



**Dominion**

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OFFICE OF SECRETARY  
RULEMAKINGS AND  
ADJUDICATIONS STAFF

# North Anna ESP Proceeding – Mandatory Hearing Docket No. 52-008-ESP; ASLBP No. 04-822-02-ESP

## Dominion's Presentation on Surface Water Impacts and Possible Mitigation Measures

Dr. Jud White

Bill Bolin

John Waddill

Dr. Stewart Taylor

Dr. Patrick Ryan

Dr. Charles Coutant

U.S. NUCLEAR REGULATORY COMMISSION

In the Matter of Dominion Nuclear North Anna, LLC

Docket No. 52-008-ESP Official Exhibit No. Dominion 15

OFFERED by Applicant/Licensee Intervenor \_\_\_\_\_

NRC Staff \_\_\_\_\_ Other \_\_\_\_\_

IDENTIFIED on 4/24/07 Witness/Panel Surface Water 1

Action Taken: ADMITTED REJECTED WITHDRAWN

Reporter/Clerk JTC

# Overview

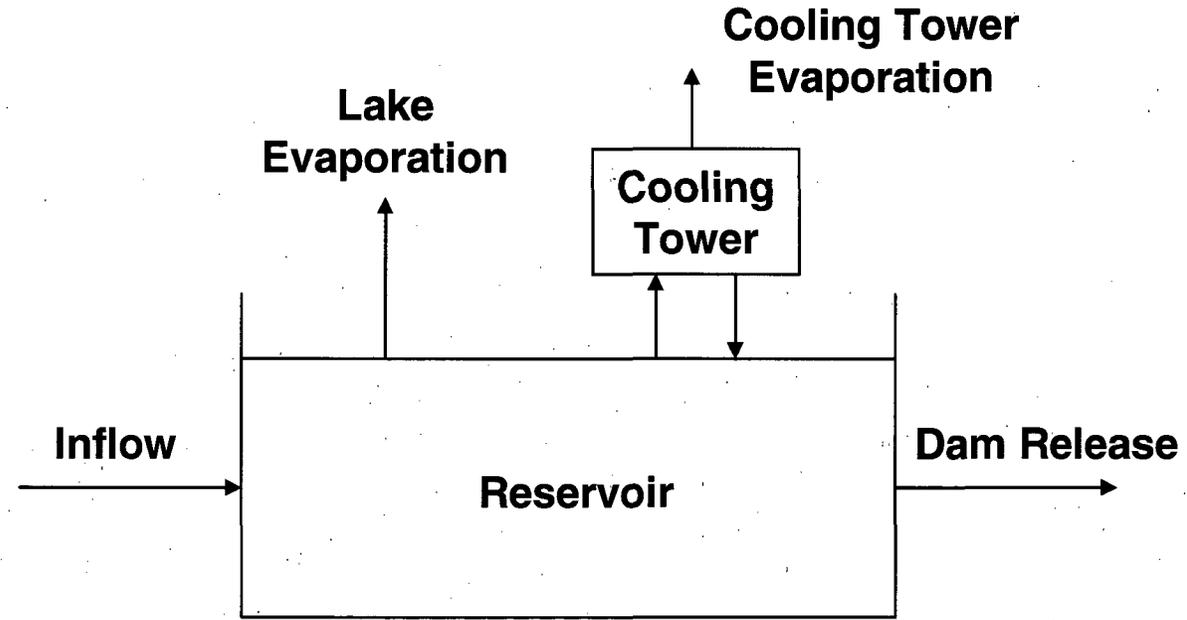
- Dr. Taylor – Effect on Lake levels and downstream flow
- Dr. Ryan – Effect on Pamunkey River flow
- Dr. Coutant – Biological assessment of downstream flow
- Mr. Bolin – Low flow study
- Dr. White – IFIM
- Mr. Waddill - Mitigation

# Dominion's Proposed Cooling System

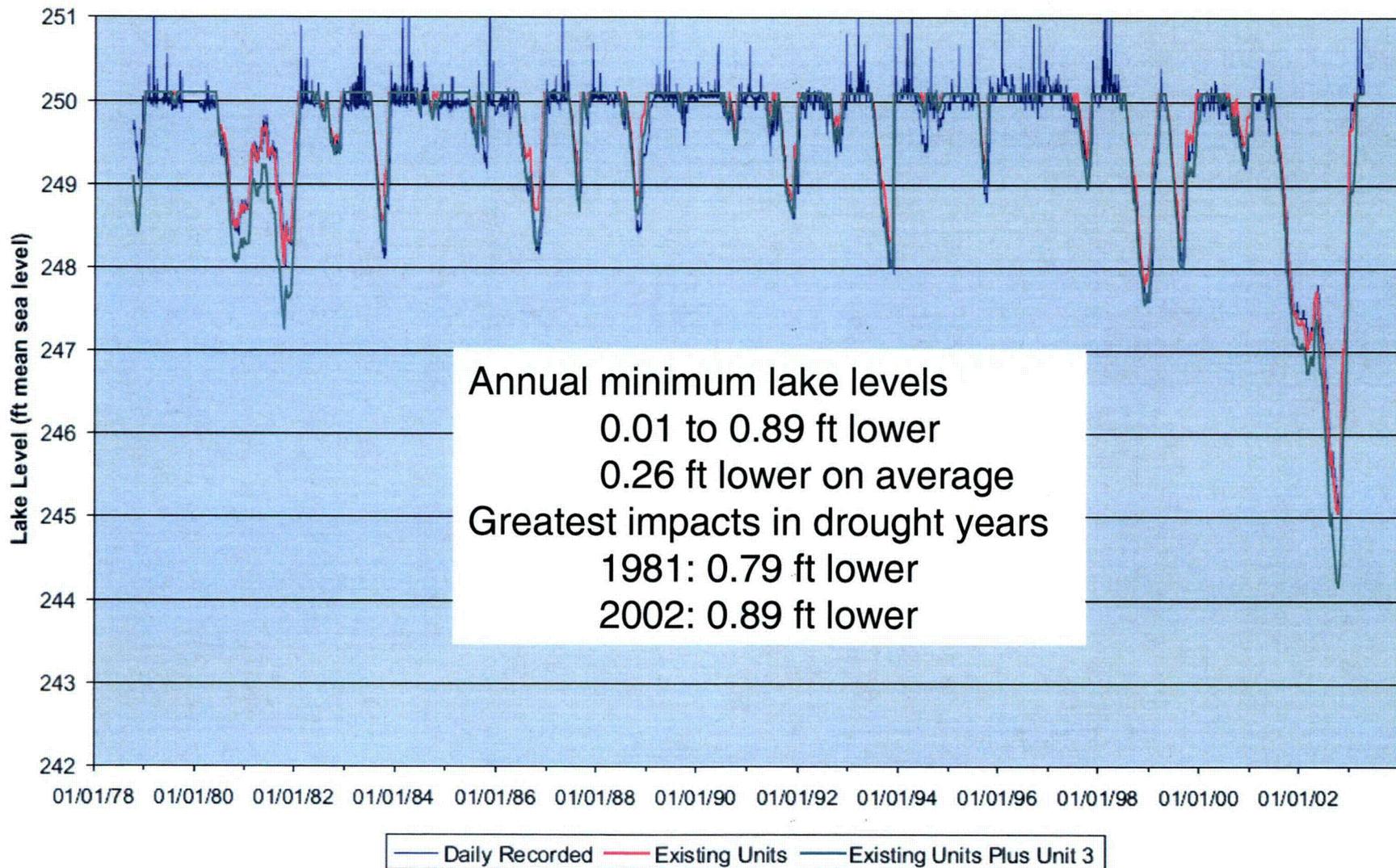
- Dominion selected a combination wet-dry cooling tower system for the third unit
  - Responsive to state and public comments
  - Essentially eliminates any thermal impact
  - Reduces consumptive water use

# Modeled Impacts on Lake Levels and Downstream Flows

- Impacts assessed using a water balance model
- Predicts weekly lake level and outflow time series (24 years)



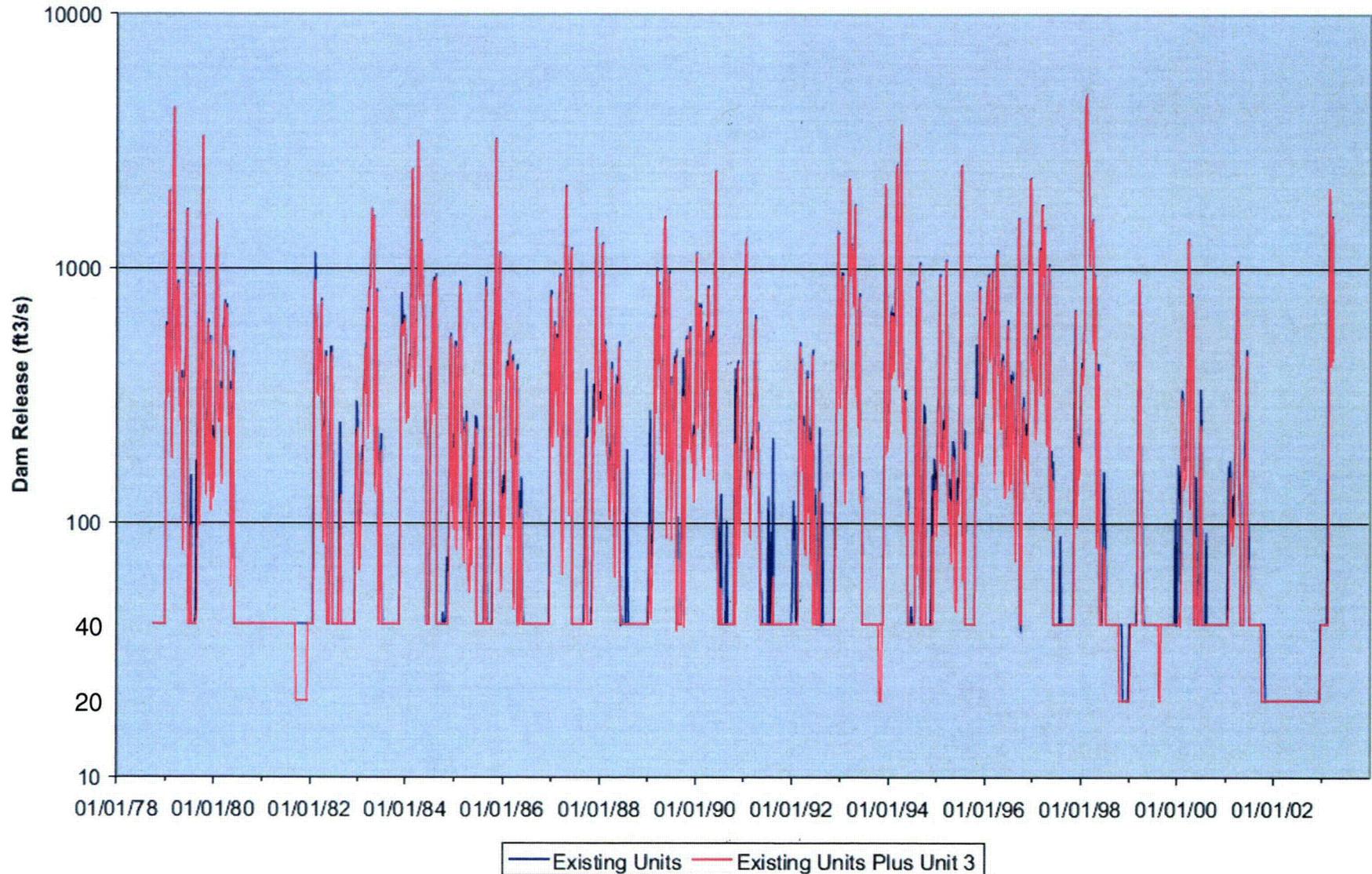
# Lake Water Level Hydrographs



# Lake Level Statistical Summary

Percent of Time Water Level is Less Than or Equal to Indicated Values		
Elevation (ft msl)	Existing Units	Existing Units plus Unit 3
248	5.2%	7.0%
246	1.1%	1.4%
244	0%	0%
242	0%	0%
Minimum Water Level	245.1 feet	244.2 feet

# Lake Outflow Hydrographs



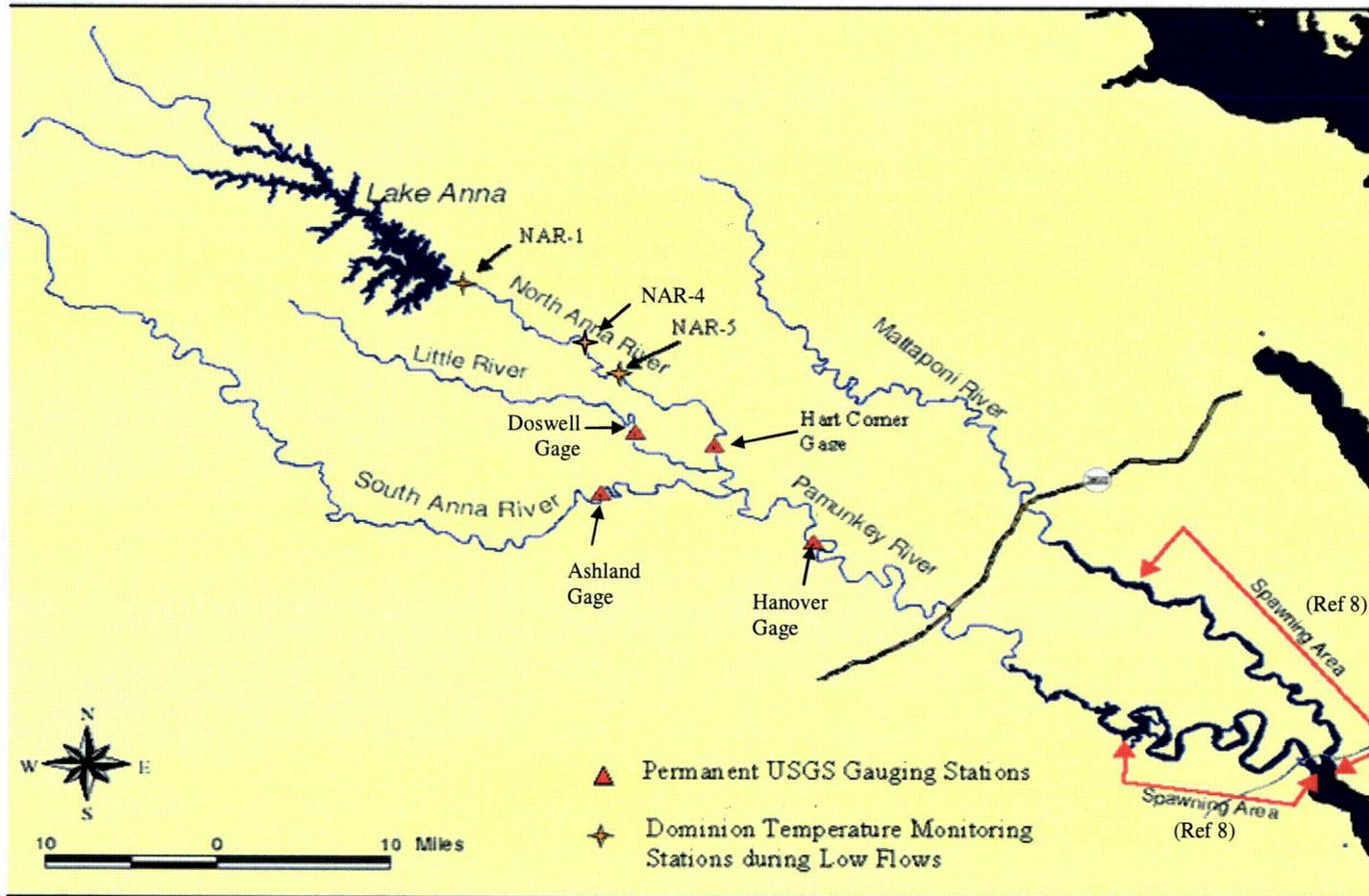
# Lake Outflow Statistical Summary

<b>Percent of Time Outflow is Less Than or Equal to Indicated Values</b>		
<b>Outflow (ft<sup>3</sup>/s)</b>	<b>Existing Units</b>	<b>Existing Units plus Unit 3</b>
100	50.6%	56.1%
80	48.2%	53.4%
60	46.5%	51.1%
40	44.6%	49.6%
20	5.2%	7.3%

# Impacts to Pamunkey River Flows

- In addition to examining changes in flow at the North Anna dam, we analyzed Pamunkey River flows at Hanover gauge
- Particular attention given to spawning periods in April and May

# York River Watershed



# Spring Impacts to Pamunkey River Flows

- Flow reduction in April - May is typically in the ~1 to 5% range
- 5%, 7-day low flow reduced from 207 to 206 cfs
- Median flow reduced from 851 to 824 cfs
- Mandated minimum flows unlikely in April and May
- Tidal flows dominate in lower reach

# River Communities

- Analyzed 1979-2003 flow data for flow variations experienced by North Anna River biological communities below the dam
- Community is adapted to wide variations in flow, within and among years
- Most biological productivity is in higher flows of spring and early summer when inflow reductions would be small
- Biology in low flows of late summer and fall is protected by minimum releases of 20 or 40 cfs
- Therefore biological effects would be small

# Striped Bass

- Evaluated studies by VIMS of striped bass spawning and early life stages in York River system since late 1980s
- Spawning and early life stages are in tidal fresh water of lower Pamunkey in April-May
- Flows there are dominated by tidal flow not freshwater inflow
- Freshwater inflow not considered an important variable for striped bass by VIMS

# Striped Bass

- Striped bass accommodate wide year-to-year variations in April-May flow
- Freshwater inflow change of ~1-5% in April-May would be insignificant for striped bass
- Mattaponi, with 57% of average flow of Pamunkey, has better striped bass production
- Therefore, effects on reproduction and early life stages of striped bass would be small

# American Shad

- Evaluated studies by VIMS of juvenile shad abundance in York River system since 1979
- Juvenile abundance indices were generally higher during low-flow, drought years
- Lower flows promote retention of larvae and their food in the river in April and May
- Same trends found in Connecticut and Hudson rivers
- Therefore, reduction of Pamunkey River flows by ~1-5% in April-May would likely have small but positive effects on juvenile American shad survival

# Low Flow Study

- A low-flow study was conducted on the North Anna River beginning in October 2001 through January 2003
- The area of study was from the Lake Anna Dam downstream to U.S. Rt. 1
- Flows were reduced by 5 cfs increments to a minimal flow of 20 cfs and held at 20 cfs for approximately 14 months

# Low Flow Study

- No noticeable change in wetted perimeter, water depth, or velocities
- Temperature and dissolved oxygen followed seasonal patterns
- No change in aquatic insect community
- No measurable changes in fish assemblage

# Instream Flow Incremental Methodology (IFIM)

- Dominion agreed to conduct IFIM study in cooperation with Virginia's natural resource agencies
- Virginia made this a condition of the November 21, 2006 concurrence with Dominion's CZMA certification
- The study is not being performed to quantify impacts for the ESP EIS; results of the study will be used to optimize state permit decision-making related to surface water management and in-stream flow conditions
- Final report is expected in early 2008

# Mitigation

- Mitigation is inherent in Dominion's proposal
- Change from open- to closed-cycle cooling represented a decision to implement this major mitigation measure
  - Eliminated thermal discharge
  - Reduced water consumption

# Mitigation

- Additional mitigation measures may include enhanced lake management
  - raising the normal lake level
  - lowering the assigned lake drought level

# Mitigation

- IFIM results will be assessed in cooperation with the state's resource agencies to identify appropriate operational strategies for the Unit 3 cooling system and downstream releases
- The Commonwealth regulates water withdrawal and discharges
- Any new water consumption limits or downstream flow requirements are expected to be implemented through the VPDES permit program to protect beneficial uses of the lake and river

## RESUME

**Dr. Judson W. White (Jud)**

2007

Dominion Resources, Inc.  
5000 Dominion Blvd.  
Richmond, Virginia 23060  
804-273-2948 (work)  
804-360-4225 (home)  
E-mail: judson.white@dom.com

**Objective:** Apply vast experience, knowledge, organizational, and communication skills in the environmental protection and conservation field to promote sustainable resource use and awareness of current environmental issues.

**Education:**

- B.S. in Biology - University of Richmond, 1972
- M.S. in Biology - University of Richmond, 1974
- Ph.D. in Public Policy and Administration - Virginia Commonwealth University, 2000 (Dissertation Title: Accountability Issues For A Point/Nonpoint Source Effluent Trading Program In Virginia – available upon request))

**Experience:** General: Employed by an energy company, Virginia Power (now Dominion), since 1975 serving in various supervisory positions associated with environmental protection programs to ensure compliance with laws and regulations while minimizing both the risk of adverse environmental impact and the cost of compliance. Also has extensive experience in environmental policy/regulatory development at state and federal levels and has served on many advisory committees and stakeholder groups involved in developing various proposed regulations and policies. Has experience in effective negotiations with many stakeholders including the public, government representatives, and non-profit organizations on environmental issues (advised company on philanthropic activity). Noted environmental/conservation subject areas with experience include watershed planning; market-based water trading; air and surface water quality; groundwater quality; drought planning, aquatic resource management including fisheries, invertebrates, and wetlands; climate change; oil storage tanks and pollution planning; and various other resource and energy issues.

- 1975-1985: Station Biologist at North Anna Nuclear Power Station in Louisa, Virginia; supervised 15 employees that evaluated the affects of station operation on the ecology of Lake Anna and the lower North Anna River; completed 10 year effort and final report that indicated no adverse impact.
- 1986-1996: Director of Environmental Services; supervised 8 employees responsible for water and waste permitting and compliance in Virginia, West Virginia, and North Carolina.
- 1997-2000: Environmental Affairs Director; performed a lead role in environmental policy issues, state/federal legislation, and public affair activities with general public and advocacy groups.
- 2001-2004: Manager-Electric Environmental Support; managed a staff of 10 involved in water, waste, and oil permitting and compliance programs in multiple states; oversaw due diligence activity for power station acquisitions
- Currently: Environmental Policy Manager; focuses on tracking and influencing water/waste policy decision-making at the federal level and in 9 states; involved in many multi-stakeholder groups to develop effective state regulations (e.g., groundwater, water quality standards, antidegradation, nutrient trading); serves as key company contact with regulatory agencies and other stakeholders such as environmental organizations; oversees major projects for the company including the environmental permitting of potential new nuclear units.
- Has served since 2002 as adjunct professor at Virginia Commonwealth University's Center for Environmental Studies; teaches graduate course titled "Business and the Environment" (syllabus available upon request)

**Knowledge/  
Skills:**

- Broad knowledge of state and federal water and waste environmental laws and regulations; some experience with air
- Maintains high ethical standards and displays competency and credibility to other stakeholders
- Vast experience in policy development (laws and regulations)
- Strategic planning skills to achieve a mission or long term goal
- Effective interpersonal skills with general public, legal and academic professions; excellent team player
- Competence in public speaking and effective communications
- Environmental program management and leadership ability
- Effective negotiation and conflict resolution skills
- PC applications (windows environment)
- Supervision and office management

**Professional  
Affiliations:**

- Appointed by Governor Kaine to Virginia Water Resources Research Advisory Board at Virginia Tech
- Vice Chairman of James River Basin Association
- Serves on Steering Committee of national Utility Water Act Group representing electric utility companies
- Past member of Public Advisory Board of Christopher Newport University
- Previous Chairman of Government Affairs Committee of Virginia Water Environment Association
- Previous Chairman of Water Quality Subcommittee of Virginia Manufacturers Association
- Member of Several Energy Industry Environmental Committees

**Additional  
Information:**

Hobbies include fishing, reading, and activities at home with family; active in church activities and teaches Sunday school as well as at Gayton Terrace Retirement Home on a monthly basis.

## **Employee Biography**

1. Legal Name: John William Bolin, III      Nickname: Bill
2. DOB: 1/15/44
3. Job Title:      Manager – Environmental Biology
4. Year started with Company:      April, 1973
5. Most Recent Prior Positions:  
Title: Director – Environmental Chemistry & Biology  
Company: Virginia Power  
Length of Time:      18 months  
Responsibilities:      Manager System Lab and Biology groups following reengineering.
6. List other positions held, Company and time spent in each position:  
Station Biologist (3 years) – Supervisor  
System Biologist (7 years) – Supervisor  
Supervisor – Environmental Lab (4 years)
7. Other Company Employed by prior to joining Dominion:  
Fairfax County School System
8. List schools and degrees, and date earned:  
University of Mississippi – 62-63  
BS – Chemistry & Biology - University of Alabama – 63-66  
Post-Graduate – Ecology – University of Alabama  
Principles of teaching & Psychology – University of Virginia
9. Professional Affiliations:  
Board of Directors – Friends of Chesterfield Riverfront  
Board of Directors – Mid-Atlantic U.S. Fish and Wildlife Foundation  
Past Chair – Avian Powerline Interaction Committee (APLIC)  
Past Chair – EEI Biologist's Task Force  
Ducks Unlimited  
Governor's Special Advisory Team for Invasive Species
10. Hobbies:  
Fishing  
Hunting  
Wildlife Artist

**John D. Waddill**

5000 Dominion Blvd.  
Glen Allen, VA 23060  
804-273-2770  
John\_Waddill@dom.com

Professional Engineer in  
North Carolina

Member, American  
Society of Mechanical  
Engineers

**Employment History****Civil/Mechanical Engineering Lead—ESP/COL Project**

2005-Present, Dominion Generation, Glen Allen, VA

- Provide technical reviews of assigned systems for the proposed new power station at North Anna
- Provide technical input concerning the conceptual design of the cooling system for the new unit.
- Provide review and support for financial and economic aspects of decision making for the new unit.

**Mechanical Engineer**

1987 - 2005, Dominion Generation, Glen Allen, VA

- Lead Mechanical Engineer on capital projects for modifications to North Anna and Surry Power Stations.
- Corporate engineer performing engineering studies, analysis, and conceptual designs for North Anna and Surry Power Stations.
- Performed evaluations of plant cooling systems and participated in heat exchanger analysis and performance testing for Surry Power Station. Member of a team that developed an on-line heat exchanger monitoring system.
- Performed spent fuel pool cooling system capability testing and analysis.
- Mechanical engineering representative on safety system functional inspections performed by the NRC.
- Project engineering responsibility for station modifications at Surry Power Station.

**Nuclear Production Engineer**

1985 - 1987, Duke Power Company, Charlotte, NC

- Technical and economic evaluation of system and equipment modifications for radioactive waste processing systems at Duke's three operating nuclear power stations.
- Developed a demonstration mass balance program for a fluidized bed incinerator/dryer system.

**Engineer Assistant / Associate / Design Engineer I**

1978 - 1985, Duke Power Company, Charlotte, NC

- Licensing engineer responsibilities for Operating Licenses for McGuire and Catawba Nuclear Stations and the Construction Permit for Perkins Nuclear Station.
- Analysis of pipe stress and support design for Catawba Nuclear Station.
- Design engineer for modifications to Oconee Nuclear Station.
- Prepared modification packages for installation of mechanical and electrical equipment and systems at a client's radioactive waste processing facility.
- Design engineer for modifications to Duke's hydroelectric stations.

**Education**

- B.S., Mechanical Engineering (Nuclear Option),  
Virginia Polytechnic Institute & State University, 1978
- M.B.A., Queens University of Charlotte, 1986

**Stewart W. Taylor**  
**Corporate Manager**  
**Geotechnical and Hydraulic Engineering Services**

**SUMMARY**

Over twenty-five years experience in hydrology, hydrogeology, contaminant fate and transport, ground water modeling, and soil and ground water remediation. Specialist in subsurface biological processes, natural attenuation of contaminants, and mathematical modeling of these phenomena. Graduate degrees. Professional registration. Project engineering and project management experience.

**EDUCATION**

Ph.D. Civil Engineering, Water Resources Program, Princeton University, 1990  
M.S. Civil Engineering, Hydraulics Program, Colorado State University, 1982  
B.S. Civil Engineering, University of Kansas, 1979

**PROFESSIONAL DATA**

Professional Registrations:

- Professional Engineer, State of California, License No. C37292 (Active)
- Professional Geologist, State of Tennessee, Registration No. TN3839 (Inactive)

Scientific and Professional Societies:

- American Geophysical Union, Member
- American Society of Civil Engineers (ASCE), Member
- Environmental and Water Resources Institute (EWRI), Member
- National Ground Water Association (NGWA), Member

Professional Activities:

- Chair, Ground Water Council, ASCE/EWRI
- Past-Chair, Ground Water Hydrology Committee, ASCE/EWRI
- Member, KSTAT Standards Committee, ASCE/EWRI
- Member, Department of Civil and Environmental Engineering Advisory Council, Princeton University
- Instructor, Hydrogeology, Engineering Professionals Program, Johns Hopkins University

**PROFESSIONAL EXPERIENCE**

**2006 – Present:** *Corporate Manager of Geotechnical & Hydraulic Engineering Services and Bechtel Fellow, Bechtel Corporation, Frederick, Maryland.* Overall responsibility for geology, hydrology, hydrogeology, seismology, and geotechnical and hydraulic engineering for the Bechtel group. Serves as a technical specialist in the areas of hydrology, hydrogeology, and contaminant hydrogeology. Selected recent experience is as follows.

- *Southern Nuclear Operating Company.* Completed radionuclide transport analysis to assess accidental releases of liquid effluents to ground and surface waters. Authored groundwater and accidental release sections of the Early Site Permit application submitted to the NRC.

1998 - 2006: Senior Principal Engineer, Geotechnical & Hydraulic Engineering Services, Bechtel Power Corporation, Frederick, Maryland. Provided geotechnical and hydraulic engineering support to the engineering, procurement, and construction of fossil and nuclear power plants. Supported other Bechtel businesses in the areas of environmental restoration and waste management. Selected experience is summarized below.

- *North Anna Power Station, Dominion Energy, Inc.* Completed water balance study to quantify impacts of additional thermal discharges to Lake Anna on lake levels and releases. Authored hydrology, water use, and water quality sections of the Early Site Permit application submitted to the NRC.
- *Coachella Stormwater Channel, Coachella Valley Water District.* Developed two-dimensional floodplain model to map extent of flooding due to breaches in the levees of a major stormwater channel.
- *Savannah River Site, U. S. Department of Energy.* Developed model to assess the potential for eroding and transporting radiologically contaminated sediments deposited in the Savannah River floodplain.
- *Connecticut Yankee Atomic Power Corporation, Haddam Neck Plant Decommissioning Project.* Completed dose modeling (RESRAD) necessary to determine Derived Concentration Guideline Levels for soil and concrete debris in compliance with 10 CFR 20.1402. Co-authored related sections of the License Termination Plan submitted to the NRC. Provided rebuttal testimony at an Atomic Safety Licensing Board hearing.
- *Central Interstate Compact, Low-Level Radioactive Waste Disposal Facility.* Prepared and provided testimony on ground water issues at a public hearing on the proposed license decision. Served as an expert witness on ground water in the matter of Entergy et al. versus the State of Nebraska.
- *Oak Ridge Reservation, On-Site Disposal Facility.* Peer reviewed the performance assessment of a low-level radioactive disposal facility located at Y-12 for the Department of Energy. Review included the conceptual hydrologic model, the ground water flow model (MODFLOW) used to determine pathways, and the performance assessment model (PATHRAE) used to assess risk and to determine waste acceptance criteria.

1992 - 1998: Principal Scientist, Bechtel National, Inc., Oak Ridge, Tennessee. Responsibilities included technical support and management of environmental projects. Selected project experience is summarized below.

- *Central Interstate Compact, Low-Level Radioactive Waste Disposal Facility.* Project Hydrogeologist responsible for site characterization modeling work supporting the licensing of this disposal facility. Supervised the conceptualization, development, and calibration of regional- and local-scale ground water flow models (MODFLOW) used for site characterization. Authored sections of the Safety Analysis Report dealing with hydrogeology and ground water flow modeling. Authored responses to comments made by Nebraska's technical review team. Familiar with requirements of 10 CFR 61.50, associated guidance documents, and Branch Technical Position papers for low-level radioactive waste performance assessment.
- *Oak Ridge National Laboratory.* Project Manager for this technical support services contract for the laboratory's environmental restoration/waste management programs. The scope of this contract

included site investigations, remedial investigations, treatability and pilot studies, decision documents, and environmental sampling.

- *Pease Air Force Base, Air Force Center for Environmental Excellence.* Project Engineer for this full service environmental remediation service contract. Supervised a team of engineers and scientists tasked with designing, constructing, and operating soil and ground water remedial actions at 20 sites located across the base. Remedial actions included landfill capping, bioventing, air sparging, soil vapor extraction, ground water containment and treatment, and monitored natural attenuation. Noteworthy contributions included application of the simulation-optimization modeling approach to design a pumping system for containing TCE-contaminated ground water, and the use of a permeable reaction wall for the *in situ* treatment of ground water contaminated with chlorinated solvents. Primary point of contact for the Air Force and State and Federal regulators on all technical aspects of the work.
- *Navy Southern Division, Environmental Response Action Contract.* Project Engineer responsible for remedial actions at Navy and Marine bases in Georgia and Florida. Developed remediation work plans, procured field services, and provided oversight during construction. Remedial technologies applied include ground water pump-and-treat, *in situ* and *ex situ* bioremediation of ground water, soil vapor extraction, and excavation, treatment, and disposal of contaminated soils.
- *Navy Southwestern Division, Comprehensive Long-Term Environmental Action, Navy Contract.* Supervised statistical analyses of soil and ground water data to develop background and exposure concentrations in support of the Long Beach Naval Shipyard and the MCAS El Toro remedial investigations. These analyses included estimation of uncertainty limits, estimation of tolerance intervals, and hypothesis testing using both parametric and non-parametric methods.
- *U. S. Environmental Protection Agency, Region IV.* Supported the Florida Petroleum Reprocessors RI/FS, which included site characterization, interpretation of hydrogeologic and chemical data, and development and evaluation of remedial alternatives for this TCE-contaminated, karst aquifer. Provided support for the Twelve Mile Creek/Hartwell Lake RI/FS. Supervised sediment transport modeling, water quality modeling, and food chain modeling to assess PCB fate and transport in a 56,000 acre reservoir.

**1989-1992:** *Assistant Professor, Department of Civil Engineering, State University of New York at Buffalo.* Taught courses in Groundwater Hydrology, Transport Phenomena in Groundwater, Environmental Fluid Mechanics, and Numerical Methods in Water Resources and Environmental Engineering. Conducted research in biological fate of organic contaminants in subsurface systems, subsurface flow and transport modeling, and sediment transport modeling.

**1985-1989:** *Research Assistant, Department of Civil Engineering and Operations Research, Princeton University.* Conducted study to quantitatively assess changes in permeability, porosity, and dispersivity in porous media due to *in situ* bacterial growth, and developed a two-dimensional finite element model to simulate *in situ* biological remediation of contaminated ground water. Developed a three-dimensional, finite-element ground water model to predict the migration of a chlorinated solvent plume, and assess the performance of a proposed well field for recovering the contamination.

**1981-1985:** *Senior Engineer, Bechtel Corporation, San Francisco, California.* Served as a hydrologist to support projects in the areas of infrastructure, power, mining, and hazardous and radioactive waste management. Technical responsibilities included analyses of stream erosion and sedimentation, stream flow prediction, hydraulic analyses of open channel flows, and sediment transport modeling

**1979-1981: Research Assistant, Civil Engineering Department, Colorado State University.** Assessed effects of bridge encroachments on water surface elevation, flood wave propagation, and stream bed scour using mathematical modeling techniques. Participated in physical model study of deep draft vessels moored in Mississippi River, including model construction, data acquisition and interpretation.

## **PUBLICATIONS**

### Refereed Journal Articles:

- Taylor, S. W., C. R. Lange, and E. A. Lesold, Biofouling of contaminated ground water recovery wells: Characterization of microorganisms, Ground Water, 35(6), 973-980, 1997.
- Hoyal, D. C. J. D., J. F. Atkinson, J. V. DePinto, and S. W. Taylor, The effect of turbulence on sedimentation to a fully absorbing bed, J. Hydraul. Res., 33(3), 349-360, 1995.
- Irvine, K. N., S. W. Taylor, M. Leonard, K. McFarland, and E. J. Pratt, Impacts of fluctuating water levels and flows to hydropower production on the Great Lakes: Planning for the extremes, The Great Lakes Geographer, 2(1), 67-85, 1995
- Atkinson, J. F., S. Blair, S. Taylor, and U. Ghosh, Surface aeration in a stratified river, J. Environ. Eng., 121(1), ASCE, 113-118, 1995.
- Jaffe, P. R., and S. W. Taylor, "Reply," Water Resour. Res., 28(5), 1483-1484, 1992.
- Taylor, S. W., and P. R. Jaffe, "Enhanced in-situ biodegradation and aquifer permeability reduction," J. Environ. Eng., 117(1), 25-46, ASCE, 1991.
- Taylor, S. W., and P. R. Jaffe, "Substrate and biomass transport in porous media," Water Resour. Res., 26(9), 2181-2194, 1990.
- Taylor, S. W., and P. R. Jaffe, "Biofilm growth and the related changes in the physical properties of a porous medium, 3. Dispersivity and model verification," Water Resour. Res., 26(9), 2171-2180, 1990.
- Taylor, S. W., P. C. D. Milly, and P. R. Jaffe, "Biofilm growth and the related changes in the physical properties of a porous medium, 2. Permeability," Water Resour. Res., 26(9), 2161-2169, 1990.
- Taylor, S. W., and P. R. Jaffe, "Biofilm growth and the related changes in the physical properties of a porous medium, 1. Experimental investigation," Water Resour. Res., 26(9), 2153-2159, 1990.
- Taylor, S. W., and H. W. Shen, "Simple methods for estimating backwater and constriction scour at bridges and abrupt encroachments, *In* Improving Estimates From Flood Studies," Transportation Research Record, 922, National Research Council, 54-64, 1983.

### Book Chapters:

- Jaffe, P. R., and S. W. Taylor, Assessment of the Potential for Clogging and Its Mitigation During In-Situ Bioremediation, In G. A. Lewandowski and L. J. DeFilippi (ed.), Biological Treatment of Hazardous Waste, John Wiley & Sons, Inc., New York, 1998.

### Conference Papers:

- Taylor, S. W., and L. C. Headland, Analysis and design of infiltration seawater intakes, ASCE/EWRI World Water and Environmental Resources Congress, Anchorage, Alaska, May 15-19, 2005.
- Ng, K. Y., Y. Zheng, and S. W. Taylor, Recent developments in hydraulic design of power plants cooling water intake structures, ASCE/EWRI World Water and Environmental Resources Congress, Anchorage, Alaska, May 15-19, 2005.
- Taylor, S. W., L. C. Smith, R. K. Carr, A. Carson, and E. Darois, Developing site-specific derived concentration guideline levels for multiple media at the Connecticut Yankee Haddam Neck Plant, Waste Management '03 Conference, Tucson, Arizona, February 23-27, 2003.
- Taylor, S. W., and D. M. Wagner, Dose modeling approach for buried concrete debris under a resident farmer scenario, ASCE/EWRI World Water and Environmental Resources Congress, Orlando, Florida, May 20-24, 2001.

- Wagner, D. M., and S. W. Taylor, The effect of pre-existing ground water radioactivity on derived concentration guideline levels for residual radioactivity in soil, ASCE/EWRI World Water and Environmental Resources Congress, Orlando, Florida, May 20-24, 2001.
- Taylor, S. W., S. A. Underhill, and A. L. Ditto, Optimizing LNAPL recovery using the observational approach, the 1999 International Water Resource Engineering Conference, Groundwater Management Symposium, Seattle, Washington, August 8-11, 1999.
- Taylor, S. W., R. K. Lambert, and A. L. Ditto, Application of the simulation-optimization approach to groundwater management: Pease Air Force Base case study, 1998 International Water Resources Engineering Conference, Groundwater Management Symposium, Memphis, Tennessee, August 3-7, 1998.
- Findikakis, A. N., V. Yucel, S. W. Taylor, S. C. Mehrotra, M. Sabbe, and J. DeOld, Effect of variable recharge rates on groundwater transport of radionuclides at a LLRW disposal facility, Waste Management '96, Tucson, Arizona, February 25-29, 1996.
- Underhill, S. A., S. W. Taylor, and J. V. DePinto, Groundwater flow and transport modeling within a geographic information system, International Groundwater Management Symposium, San Antonio, Texas, August 14-18, 1995.
- Taylor, S. W., M. G. Sholley, M. A. Sabbe, and J. H. DeOld, Groundwater flow modeling for the Central Interstate Compact, Butte, Nebraska, low-level radioactive waste disposal facility, Waste Management '95, Tucson, Arizona, February 26 - March 2, 1995.
- Taylor, S. W., In-situ bioremediation of petroleum-contaminated groundwater: Theory, 40th Anniversary Conference, Air & Waste Management Association, Mid-Atlantic States Section, Atlantic City, New Jersey, September 19-23, 1994.
- Taylor, S. W., Modeling enhanced in-situ biodegradation in groundwater: Model response to biological parameter uncertainty, 1993 Ground Water Modeling Conference, International Ground Water Modeling Center, Golden, Colorado, June 9-12, 1993.

#### Conference Presentations:

- Ng, K., and S. W. Taylor, Case Study of Power Plant Intake System Selection and Design Under the Clean Water Act 316(b) Regulations, Electric Power 2004, Baltimore, Maryland, March 30 - April 1, 2004.
- Taylor, S. W., Modeling biodegradation in groundwater under conditions of biokinetic parameter uncertainty, 1994 National Conference on Environmental Engineering, ASCE, Boulder, Colorado, July 11-13, 1994.
- Hayashida, T., and S. W. Taylor, "Non-point source contaminant loading to the Buffalo River from contaminated groundwater," 34th Meeting, International Association for Great Lakes Research, Buffalo, New York, June 2-6, 1991.
- Jaffe, P. R., and S. W. Taylor, "Transport of biomass and growth substrate in a porous medium," *EOS Trans.*, AGU, 71(17), 1990.
- Jaffe, P. R., S. W. Taylor, N. Singhal, and N. H. Baek, "The anaerobic bioremediation of TCE contaminated aquifers: A feasibility study," U. S. Geological Survey National Symposium on Water Quality, Tampa, Florida, November 12-17, 1989.
- Taylor, S. W., and P. R. Jaffe, "Constitutive equations for biofilm-affected groundwater flow and solute transport parameters," *EOS Trans.*, AGU, 69(44), 1988.
- Milly, P. C. D., S. W. Taylor, and P. R. Jaffe, "Reduction of permeability by a biofilm, Chapman Conference on Microbial Processes in the Transport, Fate, and In-Situ Treatment of Subsurface Contaminants," AGU, Snowbird Resort, Snowbird, Utah, October 1-3, 1986.

#### Research Reports:

- Taylor, S. W., Groundwater Flow to a Horizontal Well, Du Pont Remediation Services, Wilmington, Delaware, October, 1993.

- Taylor, S. W., C. R. Lange, and J. C. Fountain, Investigation of Biofouling at Groundwater Extraction Wells, Eastman Kodak Company, Rochester, New York, Department of Civil Engineering, State University of New York at Buffalo, Buffalo, New York, April, 1993.**
- Irvine, K. N., M. Leonard, and S. W. Taylor, Hydropower Evaluation for the Mainstem Projects in the Great Lakes-St. Lawrence River Basin, International Joint Commission, Great Lakes Water Levels Reference, Phase II, Report to Working Committee 3, March, 1992.**
- Taylor, S. W., and D. M. Wagner, Biological and Physical Factors Affecting Sorption of Bacteria to Subsurface Particles, Department of Civil Engineering, State University of New York at Buffalo, Buffalo, New York, September, 1992.**
- Taylor, S. W., and M. T. Panek, Mathematical Simulation Models for Evaluating the Biological Fate of Organic Contaminants in Groundwater, New York State Center for Hazardous Waste Management, State University of New York at Buffalo, Buffalo, New York, March 1991.**
- Taylor, S. W., Pollutant Loadings to the Buffalo River Area of Concern From Inactive Hazardous Waste Sites, Department of Civil Engineering, State University of New York at Buffalo, Buffalo, New York, December, 1991.**
- Jaffe, P. R., and S. W. Taylor, Design of Aquifer Bioremediation, Report No. 90-WR-1, Department of Civil Engineering and Operations Research, Princeton University, Princeton, New Jersey, January, 1990.**
- Jaffe, P. R., S. W. Taylor, N. H. Baek, P. C. D. Milly, and A. C. Marinucci, Biodegradation of Trichloroethylene and Biomanipulation of Aquifers, Report No. WR-88-3, Department of Civil Engineering and Operations Research, Princeton University, Princeton, New Jersey, August, 1988.**
- Traille, L. A., D. L. Chery, H. W. Shen, and S. Taylor, Flow Modifications by Storage Loss Through Flood Plain Encroachment - User's Manual, NCHRP, Project 15-7, August 1982.**

**EDUCATION:**

B.S., Civil Engineering  
University of Melbourne, Australia, 1963

M.S., Civil Engineering  
University of Melbourne, Australia, 1968

Ph.D., Civil Engineering Massachusetts Institute of Technology, 1973

**SUMMARY:**

**30 Years:** Waste and Heat disposal studies, including design and analysis of cooling ponds, spray canals and outfalls, design and review of coastal protection works, analysis and modeling of surface and ground water flows and contaminant transport.

**1 Year :** Deep water marine pipeline study.

**6 Years:** Research in heat disposal and reservoir behavior including the behavior of thermal outfalls and evaporation from cooling lakes/ponds.

**2 Years:** Design, construction and operation of hydrologic network in Papua, New Guinea.

**1 Year:** Maintenance and minor construction for roads and harbors in Papua, New Guinea.

**EXPERIENCE:**

**July 2006 to Present:** Technical Specialist in Hydraulic Engineering

**January 1995 – June 2006:** As Manager of Geotechnical and Hydraulic Engineering Services (G&HES), Dr. Ryan has the overall responsibility for the company-wide application of geologic and hydrologic services and hydraulic and geotechnical engineering. Bechtel's G&HES group consists of about 50 professionals and support staff located in three of Bechtel's Regional Offices and in the London and Brisbane Offices.

Besides his functional and administrative management responsibilities, Dr. Ryan also provides project oversight and planning, and marketing of the capabilities of G&HES. In addition, he provides technical direction and technical review on Bechtel projects which involve environmental hydraulic and coastal engineering studies.

**August 1994 – January 1995:** As Manager of Bechtel's Hydraulics/Hydrology Group, Dr. Ryan managed and directed the analysis and studies performed by a 26-member team of highly trained and experienced hydraulic and hydrologic engineering specialists. The Group performs a wide variety of tasks related to water resources development, the design of hydroelectric, thermal power and LNG plants, fisheries and

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waste isolation systems. Capabilities of the Group include numerical simulation of fluid flow, development of flood hydrographs, water resource assessment, and conceptual design and hydraulic analysis for coastal structures, intake and outlet works, penstocks, spillways, power tunnels, gates, valves and surge chambers, and thermal modeling for streams, rivers, estuaries and reservoirs. The Group performs field studies to collect data required for modeling and installs and monitors instrumentation. Because of their association with field studies, the group maintains information files on instrumentation and recommends state-of-the-art equipment for use on Bechtel monitoring or data collection projects.

1979 - July 1994: As Chief Hydrologic Engineer in Bechtel's Hydraulics/Hydrology Group, Dr. Ryan was responsible for siting evaluations for major projects, including the preparation of safety analyses and environmental reports (SAR and ER) for nuclear power projects; hydrologic studies related to power, mining and other industrial proposals, including site evaluation, waste and heat disposal studies, flood studies, water availability and reliability analyses, and river and reservoir regulation and sedimentation studies. He was also responsible for the development of ground water models and the modeling of ground water flow including contaminant transport for the design of hazardous-waste containment systems as well as for general water-resource projects.

1984 - 1986: Dr. Ryan directed the physical and computer model studies for the tailing disposal work for the Quartz Hill Project. Work included model development and application, plus interaction with Federal and State Agencies.

1978 - 1979: During this period, Dr. Ryan worked as a Marine Survey Specialist with Bechtel. He was a member of the team investigating routes for a gas pipeline between Algeria and Spain. He performed theoretical studies and supervised field investigations.

1974 - 1978: As Chief Hydrothermal Engineer in Bechtel's Hydraulics/Hydrology Group, Dr. Ryan was responsible for cooling water studies and coastal protection studies for steam electric power plants, including the design of cooling ponds and spray canals, intake and discharge structures for once-through systems, thermal plume studies and blowdown disposal systems; reservoir studies including thermal stratification and aeration studies; coastal protection studies.

1973 - 1974: At the Oak Ridge National Laboratory, Dr. Ryan was employed as head of Thermal Hydraulics group in Environmental Impact Reports Project. He was responsible for reviewing heat dissipation aspects of ER's for Nuclear Power Plants, and writing these sections of EIS for AEC.

1967 - 1973: During this period Dr. Ryan carried out research at the Massachusetts Institute of Technology Department of Civil Engineering, and the University of Melbourne in Australia, on the behavior of cooling ponds and stratified lakes.

1964 - 1967: As an engineer for the Hydrographic Survey Section, Australian Department of Works, Port Moresby, Papua, Mr. Ryan was responsible for the design, construction and operation of a hydrologic

network in Papua-New Guinea. Later he was in charge of maintenance and minor construction of roads, storm water drainage and harbor facilities.

#### PROFESSIONAL DATA:

Dr. Ryan is a member of the American Society of Civil Engineers and the International Association for Hydraulic Research. He was Chairman of the ASCE Hydraulic Division Executive Committee in 1984; from 1974-1978 he was Chairman of American Nuclear Society work group 2.9, involving the supply of water for nuclear plants, and a Member of the Advisory Review Committee on Power Spray Cooling to the National Science Foundation; he was awarded the 1973 Hilgard Prize (ASCE Hydraulics Award), and the 1984 ASCE Huber Research Prize. In 1971, 1972 and 1975 Dr. Ryan was an invited lecturer at the MIT Summer Course on Engineering Aspects of Heat Disposal. In 1988 he lectured at the NATO Advanced Study Institute on Physical Models. He is a member of the Dean's Advisory Council for the UCLA College of Engineering, and the Industrial Advisory Board for the Civil and Environmental Engineering Department at CalPoly. He has written and presented over 20 papers in the area of stratified lakes, cooling ponds and heat disposal. Dr. Ryan is a registered professional engineer (civil) in the State of California.

#### RELEVANT EXPERIENCE:

Since 1974 Dr. Ryan has been responsible for all cooling water studies performed by Bechtel including the following cooling ponds, spray canals, and cooling water outfalls.

Cholla Plant	- a 360 acre cooling lake in Arizona
North Anna Project	- a 9000 acre cooling lake in Virginia
Four Corners Project	- a 1200 acre cooling pond in New Mexico
Nipsco Project	- a cooling tower/cooling pond/spray pond project in Indiana
South Texas Project	- an 8000 acre cooling pond near Bay City, Texas
Midland Project	- an 880 acre cooling pond in Michigan
Big Stone Project	- a 400 acre cooling pond in Montana
Martin Pond	- a 6500 acre cooling pond in Florida
Damietta Project	- Modeling of stagnant stratified river as a cooling pond.
Sultan Project	- Modeling of a stratified lake in Washington
Greenwood Project	- Modeling of a spray canal in Michigan

In addition to the above studies, Dr. Ryan directed emergency cooling pond transient studies for the Arkansas, Midland, Callaway and Limerick projects and also directed field and model studies for the cooling water outfall investigation for the Diablo Canyon Nuclear Plant in California.

#### AWARDS:

Named a Bechtel Fellow in 1990

ASCE Hilgard Prize for Paper on Reservoir Behavior, 1973

ASCE Huber Research Prize for work on evaporation from heated water surfaces, 1984

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**PUBLICATIONS OF PATRICK J. RYAN**

Ryan, P. J., and A. N. Findikakis, "Marine Disposal of Tailings in a Stratified Fjord," presented at 25th International Conference on Coastal Engineering, Orlando, Florida, September 1996.

Lee, C. L., and P. J. Ryan, "Mixing of Thermal Discharges at Low Froude Numbers," National Conference on Hydraulic Engineering, Buffalo, New York, August 1994.

Ryan, P. J., and Kubanis, S. A., "Environmental Considerations for International Projects in Coastal Waters," 17th Annual Energy-Sources Technology Conference, New Orleans, January 1994.

Locher, F. A., Ryan, P. J., Bird, V. C., and Steiner, P., "Debris Removal from a Low-Velocity Inclined Screen," presented at 13th USCOLD Annual Meeting, Chattanooga, Tennessee, May 1993.

Lee, C. L., Ryan, P. J., and Lakicevic, Z., "Use of a Dam to Revitalize the Aquatic Environment in an Intermittent River," 13th USCOLD Annual Meeting, Chattanooga, Tennessee, May 1993.

Ryan, P. J., "Marine Intakes for Aquaculture," 23rd International Conference on Coastal Engineering, Venice, Italy, October 1992.

Namikas, D., Ryan, P. J., Locher, F. A., "Seawater Delivery for Use in Aquaculture Development," to be presented at ASCE Hydraulics '91, August, Nashville, Tennessee

Ryan, P. J., Yucel, V., "Water Supply and Aeration Demands for Shrimp Farms," presented at ASCE National Conference on Hydraulic Engineering, San Diego, August 1990.

Ryan, P. J., Tu, S., "Field Verification of a Physical Model of a Thermal Discharge," presented at the International Conference on Physical Modelling of Transport & Dispersion, Boston, August 1990.

Ryan, P. J., Ng, K. Y., "Circulation and Transport Modelling in a Semi-Enclosed Embayment," presented at 22nd International Conference on Coastal Engineering, Delft, Holland, July 1990.

Ryan, P. J., Alsaffar, A., Dessouki I., Halim, A. A., "Physical Modelling of Heated Discharges into a Stagnant River," Proceedings of the Third National Conference on Hydraulic Engineering, ASCE, New Orleans, Louisiana, August 1989.

Ryan, P. J., "Density Models," Chapter 5, Recent Advances in Hydraulic Physical Modelling, Rui Martins (Ed.), NATO ASI Series E; Applied Sciences, Volume 165, Published by Kluwer Academic Publishers, 1989.

Leighton, J. P., Ryan, P. J., and Tu, S. W., "Verification/Calibration of a Thermal Discharge Model," Proceedings of ASCE Symposium on Verification of Hydraulic Models, Colorado Springs, CO, 1988.

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Ismail, N. I., Wiegel, R. L., Ryan, P. J., and Tu, S. W., "Mixing of Thermal Discharges in Coastal Waters," presented at 21st International Conference on Coastal Engineering, Spain, June 1988.

Ryan, P. J., and Dean, R. G., "Wave Erosion of Natural Material Dikes," presented at 21st International Conferences on Coastal Engineering, Spain, June 1988.

Ryan, P. J., Tu, S. W., Ismail, N., and Wiegel, R. L., "Verification of a Physical Model of a Coastal Discharge," Proceedings of ASCE National Conference in Hydraulic Engineering, Williamsburg, VA, August 1987.

Ismail, N., Ryan, P. J., and Tu, S. W., "Role of Wave Transformation on Mixing of Coastal Surface Jets," ASCE Conference on Coastal Hydrodynamics, Newark, Delaware, June 1987.

Tu, S. W., Ryan, P. J., and Leighton, J. P., "Model/Field Comparison - Coastal Buoyant Jet," Proceedings of 20th International Conference on Coastal Engineering, Taipei, Taiwan, November 1986.

Ryan, P. J., "Behavior of Sediment Laden Plumes on Steep Slopes," Proceedings of ASCE Water Forum 1986 Conference, Long Beach, CA, August 1986.

Ryan, P. J. and Findikakis, A. N., "An Overview of Field and Modeling Program in the Submarine Disposal of Mine Tailings for the Quartz Hill Molybdenum Project," Sixth International Ocean Disposal Symposium, Asilomar, CA, April 1986.

Findikakis, A. N., Ryan, P. J., "A Study of Marine Disposal of Mine Tailings," Proceedings of Annual Meeting of Mining Engineers, New Orleans, LA, March 1986.

Virmani, J. and Ryan, P. J., "Application of Water Budget to Seepage Loss Investigation," Proceedings of ASCE Hydraulics Division Specialty Conference, Orlando, Florida, August 1985.

Ryan, P. J., Elder, R. A., and Gardiner, S. R., "Prediction of Dam Overtopping Due to Mudflows," Proceedings of ASCE Hydraulics Division Specialty Conference, Coeur d' Alene, Idaho, August 1984.

Cobb, D. A., Harper, C. M. and Ryan, P. J., "Enhancing the Performance of the Academic Consultant," presented at the Annual Meeting of the American Society of Limnology and Oceanography, Newfoundland, June 1983.

Jirka, G. H., Findikakis, A. N., Onishi, Y., and Ryan, P. J., "Dispersal of Radionuclides in Surface Waters," in Radiological Assessment, H.R. Meyer and J.E. Till, eds., Nuclear Regulatory Commission, 1983.

Findikakis, A. N., Ryan, P. J., and Farin, H., "Hydrodynamic Circulation and Temperature Distribution in the Vicinity of 6000 MW Coastal Power Plant," presented at the Fourth International Ocean Disposal Symposium, Plymouth, England, April 11-15, 1983.

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Findikakis, A. N., Locher, F. A., and Ryan, P. J., "Temperature and Turbidity Simulation in Spada Lake," presented at the Symposium on Surface Water Impoundments, Minneapolis, Minnesota, June 1980.

Locher, F. A., Elder, R. A., and Ryan, P. J., "Acquisition of Water Quality Data for Reservoir Modeling, Sultan River Project," presented at the Symposium on Surface Water Impoundments, Minneapolis, Minn., June 1980.

Ryan, P. J., Leonard, M. S., Findikakis, A. N., Segol, G. and Onishi, Y., "Aquatic Dispersal of Radionuclides," Invited Lecture at 3rd Annual Health Physics Society, Summer School, Seattle, Washington, July 1980.

Ryan, P. J., Leonard, M. S., Jain, S. C., and Elder, R. A., "Instantaneous and Time Averaged Bottom Temperatures Induced by an Ocean Outfall," Proceedings of 17th Congress of the International Association of Hydraulic Research, Vol. 3, August 1977.

Ryan, P. J. and Myers, D. M., "Spray Cooling: A Review of Thermal Performance Models," Proceedings of American Power Conference, Vol. 38, 1976.

Ryan, P. J., "Heat Dissipation by Spray Cooling," presented in Short Course in Thermal Pollution, Virginia Polytechnic Institute, Blacksburg, Virginia, August 1974.

Ryan, P. J., Harleman, D. R. F., and Stolzenbach, K. D., "Surface Heat Loss from Cooling Ponds," Water Resources Research, Vol. 10, No. 5, October 1974.

Ryan, P. J., "Engineering Aspects of Heat Dissipation in the Water Environment," presented at Georgia Institute of Technology, short course in Environmental Effects of Nuclear Power Plants, November 1973.

Ryan, P. J., Stolzenbach, K. D., "Infrared Water Temperature Surveys," 15th Congress IAHR, Istanbul, Turkey, September 1973.

Ryan, P. J. and Harleman, D. R. F., "Transient Cooling Pond Behavior," Proceedings of the ASCE Conference on Hydraulic Engineering and the Environment, Montana State University, Bozeman, Montana, August 1973.

Ryan, P. J., Stolzenbach, K. D., and Elder, R. A., "Remote Sensing of Water Temperatures," Proceedings of Second Conference on Remote Sensing of Earth Resources, Tullahoma, Tennessee, March 1973.

Ryan, P. J. and Harleman, D. R. F., "Analytical and Experimental Study of Transient Cooling Pond Behavior," Technical Report No. 161, Ralph M. Parsons Laboratory for Hydrodynamics and Water Resources, MIT, Cambridge, Massachusetts, February 1973.

Ryan, P. J., and Stolzenbach, K. D., Ch. 1: "Environmental Heat Transfer: Engineering Aspects of Heat Disposal from Power Generation," (D. R. F. Harleman, Ed.), Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, Department of Civil Engineering, M.I.T., Cambridge, Massachusetts, June 1972, June 1975.

Huber, W. C., Harleman, D. R. F., and Ryan, P. J., "Prediction of Internal and Outlet Temperatures in Stratified Reservoirs," Journal of ASCE, Hydraulics Division, April 1972.

Ryan, P. J., Ch. 2: "Temperature Distributions in Lakes and Reservoirs: Engineering Aspects of Heat Disposal from Power Generation," (D.R.F. Harleman, Ed.), Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, Dept. of Civil Engineering, M.I.T. Cambridge, Massachusetts, June 1971 and June 1972.

Ryan, P. J., Ch. 12: "Cooling Ponds: Mathematical Models for Temperature Prediction and Design: Engineering Aspects of Heat Disposal from Power Resources and Hydrodynamics," Dept. of Civil Engineering, M.I.T., Cambridge, Massachusetts, June 1971, June 1972 and June 1975.

Ryan, P. J. and Harleman, D. R. F., "Prediction of Annual Cycle of Temperature Changes in a Stratified Reservoir: Mathematical Model and User's Manual," Technical Report No. 137, Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, M.I.T. Cambridge, Massachusetts, March, 1971.

## BRIEF RESUME

### Charles C. Coutant, Ph. D.

Retired Distinguished Research Ecologist, Environmental Sciences Division  
Oak Ridge National Laboratory, Oak Ridge, Tennessee  
120 Miramar Circle, Oak Ridge, TN 37830  
(865) 483-5976; ccoutant3@comcast.net

**Education:** BA 1960 (Lehigh University); MS 1962 (Lehigh); PhD 1965 (Lehigh).

**Positions:** (1) Battelle-Pacific Northwest Laboratories, Richland, Washington (1965-70): Research Scientist, Columbia River Thermal Effects Studies;  
(2) Environmental Sciences Division, Oak Ridge National Laboratory (1970-2005): Manager Thermal Effects Program (1970-79), Leader Multimedia Modeling Project (1979-82); Manager DOE Global Carbon Cycle Program (1985-86); Manager ORNL Exploratory Studies Program (1989-1991); Senior Research Staff (1982-85, 1986-88, 1992-2004); Distinguished Research Staff (2004-2005);  
(3) Private consultant (2005-present).

**Professional Affiliations:** American Association for the Advancement of Science (Fellow); American Institute of Fishery Research Biologists (Fellow); American Fisheries Society (AFS; Presidents of Water Quality Section, Tennessee Chapter, Southern Division, and full Society; Co-Editor of journal Transactions); American Society of Limnology and Oceanography; American Society for Testing and Materials (Chair Environmental Fate Models Task Group; lapsed); Ecological Society of America (Vice Chair Applied Ecology Section); Sigma Xi (Southeast Regional Lecturer, President Oak Ridge Chapter); Water Pollution Control Federation (Literature Review Committee-Thermal Effects; lapsed).

**Honors:** Darbaker Prize in Microbiology, Pennsylvania Academy of Science; Director's Award, Battelle-Northwest; Excellence in Fisheries, TN Chapter AFS; Outstanding Publication, Martin Marietta Energy Systems (operator of ORNL); Distinguished Publication, American Society for Information Science; Distinguished Service Award, AFS; Outstanding Achievement Award, Southern Division, AFS; 2002 ORNL Distinguished Scientist of the Year.

**Publications:** 337

**Synopsis of Significant Technical Contributions:** Field study of thermal discharge effects on invertebrates of Delaware River; Laboratory and field studies of thermal effects of Hanford reactors on Columbia River salmonids and other aquatic life; annual reviews of thermal effects publications 1968-1980; evaluation of aquatic thermal effects information to provide national water temperature criteria recommendations by the National Academy of Sciences; participation in development of EPA guidelines for Clean Water Act §316(a) thermal studies of power stations; development of biological data and criteria for environmental impact assessments of steam electric power plants; participant in the establishment of the Electric Power Research Institute and member of its national

Advisory Council; development of electronic temperature telemetry of fishes as a research tool for thermal behavior studies; lead role in developing guidance for thermal power plant impact assessment for UNESCO and International Atomic Energy Agency; advisor on project evaluation to Bonneville Power Administration (BPA) Fish and Wildlife Program and member of Scientific Review Group; member of Northwest Power Planning Council's (NPPC) Independent Scientific Group; member National Marine Fisheries Service and NPPC's Independent Scientific Advisory Board for Pacific salmon restoration; member NPPC's Independent Scientific Review Panel for review of projects for BPA's Fish and Wildlife Program; elucidation of the thermal ecology of striped bass through laboratory and field research and its application to management of the species in fresh water and estuaries; evaluation of impacts of hydropower on aquatic systems; review and evaluation of §316(a) study plans, studies, and documents for power companies; new concepts for behavioral guidance of salmon smolts.

**Synopsis of Management Experience:** Leader of several research teams up to about 15 people; manager of Department of Energy intra- and extramural carbon dioxide research program (\$4 million/yr); manager of ORNL internal funding program (\$6-10 million/yr).

**Synopsis of Power Plant-related Advisory Roles:** Co-author of EPA's 316(a) guidelines (1977); Co-chair of Technical Advisory Committee for Virginia Power Company's North Anna Power Station 316(a) studies (1980s); Co-chair of Technical Advisory Committee for Commonwealth Edison Co. 316(a, b) studies on Upper Illinois waterway (1991-1996); Technical Advisor to Electricity Corp of New Zealand for thermal discharge permitting patterned after 316(a) (1991-1994); Third-party advisor for Georgia Power Co. and the State of Georgia for Plant Branch 316(a) demonstration (1993-1999); Advisor for 316(a) demonstration studies for Carolina Power and Light Co.'s H. B. Robinson Steam Plant (1994-1996); Advisor for 316(a) demonstration by Public Service Electric and Gas Co. for Hudson Station (1995-1998), Mercer Station (1998-2001) and Salem Nuclear Station (1998-2000); Advice for siting a power plant in Portugal (1997); review of Brayton Point Plant 316(a) studies for USEPA (1997-1998 and 2003); Review and testimony on Diablo Canyon thermal effects monitoring for Pacific Gas and Electric (1999-2000); Review and white paper preparation on fish population status and trends for Hudson River Utilities (2001-2002); Advised Dynegy Northeast on Danskammer and Roseton power plant relicensing issues (2002-present). Served on Fishery Panel for City of Newport News water intake (2004); Consultant to Dominion North Anna regarding biological aspects of Early Site License for additional units at North Anna Nuclear Station (2005-2007); Member of University of Tennessee team for biological assessment of thermal discharge from Blue Ridge Paper Products paper mill (2005-2006); Technical advisor to a stakeholder group evaluating revision of Colorado temperature standards (2006-2007); Participant in EPRI study of effectiveness of strobe lights for reducing impingement at power plant intakes (2006-2007); Advisor for Millstone Nuclear Power Plant re-permitting (2006-2007).