Appendix B. Annotated Bibliography by Challenge Area

This appendix contains annotated references for six topic areas. Click on a topic area name below to go directly to a subject of interest.

WATER USE AND SUPPLIES

Federal Agencies

USACE Institute for Water Resources

- Anacostia Watershed Restoration
  "This landmark plan is the product of unprecedented regional, multijurisdictional cooperation—a two-year, $2.8 million investment in identifying specific projects that can collectively turn the river and its surrounding watershed around."
- Chesapeake Bay Comprehensive Plan
  "The purposes of this reconnaissance phase are: (a) to determine whether there is a federal interest in implementing a project or projects within USACE mission areas for restoring, preserving and protecting the Chesapeake Bay aquatic ecosystem; (b) scope one or more project management plan(s) (PMP) focused on restoring, preserving and protecting the Chesapeake Bay ecosystem; and (c) negotiate a cost-sharing agreement(s) (CSA) between USACE and non-federal sponsor(s) (NFS) to cost-share the feasibility phase."

USGS

- Estimated use of water in the United States in 2010
  Maupin, M.A. et al., 2014
  "Water use in the United States in 2010 was estimated to be about 355 billion gallons per day (Bgal/d), which was 13 percent less than in 2005."
- Private Domestic-Well Characteristics and the Distribution of Domestic Withdrawals among Aquifers in the Virginia Coastal Plain
  Pope, J.P. et al., 2008
  "A comprehensive analysis of private domestic wells and self-supplied domestic ground-water withdrawals in the Coastal Plain Physiographic Province of Virginia indicates that the magnitudes of these withdrawals and their effects on local and regional ground-water flow are larger and more important than previous reports have stated."
- Statistical classification of hydrogeologic regions in the fractured rock area of Maryland and parts of the District of Columbia, Virginia, West Virginia, Pennsylvania, and Delaware
  Fleming, B.J. et al., 2013
  "Hydrogeologic regions in the fractured rock area of Maryland were classified using geographic information system tools with principal components and cluster analyses."
- A science plan for a comprehensive regional assessment of the Atlantic Coastal Plain aquifer system in Maryland
  Shedlock, R.J. et al., 2007
  "In response to a recommendation in 2004 by the Advisory Committee on the Management and Protection of the State's Water Resources, the Maryland Geological Survey and the U.S. Geological Survey have developed a science plan for a comprehensive assessment that will provide new scientific information and new data management and analysis tools for the State to use in allocating ground water in the Coastal Plain."

- Water volume and sediment accumulation in Lake Linganore, Frederick County, Maryland, 2009
  Sekellick, A.J. and W.S.L. Banks, 2010
  "To assist in understanding sediment and phosphorus loadings and the management of water resources, a bathymetric survey was conducted at Lake Linganore in Frederick County, Maryland in June 2009 by the U.S. Geological Survey, in cooperation with the City of Frederick and Frederick County, Maryland."
- Selected low-flow frequency statistics for continuous-record streamgage locations in Maryland, 2010
  Doheny, E.J. and W.S.L. Banks, 2010
  "This report presents low-flow frequency statistics for 114 continuous-record streamgage locations in Maryland."
- Changes in Streamflow and Water Quality in Selected Nontidal Basins in the Chesapeake Bay Watershed, 1985-2004
  Langland, M.J. et al., 2006
  "As part of an annual evaluation of water-quality conditions by the Chesapeake Bay Program, water-quality and streamflow data from 32 sites in nontidal parts of the Chesapeake Bay watershed were analyzed to document annual nutrient and sediment trends for 1985 through 2004."
- Estimated flood frequency and corresponding water-surface elevations at the confluence of the Potomac and Shenandoah Rivers, Harpers Ferry, West Virginia
  Doheny, E.J. and G.T. Fisher, 2000
  "This report presents updated flood-frequency analyses for the U.S. Geological Survey streamflow-gaging stations on the Potomac River at Shepherdstown, West Virginia, Shenandoah River at Millville, West Virginia, and Potomac River at Point of Rocks, Maryland."
- Methods for Estimating Drought Streamflow Probabilities for Virginia Streams
  Austin, S.H., 2014
  "Maximum likelihood logistic regression model equations used to estimate drought flow probabilities for Virginia streams are presented for 259 hydrologic basins in Virginia."
- Methods and Equations for Estimating Peak Streamflow Per Square Mile in Virginia's Urban Basins
  Austin, S.H., 2014
  "Models are presented that describe Virginia urban area annual peak streamflow per square mile based on basin percent urban area and basin drainage area."
- Assessment of hydrogeologic terrains, well-construction characteristics, groundwater hydraulics, and water-quality and microbial data for determination of surface-water-influenced groundwater supplies in West Virginia
  Kozar, M.D. and K.S. Paybins, 2016
  "In January 2014, a storage tank leaked, spilling a large quantity of 4-methylcyclohexane methanol into the Elk River in West Virginia and contaminating the water supply for more than 300,000 people. In response, the West Virginia Legislature passed Senate Bill 373, which requires the West Virginia Department of Health and Human Resources (WVDHHR) to assess the susceptibility and vulnerability of public surface-water-influenced groundwater supply sources (SWIGS) and surface-water intakes statewide. In response to this mandate for reassessing SWIGS statewide, the U.S. Geological Survey (USGS), in cooperation with the WVDHHR, Bureau of Public Health, Office of Environmental Health Services, compiled available data and summarized the results of previous groundwater studies to provide the WVDHHR with data that could be used as part of the process for assessing and determining SWIGS."
- Hydrologic budget and conditions of Permian, Pennsylvanian, and Mississippian aquifers in the Appalachian Plateaus physiographic province
  McCoy, K.J. et al., 2015
  "In response to challenges to groundwater availability posed by historic land-use practices, expanding development of hydrocarbon resources, and drought, the U.S. Geological Survey Groundwater Resources Program began a regional assessment of the Appalachian Plateaus aquifers in 2013 that incorporated a hydrologic landscape approach to estimate all components of the hydrologic system: surface runoff, base flow from groundwater, and interaction with atmospheric water (precipitation and evapotranspiration)."
  Study area includes small portion of Potomac basin.
- Estimation of traveltime and longitudinal dispersion in streams in West Virginia
  Wiley, J.B. and T. Messinger, 2013

"The U.S. Geological Survey (USGS), in cooperation with West Virginia Bureau for Public Health, Office of Environmental Health Services, compiled and evaluated traveltime and longitudinal dispersion data representative of many West Virginia waterways."

- Comparison of base flows to selected streamflow statistics representative of 1930–2002 in West Virginia
  Wiley, J.B., 2012
  "Base flows were compared with published streamflow statistics to assess climate variability and to determine the published statistics that can be substituted for annual and seasonal base flows of unregulated streams in West Virginia."
- Estimation of selected seasonal streamflow statistics representative of 1930-2002 in West Virginia
  Wiley, J.B. and J.T Atkins, Jr., 2010
  "Regional equations and procedures were developed for estimating seasonal 1-day 10-year, 7-day 10-year, and 30-day 5-year hydrologically based low-flow frequency values for unregulated streams in West Virginia."
- Estimation of flood-frequency discharges for rural, unregulated streams in West Virginia
  Wiley, J.B. and J.T. Atkins, Jr., 2010
  "Flood-frequency discharges were determined for 290 streamgage stations having a minimum of 9 years of record in West Virginia and surrounding states through the 2006 or 2007 water year."
- Hydrogeologic factors affecting base-flow yields in the Jefferson County area, West Virginia, October-November 2007
  Evaldi, R.D. et al., 2009
  "Base-flow yields at approximately the annual 75-percent-duration flow were determined for watersheds in the Jefferson County area, WV, from stream-discharge measurements made during October 31 to November 2, 2007."
- Water-Use Estimates for West Virginia, 2004
  Atkins, J.T., 2007
  "This study estimates the quantity of surface water and ground water used within West Virginia."
- Fracture Trace Map and Single-Well Aquifer Test Results in a Carbonate Aquifer in Jefferson County, West Virginia
  McCoy, K.J. et al., 2005
  "These data contain information on the results of single-well aquifer tests, lineament analysis, and a bedrock geologic map compilation for Jefferson County, West Virginia."
- Fracture trace map and single-well aquifer test results in a carbonate aquifer in Berkeley County, West Virginia
  McCoy, K.J. et al., 2005
  "These data contain information on the results of single-well aquifer tests, lineament analysis, and a bedrock geologic map compilation for the low-lying carbonate and shale areas of eastern Berkeley County, West Virginia."
- Correlations of daily flows at streamgages in and near West Virginia, 1930–2011, and streamflow characteristics relevant to the use of index streamgages
  Messinger, T. and K.S. Paybins, 2014
  "Correlation of flows at pairs of streamgages were evaluated using a Spearman's rho correlation coefficient to better identify gages that can be used as index gages to estimate daily flow at ungaged stream sites in West Virginia."
- Hydrogeology and Ground-Water Flow in the Opequon Creek Watershed area, Virginia and West Virginia
  Kozar, M.D. and D.J. Weary, 2009
  "… the U.S. Geological Survey (USGS), in cooperation with the West Virginia Department of Health and Human Services and the West Virginia Department of Environmental Protection, developed a numerical steady-state simulation of ground-water flow for the 1,013-square-kilometer Opequon Creek watershed area. The model was based on data aggregated for several recently completed and ongoing USGS hydrogeologic investigations conducted in Jefferson, Berkeley, and Morgan Counties in West Virginia and Clarke, Frederick, and Warren Counties in Virginia."
- Estimating Selected Streamflow Statistics Representative of 1930–2002 in West Virginia
  Wiley, J.B., 2008

"Regional equations and procedures were developed for estimating 1-, 3-, 7-, 14-, and 30-day 2-year; 1-, 3-, 7-, 14-, and 30-day 5-year; and 1-, 3-, 7-, 14-, and 30-day 10-year hydrologically based low-flow frequency values for unregulated streams in West Virginia."

- Hydrogeology, Aquifer Geochemistry, and Ground-Water Quality in Morgan County, West Virginia
  Boughton, C.J. and K.J. McCoy, 2006
  "Private and public wells throughout Morgan County, W. Va., were tested to determine aquifer hydraulic, geochemical, and water-quality characteristics."
- Low-Flow Analysis and Selected Flow Statistics Representative of 1930–2002 for Streamflow-Gaging Stations In or Near West Virginia
  Wiley, J.B., 2006
  "Comparisons of selected streamflow statistics are made between values computed for the five identified time periods and values computed for the 1930–2002 interval for 15 streamflow-gaging stations."
- Development and Analysis of Regional Curves for Streams in the Non-Urban Valley and Ridge Physiographic Province, Maryland, Virginia, and West Virginia
  Keaton, J.N. et al., 2005
  "Bankfull stream characteristics were assessed for stream reaches at 41 streamflow-gaging stations in the Valley and Ridge Physiographic Province in Maryland, Virginia, and West Virginia."
- Base-Flow Yields of Watersheds in the Berkeley County Area, West Virginia
  Evaldi, R.D. and K.S. Paybins, 2006
  "Base-flow yields at approximately 50 percent of the annual mean ground-water recharge rate were estimated for watersheds in the Berkeley County area, W.Va."
- Channel Gains and Losses in the Opequon Creek Watershed of West Virginia, July 25–28, 2005
  Evaldi, R.D. and K.S. Paybins, 2006
  "Discharge measurements were made during July 25–28, 2005, in streams and springs and at a wastewater-treatment plant outfall in the Opequon Creek watershed of West Virginia to describe surface-water resources during low-flow."
- Water Resources Data, Virginia, Water Year 2005, Volume 2: Ground water and ground-water-quality records
  Wicklein, S.M. et al., 2005
  "Water-resources data for the 2005 water year for Virginia consist of records of water levels and water quality of ground-water wells."
- The Virginia Coastal Plain Hydrogeologic Framework
  McFarland, E.R. and T.S. Bruce, 2006
  "A refined descriptive hydrogeologic framework of the Coastal Plain of eastern Virginia provides a new perspective on the regional ground-water system by incorporating recent understanding gained by discovery of the Chesapeake Bay impact crater and determination of other geological relations."
- Enhanced hydrologic and geomorphic monitoring in Ten Mile Creek, Montgomery County, Maryland
  In progress. "Additional development extending into the Ten Mile Creek watershed is planned over the next several years… This planned development in the Ten Mile Creek watershed presents an opportunity to monitor the surface-water hydrology and stream geomorphology before, during, and after the development to assess watershed responses over time."
- StreamStats
  - Maryland
    - Incorporation of Water-Use Summaries into the StreamStats Web Application for Maryland
      Ries III, K.G. et al., 2010
      "The U.S. Geological Survey, in cooperation with the Maryland Department of the Environment, has extended the area of implementation and added functionality to an existing map-based Web application named StreamStats to provide an improved tool for planning and managing the water resources in the BRAC-affected areas."
    - Low-flow characteristics of streams in Maryland and Delaware
      Carpenter, D.H. and D.C. Hayes, 1996

"Equations and transfer methods are developed to estimate low-flow characteristics at ungaged stream sites in Maryland and Delaware for average 7-, 14-, and 30-consecutive-day low-flow discharges for recurrence intervals of 2, 10, and 20 years."

- Pennsylvania
  - Regression equations for estimating flood flows at selected recurrence inter-vals for ungaged streams in Pennsylvania
    Roland, M.A. and M.H. Stuckey, 2008
    "Regression equations were developed for estimating flood flows at selected recurrence intervals for ungaged streams in Pennsylvania with drainage areas less than 2,000 square miles."
  - Low-flow, base-flow, and mean-flow regression equations for Pennsylvania streams
    Stuckey, M.H., 2006
    "Streamflow characteristics are commonly predicted by use of regression equations when a nearby streamflow-gaging station is not available."
- Virginia
  - Low-flow characteristics of Virginia streams
    Austin, S.H. et al., 2011
    "Low-flow annual non-exceedance probabilities (ANEP), called probability-percent chance (P-percent chance) flow estimates, regional regression equations, and transfer methods are provided describing the low-flow characteristics of Virginia streams."
  - Peak-flow characteristics of Virginia streams: U.S. Geological Survey Scientific Investigations Report 2011–5144
    Austin, S.H. et al., 2011
    "Peak-flow annual exceedance probabilities, also called probability-percent chance flow estimates, and regional regression equations are provided describing the peak-flow characteristics of Virginia streams."

Interstate Commissions

ICPRB

- 2010 Washington Metropolitan Area water supply reliability study, part 2: Potential impacts of climate change
  Ahmed, S.A. et al., 2013
- 2015 Washington Metropolitan Area Water Supply Study: Demand and resource availability forecast for the year 2040
  Ahmed, S.N. et al., 2015
- Cooperative water supply operations for the Metropolitan Washington Area
  Bencala, K.R. et al., 2013
- West Virginia consumptive use projections for 2020, 2030, and 2040
  Bencala, K.R. et al., 2013
- A test of the Ecological Limits of Hydrologic Alteration (ELOHA) method for determining environmental flows
  Buchanan, C. et al., 2013, *Journal of Freshwater Biology* 58
  "The Ecological Limits of Hydrologic Alteration (ELOHA) method described in Poff *et al*. (2010) was applied to streams and small rivers in a large central region of the Potomac River basin in the U.S.A."
- Geospatial analysis tool for estimating watershed-scale consumptive use: Potomac River basin case study
  Ducnuigeen, J. et al., 2015, Chapter In *Advances in Watershed Science and Assessment*. Springer International Publishing Switzerland. T. Younos and T.E. Parece (eds.)
  "The objective of this chapter is to present a case study model developed for the Potomac River Basin in the United States. The model consists of a basin-wide analysis and mapping tool that incorporates monthly water use data from multiple political jurisdictions, estimates consumptive water use, displays raw and summary information in an interactive geospatial format, and shares information with stakeholders via an interactive web-based mapping tool."
- Non-consumptive uses in West Virginia
  Moltz, H.L.N. et al., 2013

- Water resources sustainability and safe yield in West Virginia
  Moltz, H.L.N. et al., 2013
- Potomac Basin water withdrawals: Evaluation of state water withdrawal data collection and recommendations for aligning efforts
  Palmer, J.B. and H.L.N. Moltz, 2013
- Impacts of anthropogenic activities on low flows in West Virginia
  Palmer, J.B. et al., 2013
- Water conservation measures in West Virginia
  Palmer, J.B. et al., 2013
- Seasonal steady-state ground water/stream flow model of the upper Monocacy River basin
  Schultz, C. and J. Palmer, 2008
  Annual and seasonal water budgets for the Monocacy/Catoctin drainage area
  Schultz, C. et al., 2004
  "The objective of this study is to assess the quantity of water available in the fractured bedrock aquifers underlying a pilot study area in the upper portion of the Potomac River basin, within the framework of the watershed water budget approach."
- Washington Metropolitan Area Water Supply Alternatives: Meeting the Challenges of Growth and Climate Change
  Schultz, C.L. et al., 2017
  "This study, by the Section for Cooperative Water Supply Operations on the Potomac (CO-OP) of the Interstate Commission on the Potomac River Basin (ICPRB), was conducted to assist the suppliers in the selection of new resources and operational measures to address the need for additional water supplies by 2040, as identified in a recent planning report (Ahmed et al., 2015)."
- Improvement in HSPF's low flow predictions by implementation of a power law groundwater storage-discharge relationships
  Schultz, C.L. et al., 2013
  Journal of the American Water Resources Association 50(4)
  "We have enhanced the ability of a widely used watershed model, Hydrologic Simulation Program — FORTRAN (HSPF), to predict low flows by reconfiguring the algorithm that simulates groundwater discharge."
- Middle Potomac River watershed assessment: Potomac River sustainable flow and water resources analysis
  USACE, TNC, and ICPRB, 2014
  "The assessment consists of five distinct components: (1) a large river environmental flow needs assessment, (2) a projection of future water uses, (3) a stream and wadeable rivers environmental flow needs assessment using the Ecological Limits of Hydrologic Alteration (ELOHA) method, (4) a stakeholder engagement process, and (5) development of a concept or scope for a strategic comprehensive plan for watershed management."
- Annual drought exercise reports
- Evaluation of Travilah Quarry for water supply storage
  Prepared by Black & Veatch, 2015
  "Black & Veatch was retained by the Interstate Commission on the Potomac River Basin to perform the feasibility study of potential prerequisites for use of the Travilah Quarry as a raw water supply storage facility, to supplement the existing water supply for the Washington Suburban Sanitary Commission and the Washington Aqueduct."

State Agencies

Virginia

- Department of Environmental Quality
  - State Water Resources Plan
    2015
    Local and regional information on "existing water use and sources of supply, future projections

of population and water demand, anticipated water supply deficits, potential sources of future water supply, and current efforts to use water efficiently."

- Annual Water Resources Report
  2015
- Eastern Virginia Groundwater Management Advisory Committee
  The committee is charged with "assisting the State Water Commission and the Department of Environmental Quality in developing, revising, and implementing a management strategy for groundwater in the Eastern Virginia Groundwater Management Area."
- Groundwater Resources of the Blue Ridge Province, Virginia
  White, B.A., 2012
  "A comprehensive regional description presents hydrogeologic and geochemical characteristics and the water-bearing potential of major rock types in the Blue Ridge Geologic Belt of Virginia."
- Water Use in the Shenandoah Valley, Virginia 1982-2010
  Maynard, J.P., 2012
  "Three decades of reported surface water and groundwater use data were analyzed to identify areas of concentrated withdrawals and to create categorized water use trends for the Shenandoah Valley."
  Includes a comprehensive list of similar studies conducted at the local, county, and regional levels.
- Ground Water Characterization – Reports & Publications
- Well database
- Spring database
- Current surface withdrawal permits
- Current groundwater withdrawal permits
- Virginia Drought Assessment and Response Plan
  2003
  Outlines how drought status will be determined and voluntary or compulsory water use reductions.
- Expanding Water Reclamation and Reuse in Virginia
  2011
  Examines "opportunities to expand the reuse of wastewater (also referred to as water reclamation and reuse) with the goal of conservation and reducing nutrient pollution in the Commonwealth's surface waters."
- Presentation on water reuse program
  2015
- Wellhead Protection Plan
  2005
  Outlines basic requirements for wellhead protection (drinking water).

- Department of Health
  - Aquifer Susceptibility in Virginia, 1998-2000
    Nelms, D.L. et al., 2003
    "The fundamental premise of the study was that the identification of young waters (less than 50 years) by multiple environmental tracers could be used as a guide for classifying aquifers in terms of susceptibility to contamination from near-sur- face sources."
  - Aquifer Susceptibility in Virginia: Data on Chemical and Isotopic Composition, Recharge Temperature, and Apparent Age of Water from Wells and Springs, 1998-2000
    Nelms, D.L. and G.E. Harlow, Jr., 2003
    "The U.S. Geological Survey (USGS), in cooperation with the Virginia Department of Health (VDH), conducted the Virginia Aquifer Susceptibility (VAS) study between 1998 and 2000 to determine the susceptibility to contamination from near-surface sources of the regional aquifers in Virginia that serve as public water supplies (Harlow and others, 1999)."

Maryland

- Department of the Environment
  - Source water protection
    - Source Water Protection Program
      1999

Details Maryland's source water assessment program to meet USEPA 1997 guidance related to the 1996 update to the Safe Drinking Water Act.

- Source water assessment reports by county

- Groundwater
  - Groundwater Protection Program - Annual Report to the Maryland General Assembly
    2013
    Covers Maryland's groundwater resources, state efforts to manage and protect them, monitoring efforts, water quality issues and improvement efforts, and permit programs
  - Application for Water Allocation: Guidance Document for Public Water Systems Providing Groundwater to Municipal Corporations or Priority Funding Areas in Carroll, Frederick, and Washington Counties
    "The goal of this guidance is to provide a systematic methodology for determining whether additional groundwater can be allocated to a water system in a justifiable and sustainable manner that does not negatively impact the water resource or the current or future rights of other property owners to use groundwater associated with their properties."
- Water Resources
  - An Evaluation of the Water Resources in the Catoctin Creek Watershed
    Korsak, A. and J.H. Smith, 2006
    "The purpose of the watershed assessment is to evaluate the available water supply within a watershed as it relates to existing water demands, and to assess the potential for existing resources to meet future water demands."
  - Capacity Development Report to Governor
    2014
    "This triennial report on the efficacy of Maryland's capacity development strategy for public drinking water systems has been prepared for the Governor's office in accordance with Section 1420 (c)(3) of the SDWA."
  - Guidance for Preparing Water Supply Capacity Management Plans
    2013 (revised)
    "This Guide will explain how to: calculate available/allocable capacity, establish a system to track allocation commitments; and report certain information to the Maryland Department of the Environment (MDE)."
  - 2008 Final Report of the Advisory Committee on the Management and Protection of the State's Water Resources
    2008
    "The Advisory Committee on the Management and Protection of the State's
    Water Resources was charged with assessing the condition of the State's water resources management program, recommending steps to assure that the program will provide for the long-term use and protection of Maryland's water resources, and recommending a strategy and appropriate funding for sustainable management of these resources… the Committee urges the State to develop and fund a more robust, comprehensive, fully-integrated State water resources management program, and that it begin this effort by increasing staffing, making critical improvements to the monitoring program, providing for scientific assessments, and beginning the long-range planning necessary to ensure a sustainable water supply for Maryland's future."
  - 2006 Interim Report of the Advisory Committee on the Management and Protection of the State's Water Resources
    2006
  - 2004 Report of the Advisory Committee on the Management and Protection of the State's Water Resources
    2004
  - A Science Plan for a Comprehensive Assessment of Water Supply in the Region Underlain by Fractured Rock in Maryland
    Fleming, B.J. et al., 2012

"… a science plan for a comprehensive assessment that will provide new scientific information, new data analysis, and new tools for the State to better manage water resources in the fractured rock region of Maryland."

- A Science Plan for a Comprehensive Regional Assessment of the Atlantic Coastal Plain Aquifer System in Maryland
  2007
  "… a science plan for a comprehensive assessment that will provide new scientific information and new data management and analysis tools for the State to use in allocating ground water in the Coastal Plain."

- Drought
  - Drought Monitoring and Response Plan
    2000
    "The drought monitoring and response plan outlines the methods and steps the State will take to monitor and respond to drought conditions."
  - Drought Information
    Information on drought status, activities, and ways to address drought.
- Spill response –The Water Supply Program has an emergency response plan for drinking water events. The Land Program has an oil spill prevention program that requires facilities to be prepared for spills.

- Department of Planning
  - The Water Resources Element: Planning for Water Supply and Wastewater and Stormwater Management
    2007
    "The water resources element of the comprehensive plan should answer the following questions for a county or municipality:
    - Is there adequate water supply to meet current and future needs?
    - Is there adequate wastewater and septic supply to meet current and future needs?
    - What, if any, impact will meeting these needs have on water resources?"

    For example, Hagerstown's WRE
  - Water and Sewer Plans by county
    "… each county and Baltimore City is required to prepare, adopt, and annually maintain, a 10-year forecasted Water and Sewerage Plan to demonstrate how safe and adequate water and sewerage facilities will be provided to support planned redevelopment and new growth, outlined in their adopted Comprehensive Land Use Plan."
- Emergency Management Administration
  - 2016 Maryland Hazard Mitigation Plan
    2016
    "Identify utilities and other facilities, that could contaminate the Potomac River and other major drinking water sources statewide, if impacted by disaster (i.e., chemical spill due to flood) and work with them to ensure appropriate risk reduction measures are in place.

    Maintain and implement the State of Maryland Drought Monitoring and Response Plan, which outlines the methods and steps the State will take to monitor and respond to drought conditions when they occur.

    The Maryland Department of the Environment will continue to implement the Drought Public Information Initiative, which disseminates public information provides education on appropriate water conservation activities for public and media."

Pennsylvania

- Department of Environmental Protection
  - State Water Plan
    2002
    "The plan consists of inventories of water availability, an assessment of current and future water use demands and trends, assessments of resource management alternatives and proposed methods of implementing recommended actions. It also analyzes problems and needs associated with specific water resource usage such as navigation, stormwater management and flood control."

- Marsh and Rock Creek Water Plan
- Source water protection
  - Pennsylvania Source Water Assessment and Protection Program Technical Guidance
    2000
    "The Source Water Assessment and Protection Program (SWAPP) is required to be submitted to USEPA for approval and describes how Pennsylvania assesses all drinking water sources serving public water systems for the potential for contamination."
  - Source water assessments by county
- Drought Management in Pennsylvania

West Virginia

- Department of Environmental Protection
  - Groundwater Biennial Report to the 2014 Legislature
    "The purpose of this report is to provide a concise, yet thorough, overview of the programs charged with the responsibility of protecting and ensuring the continued viability of groundwater resources in West Virginia and to express the challenges faced, and the goals accomplished as the agencies, programs, and committees work together to protect and restore West Virginia's water resources."
  - West Virginia Water Resources Management Plan
    2013
    "This Plan details past flooding and drought in the state, examines water infrastructure needs, describes the need for continued stream gaging and includes projections of future water use. The Plan also suggests continued improvements to the state's data collection and reporting procedures, which would lead to increased understanding of the state's water resources."
  - West Virginia Water Resources Management Plan Mapping Tool
    "This site provides access to Large Quantity water user reports as well as other GIS data layers pertinent to water resource management in the state of West Virginia."
    - Instruction Manual
  - West Virginia's Watersheds – A closer look
    2013
    "Water resources and demands specific to each watershed are presented, as well as a brief summary of sources and suspected (have not been field verified) interbasin transfers."
  - Annual Progress Report to the WV Joint Legislative Oversight Commission on State Water Resources
    Carr, B.A., 2016
    Presentation contains 2015 large quantity user data; lists studies underway (consumptive use, time of travel).
    - Previous years' reports
- Department of Health and Human Resources
  - Source water protection assessments and plans
  - Source water mapping tools/downloads:
    - Source water protection areas GIS download
    - Flow Distance Above Public Water Supplies

Local Agencies

Bedford County, PA, Planning Commission

- Comprehensive Plan
  2006
  Discusses water resources and water supply; makes reference to a Bedford County Water Supply Plan.

Montgomery County, MD Planning

- Water Resources Functional Plan
  2010
  "The Plan provides information on County water and sewer service capacity in light of planned growth to 2030, summarizes an estimate of nutrient loadings on watersheds for existing and future conditions, and identifies the policies and recommendations to amend the General Plan that are needed to maintain

adequate drinking water supply and wastewater treatment capacity to 2030, and meet water quality regulatory requirements as the County continues to grow."
Includes section on water supply.

- 2017 Draft Water and Sewer Plan
  2017
  "The purpose of the Comprehensive Water Supply and Sewerage Systems Plan is to provide an overview of the planning policies, needs, issues and planned infrastructure related to community and individual water and sewerage systems, public health, environmental protection and land-use issues in Montgomery County."

Carroll County, MD, Department of Planning

- Water Resources Element
  2010
  "The land use and planned growth for the county and individual municipalities are balanced with and complementary to the water resources available in the county and the collective ability of all nine jurisdictions to maintain and protect water quality. Provision of public water supply and wastewater services continues to be concentrated in designated growth areas while protecting and preserving rural lands for continued agricultural use, open space, environmental protection, and recognition of the county's heritage."
- Water and Sewer Plan
  2014

Regional Agencies

Eastern Panhandle Regional Planning & Development Council

- Source water protection plans
- Multi-Jurisdictional Hazard Mitigation Plan
  2017
  "This 2017 Hazard Mitigation Plan Update has been prepared to meet requirements set forth by the Federal Emergency Management Agency (FEMA) and the West Virginia Department of Homeland Security and Emergency Management (WV DHSEM) in order for Berkeley and Morgan County to be eligible for funding and technical assistance from state and federal hazard mitigation programs."

Metropolitan Washington Council of Governments

- Metropolitan Washington Water Supply and Drought Awareness Response Plan: Potomac River System
  2000
  "This document provides a plan of action that would be implemented during drought conditions for the purpose of coordinated regional response."

Universities

Shepherd University

- Determination of Water Quantity and Quality in Surface Waters of the Karst System of Jefferson County, West Virginia
  Vila, P. et al., undated
  "The purpose of this study was to assess: 1) Water quality, by measuring nutrients and other ions, and bacterial contamination, and 2) Water quantity, by measuring discharge at springs and mainstem sites in the county."

Non-Profits

TNC, West Virginia

- Watershed Assessment
  2016
  "Due to its importance, the Conservancy completed an assessment in the Potomac Headwaters region of West Virginia to identify healthy waters and targets for protection and restoration. This year, these findings were added to an online tool, and the Conservancy collaborated with a variety of partners to

assist in the utilization of this tool and to show how to incorporate the results into state-wide water prioritization."
Tool can be accessed at http://www.watershedmapwv.tnc.org/#

Water Environment Research Foundation

- Quantifying Reduction in Human and Ecological Health Associated with EDCs and Nutrients with Water Reuse and Conservation Practices in the Potomac Watershed
  In progress.
  "As the region pursues measures to both expand available water resources and improve water quality, it is absolutely necessary to prioritize actions in an effort to maximize benefit to human and ecological health within the context of sustainable implementation balancing water quality, water supply, economic, and social costs and benefits."

Utilities

Utilities have information on demand, consumptive use, source water protection, spill response, and resiliency.

WATER QUALITY

Federal Agencies

USGS

- Anthropogenic organic compounds in source and finished groundwater of community water systems in the Piedmont Physiographic Province, Potomac River Basin, Maryland and Virginia, 2003–04
  Banks, W.S.L. and B. Reyes, 2009
  "A source- and finished-water-quality assessment of groundwater was conducted in the Piedmont Physiographic Province of Maryland and Virginia in the Potomac River Basin during 2003–04 as part of the U.S. Geological Survey's National Water-Quality Assessment Program."
- Natural and human influences on water quality in a shallow regional unconsolidated aquifer, Northern Atlantic Coastal Plain
  Ator, S.W., 2008
  "Data collected from more than 400 wells in the surficial unconfined aquifer in the Northern Atlantic Coastal Plain (New York through North Carolina) were compiled and analyzed to improve understanding of multiple natural and human influences on water quality in such shallow regional aquifers."
- Summary of ground-water-quality data in the Anacostia River Watershed, Washington, D.C., September–December 2005
  Klohe, C.A. and L.M. Debrewer, 2007
  "Samples were analyzed for a variety of constituents including major ions, nutrients, volatile organic compounds, semivolatile organic compounds, pesticides and degradates, oil and grease, phenols, total polychlorinated biphenyls, and other selected constituents."
- Water quality in the Anacostia River, Maryland and Rock Creek, Washington, D.C.: Continuous and discrete monitoring with simulations to estimate concentrations and yields of nutrients, suspended sediment, and bacteria
  Miller, C.V. et al., 2013
  "Concentrations and loading estimates for nutrients, suspended sediment, and E.coli bacteria were summarized for three water-quality monitoring stations on the Anacostia River in Maryland and one station on Rock Creek in Washington, D.C."
- Summary and interpretation of discrete and continuous water-quality monitoring data, Mattawoman Creek, Charles County, Maryland, 2000–11
  Chanat, J.G. et al., 2013
  "Data were analyzed for the purpose of describing ambient water quality, identifying potential contaminant sources, and quantifying nutrient and sediment loads to the tidal freshwater Mattawoman estuary."
- Contributions of phosphorus from groundwater to streams in the Piedmont, Blue Ridge, and Valley and Ridge Physiographic Provinces, Eastern United States
  Denver, J.M. et al., 2010
  "Water-quality data collected from 1991 through 2007 in paired networks of groundwater and streams in different hydrogeologic and land-use settings of the Piedmont, Blue Ridge, and Valley and Ridge Physiographic Provinces in the eastern United States were compiled and analyzed to evaluate the sources, fate, and transport of phosphorus."
- Water quality in the Upper Anacostia River, Maryland: Continuous and discrete monitoring with simulations to estimate concentrations and yields, 2003–05
  Miller, C.V. et al., 2007
  "Samples were collected for suspended sediment, nutrients, and trace metals; data were used to calculate loads of selected chemical parameters, and to evaluate the sources and transport processes of contaminants… Annual yields (loads per square area in kilograms per year per square kilometer) were estimated for suspended sediment, total nitrogen, and total phosphorus using the U.S. Geological Survey models ESTIMATOR and LOADEST."
- Water quality, sediment quality, and stream-channel classification of Rock Creek, Washington, D.C., 1999-2000
  Anderson, A.L. et al., 2002

"The U.S. Geological Survey, in cooperation with the National Park Service, investigated water quality and sediment quality in Rock Creek over a 2-year period (1998-2000), and performed a stream-channel classification to determine the distribution of bottom sediment in Rock Creek."

- Water-Quality Assessment of the Potomac River Basin: Water-Quality and Selected Spatial Data, 1992-96
  Derosier, A.L. et al., 1998
  "Data are presented from 138 ground-water wells and 125 stream sites. Ground-water measurements compiled in this report include chemical, physical, and water-level data. Streamwater measurements compiled include chemical, physical, streamflow, bed-sediment contaminants, aquatic-tissue contaminants, fish community, and selected stream habitat data."
- Hydrogeology and Groundwater Quality of the Anacostia River Watershed
  In progress. "The purpose of this project is to improve the understanding of the hydrogeologic framework, groundwater flow system, and water quality in the Anacostia River watershed in the District of Columbia."
- Monitoring for Water Quality at Sligo Creek near Takoma Park, Montgomery County, Maryland
  In progress. "Data collected for this study will be used to document current water-quality conditions at Sligo Creek and improvements to water quality as different pollution-control initiatives are implemented."
- Data Collection for Trace Metals and Bacteria at Three USGS Sampling Stations in Washington, D.C.
  In progress. "The U.S. Geological Survey is currently monitoring nutrients, suspended-sediment, and selected continuous water-quality parameters (temperature, conductance, and turbidity) within the District of Columbia in conjunction with the Chesapeake Bay Program's Nontidal Monitoring Network (NTN)."
- Water-Quality Loads and Trends at Nontidal Monitoring Stations in the Chesapeake Bay Watershed
  In progress. "Quantify nutrient and sediment loads in the nontidal rivers of the Chesapeake Bay watershed… Estimate changes over time (trends) in sediment and nutrient loads, in a manner that compensates for any concurrent trend in stream discharge."
- Baseline groundwater quality in national park units within the Marcellus and Utica Shale gas plays, New York, Pennsylvania, and West Virginia, 2011
  Eckhardt, D.A.V. and R.A. Sloto, 2012
  "Groundwater samples were collected from 15 production wells and 1 spring at 9 national park units in New York, Pennsylvania, and West Virginia in July and August 2011 and analyzed to characterize the quality of these water supplies."
- Spatial and temporal variation of stream chemistry associated with contrasting geology and land-use patterns in the Chesapeake Bay watershed—Summary of results from Smith Creek, Virginia; Upper Chester River, Maryland; Conewago Creek, Pennsylvania; and Difficult Run, Virginia, 2010–2013
  Hyer, K.E. et al., 2016
  "The objective of this study was to investigate spatial and temporal variations in water chemistry and suspended sediment in these four relatively small watersheds that represent a range of land-use patterns and underlying geology to (1) characterize current water-quality conditions in these watersheds, and (2) identify the dominant sources, sinks, and transport processes in each watershed."
- Water-quality synoptic sampling, July 1999: North Fork Shenandoah River, Virginia
  Krstolic, J.L. and D.C. Hayes, 2004
  "A study was conducted of water-quality conditions that may affect aquatic life during periods of low streamflow on the North Fork Shenandoah River, Va."
- Streamflow, water quality, and aquatic macroinvertebrates of selected streams in Fairfax County, Virginia, 2007 - 12
  Jastram, J.D., 2014
  "A cooperative monitoring effort between the U.S. Survey and Fairfax County, Virginia, was initiated in 2007 to assess the condition of county streams and document watershed-scale responses to the implementation of BMPs."
- Spatial and temporal variation of stream chemistry associated with contrasting geology and land-use patterns in the Chesapeake Bay watershed - Summary of results from Smith Creek, Virginia; Upper Chester River, Maryland; Conewago Creek, Pennsylvania; and Difficult Run, Virginia, 2010 - 2013
  Hyer, K.E. et al., 2016

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- Storms, channel changes, and a sediment budget for an urban-suburban stream, Difficult Run, Virginia, USA
  Gellis, A.C. et al., 2017, *Geomorphology* 278
  "We documented the effects of two large storms, Tropical Storm Lee (September 2011), a 100-year event, and Super Storm Sandy (October 2012) a 5-year event, on channel erosion and deposition. Variability in erosion and deposition rates for all geomorphic features, temporally and spatially, are important conclusions of this study."
- Recent and historic sediment dynamics along Difficult Run, a suburban Virginia Piedmont stream
  Hupp, C.R. et al., 2013, *Geomorphology* 180 - 181
  "Our objectives, with special reference to human alterations to the landscape, include the documentation and estimation of floodplain sediment trapping (present and historic) and bank erosion along an urbanized Piedmont stream, the construction of a preliminary sediment balance, and the estimation of legacy sediment and recent development impacts."
- Effects of distributed and centralized stormwater best management practices and land cover on urban stream hydrology at the catchment scale
  Loperfido, J.V. et al., 2014
  "Here, stream hydrologic data (March, 2011–September, 2012) are evaluated in four catchments located in the Chesapeake Bay watershed: one utilizing distributed stormwater BMPs, two utilizing centralized stormwater BMPs, and a forested catchment serving as a reference."
- Quantitative characterization of stream turbidity-discharge behavior using event loop shape modeling and power law parameter decorrelation
  Mather, A. L. and R. L. Johnson, 2014, *Water Resources Research* 50
  "Here we examine methods to quantitatively characterize event responses by modeling the shape of turbidity-discharge hysteresis loops."
- Mercury Loads in the South River and Simulation of Mercury Total Maximum Daily Loads (TMDLs) for the South River, South Fork Shenandoah River, and Shenandoah River: Shenandoah Valley, Virginia
  Eggleston, J., 2009
  "Due to elevated levels of methylmercury in fish, three streams in the Shenandoah Valley of Virginia have been placed on the State's 303d list of contaminated waters. These streams, the South River, the South Fork Shenandoah River, and parts of the Shenandoah River, are downstream from the city of Waynesboro, where mercury waste was discharged from 1929–1950 at an industrial site."
- Groundwater quality in West Virginia, 1993–2008
  Chambers, D.B. et al., 2012
  "The USGS West Virginia Water Science Center sampled 300 wells, of which 80 percent were public-supply wells, over a 10-year period, 1999–2008."
- A Reconnaissance for Emerging Contaminants in the South Branch Potomac River, Cacapon River, and Williams River Basins, West Virginia, April-October 2004
  Chambers, D.B. and T.J. Leiker, 2006
  "Several sampling strategies were used to identify emerging contaminants, including potential EDCs, and their possible sources in these river basins and at an out-of-basin reference site."
- Relation of Chlorofluorocarbon Ground-Water Age Dates to Water Quality in Aquifers of West Virginia
  McCoy, K.J. and M.D. Kozar, 2006
  "As part of the U.S. Geological Survey (USGS) National Water-Quality Assessment (NAWQA) and Ambient Ground-Water Monitoring Network (AGN) programs in West Virginia from 1997 to 2005, 80 samples from the Appalachian Plateaus Physiographic Province, 27 samples from the Valley and Ridge Physiographic Province, and 5 samples from the Ohio River alluvial aquifers were collected to estimate ground-water ages in aquifers of West Virginia."
- Summary of Nitrogen, Phosphorus, and Suspended-Sediment Loads and Trends Measured at the Chesapeake Bay Nontidal Network Stations: Water Year 2014 Update

Moyer, D.L. and J.D. Blomquist, 2016
"Changes in nitrogen, phosphorus, and suspended-sediment loads in rivers across the Chesapeake Bay watershed have been calculated using monitoring data from the Chesapeake Bay Nontidal Water-Quality Monitoring Network (NTN)… The results are summarized for

1. loads delivered directly to the tidal waters; specifically, the River Input Monitoring (RIM) stations,
2. trends in loads at the RIM stations, and
3. patterns in loads at each monitoring station in the bay watershed (that are part of the Chesapeake Bay Program [CBP] NTN)."

State Agencies

Virginia

- Department of Environmental Quality
  - 2014 Final Water Quality Report
  - Water quality data
  - South River/South Fork Shenandoah River Mercury Information
  - 2016 Reduction of Toxics in State Waters Report
    2017
    "The primary objective of the TRISW Report is to document the Commonwealth's progress toward reducing toxics in state waters and consequently improving water quality."
  - Virginia Nonpoint Source Pollution Management Program Plan
    2014
    "This plan describes the elements of this networked program, and it identifies short and long term program goals. It also serves as an update of the nonpoint source elements of the Chesapeake Bay and Virginia Waters Clean-Up Plan developed pursuant to the Chesapeake Bay and Virginia Waters Clean-up and Oversight Act."
  - Nonpoint Source Annual Reports
  - 2014 NPS Assessment and Prioritization study
    "… determination of potential loadings of nitrogen, phosphorous, and sediment (hereafter referred to as NPS pollutants) by hydrologic unit by general land use classes. The evaluation of hydrologic units by aquatic species health represents water quality measures not necessarily related to the potential NPS pollutant loads."
  - TMDL Implementation Plans
  - TMDLs
  - TMDL Implementation Projects
  - Chesapeake Bay and Virginia Waters Clean-Up Plan
    2009
    "… plan for the cleanup of the Chesapeake Bay and Virginia's waters designated as impaired by the U.S. Environmental Protection Agency. Subsequently the plan also addresses the protection of water resources not yet impaired by pollution."
  - Annual Water Quality Monitoring Plan
    "The MonPlan summarizes the water quality monitoring activities conducted during each calendar year, from 1 January to 31 December."
  - Final 2014 305(b)/303(d) Water Quality Assessment Integrated Report
  - Draft Shenandoah River Monitoring Plan
    2016
    "The preliminary monitoring plan outlines the agency's strategy for collecting data for the development of algal field methods."
- Department of Conservation and Recreation
  - Resource Management Plan Program
    2016
    "The RMP program is a voluntary participation program that promotes the use of conservation practices to maximize water quality protection. Each plan is written to include, at minimum, those BMPs that have proved most effective at reducing runoff pollution to local waters, while encouraging farmers to take conservation to the next level."

Maryland

- Department of the Environment
  - Water Quality Mapping Center
  - Integrated Report (IR) Water Quality Assessment Maps
    "The map links below provide the user with surface water quality assessment information found in the Integrated Report of Surface Water Quality."
  - State of Maryland's Comprehensive Water Monitoring Strategy
    2009
    "This Strategy identifies the programs, processes and procedures that have been institutionalized to ensure State monitoring activities continue to meet defined programmatic goals and management objectives. It is comprehensive in addressing monitoring for all water body types, including rivers and streams, lakes, tidal waters, ground water and wetlands."
  - TMDL Data Center
  - Maryland's 2014 Integrated Report of Surface Water Quality
  - MDE Fish and Shellfish Contaminant Monitoring Program
  - TMDLs
  - Water Quality Data Portal
    National Water Quality Monitoring Council product MDE uses to make data available. Data includes:
    - "The physical conditions in the environment at the time of a site visit.
    - The chemical and bacteriological make-up of the water sampled
    - Chemical analyses of fish tissue collected
    - Biological Taxon Abundance data, including population census, frequency class, group summaries, and individual results
    - Toxicity data
    - Habitat Assessment scores and their related metric scores
    - Biological Index scores and their related metric scores"
- Department of Natural Resources
  - Eyes on the Bay
  - Maryland's Environmental Resources and Land Information Network
    "MERLIN Online allows a user to produce a custom "map" for any location in Maryland, including their choice of base map and theme data layers."
    - Interactive map
    - Stream Health interactive map
  - Maryland Water Monitoring Council Water Monitoring Site Mapper
    Purpose:
    - "Provide users with a comprehensive map of Maryland waterway monitoring sites.
    - Allows users to map stations based on type of sampling (biological, chemical, physical, restoration related) or year collected.
    - This site does not store monitoring data but provides users with contact information about each site in case they would like to know more or possibly acquire the data.
    - This site will also accept basic information about monitoring program so others can see where data are collected."

Pennsylvania

- Department of Environmental Protection
  - 2016 Draft Pennsylvania Integrated Water Quality Monitoring and Assessment Report
  - Water Quality Network
    "The Pennsylvania Water Quality Network (WQN) is a statewide, fixed station water quality sampling system operated by the Department of Environmental Protection's (DEP) Bureau of Point and Non-Point Source Management (PNSM)."
  - TMDLs

West Virginia

- Department of Environmental Protection
  - Chesapeake Bay Program

- Water Quality Data Reporting Tool
- Watershed Assessment Branch, 2015 Field Sampling Standard Operating Procedures
  "The purpose of the Watershed Assessment Branch (WAB) is to collect waterbody (e.g. streams, rivers, and lakes) data in order to determine their quality in West Virginia according to the Federal Clean Water Act (CWA)."
- West Virginia's Water Quality Monitoring Strategy
  2007
  "West Virginia has a comprehensive strategy for monitoring the streams and rivers of the state. The Watershed Assessment Branch utilizes a tiered approach, collecting data from:
  - long-term monitoring stations on large streams and rivers, Ambient Sampling
  - long-term monitoring on smaller streams – LiTMuS sites (new in 2007)
  - deployed water quality meters – collecting 'continuous' data
  - targeted sites within watersheds on a rotating basin schedule
  - randomly selected sites
  - and sites chosen to further define stream impairment in support of TMDL development."
- 2014 West Virginia Integrated Water Quality Monitoring and Assessment Report
- TMDLs

- Department of Agriculture
  - Water Quality Program
    "The Water Quality sampling programs consists of sampling and analyzing water samples from seventeen (17) streams in West Virginia's eight county Eastern Panhandle."

Local Agencies

Montgomery County, MD Planning

- Environmental Resources Inventory, Potomac Subregion
- Environmental Resources Inventory, Upper Rock Creek Watershed
- Request monitoring data

Regional Agencies

Occoquan Watershed Monitoring Laboratory

"Since its founding, the Occoquan Watershed Monitoring Program (OWMP) has been successful in building a hydrologic and water quality data acquisition and analysis system that has formed the basis of regional watershed management decision-making for nearly 30 years."

Universities

- University of Maryland
  - Increased river alkalinization in the Eastern U.S.
    Kaushal, S.S. et al., 2013, *Environmental Science & Technology* 47(18)
    "We evaluated changes in bicarbonate alkalinity, a product of chemical weathering, and tested for long-term trends at 97 sites in the eastern United States draining over 260 000 km^2."
  - Surface Water Quality Is Improving due to Declining Atmospheric N Deposition
    Eshleman, K.N. et al., 2013, *Environmental Science & Technology* 47(21)
    "We evaluated long-term surface water nitrate and atmospheric nitrogen (N) deposition trends for a group of nine predominantly forested Appalachian Mountain watersheds during a recent multidecadal period (1986−2009) in which regional NOx emissions have been progressively reduced."
  - Declining nitrate-N yields in the Upper Potomac River Basin: What is really driving progress under the Chesapeake Bay restoration?
    Eshleman, K.N. and R.D. Sabo, 2016, *Atmospheric Environment* 146
    "While the conventional wisdom is that implementation of best management practices (BMP's) and wastewater treatment have turned the tide against nutrient pollution, we examined long-term (1986-present) nitrate-N trends in streams and major tributaries of the Upper Potomac River Basin (UPRB) and found that: 1) dramatic reductions in annual discharge-weighted mean nitrate-N concentrations and

yields across the UPRB can be almost universally attributed to reductions in atmospheric N deposition as opposed to on-the-ground management actions such as implementation of BMP's; 2) observed water quality changes generally comport with a modified kinetic N saturation model (MKNSM); 3) the MKNSM can separate the nitrate-N yield that is responsive to atmospheric deposition from a "non-responsive" yield; and 4) N saturation from atmospheric N deposition appears to be an inherently reversible process across most of the landscape."

- Shepherd University
  - Assessment of Escherichia coli and Chemical Data in the Surface Waters of Jefferson County, West Virginia
    Trevey, K. et al., 2009, *Shepherd University Journal of Undergraduate Research* 1
    "Two streams in the Potomac and Shenandoah drainages of Jefferson County, West Virginia, were sampled for levels of Escherichia coli and nutrients from November 2008 to February 2009."
- George Mason University – Potomac Environmental Research and Education Center
  - Diel and seasonal patterns in water quality continuously monitored at a fixed site on the tidal freshwater Potomac River
    Jones, R.C. and A.P. Graziano, 2013, *Inland Waters* 3(4)
    "We analyzed data from a continuous water quality monitor on the tidal Occoquan River, a tributary of the tidal Potomac River and Chesapeake Bay. Temperature, conductivity, dissolved oxygen (DO), and pH were collected at 15 minute intervals from April through early November of 2010."
  - Stream condition in Piedmont streams with restored riparian buffers in the Chesapeake Bay watershed
    Orzetti, L.L. et al., 2010, *Journal of the American Water Resources Association* 46
    "This study tested the efficacy of restored forest riparian buffers along streams in the Chesapeake Bay watershed by examining habitat, selected water quality variables, and benthic macroinvertebrate community metrics in 30 streams with buffers ranging from zero to greater than 50 years of age."
  - Surface Water Concentrations and Loading Budgets of Pharmaceuticals and Other Domestic-Use Chemicals in an Urban Watershed (Washington, DC, USA)
    Shala, L. and G.D. Foster, 2010, *Archives of Environmental Contamination and Toxicology* 58
    "The intent of this study was to quantify loadings of PDCs in an urban watershed. The watershed has two major branches but with wastewater discharge occurring in only one of the two major branches. Surface water from the Anacostia River (Washington, DC) was collected in base-flow and storm-flow regimes."
  - Hydrogeochemistry and transport of organic contaminants in an urban watershed of Chesapeake Bay (USA)
    Foster, G.D. et al., 2000, *Applied Geochemistry* 15
    "Stream water samples were collected in the two main free-flowing branches of the Anacostia River watershed above the head of tide over a one year time period."
  - Impact of watershed urbanization on stream insect communities
    Jones, R.C. and C.C. Clark, 1987, *Water Resources Bulletin* 23
    "The impact of urbanization on stream insect communities was determined by sampling 22 sites in northern Virginia representing a range of human population densities."
  - Relationships among Escherichia coli (E. coli), Total Suspended Solids and Flow for Three Northern Virginia Subwatersheds: Rabbit Branch, Upper Accotink Creek, and Daniels Run
    Washington, M., 2013, Master's Research Project Report, George Mason University
    "Three sites located in Fairfax, Virginia residential areas were chosen to monitor Escherichia coli concentrations between May 18th and July 19th, 2013 and to examine the relationship of E. coli to stream flow, total suspended solids (TSS) and impervious cover."
  - The influence of past and future urbanization on watershed nitrogen export and hydrology dynamics in two mid-Atlantic watersheds in Fairfax, Virginia
    Albert, R., 2007, PhD Dissertation, George Mason University
    "This study examines urban land use change and its impact on watershed hydrology and nutrient loading in the Accotink and Pohick watersheds in Fairfax County, Virginia."

Non-Profits

Potomac Conservancy

- Disruption – New Pollutants in the Potomac and Beyond - EDC conference

"Potomac Conservancy believes that these intersex fish, warn of serious problems with the ecological health of our rivers and streams. People in the metropolitan Washington, D.C. area should be particularly concerned because, at this time there is no dedicated treatment method to remove these compounds from our drinking water — almost 90% of which is drawn from the Potomac River for D.C. region residents."

Cacapon Institute

- Fecal Coliform Bacteria Monitoring for Sleepy Creek Watershed Association, Phase II Final report
  Gillies, W.N. and F.F. Rodgers, 2011
  "Supplemental monitoring for the Sleepy Creek 319 Watershed Based Plan."
- Fecal Coliform Bacteria Monitoring for the Warm Springs Watershed Association Final Report with Data
  2014
  "The results of this study support the listing of this stream as impaired for fecal coliform bacteria. The drivers for elevated fecal coliform bacteria counts at the sampled sites remain unclear."
- Fecal Coliform Bacteria Monitoring for the Warm Springs Watershed Association Supplemental Monitoring Report
  2014
- Fecal Coliform Bacteria Monitoring for the Sleepy Creek Watershed Incremental 319 Project Final Report
  2011
  "The Sleepy Creek 319 Watershed Based Plan Development Team asked Cacapon Institute (CI) to conduct 'plan implementation monitoring' for fecal coliform bacteria."
- Final report to Canaan Valley Institute on Results of Land Use Analysis for Water Quality Study Sites in the Cacapon River's Lost and North River Watersheds
  2003
  "In September 2000, Canaan Valley Institute provided financial support for Cacapon Institute to complete development and verification of GIS land use data for water quality study sites in the Lost and North rivers of the Cacapon watershed, and for production of a report describing land use influences on water quality observed in streams."
- Final Report to the U.S. Fish and Wildlife Service on Water Quality Studies in the Cacapon River's Lost and North River Watersheds in West Virginia
  2002
  "The report will provide a summary of data collected during Cacapon Institute's multi-year study of land use influences on nutrient and bacteria concentrations in the Lost and North River subwatersheds in the Cacapon River Basin of West Virginia; these watersheds have varying densities of integrated poultry agriculture."
- Land Use and Water Quality in the Lost River Watershed, WV
  Gillies, W.N. and N. Navis, date unknown
  "… Cacapon Institute chose twelve sites in the Lost River for a study to determine the nutrient and fecal bacterial characteristics of Potomac Headwater streams in relation to land use, with an emphasis on agricultural impacts in general and, specifically, poultry agriculture."
- Summary Report on Water Quality Studies in the Lost River, North River and South Branch of the Potomac River Watersheds of West Virginia
  Gillies, W.N., 1999
  "The purpose of this interim report is to provide an overview of data from Cacapon Institute's multiyear study of land use influences on nutrient and bacteria concentrations in the Lost, North and South Branch of the Potomac river watersheds, three West Virginia basins with varying densities of integrated poultry agriculture."

West Virginia Rivers Coalition

- Citizen's Directory of Volunteer Water Quality Monitoring Programs
  "While the WV-VA Water Quality Monitoring Program supports volunteers from across West Virginia and portions of Virginia, it focuses on streams that support trout populations and high quality warmwater fisheries that could face impacts from shale gas development."

Potomac Riverkeeper Network

- Assessment

"Through citizen reports and staff monitoring, we investigate pollution incidents and ongoing threats to water quality. Once a major pollution threat is identified we implement measures to find a solution."

Consulting Firms

Downstream Strategies

- The Benefits of Acid Mine Drainage Remediation on the North Branch Potomac River
  Hansen, E. et al., 2010
  "This study calculates the local economic benefits generated in these Maryland counties stemming from acid mine drainage remediation on the North Branch, so that policy makers can make informed decisions about future funding to ensure that this remediation continues."
- Poultry Litter in the Potomac Headwaters: How Can We Reach a Long-term Balance?
  Hansen, E., 1999
  "This report asks: Given the quantity of nutrients generated by the concentrated poultry industry in the Potomac headwaters of West Virginia, how can we ensure a long-term nutrient balance?"

HUMAN LAND USE

Federal Agencies

USGS

- Influences of upland and riparian land use patterns on stream biotic integrity
  Snyder, C.D., 2003
  "We explored land use, fish assemblage structure, and stream habitat associations in 20 catchments in Opequon Creek watershed, West Virginia. The purpose was to determine the relative importance of urban and agriculture land use on stream biotic integrity, and to evaluate the spatial scale (i.e., whole-catchment vs riparian buffer) at which land use effects were most pronounced."

Interstate Commissions

ICPRB

- Middle Potomac River watershed assessment: Potomac River sustainable flow and water resources analysis
  USACE, TNC, and ICPRB, 2014
  "The plots of both observed and simulated flows suggest that significant alteration in flow metrics from a baseline condition is most often linked to increases in impervious surface and urbanization, and the concomitant loss of forest, in the Middle Potomac study area."
- The effect of impervious cover on streamflow under various watershed conditions in the Potomac basin: Phase 1
  Moltz, H. and J. Palmer, 2015
  "A signature hydrologic impact of impervious cover is increased flashiness (higher high flows, lower low flows, and increased rate of change). It is plausible, however, that not all streams respond to impervious cover in the same way, but this raises the question: which watershed characteristics make streams most susceptible to the impacts of impervious cover?"
- Streamflow Alteration from Impervious Cover: Are All Watersheds Created Equal?
  Moltz, H. et al., 2017, *Journal of the American Water Resources Association* (Under Review)
- The Potomac River Basin and its Estuary: landscape loadings and water quality trends, 1895–2005
  Jaworski, N.A. et al., 2007
  "The principal goal of our treatise is to provide a broad, 110-year perspective of the water quality of the Potomac River Basin and its Estuary through a historical analysis of landscape loadings and resulting water quality trends from 1895 to 2005."
- Effects of Land Use Change on Trends in Stream Flow
  Steiner R., 1987
  "The two major issues addressed in this task are: (1) the relative consumptive loss of water with differences in land use, and (2) changes in the runoff hydrograph with differences in land use."

State Agencies

Virginia

- Department of Conservation and Recreation
  - Resource Management Plans
    "The Virginia Resource Management Planning program provides a voluntary way to promote the use of conservation practices that improve farming operations and water quality. Resource management plans can help farm owners and operators take advantage of all the conservation measures at their disposal."
  - Conservation Planning
- Office of Land Conservation
  "Its goal is to connect you with the information and agency, land trust or organization that best address your needs…to point you in the right direction."
- Virginia Outdoor Foundation
  "The primary way Virginia Outdoor Foundation protects land is by holding conservation easements, which are voluntary agreements with landowners that restrict certain types of development on land in perpetuity.

Virginia Outdoor Foundation also accepts donations of land, which it either protects with an easement and transfers to another landowner, or owns and manages for public benefit."

- Virginia Clean Water Revolving Loan Fund Land Conservation Program
- Virginia Office of Farmland Preservation

Maryland

- Department of Natural Resources
  - Maryland Rural Legacy Program
    "Maryland's Rural Legacy Program provides funding to preserve large, contiguous tracts of land and to enhance natural resource, agricultural, forestry and environmental protection while supporting a sustainable land base for natural resource based industries. The program creates public-private partnerships and allows those who know the landscape best – land trusts and local governments – to determine the best way to protect the landscapes that are critical to our economy, environment and quality of life."
  - Maryland Environmental Trust
    "Maryland Environmental Trust works with landowners, local communities, and citizen land trusts to protect Maryland's most treasured landscapes and natural resources as a legacy for future generations. We accomplish this work by providing direct assistance, information and innovative tools to ensure the ongoing stewardship and public concern for the natural, historic, and scenic resources of the state."
  - Program Open Space
    "Program Open Space Stateside preserves natural areas for public recreation and watershed and wildlife protection across Maryland through the purchase of fee-simple and easement acquisitions."
- Department of Planning
  - Land Preservation
    "The Maryland Department of Planning (Planning) works with the Maryland Department of Natural Resources (Natural Resources) and the Maryland Department of Agriculture (Agriculture) to support land preservation, including guidance for Priority Preservation Areas, which are identified in local comprehensive plans, and for local Land Preservation, Parks and Recreation Plans."
  - Transfer of Development Rights
    "Through TDR programs, which are voluntary, developers buy development rights from owners of rural land within designated sending areas, which county governments have identified for preservation. A perpetual conservation easement is then placed on the property. Developers can use their purchased development rights to build more residences, increase commercial square footage or gain other marketable features in receiving areas, which are located in areas where development and infrastructure are planned and desired."
  - Water Resources
    "Planning provides guidance, review, and technical assistance to local jurisdictions when they prepare and update Water and Sewerage Plans to ensure consistency with local comprehensive plans and state growth policies…
    Maryland's Stormwater Management Act of 2007 requires Environmental Site Design (ESD) to be used to the "maximum extent practicable" to manage stormwater associated with new development and redevelopment. Planning is conducting research and outreach to show how infill and redevelopment can be achieved while implementing ESD requirements."

Pennsylvania

- Department of Environmental Protection
  - Division of Planning and Conservation
    "The Conservation District Support Section provides financial assistance to conservation districts through the distribution of annual funding through the Conservation District Fund Allocation Program (CDFAP), and assistance to DEP Conservation District Field Representatives who deliver administrative and technical assistance to county conservation districts."

Local Agencies

Montgomery County, MD, Planning

- Agricultural Reserve

"Montgomery County is home to a surprising number of rural areas. The forward-thinking 1964 General Plan focused growth in defined corridors emanating from the population centers in and around the Capital Beltway. Between those corridors, the General Plan called for wedges of low-density residential uses, open space and protected farmland."

Carroll County, MD, Department of Land and Resource Management

- Agriculture Land Preservation Program
  "To preserve the county's best agricultural land by compensating landowners for voluntarily, and in perpetuity, forgoing land development through a Deed of Conservation Easement recorded in the Carroll County Land Records."
- Land Trust
  "To promote the preservation of farmland and open space in Carroll County through public education and donations of conservation easements that restrict the development of land and the purchase of easements when grant funds are available."
- Priority Preservation Area Element
  "The Priority Preservation Area Element identifies areas of agricultural and forestry resource land that would support agricultural production and timber harvesting for the present and future. An estimated 92,909 acres of land are delineated within the Agricultural Land Priority Preservation Area. Within this defined area, the County's goal is to permanently preserve 64,589 acres of undeveloped land for agricultural production."

Adams County Conservation District

- Adams County Comprehensive Plan (1991), Chapter 3 - Growth Management Plan
  1991
  "The Land Use Plan is concerned with the proposed location, intensity, and amount of different uses. It strives to be in harmony with trends affecting economic development in the county and its region, while minoring the values, needs, and expectations of county residents."

Universities

University of Maryland

- Land use and climate variability amplify contaminant pulses
  Kaushal, Sujay S. et al., 2010, *Eos, Transactions American Geophysical Union* 91.25
  "Together, land use and climate change may interact in unexpected ways to alter the amplitude, frequency, and duration of contaminant pulses in streams and rivers (i.e., large contaminant loads that are transported over relatively short time scales)."

Appalachian Laboratory – University of Maryland Center for Environmental Science

- Altered Ecological Flows Blur Boundaries in Urbanizing Watersheds
  Lookingbill, T. R., 2009, *Ecology and Society* 14(2)
  "We describe patterns of land-use change within the Potomac River basin and demonstrate how these changes have blurred traditional ecosystem boundaries by increasing the movement of people, materials, and energy into and within the basin. We argue that this expansion of ecological commerce requires new science, monitoring, and management strategies focused on large rivers and suggest that traditional geopolitical and economic boundaries for environmental decision making be appropriately revised."

Virginia Tech

- Regional Effects of Land Use Change on Water Supply in the Potomac River Basin
  Stagge, J. et al., 2011, *Watershed Science Bulletin* 2(1)
  "Land use change between 1985 and 1997 is responsible for a 0.1%–1.1% decrease in low flows, quantified here by the 30Q20 (Table 2). This suggests that land use change could produce more severe droughts. However, by 2005, this effect became smaller, probably as a result of reforestation in the western portion of the basin."
- Impact of the spatial distribution of imperviousness on the hydrologic response of an urbanizing basin
  Mejia, A.I. and G.E. Moglen, 2010, *Hydrological Process* 24
  "An event-based model is used to investigate the impact of the spatial distribution of imperviousness on the hydrologic response of a basin characterized by an urban land use."
- Relationships Between Land Use, Land-Use Change, and Surface Water Quality Trends in Virginia

Gildea, J.J., 2000, Master's Thesis, Virginia Tech

"This research examines the relationships between land use and surface water quality trends in Virginia." Old Dominion University

- Relationships Between Benthic Community Condition, Water Quality, Sediment Quality, Nutrient Loads, and Land Use Patterns in Chesapeake Bay

  Dauer, D.M., 2000, *Estuaries* 23(1)

  "Associations between benthic condition and anthropogenic inputs and activities in the watershed were also studied by correlation analysis."

Non-Profits

Potomac Conservancy

"Through our Land Protection program, Potomac Conservancy works one-on-one with private landowners to conserve forested, agricultural, streamside, and open space lands in the northern Shenandoah Valley of Virginia and the South Branch River Valley of West Virginia. We also provide resources for land management and cost-share programs to ensure working lands are both productive and river friendly."

Potomac Watershed Partnership

"The Potomac Watershed Partnership (PWP) is a collaborative effort among federal, state, and local partners to restore the health of the land and waters of the Potomac River Basin, thereby enhancing the quality of life and overall health of the Chesapeake Bay."

ECOLOGICAL HEALTH

Federal Agencies

EPA

- Improving Water Reuse for a Much Healthier Potomac Watershed
  In progress. "This research combines a suite of state-of-the-art techniques to actively identify contaminant hot spots (emerging contaminants and related biological activity, advanced geochemical indicators), assess the impact of those hot spots on human and ecological health endpoints (including drinking water sources and sensitive ecological areas), and quantify the impact of reuse and management solutions on these endpoints."
- CBP, Resource Lands Assessment
  "The Resource Lands Assessment (RLA) provides a regional, multi-state look at the most important remaining resource lands in the Chesapeake Bay watershed. Geographic Information Systems (GIS) models and expert knowledge help assess the value of resource lands within the watershed to: provide guidance to state and local governments in their land protection strategies, serve as a resource for the land trust community, suggest conservation focus areas to complement watershed restoration plans and identify areas important to the forest products industry."

USGS

- South Fork Shenandoah River Habitat-Flow Modeling to Determine Ecological and Recreational Characteristics during Low-Flow Periods
  Krstolic, J.L. and R.C. Ramey, 2012
  "Physical habitat simulation modeling was conducted to examine flow as a major determinant of physical habitat availability and recreation suitability using field-collected hydraulic habitat variables such as water depth, water velocity, and substrate characteristics."
- Physical Habitat Characteristics on the North and South Forks of the Shenandoah River, VA in 2002-2007
  Krstolic, J.L. and D.C. Hayes, 2010
  "The layers within this geodataset describe physical habitat characteristics in the North and South Fork Shenandoah rivers. They represent conditions during summer low-flow periods when canoeing was possible."
- Physical habitat classification and instream flow modeling to determine habitat availability during low-flow periods, North Fork Shenandoah River, Virginia
  Krstolic, J.L. et al., 2006
  "To meet the need for comprehensive information on hydrology, water supply, and instream-flow requirements of the Shenandoah River basin, the U.S. Geological Survey and the Northern Shenandoah Valley Regional Commission conducted a cooperative investigation of habitat availability during low-flow periods on the North Fork Shenandoah River."
- A demonstration of the instream flow incremental methodology, Shenandoah River, Virginia
  Zappia, H. and D.C. Hayes, 1998
  "The Instream Flow Incremental Method (IFIM) process attempts to integrate concepts of water-supply planning, analytical hydraulic engineering models, and empirically derived habitat versus flow functions to address water-use and instream-flow issues and questions concerning life-stage specific effects on selected species and the general well being of aquatic biological populations."
- Data Collection and Simulation of Ecological Habitat and Recreational Habitat in the Shenandoah River, Virginia
  Krstolic, J.L., 2015
  "This report presents updates to methods, describes additional data collected, documents modeling results, and discusses implications from an updated habitat-flow model that can be used to predict ecological habitat for fish and recreational habitat for canoeing on the main stem Shenandoah River in Virginia."

State Agencies

Virginia

- Department of Environmental Quality

- Biological monitoring
  "DEQ's Freshwater Biological Monitoring Program uses the benthic macroinvertebrate community to assess the ecological health of freshwater streams and rivers."

- Department of Game and Inland Fisheries
  - Using benthic macroinvertebrates to identify causes of fish kills in the Shenandoah River
    Voshell, J.R., Jr. et al., 2008
    "The overall purpose of these studies was to determine what the macroinvertebrate assemblage indicated about the biological condition of the Shenandoah River watershed in relation to the fish kills that have been occurring since 2004."

Maryland

- Department of the Environment
  - Biological Stressor Identification Studies
    "MDE has developed a Biological Stressor Identification (BSID) analysis that uses a case control, risk-based approach to systematically and objectively determine the predominant causes and sources of degraded biological conditions in impaired watersheds. "
- Department of Natural Resources
  - Maryland Biological Stream Survey's Sentinel Site Network: A Multi-purpose Monitoring Program
    Becker, A.J. et al., 2010
    "The major goal of this report is to describe the temporal variability in conditions at 27 SSN streams based on 10 years of annual sampling, 2000 through 2009. The secondary goal of this report is to present biological indicators as parts in a tool box of assessment parameters that could be used to track climate change effects on Maryland's non-tidal streams, and to conduct exploratory analyses of SSN data from the 10-year baseline of stream conditions against which future climate influences can be assessed."
  - A Multi-Year Update (2011 – 2014) to Maryland Biological Stream Survey's Sentinel Site Network
    Saville, J. et al., 2014
    "The major goal of this report is to describe the temporal variability in conditions at 29 SSN streams based on 15 years of annual sampling, 2000 through 2014. The secondary goals of this report are to present biological indicators as assessment parameters that could be used to track climate change effects on Maryland's non-tidal streams, and to conduct exploratory analyses of SSN data from the 15-year baseline of stream conditions against which future climate influences can be assessed."
  - Maryland Biological Stream Survey (MBSS) Round 3 (2007-2009) Population Estimates
    Dew-Baxter, J. and M. Southerland, 2013
    "While the MBSS monitors Maryland streams every year in support of multiple objectives, each statewide round of sampling focuses on random sites that provide probability-based estimates of conditions and resources with known confidence."
  - New Biological Indicators To Better Assess The Condition Of Maryland Streams; Volume 16 (2005)
    Southerland, M.T. et al., 2005
    "New fish IBIs were developed for four geographical and stream type strata: the Coastal Plain, Eastern Piedmont, warmwater Highlands, and coldwater Highlands streams; new benthic macroinvertebrate IBIs were developed for three geographical strata: the Coastal Plain, Eastern Piedmont, and Highlands streams. The addition of one new fish IBI and one new benthic macroinvertebrate IBI reduced the natural variability of these assemblages in each stratum."
  - Do Road Salts Cause Environmental Impacts?
    Stranko, S. et al., 2013
    "Hundreds of reports and scientific papers have examined potential environmental problems associated with the use of salt to de-ice roads…This document is a brief review and summary of some of that literature. Our document also describes results from the Maryland Biological Stream Survey (MBSS) data that are relevant to this topic."

West Virginia

- Department of Environmental Protection
  - Ecological Assessments

"The West Virginia DEP assesses three major aspects of watershed health when it performs an ecological assessment; water quality, habitat condition, and benthic macroinvertebrate community status."

- Biological Monitoring
  "The WAB is comprised of a staff of biologists and environmental scientists who measure and assess the chemical and physical properties of water, assess habitat conditions, and collect biological samples in the form of benthic macroinvertebrates and fish from streams and lakes throughout the state."
- Ecological Assessments
  - An Ecological Assessment of the Potomac River Direct Drains Watershed
    2005
    "Water quality, benthic macroinvertebrate community health, and habitat condition were evaluated at 67 sites."
  - An Ecological Assessment of the West Virginia Portions of the Shenandoah River Watershed – 1996
    1998
    "Assessment teams visited 15 sites in the Shenandoah River watershed during late August and early September 1996."
  - An Ecological Assessment of the South Branch of the Potomac River Watershed
    1996
    "To evaluate the health of the South Branch of the Potomac River Watershed, assessment teams visited 115 sites, most of which were on tributaries near their mouths, during August and September 1996. The assessment teams recorded qualitative observations of human impacts and land uses, streamside and instream habitat conditions, and obvious indicators of water quality."

- Department of Natural Resources
  - Assessing the Exposure of Microcystin Cyanotoxin to Smallmouth Bass via Diet Items in the South Branch of the Potomac River (presentation slides and recording)

Local Agencies

Montgomery County, MD Planning

- Habitat Assessment
  Monitoring Plan
  Data Requests
- Stream Conditions Index
  "The Stream Conditions Index measures the aquatic biological community and ranks the stream according to four categories (like a report card)."

Universities

George Mason University

- Long-term study of Gunston Cove
  "The rapid development of Fairfax county led to concerns about the effect of urban runoff, coming from the Accotink and Pohick watershed. Futhermore, there was concern about the effects of the run off from the Potomac Wastewater Treatment Plant."
- Watershed Publications
  - Stream condition in Piedmont streams with restored riparian buffers in the Chesapeake Bay watershed
    Orzetti, L.L. et al., 2010, *Journal of the American Water Resources Association* 46
    "This study tested the efficacy of restored forest riparian buffers along streams in the Chesapeake Bay watershed by examining habitat, selected water quality variables, and benthic macroinvertebrate community metrics in 30 streams with buffers ranging from zero to greater than 50 years of age."

Non-Profits

Potomac Conservancy

- Growing Native program

"In addition to providing native trees for stream restoration, Growing Native builds public awareness of the important connection between healthy, forested lands and clean water, and what individuals can do to help our local environment."

Mid-Atlantic Invasive Plant Council

"The council coordinates regional efforts to gather and share information on the identification, management and prevention of invasive species, provide training and volunteer opportunities and to identify research needs."

Mid-Atlantic Panel on Aquatic Invasive Species

"We help state, federal, and local agencies, non-profits, and private landowners in the Mid-Atlantic states tackle aquatic invasive species (AIS) issues by: identifying and prioritizing regional issues, coordinating local AIS programs, and assisting the Aquatic Nuisance Species Task Force in coordinating federal programs that promote effective methods of preventing and managing AIS introductions."

Potomac Highlands Cooperative Weed and Pest Management Area

"The Potomac Highlands Cooperative Weed and Pest Management Area (CWPMA) is a partnership between federal, state, and local agencies, community associations, non-profit organizations, and private land owners aimed at coordinating efforts and programs for addressing the threat of invasive species."

TNC

- Taking on Maryland's Invasive Species

  "The Nature Conservancy actively works to prevent the spread of invasive plants on our preserves in Maryland through restoration and removal."

Ducks Unlimited

- Potomac Watershed Targeting Tool

  "Recognizing that certain projects in particular regions would benefit the resource the greatest, Ducks Unlimited initiated a "Watershed Targeting System" to help guide habitat delivery so that individual projects provide the biggest bang for the "duck." Available conservation dollars are limited; therefore, it is important that habitat delivery is improving local habitat on a landscape scale."

Potomac Watershed Partnership

"The Potomac Watershed Partnership integrates forestry program efforts to focus on the targeted watersheds in Maryland, the Monocacy, Antietam, and Catoctin drainages. Stewardship, fire, and urban programs are coordinated to improve watershed condition, and additional resources are available to encourage greater implementation and technical assistance for watershed-friendly practices."

WATER-ENERGY NEXUS

Federal Agencies

EPA

- Water-Energy Nexus in Disasters, webinar series
  2015
- Energy efficiency and use of renewable energy sources
  2015
  USEPA-hosted meeting with WMA water utilities

State Agencies

Virginia

- Department of Mines, Minerals, and Energy
  - Virginia Energy Plan
    2014
    "The 2014 Virginia Energy Plan has been constructed to provide a comprehensive view of where Virginia has been and currently is in terms of its energy assets, and it charts a path forward for energy policy in the Commonwealth."
  - Energy in the New Virginia Economy, Update to the 2014 Virginia Energy Plan
    2016
- Department of Environmental Quality
  - Renewable Energy
    "DEQ has developed regulations for the construction and operation of renewable energy projects of 100 megawatts and less."
  - Renewable energy projects (map)
  - State Water Resources Plan
    2015
    Includes data on water use by power sector
  - Annual Water Resources Report
    Details water use including for power generation

Maryland

- Department of Natural Resources
  - Power Plant Research Program
    - A Bibliography of the Maryland Power Plant Research Program
      2010
      "This bibliography is a compilation of over 700 reports of electric power related studies conducted by the Power Plant Research Program since 1971."
    - Power Plant Cumulative Environmental Impact Report
      "The intent of the CEIR is to assemble and summarize information regarding the impacts of electric power generation and transmission on Maryland's natural resources, cultural foundation, and economic situation."
    - Electricity in Maryland - Fact Book 2014
      2014
      "It is intended to provide current information on power generation in the State, for the use of State agencies, industrial and residential electricity consumers, and the interested public."
    - SmartDG+: A Screening Tool for 1-10 MW Distributed Generation and Renewable Energy Projects
      "It is intended to help developers and officials identify promising areas for the location of new wind, solar, and CHP (combined heat and power) projects in Maryland."
    - Power Plant Locations In and Around Maryland (map)
- Department of the Environment
  - Marcellus Shale Issue Papers
    2016

"The issue papers describe the Department's current thinking with respect to key issues from the 2015 proposal. Each issue paper includes an overview of the requirements included in the 2015 proposal and the Department's tentative suggestions for revising those requirements."

- Proposed Oil and Gas Exploration and Production Regulations
  2016
- Marcellus Shale Safe Drilling Initiative
  "This initiative will assist State policymakers and regulators in determining whether and how gas production from the Marcellus shale in Maryland can be accomplished without unacceptable risks of adverse impacts to public health, safety, the environment and natural resources. The Order requires the Maryland Department of the Environment (MDE) and the Department of Natural Resources (DNR), in consultation with an advisory commission made up of a broad array of stakeholders, to undertake a study of drilling for natural gas from the Marcellus Shale in Western Maryland."

Pennsylvania

- Department of Environmental Protection
  - Oil and Gas Reports
    "The report links on this page provide oil and gas production information, permits issued, drilling commence date (SPUD date), county data, operator specific data, as well as inspections, violations and enforcement actions."
  - Marcellus Shale development permit applications
  - Oil and Gas Surface Regulations
    2016

West Virginia

- Office of Energy
  - Energy Plan 2018-2022
    In progress. "The State of West Virginia's 2018-2022 State Energy Plan will provide analysis and make policy recommendations to guide the state in reliably meeting its future energy needs in a cost-effective and sustainable manner while fostering an innovative clean energy economy."

Regional Agencies

WV Planning and Development Councils

- Region VIII
  - Draft FY 2017 Regional Development Plan Update
- Region IX
  - Eastern Panhandle Natural Gas Expansion Study

Universities

University of Maryland

- Water Resources Research Center
  - Water and Energy in Maryland 2010 Symposium
  - The Water-Energy Nexus: Why Should We Care? (presentation)
    Cardwell, H., 2010
  - Water and Electricity (presentation)
    Dunbar, P., 2010
- Appalachian Research Initiative for Environmental Science
  - Predicting release and aquatic effects of total dissolved solids from Appalachian USA coal mines
    Daniels, W. et al., 2014, *International Journal of Coal Science & Technology* 1(2)
    "Appalachian USA coal mines have been implicated as major stressors to aquatic life in headwater streams via discharge of total dissolved solids (TDS). This paper summarizes column leaching studies of spoils ($n > 50$) and refuse and TDS effects on local water quality and biotic response."
  - Long-Term Trends of Specific Conductance in Waters Discharged by Coal-Mine Valley Fills in Central Appalachia, USA
    Evans, D. et al., 2014, *Journal of the American Water Resources Association* 50(6)

"Coal surface mining causes release of dissolved sulfate, bicarbonate, calcium, magnesium, and other ions to surface waters in central Appalachia, USA, through practices that include mine rock disposal in valley fills (VFs)."

- Scenario analysis predicts context-dependent stream response to land use change in a heavily mined central Appalachian watershed
  Merriam, E. et al., 2013, *Freshwater Science* 32(4)
  "Scenario analysis has the potential to improve management of aquatic systems throughout the Mountaintop Removal–Valley Fill mining (MTR–VF) region of central Appalachia."
- Ecological Function of Constructed Perennial Stream Channels on Reclaimed Surface Coal Mines
  Petty, J.T. et al., 2013, *Hydrobiologia* 720(1)
  "We compared the ecological functions of five reference stream channels to five constructed channels (age ranging from 3 to 20 years) on reclaimed mines in southern West Virginia. Variables included stream flow, habitat, water chemistry, riparian vegetation, organic matter (OM) processing, and invertebrate and amphibian communities."

Non-Profits

Piedmont Environmental Council

- Energy Matters
  "PEC works toward energy solutions that emphasize efficiency first, use appropriate technologies for the 21st Century and respect the scenic and historic character of the Piedmont. "

West Virginia Rivers Coalition

- Citizen's Guide to Fracking Permits in WV
  "This guide describes five permits required by the State of West Virginia and explains opportunities for citizens to get involved during the permitting process."

The Nature Conservancy

- VA Chapter
  - Natural Gas Pipeline Proposals in Virginia
    "The Nature Conservancy is deeply engaged in efforts to avoid and minimize the impacts that natural gas pipeline construction could have on the forests and rivers of the Central Appalachian Mountains, tidewater Virginia, the Albemarle Sound and the coastal plain of North Carolina. Each of these regions harbor globally significant natural resources that are longstanding conservation priorities for the Conservancy."
    - Our approach to natural gas pipeline proposals in Virginia
- WV Chapter
  - Energy development
    - "funding and developing threat assessments, including predictive mapping of habitat impacts from wind energy, natural gas and coal
    - advising decisions makers, with an emphasis on national forest managers to inform energy development decisions on public lands
    - working with industry to develop practices that can reduce impacts from energy development"
- PA Chapter
  - Pennsylvania Energy Impacts Assessment
    "Assessment Goal: Develop credible energy development projections and assess how they might affect high priority conservation areas across Pennsylvania. Marcellus natural gas, wind, wood biomass, and associated electric and gas transmission lines were chosen as the focus since these energy types have the most potential to cause land-use change in the state over the next two decades. The conservation impacts focus is on forest, freshwater, and rare species habitats. The assessment does not address other potential environmental impacts, including water withdrawal, water quality, air quality and migratory pathways for birds and bats. The assessment also does not address a range of other social, economic, and climate characteristics of these energy types."
  - Report 1: Marcellus Shale Natural Gas and Wind
    2010
- Central Appalachians Program

"The Nature Conservancy - with support from the Appalachian LCC - has completed a study to assist policy makers, land management agencies, and industry in assessing potential future energy development and how that may overlap with biological and ecological values."

- Assessing Future Energy Development across the Appalachian Landscape Conservation Cooperative
  "The research combined multiple layers of data on energy development trends and important natural resource and ecosystem services to give a comprehensive picture of what future energy development could look like in the Appalachians. It also shows where likely energy development areas will intersect with other significant values like intact forests, important streams, and vital ecological services such as drinking water supplies."
- Reducing Ecological Impacts of Shale Development: Recommended Practices for the Appalachians (infographic)
- Landscape Environmental Energy Planning
  "LEEP (Landscape Environmental Energy Planning): A GIS-based tool that goes beyond constraints mapping to generate and evaluate infrastructure layouts in terms of environmental impacts and development costs"

Consulting Firms

Downstream Strategies

- Prospects for Large-scale Solar on Degraded Land in West Virginia
  James, J. and E. Hansen, 2017
  "As solar markets have exploded and the new low-carbon economy has improved its footing, West Virginia's economy has crumbled. West Virginia's miners and the once-prosperous companies that employ them have fallen on hard times. West Virginia's small towns and rural communities are dotted with degraded lands, including former mines, hazardous waste sites, landfills, Superfund sites, and Brownfield sites. This report examines the opportunities for large-scale solar development on these sites. The authors explore the environmental and economic impacts of this type of development in the Mountain State."
- Expanding Economic Opportunities for West Virginia under the Clean Power Plan
  Van Nostrand, J.M. et al., 2016
  "This analysis presents two compliance scenarios and policy recommendations that illustrate how an "all-of-the-above" energy strategy would help West Virginia comply with the Clean Power Plan while advancing economic development goals through an expanded energy economy."
- Water Resource Reporting and Water Footprint from Marcellus Shale Development in West Virginia and Pennsylvania
  Hansen, E. et al., 2013
  "In recent years, West Virginia and Pennsylvania have improved their regulation and oversight of water use and pollution from Marcellus Shale natural gas extraction. Both states now require recordkeeping and public reporting of key water quality and quantity information. In this report, we use these databases to document water withdrawals, fluid injections, and waste recovery and disposal, including the transport of waste to neighboring states."
- A Windfall for Coal Country? Exploring the Barriers to Wind Development in Appalachia
  Bailey, B. et al., 2012
  "This report identifies barriers to wind development in Appalachia and suggests methods for overcoming these barriers."

Utilities

WSSC

- Energy Service Evaluations for W/WW Facilities
  "The Washington Suburban Sanitary Commission (WSSC) owns and operates numerous water treatment and distribution facilities throughout the DC Metro area. WSSC enlisted an Energy Service Company (ESCO) to develop and energy conservation program to improve energy efficiency in their facilities."

DC Water

- Bailey Bioenergy Facility

"It efficiently produces clean, green renewable power by "pressure cooking" the solids left over at the end of the wastewater treatment process."

- Driving Net-Zero at DC Water
  "Looking to lower operating costs, reduce its carbon footprint and improve energy efficiency, DC Water implemented a series of innovative projects, including thermal hydrolysis technology."

DEICING SALTS

Federal Agencies

USGS

- Increasing chloride in rivers of the conterminous U.S. and linkages to potential corrosivity and lead action level exceedances in drinking water
  Stets, E.G. et al., 2017, *Science of the Total Environment* 613-614
  "Corrosion in water-distribution systems is a costly problem and controlling corrosion is a primary focus of efforts to reduce lead (Pb) and copper (Cu) in tap water."
- River chloride trends in snow-affected urban watersheds: increasing concentrations outpace urban growth rate and are common among all seasons
  Corsi, S.R. et al., 2015, *Science of the Total Environment* 508
  "Chloride concentrations in northern U.S. included in this study have increased substantially over time with average concentrations approximately doubling from 1990 to 2011, outpacing the rate of urbanization in the northern U.S."

State Agencies

Virginia

- Department of Environmental Quality
  - Stressor Analysis Report for the Benthic Macroinvertebrate Impairments in the Accotink Creek Watershed
    Interstate Commission on the Potomac River Basin, 2017
    "All VSCI scores from DEQ and EPA assessments in upper Accotink Creek, lower Accotink Creek, and Long Branch are below 60, the VSCI impairment threshold score."
  - Accotink Creek Chloride TMDL
    Interstate Commission on the Potomac River Basin, 2017
    "Based on benthic macroinvertebrate monitoring and assessments in the Accotink Creek watershed, DEQ has placed Accotink Creek, both above and below Lake Accotink, and Long Branch on Virginia's List of Impaired Waters (Category 5 of the Integrated List) because they are not supporting their Aquatic Life Use."
  - Salt Management Strategy Development
    "The SaMS aims to prepare a strategy that is capable of achieving the target chloride (salt) loads identified in the Accotink Creek TMDL and that proactively addresses salt application in the broader surrounding region."

Maryland

- Department of the Environment
  - The 411 on Road Salt
    "With an increase in the usage of salts comes an increase of salt in our waterways."
  - Do Road Salts Cause Environmental Impacts?
    Stranko, S. et al., 2013
    "Hundreds of reports and scientific papers have examined potential environmental problems associated with the use of salt to de-ice roads… This document is a brief review and summary of some of that literature. Our document also describes results from the Maryland Biological Stream Survey (MBSS) data that are relevant to this topic."
- Department of Transportation
  - Maryland Statewide Salt Management Plan
    2017
    "The purpose of this document is to provide guidance and direction for the optimized use of road salt (sodium chloride) during winter operations, in order to lessen the adverse environmental impacts of road salt runoff in the state."

Universities

University of Maryland

- Increased salinization of fresh water in the northeastern United States
  Kaushal, S.J. et al., 2005, Proceedings of the National Academy of Sciences: 102 (38)
  "We observed chloride concentrations of up to 25% of the concentration of seawater in streams of Maryland, New York, and New Hampshire during winters, and chloride concentrations remaining up to 100 times greater than unimpacted forest streams during summers."

Virginia Cooperative Extension, Virginia Tech

- Virginia household water quality program: Sodium and chloride in household drinking water
  Benham, B. et al., 2011, Publication 442-661
  "Higher levels of sodium and chloride in household water, however, often come from manmade sources such as road salt, industrial wastes, sewage, fertilizers, or water softeners."

Other

- Benefit-Cost of Various Winter Maintenance Strategies
  Fay, L. et al., 2015, Minnesota Department of Transportation No. CR 13-03
  "In order to facilitate that summary, it was necessary to identify past work that identified the quantified and non-quantified costs and benefits of three different winter maintenance strategies of interest to this project."
- The real cost of salt use for winter maintenance in the Twin Cities Metropolitan Area
  Fortin Consulting, Inc., 2014, Minnesota Pollution Control Agency
  "Using a 10% to 70% reduction in salt use, savings range from 34,900 tons to 244,000 tons. This would result in financial savings of $2.5 million to $17.8 million annually from lower purchases of salt, and $5.6 to $36 million annually in savings in labor and equipment."
- Twin Cities Metropolitan Area chloride management plan
  Minnesota Pollution Control Agency, 2016
  "This Chloride Management Plan (CMP) incorporates water quality assessment, source identification, implementation strategies, monitoring recommendations, and measurement and tracking of results into a performance-based adaptive approach for the TCMA."
- Guidelines for the selection of snow and ice control materials to mitigate environmental impacts
  National Academies of Sciences, Engineering, and Medicine, 2007, NCHRP Report 577
  "Guidelines for the Selection of Snow and Ice Control Materials to Mitigate Environmental Impacts explores guidelines for the selection of snow and ice control materials through an evaluation of their cost, performance, and impacts on the environment and infrastructure."
- Environmental, Health and Economic Impacts of Road Salt
  New Hampshire Department of Environmental Services
  "The sodium, chloride, ferrocyanide and impurities make their way into our environment through the runoff from rain, melting snow and ice, as well as through splash and spray by vehicles and by wind. They find their way onto vegetation and into the soil, groundwater, stormdrains, and surface waters causing significant impact to the environment."
- The original anti-skid technology
  Salt Institute
  "There's an easy, inexpensive way to save hundreds of lives and prevent thousands of injuries every year while protecting the environment."
- Projects by the USGS New England Water Science Center in Cooperation with the FHWA, State DOTs, and other Water Science Centers