

A case study in Barberry Woods: A stream system and watershed too small to care?

Ryne C. Phillips, PE

Davis & Floyd, Inc.

March 3, 2020

Photo Credit: Jared Bramblett.



DAVIS & FLOYD

SINCE 1954



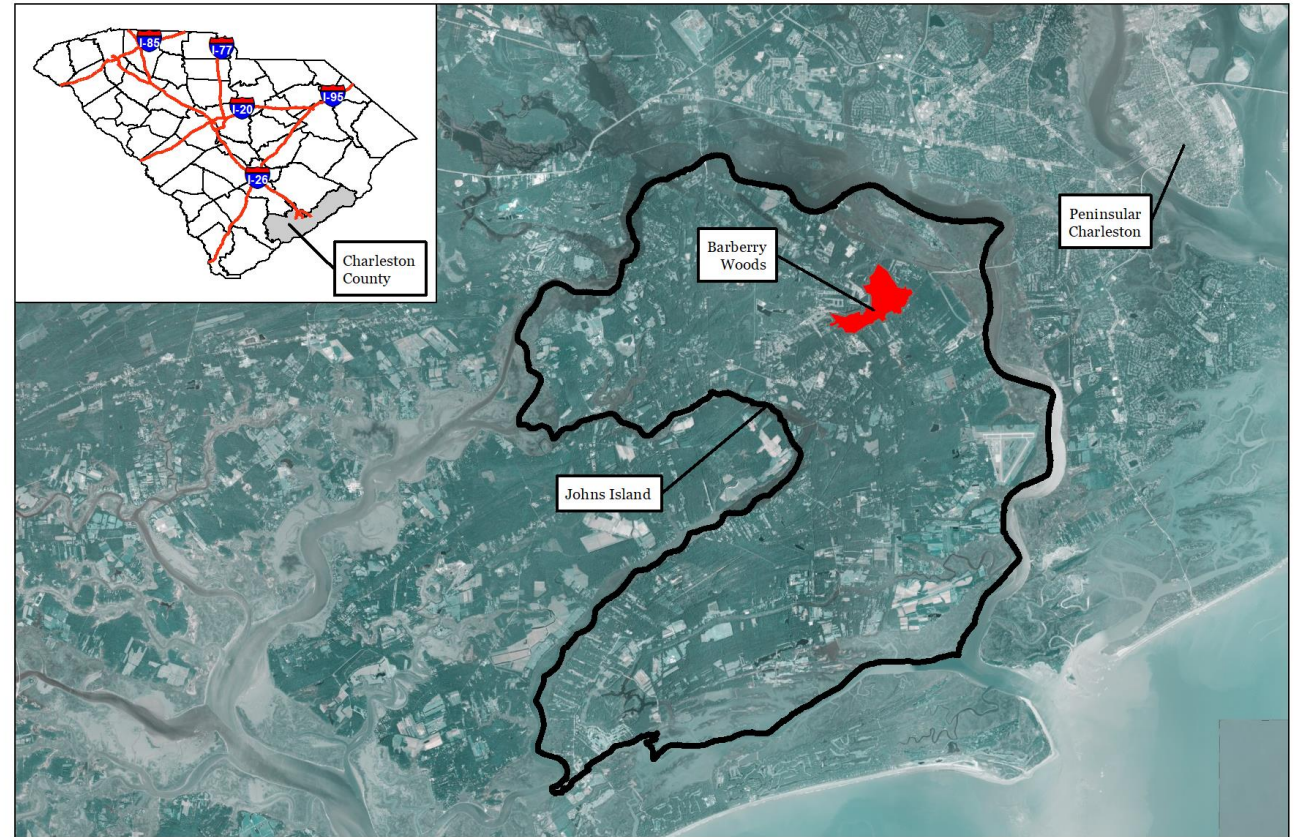
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Project Background
Modeling
Existing Conditions
Proposed Solution
Moving Forward
Questions?



Project Background

- Johns Island
 - City of Charleston
- Rapid growth
- Stream, wetland, and floodplain impacts
- Flood potential



Project Background

Another man-made flooding fiasco in the making on Johns Island

BY ABIGAIL DARLINGTON ADARLINGTON@POSTANDCOURIER.COM
FEB 28, 2018

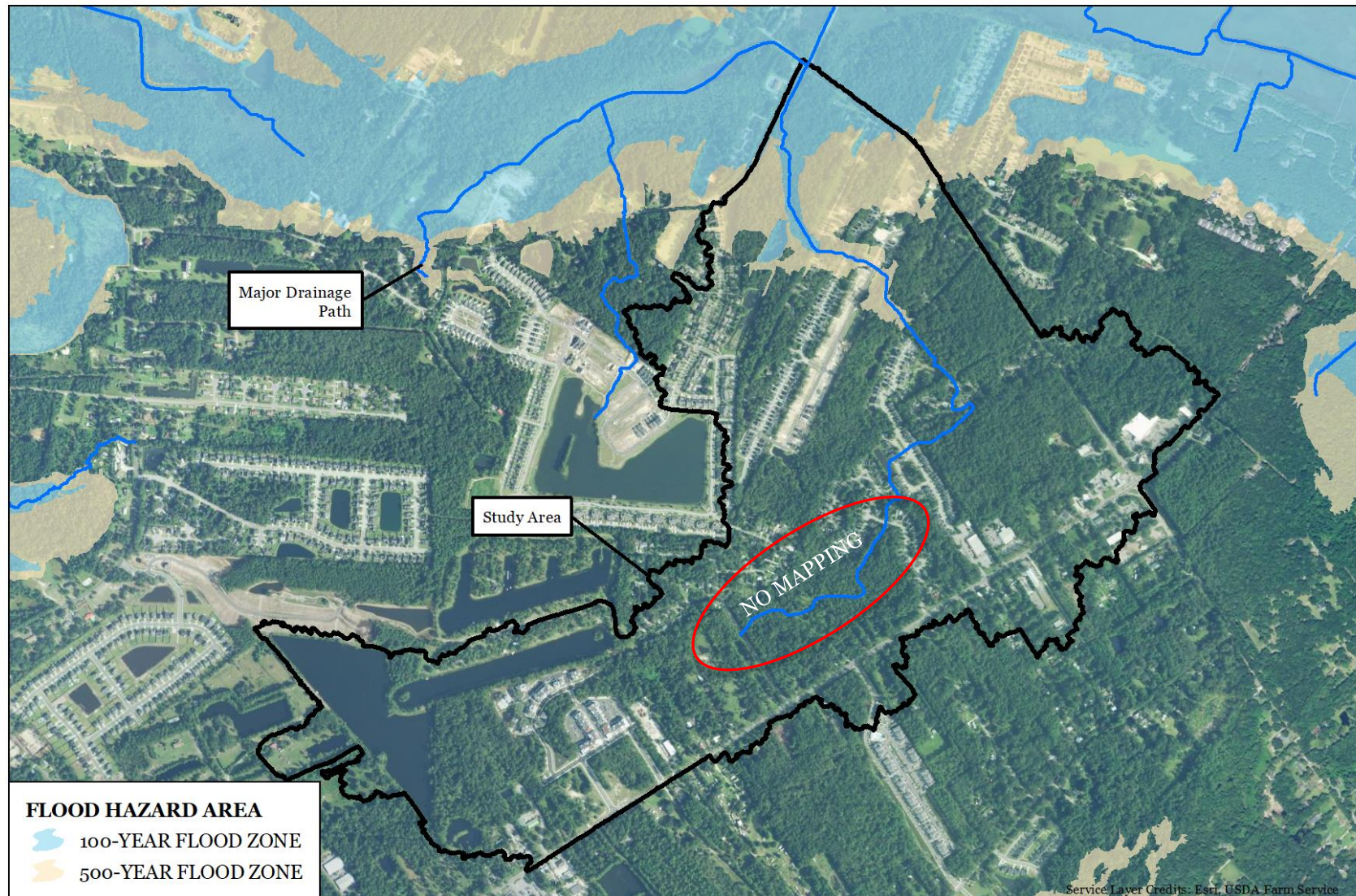


Contractors clear land and build roads for a new subdivision on Johns Island's River Road. Brad Nettles/Staff

[BUY NOW](#)

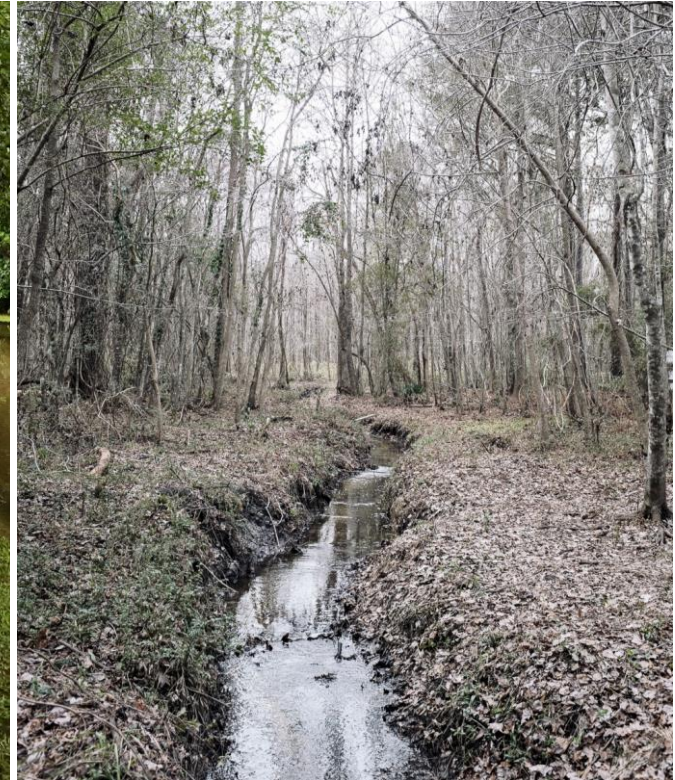
- Neighborhood flooding
- Regional hydraulics
- Coastal flood risk
 - FEMA regulated
 - Surge only (typically)
 - Unmapped flood zones

Project Background – FEMA Mapping



Barberry Woods

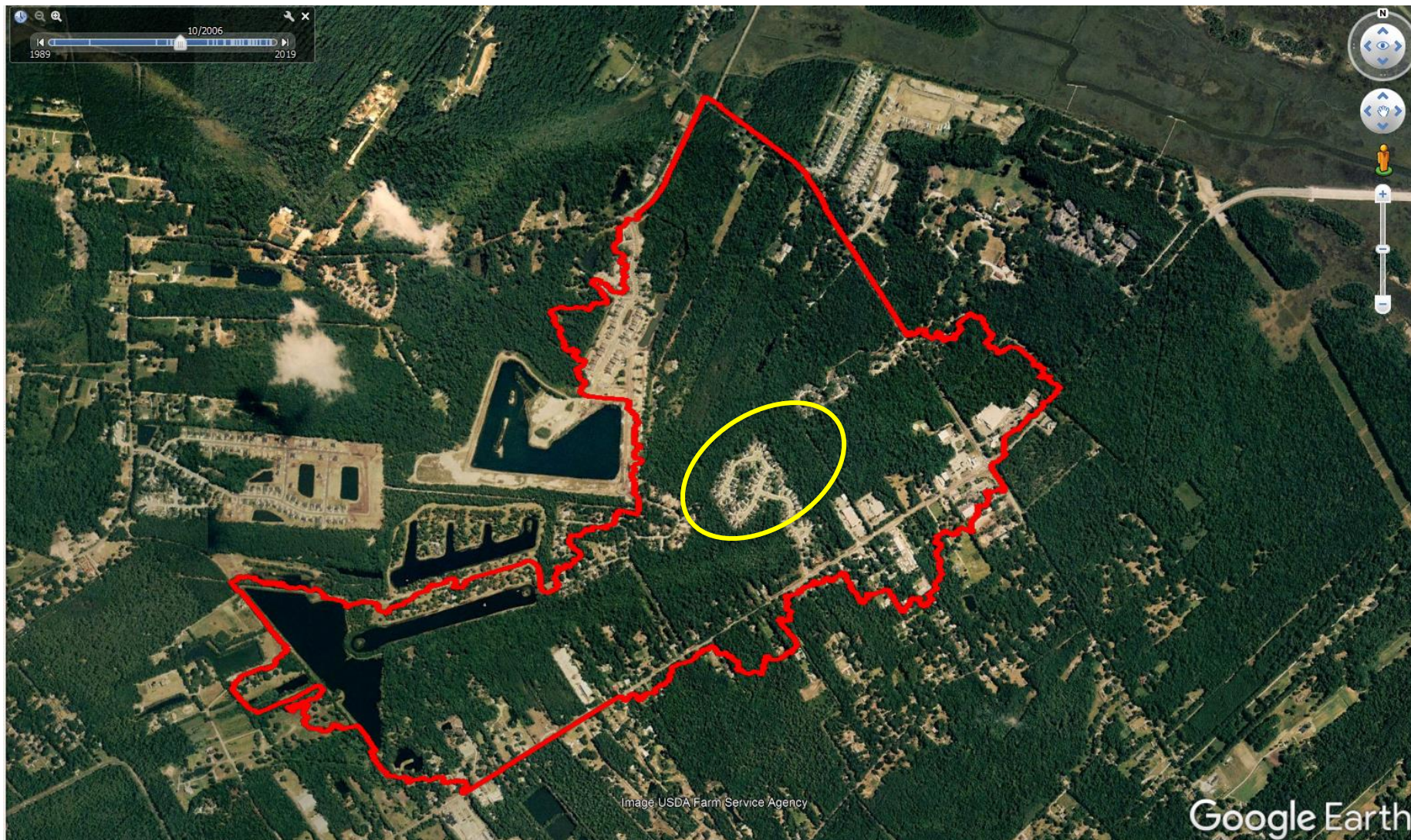
- Permitted/developed prior to strict MS4 standards
- Built within natural floodplain
- Frequent flooding
 - Roadways & yards, some structure flooding
- Extended duration road closures due to flooding (>24hrs)



Historical Imagery (2020)



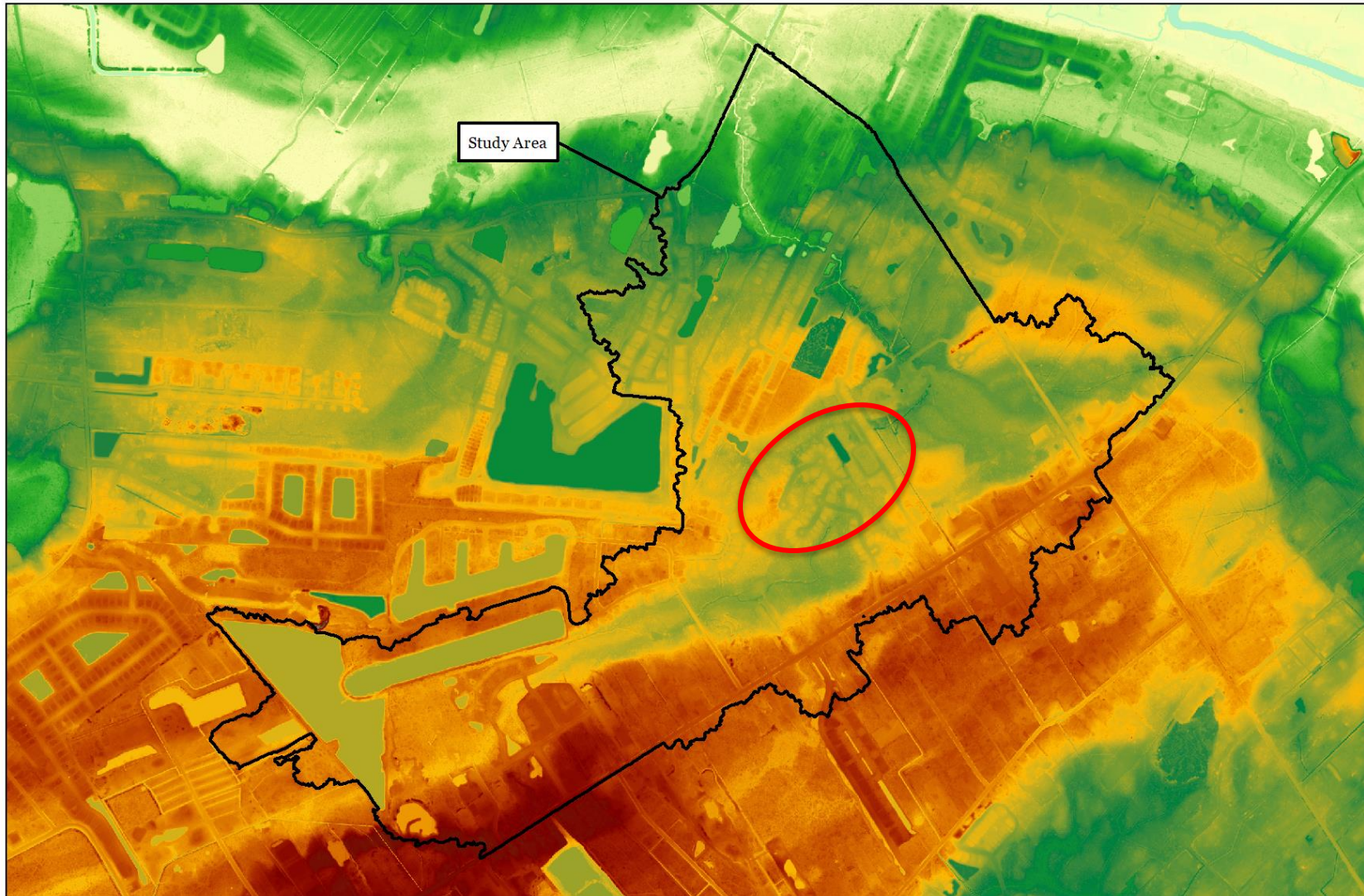
Historical Imagery (2006)



Historical Imagery (1989)

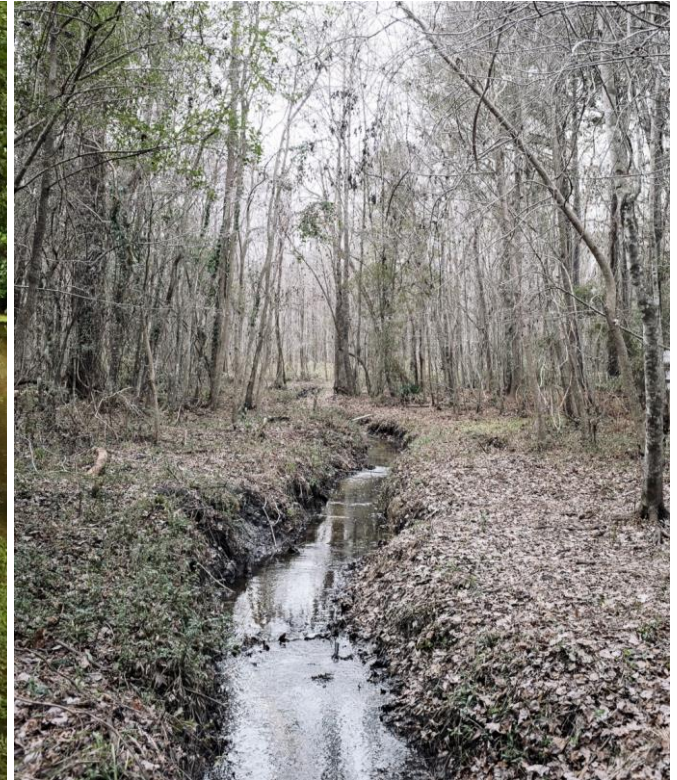


2017 LiDAR



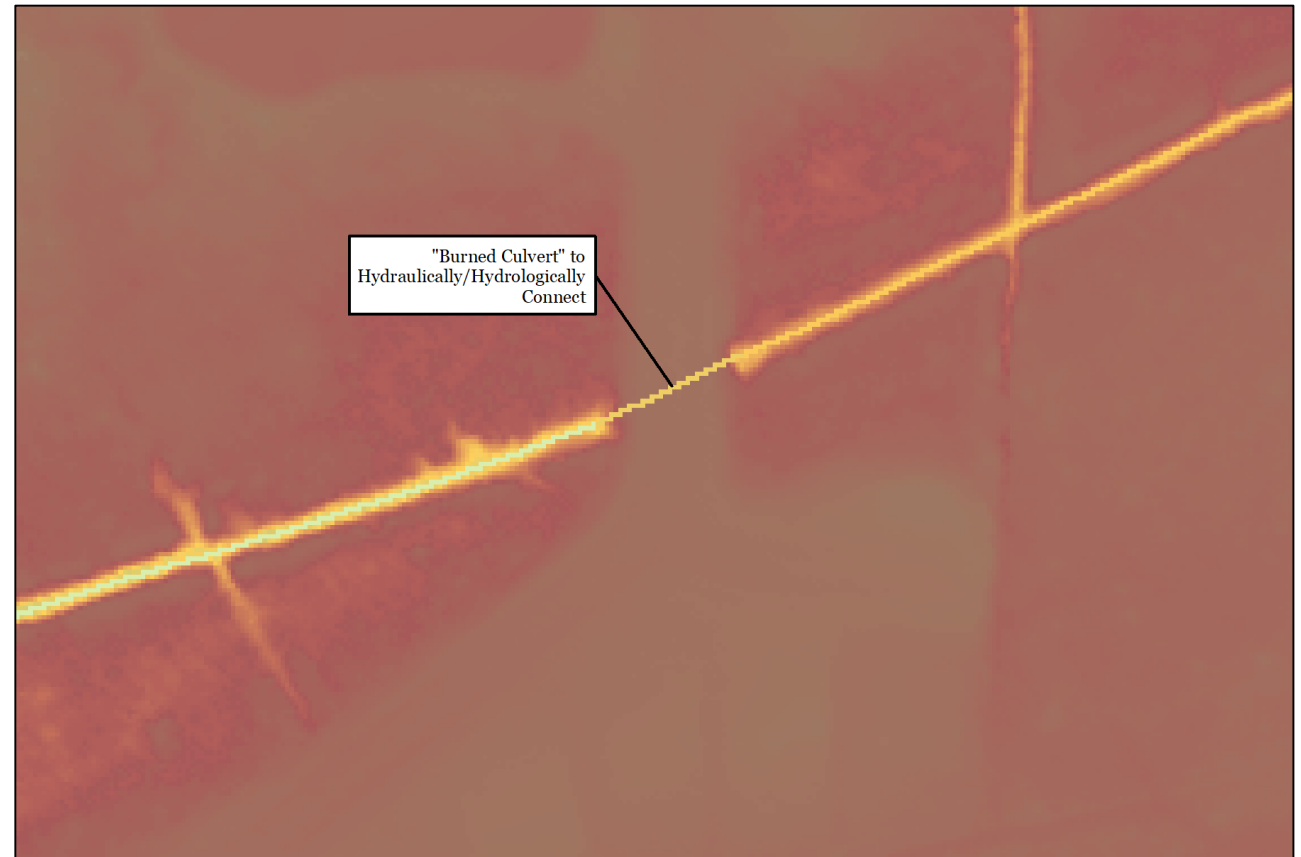
Project Objectives

- Watershed assessment
 - Major watersheds
 - Major flow paths
- 1-D/2-D Stormwater Modeling
 - Existing Conditions
 - Proposed Conditions
- Final Recommendation

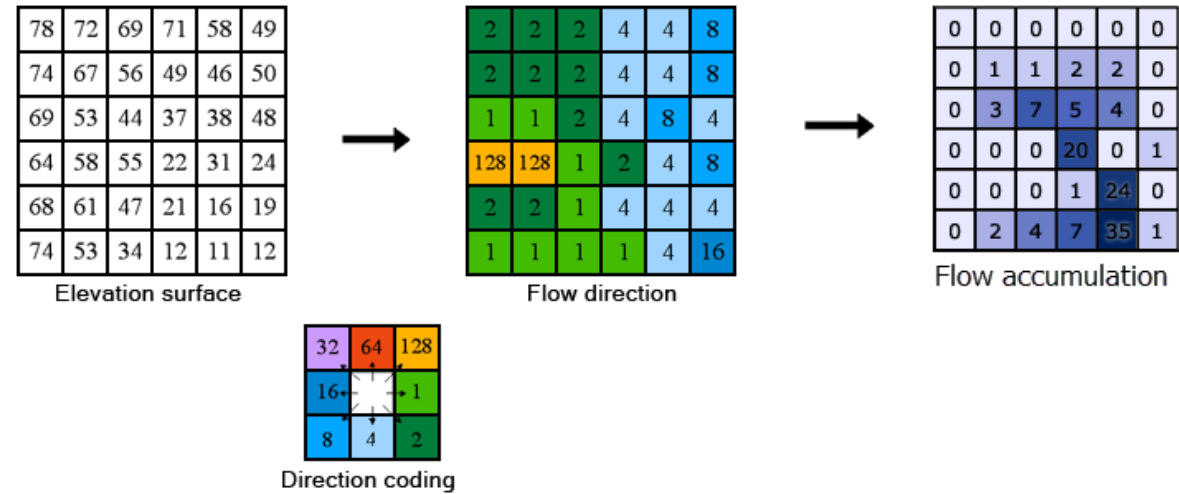
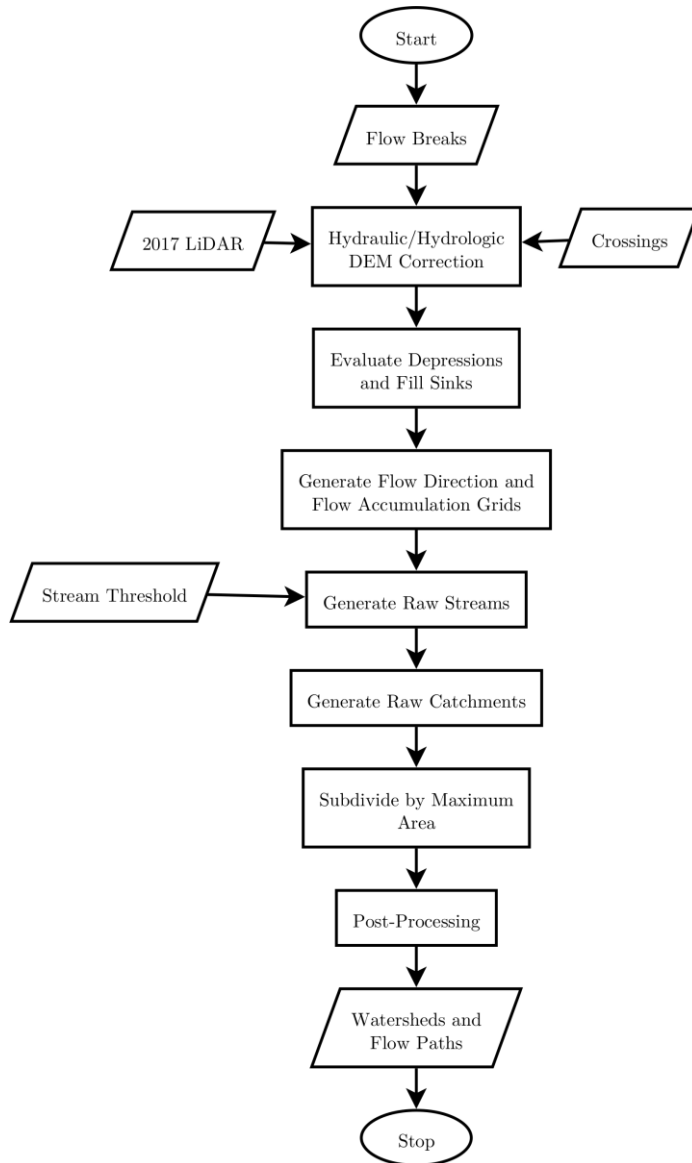


Watershed Assessment - Inputs

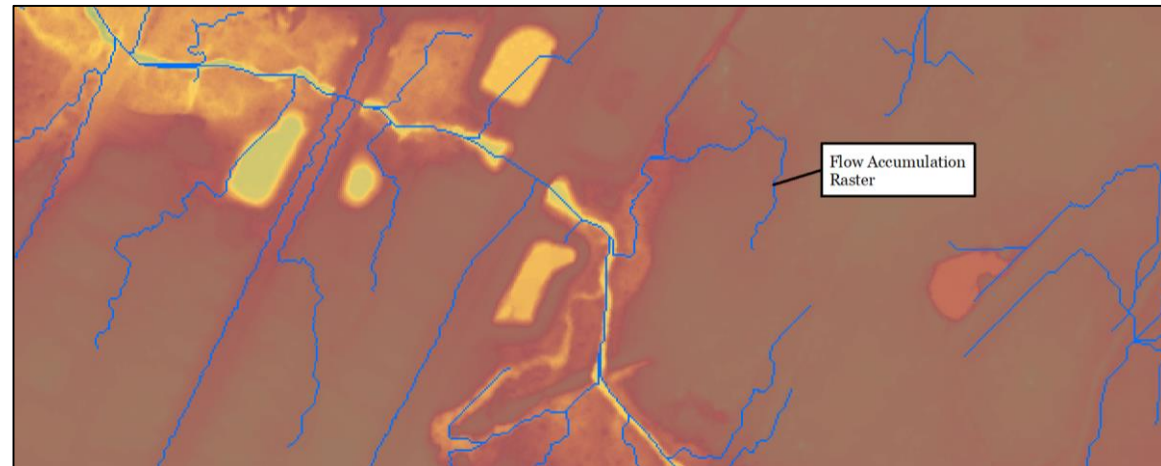
- 2017 LiDAR
 - Hydro-enforced DEM
 - 2.5-foot resolution
- Crossing data
 - County provided
 - Visual inspection
 - Survey data



Watershed Assessment - Modeling

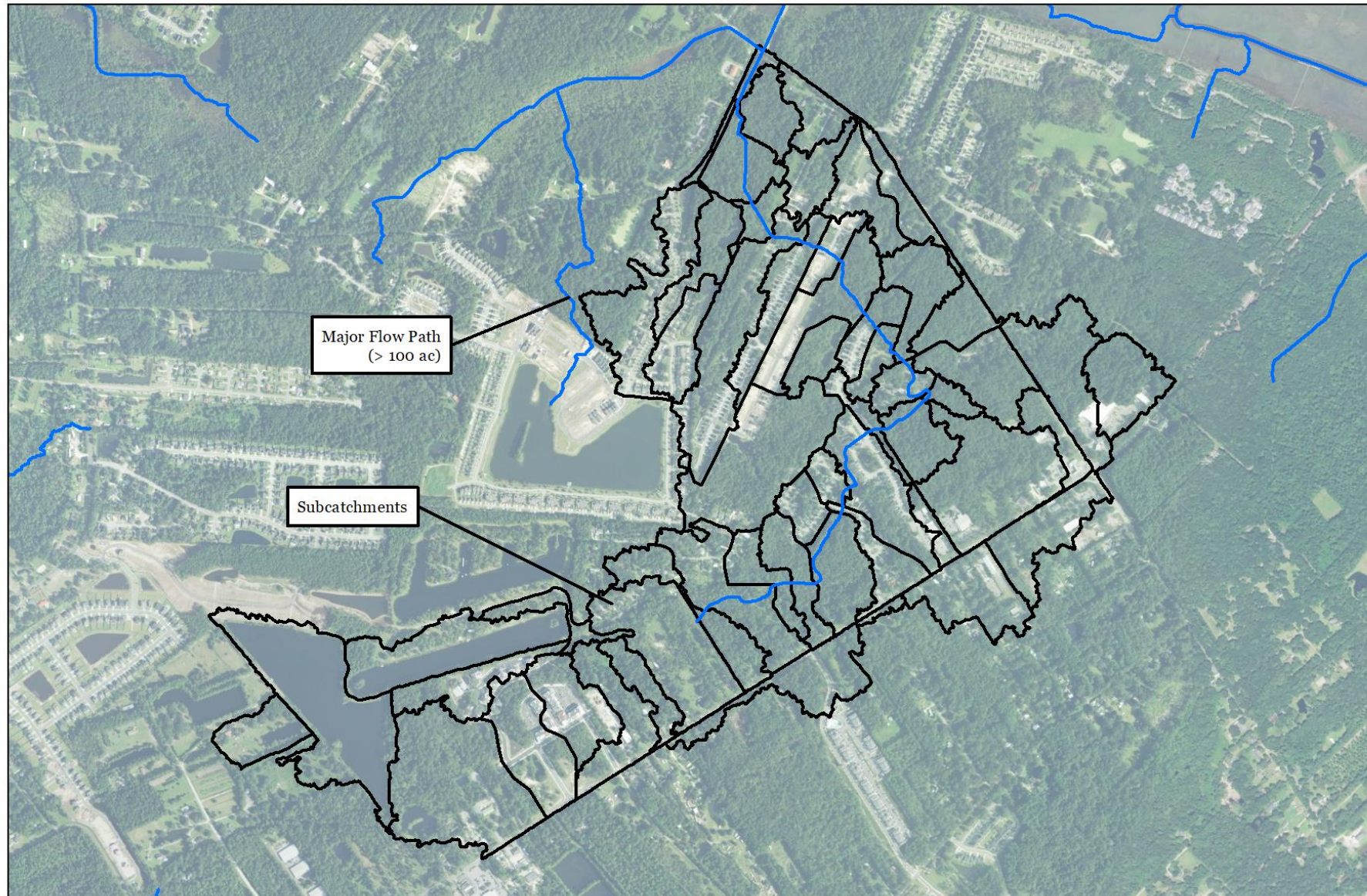


Example flow direction and flow accumulation theory (Source: ESRI).



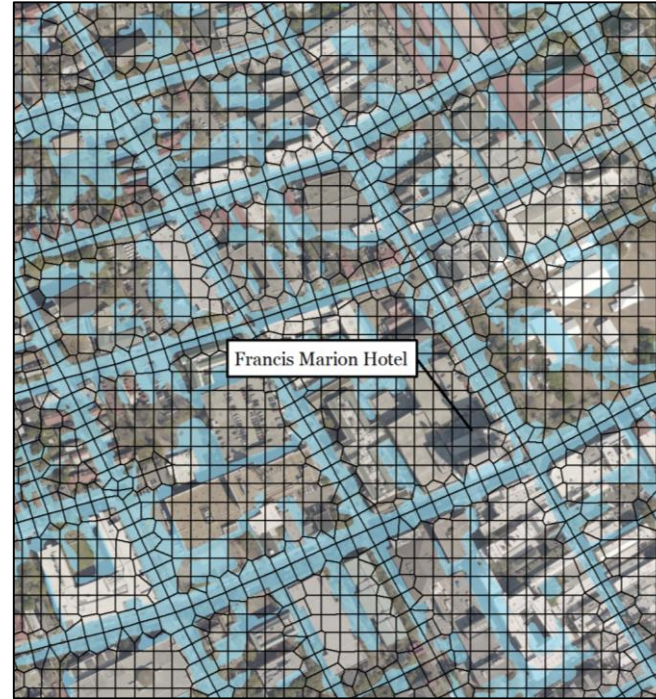
Example flow accumulation grid (Source: Davis & Floyd, Inc.).

Watershed Assessment - Results

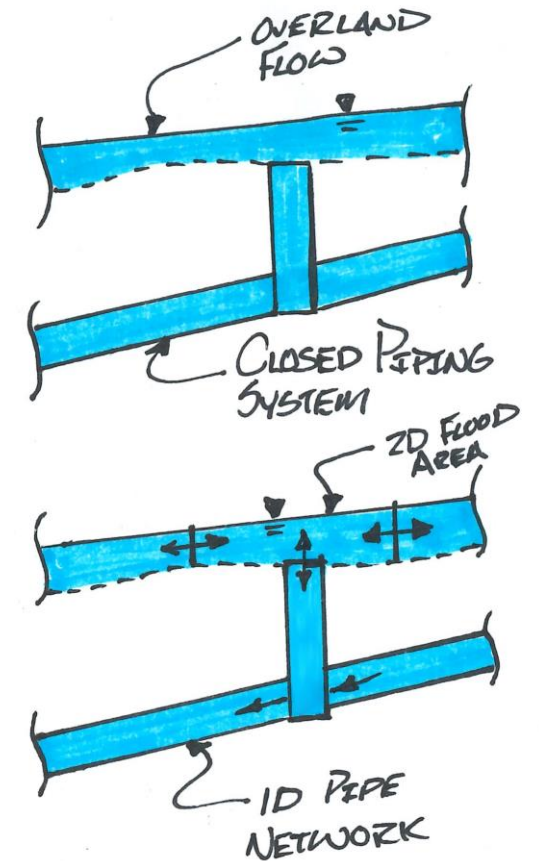


Modeling - Background

- Rain-on-grid (2-D)
 - Direct rainfall (runoff)
 - No pipes
 - Flood risk, not flood zone = planning only!
- Combined 1-D/2-D
 - Major crossings
 - Major pipe networks



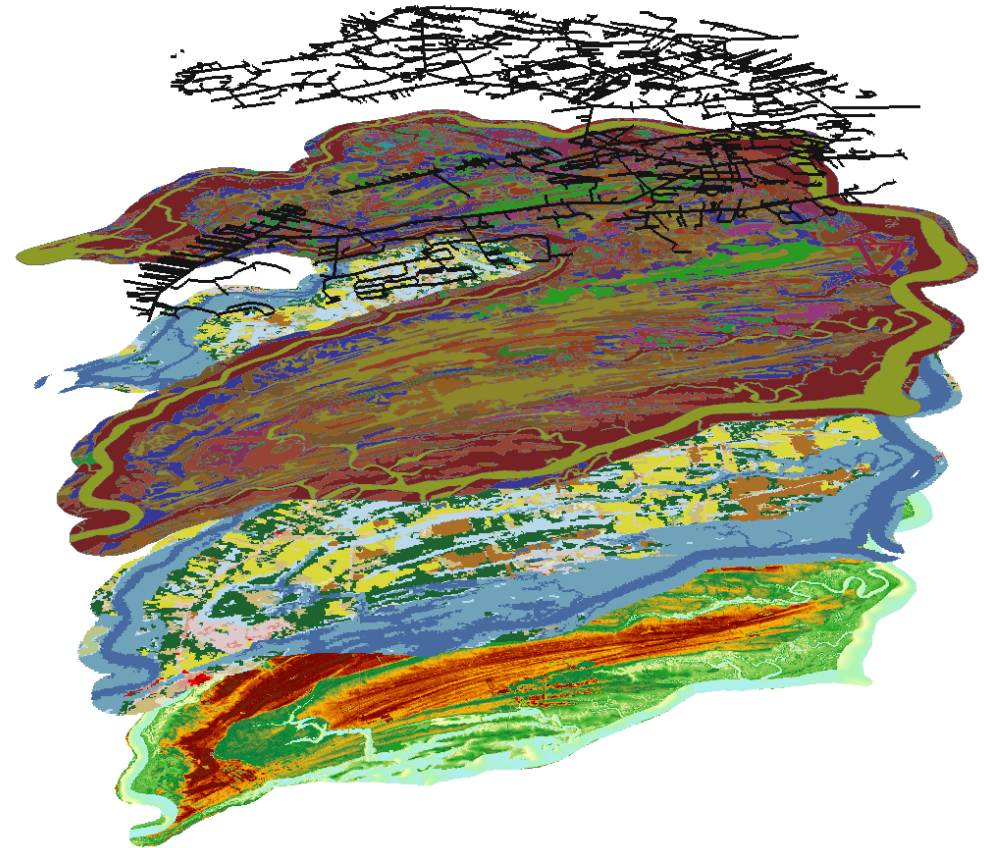
Rain-on-grid mesh



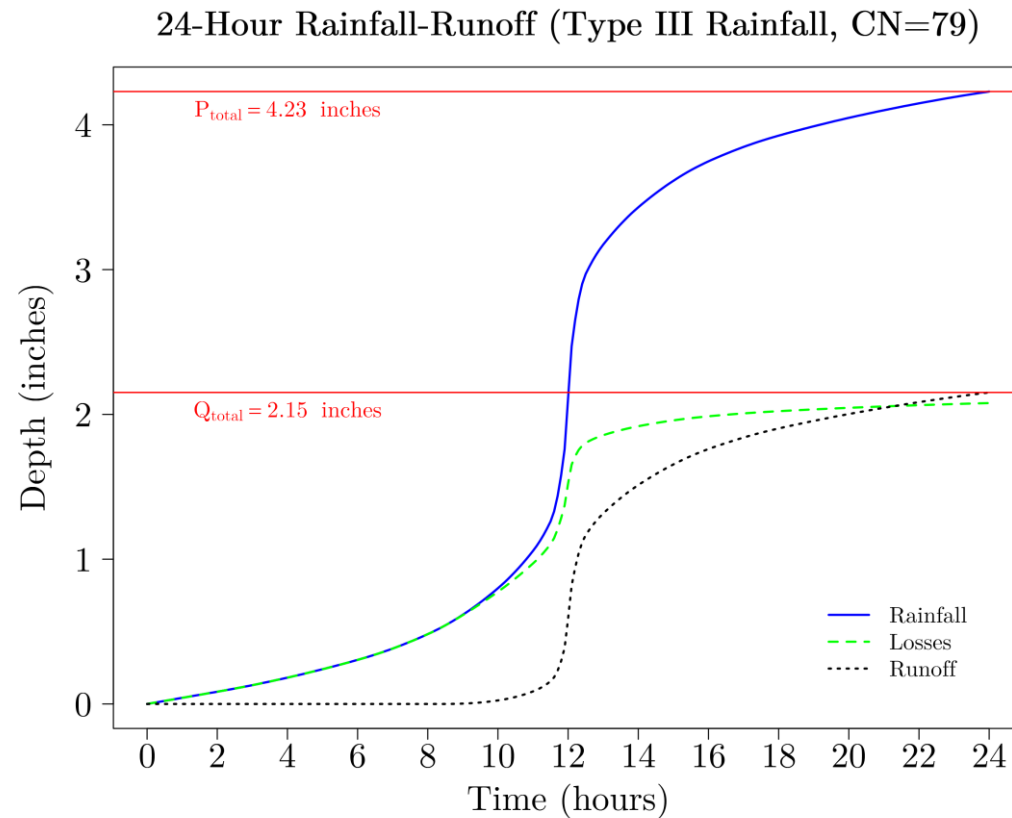
Combined 1-D/2-D
Theory

Modeling – Input Data Sets

- Road network
- USDA soils
- 2016 NLCD
- 2017 LiDAR
- Pipe networks



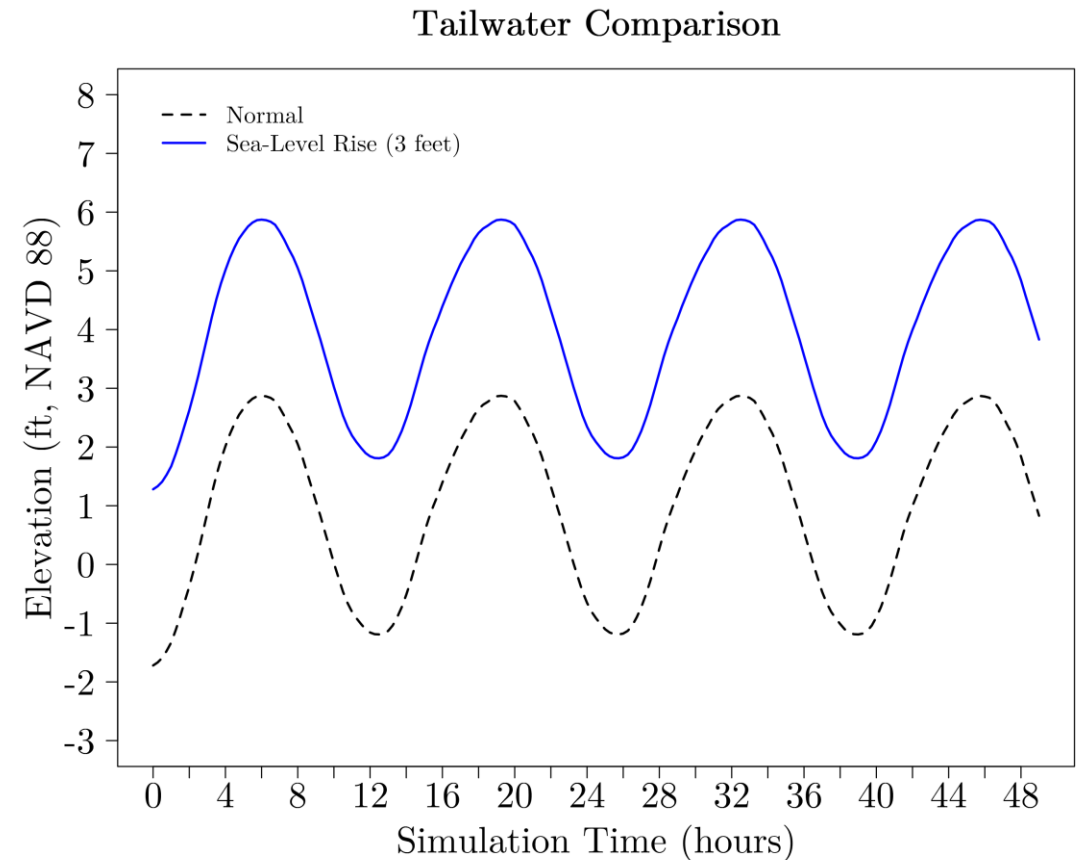
Modeling – H&H Parameters



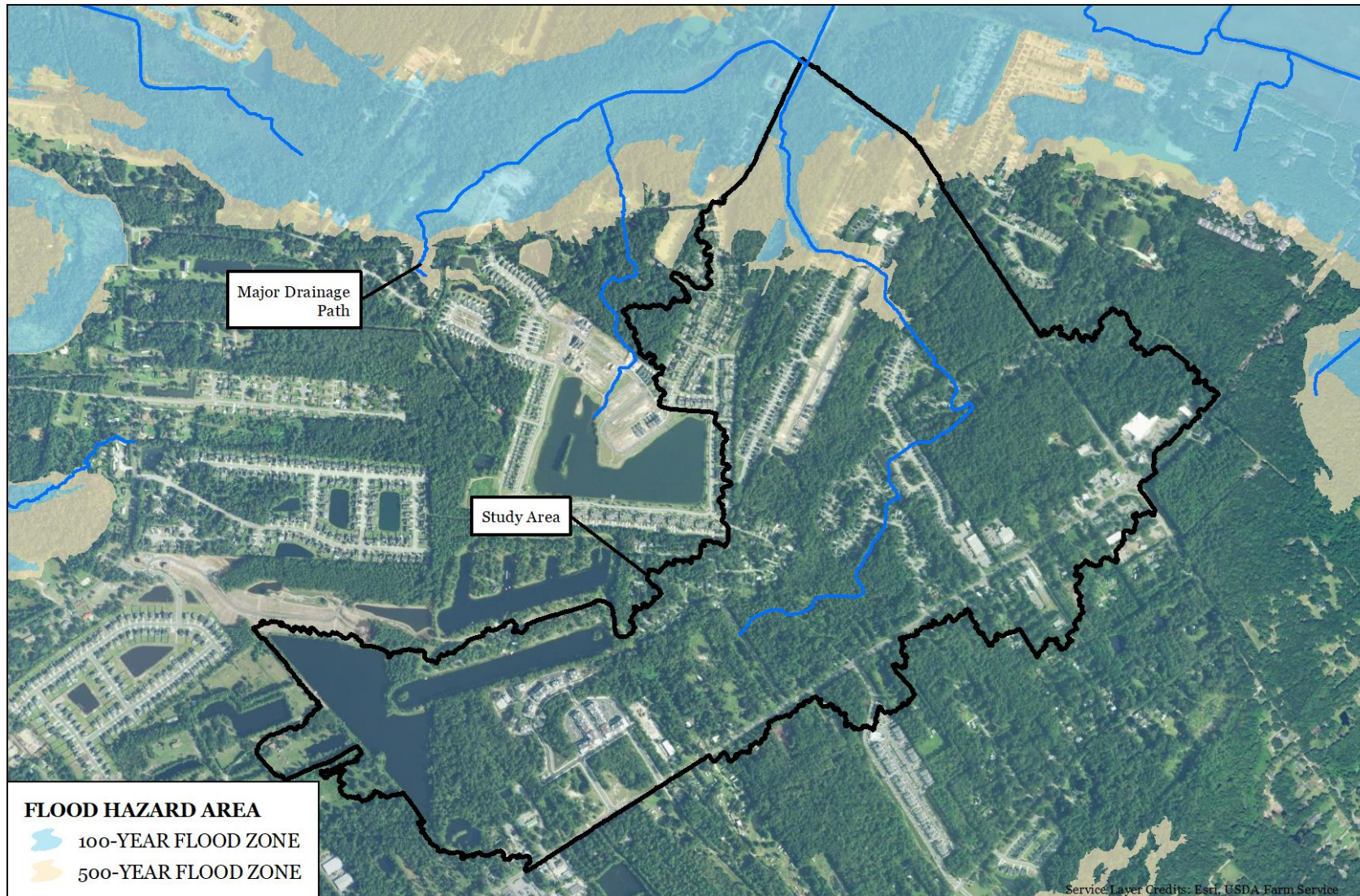
- CN method (NRCS)
 - Type III, 24-hour rainfall
 - Direct runoff time series
- 10-year to 100-year
- Dynamic average tide

Modeling – H&H Parameters

- Tailwater condition
- Normal tide
- Sea-level rise
 - Normal + 3 feet

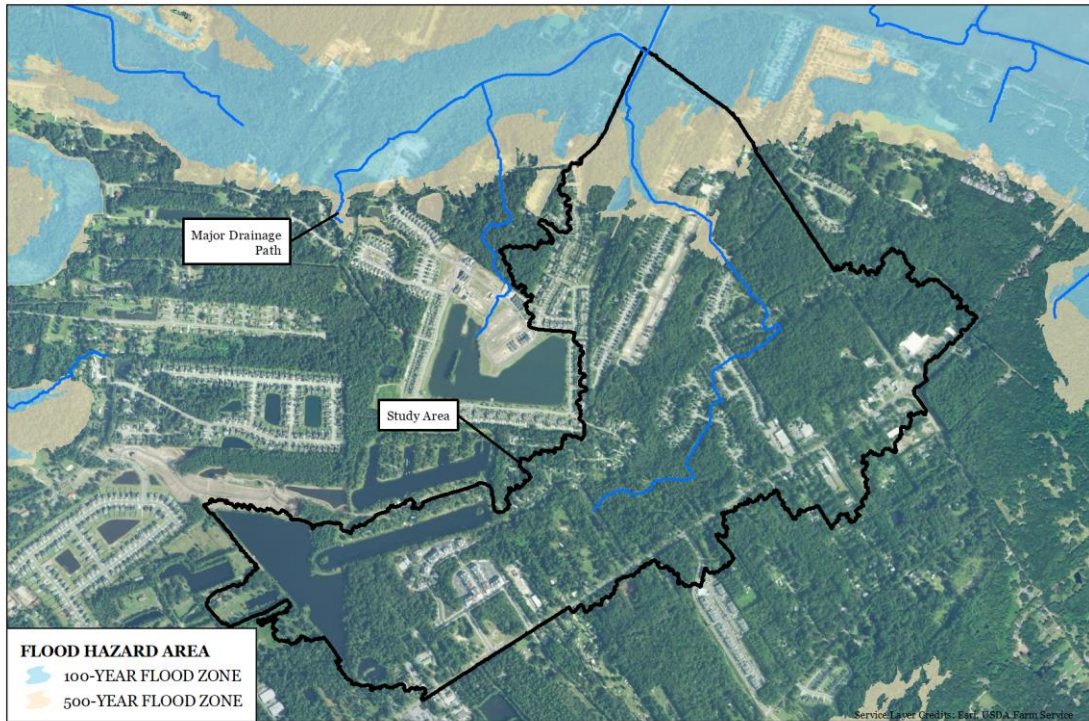


Results – Existing Conditions (FEMA)

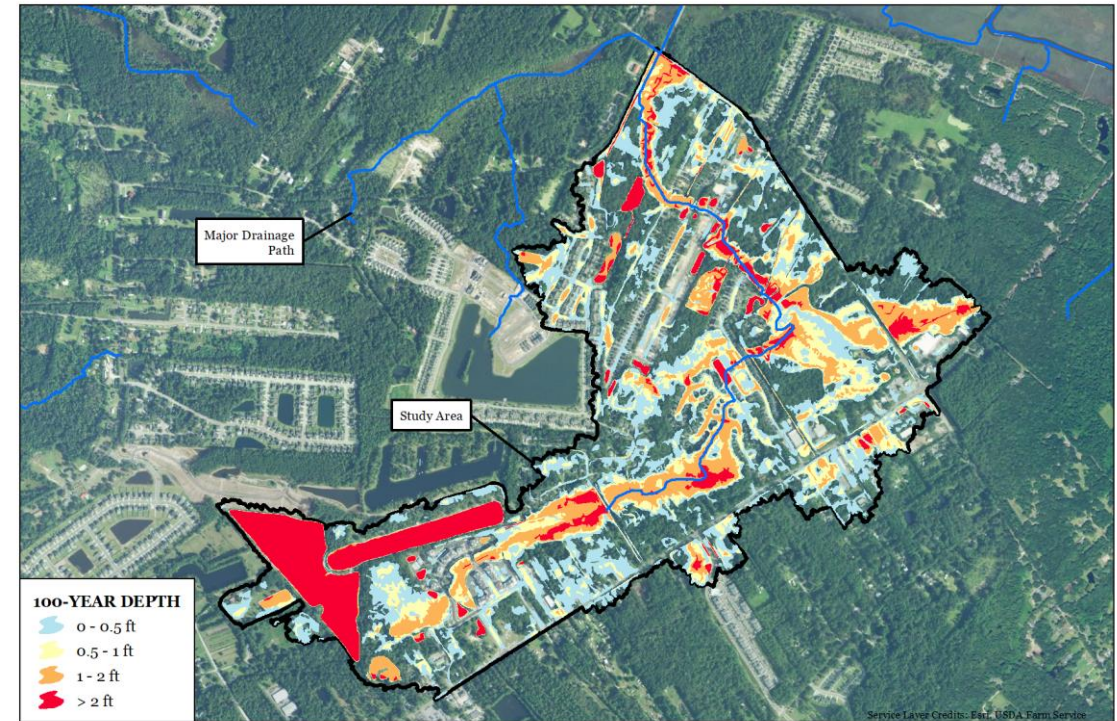


Results – Existing Conditions (FEMA vs. ROG)

FEMA

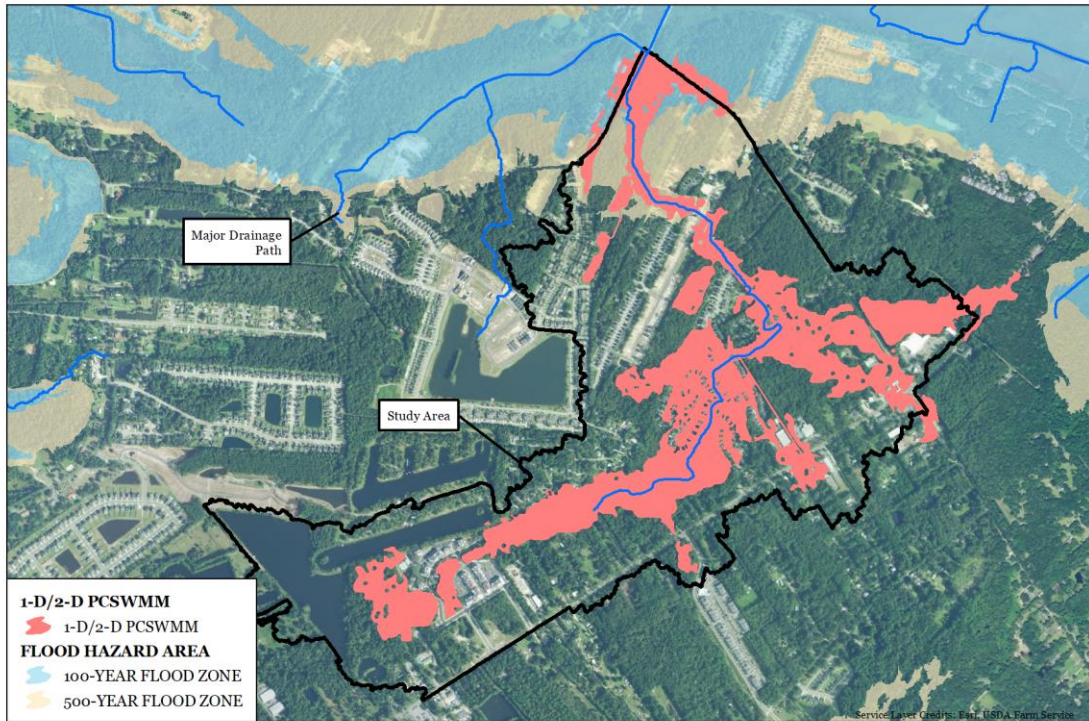


Rain-on-Grid

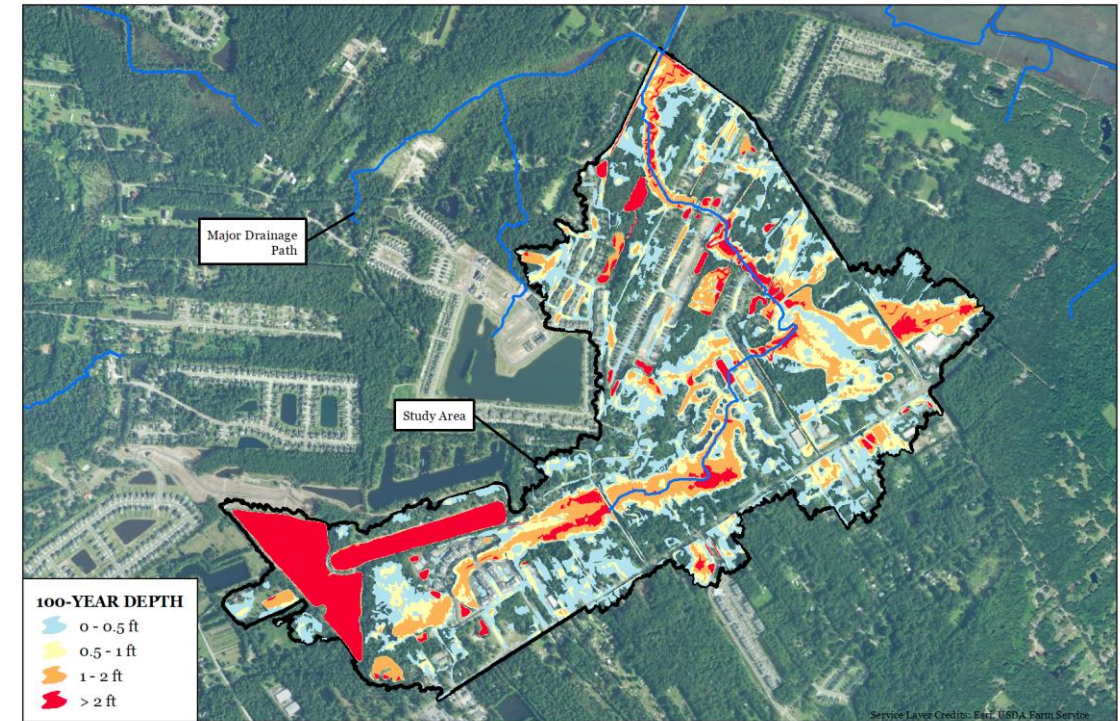


Results – Existing Conditions (FEMA vs. ROG)

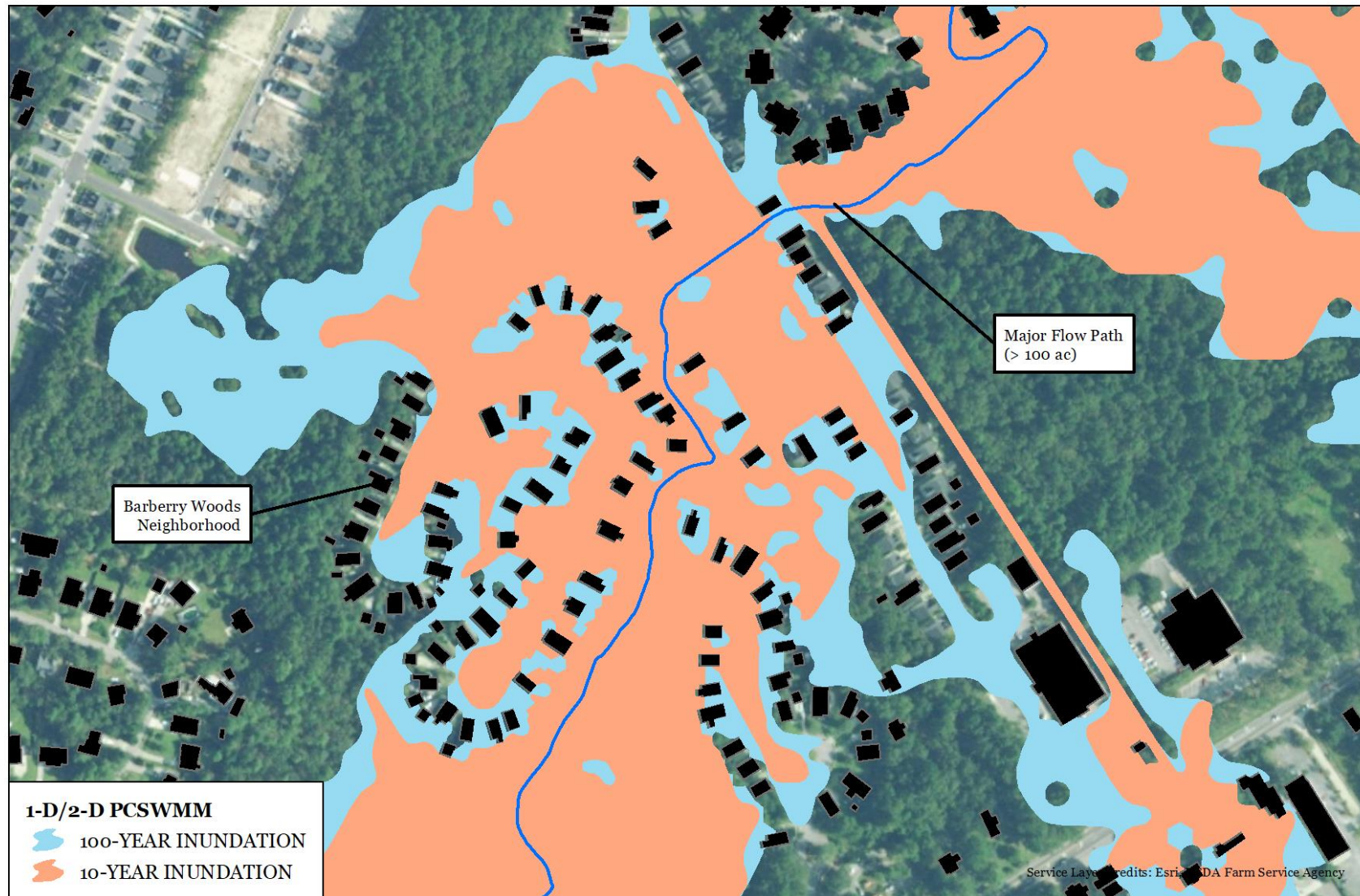
1D/2D



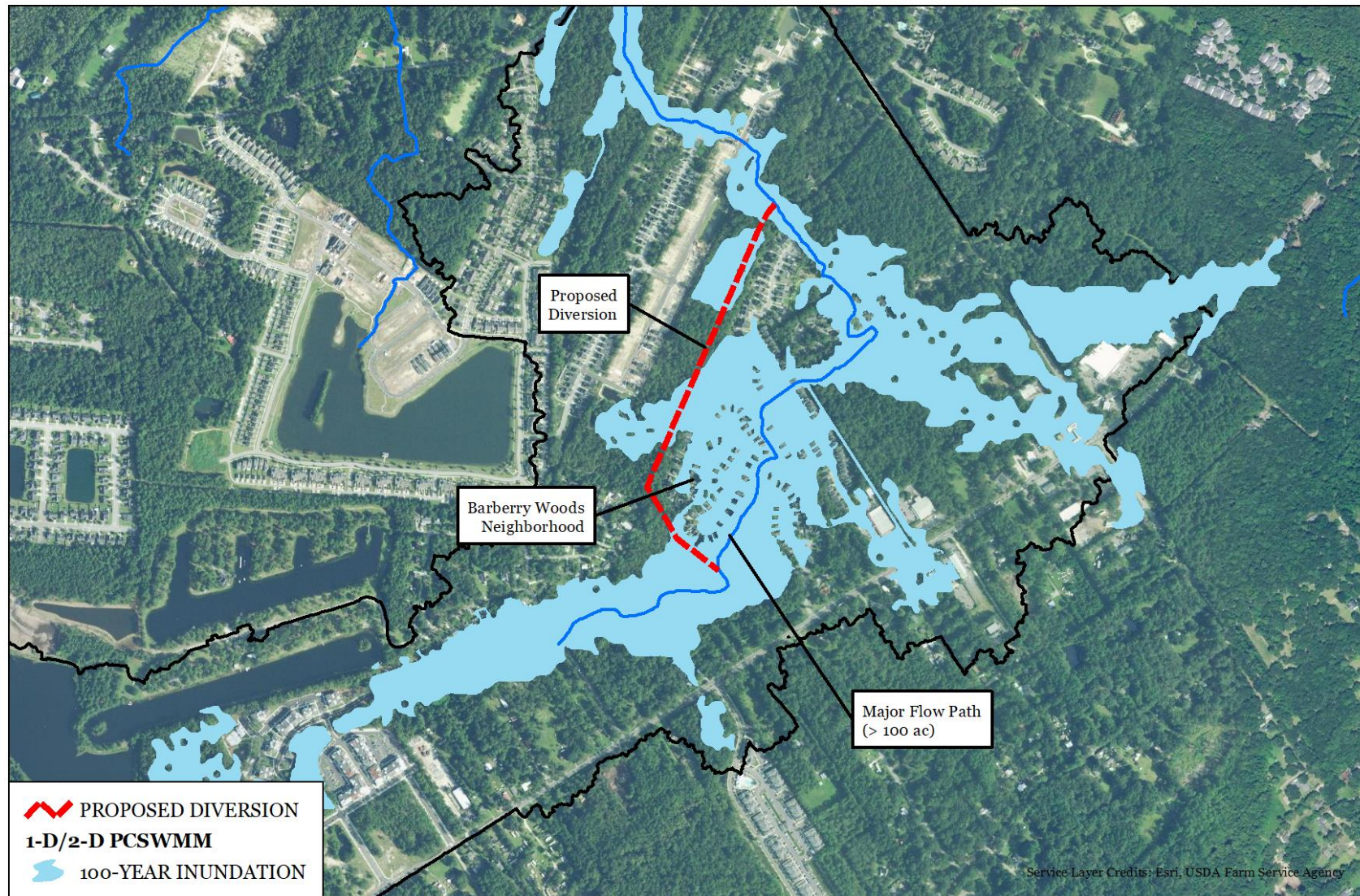
Rain-on-Grid



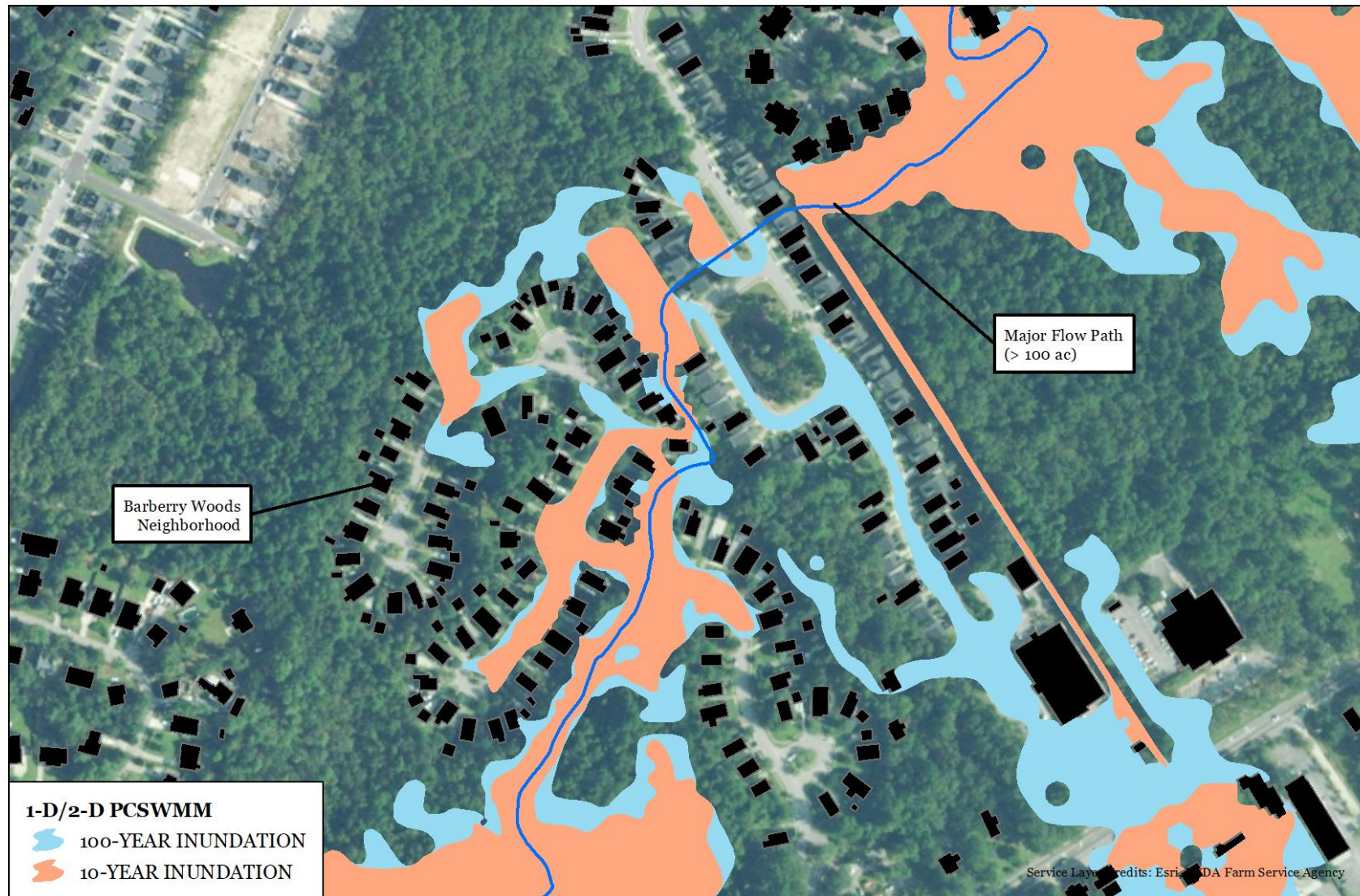
Results – Existing Conditions (10/100-Year)



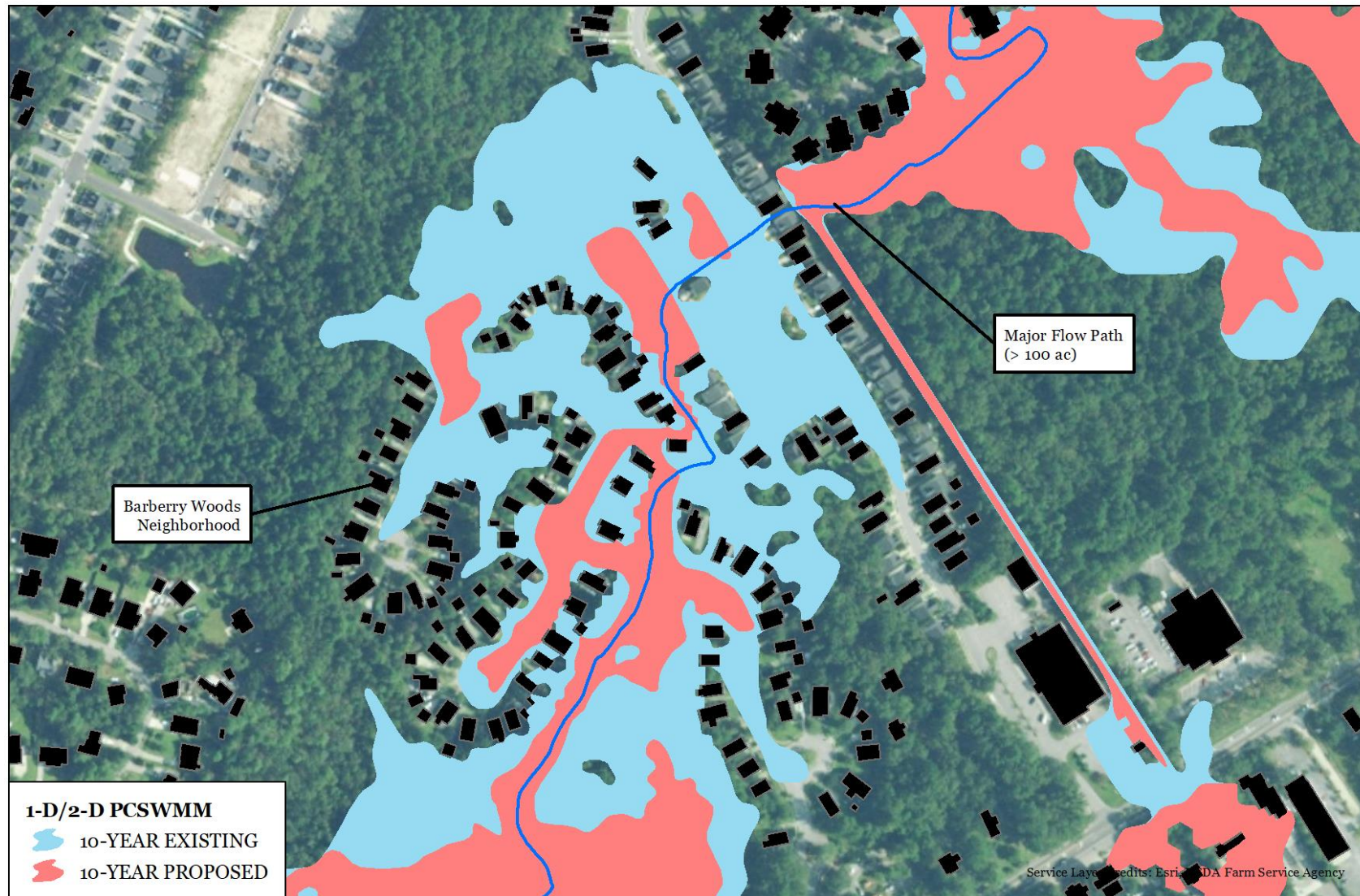
Recommended Solution



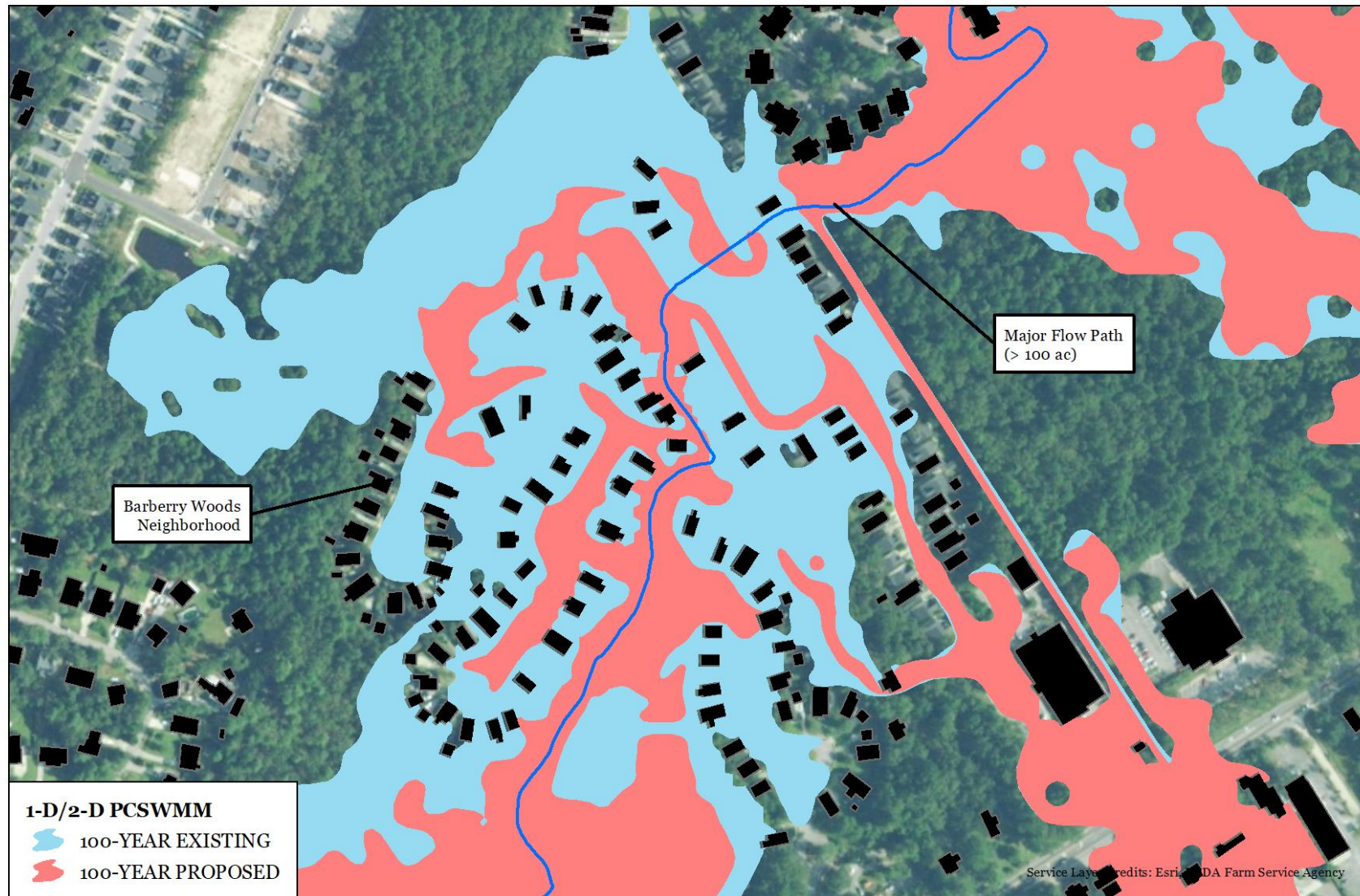
Results – Proposed Conditions (10/100-Year)



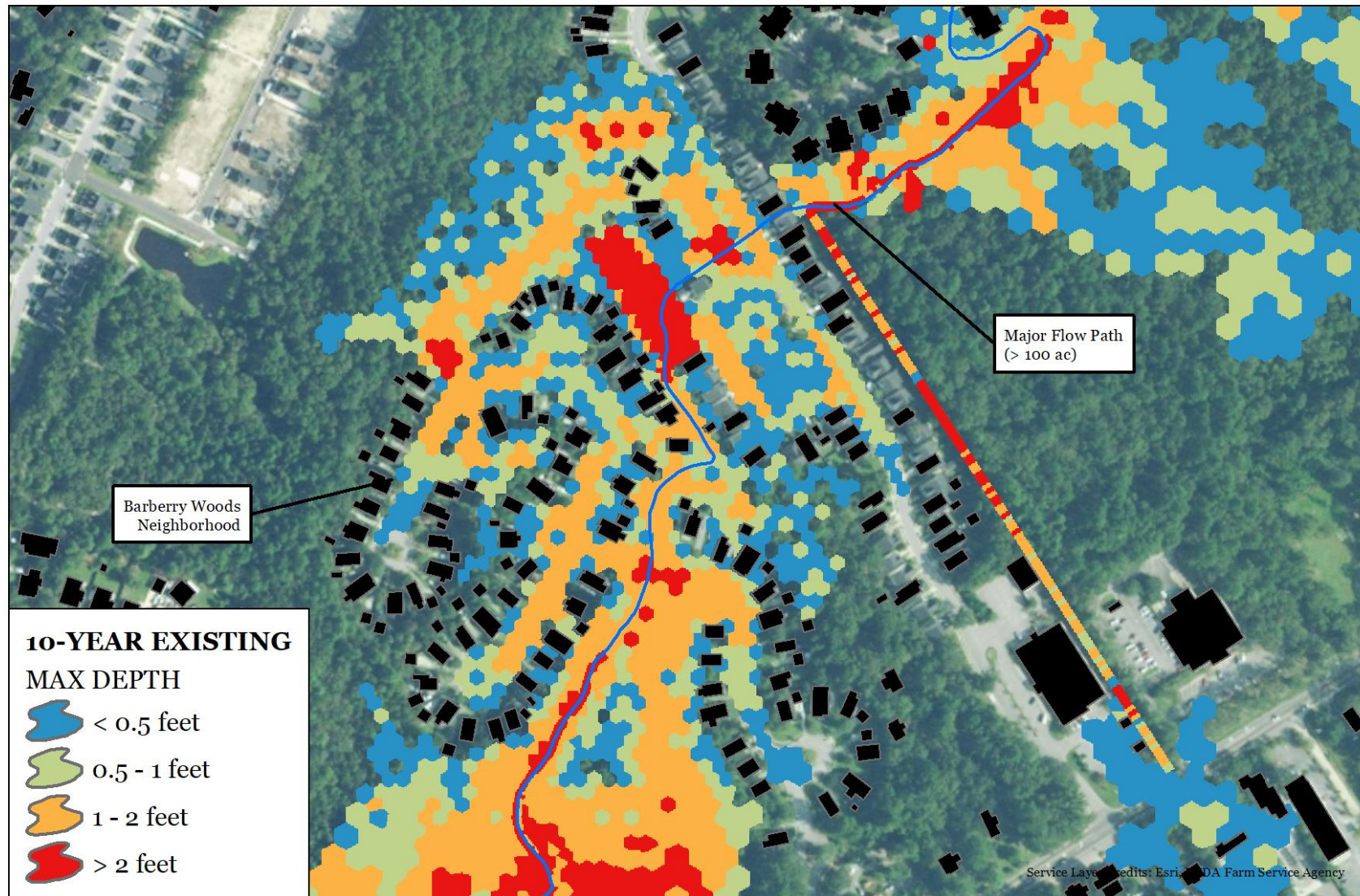
Results – Existing vs. Proposed (10-Year)



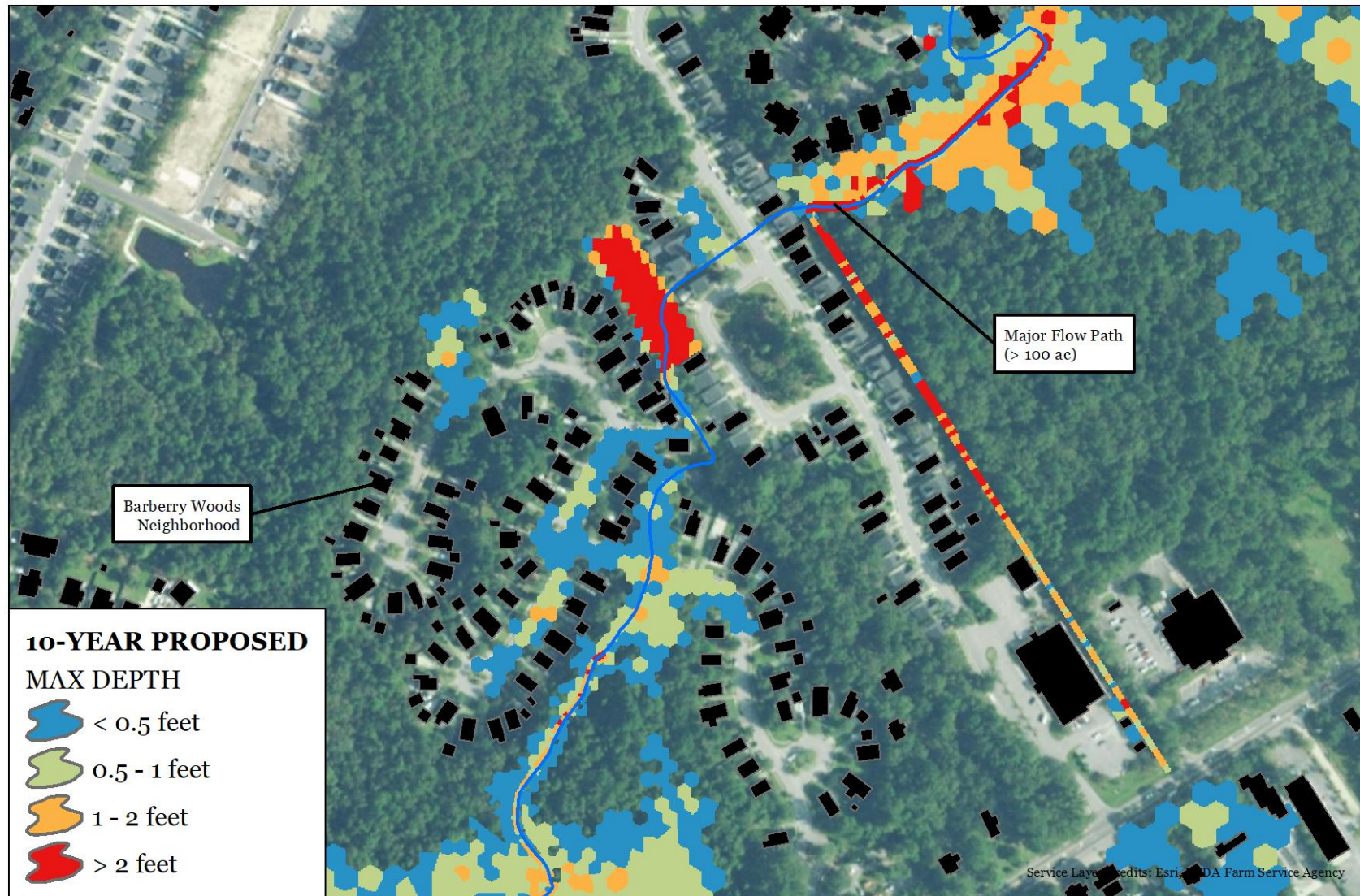
Results – Existing vs. Proposed (100-Year)



Results – Existing Conditions (10-Year Depth)



Results – Proposed Conditions (10-Year Depth)



Moving Ahead - SPAs

- New stormwater standards
- Establishment of special protection areas (SPAs)
- Planning-level flood mapping

City of Charleston	Stormwater Design Standards Manual	Design Requirements
2412		impervious area by greater than 10 percent of the impervious area at the time of submittal
2413		of a CAA.
2414	3.6	Special Protection Areas
2415		In an effort to address some of the most critical water resource problems that exist in the City,
2416		special protection areas have been established. Any development or redevelopment (see
2417		Section 3.5.2 for additional redevelopment requirements) within or discharging to these
2418		special protection areas must comply with a more stringent set of design criteria in addition to
2419		the minimum standards and LOS determined by the City. For any conflicting design criteria, the
2420		more stringent set will supersede the minimum standards for special protection areas.
2421		The City can designate any area as a special protection area. The permittee has the
2422		responsibility to contact the City through the Technical Review Committee (TRC) to determine
2423		whether the proposed project site is within or discharging to a special protection area. The
2424		Director of Stormwater Management shall make the determination on whether a site is within a
2425		special protection area.
2426	3.6.1	Areas Associated With Known Flooding
2427		Flooding occurs in many locations around the City where development has increased
2428		stormwater runoff to the point that stormwater conveyance systems have become
2429		overwhelmed. The following design criteria shall be used for projects discharging to receiving
2430		waters within these special protection areas:
2431		• For non-SFR sites of 0.5 acres or more, the post-development, peak discharge rates are
2432		restricted to one-half the pre-development rates for the 50 percent and 10 percent AEP, 24-
2433		hour storm events or to the downstream system capacity, whichever is less.
2434		• For non-SFR sites of 0.5 acres or more, the post-development runoff volumes for the 50
2435		percent, 10 percent, and 4 percent AEP, 24-hour duration storm events above the pre-
2436		development level shall be stored for 24 hours before release. The runoff volume excess
2437		between pre-development and post-development must be released steadily over a period
2438		of 48 hours after the initial 24 hours of storage.
2439		• For SFR or non-SFR of less than 0.5 acres with an increase of 500 square feet of impervious
2440		area or more, offset the increase in runoff through implementation of runoff reduction
2441		practices (e.g., disconnected downspouts, rain garden, infiltration trench, rain barrel in Table
2442		3-5). Per Low Impact Development in Coastal South Carolina: A Planning and Design Guide
2443		(Ellis et al. 2014), rain barrels should be used where there is a direct corollary reuse demand.
2444		In absence of such, an orifice outlet should be used to slowly drain to impervious surfaces.
2445		Additional stormwater design criteria may be determined and required by the Department of
2446		Stormwater Management during the permitting process.

Conclusion

- Local floodplain planning
- Riverine vs. coastal flooding
- Rain-on-grid modeling = planning tool
- Adaptive management
 - Revised stormwater standards
 - Special management areas (SPAs)

Questions?



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