

Fairfax County's Approach to a Resilient Fairfax

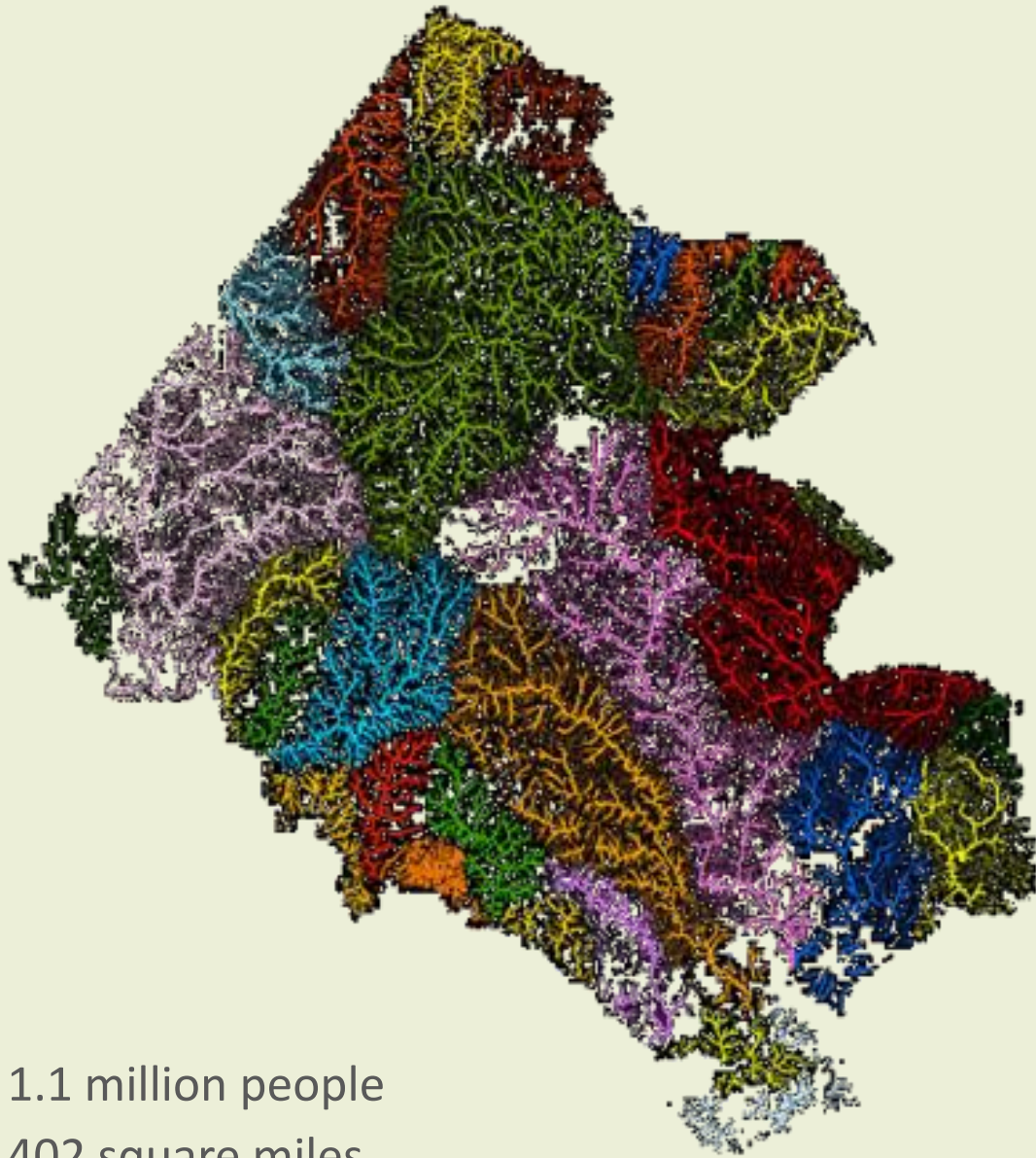
Department of Public Works and Environmental Services

Office of Environmental and Energy Coordination

MWCOG Water Resources Technical Committee



A Fairfax County, VA, publication
November 5, 2021



1.1 million people

402 square miles

1,600 miles of streams and associated channels

Fairfax County Agencies Focused on Community Flood Mitigation and Resilience

- Department of Public Works and Environmental Services
- Office of Energy and Environmental Compliance
- Department of Land Development Services
- Department of Planning and Development

Catie Torgersen, catherine.torgersen@fairfaxcounty.gov, DPWES

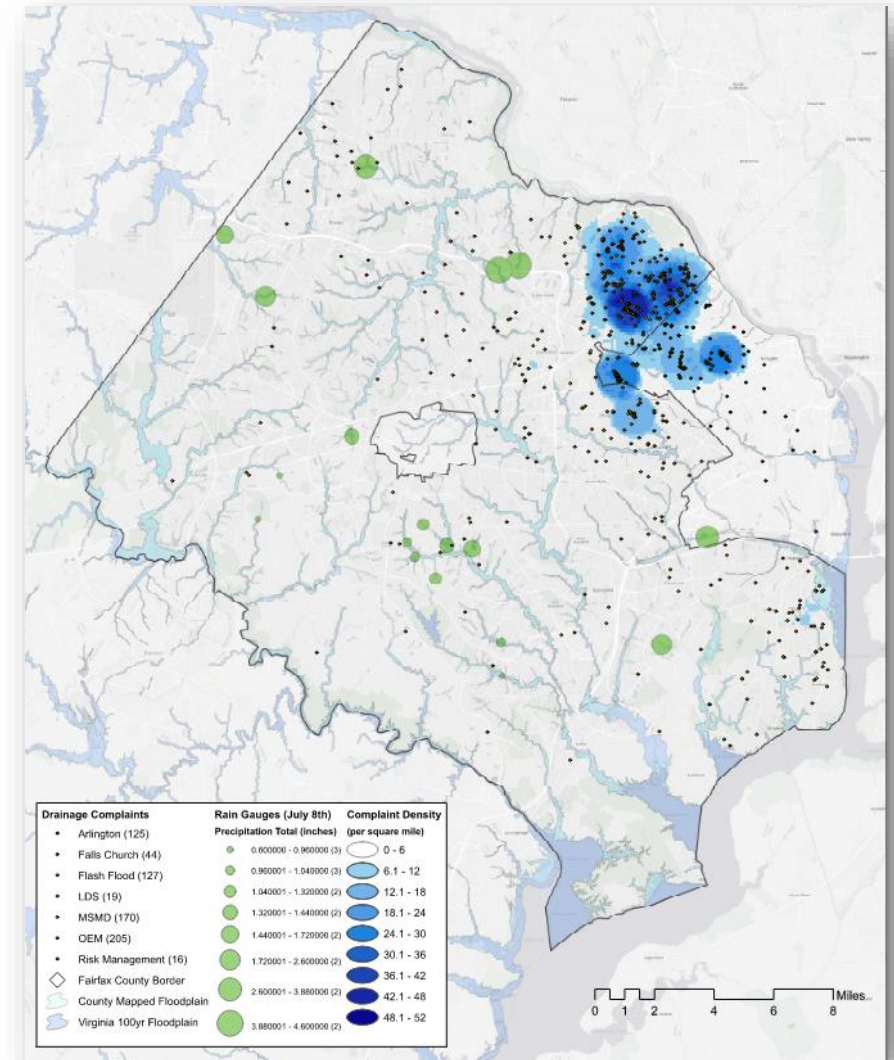
Ellie Coddington, eleanor.coddington@fairfaxcounty.gov, DPWES

Matt Meyers, matthew.meyers@fairfaxcounty.gov, OEEC

Resilient Fairfax: Climate Adaptation and Resilience Plan

Background:

- Board of Supervisors
 - [Environmental Vision](#)
 - [Fairfax Green Initiatives Board Matter](#)
 - To address increasing storm severity, flooding, extreme heat, sea level rise and other effects already seen in the county



July 8, 2019: Storm Response

Resilient Fairfax: Background

1. What climate conditions and hazards do we face now? In the future?

- Climate Projections Report
- Temperatures, precipitation, flooding, storm severity, drought

2. Where are we vulnerable?

- Climate Vulnerability and Risk Assessment
- Homes, businesses, neighborhoods, infrastructure, services & operations, people in path of climate effects

3. How are we currently doing in terms of resilience?

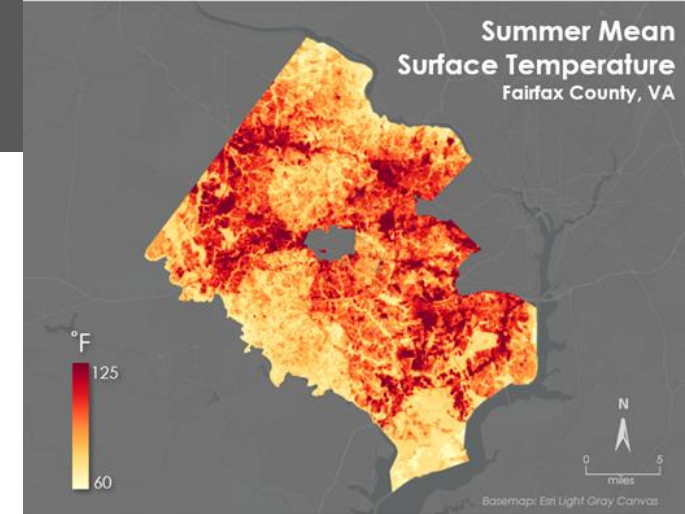
- Audit of Existing Policies, Plans, and Programs
- Which programs are working well? Where do we have gaps?

4. Which strategies will strengthen our resilience?

- Adaptation and Resilience Strategies
- Physical upgrades, policies, design standards, services, staffing, procedural changes, agency coordination, etc.

5. What is the path to implementation?

- Implementation Roadmap
- Funding sources, staffing, timelines



Climate Change in Fairfax County

In the coming decades, Fairfax County will experience

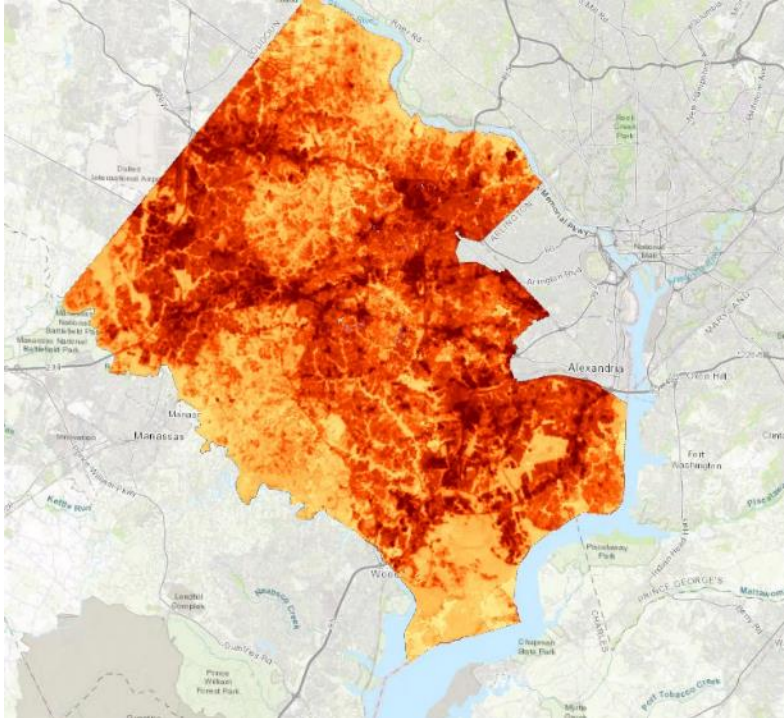
Warmer, Wetter, Weirder

climate conditions.



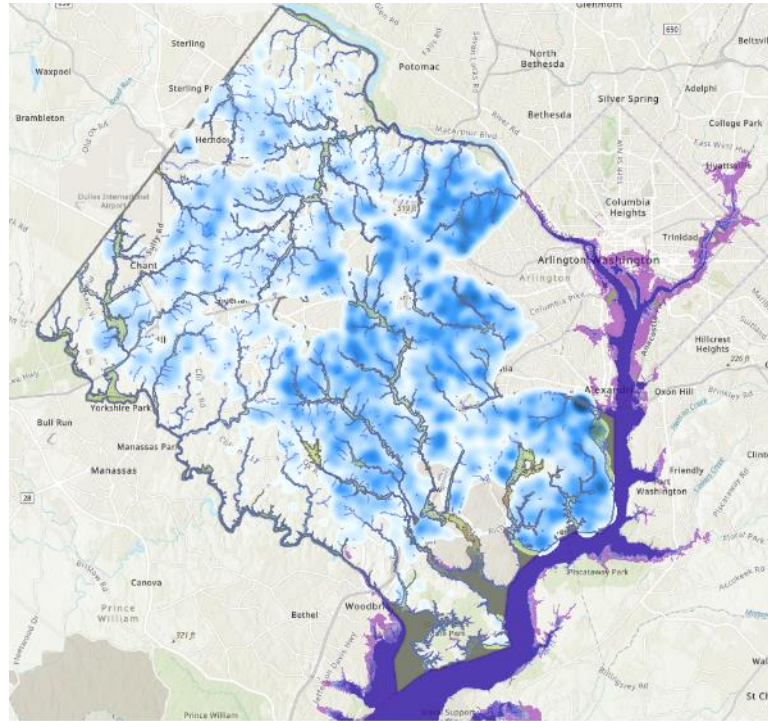
Climate Change in Fairfax County

Warmer



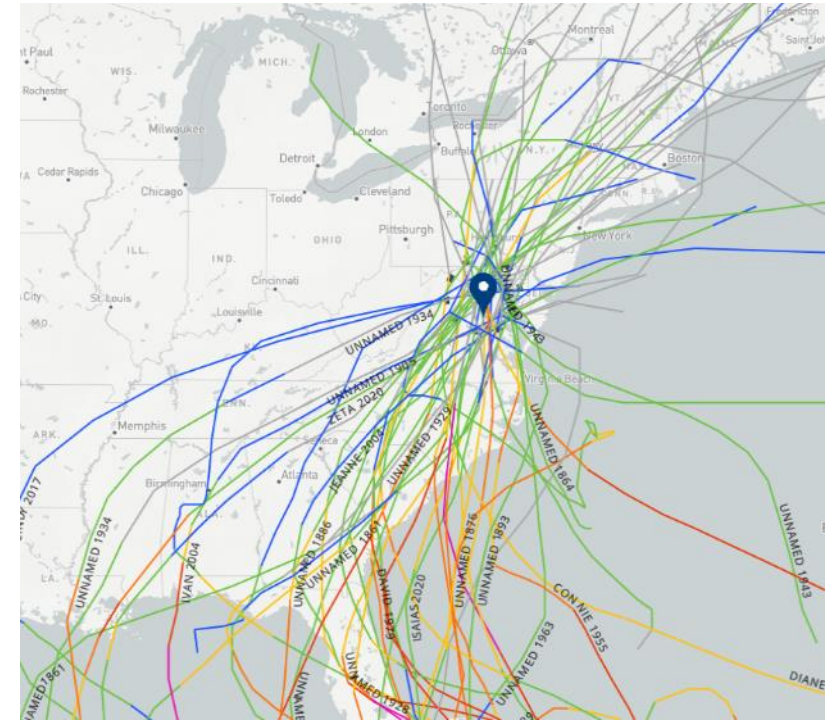
- **Annual temperature rise 4.4 – 8°F** by 2085
- **Extreme heat days** projected to increase from 7 to 70 days per year by 2085
- **Urban Heat Island Effect** on top of temperature increase

Wetter



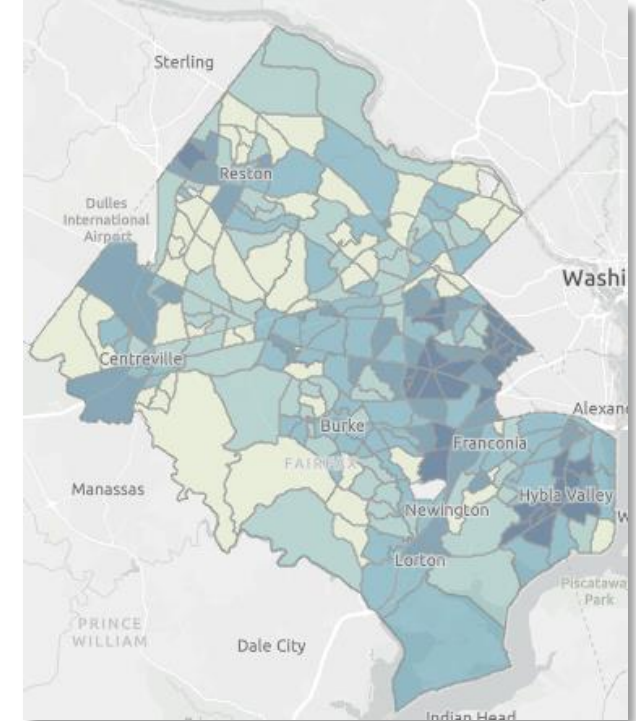
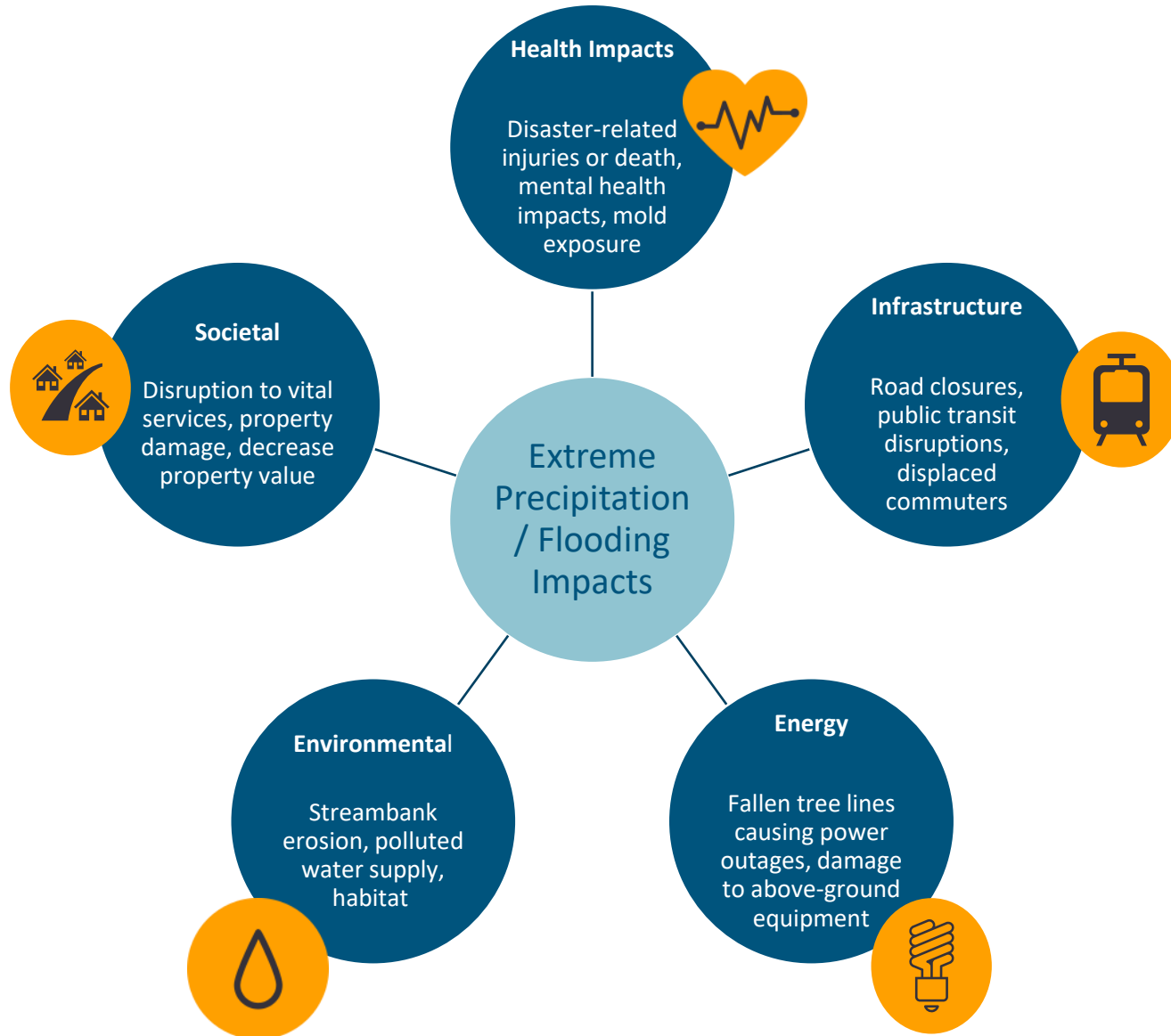
- **Annual and seasonal precipitation** increase
- **Precipitation intensity** increase across all return periods
- **Sea level rise** of 3 feet --> Potomac River

Weirder



- **Severe storm strength** increase, including tropical storms, derechos, hurricanes, nor'easters
- **Unseasonably warm/cool** temperatures
- **Periods of no precipitation** followed by sudden, heavy precipitation





Wetter & Weirder: Impacts



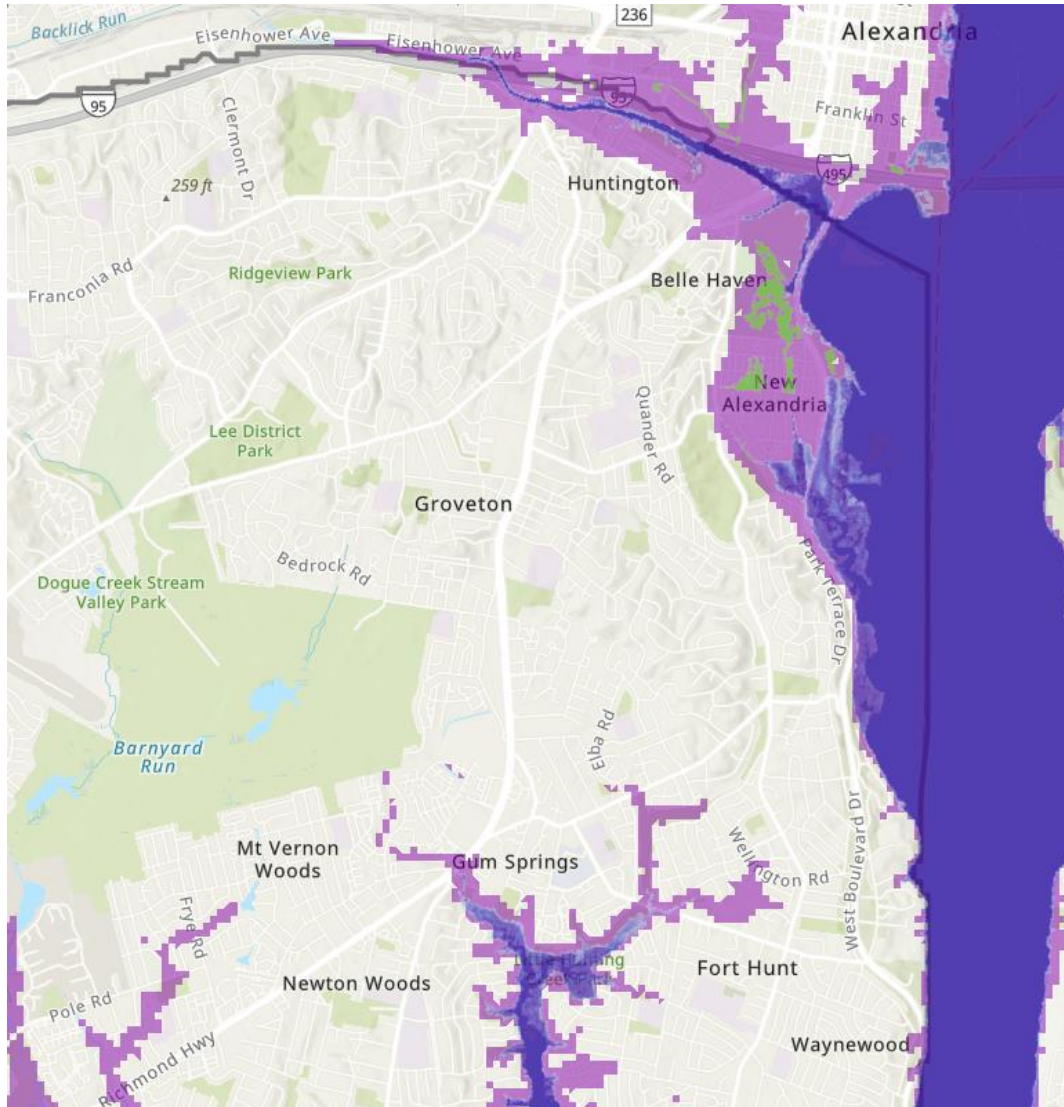
One Fairfax Vulnerability Index

Flooding Types

There are 4 major types of climate-related flooding in Fairfax County

INLAND FLOODING		COASTAL FLOODING	
1. Stormwater Issues Heavy rain overwhelms stormwater infrastructure	2. Floodplains Heavy rain makes rivers and streams overflow	3. Sea Level Rise Rising sea means rising Potomac River	4. Coastal Storm Surge Hurricanes, tropical storms, etc. push water on shore
			

Coastal Flooding



Sea Level Rise and Storm Surge

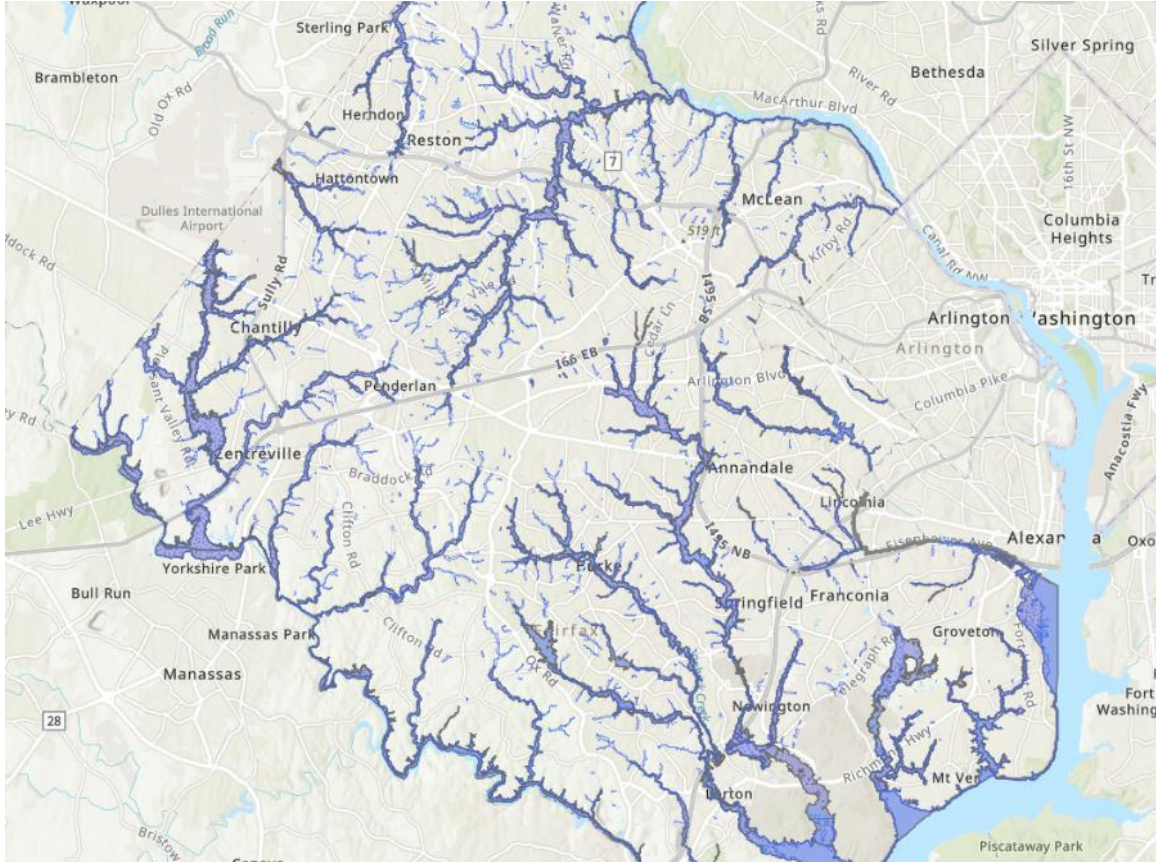


Huntington Levee



New Alexandria/Belle View

Inland Flooding



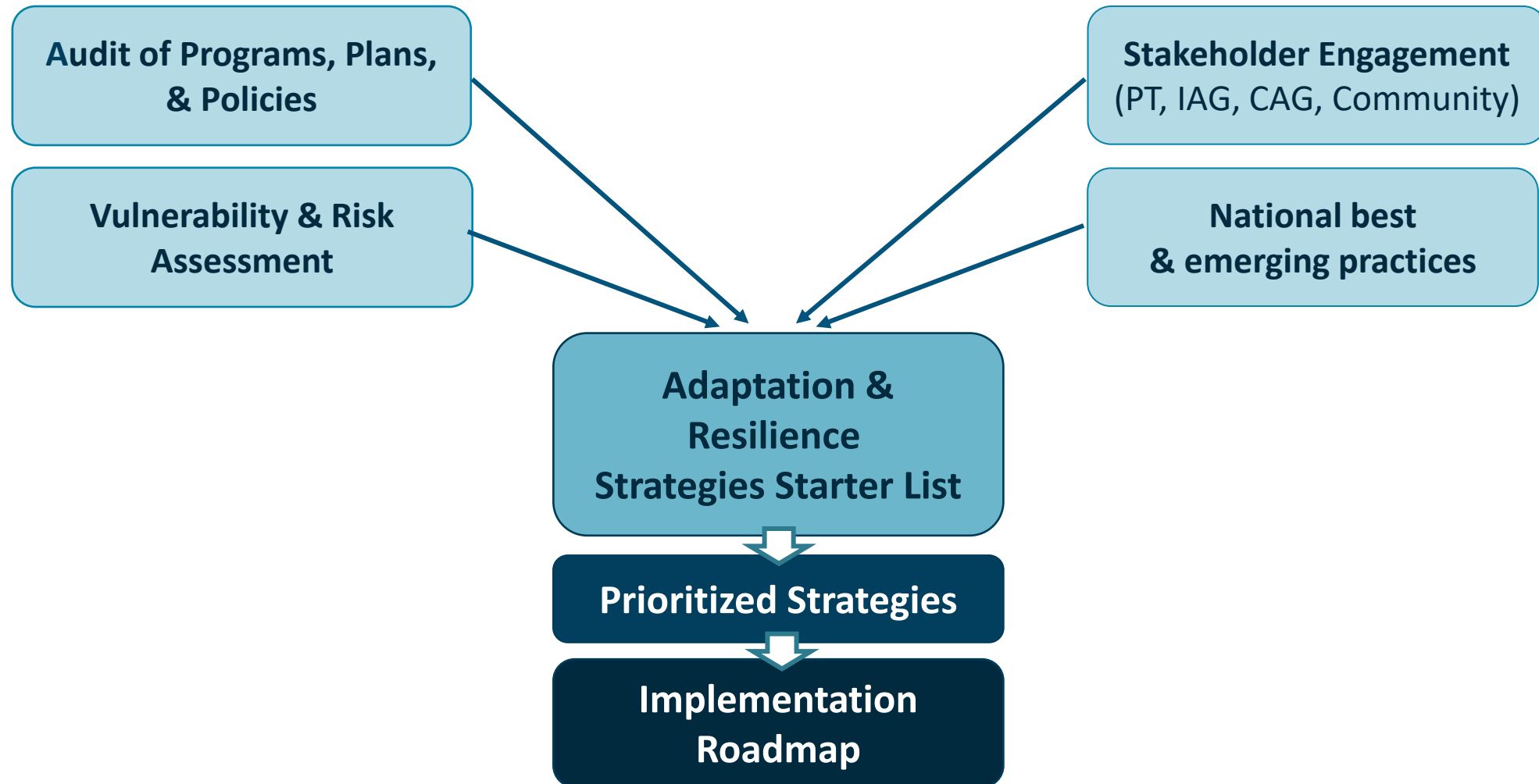
Floodplains



Interior Flooding
Older Neighborhoods and Roads

What do we do about it?

Strategy Development Approach



Regulation and Policy Drivers: Developers v. County

Infill Development

**New Development:
By-right v. Entitlement**

Water Quality Needs



**Existing Neighborhoods
Lacking Infrastructure**

**Partnerships:
VDOT & FCDOT & FCPS**

**Increasing Precipitation
Intensity**

GOAL: Balance community needs with “no regrets” choices and agility

Current County Stormwater Regulations

Chapter 124 – Stormwater Management Ordinance (SWMO)

Chapter 118 – Chesapeake Bay Preservation Ordinance (CBPO)

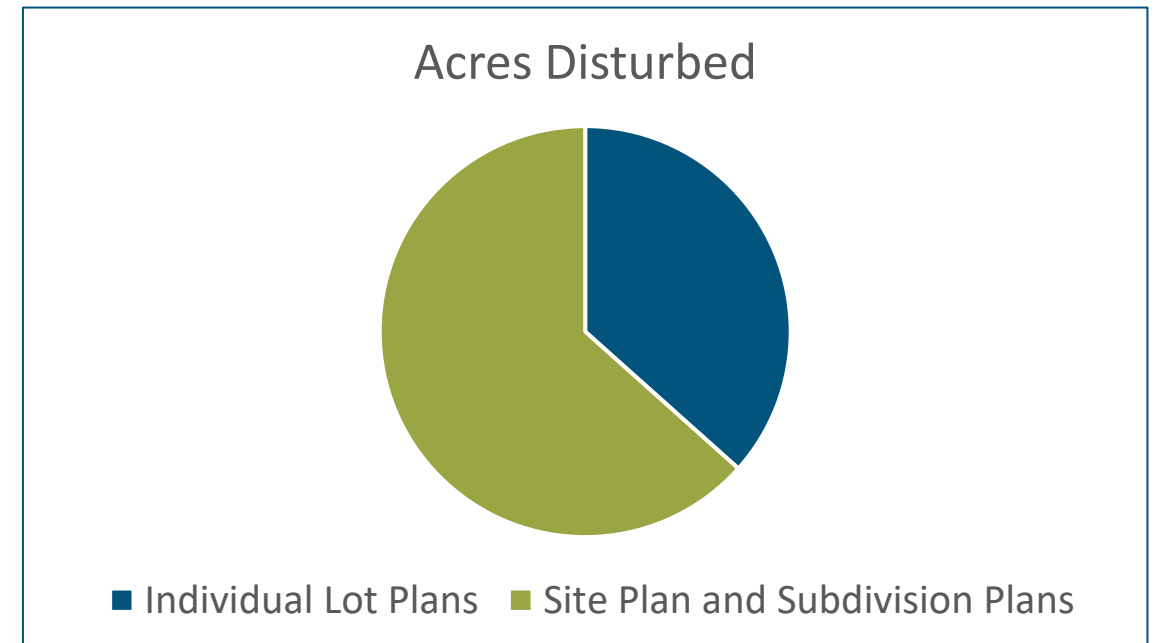
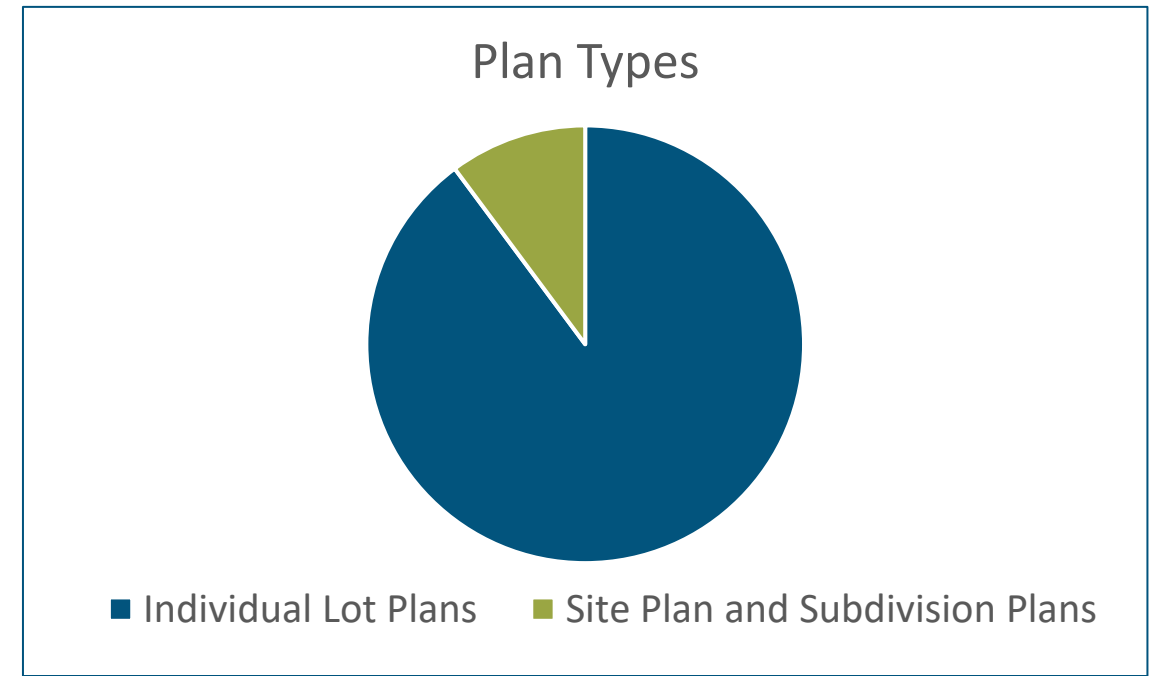
Chapter 122, Article 5105 – Zoning Ordinance

Chapter 104 – Erosion and Sediment Control Ordinance

Public Facilities Manual

Which Matters More? Infill or Major Development?

- Individual lot plans: about 90% of the plans submitted in Fairfax
- Site Plans and Subdivision Plans account for more acres disturbed
- Approximately 1/3 of Infill Lot Grading Plans are exempt from the SWMO
 - Previously, this exempted them from most detention requirements
 - Now, required to evaluate on a case-by-case basis





Individual Lot Grading Plans exempt from SWMO?

NOT EXEMPT: All projects discharging concentrated flow (124-4-4.B & C)

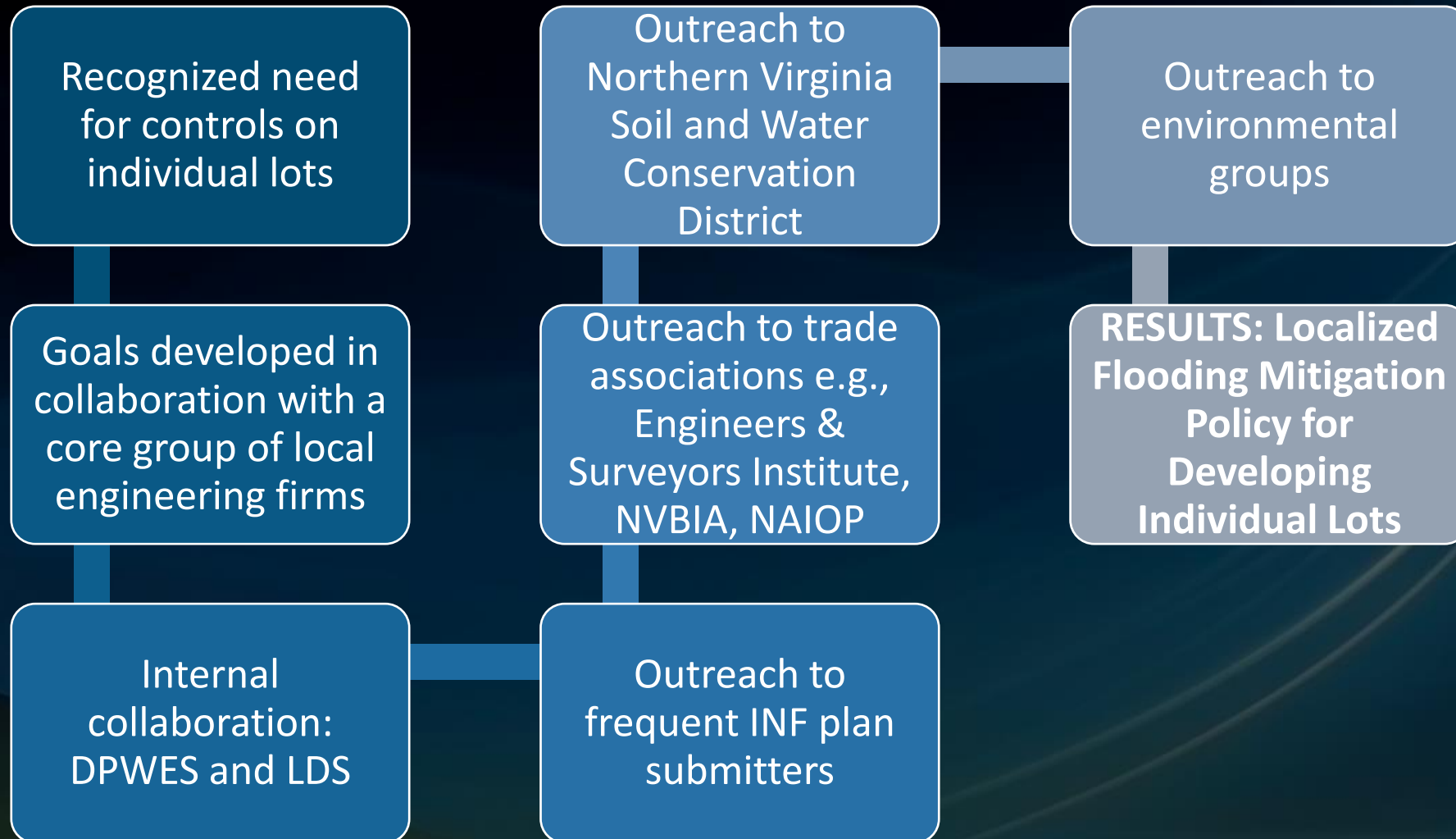
NOT EXEMPT: Projects without concentrated flow but with known downstream issues (124-4-4.E) *Review policy changed 2017 – 2021*

EXEMPT: Lots < 18% or 2,500 square feet impervious area, and lots < 0.5 acre adding < 500 square feet impervious area (§ 124-1-7.3.b)

OVERALL: Approximately one-third of Infill Lot Grading Plans are exempt from the SWMO

NO REGRETS SOLUTION: SWMO-exempt projects now required to provide detention based on different authorities on a case-by-case basis

How much is reasonable to put on an individual lot?



Localized Flooding Mitigation Policy Compliance Tool

- Example: template design & calculations sheet for detention “plug and play” calculations
- Benefits:
 - Minimizes future flooding
 - Standard methods speed design and review
 - Standard facilities speed installation and inspection
 - Maintainability was a primary design consideration

CONSTRUCTION NOTE FOR UPD FACILITIES:
 ALL UPD SYSTEM CONSTRUCTION MUST CONFORM, WHERE APPLICABLE, TO THE CURRENT VDOT ROAD AND BRIDGE SPECIFICATIONS, PIPING AND MANUFACTURER'S REQUIREMENTS AND RECOMMENDATIONS, WITH THE MOST STRINGENT CRITERIA GOVERNING FOR ANY PARTICULAR REQUIREMENT.

PIPE SPACING TABLE

PIPE DIA.	PIPE TO PIPE	PIPE TO WALL
24"	14"	12"
30"	18"	18"
36"	22"	18"

CONVEYANCE PIPE SIZE REQUIREMENTS
 (BASED ON SQ. FT. OF DRAINAGE AREA SERVED)

PIPE DIA.	MAX. DA	PIPE DIA.	MAX. DA
4"	100	6"	2,500
6"	2,000	8"	8,000
8"	4,500	8"	15,000
12"	8,000	12"	25,000
18"	15,000	18"	25,000

GENERALIZATION OF NO CHANGE
 THESE SHEETS HAVE BEEN MADE TO BE APPLICABLE TO THE APPLICABLE DESIGN SHEET. UNLESS NOTED OTHERWISE, ALL DIMENSIONS ARE TO BE AS SHOWN. THE DESIGN CALCULATIONS GENERATED FOR THIS PROJECT BY THE UPD STANDARD DESIGN CALCULATOR APPLIED HEREIN.

UNDERGROUND PIPE DETENTION (UPD) FOR INFILL LOTS: DESIGN QUANTITIES TABLE

A separate stand-alone design & Design Quantities Table is required for each lot.

Enter the requested design data in the yellow cells below:

Net additional impervious area created by proposed project:	8000 sq. ft.
Net additional impervious area to be drained by UPD(s):	4000 sq. ft.
Total drainable impervious area to be drained by UPD(s):	8000 sq. ft.
% of equivalent net impervious area to be drained by UPD(s):	67 %
Total required stormwater volume to be detained by UPD(s):	2
Number of individual UPD(s) proposed:	2

Provide the total contributing **drainable** impervious area, the pipe diameter and material, and the typical row length (RL) for each proposed UPD facility, below, to obtain the required # of typical pipe rows and other design quantities. NOTE: **drainable** impervious area is the total impervious area to be drained by UPD(s) (not < 600 sq. ft.) with no previous area allowed. **drainable** flows must be bypassed.

Design data by lot: **MUST** be used for reviewing the individual UPD design data, and **used 2nd.** Not following this order may lead to erroneous "remaining" quantities.

#1 UPD-100 (enter plan number for UPD)

Contributing drainable impervious area =	2500 sq. ft.
Impervious area must not be less than 600 sq. ft.:	OK
UPD facility Pipe Diameter, and Pipe Material: polyethylene (HDPE), polypropylene (PP), or aluminum (CAP) smooth bottom required per PFM	18 in. HDPE
Required UPD facility stormwater storage capacity =	530 cu. ft.
Minimum total length of required UPD facility pipe =	109 ft.
Approx. equiv. pipe-length for 90° corner connections =	4 ft.
Approx. equiv. pipe-length for tee-connections =	5 ft.
Length (RL) of typical UPD facility pipe row =	18 ft.
Number of typical Pipe Rows required for UPD facility =	4
Total length of proposed UPD facility equiv. pipe =	110 ft.
Proposed pipe length must not be less than required:	OK

This facility has excess capacity for future imperv. area = 0 sq. ft.

Remaining **drainable** imperv. area to be captured by UPD(s) = 1500 sq. ft.

10-yr predevelopment Q = allowable facility discharge = 0.12 cfs

Design head for control-orifice calc. = pipe diameter = 2.0 ft.

Square (or round) D-control orifice dimension for allow. Q = 1.3 in.

Design D-control Orifice dimension (min. = 1.0 inch) = 1.3 in.

#2 UPD-200 (enter plan number for UPD)

Contributing drainable impervious area =	1500 sq. ft.
Impervious area must not be less than 600 sq. ft.:	OK
UPD facility Pipe Diameter, and Pipe Material: polyethylene (HDPE), polypropylene (PP), or aluminum (CAP) smooth bottom required per PFM	18 in. PP
Required UPD facility stormwater storage capacity =	320 cu. ft.
Minimum total length of required UPD facility pipe =	102 ft.
Approx. equiv. pipe-length for 90° corner connections =	4 ft.
Approx. equiv. pipe-length for tee-connections =	4 ft.
Length (RL) of typical UPD facility pipe row =	18 ft.
Number of typical Pipe Rows required for UPD facility =	4
Total length of proposed UPD facility equiv. pipe =	162 ft.
Proposed pipe length must not be less than required:	OK

The facilities have excess capacity for future imperv. area = 0 sq. ft.

Remaining **drainable** imperv. area to be captured by UPD(s) = 0 sq. ft.

10-yr predevelopment Q = allowable facility discharge = 0.07 cfs

Design head for control-orifice calc. = pipe diameter = 2.0 ft.

Square (or round) D-control orifice dimension for allow. Q = 1.3 in.

Design D-control Orifice dimension (min. = 1.0 inch) = 1.3 in.

TYPICAL UPD GENERALIZED PLANVIEW

DOUBLE MAINFLOW SYSTEM

SINGLE PIPELINE CONFIGURATIONS

SEE THE DESIGN QUANTITIES TABLE FOR THE SIZE & TOTAL LENGTH OF PIPE REQUIRED. ANY REQUIRED FITTINGS ARE ADDITION TO THE REQUIRED TOTAL LENGTH OF PIPE.

DOUBLE MAINFLOW SYSTEM

SEE GENERAL NOTE 23 FOR BACKFILL REQUIREMENTS.

SINGLE PIPELINE CONFIGURATIONS

SEE GENERAL NOTE 23 FOR BACKFILL REQUIREMENTS.

UNDERGROUND PIPE DETENTION (UPD) FACILITIES FOR INFILL LOTS: DESIGN DATA

UPD Facility ID	Drainage Area (sq. ft.)	Facility Configuration	Pipe Dia. (in.)	# Pipe Rows	Orifice Dim. (in.)	A	B	C
UPD-100	2500	Double Mainflow	18"	4	2.0	250.00	245.25	244.00
UPD-200	1500	Double Mainflow	18"	4	2.0	248.00	243.50	243.00

PRETREATMENT PRACTICES

UPD Facility ID	For Roof/Golf Course	For Driveway	For Inflow Hydrology	OUTLET PROTECTION	MIN UPD (SQ. FT. COVER)
UPD-100	Leaf Screen	In-Area Leaf Strainer/Debrisator		Stake, Imperv. Surface	2.0
UPD-200		Debris Trap		Stake, Imperv. Surface	2.2

UNDERGROUND PIPE DETENTION FACILITY AND ANCILLARY STRUCTURE LOCATION COORDINATES

UPD Facility ID	Drainage Area (sq. ft.)	Facility Configuration	Pipe Dia. (in.)	# Pipe Rows	Orifice Dim. (in.)	A	B	C
UPD-100	2500	Double Mainflow	18"	4	2.0	250.00	245.25	244.00
UPD-200	1500	Double Mainflow	18"	4	2.0	248.00	243.50	243.00

UNDERGROUND PIPE DETENTION FACILITY AND ANCILLARY STRUCTURE LOCATION COORDINATES

UPD Facility ID	Drainage Area (sq. ft.)	Facility Configuration	Pipe Dia. (in.)	# Pipe Rows	Orifice Dim. (in.)	A	B	C
UPD-100	2500	Double Mainflow	18"	4	2.0	250.00	245.25	244.00
UPD-200	1500	Double Mainflow	18"	4	2.0	248.00	243.50	243.00



Land Development Services

Technical Bulletin

Subject: Localized Flooding Mitigation Policy for Residential
Infill Development-Detention Requirements

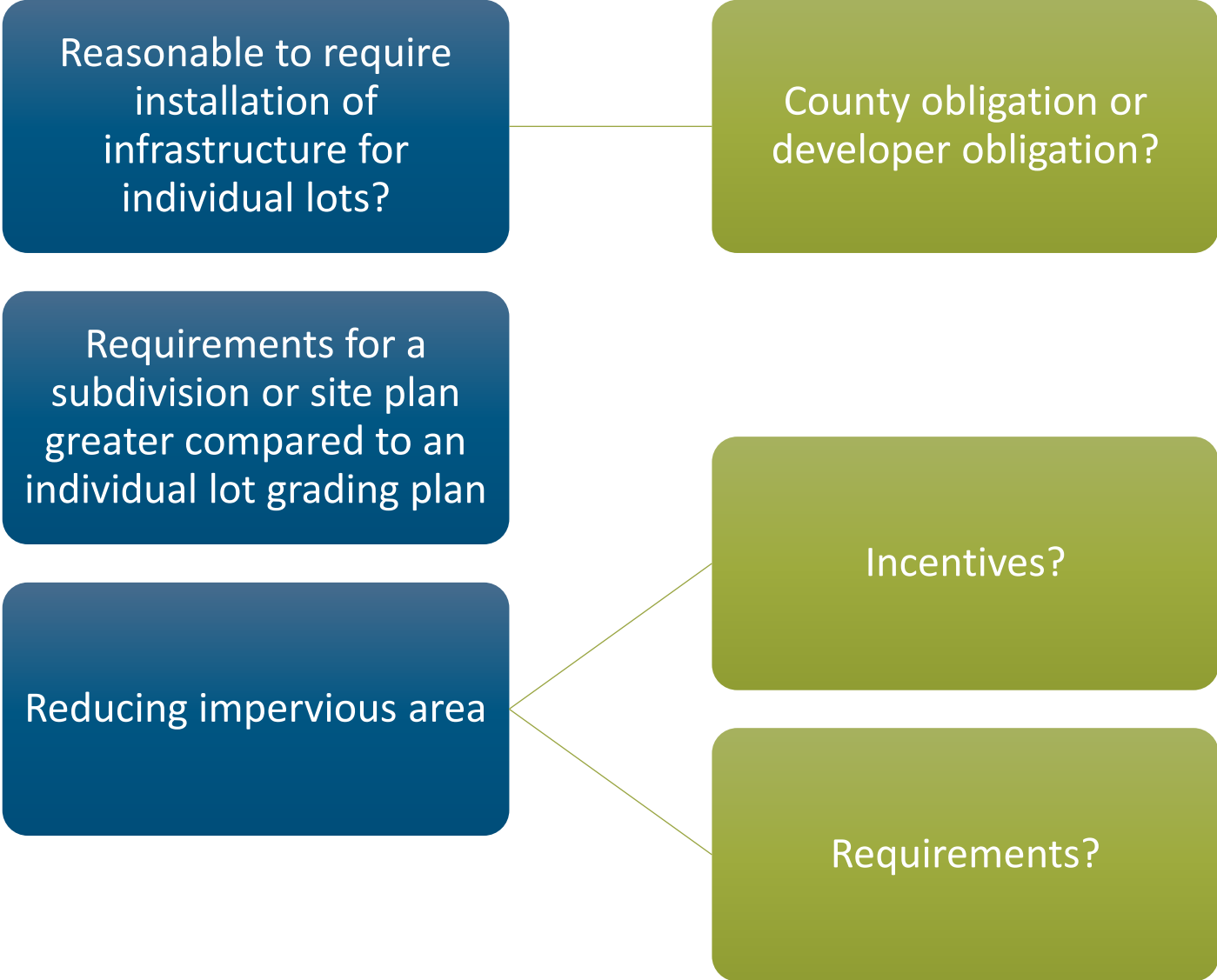
Date:

No.:

Almost Final: Localized Flooding Mitigation Policy

- Acknowledges known drainage issues
- Reiterates SWMO requires detention when downstream issues exist
- Reaffirms detention requirement for drainage to inadequate systems in all cases
- Provides compliance tools: template detention facility designs, and calculation spreadsheets
- Will be issued in upcoming Technical Bulletin

Is that the best we can do for infill development?



Regulation and Policy Drivers: Developers v. County



Infill Development

**New Development:
By-right v. Entitlement**



**Existing Neighborhoods
Lacking Infrastructure**

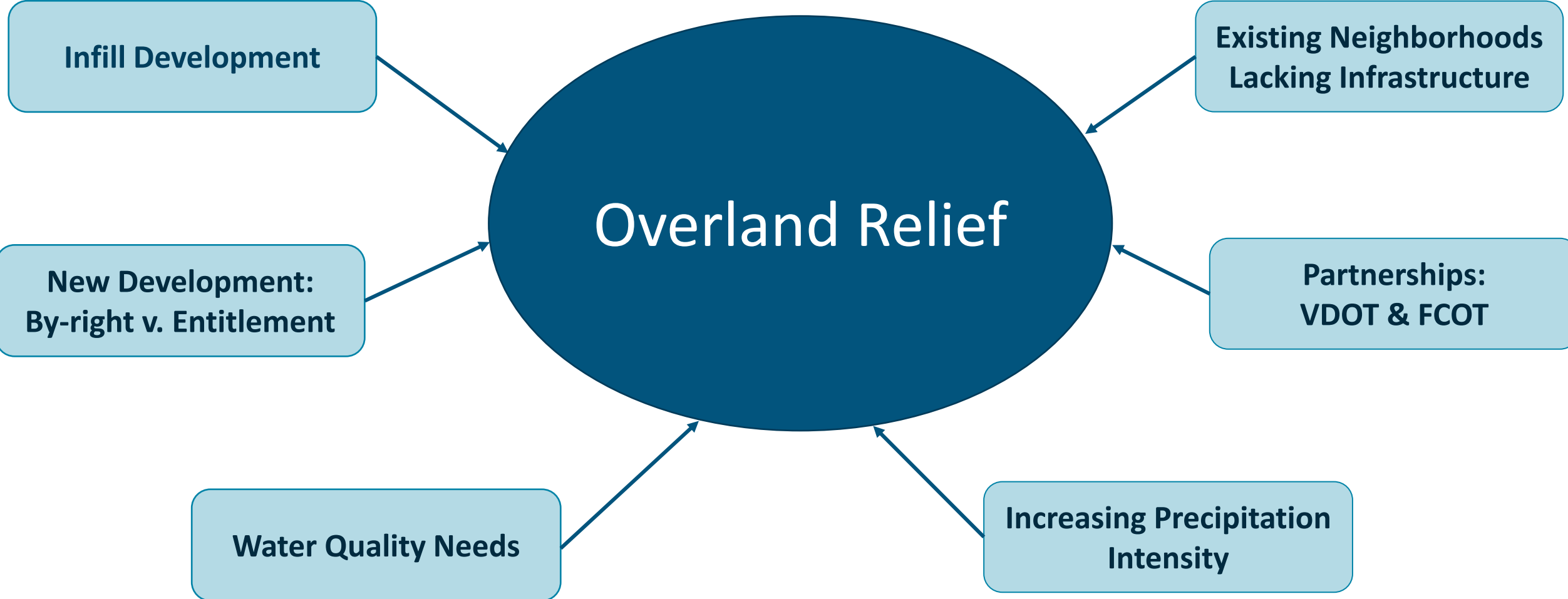
**Partnerships:
VDOT/FCDOT**

Water Quality Needs

**Increasing Precipitation
Intensity**

GOAL: Balance community needs with “no regrets” choices and agility

Overland Relief is Common Element



Prospective Development Goal: Increase overland relief



Importance of
Overland Relief:
Bigger Storms
Overpower
Minor Systems

- Photo shows addition placed where overland relief used to be
- Dwelling flooded through walkout basement door
- Construction w/o permits





Basements – Most of Fairfax County’s Structural Flooding

FAIRFAX COUNTY’S PUBLIC FACILITIES MANUAL

4-0000 GEOTECHNICAL GUIDELINES

4-0300 GEOTECHNICAL REPORT

4-0305 Setting Basement or Lowest Finished Floor Elevation Above the Groundwater Table for Residential Structures.

4-0305.1 For construction of residential single-family detached and attached dwellings, including stacked townhouses, where the results of a geotechnical investigation and/or report must be submitted for approval, design engineers must evaluate the proposed basement floor elevation or the lowest finished floor elevation as compared to the seasonal high water table (SHWT) elevation and include appropriate mitigation on the plans to address potential problems with groundwater intrusion into basements or lowest finished floors and its impacts on the site and adjacent or downstream properties. The required groundwater mitigations depend on the freeboard outlined below. Freeboard is defined as the distance between the SHWT and the basement or lowest finished floor elevation.

A. Case 1: Freeboard is greater than 2.5 feet (SHWT is more than 2.5 feet below the basement or lowest finished floor elevation). For this case:

- Public Facilities Manual design standards
 - Effective October 2020
 - For some soil types, places lowest finished floor elevation 2.5 feet higher
- Push back from the development community on time and expense of groundwater investigation and building height restrictions
- Even in problem soil areas, still getting basements (set higher)
- This was a no-regrets first step

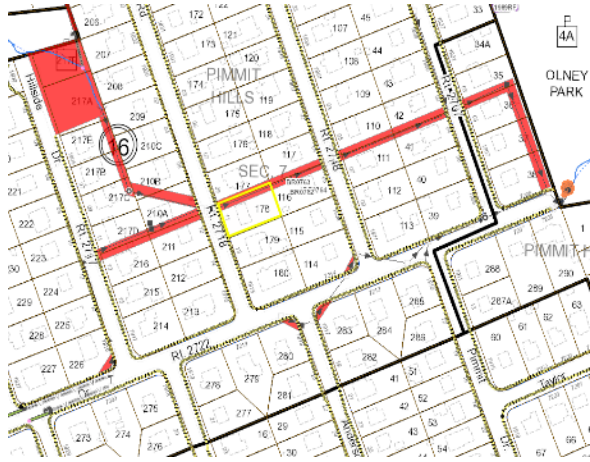
Overland Relief Enters Basement



- Drainage analysis on INF said 3.7 acres but it's >80 acres
- No easement over minor floodplain (subdivision predates requirement)
- Floodplain setback not met
- Flooding occurred through areaway – changed sides during construction

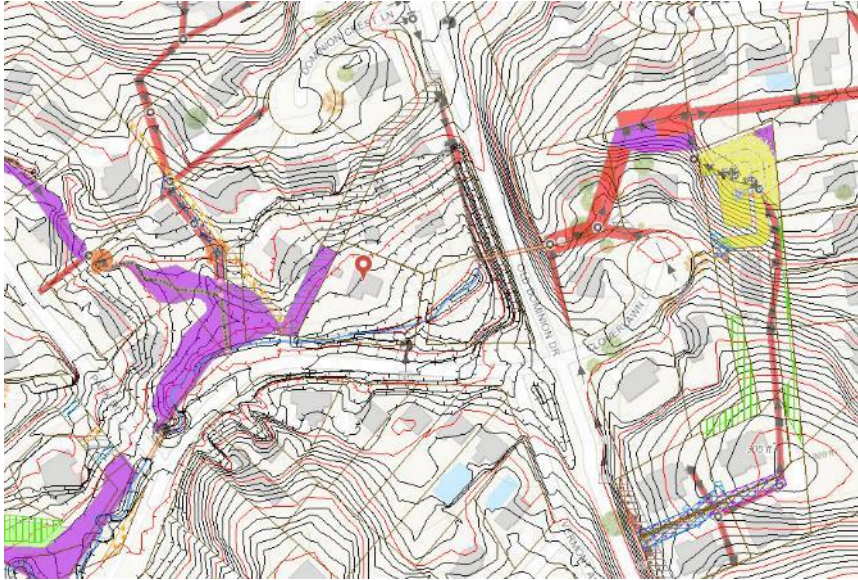


Old Infrastructure, Insufficient Overland Relief



- Undersized infrastructure from 1950s
- Runoff entered the property from the street
- Overtopping flow eroded curb inlet
- Lot lacks overland relief
- Point of entry: on-grade window wells

Dwelling in Overland Relief Path without Storm Drainage Easement



- No SDE on or adjacent to lot
- Dwelling flooded through garage and into basement
- Open channel and culvert on lot overwhelmed
- Site sits in a sump



Next Steps – Regulatory and Project

Prospective Development: Developers

Additional standards in Public Facilities Manual?

Right sizing “C” coefficients

Overland relief requirements (freeboard?), basements

Precipitation intensity updates

Minimize impervious area

State and local regulation updates: SWMO and Ches Bay Preservation Ordinance

Existing Infrastructure: County

Continue known project needs: individual lot, neighborhood

County-wide project effort:

Floodplain mapping, county-wide flood risk identification and prioritization

Partnering with VDOT

Understanding Flood Risk

Reactive



Complaint Driven



Lot Scale Projects



Proactive



**Flood Prone Properties and
Neighborhoods Map**

Flood Prone Properties and Neighborhoods Map

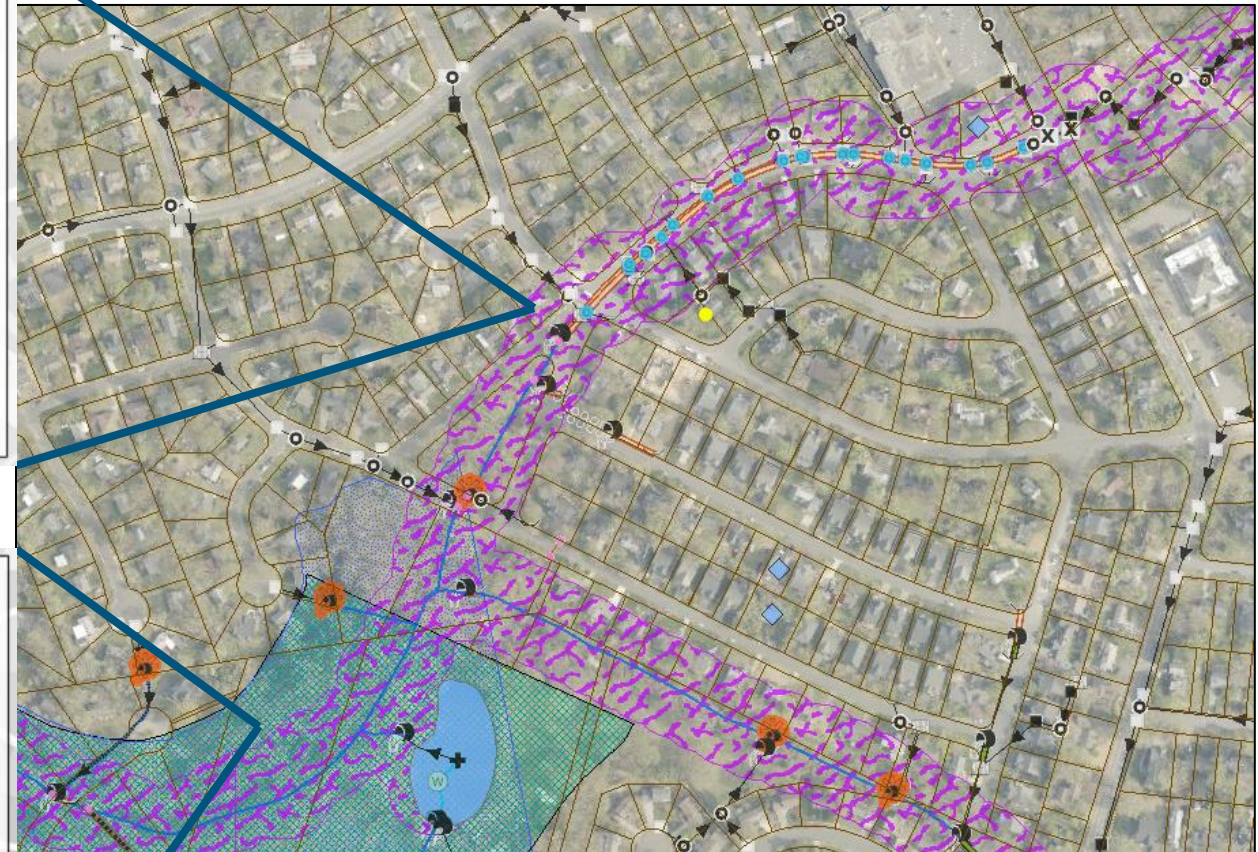
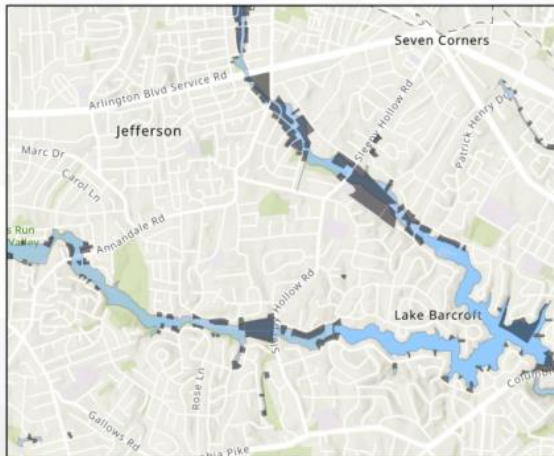
Structure in 25 foot stream buffer

Buildings intersecting streams draining a watershed with a drainage area of greater than 70 acres.



Structures within 30 feet of FEMA Floodplain

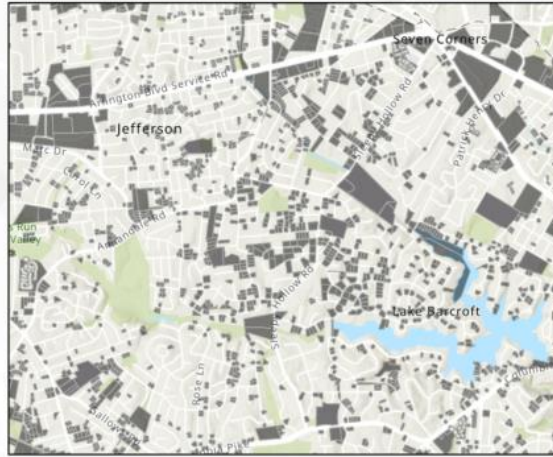
Buildings intersecting the approximate location of the 100 year floodplain based on recorded easements 30 foot buffer.



Flood Prone Properties and Neighborhoods Map

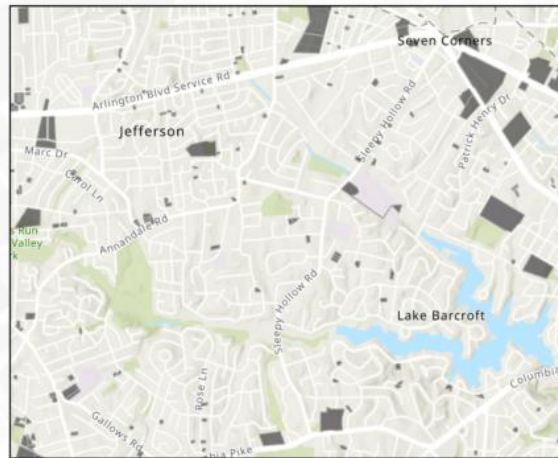
Parcel in Sump

Parcels with a stormwater "pit" that holds all runoff before it drains away through the connected drainage pipes or overland relief path.

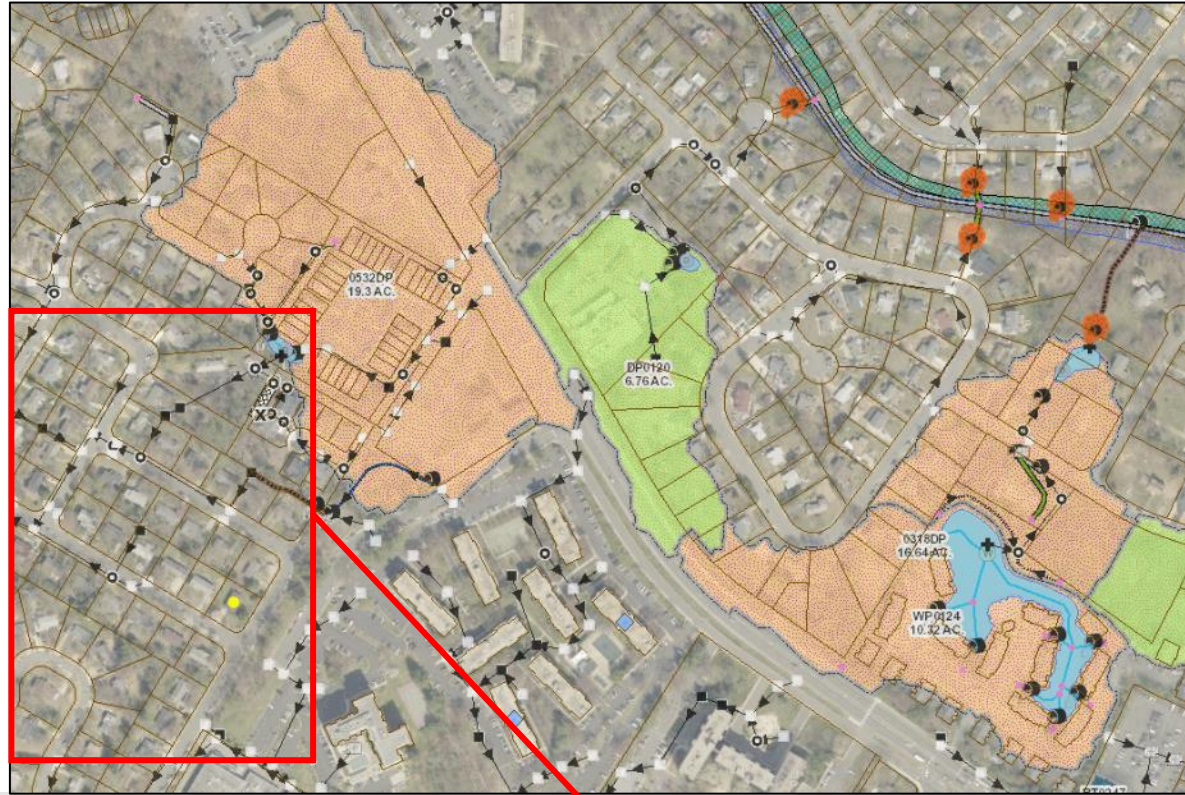


Structure in Sump

Buildings intersecting a stormwater sump that holds all runoff before it drains away through the connected drainage pipes or overland relief path.



Flood Prone Properties and Neighborhoods Map



Subdivision Age older than 1972

Subdivisions built before most modern ordinance requirements, including stormwater quality and quantity control standards.

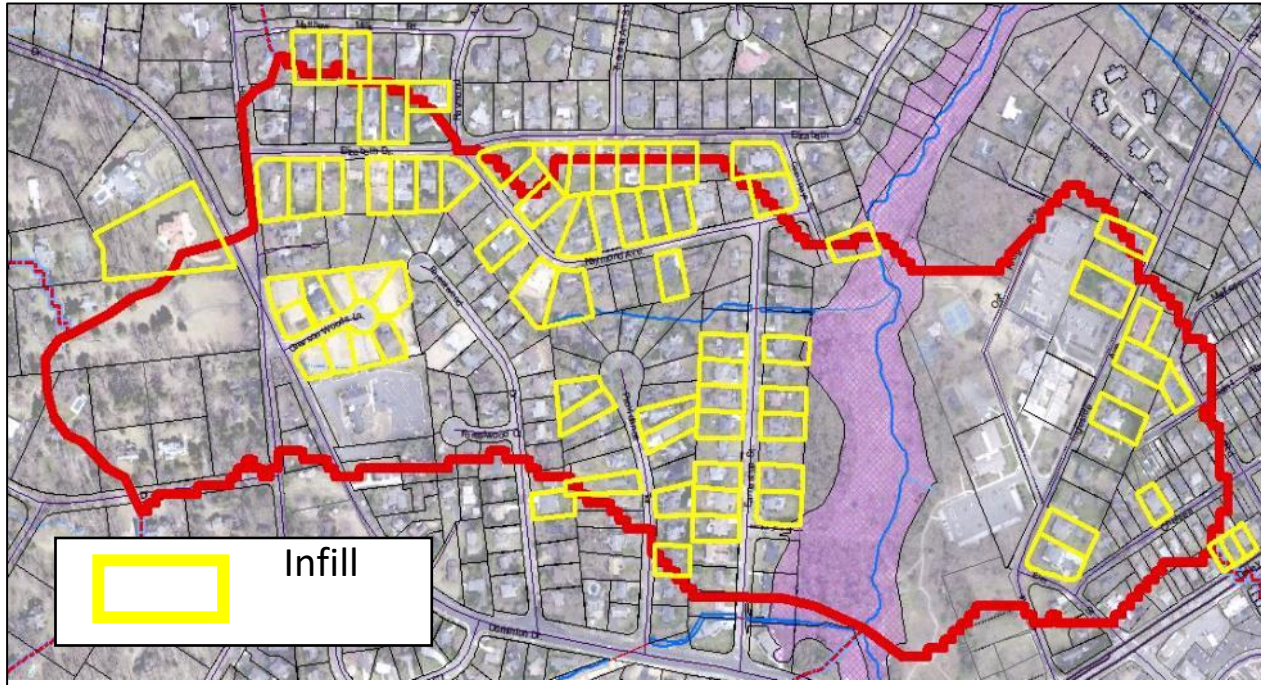


Subdivision outside Facility Drainage Area

Subdivisions outside of stormwater management facility drainage areas which control stormwater runoff in Fairfax County.

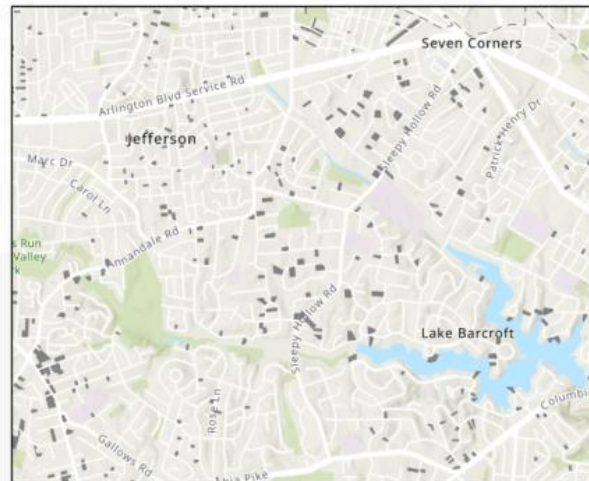


Flood Prone Properties and Neighborhoods Map



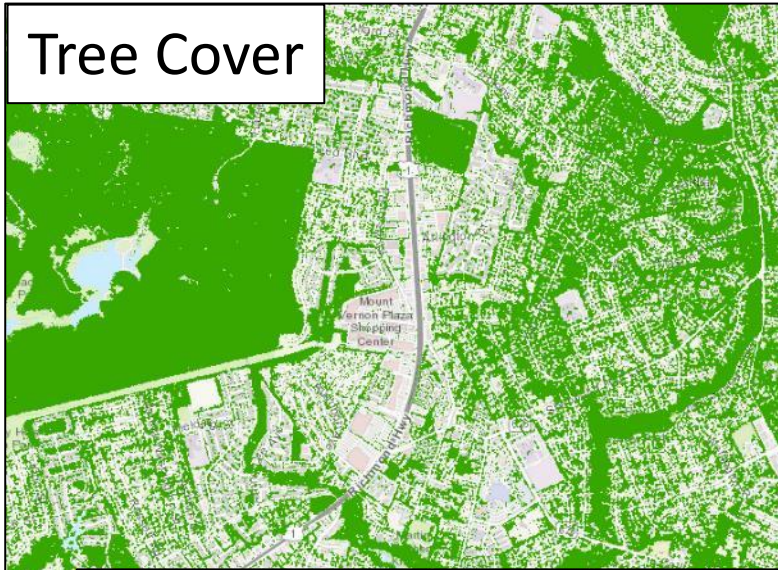
Infill Lots

Residential development that has occurred proximate to, or within, already established neighborhoods had been referred to as "infill" development.



Flood Prone Properties and Neighborhoods Map

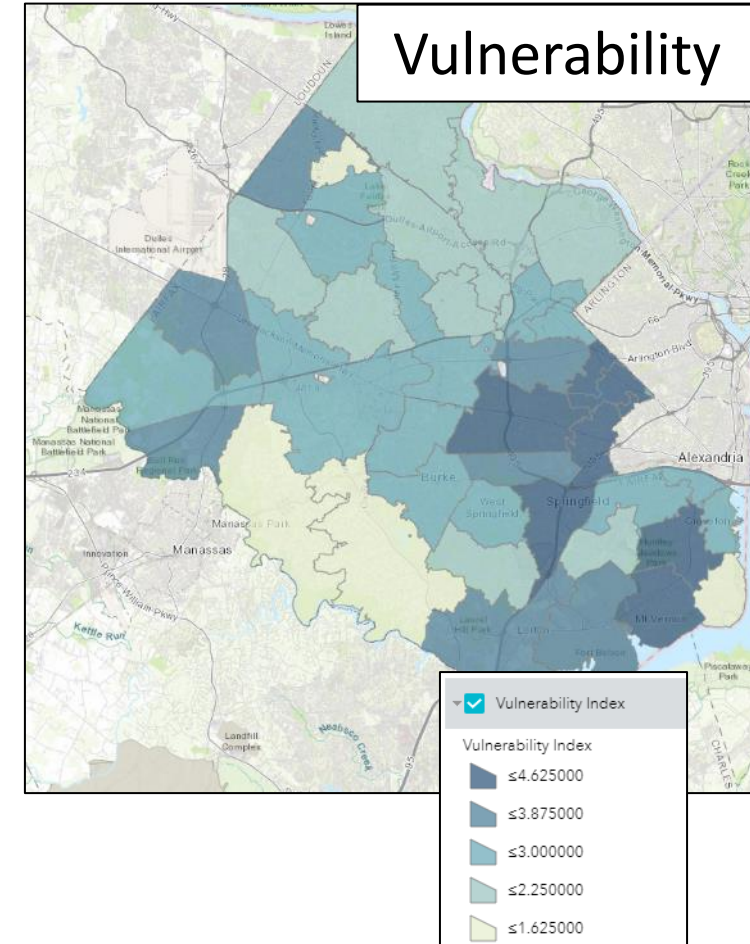
Tree Cover



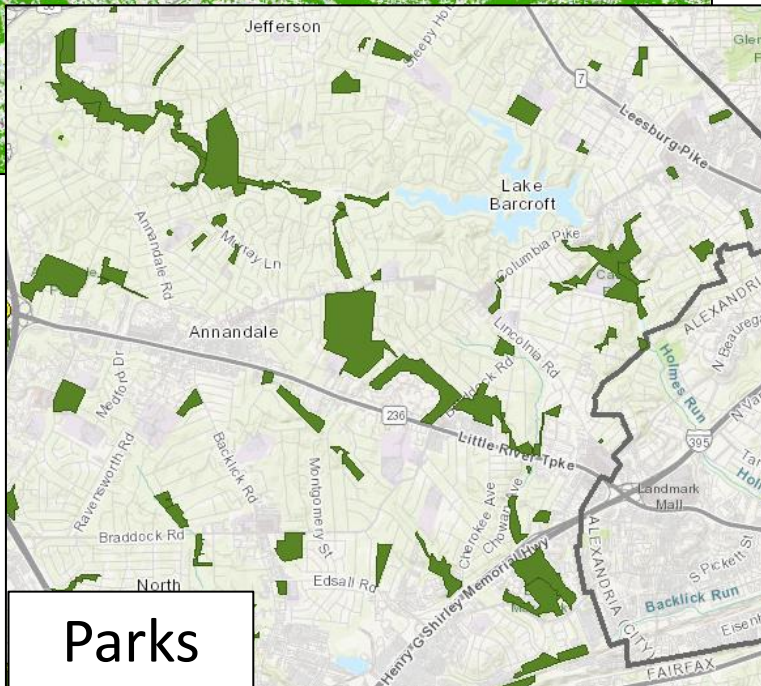
The Flood Prone Properties and Neighborhoods Map will:

- Provide a comprehensive and objective look at flood risk
- Align flood resiliency with other county initiatives
- Incorporate equity into project selection and prioritization
- Plan for future development and climate change

Vulnerability



Parks

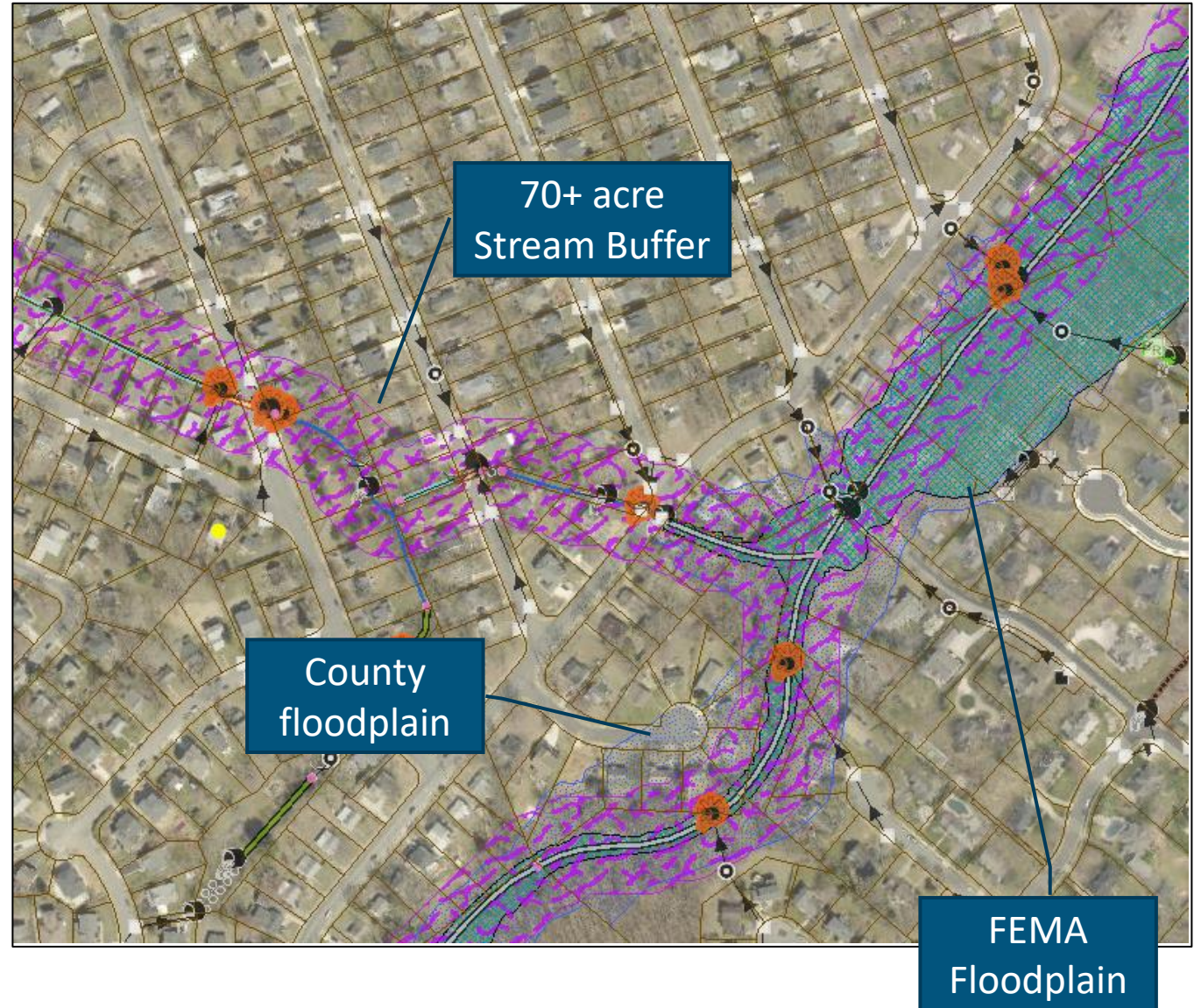


County Regulated Floodplain Map Updates

Minor- > 70 acres

Major- ≥ 360 acres

FEMA- > 1 square mile



County Regulated Floodplain Map Updates

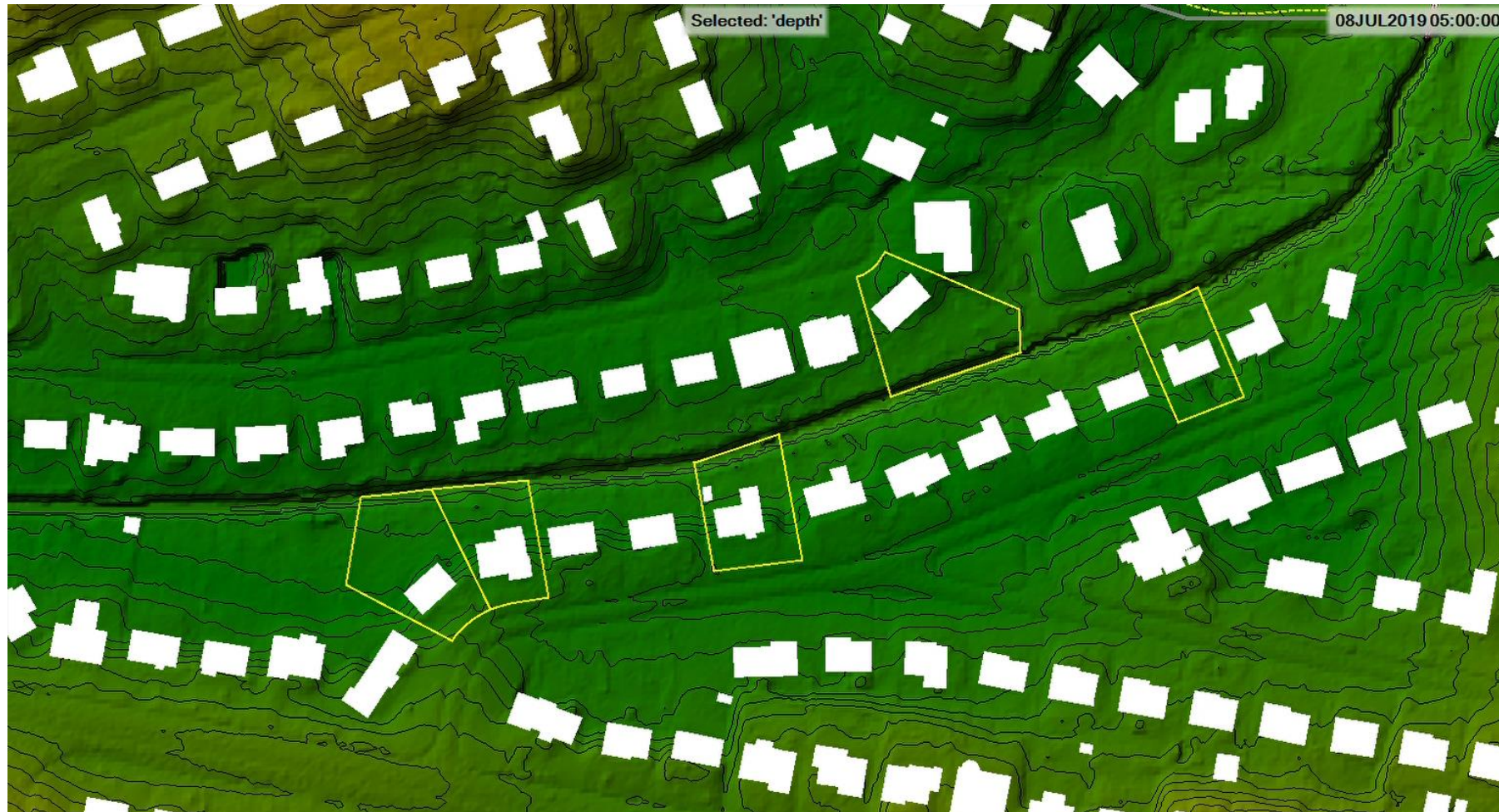
County regulated floodplain map updates will:

- Develop a comprehensive regulated floodplain map with clear and consistent base flood elevations
- Map unmapped portions of the regulated floodplain
- Increase community flood risk awareness
- Allow for the incorporation of future climate projection conditions



Flood Response: Rain-on-Grid Analysis

Simulated July 8, 2019 storm event and 100-year



Funding Sources

County Stormwater
Budget: Special
Revenue Fund

Always Seeking Grants

ARPA, Infrastructure,
VA Community Flood
Preparedness

Harder to get the
benefit:cost ratio > 1
for FEMA/VEMA's BRIC
funding

FEMA HMA within
Special Flood Hazard
Area

Prospective
Development

Existing Undersized
Infrastructure

Partner with VDOT on
areas of shared
concern

Questions?



The Good News

- 1959 Floodplain laws protected much of the county
- We regulate to the 70-acre drainage size
- Newer neighborhoods have fewer drainage issues
- Prospective Infill will contribute less to drainage issues

The opportunities

- Older, undersized infrastructure
- Countywide flood mapping
- Preparing for precipitation intensity increase
- Proactive flood response
- Bigger picture of new development and redevelopment