Virginia Water Central

Virginia Water Resources Research Center Blacksburg, Virginia March 2003 (No. 25)

FEATURE ARTICLE

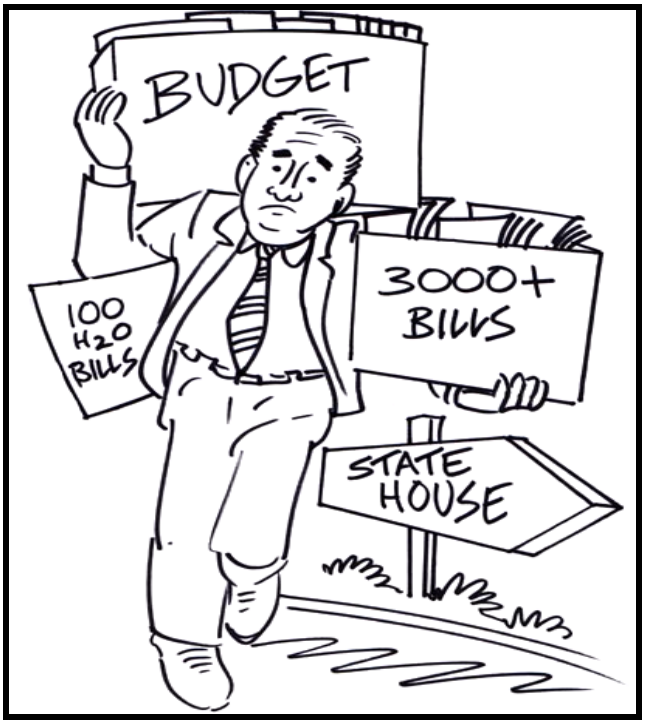
Water in the 2003 Virginia General Assembly

The 2003 Virginia General Assembly convened on January 8 and adjourned on February 22, with a reconvened ("veto") session planned for April 2. The legislature considered **3277 measures**; **1585 passed** and **1692 failed**. The legislature also considered amendments to the Fiscal Years 2003/2004 biennial budget that had been adopted in the 2002 session.

Beginning on page 2, this article lists 99 measures related to water resources or to land resources with a potential impact on water. The list comes from the Legislative Information Service (LIS) Web-site, at leg1.state.va.us. The bill summaries below were taken directly from LIS, with some editing for space, clarity, or emphasis.

Bills that passed are listed first, followed by bills that failed. In each group, bills are listed in order of their **bill number**, using the following abbreviations: **HB** = bill started in House of Delegates; **HJ** = joint resolution started in the House; **SB** = bill started in the Senate; and **SJ** = joint resolution started in the Senate. The consecutive numbers (1—99) are for convenience within this article and have no *legislative* significance.

The listed bills were found by searching for water-related legislation in nine LIS categories: 1) Conservation; 2) Drainage, Soil Conservation, Sanitation, and Public Facilities Districts; 3) Fisheries and Habitat of Tidal Waters; 4) Game, Inland Fisheries and Boating; 5) Health; 6) Mines and Mining; 7) Waste Disposal; 8) Water and Sewer Systems; and 9) Waters of the State, Ports and Harbors. Pages 10—12 list this year's bills according to these LIS categories (without summaries).



INSIDE THIS ISSUE

Virginia Tech
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

PASSED

1. **BUDGET BILLS—HB 1400/SB 700:** Appropriation of the public revenue for the two years ending respectively, on the thirtieth day of June, 2003, and the thirtieth day of June, 2004. For access to the text of these bills and of their amendments, go on-line to leg2.state.va.us/MoneyWeb.NSF/sb2003.
2. **HB 1451 Staunton State Scenic River:** Extends the segment of the Staunton River that is designated a state scenic river from 40.5 river miles to 51.3 river miles.
3. **HB 1459 Erosion and Sediment Control; requirements for plan approval:** Changes the requirement to provide the name of an individual holding a certificate of competence *prior to approval* of erosion and sediment control plans to requiring instead that the name of such certificate holder must be provided *prior to actual land-disturbance.*
4. **HB 1476 Rudee Inlet Authority:** Repeals the 1960 Act of Assembly that created the authority, whose duties have been taken over by the Virginia Beach Erosion Committee and the Beaches and Waterways Commission.
5. **HB 1481 Waterfowl sanctuaries and blinds:** Repeals a number of Acts of Assembly that provide for the establishment of waterfowl sanctuaries in various localities, including the Act prohibiting hunting from floating blinds in five Tidewater counties and in several segments of the Rappahannock and Potomac rivers, and the Act that establishes wildlife sanctuaries in areas of what is now Virginia Beach (no longer needed because Virginia Beach has adopted an ordinance that prevents hunting in these areas).
6. **HB 1504 Harvesting of oysters from private oyster beds:** Allows the Virginia Marine Resources Commission to grant a special exemption to allow harvesting of oysters from private oyster beds one hour prior to sunrise from June 15 to September 1, with 24 hours notice.
7. **HB 1505 Emergency water supply permit:** Authorizes the State Water Control Board (SWCB) to issue an emergency Virginia Water Protection Permit to an applicant seeking to develop an additional source of water supply, if the Board finds that there is an insufficient drinking water supply for an area served by a public water system. (A proposed activity that will affect a water resource may receive a Water Protection Permit if the SWCB determines that the proposed activity is consistent with the Clean Water Act and state law in protecting instream beneficial uses.[1])
8. **HB 1525 Waterway "pass-through" zones; local ordinances; penalties:** Allows localities, after notifying the Department of Game and Inland Fisheries, to enact ordinances establishing "pass-through" zones where watercraft traffic congestion routinely poses a significant safety risk. The ordinance must require watercraft operators to maintain reasonable and safe speeds and must prohibit them from anchoring, loitering, or engaging in recreational activities while in such a zone.
9. **HB 1526 Personal watercraft; local ordinances; penalty:** Allows the city of Virginia Beach (defined by population bracket) to enact ordinances establishing minimum distances from the shoreline beyond which personal watercraft may be operated in excess of the slowest possible speed required to maintain steerage and headway (but must be at least 100 feet from the shoreline and 200 feet from swimmers in ocean waters).
10. **HB 1532 Landfill siting:** Allows Halifax County to site a landfill closer than five miles up-gradient from a water source, if the director of the Department of Environmental Quality determines that such distance would not be detrimental to human health and the environment. Currently, only Mecklenburg has an exemption that allows it to construct a landfill closer than the statewide five-mile up-gradient separation requirement.
11. **HB 1627 Virginia Scenic River Board:** Creates the Virginia Scenic River Board, eliminates the Virginia Scenic River Advisory Boards, corrects a mileage error related to the Staunton State Scenic River, designates the Historic Lower James River as a state scenic river, codifies the St. Mary's River as a river segment worthy of designation, and requires a report by the Department of Conservation and Recreation in 2009 to evaluate the effectiveness of the new state board. This bill incorporated a related proposed measure, **HB 1970** (same title).
12. **HB 1661 Private piers:** Establishes size specifications for exemptions from the requirement by the Virginia Marine Resources Commission for a permit for private piers.

[1] See *Virginia Code*, § 62.1-44.15:5, "Virginia Water Protection Permit."

13. **HB 1671 Virginia Envirothon Program:** Authorizes Soil and Water Conservation Districts to coordinate and implement the Virginia Envirothon, a resource-conservation program for high school students.
14. **HB 1748 Virginia Water Facilities Revolving Fund; brownfields remediation:** Clarifies the intent of the Brownfields Restoration and Land Renewal Act of 2002 to allow the State Water Control Board to extend loans from the Water Facilities Revolving Fund to localities, public authorities, partnerships, or corporations for brownfield-remediation activities. A brownfield is real property for which expansion, redevelopment, or reuse may be complicated by the presence or potential presence of a hazardous substance.
15. **HB 1875 Virginia Soil and Water Conservation Board:** Reduces the total membership of the Board from 12 to 10 members, eliminates *ex-officio* voting members except for the director of the Department of Conservation and Recreation, and adds two members appointed by the governor from the Commonwealth at-large.
16. **HB 1876 Water and sewer charges:** Adds the City of Roanoke to localities that may provide that taxes or charges imposed for a waterline or sewer, or the use thereof, within or outside the locality shall be a lien on the real estate served by such waterline or sewer.
17. **HB 1953 Creation of the Low Impact Development Assessment Task Force:** Requires the director of the Department of Environmental Quality to appoint a Low Impact Development Assessment Task Force to (i) develop a certification process for low-impact development techniques in achieving quantifiable pollution prevention or abatement results, (ii) develop other guidance for local governments and the general public as necessary to promote a more complete understanding of the most effective use of low-impact development techniques, (iii) recommend changes to existing statutes and regulations to facilitate the use of low-impact development techniques, and (iv) develop a model ordinance for use by local governments.
18. **HB 1972 Health; water quality analysis:** Adds Warren and Goochland counties to the localities that may establish testing requirements for compliance with state drinking-water quality standards pursuant to the state regulation (12-VAC-5-630) for building-permit applicants who propose to use private groundwater wells.
19. **HB 1992 Fees for solid waste disposal:** Restates a population bracket, originally intended to apply to Accomack County, based on the 2000 U.S. Census. The existing language authorizes certain counties to impose fees related to the disposal of solid waste. Accomack County is also granted additional authority related to charging and collecting the fee, such as fee prorating, late penalties, and discounts.
20. **HB 2156 Water supply fund:** Authorizes the Virginia Board of Health to enter into an agreement with the State Water Control Board to manage certain aspects of this fund, such as reviewing financial assistance applications and project bid documents, monitoring projects, and ensuring compliance with environmental review.
21. **HB 2236 Water quality reports:** Requires the Department of Conservation and Recreation to submit its report on the impacts of nonpoint source pollution on water quality to the Department of Environmental Quality for inclusion in the state water-quality report submitted to the U.S. Environmental Protection Agency.
22. **HB 2239 Haul seine nets:** Changes the definition of a haul seine net. The current definition is ambiguous, has resulted in confusion in the proper setting and use of the gear, and has forced haul seiners to work in shallow waters where submerged aquatic vegetation (SAV) beds are located. Changing the definition will allow the Marine Resources Commission to prepare a management plan that recognizes a more appropriate use of the gear, which will minimize the impact of the net on the SAV beds.
23. **HB 2314 Erosion and Sediment Control Law:** Clarifies that shoreline-erosion control projects involving land-disturbing activities in tidal waters under the regulatory authority of local wetlands boards, the Virginia Marine Resources Commission, and the U.S. Army Corps of Engineers are *not* subject to the Virginia Erosion and Sediment Control Law.
24. **HB 2376 Cathode ray tube recycling program:** Requires the Virginia Waste Management Board to adopt regulations to encourage cathode ray tube and electronics recycling. The bill also authorizes a locality to prohibit disposal of cathode ray tubes in any privately operated landfill within its jurisdiction, so long as the locality has

implemented a recycling program that is capable of handling all cathode ray tubes generated within the jurisdiction. This bill incorporated a related measure, **HB 2375, Electronic Equipment Recycling Program**.

25. **HB 2393 Department of Conservation and Recreation Board consolidation:** Creates special funds, reorganizes the Board of Conservation and Recreation as a policy board, and merges both the Board on Conservation and Development of Public Beaches and the State Park Foundation into the Board of Conservation and Recreation.
26. **HB 2396 Virginia Outdoors Foundation's; regional open-space preservation:** Eliminates the Outdoors Foundation's regional open-space preservation advisory boards and recommends a broad geographical representation for the members of the Foundation's board of trustees.
27. **HB 2434 Silvicultural Activities; best management practices:** Provides that a notice, special order, or emergency special order issued by the State Forester regarding the conduct of silvicultural activities shall remain in effect until the State Forester determines that the corrective measures specified therein have been implemented.
28. **HB 2436 Invasive Species Council established:** Establishes the nine-member Invasive Species Council, composed of executive branch agency heads and chaired by the secretary of Natural Resources, to provide leadership regarding prevention and control of invasive species and guide preparation of an invasive species management plan. There is 2006 "sunset" on the Council.
29. **HB 2602 Construction and operation of treatment works:** Gives the State Water Control Board and the Department of Environmental Quality *sole* authority to regulate the construction and operation of sewage treatment plants, including the review and approval of the plans and specifications for such facilities (removing the Board of Health from joint responsibility for issuing certificates to construct and operate facilities).
30. **HB 2631 Soil and Water Conservation District Boards:** Specifies that *vacant* director positions is soil and water conservation districts will *not* be considered for constituting a quorum for board business.
31. **HB 2702 Mandatory connection to water and sewage systems in certain counties:** Adds Wythe County to the localities that may require mandatory connection to their water and sewage systems by certain owners of property potentially served by such systems, but that may *not* charge a non-user fee.
32. **HB 2726 Property tax; certified pollution control equipment and facilities:** Adds to the definition of certified pollution-control equipment and facilities—for property tax classification purposes—any equipment used to grind, chip, or mulch trees, tree stumps, underbrush, and other vegetative cover for reuse as mulch, compost, or fuel.
33. **HB 2742 Herbert H. Bateman Advanced Shipbuilding and Carrier Integration Center:** Extends to June 30, 2008, the period that operations grants for activities of this Center may be awarded (from the current deadline of June 30, 2006).
34. **HB 2752 Nonindigenous Aquatic Nuisance Species Act:** Creates the Nonindigenous Aquatic Nuisance Species Act within the Department of Game and Inland Fisheries; declares the Zebra Mussel, the Quagga Mussel, and Northern Snakehead fish as nonindigenous aquatic nuisance species; authorizes the Board of Game and Inland Fisheries to declare other nonindigenous aquatic nuisance species if it finds that the presence of such nonindigenous aquatic species in state waters poses or is likely to pose a significant threat of harm; makes it illegal to knowingly import, possess, transport, sell, purchase, give, receive, or introduce into state waters, any nonindigenous aquatic nuisance species without a permit from the director (which permits require satisfactory assurance that adequate safeguards will be maintained to prevent the escape or introduction of any such species into state waters); and sets penalties for violation up to $25,000 plus liability for the costs of investigation, control, and eradication incurred by any state agency or local government of the Commonwealth as a result of such unlawful conduct. This bill incorporated a related proposed measure, **HB 2814** (same title).
35. **HB 2789 Trichloroethylene prohibited; penalty:** Adds trichloroethylene (TCE) to the list of hazardous household chemicals identified by the Department of Environmental Quality and prohibits the use or sale of any household product containing TCE as of January 1, 2004, with violation a Class 3 misdemeanor.

36. **HJ 550 Commending the United States Coast Guard Auxiliary:** The General Assembly commends the United States Coast Guard Auxiliary for 63 years of meritorious service to the people of Virginia.
37. **HJ 633 Study; collection of rents and royalties:** Directs the Virginia delegation to the Chesapeake Bay Commission to study the collection of rents and royalties for the use of state-owned bottomlands. The delegation is to examine (i) the current moratorium on the collection of rents and royalties, (ii) establishment of a regulatory framework for use of state waters and bottomlands, and (iii) proposals by the Institute of Marine Science regarding shallow-water management.
38. **SB 726 Sale of hunting and fishing licenses:** Relieves a clerk of a circuit court from the responsibility of selling hunting and fishing licenses, if the Board of Game and Inland Fisheries has designated an agent to sell hunting and fishing licenses in the county or city in which the clerk is located.
39. **SB 766 Virginia Outdoors Foundation's regional open-space preservation advisory boards:** Identical to **HB 2396**, # 26 above, which also passed.
40. **SB 786 Admittance, parking and use at Department-owned facilities; penalty:** Allows the Department of Game and Inland Fisheries to establish admittance, parking, or other use fees at department-owned facilities. Any person holding a valid hunting, trapping, or fishing permit, or a current certificate of boat registration issued by the department does not have to pay these fees.
41. **SB 896 Confined animal feeding operations:** Authorizes the State Water Control Board to promulgate regulations requiring Virginia Pollutant Discharge Elimination System (VPDES) permits for confined animal feeding operation to the extent necessary to comply with Section 402 of the federal Clean Water Act. Certain confined animal feeding operations will be covered under VPDES permits as opposed to a general Virginia Pollutant Abatement permit. The bill also requires the State Water Control Board to impanel an advisory group.
42. **SB 913 Erosion and sediment control law; certificate of competence:** Grants erosion and sediment control plan-approving authorities the option to waive the requirement for a certificate of competence (for land-disturbing activity) for agreements in lieu of a plan. An agreement in lieu of a plan is a contract between the plan-approving authority and the landowner, used for ensuring proper implementation of conservation measures during construction of a single-family residence. Currently, all plan-approving authorities must require that the name of an individual, who holds a certificate of competence and who will be in charge of and responsible for carrying out the land-disturbing activity, be provided both on erosion and sediment control plans and on agreements in lieu of a plan.
43. **SB 914 Department of Conservation and Recreation Board consolidation:** Identical to **HB 2393**, # 25 above, which also passed.
44. **SB 965 Waste tire piles and tire tax:** Strengthens the Department of Environmental Quality's ability to clean up the 339 remaining tire piles throughout the state; authorizes and specifies conditions for the establishment of tire convenience centers as collection points for temporary storage of tires; establishes a strict liability standard for damages incurred by neighboring property owners and other third parties when a tire pile burns, applicable in the case of an un-permitted tire piles of more than 100 tires (currently, strict liability applies when there are more than 50,000 tires); grants the department the authority to enter property and remove a tire pile if the owner refuses an order to remove the tires; grants the department the right to obtain a lien against the property for the amount expended from the Waste Tire Fund to clean up the tire pile; and over three years increases the new-tire fee from $.50 per new tire sold to $1.00 per tire, with the extra revenue generated to be used solely for removing tire piles.
45. **SB 966 Certain private waterworks; appointment of receiver:** Grants the Commissioner of Health the authority, in addition to the other civil and criminal penalties and injunctive or other relief, to petition the circuit court for the jurisdiction in which any private waterworks is located for the appointment of a receiver, if the Commissioner finds that the waterworks is unable or unwilling to provide adequate and safe service for any of several reasons stipulated by the bill. The bill also stipulates the petition process, the powers and duties of the receiver, and court options following receipt of a petition.

46. **SB 1013 Conservation of trees during localities' development:** Amends current provisions that allow localities to provide by ordinance for the planting and replacement of trees during the development process.
47. **SB 1051 Virginia Water Facilities Revolving Fund:** Allows the State Water Control Board to make loans from the Virginia Water Facilities Revolving Fund to local governments or "holders" for purchasing or acquiring an interest in real property. The Board must consult with the Department of Conservation and Recreation to verify that the purchase protects or improves water quality; prevents water pollution; and protects natural or open-space values of the property, or assures its availability for agricultural, forestal, recreational, or open-space use.
48. **SB 1053 Conservation easements; requirements to be a holder:** Allows organizations that have been in existence for at least five years and are registered and in good standing with the State Corporation Commission to be sole holders of conservation easements if they also meet the other existing criteria (prior to this law, such entities could only *co-hold* conservation easements and the *principal office* of a sole holder of a conservation easement had to have been in the state for five years).
49. **SB 1075 Fees for solid waste disposal:** Pertaining to Accomack County, this bill is identical to **HB 1992**, # 19 above, which also passed.
50. **SB 1088 Land application of sewage sludge; requirements and regulations:** Amends current law regarding land-application of sewage sludge, also called "biosolids." Its provisions include the following: establishes standard complaint and investigation procedures, including the maintenance of a searchable electronic database of complaints by the Virginia Department of Health (VDH); requires nutrient-management plans by certified persons for all land application sites, regardless of the frequency of application, a change from the current regulations covering sites where biosolids are applied more than once every three years; requires Department of Conservation and Recreation approval of certain nutrient-management plans; allows VDH to incorporate into the permit reasonable site-specific special conditions to protect the environment or persons residing in the vicinity of the proposed application site; requires permit holders to provide VDH with evidence of financial responsibility that will be available to pay claims for cleanup costs, personal injury, and property damage; creates a land-application certification program to be established by VDH, under which a certified land applicator must be on location at all times during the application process; grants to localities that have adopted an ordinance for testing and monitoring biosolids the authority to order abatement of land-application activity for violations of relevant laws and regulations; and requests that VDH review certain reports of the National Research Council and the U.S. Environmental Protection Agency, report its findings to the Virginia Board of Health by June 30, 2004, and, if requested by the Board, initiate rulemaking proceedings by September 1, 2004. A related measure, **HB 2083 Sewage sludge**, failed (see # 73 below).
51. **SB 1094 Small Water or Sewer Public Utility Act rate increases:** Requires a small water or sewer utility that implements a rate increase of 50 percent or more to file financial data with the State Corporation Commission. If a hearing is ordered on the increase, the Commission shall expedite the hearing and the funds produced by the increase shall be held in escrow until the Commission has rendered its decision.
52. **SB 1137 Transporting wastes on state waters:** Eliminates the stacking limitation for containers on barges and the prohibition on transporting waste on the Rappahannock, James, and York rivers. This bill broadens the Waste Management Board's authority to establish a waste barging fee to fund not only administration and enforcement costs but also activities for abating pollution caused by barging of waste, improving water quality, or other environmental improvement purposes.
53. **SB 1168 Mandatory connection to water and sewage systems in certain counties:** Adds Bland County to the counties that may require mandatory connection to their water and sewage systems by owners of property that may be served by such systems.
54. **SB 1186 State water-safety zones and restricted areas; penalty:** Allows the Virginia Marine Resources Commission, after consultation with the U.S. Coast Guard and U.S. Corps of Engineers, to establish by regulation state water-safety zones or restricted areas in tidal waters wherein public access shall be restricted or prohibited in the interest of public safety. These regulations

will be exempted from the Administrative Process Act and enforced by the Virginia Marine Police. In times of official state or national emergency, the governor is authorized to adjust the boundaries of safety zones or restricted areas by executive order.

55. **SB 1193 Regulation of stormwater:** Allows localities to provide full or partial waivers of storm drainage and facilities fees to any person who develops, redevelops, or retrofits outfalls, discharges, or property so that there is a permanent reduction in post-development stormwater flow and pollutant loading. Prior to this bill, such waivers were available only to persons holding permits from the Department of Environmental Quality for complete private maintenance of stormwater facilities. This bill is intended to provide more flexibility to localities in encouraging development that reduces stormwater drainage in instances not currently subject to state permitting requirements.
56. **SB 1221 Water-supply planning:** Requires the State Water Control Board, in consultation with the State Health Commissioner, local governments, public service authorities, and other interested parties, to establish a comprehensive water-supply planning process for the development of local, regional, and state water-supply plans. The planning process is to ensure adequate and safe drinking water, encourage and protect all beneficial uses, and develop and promote incentives for alternative water sources. A citizens' technical advisory committee is to continue to advise the Department of Environmental Quality and the Department of Health regarding changes needed in state water-resources policies and programs. By December 1, 2003, the Board is to prepare a preliminary state plan and proposed criteria for development of the local and regional plans. This bill incorporated two other measures, **SB 1245** and **SB** 1259. A related bill, **SB 2401, Comprehensive water-supply plan**, # 80 below, failed.
57. **SB 1275 Division of Consolidated Laboratory Services; environmental laboratory:** Authorizes the Director of the Division of Consolidated Labs to provide variances to environmental labs conducting any tests, analyses, measurements, or monitoring required pursuant to the Virginia Waste Management Act (*Virginia Code* Section 10.1-1400 *et seq*.), or the State Water Control Law (*Virginia Code* Section 62.1-44.2 *et seq*.), if the variance meets the goals of applicable state law and does not conflict with federal or state law or regulations.
58. **SB 1307 State Corporation Commission regulation of sewer utilities:** Limits the State Corporation Commission's jurisdiction to regulate the rates, terms, and conditions of sewage treatment services that are provided by certain public utilities under the terms of a franchise agreement between such a public utility and a Virginia municipality.
59. **SJ 381 Study; desalinization:** Requests the Virginia Water Resources Research Center to study desalinization as part of a strategy to meet Virginia's drinking-water needs. The study will examine costs and benefits of the technology and whether it would be a cost-effective option for localities located near the ocean or a brackish water source.
60. **SJ 424 Nitrogen reduction in the Chesapeake Bay:** Urges Congress to adopt legislation in support of funding for nitrogen reduction technology. The Commonwealth is a signatory to the Chesapeake 2000 Agreement, in which Virginia pledges to reduce nitrogen to levels sufficient to remove the Chesapeake Bay from the state's list of impaired waters by 2010.

FAILED

61. **HB 1442 Virginia Conservation Easement Act; requirements for easement holders:** Would have decreased, from five years to three, the time that a prospective holder must have had a principal office in the Commonwealth before holding a conservation easement *without* a co-holder.
62. **HB 1463 Economic development; Virginia Maritime Investment Act:** Would have established a grant program to be paid (subject to appropriation) from the Maritime Investment Partnership Grant Fund, to eligible ship-repair companies making a capital investment of at least $50,000.
63. **HB 1490 Fishing Class II guide license:** Would have created a fishing Class II guide license for owners of recreational headboats or charterboats, and included fees and other requirements for obtaining such a license. An identical bill passed in 2002 but contained a reenactment clause for the 2003 General Assembly in order for the bill to take effect.

64. **HB 1591 Onsite sewage evaluations and septic system permits:** Would have provided that, when a field analysis is necessary to protect the public health and integrity of the Commonwealth's environment, the Department of Health must conduct the field analysis prior to issuing a letter, permit, or approval; plus other related provisions.
65. **HB 1660 Personal flotation devices required for children; civil penalty:** Would have required all children under the age of seven to wear a Type I, II, III, or Type V U.S. Coast Guard-approved personal flotation device on recreational vehicles under 21 feet, with the operator subject to a fine up to $250.
66. **HB 1711 Watercraft and aircraft sales and use tax rate increase:** Would have increased, from two to three percent, the sales and use tax rate on watercraft and aircraft.
67. **HB 1809 Landfill permit exemption:** Would have exempted, from having to obtain a landfill permit to store the wood waste byproduct, wood- and timber-processing facilities that are in compliance with all state and federal stormwater laws and regulations and those that have implemented a stormwater pollution-prevention plan.
68. **HB 1883 Deed recordation fee for open-space preservation:** Would have imposed a one-dollar fee on every deed admitted to record as of July 1, 2003, and required the Comptroller to distribute the revenue from such collected fees to the Virginia Outdoors Foundation for the purposes of promoting the preservation natural, scenic, historic, scientific, open-space, and recreational areas.
69. **HB 1963 Solid waste landfills; permit requirements:** Would have exempted public service authority-owned or -operated landfills from the permit requirements of (i) local government certification of consistency with all applicable ordinances, and (ii) local government host-agreement certification when permit applications are for new or expanded solid waste landfills on property contiguous to existing permitted landfills.
70. **HB 1973 Health; location and testing of water:** Would have added Warren County to those localities that may adopt standards for location and testing of water from private wells that are consistent with the Board of Health, and standards for construction and abandonment that are more stringent than those adopted by the Board.
71. **HB 1996 Recreational boat freshwater fishing license:** Would have established a recreational boat freshwater fishing license ($50 per year per boat) that would cover the license holder and resident passengers while fishing from such boat, in lieu of the other fishing license requirements.
72. **HB 2055 Suspension of water and sewer connections:** Would have allowed a locality or a water and wastewater authority to suspend connections to its water and sewer systems during periods when mandatory water-conservation measures have been imposed by the locality or the Commonwealth in the area of the connection.
73. **HB 2083 Sewage sludge:** Would have authorized localities to adopt an ordinance requiring land-applied sewage sludge to contain between 1,001 and 50,000 fecal coliform counts per gram of dry weight. A related measure, **SB 1088 Land application of sewage sludge**, # 50 above, passed.
74. **HB 2114 Concealed Weapons Permits; retired Virginia Marine Police officers:** This bill was incorporated into **HB 2798**, a broader concealed-weapons bill, which failed.
75. **HB 2119 Criminal history record for public water supply employees:** Would have allowed localities to require criminal-history information on public water supply employees hired after September 11, 2001.
76. **HB 2129 Mandatory connection to water and sewage systems in certain counties:** Would have added Montgomery County to the counties that may require mandatory connection to water and sewage systems by owners of property potentially served by such systems.
77. **HB 2154 Virginia Department of Game and Marine Resources; established:** Would have combined the Department of Game and Inland Fisheries and the Virginia Marine Resources Commission to form the Virginia Department of Game and Marine Resources.
78. **HB 2163 Local coal and gas severance tax; Dickenson County:** Would have allowed Dickenson County to use *for any purpose* up to $1 million per year from the one-percent severance tax on coal and gas. Under current law all such revenues are to be paid into a special fund and used solely for road improvement, water quality improvement, and economic development.
79. **HB 2315 Environmental permit fees:** Would have directed the Virginia Waste Management Board and the State Water Control Board to establish a schedule of fees

to recover the *full* costs of operating solid-waste, hazardous-waste, and water programs. The 2002 General Assembly passed legislation directing the Waste Management Board to develop a new permit fee schedule to cover *no more than 20 percent* of the direct costs of the solid waste and hazardous waste programs; the 2002 bill also tripled statutory caps on water-permit fees and set a July 1, 2004, sunset on the new fee structure. The 2003 measure would have eliminated the sunset and imposed a new fee structure.

80. **HB 2401 Comprehensive water supply plan:** Would have required the State Water Control Board to develop a comprehensive, statewide water-supply plan covering each of Virginia's major river basins and including the projected water need for a 25-year period, demand management and supply alternatives, conservation measures, and provisions for the protection of ground water, headwaters, and estuaries. Local governments were to develop regional watershed plans for inclusion in the state plan. A related bill **SB 1221, Water-supply planning**, # 56 above, which passed.
81. **HB 2466 Vehicle registration fees:** Would have required that well-drilling *support* equipment be treated the same as well-drilling equipment.
82. **HB 2565 Board of Health; regulations; waterworks:** Would have provided that Board of Health waterworks regulations require water meters installed after January 1, 2004, to conform to American National Standards Institute/National Sanitation Foundation Standard 61, which provides for the certification of devices as lead-free.
83. **HB 2781 Chesapeake Bay Local Assistance Department:** Would have authorized the Chesapeake Bay Local Assistance Department to administer the Virginia Coastal Resources Management Program, including the program's annual grant award received from the National Oceanic and Atmospheric Administration.
84. **HB 2783 Financial assurance for landfills:** Would have required the Virginia Waste Management Board, when calculating the amount an owner should set aside for proper closure of a landfill, to include the interest earned by an escrow account.
85. **HB 2784 Wastewater and drinking water programs:** Would have transferred the Sewage Disposal program, the Sewage Handling and Disposal Appeal Review Board, the Public Water Supplies program, the Private Well Construction program, and the Gray Water program from the Department of Health to the Department of Environmental Quality.
86. **HB 2832 No discharge zone:** Would have removed the restriction on the State Water Control Board that prohibits it from promulgating no-discharge regulations that are *more restrictive* than federal law.
87. **HJ 600 Study; hunting and fishing license exemptions; report:** Would have requested the Virginia Department of Game and Inland Fisheries to study the various exemptions from hunting and fishing license requirements to determine the potential financial impact that these exemptions have on department revenue.
88. **SB 760 Personal watercraft education course:** Would have required all owners or operators of personal watercraft to complete a boating-safety course approved by the Department of Game and Inland Fisheries or an equivalent course in another state or country. Currently this is only required of operators 14 or 15 years old and of all persons renting personal watercraft to others.
89. **SB 781 Regulation of outdoor lighting near public waterways:** Would have allowed localities east of the Fall Line to regulate outdoor lighting near public waterways so as to minimize glare and water surface reflections that might interfere with the ability of boat operators to maintain visual contact with illuminated navigation aids.
90. **SB 886 Landfill closure requirements; exemption:** Would have exempted from the priority closure schedule developed by the Department of Environmental Quality—pursuant to the Virginia Landfill Clean-up and Closure Fund—any municipal solid-waste landfill having a Year 2000 average volume of less than 25 tons per day.
91. **SB 917 License fees for commercial and recreational saltwater fisheries:** Would have increased the annual license fees for registering a commercial fisherman from $150 to $175; for a saltwater recreational fishing license from $7.50 to $12.50; for registering a recreational boat used for saltwater recreational fishing from $30 to $50; and for a temporary license from $5 to $10.
92. **SB 961 Protection of certain female crabs; penalty:** Would have made it unlawful, for 14 working days between July 1 and August 15 each year (the specific days each year to be set by the Virginia Marine

Resources Commission), to catch, possess, or sell an egg-bearing female crab or a female crab from which the egg pouch, sponge, or bunion has been removed.

93. **SB 968 Adequate public facilities related to water supply:** Would have provided that a subdivision ordinance may include reasonable provisions allowing the locality to determine whether public water-supply facilities can support the services that a proposed subdivision will require.
94. **SB 1089 Commission on the Future of Virginia's Environment:** Would have established the Commission on the Future of Virginia's Environment as a permanent commission in the legislative branch, with the purpose of the Commission being to review, evaluate, and formulate recommendations concerning Virginia's environment and natural resources.
95. **SB 1106 Sale of liquid mercury fever thermometers prohibited:** Would have banned the sale of liquid-mercury fever thermometers in Virginia and required the Department of Health, in cooperation with the Department of Environmental Quality, to provide information for local governments and other landfill operators to inform the public on the proper disposal of such thermometers.
96. **SB 1116 Chesapeake Bay Preservation Act:** Would have abolished the Chesapeake Bay Local Assistance Department and placed responsibility for administering the Chesapeake Bay Preservation Act with the Department of Conservation and Recreation.
97. **SB 1120 Personal flotation devices required for children; civil penalty:** Identical to **HB 1660**, # 65 above, which also failed.
98. **SB 1349 Environmental permit fees:** Would have modified the permit-fee exemption, for permits issued by the State Water Control Board, for farming operations engaged in production for market to include the washing and packing of produce by the grower for shipment to market.
99. **SJ 352 Study; alternative water sources:** Would have directed the State Water Commission to study alternative technologies to develop additional water supplies and determine whether incentives could be provided to those localities that implement alternative water sources.

The following list groups the bills by the categories used by the Virginia Legislative Information System (LIS). "P" = bill passed; "F" = bill failed. Please note: LIS placed some bills in more than one category, but all bills are listed in only one category here.

Conservation

HB 1442 Virginia Conservation Easement Act; requirements for easement holders. F
HB 1451 Staunton State Scenic River. P
HB 1459 Erosion and Sediment Control; requirements for plan approval. P
HB 1627 Virginia Scenic River Board. P
HB 1671 Virginia Envirothon Program. P
HB 1748 Virginia Water Facilities Revolving Fund; brownfields remediation. P
HB 1875 Virginia Soil and Water Conservation Board. P
HB 1883 Deed recordation fee for open-space preservation. F
HB 1953 Creation of the Low Impact Development Assessment Task Force. P
HB 2236 Water quality reports. P
HB 2314 Erosion and Sediment Control Law. P
HB 2376 Cathode ray tube recycling program. P
HB 2393 Department of Conservation and Recreation Board consolidation. P
HB 2396 Virginia Outdoors Foundation; regional open-space preservation. P
HB 2434 Silvicultural Activities; best management practices. P
HB 2436 Invasive Species Council established. P
HB 2631 Soil and Water Conservation District Boards. P
HB 2726 Property tax; certified pollution control equipment and facilities. P
HB 2781 Chesapeake Bay Local Assistance Department. F
HB 2784 Wastewater/drinking-water programs. F
HB 2789 Trichloroethylene prohibited; penalty. P
SB 766 Virginia Outdoors Foundation's regional open-space preservation advisory boards. P
SB 896 Confined animal feeding operations. P
SB 913 Erosion and sediment control law; certificate of competence. P
SB 914 Department of Conservation and Recreation Board consolidation. P

SB 1013 Conservation of trees during localities' development. P
SB 1051 Water Facilities Revolving Fund. P
SB 1053 Conservation easements; requirements to be a holder. P
SB 1089 Commission on the Future of Virginia's Environment. F
SB 1116 Chesapeake Bay Preservation Act. F
SB 1137 Transporting wastes on state waters. P
SB 1193 Regulation of stormwater. P
SB 1275 Division of Consolidated Laboratory Services; environmental laboratory. P
SB 1349 Environmental permit fees. F
SJ 424 Nitrogen reduction in Chesapeake Bay. P

Drainage, Soil Conservation, Sanitation and Public Facilities Districts

HB 1875 Soil and Water Conservation Board. P
HB 2631 Soil and Water Conservation District Boards. P
SB 913 Erosion and sediment control law; certificate of competence. P

Fisheries and Habitat of Tidal Waters

HB 1490 Fishing Class II guide license. F
HB 1504 Harvesting oysters from private beds. P
HB 1661 Private piers. P
HB 2114 Concealed Weapons Permits; retired Virginia Marine Police officers. F
HB 2239 Haul seine nets. P
SB 917 License fees for commercial and recreational saltwater fisheries. F
SB 961 Protection of certain female crabs. F

Game, Inland Fisheries and Boating

HB 1481 Waterfowl sanctuaries and blinds. P
HB 1525 Waterway "pass-through" zones; local ordinances; penalties. P
HB 1526 Personal watercraft; local ordinances. P
HB 1660 Personal flotation devices required for children. F
HB 1711 Watercraft and aircraft sales and use tax rate increase. F
HB 1996 Recreational boat freshwater fishing license. F
HB 2154 Virginia Department of Game and Marine Resources; established. F
HB 2752 Nonindigenous Aquatic Nuisance Species Act. P
HJ 600 Study; hunting and fishing license exemptions; report. F
SB 726 Sale of hunting and fishing licenses. P
SB 760 Personal watercraft education course. F
SB 786 Admittance, parking and use at Department-owned facilities; penalty. P
SB 1120 Personal flotation devices required for children; civil penalty. F

Health

HB 1972 Health; water quality analysis. P
HB 1973 Health; location and testing of water. F
HB 2565 Board of Health; regulations; waterworks. F
SB 1106 Sale of liquid mercury fever thermometers prohibited. F

Mines and Mining

HB 2163 Local coal and gas severance tax; Dickenson County. F

Waste Disposal

HB 1532 Landfill siting. P
HB 1809 Landfill permit exemption. F
HB 1963 Landfills; permit requirements. F
HB 1992 Fees for solid waste disposal (Accomack County). P
HB 2315 Environmental permit fees. F
HB 2602 Construction and operation of treatment works. P
HB 2783 Financial assurance for landfills. F
SB 886 Landfill closure requirements; exemption. F
SB 965 Waste tire piles and tire tax. P
SB 1075 Fees for solid waste disposal (Accomack County). P

Water and Sewer Systems

HB 1591 Onsite sewage evaluations and septic system permits. F
HB 1876 Water and sewer charges. P
HB 1953 Creation of the Low Impact Development Assessment Task Force. P
HB 2055 Suspension of water and sewer connections. F
HB 2083 Sewage sludge. F
HB 2119 Criminal history record for employees involved; public water supply. F
HB 2129 Mandatory connection to water and sewage systems in certain counties. F
HB 2466 Vehicle registration fees. F
HB 2602 Construction and operation of treatment works. P
HB 2702 Mandatory connection to water and sewage systems in certain counties. P
HB 2784 Wastewater and drinking water programs. F
SB 966 Certain private waterworks; appointment of receiver. P
SB 968 Adequate public facilities related to water supply. F

SB 1088 Land application of sewage sludge; requirements and regulations. P
SB 1094 Small Water or Sewer Public Utility Act rate increases. P
SB 1168 Mandatory connection to water and sewage systems in certain counties. P
SB 1193 Regulation of stormwater. P
SB 1307 State Corporation Commission regulation of sewer utilities. P
SJ 352 Study; alternative water sources. F
SJ 381 Study; desalinization. P

Waters of the State, Ports and Harbors

HB 1451 Staunton State Scenic River. P
HB 1463 Economic development; Virginia Maritime Investment Act. F
HB 1476 Rudee Inlet Authority. P
HB 1505 Emergency water supply permit. P
HB 1525 Waterway "pass-through" zones; local ordinances; penalties. P
HB 1748 Virginia Water Facilities Revolving Fund; brownfields remediation. P
HB 2156 Water supply fund. P
HB 2236 Water quality reports. P
HB 2314 Erosion and Sediment Control Law. P
HB 2401 Comprehensive water supply plan. F
HB 2742 Herbert H. Bateman Advanced Shipbuilding and Carrier Integration Center. P
HB 2832 No discharge zone. F
HJ 550 Commending the United States Coast Guard Auxiliary. P
HJ 633 Study; collection of rents and royalties. P
SB 781 Regulation of outdoor lighting near public waterways. F
SB 896 Confined animal feeding operations. P
SB 1051 Water Facilities Revolving Fund. P
SB 1137 Transporting wastes on state waters. P
SB 1186 State water safety zones and restricted areas; penalty. P
SB 1221 Water supply planning. P
SB 1349 Environmental permit fees. F

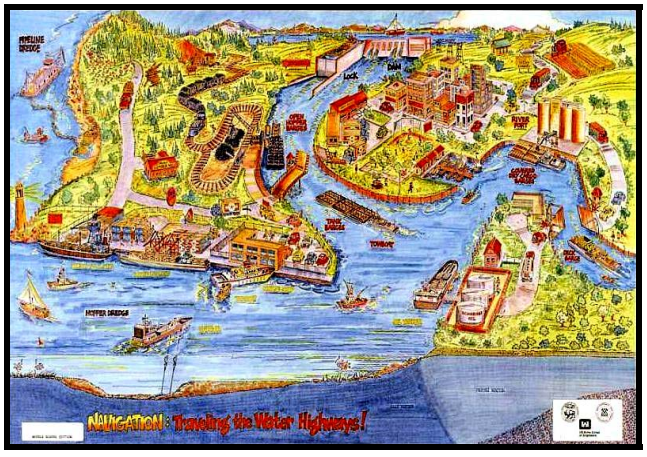
—By Alan Raflo

Water Central thanks Heidi Clark, undergraduate research assistant at the Water Center, for her assistance with this article.

TEACHING WATER
Especially for Virginia's K-12 teachers

USGS Water Education Posters

The U.S. Geological Survey (USGS) offers six water education posters on groundwater, navigation, wastewater, water quality, water use, and wetlands (a copy of the navigation poster is shown below). Posters are available in color or black and white. The reverse sides of the color posters contain educational activities: one version for grades 3—5 and another version grades 6—8. The black-and-white posters allow for coloring (grades K—5). For more information or to order, phone toll-free (888) ASK-USGS; or visit water.usgs.gov/outreach/OutReach.html.



This Issue and the Virginia Standards of Learning

Below are suggested Virginia Standards of Learning (SOLs) supported by this issue's Feature Article (pp. 1—12) and Science Behind the News Article (pp. 13—21). Abbreviations: BIO=biology; LS=life science.

Feature Article—General Assembly Water-related Legislation
Social Studies SOLs: 7.2, 7.4, 12.8.

Science Article—Mosquitoes
Science SOLs: 4.5, 4.8, 6.8, LS.4, LS.7, LS.9, BIO.2, BIO.5.
Social Studies SOL: 10.13.

SCIENCE BEHIND THE NEWS

Mosquitoes and Water

Loudoun County Mosquitoes Test Positive for Malaria—Associated Press, 9/30/02.
Dead Birds at MCV are Tested; West Nile Virus Raises Concern for Human Ills—*Richmond Times-Dispatch*, 10/8/02.

In late summer and early fall of 2002, mosquitoes were frequently in the news. The main story was the spread of West Nile Virus, a **pathogen** (a disease-causing organism) that can be transmitted by certain species of mosquitoes. Starting in August 2002, the number of reported cases of the disease steadily increased, as did the number of states reporting cases. As of February 5, 2003, the Centers for Disease Control in Atlanta had recorded 4008 human cases of West Nile Virus in 39 states and the District of Columbia since August 2002, including 263 fatalities. In Virginia, 29 cases were reported during that time, with two deaths. Also unsettling were the September and October 2002 discoveries in Loudoun and Fairfax counties, respectively, of mosquitoes carrying the pathogen that causes malaria.

As spring approaches in Virginia, so does the mosquito season, as temperatures warm to the level mosquitoes need to become active. This "Science Behind the News" article aims to help you be better informed about and prepared for this inevitable natural cycle. The article describes how mosquitoes are connected to water resources, what Virginia localities do to control mosquitoes, and what citizens can do to reduce their potential for exposure to these always annoying and sometimes dangerous insects.

Life Cycles Tied to Water

A bit of scientific classification is necessary to make distinctions among the many kinds of mosquitoes, their habits, and their impacts.[2] Mosquitoes are, of course, insects, and they are grouped with other insects whose *adults have only two wings* in the insect **order** called Diptera ("di-" meaning two and "ptera" from the Greek word for wing). This order contains the insects known as the "true flies" (the word "mosquito" is the diminutive form of the Spanish and Portuguese word "mosca," meaning "fly.") Within this order, mosquitoes are classified as a separate **family**, Culicidae. The next major classification level under family is a **genus**, and within a given genus are one or more **species**; later we will focus on several mosquito genera (plural of genus) and species that are particularly important in Virginia.

Like many other familiar insects, mosquitoes undergo a life cycle known as

[2] About 3000 mosquito species occur worldwide, according to Robert Harwood and Maurice James, *Entomology in Human and Animal Health* (New York: Macmillan), p. 171.

complete metamorphosis, including **egg**, **larva** (plural "larvae"), **pupa** (plural "pupae") and **adult** stages.[3] *All mosquitoes require a water habitat for their larvae and pupae.* A recent book by a Virginia entomologist describes the variety of breeding habitats used by mosquitoes as follows:

> "Mosquito larvae can live in almost every type of still-water habitat [including natural habitats such as] woodland pools, marshes, swamps, ponds, lakes, and backwaters and pools of streams and rivers, [as well as human-created habitats such as] automobile tires and food and beverage containers."[4]

Other authors add this description of mosquitoes' habitat versatility:

> "Great swarms may be produced from practically all sorts of still water, fresh and brackish, foul or clear; water in tin cans, car and airplane tires, hoof prints, tree holes, deposits in leaf cups; [and] the margins of streams rivers, lakes, and water impoundments."[5]

Temporary habitats like water-filled containers can provide breeding habitat for mosquitoes because a *mosquito's life cycle is typically short*. In warm weather, the cycle runs from only a few days to two weeks, with usually 7 to 10 days a typical period (although it may span several months in some species and some circumstances). A short life cycle also makes possible several generations per year (as in most species).

Let's look more closely at the stages of the mosquito life cycle, beginning with the most familiar stage, the adults.

Adult. Using their brushy antennae to detect sound, male mosquitoes are attracted to females for mating by the sound of females' beating wings. In the mosquito species that are of most importance to humans—the species that bite humans and economically valuable animals—fertilized eggs require a protein found in blood to grow and develop properly.[6] Accordingly, females need a *blood meal before egg laying* (females eat nectar or plant juices for other activities) (Males do not have mouthparts adapted for blood feeding, so males do not bite.)

Two groups of mosquitoes—classified as **subfamilies**—have blood-feeding females. One is the Culicinae, containing most of the U.S. mosquito species and particularly the important genera *Aedes* and *Culex*. The other is the Anophelinae, containing in the United States only one, very important genus, *Anopheles*. In most species, the female feeds on blood of mammals or birds, but some species will select fish, amphibians, reptiles, or the larvae of other insects. Most species feed on animals other than humans, but some species do prefer humans.

The Next Time a Mosquito Lands on Your Arm…

…you might take a few seconds to see if you can determine its classification group. The two subfamilies of blood-feeding mosquitoes can be distinguished by the *adults' resting position.* Species in the Anopholinae group typically rest with their body and *proboscis* (the needle-like mouthpart used for piercing flesh and sucking blood) in nearly a straight line at an angle to the surface (somewhat the appearance of standing on its head). Species in the Culicinae group typically rest with their body parallel to the surface but the proboscis bent toward the surface. For a good illustration of this difference, see p. 267 of *A Field Guide to the Insects*, by Donald Borror and Richard White (Houghton Mifflin, 1970) or another general reference on mosquitoes.

Egg. Females lay eggs either singly or in groups (called "rafts") of up to several hundred. In some species, females lay their eggs either directly onto the surface or along the edges of pools or other quiet water. Other

[3] Butterflies and moths provide a familiar example of complete metamorphosis in insects, with larvae known as caterpillars and pupae of many species encased in a silken cocoon.

[4] J. Reese Voshell, Jr., *A Guide to Common Freshwater Invertebrates of North America* (Blacksburg, Va.: McDonald and Woodward, 2002), p. 415.

[5] Harwood and James, *Entomology in Human and Animal Health*, p. 169.

[6] In one subfamily of mosquitoes, the eggs do not require blood for development, so adult females feed only on flowers.

species, however, lay their eggs in various kinds of areas that will become covered by water *at some later time*, either from rainfall, tides, or flooding. (Some species, for example, lay their eggs in tree holes that will eventually fill with rainwater.) Some species in the genus *Aedes* lay eggs during summer and fall; the eggs remain under snow for the winter and hatch when melted snow provides suitable habitat for the larvae. The eggs of floodwater species do not necessarily hatch all at once. Although typically most will hatch with the first flooding, some remain until later submergences (with some species even taking as along as four years of intermittent flooding before hatching).

Eggs of some species can survive for months or even years; this requires that they be kept moist in some species, but other species have eggs that can survive for months even in dry conditions.[7]

Larva. Mosquito eggs hatch into larvae, known as "wrigglers" because of their active movement pattern. Larvae go through several periods, called **instars**, as they grow and prepare to enter the pupa stage. Larvae in the two blood-feeding subfamilies develop in about seven days (in Culicinae) or a bit longer (in Anophelinae), if conditions such as temperature and food supply are suitable. Larvae of other species, however, may take several months to develop.

Pupa. Ultimately a larva forms a pupa, a non-feeding stage. Mosquito pupae, compared to the pupae of some other kinds of insects (butterflies and moths, for example), are relatively active. When disturbed, mosquito pupae descend in a rolling fashion from the surface to deeper water, hence the name "tumblers." As with larvae, the length of the pupa stage varies among species from two days to about two weeks, but the typical duration is two to three days.

And Back to Adult. At the end of the pupa state, a new adult emerges. During normal summer activity, adult males live up to one week, females two to four weeks. While many species survive the winter in the egg stage, some species overwinter as adults.

Impacts of Mosquitoes

In the 1979 book *Entomology in Human and Animal Health*, authors Robert Harwood and Maurice James devote 65 out of 463 pages to mosquitoes, more space than to any other single group of insects. This was for good reason:

> "Mosquitoes are the most prominent of the numerous kinds of bloodsucking arthropods[8] that annoy man, other mammals, and birds…Losses resulting from lowered productivity of industries concentrating on outdoor activities are frequently considerable because of mosquito annoyance…These losses must be added to widespread suffering and death due to mosquitoes as vectors of pathogens causing disease."[9]

Mosquito annoyance is, of course, familiar to anyone who has been bitten, harassed by persistent whine, or driven from a recreation area. Less familiar, perhaps, are the many ways that these insects, when in great numbers, can annoy animals; examples include disruption of bird nesting, effects on migratory activities of reindeer and caribou, reduced weight gain in livestock, and reduced milk production by dairy cows.[10] The following quote about *Aedes nigromaculis*, a species found in the western and central United States, captures the essence of mosquito annoyance:

> "Swarms of these fierce daytime biters may bring recreational activities and normal behavior of livestock to a virtual standstill."[11]

---

[7] Eggs of *Aedes aegypti*, which transmits yellow fever, can survive up to a year under dry conditions, according to Harwood and James, *Entomology in Human and Animal Health*, p. 183

[8] Arthropods are a large group of animals, including insects, spiders, and crustaceans, which have in common these key features: no backbone (invertebrate), an external skeleton, and jointed limbs.

[9] Harwood and James, *Entomology in Human and Animal Health*, p. 169.

[10] Ibid.

[11] Ibid., p. 180.

The impacts of mosquitoes as annoying little creatures or as annoying huge swarms are considerable. But even more crucial is the role of mosquitoes as a disease **vector**, that is, as a route for the transmission of disease-causing organisms. We turn now to that unpleasant topic.

Mosquitoes and Disease

Several factors make mosquitoes highly effective vectors of human disease: they breed abundantly; they are easily infected by one or more pathogens; their bodies provide favorable conditions for pathogen development; they feed readily on humans; they invade human homes; and their normal life span allows time both for pathogens to develop and for the insects to feed on humans repeatedly.[12]

Mosquitoes are vectors of three general kinds of pathogens:

- single-celled animals (or Protozoa), particularly the four species of *Plasmodium* that cause **malaria**;
- immature forms of parasitic worms known as **filarial worms**, which cause serious diseases of the human lymph system; and
- viruses, including those that cause **yellow fever**, various types of **encephalitis**, **West Nile disease**, and many others.

Tropical areas of the world endure much more mosquito-transmitted disease than do more temperate areas. Malaria, yellow fever, and filarial worms remain serious problems for large parts of the world, but in the United States malaria appears only sporadically, while neither yellow fever nor filariasis occur here.[13] (Please see the accompanying box, "Malaria in Virginia.")

Malaria in Virginia, From Time to Time

To persist in an area, the single-celled *Plasmodium* organisms that cause malaria need a "reservoir"—that is, a host organism where populations of the parasite survive over time. In many parts of the world, infected monkeys, apes, and humans serve as reservoirs, but in North America the only significant reservoirs are 1) infected humans who have come from countries where malaria is endemic, or 2) *Anopheles* mosquitoes that have bitten such people. In the United States, most of the locally transmitted malaria cases involve the pathogen *Plasmodium vivax,* which can lie dormant in an infected person who shows no symptoms (an "asymptomatic carrier"). Because no symptoms arise, such a person may never realize they carry the pathogen and consequently never seek treatment to remove it. (Other malarial pathogens, such as *P. falciparum,* cause such severe illness that infected persons quickly seek treatment.) Mosquitoes that bite a carrier can then transmit the pathogen to other people who may then develop symptoms of the disease.

The two cases of malaria in Fairfax and Loudoun counties in fall 2002 were due to the same variety ("strain") of *P. vivax* from Latin America (the Centers for Disease Control used samples from both patients to compare the genetic "fingerprint" of the pathogens). Both patients frequented an area in a neighborhood that is heavily populated with immigrants from El Salvador (malaria occurs in the most southern parts of Mexico and many Central American countries, especially in rural areas). This particular neighborhood is adjacent to a creek, and drought conditions in summer and fall 2002 had dried this creek down to a series of stagnant pools that were breeding large numbers of *Anopheles quadrimaculatus*, a vector of malaria.

Source: David Gaines, Virginia Department of Health/Office of Epidemiology, February 26, 2003.

Other mosquito-borne diseases, however, especially the viral diseases, do cause problems in the continental United States. Mosquito-borne disease is due *primarily* (but not completely) to species within three mosquito genera: *Aedes*, *Anopheles*, and *Culex*. We offer some basic information about these mosquitoes here, and the next section

[12] Ibid., p. 197.

[13] For many years after European colonization, both malaria and yellow fever were serious problems in North America. As recently as the 1930s there were several million malarial cases in the continental United States. Yellow fever, transported to the Americas along with its mosquito vector (*Aedes aegypti*) in slave ships in the 1500s, affected large parts of this country until successful mosquito-eradication efforts were completed in the early 1900s.

will include information about particular species of importance in Virginia.[14]

•***Aedes.*** This genus contains about half of all North American mosquito species. Breeding areas for different species include salt marshes, floodplains, snowmelt, tree holes, water from irrigation, and containers and other human-generated habitats. Most species bite in the evening, but some bite during the day. *Aedes aegypti* is the carrier of yellow fever; several species transmit other viral diseases. Some species formerly classified in this genus, including important vectors in Virginia, are now classified in the genus *Ochlerotatus* (see Table 1 below).

•***Anopheles.*** The genus contains nearly 400 species worldwide but only about 15 species in North America. Breeding habitat varies considerably, even among species that are very similar physically. Different species transmit malaria in different regions: *Anopheles quadrimaculatus* in the eastern, central, and southern parts of the United States; *Anopheles freeborni* in the southwestern United States; and many other species in other parts of the world. The preferred breeding habitat for *Anopheles quadrimaculatus* includes clean, still water with some sunlight and some shade.

•***Culex.*** The genus contains the common House Mosquito, *Culex pipiens*, found worldwide and capable of transmitting encephalitis as well as other diseases, including dog heartworm. Females of this species will lay eggs in all kinds of still water and human-made containers; good breeding conditions can produce huge numbers.

Mosquitoes in Virginia: Important Virginia Species and Their Impacts

Of 166 North American species of mosquitoes, 55 species are currently known to occur in Virginia and 25 species occur commonly, according to the Virginia Mosquito Control Association. While almost all of Virginia's species have blood-feeding females, six species create particularly serious disease problems in the state. Table 1 lists these "Top Six" Virginia mosquito problems.

Found statewide, all six species carry one or more viral diseases, specifically West Nile disease, La Crosse encephalitis, and eastern equine encephalitis. Other species carry these diseases as well, but these six pose special problems. Three are daytime biters, which increases the chances of human interaction; one is particularly effective at increasing West Nile virus in bird populations; one is particularly effective at transmitting West Nile virus from birds to humans; and one is noteworthy because it is frequently found breeding in even the smallest containers, such as film canisters.

Table 1. "Top Six" Current Mosquito Vector Problems in Virginia.

Species	Diseases Transmitted	Special Problems
Aedes albopictus	West Nile Virus	Daytime biter
Aedes vexans	West Nile Virus, Eastern Equine Encephalitis	Daytime biter
Culex pipiens	West Nile Virus	Effective at amplifying virus in bird populations
Culex salinarius	West Nile Virus	Effective in movement of virus from birds to humans
Ochlerotatus japonicus (formerly *Aedes japonicus*)	West Nile Virus	Daytime biter
Ochlerotatus triseriatus (formerly *Aedes triseriatus*)	West Nile Virus, La Crosse Encephalitis	A common tree-hole breeder, and adept at breeding in small containers

Source: David Gaines, Virginia Department of Health/Office of Epidemiology, 2/20/03.

[14] The information about these genera comes mainly from Harwood and James, *Entomology in Human and Animal Health*, pp. 177—198.

Beneficial Aspects of Mosquitoes

While most mosquito larvae feed upon debris or microscopic organisms in water or sediments, some species (found in two genera, *Toxorhynchites* and *Psorophora*) eat other mosquito larvae. Other benefits include mosquito larvae serving as a food source for fish and other aquatic insects; adult mosquitoes being used for food by various birds and other insects, such as dragonflies; and adults helping to pollinate flowers in which they seek nectar. One might also make a case that mosquitoes' blood-feeding activity (and the resulting disease) has broad ecological or evolutionary importance—but that's a case for another day.

Mosquito Control

Large-scale mosquito control[15] has been the focus of extensive research resulting in comprehensive manuals on the subject. Three approaches are widely used: eliminate breeding areas by various environmental modifications; apply chemicals to water surfaces to kill larvae or pupae; or spray insecticides to kill adults. A less common approach is to use natural predators of mosquitoes, either by *adding a predator* like the Mosquitofish to a water body or by *modifying a habitat* to enhance native predators like birds or other insects. The accompanying box, "Wetlands and Mosquitoes," provides an example of this latter approach.

Control methods are most effective when adequate *monitoring* of mosquito populations occurs. Monitoring (or "surveillance") involves being aware of environmental conditions that affect mosquitoes and using sampling techniques to determine the presence and abundance of mosquito species.

Let's look now at some large-scale mosquito-control efforts in Virginia.

[15] Recognizing a worthy foe, professionals in mosquito control often refer to their field as mosquito *abatement*, an acknowledgment that actual "control" of mosquitoes is often not feasible.

Wetlands and Mosquitoes—Good, Bad, or It Depends?

One debate within the world of mosquito control concerns the impact of wetlands. In many cases in the past, people viewed marshes and other wetlands only as barriers to agriculture or development and as mosquito nurseries to boot. Since at least the 1980s, however, the beneficial ecological and water-quality aspects of wetlands have received widespread attention. In contrast to temporary mosquito-breeding habitats such as water-filled tires or containers, wetlands—while certainly providing breeding areas for mosquitoes—can at the same time provide habitat other than just still water, habitat that can support dragonflies, damselflies, and other insects that may prey upon mosquitoes.

Some communities have used enhancement of fairly large areas of marsh habitat to increase populations of mosquito predators. New Jersey uses a technique of Open Marsh Water Management, which seeks to eliminate breeding depressions and increase natural predators, without use of insecticides. One example from the Cape May Mosquito Extermination Commission: in 1969 the commission implemented the method on a 548-acre marsh, and 25 years later the marsh still had not needed maintenance, cleaning, or pesticides. Use of this method saved the locality an estimated $669,000 over the 25 years.

Source: Indiana Department of Natural Resources, "Did You Know?…Healthy Wetlands Devour Mosquitoes," fact sheet located at www.in.gov/dnr/fishwild/publications/inwetcon/hlywet.pdf, 2/21/03.

For more on mosquito-control practices using wetlands in New Jersey, please see *BMPs for Mosquito Control and Freshwater Wetlands Management*, New Jersey Office of Mosquito Control Coordination, P. O. Box 400, Trenton, NJ 08625-0400; (609) 292-3649.

Mosquito-control Efforts in Virginia

David Gaines, in the Virginia Department of Health's Office of Epidemiology, coordinates a program to inform Virginia localities about mosquito issues and appropriate control approaches. Below, Mr. Gaines summarizes large-scale mosquito-control efforts in Virginia. His comments cover the local responsibility for mosquito control in Virginia, his program's

educational efforts, typical control practices in Virginia, and an example of a less-typical control practice being tried in the state.

On local responsibility: The *Code of Virginia* requires that all mosquito control be funded and managed as a part of local government. No state funds support mosquito surveillance or control and currently no federal funds are available for control. Most control programs in the state are mosquito-control districts run by local mosquito-control commissions. There are also a number of programs run by county or city public works programs and a few programs run by county or city health departments.[16]

On the state-level program: The VDH Office of Epidemiology's program focuses on promoting surveillance for mosquito-borne viral diseases and mosquito-control programs to health departments or local governments statewide. The program's entire budget comes from a grant from the Centers for Disease Control for West Nile virus surveillance and public education. The VDH's promotion campaign has mostly consisted of regional presentations for government officials on West Nile virus, mosquito biology, mosquito surveillance, and the technical and material requirements for implementing a mosquito-control program.

The VDH's efforts stress the need for surveillance: local governments need a surveillance program to identify and quantify their local mosquito problem areas before they can plan and invest in a control program. After that, the surveillance program should provide a way of appropriately targeting control measures.[17]

On typical mosquito-control practices: Most mosquito-control efforts in Virginia consist of drainage maintenance (using ditching), larviciding (applying pesticides to water to kill larvae), and fogging (using air-borne pesticides to kill adults), listed from first to last in order of effort and budget. These few established programs are all located in Tidewater where ditches are an important part of floodwater management. Several new programs have begun in northern Virginia and in the Richmond area; these programs mainly use larvicides targeted at stormwater systems.

On other control approaches used in Virginia: Recently, the York County Mosquito Control Program started a Mosquitofish (*Gambusia affinis*) hatchery to produce fish for use in their program. The state Department of Game and Inland Fisheries (DGIF) imposes restrictions on the use of Mosquitofish, including requiring that Mosquitofish not be stocked in water bodies that provide habitat for game fish.[18] Counties that want to use Mosquitofish must first provide DGIF with a list of the locations where they plan to use the fish. After review of the proposed sites, DGIF decides whether or not to issue a use permit to that county. The VDH Office of Epidemiology considers Mosquitofish an appropriate option in places such as stormwater management ponds, backyard ornamental pools, and animal watering troughs.

---

[16] Chesapeake, Hampton, Newport News, Norfolk, Portsmouth, Suffolk, Virginia Beach, and York all have full-time mosquito-control programs with surveillance, control, and public education. The following localities have part-time programs: Arlington, Buena Vista, Chesterfield, Chincoteague, Emporia, Gloucester, Henrico, Lexington, Prince William, Richmond City, and Williamsburg have a part-time program. Alexandria, Loudoun, and Fairfax County use a contract system.

[17] In Virginia localities with formal mosquito programs, surveillance activities include the use of traps that catch females seeking a place to lay eggs, light traps baited with carbon dioxide for monitoring adults, dip sampling into water for monitoring larvae, and monitoring of landing rates on humans (the latter technique is not widely used).

[18] Restrictions are placed on the use of the Mosquitofish because of the potential for populations of this fish to increase or to spread to other locations and displace other species (particularly game species).

Reducing Your Exposure to Mosquitoes

In Virginia, mosquitoes are active generally from March to November, that is, when daytime temperatures are consistently above 50 degrees F (depending on one's location within the state). During that time, a variety of actions can help you reduce your exposure to mosquitoes. Such actions are generally of two kinds: 1) those to help prevent bites from existing mosquitoes; and 2) those to help reduce mosquitoes' breeding areas (based on the aquatic life of mosquito larvae and pupae).

The following list compiles the main mosquito-avoidance recommendations from the following sources: the federal Centers for Disease Control (CDC) Web-site at www.cdc.gov/ncidod/dvbid/westnile/qa/prevention.htm;
the Virginia Mosquito Control Association Web-site at www.mosquito-va.org; and
the Virginia Department of Health Web-site at www.vdh.state.va.us/epi/wnv.htm (all as of February 20, 2003).

1. Protecting Oneself from Mosquito Bites

- Install or repair window and door screens.
- If possible, avoid outdoor activity at dawn and dusk—the times when mosquitoes bite most actively.
- If possible, wear a long-sleeved shirt and long pants when outdoors.
- Wear light-colored, loose-fitting clothing—mosquitoes are attracted to dark objects and can more easily reach your skin through tight clothing.
- When outdoors with an infant in a high-mosquito area or at peak biting times, place mosquito netting over the infant's carrier.
- If you use a mosquito repellent (or *any* insecticide), read and follow the manufacturer's *directions for use*, printed on the product.
- Apply *sparingly* to exposed skin an insect repellent containing the compound DEET. Adults should use a product with 20—30 percent DEET; children, one with less than 10 percent DEET. The CDC notes that a higher percentage of DEET in a repellent increases the length but not the degree of protection (and concentrations higher than 50 percent do not increase the length of protection).
- *Do not* use a DEET-containing product if you are pregnant, nor on infants.
- *Do not* apply repellent near eyes or mouth, nor to children's hands (as they may apply it to their eyes or mouth).
- With repellents in a spray container, *do not* spray repellent to the face. Spray on hands, then apply to face.
- *Do not* apply an insect repellent over cuts or other open wounds, nor on sunburned or otherwise irritated skin.
- Spray clothes with a repellent containing either permethrin or DEET. *Do not* apply a repellent containing *permethrin* to exposed skin. If you spray clothing, it is not necessary to spray repellent containing DEET on the skin under the clothing.
- After your outdoor activity, wash off insect repellent.

Reducing Mosquito-Breeding Areas

- Remove unneeded outdoor items that can collect water, such as old tires and plastic containers.
- Drill holes in tires being used for playground equipment.
- Store bottles and other containers being saved for recycling in a covered trash can or sealed bag.
- Cover garbage cans.
- Once or twice a week, empty outdoor items that can collect water: plant pots, pet food and water dishes, birdbaths, wading pools, swimming pool covers, buckets, barrels, cans, wheelbarrows, toys, boats.
- Adjust tarps over firewood, grills, boats, swimming pools, straw, or other items to prevent pooling of water. If it is not possible to prevent pooling, remove the water once or twice a week.
- Check for water-holding items under your house, in shrubbery, or in other hard-to-see places.
- Clean out rain gutters clogged with debris.
- Keep swimming pools clean and chlorinated.
- Remove standing water that may collect on a flat roof.

No Mosquitoes in the Air Without Water on the Ground

A film named "Kudzu," produced in the 1970s in South Carolina, includes a man speaking a memorable line about the three things he hates: "Kudzu, skeeters, and city livin'." Many people love city life, and not everyone is familiar with the woes of the invasive plant Kudzu, but few would disagree with putting "skeeters"—mosquitoes, that is—on their "I hate" list. As we have seen, the summertime annoyance most Virginians experience from a few kinds of mosquitoes is but a sample of the disturbance and disease that dozens of species cause worldwide.

We'll never like mosquitoes, but we'll probably always have to live with them. Mosquitoes are unavoidable wherever there is still water and warm temperatures, and control practices can eradicate mosquitoes only in limited areas.

Faced with such a prolific and persistent pest, we have the powerful tool of knowing what kinds of aquatic habitats mosquitoes use for breeding and how residential practices affect the supply of mosquito-breeding areas. Water-collecting items filled by warm-season rains make lovely nurseries for mosquito larvae; emptying such items within a few days will help send the "skeeters" elsewhere.

References and Further Reading

Print References

Borror, Donald J. and Richard E. White. *A Field Guide to the Insects* (Peterson Field Guide Series), Boston: Houghton Mifflin, 1970.

Evans, Howard E. *Life on a Little-known Planet*. New York: Dell, 1968.

Fichter, George S. *Insect Pests*. Racine, Wisc.: Golden Press/Western, 1966.

Harwood, Robert F. and Maurice T. James. *Entomology in Human and Animal Health*. 7th ed. New York: Macmillan, 1979.

Merritt, Richard W. and Kenneth W. Cummins. *An Introduction to the Aquatic Insects of North America*. 2nd ed. Dubuque, Ia.: Kendall/Hunt, 1984.

Voshell, J. Reese, Jr. *A Guide to Common Freshwater Invertebrates of North America*. Blacksburg, Va.: McDonald and Woodward, 2002.

Useful Organizations

Centers for Disease Control/National Center for Infectious Diseases. "Mosquito-borne Diseases" is available at www.cdc.gov/ncidod/diseases/list_mosquitoborne.htm. To request information by phone from the CDC, call (toll-free) (800) 311-3435.

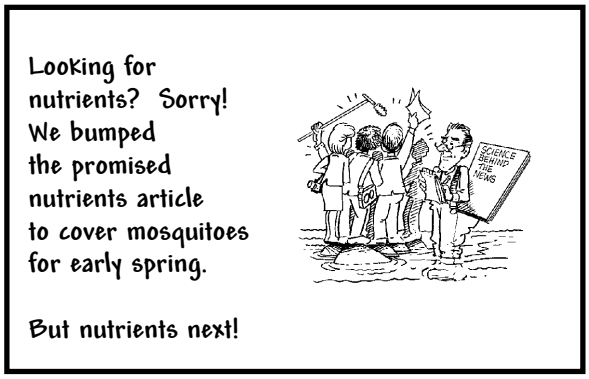
Virginia Cooperative Extension. For general information about mosquitoes and more detailed information available through Virginia Tech, contact the local Cooperative Extension office, listed your local phone book.

Virginia Department of Health. The West Nile Web-site, www.vdh.state.va.us/epi/wnv.htm, includes a colorful poster that highlights potential mosquito-breeding places around a house. The phone number for the Office of Epidemiology in Richmond is (804) 786-6261; e-mail: epi-comments@vdh.state.va.us. For general information about mosquitoes in any Virginia locality, contact the local Health Department office, listed in your local phone book.

Virginia Mosquito Control Association. This nonprofit organization is dedicated to the control of mosquitoes and prevention of mosquito-borne diseases. The Association's Web-site, www.mosquito-va.org, includes information about mosquito-borne diseases and control practices; common mosquitoes in Virginia with illustrations and basic facts; links to mosqutio-control groups in other states; and the organization's newsletter, *Skeeter*. The Association is available by phone at (757) 382-3450 (Chesapeake Mosquito Control).

—By Alan Raflo and Eric Day

Eric Day manages the Insect ID Lab for the Department of Entomology at Virginia Tech. Water Central thanks David Gaines, Virginia Department of Health, for his assistance.



MORE SCIENCE!

Forest Reference Stream Monitoring and Research

[Editor's note: Creek, brook, run, draft, river—the different names for streams reflect the great variety found among flowing bodies of water. In the following, Sam Austin, a forest hydrologist with the Virginia Department of Forestry, describes his research to classify the variety of conditions found in Virginia streams.]

Forest **reference streams** provide a benchmark or "reference point" describing stream conditions within their normal range of values. Because forest reference streams are streams in their natural or nearly natural state, they exhibit few of the effects caused by human activities such as road building, timbering, or development.

The Virginia Department of Forestry (DOF) has developed a network of continuously monitored reference streams in protected watersheds with naturally occurring older forests. Data collected at these sites help identify the conditions one would expect in undisturbed freshwater streams in Virginia. The reference streams provide clues to the natural range of physical, chemical, and biological features in Virginia streams. Information about natural stream conditions can help in water-resource management decisions, including the following:

- development of Best Management Practices;
- plans for stream and watershed restoration.
- development of Total Maximum Daily Loads (TMDLs) for impaired waters; and
- development of instream flow criteria.

Data Collection

DOF is currently monitoring five sites in Virginia. Two additional sites are planned for 2003. At each site, we collect data on stream **geomorphology** (the size, pattern, and gradient of the stream), streambed sediments, water flow, water quality (a sample collected automatically every 30 minutes), and stream organisms.

Sam Austin examines data-collection equipment at a stream in the Appomattox-Buckingham State Forest.

This probe contains sensors for continuous monitoring of water quality and depth.

Data Placed In Context

The reference streams exhibit natural variation in landscapes and water flow patterns. To help make sense of this natural variation, we use the **Rosgen System of stream classification**. The Rosgen System identifies seven classes and six subclasses of streams based on the streambed and floodplain form and on the streambed sediment size. Just as species names help us identify and compare plants or animals, Rosgen stream types help us identify and compare streams. Applying the Rosgen classification allows us more accurately to compare the data from the reference streams to other Virginia streams with the same Rosgen classification.

Data Availability

Data are being made available on the DOF Web-site, state.vipnet.org/dof/. A booklet containing reference data for major Rosgen stream types in Virginia will be printed in 2004. For more information contact Sam Austin, (434) 977-6555, austins@dof.state.va.us. DOF hopes to continue to promote the collection and productive use of data describing these natural stream systems.

IN AND *OUT OF* THE NEWS
Newsworthy Items You May Have Missed

The following summaries are based on information in the source(s) indicated in parentheses, usually at the end of each item. Selection of this issue's items ended February 28, 2003. Unless otherwise noted, all localities mentioned are in Virginia and all dates are in the year 2003.

Weather News

•**No longer dry in Virginia:** The Virginia Drought Monitoring Task Force's Web-site (www.deq.state.va.us/info/drought.html) has had no new Drought Status Reports since November 16, 2002. As of February 25, the U.S. Drought Monitor map (www.drought.unl.edu/dm/monitor/html) showed **no areas of drought in Virginia**. Many western and midwestern states , however, were still experiencing drought conditions ranging from "abnormally dry" (least severe) to "exceptional drought" (most severe). The driest conditions were in southwestern and Rocky Mountain states. Parts of Georgia, North Carolina, and South Carolina remained abnormally dry.

•**But cold in January:** Virginia Beach's Back Bay became almost completely ice-covered for the first time in residents' memory (*Virginian-Pilot*, 1/29/03). In late January, ice in the upper Chesapeake Bay prevented normal boat traffic to Virginia's Tangier Island; after residents had been frozen in for a week, a Coast Guard cutter cleared a path for a ferry to bring supplies to the island on January 28 (*Roanoke Times*, 1/29/03).

On January 31, Governor Warner declared a **state of emergency for Buchanan and Tazewell counties**, as the two far southwestern Virginia localities were having water shortages after **cold weather cracked water lines**. The Virginia Department of Emergency Management provided bottled water to residents and tanker trucks to refill storage tanks. Volunteer firefighters, the National Guard, and private carriers were all involved in hauling water. On February 20, the Virginia Coalfield Development Authority approved a $1.3 million emergency loan to Buchanan County for a new well and water-treatment project. (Governor's press release, 1/31/03; *Richlands News-Press*, 2/5/03; *Roanoke Times*, 2/22/03)

•**And wet in February:** Virginia received **damaging snow and rain in February**. The February 15—17 winter storm brought snowfall ranging from three inches in Williamsburg to 35 inches in Warren County; the storm produced heavy rain in southwestern Virginia, causing local flood emergencies in Buchanan, Dickenson, Tazewell, and Wise counties (*Richmond Times-Dispatch*, 2/18/03). Heavy rain the following weekend caused moderate flooding, with the most serious impacts again in southwestern Virginia, where two deaths occurred (*Roanoke Times*, 2/24/03; *Richmond Times-Dispatch*, 2/25/03). U.S. Representative Richard Boucher (D-9th Va.) was to meet in late February with the Army Corps of Engineers to discuss flooding problems in the southwestern Virginia region. (*Smyth County News & Messenger*, 2/27/03) On February 26, the Department of Health banned shellfishing on 44 miles of the James and Rappahannock rivers, due to high bacteria counts resulting from runoff; such a ban last occurred in 1998. Restrictions were to remain in place until two consecutive daily samples showed acceptable bacterial levels. (*Virginian-Pilot*, 2/28/03)

Other News in Virginia…

•On December 17, 2002, the 93-mile "Patriot Extension**" gas pipeline in south-central Virginia** received approval from the Virginia Marine Resources Commission (VMRC). After the Federal Energy Regulatory Commission had approved the project in November, the VMRC actually had no authority *not* to approve the project, to be built by East Tennessee Natural Gas, a subsidiary of Duke Energy. VMRC did have authority to impose conditions, however, and it placed nine conditions regarding the timing and methods of crossing streams and rivers, including the plan for going under the New River. (*Roanoke Times*, 12/18/02) (For a previous item, please see the Dec. 2002 *Water Central*, p. 16.)

•A recent study by the Chesapeake Bay Commission estimates that it will cost over **$19 billion through 2010 to meet the goals of the Chesapeake 2000 agreement**. The largest expense is $10.9 billion to accomplish nutrient and sediment reductions needed to meet water-quality goals. The study estimated costs for Virginia at $6.1 billion, Maryland $6.5 billion, and

Pennsylvania, $6.4 billion; current state and federal funding levels would generate only an estimated $6.1 billion. (*Bay Journal*, Dec. 2002) (For other estimates of Bay Agreement costs, please see the Feb. 2002 *Water Central*, p. 12).

•Due to chronic diseases made worse by drought, the 2002—2003 **Chesapeake Bay oyster harvest will be one of the smallest since the late 1800s**. In December 2002, Maryland biologists predicted that state's harvest would be lower than current low-harvest record (79,618 bushels in 1993—94), and Virginia officials predicted a harvest of around 20,000 bushels, typical for the past few years. In the 1950s and 1960s, annual harvests were 3—6 million bushels per year. (*Bay Journal*, Dec. 2002)

Faced with such low harvests, the Virginia Marine Resources Commission on February 25 approved **a proposal by the Virginia Seafood Council to raise one million Asian Suminoe Oysters**, a native of China, at eight hatchery sites in the Bay and two in the Atlantic. The Council's plan calls for using only oysters genetically modified to be incapable of reproducing, so as to reduce the currently unknown risks of the non-native species establishing a breeding population in the Bay. A report is due in June 2003 from the National Academy of Science on the use of the Asian Oyster in the Bay. (*Baltimore Sun*, 2/25/03) (For more on this issue, please see the Oct. 2002 *Water Central*, p. 18)

•A **groundwater-recharge study for southern Frederick County** began in early February. Thomas Burbey, a professor of geological sciences at Virginia Tech, is leading the study, which is being done for the Frederick County Sanitation Authority. (*Winchester Star*, 1/29/03)

•The **National Wildlife Refuge System turned 100 years old** on March 13, 2003. Beginning with Pelican Island off the coast of Florida in 1903, the system of federal lands dedicated to wildlife now includes over 93 million acres in 575 refuges and wetland management districts. About 98 percent of these lands are available for public education and recreation, including recreational hunting and fishing on over 50 percent of the lands. Refuges in Virginia are Back Bay NWR, Virginia Beach; Chincoteague NWR, Chincoteague; Eastern Shore of Virginia NWR, Cape Charles; Great Dismal Swamp, Suffolk; Occoquan Bay NWR, Woodbridge; Presquile/James River NWR, Prince George; Potomac River NWR Complex, Woodbridge; and Rappahannock River NWR Complex, Prince George. For more information, including a copy of the Refuge System Guide, phone (800) 344-9453 or visit the Web-site at refuges.fws.gov/. (*Bay Journal*, Jan.-Feb. 2003)

•In January, **the Nature Conservancy of Virginia offered for sale a 2,900-acre, forested mountain tract** along the border between Montgomery and Roanoke counties. Aiming to preserve water quality on the tract, which lies within the Roanoke River Basin, the group is seeking a buyer that will place a conservation easement on the land. The organization is asking $2.5 million for the land. (*Roanoke Times*, 1/31/03)

•On February 24, the State Water Control Board issued a **proposed regulation for wastewater reclamation and reuse** (9VAC 25-740). The public comment period runs until April 25. For more information, contact Lily Choi, Va. Dept. of Environmental Quality, P. O. Box 10009, Richmond 23240-0009; (804) 698-4054; e-mail: ychoi@deq.state.va.us. (Va. DEQ public notice, 2/24/03)

…and Outside of Virginia

•On December 15, 2002, U.S. EPA Administrator Christine Whitman signed a final rule addressing **water-quality impacts from concentrated animal feeding operations** (the **CAFO** rule). The regulation requires that by 2006 about 11,000 additional large livestock operations (joining about 4,500 operations already regulated) must apply for a permit under the National Pollution Elimination Discharge System, submit an annual report, and follow a plan for managing manure and wastewater. Under the new rule, "large CAFOs" are defined as operations raising more than 1,000 cattle, 700 dairy cows, 2,500 swine, 10,000 sheep, 125,000 chickens, 82,000 laying hens, or 55,000 turkeys. The regulation's purpose is to reduce pollution of waterways by runoff of nutrients, pathogens, sediments, and metals from large CAFOs. Under the rule, states are given authority to determine the type of permits used and the provisions of nutrient-management plans, as well as to set performance standards to encourage use of new technologies. (EPA press release, 12/16/03. The text of the rule and extensive information are available at www.epa.gov/npdes/caforule.)

The rule will affect only about 10 percent of CAFO's, but those operations generate about 60 percent of livestock waste, according to the EPA. The EPA also estimates that the new rule will reduce nitrogen releases nationwide by over 100

million pounds annually and phosphorus releases by about 56 million pounds annually. The EPA estimates the new rule will cost $335 million per year, compared to the estimate of $840—$950 million under the rule as it was originally proposed in 2000. (*Bay Journal*, Jan.-Feb. 2003)

•In December 2002, President Bush signed the **Dam Safety and Security Act of 2002** (now Public Law 107-310), amending the National Dam Safety Program Act. The key provisions of the 2002 legislation are as follows:
**requires the Federal Emergency Management Agency (FEMA) to prepare a strategic plan for improving dam safety and cooperating with relevant state agencies;
**requires FEMA to establish the National Dam Safety Review Board, which will monitor state implementation of dam safety and advise the FEMA director on policy;
**requires FEMA to provide dam-safety training to states that request such assistance. (*Natural Hazards Observer*, Jan. 2003)

In Virginia, the Department of Conservation and Recreation administers the Dam Safety Program. Information about Virginia's program is available by phone (804) 371-6095, e-mail to dam@dcr.state.va.us, or on-line at www.dcr.state.va.us/sw/damsafty.htm.

•**Atlantic Coast lobster populations seem to be thriving** despite heavy fishing pressure. The annual catch has increased from 20 million pounds in the 1970s to about 50 million pounds currently. Scientists, fishery managers, and lobster fishers are seeking to understand why lobster populations have done well, while fishing pressure has significantly impacted populations of other heavily harvested North Atlantic species, such as haddock and cod. Lobster fishers claim that an important factory has been their conservation practice of marking breeding females with a tail notch and then throwing back marked females caught again later. Oceanographers, meanwhile, are investigating the importance of where ocean currents deposit newly hatched lobster larvae; subtle current changes might be a big factor in whether or not larvae reach suitable nursery habitat. (*Christian Science Monitor*, 1/9/03)

•The **EPA's Office of Water** has stated that its **regulatory priorities for 2003** are cooling-water intakes, industrial and municipal wastewater pollution, concentrated animal feeding operations, the Total Maximum Daily Load (TMDL) program, Clean Water Act jurisdiction, and drinking water. Specific water regulatory action expected from EPA in 2003 includes the following:
Possibly issuing the so-called "watershed rule," a regulation to change the existing impaired waters and **TMDL program.
Proposal of a **sanitary sewer overflow rule, a set of regulations designed to reduce wet-weather sewage spills;
Release of a National Pollution Discharge Elimination System regulation on wastewater treatment systems' **use of "blending" (mixing fully treated and partially treated sewage when wet weather threatens to exceed a systems storage or treatment capacity);
Release of **effluent-limitation guidelines for several industries—including meat and poultry, construction and development, aquaculture, and metals and machinery—as part of the requirements of a 1992 consent decree with the Natural Resources Defense Council (the decree ends in June 2004);
Release of a rule on limits of **dioxin and dioxin-like substances in **sewage sludge** (due by court order by October 17, 2003);
Revision, following criticism by the Office of Management and Budget, of a proposed rule addressing construction and operation of **cooling-water intakes at power plants;
Efforts to simplify regulations governing **pretreatment of industrial discharges to sewage systems (promulgation of new regulations expected in December 2004);
Promulgation of a regulation addressing **radon in drinking water (first proposed in 1991 and expected by December 2003);
Continued development of regulations addressing the potential for **fecal contamination of groundwater-based drinking water;
Continued development of "Stage 2" of regulations addressing **disinfection by-products in drinking-water;
Continued development of the Long Term 2 Enhanced **Surface Treatment Rule, addressing the potential for microbial contamination of surface-water-based drinking water; and
Completion of a **review of national drinking-water regulations (required every six years by the Safe Drinking Water Act). A preliminary finding was to consider changing only the existing total-coliform rule. (*Inside EPA's Water Policy Report*, 1/13/03; EPA Web-site at www.epa.gov/epahome/rules.html#proposed, 1/28/03)

(The Feb. 2002 *Water Central*, p. 12, has a list of the water-regulatory actions that were expected in 2002.)

•On January 13, U.S. EPA Administrator Christine Whitman announced the proposed **National Water Quality Trading Policy**. Proposed for implementation over the next year or two, the policy would allow industrial, agricultural, and wastewater dischargers regulated under the Clean Water Act to purchase credits from dischargers in the same watershed who are performing *better* than water-quality standards require. The credits would count toward the purchasing dischargers' overall regulatory compliance. The program is based on principles similar to the air-pollution credit trading system already operating under the Clean Air Act. (*Washington Post*, 1/13/03)

•Two bills to provide **federal funding for water and wastewater infrastructure** were introduced in Congress in January. On January 7, U.S. Rep. Sue Kelly (R-New York) introduced H.R. 20, which would authorize $25 billion over five years for state water-pollution control revolving funds and grants to wastewater systems in financially distressed communities; as of January 28, the bill was in the House Committee on Transportation and Infrastructure. On January 15, Sen. George Voinovich (R-Ohio) introduced S. 170, which would authorize $15 billion over five years for the Clean Water State Revolving Fund; as of January 29, the bill was in the Senate Environment and Public Works Committee. Also in January, a coalition of four state associations was drafting a bill to provide funds to state revolving funds for drinking water and wastewater. (*Inside EPA's Water Policy Report*, 1/13 and 1/2703; and Thomas Legislative Information, thomas.loc.gov/, 1/29/03.)

•The state of **Nebraska's lawsuit challenging the constitutionality of the federal Safe Drinking Water Act** is proceeding in the U.S. Court of Appeals for the District of Columbia Circuit. Nebraska's suit targets specifically the EPA's regulation of **arsenic in drinking water**, following EPA's October 2001 regulation setting a 10 parts per billion (ppb) limit for arsenic (lowered from 50 ppb). Many small drinking-water systems in the state depend on groundwater with relatively high arsenic levels. Nebraska is arguing that regulation of a *non-contagious* contaminant in *intrastate* waters exceeds Congress' authority constitutional authority to regulate interstate commerce (Article I, Section 8); that the SDWA itself intrudes upon a traditional state function, thereby violating the Tenth Amendment; and that public notification requirements of the arsenic rule violate water systems' First Amendment rights. The Department of Justice and the EPA are defending the case, which is *Nebraska, et al. v. EPA*. (*Inside EPA's Water Policy Report*, 1/27/03)

•The American Mosquito Control Association (AMCA) and other residential pesticide applicators are seeking **clarification of, and possible exemption from**, a November 2002 U.S. Court of Appeals that **spraying of pesticides** directly onto a water body **constitutes a point source of pollution**, subject to regulation under the Clean Water Act. On January 16, AMCA petitioned the EPA to craft a regulation that exempts pesticide application from being considered a pollutant discharge, as long as the pesticide is *registered* under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and its *application complies* with label instructions required by FIFRA. (*Inside EPA's Water Policy Report*, 1/27/03.)

•On January 29, the **U.S. Court of Appeals** for the 4th Circuit (located in Richmond) **reversed a May 2002 ruling** by U.S. District Judge Charles Haden in West Virginia that had prohibited any new federal permits for the practice of placing waste rock and dirt from mining operations into stream channels—a practice referred to as "**valley fills**." Haden's ruling, in a lawsuit brought by Kentuckians for the Commonwealth, had blocked the U.S. Army Corps of Engineers from issuing new permits for the practice. The appeals court's 55-page decision ruled that the Corps and the U.S. EPA, in issuing a valley-fill permit to the Martin County Coal Corporation, acted within their authority under the Clean Water Act. (*Washington Post*, 1/31/03) (For a previous item, please see the Dec. 1999 *Water Central*, p. 8.)

Closing Note

"The best news to hit the [Roanoke] valley since Elvis was given the key to the city." So said Gary Robertson, Roanoke County's utilities director, about the announcement on February 27 that his county and the City of Roanoke are creating a joint water and sewer authority. Under the authority, the two localities will share assets, debts, and customer bases, and they will gradually equalize their rates. July 2004 is the target date for the authority to be operating. (*Roanoke Times*, 2/28/03)

—By Alan Raflo

N O T I C E S

On the DEQ Public Calendar

The Va. Dept. of Environmental Quality's "Public Calendar" is located at www.deq.state.va.us/info/. The phone number for the DEQ's Central Office in Richmond is (800) 592-5482 (toll-free in Virginia).

•**March 27**— Public meeting on TMDL for Toms Brook, Shenandoah County. Fire Department in Toms Brook, 7 p.m. For more information, contact Sandra Mueller, e-mail: stmueller@deq.state.va.us, or by phone at the number listed above.
•**March 27**—Drought Response Technical Advisory Committee meeting. DEQ Piedmont Regional Office, Richmond. For more information, contact Scott Kudlas, e-mail: swkudlas@deq.state.va.us, or by phone at the number listed above.
• **March 27**— Public meeting on TMDL for Upper and Lower Opequon creeks, Frederick County. Shenandoah Univ., Winchester, 7 p.m. For more information, contact Sandra Mueller, e-mail: stmueller@deq.state.va.us, or by phone at the number listed above.

Watershed Workshops

The Virginia Tech Institute for Innovative Governance and Virginia Cooperative Extension will conduct a series of workshops in April and May on Community Watershed Management and Planning. The first three workshops are directed to state and federal agency personnel. The next six workshops are directed to citizens, local officials, watershed organization persons, and Extension agents. Dates and locations: 4/15, Richmond; 4/22, Harrisonburg; 4/24, Abingdon; 5/6, Manassas; 5/7, Richmond; 5/8, Lynchburg; 5/13, Harrisonburg; 5/15, Abingdon; 5/22, Hampton Roads. For more information: Waldon Kerns, (540) 231-5995, e-mail: kerns@vt.edu.

Shenandoah River Basin Grants

The Shenandoah Basin Project (SBP) is a multi-year effort to help community watershed organizations increase their capacity and improve their watersheds. A collaborative partnership of several groups, the SBP offers technical assistance and grants up to $3,500 per project category (organizational capacity building, education and outreach, water-quality monitoring, and riparian restoration). In addition, Shenandoah Valley Pure Water Forum 2000 offers grants of $200 to $2,500 for practices, environmental education, or citizen-involvement activities designed to reduce water pollution. For more information about either grant program, contact Bruce Lundeen, Watershed Coordinator, (540) 568-8793, e-mail: pw2000@jmu.edu, or visit the Web-site at www.cisat.jmu.edu/purewater.

Recording Virginia's Biodiversity

At the 2003 Virginia **"BioBlitz"** on May 17—18 at Douthat State Park in Bath County, volunteers will gather to count as many species as possible during a 30-hour period (9 a.m. Saturday to 3 p.m. Sunday). To volunteer or for more information, contact Art Evans at (804) 264-0488, e-mail: arthurevans@earthlink.net.

To the Boats!

The Alliance for the Chesapeake plans four **river sojourns**—week-long educational paddling trips—for this summer. The rivers, dates, and contacts are as follows:
Susquehanna: June 8—15, Brook Lenker, (717) 737-8622, or e-mail: Blenker@acb-online.org.
Potomac: June 14—21, Jamie Alberti, (202) 466-4633, or e-mail: Jalberti@acb-online.org.
Patuxent: June 22—29, Jamie Alberti, (202) 466-4633, or e-mail: Jalberti@acb-online.org.
James: June 22—29, Hadley Milliken, (804) 775-0951, or e-mail: Hmilliken@acb-online.org.

Water Infrastructure Security

The December 2002 issue of *Texas Water Resources*, the Texas Water Resources Institute's quarterly newsletter, focuses on security at water and wastewater facilities. For a copy of the newsletter, contact the institute at (979) 845-1851; e-mail: twri@tamu.edu; or Web-site: twri.tamu.edu. The newsletter listed the following Internet resources for information:
•The U.S. EPA provides extensive information at www.epa.gov/safewater/security.
•The April 2002 EPA publication, "Guidance for Water Utility Response, Recovery, & Remediation Actions for Man-Made and/or Technological Emergencies" is available at www.epa.gov/safewater/security/er-guidance.pdf.
•The Vulnerability Self-Assessment Tool, a systematic approach for assessing risk to natural and human-caused disasters, is available free to water and wastewater utilities through this site: www.vsatusers.net.

Marina Site Suitability Tool

The Virginia Institute of Marine Science (VIMS) offers a new tool for evaluating the environmental suitability of shoreline areas for marinas. Color-coded maps indicate whether areas are "desirable," "desirable with limitations," or "undesirable," based on the Virginia Marine Resources Commission's Marina Siting Guidelines. The maps are available only on-line, at www.vims.edu/ccrm/marinasiting.htm.

Conferences and Other Gatherings

•**American Wetlands Conference.** May 1—4, 2003, Minneapolis; sponsored by the Izaak Walton League. For more information: League phone (800) 284-4952; Web-site www.iwla.org/sos/awm/conference.

•**Water Security in the 21st Century.** July 30—August 1, 2003, Washington, D.C. For more information: Margaret Skerly, Universities Council on Water Resources, (618) 536-7571, e-mail: mskerly@siu.edu.

•**Coastal Zone Management Through Time.** July 13—17, 2003, Baltimore; sponsored by the National Oceanic and Atmospheric Administration. For more information: Gale Peek, (843) 740-1231, e-mail Gale.Peek@noaa.gov; Web-site www.csc.noaa.gov/cz2003/.

At the Water Center

To reach the Water Center, phone (540) 231-5624; e-mail: water@vt.edu; or visit www.vwrrc.vt.edu.

New CD-ROM for Loan: "Urban Best Management Practices"

The Water Center has for loan a copy of this CD from the Lake Barcroft Watershed Improvement District in Fairfax County. Among the many topics covered are habitat, homeowner information, pollution removal, public policy, waterless street sweepers, and even "Godzilla" (a lake-dredging machine).

New Video for Loan: "A Journey in the History of Water"

The Water Center has for loan a copy of this video series (four 45-minute shows on two cassettes) exploring different themes related to the importance of water throughout the world and world history. The films, produced in 2001 by the Norwegian Broadcasting Corporation and University of Bergen, are well done and informative, covering an impressive range of locations and topics. The material is appropriate for upper high school, college, and adult audiences. Descriptions of the programs, sample video, and information about how to order a copy are available on-line at watervideo.com/video.htm.

New CD-ROM Series for Loan: "Watershed Leadership Kit, Vols. 1--3"

The Water Center has for loan a copy of these three CDs, developed in 1999 by the Center for Watershed Protection in Ellicott City, Md. The CDs contain PowerPoint™ presentations about water-quality preservation (the CDs will install PowerPoint if it is needed for the presentation). CD 1 is "Better Site Design," CD 2 is "Impacts of Urbanization," CD 3 is "Eight Tools of Watershed Protection." Each CD contains an interactive quiz. The programs are appropriate for adult students and citizens interested in its watersheds.

If you prefer to order the CDs ($25 each), contact the Center for Watershed Protection, (410) 461-8323, Web-site www.cwp.org.

Call for Papers: 2003 Virginia Water Research Symposium
October 8—10, 2003
Virginia Tech, Blacksburg, Virginia

The Water Center calls for basic and applied research papers in all areas related to water and the environment (natural sciences, policy, and socio-economic issues). Researchers at colleges and universities (faculty, graduate and undergraduate), federal and state agencies, private organizations, consulting firms, and other groups are invited to present papers and lead workshops.

The symposium will feature the following:
•Keynote presentations by prominent researchers and research administrators;
•Best Paper awards to one graduate and one undergraduate researcher;
•Workshops on research funding opportunities and other topics; and
•A tour of Virginia Tech water-research laboratories.

The deadline for paper submission and workshop proposals is April 30, 2003. For details: Jane Walker, (540) 231-4159, e-mail: janewalk@vt.edu; or Web-site www.vwrrc.vt.edu/2003symposium.

Water Central thanks Heidi Clark, undergraduate research assistant at the Water Center, for her assistance with this section.

Call for Funding Proposals and Award Applications for 2003

1. Competitive Grants—Request for Proposals

The Virginia Water Resources Research Center requests research proposals to be considered for funding up to $25,000/year and project duration of one year. Project duration is July 1, 2003 through June 30, 2004.

Proposals will be considered in all areas related to water environment, water supply, and water-resources management, but research proposals on **developing innovative urban stormwater treatment and reuse will receive high priority**. Submitted proposals will be reviewed and ranked by the Water Center's Technical Advisory Panel. Research proposals should demonstrate the potential for significant contribution to advancing the scientific foundation for water quality and/or water supply management in the Commonwealth of Virginia. Demonstration of the importance of research to decision making in Virginia should be documented in the proposal. The proposed project should provide research opportunities for graduate and undergraduate students. A detailed budget justification is required. Approved projects will be eligible for additional funding in future competitions.

Guidelines for proposal preparation can be found on the Water Center's Web-site, www.vwrrc.vt.edu. **The deadline for proposal submission is 5:00 p.m., March 31, 2003.** Successful proposals will be announced by May 30, 2003. Please mail five hard copies and an electronic version of the proposal to Dr. Tamim Younos, Interim Director, VWRRC, 10 Sandy Hall, Virginia Tech, Blacksburg, VA 24061-0444. For more information, contact Dr. Younos at (540) 231-8039, or email: tyounos@vt.edu.

2. Seed Grants—Request for Proposals

The Virginia Water Resources Research Center will provide a limited number of research seed grants, of up to $5,000, to be used in support of background studies and preliminary research that will lead to full water resources research proposals to outside funding agencies.

By accepting a seed grant award, the principal investigators commit to the development of a full proposal suitable for submission for full funding to outside funding agencies. Proposals submitted to external funding agencies should include a two-percent surcharge to be returned to the Water Center upon successful funding. Duration of each award is one year (July 1, 2003 to June 30, 2004). Funds may be used for student support, lab supplies, preliminary analysis to develop a project proposal, and travel to visit a potential research site or to establish appropriate linkages with funding agencies. Funds may not be used to purchase office supplies.

Recipients of seed grants are expected to submit to the VWRRC a brief (two pages) progress report by December 30, 2003; and a final report in the form of a full research proposal suitable for submission to a funding agency by June 30, 2004.

Guidelines for proposal preparation can be found on the Water Center's Web-site, www.vwrrc.vt.edu. **The deadline for submission of a seed grant proposal is 5:00 p.m., March 31, 2003.** Successful proposals will be announced by May 30, 2003. Please mail three hard copies and an electronic version of the proposal to Dr. Tamim Younos, Interim Director, VWRRC, 10 Sandy Hall, Virginia Tech, Blacksburg, VA 24061-0444. For more information, contact Dr. Younos at (540) 231-8039, or email: tyounos@vt.edu.

3. William R. Walker Graduate Research Fellow Award 2003

The Virginia Water Resources Research Center began William R. Walker Graduate Research Fellow Award program in 1999. The award of up to $2,500 is intended for individuals preparing for a professional career in water resources. **Only individuals pursuing graduate work in a field different from the field of emphasis as an undergraduate, or individuals with work experience returning to graduate school, are eligible to apply.** A special panel selects the award recipient. The award will be effective July 1, 2003 and can be used at the recipient's discretion during residency in a university as a student, for professional development (such as attending workshops and conferences), and purchasing materials that will enhance professional productivity (such as books and software).

Application deadline is March 31, 2003. The competition results will be announced on May 30, 2003. Application material for the award is available on the Water Center's Web-site (www.vwrrc.vt.edu). For more information, contact Dr. Tamim Younos, Interim Director, Virginia Water Resources Research Center, 10 Sandy Hall, Virginia Tech, Blacksburg, Virginia 24061-0444; phone 540-231-8039; e-mail: tyounos@vt.edu.

Guide to *Water Central* articles, June 1998—December 2002

The following lists the main articles and features included in *Water Central* issues from June 1998 (the first issue) through December 2002 (issue #24). Titles are grouped by topic and listed alphabetically. The list does not include items from the "In and Out of the News" or "Notices" sections of the newsletter.

Aquatic Life

A "Fish-eye" View of Water Quality	Oct. 1998, p. 6
Bottom-dwellers Tell Stories about the Water Above (benthic macroinvertebrates)	Apr.-Jun. 2002, p. 11
Dolly the Sheep and Dolly Varden the Trout (genetics)	Apr. 1999, p. 8
Don't Panic, But There's a Huge Crowd of Bacteria Outside…	Aug. 1998, p. 5
Loch, Lac, or Reservoir: There's More to Lakes than Water	Jun. 1999, p. 5
Out of the Water, But Not Forever (amphibians)	Apr. 2001, p. 6
Pfiesteria or Not, There's Always Algae	Jun. 1998, p. 9
Plants Don't Stop at the Water's Edge	Nov. 2000, p. 7
Tracking the Wild—and Domestic—Bacteria	Oct. 1999, p. 8
When Aquatic Visitors Become Unwelcome Residents (nonnative species)	Aug.-Sept. 2001, p. 7

Groundwater

Groundwater Issues in Virginia, 2002	Oct. 2002, p. 1
Into the Saturated Zone	Oct. 2002, p. 9

Information Sources

Aquatic-life Information Sources	Nov. 2000, p. 19
Coastal and Marine Resources Information	Jun. 2001, p. 19
Federal Water Regulations	Jun.-Aug. 2000, p. 19
Finding Drinking Water Information	Aug. 1998, p. 14; and Apr.-June 2002, p. 27
Finding Water Quality Information	Oct. 1998, p. 15; and Dec. 2001, p. 19
Following State Water Regulations	Apr. 2000, p. 15
Following the Virginia General Assembly	Feb. 2000, p. 15; and Dec. 2001, p. 18
Groundwater Information Sources	Feb. 1999, p. 15; and Apr. 2001, p. 19
Hydrologic Information Sources	Dec. 1998, p. 15; and Feb. 2002, p. 17
Maps for Water Resources	Jan. 2001, p. 18
Tracking Federal Legislation and EPA Regulations	Jun. 1998, p. 15
Water Law and Water Rights	Dec. 1999, p. 10
Water Use	Jun. 1999, p. 15
Weather and Climate	Apr. 1999, p. 15; and Aug. 2002, p. 17
Wetlands Information Sources	Oct. 1999, p. 15

Law and Policy

1998 Virginia General Assembly Water-related Legislation	Jun. 1998, p. 3
1999 Virginia General Assembly Water-related Legislation	Apr. 1999, p. 1
2000 Virginia General Assembly Water-related Legislation	Apr. 2000, p. 1
2001 Virginia General Assembly Water-related Legislation	Jun. 2001, p. 1
2002 Virginia General Assembly Water-related Legislation	Apr.-Jun. 2002, p. 5
Budget Cuts (Fall 2002) for Agencies with Water Resource Programs	Oct. 2002, p. 22
Expanding the "Viewshed" on State Water Legislation	Jun. 1999, p. 1
Finding the Path to No Net Loss of Virginia's Non-tidal Wetlands	Nov. 2000, p. 1

Law and Policy, cont.

Research on Water in Virginia

Teaching Resources

Watersheds and Surface Water Movement

Miscellaneous

Virginia Water Central

Published by the Virginia Water Resources Research Center, 10 Sandy Hall (0444), Blacksburg, VA 24061; (540) 231-5624; fax (540) 231-6673; e-mail: water @vt.edu; Tamim Younos, interim director.

Water Central staff: Alan Raflo, editor; George Wills, illustrator.

Opinions expressed herein are not necessarily those of the Water Center or Virginia Tech, nor does the mention of trade names, commercial products, or services constitute an endorsement. Reproduction of articles, with proper credit, is welcomed.

You can find *Water Central* on the Internet at **www.vwrrc.vt.edu**. If you prefer to read the newsletter there, instead of receiving a paper copy, please send an e-mail requesting this to water@vt.edu, and we will notify you whenever a new issue is posted.

YOU GET THE LAST WORD

Please answer the following questions to let us know whether the newsletter is meeting your needs. Please mail this page to the Water Center address listed in the box to the left, or e-mail your responses to water @vt.edu. Thank you.

1. Would you rate the content of this issue as good, fair, or poor?

2. Would you rate the appearance as good, fair, or poor?

3. Would you rate the readability of the articles as good, fair, or poor?

4. Is the newsletter too long, too short, or about right?

5. Do the issues come too frequently, too seldom, or about right?

6. Please add any other **comments** you wish to make.

Virginia Water Resources Research Center
10 Sandy Hall (0444)
Blacksburg, VA 24061

Return Service Requested

Non-profit Org.
U.S. Postage Paid
Blacksburg, VA 24060
Permit #28

Printed on recycled paper
VT/348/0303/2.5M/232210