# *COMMONWEALTH of VIRGINIA*

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To: The Honorable Robert F. McDonnell

The Honorable Edward Scott, Chair
House Committee on Agriculture, Chesapeake and Natural Resources

The Honorable Emmett Hanger, Chair
Senate Committee on Agriculture, Conservation and Natural Resources

From: David K. Paylor

Date: January 2, 2014

Subject: 2013 Report on Toxics Reduction in State Waters

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I am pleased to provide you with a copy of the "2013 Report on Toxics Reduction in State Waters." This report has been prepared pursuant to § 62.1-44.17:3 of the *Code of Virginia* and summarizes the Department of Environmental Quality's toxic reduction activities during 2013.

This report also is being made available at http://www.deq.virginia.gov/LawsRegulations/ReportstotheGeneralAssembly.aspx. If you have any questions concerning this report or if you would like a hard copy of this report, please contact Angie Jenkins, Policy Director at (804) 698-4268.

# 2013 Report on Toxics Reduction in State Waters

The complete set of Tables, Folders with Figures, and Appendices associated with this report, as well as the text document, are available from the WebPages of the Department of Environmental Quality at

http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityMonitoring.aspx.

**VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY**

**JANUARY 1, 2014**

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**All Tables, Folders, Figures and Appendices referred to in the text are available as "Read Only" files from DEQ's WebPages:**

http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityMonitoring.aspx.

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(1) Historical data arranged by state fiscal year for all toxic parameters in the class;
(2) Historical data arranged by toxic parameter for years 1997 through the present.

Note: Because of restrictions for naming electronic folders and files, the names of some folders and files stored on disk may not appear exactly the same as those listed below.

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# Glossary of Acronyms, Abbreviations and Technical Terms

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| **Ambient Monitoring** | The monitoring of physical and chemical characteristics within the Commonwealth's rivers, streams, lakes and estuaries. Ambient monitoring and assessment characterize ecological stressors and evaluate their potential impact on aquatic organisms and other wildlife, and on human health and recreational use of Virginia's waters. |
| **AMD** | Acid Mine Drainage |
| **Aroclor** | Aroclor is a PCB mixture produced from approximately 1930 to 1979. (http://www.epa.gov/osw/hazard/tsd/pcbs/pubs/aroclor.htm) |
| **ALU** | Aquatic Life Designated Use |
| **B4B** | Businesses for the Bay Program |
| **BDE** | Bromated diphenyl ether |
| **B-IBI** | Benthic Index of Biotic Integrity |
| **BTU** | British Thermal Unit - the amount of energy required to increase the temperature of 1 pound of water by 1 degree Fahrenheit, at normal atmospheric pressure. |
| **CBP** | Chesapeake Bay Program |
| **CEDS** | Comprehensive Environmental Data System |
| **CIMS** | CBP Information Management System |
| **Compliance Monitoring** | The monitoring of in-pipe concentrations of permitted discharges, which is one element in the prevention of contamination by toxics. Compliance monitoring evaluates whether or not the concentrations of potential pollutants in industrial, municipal or other permitted discharges are within the allowable limits specified in their permits. |
| **CPMI** | Coastal Plain Macroinvertebrate Index – used to evaluate the health of freshwater benthic communities in the Coastal Plain Region of Virginia |
| **CVs** | Consensus-Based Sediment Quality Guidelines – Critical values for contaminants in freshwater sediment (replace freshwater use of previously utilized ER-L and ER-M values intended for assessment of estuarine and marine sediments; MacDonald et al. 2000). See also PEC, below. |
| **CWA** | Federal Clean Water Act (1983) that first described the scope and purpose of water quality standards and defined the authority and responsibility of the U.S. EPA and the various states in relation to the requirements for, submission of, and establishment of such standards. |
| **DCLS** | Division of Consolidated Laboratory Services |
| **DEQ** | Department of Environmental Quality |
| **DMR** | Discharge Monitoring Report |
| **EDAS** | Ecological Data Application System (database) |
| **EEC** | Extreme Effects Concentration – the concentration of a contaminant above which adverse effects to sediment-dwelling organisms frequently or always occur |
| **ELG** | Effluent Limitation Guidelines |
| **EMAP** | Environmental Monitoring and Assessment Program – US Environmental Protection Agency |
| **EMS** | Environmental Management System |
| **ER-L** | Effects Range-Low |
| **ER-M** | Effects Range-Moderate |
| **EPA** | Environmental Protection Agency |
| **FY** | Fiscal year |
| **IBI** | Index of Biological Integrity |
| **ICPRB** | Interstate Commission for the Potomac River Basin |

**IR** "Integrated Report" – abbreviation for the 305(b)/303(d) Water Quality Integrated Assessment Report

**IRIS** Integrated Risk Information System - a database of human health effects that may result from exposure to various substances found in the environment. IRIS is provided online by EPA and its Office of Research and Development, National Center for Environmental Assessment. (http://cfpub.epa.gov/ncea/iris/index.cfm)

**MAIA** Mid-Atlantic Integrated Assessment carried out by the US EPA Environmental Monitoring and Assessment Program (EMAP)

**MEC** Midrange Effect Concentration – the concentration of a contaminant above which adverse effects to sediment-dwelling organisms frequently occur

**MGD** Millions of Gallons per Day

**Microgram** (µg or ug) One millionth of a gram.

**MonPlan** Annual Water Quality Monitoring Plan

**MY** Monitoring Year

**Nanogram** (ng) One billionth of a gram

**NARS** National Aquatic Resources Survey

**NCCA** National Coastal Condition Assessment

**NELAP** National Ecological Laboratory Accreditation Program

**NOAA** National Oceanic and Atmospheric Administration

**NPEP** National Partnership for Environmental Priorities

**NPS** Non-Point Source (pollution)

**OC-Pesticides or OCP** Organo-chlorinated Pesticide

**OEE** Office of Environmental Education

**OP-Pesticides or OPP** Organo-phosphorylated Pesticide

**OPP or OP2** Office of Pollution Prevention

**PAH** Polycyclic Aromatic Hydrocarbon

**PBT**s Persistent Bioaccumulative Toxics – Toxic substances that accumulate (bio-concentrate) and persist in the tissues of living organisms.

**PCB** Polychlorinated biphenyl

**PEC** Consensus-based *Probable Effects Concentrations* for chemical contaminants in freshwater sediments (MacDonald et al. 2000). See also CV, above.

**Picogram** (pg) One trillionth of a gram

**PMP** Pollutant Minimalization Plan - An iterative plan with a programmed schedule and final goal for the reduction (minimalization) of toxic discharge (e.g. in particular PCBs) from a permitted point source. It supplants the necessity of establishing a reduced, fixed numerical limit which may be impossible to attain for a permitted discharge.

**POTW** Publicly Owned Treatment Works

**P2 or PP** Pollution Prevention Program

**ProbMon** Probabilistic Monitoring Program

**QAPP** Quality Assurance Program and Project Plan

**RBP** Rapid Bioassessment Protocol

**SCI** Stream Condition Index, used to evaluate the health of freshwater benthic communities of upland streams based on their macroinvertebrate community

**SFY** State Fiscal Year (July 1 – June 30)

**SIC** Standard Industrial Classification

**SOP** Standard Operating Procedure

**SPMD** Semi-Permeable Membrane Device

**STORET** EPA's legacy national ecological database (short for data 'STOrage and RETrieval' system)

**SV** Screening Value

**TBT** Tributyltin

| | |
|---|---|
| **TEC** | Threshold Effect Concentration – the concentration of a contaminant below which adverse effects to sediment-dwelling organisms are unlikely to occur |
| **TMDL** | Total Maximum Daily Load |
| **TMP** | Toxics Management Program |
| **TMR** | Toxics Management Regulation |
| **TOC** | Toxics of Concern |
| **TRE** | Toxics Reduction Evaluation |
| **TRI** | Toxic Release Inventory - The Toxics Release Inventory documents the total quantities of EPA-listed toxic compounds that are released annually (to the waters, the air and the land) by permitted facilities within the Commonwealth. Changes in the quantities of toxics released are indicative of the effectiveness of pollution prevention programs, but are not an adequate or representative measure of environmental impact or impairment. |
| **TRISW** | Toxics Reduction in State Waters (report) |
| **TSV** | Tissue Screening Value – risk-based screening values used by DEQ and VDH for evaluating fish-tissues for human consumption |
| **USGS** | United States Geological Survey |
| **VISE** | Virginia Information Source for Energy (Website) |
| **VDH** | Virginia Department of Health |
| **VEEP** | Virginia Environmental Excellence Program |
| **VELAP** | Virginia Environmental Laboratory Accreditation Program |
| **VERC** | Virginia Emergency Response Council |
| **VIMS** | Virginia Institute of Marine Science |
| **VMN** | Virginia Mentoring Network |
| **VPDES** | Virginia Pollutant Discharge Elimination System |
| **VPI** | Virginia Polytechnic Institute and State University |
| **VSCI** | Virginia Stream Condition Index – used to evaluate the health of freshwater benthic communities in the Piedmont and Mountain Regions of Virginia. |
| **WET** | Whole Effluent Toxicity |
| **WQBEL** | Water Quality Based Effluent Limitation |
| **WQM** | Water Quality Monitoring |
| **WQMA** | Office of Water Quality Monitoring and Assessment |
| **WQS** | Water Quality Standard(s) |
| **WQX** | Water Quality Exchange – EPA's new generation water quality information storage database, which has replaced the legacy STORET database. |
| **WTPs** | Water Treatment Plants |
| **WWTPs** | Wastewater Treatment Plants |

# Executive Summary

The Virginia Department of Environmental Quality (DEQ) submits the annual Toxics Reduction in State Waters (TRISW) Report to the Governor and General Assembly of the Commonwealth on January 1st of each year, in accordance with Virginia Code § 62.1 - 44.17:3.

The primary objective of the TRISW Report is to document the Commonwealth's progress toward reducing toxics in state waters and consequently improving water quality. This commitment includes three principal types of activities: (1) the **prevention** of contamination of the Commonwealth's waters by toxics, (2) the continued **monitoring** of those waters for the presence of toxics and (3) the implementation of **remedial measures** to reduce and/or eliminate toxics found in the Commonwealth's waters.

## Prevention

**Permitting:** Compliance monitoring, the monitoring of in-pipe concentrations of permitted discharges, is one essential element of the prevention of contamination by toxics of the Commonwealth's waters. During State Fiscal Year 2013 (SFY13), DEQ's Toxics Management Program (TMP) included 289 facilities with 755 outfalls that had active permit-defined toxics limits in their effluents, as recorded in DEQ's Comprehensive Environmental Data System (CEDS) database. During SFY13, 286 facilities reported their discharge monitoring results. Among 8172 parameter specific Discharge Monitoring Reports (DMRs) filed during SFY13, a total of 107 (1.31%) violated permit-specified concentration limits. The vast majority of these were trivial, low-level violations for metals in the discharge stream at municipal wastewater treatment facilities: total recoverable Copper (72 = 67.29% of violations), total recoverable Zinc (31 = 28.97%), total recoverable Cadmium (1 = 0.93%), and Lead (1 = 0.93%). Only one single event violation was for an organic compound: 2,3,7,8-Tetrachlorodibenzofuran (1 = 0.93%). Forty-six (42.99%) of the violations were short-term (one or two consecutive event) occurrences. Sixty-two violations (57.94%) occurred in six strings of seven to 12 consecutive occurrences, all for total recoverable Copper (four strings) or Zinc (two strings), only one of which was at an industrial facility.

**Pollution Prevention:** The 2013 Pollution Prevention Annual Report should be available on the DEQ Website at http://www.deq.virginia.gov/Programs/PollutionPrevention.aspx by January 1, 2014. Among the highlights of Pollution Prevention successes affecting reduction of toxics in state waters in the past year are the following:

- Virginia still provides performance-based permit fee discounts (from 2 to 20%) for "going beyond compliance." In 2013, over $81,000 in fee discounts were distributed among Virginia Environmental Excellence Program (VEEP) facilities that implemented and carried out their Environmental Management System (EMS) plans. Environmental benefits from EMS plans contributed to the itemized 2012 calendar year summary in the annual P2 Report: 7.1 million tons of non-hazardous waste recycled, greenhouse gases reduced by more than 6,000 tons, hazardous waste disposal reduced by 119,000 tons, water consumption reduced by 2.6 billion gallons, use of hazardous materials reduced by 83 tons, and 487,000 tons of recycled materials utilized.
- A review of VEEP annual performance for 2013 reported a reduction of 83 tons in the use of hazardous materials and a decrease of 119,000 tons in hazardous waste disposal during the past year. Total water use was reduced by 2.6 billion gallons during the past year. The reduction of energy consumption continues to be a priority. Twenty-six E3 Technical Assessments carried out in south central and southwest Virginia totaled $784,000 in energy savings.
- DEQ's Voluntary Mercury Reduction Initiatives also have been continued successfully. Almost 300 facilities now participate in the "Virginia Switch Out" Project for the recycling of automotive mercury

switches. To date nearly 73,000 switches have been collected, equating to more than 164 pounds of mercury. Fifty-four facilities have accepted the "Virginia Fluorescent Lamp Recycling Challenge" and pledged to annually recycle over 54,000 energy efficient fluorescent light bulbs, which also contain small quantities of mercury. (Refer to DEQ's Mercury Reduction WebPages - http://www.deq.virginia.gov/Programs/PollutionPrevention/MercuryReduction.aspx.)

**Environmental Education:** In the past, DEQ's Office of Environmental Education (OEE) contributed to toxics reduction in various ways. On July 1, 2012, various components of OEE were transferred from DEQ to the Department of Conservation and Recreation (DCR). During the most recent state fiscal year (2012-2013) the Virginia Office of Environmental Education (VOEE), at the DCR, managed nine state-wide programs: Adopt-a-Stream, Environmental Educators Leadership Program, Project Underground, Regional Environmental Education (EE) Teams, Stewardship Virginia, Virginia Naturally, Virginia Natural Resource Leadership Institute, Virginia Resource Use Education Council, and Your Backyard Classroom.

The 2013 Flora and Fauna of Virginia Environmental Education Conference, held at Shrine Mont in Orkney Springs, October 16–18, had 88 attendees. Thirty-six additional educators enrolled in the Environmental Educators Leadership Program during the past year, with 11 receiving special recognition. Three new Regional EE Teams were organized in the Richmond, Southern, and New River areas of Virginia, bringing the total number of teams to thirteen. There are now 1,291 Virginia Naturally partners, which is an increase of 166 from the previous year. The 14th class of the Virginia Natural Resource Leadership Institute began in the fall of 2013, with 27 participants. The Virginia Resource Use Education Council met four times this past year.

Project WET (Water Education for Teachers) at DEQ is an international organization whose mission is to reach children, parents, teachers and community members of the world with water education. In the past year 345 formal and non-formal educators have been trained in WET through a series of 6-hour workshops. These educators have learned about the state of Virginia waters, have gained a better understanding of Virginia watersheds, examined the impacts that humans have on our waters, and studied best management practices. Each of these educators received the Curriculum and Activity Guide 2.0, a full-color 592 page book with 64 multi-disciplinary water related activities, to use as they educate Virginia's children. Additional information about Project WET can be found on DEQ's website at: http://www.deq.virginia.gov/ConnectWithDEQ/EnvironmentalInformation/ProjectWet.aspx.

The Watershed Educators Institute (WEI), unique to DEQ, was established in 2010 with a three year B-WET grant from NOAA to train non-formal educators so that they may coordinate with formal educators on meaningful watershed educational experiences (MWEE) for students. DEQ has received another three year NOAA B-WET grant to continue this objective and build the network between formal and non-formal educators. The WEI consists of a series of ten one- and two-day workshops on a variety of water quality and watershed topics. A participant who receives 30 hours of training is formally recognized as a watershed educator leader in Virginia. In SFY13 twenty-one educators received recognition while over 65 participated in one or more workshops. The new WEI that started in October 2013 currently has 58 educators enrolled with 39 of those on track to be recognized. There is also a waiting list for every single workshop being offered.

**Toxics Release Inventory (TRI):** The Toxics Release Inventory documents the total quantities of EPA listed toxic compounds that are released annually to water, air and the land by permitted facilities within the Commonwealth. Changes in the quantities of toxics released are indicative of the effectiveness of pollution prevention programs, but are not an adequate or representative measure of environmental impact or impairment.

The most recent TRI Report is available on the DEQ Website at: http://www.deq.virginia.gov/Programs/Air/AirQualityPlanningEmissions/SARATitleIII.aspx . It summarizes data from calendar year 2011, during which 412 Virginia facilities filed 1,418 individual reports on the release, transfer, or management of TRI chemicals or chemical categories. Statewide toxic releases to the water totaled approximately 16.71 million pounds or 42.6% of the total onsite releases to all media during 2011. This quantity represents a 7.2% decrease compared to what was released to the water in 2010. Nitrate compounds (16.25 million pounds) represented 97.22% of all TRI chemicals released to water. Nitrates, however, are of much more concern for their effects as nutrients rather than as toxics. Toxics criteria for dissolved nitrates in drinking water were not exceeded during SFY 2013.

## Monitoring

**Water Quality Monitoring (WQM) Programs:** Ambient water quality monitoring consists of the measurement of physical and chemical characteristics within the Commonwealth's streams, rivers, lakes, reservoirs and estuaries. Ambient monitoring and assessment characterizes ecological stressors and evaluates their potential impact on aquatic organisms and other wildlife, and on human health and recreational use of Virginia's waters.

Periodic updates and revisions of the agency's WQM Strategy are necessary as part of the continual planning process within DEQ's Water Quality Monitoring and Assessment (WQMA) Program. By 2008, the monitoring program had fully implemented two major changes in the 2007 WQMA Strategy that affected toxics monitoring and assessment: (1) the adaptation of the monitoring program to the newly delineated 12-digit, 6$^{th}$ Order sub-watersheds of the National Watershed Boundary Dataset (NWBD) and (2) the realignment of the monitoring year to correspond with the calendar year rather than the state fiscal year. Between 2002 and 2012, more than 98% of the Commonwealth's 1247 small watersheds were monitored. A new revision of the Water Quality Monitoring Strategy, implementing changes required by the successive reduction of available resources between 2007 and 2012, was completed in 2013, and the agency is currently waiting for comments from EPA Region 3 and the general public.

Summer (Jun-Sep) of 2013 was the thirteenth year of DEQ's Estuarine Probabilistic Monitoring (ProbMon) Program and the spring and fall of 2013 comprised the thirteenth year of its Freshwater ProbMon Program. Because of resource limitations, the sampling and analysis for sediment organic contaminants was suspended at freshwater ProbMon sites in SFY07. Sediment chemistry (metals and organics) sampling and analyses and sediment toxicity testing were continued at estuarine ProbMon sites during the 2012 and 2013 field seasons (SFY13 and SFY14) with resources provided by a probabilistic survey-targeted supplement to the federal §106 grant and DEQ general funds.

In the 2012 305(b)/303(d) Water Quality Integrated Assessment Reports (2012 Integrated Report or IR), sediment chemistry, sediment toxicity and benthic taxonomic results from DEQ's Estuarine Probabilistic Monitoring Program were used for toxics-related "Weight-of-Evidence" assessments of Aquatic Life Use (ALU) at 300 estuarine sites sampled over the most recent six years (2005 – 2010). These results, primarily from minor tidal tributaries, complement those from the Chesapeake Bay Program's benthic probabilistic monitoring program, which emphasizes the Bay mainstem and extensive mainstem areas of major tidal tributaries. More recent ProbMon results from a 2010 survey at 50 near-shore oceanic sites were also incorporated into the 2012 Integrated Report. An additional line of chemical evidence, based on the solubility of polycyclic aromatic hydrocarbons (PAHs) present in the sediment, was added to the weight of evidence assessment procedure in 2006 (analysis of 2005 data). The analytical data from the 2012

Estuarine ProbMon Program (SFY13) are included in the tables and folders of this TRISW Report. The Weight-of-Evidence assessments from the 2011 and 2012 estuarine surveys (an additional 100 sites) will be incorporated into the next Integrated Report, due in April of 2014.

DEQ's Fish Tissue and Sediment Monitoring Program was revived in the summer of 2012 after having been suspended since 2009 because of limited resources (http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityMonitoring/FishTissueMonitoring.aspx). In 2012, fish tissue and/or sediment samples were collected from 38 sites, primarily in the New River and James River basins (with special emphasis on the Elizabeth River). The sites were selected to gather supplemental analytical chemical data for the development and/or implementation of Total Maximum Daily Loads (TMDLs) for segments of water bodies which have been included in previous 305(b) Reports /303(d) Impaired Water Listings due to contamination of fish by polychlorinated biphenyls (PCBs). The results for the 2012 collections were received at the end of September, 2013. The data were evaluated for Quality Control, summarized, and sent to VDH as well as to DEQ's 305(b) assessors and TMDL staff for their use after the results and accompanying QA/QC were confirmed (October/ November, 2013). Thereafter, results were posted online at http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityMonitoring/FishTissueMonitoring.aspx.

Twenty-three sites were sampled for fish tissue and sediment during the summer and fall of 2013, six in the Rappahannock River Basin and 17 in the Roanoke/Dan River Basin. These samples were frozen until the end of the field season and shipped to VIMS for analysis in the fall. Analytical results are anticipated for September 2014, and following QA/QC review should be available for the January 2015 Toxics Report.

Current plans are to conduct additional fish tissue and sediment sampling for PCBs in the Bluestone River of the New River Basin, the Shenandoah River, and in embayments of the tidal Potomac River during the 2014 field season.

## Assessment and Remediation

**Assessment:** The 2012 Integrated Report identified 13,145 miles of impaired streams and rivers, 94,041acres of impaired lakes, and 2,128 square miles of impaired estuaries. Of those impaired by toxics, over 99% were listed for fish consumption advisories, primarily for PCBs (6% of impaired river miles, 66% of impaired lake acres, and 91% of impaired estuaries) or mercury (11% of river miles, 49% of lake acres, and less than 1% of estuaries). These figures will be updated with the completion of the next Integrated Report in 2014. Because the number of segments united into each Total Maximum Daily Load (TMDL) varies with the hydrography and the extent of the impairment, the exact number and schedule of toxics-related TMDLs to be developed and implemented is not certain. DEQ's PCB Strategy (2005) established priorities for TMDL development and discusses various options for remediation. Analyses for the 2014 Integrated Report began in 2013, and any new PCB-impaired segments will be integrated into the Strategy. Changes in the prevalence and geographic distribution of contaminants included in the 2014 Integrated Report will be discussed in the next (January 2015) Toxics Reduction Report.

**Remediation / Reduction:** In April 2011 a TMDL for mercury in the North Fork Holston River was approved by EPA. Three additional toxics-related TMDLs were phased for completion in 2013: (1) Levisa Fork and Garden Creek of the Big Sandy basin – PCBs, bacteria, sediment, (2) Smith River watershed – potential PAHs (phased benthic), and (3) Powell River of the Tennessee basin - TDS, TSS, potential PAHs (phased benthic). A Phase II study was completed for Total PCBs in Levisa Fork and Garden Creek that resulted in no adjustment to the PCB TMDL. Additional source investigation will occur during

implementation. While the Phase II study for the Powell River did not result in changes to the stressor (sediment) or actual TMDL, PAHs have been retained as a possible stressor. These studies and conclusion are pending approval from EPA. The Smith River stressor analysis has yet to be resolved due to factors other than toxicants that may be contributing to the benthic impairment. A Phase II study report will be developed upon completion of the stressor analysis.

PCB TMDL development initiated for the upper tidal James River and the Elizabeth River in 2009 has continued with periodic sampling for PCB source investigation and model calibration. Public meetings were held in December 2010 and January 2011. Completion of this extensive TMDL is scheduled for 2015.

The agency's TMDL history, current status and development plans are available at http://www.deq.state.va.us/Programs/Water/WaterQualityInformationTMDLs/TMDL/TMDLDevelopment/DraftTMDLReports.aspx.

As these TMDLs are completed and scheduled for implementation, and others are added, follow-up monitoring will be initiated to evaluate their effectiveness in reducing toxic contamination. The effective implementation of these TMDLs should result in measurable reductions of contaminants in a number of the state's watersheds within a few years.

A number of water bodies and/or segments previously listed for various toxics were recently removed from the 303(d) list (2012 Integrated Report) due to improvements in water quality. They are listed in "Appendix K.2 – Delisted Toxics-Impaired Segments 2012 IR." This list will be updated following the submission of the next Integrated Report in the spring of 2014.

## Continued Commitment

DEQ continues its commitment to toxics reduction by the prevention of contamination, continued water quality monitoring, and the implementation of remedial measures. The Virginia Pollutant Discharge Elimination System, the Pollution Prevention Program, and the Environmental Education Program in conjunction with other agencies, programs and stakeholders are working to promote public awareness, as well as to control and reduce toxics releases. The Toxics Release Inventory and various water programs constantly monitor and document the release to, and the presence and movement of toxics in aquatic environments. Close coordination between monitoring and assessment activities will identify new sources of contamination as they occur and document the effectiveness of load allocations and other remedial measures developed and implemented by the TMDL Program. The agency anticipates significant reductions of toxics in the state's waters as a result of continued TMDL implementation.

# Foreword

**State Fiscal Year 2013 Toxics Reduction in State Waters Report** (January 2014)

The Virginia Department of Environmental Quality (DEQ) plans and executes its Ambient Water Quality Monitoring Program on an annual basis. Guidelines for the program include:

- A long-term Water Quality Monitoring and Assessment (WQMA) Strategy was revised and submitted to EPA Region 3 in August of 2013. DEQ is currently waiting for comments and/or approval. (Another major revision is scheduled for 2019.),
- Formal Quality Assurance Program and Project Plan (QAPP),
- Established Standard Operating Procedures (SOPs), and
- Standardized Sampling Protocols.

The agency's annual monitoring program plan (MonPlan) corresponds with the calendar year. This helps synchronize various monitoring activities and assessment periods with the 'ecological' or 'water year'. The Monitoring activities summarized in this Toxics Report, however, refer to the State Fiscal Year (SFY - July 1 of each year through June 30 of the following year) in order to maximize the availability of analytical results by January 1.

The SFY13 Toxics Reduction in State Waters Report (TRISW- Jan. 14 - sixteenth in the series) summarizes all toxics monitoring and reduction activities carried out between July 1, 2012 and June 30, 2013. The historical summaries of toxics monitoring results in Folders 3 through 6 are cumulative, with the addition of the corresponding year's results in each new report.

To minimize the size of the report, reduce production time and costs, and facilitate its distribution to interested parties, the data tables, figures and appendices of this report are presented in their complete form on, and may be downloaded from the DEQ WebPages at http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityMonitoring.aspx. Electronic copies of the complete report, including tables, figures and appendices, are available on CD upon request.

In the Water Quality Monitoring section, data summaries of yearly sets of monitoring results are available in both tabular and graphical forms. Graphical summaries of historical toxics monitoring results (which use statistical interval estimates for median parameter values) will continue to appear with each annual report to assist in the evaluation of:

- Two- to five-year (short-term) changes in water and sediment quality,
- Differences among drainage basins (contemporary, geographic trends) year by year, and
- Differences among years within individual basins (basin-specific, short-term temporal variations).

Eventually, as each year's results are added to the report, historical results in the form of graphed statistical interval-estimates will facilitate the visual evaluation of longer-term trends. Graphed historical summaries (SFY97 – SFY13) for each major drainage basin appear in this year's report, but the relatively short period of record and changes in methodologies and detection limits make the interpretation of trends difficult.

# 1.0 Introduction

The Virginia Department of Environmental Quality submits a Toxics Reduction in State Waters (TRISW) Report to the Governor and the General Assembly of the Commonwealth by January 1st of each year, in accordance with Chapter 3.1, Title 62.1, § 62.1-44.17:3 of the Code of Virginia.

## 1.1 The Report: Toxics Reduction in State Waters

The primary objective of the TRISW Report is to document the state's commitment to improving water quality, more specifically in relation to chemical contamination which may induce toxic effects on aquatic life, other wildlife or on human health. This commitment includes:

1. The prevention of contamination of the Commonwealth's waters by toxics,
2. The persistent monitoring of those waters for the presence of toxics, and
3. The implementation of remedial measures to reduce and/or eliminate toxics found in the state's waters.

Each report provides a summary of the toxics-related prevention, monitoring and remediation activities of the previous State Fiscal Year.

Although the reduction of toxics in the state's waters is primarily the responsibility of the DEQ, various other agencies and organizations participate in the process, including the Virginia Department of Conservation and Recreation (DCR), the Virginia Department of Health (VDH), the Environmental Protection Agency's (EPA) Chesapeake Bay Program Office (CBPO), and the U.S. Geological Survey (USGS). This report summarizes the results of current activities directed toward toxics reduction and provides guidance on how to access further resources and information on specific subjects.

DEQ submitted the first TRISW Report in January 1998. The January 1999 report provided basic background information related to the report's objectives and a basic model for its continued evolution. The current, sixteenth TRISW Report (January 2014) contains tables of both raw data and statistical summaries of SFY13 monitoring results, as well as cumulative graphical summaries of results from 1997 through the present.

## 1.2 Functional Definitions: Toxicity, Water Quality Criteria, and Water Quality Standards

### 1.2.1 Defining "Toxicity"

The Virginia Code (Chapter 3.1, Title 62.1, § 62.1-44.17:2) defines "toxicity" as "the inherent potential or capacity of a material to cause adverse effects on a living organism, including acute or chronic effects on aquatic life, detrimental effects on human health, or other adverse environmental effects." This definition is rather broad, since an excess or even a deficit of many non-toxic substances can also cause adverse effects, both acute and chronic, on living organisms. Since § 62.1-44.17:3 requires the State Water Control Board to report on its efforts to "reduce the level of toxic substances in state waters," this report uses a definition of "toxicity" that includes only those substances that are directly and "chemically" detrimental to living organisms when they are "in excess." Direct chemical effects would exclude the physical effects of excess sedimentation or the indirect effects of nutrient enrichment, for example, both of which would also be detrimental to aquatic life. Furthermore, the concept of "other adverse environmental effects" set forth in § 62.1-44.17:2 must be defined in biological terms, since toxicity can only be observed, described, and

quantified in relation to living organisms. The classification of chemical substances ("a material") within the category of "toxics" (those that cause toxicity) is always based on the observed effects of their presence on specific living organisms. In fact, the concept of "excess" itself is defined herein in terms of the concentrations at or above which living organisms experience detrimental effects.

Toxicity varies considerably among chemical substances. The absolute amount and relative concentration of a substance necessary to demonstrate "deleterious effects" also varies. The Federal Clean Water Act (CWA) defined the responsibility of the Environmental Protection Agency in identifying the critical concentrations at which distinct chemical substances begin to elicit a specified degree of deleterious effect, and establishing the associated "Water Quality Criteria" to identify impaired waters.

### 1.2.2 Federal Water Quality Criteria

The CWA first described the scope and purpose of water quality standards and defined the authority and responsibility of the EPA and the various states in relation to the requirements for, submission of, and establishment of, such standards. Since then, EPA has published various lists of toxic materials for which the movement, use, and/or release into the environment must be documented or for which concentrations in the environment must be monitored and their effects assessed and subsequently controlled. EPA reviews the results of published studies (both academic and commercial) and conducts its own research to determine what concentrations of chemical substances are detrimental to aquatic life, other wildlife and human health, and to what degree. Based on the results of this evaluation, "Water Quality Criteria" may be established for freshwater, saltwater or drinking water, identifying the concentrations that induce direct chronic or acute toxic effects on aquatic life, subsequent poisonous effects on wildlife or humans, or long term carcinogenic (cancer producing) effects on human health.

- On December 22, 1992, the EPA published in the *Federal Register* a comprehensive list of 126 chemical substances for which it had established water quality criteria related to aquatic life in freshwater and saltwater and/or to human health risks.
- Subsequent studies often (1) identified additional toxics for which criteria were established, or (2) resulted in the establishment of new criteria for previously defined toxics. The list was modified during the ensuing years. For example, the EPA's publication of conversion factors in May 1995 lowered the acute and chronic freshwater criteria and the acute saltwater criteria for the dissolved metals arsenic, cadmium, chromium III and VI, copper, lead, mercury, nickel, silver, zinc, and selenium.
- The EPA provides its most recent complete list of nationally recommended water quality criteria for both priority (P) and non-priority (NP) toxic pollutants in electronic form on the EPA website at: http://www.epa.gov/waterscience/criteria/wqcriteria.html.
- Additional modifications of existing criteria, as well as the establishment of criteria for new substances, continue to update the EPA list and help maintain or improve the quality of the nation's waters. Detailed information on recent updates may be found at:
    - Aquatic Life: http://www.epa.gov/waterscience/criteria/aqlife.html#final
      (*e.g.*, see new 2013 Final Aquatic Life Criteria for Ammonia).
    - Human Health: http://www.epa.gov/waterscience/criteria/humanhealth/15table-fs.htm
      (e.g., see the updated human health water quality criteria for fifteen chemicals).

### 1.2.3 State Water Quality Standards - WQS

Once federal "Water Quality Criteria" have been established for a chemical substance, it is the responsibility of the individual states to establish "Water Quality Standards" within state laws and regulations that are protective of the "designated use(s)" assigned to each body of water. The most commonly designated uses include the support of aquatic life, other wildlife, fish consumption, shellfish consumption, human primary contact (swimming) or secondary contact (fishing, boating) recreation, and public water supplies (where applicable).

The Commonwealth of Virginia has established and periodically revised its water quality standards, which EPA reviews and must approve prior to their application. These standards are set forth at 9 VAC 25-260. The standards undergo a formal triennial review for periodic updating. In reality, the Commonwealth's WQS are almost constantly under review. The most recently (January 2011) adopted WQS are presented in their entirety in Appendix A. The most up to date version is always available linked to the DEQ website: http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityStandards.aspx. The current Virginia Water Quality Standards, with the most recent amendments, became effective upon EPA approval on January 6, 2011.

No toxics-related triennial review activities took place during SFY13. A public meeting held at the Piedmont Regional Office in September 2013 reviewed the primary issues to be considered during the current Triennial Review, which should be submitted in early 2015 for certification by the Attorney General's Office and EPA approval. Toxics-related issues to be considered include revision of existing standards for Manganese[1], Lead, and Cadmium, updating standards for ammonia, Copper, and Acrolein (biocide), and establishing chronic and acute standards for Carbaryl (Sevin - insecticide).

### 1.3 Federal Reporting Requirements

In addition to the biennial 305(b)/303(d) Water Quality Integrated Report, federal law requires reporting procedures for the production, movement, storage, use, and release of many of these toxic substances. These procedures, as well as Virginia's annual Toxics Release Inventory (TRI) Report, are discussed more fully below.

## 2.0 Activities Directed toward Toxics Reduction

As indicated above, DEQ's activities directed toward the reduction of toxics in state waters fall into three general categories: the prevention of contamination of the Commonwealth's waters by toxics, the monitoring of those waters for the presence of toxics, and the implementation of remediation to reduce and/or eliminate toxics found in the state's waters. All three classes of activity are geared toward maintaining the concentrations of potentially toxic substances in the state's waters below those concentrations that result in toxic effects, *i.e.*, within the bounds defined by water quality standards, with the knowledge that many such substances can never be completely eliminated from the environment.

[1] The element Manganese is not considered toxic; the standard is for the protection of drinking water against organoleptic effects (odor & staining).

## 2.1 Prevention

The primary prevention activities carried out by DEQ may be characterized as regulatory, non-regulatory, and educational.

The regulatory Virginia Pollutant Discharge Elimination System (VPDES) requires that concentration limits be established for all potentially toxic substances in permitted discharges from industrial, institutional, and/or municipal wastewater treatment facilities to ensure that Virginia's water quality standards are not violated in the water bodies receiving such discharges.

The non-regulatory programs of the Office of Pollution Prevention (OPP) encourage industries, commercial enterprises, governmental and private facilities throughout the Commonwealth to establish Environmental Management Plans (EMPs) to minimize the use of hazardous materials, and to maximize the recycling of wastes and the use of "green products and services."

In the past, the DEQ Office of Environmental Education (OEE) has provided environmental orientation and educational programs for teachers and students through electronic newsletters and other outreach activities (workshops and other training events, meaningful watershed experiences, oyster and fish festivals, etc.) to foster environmental stewardship, including non-competitive litter prevention and recycling grants. On July 1, 2012 various components and/or activities of OEE were transferred from DEQ to DCR: Virginia Naturally (website, newsletter, partners map), Environmental Educators Leadership Program, Regional Environmental Education Team coordination, and Annual Environmental Education Conference.

## 2.2 Monitoring and Assessment

The VPDES Program performs end of pipe compliance monitoring in the form of announced and unannounced facility inspections, as well as requiring permitted facilities (industrial and municipal) to monitor their discharges and to file periodic electronic Discharge Monitoring Reports (DMRs) to document their compliance with permit limit requirements.

DEQ's integrated ambient WQM Program collects water, sediment, benthic organisms, and fish tissue samples from the Commonwealth's streams, rivers, lakes and reservoirs, and estuaries to document compliance with water quality standards and sediment and fish tissue screening values. The structure and integration of the various components of the ambient WQM Program are described in detail in DEQ's Water Quality Monitoring Strategy. The revised 2013 edition will be available on the DEQ website at: http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityMonitoring.aspx in early 2014. The major components involved with toxics monitoring normally include the freshwater and estuarine probabilistic monitoring networks, and special studies, including the TMDL Program. Some program specific monitoring also contributes to the toxics efforts: the Chesapeake Bay Program, the Lakes Monitoring Program, the Biological Monitoring Program, and the Targeted Fish Tissue and Sediment Monitoring Program.

DEQ's SARA Title III Program receives annual electronic Toxics Release Inventory (TRI) summaries from reporting facilities statewide, and produces an annual TRI Report, as prescribed by federal regulations, that documents the movement, on site disposal, off site transfer, and release of toxic materials to the air, water and land.
(http://www.deq.virginia.gov/Programs/Air/AirQualityPlanningEmissions/SARATitleIII/SARA313ToxicsReleaseInventory/VA2011ToxicsReleaseInventoryReport.aspx)

### 2.3 Remediation

Although DEQ participates in several programs that deal with the remediation of toxic contamination (e.g., Brownfields Program, Federal Facilities Program, Superfund Program, etc.), the primary agency-driven program involved in remediation of toxics-related impairments in aquatic environments is the Total Maximum Daily Load (TMDL) Program. Once impaired waters have been identified, it is the responsibility of the TMDL Program to confirm the cause of the impairment, identify its source(s), and develop plans to restore and maintain the water quality. TMDL is a term that represents the total pollutant (toxicant) a waterbody can assimilate and still meet water quality standards. Once a TMDL has been reviewed and approved by EPA, an implementation plan (based on the TMDL) is developed for reducing the input of the associated toxics into the system. Depending on the type of toxicant, its source(s), and the historical background of the contamination, implementation may include reducing permit limits for a toxicant in the discharge from permitted facilities or, in the specific case of PCBs, establishing programmed Pollutant Minimalization Plans (PMPs) with permitted point sources, executing Best Management Plans (BMPs) for non-point sources or, on occasion, the physical removal of contaminated substrate from legacy point sources.

### 2.4 Analysis of Toxics from Ambient Waters

The majority of toxics-related samples collected by the ambient WQM Program are analyzed by the Division of Consolidated Laboratory Services (DCLS) of the Virginia Department of General Services, although academic or commercial laboratories are commonly contracted for some specialized analyses. Toxic elements and chemical compounds are generally categorized into several primary groups, each of which has specific codes to identify the procedures necessary for its complete chemical analysis by DCLS. The primary groups considered include:

- Clean dissolved and total trace metals in the water column,
- Toxic metals in the sediment,
- Dissolved organic contaminants,
- Organic contaminants in the sediment, and
- Toxic metals and organics in fish tissues.

The data summaries provided in the following sections of this report are organized to correspond to these categories. Various groups of toxic organic compounds (*e.g.*, PCBs, PAHs, and other semi-volatiles) are often evaluated together with pesticides.

## 3.0 Toxics-Related Results – SFY13

### 3.1 Prevention

#### 3.1.1 Reduction of Toxics by Pollution Prevention

DEQ's Office of Pollution Prevention (OPP) contributes to the reduction of toxics in the state's waters through its multimedia (i.e., air, water, and waste) non-regulatory Pollution Prevention (P2) Program. The

P2 Program focuses primarily on the reduction of resource consumption and solid wastes. The reduction of resource consumption and waste, however, also reduces the movement, use, and release of toxic materials. Such reductions occur not only within the consumer population but also among retail outlets and among industries using and/or producing toxic materials.

The annual Pollution Prevention Report, submitted to the Governor and the General Assembly in December of each year, describes OPP's activities for the year. The December 2013 report summarizes the pollution prevention strategies developed and implemented by the Virginia Pollution Prevention Program and characterizes activities carried out by the major components of the P2 Program during the past calendar year. Several of these are briefly summarized below.

- **Virginia Green Tourism** - Virginia Green (VG), the Commonwealth's voluntary initiative to promote pollution prevention within the tourism industry, began its pilot phase in 2006. Prior to September 2013 membership had reached 1,400 participants within the entire travel and tourism sector, including lodging, restaurants, attractions, conference facilities, convention centers, campgrounds, events, visitor centers, wineries, golf courses, transportation facilities and supporting organizations.

  Although Virginia Green does not require annual reporting of environmental results, environmental progress is documented through the annual awards program and through ongoing technical assistance and outreach. The program also uses the American Hotel & Lodging Association's green guide and various other publications to make conservative estimates of its progress. Based on that guidance, program participants are achieving the following estimated annual reductions:

| Environmental Benefits | Quantity | Cost Savings for Participants |
|---|---|---|
| Wastes Recycled / Diverted from Landfills | 10-12,000 tons | $150,000 |
| Reduced Electricity Use | 264 million kilowatt hours | $26-30 million |
| Reduced Natural Gas Use | 110,000 trillion cubic feet | $1.5 million |
| Reduced Water Use | 1.2 million hundred cubic feet | $1.8 million |
| Greenhouse Gas Emissions | Reduced 450 million pounds | |

- **Virginia Environmental Excellence Program (VEEP) -** There are four types of participation options for interested facilities: (1) E2 (Environmental Enterprise) for facilities that have made significant progress toward the development of an Environmental Management System (EMS), have made a commitment to pollution prevention, and have a record of sustained compliance with environmental regulations, (2) E3 (Exemplary Environmental Enterprise) for facilities that have exceeded the E2 requirements and have a fully-implemented EMS, (3) E4 (Extraordinary Environmental Enterprise) for facilities that have exceeded the E3 requirements, have completed at least one full cycle of an EMS as verified by a third-party auditor, and have demonstrated a commitment to continuous and sustainable environmental progress and community involvement, and (4) SP (Sustainability Partners), the newest VEEP track, which is designed to encourage organizations to make environmental sustainability part of their culture through leadership, innovation, and continual improvement.

- Thirteen entries were recognized with awards in the categories of Environmental Sustainability and Land Conservation at the 24th Environment Virginia Symposium in Lexington. An additional nine entries were presented Honorable Mention certificates. Winners are highlighted in detail in the 2013 Annual Pollution Prevention Report: http://www.deq.virginia.gov/Programs/PollutionPrevention.aspx.

- Virginia still provides performance-based permit fee discounts for "going beyond compliance." Potential discounts vary by category: 5-20% for hazardous waste reduction, 10-20% for solid waste

reduction, and 2-20% for reduction of water use and release. In 2013, over $81,000 in fee discounts were distributed among VEEP facilities.

- A review of VEEP annual performance reports for calendar year 2012 (reported in 2013) indicated the following results: 7.1 million tons of non-hazardous wastes were recycled, and the emission of greenhouse gases was reduced by more than 6,000 tons. Total water use was reduced by 2.6 billion gallons. The use of hazardous materials decreased by 83 tons, hazardous waste disposal was reduced by 119,000 tons, and 487,000 tons of recycled materials were used. More than $107 million in cost savings were realized during this process.

- DEQ's Voluntary Mercury Reduction Initiatives also have been continued successfully. Almost 300 facilities now participate in the "Virginia Switch Out" Project for the recycling of automotive mercury switches. To date nearly 73,000 switches have been collected, equating to more than 164 pounds of mercury. Fifty-four facilities have accepted the "Virginia Fluorescent Lamp Recycling Challenge" and pledged to annually recycle over 54,000 energy efficient fluorescent light bulbs, which also contain small quantities of mercury. (Refer to DEQ's Mercury Reduction WebPages: http://www.deq.virginia.gov/Programs/PollutionPrevention/MercuryReduction.aspx.)

For additional information concerning the Pollution Prevention (P2) Program, visit the DEQ website at http://www.deq.virginia.gov/Programs/PollutionPrevention.aspx.

### 3.1.2 Reduction of Toxics from Permitted Discharges and Compliance Monitoring of Permitted Facilities

Both private and public facilities that discharge effluents into the state's waters are required to obtain permits from the State Water Control Board. The Virginia Pollutant Discharge Elimination System (VPDES) Program requires the establishment of limitations for such permits to ensure that Virginia's water quality standards are not violated in the water bodies receiving such discharges.

"Appendix B - Facilities & Outfalls with Toxics Parameter Limits SFY13" of this report lists facilities that currently have, or have applied for, permits that contain limits on the quantity or concentration of discharged toxics in their effluents. The same spreadsheet includes geographic locations, receiving streams, etc. During SFY13, 289 facilities with 755 outfalls had one or more toxics limits in their permits. The effective limits (when specified) and reporting frequencies for toxics may vary, depending upon the chemical parameters involved. In some years, a permit may be modified, reissued, or adjusted in terms of the current limits within the past year. No new permits or renewals were recorded in CEDS during SFY2013 (see Start Date in "Appendix C"). The current toxics parameters included in each permit, along with their limits and required reporting frequencies, are also listed in "Appendix C – Permits, Parameters, Units & Frequencies SFY13." The compliance results of each permitted facility's Discharge Monitoring Reports (DMRs) during SFY13 are reported in "Appendix D – Permitted Toxics Parameters & DMR Results SFY13." Some facilities may hold permits requiring only that they report, without a limit-specified value with which they must comply. Since the facility's permit does not have a specified numerical limit, such DMR results cannot be used for compliance determinations. Of 8,172 parameter-specific DMRs filed in SFY13, 4,818 provided the average concentrations of a toxicant. Of these, 101 (2.10%) reports exceeded their permit limit for average concentration. Parameter-specific maximum concentrations were reported in 6,757 DMRs. Of these, 5201 (76.97%) contained specified limits on maximum concentration and 107 (2.06%) exceeded the limit specified in their permit. Forty-five (42.06%) of the violations were short-term (one or two consecutive event) occurrences, primarily for total recoverable copper or total recoverable zinc at municipal wastewater treatment plants (WWTP) or Sewage Treatment Plants (STP). Individual single

parameter violations consisted of Copper (N = 72, 67.29%), Zinc (N = 31, 28.97%), Cadmium (N= 1, 0.93%), Lead (N = 1, 0.93%), cyanide (N = 1, 0.93%) and a single organic compound: 2,3,7,8-tetrachlorodibenzofuran (N = 1, 0.93%).

### 3.1.3 Reduction of Toxics by Environmental Education

In the past, DEQ's Office of Environmental Education (OEE) contributed to toxics reduction in various ways. On July 1, 2012 various components of OEE were transferred from DEQ to the Department of Conservation and Recreation (DCR). During the most recent state fiscal year (2012-2013) the Virginia Office of Environmental Education (VOEE), at the DCR, managed nine state-wide programs: Adopt-a-Stream, Environmental Educators Leadership Program, Project Underground, Regional Environmental Education (EE) Teams, Stewardship Virginia, Virginia Naturally, Virginia Natural Resource Leadership Institute, Virginia Resource Use Education Council, and Your Backyard Classroom.

The 2013 Flora and Fauna of Virginia Environmental Education Conference, held at Shrine Mont in Orkney Springs, October 16–18, had 88 attendees. Thirty-six additional educators enrolled in the Environmental Educators Leadership Program during the past year, with 11 receiving special recognition. Three new Regional EE Teams were organized in the Richmond, Southern, and New River areas of Virginia, bringing the total number of teams to thirteen. There are now 1,291 Virginia Naturally partners, which is an increase of 166 from the previous year. The 14th class of the Virginia Natural Resource Leadership Institute began this fall with 27 participants. The Virginia Resource Use Education Council met four times this past year.

Additional information about the DCR Environmental Education Program is available at: http://www.dcr.virginia.gov/environmental_education/index.shtml.

Project WET (Water Education for Teachers) is an international organization whose mission is to reach children, parents, teachers and community members of the world with water education. In the past year 345 formal and non-formal educators have been trained in WET through a series of 6-hour workshops. These educators have learned about the state of Virginia waters, gained a better understanding of Virginia watersheds, examined the impacts that humans have on our waters, and studied best management practices. Each of these educators received the Curriculum and Activity Guide 2.0, a full-color 592 page book with 64 multi-disciplinary water related activities, to use as they educate Virginia's children. Additional information about Project WET can be found on DEQ's website at: http://www.deq.virginia.gov/ConnectWithDEQ/EnvironmentalInformation/ProjectWet.aspx.

The Watershed Educators Institute (WEI), unique to DEQ, was established in 2010 with a three year B-WET grant from NOAA to train non-formal educators so that they may coordinate with formal educators on MWEE (Meaningful Watershed Educational Experiences) for students. DEQ has received another three year NOAA B-WET grant to continue this objective and build the network between formal and non-formal educators. The WEI consists of a series of ten one- and two-day workshops on a variety of water quality and watershed topics. A participant who receives 30 hours of training is formally recognized as a watershed educator leader in Virginia. In SFY 2013 twenty-one educators received recognition while over 65 participated in one or more workshops. The new WEI that started in October 2013 currently has 58 educators enrolled with 39 of those on track to be recognized. There is also a waiting list for every single workshop being offered.

### 3.1.4 Virginia Toxics Release Inventory

Under the provisions of Section 313 of the Emergency Planning and Community Right-to-Know Act of 1986, also known as SARA Title III, Virginia manufacturing and federal government facilities that release certain chemicals to the air, water or land, or that transfer these chemicals for off-site treatment, disposal, recycling, or energy recovery, are required to submit reports to the EPA. This information is reported on Form R - Toxic Chemical Release Inventory Reporting Form and is collectively referred to as the Toxic Release Inventory. Although the Report itself is a "hindsight" monitoring tool, the intent of the program is to minimize the quantity, movement, and disposal of toxic materials.

The most recent Virginia Toxic Release Inventory Report (SARA Title III TRI, March 2013 for the 2011 calendar [activity] year) indicated that 412 Virginia facilities filed 1,418 individual reports on the release, transfer, or management of TRI chemicals or chemical categories. This was a 2.60 percent decrease from the 423 facilities and a 4.89 percent decrease from the 1,491 reports filed for calendar year 2010: (http://www.deq.virginia.gov/Programs/Air/AirQualityPlanningEmissions/SARATitleIII/SARA313ToxicsReleaseInventory/VA2011ToxicsReleaseInventoryReport.aspx). These reports included 156 of more than 650 chemicals and chemical categories for which TRI reporting is required.

Statewide, the tallied toxic releases to the water totaled approximately 16.71 million pounds or 42.3% of the total onsite releases to all media during 2011. This quantity represents a 7.2% decrease from the 18.02 million pounds released to the water in 2010. On-site releases to water include discharges to surface waters, such as rivers, lakes, ponds, and streams. On-site releases to the land (~ 2.55 million lbs. or 6.5% of the total on-site releases) refer to discharges to landfills, surface impoundments, land treatment, application farming, or any other release of a TRI chemical to land within the boundaries of a facility. Some of these discharges may eventually find their way into the Commonwealth's surface waters as well. Virginia does not permit under-ground injection as a method of hazardous waste disposal; consequently, no under-ground injection of TRI chemicals was reported in 2011. An additional 19.97 million pounds (50.9%) was released to the air, either from stacks or as fugitive air. A portion of these releases may also return to the Commonwealth's soil and waterways in the form of aerial deposition.

The top ten chemicals and chemical categories accounted for more than 99.9% of the on-site TRI chemical releases to water. The top ten TRI chemicals released to water were:

| TRI Chemical or Class | Annual Release to Water (2011) |
|---|---|
| 1. Nitrate Compounds | 97.22% = 16,250,000 pounds |
| 2. Ammonia | 0.872% = 145,000 pounds |
| 3. Barium & Barium compounds | 0.436% = 73,000 pounds |
| 4. Cyclohexanol | 0.353% = 59,000 pounds |
| 5. Manganese and Manganese compounds | 0.275% = 46,000 pounds |
| 6. Dimethylamine | 0.239% = 39,000 pounds |
| 7. Zinc and Zinc compounds | 0.237% = 39,000 pounds |
| 8. Nitroglycerin | 0.118% = 19,000 pounds |
| 9. Methanol | 0.073% = 12,000 pounds |
| 10. N-Methyl-2-pyrrolidone | 0.048% = 8,000 pounds |
| 11. All other chemicals | 0.129% = 21,000 pounds |

All other releases to water totaled 0.129% and approximately 21,000 pounds. Nitrate compounds are a common byproduct of industrial and domestic wastewater treatment processes and have consistently been reported as the major chemical released to surface water. Nitrates often induce nutrient problems in water bodies at lower than toxic concentrations.

Additional information on specific groups of chemicals and the quantities of their chemical releases is available in analyses within the original report (2011 Virginia Toxics Release Inventory Report - March 2013) and is available on the DEQ Website at:
http://www.deq.virginia.gov/Programs/Air/AirQualityPlanningEmissions/SARATitleIII.aspx.

Additional sources of information on the TRI: Community Right-to-Know, including the access and use of TRI data and fact sheets for individual states, are available on EPA's website at: http://www.epa.gov/tri/. The next Virginia TRI report, summarizing toxic releases for calendar year 2012, will be available in March 2014.

## 3.2 Monitoring of Toxics in Ambient Waters – SFY13

### 3.2.1 Surface Waters and Sediments

During the assessment process, concentrations of toxic contaminants found in the water column are compared with the corresponding Virginia Water Quality Standards (Appendix A - DEQ Water Quality Standards Jan. 2011), and concentrations of toxic contaminants found in sediment are compared with the screening values found in "Appendix E - Summary of Sediment Screening Values SFY13." "Appendix G – WQM Toxics Monitoring Station Group Code List SFY13" lists all monitoring stations where water and/or sediment samples were collected for each DCLS toxics parameter group code during SFY13.

Numerous tables and folders containing raw and summarized monitoring results are described in the following sections of this report. The tables contain all the descriptive information (metadata) relative to each monitoring station, the raw data results for each analyte, and descriptive statistical summaries for the results from each major river basin during SFY13. Corresponding folders contain cumulative historical summaries of the results from each year in which a TRISW Report has been produced, by river basin and analyte. A Microsoft Excel® file titled "Introduction to Tables and Folders" is included in each of the two directories containing the Tables and Folders. This introductory file lists the specific analytes contained in each table and folder, and explains the meaning of the Program Codes associated with the samples.

At the present time, all existing water quality criteria and standards for toxic substances in water are defined in terms of dissolved concentrations. In many cases, the defined standards are extremely low concentrations, near or below the detection limits of common analytical instruments and methodologies. In the past, it was often necessary to collect and concentrate large volumes of water samples to produce meaningful results. Sampling of waters with such low concentrations of toxics also presents severe problems in terms of sample contamination. Consequently, careful planning and specific Standard Operating Procedures (SOPs) are necessary to ensure the quality control of sample collection, preservation, and transport of the sample, as well as subsequent chemical analyses, to guarantee the accuracy and defensibility of the results. A number of newly developed sampling and analytic technologies are now in use for improving the representativeness, accuracy, and precision of measuring dissolved toxics in the water column. For more detailed descriptions of these procedures, refer to the January 2007 TRISW Report.

The analysis of toxic substances in ambient samples is expensive, especially for the analysis of organic compounds such as pesticides, PAHs and PCBs. Exceedances of water quality standards or of sediment quality guidelines are rare, except where known legacy contamination exists. Consequently, with the recent significant and recurrent reductions in DEQ resources, the ambient monitoring of toxics in sediments and in the water column has been considerably reduced, and few new results are listed in the following sections except where additional resources were available (*e.g.*, targeted federal grants and grant supplements for probabilistic monitoring). Other resources are directed to the Fish Tissue and Sediment Monitoring Program for follow-up monitoring in TMDL development and implementation.

#### 3.2.1.1 Dissolved Metals in Surface Waters

DEQ's dissolved clean metals SOP (DEQ-WQA, 1998) is applied in the collection and analysis of 21 dissolved trace metals in freshwater and of 17 metals in brackish and saltwater samples (Vanadium was added in 2010). "Table 3.2.1.1 - Dissolved Metals in Surface Waters SFY12" presents the results of clean, dissolved metals monitoring during SFY12. Individual spreadsheets in the Table summarize the results from Freshwater Probabilistic Monitoring Program and associated monthly PA sites, the Shenandoah River Basin Mercury Special Study and several TMDLs and other Special Studies. Clean metals sampling (both dissolved and total) was suspended in the Estuarine Probabilistic Monitoring (C2) Program in 2012, since five years of sampling (275 random sites) had not revealed a single exceedance of Water Quality Standards. The resources for the C2 clean metals sampling were transferred to the Fish Tissue and Sediment Program, which had been suspended for several years for lack of resources. Basin-by-basin historical summaries of clean dissolved metals results can be found in the Excel® workbooks of "Folder 3.2.1.1 – Historical Dissolved Metals in Surface Waters."

#### 3.2.1.2 Total Metals in Surface Waters

Because there are no Water Quality Standards for total metals in the water column, the sampling of total metals has not historically been included in ambient water quality monitoring. In recent years, however, sampling for benthic TMDL studies has revealed that the health of benthic communities in freshwater streams is often more highly correlated with the concentrations of total metals in the water column than with dissolved metals. Consequently, more recently total clean metals have been sampled along with dissolved metals at most probabilistic monitoring stations. During SFY13, DEQ researchers also collected clean total mercury samples from the Shenandoah River basin for the purpose of monitoring the transport of mercury (Hg) at many of the same sites where clean dissolved mercury samples were collected. Additional total metals samples were collected for Mercury TMDL studies in the James/Chickahominy, Blackwater, Nottoway, Mattaponi, Pamunkey, and Rappahannock Basins, in the newly established Groundwater Monitoring Program, and for several incident response studies and for industrial compliance monitoring. The resultant data from these samples are included in the spreadsheets of "Table 3.2.1.2 - Total Metals in Surface Waters - SFY13" and in the workbooks of "Folder 3.2.1.2 – Historical Total Metals in Surface Waters."

#### 3.2.1.3 Total Metals in Sediments

"Table 3.2.1.3 - Total Metals in Sediments All Basins - SFY13" presents tabular results and a statistical data summary of the SFY13 WQM sediment metals data. Only three estuarine sediment samples were analyzed by DCLS (Parameter Group Code MET1S) during SFY13, as part of a follow-up study on a

potentially PAH- and metal-contaminated 2011 estuarine probabilistic site. Although both metals and PAHs were elevated at the site, none of the analytes examined exceeded their sediment screening values. Table 3.2.1.3 also includes results from 55 sediment metals analyses from 50 sites in the Estuarine Probabilistic Monitoring Program samples that were collected during the 2013 fiscal year and were analyzed by a DEQ-contracted commercial laboratory (RTI Laboratories Inc., Livonia, MI). These results were utilized in weight-of-evidence assessment of the 50 estuarine sites for the forthcoming 2014 Integrated Water Quality Report to EPA and the U.S. Congress.

Screening Values for the evaluation of metal and organics concentrations in both freshwater and saltwater sediments can be found in "Appendix E - Summary of Sediment Screening Values SFY12."

The Excel® workbooks of "Folder 3.2.1.3 - Historic Metals Sediment All Basins," present historical summaries of sediment metals in both non-tidal freshwaters and tidal estuarine waters.

### 3.2.1.4 Dissolved Pesticides and Other Organic Contaminants

The concentrations of dissolved organic compounds in the water column are generally extremely low, often at or below the detection limits of generally available analytical methods. For this reason, DEQ has suspended most ambient monitoring of dissolved organics using traditional methods. Semi-Permeable Membrane Devices (SPMDs) have been employed in several special studies on the distribution of polychlorinated biphenyls (PCBs) in the past.

To assist in the generation of PCB data for use in the development of TMDLs, DEQ now utilizes EPA's low-detect Method 1668. Historically, PCBs were not detected in ambient river water or effluents using traditional compliance methods (EPA Method 608 and 8082). These methods have elevated detection levels and are selective toward mixed PCB Aroclor analysis. Recently, EPA recommended the use of Method 1668 for TMDL development since it is capable of detecting much lower concentrations of PCBs. It uses clean sampling techniques and a congener-specific, high resolution/low detection analytical method to measure concentrations in the pg/L (one picogram or one trillionth of a gram per liter) range. Data have been generated using this method for TMDL development within PCB impaired water bodies in the tidal Potomac River, the Roanoke (Staunton) River, Levisa Fork, New River, the upper tidal James River and the Elizabeth River watersheds, and such monitoring was continued during SFY13. Some recent results from the James and Elizabeth rivers, Rappahannock River basin, and the New River studies are presented in "Appendix J1 – Compiled Water PCB data 2011-2012" of this report. Fish tissue and sediment results from these studies are summarized in "Appendix J2 – Compiled Fish Tissue & Sediment PCB data 2012-2013."

During SFY13 only six water samples were analyzed for semi-volatile organics base, neutral and acid compounds in water, one for a facility inspection and five others for incident responses. Among the six samples and the 54 analytes included in Parameter Group Code SVW, only two detectible concentrations were found, one for 2,4-DIMETHYLPHENOL and one for BIS(2-ETHYLHEXYL)PHTHALATE. These samples are summarized in Table 3.2.1.4_Dissolved_Organics_Water_SFY13.

### 3.2.1.5 Pesticides and Other Organics in Sediment

Because of the high costs for analyses of organic contaminants and limited DEQ budgetary resources, generalized ambient monitoring for pesticides, herbicides, polycyclic aromatic hydrocarbons (PAHs),

polychlorinated biphenyls (PCBs), and other organics have been limited to TMDL special studies and other known or suspected "hot spots." Analyses are generally limited to the specific class(es) of organics identified in previous studies. The specific cases where special study monitoring of sediment organics has been carried out are described in the paragraphs that follow.

#### 3.2.1.5.1 Chlorinated Pesticides in Sediment

"Table 3.2.1.5.1a OC Pesticides Sediment Fw All Basins SFY13" indicates that no chlorinated pesticide analyses of freshwater were carried out in SFY13. "Table 3.2.1.5.1b – OC Pesticides Sediment Estuarine All Basins SFY13" summarizes the results of estuarine probabilistic sampling during SFY13. These sediment samples were analyzed by a contracted commercial laboratory. Among 935 results from 17 pesticide analytes at 50 sites within seven estuarine basins, 910 (97.33%) of the results were negative (non-detect). Twenty-five results from 17 sites were positive (several positives were QA duplicates from the same site), but none exceeded their sediment screening values. As can be seen from the table and the associated "Folder 3.2.1.5.1 - Historical OC Pesticides Sediment," chlorinated pesticide contamination is very limited in estuarine waters.

#### 3.2.1.5.2 Phosphorylated Pesticides in Sediment

No analyses of phosphorylated pesticides were carried out during SFY13. Tables 3.2.1.5.2a (Group 1) and 3.2.1.5.2b (Group 2) are included in this Report only as placeholders. The historical phosphorylated pesticides in sediment results are maintained in "Folder 3.2.1.5.2 – Historical OP Pesticides Sediment."

#### 3.2.1.5.3 Herbicides in Freshwater Sediment

No sediment herbicide samples from any basin were collected or analyzed during SFY13. Table 3.2.1.5.3 is included in this Report as a placeholder. "Folder_3.2.1.5.3_-_Historical_Herbicides_Sediment" contains the historical record of sediment herbicide results.

#### 3.2.1.5.4 Polycyclic Aromatic Hydrocarbons (PAHs) in Sediment

"Table 3.2.1.5.4a - PAHs Sediment Grp1 All Basins SFY13" and "Table 3.2.1.5.4b - PAHs Sediment Grp2 All Basins SFY13" indicate that no PAH sampling or analyses of freshwater sediments were carried out during SFY13. "Table 3.2.1.5.4c - PAHs Sediment Estuarine All Basins SFY13" summarizes the PAH results from estuarine probabilistic monitoring during SFY13, which are also included in "Folder 3.2.1.5.4 - PAHs Sediment Historical."

The weight-of-evidence assessment of summer 2011 (SFY12) probabilistic estuarine sites for Aquatic Life Designated Use (ALU) identified one site in a minor tidal tributary to the York River (VA11-019A = Station 8-ADA001.65 in Adams Creek) which was apparently highly contaminated with PAHs and had a very high risk of PAH-induced effects on the benthic community. Three different benthic indices revealed that the condition of the macro-benthic fauna at the site was degraded to severely degraded, but toxicity tests of the sediment did not result in any acute mortality to the test organism (*Leptocheirus plumulosus*, a marine amphipod). A follow-up study was carried out in mid November 2012 to confirm the degree and local distribution of the contamination. Sediment samples were collected from the original site and secondary sites 100 meters upstream and downstream from the original site. Results from the state laboratory (DCLS) revealed gradients in the concentrations of several metals and total PAHs declining from upstream to downstream, but none of the concentrations exceeded any sediment screening values. (See Adams Creek tab in "Table 3.2.1.5.4c - PAHs Sediment Estuarine All Basins SFY13.") The site was consequently reclassified from being listed as impaired, which would have required developing a TMDL

for its remediation, to Class 3B "Observed Effects" requiring follow-up monitoring to acquire more data. Low oxygen concentrations in the bottom waters may have caused the benthic degradation.

#### 3.2.1.5.5.1 Semi-volatile Organics in Freshwater Sediment

"Table 3.2.1.5.5.1 - Semi-Volatiles Sediment All Basins SFY13" shows that no semi-volatile organics analyses were performed on freshwater sediment samples in SFY13. Two semi-volatiles, biphenyl and dibenzothiophene (synfuel) were analyzed in sediments collected by the Estuarine Probabilistic Monitoring Program. Their results are included in a separate tab of "Table 3.2.1.5.4c - PAHs Sediment Estuarine All Basins SFY13."

#### 3.2.1.5.5.2 Volatile Organics in Freshwater

Dissolved volatile organics were sampled and analyzed during one facility inspection (FI), three incident responses (IR), and one TMDL (TM) sampling event. The results are summarized in "Table 3.2.1.5.5.2 – Volatiles Water All Basins SFY13." Almost all results were below method detection limits.

#### 3.2.1.5.6 Polychlorinated Biphenyls (PCBs) in Sediment

No ambient freshwater sediment samples were collected or analyzed for PCBs during SFY13. "Table 3.2.1.5.6a - PCBs Sediment Freshwater All Basins SFY13" is included in this Report as a placeholder. Sediment PCBs sampled and analyzed in the TMDL Program are summarized in "Appendix J2 – Compiled Fish Tissue & Sediment PCB Data 2012-2013."

"Table 3.2.1.5.6b - PCBs Sediment Estuarine All Basins SFY13" summarizes the results of analyses of 21 PCB congeners in sediment from 50 estuarine probabilistic sites (plus five QA duplicates) sampled during the summer (late June – September) of 2012. Of 55 samples from 50 sites, 87.04% were non-detect. Of the seven positive samples, five were in the James Basin, one was in a Potomac tributary (Potomac Creek), and one was in a minor tributary to the Chesapeake Bay (Back River).

### 3.2.2 Fish Tissue Contamination

"DEQ's Fish Tissue and Sediment Monitoring Program was revived in the summer of 2012 after having been suspended since 2009 because of limited resources (http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityMonitoring/FishTissueMonitoring.aspx). In 2012, fish tissue and/or sediment samples were collected from 38 sites, primarily in the New River and James River basins (with special emphasis on the Elizabeth River). The sites were selected to gather supplemental analytical chemical data for the development and/or implementation of Total Maximum Daily Loads (TMDLs) for segments of water bodies which have been included in previous 305(b) Report /303(d) Impaired Water Listings due to contamination of fish by polychlorinated biphenyls (PCBs). The results for the 2012 collections were received at the end of September, 2013. The data were evaluated for Quality Control, summarized, and sent to VDH as well as to DEQ's 305(b) assessors and TMDL staff for their use once the results and accompanying QA/QC were confirmed (October/ November, 2013). Thereafter, the results were posted online.

Twenty-three sites were sampled during the 2013 season from June through September. The 2013 Fish Tissue and Sediment Monitoring focused on the following watersheds: (1) Roanoke (Staunton) River watershed including its tributary Cub Creek – from below Leesville Lake Dam to upstream of Kerr Reservoir, (2) Dan River watershed including its tributaries Banister River and Hyco River – from Danville to just upstream of Kerr Reservoir, and (3) Mountain Run, a tributary of the Rappahannock River,

from Culpeper to near the confluence with the Rappahannock River. The resultant samples are being sent to VIMS for analysis and the results should be received by the end of September, 2014.

A list of the sites sampled in the Fish Tissue and Sediment Program in 2012 and 2013 is included in "Appendix F1 Fish Tissue Sampling Sites SFY12-SFY13."

Current plans are to conduct additional fish tissue and sediment sampling for PCBs in the Bluestone River of the New River Basin, the Shenandoah River, and in embayments of the tidal Potomac River during the 2014 field season.

### 3.2.3 Benthic Monitoring

**Benthic Community Evaluation**: Field sampling and evaluation of both freshwater and estuarine benthic communities has proven to be an invaluable tool in the assessment of water and sediment quality. Significantly stressed benthic communities may indicate the impact of toxics in the environment, but follow-up evaluation is required to confirm the cause of the observed benthic impairment.

#### 3.2.3.1 Freshwater Benthic Monitoring

"Appendix H1 – Freshwater Biological Stations SFY13" of this report lists the freshwater biological monitoring stations visited during the fall of 2012 and the spring of 2013. Many sites visited during the spring of 2013 have not yet been recorded in the Ecological Data Application System (EDAS) database used for freshwater biological data. Between spring of 2012 and spring of 2013 regional biologists collected a total of at least 645 samples at 345 biological monitoring sites; 315 sites in the Piedmont and Appalachian Zones were subsequently evaluated using the Virginia Stream Condition Index (VSCI). Of those visits, approximately 16.52% resulted in evaluations of severe stress, possibly related to toxics. An additional 58 samples were collected at 30 sites for evaluation using the Coastal Plain Macroinvertebrate Index (CPMI). Approximately 29 (38.00%) of those scores also indicated severe stress. The list in Appendix H1 includes a number of the freshwater probabilistic sites that are also described in Appendix H2.

"Appendix H2 - Freshwater Probabilistic Monitoring Sites SFY13" provides a comprehensive list from CEDS of the freshwater probabilistic monitoring stations that were included in the ambient program during fiscal year 2013. Many of these (the wadeable sites) were also sampled for benthic invertebrate populations and are also included in Appendix H1. This list summarizes 177 site visits to 102 freshwater probabilistic stations, including autumn visits to calendar year 2012 sites, as well as a number of follow-up visits for other purposes (e.g., TMDL or other special study projects). Eighty-seven of the sites are sampled only in the spring and fall as normal Freshwater Probabilistic sites (Program Code FP). An additional 15 sites are being sampled monthly under the Program Code PA - Monthly Monitoring for physical and chemical parameters. Some spring visits in calendar year 2013 may not yet have been entered into the EDAS database.

#### 3.2.3.2 Estuarine Benthic Monitoring

**Chesapeake Bay and other tidal waters:** The Chesapeake Bay Program (CBP) conducts probabilistic monitoring of benthic communities. As a second phase of assessment based on the CBP Benthic Index of Biotic Integrity (B-IBI), a stressor diagnostic tool calculates the probability of contamination as a cause for each impaired benthic sample. Another benthic assessment methodology is used for estuarine probabilistic monitoring following National Coastal Condition Assessment (NCCA) sampling protocols in minor tidal tributaries to the Bay and in other tidal estuarine waters. It consists of a weight-of-evidence evaluation based on the Sediment Quality Triad (SQT). Estuarine probabilistic monitoring following the NCCA protocols provides data on the chemical contamination of sediment, the acute toxicity of sediment, and an evaluation of benthic community wellbeing using three indices of stress, the CBP's B-IBI plus Diagnostic Tool in tidal Chesapeake Bay waters, the Middle Atlantic Region B-IBI for other tidal coastal waters, and EPA's Environmental Monitoring and Assessment Program's Mid-Atlantic Integrated Assessment (EMAP-MAIA) Index of Estuarine Condition discriminant function for the Virginia Biogeographic Province (VA-IEC) as a secondary index in all tidal waters. This methodology is described in detail in the current Assessment Guidance Manual for the 2012 Integrated Report (http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityAssessments.aspx).

Weight-of-evidence assessments for sites sampled during the 2005 – 2010 period were included in the 2012 Integrated Report (IR). The SFY12 and SFY13 estuarine probabilistic monitoring sites will be assessed using the same methodology and will be included in the 2014 IR.

### 3.2.4 Special Studies Related to Toxics

#### 3.2.4.1 Regional Special Studies Involving Toxics

Special studies are often initiated independently at the Regional Office (RO) level in response to locally recognized problems. Often, these regional special studies are related to TMDL development for impaired waters, but they may also be initiated to evaluate new monitoring or analytical methods, or to investigate potential problems with new practices, etc. Regional special studies that dealt specifically with toxics during SFY12 are summarized within "Appendix I – Special Studies Related to Toxics SFY13." Briefly summarized, they consist of:

| | |
|---|---|
| **Central Office** | Artificial Hardness special study was concluded in 2013 (with participation of NRO, PRO, and BRRO-Lynchburg)<br>Water Quality Sampling in the Upper Clinch River watershed of Southwest Virginia in support of the Clinch-Powell Clean Rivers Initiative (CPCRI) by The Nature Conservancy (see below) |
| **Northern RO** | Broad Run Benthic Study (metals)<br>Jeffries Branch Benthic (metals sampling)<br>North Fork Catoctin Creek Benthic (metals sampling) |
| **Piedmont RO** | James River PCB Study<br>Low level dissolved PCB sampling at various MS4 outfalls |

| | |
|---|---|
| | Four monthly sampling runs for total mercury in the Chickahominy, Mattaponi, Pamunkey and Rappahannock River watersheds in preparation for future Hg TMDLs for fish tissue consumption advisories |
| **Blue Ridge RO**<br>**- Lynchburg**<br>**- Roanoke** | Smith River Benthic Study (possible PAHs)<br>Roanoke River PCB Study<br>New River PCB Study |
| **Southwest RO** | Bluestone River PCB Study<br>Levisa Fork PCB Study<br>Clinch River Low Level Mercury Sampling Study<br>Straight-pipe Sewage Benthic Study (complicated by toxic coal mine drainage). This study was completed in 2012 and its final report was included in last year's Toxics Reduction Report.<br>Water Quality Sampling in the Upper Clinch River watershed of Southwest Virginia in support of the Clinch-Powell Clean Rivers Initiative (CPCRI) by The Nature Conservancy (see below)<br>New River PCB TMDL |
| **Tidewater RO** | Low Level PCB Study in Elizabeth and Lower James Rivers |
| **Valley RO** | Continuing South River Mercury Studies<br>Continued coordination with the South River Science Team<br>Continued participation in the Natural Resources Damage Assessment (NRDA) for South River and South Fork Shenandoah |

During the summer of 2012, DEQ (Central Office and Southwest RO) began quarterly water quality monitoring (including trace metal sampling) in support of additional research work conducted in the Clinch River. The Nature Conservancy, the U.S. EPA, the Tennessee Department of Environment & Conservation, the U.S. Geological Survey - Virginia Water Science Center and Tennessee Water Science Center are all participating in the project. Over the past three decades, freshwater mussel populations declined in the reach of the Clinch River from western Russell County to southern Scott County in Virginia. During the same time span, mussel populations in the Tennessee portion of the Clinch River thrived and maintained species richness. No consensus understanding of this biological response pattern exists among biologists or regulatory agencies. Therefore, a group of scientists associated with the Clinch-Powell Clean Rivers Initiative (CPCRI) began a coordinated research project to investigate the issue. The research project includes biological, chemical, and land use analytical components conducted concurrently to determine most likely stressors related to mussel declines. The water quality sampling and analyses being carried out by DEQ are critical to the success of the overall research effort. Additional information on the progress of this intensive study is available on the CPCRI website (http://vwrrc.vt.edu/cpcri/).

Interim or final reports from various toxics-related studies are also available on the DEQ website - "Water Reports" page (http://www.deq.virginia.gov/Programs/Water/ReportsPublications.aspx) and "TMDLs in Virginia" page (http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/TMDL.aspx).

### 3.2.5 Other Program Specific Studies

#### 3.2.5.1 The Chesapeake Bay Program

##### 3.2.5.1.1 Toxics Reduction and Prevention Strategy

The 1987 Chesapeake Bay Agreement committed the signatories to develop, adopt, and begin implementation of a basin wide toxics strategy to achieve a reduction of toxics, consistent with the Water Quality Act of 1987, which would ensure protection of human health and living resources. Following the implementation of a multi-jurisdictional effort to define the nature, extent, and magnitude of toxics problems, the initial strategy was further strengthened with the adoption of the 1994 Basin Wide Toxics Reduction and Prevention Strategy. The primary goal of the 1994 strategy was to have a:

> *"Bay free of toxics by reducing and eliminating the input of chemical contaminants from all controllable sources to levels that result in no toxic or bioaccumulative impact on living resources that inhabit the Bay or on human health[2]."*

##### 3.2.5.1.2 Toxics 2000 Strategy

Building upon progress achieved through the implementation of the 1994 Strategy, the Chesapeake Bay Program Executive Council adopted a revised strategy in December 2000 known as the "Toxics 2000 Strategy.[3]" With the retention of the 1994 goal, new objectives and commitments were developed and incorporated into the document. An important strategy objective was to strive for zero release of chemical contaminants from point and non-point sources through pollution prevention and other voluntary means. For those areas with known chemical contaminant problems and referenced as Regions of Concern, such as the Elizabeth River in southeastern Virginia, the strategy included commitments leading to restoration. Finally, the strategy included commitments that would provide the means to measure progress toward meeting the overall strategy goal. One approach consisted of periodic toxics characterizations, accomplished in 1999 and again in 2008, in which information derived from biological and chemical monitoring were synthesized within the context of toxicological impacts. Those characterizations focused primarily on the Chesapeake Bay mainstem and major tidal tributaries. An additional characterization reached its conclusion in December of 2012. The current efforts, based primarily on 305(b)/303(d) Water Quality Reports and Impaired Waters Listings and other published studies in member states (Virginia, Maryland, Pennsylvania, West Virginia, and Delaware) also include non-tidal waters of the Bay watershed (see below).

##### 3.2.5.1.3 Current Toxics-Related Activities

A general organizational restructuring of the Chesapeake Bay Program was carried out in 2008 and activities of the former Toxics Subcommittee were temporarily suspended. The new structure does not expressly include a Toxics Subcommittee, but it does include a "team" with the objective to "Protect and Restore Water Quality." The current partial shift in alignment of CBP monitoring efforts from tidal to non-tidal watershed sources (both point and non-point) of nutrient and sediment input, and emphasis on the

[2] "Chesapeake Bay Basinwide Toxics Reduction And Prevention Strategy" - www.chesapeakebay.net/content/publications/cbp_12368.pdf

[3] "Chesapeake 2000" - http://www.chesapeakebay.net/content/publications/cbp_12081.pdf

Bay-wide TMDL development for these stressors, temporarily resulted in less emphasis on toxics in tidal waters.

In October 2011 the EPA Interstate Chesapeake Bay Program Office (CBPO), Department of the Interior (DOI - USGS, FWS), National Oceanic and Atmospheric Administration (NOAA), and the U.S. Department of Agriculture (USDA), along with various other state and academic stakeholders, held a workshop to initiate compliance with Executive Order 13508 – Chesapeake Bay Protection and Restoration (May 2009). The Chesapeake Bay Workgroup for Toxic Contaminants issued a report in December of 2012, summarizing the extent and seriousness of toxic contaminants in the Bay and its watershed (both estuarine and non-tidal waters): http://executiveorder.chesapeakebay.net/ChesBayToxics_finaldraft_11513b.pdf.

Each summer during July, August, and September the DEQ Estuarine Probabilistic Monitoring Program collects sediment samples from 50 randomly selected estuarine sites within the Commonwealth. Thirty-five (70%) of those samples are collected within the Chesapeake Bay watershed, and the remaining 15 (30%) are collected from coastal Delmarva and the Back Bay/North Landing River region. Subsamples are chemically analyzed for 15 trace metals, 25 polycyclic aromatic hydrocarbons (PAHs), 21 congeners of polychlorinated biphenyls (PCBs), and 20 pesticides and their derivatives. The chemistry results from the SFY13 sampling (July – September 2012) are included in the tables of this report. Analytical results from samples collected during the summer of 2013 will be included in next year's TRISW Report.

Additional information on the concentrations and trends of toxic substances and other water quality parameters, in the Chesapeake Bay and its tributaries, is currently available on the Chesapeake Bay Program website at http://www.chesapeakebay.net/issues/issue/chemical_contaminants, or by using the search engine available at http://www.chesapeakebay.net/. Additional information about DEQ's Chesapeake Bay monitoring is available at: http://www.deq.virginia.gov/Programs/Water/ChesapeakeBay/ChesapeakeBayMonitoring.aspx.

#### 3.2.5.2 The Elizabeth River Program

In 1997, in response to indications of water quality impairment by toxics in the Elizabeth River and its tributaries, DEQ and a group of Elizabeth River Project (ERP) stakeholders collaborated to produce a comprehensive Water Quality Monitoring plan for the water bodies of concern. Under guidelines included in that plan, a baseline environmental study began in January 1998 with the goal of allowing the future assessment of trends in contaminant concentrations and their effects. Scientists from the Virginia Institute of Marine Science, Old Dominion University, and DEQ worked with representatives from state, federal, and local authorities and other stakeholders to design and conduct the monitoring effort.

While DEQ continues to monitor for conventional pollutants and nutrients, most studies specifically involving toxics and their effects in the Elizabeth River system have been concluded. Because of reduced regional office staff and lack of Elizabeth River funding, toxics-related activities during 2012 were restricted to sediment PAH study and continued sampling and public meetings related to PCB studies and TMDL model development.

The DEQ contracted with the ERP to conduct a preliminary evaluation of PAHs off-shore of the former Atlantic Creosoting and Wood Preserving Works located on the Eastern branch of the Elizabeth River. This facility operated in the early part of the 1900's and historical documents describe a fire and explosion in 1907. Site assessments for the upland part of the site revealed creosote odors and sheen in drainage

areas of the site. In January 2012, 45 near surface sediment samples were collected over a 32 acre investigation area. PAH concentrations ranged from non-detectable to 332.5 mg/Kg. Additional investigations are needed to further define the vertical and horizontal extent of PAH contamination at this site.

The Elizabeth River and its tributaries have VDH fish consumption advisories for PCBs. Ambient water samples for PCB analyses were collected under both "dry" and "wet" weather conditions from locations throughout the watershed during 2010-2011. Available results were reported in the January 2012 TRISW Report (Appendix J.1). More recent results are included in "Appendix J1 – Compiled Water PCB data 2012-2013" and "Appendix J2 – Compiled Fish Tissue & Sediment PCB data 2012-2013" of this Report and will be used to support model calibration for a PCB TMDL within the watershed. Completion of this TMDL is now scheduled for 2014.

Additional information on the Elizabeth River Project is available at http://www.elizabethriver.org/.

### 3.3 The Calendar Year 2014 Water Quality Monitoring Plan

The Annual Monitoring Plan (MonPlan) provides a complete list of the ambient WQM stations that will be actively sampled during the corresponding calendar year and the types of samples that will be collected at each. The DEQ Monitoring Year corresponds to the calendar year in order to synchronize various ambient monitoring program schedules with one another, with the ecological and water year cycles, and with the "assessment window" or monitoring period considered for each 305(b)/303(d) Water Quality Integrated Report assessment and listing cycle. The synchronization scheme is described in detail in the 2007 and 2013 revisions of DEQ's Water Quality Monitoring Strategy: (http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityMonitoring/DEQsWaterQualityMonitoringStrategy.aspx).

The MonPlan for each calendar year is normally completed in December and is implemented on January 1 of the following year. That portion of the new plan that deals with long-term trend stations continues with minimum modification. However, because 2012 completed the third two-year rotation (January 1, 2011 through December 31, 2012) in the second six-year cycle (2007 – 2012) of DEQ's statewide Watershed Monitoring Network, the calendar year 2013 MonPlan required significant reorganization. Other aspects of the Plan, which deal with TMDLs and other special studies or with shorter term rotations such as lake monitoring or citizen requests, also require significant updating for inclusion in each new MonPlan. A face-to-face statewide meeting of DEQ's monitoring staff was held in Harrisonburg in late October 2012, to discuss priorities for modifications in the 2013 MonPlan. Significant reductions in the resources available for monitoring during the past four years have required a number of alterations to the WQ Monitoring Strategy. Descriptions of program modifications introduced in the 2013 Monitoring Plan were included in the 2013 revision of DEQ's WQMA Monitoring Strategy.

Once finalized, the 2014 annual Monitoring Plan will be summarized and linked to the DEQ website at http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityMonitoring.aspx.

## 4.0 Assessment of Toxics in Ambient Waters

### 4.1 The 305(b)/303(d) Water Quality Integrated Assessment Report

The most recent Water Quality Integrated Assessment Report (IR) was prepared and submitted to EPA in the spring of 2012. The assessment window for that IR extended from January 1, 2005 – December 31, 2010. The list of impaired segments submitted to EPA for delisting included several segments that had previously been 303(d)-listed for toxics-related impairments. The complete list of toxic-related delistings is contained in "Appendix K.2 – Delisted Toxics-Impaired Segments – 2012 IR." An updated list will become available with the submission of the 2014 IR in the spring of 2014.

The 2010 IR and the 2012 IR and interactive maps are still available on the DEQ website at: http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityAssessments.aspx . The 2012 Report is still listed as a "draft" pending final EPA approval. Any recent changes in assessment methodologies for toxics, such as revised or new water quality standards, are described in the 2012 Assessment Guidance Manual. The 2014 Assessment Guidance Manual has not yet been released, pending EPA approval of the 2012 IR. If the 2012 Report is approved by the end of the year, the new Guidance will be "public-noticed" in January 2014.

### 4.1.1 The 305(b) Water Quality Assessment

The next 305(b) Water Quality Assessment Report is scheduled for submission in the spring of 2014. Once that report has been finalized, submitted to, and approved by EPA its conclusions will be summarized for the following Toxics Reduction in State Waters report.

The previous (2012) Assessment identified a total of 13,145 miles of impaired rivers (25.1% of all assessed river miles; EPA Categories 4 - 10% and 5 - 15.1%), 94,041 acres of lakes (80.8% of all assessed significant lakes; EPA Categories 4 – 3% and 5 – 77.8%), and 2,128 square miles of impaired estuaries (79.3% of all assessed estuaries; EPA Categories 4 – 2.9% and 5 – 76.4%). In 2012, DEQ added 840 stream miles, 100 lake acres and 2 square miles of estuaries to the impaired waters list. Rather than reflecting worsening conditions, the increase in the number of water bodies is due primarily to the monitoring of waters that had not previously been assessed. It should also be noted that DEQ removed 260 stream miles and 2700 lake acres from the Impaired Waters List due to improvements in water quality. The extents of current impairments caused by specifically identified toxics are summarized in Text Table 4.1.1 below. The total river miles, lake acres and estuarine square miles of toxics impairments summed at the foot of the table are not directly comparable to the totals cited above, because many of the impaired segments summarized in the table may be included under two or more causes (e.g., the same river mile may be listed under PCBs in fish tissue and mercury in fish tissue). Of the listings in the table, the vast majority were the result of fish consumption advisories. Fish consumption advisories were primarily for PCBs or mercury. Both of these contaminants are persistent and bioaccumulative, that is, they are found in much higher concentrations in fish tissues than in the surrounding environment.

| Aquatic Resource Class > / Categories of Toxic Compounds | Rivers & Streams | | Lakes & Reservoirs | | Estuaries | |
|---|---|---|---|---|---|---|
| | Percentage of All River Miles Statewide | River Miles Impaired by Each Category | Percentage of All Lake Acres Statewide | Acres Impaired by Each Category | Percentage of All Estuarine Square Miles Statewide | Square Miles Impaired by Each Category |
| PCBs in Fish Tissue | 1.98% | 1036.4 | 64.02% | 74496.3 | 77.79% | 2088.0 |
| PAHs in Fish Tissue | 0.01% | 7.3 | 0.06% | 73.8 | 0.03% | 0.7 |
| PCBs in Water Column | 0.40% | 207.7 | 1.07% | 1245.1 | 0.32% | 8.6 |
| Cadmium | 0.02% | 10.8 | 0.05% | 52.8 | 0.00% | 0.0 |
| Copper | 0.03% | 17.7 | 0.99% | 1148.2 | 0.00% | 0.0 |
| Mercury in Fish Tissue | 3.94% | 2058.9 | 47.95% | 55794.8 | 0.76% | 20.5 |
| Zinc | 0.03% | 15.1 | 0.05% | 52.8 | 0.00% | 0.0 |
| Aldrin | 0.01% | 6.0 | 0.00% | 0.0 | 0.00% | 0.0 |
| Chlordane | 0.01% | 5.1 | 0.00% | 0.0 | 0.00% | 0.1 |
| DDT & Derivatives | 0.02% | 10.1 | 0.11% | 131.6 | 0.00% | 0.0 |
| Heptachlor Epoxide | 0.01% | 4.6 | 0.00% | 0.0 | 0.00% | 0.0 |
| Mirex | 0.10% | 54.3 | 0.00% | 0.0 | 0.00% | 0.0 |
| Totals | | 3,433.9 | | 132,995.3 | | 2,117.8 |

**Text Table 4.1.1** Amount of each aquatic resource class impaired by a specifically identified category of toxic compounds, and its percentage of the total statewide resource in that class. (Extracted directly from Appendix K.1 – Segments Potentially Impaired by Toxics - 2012 303(d) Report.)

#### 4.1.1.1 The 303(d) Impaired Waters List

The impaired waters list from the 2012 Integrated Report included a total of 8593 impaired waterbody segments. Of these, 1521 segments (17.7%) are directly related to contamination by toxic substances ("Appendix K.1 – Segments Potentially Impaired by Toxics – 2012 303d Report"). The percentages of total statewide stream miles, lake acres, and estuarine square miles represented by each category of toxic contaminant are summarized in Text Table 4.1.1 above. Bioassessment of benthic communities accounted for another 674 impaired segments (7.8%), but impaired benthic communities are more often the result of excessive sedimentation, eutrophication, hydrological modification, or other forms of habitat disturbance than a result of contamination.

Of the 1521 impairments associated with specifically identified contaminants, the vast majority (1453 segments or 95.5%) were for fish consumption. Fish consumption advisories were posted based on fish tissue screening values being exceeded by PCBs (1094 segments), metals (mercury - 316 segments), pesticides (15 segments), dioxin (20 segments), and PAHs (8 segments).

Future TMDLs will be developed to address the current listings, but because the size and number of segments united into each TMDL vary with the hydrography and the extent of the impairment, the exact number of TMDLs to be developed and implemented, and the schedule for doing so are not yet certain. DEQ's PCB Strategy (2005) establishes priorities for TMDL development and identifies various options for remediation. Any new PCB-impaired segments identified in the 2012 Integrated Report will be integrated into the strategy.

#### 4.1.1.2 Delisted, previously impaired segments

Thirty-six segments with toxics-related impairments (fish consumption) were included in the delisting package prepared for submission to EPA in the spring of 2012 ("Appendix K.2 – Delisted Toxics Impaired

Segments – 2012 IR"). They included 407.5 acres of reservoirs (3 segments in the Ni River reservoir – mercury in fish tissue), 9.6 miles of streams (3 segments in the New River – miscellaneous pesticides in fish tissue), and 8.9 square mile of estuary (30 segments – primarily minor tributaries and embayments to the southern Chesapeake Bay - PCB and/or mercury in fish tissue). That list has already been tentatively approved by EPA Region 3. This list will be updated for the SFY14 TRISW Report (January 2015).

Although listings for benthic macroinvertebrate impairments are not necessarily related to toxics, they are used as a warning flag to prompt the search for causative stressors. In 2012, 130.9 miles of streams (22 segments) and 327.8 square miles of estuaries (91 segments) were delisted for benthic impairments because more recent evaluations of benthic macroinvertebrate communities scored the previously listed sites as now being non-degraded and having met benthic community goals.

### 4.2 Most Recent Virginia Department of Health Fishing Restrictions and Health Advisories

The Virginia Department of Health (VDH) regularly issues "Fish Consumption Advisories and Restrictions" for Virginia Waterways based upon the results from the DEQ Fish Tissue and Sediment Monitoring Program and other sources. All waters subject to these restrictions and advisories are included in DEQ's biennial 303(d) lists. The VDH website contains the most recently published updates to fishing restrictions and closures due to concerns related to human health and fish consumption. The complete VDH fishing restrictions and health advisories currently in effect for any waters in the state can be found summarized and mapped by basin at:
http://www.vdh.virginia.gov/epidemiology/DEE/PublicHealthToxicology/Advisories/index.htm.

The DEQ Fish Tissue and Sediment Monitoring Program was temporarily suspended in 2010 because financial resources were not available, but it was resumed on a limited basis in the summer of 2012. The final fish tissue and sediment sampling plans for 2012 and 2013 can be found in Appendix F1. Sampling in 2012 was concentrated primarily in the New River basin and lower James River basin. Sampling in 2013 was focused on the Roanoke/Dan River basin and major tributaries (Bannister and Hyco Rivers). Results from the analyses of fish tissue and sediment samples collected during 2012 were received in late September 2013 and following QA/QC reviews were sent to the Virginia Department of Health and to regional DEQ Assessors. The 2012 results should be posted to the Fish Tissue and Sediment WebPages by January 2014. Analytical results from the 2013 samples sent to the Virginia Institute of Marine Science are expected to be completed by June 30, 2014. Their review and availability should follow the same relative schedule as those from 2012.

No new fishing restrictions or health advisories were issued during SFY13. The most recent new advisories and modifications of previous advisories were issued during SFY10, as a result of sampling in 2009. Advisories on PCB contamination in blue crabs, specifically related to consumption of the hepatopancreas or "mustard," were issued in January 2009 for the Southern Branch Elizabeth River and for King Creek, a tributary to the York River. In October 2009, geographic extensions were added to several previous advisories on PCBs in fish tissues, among them tidal embayments and tributaries to the Potomac River, Mill Creek near Fort Monroe (Hampton City), Dan River below Danville, Lovills Creek Lake –Yadkin River, lower Nottoway River, Emporia Reservoir and lower Meherrin River, tidal Poquoson and Piankatank Rivers, Mattaponi and Pamunkey Rivers. An additional fish consumption advisory was announced by the Virginia Department of Health on November 18, 2009. This was in response to a North Carolina Division of Public Health advisory for mercury in walleye collected in the North Carolina portion of Lake Gaston.

A general description of the Fish Tissue and Sediment Monitoring Program, related current and past special studies, and several recent reports as well as analytical results from fish tissue and sediment monitoring by the agency are available on the DEQ website at http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityMonitoring/FishTissueMonitoring.aspx.

# 5.0 Remediation of Toxics in Ambient Waters

**Total Maximum Daily Load (TMDL) Program**

The TMDL Program is an important component of DEQ's toxics remediation in aquatic environments. A number of toxics-related TMDLs have been completed and approved in recent years. Completed TMDLs can be identified and viewed by using the search form on the "TMDL Development" link on the DEQ website at http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/TMDL/TMDLDevelopment/ApprovedTMDLReports.aspx. Queries can be performed based on pollutant, major river basin, political jurisdiction, and water body name or watershed identification. A comprehensive list of all approved TMDLs (currently 283) can be queried out by leaving the search form blank and clicking on the "Search" button.

The development of additional toxics-related TMDLs has been on-going. TMDL investigations to identify PCB sources began in SFY09 and are scheduled to be completed in 2015 for the Tidal James River Basin, including the Elizabeth River. PCB samples have been collected to spatially and temporally augment the existing dataset. PCB source investigation work has also been on-going in the New River Basin (data also presented in Appendices J1 and J2) with TMDL development scheduled to begin in 2014. The impaired New River segments above Claytor Lake, as well as Claytor Lake, have been added to the study. To address the Mountain Run PCB impairment, two rounds of PCB samples have been collected (Appendix XX). While a TMDL development schedule has yet to be established for this impaired waterbody, the source investigation study is the first step of the process.

As additional TMDLs are completed and scheduled for implementation, and others are added, follow-up monitoring will be initiated to evaluate their effectiveness in reducing toxics contamination. The effective implementation of these TMDLs should result in measurable reductions of contaminants in the state's waters within a few years. The agency's TMDL history, current status, and other development plans are available at http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/TMDL.aspx.

Close coordination between monitoring and assessment activities identifies new sources of contamination as they occur and document the effectiveness of load allocations and other remedial measures developed and implemented by the TMDL Program. The agency anticipates significant reductions of toxics in the state's waters as a result of continued TMDL implementation.

# 6.0 References

A cumulative bibliography of general references and publications cited in this and previous TRISW Reports is included in "Appendix L – References."