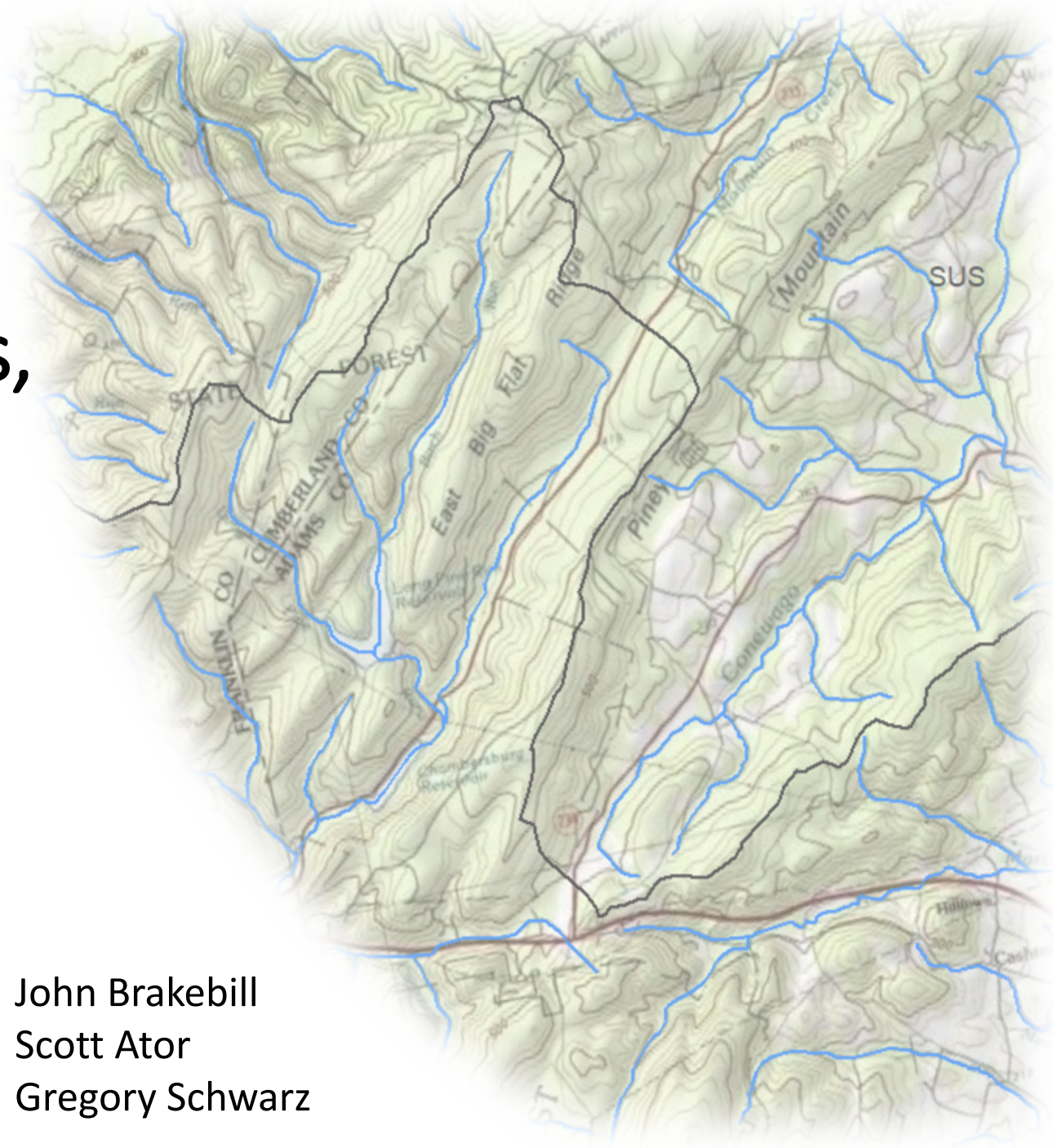
Enhancements to NHDPlus, v2 for use in Regional SPARROW Modeling

CBP Modeling Workgroup, May 21, 2020



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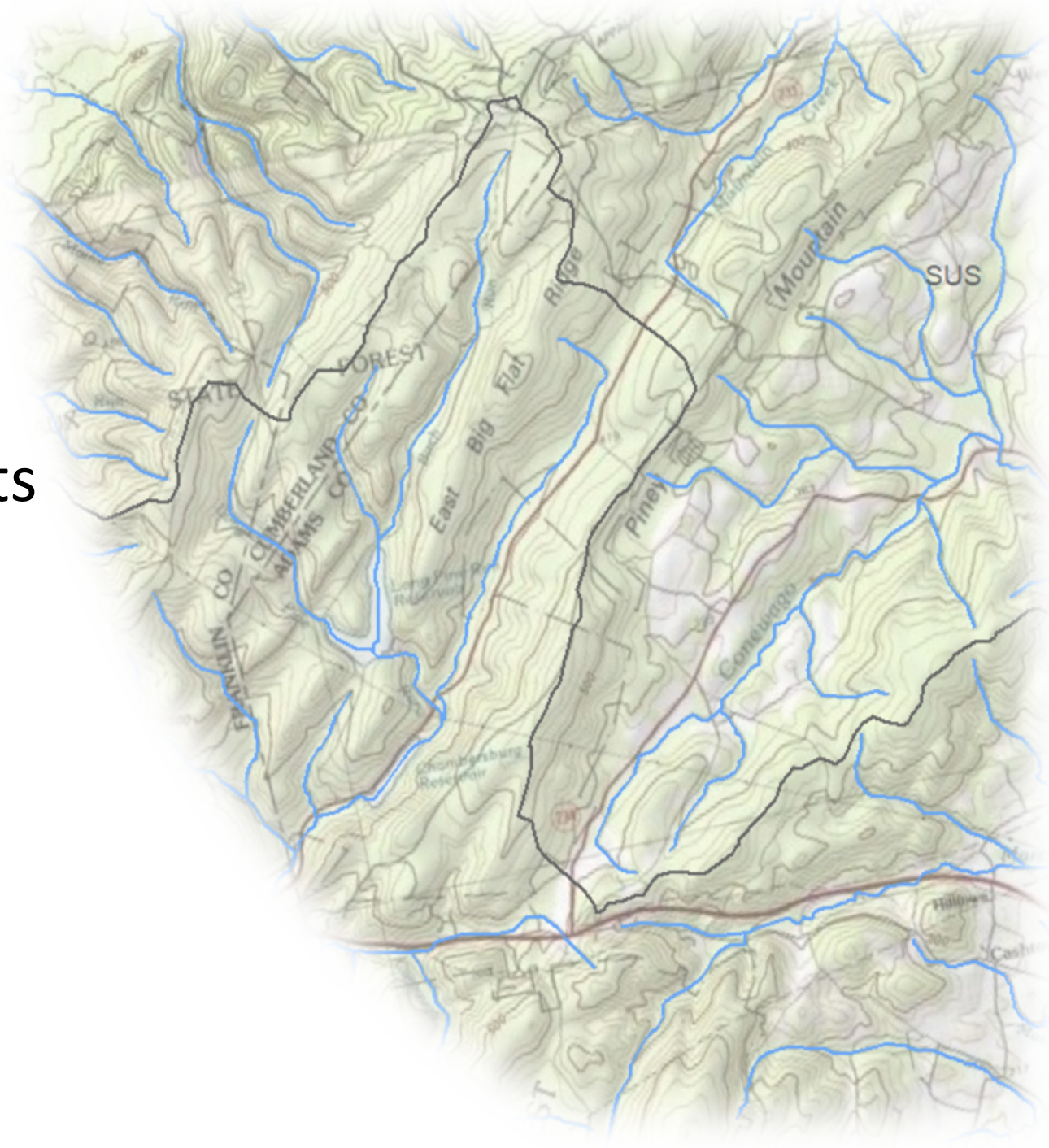
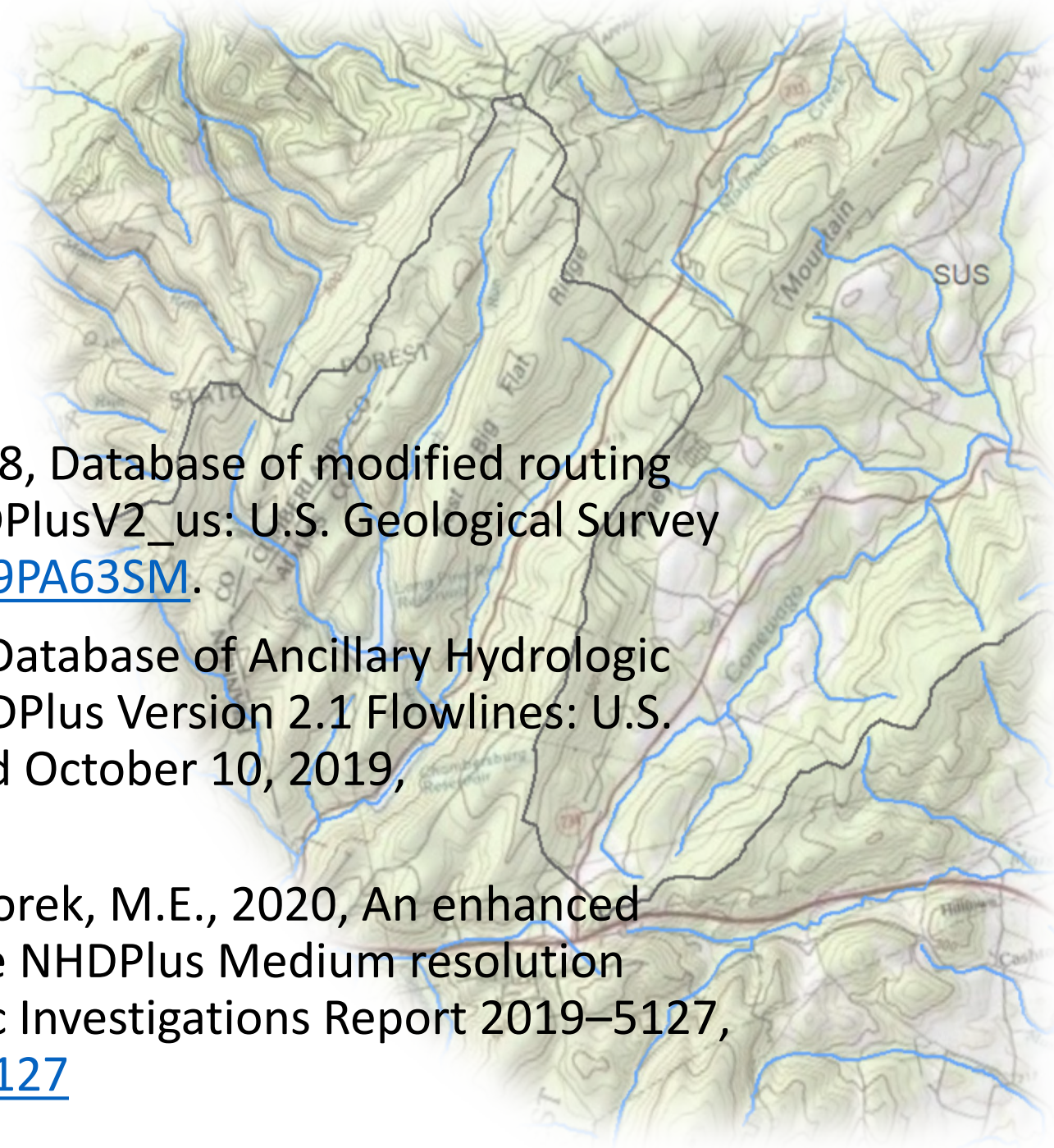
Purpose

- Describe routing enhancements
- Describe attribute enhancements
- Emphasize development for national modeling applications
- USGS plans for reporting water use



NHDPlusV2 related enhancements



- Schwarz, G.E., and Wieczorek, M.E., 2018, Database of modified routing for NHDPlus version 2.1 flowlines: ENHDPlusV2_us: U.S. Geological Survey data release, https://doi.org/10.5066/P9PA63SM.
- Schwarz, G.E., 2019, E2NHDPlusV2_us: Database of Ancillary Hydrologic Attributes and Modified Routing for NHDPlus Version 2.1 Flowlines: U.S. Geological Survey data release, accessed October 10, 2019, https://doi.org/10.5066/P986KZEM
- Brakebill, J.W., Schwarz, G.E., and Wieczorek, M.E., 2020, An enhanced hydrologic stream network based on the NHDPlus Medium resolution dataset: U.S. Geological Survey Scientific Investigations Report 2019–5127, 48 p., https://doi.org/10.3133/sir20195127

NHD Attributes

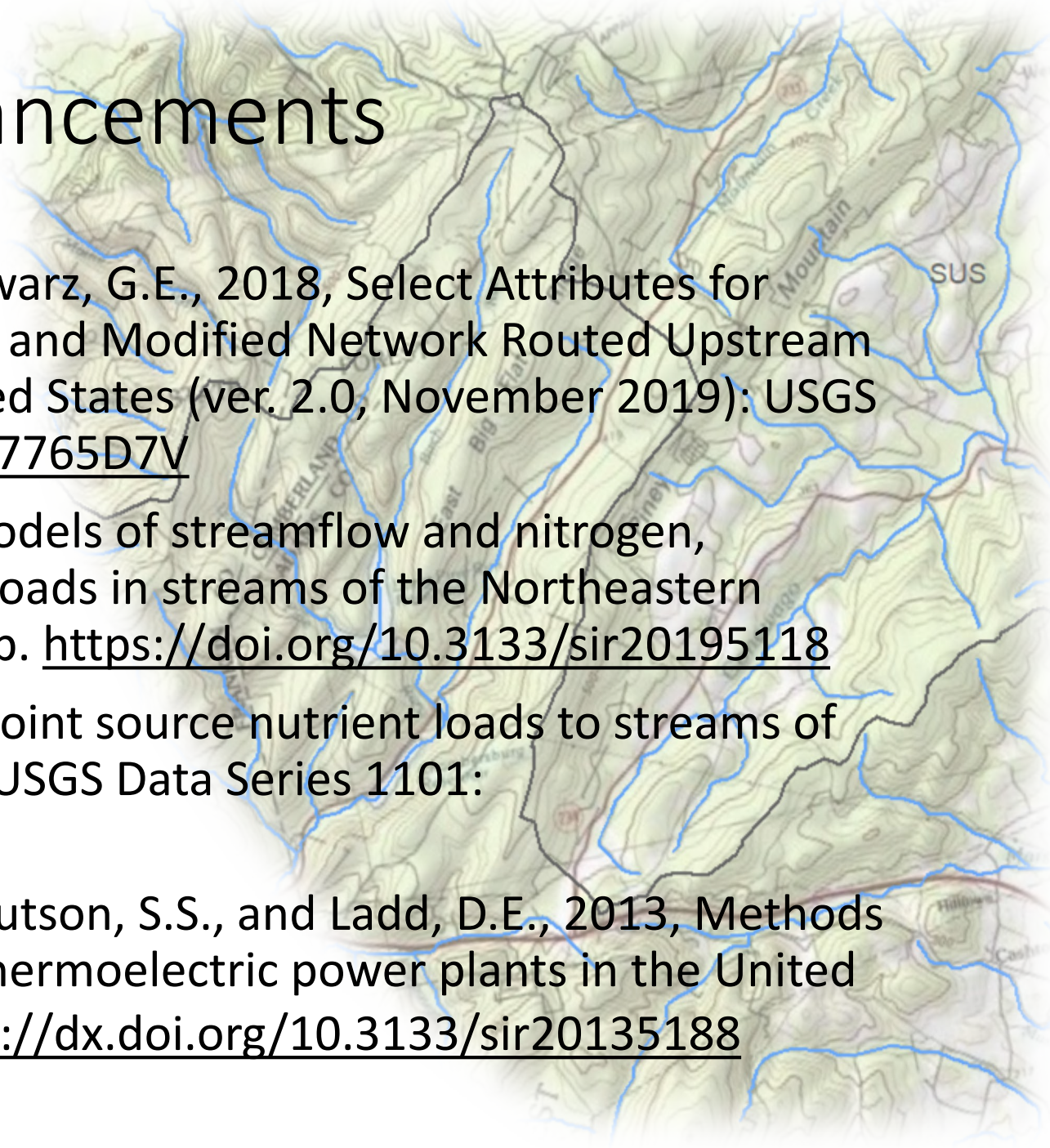
Chesapeake Bay (n=85,620)	
Reach Type	Count
Artificial Path	19,074
Canal	98
Connector	663
Coastline	1,406
Pipe	3
Stream	64,376

		Number of occurrences
Routed flowlines		2,691,344
With catchments		2,638,935
With headwater area		940,413
In waterbody		359,660
Type:		
	Artificial path	378,207
	Canal/ditch	25,930
	Connector	25,316
	Coastline	23,590
	Pipe	183
	Stream	2,238,112
	Unspecified	6
Non-routed flowlines		302,180
Type:		
	Artificial path	6,959
	Canal/ditch	177,815
	Connector	746
	Coastline	3,102
	Pipe	2,239
	Stream	111,317
	Unspecified	2
Catchments*		2,647,454
Sinks		8,520

		Number of occurrences
Waterbodies		465,249
Attached to routed flowlines		132,900
Type:		
	Canal	259
	Ice	46
	Lake	122,594
	Playa	170
	Reservoir	396
	Stream	6,510
	Swamp	2,481
	Unspecified	444
Unattached to routed flowlines		332,349
Type:		
	Canal	254
	Ice	1,156
	Lake	251,271
		1,512
		4,826
		429
		63,835
		9,066

Chesapeake Bay (n=6,592)	
Water Body Type	Count
Canal / Ditch	1
Lake / Pond	6,204
Reservoir	22
Stream / River	217
Swamp / Marsh	148

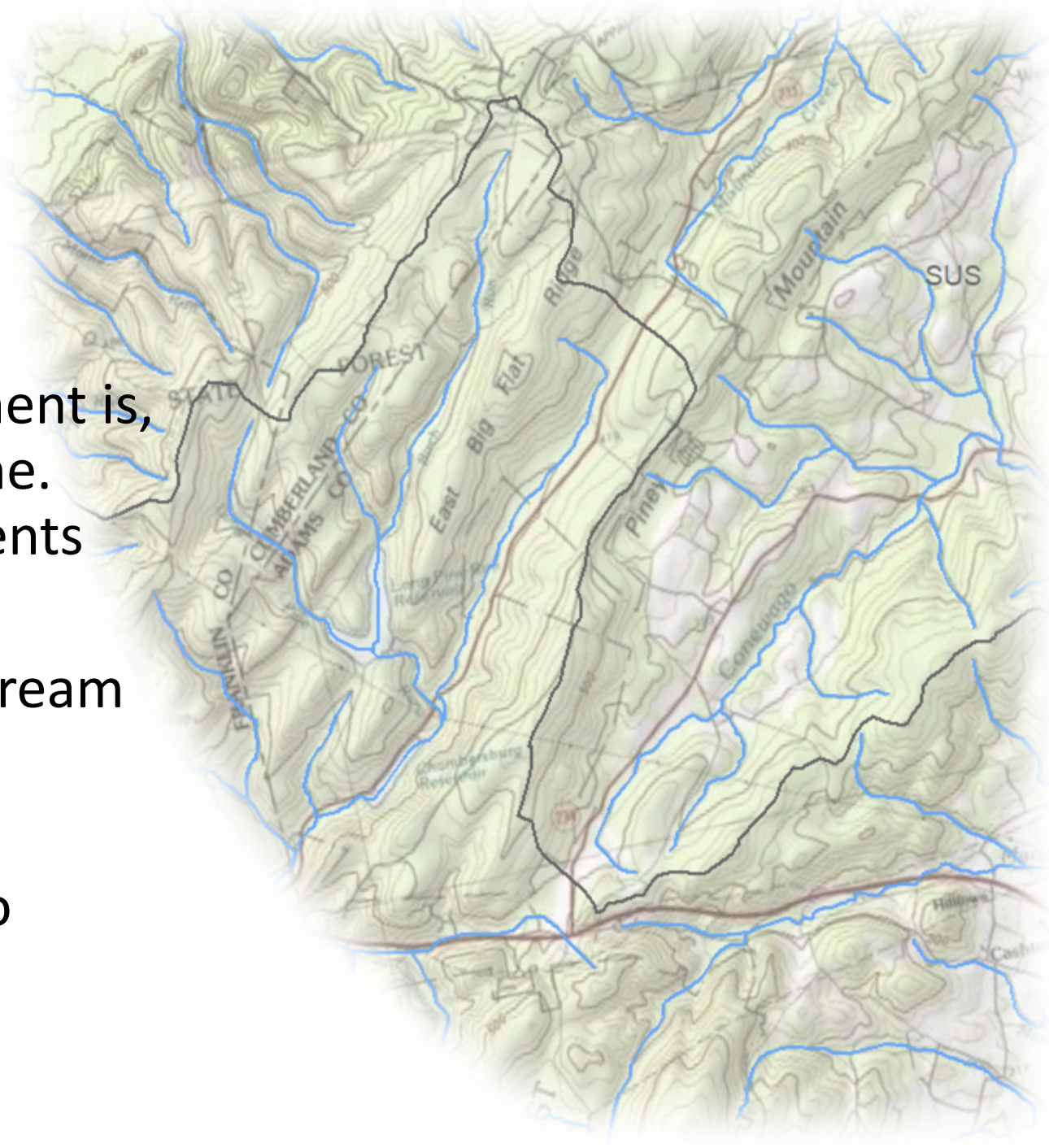
NHDPLusV2 related enhancements



- Wieczorek, M.E., Jackson, S.E., and Schwarz, G.E., 2018, Select Attributes for NHDPlus Version 2.1 Reach Catchments and Modified Network Routed Upstream Watersheds for the Conterminous United States (ver. 2.0, November 2019): USGS data release, https://doi.org/10.5066/F7765D7V
- Ator, S.W., 2019, Spatially referenced models of streamflow and nitrogen, phosphorus, and suspended-sediment loads in streams of the Northeastern United States: USGS SIR 2019-5118. 57 p. https://doi.org/10.3133/sir20195118
- Skinner, K.D. and Maupin, M.A., 2019, Point source nutrient loads to streams of the conterminous United States, 2012: USGS Data Series 1101: https://doi.org/10.3133/ds1101
- Diehl, T.H., Harris, M.A., Murphy, J.C., Hutson, S.S., and Ladd, D.E., 2013, Methods for estimating water consumption for thermoelectric power plants in the United States: USGS SIR 2013–5188, 78 p., http://dx.doi.org/10.3133/sir20135188

How routing works

- There are flowlines that do not have associated catchments. Every catchment is, however, is associated with at flowline. Consequently, there are less catchments than flowlines.
- Every flowline reach starts at an upstream node (“from node”) and ends at a downstream node (“to node”)
- A hydrologic sequencing number also defines flow direction



NHDPlus Network Properties

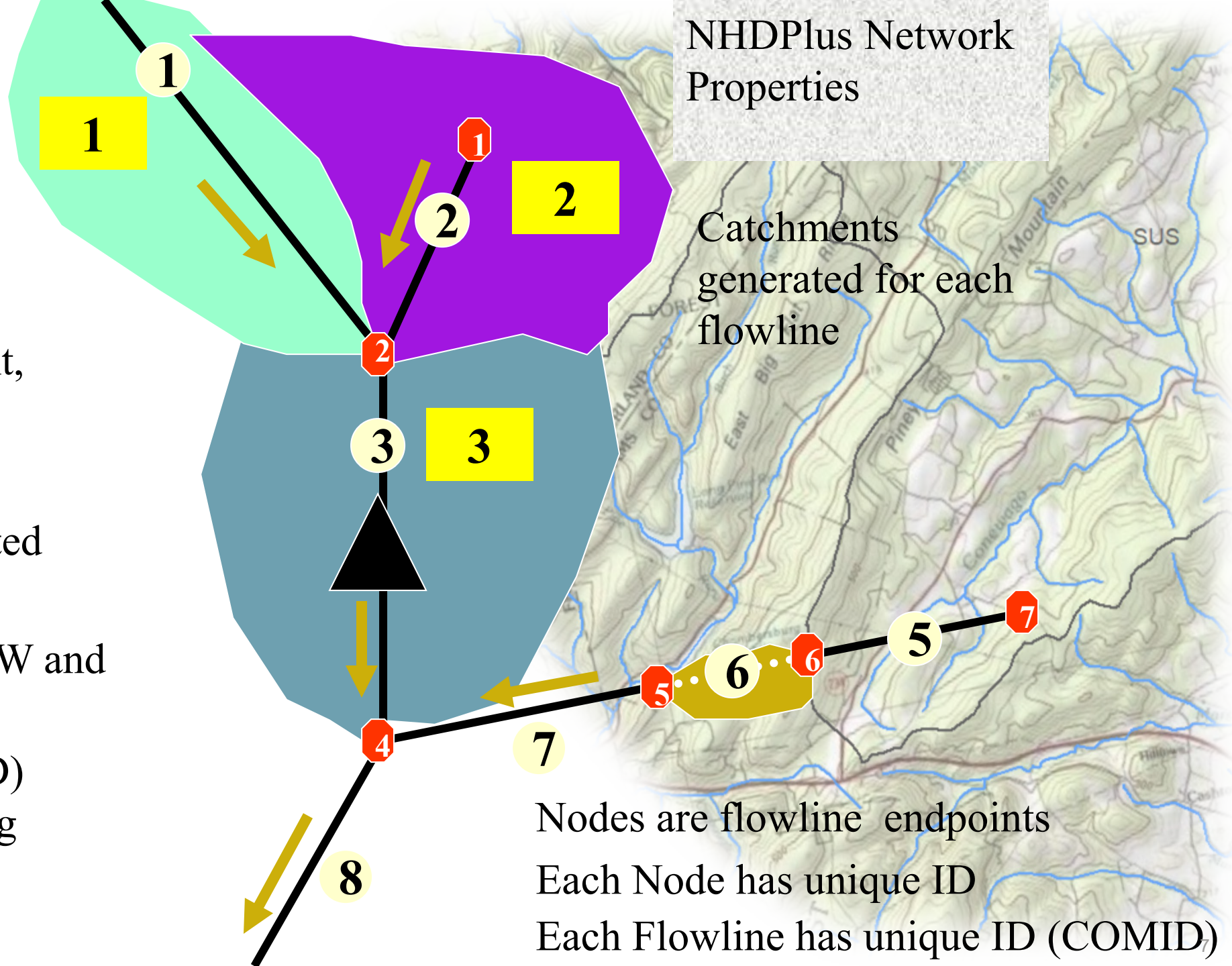
A single flowpath represents the basic building block (flowline).

Orientation consistent, same direction as streamflow.

Continuous (Connected and sequenced).

Referenced Gages/QW and Reservoirs

Unique IDs (COMID) allows for associating stream reaches to catchments



Catchments generated for each flowline

Nodes are flowline endpoints

Each Node has unique ID

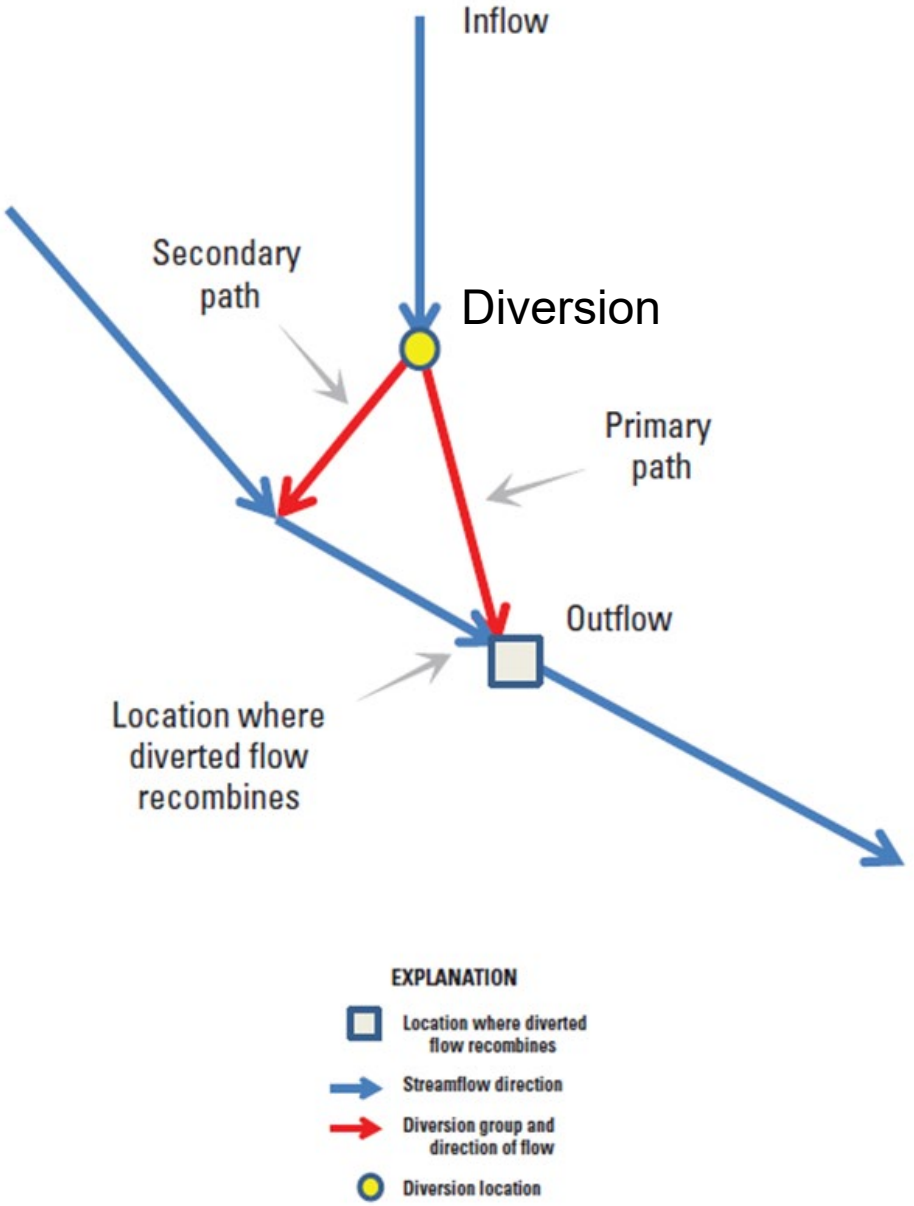
Each Flowline has unique ID (COMID)

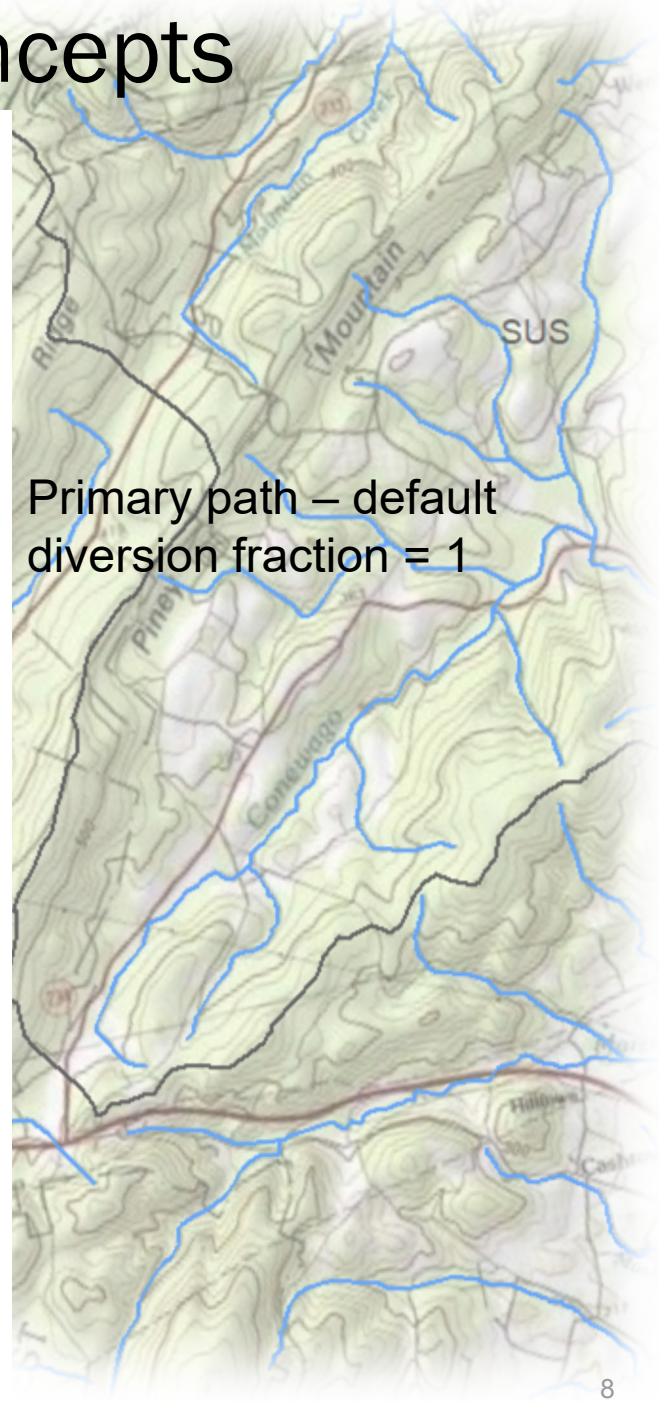
NHDPlusV2 Diversions – Basic Concepts

Secondary path – default diversion fraction = 0

All NHDPlusV2 diversions are assigned a primary path and a secondary path

For almost all diversions, NHDPlusV2 accumulations assign a diversion fraction of 1 to the primary pathway and a diversion fraction of 0 to all secondary pathways





Primary path – default diversion fraction = 1

Greg Schwarz

Diversion classes, nice to have summary table at least for the important ones

Table 2. Classes of diversions in NHDPlusV2.1 and their defining characteristics.

Type of diversion	Defining characteristic for routing
Braided channels/islands	Can be important for flow uncertainty depending on monitoring station location; generally affects local routing only.
Natural diversions to ground	Generally not important in affecting flow on main pathways and can be ignored.
Diversions in drainage ditches	Not generally important unless main pathways become incorporated into field drainage pathways; difficult to assess because channels are not naturally formed and flow is intermittent.
Multiple outlets at lakes/reservoirs	Can be important for flow accounting; operational control in reservoirs makes it difficult to assess mean routing of flow.
Irrigation diversions to ground	Important in aggregate in the West; difficult to assess because the channels are not naturally formed and flow is seasonal.
Cross-basin transfers	Important for flow accounting; many have gaging stations assigned.
Diversions in coastal areas	Common but tidal effects make them difficult to assess in non-tidal areas.
Divides	An uncommon feature where NHDPlus shows two flowlines connected across a divide, but the flowlines actually flow in opposite directions, tend to occur in headwater areas of low relief, and are typically associated with a marsh.
Diversions at stream confluences	Common in low relief areas where small tributaries connect with larger streams; affects local routing only; frequent cause of incorrect flow direction and primary path routing.
"Oxbow" diversions	Common in large rivers in flat relief; difficult to assess fraction diverted as width of feature a poor indicator of flow; typically occur in wooded areas making remote visual assessment difficult.

Diversion Modifications, highlight region 01 and 02. Just want to show how many

85,620 flowlines in Bay Watershed
83,632 – catchments
Divfrac >0 and < 1 – 5 sets.

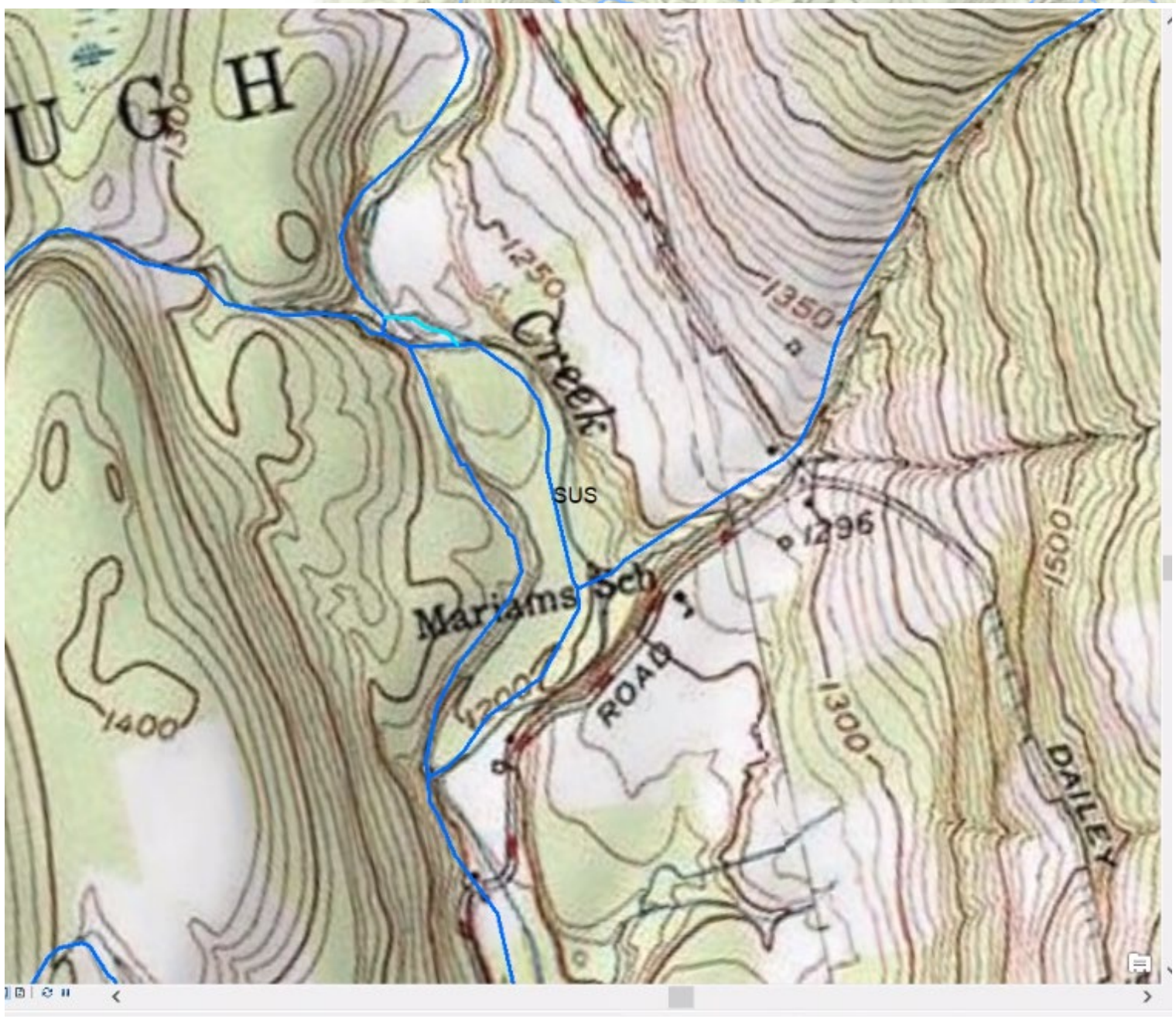
Chesapeake Bay (n=85,620)	
Reach Type	Count
Flowing	78,041
Impounded (NHD)	6,137
Coastline	1,406
Impounded (NID)	36

Table 5. Diversion-related modifications to NHDPlusV2.

[Numbers for modified diversion code and fraction pertain to distinct diversions consisting of multiple flowlines; values for modified flow direction pertain to individual flowlines and do not include flowlines requiring a modification of the hydro-sequence attribute]

NHDPlus Region	Modified diversion code	Modified diversion fraction	Modified flow direction
01	41	37	23
02	14	41	2
03N	47	85	16
03S	20	43	1
03W	14	23	8
04	171	252	82
05	77	136	22
06	62	106	23
07	736	1,309	267
08	19	12	5
09	270	378	93
10L	43	57	2
10U	18	42	0
11	39	38	12
12	16	17	3
13	3	4	0
14	10	22	0
15	7	17	0
16	13	34	1
17	22	61	3
18	47	95	4
Total	1,689	2,809	567

A Diversion in the Chesapeake Bay Watershed



Addition/Removal (AR) Events

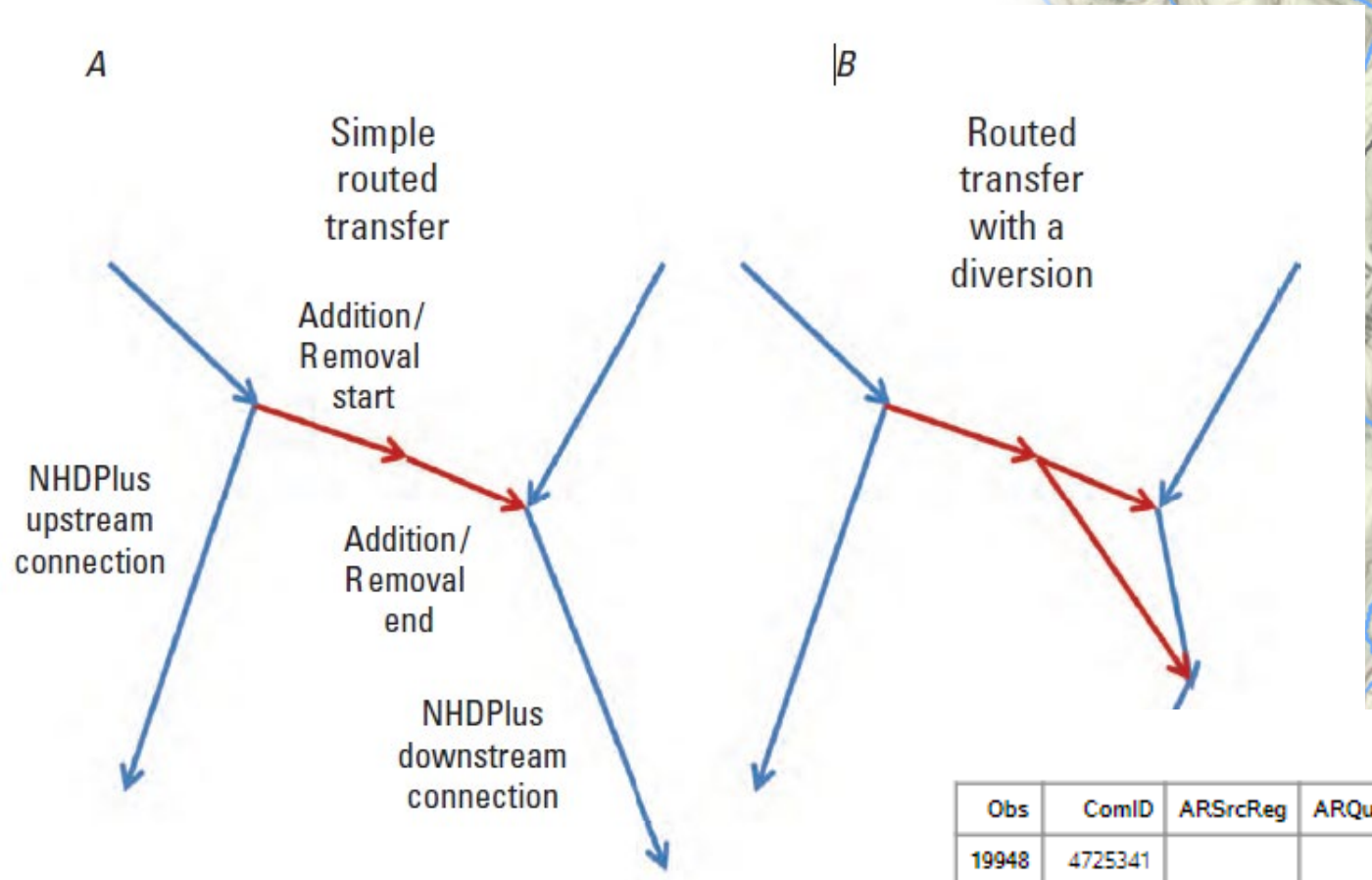


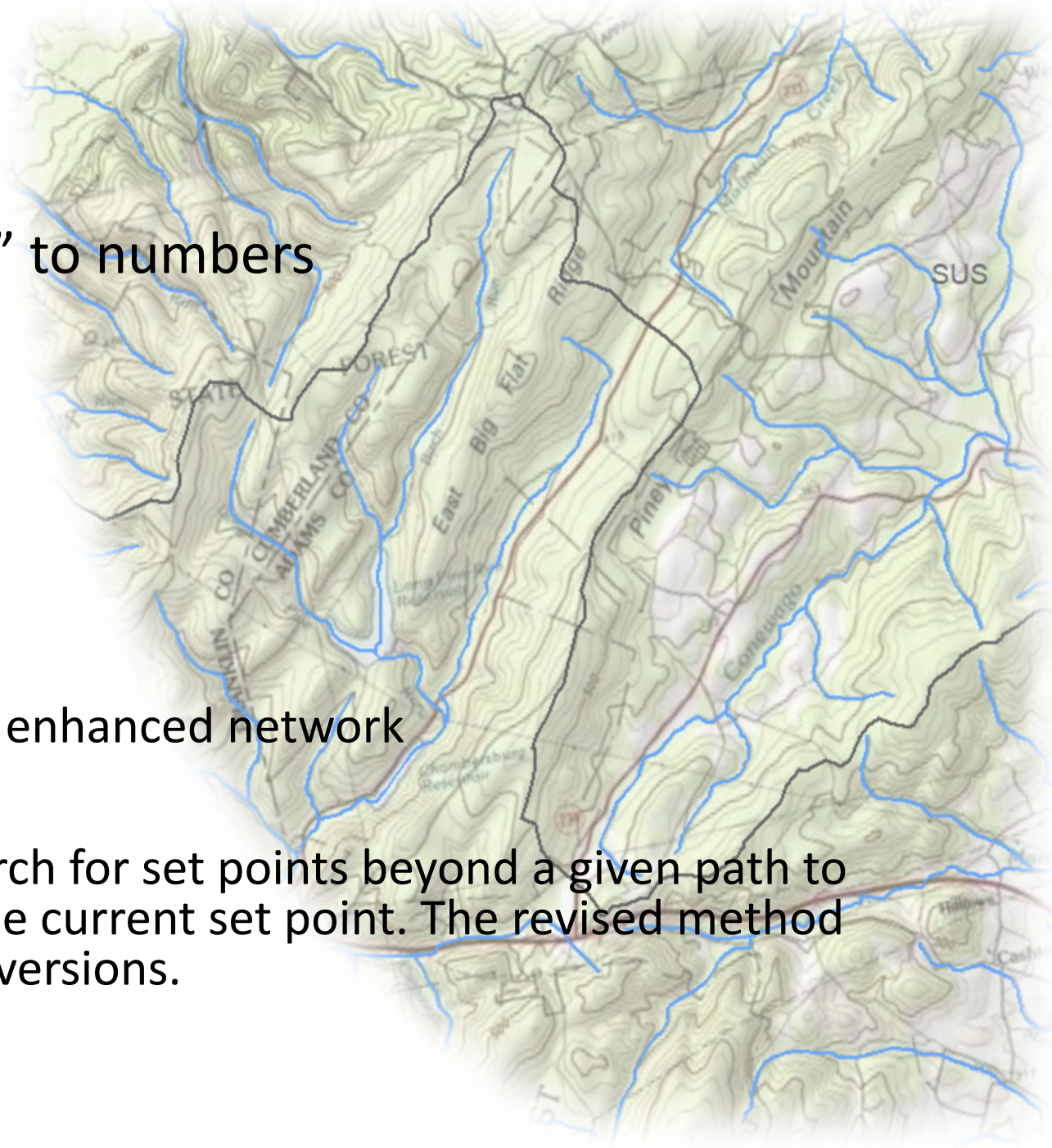
Figure 4. *A*, A simple routed transfer and *B*, a routed transfer with a diversion.

AR Reaches 14:14 Friday, May 1

Obs	ComID	ARSrcReg	ARQuantity	ARDivFrac	AREventCd	ARDWType	ARName
19948	4725341		61	0.28638	2	1	Chester PA public supply
20551	4726595		137	0.00333	2	1	Baltimore City public supply
74533	10054558	03N	29.2	.	1	.	Western Branch Reservoir Diversion
74897	10055358		29.2	0.36318	2	1	Norfolk public supply

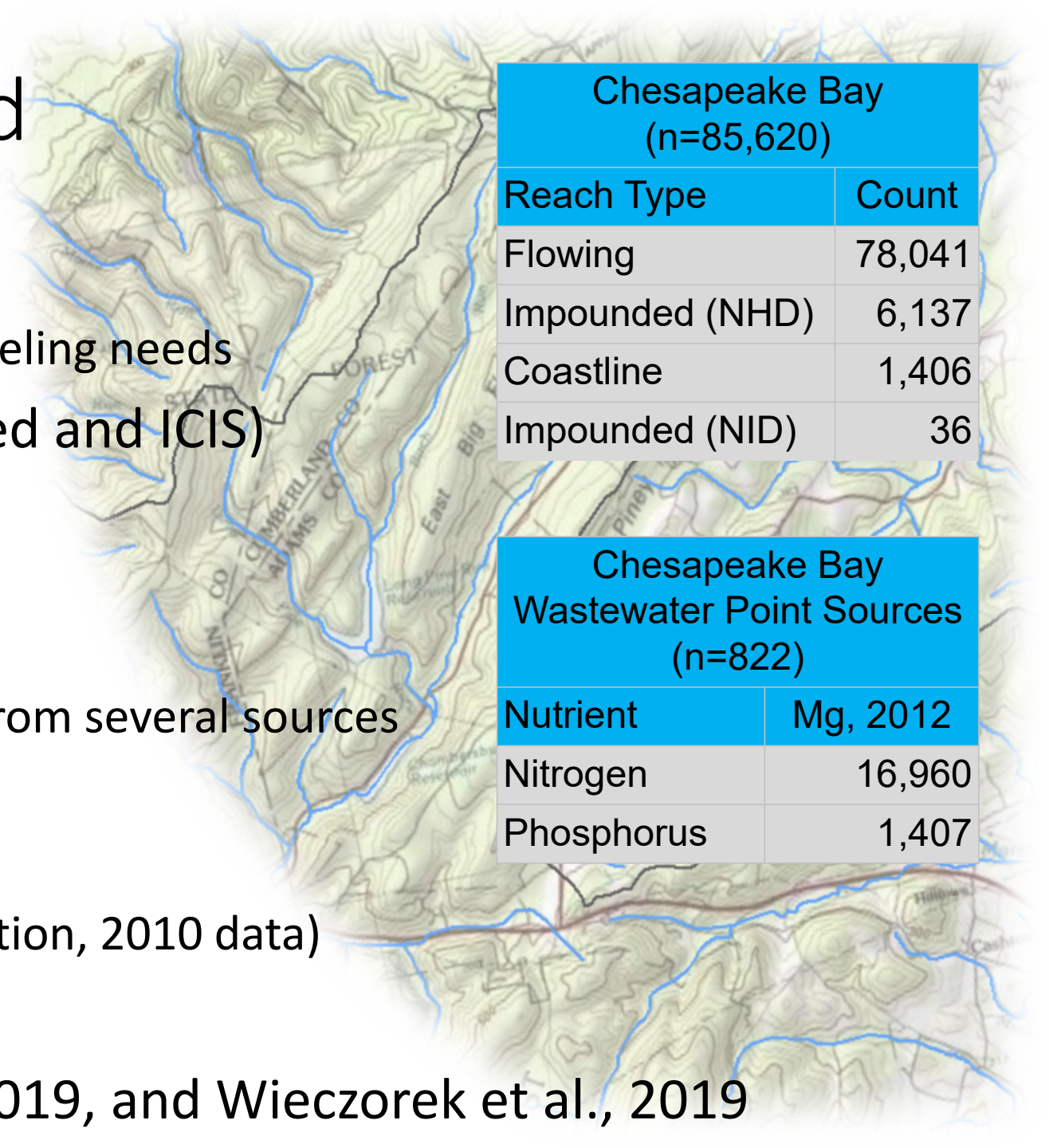
Key attributes updated

- Converted many character “flags” to numbers
- Topology
  - Hydrologic Sequencing
  - Re-number and compact nodes
  - Fix networking issues
- Mean annual flow
  - Enhanced Unit Runoff Method
  - Modified to run simultaneously on enhanced network
- Slope
  - Revised method expanded the search for set points beyond a given path to include all nodes upstream from the current set point. The revised method includes evaluating for potential diversions.



Key attributes assigned

- USGS streamflow
  - Tied to water-quality station
  - These were screened to meet modeling needs
- Municipal discharge (CBP provided and ICIS)
  - Majors
  - Minors
- NID dams
  - Reservoir surface area computed from several sources
- Water Use
  - Population served (2013)
  - Withdrawals (from county compilation, 2010 data)
- HUC12
- Other data from Brakebill et al, 2019, and Wieczorek et al., 2019



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Chesapeake Bay Wastewater Point Sources (n=822)	
Nutrient	Mg, 2012
Nitrogen	16,960
Phosphorus	1,407

Plans for USGS reporting water use data

- County Compilations
  - Every 5 years since the 1950's
  - Annual estimates by sector
  - Not sure what the 2020 data will look like
- Moving from 5 year annual county compilations to daily HUC12 modeled estimates
  - TE and Public Supply first priority
    - TE models operating
    - Plant locations assigned to NHD
    - Service area boundaries (PS)
  - Timeline
    - Snapshot by the end of the calendar year 2020
    - Working to develop operational models
    - Many estimates (daily) for the first cut will be linear interpolation of monthly or annual data with seasonal influences factored in
  - Irrigation