Virginia Department of Environmental Quality

www.deq.virginia.gov

Commonwealth of Virginia

State Water Resources Plan

Preface

The State Water Resources Plan (State Plan) is the first document of its kind in the Commonwealth of Virginia. While Virginia has a history of planning for water resources, this is the first comprehensive plan that incorporates information from locally-developed water supply plans and includes basin-wide cumulative impact analyses of the information and the probable impact of future water demand on beneficial uses. The State Plan is a compilation and synthesis of the 48 local and regional water supply plans developed by local governments to assess their future water supply needs. The State Plan takes an extensive look at surface water and groundwater sources currently being used in the Commonwealth and assesses the capacity of these sources relative to all beneficial uses. All beneficial uses of water are examined, both current use and projected water demand to 2040, and an assessment of the ability of current sources to meet the future need is detailed. The State Plan also outlines challenges faced by the Commonwealth and identifies recommendations to address these challenges. The State Plan will be updated every five years following the review and update of all the local and regional plans.

Acknowledgements

The State Water Resources Plan (State Plan) is possible because of the time, effort, and expertise of many people and organizations throughout the Commonwealth of Virginia. The Virginia Department of Environmental Quality (DEQ) would like to thank everyone who participated in the development of the 48 local and regional water supply plans and the State Plan.

DEQ would also like to acknowledge the assistance from the Water Supply Plan Advisory Committee, which provided a final report that included guidance relevant to drafting this important document. Also, DEQ would like to thank the members of the original Water Policy Technical Advisory Committee (WP-TAC) that assisted in writing the Water Supply Planning Regulation.

Further appreciation goes to the following Virginia state agencies, which provided review and evaluation of the local and regional water supply plans: Department of Health, Department of Conservation and Recreation, Marine Resources Commission, Department of Historic Resources, and Department of Game and Inland Fisheries.

Table of Contents

Preface ii
Acknowledgements iii
Table of Contents iv
List of Tables xi
Executive Summary xii
Acronyms and Abbreviations xxiii
Glossary xxv
Chapter 1 Virginia's Water Resources Planning Process 1
Planning and Water Resources Management in Virginia 1
Establishment of a Comprehensive Water Supply Planning Process 3
Development of the State Water Resources Plan 5
Interrelationship between Water Supply Planning and Water Use Permitting 6
Population, Economy, and Growth Depend upon Water 6
Chapter 2 Virginia's Collaborative Water Management Framework 8
Natural Resources Policy 8
State Water Resources Policy 8
State Regulatory Controls Regarding Water Use 9
Chapter 3 Virginia's Environmental Resources 25
Climate 25
Influences of Landscape, Rivers, and Streams on Climate 27
Hydrology of Virginia 27
Geology and Groundwater 31
Chapter 4 A Comparison of Water Supply and Water Use across the Commonwealth 41
Identification of Water Planning Areas and Basin Assignments 41
Water Source and Use Data Collection 43
Existing Water Sources 45
Current Trends in Off-stream Water Use 46
Projections of Future Off-stream Water Demand 54
Chapter 5 Assessing the Long Term Sustainability of Water Resources 59
Introduction to Cumulative Impact Analysis 59

Drought as Critical Condition 59
Flow Metrics to Describe Risk to Critical Conditions 60
Method I: Cumulative Impact Modeling 61
Understanding the Water Budget 62
Method II: Metrics for Cumulative Impact Analysis 67
Flow Statistics and Metrics 67
Flow Needs and Cumulative Impacts 77
Evaluating System Stress during Drought Flows 77
System Stress: Withdrawals as Percentage of Baseline Drought Flow 89
Cumulative Effects of Groundwater Pumping 90
Cumulative Impacts Analysis: Conclusions 97
Chapter 6 Water Supply Challenges and Recommendations 100
1. Challenge: Understanding the Impact of Unpermitted Water Withdrawals 100
2. Challenge: Gaps in Water Withdrawal Reporting, Differences in Reporting Thresholds between WSP and VWWR Regulations, and Lack of Adequate Data 101
3. Challenge: Quantifying Current and Future Risks to Groundwater Availability Outside of Current Groundwater Management Areas 102
4. Challenge: Reservoir Site Development 103
5. Challenge: Threats to Water Quality 104
7. Challenge: Promoting Increased Conservation to Reduce Long-Term and Short-Term Demand 105
8. Challenge: Critical Infrastructure Deficiencies 105
9. Challenge: Sea Level Rise, Changes in Precipitation Patterns, and Land Subsidence 106
10. Challenge: Source Water Protection 106
11. Challenge: Conflict Resolution 107
12. Challenge: Public Education and Outreach 107
Bibliography 109
Introduction to Appendices 110
Appendix A: Water Supply Plans and Participating Localities 117
Local Water Supply Plans 118
Regional Water Supply Plans 118
Appendix B: Major Basin Summaries 121

Albemarle-Chowan River Basin Summary 122
Chesapeake Bay-Small Coastal Basin Summary 135
James River Basin Summary 147
New River Basin Summary 168
Potomac-Shenandoah River Basin Summary 180
Rappahannock River Basin Summary 195
Roanoke River Basin Summary 209
Tennessee-Big Sandy River Basin Summary 225
York River Basin Summary 238
Appendix C: Local/Regional Water Supply Plan Reviews and Conditions of Approval 251
Accomack County and Towns Regional Water Supply Plan Compliance Determination 252
Albemarle County Regional Water Supply Plan Compliance Determination 254
Amelia County Water Supply Plan Compliance Determination 255
Appomattox River Water Authority and the City of Hopewell Regional Water Supply Plan Compliance Determination 256
Blacksburg/Christiansburg Regional Water Supply Plan Compliance Determination 258
Buckingham County and the Town of Dillwyn Water Supply Plan Compliance Determination 259
Caroline County and the Town of Bowling Green Regional Water Supply Plan Compliance Determination 260
Charles City County Water Supply Plan Compliance Determination 261
Charlotte County and Towns Regional Water Supply Plan Compliance Determination 262
Chincoteague (Town of) Water Supply Plan Compliance Determination 263
Craig County and the Town of New Castle Regional Water Supply Plan Compliance Determination 264
Culpeper County Regional Water Supply Plan Compliance Determination 265
Cumberland, Goochland, Henrico, and Powhatan Counties Regional Water Supply Plan Compliance Determination 266
Fauquier County Regional Water Supply Plan Compliance Determination 268
Fluvanna County and the Town of Columbia Regional Water Supply Plan Compliance Determination 269
Greene County and the Town of Stanardsville Regional Water Supply Plan Compliance Determination 270
Greensville County/Sussex County/City of Emporia Regional Water Supply Plan Compliance Determination 271

Halifax County Regional Water Supply Plan Compliance Determination 272
Hanover County and the Town of Ashland Regional Water Supply Plan Compliance Determination 273
Town of Hillsboro Water Supply Plan Compliance Determination 275
Hampton Roads Regional Water Supply Plan Compliance Determination 276
King George County Water Supply Plan Compliance Determination 278
Lake Country Water Supply Plan Compliance Determination 279
Louisa County Long Range Regional Water Supply Plan Compliance Determination 280
Lunenburg County Regional Water Supply Plan Compliance Determination 281
Madison County Regional Water Supply Plan Compliance Determination 282
Middle Peninsula Regional Water Supply Plan Compliance Determination 283
New Kent County Water Supply Plan Compliance Determination 284
New River Valley Regional Water Supply Plan Compliance Determination 285
Northampton County Regional Water Supply Plan Compliance Determination 286
Northern Neck Regional Water Supply Plan Compliance Determination 288
Northern Shenandoah Regional Water Supply Plan Compliance Determination 290
Northern Virginia Regional Water Supply Plan Compliance Determination 292
Nottoway Water Supply Plan Compliance Determination 295
Orange County Regional Water Supply Plan Compliance Determination 296
Town of Port Royal Water Supply Plan Compliance Determination 297
Prince Edward County and the Town of Farmville Regional Water Supply Plan Compliance Determination 298
Roanoke Valley Regional Water Supply Plan Compliance Determination 300
Rappahannock County Regional Water Supply Plan Compliance Determination 302
Region 2000 Regional Water Supply Plan Compliance Determination 303
City of Richmond Water Supply Plan Compliance Determination 306
Southwest Virginia Regional Water Supply Plan Compliance Determination 307
Spotsylvania County, VA and the City of Fredericksburg Regional Water Supply Plan Compliance Determination 310
Stafford County Water Supply Plan Compliance Determination 312
Upper James River Basin Regional Water Supply Plan Compliance Determination 313
Upper Shenandoah Water Supply Plan Compliance Determination 315
Town of Warrenton Water Supply Plan Compliance Determination 316

West Piedmont Regional Water Supply Plan Compliance Determination 317
Appendix D: Snapshots of Water Resources by Locality..... 318
Appendix E: Public Comments and Next Steps 452
Table 1. State Plan as a Living Document Work Plan 473
Table 2. 2015 State Water Resources Plan Presentation Schedule 474
Table 3. 2015 State Plan Public Comments..... 475

List of Figures

Figure 3-1 Average Annual Precipitation across Virginia 26
Figure 3-2: Virginia's Major River Basins 28
Figure 3-3: Measured monthly precipitation and long-term average precipitation at Bremo Bluff, Fluvanna County: 1998-2004 30
Figure 3-4: Physiographic Provinces of Virginia 31
Figure 3-5 Three Peninsulas in the Coastal Plain....36
Figure 3-6: Vertical section through the Coastal Plain Physiographic Province....38
Figure 3-7: Chesapeake Bay Impact Crater 39
Figure 4-1: Local and Regional Water Supply Planning Areas in the Commonwealth 42
Figure 4-2 Current Water Use (MGD) in Virginia by HUC8....43
Figure 4-3: Statewide Source Type by User Type....45
Figure 4-4: Statewide Water Withdrawal (VWWR) and Use (WSP) Comparison....47
Figure 4-5: Statewide VWWR Average Reported Water Withdrawals by Source and Type....48
Figure 4-6: Statewide WSP Reported Water Use by Source and Type 49
Figure 4-7: Statewide Percentage of WSP 2010 Reported Use by User Type 49
Figure 4-8: Statewide Projected Population by Decade (2000–2040)....55
Figure 4-9: Statewide Projected Water Demand (2010 – 2040)....56
Figure 4-10: Statewide Percentage of 2040 Projected Demand by User Type....57
Figure 4-11: Statewide 2040 Projected Demand by Source Type 57
Figure 4-12: Statewide 2010 Reported Use and 2040 Projected Demand by Source Type....58
Figure 5-1: Map of the projected change in daily withdrawal from surface waters in non-tidal watersheds in the Commonwealth of Virginia....60
Figure 5-2: A map of the extent of the VAHydro rainfall-runoff model for simulation of the cumulative impacts of current and future water supply actions; cross-hatched areas are not simulated because of significant tidal influence or drain outside of Commonwealth boundaries....64
Figure 5-3: Box and whisker plot of the three flow statistics selected for this State Plan. These plots show relationships between the median, standard deviation, and outliers for small to medium sized streams within the Commonwealth. 67
Figure 5-4: Observed average daily streamflows by year in the Big Otter River near Evington VA (USGS 02061500) from 1984-2005. This period saw a low of 67 cfs, an average of 354 cfs and a high of 570 cfs 72
Figure 5-5: Observed median daily baseline streamflows by month in the Big Otter River near Evington VA from 1936-2013....72
Figure 5-6: Observed monthly 10 percent non-exceedance flows average streamflows in the Big Otter River at Evington VA (USGS 02061500); the 10 percent flows correspond to a "drought watch" status according to the Virginia statewide drought indicators....73
Figure 5-7: A plot of monthly 10% flows for July-October along with the current and projected mean daily surface water demands....77
Figure 5-8: A plot of number of Taxa benthic insectivores as a function of alteration in August minimum flow in non-tidal Virginia streams (2011 USEPA sponsored Healthy Watersheds Initiative study)....79
Figure 5-9: Flow-habitat relationship in the North Fork Shenandoah at the Spring Hollow sampling site from the 2004 study entitled "Stream Habitat Modeling to Support Water Management Decisions for the North Fork Shenandoah River, Virginia" 81
Figure 5-10 Median change in August Low Flow by HUC....86

Figure 5-11 Projected changes in ALF for the most highly impacted 10% of watersheds in each HUC....86
Figure 5-12: Median projected changes in 7Q10 by HUC....87
Figure 5-13: Projected changes in 7Q10 for the most highly impacted 10% of watersheds in each HUC .87
Figure 5-14: Median change in September drought of record flow by hydrologic boundaries....89
Figure 5-15: Projected changes in September drought of record flow for the most highly impacted 10% of watersheds in each HUC....89
Figure 5-16: Median Cumulative withdrawals as a percentage of September Drought Warning flow in Virginia by 8-Digit NHD HUC....90
Figure 5-17: Cumulative withdrawals as a percentage of September Drought Warning flow for the most highly impacted 10% of watersheds in each HUC....90
Figure 5-18 Aquia Aquifer....93
Figure 5-19 Piney Point Aquifer....94
Figure 5-20 Potomac Aquifer....95
Figure 5-21 Virginia Beach Aquifer....96
Figure 5-22: Projected groundwater demand in 2040 givein in MGY/square mile. This data is presented by Federal Information Processing Standards (FIPS) locality because the resolution of Water Supply Plan residential groundwater data is limited to the locality scale....97

List of Tables

Table 1-1 Population Estimates for U.S. and Virginia: 2010–2040 7
Table 3-1: Average Precipitation for the five climate regions within Virginia 26
Table 4-1: Statewide WSP 2010 Reported CWS Use by Major Basin 50
Table 4-2: Statewide WSP 2010 Reported SSU_LG Use by Major Basin 51
Table 4-3: Statewide WSP 2010 Reported AG Use by Major Basin 52
Table 4-4: Statewide WSP 2010 Reported SSU_SM Residential Groundwater Use by Major Basin 53
Table 4-5: Statewide WSP 2010 Reported Non-Consumptive Power Cooling Use by Major Basin 54
Table 4-6: Statewide Projected Water Demand by User Type (2010-2040) 56
Table 5-1: Cumulative Impact Analysis indicators used in the 2014 State Plan; indicators reflect impacts on infrastructure, downstream uses, aquatic life, and assimilative capacity due to increased water use 61
Table 5-2: The "flow metrics" used in this State Plan to indicate risk of negative impact to beneficial uses from flow alteration caused by cumulative water supply activities 69
Table 5-3: Observed annual average streamflow in the Big Otter River at Evington VA (USGS 02061500) from 1984-2005; flow values for 5th, 10th and 25th percentile correspond to the drought Watch, Warning, and Emergency thresholds for a given month 74
Table 5-4: Water supply system activities and infrastructure that are the largest contributors to flow alteration in Virginia 75
Table 5-5: Beneficial uses and their vulnerability to decreases in various seasonal flow conditions 77
Table 5-6: Virginia streams with completed flow-habitat modeling studies as of February 2014 80
Table 5-7: Design flows for Point Source Discharge Regulation in Virginia 83
Table 5-8 Pumping Values involved in planning simulation 92
Table 5-9: Modeled changes to key indicators for watersheds in Virginia based on projected demand changes from 2010-2040 99