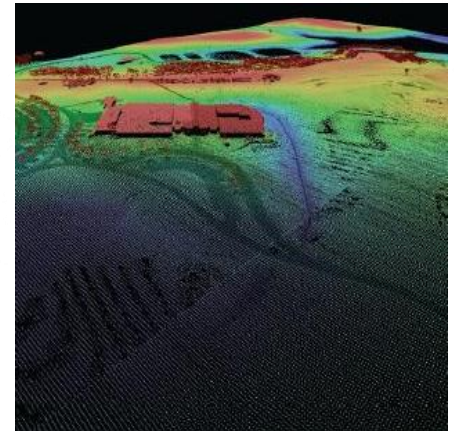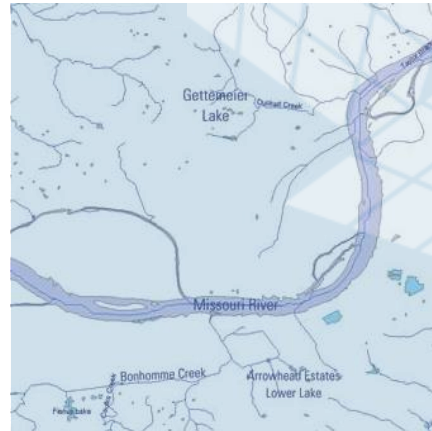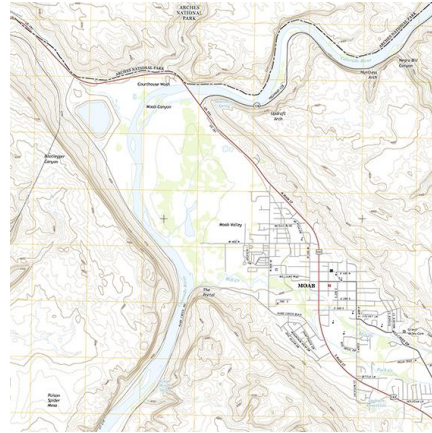# Integration of Lidar-Derived Surface-Water With Storm-Water Systems in Washington DC Into the National Hydrographic Dataset

Roger Barlow, Physical Scientist,
U.S. Geological Survey

George Onyullo, Environmental Protection Specialist, DC Dept. of Energy & Environment
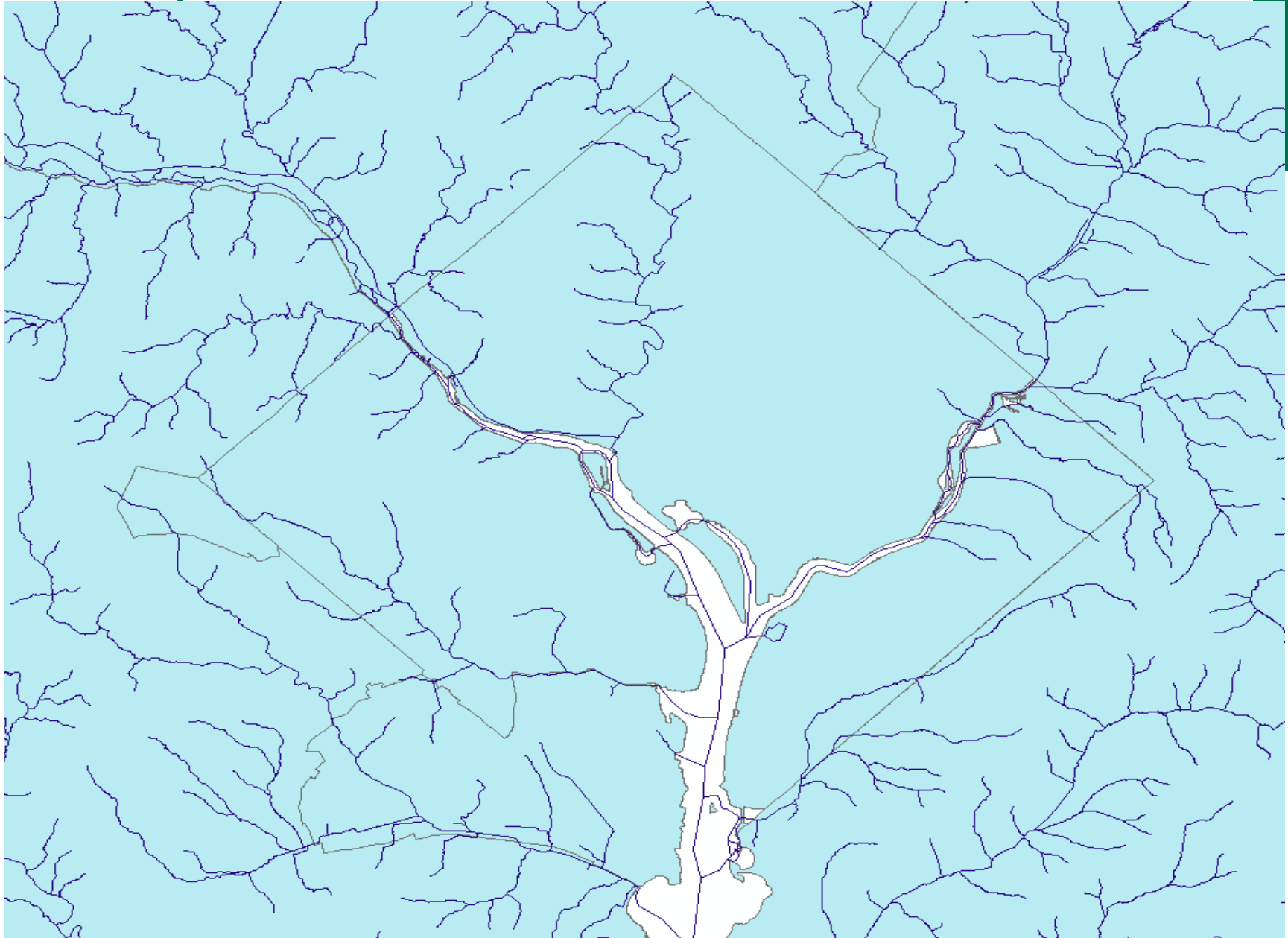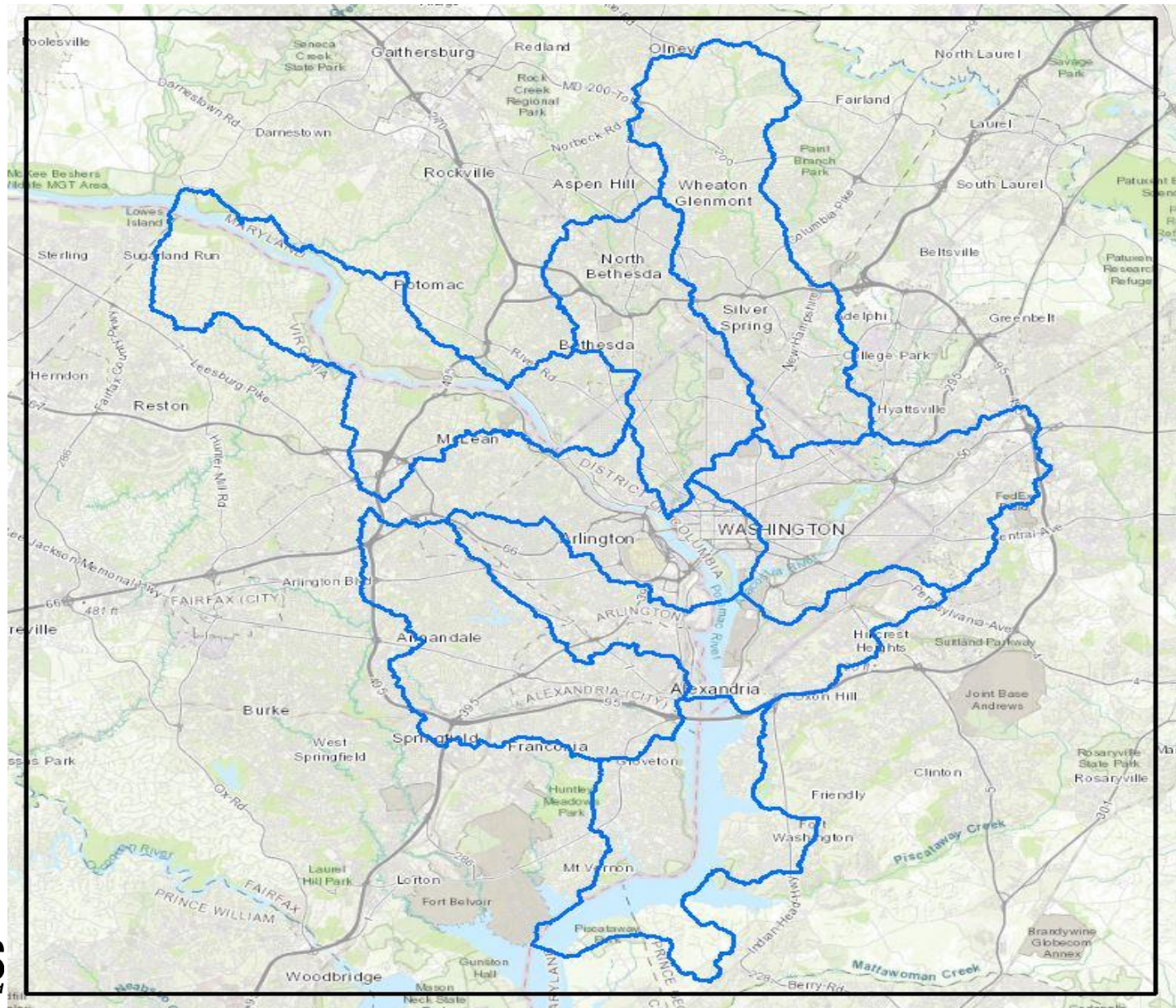
2019 GIS Day-University of Richmond

Sub title
Date
Name

+ The Problem:

❑ Current 24K NHD data is too small a scale for local use

❑ Current NHD is discontinuous

❑ No connectivity to storm-water system

❑ Prior DC stream data are not maintained / out of date

❑ Prior DC graphic stream data in multiple representations

❑ Current DC stream data is not continuous with neighbor jurisdictions

❑ Prior WBD to 12 digit HU, inaccurate in impervious areas

❑ Current DC stream data does not serve science and analytical needs

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+ Graphic View of the Issue

Lidar-derived NHD and Storm-water Integration
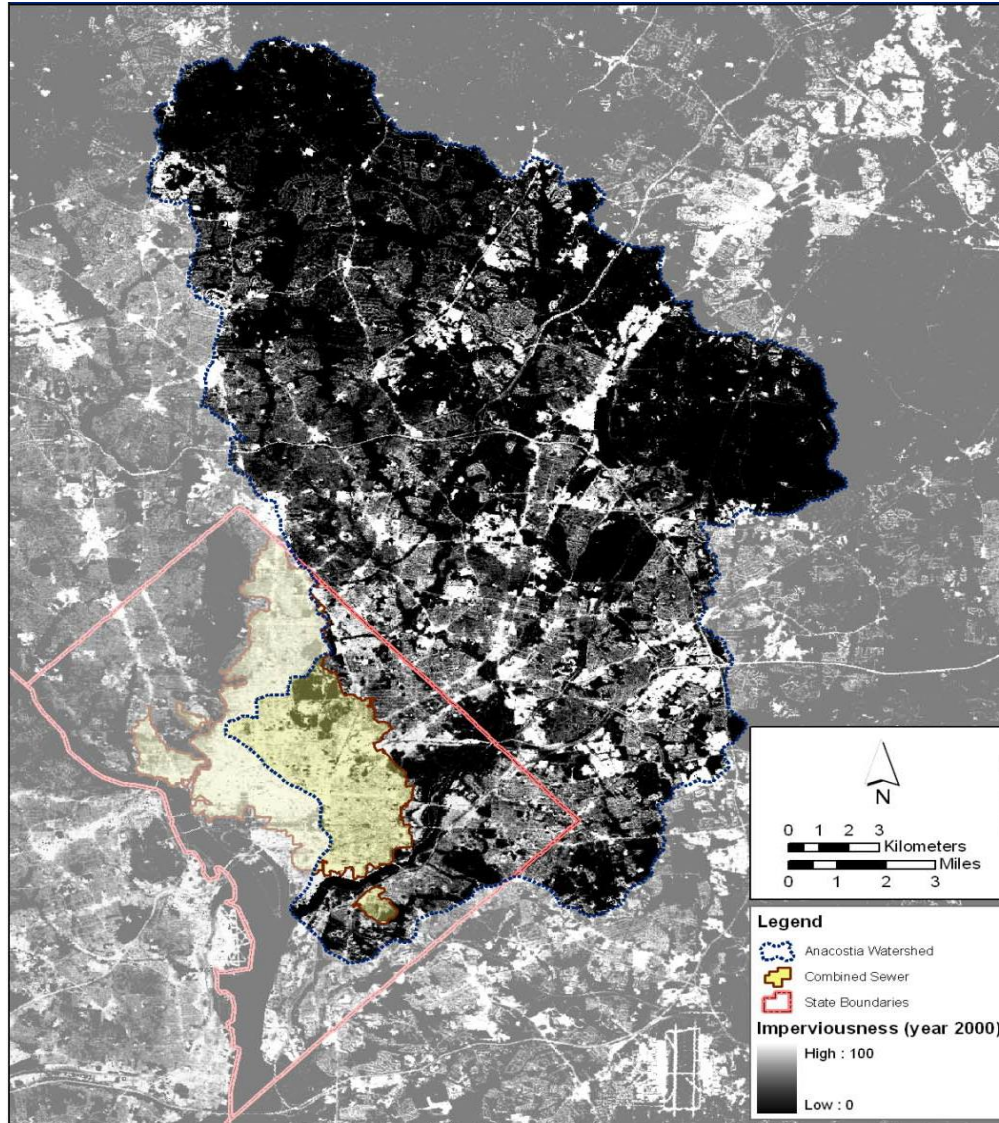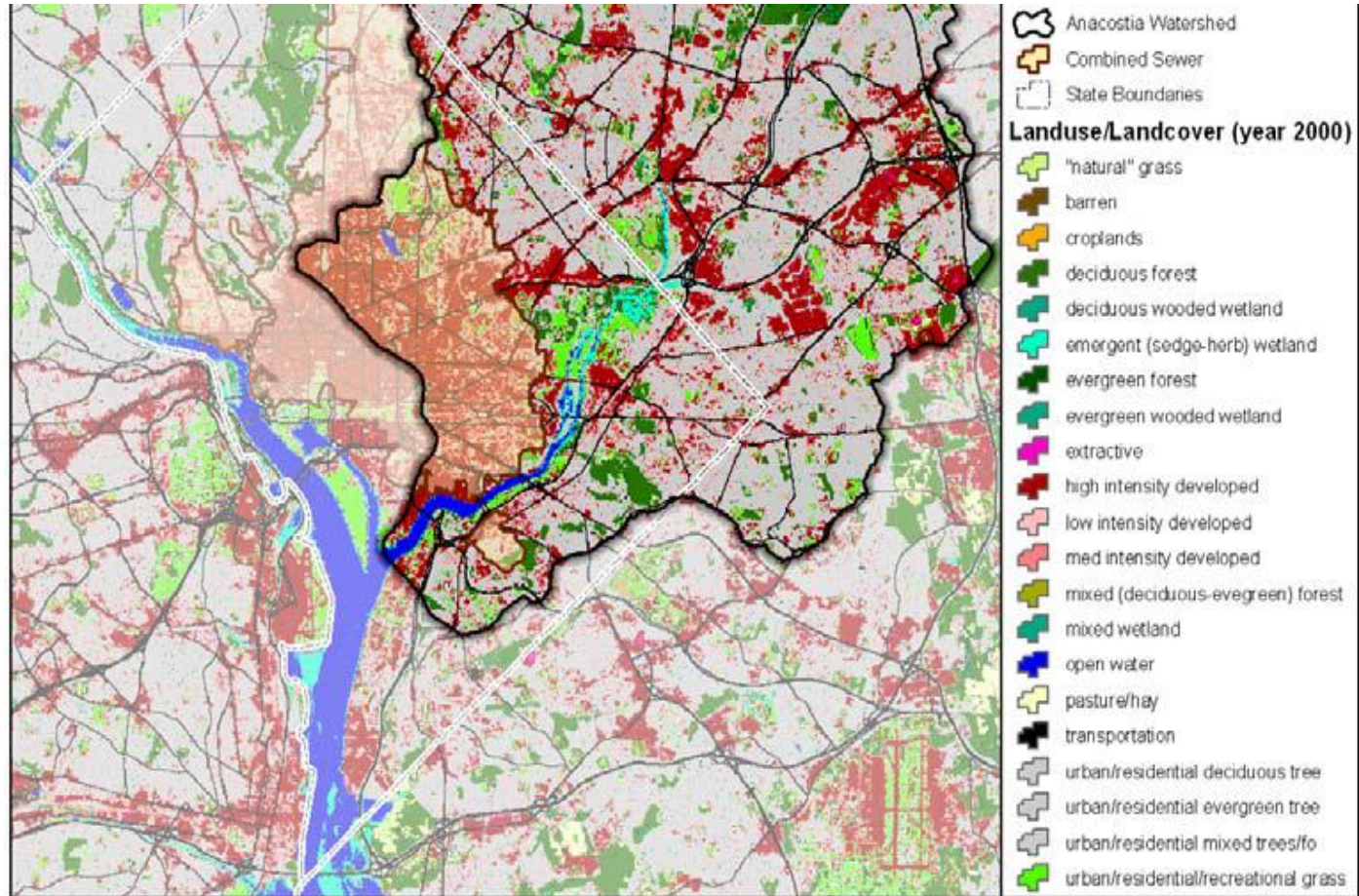## AOI for District of Columbia, 8 HU-12 Watersheds
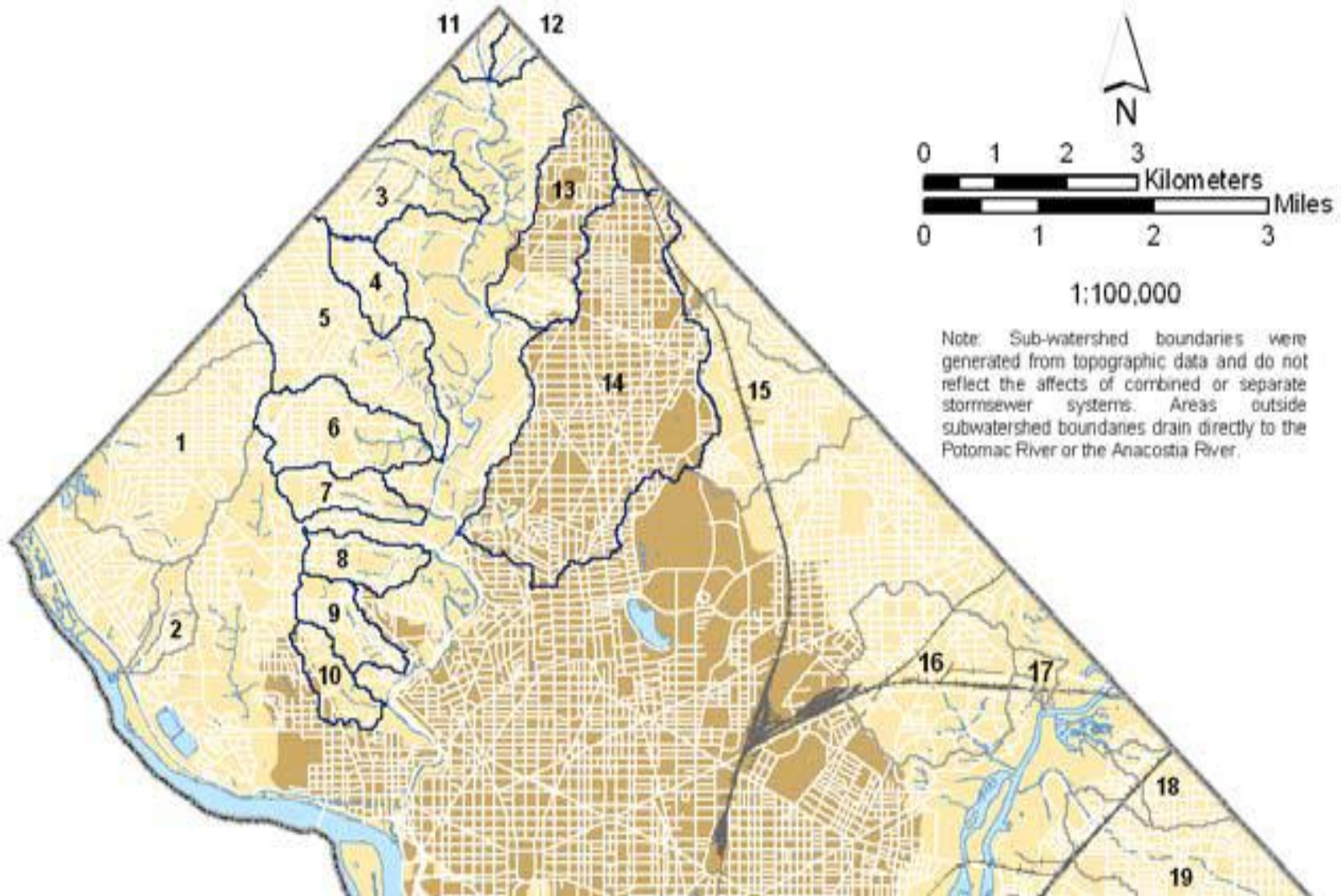
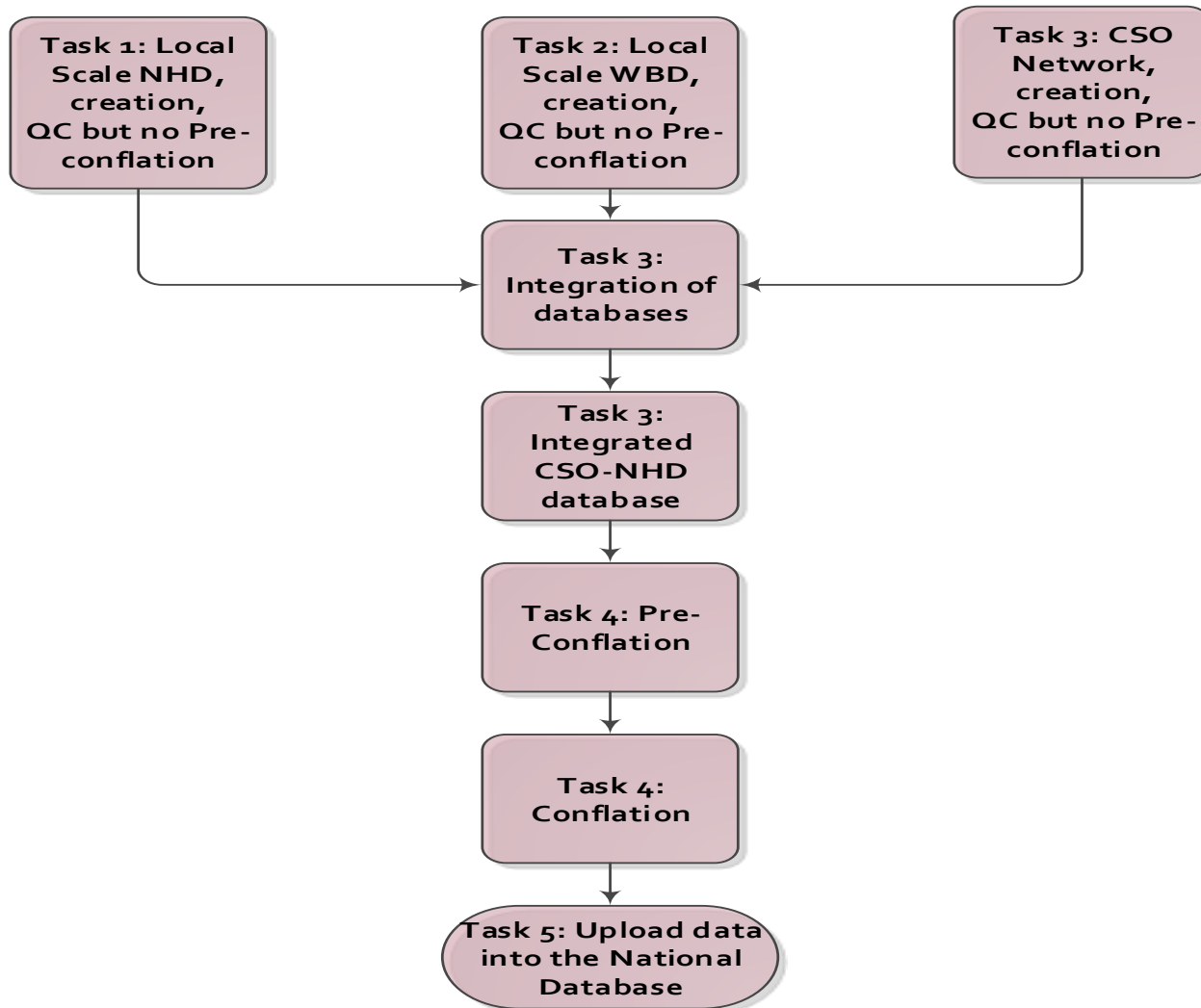# DC and Anacostia Watershed Imperviousness

+ DC Land Cover

The Solution:

❖ Revise DC surface water as part of NHD Local Resolution, use available QL-2 lidar to position and add surface water features-1:2400-scale

❖ Use DC Water Infalls/Outfalls &Water Pipe GIS data to create a complete water network

❖ Map & <u>field check</u> culverts, infalls/outfalls, bridges, piped storm-water, flow direction

❖ Revise watershed boundaries to 16-digit hydrologic units (HU)

❖ Obtain updated extra-jurisdictional stream data for HU area bounding DC

❖ DC Dept. of Energy & Environment is the funding & coordinating partner

❖ USGS Quality Assures NHD and WBD data as part of National Datasets

❖ Quantum Spatial Incorporated was the USGS contractor

❖ Data contributors, City of Alexandria, Arlington Co, Fairfax Co, Maryland Dept. of the Environment (MDE)

❖ Create *thinned* and *unthinned* storm-water network content

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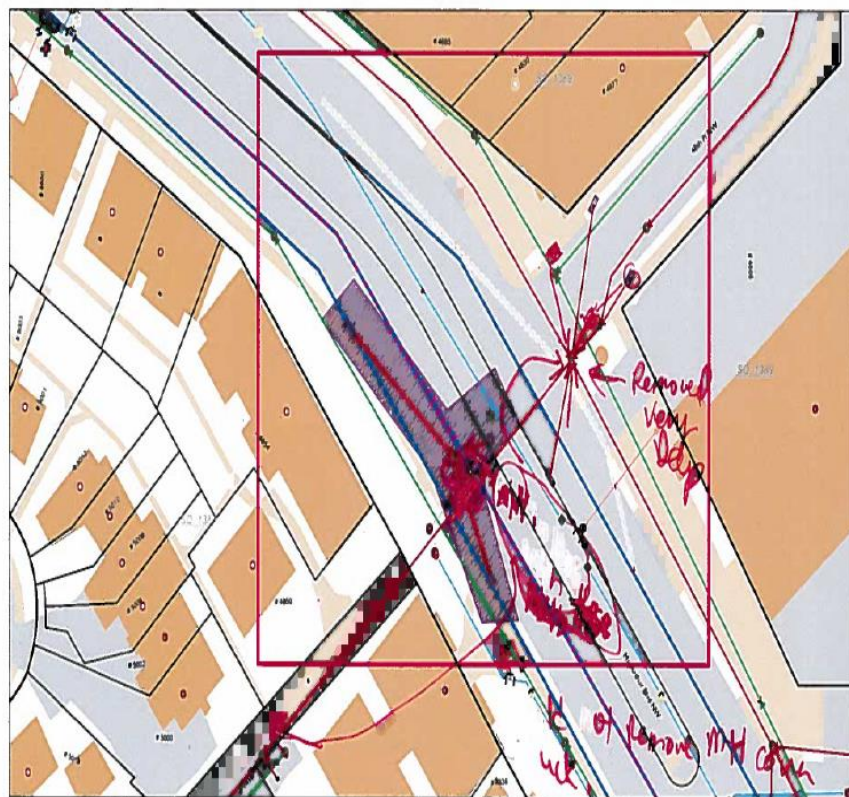Your Source for Topographic Information

NHD/WBD Production Overview

+ Project Preparation

Assemble Data, Field Verification, create project specifications

o 2014 QL2 Lidar-derived 1-meter DEM (DC, Prince George, Fairfax, Arlington)

o 2013 QL3 Lidar-derived 1-meter DEM (Montgomery)

o DC Water Infalls/Outfalls…update & reconcile versions

o DC Water storm-water pipes & flow field check

o Find and combine data sources for Culverts/bridges/tunnels. Field check

o Sewershed/MS 4 data

o Acquire Alexandria/ Arlington Co/ Fairfax Co Virginia data

o Create tool to resolve connectivity issues using contours, flow accumulation grid, orthoimagery, oblique imagery, storm-water pipes, existing streams

o Create project specifications, project deliverable data

o Joint Funding Agreement, Task Order, selected contractor=QSI
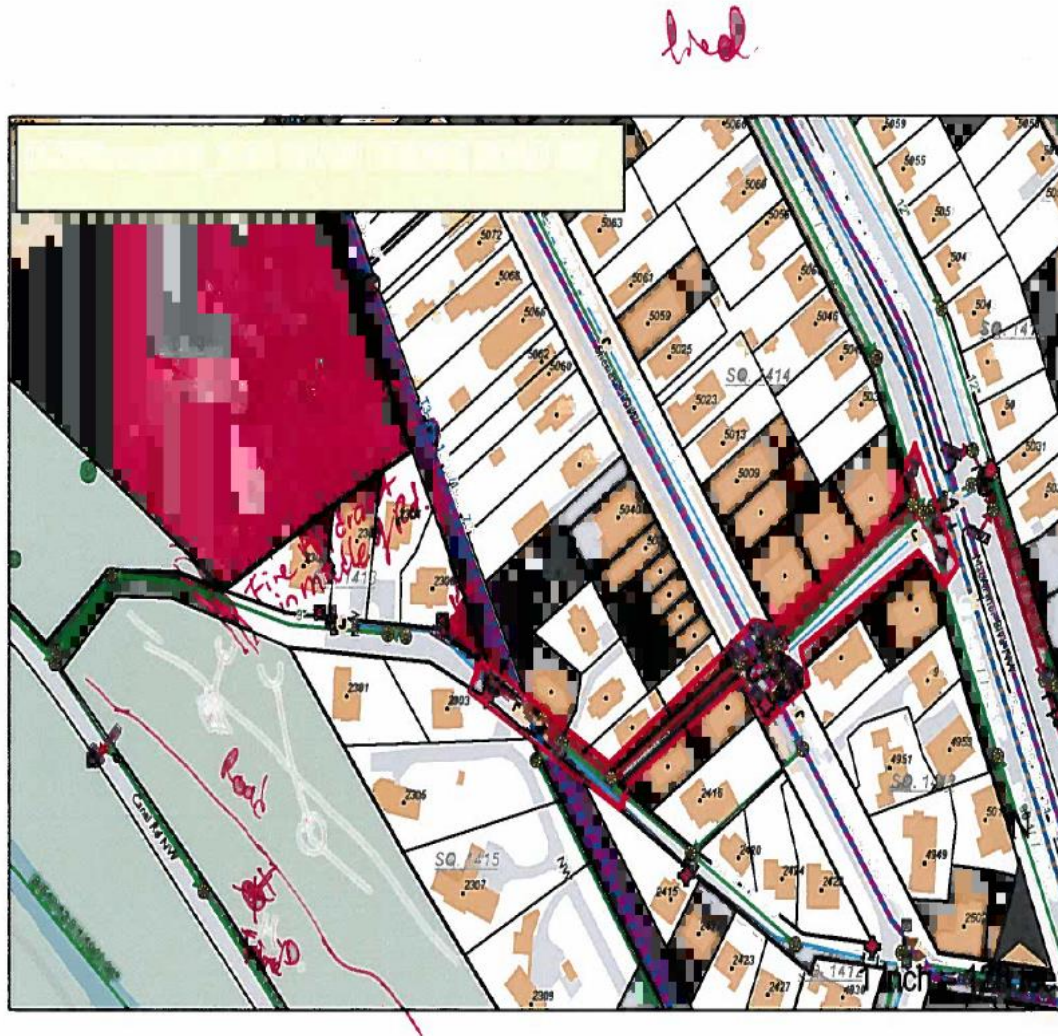
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+ Field Annotation MacArthur Blvd NW

Field Annotations Chain-Bridge Rd NW

Field Annotations 44th Street NW

Generating Flow Lines

Run ArcHydro Routine	Examine the resulting stream definition for areas where flow appears artificially impeded	Create Hydro-Enforcement Breaklines	Enforce Breaklines in Model	Re-run Archydro Routine
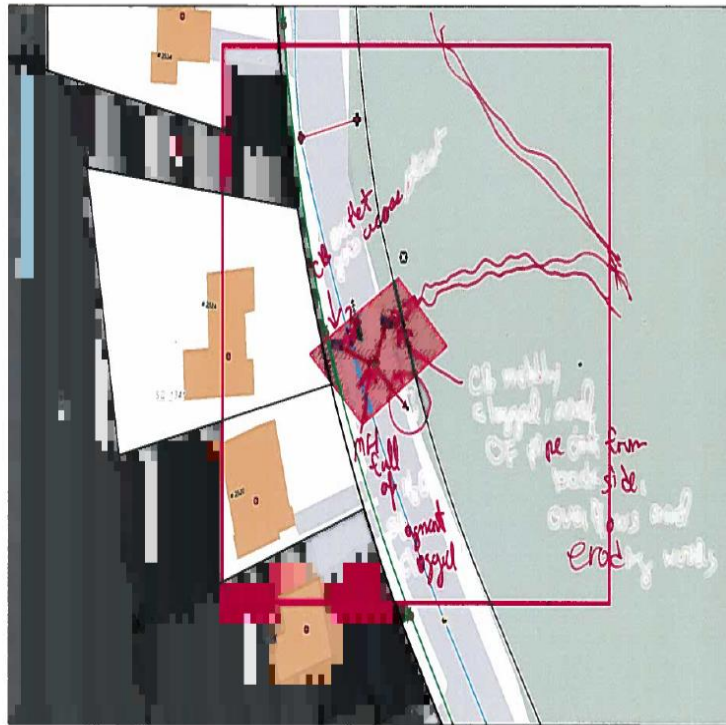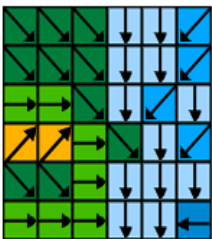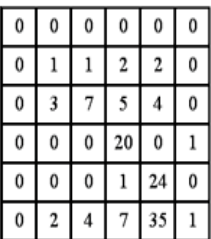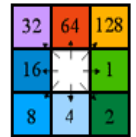
1) Fill Sinks
2) Calculate Flow Direction Grid
3) Calculate Flow Accumulation Grid
4) Define Stream Definition Threshold

Flow direction

0	0	0	0	0	0
0	1	1	2	2	0
0	3	7	5	4	0
0	0	0	20	0	1
0	0	0	1	24	0
0	2	4	7	35	1

Flow accumulation

32	64	128
16		1
8	4	2

Direction coding

Determining the accumulation of flow

Automated Flowlines to edit

Attribution of Flowlines – Feature Codes

-Initial spatial join of current
NHD attribution

Dry Creek and Thompson River AOI

NHD Waterbodies

EType - Fcode
- CANAL/DITCH - CANAL/DITCH
- ? - CONNECTOR
- CENTERLINE - ARTIFICIAL PATH
- CULVERT - CANAL
- CULVERT - STREAM
- DAM/WEIR - DAM/WEIR
- ? - PIPELINE, GC UNDERGROUND
- STREAM/RIVER - STREAM/RIVER INTERMITTENT
- STREAM/RIVER - STREAM/RIVER, PERENNIAL
- SPILLWAY - ARTIFICIAL PATH

0   2.5   5   10 Miles

N
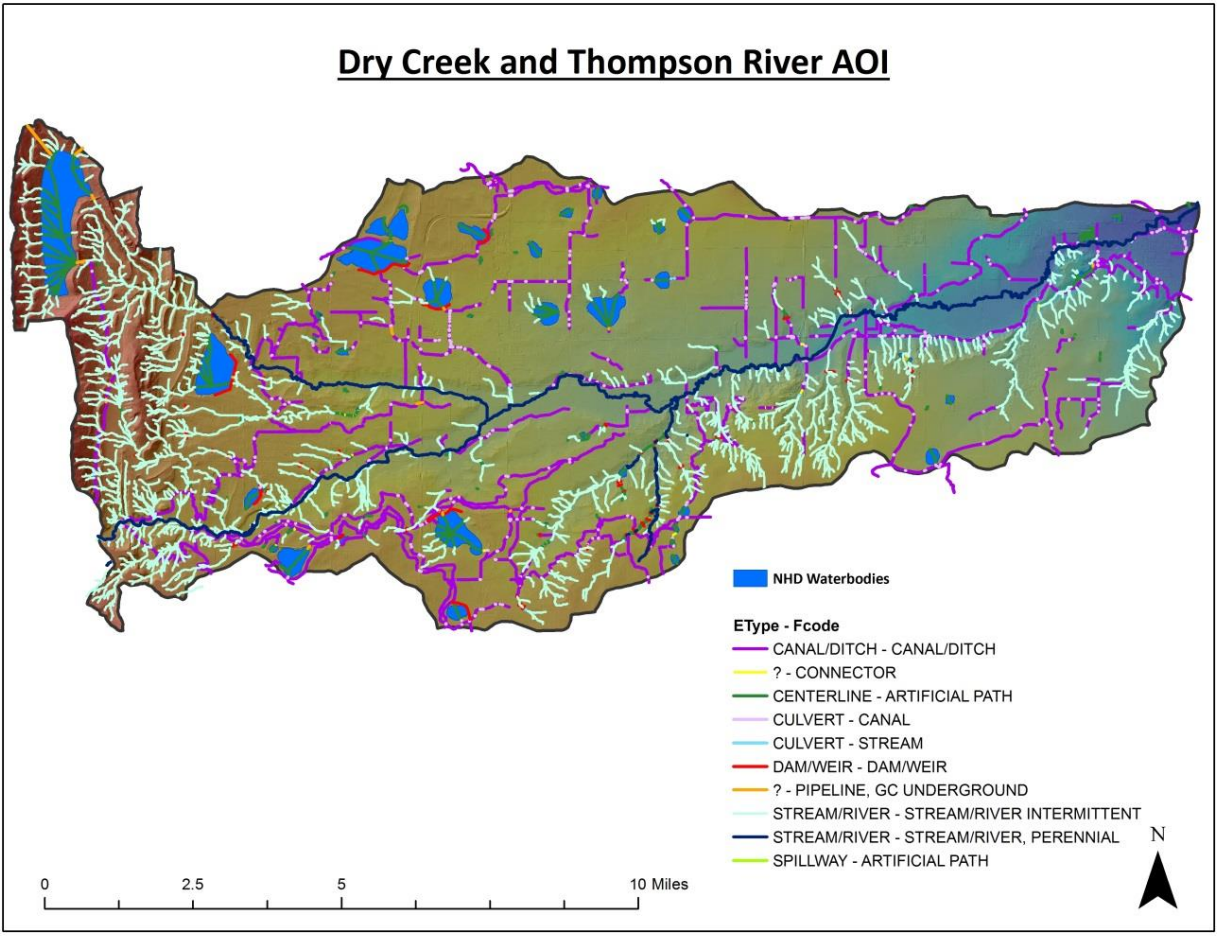
Waterbody Delineation

LiDAR derived breaklines will provide some of the boundaries, additional water delineation is required.

Object Based Image Analysis (OBIA)

- **LiDAR derived layers**
    - **Terrain descriptors**
    - **LiDAR descriptors**
- **Initial Segmentation**
    - **Homogenous objects (Slope, Intensity)**
- **Initial Classification**
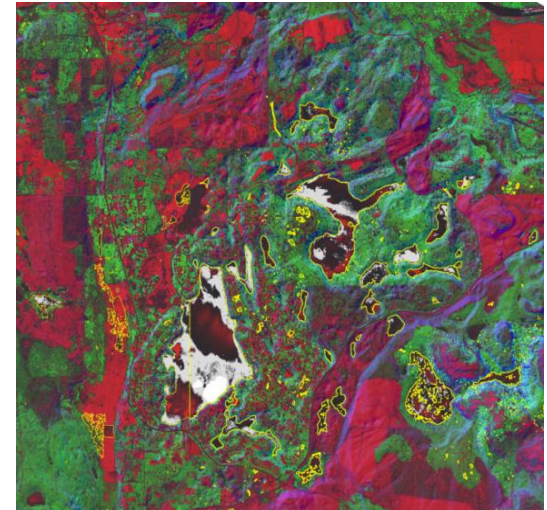   - **Finds known water (Native Density)**
    - **Finds known land (Slope)**
- **Contextual Classification**
    - **Iteratively classifies water**
    - **Spatial relationship to known water**
    - **Unknown areas (nDSM, GD)**
- **<u>Consistent and Reproducible</u>**
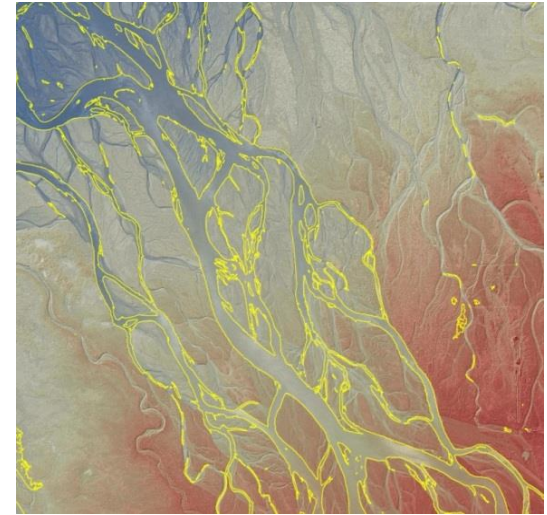
New Integrated NHD-Storm-water System Network

Washinton DC Local Resolution NHD Update

Legend:
- DC Boundary
- Thinned DC CSO Network
- Unthinned CSO Network
- Current NHD
- Updated NHDFlowlines
- Updated NHDArea
- Updated NHDWaterbody

0   1.25   2.5   5 Miles

N
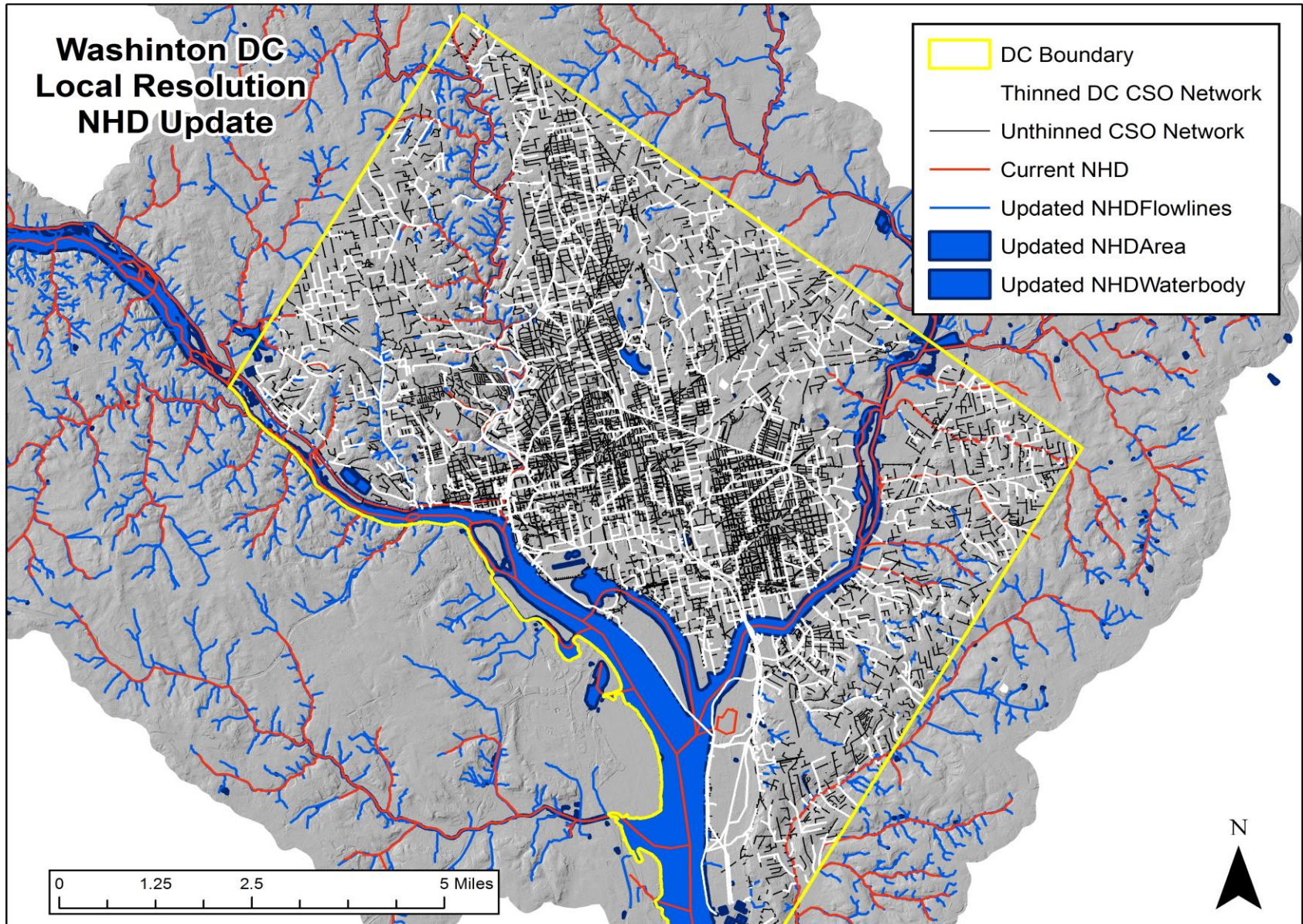
Hydrologic Unit-12 DC Project Area, NHD Network

Washinton DC
Local Resolution
NHD Update

Legend:
- DC Boundary
- Current NHD
- Updated NHDFlowlines
- Thinned DC CSO Network
- Updated NHDArea
- Updated NHDWaterbody

0   2.5   5   10 Miles
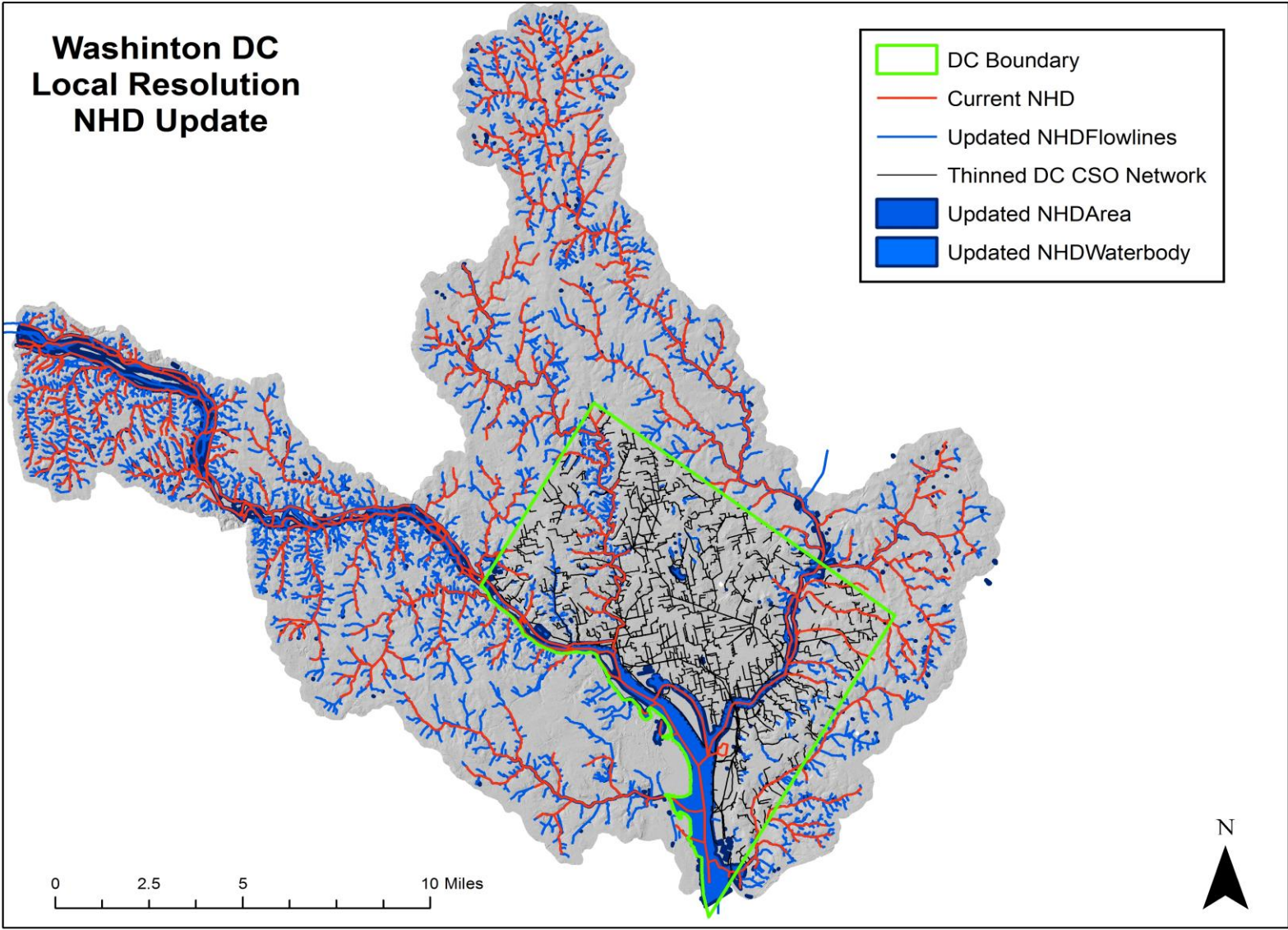
Watts Branch Integrated NHD-Storm-water Network

Washinton DC
Local Resolution
NHD Update

Legend:
- Watts Branch Watershed
- Current NHD
- Updated NHDFlowlines
- Thinned DC CSO Network
- Unthinned CSO Network
- Updated NHDArea
- Updated NHDWaterbody

0   0.3   0.6   1.2 Miles

N
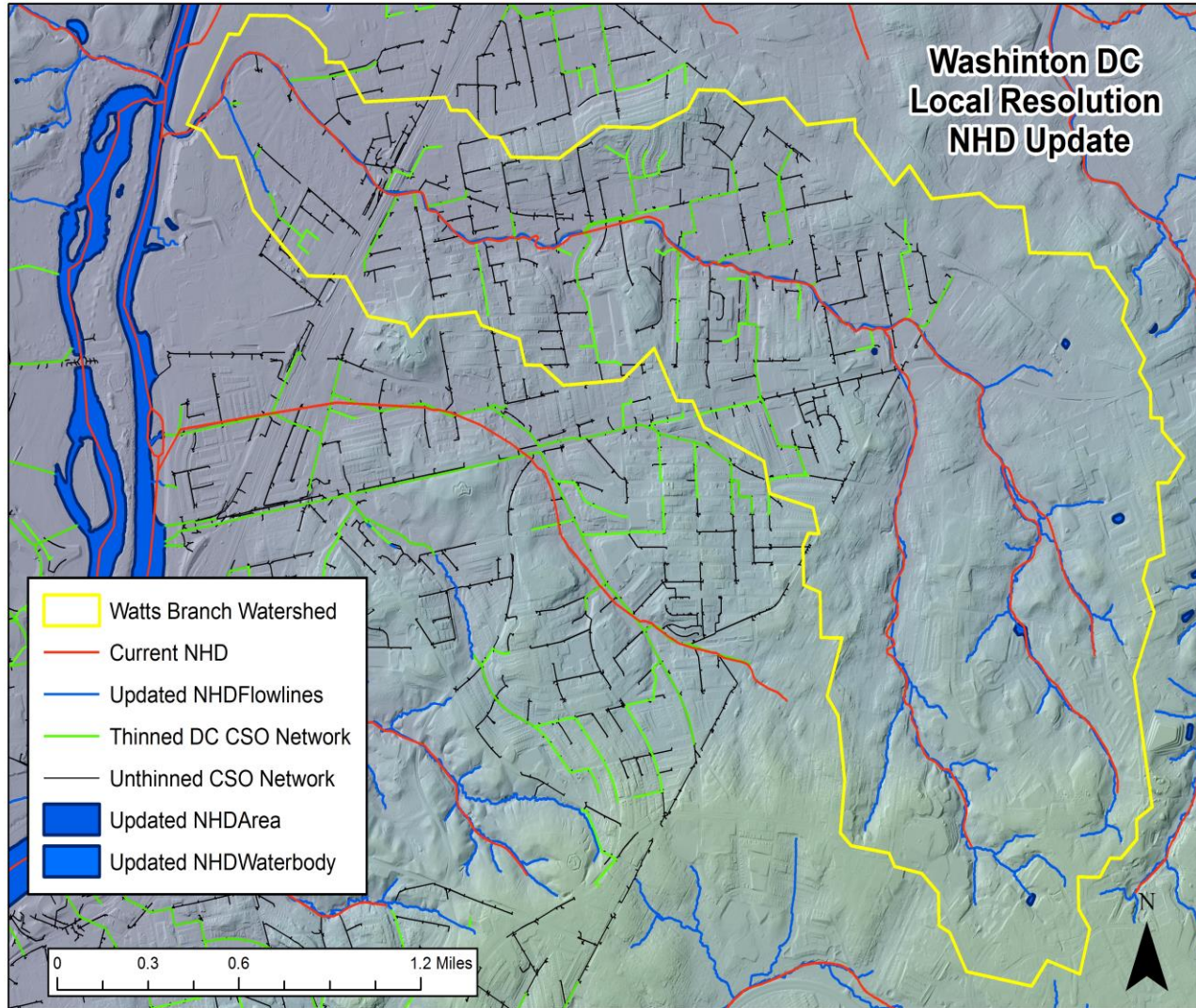
Upper Rock Creek, Montgomery County, MD, Maryland Dept. of Environment – 24K Content
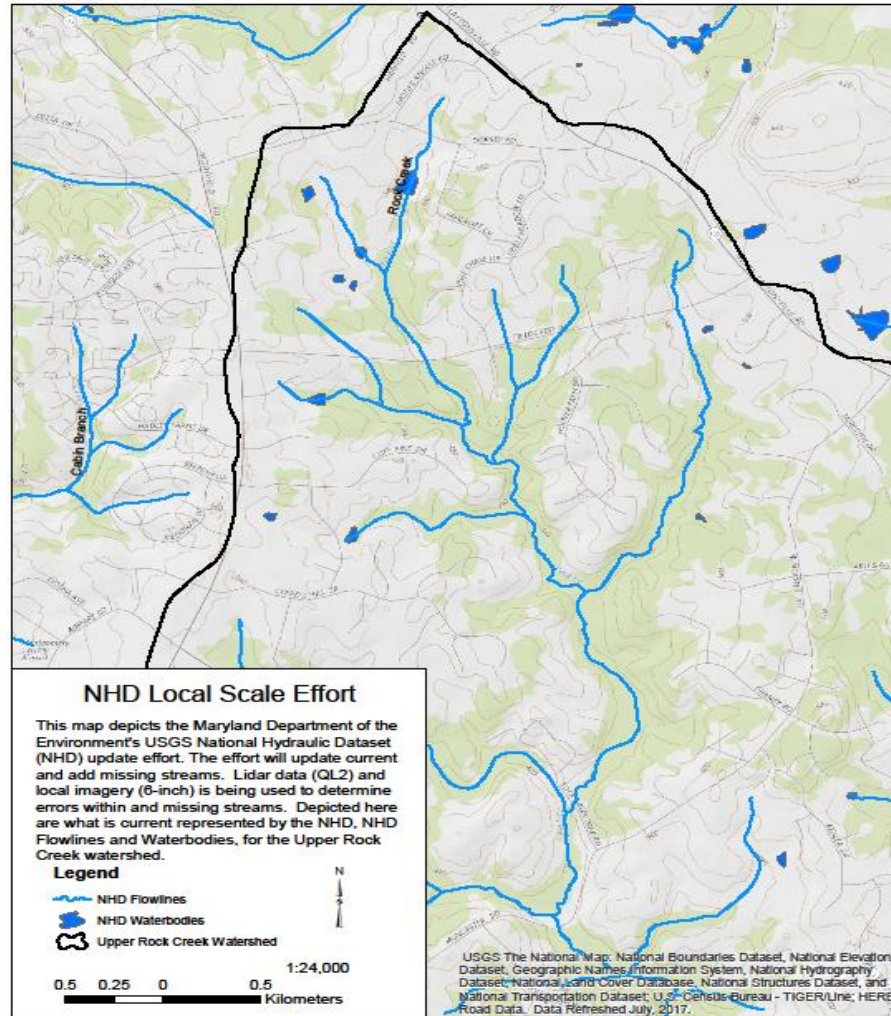
+ Upper Rock Creek, Montgomery County, MD New *DRAFT* Local Resolution Content

+
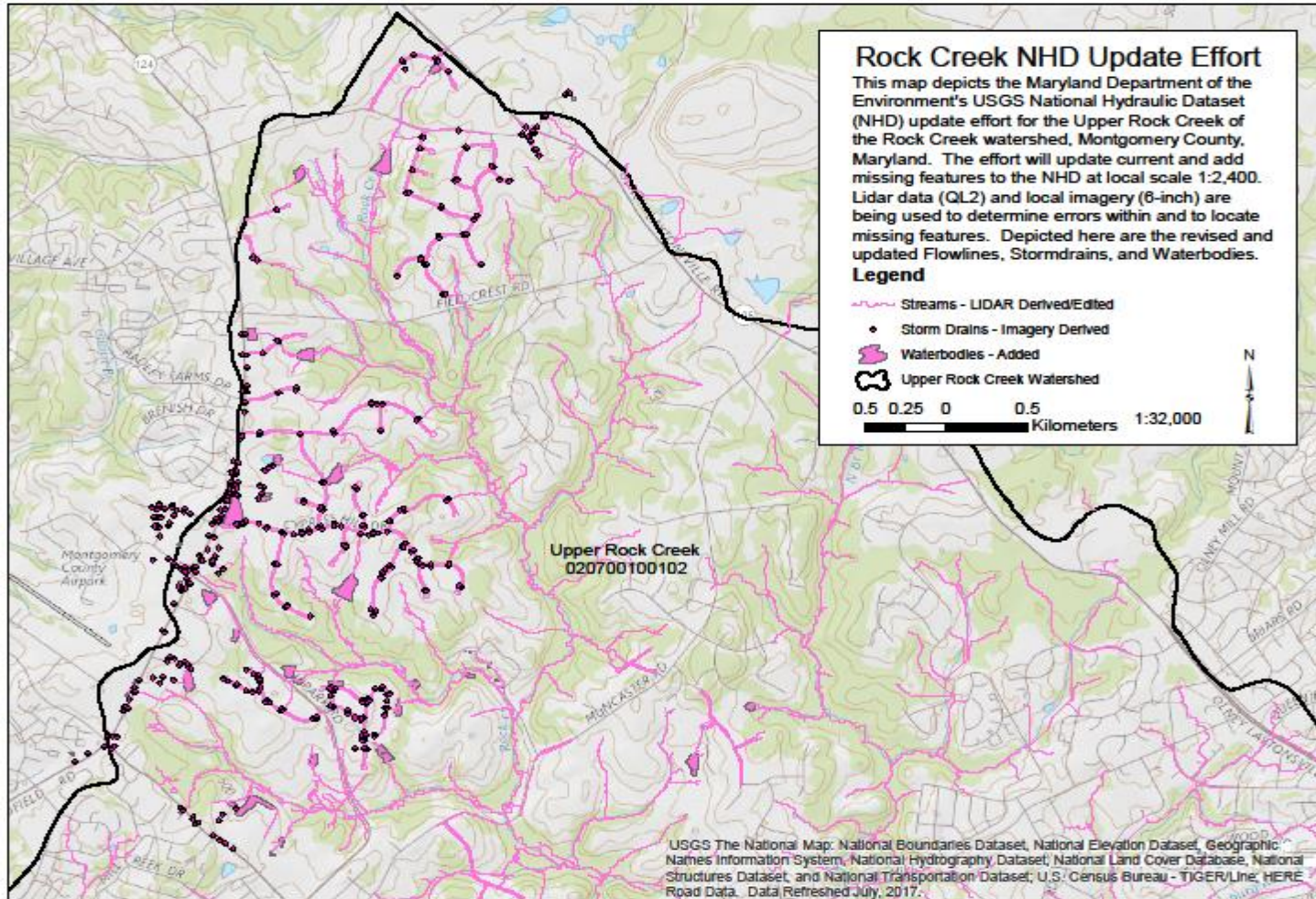
NHD and WBD Limitations

- NHD not designed for full content large-scale storm-water content

- No existing automated stream creation ability from DEM

- NHD is time and expertise intensive-training required for heavy content revision

- Newly released NHD Mark-up tool should ease editing-for light content revision, but not suitable for this project scope

- WBD, no *consistent* standards for 16-digit small watersheds, we created draft standard with WBD team

- WBD coding scheme limited to 99-sub-units

- WBD had only used topographic data to create watersheds

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Benefits of this Project Method

➢ Streams and Water-bodies integrated with elevation data

➢ NHD and WBD data included with National database, creates extensive urban hydrography, publicly available

➢ Provides integrated surface-water & storm-water network for DC

➢ Field-checked and Hydro-enforced

➢ Local resolution NHD and WBD will fit with other DC GIS base data

➢ Integrated network supports "interior" flooding analysis

➢ DOEE as NHD & WBD Steward will maintain this data

➢ MDE to complete upstream surface water network into DC

➢ Apply this method to other urban hydrography "deserts"

➢ Created a culvert database*

➢ Creates a platform for future urban hydrography enhancements

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+ Future Data Development

a) StreamStats

b) Local – Resolution NHDPlus *Really*-high Resolution?

c) Near Real-time monitoring, prediction, and management of storm-water flow

d) Improved identification of nutrient source areas & nutrient management

e) Targeted small watershed BMPs for storm-water

f) Flow regime attribution

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+ FIRSTS

- First field-validated storm-water content conflated to the NHD

- First integrated and field checked storm-water, infall/outfall to surface water data in NHD

- First WBD data created using data other than surface topography, MS4 sewersheds in impervious surface areas

Thank you   *Q U E S T I O N S ?*

Georgetown Waterfront – Potomac River
Roger Barlow, USGS-NGP, rbarlow@usgs.gov

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