Analysis of the Revisions to the Buffer System of the Inland Bays Pollution Control Strategy

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Intent of Analysis

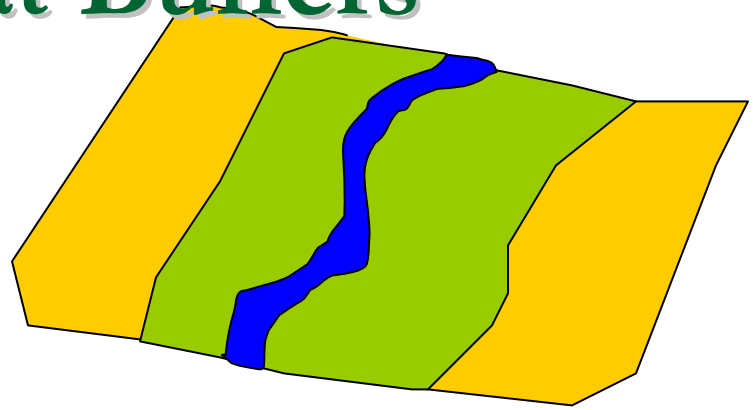
- This analysis is intended to compare the relative nutrient load reductions between two proposed buffer systems.
- This analysis is intended to guide the formulation of an appropriate buffer system for the Inland Bays watershed
- This analysis is in no way a reliable estimate for the effect of the proposed buffer systems on the nutrient reductions at the scale of the entire watershed.

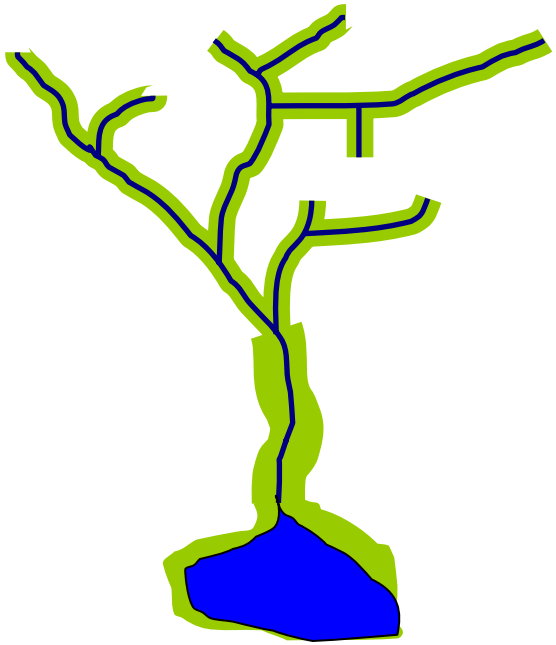
Why is a Buffer System Important to a Pollution Control Strategy?

- Buffers are hotspots of non-point nutrient and sediment reduction
- Buffers are the last bastion of protection before pollutants enter waterways
- Conversion of land without buffer installation may prove expensive or impossible if buffers are determined necessary in the future
  - Think of Rehoboth Wastewater Treatment Plant removal in 1970s

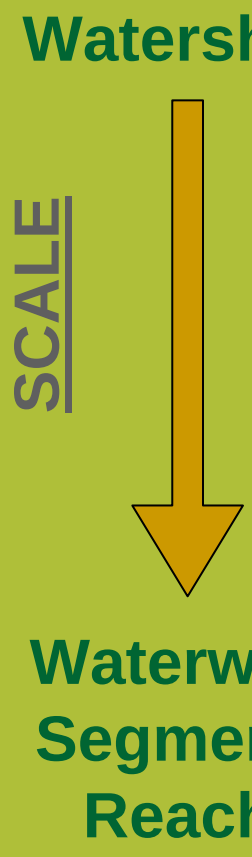
Two Ways to Look at Buffers

- **Riparian Buffer** – linear zone between aquatic resources and areas subject to human alteration.
- **Riparian Buffer System** – the watershed-level extent of buffer coverage and its characteristics including waterway type buffered, buffer width, and vegetation composition





Important Components of a Buffer System



- Buffer Extent *(length of waterway buffered)*
  - By subwatershed
    - Per TMDL requirements
    - Per hydrogeomorphic regions
  - By waterway type
    - Wetlands
    - Tidal, perennial, intermittent waterways
- Buffer Width
- Buffer Vegetation Requirements
  - Structure, Composition
  - Variances, Viewscapes

Buffer System Regulation Comparison:

	PCS 5/05	PCS 8/06	Sussex Co.
Tidal Waters/Wetlands	100’	50’	50’
Isolated Wetlands	100’*	No Buffer	No Buffer
Federal Reg. Wetlands	100’	No Buffer	No Buffer
Perennial Streams	100’	50’	50’
Perennial Ditches	100’	50’	No Buffer
Intermittent Waterways	100’	No Buffer	No Buffer

* PCS 05/05 offers *de facto* protections of isolated wetlands

PCS Language Comparison: Buffer

PCS 05/05

"A vegetated riparian buffer zone of 100 feet from all perennial and intermittent streams and along all tidal and non-tidal wetlands consisting of three tiers is hereby established landward from the upland boundary of all wetlands, from the mean high water line of all tidal waters, and from the stream bank of the active channel of non-tidal, intermittent, and perennial rivers and streams."

PCS 08/06

"A vegetated buffer of 50 feet is hereby established landward from the limit of tidal wetlands, as shown on the State wetlands map, or the mean high water line of all tidal waters, whichever extends farther upland, and from the ordinary high water mark of perennial streams, perennial ditches, and ponds in line with these perennial waterbodies."

PCS Language Comparison: Streams

PCS 05/05

"*Perennial Nontidal Rivers and Streams*: Any body of water which continuously flows during a year and which is not subject to tidal influence. Perennial rivers and streams are those which are depicted on a USGS map with a solid blue line."

Intermittent streams: no def.

PCS 08/06

"*Perennial Stream, Pond or Ditch" means a stream, portion of a stream, ditch or a pond in line with a perennial stream that flows continuously during periods of average rainfall as a result of groundwater discharge or surface runoff.*

"'Intermittent Stream' means a well-defined channel that contains water for only part of the year and is fed by groundwater."

PCS Language Comparison: Wetlands

PCS 05/05

"*Wetlands:* Those tidal and non-tidal wetlands within the State as shown on the Delaware SWMP maps…"

PCS 08/06

"*Wetlands*" means, for the purposes of these regulations, wetlands are those regulated by the State of Delaware and the Army Corp of Engineers as mapped or otherwise field verified.

PCS Comparison: Vegetation

PCS 05/05

100-buffer, three tiered
Tier 1: 0 – 50' native forest
Tier 2: 50 – 75' native forest
Tier 3: 75 – 100' at minimum vegetated

- Variable width – 80% w/ min. of 50'; total ac. = to 100' along buffered feature
- Stormwater Management Facilities allowed from 50' out
- View Corridors allowed

PCS 08/06

50 foot buffer "vegetated" at minimum. Only applies to major subdivisions (5 or more lots).

- 5% buffer allowed impervious paths
- Stormwater Management Facilities allowed from 25' out

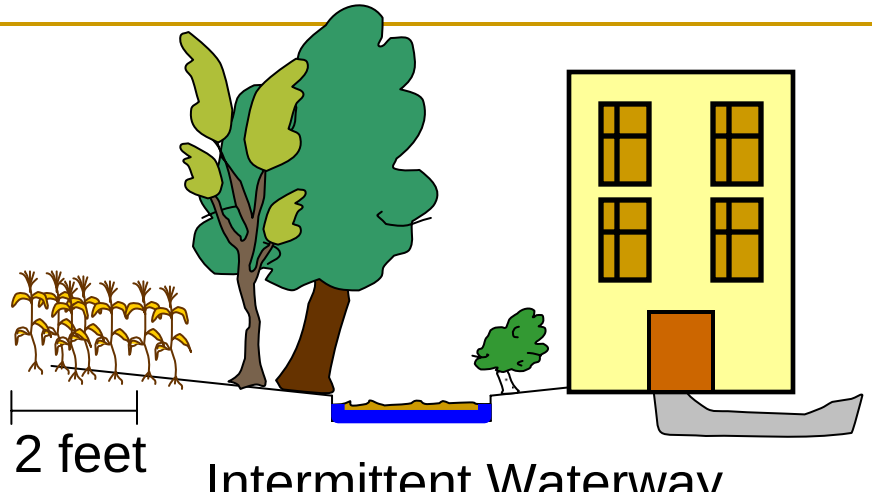
Sussex Co. Code

50 foot buffer "natural vegetation" (compare with planted vegetation) Applies to all subdivisions

- Stormwater Management Facilities allowed

Waterways

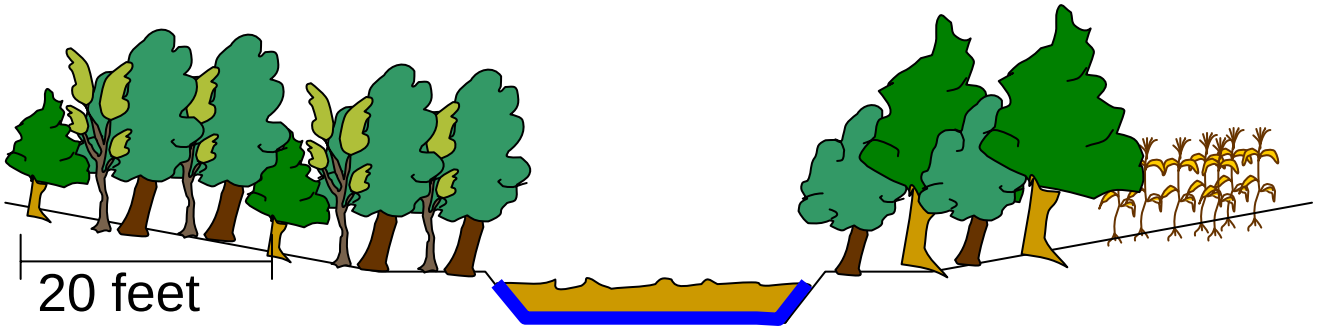
	Intermittent	Perennial
Nature	Ditches, Streams	Ditches, Streams
Size	Small	Larger
Dominant Water Source	Groundwater	Groundwater & Surfacewater
Flow Regime	Flows part of year (some only after rains)	Flows all year
Proportion of total waterway length	~75%	~25%
Importance to Water Quality Protection	Most Important	Important
Protection under proposed PCS	None	50’ buffer from channel



Intermittent Waterway

(high channel surface-to-stream water volume ratio)

Area of maximum nutrient processing



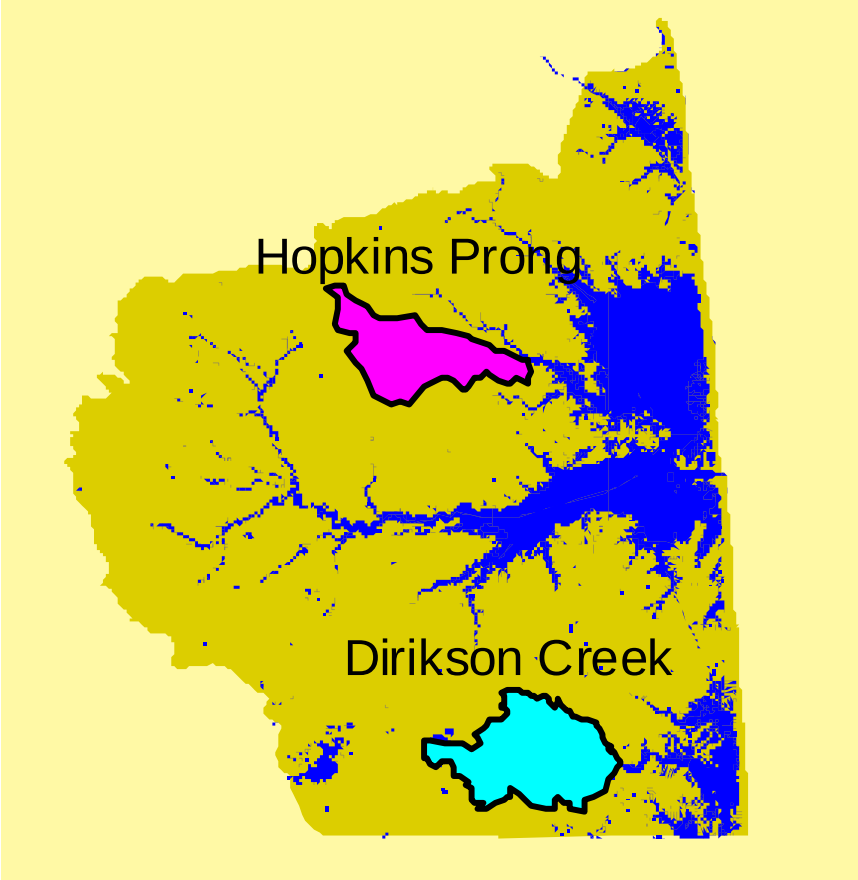
Perennial Waterway

(low channel surface-to-stream water volume ratio)

Headwaters are smaller, more numerous, more closely connected to the surrounding landscape, and provide proportionately greater areas of nutrient processing than larger streams.

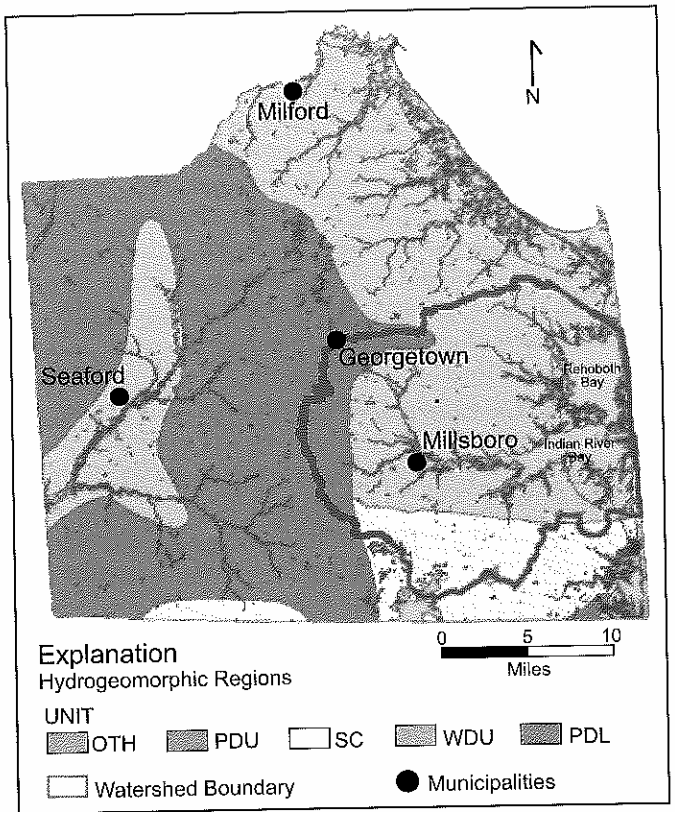
Comparison of the PCS Versions

- What is the difference in effect on nutrient loads between the two proposed systems?
- Analyze 2 similar sized subwatersheds in 2 different regions
- Arbitrarily selected



Comparison of the PCS Versions

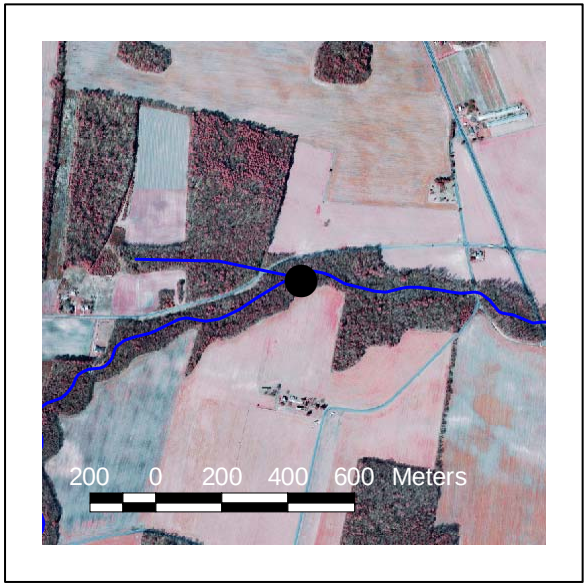
- What is the difference in effect on nutrient loads between the two proposed systems?
- Analyze 2 arbitrarily-selected, similar-sized subwatersheds in 2 different regions



HGM Regions: Andres & Martin '05

Hydrography Analysis

- Isolated wetlands = those not within 5-m of waterway or non-isolated wtlnds.
- Added missing waterways to hydrography, removed ponds
- Where two natural stream channels (determined via topo contours) connected was divide between intermittent and perennial waterways
- Moved this upstream in some cases in Dirickson due to increased drainage density and field experience



Intermittent/Perennial Divide

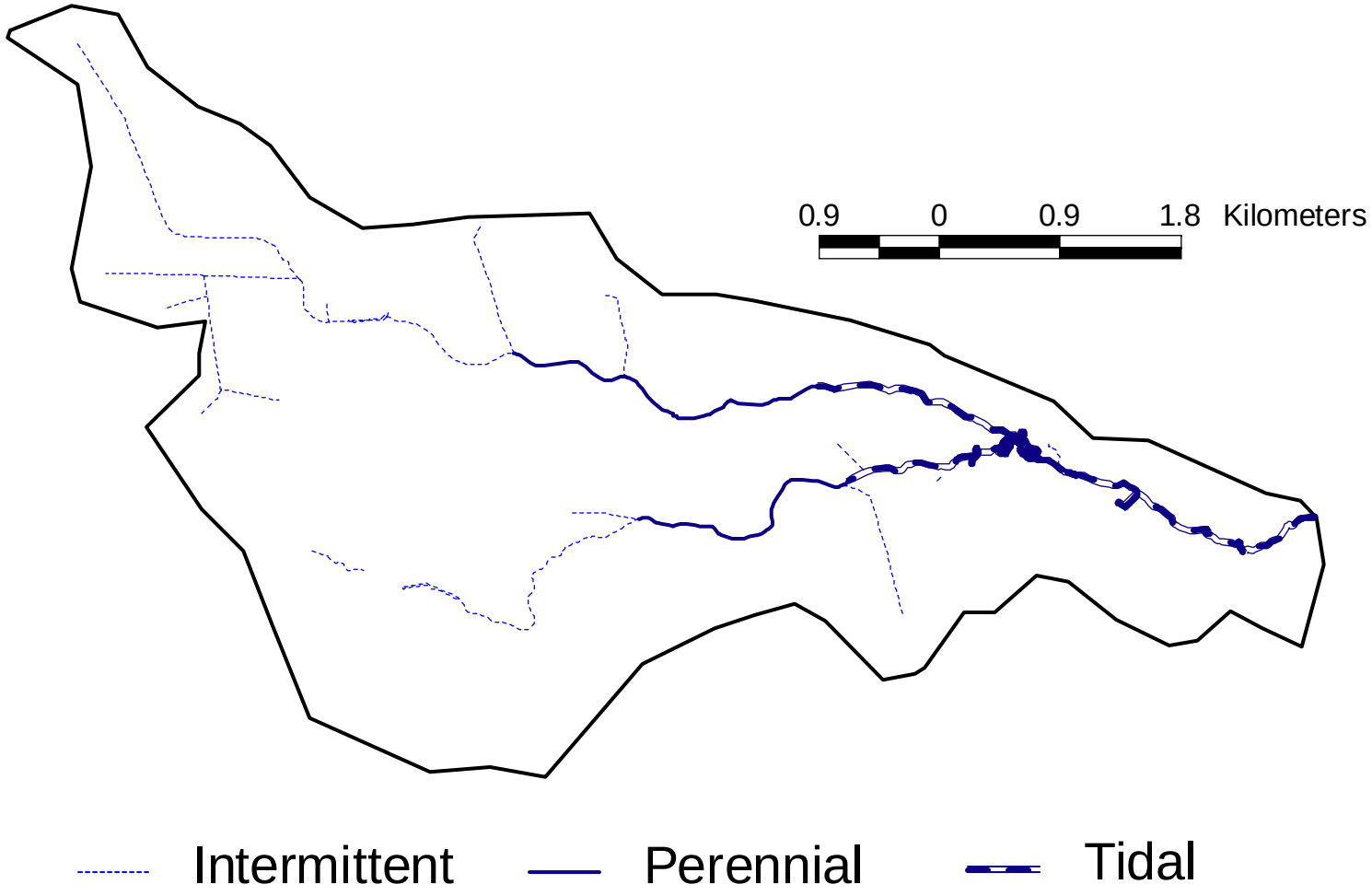
Subwatershed Comparison

	Hopkins Prong		Dirickson Creek	
Watershed Area (ac)	5,908		7,858	
Intermittent Waterway Length	15,802	(58%)	181,619	(93%)
Perennial Waterway Length	4,472	(16%)	9,773	(5%)
Tidal Stream Length	7,113	(26%)	3,959	(2%)
Total Waterway Length	27,388	(100%)	195,352	(100%)

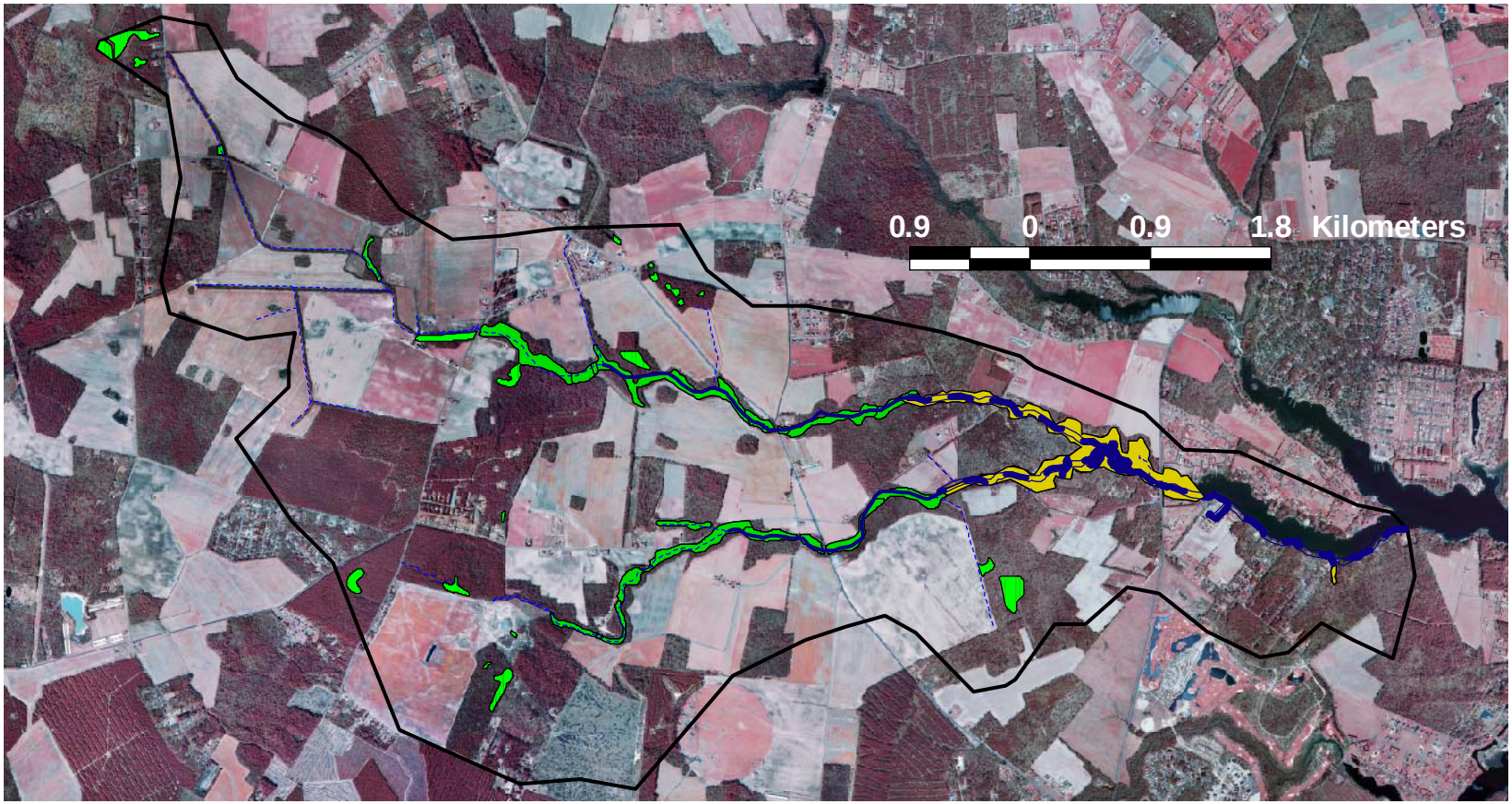
Length is in feet

Dirickson hydrography with all waterways.

Hopkins Prong Hydrography



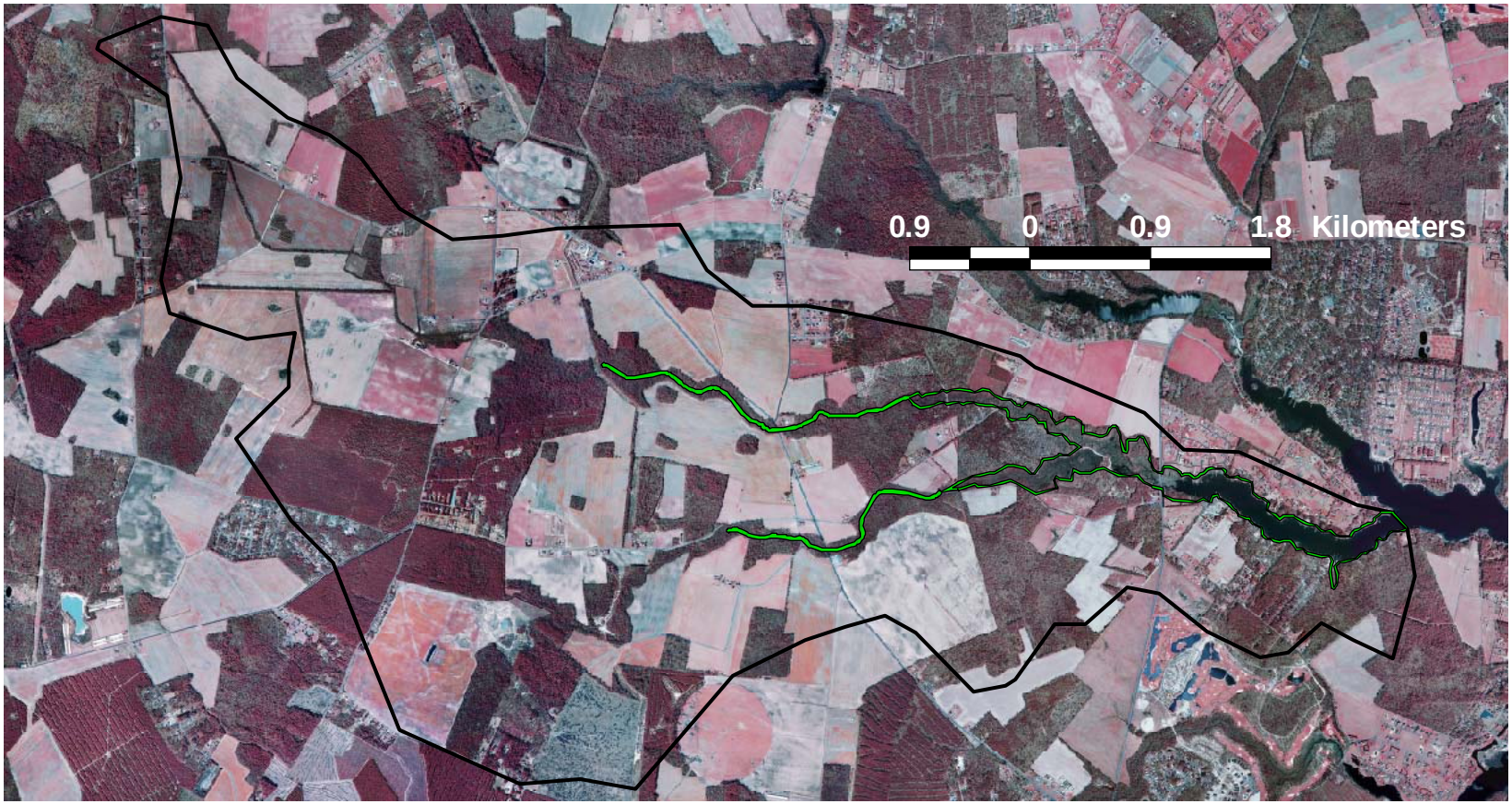
Hopkins Prong Hydrography



Hopkins Prong Buffer Area: PCSv1

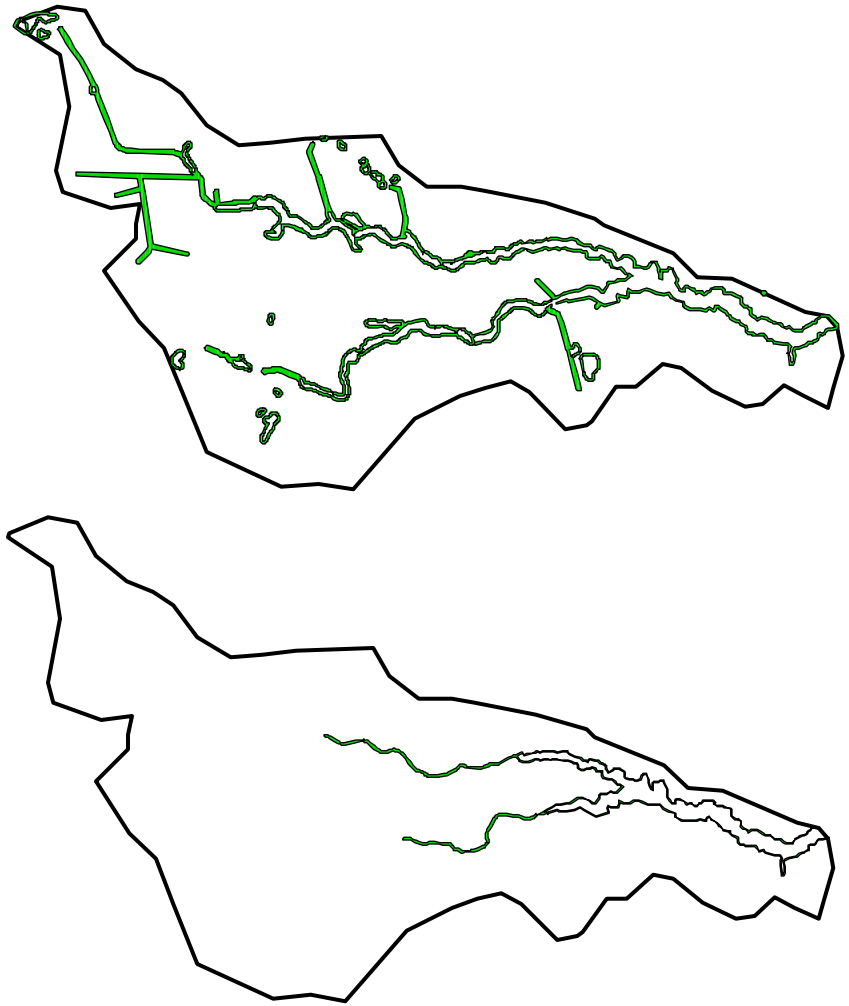
Area in Buffer = 459 ac, 8% of subwatershed

Hopkins Prong Buffer Area: PCSv2



Area in Buffer = 80 ac, 1% of subwatershed

Hopkins Prong Buffer Area Comparison



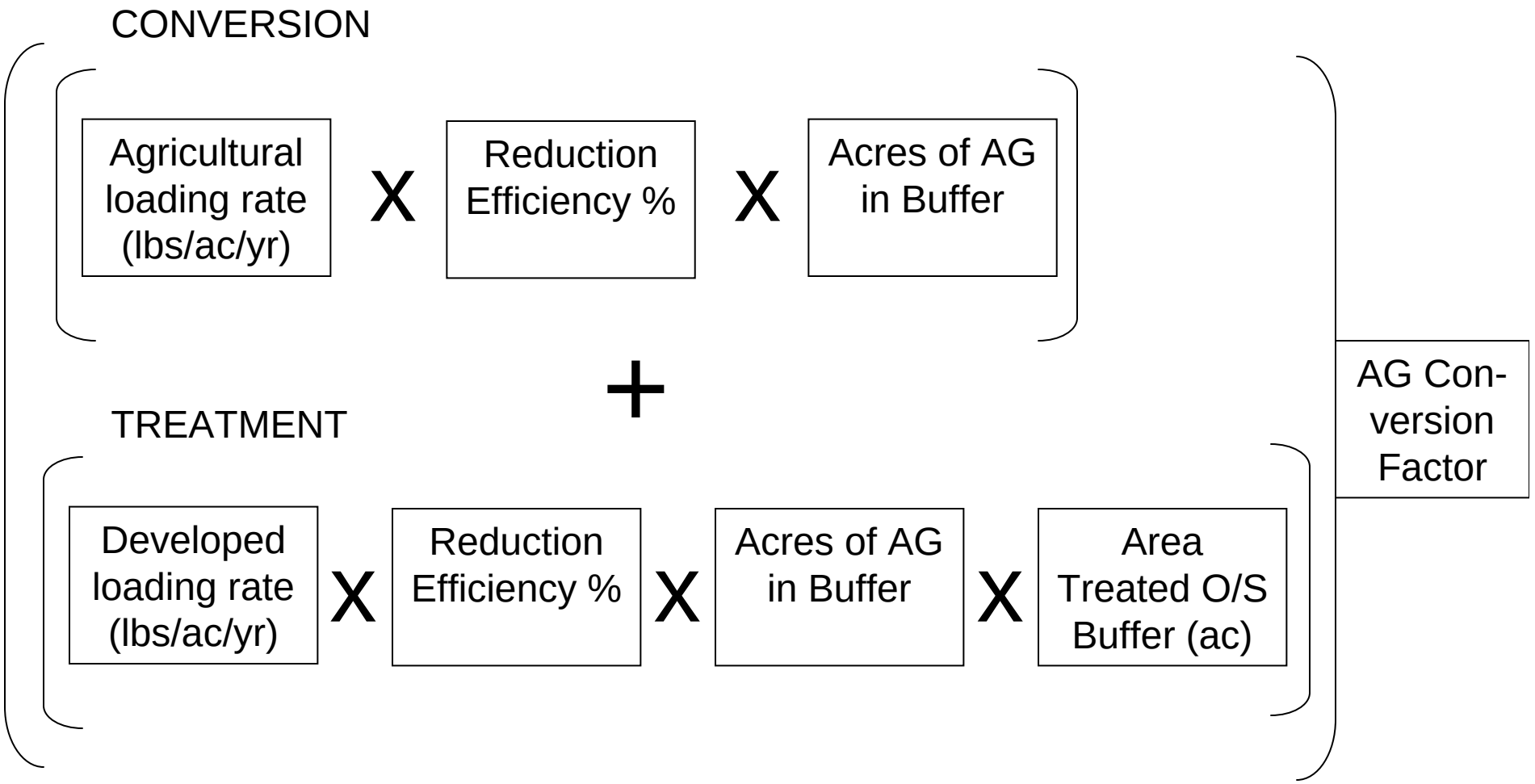
Partial Effect of Buffers on Nutrient Loads by PCS Version: Hopkins Prong Watershed

	NITROGEN			PHOSPHORUS		
	PCS 5/05	PCS 8/06	%DIF	PCS 5/05	PCS 8/06	%DIF
Acres AG in Buffer	152.3	2.34	98.5	152.3	2.3	98.5
Ag Conversion Factor	0.50	0.50		0.50	0.50	
Load Reduction (lbs/year)	769	7.90	99.0	47.5	0.6	98.8
Load Reduction (lbs/day)	2.11	0.02	99.0	0.13	0.0016	98.8

Detailed Loading Reduction (Hopkins for N)

	PCS1	PCS2	% Dfrnc.
Acres Agriculture in Buffer	152.3	2.336	98.5
Agriculture Conversion Factor	0.5	0.5	
Ag. Loading Rate (lbs/acre/yr)	12.55	12.55	0.0
Buffer reduction efficiency	0.58	0.39	32.8
Developed Loading Rate (lbs/acre/yr)	4.87	4.87	0.0
Area affected by buffer (ac)	1	1	0.0
Load Reduction (lbs/year)	769.4	7.9	99.0
Load Reduction (lbs/day)	2.11	0.02	99.0

Buffer Nutrient Load Reduction Equation



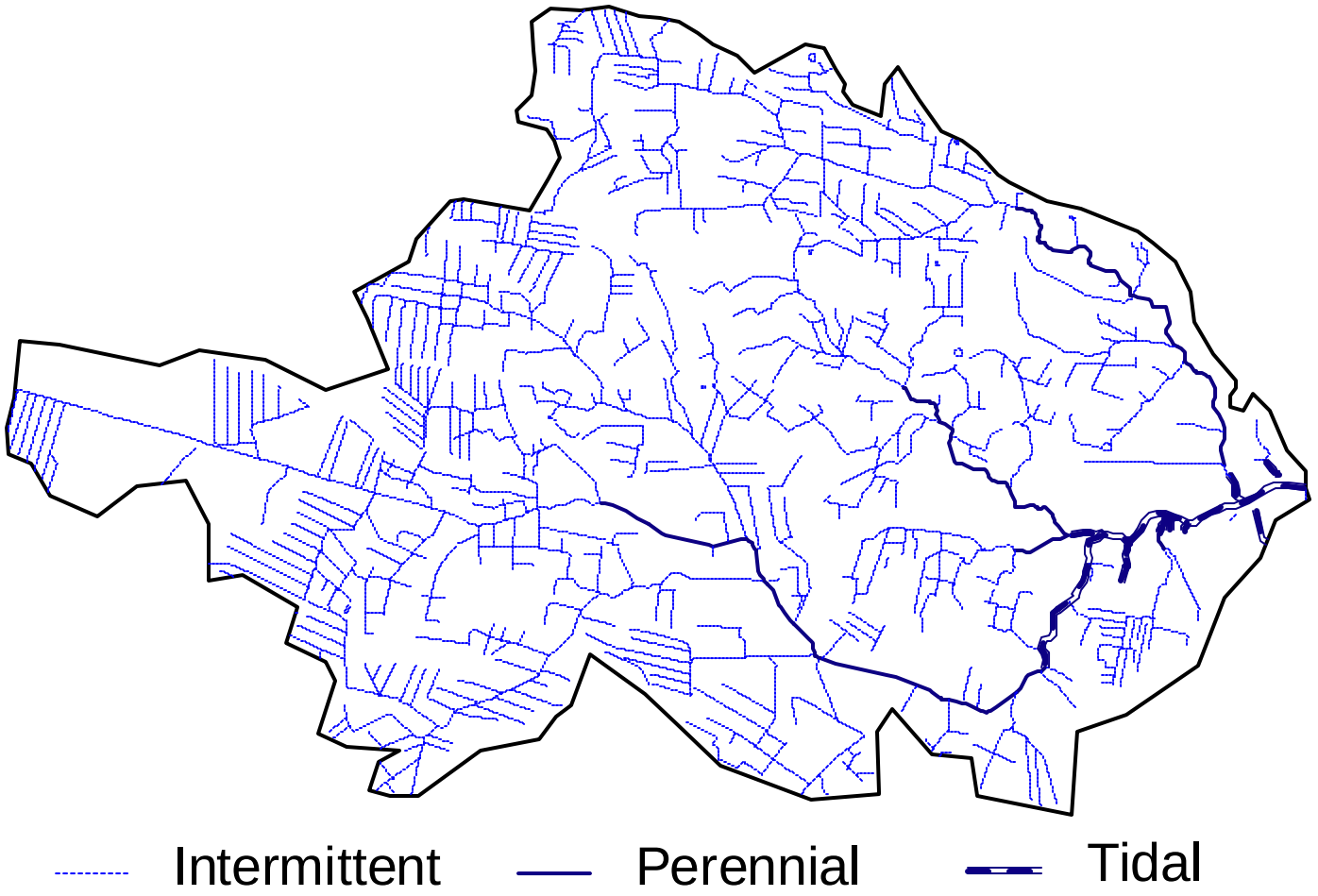
Equation Terms

- Agriculture Loading Rate
  - Assumed rate resulting from 50% attainment of PCS AG NPS reduction goals.
    - N = 21 lb/ac/yr – (16.9 lb/ac/yr *0.50) = 12.55 lb/ac/yr
    - P = 0.8 lb/ac/yr – (0.25 lb/ac/yr * 0.50) = 0.675 lb/ac/yr
    - Liberal reductions because buffers are included in PCS goals
- Developed Loading Rate
  - Assumed all development meets PCS stormwater reqs.
    - N – assumed 15.13 lb/ac/yr reduction due to DNREC wet & dry ponds and other stormwater bmps from 20.0 lb/ac/yr (4.87) (Ward 2001).
    - P -- assumed 52% reduction of 0.7 lbs/ac/yr (0.364) (Ward 2001) from PCS requirements for stormwater weighted by high and low reduction areas (65% and 40% respectively).
    - Conservative reductions because reductions from septic upgrades not incorporated.

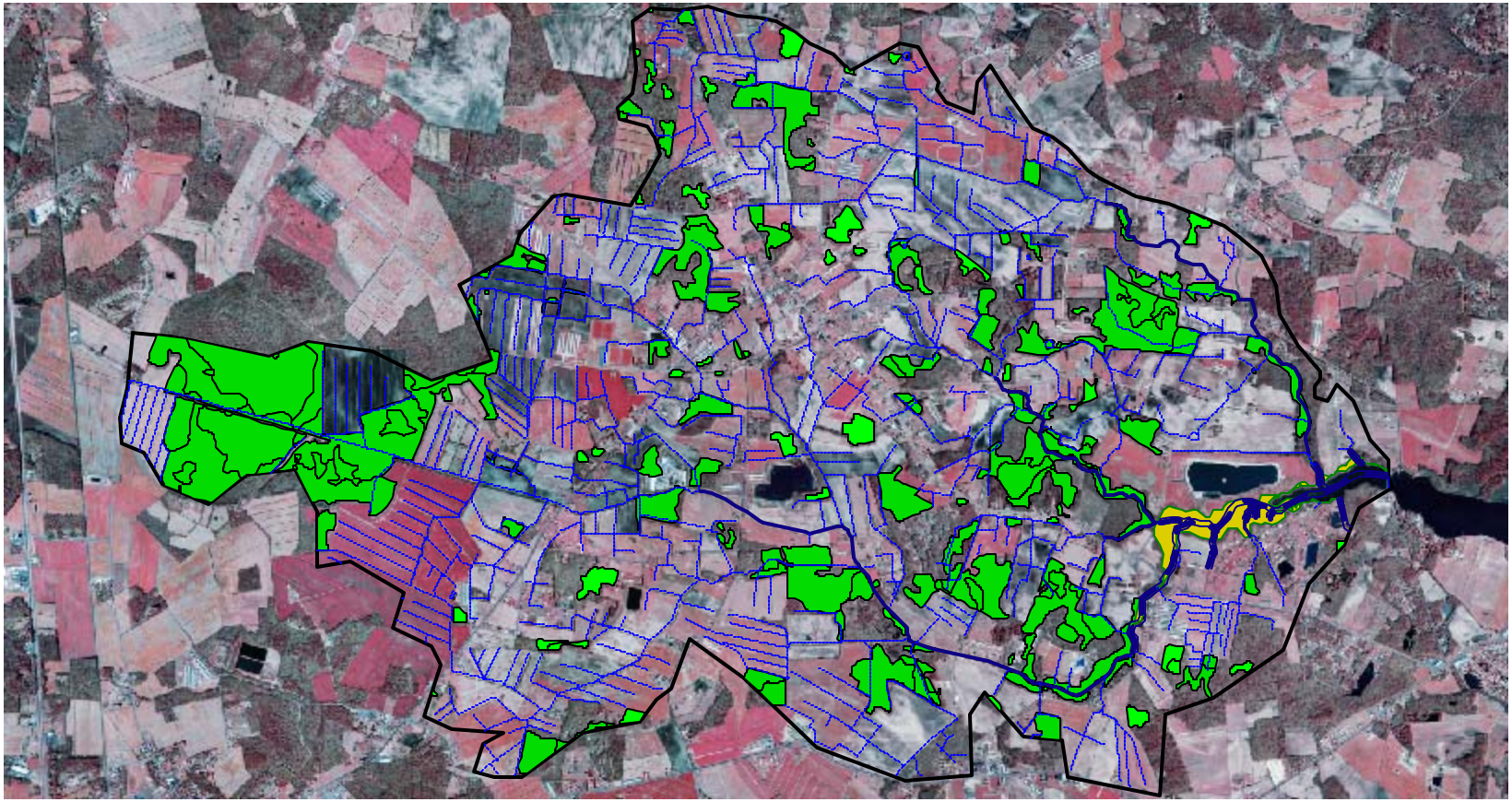
Equation Terms

- Buffer Reduction Efficiency
  - 05/05 = Average of DNREC PCS efficiencies weighted by % of veg. type (75% forested & 25% grassed 100’ buffer)
  - 08/06 = Grassed Buffer DNREC PCS efficiency minus 7% efficiency due to width reduction to 50’ (see Mayer et al. ’06 and Desbonnet et al. ’94)

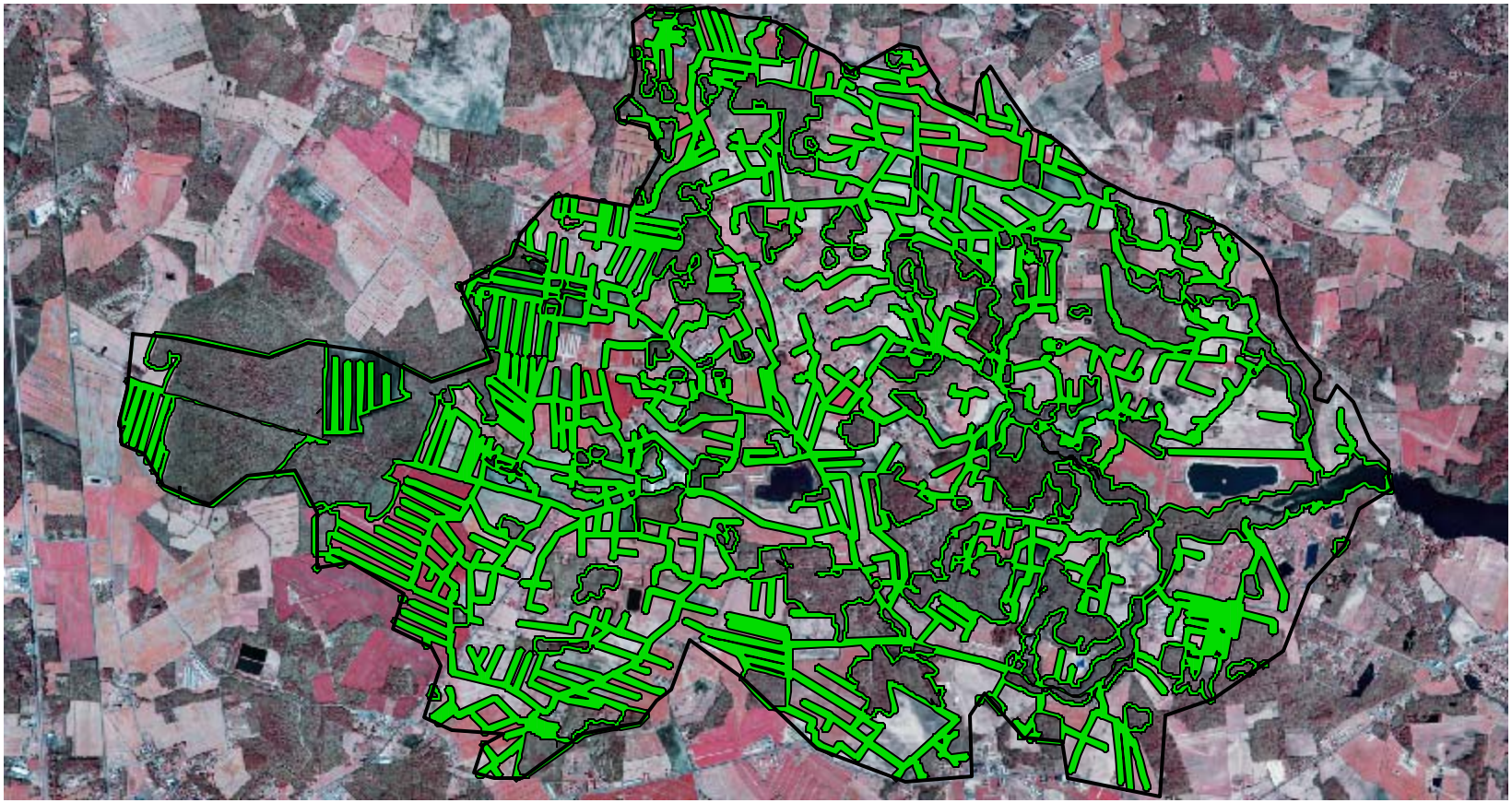
Dirickson Creek Hydrography



Dirickson Creek Hydrography



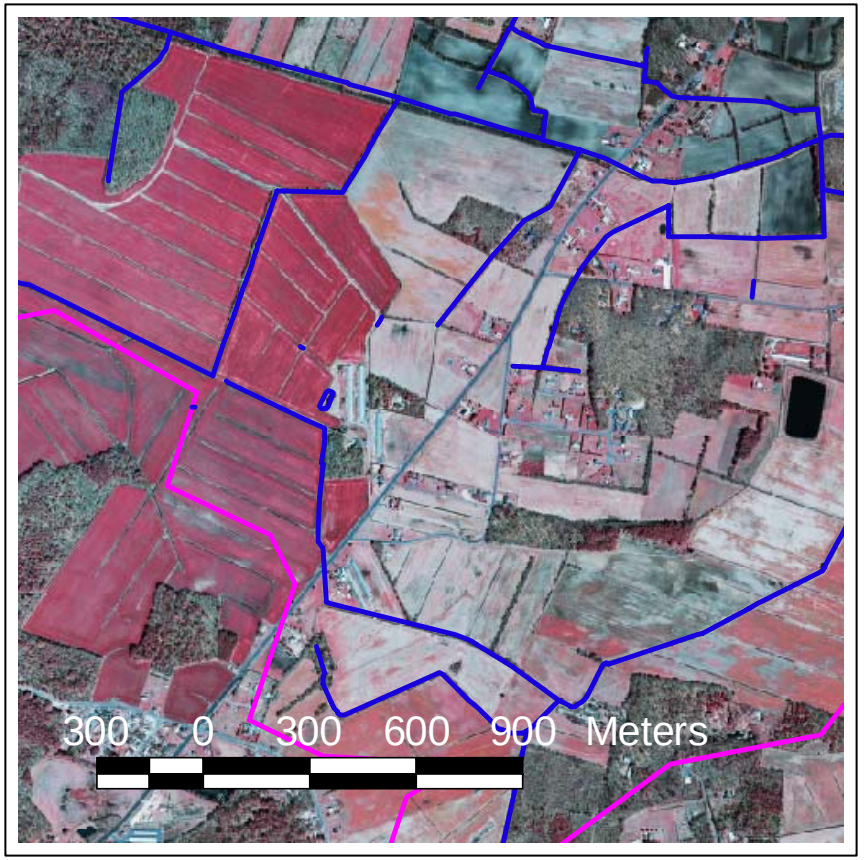
Dirickson Creek Buffer Area: PCSv1



Area in Buffer = 3,065 ac, 39% of watershed

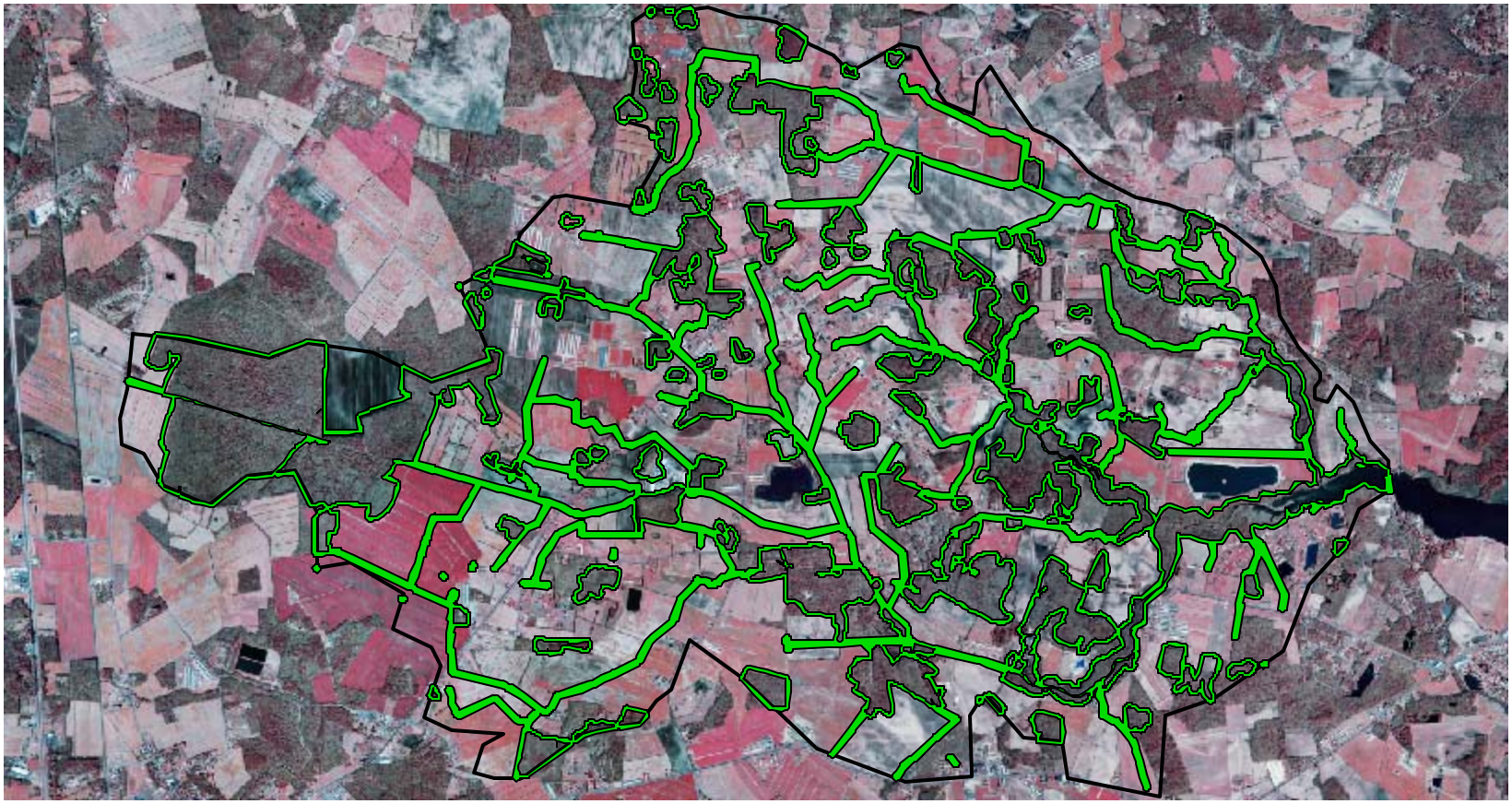
Alteration of Dirickson Drainage Network

- Non-Primary drainage ditches removed from buffering
  - Lateral field ditches (~ 300 ft spacing)
  - Minor ditches
- Necessarily subjective
- Objectifiable with rules/guidelines



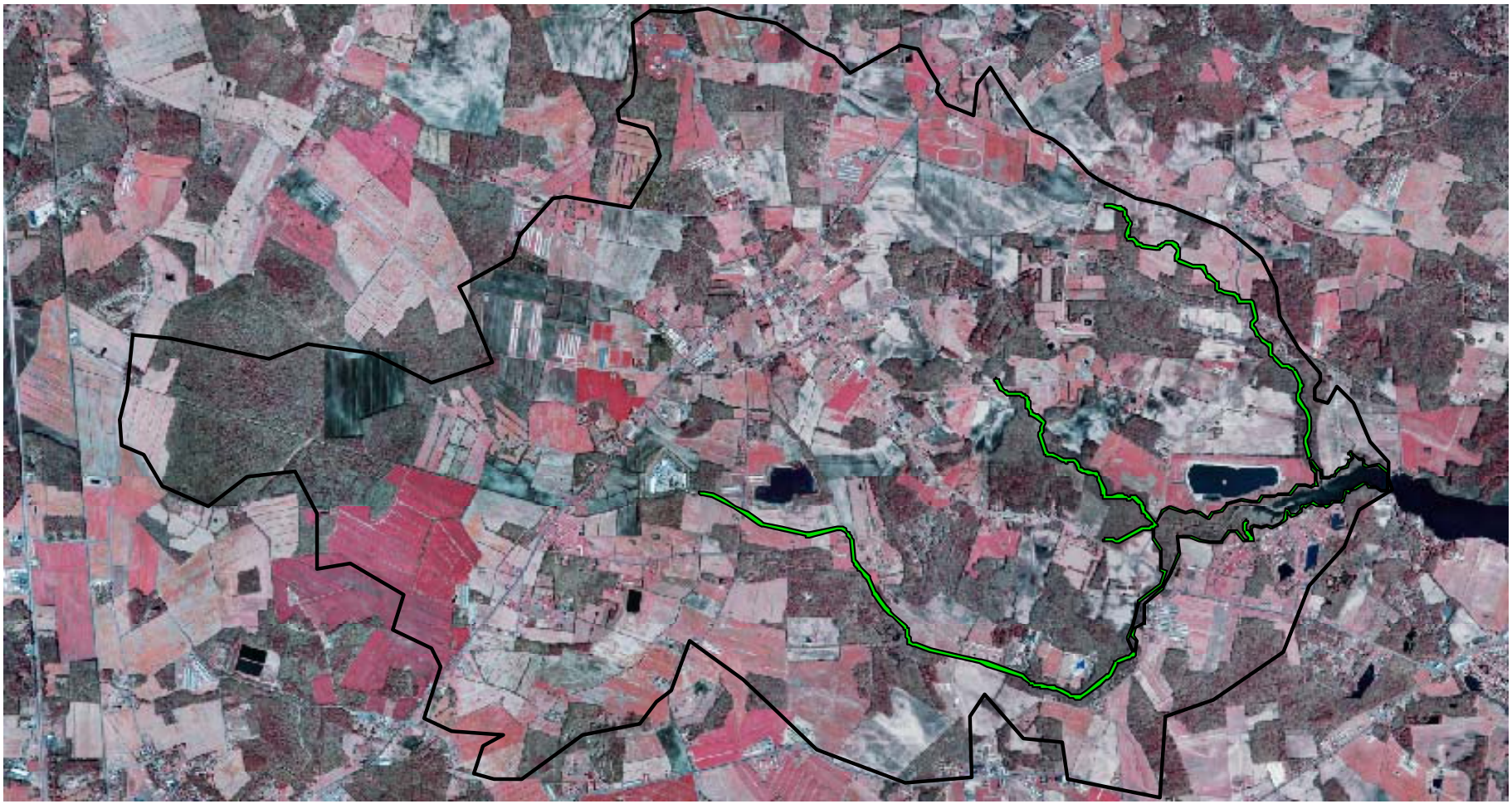
Dirickson Creek Buffer Area: PCSv1

Minor Ditches Removed



Area in Buffer = 1,639 ac, 21% of subwatershed

Dirickson Creek Buffer Area: PCSv2



Area in Buffer = 97 ac, 1% of subwatershed

Partial Effect of Buffers on Nutrient Loads by PCS Version: Dirickson Watershed

	NITROGEN			PHOSPHORUS		
	PCS1 5/05	PCS2 8/06	%DIF	PCS1 5/05	PCS2 8/06	%DIF
Acres of Ag in Buffer	996	33	96.6	996	33	96.6
Ag Retention Factor	0.50	0.50		0.50	0.50	
Load Reduction (lbs/year)	5,030	114.5	97.7	310.4	8.2	97.3
Load Reduction (lbs/day)	13.78	0.31	97.7	0.85	0.02	97.3

Scaling Up to the Entire Watershed

- Northern HGM region
  - Includes Well Drained Uplands and Poorly Drained Uplands Regions
  - 119,803 acres or 68.7% land area
  - Hopkins Represents ~1/20th acreage of this region
- Southern HGM region
  - Includes Surficial Confined and Poorly Drained Lowlands Regions
  - 54,693 acres or 31.3% land area
  - Dirickson represents ~1/7th of this region

Conclusions

- This model can best estimate relative differences in nutrient load reductions between buffer strategies
- This analysis does not consider known substantial differences in nutrient processing capacity between intermittent and perennial streams
- This analysis does not consider the increase in nutrient retention capacity and subsequent reductions as buffered waterways mature and equilibrate
- This analysis does not consider nutrient reductions due to differences in wetland protection provisions between strategies
- Large and un-quantified sources of error from PCS implementation and “scaling up” are a part of the whole watershed reductions

Conclusions

- Revisions to the PCS buffer system appear have rendered it relatively ineffective for nutrient load reduction.
- Revisions to the PCS buffer system may have reduced its efficiency for nutrient reduction relative to the current Sussex County Code.
- Regulations that are formulated to address only one function of riparian buffer ecosystems are inappropriate as they ignore equally important functions such as biodiversity protection, protection of wetland condition, wildlife population maintenance, and flood control.