ability allows zones of critical concern to be delineated for any river or stream in WV. Only large rivers that border WV, such as the Ohio, Tug, and Potomac can not be interactively delineated using this method. This is due to unknown drainage areas for these bordering rivers and unknown tributaries to these major rivers coming from the bordering states. This is the major limitation of this modeling approach for WV. We were not able to delineate zones of critical concern for surface water intakes along the Tug and Potomac Rivers of WV. Using the automatic zone of critical concern delineation for the Tug and Potomac will not fully capture the time of travel values. This is due to our study area extent, which does not include all tributaries and hydrological grids for the PA, MD, KY, and VA locations that we share a river border.

The Ohio River Sanitation Commission (ORSANCO) is responsible for delineating zones of critical concern for the intakes along the Ohio River. ORSANCO uses uniform 25-mile upstream distances for zones of critical concern for intakes along the Ohio River. This same approach could be applied to other rivers such as the Tug and Potomac in WV.

For reservoirs and lakes within the watershed delineation area, a set of standards was set by the Bureau of Public Health was used in this study. For a reservoir, a buffer of 1000 feet on each bank and 500 feet on each bank of the tributaries that drain into the lake or reservoir was used. When a lake or reservoir is encountered within the five-hour time of travel, the following delineation was used. If the length of the lake/reservoir was less than or equal to the five hour calculated time of travel distance from the intake, then the entire water body was included. If the length of the lake/reservoir was greater than the calculated five hour time of travel distance from the intake, then the section of water body within the five hour time of travel distance was used to establish the zone of critical concern.

Component 5. Stream flow model from multivariate regression

Overview

This project component for SWPS used multivariate techniques to evaluate stream flow estimation variables in West Virginia. The techniques included correlation analysis, multiple regression, cluster analysis, discriminant analysis and factor analysis. The major goal was to define watershed scale factors to estimate the stream flow at recorded USGS gauges. To do this, the contributing area upstream of each gauge was first delineated. Next, annual averages of precipitation and temperature and landscape based variables for the contributing upstream area were calculated and regressed against 30-year average annual flow at the USGS gauge. Results from the statistical analysis techniques found the most important variables to be upstream drainage area, 30-year annual maximum temperature, and stream slope. While this analysis was limited by the availability of data and assumptions to predict stream flow, the results indicate that stream flow can be modeled with reasonably good results.

The following sections include a review of the literature on stream flow estimation techniques, a description of the variables used in this study to predict stream flow, the multivariate statistical methods, and a discussion of results and limitations of the study.

Literature Review

The intent of this literature review was to determine variables that were used to estimate stream flow in other studies, identify different statistical procedures, and to find limitations in this study based on other papers.

The impact of land-use, climate change and groundwater abstraction on stream flow was examined by Qerner et al. (1997). They analyzed the effects of these factors using physical models BILAN, HBVOR, MODFLOW and MODGROW. The models were used to simulate the impact of afforstation, climate warming by 2 and 4 degrees Celsius in combination with an adoption of the precipitation changes in groundwater recharge and groundwater abstractions on stream flow droughts. The authors found that all the

physical models can be used to assess the impacts of human activities on stream flow. They also concluded that based on some climate change scenarios they followed out, that the deficit volume of water is very sensitive to both an increase in temperature and a change in precipitation. Even in basins with abundant precipitation, the warming of 2 degrees Celsius would result in a rise in the deficit volume of water by 20 percent. Their findings also acknowledge the importance of using precipitation, temperature, groundwater recharge and groundwater abstractions along with water storage holding capacity of watersheds.

Timofeyeva and Craig (1998) used Monte Carlo techniques to estimate month by month variability of temperature and precipitation for drainage basins delineated by a digital elevation model. They also used a runoff grid from the digital elevation model to estimate discharge at selected points and compared this to known gauge station data. The variance of temperature was modeled as the standard error of the regression from the canonical regression equation. For precipitation, they modeled the variance as the standard error of the prediction. This was done to achieve unbiased estimators. When comparing the climate and resulting runoff and stream flow estimators calculated by Monte Carlo estimation, to the observed flow, the simulated results were within the natural variability of the record (Timofeyeva and Craig, 1998).

Long-range stream flow forecasting using nonparametric regression procedures was developed by Smith, (1991). The forecasting procedures, which were based solely on daily stream flow data, utilized nonparametric regression to relate a forecast variable to a covariate variable. The techniques were adopted to develop long-term forecasts of minimum daily flow of the Potomac River at Washington, D.C. Smith's key finding was that to implement nonparametric regression requires the successful specification of "bandwidth parameters." The bandwidth parameters are chosen to minimize the integrated mean square error of forecasts. Basically, his stream flow technique focussed on examining past history of stream flow and making nonparametric regression forecasts based on what is likely to occur in the future. No additional variables besides historic flow were used to model future conditions.

Another nonparameteric approach to stream flow simulation was done by Sharma et al. (1999). They used kernal estimates of the joint and conditional probability density functions to generate synthetic stream flow sequences. Kernal density estimation includes a weighted moving average of the empirical frequency distribution of the data (Sharma, et al. 1997). The reason for this method is to estimate a multivariate density function. This is a nonparametric method for the synthesis of stream flow that is data driven and avoids prior assumptions as to the form of dependence (linear or non linear) and the form of the probability density function. The authors main finding was that the nonparametric method was more flexible for their study than the conventional models used in stochastic hydrology and is capable of reproducing both linear and nonlinear dependence. In addition, their results when applied to a river basin indicated that the nonparametric approach was a feasible alternative to parametric approaches used to model stream flow.

Garren (1992) noted that although multiple regression has been used to predict seasonal stream flow volumes, typical practice has not realized the maximum accuracy obtainable from regression. The forecasting methods he mentions which can help provide superior forecasting include: (1) Using only data known at forecast time; (2) principal components regression; (3) cross validation; and (4) systematically searching for optimal or near-optimal combinations of variables. Some of the variables he used included snow water equivalent, monthly precipitation, and stream flow. The testing of selection sites for a stream flow forecasting study, he feels should be based on data quality, correlation analyses, conceptual appropriateness, professional judgement, and trial and error. The use of principal components regression provides the most satisfactory and statistically rigorous way to deal with intercorrelation of variables. He concluded that the maximum forecast accuracy gain is obtained by proper selection of variables followed by the use of principal components regression and using only known data (no future variables).

The results of a multiple-input transfer function modeling for daily stream flow using nonlinear inputs was studied by Astatkie and Watt (1998). They argue that since the relationship between stream flow and its major inputs, precipitation and temperature, are nonlinear, the next best alternative is to use a multiple input transfer function model identification procedure. The transfer function model they use includes variables such as type of terrain, drainage area, watercourse, the rate of areal distribution of rainfall input, catchment retention, loss through evapotranspiration and infiltration into the groundwater, catchment storage, and melting snow. When comparing their modeling technique for stream flow to that of a nonlinear time series model, they found their transfer function model to be direct and relatively easy for modeling multiple inputs. They also found it more accurate in head to head tests against the nonlinear time series model.

Since stream flow modeling is an outcome of many runoff estimation models, the literature for deriving runoff grids is applicable to stream flow studies. Anderson and Lepisto (1998) examined the links between runoff generation, climate, and nitrate leaching from forested catchments. One of the things they sought out to prove in their study was that climate will influence the amount of nitrate that can be leached from the soil and the water flow that will transport it to the streams. They found that a negative correlation existed between stream flow and temperature. Significant positive correlation between modeled surface runoff and concentrations of nitrate was found when they considered periods of flow increases during cold periods. Their study identified the importance for identifying and calculating the surface runoff fraction, daily dynamics of soil moisture, groundwater levels, and extensions of saturated areas when doing a contaminant transport or flow estimation study.

In another study, Moore (1997) sought to provide an alternative to the matching strip, correlation, and parameter-averaging methods for deriving master recession characteristics from a set of recession segments. He then choose to apply the method to stream flow recession segments for a small forested catchment in which baseflow is provided by drainage of the saturated zone in the shallow permeable soil. His plots told him the recessions were non-linear and that the recessions did not follow a common

single valued storage outflow relation. He settled on a model with two linear reservoirs that provided substantially better fit than three single reservoir models, indicating for him that the form of the recession curve probably depends on not just the volume of subsurface storage, but also on its initial distribution among reservoirs.

Gabriele et al. (1997) developed a watershed specific model to quantify stream flow, suspended sediment, and metal transport. The model, which estimated stream flow, included the sum of three major components: quick storm flow, slow storm flow, and long-term base flow. Channel components were included to account for timing effects associated with waters, sediments, and metals coming from different areas. Because of relatively good results from the modeling process, the conceptualizations supported that the study area river was strongly influenced by three major components of flow: quick storm flow, slow storm flow, and long-term base flow. Therefore, they can associate sediment inputs with each of those stream flow components and assign metal pollution concentrations to each flow and sediment input.

From this review of other studies, we found stream flow estimation variables that have been used successfully. Examining the limitations of other studies has also informed us of things that we may not be able to include. Of the statistical techniques used, we believe the multivariate approach, in which components are added or subtracted to achieve the best fit possible, is a sound statistical procedure. In addition to this approach, testing the correlations between variables is another way of finding a model for estimating stream flow in WV.

Methodology

The first step in assembling data for this study was to delineate the total upstream contributing area for each of thirteen USGS gauge stations in West Virginia. Figure 3 displays the location of each gauge and the defined upstream drainage area for that gauge.

For every drainage area, we then found values for the following criteria; total area, 30 year average annual precipitation, 30 year average annual maximum temperature, 30 year average annual minimum temperature, average drainage area slope, and stream slope. These variables were explanatory variables, which would be regressed against the dependent variable, the 30year average annual flow recorded at the gauge stations. The figures 4 to 7 show the distribution of 30-year precipitation, maximum temperature, minimum temperature, and elevation across the different areas. By using GIS techniques, we found the average value in the drainage areas along with drainage area slope and stream slope for each of the variables. The data for each gauge area and assembled variables is summarized in table 1 (All tables and figures are included as appendices at the end of this report).

The first step in analyzing the data in table 1 was to perform some basic statistics. We were interested in the variance and distribution of the values across the different gauging station locations. The summarized statistical data is shown in table 2.

From table 2, we noticed which variables were closely grouped and which varied significantly among all the 13 different gauges. The area and flow variables have the highest standard deviation while the precipitation, maximum and minimum temperatures, and watershed slope have the lowest standard deviation. Other simple statistical graphs, which were used to gain insights into the data distribution and spreads, are shown in figures 8 to 14. The figures provided a graphical display of the distribution of values across the 13 gauges.

The next step in analyzing the data was to use a linear regression model. We generated best-fit line plots for each of the independent variables in table 1 regressed against the dependent variable stream flow. These plots are shown in figures 15 to 20. From these best-fit line plots, the area, stream slope, and watershed slope variables had the best R squared values and positive linear relationship. The maximum and minimum temperature variables along with precipitation had the worst linear fit with stream flow. Their R squared values were very low with the precipitation variable looking very random in describing stream flow. At this point in the analysis it appears that the area, stream slope and watershed slope will be the better variables to predict stream flow.

While the linear regression plots provided some idea of the extent of the relationship between two variables, the correlation coefficient gives a summary measure that communicates the extent of correlation between two variables in a single number (Kachigan, 1986). The higher the correlation coefficient, the more closely grouped are the data points representing each objects score on the respective variables. Some important assumptions of the correlation coefficient are that the data line in groupings that are linear in form. The other important assumptions include that the variables are random and measured on either an interval or a ratio scale. In addition, the last assumption for the use of the correlation coefficient is that the two variables have a bivariate normal distribution. The correlation matrix for the data used in this study is shown in table 3.

The variables with significant correlations ($R > .7$) are shaded in table 3. The variables listed in order of highest correlation to lowest significance are mintemp and maxtemp, flow and area, precip and maxtemp, and precip and mintemp. The correlations between the weather data were expected. In areas of higher precipitation, the temperature will be cooler (the annual averages for maximum temperature will be lower and the annual average for minimum temperatures will be lower) hence the high negative correlation. The other high positive correlated variables indicate that the variation in one variable will lead to variation in the other variable.

Performing regression analysis on the data was the next step in formulating a relationship and model to predict and estimate stream flow. Using the technique by Garren (1992) we set out to first create a regression equation with all the variables included, evaluate the P values of each variable, and eliminate variables until the highest adjusted R square is found. The first run with the regression analysis indicates that the variables area,

strmslop and maxtemp will have the most influence on flow because of their low P values. Table 4 shows the regression analysis including all the variables.

By systematically removing the variables with a high P value and noting the R squared adjusted value, we can arrive at a final set of variables to use in a regression equation to estimate stream flow. Table 5 shows the regression analysis results after removing the variable with the highest P value (mintemp).

The R squared adjusted improved slightly to 89.9% with mintemp removed. This process of removing the current highest P value variable and re-running of the model was repeated six times. The associated R squared values were noted and table 6 was created from the results.

As table 6 indicates, the combination of variables that provided the highest R squared adjusted value were area, maxtemp, and strslope. The associated regression equation with the optimal set of variables is:

$$\text{flow} = 1232 + 0.00304\ \text{area} - 23.6\ \text{maxtemp} + 0.338\ \text{strmslope}$$

The next procedure used in the analysis was discriminant analysis. We used this technique to identify relationships between qualitative criterion variables and the quantitative predictor variables in the dataset. We wanted to identify boundaries between the groups of watersheds that the gauges were associated. The boundaries between the groups are the characteristics that distinguish or discriminate the objects in the respective groups. Discriminant analysis allows the user to classify the given objects into groups – or equivalently, to assign them a qualitative label – based on information on various predictor or classification variables (Kachigan, 1992).

The gauge station dataset was assigned a qualitative variable based on which major drainage basin in West Virginia the area was located. The major basins used were the Monongahela (m), Gauley (g) and Other (x). The class "other" was assigned to gauges that did not fall in the Monongahela or Gauley drainage basins. Running the discriminant analysis in Minitab produced the results shown in table 7.

Only gauge one and gauge five were reclassified from the discriminant analysis results. It should be noted however that the discriminant function should be validated by testing its efficacy with a fresh sample of analytical objects. Kachigan (1992) notes that the observed accuracy of prediction on the sample upon which the function was developed will always be spuriously high, because we will have capitalized on chance relationships. The true discriminatory power of the function will be found when tested with a completely separate sample.

By using discriminant analysis, we were interested in how the given groups differ. In the next analysis step, cluster analysis, our goal is to find whether a given group can be partitioned into subgroups that differ. The advantage of the approach is in providing a

better feel of how the clusters are formed and which particular objects are most similar to one another.

The cluster analysis was performed with distance measures of Pearson and Average and link methods of single and Euclidean. The Average and Euclidean choices worked the best in identifying clusters. Figure 21 shows the dendrogram results and table 8 lists the computation results.

From the clustered results, gauges 1 and 7 (g1 and g13) are the most alike and merge into a cluster at around 85 on the similarity scale. Gauges 3 and 11 (g7 and g22) are the next most similar at the 78 level. However, these objects do not form the same cluster until a lower level of similarity around the 35 level. By clustering the objects, we were able to identify groups that are alike and because of the small dataset, it was easy to examine the data table and discover values that make the objects similar.

After cluster analysis, we choose to do a factor analysis as an aid in data reduction. Although we only have seven variables, we thought we might gain insight into removing the duplicated information from among the set of variables. The results were assembled as a loading plot – figure 22, a score plot – figure 23, and a scree plot – figure 24. The output session data is listed in table 9.

From these results, the variables high in loadings on a particular factor would be those which are highly correlated with one another, but which have little or no correlation with the variables loading highly on the other factors. The negative loading variable has a meaning opposite to that of the factor. The size of the loading is an indication of the extent to which the variable correlates with the factor.

Limitations, and Discussion of Results

The limitations with this study can be attributed to the number of gauges used and the variables used to predict stream flow. With more complete data over the state, we would have been able to assemble more gauges for this component of the project. Also, if possible it would have been good to include variables used to describe interception, evapotranspiration, infiltration, interflow, saturated overland flow, and baseflow from groundwater. The rate and areal distribution of rainfall input would have been helpful in establishing the catchment retention.

Other issues with the data collection make the estimation of stream flow difficult. First, there is very high variability in recording stream flow data. The stream flow variable exhibited the highest standard deviation and variation across the year. Second, taking yearly annual averages was a crude method in which to characterize the varying conditions that occur across seasons, months, weeks, and even days. Third, the precipitation and temperature data used in the study needed to be better allocated to the gauge drainage areas (as compared to using the drainage area average for the variable) because of the amount of variability that is present in the entire watershed for the precipitation and temperature data. Overall, the choice of variables to analyze were

appropriate based on the success other studies found. In the study the results of the multivariate regression indicated that stream flow could best be estimated using area, stream slope and 30 year annual average maximum temperature. Other data analysis techniques revealed the correlation present between the two temperature variables, flow and area, and precipitation to the two temperature variables.

The last important summary from the tests came from the cluster analysis that grouped the gauge station objects based on similarity. The grouped gauges shared the same ecoregions. Ecoregions are defined as "regions of relative homogeneity in ecological systems or in relationships between organisms and their environments" (Omernik 1987). Omernik (1987) mapped the ecoregions of the conterminous United States, based on regional patterns in individual maps of land use, land surface form, potential natural vegetation, and soils. A discriminant analysis using the ecoregion of each gauge station catchment area would have been a better choice than the using the major river basins used in this study. The similar gauge station catchment areas identified by the cluster analysis and the associated ecoregion borders in West Virginia are displayed in figure 25.

Component 6. The environmental database

An environmental database of point data was included within SWPS. These points are found in the shapefiles directory of SWPS and are loaded for viewing when a user defines a study area location in the state. A brief listing of some of the files in the environmental database follows:

- National pollution discharge elimination system sites
- Landfills
- Superfund sites (CERCLIS)
- Hazardous and solid waste sites (RCRIS)
- Toxic release inventory sites
- Coal dams
- Abandoned mine land locations
- Animal feed lots
- Major highways
- Railroads

Component 7. UTM latitude/longitude conversion utility

This capability of SWPS allows the user to map coordinates in degrees, minutes and seconds by using an input dialog screen. The user's points are then mapped in the UTM zone 17 projection. Points may be added to an existing point feature theme or a new point theme can be created. The ability to type coordinates and have the points reprojected saves the user many extra steps. In addition to mapping points from user input, a point can be queried for its x and y locations in UTM, stateplane, or latitude and

Appendices
Listing of Tables

Table 1. Data used in study

id#	USGS Gauge name	Upstream drainage area (acres)	30yr annual precip ave (inches)	30yr annual ave temp max(F)	30yr annual ave temp min(F)	30yr annual Stream flow (cfs)	stream elevation drop max-min in (meters)	Watershed Slope average (degree)
g1	1595200	31296	52	54	35	99.68	418	5
g5	3050000	120352	50	57	37	379.37	607	15
g7	3053500	176708	46	60	38	613.56	643	11
g10	3061000	484507	43	62	39	1158.14	26	13
g11	3061500	74501	42	61	39	168.99	130	13
g12	3062400	7146	43	60	37	16.54	189	9
g13	3066000	55068	53	54	36	210.40	289	6
g17	3114500	289609	42	62	40	665.40	57	15
g19	3180500	85166	53	55	36	273.49	435	14
g21	3189100	338131	53	57	37	1445.61	743	13
g22	3190400	232990	50	59	38	750.36	830	11
g24	3195500	346231	48	59	38	1176.66	933	17
g26	3202400	196645	47	63	39	421.78	583	18

Table 2. Basic statistics

Variable	N	Mean	Median	TrMean	StDev	SE Mean	Minimum	Maximum	Q1	Q3
area	13	187565	176708	176972	144629	40113	7146	484507	64784	313870
precip	13	47.85	48	47.91	4.34	1.2	42	53	43	52.5
maxtemp	13	58.692	59	58.727	3.066	0.85	54	63	56	61.5
mintemp	13	37.615	38	37.636	1.446	0.401	35	40	36.5	39
flow	13	568	422	538	455	126	17	1446	190	954
strmslop	13	452.5	435	447.6	299.3	83	26	933	159.5	693
wsslope	13	12.31	13	12.45	3.88	1.08	5	18	10	15

Table 3. Correlation matrix

	area	precip	maxtemp	mintemp	flow	strslope	wsslope
area	1	-0.212	0.470	0.571	0.922	0.138	0.516
precip	-0.212	1	-0.850	-0.781	0.039	0.560	-0.279
maxtemp	0.470	-0.850	1	0.930	0.245	-0.226	0.590
mintemp	0.571	-0.781	0.930	1	0.356	-0.217	0.647
flow	0.922	0.039	0.245	0.356	1	0.392	0.435
strslope	0.138	0.560	-0.226	-0.217	0.392	1	0.245
wsslope	0.516	-0.279	0.590	0.647	0.435	0.245	1

Table4.

Regression Analysis including all variables

The regression equation is
flow = 2325 + 0.00310 area - 12.0 precip - 37.3 maxtemp + 8 mintemp
+ 0.423 strmslope - 4.8 wsslope

Predictor	Coef	StDev	T	P
Constant	2325	4370	0.53	0.614
area	0.0030987	0.0004281	7.24	**0.000**
precip	-12.02	30.84	-0.39	0.710
maxtemp	-37.31	53.50	-0.70	**0.512**
mintemp	7.8	100.7	0.08	0.941
strmslop	0.4235	0.2281	1.86	**0.113**
wsslope	-4.83	18.54	-0.26	0.803

S = 156.3 R-Sq = 94.1% R-Sq(adj) = 88.2%

Table 5.

Regression Analysis with mintemp removed

The regression equation is
flow = 2492 + 0.00311 area - 12.3 precip - 35.0 maxtemp + 0.421 strmslope
- 4.3 wsslope

Predictor	Coef	StDev	T	P
Constant	2492	3522	0.71	0.502
area	0.0031121	0.0003628	8.58	0.000
precip	-12.35	28.30	-0.44	0.676
maxtemp	-35.00	41.23	-0.85	0.424
strmslop	0.4208	0.2089	2.01	0.084
wsslope	-4.33	16.11	-0.27	0.796

S = 144.7 R-Sq = 94.1% R-Sq(adj) = 89.9%

Table 6. Multiple regression results

Variables included in the regression	R squared adjusted
Area, mintemp, maxtemp, precip, strslope, wsslope	88.2
Area, maxtemp, precip, strslope, wsslope	89.9
Area, maxtemp, precip, strslope	91.1
Area, maxtemp, strslope	91.8
Area, strslope	90.5
Area	83.6

Table 7.

Discriminant Analysis

Linear Method for Response: class
Predictors: area precip maxtemp mintemp flow strslope wsslope

Group	g	m	x
Count	2	5	6

Summary of Classification

Put into Group	....True Group.... g	m	x
g	2	0	0
m	0	4	1
x	0	1	5
Total N	2	5	6
N Correct	2	4	5
Proportion	1.000	0.800	0.833

N = 13 N Correct = 11 Proportion Correct = 0.846

Squared Distance Between Groups

	g	m	x
g	0.0000	14.5434	17.0393
m	14.5434	0.0000	4.5539
x	17.0393	4.5539	0.0000

Linear Discriminant Function for Group

	g	m	x
Constant	-7379.7	-7053.9	-7003.2
area	-0.0	-0.0	-0.0
precip	85.6	83.5	83.6
maxtemp	86.5	84.2	84.3
mintemp	157.5	155.0	153.0
flow	0.8	0.7	0.7
strslope	-0.3	-0.3	-0.3
wsslope	-38.0	-37.0	-36.6

Summary of Misclassified Observations

Observation	True Group	Pred Group	Group	Squared Distance	Probability
1 **	x	m	g	20.956	0.000
			m	5.163	0.578
			x	5.796	0.421
2 **	m	x	g	23.906	0.000
			m	5.223	0.229
			x	2.790	0.771

gauge id	majshed	class	FITS1
g1	NorthBranch	x	m
g5	Tygart	m	x
g7	Tygart	m	m
g10	WestFork	x	x
g11	MonRiver	m	m
g12	MonRiver	m	m
g13	Cheat	m	m

Listing of Figures

Figure 3

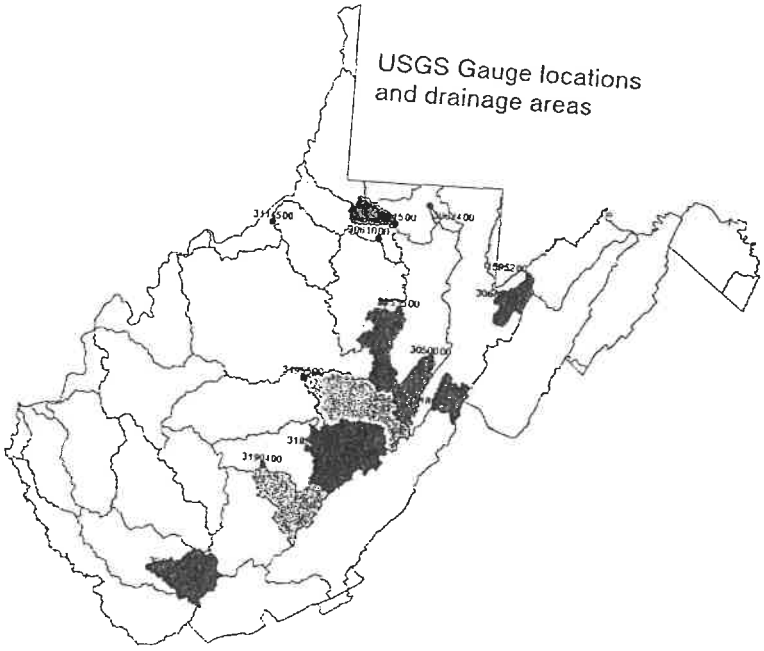
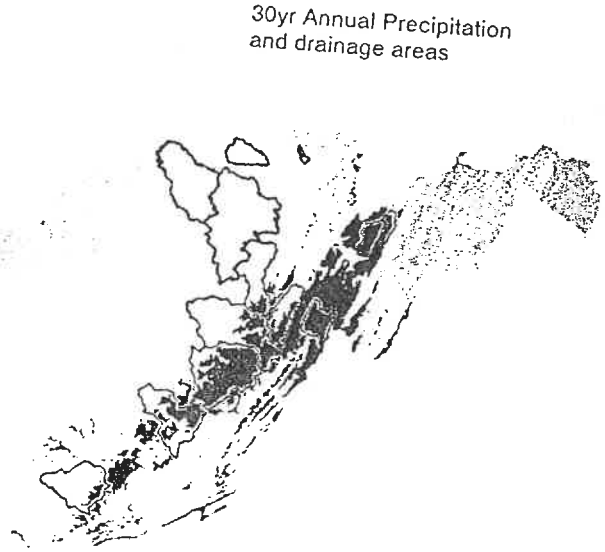


Figure 4



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

OCT 25 2000

Dr. Edward Snyder, Ph.D., Chairman
West Virginia Environmental Quality Board
1615 Washington Street, East
Suite 301
Charleston, WV 25311

Dear Dr. Snyder:

I was extremely disappointed to learn the details of the Board's decisions concerning the proposed antidegradation procedures that will be referred to the West Virginia legislature for enactment, as reflected in the August 31 proposal referred to the Secretary of State. As you are aware, the Environmental Protection Agency (EPA) repeatedly voiced its concern that these procedures remain faithful to the State's antidegradation policy and the underlying requirements of the Clean Water Act.

On August 16, 2000, I transmitted to the Board EPA's views concerning those aspects of the proposed procedures that would need to be strengthened if the procedures are to receive EPA approval. Our objections, while limited, addressed fundamental issues such as the unduly narrow scope of Tier 2 antidegradation review, the multiple exemptions to such review, and the failure to achieve the 'highest statutory and regulatory' requirements for all sources. Notwithstanding the strength of EPA's objections, the Board did not respond to EPA's concerns and instead incorporated changes that further weakened the proposal earlier published for comment.

In light of the Board's action, there appears little prospect that the flaws in the current proposal will be remedied by the West Virginia Legislature in a manner that could lead to EPA approval upon enactment. Accordingly, EPA is immediately proceeding to prepare a draft proposal for Federal procedures that will be applicable in lieu of state-promulgated procedures.

– Exhibit "B" –

This is unfortunate. EPA's clear preference has been and remains that West Virginia maintain its lead role in implementing its antidegradation policies. The West Virginia Division of Environmental Protection (DEP) has a similar view, and has been discussing with us alternative approaches that might address EPA's concerns. We remain open to a dialogue with DEP that might obviate the need for Federal action, but the process of promulgating a Federal proposal will proceed apace while that dialogue continues.

I assure you that in developing the Federal proposal, we will endeavor to work from the proposal initially before the Board, we will limit the changes to those necessary to address concerns of EPA and other interested members of the public, and we will consult with all of the constituency groups that the Board convened to support its proposal. Our hope is to circulate a draft proposal to these constituency groups and to the Board as early as November.

West Virginia's protracted delay, and the Board's ultimate ineffectiveness, in developing proper implementation procedures for antidegradation in its water quality standards program also suggests the need for additional oversight measures to ensure that the protection of water quality in West Virginia is not diminished by the continuing failure to have antidegradation procedures in place. EPA will immediately initiate discussions with DEP to address this issue. We also will be raising with DEP the consequences of this failure in terms of EPA's continued funding of West Virginia's water quality programs.

There may yet be an opportunity for West Virginia to reassert its leadership in resolving this issue. EPA's experience with the Board on this issue over the past decade gives little room for optimism, however, and so the process of Federal promulgation should begin now. If you have any questions please call me or Ray George at 304-234-0234.

Sincerely,

Bradley M. Campbell
Regional Administrator

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Bureau of Environment

Cecil H. Underwood
Governor

Michael C. Castle
Commissioner

October 27, 2000

Brad Campbell, Regional Administrator
EPA Region 3, 3RA00
1650 Arch Street
Philadelphia, PA 19106

Dear Mr. Campbell:

I am writing in response to your October 25, 2000, letter to the Environmental Quality Board ("EQB") regarding West Virginia's proposed anti-degradation implementation plan that has been submitted for legislative rulemaking.

Although the EQB has worked hard to develop an acceptable anti-degradation implementation plan over the past two years or more, including sponsorship of a diverse stakeholder group to assist in developing an anti-degradation implementation plan for West Virginia, I understand that the United States Environmental Protection Agency ("EPA") remains dissatisfied with the final EQB proposal.

The West Virginia Division of Environmental Protection ("DEP"), as the agency charged with implementing West Virginia's water quality standards, including its anti-degradation policy, remains committed to working with the EPA on an acceptable anti-degradation implementation plan. The DEP intends to take the lead in working to address the EPA's concerns within the timeframe specified in your October 25, 2000, letter to the Board.

The DEP intends to build on the work of the Board and the anti-degradation stakeholder group, consult with all of the constituency groups that the Board convened to support its proposal, and is committed to working with EPA on developing a final document that both the DEP and EPA find to be fair and consistent with federal law and guidance.

Sincerely,

Michael C. Castle

Michael C. Castle
Commissioner

MCC/at
cc: Dr. Edward Snyder, EQB Chair
Libby Chatfield, EQB Tech. Advisor
Allyn G. Turner, OWR Chief
Joseph Petrowski, EPA Region III
Robert Koroncai, EPA Region III

November 27, 2000

Bradley M. Campbell, Regional Administrator
US Environmental Protection Agency, Region III
1650 Arch Street
Philadelphia, PA 19103-2029

Dear Mr. Campbell:

I am responding on behalf of the Board to your letter dated October 25, 2000. In that letter you express concern about the proposed antidegradation implementation procedures which the Board submitted last month to the Legislative Rule-Making Review Committee of the West Virginia Legislature. Based on your disagreement with some provisions in the proposal, you explained that you are attempting to work with Mike Castle, Director of the Division of Environmental Protection to further revise the proposed document.

At our meeting on November 17th, the Board discussed your letter and spoke with Director Castle about the role that his agency is taking in this effort. Mr. Castle explained that he has met with you to discuss the EPA's position on the content of the proposed procedures. He also told us that he is attempting to resolve the outstanding issues by soliciting informal comments from the members of the Board's antidegradation stakeholder group. He indicated that he hopes to build on the Board's work and try to develop a product which all of those involved, including your agency, can agree to.

The Board hopes that, in spite of your disagreement with some specific items in the proposed document, you are aware of our commitment to the development of antidegradation implementation procedures that meet both the letter and the spirit of the Clean Water Act. The antidegradation provisions have sparked an extraordinary amount of public interest and the Board has gone to great lengths to include everyone in the decision making process and to develop a proposed policy that will move West Virginia in the direction needed to provide stream protection while recognizing the many and varied uses of our streams. We acknowledge the concerns that you have outlined in your letter and wish to offer our assistance to both you and Director Castle as these ongoing revisions take place. Please don't hesitate to call me (304-876-5428) or Libby Chatfield, our Technical Advisor, if you have questions or concerns.

Sincerely,

Edward M. Snyder, Ph. D.
Chair

cc: Mike Castle, DEP Director

Commissioner's Office
#10 McJunkin Road
Nitro, WV 25143-2506
(304) 759-0515
(304) 759-0526

Bureau of Environment

Cecil H. Underwood
Governor

Michael C. Castle
Commissioner

October 27, 2000

Brad Campbell, Regional Administrator
EPA Region 3, 3RA00
1650 Arch Street
Philadelphia, PA 19106

Dear Mr. Campbell:

I am writing in response to your October 25, 2000, letter to the Environmental Quality Board ("EQB") regarding West Virginia's proposed anti-degradation implementation plan that has been submitted for legislative rulemaking.

Although the EQB has worked hard to develop an acceptable anti-degradation implementation plan over the past two years or more, including sponsorship of a diverse stakeholder group to assist in developing an anti-degradation implementation plan for West Virginia, I understand that the United States Environmental Protection Agency ("EPA") remains dissatisfied with the final EQB proposal.

The West Virginia Division of Environmental Protection ("DEP"), as the agency charged with implementing West Virginia's water quality standards, including its anti-degradation policy, remains committed to working with the EPA on an acceptable anti-degradation implementation plan. The DEP intends to take the lead in working to address the EPA's concerns within the timeframe specified in your October 25, 2000, letter to the Board.

The DEP intends to build on the work of the Board and the anti-degradation stakeholder group, consult with all of the constituency groups that the Board convened to support its proposal, and is committed to working with EPA on developing a final document that both the DEP and EPA find to be fair and consistent with federal law and guidance.

Sincerely,

Michael C. Castle

Michael C. Castle
Commissioner

MCC/at
cc: Dr. Edward Snyder, EQB Chair
Libby Chatfield, EQB Tech. Advisor
Allyn G. Turner, OWR Chief
Joseph Petrowski, EPA Region III
Robert Koroncai, EPA Region III

— Exhibit "C" —

Executive Office
#10 McJunkin Road
Nitro, West Virginia 25143-2506
Telephone 304-759-0515
Fax 304-759-0526

West Virginia Division of Environmental Protection

Cecil H. Underwood
Governor

Michael C. Castle
Director

November 8, 2000

Letters mailed individually to:
Libby Chatfield, WV Environmental Quality Board
Randy Sovic, DEP Office of Water Resources
Tom Brand, Moorefield, WV
Wayne Appleton, Charleston, WV
Dan Ramsey, U. S. Fish and Wildlife Service
Joe Lovett, Mountain State Justice, Inc.
Helen Gibbins, Huntington, WV
Joyce Manyik, St. Albans, WV
Jim Green, Morgantown Utility Board
Tim Stranko, Morgantown Utility Board
Bruce Brenneman, Westvaco
Tom Storch, Marshall University College of Science — NOT MAILED STORCH NO LONGER AT MARSHALL

Dear Stakeholder Representative:

As you know, the West Virginia Division of Environmental Protection ("DEP") has recently committed to working with the United States Environmental Protection Agency ("EPA") on developing an acceptable anti-degradation implementation plan.

The DEP plans to focus its efforts on the issues critical to compliance with the federal Clean Water Act. Accordingly, although the formal comment period on the Environmental Quality Board's ("EQB") proposal has already taken place, the DEP would like to invite any additional, informal comment you may choose to offer on the pending EQB proposal. In particular, the DEP is interested in comments, if any, on the non-consensus portions of the proposed implementation policy that in your view are most critical to achieve compliance with federal law.

The DEP is requesting this input from you because of your recent involvement in the EQB's stakeholder process, and because the stakeholder group was designed to represent a broad spectrum of interests. If you choose to submit informal comments, I am requesting that you submit them by November 20, 2000.

Building on the work of the Board, the anti-degradation stakeholder group, and any informal comments received pursuant to this correspondence, the DEP intends to continue to work with EPA to develop a final document that both the DEP and EPA find to be fair and consistent with federal law and guidance, and hopes to complete these steps prior to the beginning of West Virginia's 2001 legislative session.

I appreciate your continued interest in implementation of West Virginia's anti-degradation policy.

Sincerely,

Michael C. Castle

Michael C. Castle
Director

cc: Dr. Snyder, EQB Chair
Libby Chatfield, EQB Tech. Advisor
Allyn G. Turner, OWR Chief
Joseph Petrowski, EPA Region III
Robert Koroncai, EPA Region III

FROM

PAM MOE-MERRITT
CONSERVATION PROGRAM DIRECTOR

WEST VIRGINIA
RIVERS COALITION

HEADQUARTERS
801 N. Randolph
Elkins WV 26241
Phone: 304.637.7201
Fax: 304.637.4084

SHAVERS FORK OUTPOST
ROUTE 1, BOX 29B
KERENS, WV 26276
(304) 478-4922
PHONE [redacted]

TO

EQB
304.558.4116

SENT BY	ATTENTION:	NO. PAGES (INCLUDING COVER)
Pam	Libby Chatfield	

MESSAGE:

11-15-00
12 pages Total

Libby -

for you + Dr. Snyder + Board -- fyi - comments we sent to DEP on their requests. they are the same as we submitted to EQB w/ some changes in wording/paras.

Pam

FROM

WEST VIRGINIA
RIVERS COALITION

801 N. RANDOLPH AVE.
ELKINS, WV 26241
PHONE (304) 637-7201
FAX (304) 637-4084

TO

WV DEP
304.759.0526

SENT BY Pam Moe Nuttall

ATTENTION: Mike Castle, Director, WVDEP
X0575

NO. PAGES (INCLUDING COVER) 11

MESSAGE:

November 15, 2000

Dear Mr. Castle,

Please consider these comments on behalf of the West Virginia Rivers Coalition and 15 organizational members of the West Virginians for Clean Water Campaign as you work with EPA on an antidegradation implementation policy that is fully consistent with the Federal Clean Water Act.

Sincerely,

Pam Moe Nuttall

West Virginia Rivers Coalition◆West Virginia Highlands Conservancy◆West Virginia Council Trout Unlimited◆West Virginia B.A.S.S. Federation◆Ohio Valley Environmental Coalition◆Potomac Headwaters Resource Alliance◆Raymond Proffitt Foundation◆Student Environmental Network◆Mountaineer Chapter Trout Unlimited◆Concerned Citizens Coalition◆Blue Heron Environmental Network ◆Coal River Mountain Watch◆Green Club of West Virginia Wesleyan College ◆Shavers Fork Coalition◆Friends of the Cacapon River◆American Whitewater

November 15, 2000

Mr. Michael Castle
Director, West Virginia Division of Environmental Protection
10 McJunkin Road
Charleston, WV 25143-2506

Dear Mr. Castle :

As concerned citizens of West Virginia, who utilize our state's waters for drinking, swimming, fishing, boating and other recreational uses; and as members of the West Virginians for Clean Water Campaign, we urge the WV Division of Environmental Protection (DEP) to consider the following comments as you consider the finalization of an antidegradation implementation policy for our waters. These comments cover both the July 3, 2000 draft Environmental Quality Board (EQB) document and the June 29, 2000 Environmental Protection Agency (EPA), Region III letter of comment on the document.

Process Issues

Changes were made to prior draft implementation documents via input from a stakeholder committee convened in 1999. It was our understanding that the mission of the stakeholder committee was to submit consensus comments to the EQB using a prior Board draft as a template for those discussions. Instead, a draft industry document was used for many stakeholder discussions and thus the industry document was allowed to drive the stakeholder process. While the stakeholder document finally submitted to the EQB shows areas of consensus, it also shows the vote tallies in areas where consensus was not achieved. We believe this undermines the nature of the consensus process and gives additional weight to the collective votes of dischargers. This flawed process has led to a draft antidegradation implementation plan that is inconsistent with federal regulations and West Virginia's own antidegradation policy. The policy clearly does not serve the best interests of the citizens of West Virginia or adequately protect the waters of the state.

Specific comments:

4A.1 Applicability to only new and expanded regulated activities is counter to federal regulations that state "the State shall assure that there shall be achieved the highest statutory and regulatory requirements for all new and existing point sources". This

portion of the policy is also counter to West Virginia's own antidegradation policy at 46-1-4.1.b.

Grandfathering gives existing dischargers a clear and permanent advantage over new activities - forever. It rewards existing activities that may not be in the public interest or capable of passing an antidegradation review. Grandfathering penalizes new and environmentally cleaner industries and places them at a competitive disadvantage relative to existing dischargers.

We urge changing the language of the first sentence in the opening paragraph at 4A.1 to read: "The antidegradation implementation procedures herein apply to all activities."

4A.2. New language added to the antidegradation policy at 4.1.b makes clear that it applies to all waters. This language could be re-located to clear up any ambiguity in this regard.

Additionally, we would like to respond to the August 3, 2000 comments submitted by the West Virginia Forestry Association. We would like to remind the DEP that the stakeholder group thoroughly discussed this issue, agreeing that the water quality standards were meant to apply to all waters on a waterbody by waterbody approach. Our stakeholder representative, Joe Lovett, received an email request to make a slight change in this language. The July 28, 2000 email request from the West Virginia Forestry Association said they had no problems with the substance but "we could ask that it be changed more as a clerical that substantive 'fix'". (See Attachment #2). Now the WV Forestry Association request is asking to get rid of the language entirely.

There was no dissent within the stakeholders group regarding this issue when it was meeting. And there was no dissent when the stakeholders discussed the policy. The stakeholder group voted unanimously on this issue without any controversy. We believe the language should remain as is.

4A.3. We concur with EPA's letter of June 29, 2000 on this section.

4B.1.a. The phrase "physical problems such as substrate or flow that prevent the use from being attained" should be eliminated. The Clean Water Act (CWA) provides for a Use Attainment Analysis (UAA) to determine whether or not an existing use may be achieved. It is inappropriate to use the antidegradation implementation policy as a substitute for a UAA.

4B.1.c. Please see comments above.

4B.2.a. We agree with EPA in that an antidegradation policy should serve to protect existing uses and **existing water quality** (emphasis added) not merely water quality standards.

4B.2.b. We concur with EPA's letter of June 29, 2000 on this section.

4B.2.c. We concur with EPA's letter of June 29, 2000 on this section.

4B.4. Some members of our Campaign have strong reservations about trading. But since trading is likely to go forward, we offer the following comments:

We strongly object to EPA's letter of June 29, 2000 changing the language "shall ensure that improvement in water quality occurs" to "a lowering of water quality does not occur".

Discharging into the waters of the state is a privilege given to dischargers by the public. Trading is an additional privilege that requires the public to accept some risk that the trade will be implemented as planned. By accepting this risk the public is owed reassurances that the trade be designed to lead to an improvement in water quality. The public also deserves every possible legitimate safeguard for the trade to be carried out in a reliable and straightforward manner.

We believe the trading language is weak and riddled with loopholes that are counter to the intent of 40 CFR §131.12(a)(2). The following points must be included in future trading language:
1) the trade must be for the same form of the parameter;
2) a trade must have a trading offset of 2:1;
3) all trades must be enforceable and must be clearly defined in the permits of involved point source dischargers – those dischargers being liable for the required improvements in water quality;
4) entities involved in trades must have good compliance records and be free of CWA violations;
5) trades should be limited only to requirements that are over and above effluent limits that are already required for dischargers of a type – we must continue to embrace the CWA goal of reducing, not merely trading, discharges to the waters of the state;
6) trades must avoid all "hot spots" and never degrade water quality in any trading segment;
7) if unforeseen "hot spots" do occur the trade should be revisited prior to permit renewal;
8) offset controls should be instituted and put in place prior to any increase in discharge;
9) at no point should trades involve different types of pollutants;
10) trades must occur within the same 8-digit Hydrologic Unit Code;

11) trades involving toxics must be prohibited;
12) trades should involve EPA oversight; and,
13) water quality monitoring sufficient to fully document water quality in the trade stream segments should be required at the expense of the trading partners.

4C.1. through 4C.2.a.1.5. 2. The draft procedures provide that there will not be any Tier 2 review unless the proposed activities degrade the ambient concentration by more than 5% or reduce the assimilative capacity by more than 5%.

This provision effectively exempts from review repeated 5% degradations of water quality. This clearly violates the main purpose of the CWA, which is to reduce and eventually eliminate the discharge of pollutants. 33 U.S.C. §1251(a). Proper implementation of an antidegradation policy is the key to achieving this purpose. These deminimus values should be removed from the policy.

The clear language of the current state antidegradation policy and the current federal antidegradation policy requires the elimination and reduction of pollution wherever possible, not the determination maximum allowable degradation.

Furthermore, there is no scientific basis for the idea that allowing repeated 5% degradations will not impair the existing uses of water. Indeed, as written, the regulation could allow increasing impacts, without any review. For example, if the existing ambient concentration is 100mg/l, the first 5% permitted could increase the ambient concentration to 105mg/l. Then the second 5% permitted would be 5.25mg/l (5% of 105mg/l). The third 5% permitted would be an increase of 5.51mg/l. (5% of 110.25mg/l). And so on ad infinitum. No mater how impaired the water quality becomes, it can always be further degraded, as long as the amount of degradation is "only" an additional 5% of the more restrictive of ambient concentration or assimilative capacity.

Clearly, this deminimus language effectively prevents the implementation policy from addressing cumulative impacts. That is, the cumulative impacts of repeated 5% degradations do not trigger any antidegradation review. The process is driven by individual discharges. If impacts fall below the 5% criteria, but have a cumulative impact of greater than 5%, they can still go forward without any antidegradation review.

We urge adoption of the following language for the first sentence at 4C.2.a.1.A.: "Any proposed activity, including any indirect or cumulative effects of related activities that would degrade the stream at critical flow conditions shall be required to comply with all requirements of Tier 2."

4C.2.a.2. The draft Antidegradation Implementation Procedures contain 14 exemptions. According to the draft, each exemption "shall not be subject to further Tier 2 review requirements". Thus, each of the 14 exemptions is automatically and categorically excluded from antidegradation review.

There is no scientific basis for excluding certain parameters or activities from the requirements of an antidegradation implementation policy. Furthermore, the Federal regulations allow degradation only after all the requirements of a Tier 2 review have been met. 40 CFR §131.12(a)(2). Any attempt to create an automatic waiver is not minimally consistent with the Federal requirements.

4C.3. This section is flawed because it is based on a flawed deminimus concept.

4C.4. We concur with EPA's letter of June 29, 2000 on this section.

4C.5.a. We concur with EPA's letter of June 29, 2000 on this section but will have additional comment in the definition section of the document.

4C.6. through 4C.7 Option 1 and Option 2. In 4C.6.d we support the language in past documents that has been eliminated in this draft i.e. we support the inclusion of "and the proposed activity shall not be allowed." In terms of the proposed options one and two, we have the following comments:

The Federal rule requires, as part of a Tier 2 review, that there be "full satisfaction of the intergovernmental coordination and public participation provisions of the State's continuing planning process". 40 CFR §131.12(a)(2). This provision is practically meaningless as applied to West Virginia, which has not revisited the continuing planning process for 30 years.

The draft Antidegradation Implementation Procedures contain two Options regarding intergovernmental coordination and public participation. §§ 4C.6 - 4C.8, Options 1 and 2. Both Options only require public notice that a proposed activity has been determined to comply with the antidegradation rule. There is no requirement that a period of time be allowed for public comments. Indeed there is no requirement that public comments are to be considered before a final action is taken. Further, there is no provision allowing the public to ask for a hearing. Interestingly, these omissions of a basic public participation process are in violation of West Virginia's own Antidegradation Policy, which requires "opportunity for public comment and hearing". 46 CSR § 1-4.1.b.

Also, the intergovernmental coordination process is unclear in its ability to function appropriately and to meet the Clean Water Act requirement to fully protect existing uses.

Thus far, it is simply a list of the agencies which will be notified (Option 1) or convened in a panel (Option 2). There must be far more guidance on how this will work. That is, what is the protocol for decision making and what are the specific obligations of the state and federal agencies involved? Both Option 1 and Option 2 are seriously flawed. We suggest that a decision-making matrix be worked out by the agencies involved so that these questions are adequately answered and support the intent of the law.

4C.8/(?). We concur with EPA's letter of June 29, 2000 on this section.

4D.4. See comments for 4B.4, however, we believe trading is inappropriate in Tier 2.5 waters.

4D.5. We support the removal of the sentence that says "Activities which result in less than a 5% change may be deemed to have limited effects." Some parameters would be significant even if they were temporary and/or less than 5% change. For example, parameters that concentrate in sediment or bioaccumulate. Also in this section there is no time restriction on what is deemed "short term". We believe short term should be defined as one month or less.

We strongly support the EPA statement that many waters of the state are of special value or importance and should be afforded the special protection provided under Tier 2.5.

4E. This section refers to the description of Tier 3 waters from the main body of the WV Water Quality Standards at 4.1.d. We strongly believe West Virginia's definition of Tier 3 waters is contrary to federal regulations. Federal regulations at 40 CFR 131.12 describe Tier 3 as including high quality waters which meet one or more other factors. These factors include "waters of National and State parks and wildlife refuges." The current West Virginia definition of Tier 3 does not specifically allow for inclusion of these waters. The DEP should redefine Tier 3 waters to be consistent with federal regulations.

We support the approach of prohibiting permanent new or expanded point or nonpoint discharge of pollutants to any waterbody segment that has been designated as an Outstanding National Resource Water.

4E.3. We concur with the language in this section.

4E.4.b. We concur with EPA's letter of June 29, 2000 on this section.

Comments referring to the definition section of the document.

Reasonable less-degrading or non-degrading alternatives: The EQB draft defines "reasonable alternatives" to be less than 110% of the cost of pollution control measures associated with the proposed activity. There may be a case where an alternative that costs 111% of the cost of pollution control is not only reasonable but desirable. Such a possibility should not be prohibited in advance. The current proposal is too inflexible and is minimally demanding on dischargers. The DEP should use a guide of 130% of the cost of pollution control measures but the Director should also be allowed some discretion to go above that figure relative to the environmental improvements that would be gained.

There may be instances where a 25% increase in control measure expenditures is very nearly as effective as 30% and likewise the difference between 30% and 35% may be a remarkable improvement in water quality. The rigid % parameter also tends to reward those who have historically spent the least for environmental controls. This would in effect reward some dischargers who have circumvented environmental expenditures and/or been chronic enforcement problems in the past.

The future well being of West Virginia's waterways and environment, its people and economy, rests with the important work of establishing appropriate policies that adhere with federal standards. Please do your utmost to uphold the Clean Water Act and protect the waters that are so precious and vital to West Virginia's future.

Sincerely,

Pamela C. Moe-Merritt
West Virginia Rivers Coalition

Dr. Margaret Janes
Potomac Headwaters Resource Alliance

Frank Young
West Virginia Highlands Conservancy

James Summers
West Virginia B.A.S.S. Federation

Ed Crum
West Virginia Council Trout Unlimited

Donald S. Garvin, Jr.
Mountaineer Chapter Trout Unlimited

Dianne Bady pmm
Dianne Bady
Ohio Valley Environmental Coalition

Trenton Harper pmm
Trenton Harper
Student Environmental Network

Joe Turner pmm
Joe Turner
Raymond Proffitt Foundation

Vivian Stockman pmm
Vivian Stockman
Concerned Citizens Coalition

Sherry Evasic pmm
Sherry Evasic
Blue Heron Environmental Network

Judy Bond pmm
Judy Bond
Coal River Mountain Watch

Ruth Blackwell Rogers pmm
Ruth Blackwell Rogers
Shavers Fork Coalition

Dr. Jeff Simmons pmm
Dr. Jeff Simmons
Green Club/West Virginia Wesleyan College

Abby Chapple pmm
Abby Chapple
Friends of the Cacapon River

John Gangemi pmm
John Gangemi
American Whitewater

cc:

Dr. Edward Snyder, Chair, WV EQB
Libby Chatfield, Technical Advisor, WV EQB
Allyn Turner, Chief, WVDEP Office of Water Resources
Bradley Campbell, Regional Director, US EPA Region III
Carol M. Browner, Administrator, US EPA
George T. Frampton, Jr., Acting Chair, Council on Environmental Quality
J. Charles Fox, Assistant Administrator, Office of Water, US EPA
Joan Mulhern, Senior Legislative Council, Earthjustice Legal Defense Fund
Leon Szeptyski, Eastern Conservation Director, Trout Unlimited
Ed Hopkins, Senior Washington Representative, Sierra Club
Courtney Cuff, Legislative Director, Friends of the Earth
Daniel Rosenberg, Staff Attorney, Natural Resources Defense Council
Thomas R. Michael, Esq., Michael & Kupec
Joseph Lovett, Esq., Mountain State Justice

Attachment #1

----- Original Message -----
From: Joe Lovett <jlovett@citynet.net>
To: Bruce B. Brenneman <BBBRENN@westvaco.com>
Sent: Tuesday, July 25, 2000 11:40 AM
Subject: Re: BMP Wording in 46-1-4.1.b

Bruce,

Although I like the current language better than the language that you propose, I would reluctantly agree to your change if the comment also contains a promise to support the new language throughout the process, including supporting the rule when it is before the legislature. Joe

----- Original Message -----
From: Bruce B. Brenneman <BBBRENN@westvaco.com>
To: <JLGreen@aol.com>; <jmbrown@ape.com>; <jlovett@citynet.net>; <Daniel_Ramsey@fws.gov>; <rsovic@mail.dep.state.wv.us>; <gibbins@marshall.edu>; <tbrandjr@yahoo.com>
Cc: <chatfe@mail.wvnet.edu>
Sent: Wednesday, July 19, 2000 5:06 PM
Subject: BMP Wording in 46-1-4.1.b

On August 26, 1999, after discussion of the nonpoint source statement in 4.A.2 of Appendix F, we further agreed to amend 4.1.b. of 46CSR-1-4 to add "The Director shall assure that BMPs are sufficient to satisfy the requirements of the Water Quality Standards. If BMPs are demonstrated to be inadequate to meet Water Quality Standards, the Director shall work with the appropriate authorities to require that BMPs be revised or adopted to assure compliance with those standards, or shall require the activity causing the nonpoint source pollution to cease."

I think Joe proposed this language, and we all agreed. My understanding was that the Director would first try to have the BMP fixed, and if this failed, the activity would then cease.

Some in the nonpoint source community think that this could be interpreted to mean that the Director could initially decide whether to either fix the BMP or cause the activity to cease (without first trying to fix it.). These folks would like the language to be clarified.

I propose that we change the statement to read, "the Director shall work with the appropriate authorities to require that BMPs be revised or adopted to assure compliance with the standards, and if this action fails to correct the violation, shall require the activity causing the nonpoint source pollution to cease".

I hope that we can all agree to the change, and allow it to be presented as a consensus agreement during the public comment period. If we are not able to do so, the nonpoint source spokespersons may request deletion of "or shall require the activity causing the nonpoint source pollution to cease".

May I have consent for the proposed change from each of you?

Attachment #2

----- Original Message -----
From: Roger L. Sherman <RLSHERM@westvaco.com>
To: <jlovett@citynet.net>; Bruce B. Brenneman <BBBRENN@westvaco.com>
Sent: Friday, July 28, 2000 11:23 AM
Subject: Re: BMP Wording in 46-1-4.1.b

Joe, thanks for your response to Bruce. I was the one who brought this matter up. I felt that it was simply a drafting issue in that the language left open an interpretation that did not represent my understanding of the intent of the group. It was my hope that if everyone agreed with that understanding we could ask that it be changed more as a clerical than substantive "fix". I'm surprised but I certainly don't expect you to agree to such a change if you feel it was the intent of the group to give the director authority to leapfrog the existing BMP process and immediately shut down an activity. I genuinely felt that the process would benefit if everyone agreed. I'm not sure what you are asking in exchange for your agreement but I wasn't trying to coerce anyone to change an agreed position - I apologize if that appeared to be our intent. Again, thanks for responding.