
WATER RESOURCES ENGINEERING INTERNATIONAL, INC.

955 Massachusetts Avenue, #349 ■ Cambridge, MA 02139-3233

Phone: (617)492-1011 ■ Fax: (617)868-8209

Email: www.wrei98@yahoo.com

James W. Morris, Ph.D.,P.E.
Chief Technology Officer
Bion Environmental Technologies, Inc.

Dear Dr. Morris;

I have contacted three experts in the field of nonpoint source monitoring and modeling of estuarine ecosystems. All three have extensive experience in nutrient loading estimation, impact analysis and control practices. Each of the three has agreed with my analysis and statement sent to you on April 18, 2009, which is attached for reference.

The three experts offering support include:

Barry M. Evans, Ph.D. - expert in non-point source modeling, including extensive Chesapeake Bay applications

William F. Ritter, Ph.D.,P.E. - expert in water quality monitoring and control systems, including extensive Chesapeake Bay applications

Robert Shannon, Ph.D. - expert in biogeochemistry and pollutant impacts on aquatic systems

Please find enclosed, supporting statements by the three experts, the resumes of three experts and the introductory letter I sent to each. I have also included the original N loading question and my response statement as well as my resume.

In summary, All four of the professional water quality experts that reviewed the "Nitrogen Loading Example" agreed that their was no expected significant difference between a "3 year average reduction with variation around the base level" and the "3 year constant base value" as stated in the original example. In addition to the supporting expert opinions, it should be noted that other large-scale nutrient reduction programs for nutrient stressed ecosystems such as the Lake Okeechobee – Everglades (South Florida Water Management District) project utilize a 5-year running average method to achieve load reduction objectives.

Please do not hesitate to contact me if you have further questions about these opinions.

Sincerely,

Paul D. Robillard

(signed electronically 4/30/09)

Paul D. Robillard, Ph.D.
President

Benefits to the Chesapeake Bay ecosystem resulting from nitrogen load reductions averaged over a three-year period.

Background

The Pennsylvania Department of Environmental Protection's document, "Pennsylvania's Chesapeake Bay Tributary Strategy" (2005) provides the following context information on the Chesapeake Bay.

- The Bay is under stress from excessive nitrogen load.
- A total average annual nitrogen load to the Bay is approximately 285,000,000 lb N/year.
- The goal is to reduce the annual nitrogen load to about 175,000,000 lb N/year.
- Roughly 109,000,000 lb N/year is contributed by sources within Pennsylvania.
- Pennsylvania's agricultural activities are responsible for approximately 54,000,000 lb N/year to the Bay, or about 49% of the load from Pennsylvania .

Core question

A hypothetical nitrogen reduction program is being considered that will reduce nitrogen loads on a targeted three-year running average basis. Will variation around a yearly target amount result in negative impacts to the overall load reduction benefit experienced by the Bay's ecosystem over a three-year period from the same load received at a constant yearly amount equal to the three-year average, even though the load reduction in any given year will vary from the three-year period's targeted average?

Example to consider

The example hypothetical nitrogen reduction program is expected to result in average reductions in the nitrogen load reaching the Chesapeake Bay's ecosystem of about 200,000 lb N/year. This represents a reduction in the Bay's current total load of around 0.0007 (0.07%). Compared to the target Bay load goal of 175,000,000 lb N/year, the hypothetical nitrogen reduction program is about 0.0011 (0.11%).

For example, if the variations in this hypothetical example result in 300,000 lb N/year reduction in load to the Bay in the first year, a reduction of 100,000 lb N/year in the second year, and a third year Bay load reduction of 200,000 lb N/year, which is roughly a reduction of total Bay load of 0.07%, $\pm$ a variation of 0.035% with the three-year average remaining at the target 200,000 lb N/year.

Would there be any substantive difference to the benefit realized by the Bay between the example varying load each of the three years (300,000; 100,000; 200,000 lb N/year) for an overall average of 200,000 lb N/year compared to the benefit that would be provided if the load reduction each year was a constant equal to the average at 200,000 lb N/year?

To simplify the core question and example, “Case 1” and “Case 2” will be referenced in this document, where:

Case 1- a three year running average of mass N load reduction, where the annual load varies each year but the average over the three-year period is equal to the target load reduction. (In the example, 300,000; 100,000; and 200,000 in years 1, 2, and 3 respectively, with the yearly average equaling 200,000 lb N/year.

Case 2 –A mass N load/year equal to the target load reduction with no variation from year to year. A constant delivered nitrogen mass load reduction all three years equaling 200,000 lb N/year.

Review Statement by Paul D. Robillard, Ph.D.

After reviewing the above “Nitrogen Loading Background, Core Question and Example” information, it is my opinion that for the range of mass load reductions and the mass variation as described, the difference in delivered N load reduction benefit between a load of 200,000 lb N/year with no variation and the same running average load with a variation around that average load of 100,000 lb N/year will not result in significant difference in impact to the Chesapeake Bay ecosystem. Stated another way, the benefit to the Bay’s ecosystem due to the described reductions for the two cases would be essentially the same or a total reduction of 600,000 lb N/ 3years at an average of 200,000 lb N/year. This conclusion is based on the following points:

- The N loads indicated in the hypothetical example are very small compared with the total target delivered N load to the Bay (approximately 0.11%).
- Flow rates through the Bay will typically vary greatly between events, seasons and annual values. Changes in climate and Bay dynamics control much of the year-to-year variability. Thus the Bay’s ecosystem is somewhat buffered from the dynamic nature of surface inflow and nitrogen loads.
- The time lag for an ecological response from annual nutrient loads for a large water body such as the Chesapeake Bay is often measured in years and even decades.
- The existing average fixed N load in the Bay is likely much larger than the N reductions variation given in the example above based on the total monitored load estimated at approximately 285,000,000 lb N/year. (Case 1 & 2)
- Given the relatively small component of load associated with the variability in the example above (Case 1), it would be expected that the impact of this variability on Bay ecosystem processes would be very small or negligible. For example, total monitored N load could vary by 10%* or more each year (approximately 28,500,000 lb N/year). The variations described above for case 1 are approximately 100,000 lb N/year or 0.035% of the total monitored N load. Therefore, the relative impact of a 10% variation in N load

compared with a 100,000 lb N/year variation in N load reduction would be 285 to 1. Thus the variation in N load reduction would have to increase by 2 or 3 orders of magnitude to even approach levels that could be interpreted as a significant impact on the Bay's ecosystem.

- Generally evaluation and predictive estimates of ecosystem impacts are based on long-term average parameter values recognizing that often, substantial variation occurs around these averages.

In summary, variations in nutrient loads are inevitable due to the dynamic nature of climate and related flow processes. The Bay's ecosystem has adapted to this dynamic environment over decades. Estimated target loads are generally based on parameters with long-term average values. In addition, when the variability of a particular average N load reduction is very small compared to the total delivered load and the variability around that average is even smaller, negligible impacts due to that small variation are likely to be observed. The most important parameter is the target delivered load reduction over a period of years, which is the same value in the 3-year running average (Case 1) and the no variation (Case 2) hypothetical examples described above. Therefore the example given realistically reflects the load reduction goals and sound methods to incorporate unavoidable variability in the implementation of those goals. I would consider the 3-year running average N load reduction calculation (Case 1) to be a sound method associated with an effective program to reduce N loading and improve ecosystem health and sustainability in the Chesapeake Bay.

*Based on my professional experience, it is not uncommon for annual monitored mass nutrient loads to vary from 10-50 % from year to year, and higher when periods of extreme climatic events (such as flooding and drought events) are included in the average annual load calculation.

Dear _____,

April 21, 2009

I have been retained by an entity to obtain an expert opinion concerning a particular scenario for the reduction of nitrogen stress on the Chesapeake Bay . This request is for an independent, peer level, third party opinion on the specific situation detailed in the attached document. To retain independent detachment the nature of the entity will not be revealed; whether regulatory, environmental advocate, industry, agricultural, consultant, legislative or legal; other than to say they are interested from a Pennsylvania perspective.

The attached document details the question to be addressed and provides you my professional response. The situation to be considered is fairly straightforward and the statement to describe it is brief (well under three pages total including my response). Your response can be at the level of effort you feel appropriate. Thus, you may respond with a very few sentences (even one would suffice) stating your concurrence with the opinion I have offered; or you could use the attached document as a draft to which you can make edits as needed to accurately reflect your opinion, or indeed you may feel free to create your own opinion document; whichever approach serves you best.

The opinion is requested from you as an expert and not as a representative of your employer or other organization with which you may have an affiliation. Since your opinion is at the peer level, I would respectfully request that you append a vitae or resume to your response.

Since a professional opinion is being requested, please invoice

me directly (Paul Robillard, 955 Mass. Ave., #349, Cambridge, MA 02139) at your usual professional services fee rate.

Thanks for taking the time to consider this request. Please let me know whether you will be responding or not.

Sincerely,

Paul

Paul D. Robillard , Ph.D.

Supporting Statements by Experts

Robert Shannon, Ph.D.

"I looked over your scenarios and question, and see no significant difference in benefits between the Case 1 scenario (wide annual variability in N load reduction) vs Case 2 (no variability over three years). That is, I agree with your statement."

Barry M. Evans, Ph.D.

"I've read your review and agree with your conclusions."

William F. Ritter, Ph.D., PE

"I concur with your statement regarding nitrogen loads to the Chesapeake Bay. You can get considerable variation in nitrogen loads from year to year from nonpoint sources given the fact that you can get largest extremes in hydrologic events and runoff from year to year. Nitrogen transported from Pennsylvania has a fairly long detention time in the Bay itself so you should not see a great effect from the variation in nitrogen load in one given year. Resulting effects in the Bay from nitrogen load reductions will occur gradually over many years. "

BARRY M. EVANS

EDUCATION

Pre-Engineering. Vincennes University, 1970-71.
B.S., Natural Resources. The Ohio State University, 1975.
M.E.P.C., Environmental Pollution Control. The Pennsylvania State University, 1978.
Ph.D., Soil Science. The Pennsylvania State University, 2002.

CAREER SUMMARY

2002-Present Senior Research Associate, Penn State Institutes of Energy and the Environ.

Dr. Evans is Director of the GIS Support Center, a research unit affiliated with the Penn State Institutes of Energy and the Environment (PSIEE). At PSIEE, he is primarily responsible for obtaining and managing research projects funded by a variety of governmental and institutional sponsors. One of his primary activities recently has been to manage a multi-year, multi-million dollar open-end contract to provide environmental /GIS support services to the Pennsylvania Department of Environmental Protection (PaDEP), as well as other state agencies. Of late, he has been primarily involved in developing specialized software applications to support water resource/water quality assessment needs. To date, Dr. Evans' group has developed numerous software applications (e.g., AVGWLF, MapShed, AVStreams, PRedICT, AVNPSTool and SWAP-GIS) to support ongoing activities in the areas of watershed modeling, TMDL assessment, source water protection, and evaluation of pollution mitigation strategies at the watershed level. Dr. Evans has also completed a number of water quality assessment projects for the PaDEP, National Park Service, and USEPA that have involved BMP evaluation, nutrient trading, water quality data analyses and water quality modeling. In addition to his state and national work, he has also provided technical expertise to various international groups such as the Joint Research Commission of the European Union; Mexican Institute of Water Technology; the State of Nuevo Leon, Mexico; the Swedish Meteorological and Hydrological Institute; the Environment Agency (of England and Wales), the National Water Commission of Israel; the Argentine Institute of Oceanography; and to local and provincial groups in Ontario, Canada.

1995-2002 Senior Research Assistant, Environmental Resources Research Institute, Penn State University

Primarily responsible for obtaining and managing GIS projects funded by a variety of governmental and institutional sponsors. Managed a multi-year, multi-million dollar contract to provide GIS services to the Pennsylvania DEP and other state agencies.

1988-1995 President, Geo Decisions, Inc., State College, PA

Responsible for corporate management as well as obtaining and managing GIS and environmental projects undertaken by GDI, a large, nationally-recognized firm specializing in geo-spatial technologies..

1984-1988 Research Assistant, Environmental Resources Research Institute, Penn State University

Managed and conducted a variety of environmental assessment and mapping projects conducted using GIS and remote sensing technology.

1981-1984 Manager of Environmental Mapping Section, Resource Technology Corporation, State College, PA

Managed and supervised contracted work related to environmental mapping, geomorphology, and landscape analysis.

1980-1981 Owner/Manager, Remote Sensing Consultants, State College, PA

Obtained and managed contracted work such as septic system surveys, development of a wetlands analysis manual, and various non-point pollution source inventories.

1978-1980 Consultant, Development Sciences, Inc., Sagamore, MA

Worked on engineering sanitary surveys, various EPA-sponsored projects, and environmental resource inventories.

1976-1978 Project Manager, Trident Engineering, Warrenton, VA

Worked as an on-site contractor at the U.S. EPA's Environmental Photographic Interpretation Center. Projects completed involved use of aerial photography for various environmental analyses and mapping activities such as hazardous waste inventories, septic system analyses, oil spill emergencies, and land use/cover mapping.

PROFESSIONAL MEMBERSHIPS

Soil and Water Conservation Society
American Water Resources Association
International Environmental Modeling and Software Society
International Water Association

RECENT CONSULTANCIES

Greenland International Consulting, Inc.
Skelly & Loy, Inc.
Clear Creeks Consulting, Inc.
Louis Berger International, Inc.
CH2M-Hill, Inc.
Amazon Center for Environmental Education and Research
Swedish Meteorological and Hydrological Institute
Mexican Institute of Water Technology
National Water Commission, State of Israel
Argentine Institute of Oceanography
The Cadmus Group, Inc.
Environment Agency of England and Wales

OTHER

U.S. Representative on Management Committee of the Diffuse Pollution Sub-Group of the International Water Association

PUBLICATIONS AND REPORTS

Evans, B. M., 2008. An Evaluation of Potential Nitrogen Load Reductions to Long Island Sound from the Connecticut River Basin. Report to the New England Interstate Water Pollution Control Commission, Penn State Institutes of Energy and the Environment, 66 pp.

Strobl, R.O., B.M. Evans, F. Somma, E. Garcia-Gorriz, A. Stips and J.M. Zaldivar, 2008. Feasibility Study of the Application of the LOICZ Budget to the Mediterranean Sea. Joint Research Commission, European Union, 25 pp.

Markel, D., F. Somma, and B.M. Evans, 2006. Using a GIS Transfer model (AVGWLF) to evaluate pollutant loads in the Lake Kinneret watershed, Israel. *Water Science & Technology*, Vol. 53, No. 10.

Evans, B.M., 2006 A Statewide Approach to Identifying, Quantifying and Mitigating Diffuse Pollution-Related Problems. In: *Managing Rural Diffuse Pollution, Proceedings SAC and SEPA Biennial Conference*, Edinburgh, Scotland, April 2006.

Evans, B.M., 2005. Recent Enhancements to AVGWLF and Related Software Tools to Support Pollutant Load Estimation and Evaluation of Pollution Mitigation Strategies. In: *Proc. of Specialist Conference on Diffuse Pollution*, Johannesburg, South Africa, p. 36.

Watts, S., B. Gharabaghi, R.P. Rudra, M. Palmer, T. Boston, B. Evans, and M. Walters, 2005. Evaluation of the GIS-Based Nutrient Management Model CANWET in Ontario. In: *Proc. 58th Natl. Conf. Canadian Water Resources Assoc.*, June 2005, Banff, Canada.

Evans, B.M. and T. Hristov, 2004. Simulation of Stream Flow in the Yantra River Basin, Bulgaria via a GIS-Based Modeling Approach, 2004. In: Pahl-Wostl, C., Schmidt, S. and Jakeman, T. (eds) *iEMSs 2004 International Congress: "Complexity and Integrated Resources Management"*. Intl. Environ. Modelling and Software Soc., Osnabrueck, Germany, June 2004.

Sheeder, S.A. and B.M. Evans, 2004. Development of Nutrient and Sediment Threshold Criteria for Pennsylvania TMDL Assessment. *J. American Water Resources Association*, Vol. 40., No. 4, pp.881-888.

Sheeder, S.A., B.M. Evans, and E. Louis. 2004. Developing Statistical Models to Establish the Relationship Between Urban Nonpoint Source Pollutant Loads and Watershed Characteristics in the Chesapeake Bay Watershed. Prepared for U.S. EPA, Chesapeake Bay Program Office, Project ID: LU-B.

Graczyk, T.K., C.J. Shiff, E. Nizeyimana, B. Evans, and J.A. Patz, 2003. Ecology of zoonotic cryptosporidiosis in watersheds containing cattle farming operations. In: *"Cryptosporidium from Molecules to Disease"*, R.C.A. Thompson, U. Morgan, and A. Armson (eds.). Elsevier Science, Amsterdam, pp. 353-358.

Evans, B.M., S.A. Sheeder, and D.W. Lehning, 2003. A Spatial Technique for Estimating Streambank Erosion Based on Watershed Characteristics. *J. Spatial Hydrology*, Vol. 3, No. 2., (www.spatialhydrology.com).

- Evans, B.M., 2003. A Generic Tool for Evaluating the Utility of Selected Pollution Mitigation Strategies within a Watershed. Proc. 7th International Conf. On Diffuse Pollution and Basin Management, Dublin, Ireland, Vol. 2 of 4, pp. 10.7 – 10.12.
- Evans, B.M., D.W. Lehning, K.J. Corradini, G.W. Petersen, E. Nizeyimana, J.M. Hamlett, P.D. Robillard, and R.L. Day, 2002. A Comprehensive GIS-Based Modeling Approach for Predicting Nutrient Loads in Watersheds. J. Spatial Hydrology, Vol. 2, No. 2., (www.spatialhydrology.com).
- Evans, B.M., D.W. Lehning, K.J. Corradini, and M.C. Anderson, 2002. Description of GIS-Based Methodology Used to Conduct Source Water Assessments for Small Community Water Systems in Pennsylvania. Environ. Resources Research Institute, Penn State University, 23 pp.
- Chang, H., B.M. Evans, and D. Easterling, 2001. The Effects of Climate Change on Stream Flow and Nutrient Loadings. J. Amer. Water Resources Assoc., Vol. 37, No. 4, pp.973-986.
- Hamlett, J.M., B.M. Evans, C.G. Knight, J.J. Carmichael, T.N. Hristov, D. Dimitrov, V.D. Ioncheva, I.I. Nikolov, M.P. Staneva and H. Chang, 2001. Yantra decision support system: Linking GIS with nonpoint source and in-stream models. ASAE Microfiche No. 01-2123. ASAE, St. Joseph, MI.
- Ghebremichael, L.T., J.M. Hamlett, and B.M. Evans, 2001. Incorporating a pesticide component into the AVGWLF model for water quality assessments. ASAE Microfiche No. 01-2129. ASAE, St. Joseph, MI.
- Evans, B.M., S.A. Sheeder, and K.J. Corradini, 2001. AVGWLF, Version 4.03: Users Guide. Environmental Resources Research Institute, Penn State University, 73 pp.
- Dávila, J.I., M.A. Gómez, F.A. Córtez, B.M. Evans, R. Heidl and M.A. Mijangos, 2000. Evaluation of Diffuse Contamination in the Rio Apatlaco Basin Via Application of the ArcView-GWLF Interface. Proc. 29th Latin American Congress on Hydrology, Cordoba, Argentina.
- Graczyk, T.K., B.M. Evans, C.J. Shiff, H.J. Karreman, and J.A. Patz, 2000. Environmental and Geographical Factors Contributing to Watershed Contamination with *Cryptosporidium parvum* Oocysts. Environmental Research, Section A, Vol. 82, pp. 263-271.
- Arnold, J., R. Binger, D. Burrows, P.A. DeBarry, E.T. Engman, B.M. Evans, T.A. Evans, J. Garbrecht, L. Garcia, L.E. Johnson, J.D. Jorgeson, V. Krysanova, G. Leavesley, D.R. Maidment, E.J. Nelson, F.L. Ogden, F. Olivera, R.G. Quimpo, T.A. Seybert, W.T. Sloan, and F. Theurer, 2000. GIS Modules and Distributed Models of the Watershed. American Society of Engineers, Reston, VA, 120 pp.
- Mustalish, R.W., C. Tucker, K. Klein and B. Evans, 1999. The Development of a GIS for Managing Natural Resources in the Peruvian Amazon. Proc. Manejo de Fauna Silvestre en la Amazona (Conf. on Wildlife Management in the Amazon), Lima, Peru.
- Evans, B.M., 1998. Development of an Historic State-Wide Defoliation Database in Pennsylvania. In: Proc. 1st International Conference On Geospatial Information in Agriculture and Forestry, Lake Buena Vista, FL, pp. 309-313 (Vol. II).

- Evans, B.M. and E. Nizeyimana, 1998. GIS-Based Quantification of Regional Nutrient Loads. Proc. 3rd International Conf. On Diffuse Pollution, Edinburgh, Scotland, pp. 48-55.
- Evans, B.M., 1998. GIS-Based Quantification of Statewide NPS Nutrient Loads in Pennsylvania. In: Proc. Watershed Mgmt: Moving from Theory to Implementation, Denver, CO, pp. 841-848.
- Petersen, G.W., E. Nizeyimana, and B.M. Evans, 1998. Applications of Geographic Information Systems in Soil Degradation Assessments. In: B.A. Stewart (ed) Methodologies for Assessing Soil Degradation, Advances in Soil Science, CRC Press, Boca Raton, FL.
- Nizeyimana, E. and B.M. Evans, 1997. Evaluation of Potential GIS/Groundwater Model Linkages. Environ. Resources Research Institute, Penn State Univ., Pub. No. ER9711, 24pp.
- Nizeyimana, E., B.M. Evans, M.C. Anderson, G.W. Petersen, D.R. DeWalle, W.E. Sharpe, J.M. Hamlett, and B.R. Swistock, 1997. Quantification of NPS Pollution Loads within Pennsylvania Watersheds. Environ. Resources Res. Institute, Penn. State University, Pub. No. ER9708, 61pp.
- Mustalish, R.W., B.M. Evans, C. Tucker and K. Klein, 1996. Development of a Phytohabitat Index for Medicinal Plants in the Peruvian Amazon. Proc. Int. Symp. Medicinal and Aromatic Plants, Acta Hort. 426, ISHS.
- Evans, B.M., M.C. Anderson, E. Nizeyimana and G. Baumer, 1996. Specification of a GIS-Based Spatial Decision Support System for Use in the Statewide Evaluation of Non-Point Source Pollution Problems: Final Report to the PA Dept. of Environmental Protection. Environmental Resources Research Institute, Pennsylvania State University, Pub. No. ER9605, 43pp.
- Myers, W.L., B.M. Evans and M.C. Anderson, 1996. Spatial (In)consistency of Watershed Delineations Among Agencies and Scales in Pennsylvania. In: Proc. 2nd Intl. Symp. Spatial Accuracy Assessment in Nat. Res. and Environ. Sciences, Colo. State Univ., Fort Collins, CO.
- Nizeyimana, E., G.W. Petersen, M.C. Anderson, B.M. Evans, J.M. Hamlett and G.M. Baumer, 1996. GIS/Census Data Assessment of Nitrogen Loadings from Septic Systems in Pennsylvania. Journal of Environmental Quality, Vol. 25, pp. 346-354.
- Hamlett, J.M., G.W. Petersen, B.M. Evans, L.A. Deichert, S.R. Messier, M.C. Anderson, and G.M. Baumer, 1995. Statewide Screening of Groundwater Nitrate Pollution Potential from Agricultural Lands in Pennsylvania. Environ. Res. Res. Inst., Penn. State Univ., Pub. ER9502.
- Evans, B.M., R.A. White, G.W. Petersen, J.M. Hamlett, G.M. Baumer and A.J. McDonnell, 1994. Land Use and Nonpoint Pollution Study of the Delaware River Basin. Environmental Resources Research Institute, The Pennsylvania State University, Pub. No. ER94-06, 76 pp.
- Mercado, R.M. and B.M. Evans, 1993. Regional Impact Assessment of Agricultural/Industrial Practices on Water Resources Using Integrated GIS/Remote Sensing/Computer Modeling Technology. In: Proc. Workshop on Development of Water Related Information Systems, Alexandria, VA, May 1993.
- Evans, B.M., J. Grimm, L. Thornton and P. Saunders, 1992. Linking GIS with Hydrologic Modeling. In: Proc. Water Forum '92, Baltimore, MD, pp. 499-504.

Sasowsky, K.C., G.W. Petersen, and B.M. Evans, 1992. Accuracy of SPOT Digital Elevation Model Derivatives: Utility for Alaska's North Slope. *Photog. Engineer. & Remote Sensing*, Vol. 58, No. 6, pp. 815-824.

Evans, B.M. and W.L. Myers, 1990. A GIS-Based Approach to Evaluating Regional Groundwater Pollution Potential with DRASTIC. *Journal of Soil and Water Conservation*, pp. 242-245.

Walker, D.A., E. Binnian, B.M. Evans, N.D. Lederer, E. Nordstrand, and P.J. Webber, 1989. Terrain, Vegetation and Landscape Evolution of the R4D Research Site, Brooks Range Foothills, Alaska. *Journal of Holarctic Ecology*.

Evans, B.M., D.A. Walker, C.S. Benson, E.A. Nordstrand, G.W. Petersen. 1989. Spatial Interrelationship Between Terrain, Snow Distribution and Vegetation Patterns at an Arctic Foothills Site in Alaska. *Journal of Holarctic Ecology*, 12:270-278.

Evans, B.M. and D.A. Miller, 1988. Modeling Nonpoint Pollution at the Watershed Level with the Aid of a Geographic Information System. In: *Proc. Symp. on Nonpoint Pollution: Policy, Economy, Management, and Appropriate Technology*, American Water Resources Assoc.

Evans, B.M. and D.A. Miller, 1988. Quantifying Hydrologic Model Input with a Geographic Information System. In: *Proc. Symp. on Floodplain and Stormwater Management*, Penn State University Office of Continuing Education.

Evans, B.M. 1987. Assessing Regional Groundwater Pollution Potential with a Geographic Information System. In: *Proc. 3rd Annual Groundwater Technology Conf.*, The City University of New York, NYC.

Myers, W.L., B.M. Evans and G.M. Baumer, 1987. Synergism Between Human Interpretation and Digital Pattern Recognition in Preparation of Thematic Maps. *ISPRS J. Photogramm. Remote Sensing*, 44: 85-96.

Evans, B.M. and L. Mata. 1984. Acquisition of 35-mm Oblique Photographs for Stereoscopic Analysis and Measurement. *Photogrammetric Engineering and Remote Sensing*, 50 (11).

Evans, B.M. and L. Mata. 1984. Aerial Photographic Analyses of Hazardous Waste Disposal Sites. *Proceedings, National Conference on Hazardous Waste and Environmental Emergencies*, Houston, TX.

Evans, B.M. 1983. Using Aerial Photography to Detect Vegetation Damage in a Large-Scale Air Quality Monitoring Program. *Proceedings, Ninth Biennial Workshop on Color Aerial Photography in the Plant Science*, Orlando, FL.

Evans, B.M. 1982. Aerial Photographic Analysis of Septic System Performance. *Photogrammetric Engineering and Remote Sensing*, 48(11).

Evans, B.M. 1979. Aerial Sanitary Surveys in Rural Lake Wastewater Planning. *Proceedings, Sixth National Conference on Individual On-site Wastewater Systems*, National Sanitation Foundation, Ann Arbor, MI.

PAUL DAVID ROBILLARD

Executive Director
World Water Watch
955 Massachusetts Avenue, #349
Cambridge, MA 02139

Phone: 617-492-1011
Fax: 617-868-8209
Email: pdr@worldwaterwatch.org
WEB: www.worldwaterwatch.org

Education

Ph.D. Agricultural Engineering, Cornell University
• Research focus: Watershed Monitoring and Conservation Systems
M.S. Resource Economics, Cornell University
• Research focus: Nonstructural Flood Control Methods
B.S. Civil Engineering, University of Notre Dame
• Concentration: Water Resources Engineering
Foreign Language: Spanish (Foreign Service Institute 3/5)

Professional Experience

EXECUTIVE DIRECTOR: World Water Watch, 2003-present
Watershed monitoring and conservation systems in support of community water supply;
surface and groundwater quality protection and restoration; conservation programs
DIRECTOR: Center for AI in Water Quality Control Systems, Environmental Resources Research
Institute, Penn State University, 1996-2003. Led team of researchers and graduate students
in watershed water quality research and outreach programs
ASSOCIATE PROFESSOR: Penn State University, Agric. and Biological Engineering, 1993-2003
Knowledge-based systems applications for water quality control processes
FULBRIGHT SCHOLAR: Council for the International Exchange of Scholars and the J. William
Fulbright Commission, 1995-1996. Research and lecturing on “Design of Water Quality
Monitoring Networks” with primary applications for ecological reserves in Ecuador
VISITING PROFESSOR: Dept. of Civil and Environmental Engineering, Tufts University, 1995-1996
Integration of hydrologic models and statistical methods into expert systems software
ASSISTANT PROFESSOR: Penn State University, Agric. and Biological Engineering, 1987-1993
Watershed monitoring and control systems for surface and groundwater quality
RESEARCH ASSOCIATE: Cornell University, Agricultural Engineering, 1986-1987
Watershed monitoring and evaluation applications
RESEARCH ENGINEER: Cornell University, Agricultural Engineering, 1977-1985
Design and operation of laboratory and field experimental research methods
for water quality monitoring and remediation measures
TEACHING AND RESEARCH ASSISTANT: Cornell University, 1973-1976
Conducted research related to nonstructural flood control measures
INSTRUCTOR: Wardlaw School, Plainfield, New Jersey, 1970-1971
Teacher of mathematics, Spanish and mechanical drawing at the high school level
CIVIL ENGINEER: Peace Corps/Ecuador, 1968-1970
Design and construction of potable water systems and irrigation distribution systems
ENGINEERING INTERN: Fay, Spofford and Thorndike, Boston, Massachusetts, summer 1967

Awards and Honors

2001: W. Lamar Kopp Award, Pennsylvania State University. Awarded annually to one faculty member in the 23 campus Penn State system for international contributions
1995-96: Fulbright Scholar, Council for the International Exchange of Scholars
1994: National Gunlogson Engineering Award, The Society for Engineering in Agricultural, Food, and Biological Systems for career contributions in water resources engineering
1990 and 1993: National Software Awards, The Society for Engineering in Agricultural, Food, and Biological Systems for Drinking Water Solutions (DWS) software system (93) and Computer-Aided Water Well Design Instruction Modules (90)
1993-Present: National Expert and Advisor, South Florida Water Management District
1987-93: Advisor to USDA-EPA National Rural Clean Water Program
1992-93: Technical Advisor to NOAA-EPA-USDA Coastal Zone Management Program
1990-92: Evaluation Team, National Water Quality Evaluation Project
1985: General Electric 'Faculty of the Future Award', Cornell University
1968: Federal Water Pollution Control Administration (FWPCA) Fellowships in Civil Engineering to Cornell University and Stanford University.

Academic Honor Societies and Public Service

Chi Epsilon, Civil Engineering (officer)
Alpha Epsilon, Agricultural Engineering
Gamma Sigma Delta, Agricultural Sciences (officer)
Sigma XI, Scientific Research Society

World Water Center, Board of Directors, Washington, DC
Cambridge Water Board, Cambridge, Massachusetts
Fresh Pond Advisory Board, Cambridge, Massachusetts
Institute for Environmental Science and Policy Board, University of Illinois at Chicago
Reviewer of Fulbright Applications

Lecturing, Research and Outreach for Watershed Monitoring and Conservation Systems Summary of Accomplishments

- 200+ publications related to research and outreach contributions
- 50+ invited lectures, seminars, workshops and presentations in the U.S., Canada, Central and South America
- Worked extensively on international water resources engineering and conservation research and educational outreach applications.
- Recipient of \$4 million+ in research and outreach grants
- Advised 27 graduate students (Ph.D. and M.S.)

Recent and Representative Publication

- Strobl, R.O. and P.D. Robillard. 2008. Network design for water quality monitoring of surface freshwaters: a review. IN: Microbial and nutrient contaminants of fresh and coastal waters. Journal of Environmental Management (Special Edition).
- Strobl, R.O., P.D. Robillard, R.D. Shannon, R.L. Day, and A.J. McDonnell. 2006. A water quality monitoring network design methodology for the selection of critical sampling points: Part I. Environmental Monitoring and Assessment 112: 137-158.
- Strobl, R.O. and P.D. Robillard. 2006. Comparison of united states and german wellhead protection area delineation methods in agricultural settings. Journal of the Water Research Commission-Water SA 32(4) 507-518.
- Strobl, R.O., P.D. Robillard, and P. Debels. 2006. Critical sampling points methodology: case studies of geographically diverse watersheds. Environmental Monitoring and Assessment 129 (1) 115-131.
- Strobl, R.O., P.D. Robillard, R.D. Shannon, R.L. Day, and A.J. McDonnell. 2006. A water quality monitoring network design methodology for the selection of critical sampling points: Part II. Environmental Monitoring and Assessment 122: 319-334.
- Strobl, R.O. and P.D. Robillard. 2006. Artificial intelligence technologies in surface water quality monitoring. Water International 31(2) 198-209.
- Strobl, R.O. and P.D. Robillard. 2005. Review of USEPA-recommended and German wellhead protection area delineation methods. Journal of Environmental Hydrology, Vol. 13, Paper 3.
- Robillard, P.D., W.E. Sharpe, and B.R. Swistock. 2004. Reducing radon in drinking water. The Encyclopedia of Water, J.H. Lehr (ed.), John Wiley and Sons, Hoboken, NJ.
- Swistock, B.R., W.E. Sharpe, and P.D. Robillard. 2004. The influence of well construction on bacterial contamination. Penn State Institutes for the Environment, Pennsylvania State University, University Park, PA.
- Srivastava, P., J.M. Hamlett, P.D. Robillard, and R.L. Day. 2002. Watershed optimization of best management practices using AnnAGNPS and a genetic algorithm. Water Resources Research 38(3).
- Parson, S., J.M. Hamlett, P.D. Robillard, P. Johnson, M. Urquidi-MacDonald. 2002. Development of the internet watershed education tool (InterWET). Informing Science (3) 185-193.
- Robillard, P.D., M.A. Foster, R. Zhao, D.W. Lehning. 2002. STEWARD: A knowledge-based system for selection, assessment, and design of watershed water quality control systems. Center for AI in Water Quality Control Systems, Environmental Resources Research Institute, Pennsylvania State University, University Park, PA., 32 pp.
- Srivastava, P., R.L. Day, P.D. Robillard, and J.M. Hamlett. 2001. AnnGIS: integration of GIS and a continuous simulation model for non-point source pollution assessment. Transactions in GIS, 2001, 5(3): 221-234.
- Robillard, P.D., R.H. Galarraga, D.B. Klindienst, J.M. Madsen, O. Parra, J. Pritchard, A. Villarroel, and V. Zapata. 2000. Local to global environmental interactions: Sustaining Earth Systems: Water-The Lifeline of Biodiversity. Environmental Resources Research Institute, Pennsylvania State University, University Park, PA.
- Parson, S.C., J.M. Hamlett, P.D. Robillard, M.A. Foster. 1998. Determining the decision-making risk from AGNPS simulations. Transactions of ASAE 41(6):1679-1688.

- Foster, M.A. and P.D. Robillard. 1997. GIS, model, and internet-based decision support for targeting water quality control practices. IN: Proceedings of the American Water Resources Association Symposium: GIS and Water Resources. Fort Lauderdale, FL. pp.142-148.
- Robillard, P.D. 1992. Extending the RCWP knowledge-base to future nonpoint source control projects. The National Rural Clean Water Symposium. Center for Environmental Research, U.S. Environmental Protection Agency, Cincinnati, OH. pp.375-384.
- Robillard, P.D. and R.L. Droste. 1992. Design and maintenance of rural water supply systems for improved performance. Proceedings of the Water Resources Division, American Society of Civil Engineers, Baltimore, MD. pp.523-528.
- Robillard, P.D., J. C. Clausen, E.G. Flaig, and D.M. Martin. 1992. Research needs and future vision for nonpoint source projects. The National Rural Clean Water Symposium. Center for Environmental Research, U.S. Environmental Protection Agency, Cincinnati, OH. pp. 385-392.
- Robillard, P.D. and P.B. Kubek. 1992. Use of contaminant mobility and transport parameters to determine water testing protocol. Proceedings of the Water Resources Division, American Society of Civil Engineers, Baltimore, MD. pp.831-836.
- Robillard, P.D., P.B. Kubek, and M.A. Foster. 1991. Nonpoint source database (NPSDB) development and design. Coastal Zone Applications. U.S. Environmental Protection Agency, Washington, DC. 58 pp.
- Robillard, P.D. and R.L. Droste. 1990. Water supply systems: Applications to developing countries. American Water Resources Association, Denver, CO. November. 12 pp.
- Robillard, P.D. 1990. Linking GIS to expert systems for water resources management. Proceedings of Geographic Information Systems, Simulation Models and Knowledge-based Systems for Landuse Management. Virginia Polytechnic Institute, Blacksburg, VA. pp.1-10.
- Robillard, P.D. 1990. Innovative nonpoint source control practices. Microfiche No. 90-2058. American Society of Agricultural Engineers, St. Joseph, MI. 12 pp.
- Robillard, P.D., R.C. Brandt, and J.M. Hamlett. 1990. Applications of GIS in water resources engineering. Microfiche No. 90-3032. American Society of Agricultural Engineers. St. Joseph, MI. 14 pp.
- Robillard, P.D., W.E. Sharpe, B.R. Swistock, K.S. Martin, and C. Doscher. 1990. Incidence of lead and nitrate contamination in rural Pennsylvania water supplies. Technical Paper NABEC 90-303. Northeast Agricultural and Biological Engineering Conference. Pennsylvania State University, University Park, PA. 14 pp.
- Robillard, P.D. and P.B. Kubek. 1990. Staged water contaminant testing protocols. American Water Resources Association, Denver, CO. November. 15 pp.
- Robillard, P.D. and H.A. Elliott (Eds.). 1989. Water conservation and waste management in the food processing industry. Proc., Food Industry Council of Penn., Harrisburg, PA. 164 pp.
- Robillard, P.D. and M.F. Walter. 1982. The technical grouping of soils to retain nutrients from livestock manure applications. International Federation of Organic Agriculture, Massachusetts Institute of Technology, Cambridge, MA. 14 pp.
- Robillard, P.D., M.F. Walter, and L.M. Bruckner. 1982. Planning guide for evaluation of agricultural nonpoint source water quality controls. Environmental Research Laboratory, U.S. EPA. National Technical Information Service, Washington, DC. 733 pp.

Resume

William F. Ritter
Professor
Bioresources Engineering Department
University of Delaware
265 Townsend Hall
Newark, DE 19716-2140

Professional Experience:

University of Delaware, Newark, DE:

I have been involved in teaching, research, extension and administration, Active areas of research include Groundwater Pollution, Waste Management, Water Quality Modeling, Surface Water Contamination and Irrigation Management.

2003 – Present: Department Chair of the Bioresources Engineering Department, Professor in Bioresources Engineering Department and Civil and Environmental Engineering Department, Senior Policy Fellow in Center for Energy and Environmental Policy

1998 – 2003: Professor in Bioresources Engineering Department and Civil and Environmental Engineering

1993 – 1998: Department Chair and Professor in the Bioresources Engineering Department and Professor of Civil and Environmental Engineering

1982 – 1993: Professor in Bioresources Engineering Department

1977 – 1982: Associate Professor in Bioresources Engineering Department

1971 – 1977: Assistant Professor in Bioresources Engineering Department

Wik Associates, Inc., New Castle, DE

Environmental consulting in hazardous waste management and sediment and storm water management.

Jan. 1992 – Jun. 1992: Project Manager

Iowa State University, Ames, Iowa

1966 – 1971: Research Associate

Education

Iowa State University, Ames, IA

Ph.D.; Sanitary Engineering and Agricultural Engineering, 1971

Iowa State University, Ames, IA

M.S., Water Resources, 1968

B.S., University of Toronto, Toronto, Ontario, Canada

Civil Engineering, 1966

B.S., University of Guelph, Guelph, Ontario, Canada

Agricultural Engineering, 1965

Professional Memberships:

Diplomat, American Academy of Environmental Engineers

American Society of Civil Engineers

American Water Works Association

Canadian Society of Agricultural Engineers

Canadian Water Resources Association

American Society of Engineering Education

Water Environment Federation

Delaware Association of Professional Engineers

Professional Registration

I have been a registered P.E. in Civil Engineering since 1970. Presently registered in Delaware and Pennsylvania . I am also a diplomat of the American Academy of Environmental Engineers and certified in water and wastewater

Honors And Awards

1979 EPA Superior Achievement Award.
ASAE North Atlantic Young Engineer of the Year, 1981.
Distinguished Toastmaster Award (highest award in Toastmasters International).
1984 New Castle County Water Resources Award.
University of Delaware Fellow to Salzburg Seminar, 1987.
ASAE Gunlogson Countryside Engineering Award, 1988.
College of Agricultural Sciences, F.D. Chester Outstanding Research Award, 1990.
ASCE Irrigation and Drainage Division Outstanding Service Award, 1993.
Elected a Fellow of ASAE, 1994.
ASAE - NABEC Distinguished Lecturer, 1994-95.
ASCE Water Resources Engineering Division Service Award, 1995.
ASCE Fellow, 1997.
ASCE Outstanding News Correspondence Award, 1997.
AWWA Life Member, 1998
ASCE Delaware Section Member of the Year Award, 1999.
ASAE-NABEC Distinguished Service Award, 2003.
ASCE Royce Tipton Award, 2004

Selected External Support:

I have been principal investigator or co-principal investigator on contracts and grants with total funding of over \$4,000,000.
2008-2010. U.S. Department of Agriculture National Research Initiative Program. "Characterization of PM2.5 and PM10 Particulate Emissions and the Relationship to Activity in Typical Poultry Houses". \$537,000.
2007 – 2008: Delaware Department of Natural Resources and Environmental Control. "Evaluation of Rapid Infiltration Basins For Wastewater Disposal: Phases I and II." \$210,000
2004 – 2009: New Castle County. "Monitoring and Evaluation of Land Application of Wastewater." \$125,000
2004-2007: University of Delaware Soils and Environmental Quality Institute. "Modeling BPMs in the Inland Bays Watershed". \$51,000
2004 – 2007: Wicomico County. "Wicomico County. Environmental Impact of long Piers on Vegetated Tidal Wetlands." \$179,220
2004 – 2005: U.S. Environmental Protection Agency. "Evaluation of Land Application of Wastewater as a Nutrient Reduction Control Strategy." \$39,132.
2003 – 2006: U.S. Environmental Protection Agency. "Hydrology and Water Quality of Freshwater Wetlands." \$198,000
2003 – 2005. Sussex County Conservation District. "Evaluation of Vegetative Control with the Weed Wiper." \$13,500
2003 – 2004. Blue Moon Foundation. "Health, Ecological, Energy and Economic Impacts of the 4 in 1 System and Institutional Strategies for its Successful Application in Rural China." \$50,000
2002 – 2003. State of Delaware. "Odessa National NPS Monitoring." \$13,000
2002 – 2003. Sussex County Conservation District. "Evaluation of Vegetative Control with the Weed Wiper." \$5,000
2002 – 2003. DuPont Company. "Composting of Biomax Material." \$25,474

2001 – 2002. EPA Chesapeake Bay Program. “Identification of Improved Nonpoint Source Best Management Practices for Consideration in Revised Tributary Strategies”. \$72,500

2001 – 2002. New Castle County. “Optimization Study of M-O-T Wastewater Treatment Plant and Spray Irrigation.” \$14,800

2001 – 2002. CABA Associates. “Wastewater Biodegradability Studies for Nitrogen.” \$4,143

2000 – 2003: U. S. Department of Interior: “Environmental Policies for a Sustainable Poultry Industry in Sussex County.” \$48,000

2000 – 2001: U. S. Department Interior. “Nutrient Management Undergraduate Student Research Internships.” \$10,000

Publications:

Author of over 300 publications and papers, 64 refereed publications, 7 book chapters, 3 books and manuals, Over 170 papers presented at meetings and 84 invited presentations. Some recent publications

Williams, M.K. and **W.F. Ritter**. 2007. Evaluation of land application of wastewater as a nutrient reduction control strategy in the Chesapeake Bay watershed. In Proceedings of ASABE International Symposium on Air Quality and Waste Management for Agriculture, September 16-19, 2007, Bloomfield, CO. CD-ROM.

Ritter, W.F. and L.M.Stehr. 2007. Environmental and economic policies for a sustainable poultry industry in Sussex County, Delaware. In Proceedings of ASABE International Symposium on Air Quality and Waste Management for Agriculture, September 16-19, 2007, Bloomfield, CO. CD-ROM.

Rao, S.K. and **W.F.Ritter**. 2007. Ammonia emissions from poultry house and its fate: a modeling study. In Proceedings of EWRI/ASCE World Water and Environmental Congress, May 15-18, 2007, Tampa, FL. CD-ROM.

Ritter, W. F. and B.A. Icenogle. 2007. Modeling water quality impacts in a rural watershed in Delaware. In Proceedings of EWRI/ASCE World Water and Environmental Congress, May 15-18, 2007, Tampa, FL. CD-ROM.

Ritter, W.F. and S.R. Chitikela. 2007. Modeling ammonia and odor emissions from livestock and poultry facilities: a review. In Proceedings of EWRI/ASCE World Water and Environmental Congress, May 15-18, 2007, Tampa, FL. CD-ROM.

Sung, M and **W. F. Ritter**. 2007. Food waste composting with selected paper products. Compost Science and Utilization. In press.

Chirside, A.E.M., **W.F.Ritter** and M Radosevich. 2007. Isolation of a selected microbial consortium from a pesticide-contaminated mix-load site soil capable of degrading the herbicides atrazine and alachlor. Soil Biology & Biochemistry, 39:3056-3065.

Ritter, W.F. 2006. Potential for reducing nutrients from the poultry industry in the Chesapeake Bay watershed. In Proceedings of EWRI/ASCE World Water and Environmental Congress, May 21-25, 2006, Omaha, NB. CD-ROM.

Ritter, W.F. and S. Hoffman. 2006. Modeling phosphorus in the Appoquinimink watershed with AGNPS. In Proceedings of EWRI/ASCE World Water and Environmental Congress, May 21-25, 2006, Omaha, NB. CD-ROM.

Ritter, W.F. and M Sung. 2006 Challenges in composting food wastes. In Proceedings 21st International Conference on Solid Waste Management and technology, March 26-29, 2006, Philadelphia, PA. CD-ROM.

Chirside, A.E.M., **Ritter, W.F.** and M. Radosevich. 2005. Bioremediation strategies for pesticide-contaminated soil:III. Bioremediation utilizing fungal enzymes derived from *phanerochaete chrysosporium*. In Proceedings of the 8th International In Situ and On-Site Bioremediation Conference, June 6-9, 2005, Baltimore, MD. CD-ROM.

Ritter, W.F. 2005. Potential for reducing nutrient loads from the dairy industry in the Chesapeake Bay watershed. In Proceedings of ASCE Watershed Management Conference, July 19-22, 2005, Williamsburg, VA. CD-ROM.

Ritter, W. F. and A.E.M.Chirnside. 2005. Water quality issues and nutrient management in the Nanticoke watershed. In Proceedings of EWRI/ASCE World Water and Environmental Congress, May 15-19,2005, Anchorage, AK. CD-ROM.

Ritter, W. F. 2005. Greenhouse gases and animal agriculture: Extent of problem and controls. In Proceedings of EWRI/ASCE World Water and Environmental Congress, May 15-19,2005, Anchorage, AK. CD-ROM.

Ritter, W. F. 2005. TMDL for the Nanticoke River. In Proceedings of USCID 3rd International Conference on Irrigation and Drainage. March 30-April 2,2005, San Diego, CA. pp 603-612.

Ritter, W.F. 2005. Nutrient management regulations in Delaware and Maryland. In Proceedings of USCID 3rd International Conference on Irrigation and Drainage. March 30-April 2,2005, San Diego, CA. pp 409-414.

Chitikela, S.R. and **W.F.Ritter.** 2004..Ammonia Emissions from poultry operations in the state of Delaware: A critical review, estimation and fate. In Proceedings of EWRI/ASCE World Water and Environmental Congress, June 27-July 1, 2004, Salt Lake City, UT. CD-ROM.

Ramasamy, N., P. Krishnan, J.C. Bernard and **W. F. Ritter.** 2003. Modeling nitrate concentration in ground water using regression analysis and neural networks. In Proceedings of Northeast Decision Sciences Institute, March 27-29, 2003, Providence, RI. pp. 370-375.

Sudhakar, P., P. Krishnan, J. C. Bernard and **W. F. Ritter.** 2003. Modeling nitrogen loading rates to Delaware lakes and streams using regression analysis and neural networks. In Proceedings of Northeast Decision Sciences Institute, March 27-29, 2003, Providence, RI. pp 376-380.

Ward, L.M. and **W.F. Ritter.** 2003. Overcoming market barriers for poultry litter compost. In Proceedings of 18th Solid Waste Technology and Management Conference, March 22-25, 2003, Philadelphia, PA CD-ROM.

Curriculum Vitae

ROBERT D. SHANNON

**Program Coordinator, Environmental Resource Management
Associate Professor of Agricultural Engineering**

Education:

- 1993 Ph.D., Environmental Science, Indiana University, Bloomington, IN
- 1988 M.S., Environmental Science and Engineering, Virginia Polytechnic Institute & State University; Blacksburg, VA.
- 1979 B.S., Environmental Resource Management, secondary major in Biology, The Pennsylvania State University, University Park, PA.

Professional Experience:

- 2002- **Program Coordinator, Environmental Resource Management program**, College of present Agricultural Sciences, The Pennsylvania State University. Serve as faculty administrator for interdepartmental undergraduate program (~100 students) in College of Agricultural Sciences.
- 2001- **Associate Professor of Agricultural Engineering**, Department of Agricultural and Biological present Engineering, The Pennsylvania State University. Teaching and advising appointment in Environmental Resource Management program; member of graduate faculty in Environmental Pollution Control and Ecology programs. Currently teach the following courses: Careers and Issues in Environmental Resource Management (ERM 151), Resource Systems Analysis (ERM 412), Wetland Conservation (ERM 450), ERM Internships (ERM 495)
- 1995- **Assistant Professor of Agricultural Engineering**, Department of Agricultural and Biological 2001 Engineering, The Pennsylvania State University.
- 1994- **Adjunct Assistant Professor**, School of Public and Environmental Affairs, Indiana 1995 University
- 1988- **Research Assistant and Postdoctoral Researcher and Research Assistant**, School 1994 of Public and Environmental Affairs, Indiana University
- 1993 **Consultant to Environmental Protection Agency**, Arctic Contaminant Research Program, Brooks Range, AK
- 1986- **Graduate Teaching Assistant**, Department of Civil Engineering, Virginia Tech 1987
- 1980- **County Conservationist**, Dauphin County Conservation District, Harrisburg, PA 1986

Robert D. Shannon

Recent Research Publications:

Confessor, R.B., Jr., J. M. Hamlett, R.D. Shannon, and R.E. Graves. 2008. Potential Pollutants from Farm, Food and Yard Waste Composts at Differing Ages: Physical and Chemical Properties. Part I. *Compost Science & Utilization* 16(4): 228-238.

White, J.R., R.D. Shannon, S.D. Bridgham, J.F. Weltzin, and J. Pastor, 2008. Effects of soil warming and drying on methane cycling in a northern peatland mesocosm study. *J. Geophys. Res.* 113, G00A06, doi:10.1029/2007JG000609.

Confesor, R.B., J.M. Hamlett, R.D. Shannon, and R.E. Graves. 2007. Movement of nitrogen and phosphorus downslope and beneath a manure and organic waste composting site. *Compost Science and Utilization* 15(2): 119-126.

Walker, C.W., and R.D. Shannon. 2006. Nitrate and phosphate removal effects of compost amendments in wetland mesocosms. *Trans. of American Society of Agricultural and Biological Engineers* 49(6): 1773-1778.

Strobl, R.O., P.D. Robillard, R.D. Shannon, R.L. Day, and A.J. McDonnell. 2006. A water quality monitoring network design methodology for the selection of critical sampling points: Part I. *Environmental Monitoring and Assessment* 112:137-158.

Ehrhart, B. J., R.D. Shannon, and A. R. Jarrett. 2002. Effects of construction site sedimentation basins on receiving stream ecosystems. *Trans. of the ASAE* 45: 675-680.

Avery, G. B., R.D. Shannon, J. R. White, C. S. Martens, and M. J. Alperin. 2002. Controls on methane production in a tidal freshwater estuary and a peatland: Methane production via acetate fermentation and CO₂ reduction. *Biogeochemistry* 62: 19-37.

Rauhofer, J., A. R. Jarrett, and R. D. Shannon. 2001. Effectiveness of sedimentation basins that do not totally impound a runoff event. *Trans. of American Society of Agricultural Engineers* 44:813-818.

Awards, Honors, and Accomplishments related to Teaching and Advising:

2006 University Excellence in Academic Advising Award

2002 Community of Teaching Excellence Award, College of Agricultural Sciences

2001 Nomination for University Outstanding Advising Award

1998 Excellence in Academic Advising Award, awarded by Penn State University's College of Agricultural Sciences Alumni Association

Scientific and Professional Societies - Membership and Current Activities:

Society of Wetland Scientists (Professional Wetland Scientist Certification Review Panel, 2000-present)

Sigma Xi

American Society of Agricultural and Biological Engineers

American Society of Limnology and Oceanography

American Geophysical Union

Soil Science Society of America

American Association for the Advancement of Science

Service on 33 graduate committees (10 Ph.D., 21 Master's)