Prince William County

10-A

Water Quality and Supply in Prince William County

Board of County Supervisors Work Session

June 7, 2022

Directive/Background

- DIR 22-16 - Staff was directed to schedule a presentation/work session, to include the appropriate organizations and individuals, to begin a comprehensive discussion on water quality and supply in Prince William County
- Also considered Board discussions and concerns raised during public comment time
- Invited a panel who have knowledge and expertise in the areas of water quality and water supply in the region

Presentation Panel

- Fairfax Water (Occoquan Reservoir and Source Water Protection)
    - Jamie Bain Hedges, P.E., General Manager
    - Greg Prelewicz, P.E., Manager, Planning

- Virginia Department of Environmental Quality (Water Quality Regulations)
    - Tom Faha, Regional Director, Virginia Department of Environmental Quality, Northern Regional Office

- Virginia Tech/Occoquan Watershed Monitoring Lab (Water Quality in Reservoir)
    - Dr. Stanley Grant, Director, Occoquan Watershed Monitoring Lab (OWML) Professor of Civil & Environmental Engineering, Virginia Tech

- Northern Virginia Regional Commission (Occoquan Watershed Nonpoint Source Pollution Program)
    - Normand Goulet, Director, Division of Environmental and Resiliency Planning

Prince William County

The Occoquan Reservoir and Source Water Protection

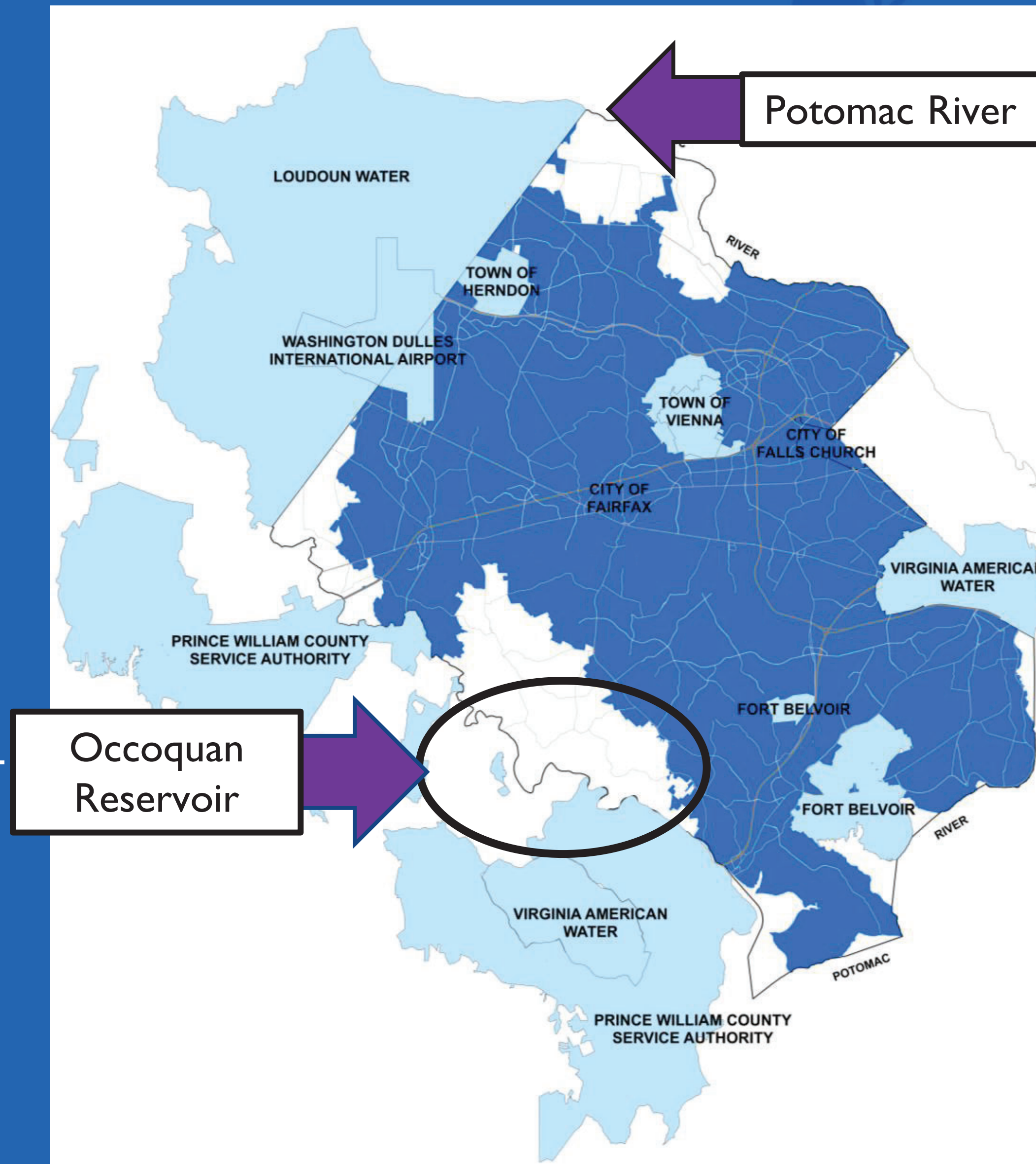
Jamie Bain Hedges, P.E., General Manager
Greg Prelewicz, P.E., Manager, Planning

June 7, 2022

Fairfax Water

FAIRFAX WATER – WHO ARE WE?

- Single Purpose Agency
- Not- for-profit Utility
- Drinking water supplier for 2 Million residents of Northern Virginia
- Corbalis Water Treatment Plant – Potomac River
- Griffith Water Treatment Plant – Occoquan Reservoir



WATER SUPPLY & TREATMENT

- Treated water quality surpasses all Environmental Protection Agency (EPA) and Virginia Department of Health (VDH) regulations
- Conventional treatment plus ozone & granular activated carbon
- Griffith Water Treatment Plant (WTP) - 120 MGD
- Corbalis Water Treatment Plant (WTP) - 225 MGD

Griffith WTP

Corbalis WTP

BACKGROUND

- Occoquan Reservoir acquired by Fairfax Water in the late 1960s
- Water quality concerns in the 1960s/1970s led to *Occoquan Policy* (1971)
- Fairfax Water (FW), Prince William County (PWC) and other watershed jurisdictions have been participants in regional efforts to assess and protect the Occoquan Reservoir for nearly a half-century
- Occoquan Reservoir is a vital regional supply source, now and for future generations

Occoquan Reservoir, 1973

Occoquan Reservoir, 2013

References: OWML, 1973, Eckert, 2003, Fairfax Water 2013

ROLE OF SOURCE WATER PROTECTION

- U.S. EPA establishes national drinking water regulations through the Safe Drinking Water Act (SDWA)
- Virginia Department of Health (VDH) administers the program
- Source water protection is a key component of the multi-barrier approach to safe drinking water
- Good water quality starts with the best available source
- VDH Waterworks Regulations:

Preference shall be given to the best available sources of supply that present minimal risks of contamination from point and nonpoint pollution sources that contain a minimum of impurities that may be hazardous to health and that give the greatest potential of ensuring a sufficient quantity of potable water.

Reference: 12VAC5-590-820

Occoquan Reservoir

FAIRFAX WATER
SOURCE WATER PROTECTION GOALS

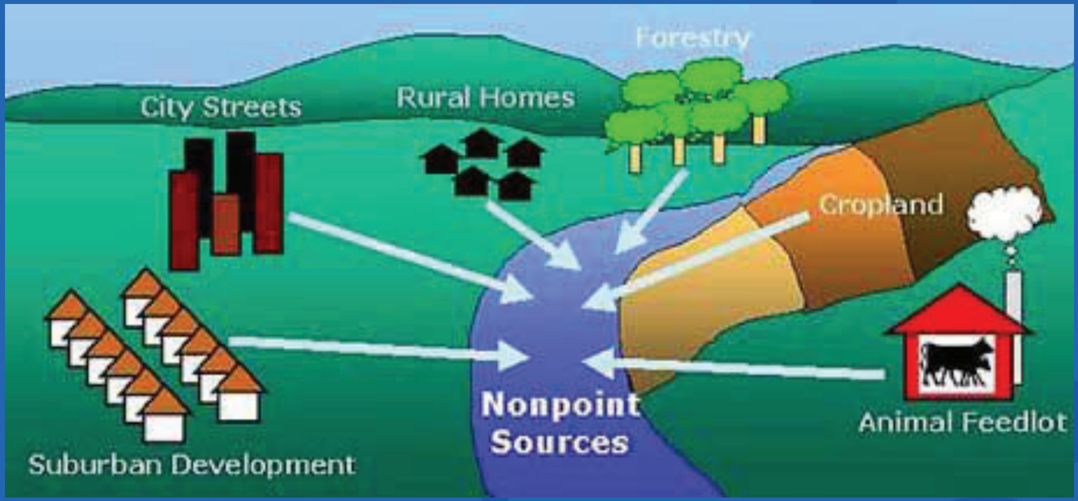
Preserve, and improve where needed, the reliability and high quality of the sources of supply in order to provide ample safe drinking water.

- Protect drinking water sources by preventing existing and potential contaminants from reaching the source waters.
- Provide clean, safe water that minimizes treatment expenses, protects public health, and sustains communities.
- Fairfax Water has responded to source water protection challenges by developing innovative programs and solutions to protect the community's water supply.

Fairfax Water Stakeholder Outreach Grant Program

SOURCE WATER PROTECTION CHALLENGE NON-POINT SOURCE (NPS) RUNOFF

- Most NPS occurs as a result of runoff.
- Excess fertilizers, herbicides and insecticides from agricultural lands and residential lands
- Sediment from unmanaged construction sites, crop and forest lands, and eroding streambanks



Reference: EPA, 841-F-96-004G

- Bacteria and nutrients from livestock, pet wastes and failing septic systems
- Road salts; heavy metals and other chemicals from urban runoff
- Difficult to control because it comes from many different sources and locations
- What happens in the watershed eventually affects the Reservoir

SOURCE WATER CHALLENGES – IMPACTS ON HYDROLOGY AND HYDRAULICS

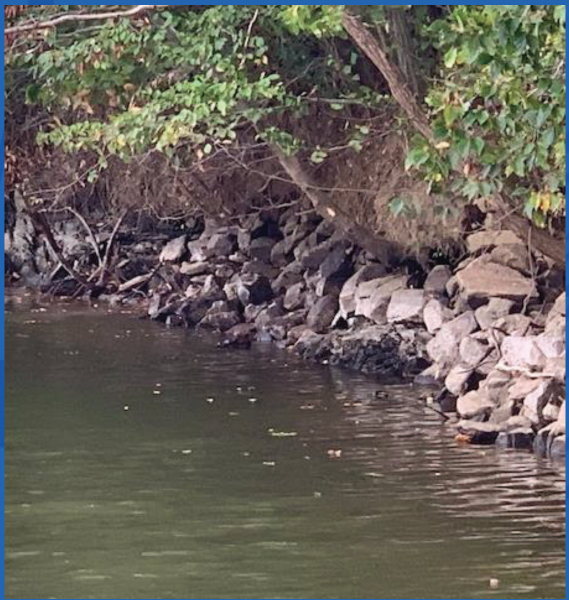
- More impervious area, less groundwater recharge, less baseflow in streams, accelerated shoreline erosion
- Stormwater runoff mobilizes and transports nutrients, sediments and contaminants.
- Sediment transport and erosion of the shoreline.
- Forests have a significant role in the hydrologic regime of a watershed. Deforestation tends to decrease evapotranspiration, increase stormwater runoff and soil erosion, and decrease infiltration to groundwater and baseflow of streams.

Occoquan Reservoir Shoreline

OCCOQUAN SHORELINE EASEMENT & STABLIZATION

- FW has easements around the Reservoir, provide riparian buffer
- PWC Watershed Management staff share information with FW
- Effectively work together on joint issues within the Fairfax Water easement and PWC's Resource Protection Area (RPA)
  - FW has worked with dozens of PWC residents to stabilize their properties
  - FW grants support community and property owner efforts to protect our source water

Occoquan Reservoir



INDUSTRIAL DISCHARGES TO UPPER OCCOQUAN SEWAGE AUTHORITY (UOSA)

- Some chemicals not easily treated by and thus “pass through” municipal wastewater plants
- Industrial pre-treatment programs work within EPA/DEQ framework
- Micron Technology voluntarily changed chemicals to reduce sodium concentrations
- Recirculating industrial and commercial cooling systems must maintain a disinfection residual
  - Bromide and Sodium commonly used chemicals that “pass through” wastewater treatment
- Other emerging and “pass through” contaminants

Micron Technology, Manassas, VA

SALT IN SOURCE WATERS

- Not removed in most water treatment processes
    - Requires expensive, energy intensive membrane treatment
- Increasing regionally and nationally in freshwater sources
- Long-term upward trend in Occoquan source
- EPA Advisory - Sodium
- Regional efforts to address salts in freshwater
    - Salt Management Strategy (SaMS)-NVRC
    - Metropolitan Washington Council of Governments (MWCOG,) FW education efforts
    - Occoquan Watershed Monitoring Lab (OWML) – National Science Foundation (NSF) grant project,

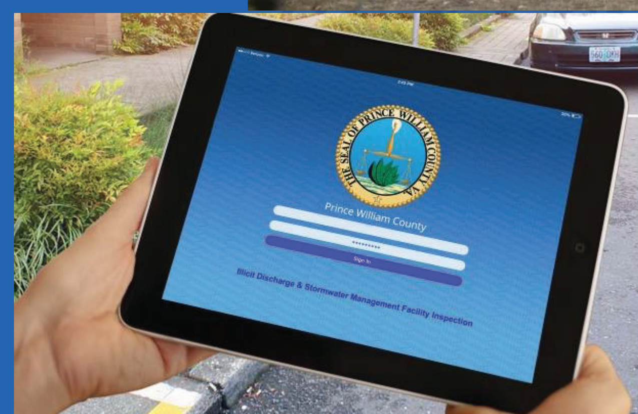
POTENTIAL MEASURES TO MITIGATE IMPACT

SOURCE WATER PROTECTION STORMWATER MANAGEMENT PRACTICES

- Prince William County (PWC) adopted new Stormwater Regulations in 2014
  - New development activities design criteria reduce total phosphorus to 0.41 pounds per acre
  - Consider additional stormwater management ordinance requirements
- Possible Additional Measures
  - Adopt Stormwater Management Practices above and beyond State Requirements
    - Phosphorus pollution is also closely associated with sediments
  - Reduce phosphorus with additional management measures

  Examples: Chesterfield County, VA, Fairfax County, VA

Stormwater BMP



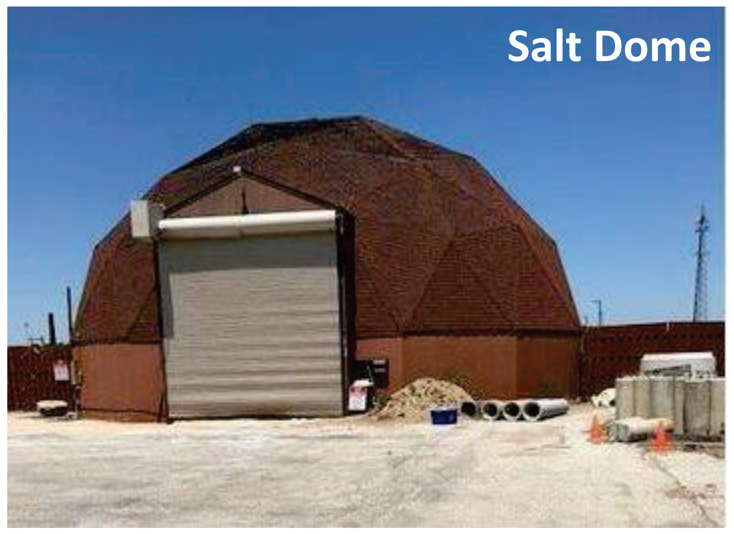
Timmons Group

SALT MANAGEMENT MEASURES

- Reduce salts from commercial and industrial activities such as cooling blowdown by encouraging the use of air-cooling of data centers or the adoption of other site specific measures to reduce sodium and bromide

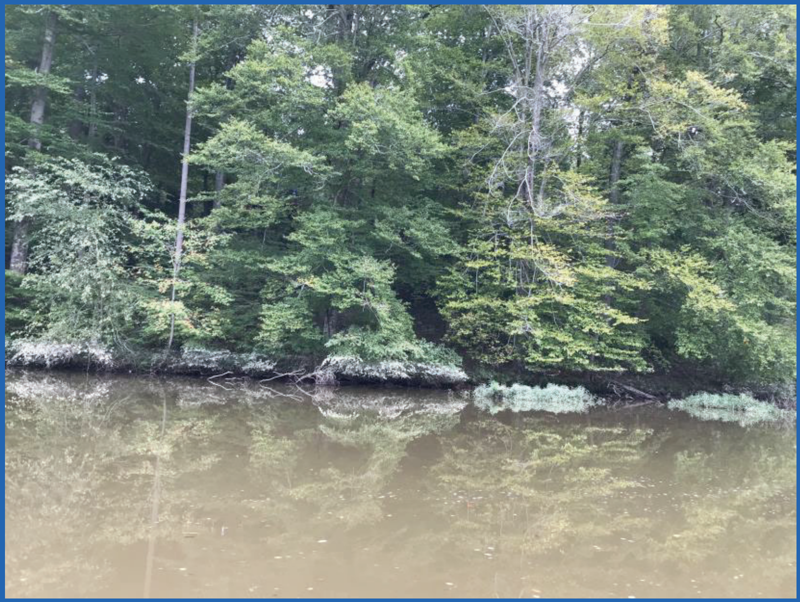
- Actively use and enforce its stormwater management regulations that prohibit discharge of runoff water to storm drainage systems and streams from uncovered or uncontained salt or sand storage piles.


Data Center


Salt Dome

STRENGTHEN ENVIRONMENTAL, STREAM RESOURCE, AND TREE CANOPY PROTECTIONS

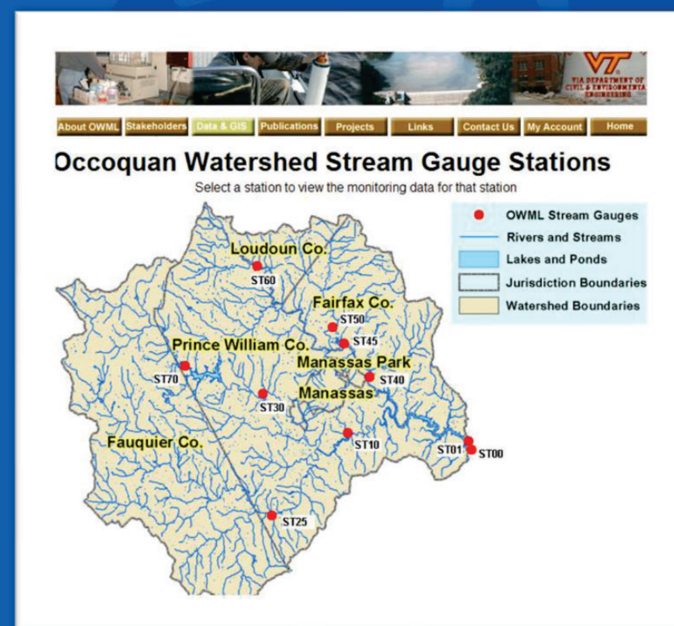
- Preservation of stream buffers, wetlands and other environmental resources can protect source water quality.
- Adopt policies, Zoning Ordinance amendments and Comprehensive Plan Action Strategies to preserve sensitive environmental resource areas.



Occoquan Reservoir

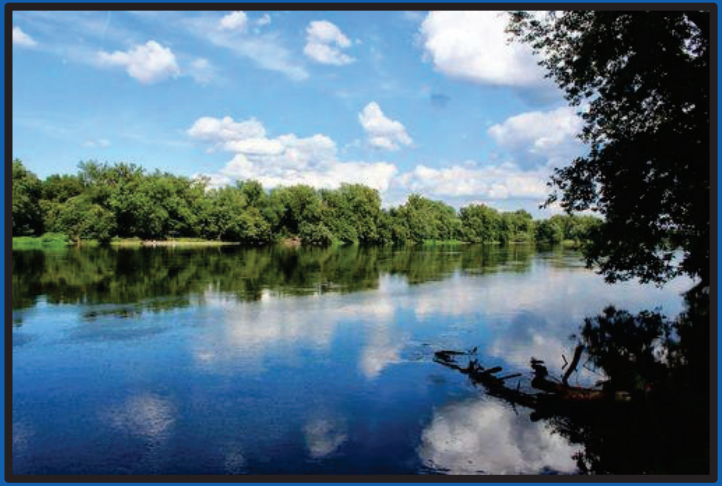
STREGTHEN ASSESSMENT AND MONITORING OF SOURCE WATER QUALITY

- Enhance long-term stream monitoring
- Provide an ongoing evaluation of stream health and identify trends in the conditions of waterways.
- Augment existing OWML water quality sample stations for more specific area / streams



PARTICIPATE IN OCCOQUAN MODELING EFFORTS

- Provide periodic updates on initiatives to the Northern Virginia Regional Commission (NVRC)
- Support efforts to maintain the Occoquan Model as a planning tool
- Use results to help inform and update ordinances, practice manuals and other regulations



Occoquan Reservoir

SUMMARY

- Source water protection is a key barrier in a multi-barrier approach to providing high-quality drinking water.
- Potential sources of contaminants come from various sources, including point and non-point sources.
- As an urbanized watershed, impacts of hydrology and land cover changes are seen along the shoreline and in the Occoquan Reservoir.
- Salts and some emerging contaminants may not be removed in the municipal water and wastewater treatment process.
- Additional mitigation measures should be considered as part of the land development process. Where possible, critical environmental resources should be protected.
- Long-term monitoring and assessment of water resources can assist planning and zoning efforts.
- The Occoquan Model is an important regional tool that should be used as part of the long-term planning process and to inform site design criteria.

PRINCE WILLIAM COUNTY

Virginia State Water Control Board Water Quality Regulations Brief Overview

June 7, 2022

Virginia Department of Environmental Quality
Northern Regional Office

Thomas Faha   Regional Director

Sarah Sivers   Manager Wastewater Permits, Planning, Monitoring

April Rhodes   Manager Stormwater Plan Reviews

State Water Control Board Regulations

- **Water Quality Standards (9VAC25-260)**
  - Beneficial uses
  - Water quality criteria

- **Water Quality Management Planning (9VAC25-720)**
  - Sets forth planning necessary to protect water quality
  - Total Maximum Daily Load (TMDL) and wasteload allocations

- **Virginia Pollutant Discharge Elimination System Permit (9VAC25-31)**
  - Authorizes discharge of treated wastewater, stormwater, etc. to surface waters
  - Sewage treatment plants, water treatment plants, industrial, commercial

State Water Control Board Regulations

- **Virginia Pollution Abatement Permit (9VAC25-32)**
  - Non-discharge treatment systems, e.g. spray irrigation systems

- **Virginia Water Protection Permit Program (9VAC25-210)**
  - Authorizes activities in surface waters (wetlands)
  - Impacts to wetlands, streams, water withdrawals

- **Erosion and Sediment Control Regulations (9VAC25-840)**
  - Sets requirements for E&S controls during construction

State Water Control Board Regulations

- **Virginia Stormwater Management Program Regulation (9VAC25-870)**
  - Sets minimum water quality and water quantity requirements for new and re-development:
    - Administrative requirements including VSMP Authorities
    - Technical requirements during construction and post-construction
  - Sets requirements for Municipal Separate Storm Sewer System (MS4)
    - Authorizes stormwater discharges from urban areas
    - Permit requirements for management and monitoring of stormwater

- **Chesapeake Bay Preservation and Area Designation and Management Regulations (9VAC25-830)**
  - Sets administrative requirements for local governments to incorporate water quality protection in land use decision-making
  - Sets criteria for program development and implementation

State Water Control Board Regulations

- **Occoquan Policy (9VAC25-410)**
  - Adopted 1971, pre Clean Water Act, State Water Control Law
  - Addressed poor water quality
  - Addressed low achieving sewage treatment plants
  - Restricted sewage treatment discharges to preferably 2, max 3, high performing regional sewage treatment plants (UOSA)
  - Set forth very stringent effluent limits for regional plants
  - Restricted major industrial discharges
  - Allows for single family residential failing septic systems to obtain discharge permit and small industrial discharges
  - Established monitoring program to study and assure minimal impact of regional sewage treatment plant on drinking water supply and non-point sources

PRINCE WILLIAM COUNTY

VIRGINIA TECH

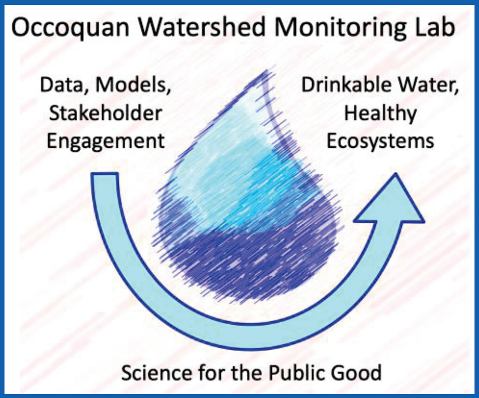
Water Quality in the Occoquan Reservoir: Past, Present and Future

Stanley Grant

Director, Occoquan Watershed Monitoring Lab

Professor Civil & Environmental Engineering, Virginia Tech

June 7, 2022



Occoquan Watershed Monitoring Lab (OWML)

- Integral part of the U.S.'s first deliberate indirect potable reuse experiment (1978 to present)
- Occoquan Reservoir provides **30 to 40 %** of the Raw Drinking Water for **Fairfax Water**
- Reservoir receives inflow from the watershed plus highly treated wastewater from the Upper Occoquan Service Authority (**UOSA**)
- Lab established in **1972** to protect public health and serve as an honest broker of water quality

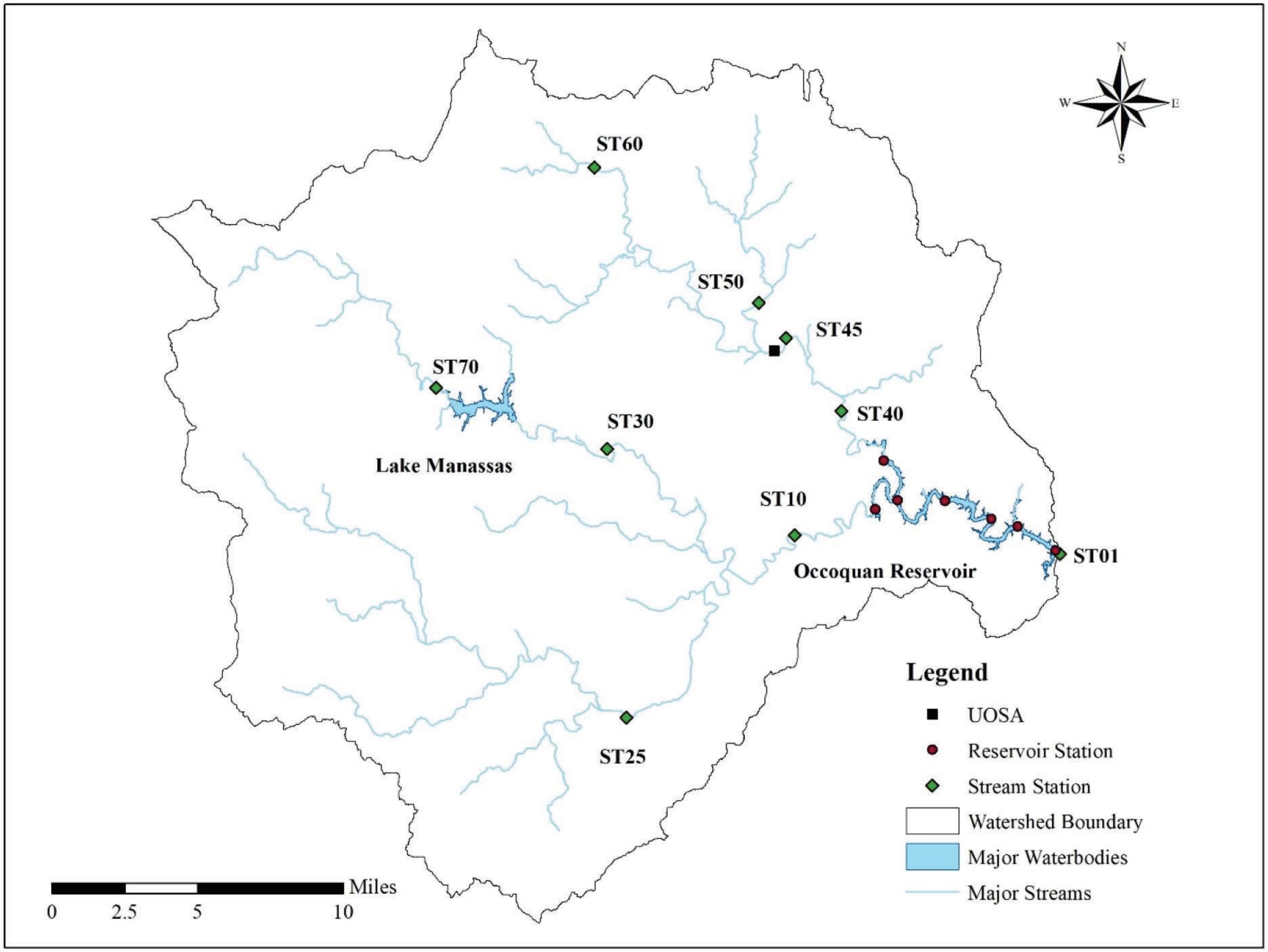
Lab's Current Mission

- Long-term stream and reservoir monitoring to support management decisions based on water quality trends
- Independent source of information to balance competing uses. Provides unbiased assessments.
- Helps formulate UOSA wastewater treatment requirements (flow and quality)
- Identification of urban and rural non-point source impacts on the watershed

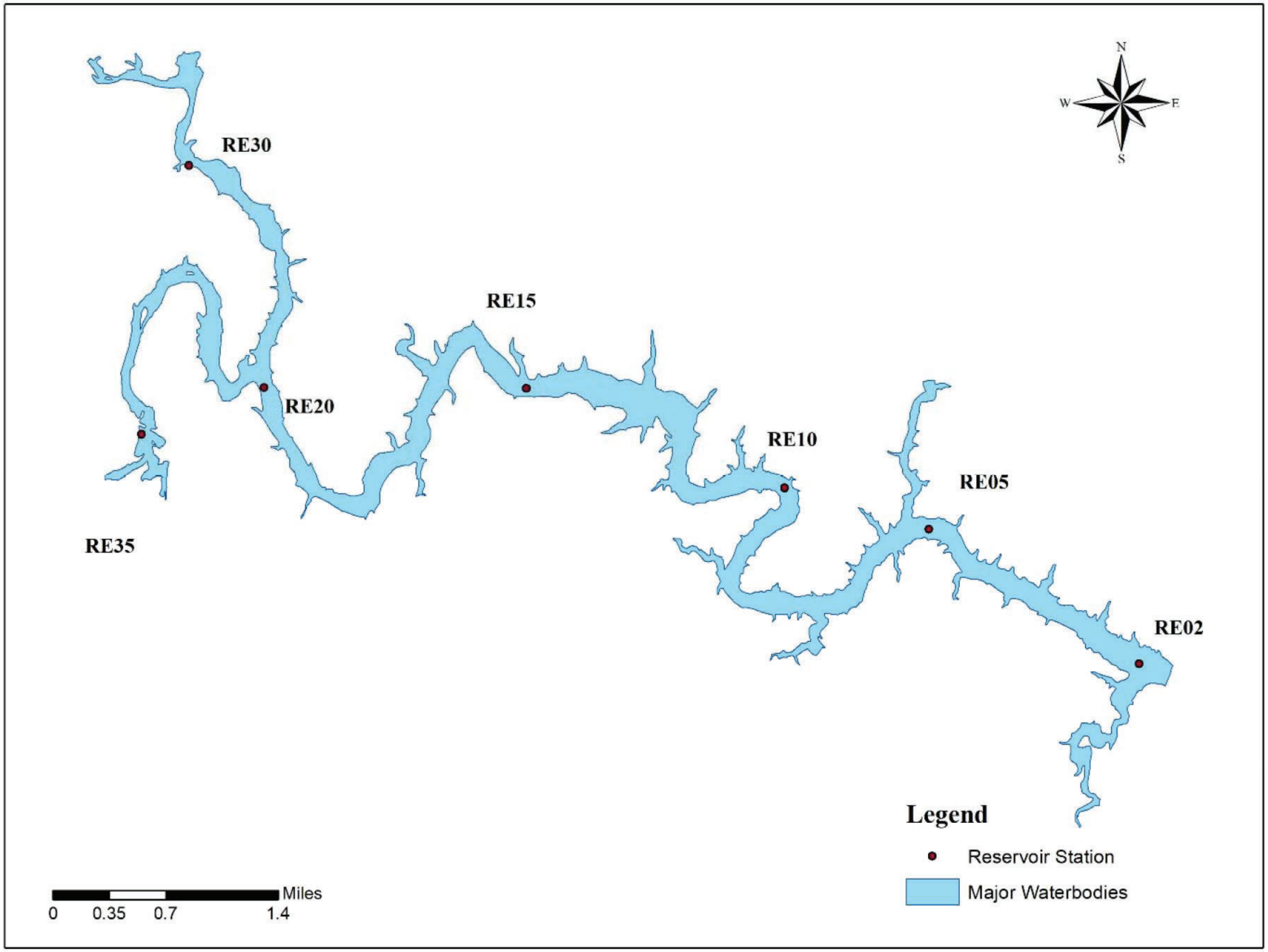
Unique Long-Term Water Quality Dataset (partial list)

- Occoquan Watershed and Reservoir Stations
  - DO, pH, T, conductance, alkalinity, N and P species, turbidity, TSS, COD, cations, anions, hardness (1973 to present, monthly to weekly)
  - Metals (1973 to present, quarterly)
  - Pesticides and Herbicides, including fish assays (1982 to present, every six months)
- 12 Rain Gages
- 7 Stream Gages in the watershed & 1 at the dam
- Stormwater sampling at all 7 stream stations (try to collect samples for every storm)

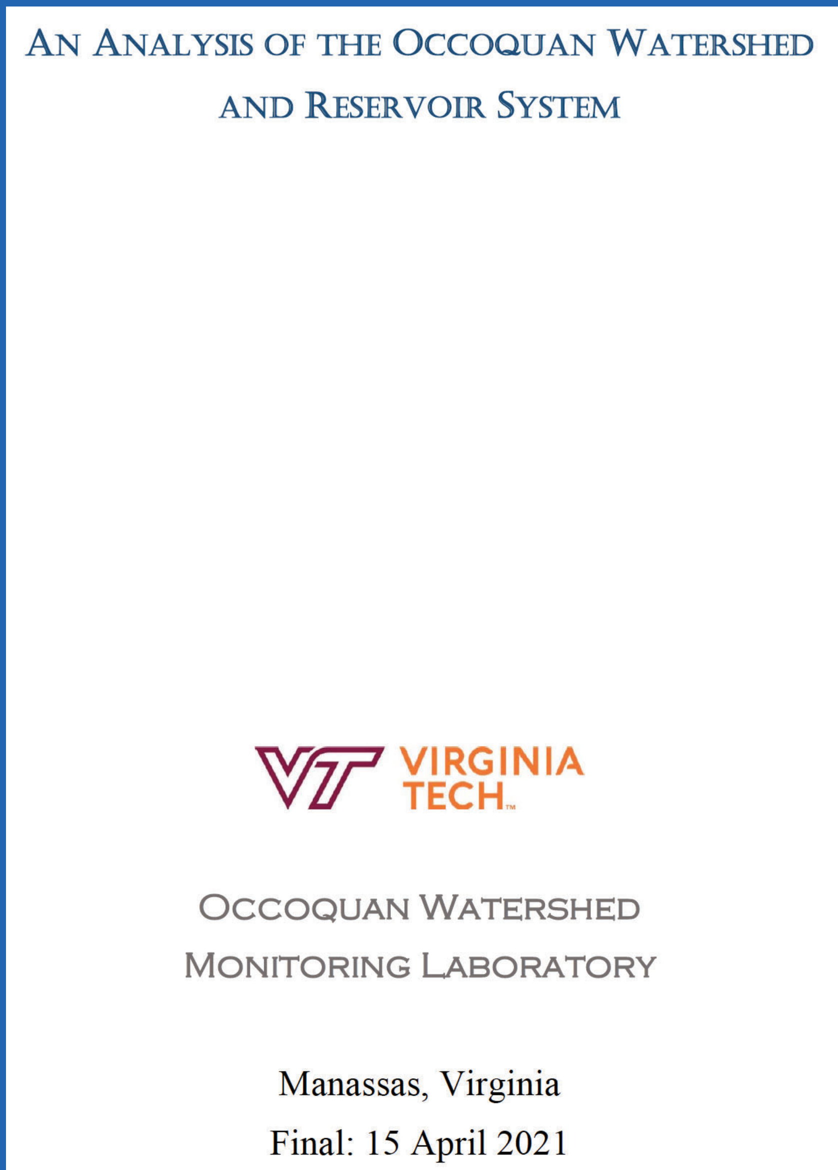
Monitoring Stations



Monitoring Stations - Reservoir



Reservoir Features & Inflows



AN ANALYSIS OF THE OCCOQUAN WATERSHED AND RESERVOIR SYSTEM

VIRGINIA TECH

OCCOQUAN WATERSHED MONITORING LABORATORY

Manassas, Virginia

Final: 15 April 2021

Adil Noshirwan Godrej
1957 - 2022

Occoquan Reservoir

- "While the Occoquan Reservoir itself continues to be eutrophic (that is, enriched with nitrogen and phosphorus species that can result in undesirable quantities of algae to grow in the reservoir), the water quality management programs implemented via best management practices (BMPs), such as wet and dry ponds (older technology) and rain gardens and green roofs (newer technology) in the watershed by the jurisdictions within the watershed have helped maintain water quality." - Adil Godrej

Occoquan Reservoir Characteristics

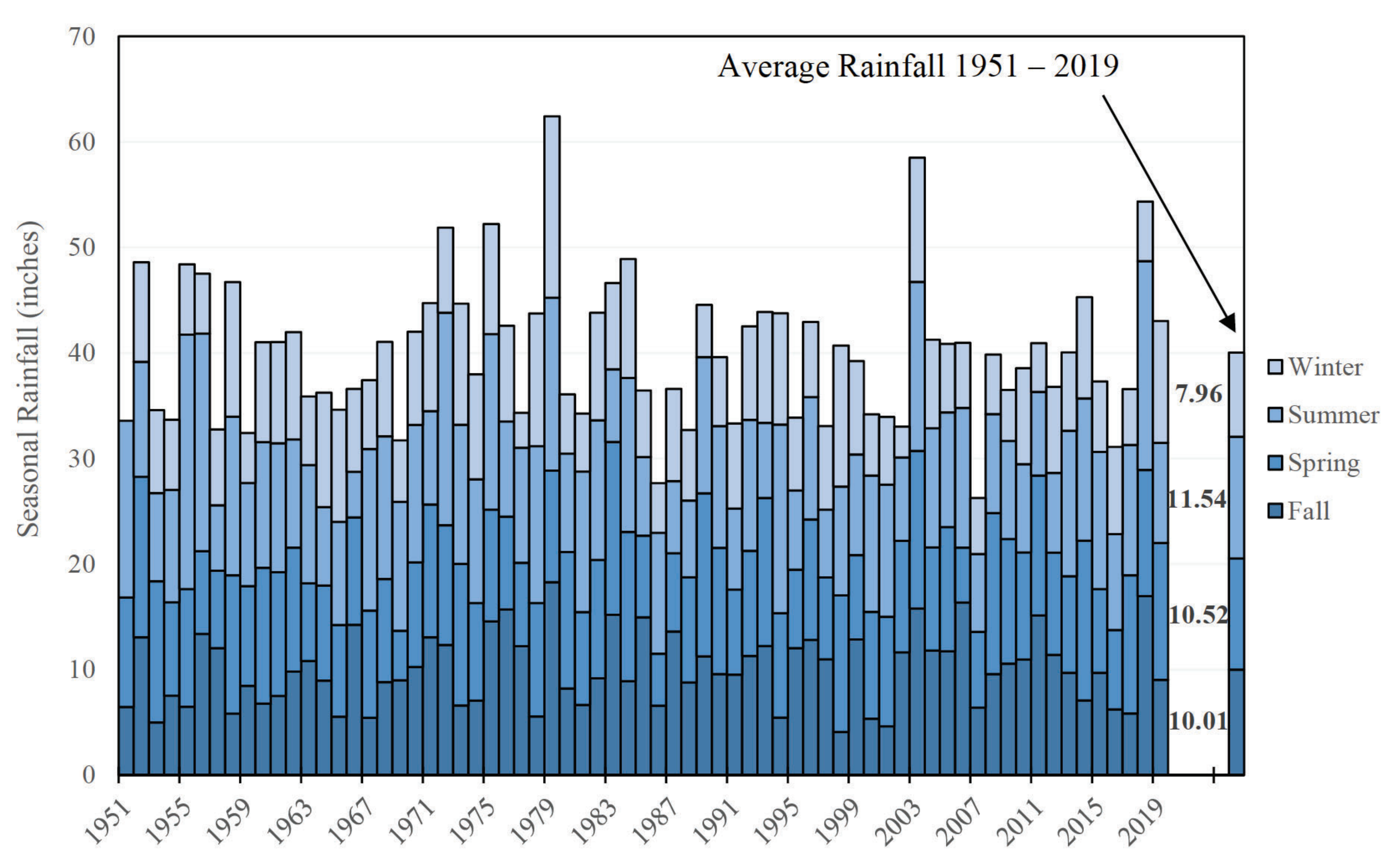
Parameter	Value	Source
Watershed Drainage Area	570 mi^2 (1,480 km^2)	OWML, 1998
Pool Area	1539 acres (6.23 km^2)	2010 Hydrographic Survey
Volume	8.33 billion gallons ($31.4 \times 10^6 m^3$)	2010 Hydrographic Survey
Watershed Area: Pool Area	238:1	Calculated
Length	14 mi (22.5 km)	Van Den Bos, 2003
Mean Depth	16.7 ft. (5.1 m)	Calculated
Maximum Depth	65 ft. (20m)	Grizzard, 2001
Maximum Width	900 ft. (275 m)	Van Den Bos, 2003
Dam Height	122 ft. (37.2 m) above mean sea level	OWML, 1998
Average Hydraulic Residence Time	19.6 days	Van Den Bos, 2003
Shoreline Development Index	10.9	OWML, 1998
Natural Safe Yield	65 mgd (250,000 m^3/d)	Van Den Bos, 2003
Reclaimed Water Addition	34 mgd (130,000 m^3/d)	UOSA, 2019

On average, water takes about 20 days to travel the full length of the reservoir

Reservoir is narrow and long

Godrej (2021) An Analysis of the Occoquan Watershed and Reservoir System. OWML Report. Virginia Tech

Rainfall is very evenly distributed over the year



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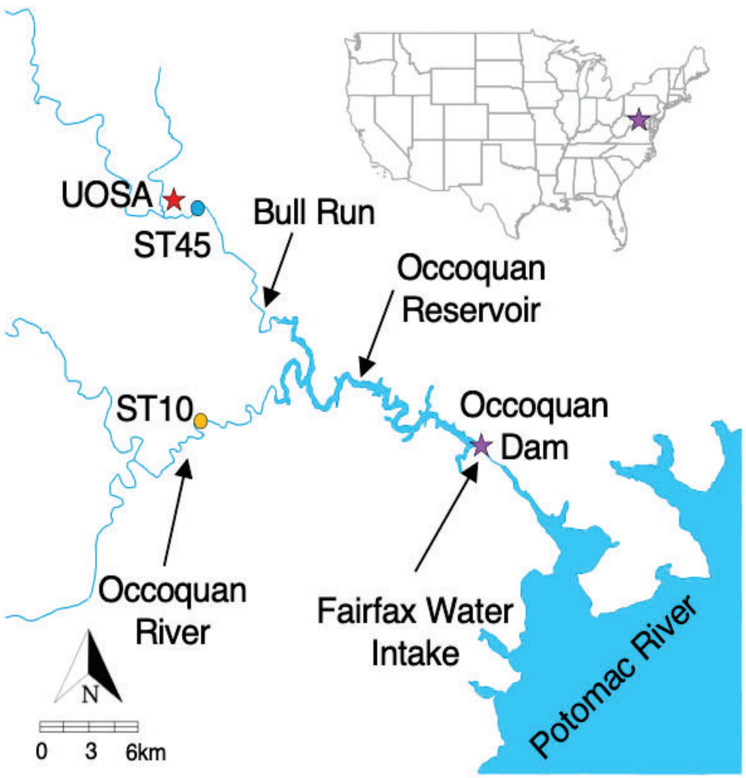
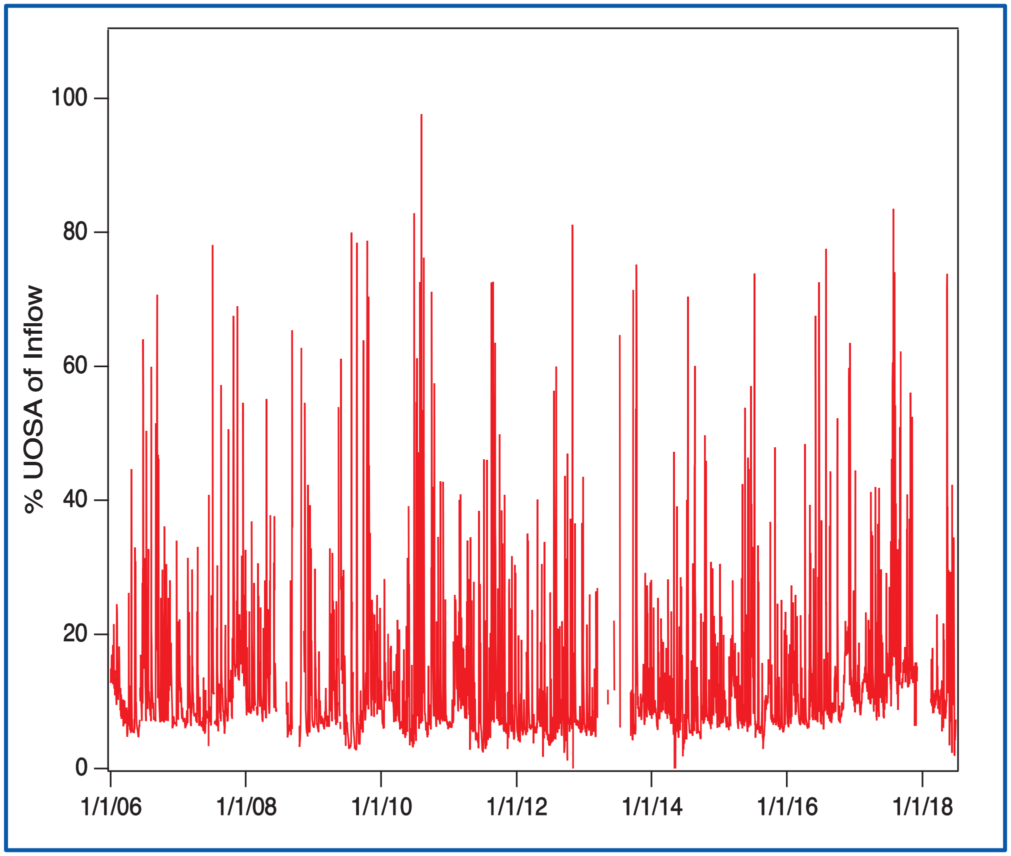
Percent Daily Flow into Reservoir (from Bull Run and Occoquan River) that is UOSA Effluent

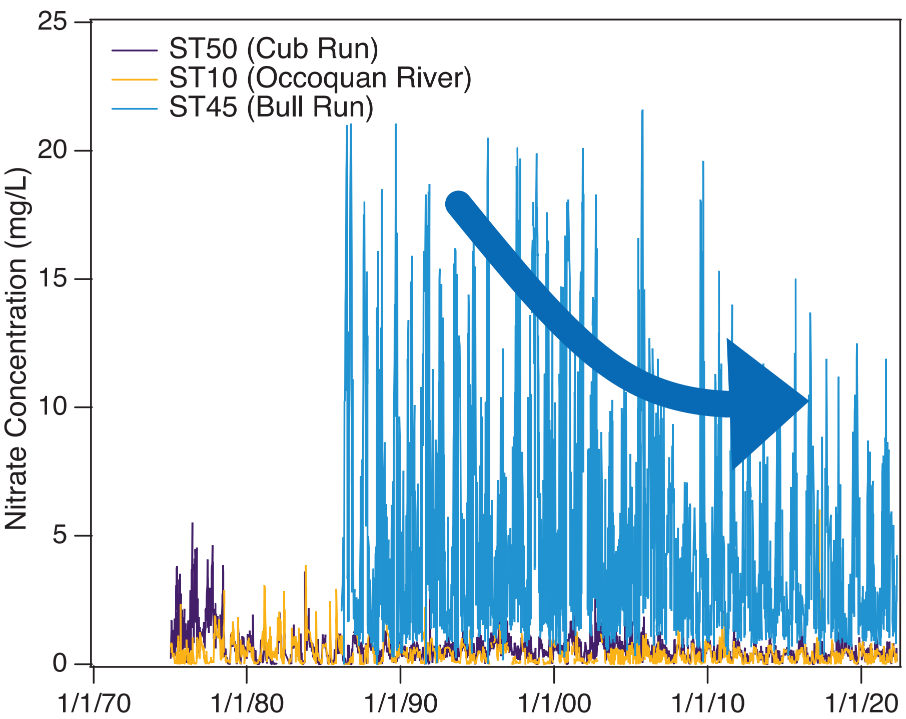




Grant (2022), unpublished

Some Long-Term Water Quality Trends (~1980 to present)

Long-Term Trends: Nitrate - Stream Sites



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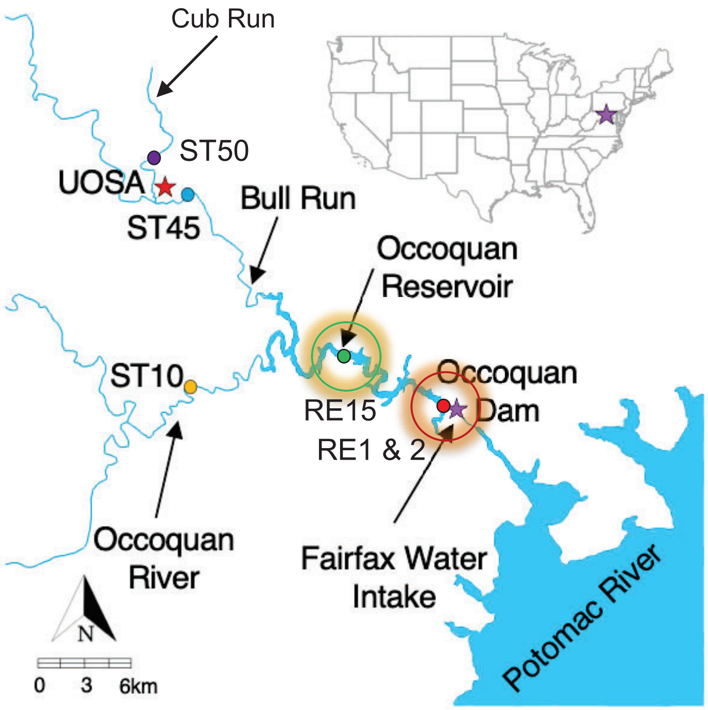
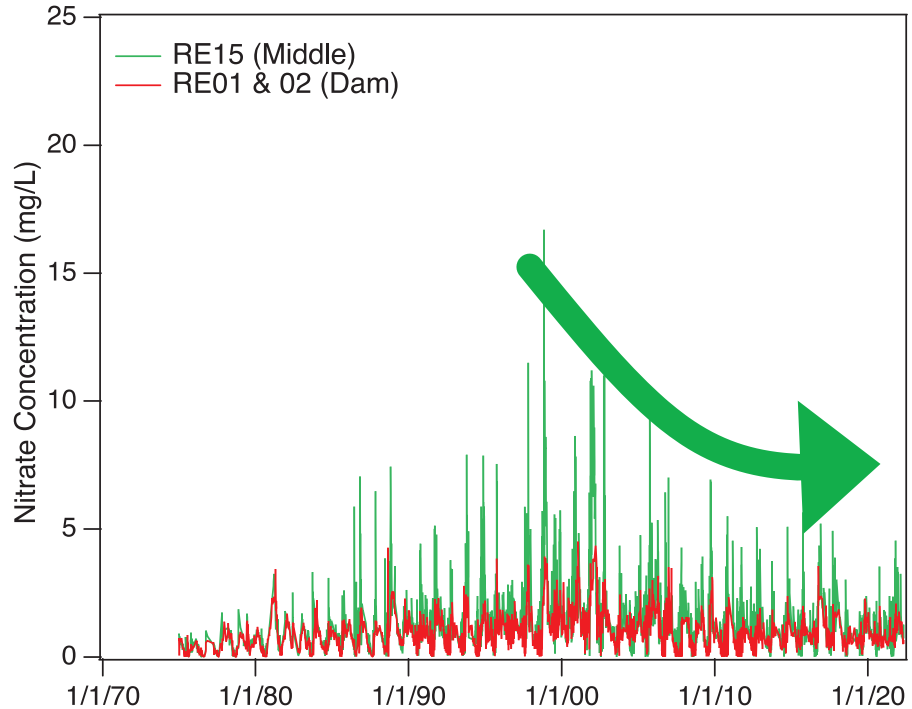
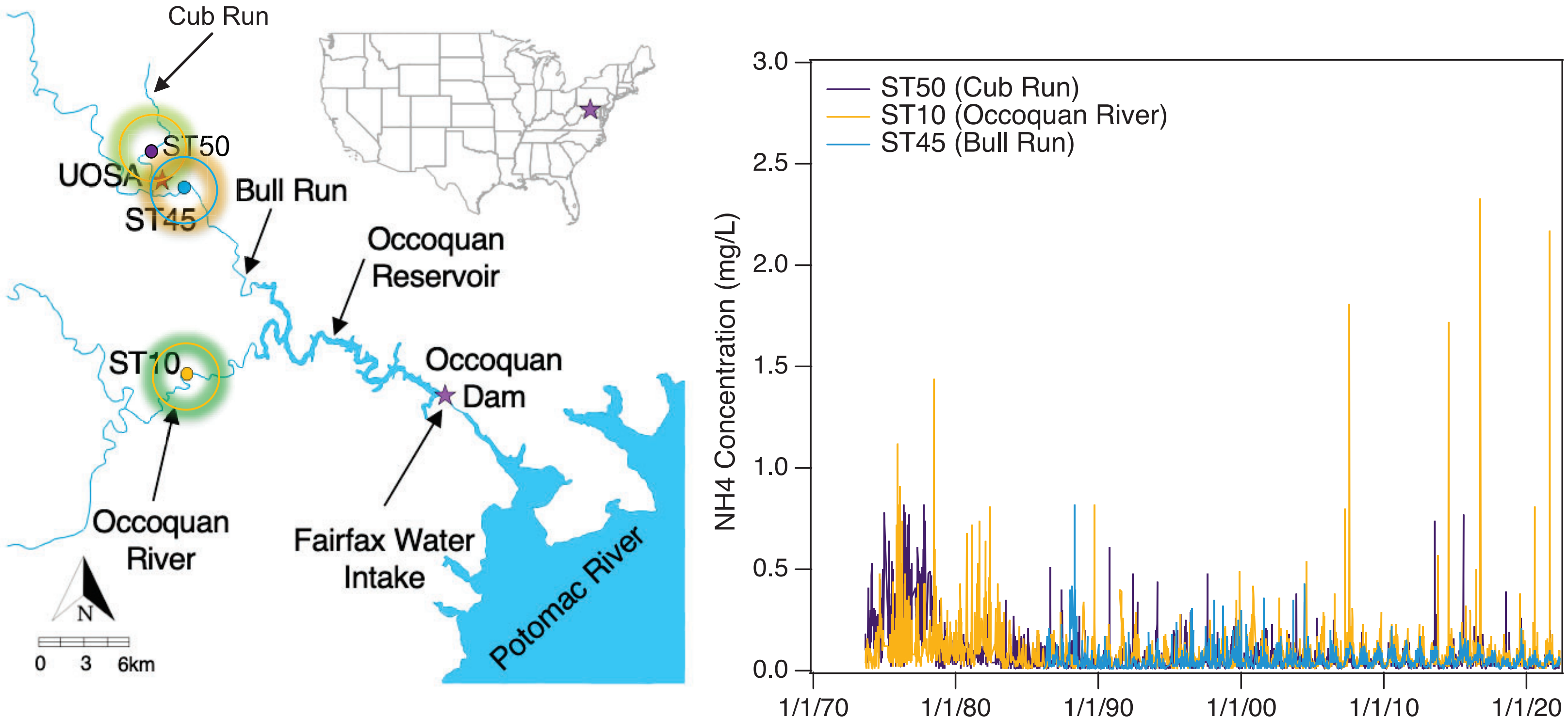




Grant (2022), unpublished

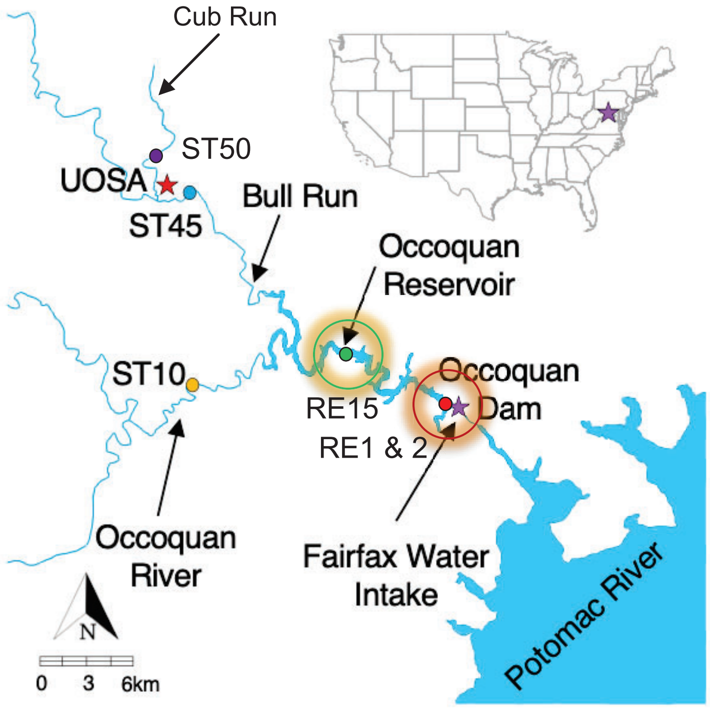
Long-Term Trends: Ammonium - Stream Sites

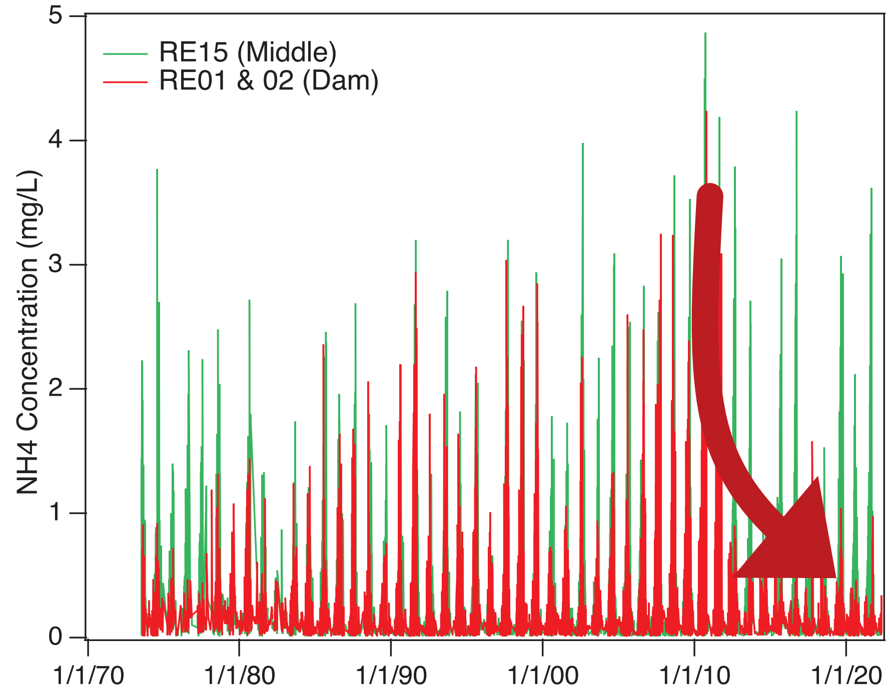


Grant (2022), unpublished

Long-Term Trends: Ammonium - Reservoir Sites

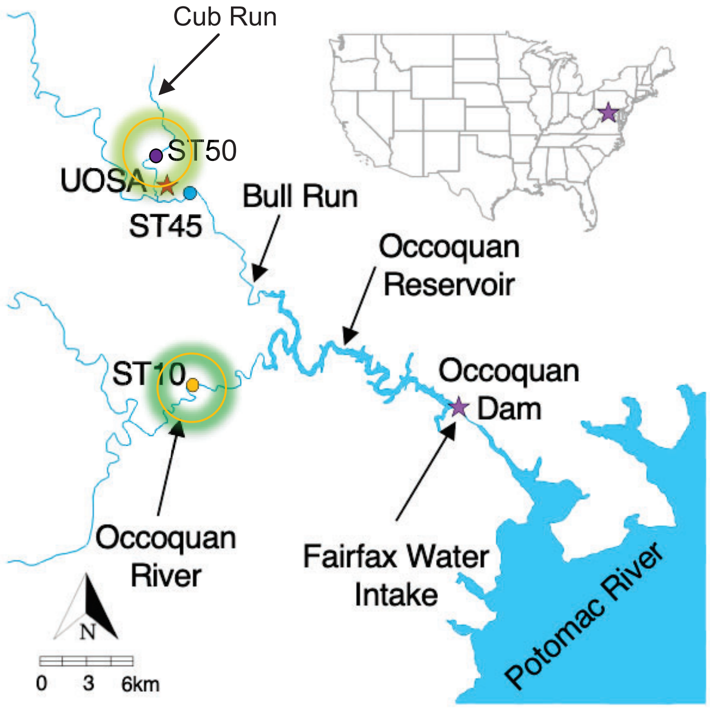
PRINCE WILLIAM COUNTY

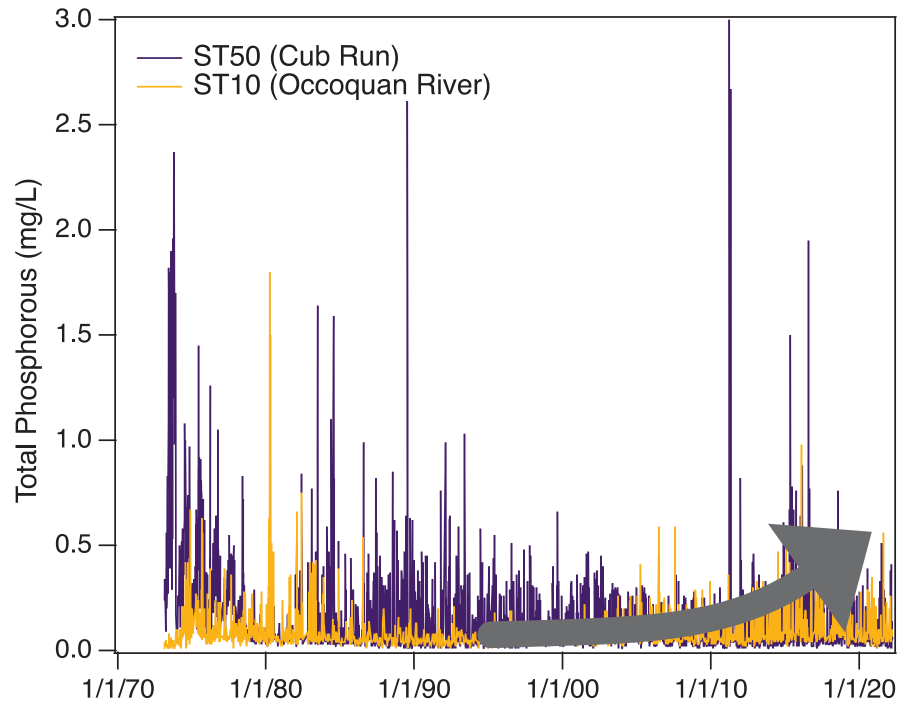




Grant (2022), unpublished

Long-Term Trends: Total Phosphorous - Stream Sites





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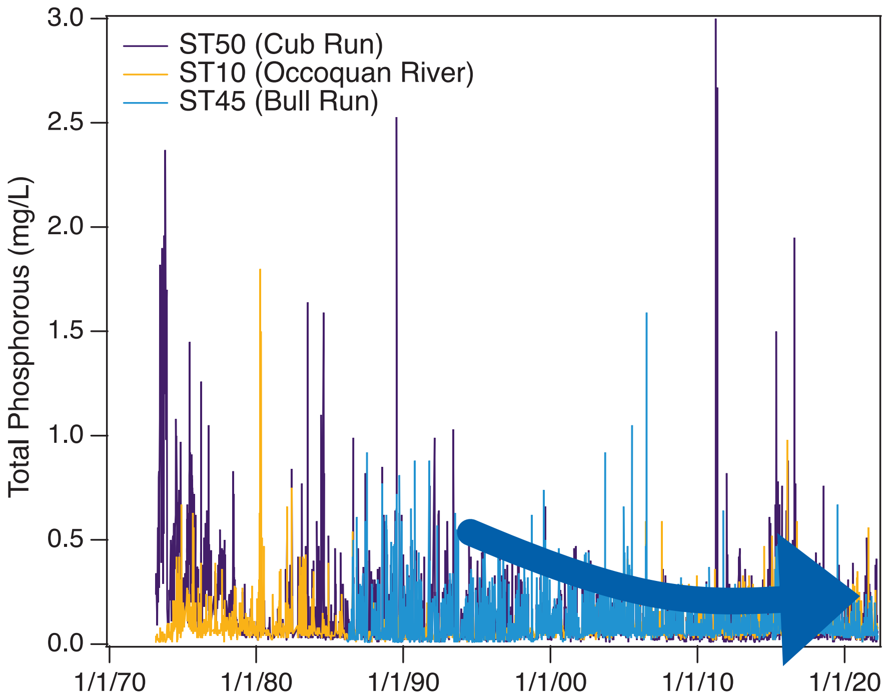

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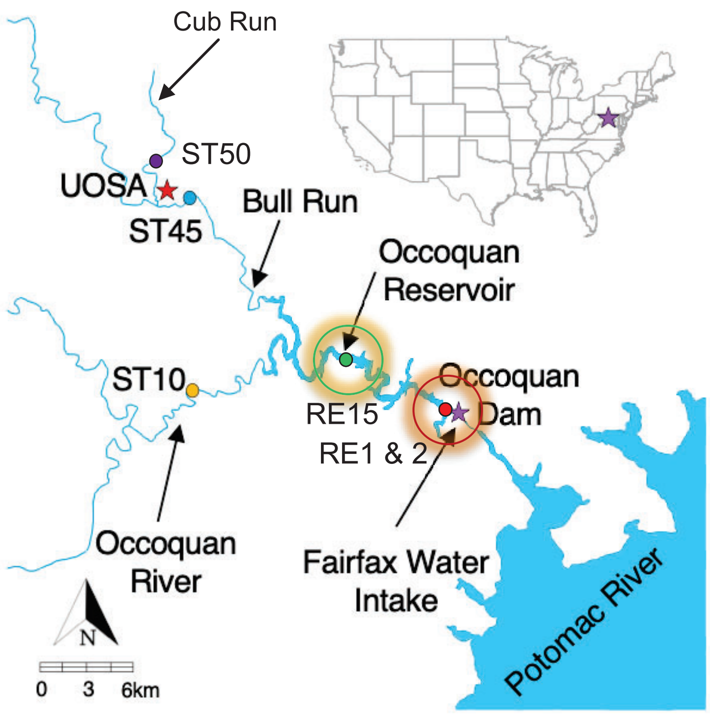
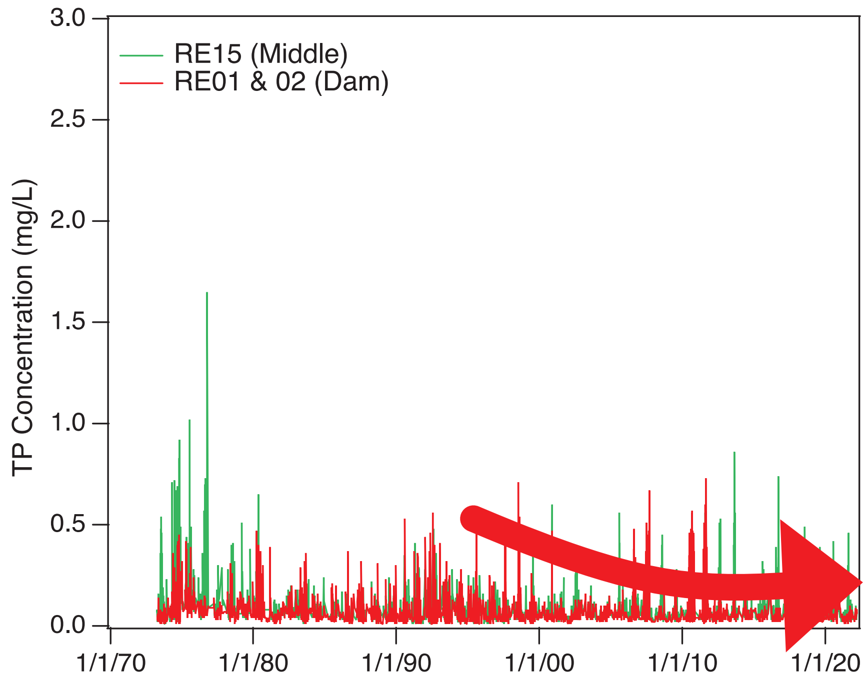
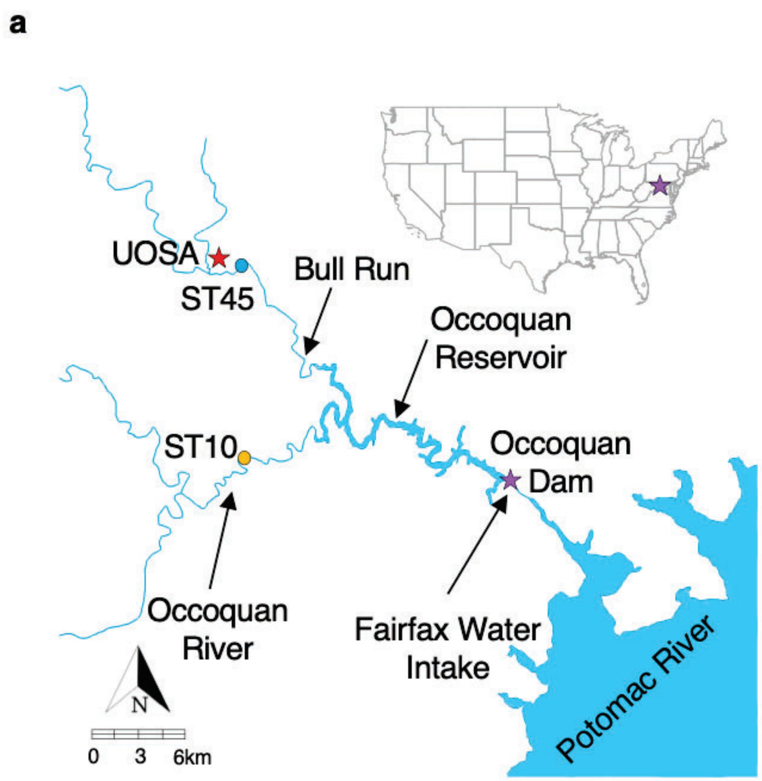
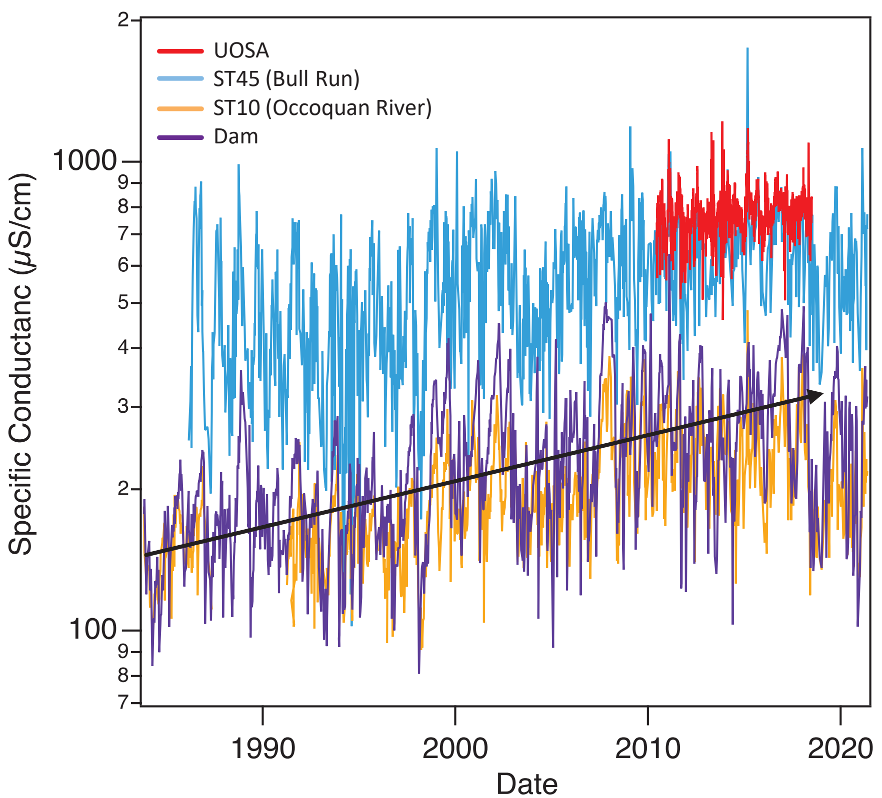




Grant (2022), unpublished

Rising Specific Conductance in the Occoquan Reservoir





Rising Sodium Concentration in the Occoquan Reservoir

Prince William County

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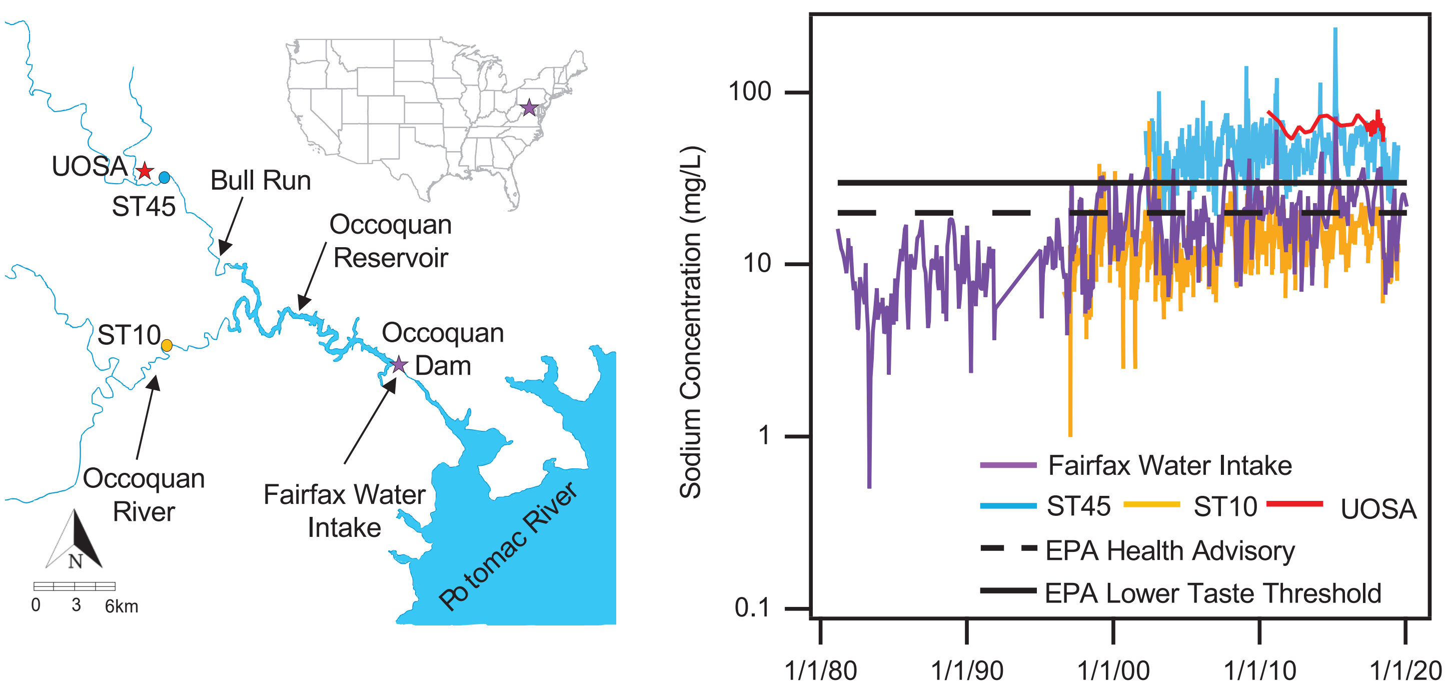
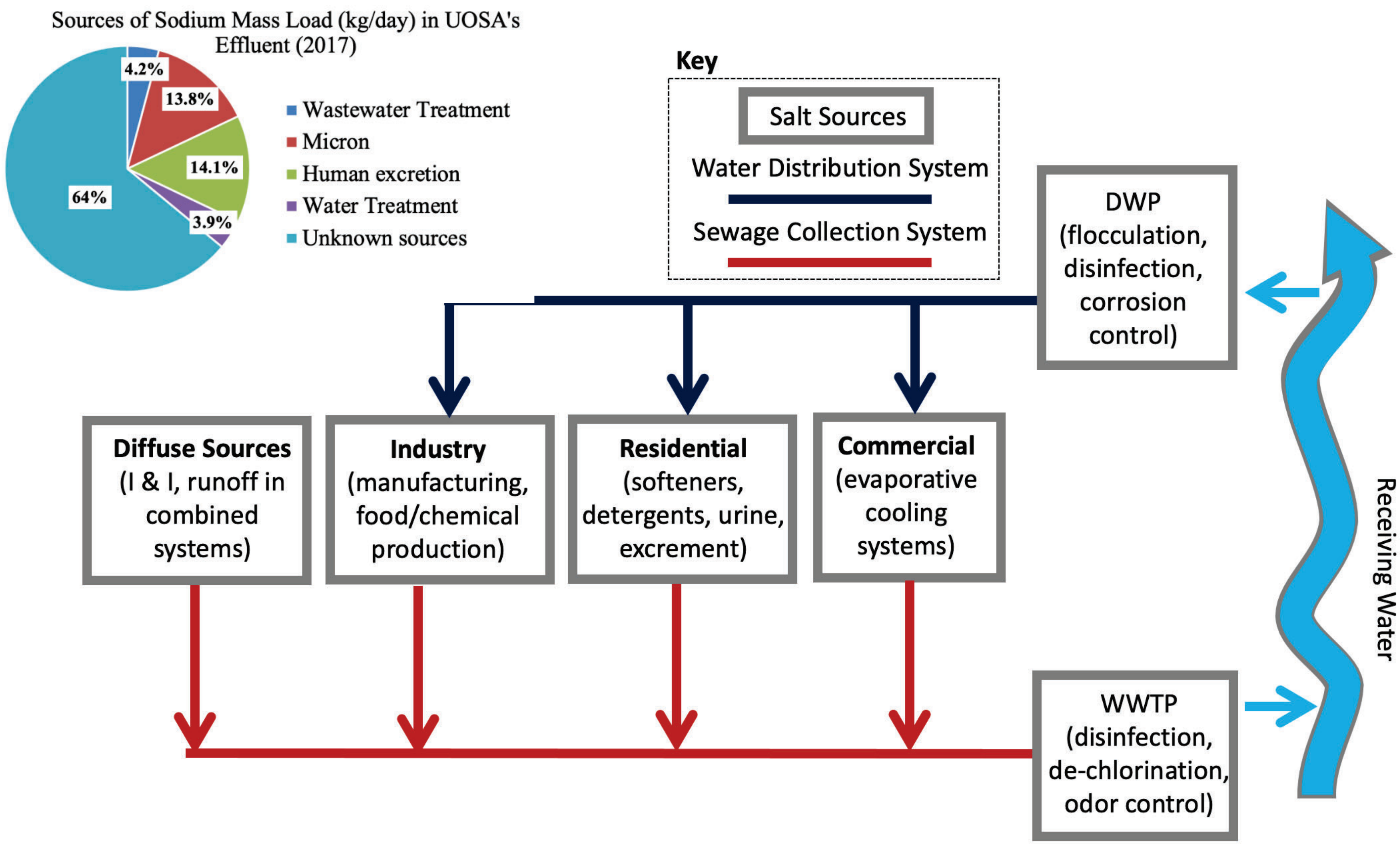
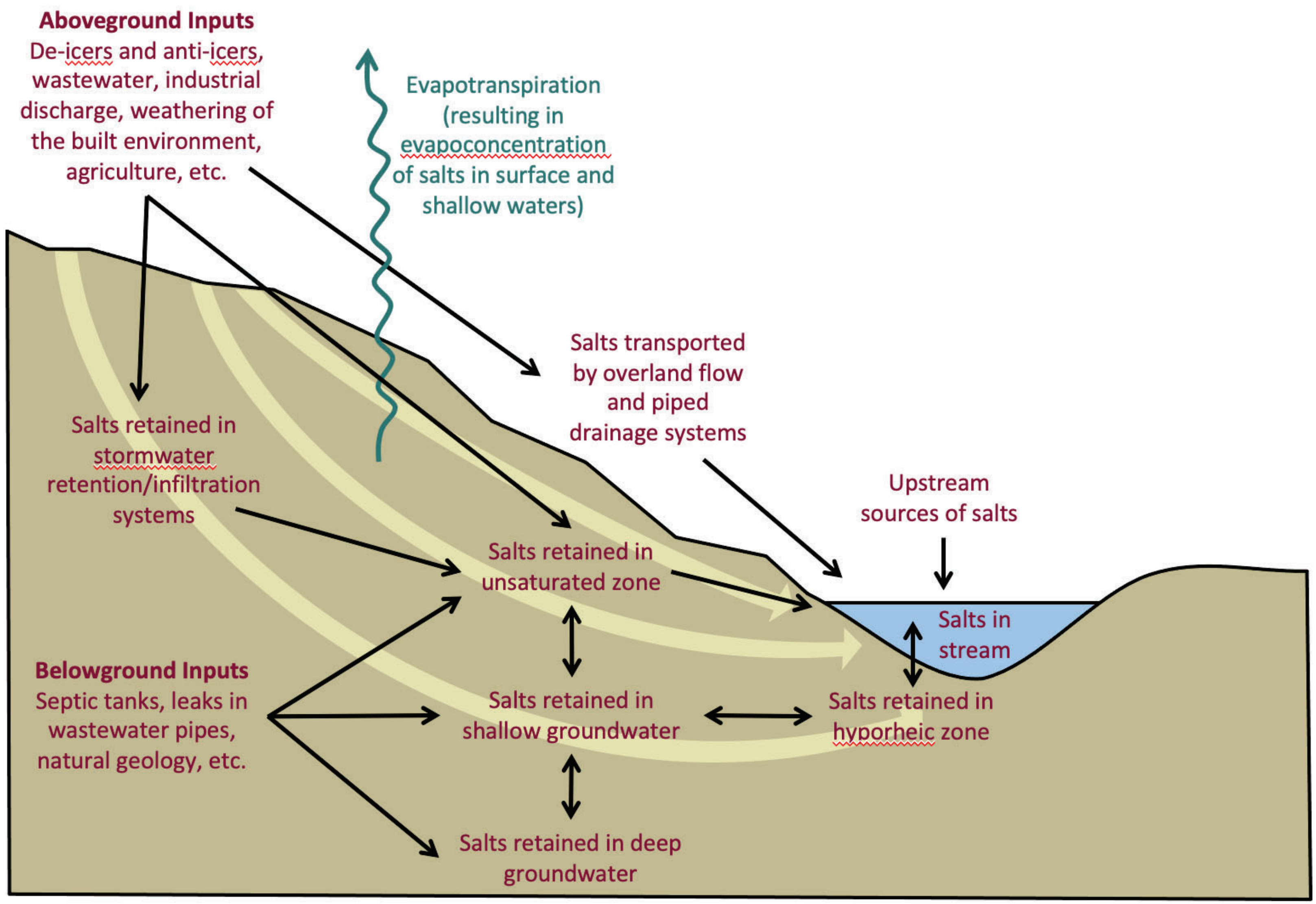


Bhide, S.V.; Grant, S.B; et al. (2021) Addressing the contribution of indirect potable reuse to inland freshwater salinization. *Nature Sustainability*. https://doi.org/10.1038/s41893-021-00713-7

Potential salt sources in Wastewater



Potential salt sources in the Watershed



Summary

- We have a world-class dataset on historical water quality trends in the reservoir and its tributaries
- Based on these historical trends, there is some good news:
  - Nitrate concentrations are currently stable on Cub Run and the Occoquan River
  - Nitrate concentrations have declined on Bull Run, downstream of UOSA (plant denitrification)
  - The Occoquan Reservoir removes (or dilutes) nitrate along the flow path, and consequently nitrate concentrations are lower at the dam

Summary

- Based on these historical trends, there is some good news (cont.):
  - Ammonium concentrations are mostly stable on Cub Run and have declined over time on Bull Run
  - The Occoquan Reservoir removes ammonium along the flow path, and consequently ammonium concentrations are much lower at the dam, especially post 2010
  - Total Phosphorous concentrations have declined over time on Bull Run (below UOSA)

Summary

- But there is some not-so-good news:
  - We are seeing more spikes over time in the concentration of ammonium on the Occoquan River tributary to the reservoir
  - Phosphorous concentrations appear to be increasing over time on the Occoquan River tributary to the reservoir
  - Specific conductance (a measure of salinity) is increasing at both stream and reservoir sites
  - Sodium concentrations are increasing, and at the dam occasionally surpass EPA advisory levels for taste and low-salt diets

Final Take Aways

- We are relying heavily on the ecosystem services provided by the reservoir:
  - Drinking water provision (for ~1M people)
  - Nitrogen removal (e.g., by denitrification and coupled nitrification-denitrification)
  - Phosphorous removal (by sediment sequestration)
  - Dilution of salts
  - Wildlife habitat
  - Recreational activities (e.g., fishing)
  - Aesthetic benefits
- Despite substantial growth in the Bull Run and Occoquan River watersheds, the reservoir continues to perform these functions well, largely due to the reliable supply of water provided by UOSA and the careful management of point and non-point source pollution by the local jurisdictions
- Protection of these ecosystem services should remain a top priority for the region

Thank you!

PRINCE WILLIAM COUNTY

Occoquan Watershed Nonpoint Source Pollution Program

Normand Goulet

Northern Virginia Regional Commission

June 7, 2022

Occoquan Watershed Regional Nonpoint Program

Stated Goal

Supplement the Benefits of the Basin’s Advanced Wastewater Treatment Policy to Enhance and Preserve Water Quality within the Water Supply Watershed in Order to Provide Safe Drinking Water for the Present and Future Residents of Northern Virginia.

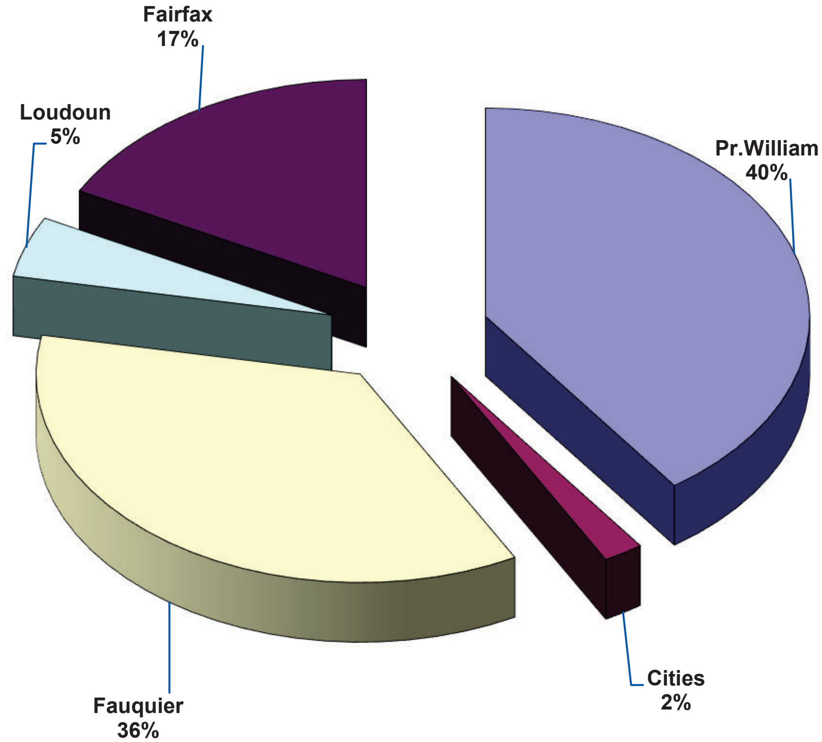
Occoquan Watershed Regional Nonpoint Program

- Established through a Formal Inter-jurisdictional Agreement
- All Watershed Jurisdictions and two Service Authorities
- Strictly Advisory in Nature – No Regulatory Authority
- Manages Stormwater for the Control of Phosphorus and to a Lesser Extent Sediment
- Regional Cooperative Program
  - Vehicle for fostering inter-jurisdictional cooperation
  - Help shape through guidance and consensus building stormwater management policy
  - Technical assistance to local staffs
  - Upkeep and continued maintenance Occoquan Watershed Model

Occoquan Watershed Regional Nonpoint Program

PRINCE WILLIAM COUNTY

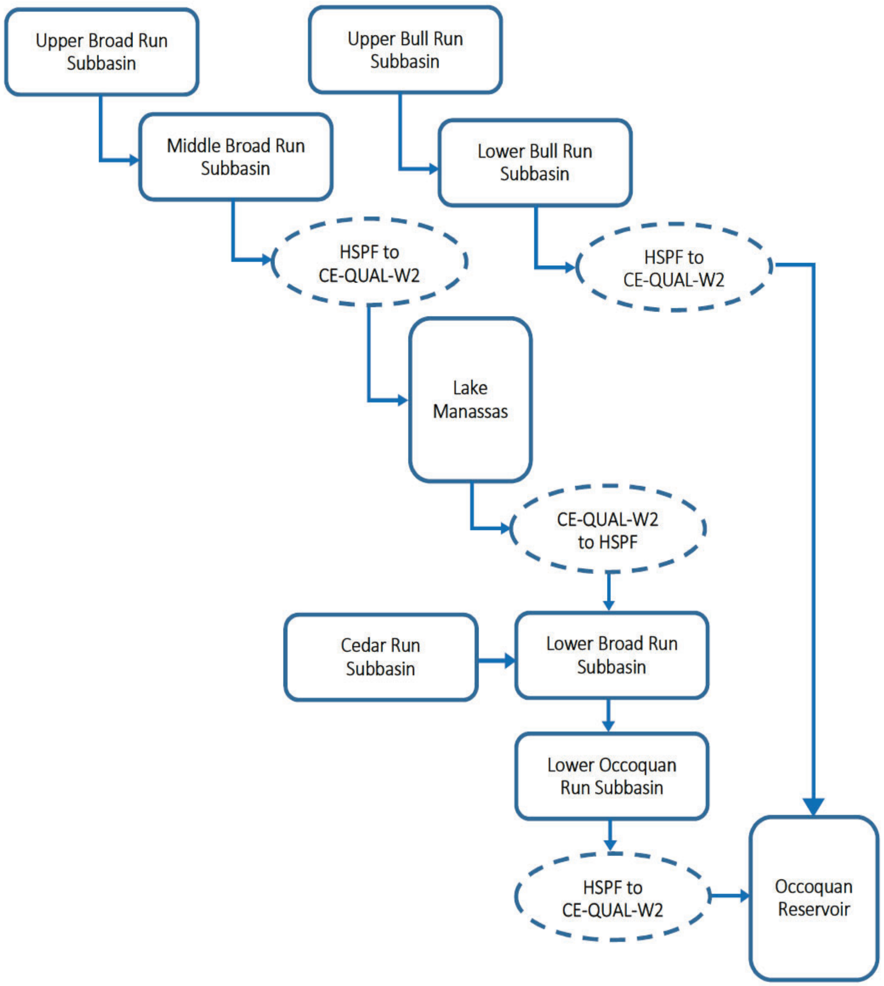
- Governance
  - Policy Board
    - County/City/Authority Managers
  - Technical Advisory Committee
    - Public Works Directors
    - Authority Representatives
    - Soil and Water Conservation District
- Governance Change
  - Modeling Subcommittee
    - Technical Staff



Land Area of the Occoquan Watershed

Occoquan Watershed and Reservoir Model

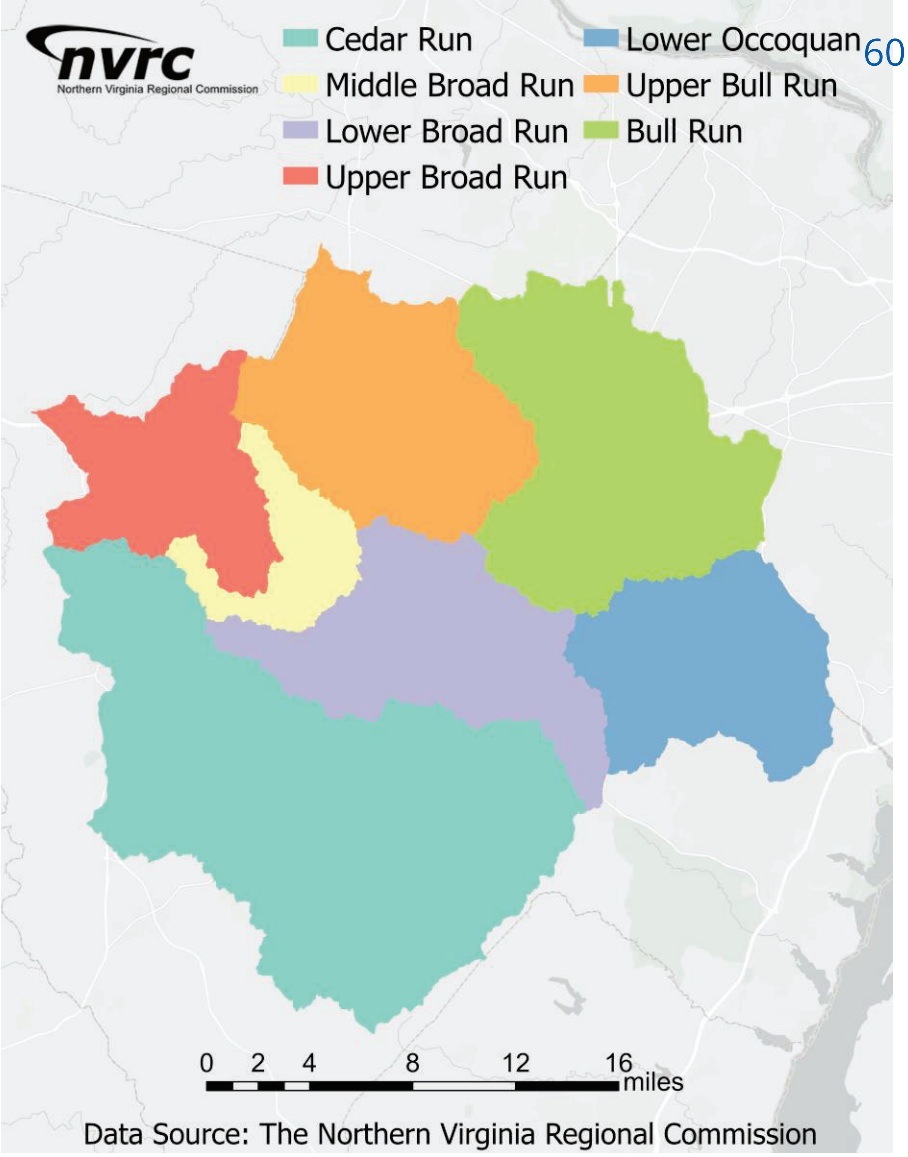
- Informational Tool not a Regulatory Tool
- Product of Occoquan Jurisdictions and Water Authorities
- Calibrated against OWML Stream and Reservoir Monitoring Data
- Assumes Site-level Stormwater BMP Controls
- Used to Support a Variety of Policy Discussions



Modeled Sub-Watersheds

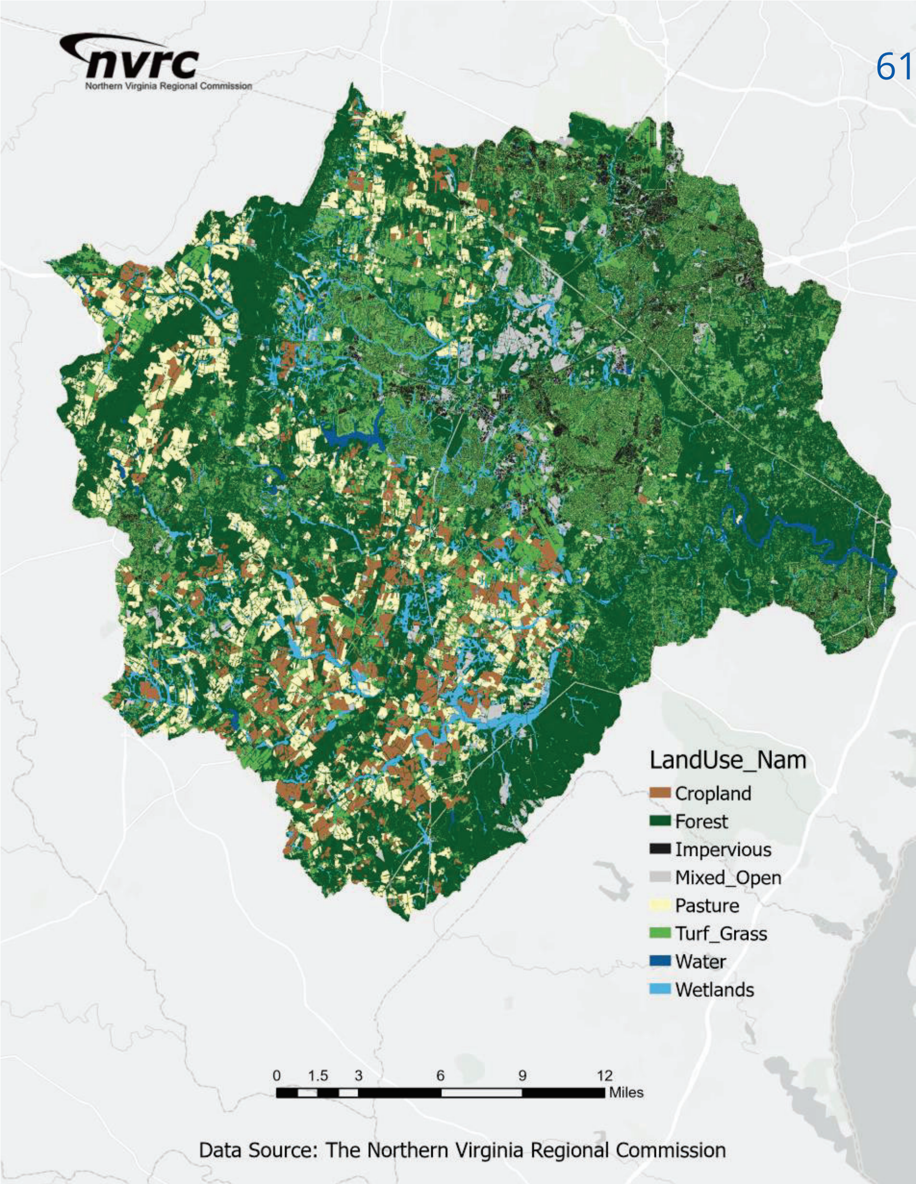
PRINCE WILLIAM COUNTY

- Number Directly Limited by Number of Water Quality Monitoring Stream Stations
- Current Version
  - 7 Model Sub-Watersheds
  - 87 Total Sub-Segments
    - Average Sub-Segments Size: 4,300 Acres
- Model Limitations
  - Calibrated Accuracy Also Impacts Scale of Analysis
  - Not a Site Design Tool
  - Cannot Discern Local Stream Impacts



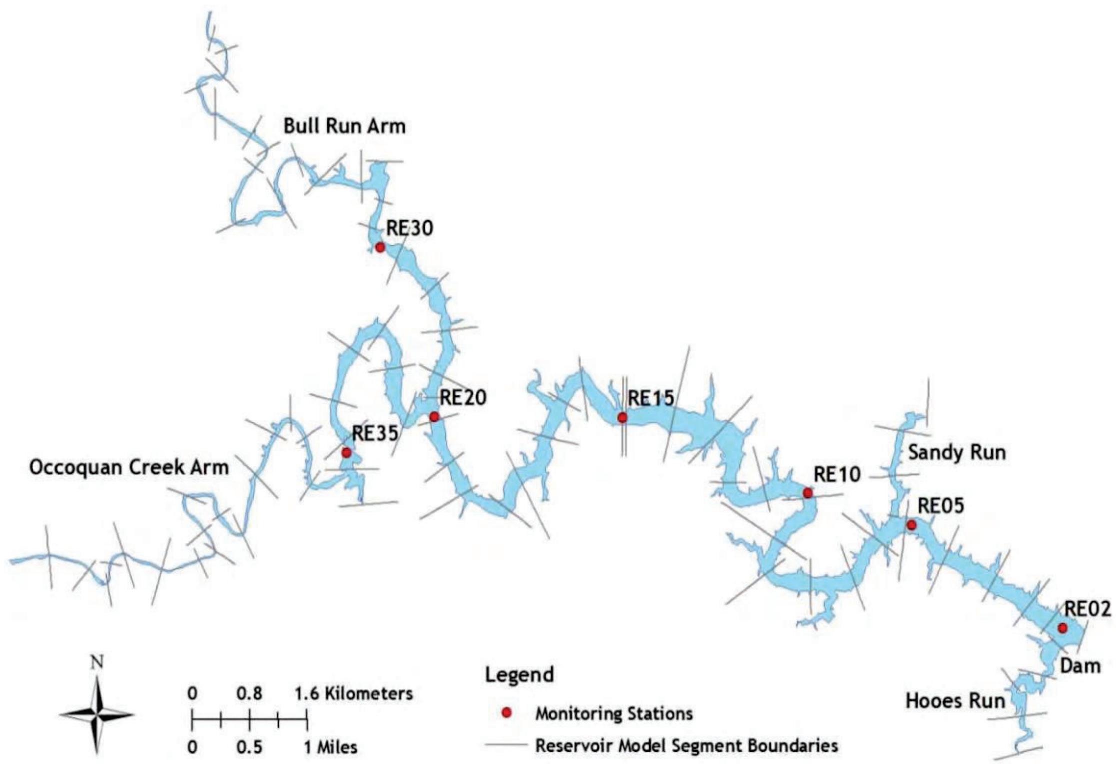
Land Use Component

- Actual Watershed Land Use
    - Watershed High Altitude Aerial Photography Surveys
        - Approximately every 5 years
    - Current Land Use (2015 Update)
        - 2014 High Resolution 1 Meter Data from ChesBay Program
            - Became Available December 2020
        - Same Land Use in Most Current CBP Phase 6 Model
- Focus on Impervious and Pervious Land Cover
    - Planned 2021/2022 Update sometime in 2025/2026



Current Model Status

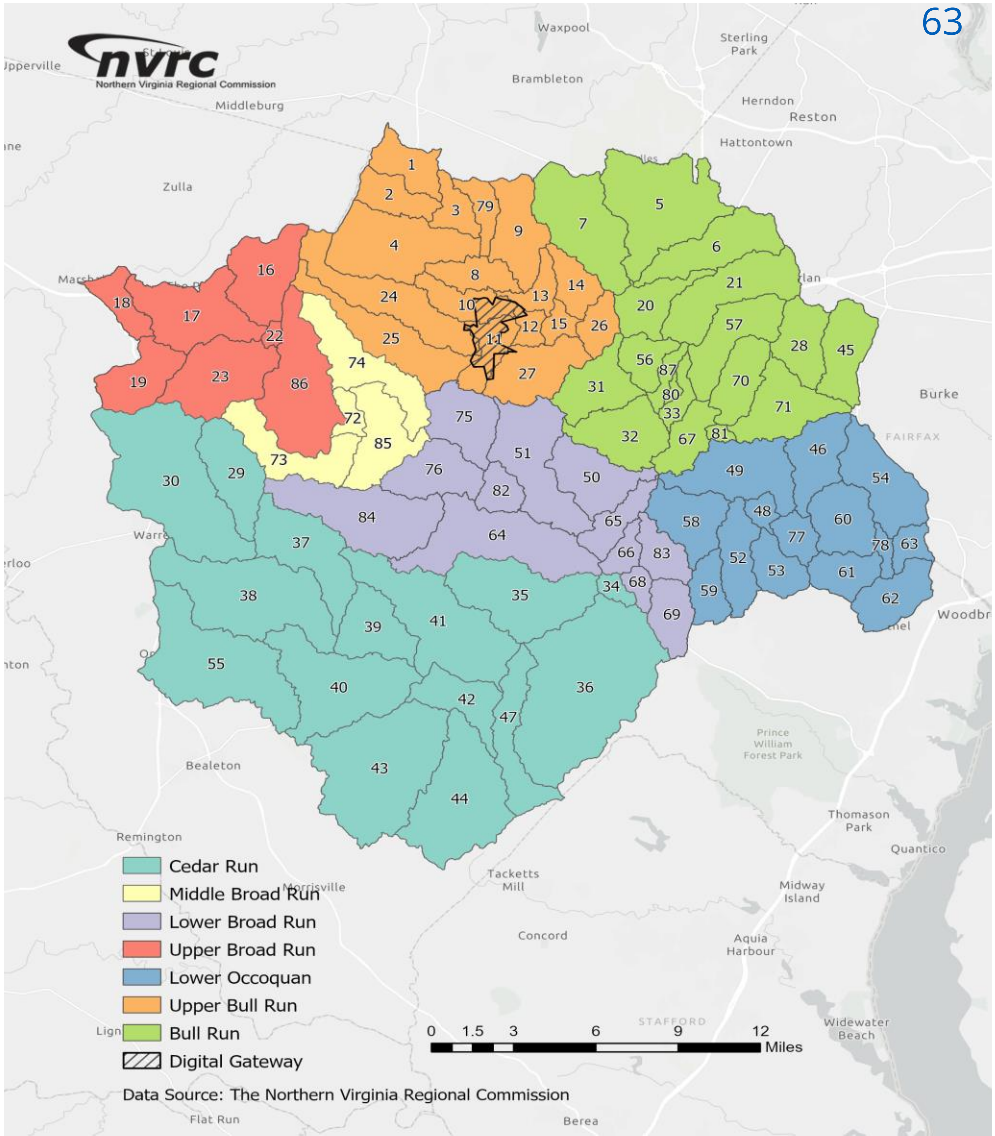
- 2010 Model Version
  - Fully Calibrated
- 2015 Model Version
  - Land Use Fully Incorporated
  - Hydrology and Water Quality Calibration Underway
    - Anticipated Completion Late Summer/Early Fall
    - Impacted Somewhat by Recent Passing of Dr. Adil Godrej, OWML



Digital Gateway Model Segment of Interest

PRINCE WILLIAM COUNTY

- Upper Bull Run Sub-Watershed
  - Surface Area: 50,742 acres
  - Number of Sub-Segments: 17
  - Average Segment Size: 2,985 acres
- Digital Gateway CPA
  - Approximately 2,130 acres
  - Occupies portions of Sub-Segments: 10,11 and 12
  - Represents less than 5% of the Upper Bull Run Model Sub-Watershed



Next Steps in Occoquan Program

- Continue Technical Support to Regions Staff
- Complete the Calibration of the Occoquan Model with 2015 Land Use
- Conduct Simulations with the Occoquan Model to Assess Loading of Nutrients (Phosphorous and Nitrate), Total Suspended Solids (TSS), Sodium
    - What are the long-term impacts to the Occoquan Reservoir from nutrients, sediment, sodium, and other emerging contaminants?
    - How close is the reservoir to reaching those thresholds of concern?
    - What are the implications for: a) increasing wastewater input to UOSA? b) land-development in the tributary watersheds? c) climate change?

Prince William County

Questions?