Occoquan Watershed

"Where is it and What's in it"

Normand Goulet

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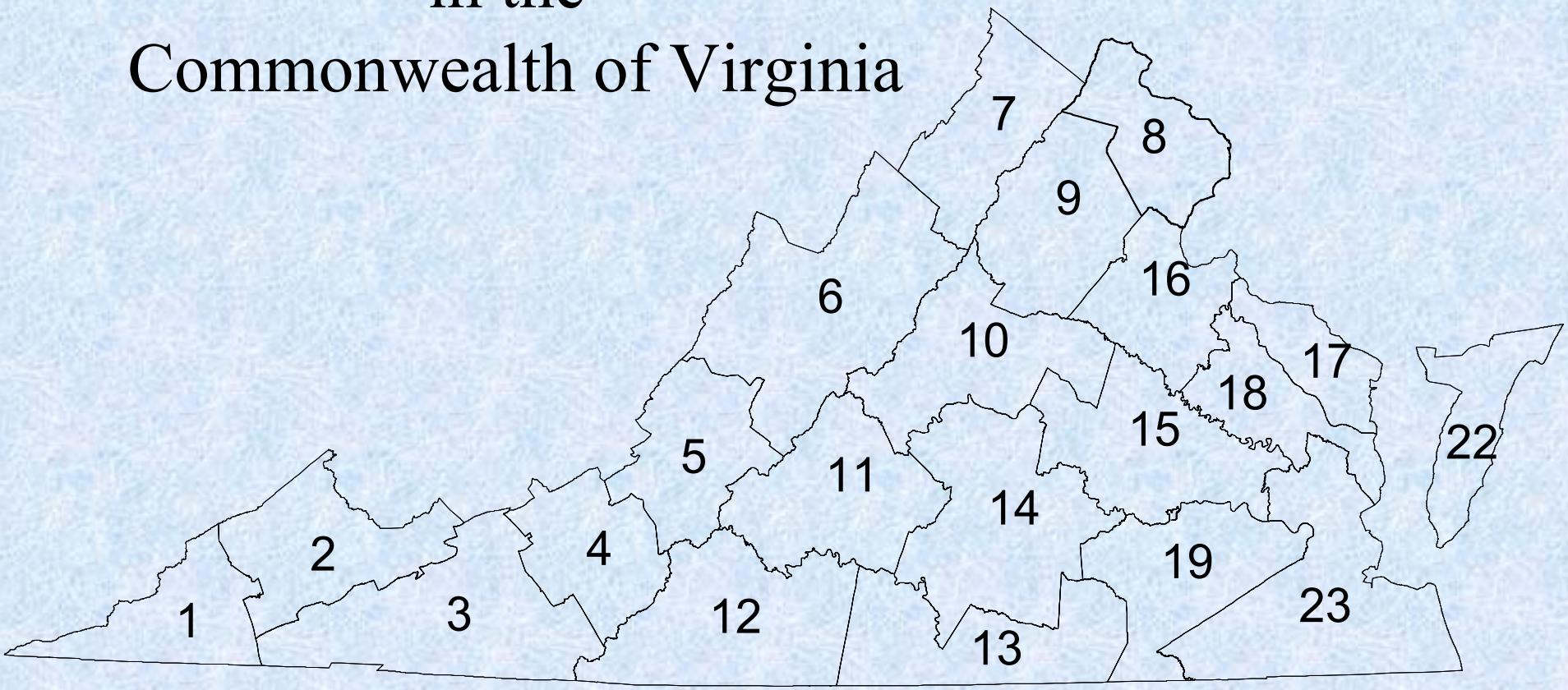
Planning District Commissions in the Commonwealth of Virginia



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- PDC 8 -
"Northern Virginia Regional Commission"

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The ***Northern Virginia Regional Commission (NVRC)*** is a regional council of local governments in Northern Virginia.

NVRC's programs and policies:

• established by a 41-member Board of Commissioners composed of elected officials and appointed citizen representatives.

NVRC serves as a:

• neutral forum for decision-making;

• provide information and analyses necessary to make sound local and regionally beneficially decisions;

• provide professional and technical services to enable member governments to plan for their future, both individually and as a region.

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“Occoquan Program”

Purpose:

Maintain acceptable levels of water quality within the Occoquan Basin’s free flowing streams and impoundment's through the management of nonpoint pollution loadings.

Program Statement, 1982

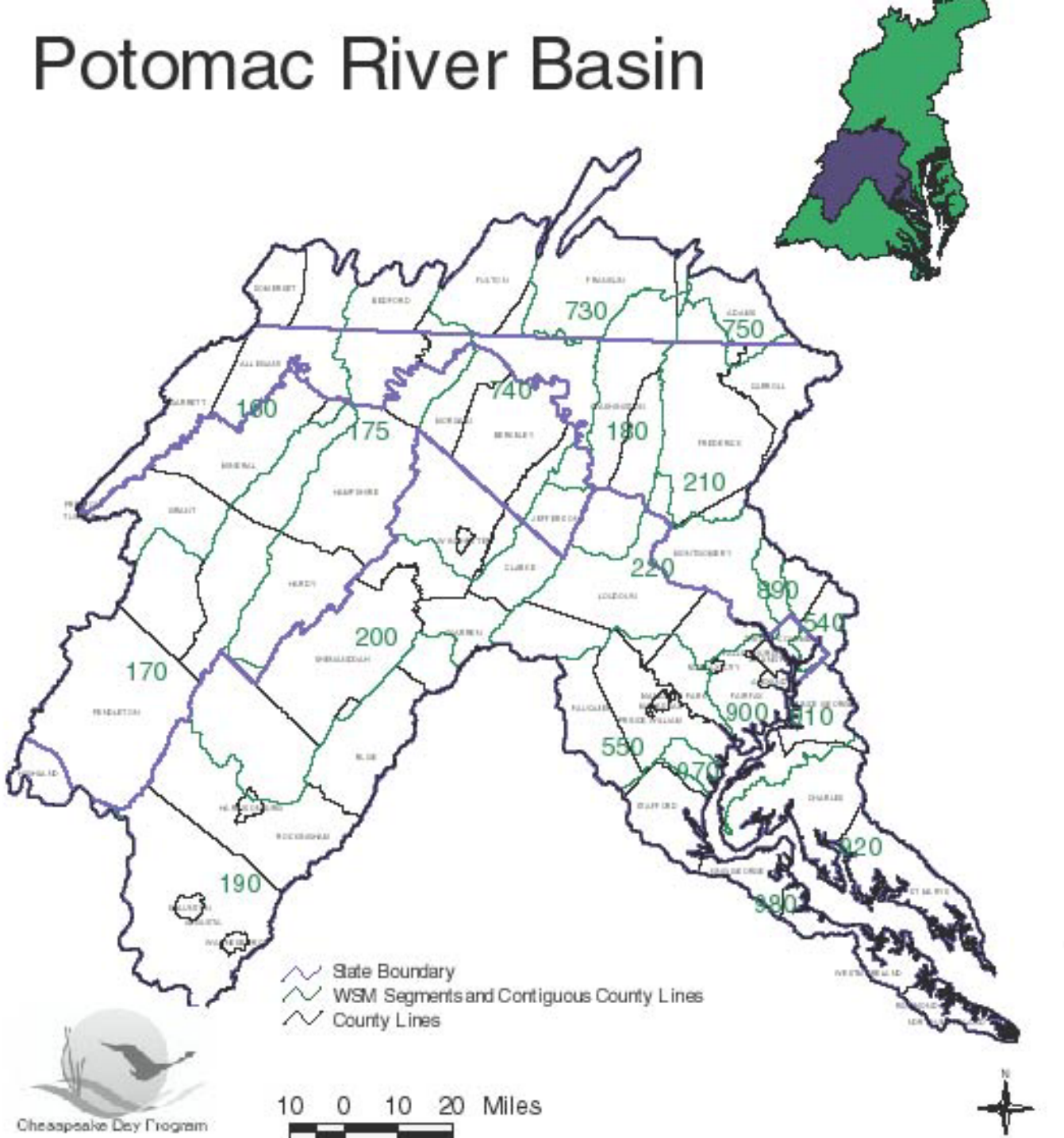
Occoquan Program Concept

- Consensus Building
  - Program is Strictly Voluntary
  - No Regulatory or Enforcement Authority
  - No “ Majority Rules”
  - Lives and Dies by Consensus

Occoquan Program Elements

- Technical Investigations and Support
  - Northern Virginia BMP Handbook
  - Nonstructural Urban BMP Handbook
  - Guide to BMP Management for Private Operators
  - Land Use Inventory and Updates
  - TMDL Development for Cedar and Licking Run
  - Membership on numerous Federal, State and Local scientific committees and workgroups

Potomac River Basin



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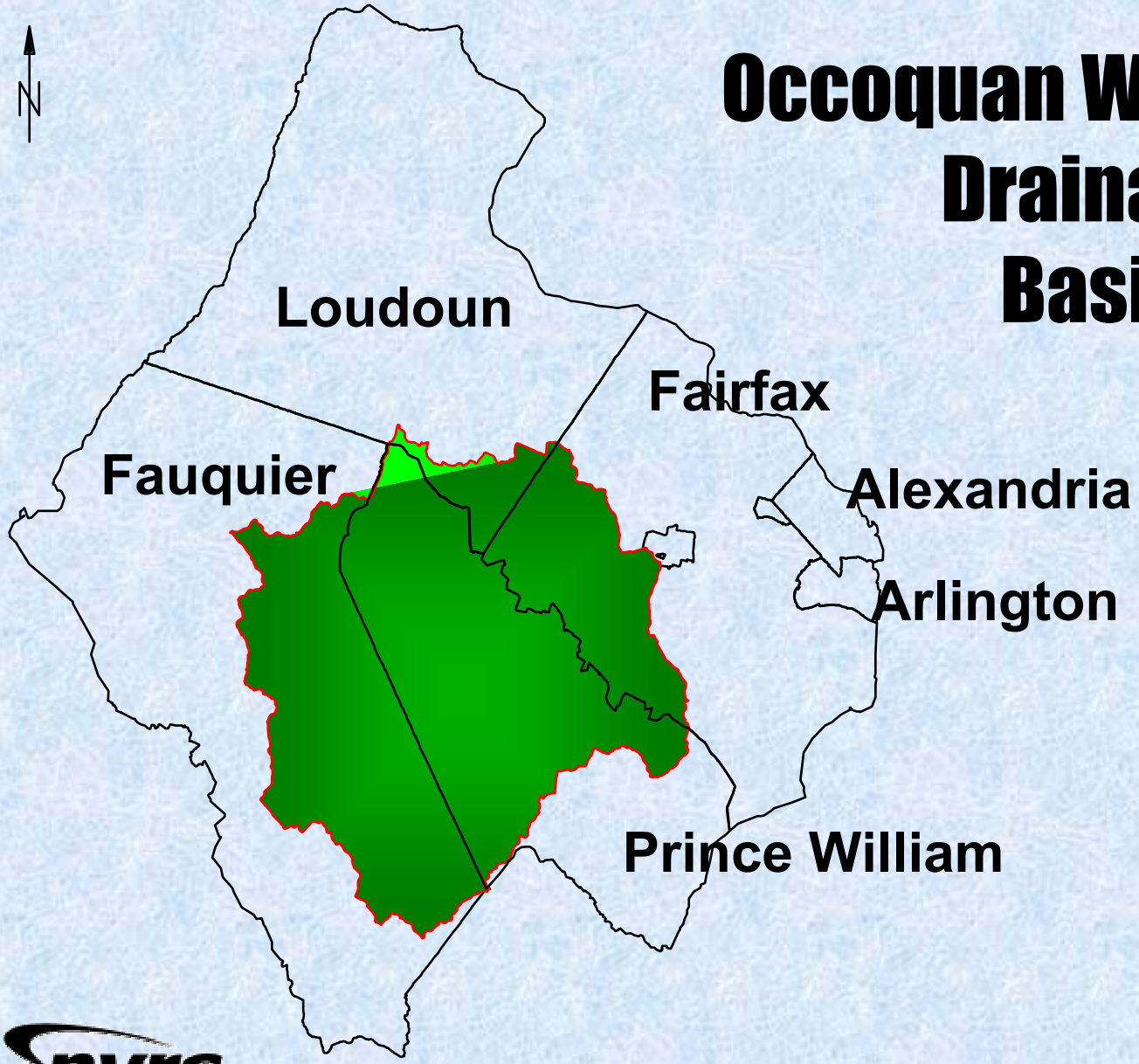
Occoquan Watershed Drainage Basin



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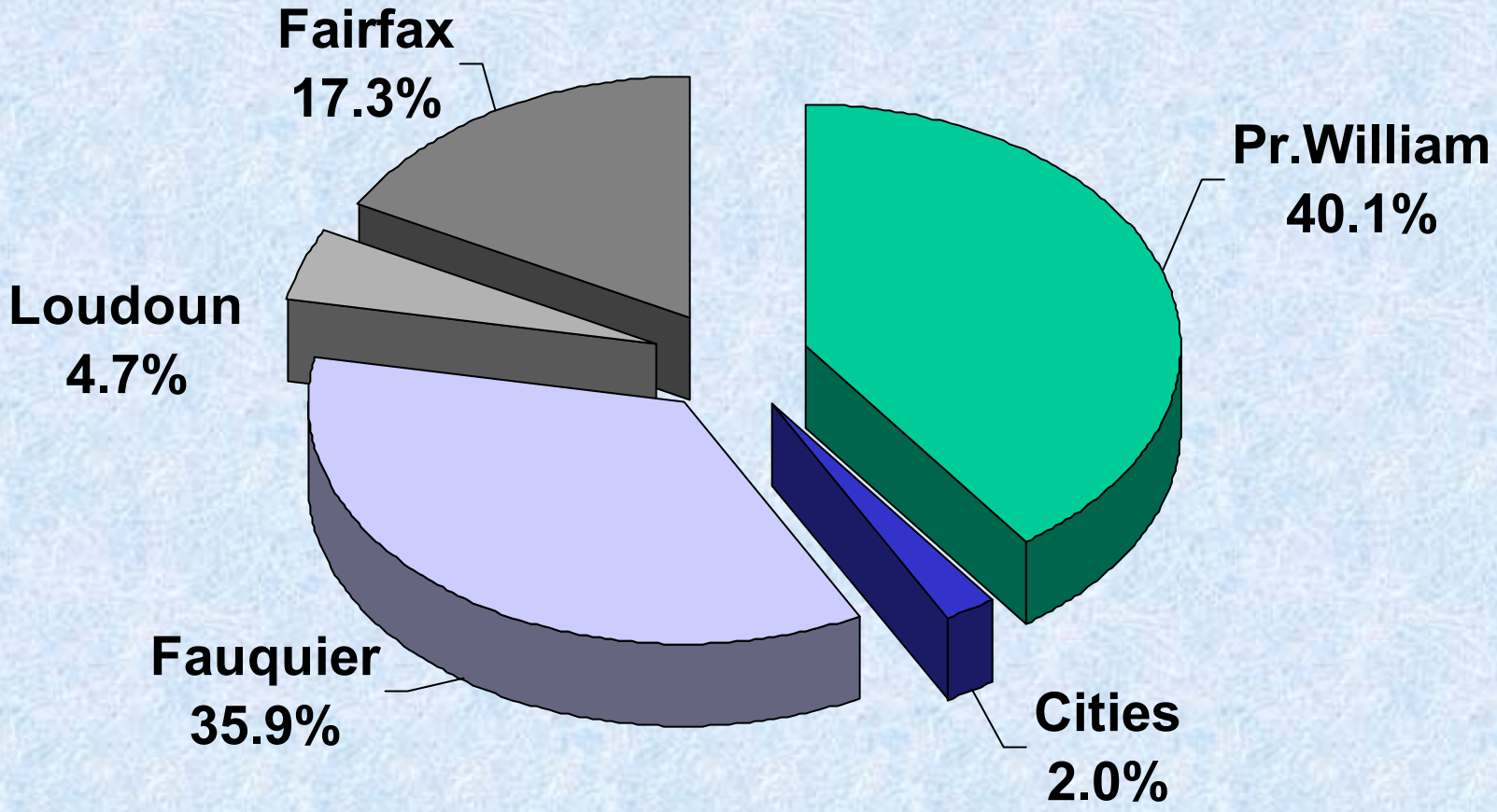
Percentage of Land Area in the Occoquan Basin by Jurisdiction



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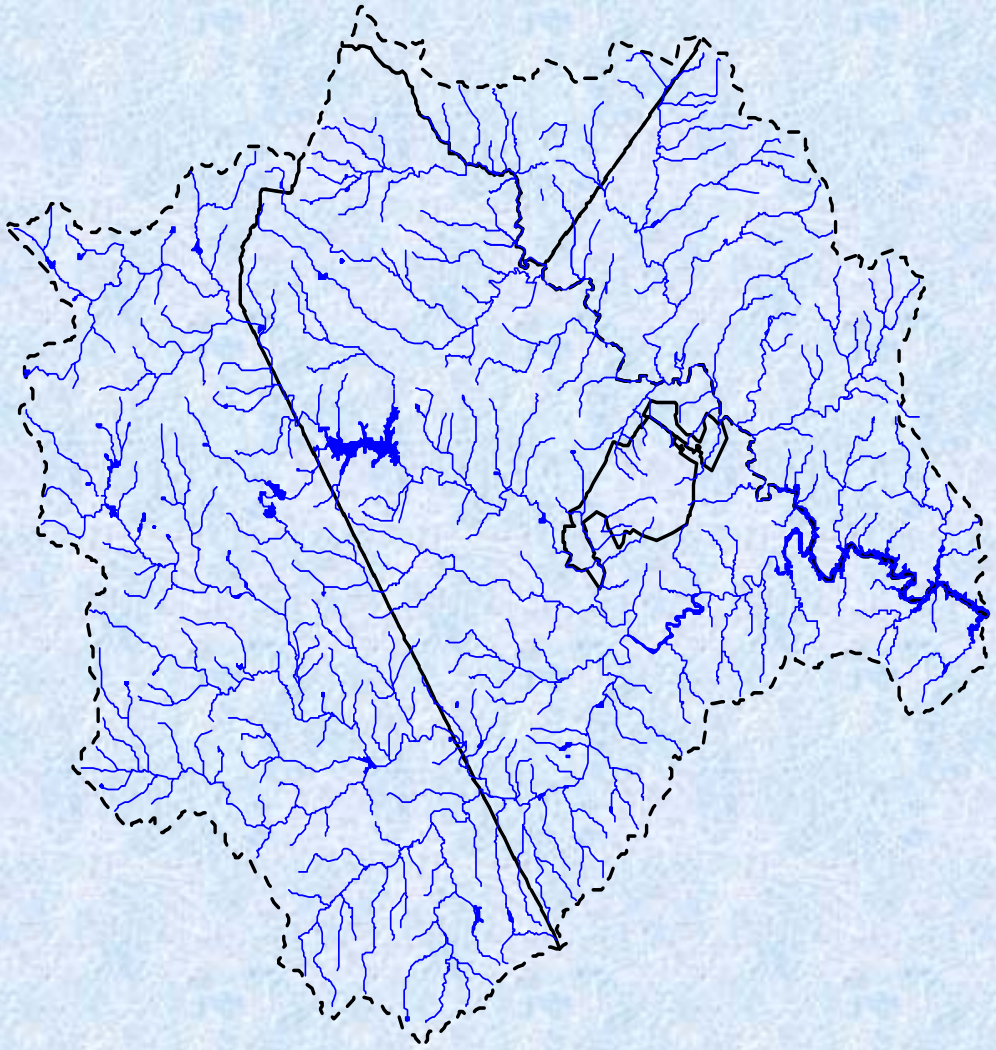
Occoquan Watershed



- 590 Square Miles
- 1,300 Stream Miles
- 3 Major Impoundment's
  - Lake Manassas
  - Lake Jackson
  - Occoquan Reservoir

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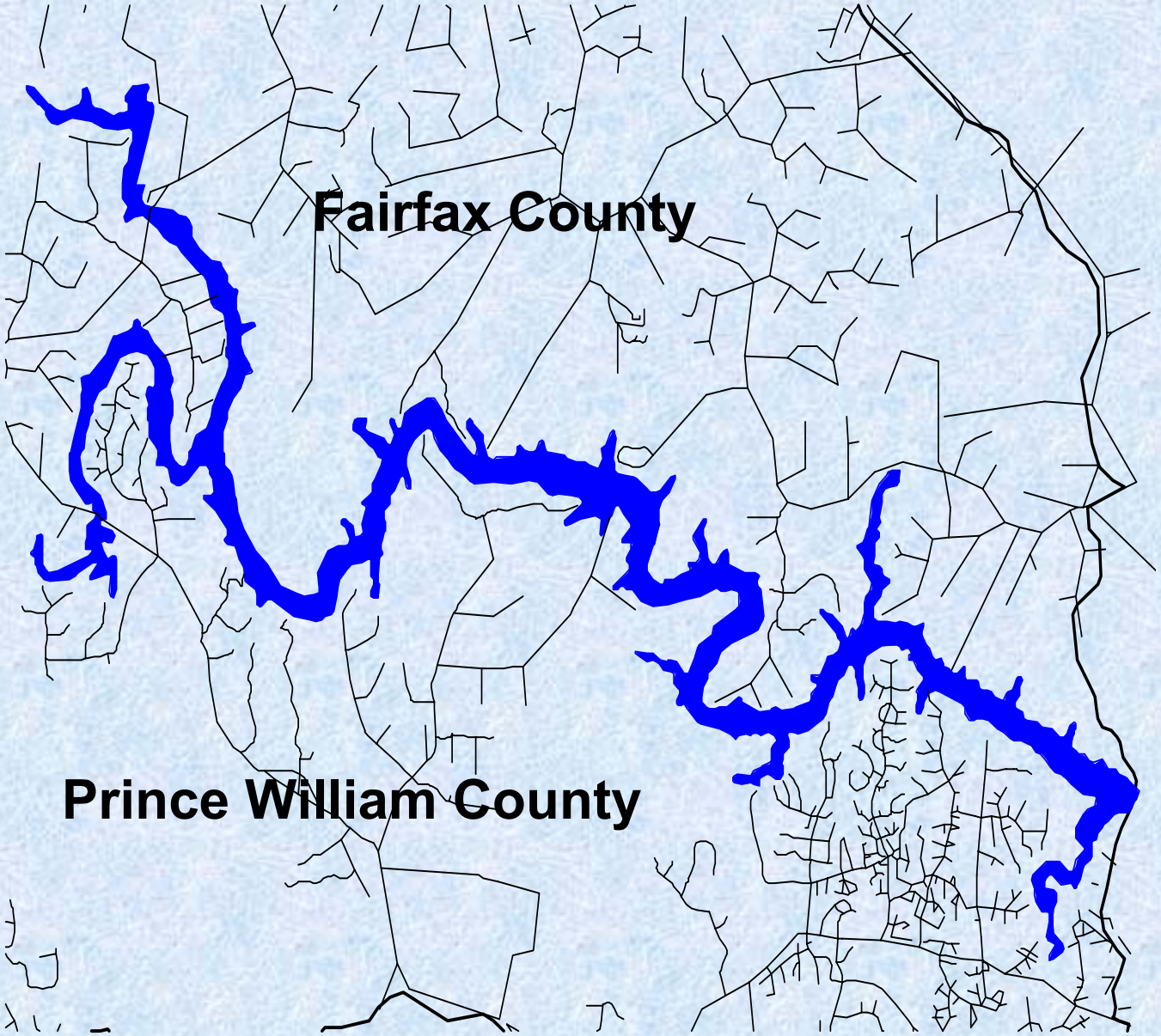
Occoquan River Reservoir



- 15 Miles Long
- Width < 0.2 miles
- Avg. Depth 13 ft.
- Max Depth 65 ft.
- 8.5 Billion Gallons

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Occoquan Reservoir High Dam

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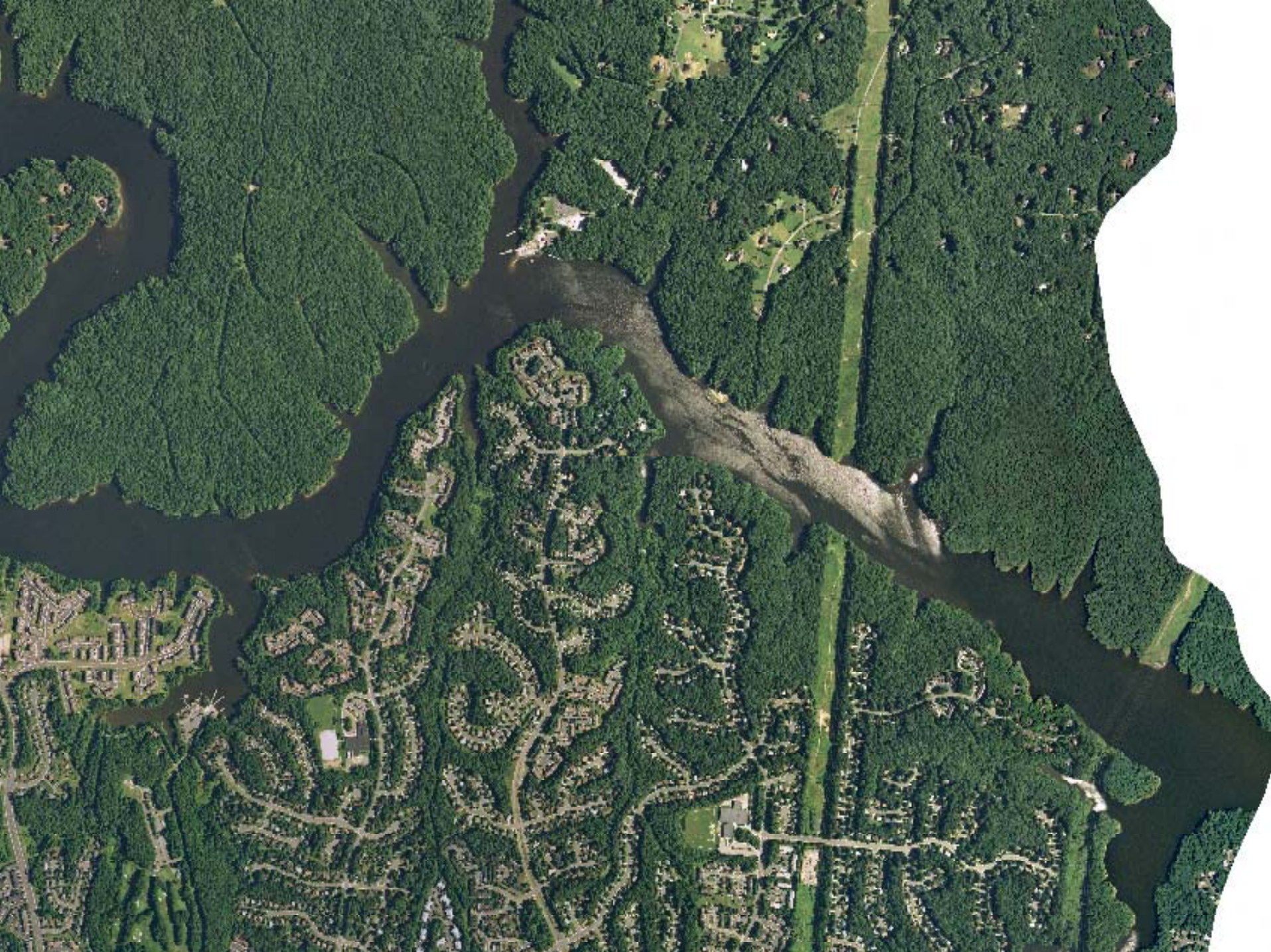
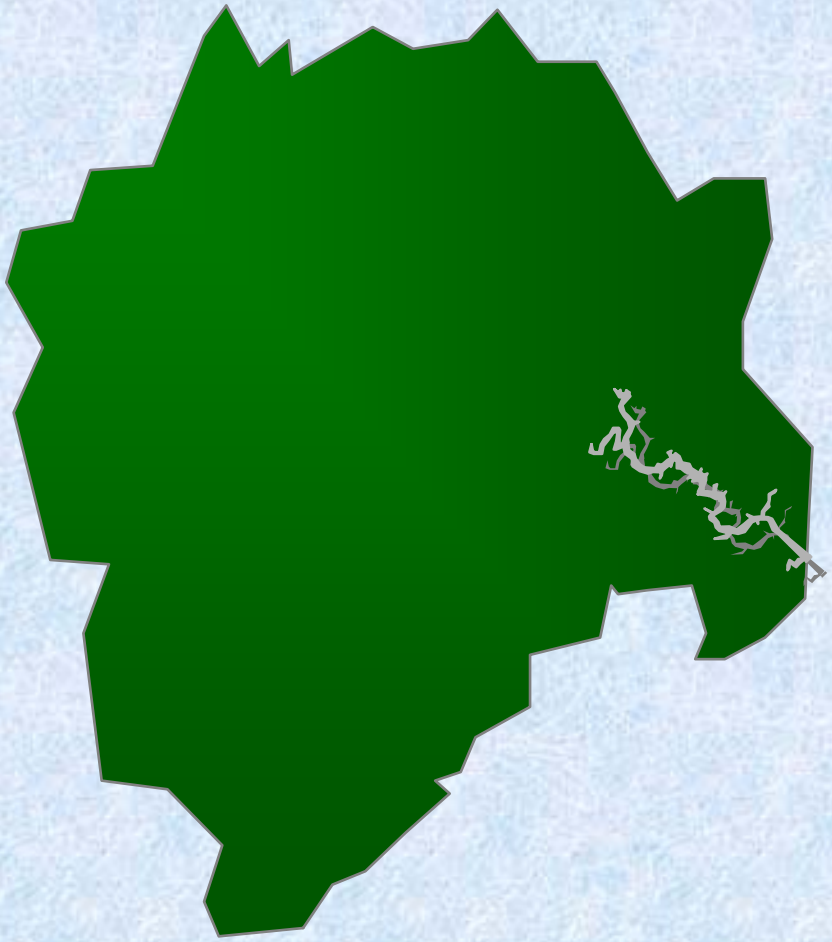


Principal Interests on the Watershed



- Public Water Supply
- Wastewater Disposal
- Recreation
- Communities

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Historical Reservoir Uses

Drinking Water Supply

- In 1957, the Upper Occoquan Dam was constructed.
- In 1967, ownership of the Occoquan Dam and its related water treatment facilities passed to Fairfax County Water Authority.
- 1982 dam elevation increased by two feet increasing storage capacity to ~8 Million Gallons.
- In 1999, ~ 21,000 Billion Gallons withdrawn for drinking water.
- Supplies ~ 40% demand for 1.2 million people.
- In Emergency can supply complete demand.

River Station and Lorton Plants and New Construction at Griffith Plant

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Lorton and River Station Treatment Works and Sludge Disposal Quarry

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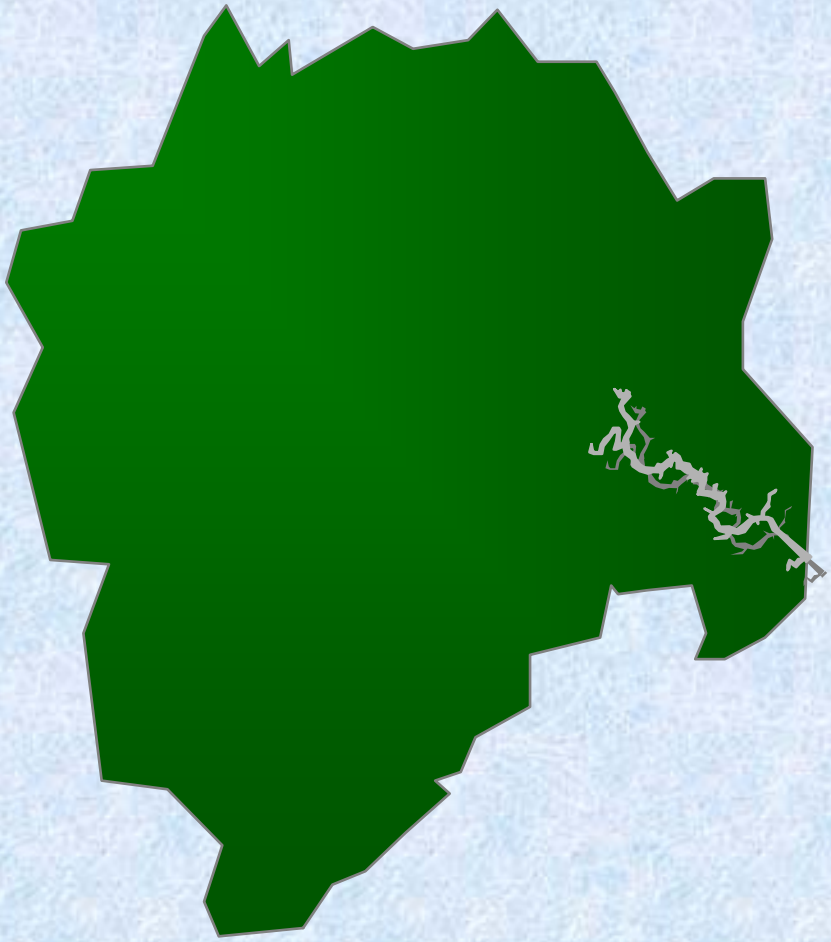
Indirect ReUse of the UOSA Discharge has Increased Reservoir Safe Yield

- 1960's
  - Safe Yield from Natural Streamflow: 65 mgd
- Current
  - Safe Yield from Natural Streamflow: 65 mgd
  - UOSA Discharge, 1998: 20 mgd
  - Total Yield: 85 mgd
- Future
  - Safe Yield from Natural Streamflow: 65 mgd
  - UOSA Discharge, 2001: 38 mgd
  - Total Yield: 103 mgd

Principal Interests on the Watershed



- Public Water Supply
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Post-World War II Population Trends Virginia Suburbs of Washington, D.C.

- Population initially moved south from the developed core of Arlington and Alexandria
  - Facilitated by presence of I-95
- Next trend was characterized by movement west
  - Western Fairfax
  - Western Prince William
  - Manassas, Manassas Park
  - Completion of I-66 increased pace of development

Water Quality Problems: The 1960's

- Frequent & intense blue-green algae blooms
- Frequent taste & odor episodes in water treatment
- Treatment problems from algal mats in raw water
- Oxygen loss and and fish kills in reservoir
- Sulfide in deep waters during stratification
- Increased organic matter in the reservoir system
- Active viruses detected in streams and reservoir
- During low flow, conventionally treated wastewater was a major part of inflow

Algal Bloom in Occoquan Reservoir: Summer, 1973

Source: OWML

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Algal Bloom in Occoquan Reservoir: Summer, 1973

Source: OWML

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Algal Bloom in Occoquan Reservoir: Summer, 1973

Source: OWML

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Algal Bloom in Occoquan Reservoir: Summer, 1973

Source: OWML

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Regulatory Agency Response to Water Quality Problems

- State Water Control Board commissioned firm of Metcalf & Eddy to conduct comprehensive study of the Occoquan Watershed and Reservoir
- Studies directed by Dr. Clair N. Sawyer
- 1968 - 1969

Metcalf & Eddy Study Results

- Both point and nonpoint source pollution contributed to water quality degradation
- Principal water quality problem identified to be discharges from 11 secondary sewage treatment plants in the watershed
- Study provided three principal recommendations

Metcalf & Eddy Recommendations

- Option 1
  - Export wastewater and treat outside Occoquan Watershed
- Option 2
  - Provide highest treatment technically achievable
  - Contract with local jurisdictions to purchase reclaimed water for direct reuse as drinking water
  - Limit watershed population to that which would use reclaimed water
- Option 3
  - Provide highest treatment technically achievable
  - Discharge reclaimed water to the Occoquan Watershed for indirect reuse
  - Limit Basin Population to 100,000

State Water Control Board Proposed In-Basin Solution

- High performance regional water reclamation plant to replace existing plants in the watershed
  - New public service authority created: UOSA
- Independent agency to monitor reservoir water quality
  - New laboratory established: OWML
    - Virginia Tech Department of Civil and Environmental Engineering

A Policy for Wastewater Treatment and Water Quality Management in the Occoquan Watershed
"The Occoquan Policy"

- Adopted by VSWCB in 1971, revised in 1981, 1991
- Limited AWT plants in watershed to three (3)
- Limit of technology effluent requirements:

– COD	10 mg/L	- TSS (current)	1 mg/L
– TN*	1 mg/L	- TP	0.1 mg/L
– MBAS	0.1 mg/L	- Turbidity	0.5 NTU

***Note:** TN is as total unoxidized N (TKN). Also, process to be operated to maintain less than 5 mg/L NO_3-N at raw water intake.

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UOSA Treatment Processes

- Solids Separation: grit removal; primary; secondary
- Biological Treatment (nitrifying suspended growth treatment with denitrification capability)
- Chemical Precipitation (high lime dose phosphorus precipitation and ancillary disinfection)
- Mixed Media Filtration
- Granular media Activated Carbon Adsorption
- Chlorination and Dechlorination
- System-wide flow storage and final effluent reservoir

Upper Occoquan Sewage Authority Wastewater Reclamation Facility

Source: Upper Occoquan Sewage Authority

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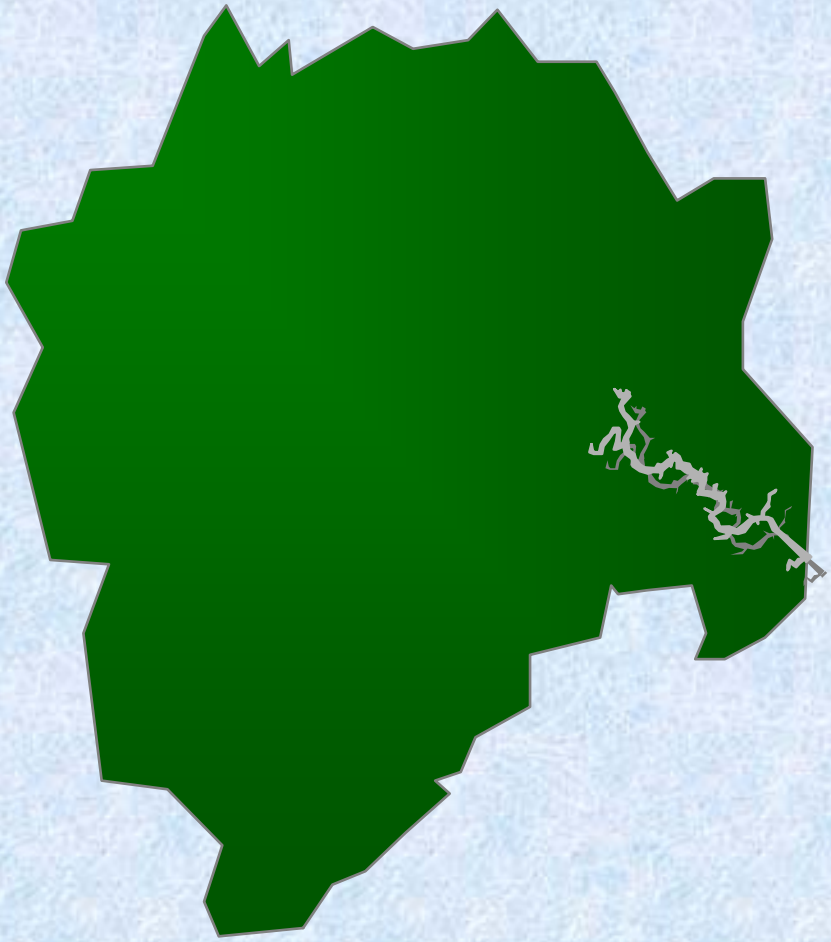
Principal Interests on the Watershed



- Public Water Supply
- Wastewater Disposal
- Recreation
- Communities

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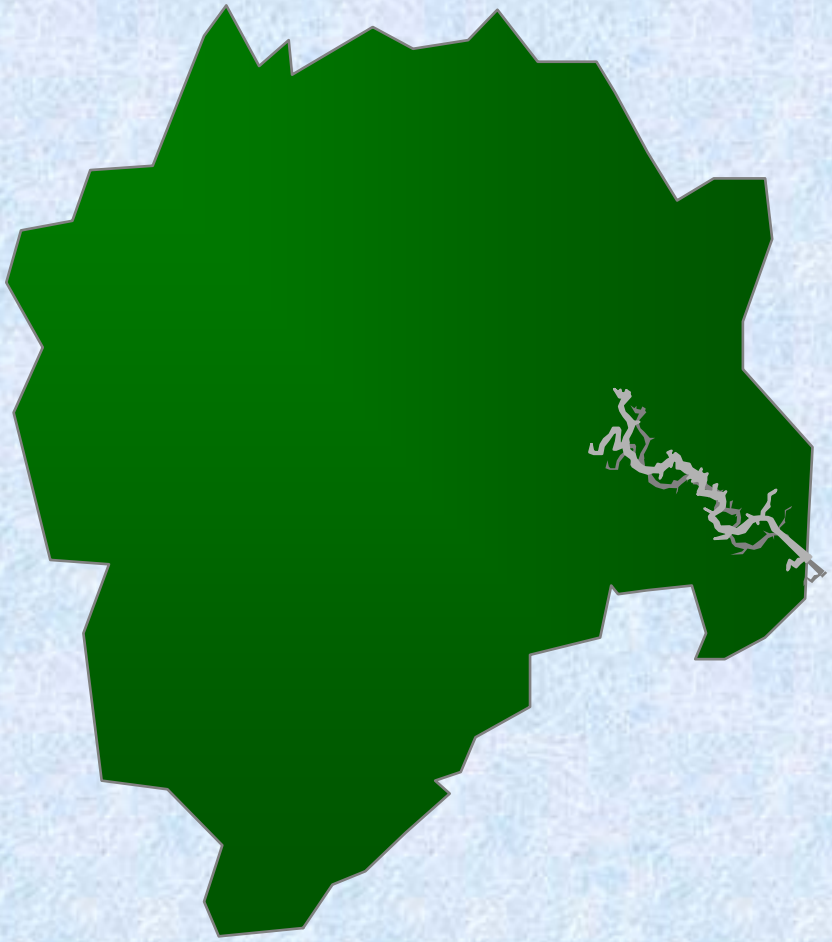
Historical Reservoir Uses

Recreational Uses

- Fairfax County
  - Three Regional Parks:
    - Fountainhead, Bull Run Marina, Sandy Run
  - 25 mile stretch of regional parklands
  - Boat launches: 1,800 in 1980
    3,500 in 1990
- Prince William County
  - Lake Ridge Community Park
  - Day-use facility: picnicking, miniature golf
  - Boat Rentals

Principal Interests on the Watershed



- Public Water Supply
- Wastewater Disposal
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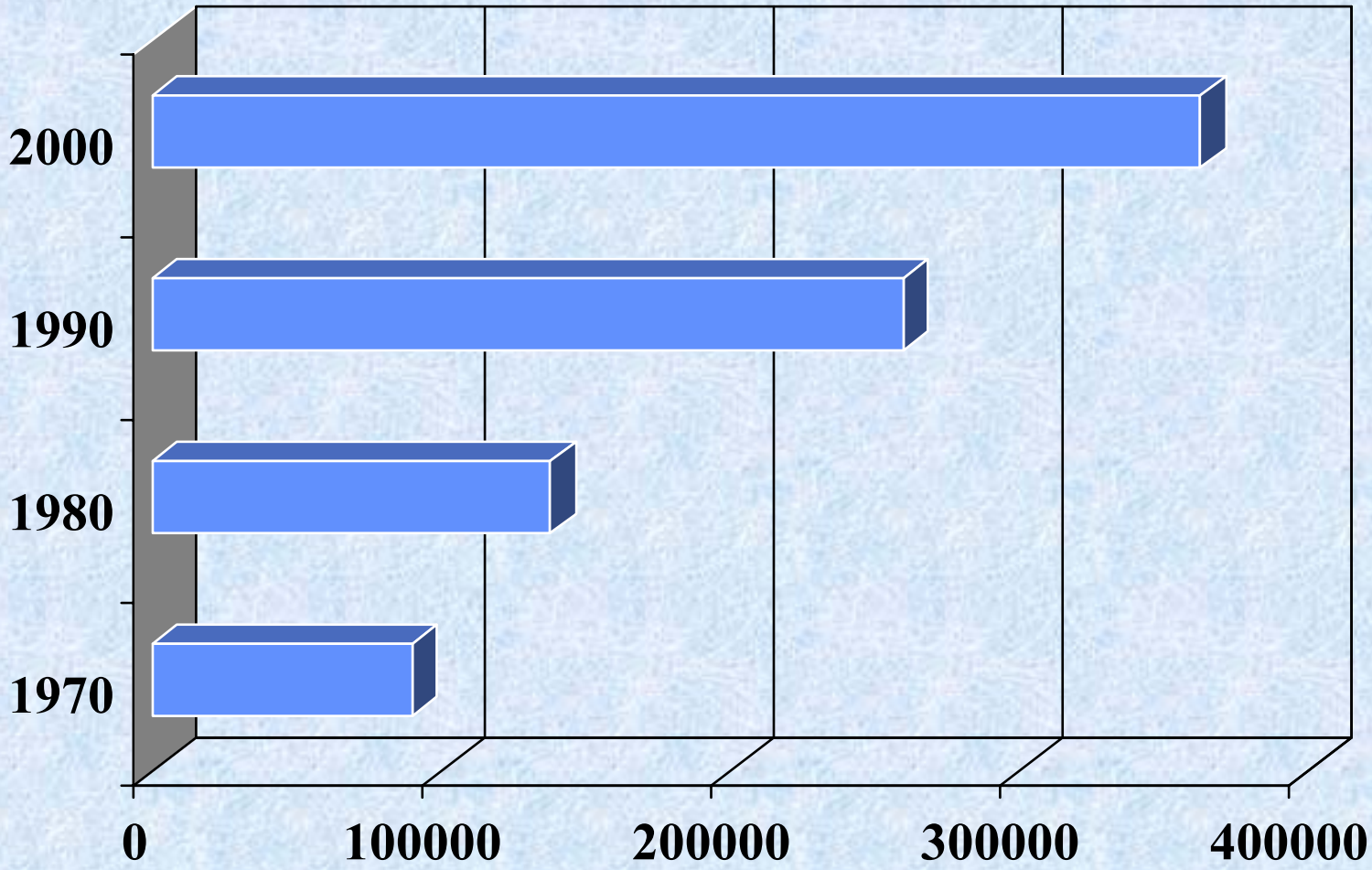
Occoquan Watershed Population Growth



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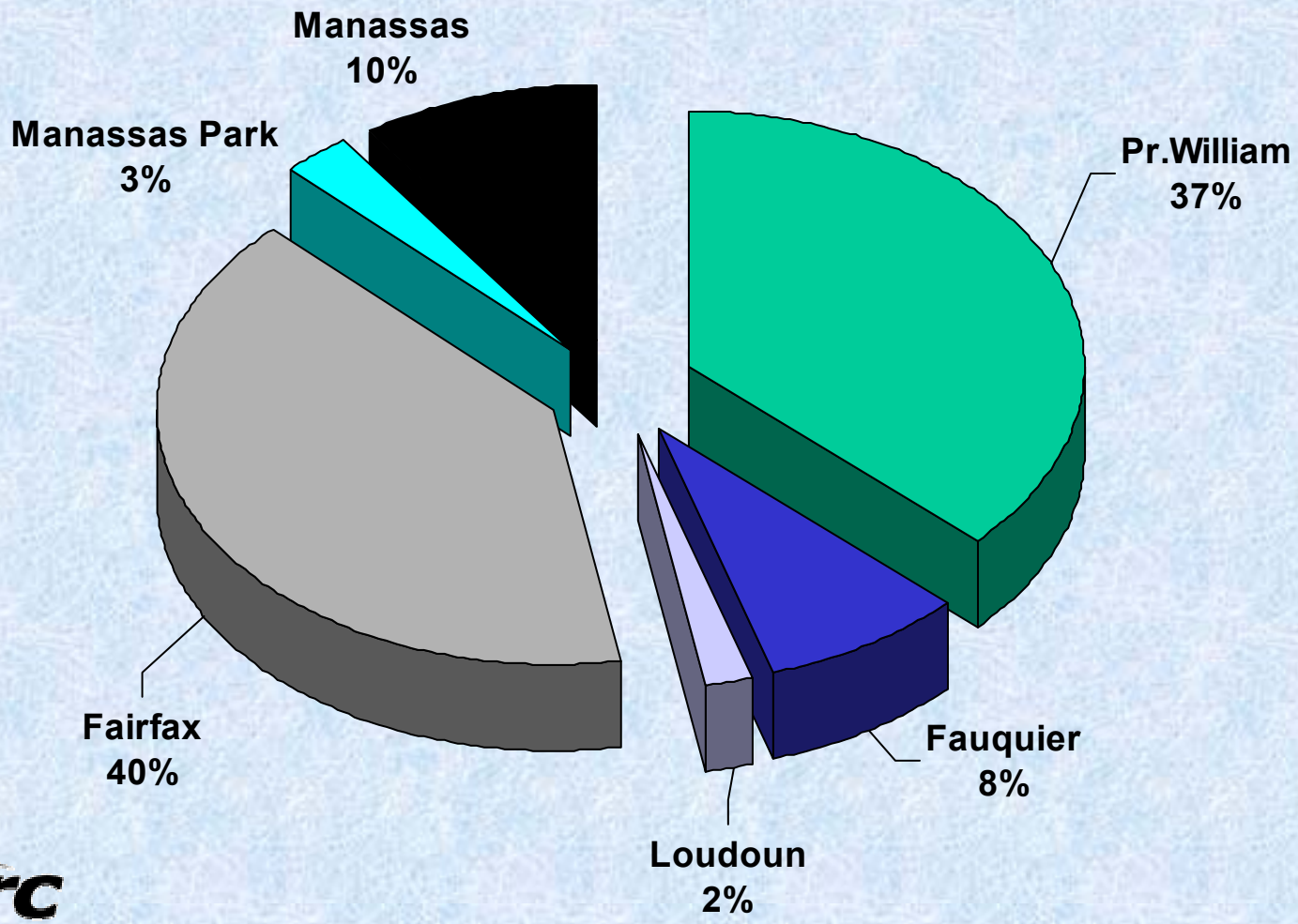
Percentage of Population in the Occoquan Basin by Jurisdiction



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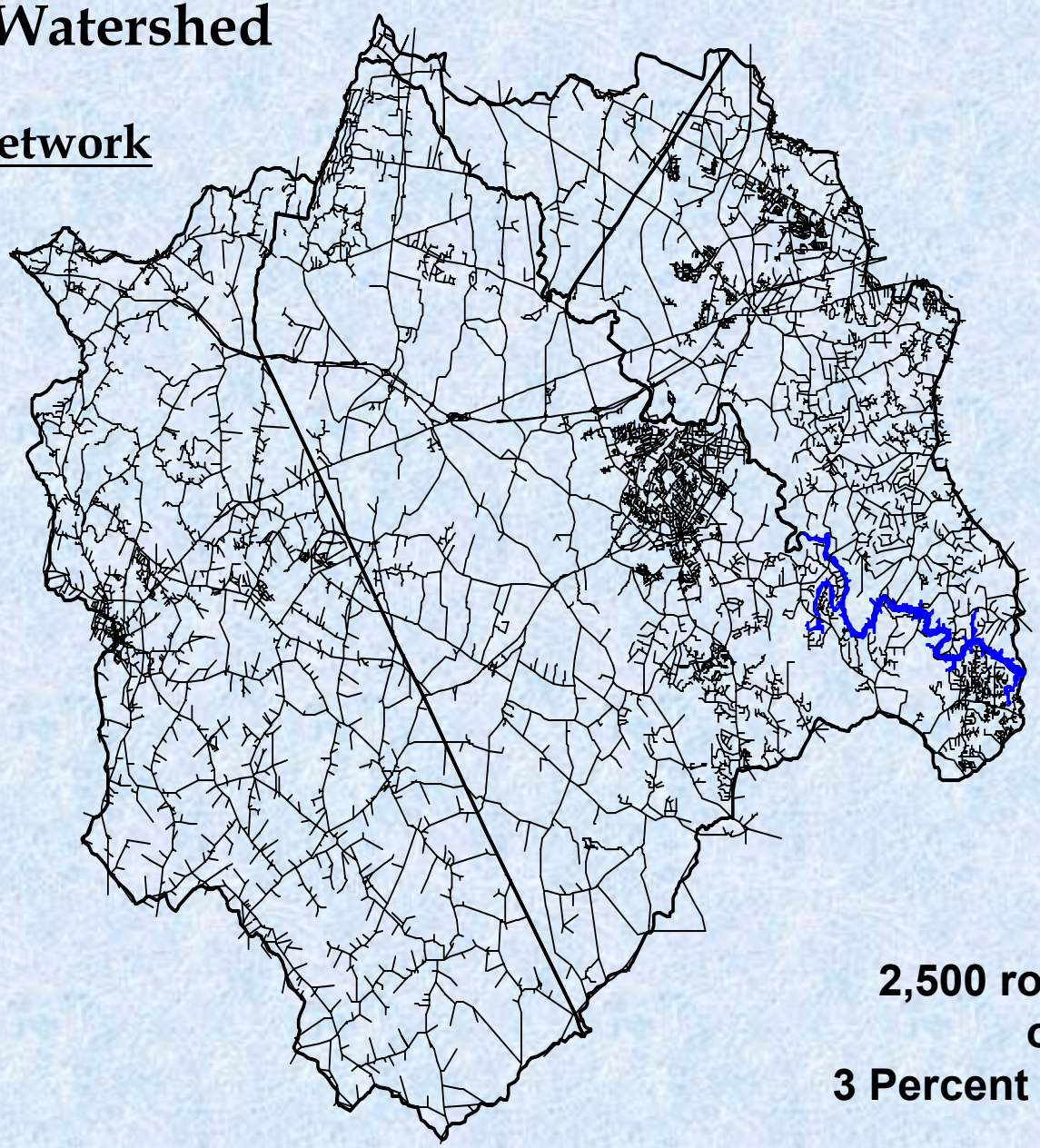
Occoquan Watershed

Road Network



2,500 road miles
or
3 Percent Watershed

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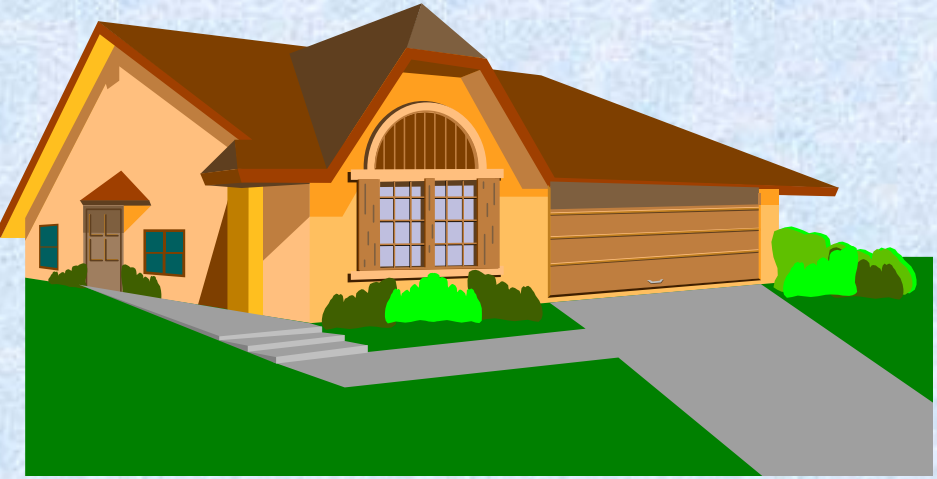
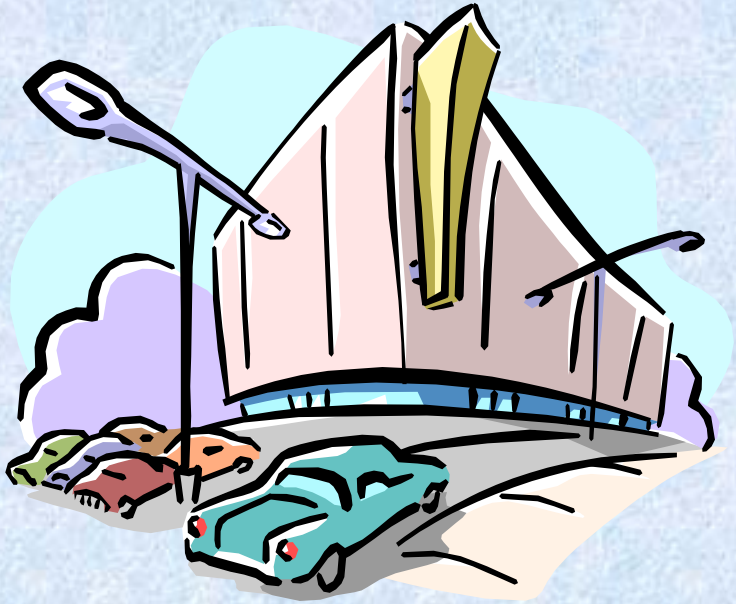
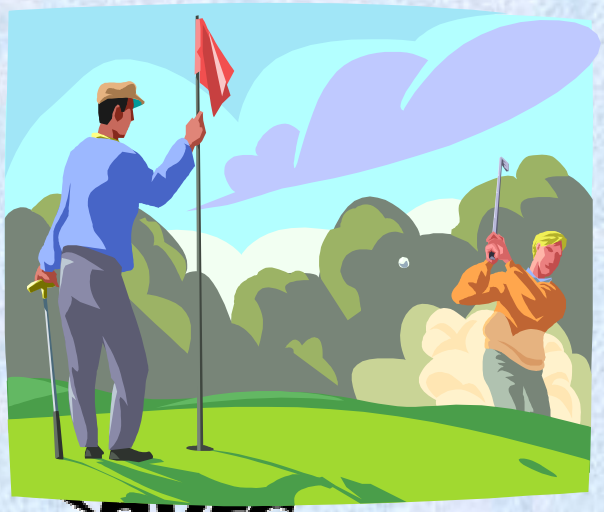




2000 Occoquan Basin Land Use



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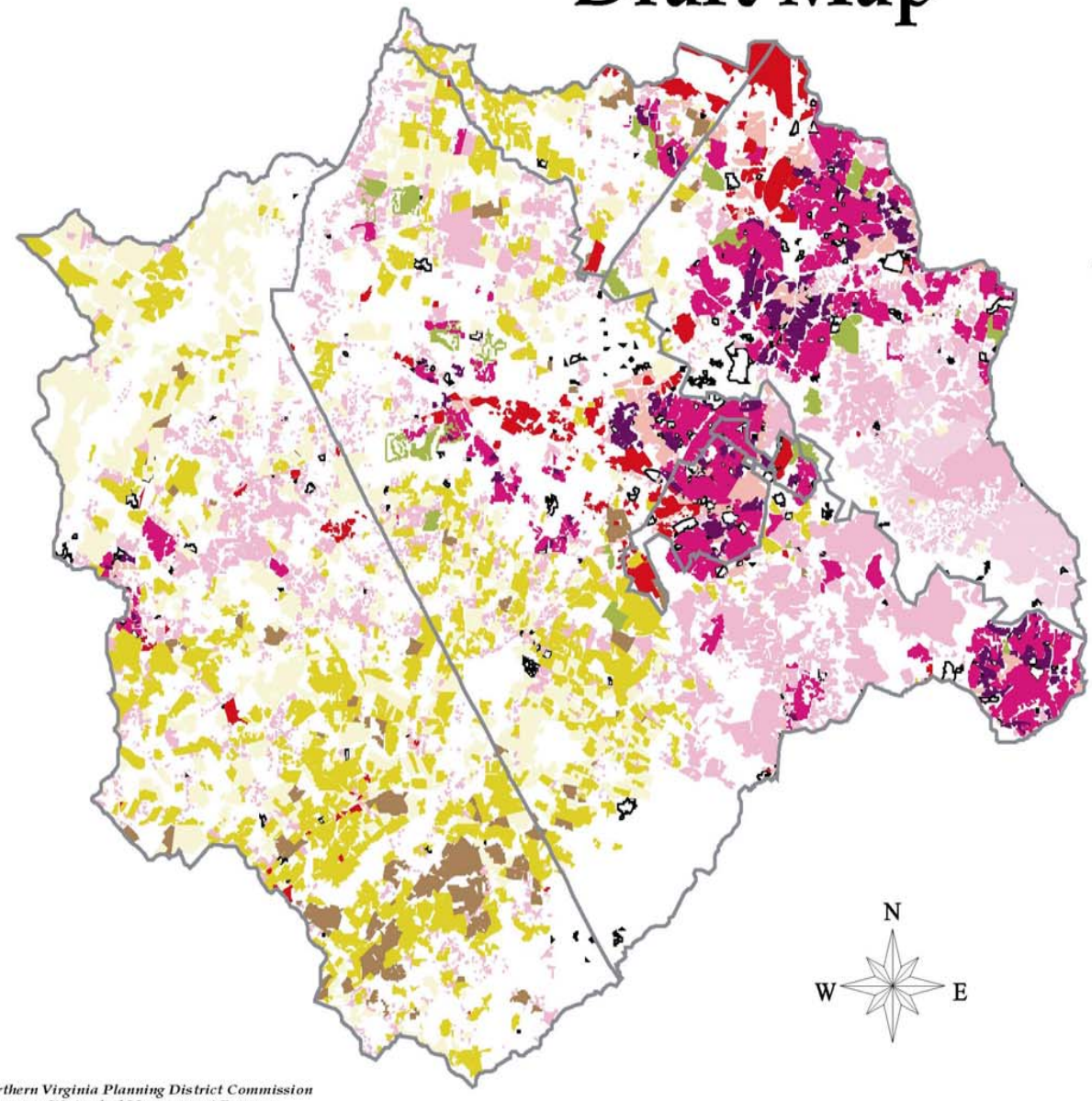
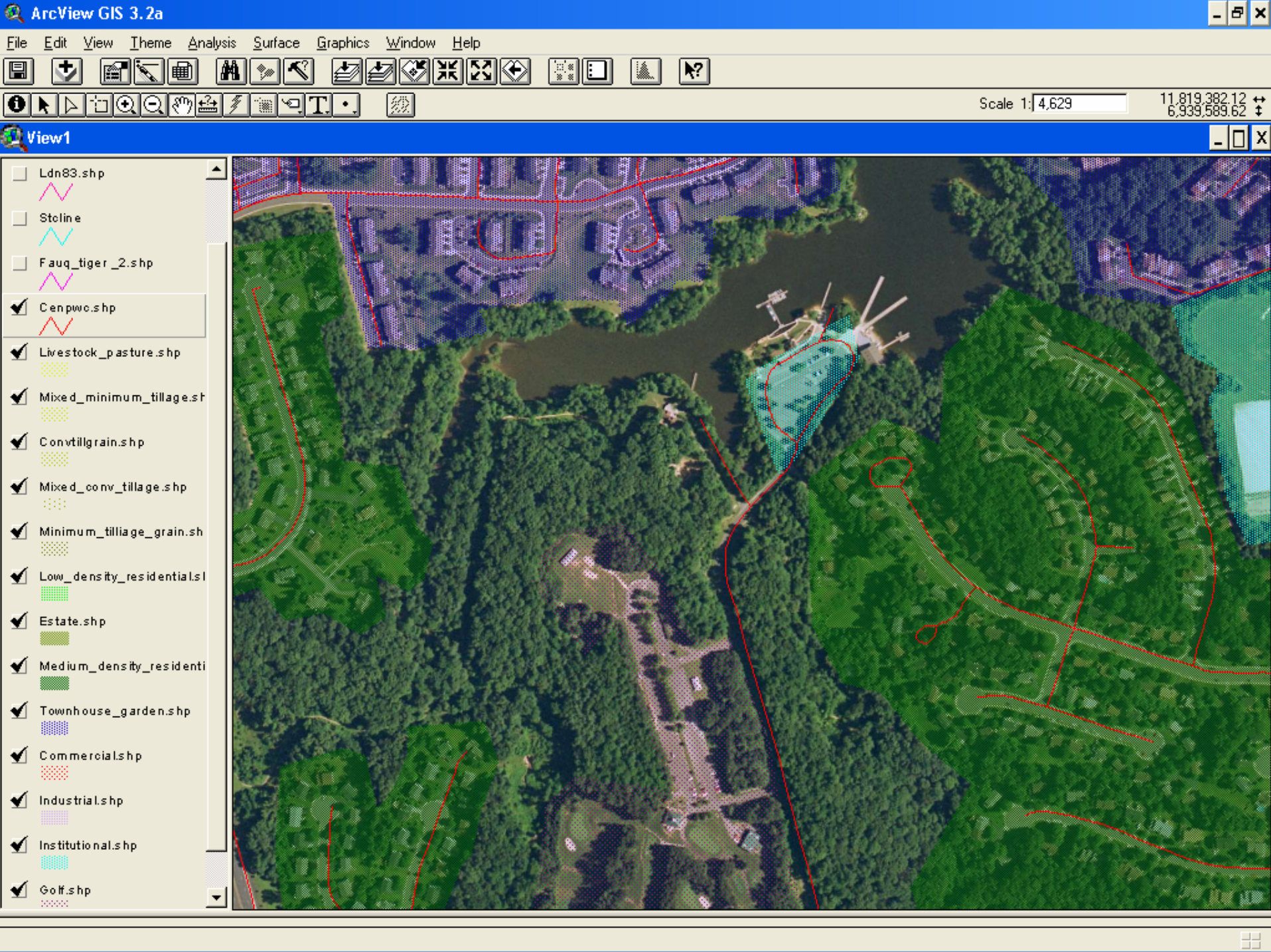
2000 Occoquan Watershed Land Use Survey
Draft Map



- Forest & Idle Land
- Estate Residential
- Low Density Residential
- Medium Density Residential
- Townhouse & Garden Apartments
- Commercial Lands
- Industrial Lands
- Livestock & Pasture
- Minimum Tillage
- Mixed Minimum Tillage
- Mixed Conventional Tillage
- Conventional Tillage
- Golf Course
- Institutional Lands

Northern Virginia Planning District Commission
Occoquan Watershed Management Program
April, 2002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Commercial.shp
Industrial.shp
Institutional.shp
Golf.shp

ArcView GIS 3.2a

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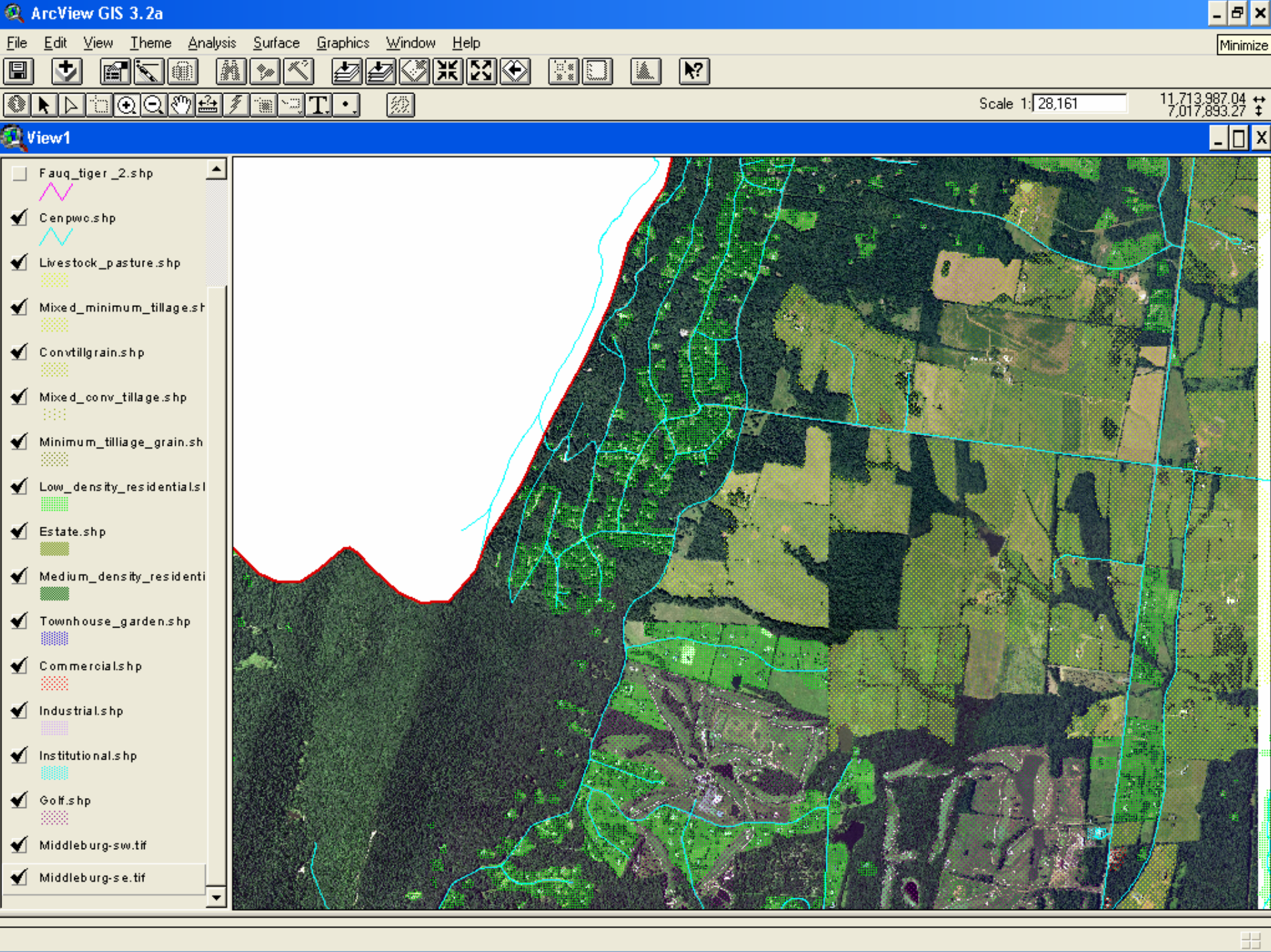
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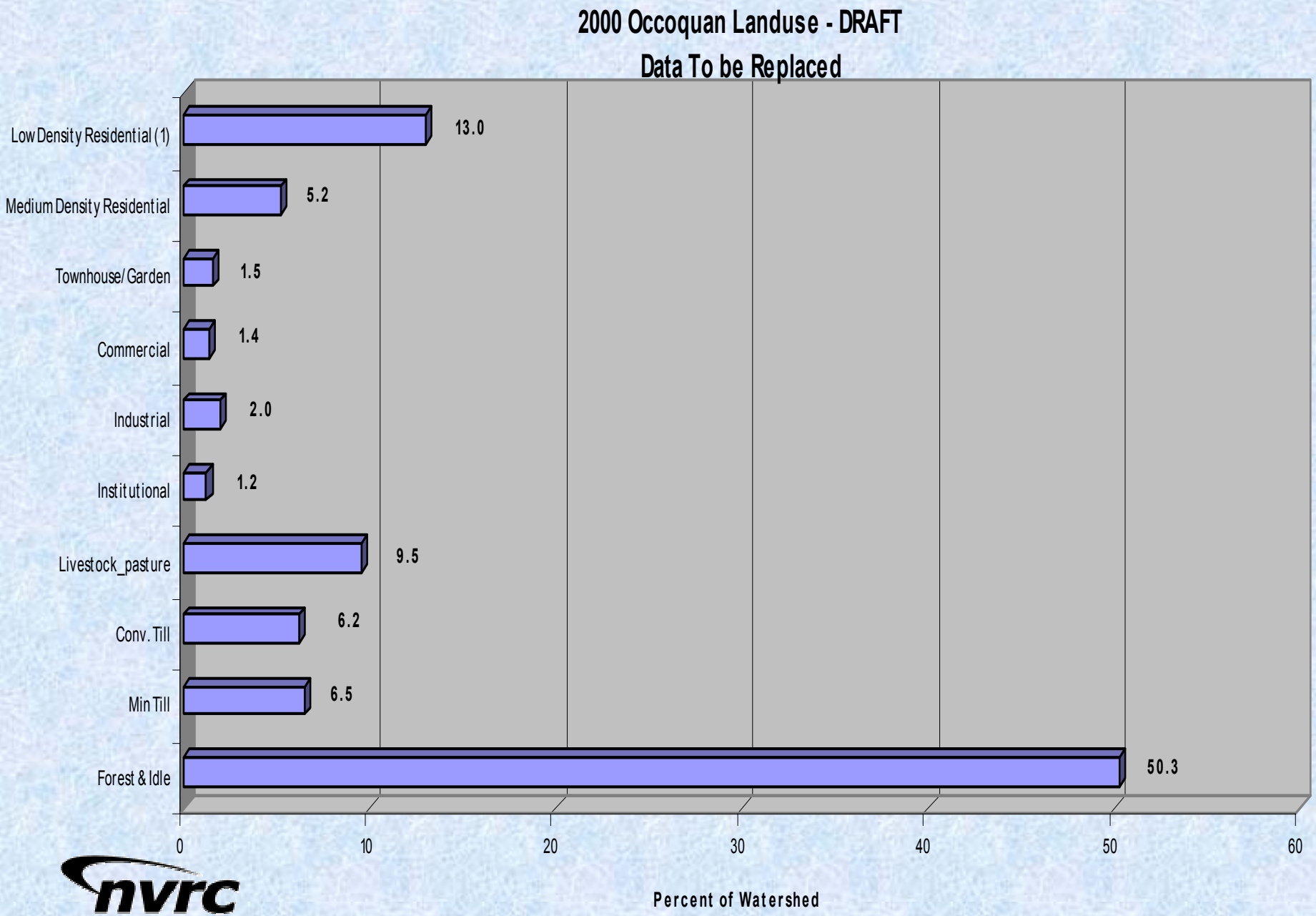

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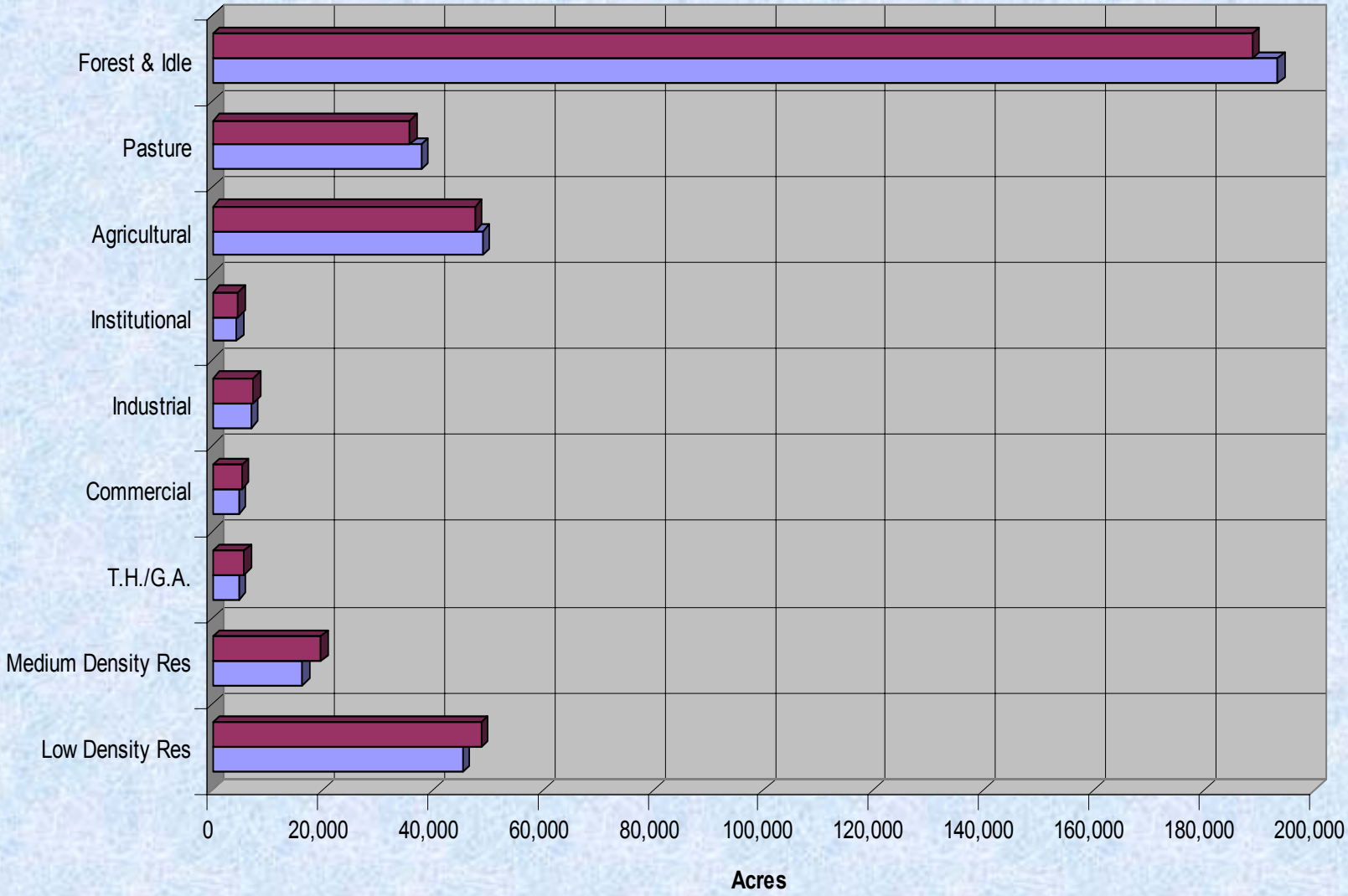

	Low Density Res	Medium Density Res	T.H./G.A.	Commercial	Industrial	Institutional	Agricultural	Pasture	Forest & Idle
2000	48,785	19,664	5,748	5,234	7,343	4,588	47,594	35,811	188,921
1995	45,473	16,328	4,771	4,788	7,006	4,311	49,053	37,872	193,408

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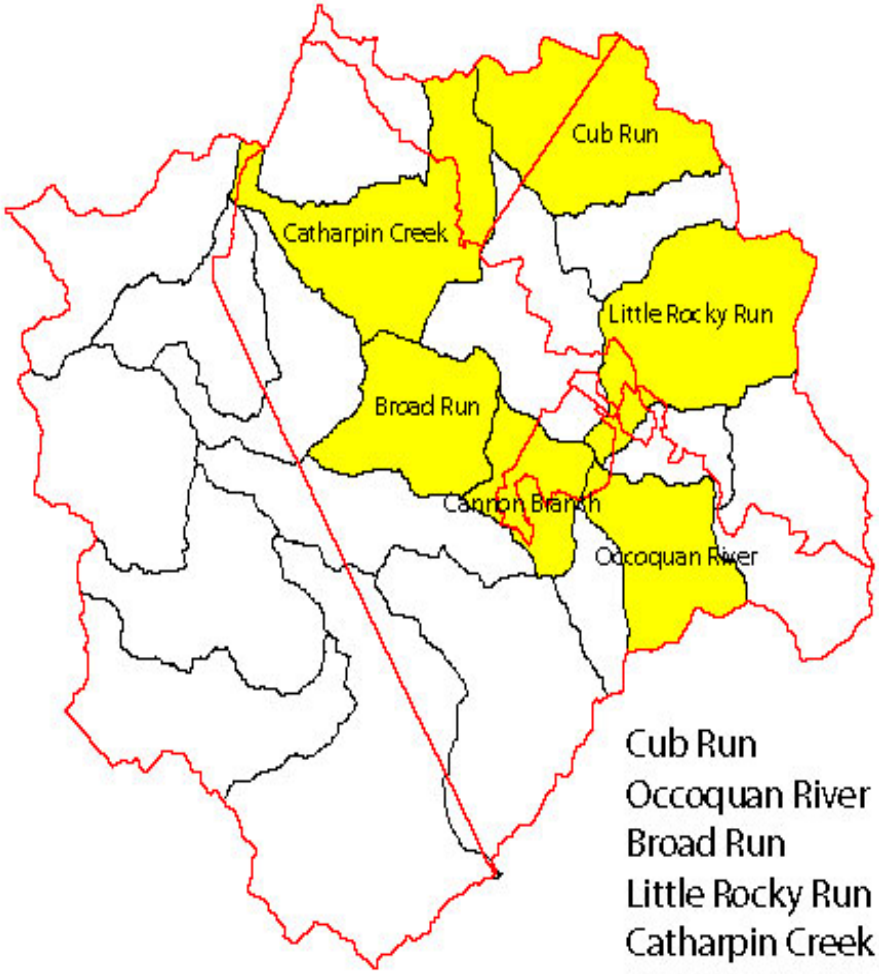
2000 Land Use

Most Active Subsheds - Urban Acres Added



Cub Run	+1,524 acres
Occoquan River	+1,118
Broad Run	+1,083
Little Rocky Run	+1,000
Catharpin Creek	+604
Cannon Branch	+536

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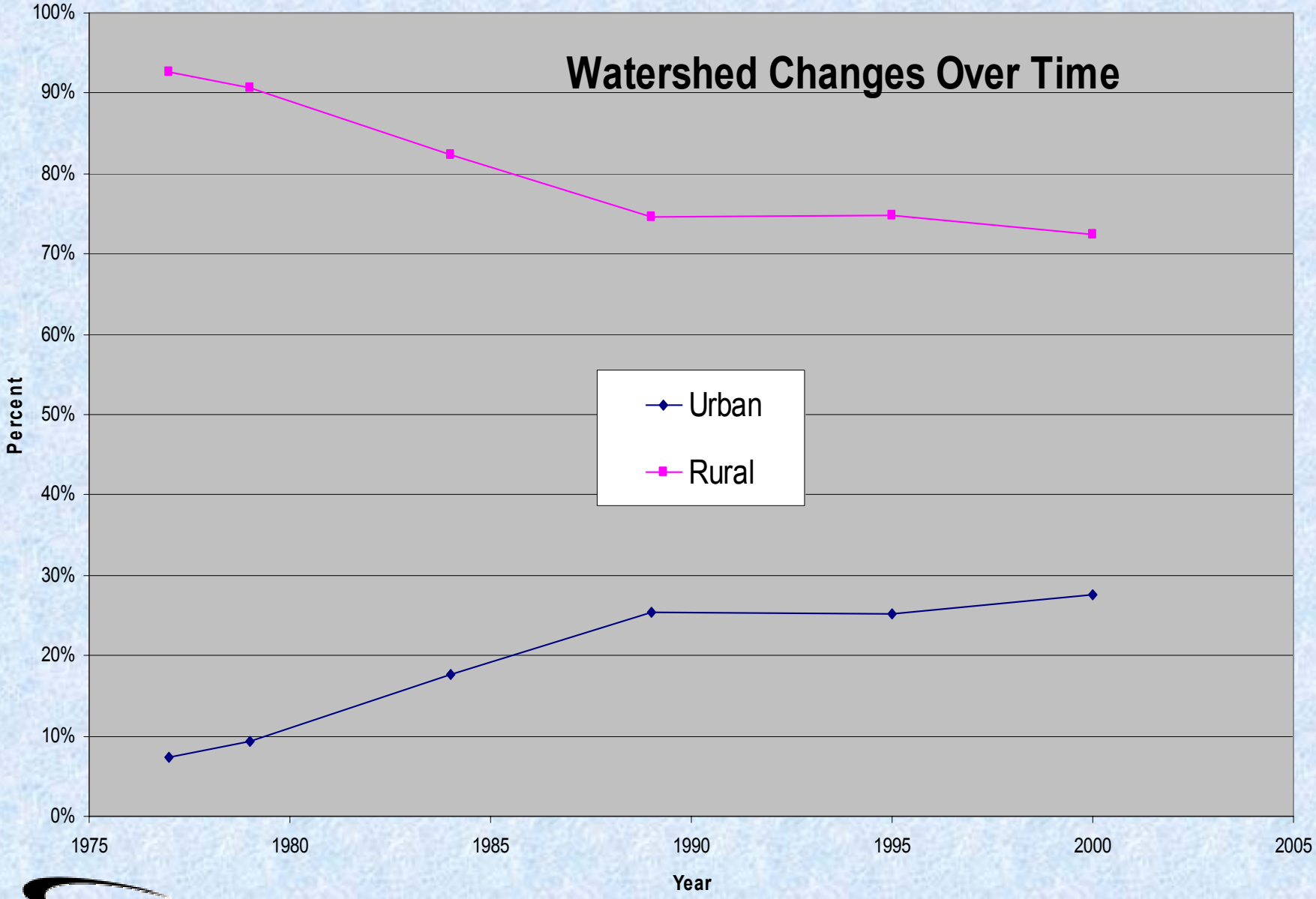

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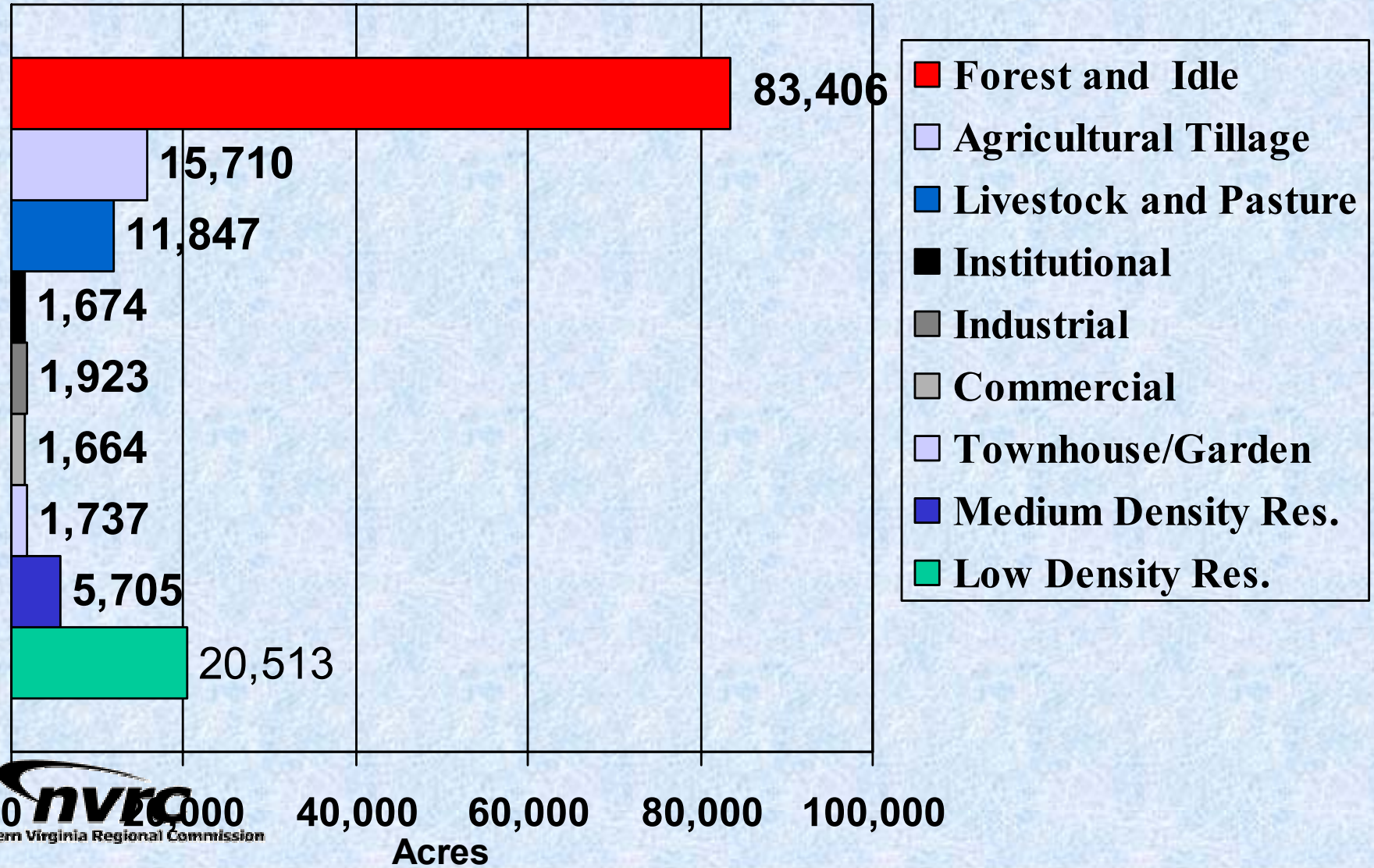
Prince William County
Land Use in Watershed



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Impervious Surface Estimates

	2000	Low	High
Low Density Res	48,785	1,951	8,781
Medium Density Res	19,664	5,506	6,686
T.H./G.A.	5,748	2,299	3,449
Commercial	5,234	4,187	4,711
Industrial	7,343	5,874	6,608
Institutional	4,588	1,376	2,294
Agricultural	47,594	952	952
Pasture	35,811	716	716
Forest & Idle	188,921	3,778	3,778
Roads	12,137	9,710	10,923
		10%	13%

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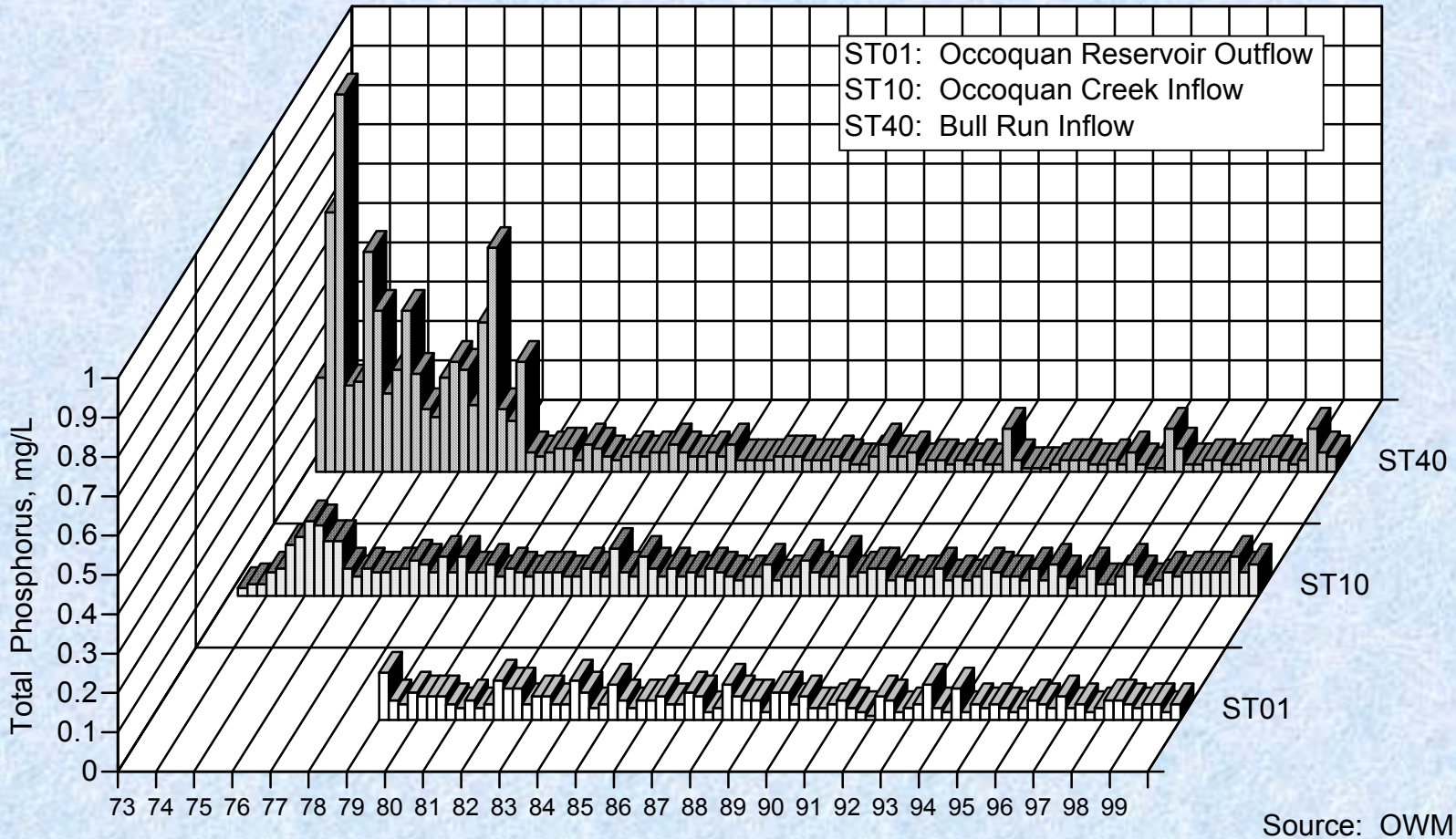
Nonpoint Source Control in the Occoquan Watershed

- Local government NPS programs were in early 1980's, and significantly in advance of state and federal regulatory requirements
- Structural and non-structural BMP programs widely applied in both urban and agricultural areas of basin:
  - Regional and site level stormwater management
  - Land Use Planning
  - Zoning
  - Acquisitions for parkland
- Education programs: agricultural and urban

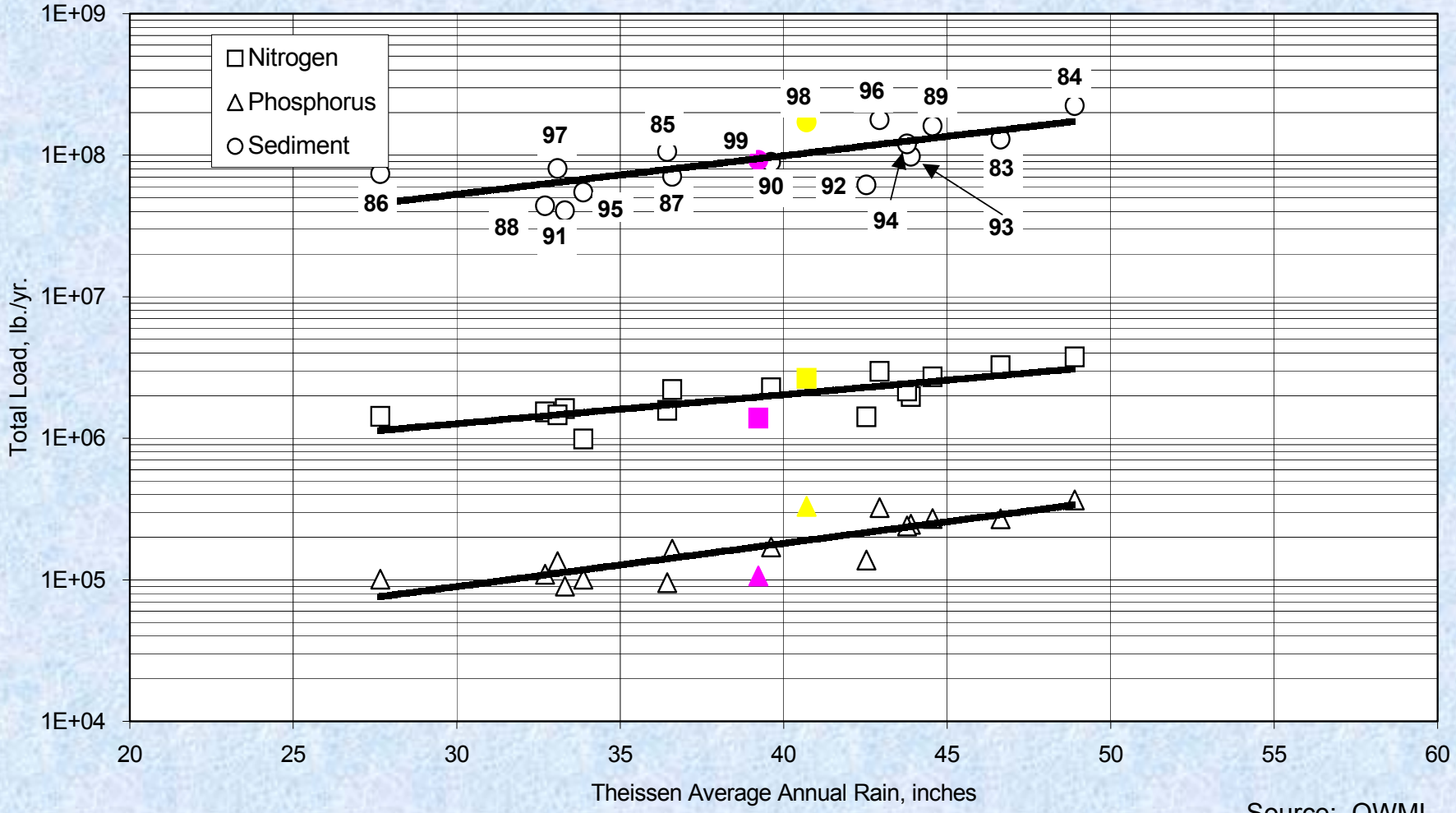
The Results

Seasonal Average Total Phosphorus in Reservoir Inflows and Outflows



Source: OWML

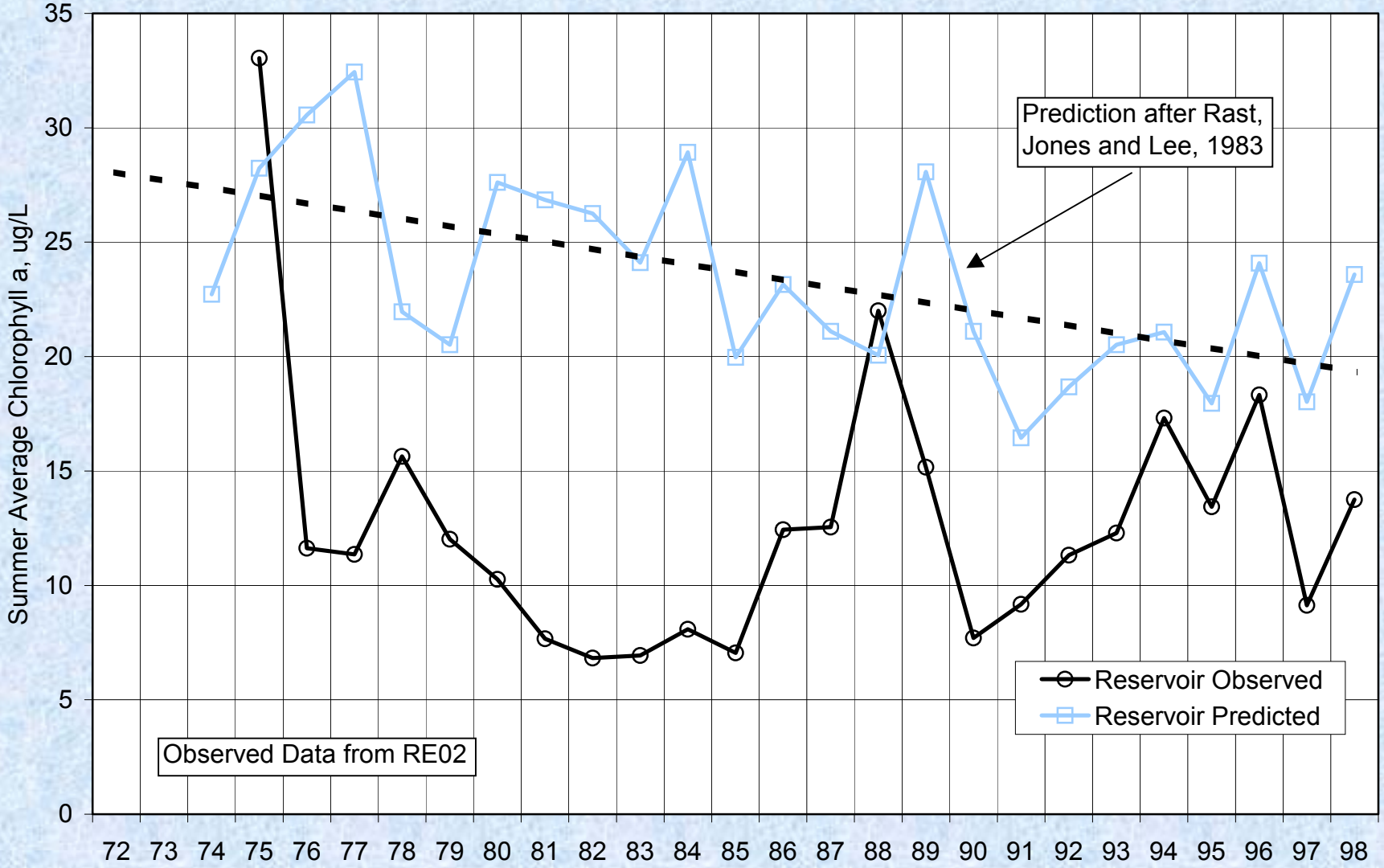
Annual Nutrient and Sediment Loads as a Function of Theissen Average Annual Rainfall 1983 - 1999



Source: OWML

Source: OWML

Predicted and Observed Summer Average Chlorophyll *a* at Occoquan Dam, 1974 - 1998



Summary of Load Sources and Retention or Conversion in Occoquan Reservoir: 1983 - 1999

Constituent	Average Annual Load (lb.)	Nonpoint Sources (%)	POTW's (%)	Atmospheric Deposition (%)	Retention or Conversion in Reservoir (%)
Total Nitrogen	3.11E+06	68.1	31.5	0.4	34.21
Total Phosphorus	2.05E+05	95.0	4.8	0.2	53.29
Total Sediment	1.06E+08	100.0	0.0	0.0	81.04

Northern Virginia Regional Commission

Source: OWML

Stream Conditions ?

Figure 12. Site condition ratings for Occoquan subwatersheds.

SPS Sites with Subsheds Located Primarily Within the Downzoned Area of the Occoquan Watershed

Watershed	Stream Name and Site Code	Composite: Site Condition Rating	Environmental Variables: Index of Biotic Integrity	Habitat Score	Fish Taxa Richness	Current Percent Impervious Surfaces	Projected Percent Impervious Surfaces[1]
Bull Run	Bull Run Tributary (BLBT01)	Excellent	Excellent	Fair	High	0.8	5
Johnny Moore Creek	Johnny Moore Creek 1 (JMJM01)	Excellent	Good	Good	High	2.6	6
	Johnny Moore Creek 2 (JMJM02)	Excellent	Poor	Good	High	2.4	5
Popes Head Creek	Castle Creek (PHCC01)	Excellent	Fair	Good	High	3.9	5
Old Mill Branch	Old Mill Branch (OMOM01)	Excellent	Excellent	Fair	Low	3.5	5
Wolf Run	Wolf Run 1 (WRWR01)	Fair	Excellent	Fair	Very Low	3.3	5
	Wolf Run 2 (WRWR02)	Excellent	Excellent	Good	Moderate	3.9	5
Ryans Dam	Ryans Dam Unnamed Trib (RDRT01)	Excellent	Excellent	Fair	Moderate	3.3	5
Sandy Run	Sandy Run 1 (SASA01)	Excellent	Good	Good	High	6.1	6
	Sandy Run 2 (SASA02)	Excellent	Good	Good	Moderate	4.4	5
	Sandy Run Unnamed Trib. (SASA02)	Fair	Good	Fair	Very Low	1	8
Occoquan	Elk Horn Run (OCEH01)	Excellent	Excellent	Excellent	Low	3.6	14

SPS Sites Within the Downzoned Area, But With Some Headwaters Outside the Downzoned Area

Popes Head Creek	Piney Branch 1 (PHPI01)	Fair	Poor	Fair	High	12.8	14
	Popes Head Creek 1 (PHPH01)	Good	Poor	Fair	High	13.1	20
	Piney Branch 2 (PHPI02)	Fair	Poor	Poor	High	8.3	9
	Popes Head Creek 2 (PHPH02)	Fair	Fair	Poor	Moderate	11.4	14
	Castle Creek (PHCC01)	Excellent	Fair	Good	High	3.9	5
	Popes Head Creek 3 (PHPH03)	Good	Poor	Fair	Moderate	8	10

SPS Sites with Subsheds Located Primarily Outside the Downzoned Area of the Occoquan Watershed

Cub Run	Cain Branch (CUCB01)	Fair	Fair	Poor	Moderate	16.8	51
	Cub Run (CUCU02)	Good	Good	Fair	Low	8.4	43
	Flatlick Branch 1 (CUFB01)	Poor	Poor	Poor	High	21.2	39
	Flatlick Branch 2 (CUFB02)	Poor	Fair	Fair	Low	22.6	49
	Cub Run 2 (CUCU03)	Good	Poor	Good	Moderate	10.4	46
	Big Rocky Run 1 (CUBR01)	Good	Fair	Excellent	High	27.4	47
	Big Rocky Run 2 (CUBR02)	Fair	Fair	Fair	Moderate	27.7	44
	Elklick Run (CUER02)	Fair	Fair	Fair	Very Low	2.2	5
	Cub Run 3 (CUCU04)	Poor	Fair	Very Poor	Moderate	12.2	32
	Cub Run 4 (CUCU05)	Good	Fair	Fair	Moderate	12	31
Little Rocky Run	Little Rocky Run 1 (LRLR01)	Fair	Poor	Good	High	14.6	27
	Little Rocky Run 2 (LRLR02)	Good	Fair	Good	High	17.7	32
	Little Rocky Run 3 (LRLR03)	Fair	Poor	Good	Moderate	19.1	33

[1] The method that was used in the SPS baseline study, to determine the projected percent of impervious surface, was not accurate enough to provide precise projections.

Source: Fairfax County – New Millennium Task Force Report

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Summary of the Occoquan Experience

- Institution of AWT Practices and NPS controls have ameliorated extremely poor water quality conditions of the 1960's and 1970's
- Reservoir remains eutrophic but enrichment rate is substantially lower
- Continued care in management of point and non-point sources can maintain acceptable source water quality while allowing an appropriate mix of land uses and activities

Occoquan Watershed

"Where is it and What's in it"

Normand Goulet

NVRC

Northern Virginia Regional Commission