BLOSSOM
CONSULTING & ENGINEERING

Headwaters to Shoreline

Where Stream Restoration Meets Infrastructure and Emergency Management.

Case Studies by Watershed

The role of stream restoration in improving our ability to manage natural resources and design infrastructure with less risk is becoming more important and critical.

1.) Yarmouth Creek Headwater Restoration

2.) Mattaponi Living Shorelines

3.) Chickahominy River Multi Terrace Riverbank Stabilization

4.) Wachapreague Tidal Wetland Mitigation

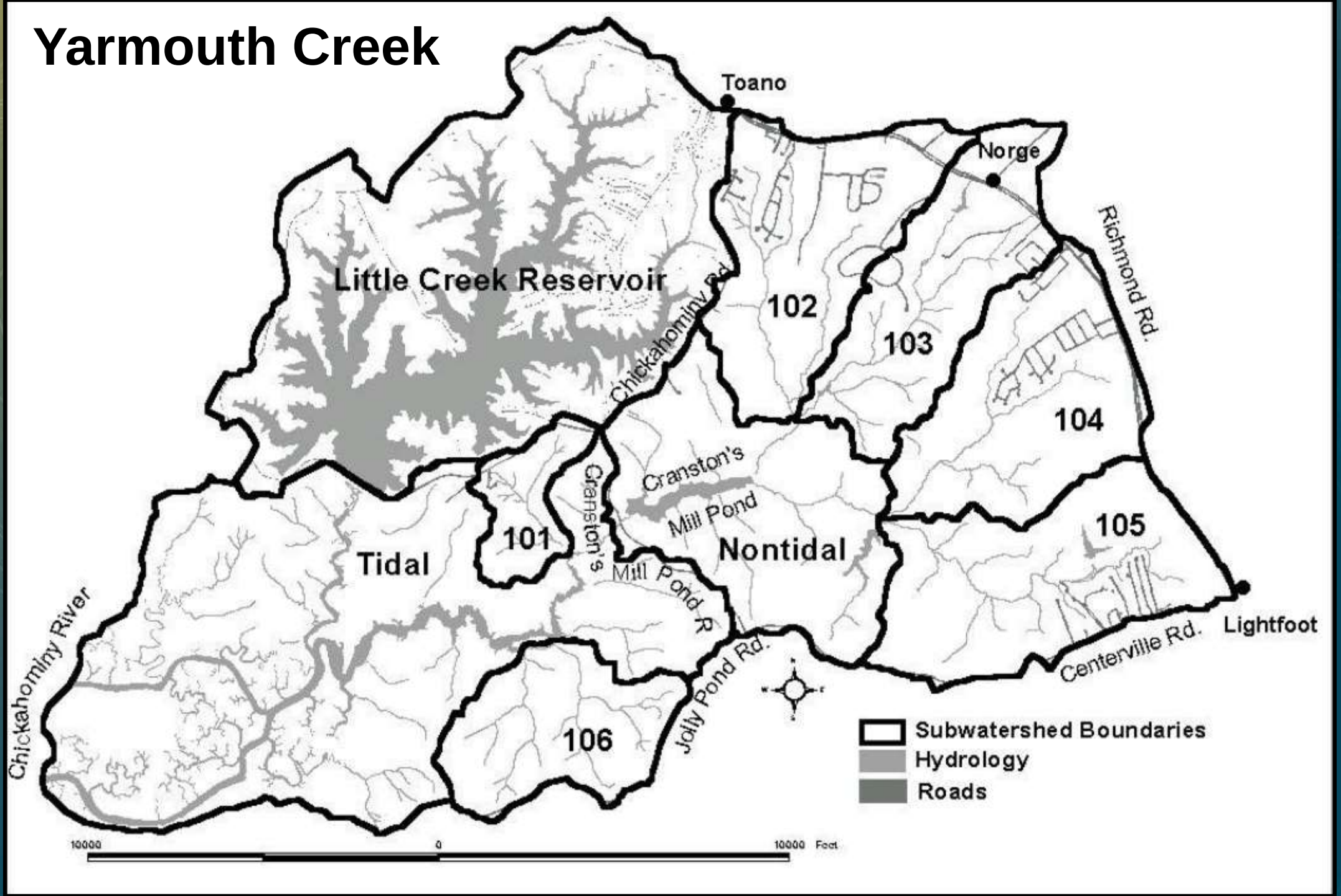
5.) Shenandoah River – North Fork Community Outreach

6.) Beaver Creek Watershed Study

7.) Cold Springs Nutrient Bank Monitoring Update

8.) International Concepts

Yarmouth Creek



Regenerative Design in the Headwaters

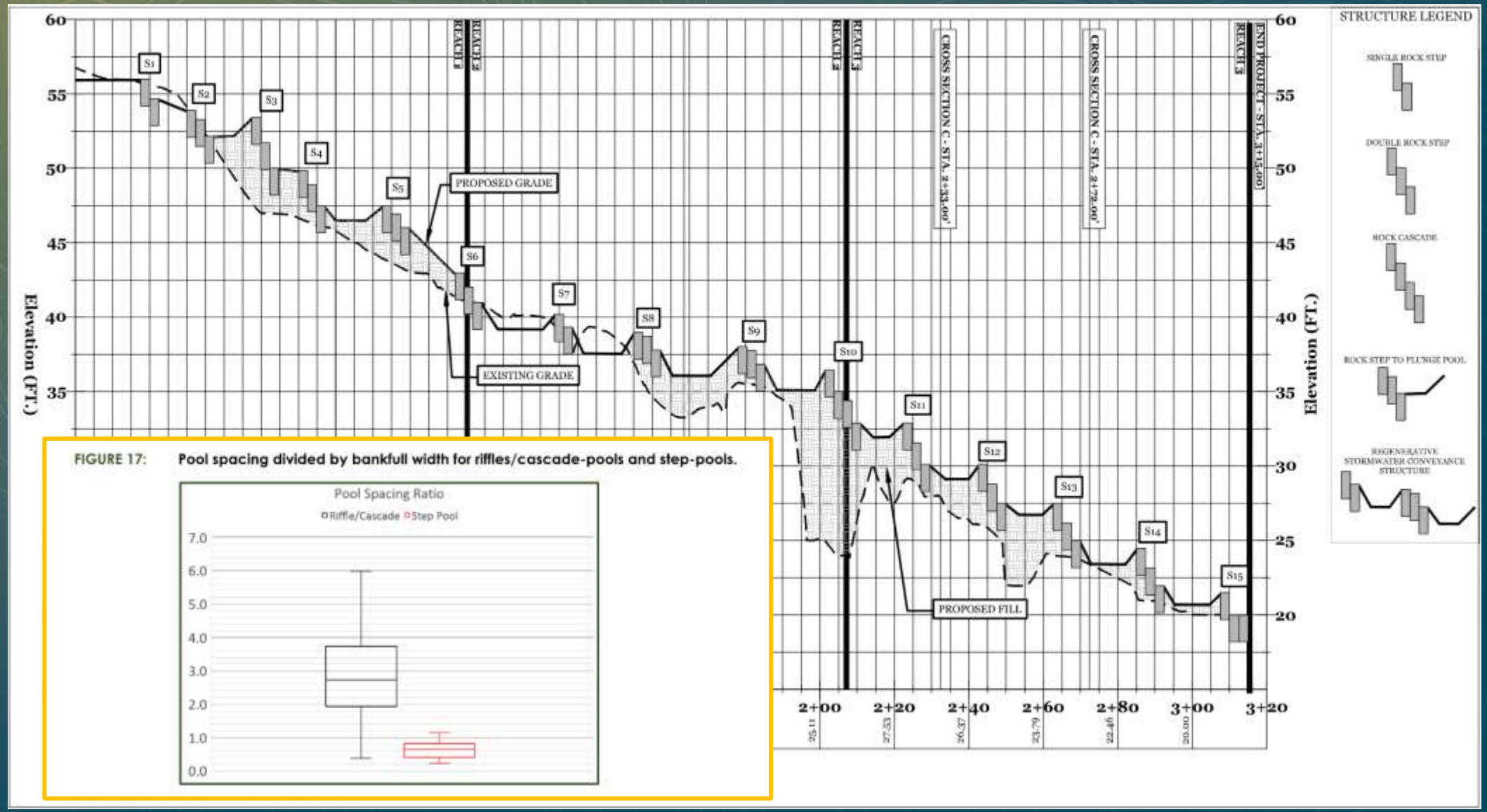
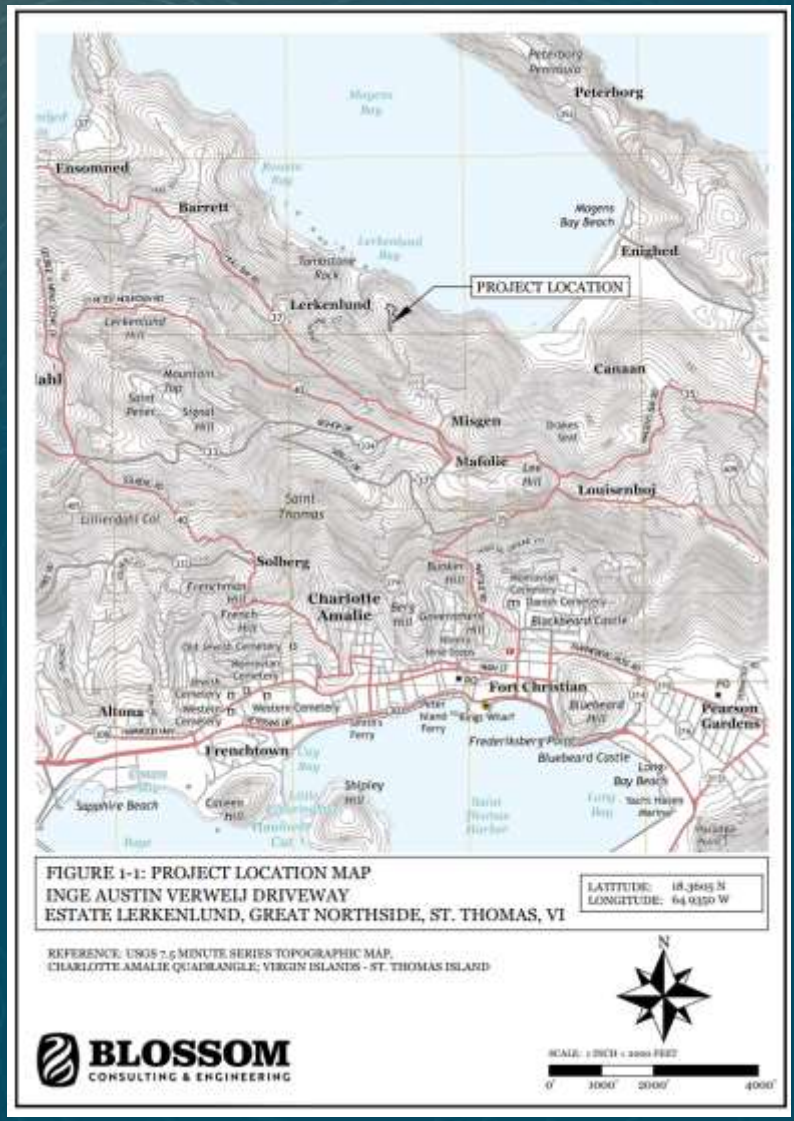
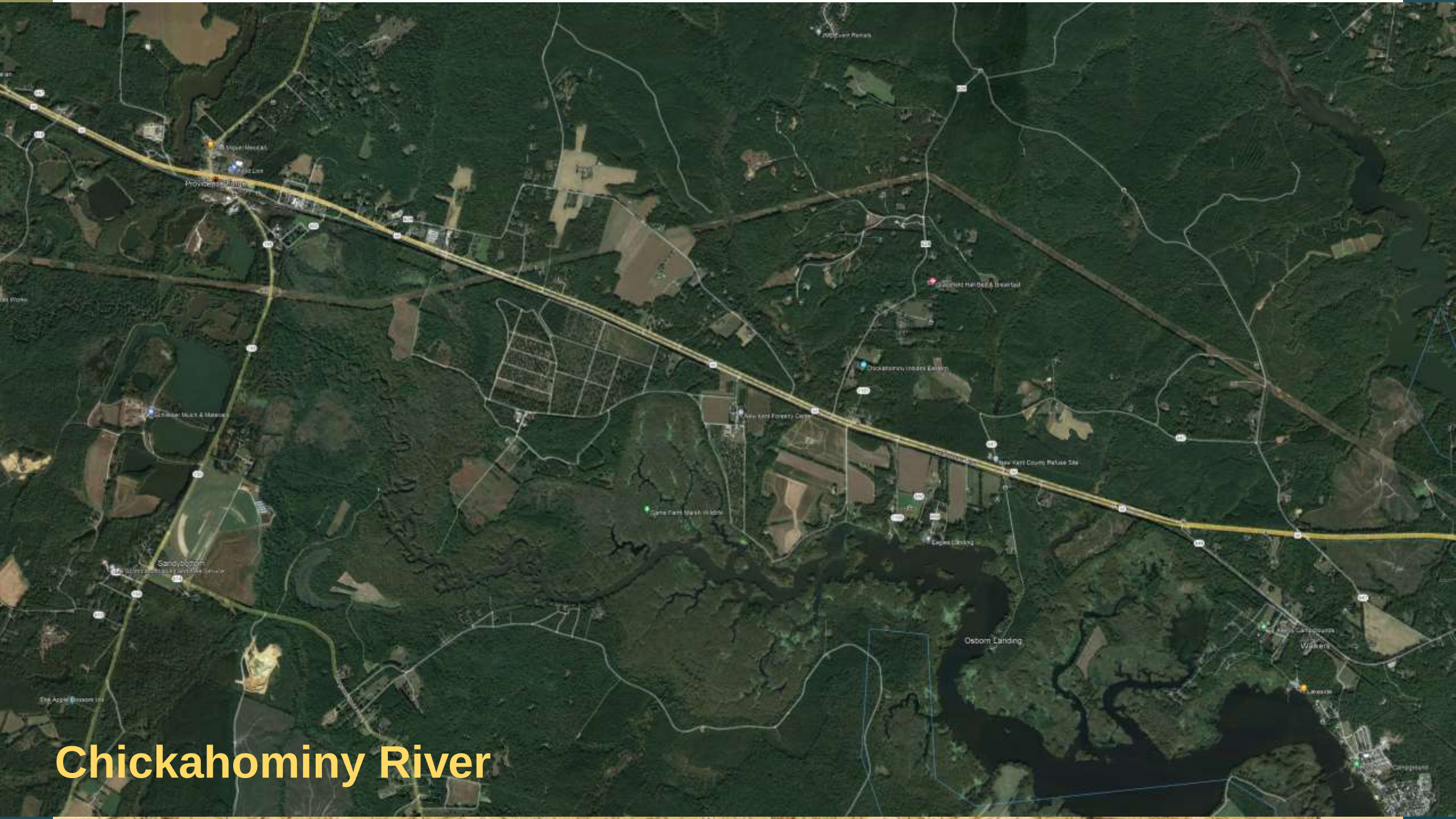


FIGURE 17: **Pool spacing divided by bankfull width for riffles/cascade-pools and step-pools.**

Harman, Will, 2018. Application of Natural Channel Design Techniques in Sub-Arctic Alaska

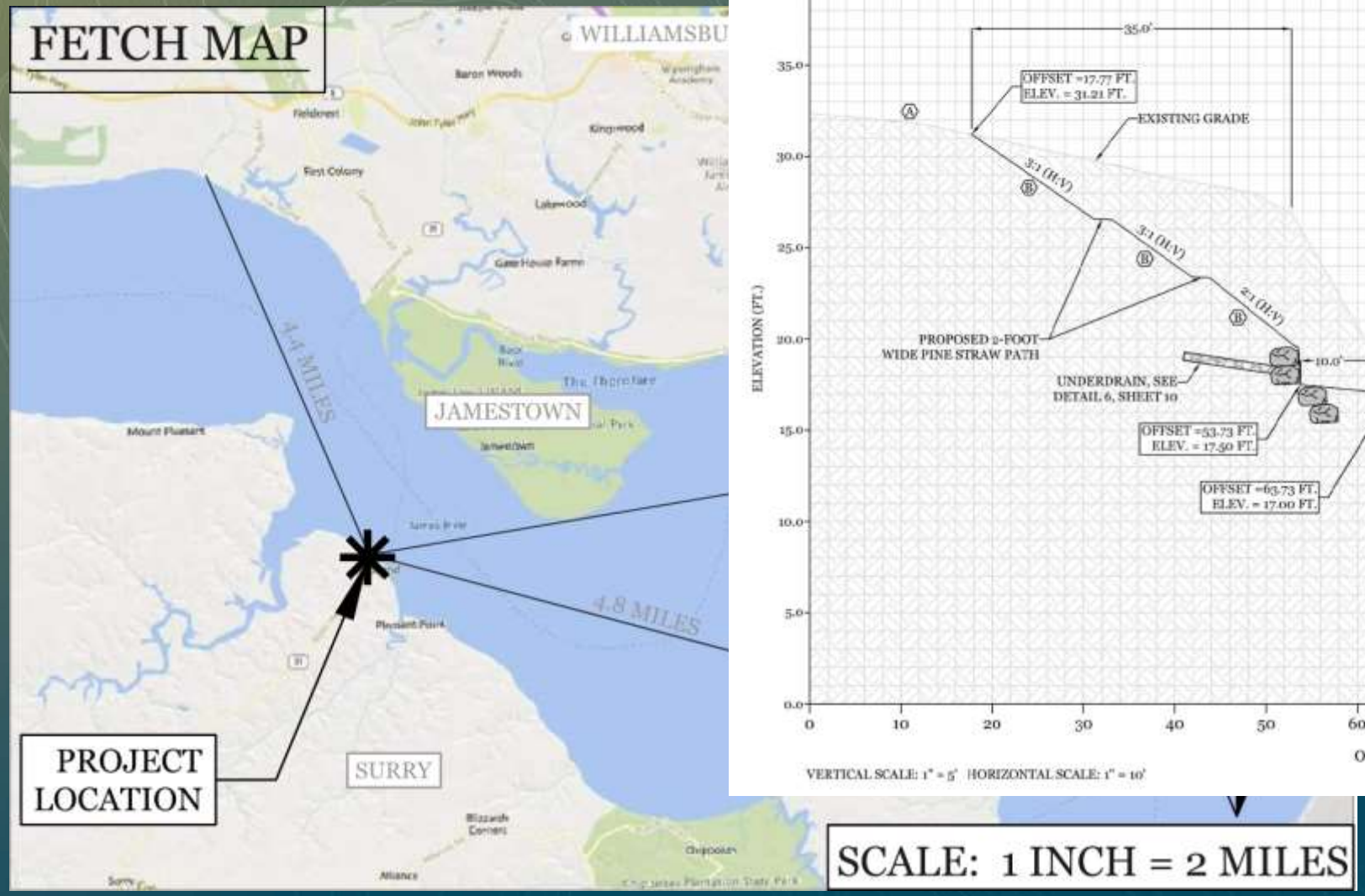
Regenerative Design in the Headwaters

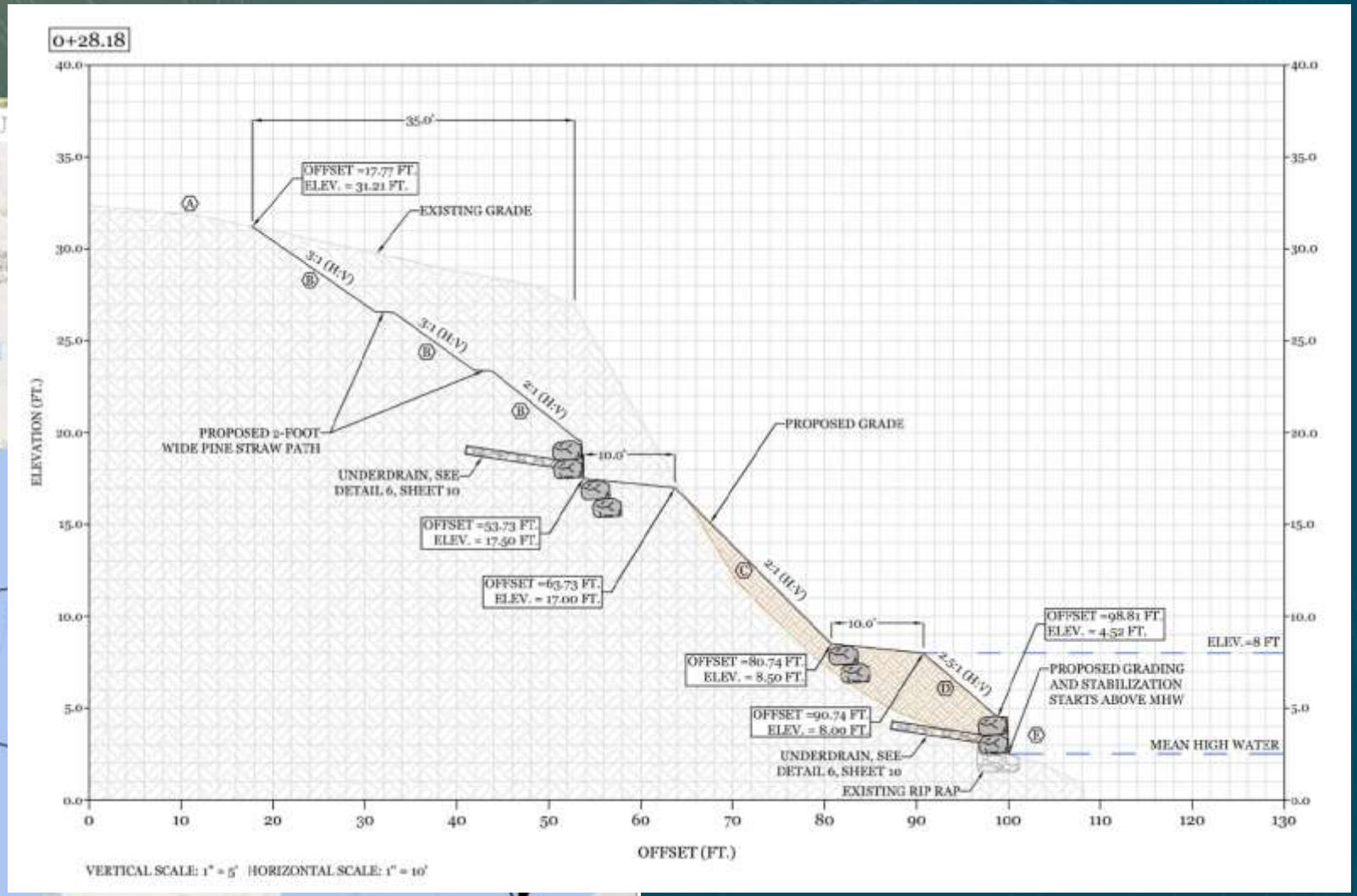


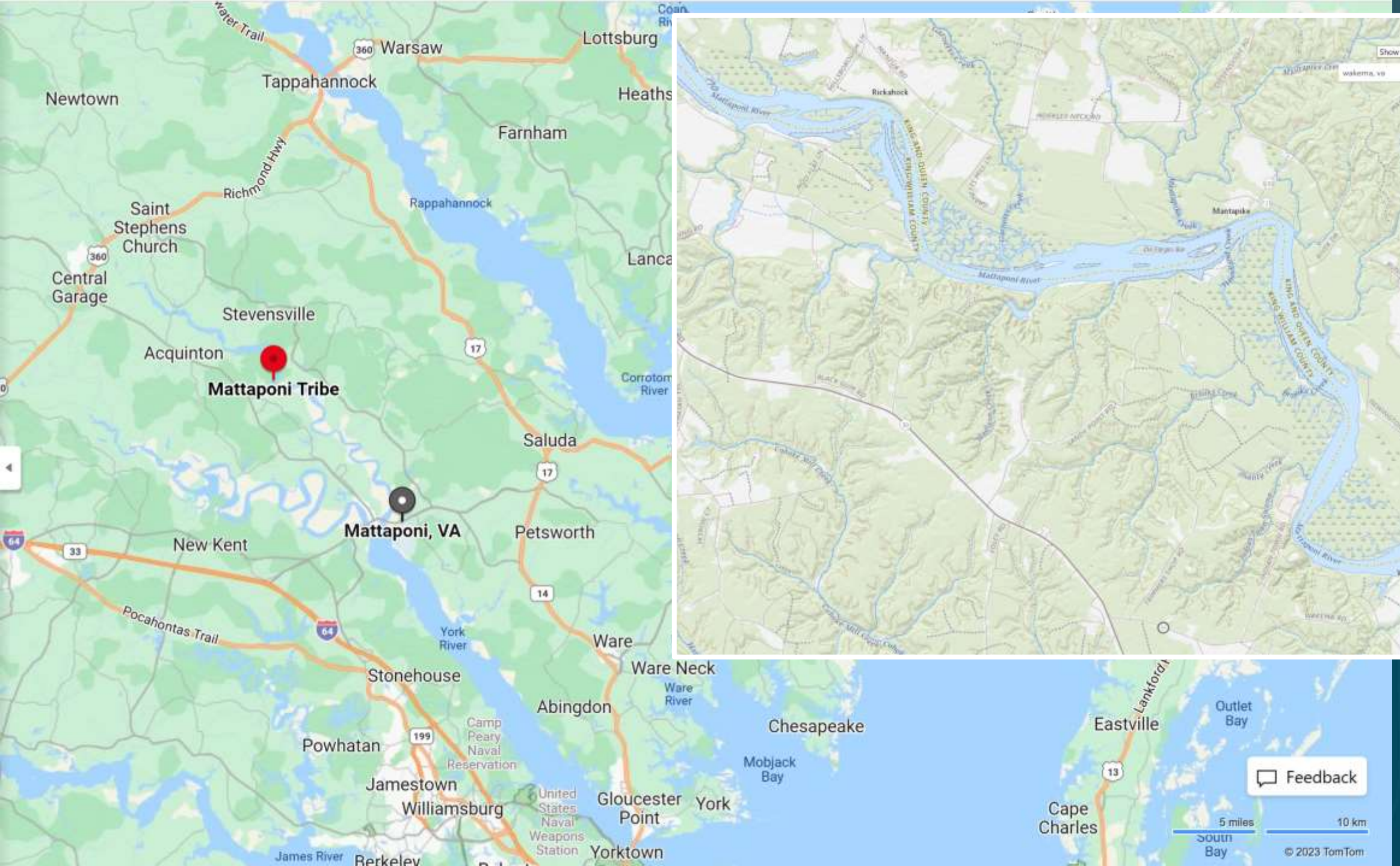


Chickahominy River

Riverbank / Shoreline Stabilization






Warsaw
Lottsburg
Tappahannock
Newtown
Heaths
Farnham
Richmond Hwy
Rappahannock
Saint Stephens Church
Central Garage
Lanca
Stevensville
Acquinton
Mattaponi Tribe
Corrotom River
Saluda
Mattaponi, VA
New Kent
Petsworth
Pocahontas Trail
York River
Ware
Ware Neck
Ware River
Stonehouse
Abingdon
Camp Peary Naval Reservation
Chesapeake
Powhatan
Mobjack Bay
Jamestown
Williamsburg
United States Naval Weapons Station
Gloucester Point
York
Yorktown
James River
Berkeley
Eastville
Outlet Bay
Cape Charles
South Bay
Feedback
5 miles
10 km
© 2023 TomTom

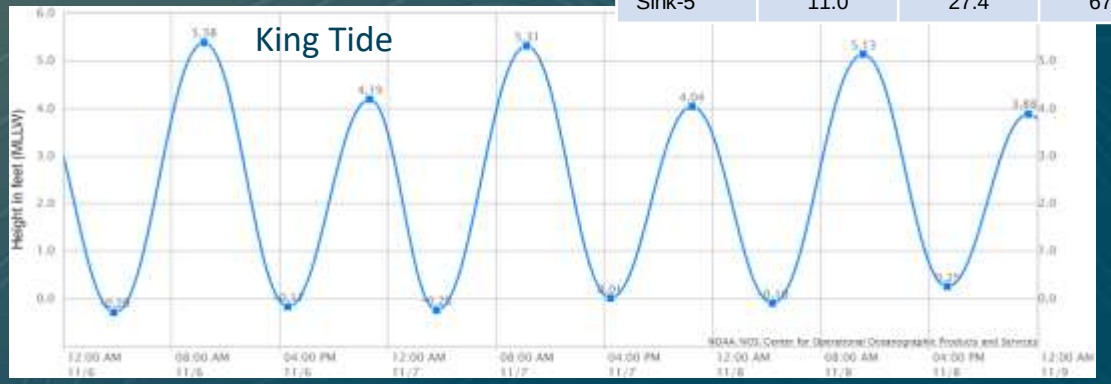
Mattaponi River

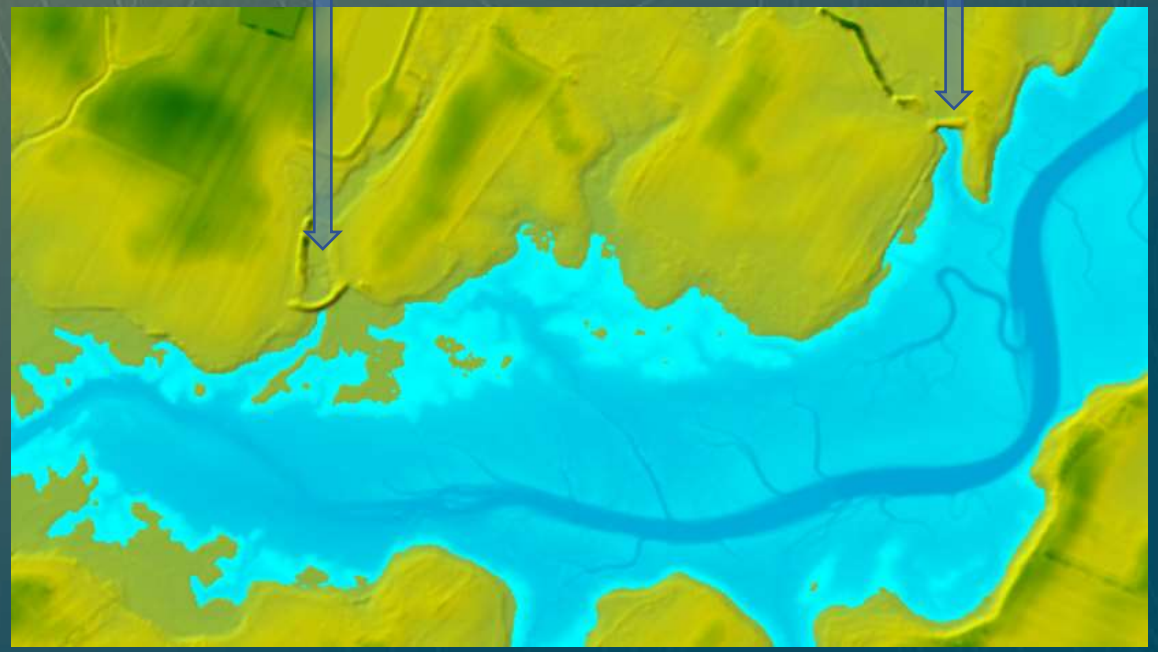
Forward thinking tidal wetland mitigation designed to adapt to rising tides

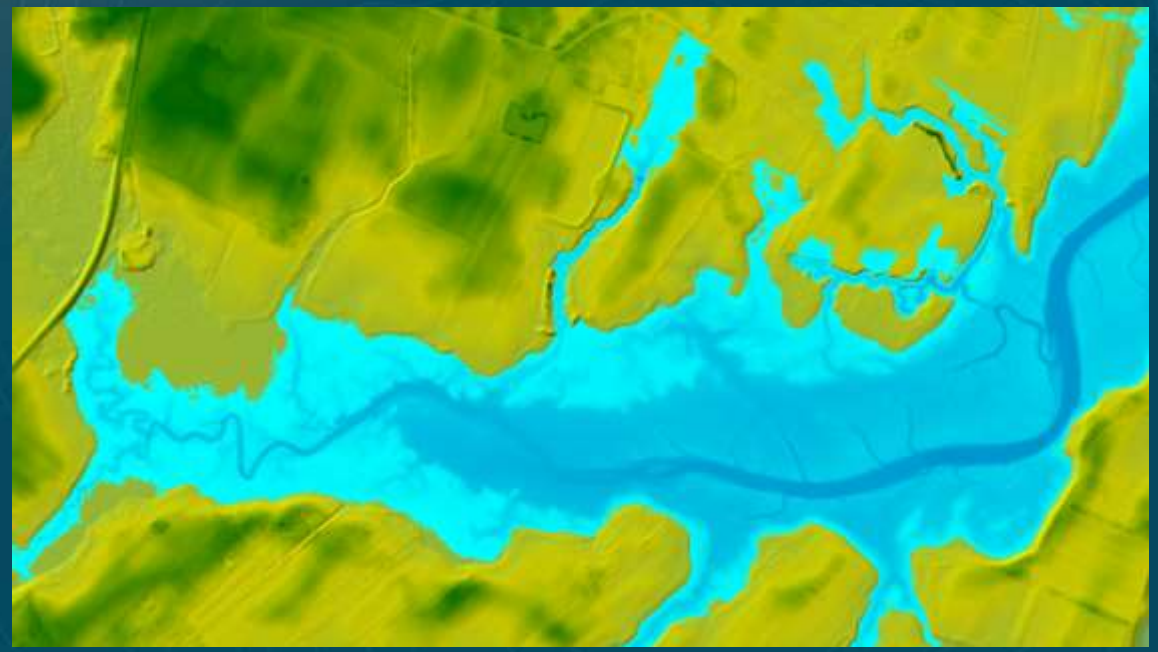
Hydraulic Modelling

- Comparative Analysis of tidal inundation from existing to proposed conditions
- Sediment Transport Analysis

Tributary	Qpeak (CFS)		
	2-year	10-year	100-year
Sink-1	23.7	58.9	141.8
Sink-5	11.0	27.4	67.4

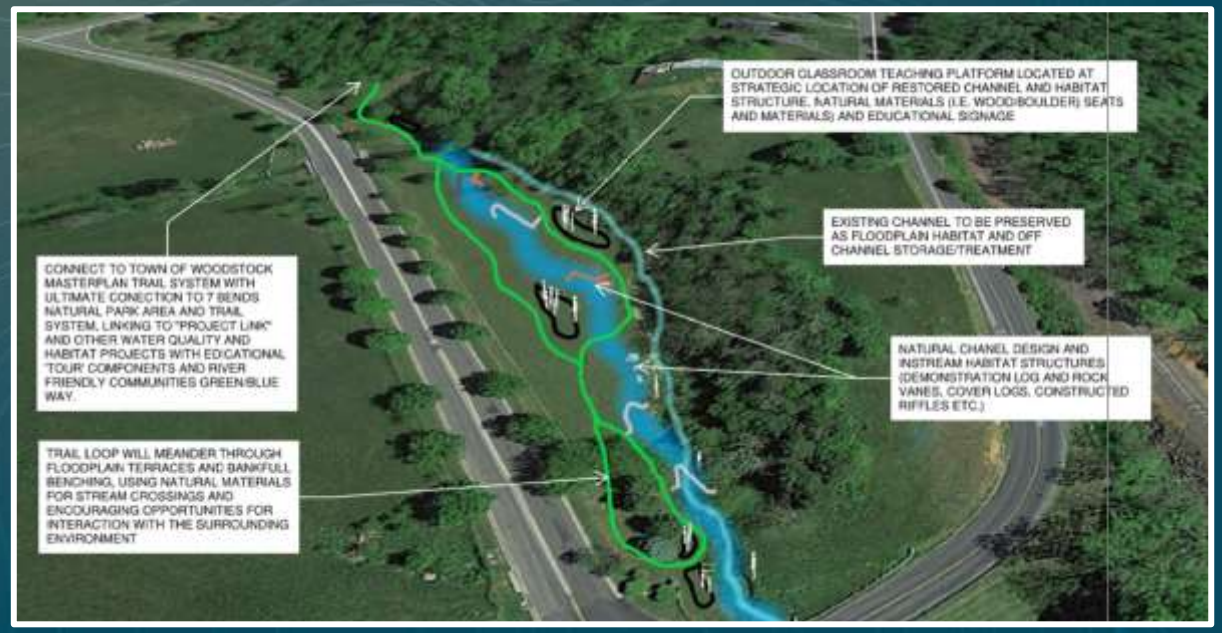






Potomac River Basin

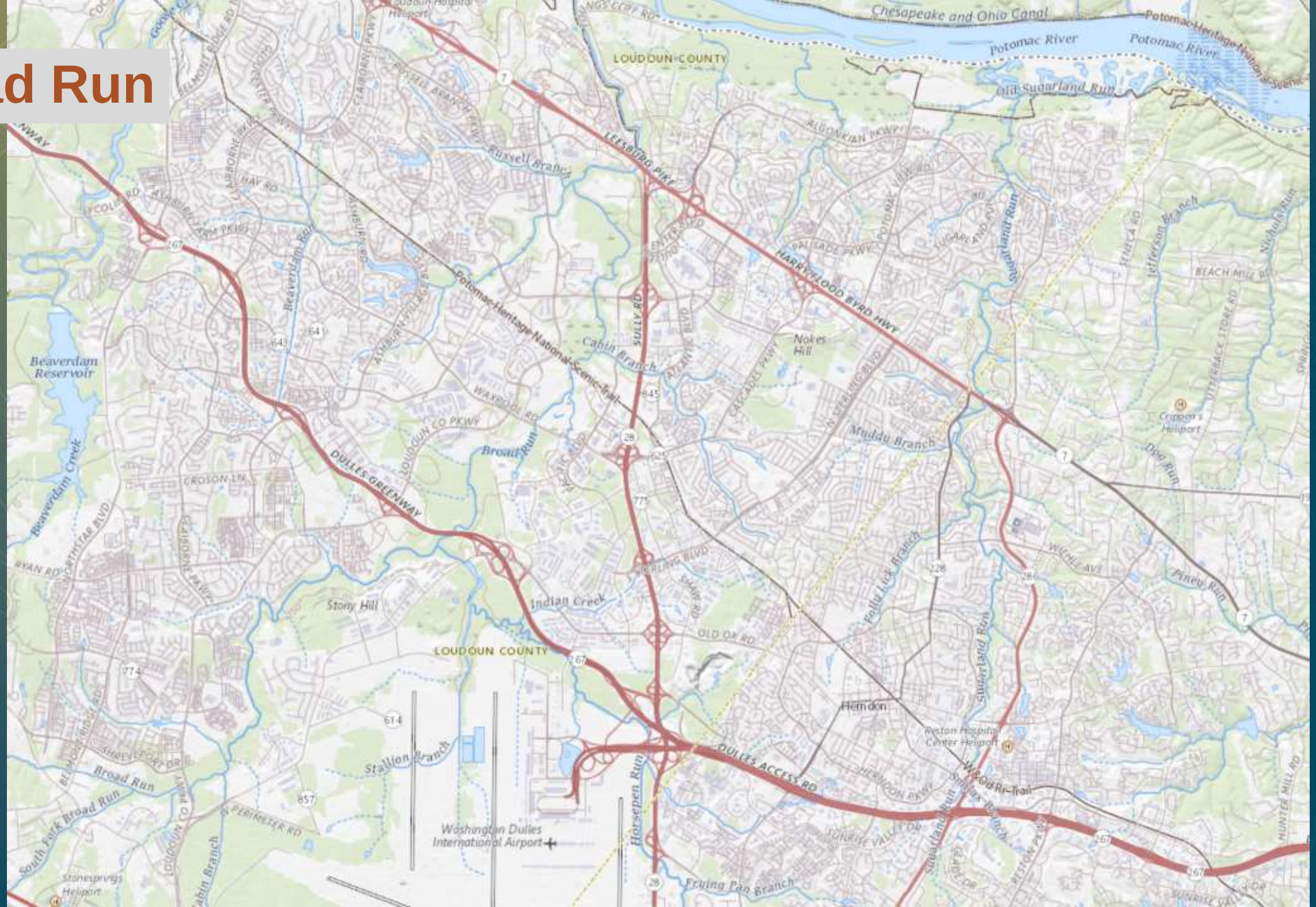
Shenandoah River (North Fork)



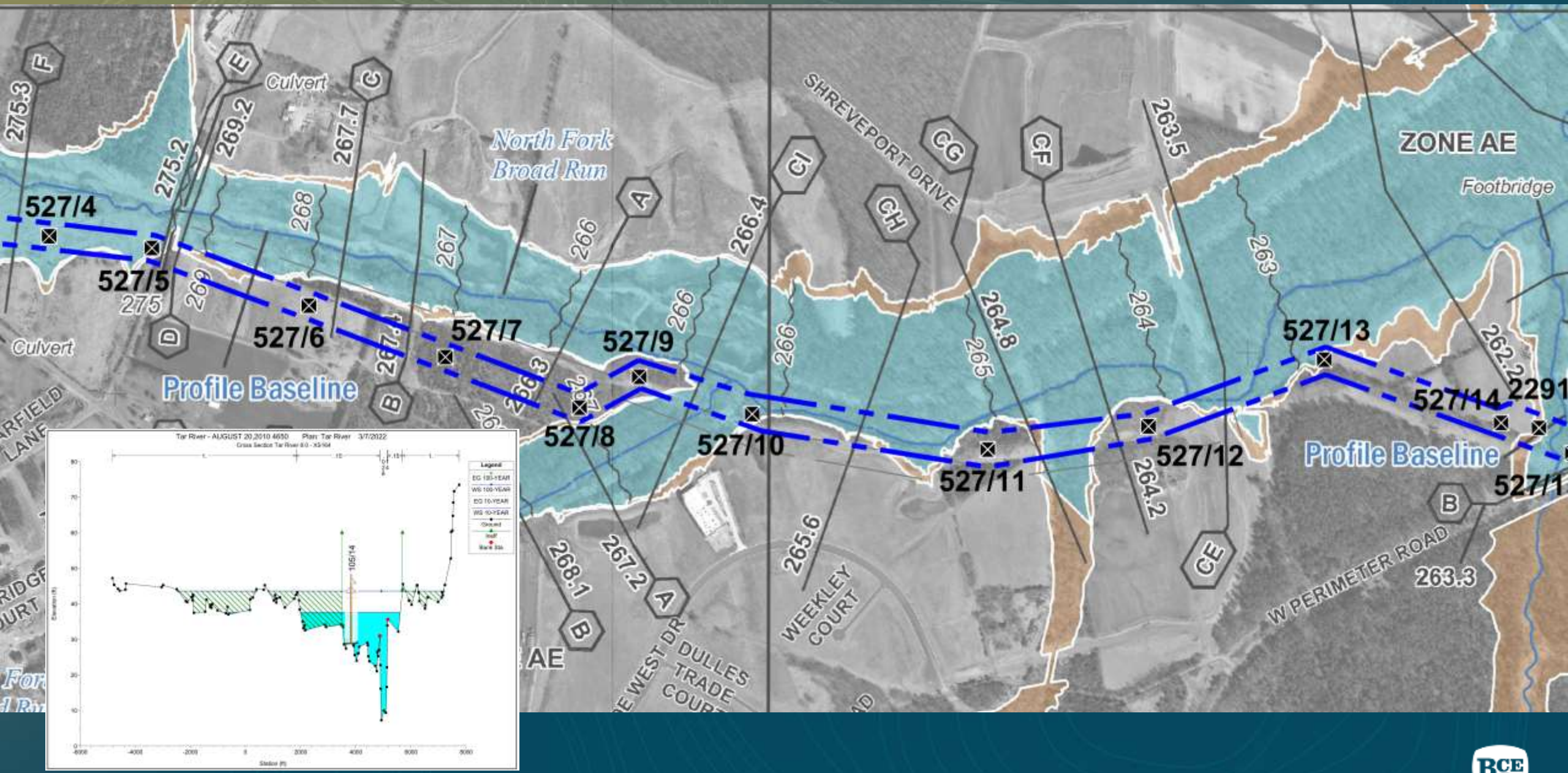
Eastern Brook Trout Priority Watershed

Project LiNK: Connecting Shenandoah River Friendly Communities

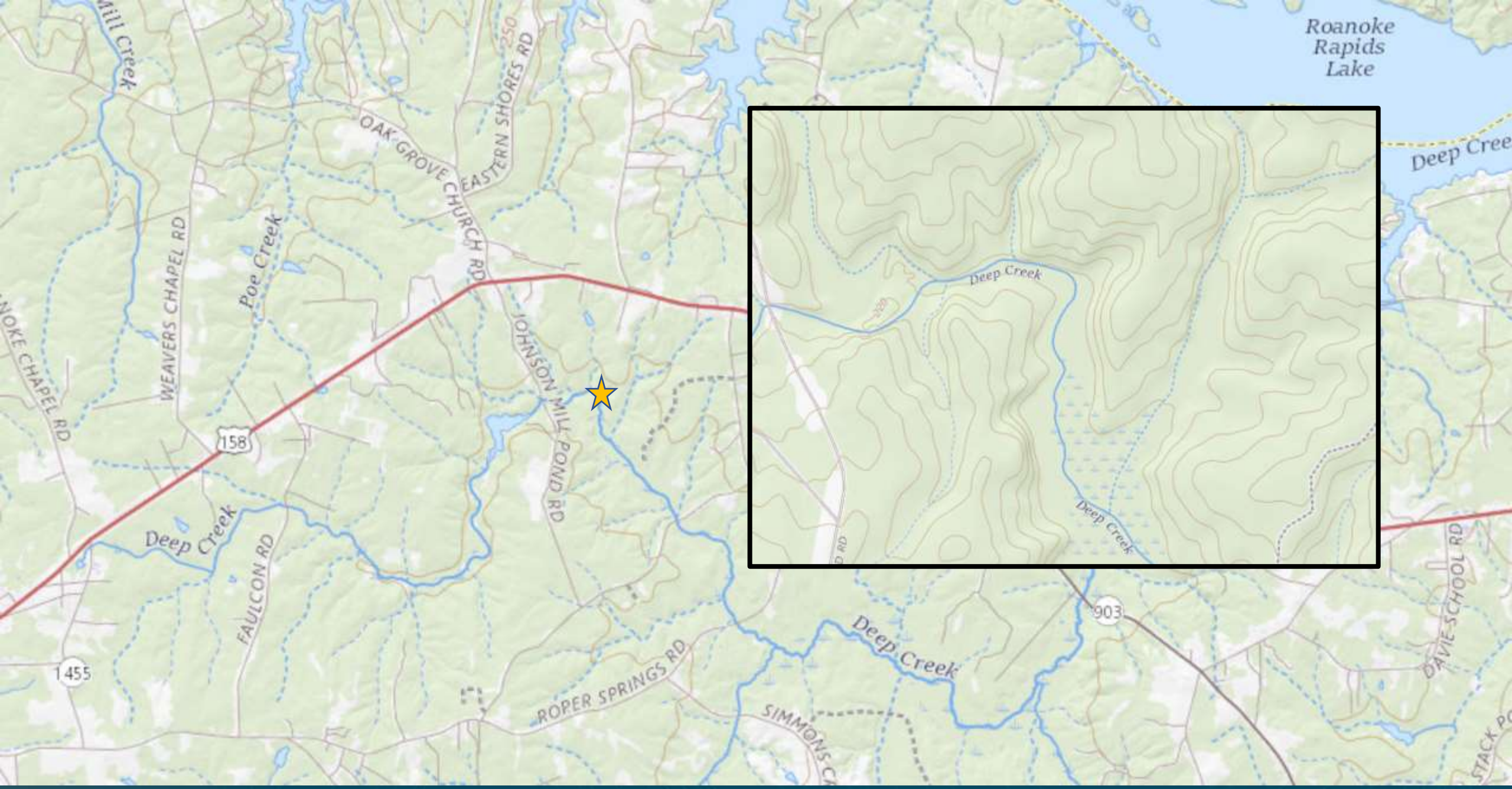
Broad Run



Chesapeake and Ohio Canal
Potomac River
Potomac-Heritage National Scenic
Old Sugarland Run
LOUDOUN COUNTY
LEESBURG PIKE
Russell Branch
HARRY FLOOD BYRD HWY
Potomac-Heritage National Scenic Trail
Cabin Branch
SULLY RD
Nokes Hill
Beaverdam Reservoir
Beaverdam Creek
Broad Run
DULLES GREENWAY
Muddu Branch
Sugarland Run
Jefferson Branch
Nichols Run
Dog Run
Cripper's Heliport
Pineu Run
Follu Lick Branch
Indian Creek
Stony Hill
LOUDOUN COUNTY
Herndon
Reston Hospital Center Heliport
DULLES ACCESS RD
Stallion Branch
Horsepen Run
Washington Dulles International Airport
Fruing Pan Branch
South Fork Broad Run
Stonesprings Heliport



Culvert
North Fork Broad Run
SHREVEPORT DRIVE
ZONE AE
Footbridge
527/4
527/5
527/6
527/7
527/8
527/9
527/10
527/11
527/12
527/13
527/14
Profile Baseline
Profile Baseline
W PERIMETER ROAD
WEEKLEY COURT
DULLES TRADE COURT
Tar River - AUGUST 20,2010 4650 Plan: Tar River 3/7/2022
Legend

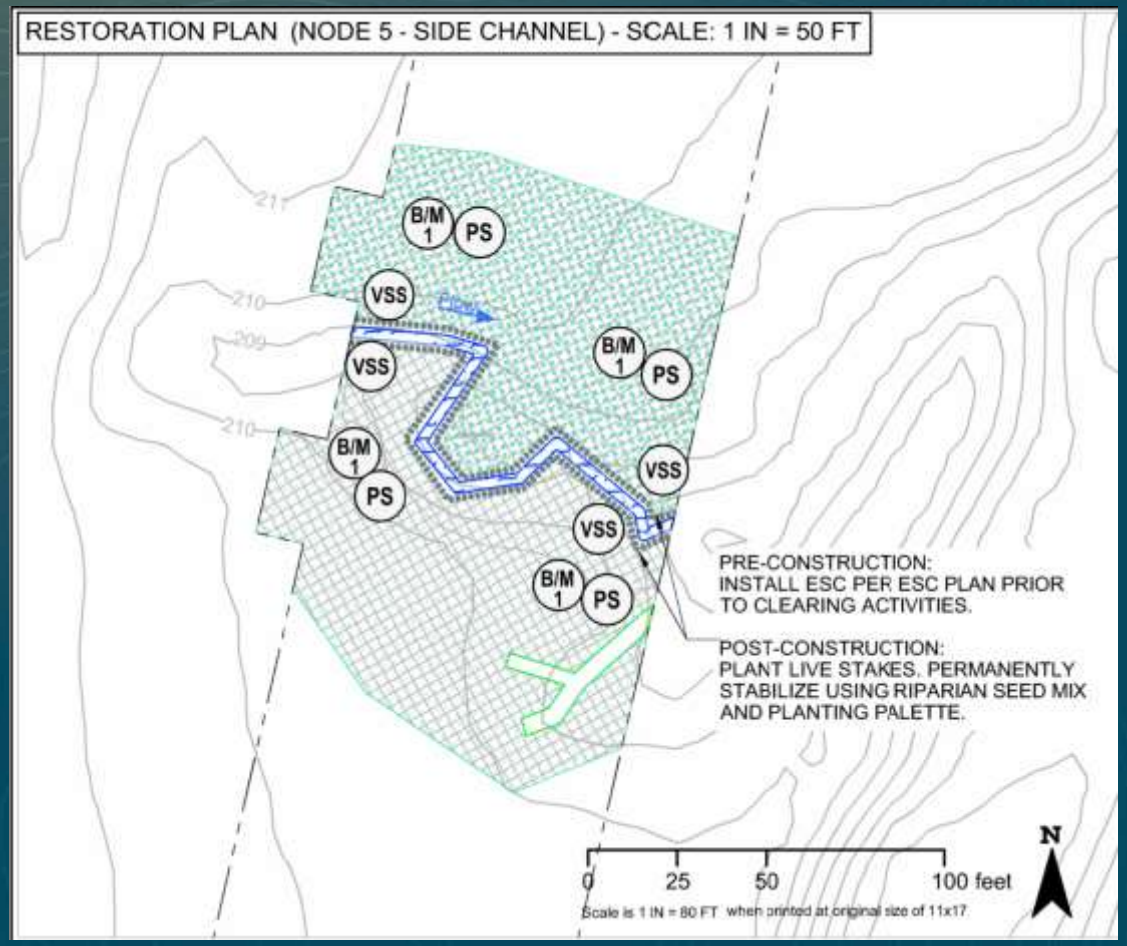

Roanoke Rapids Lake
Deep Cree
Mill Creek
OAK GROVE CHURCH RD
EASTERN SHORES RD
250
WEAVERS CHAPEL RD
Poe Creek
JOHNSON MILL POND RD
NOKE CHAPEL RD
158
Deep Creek
FAULCON RD
1455
ROPER SPRINGS RD
SIMMONS
Deep Creek
903
DAVIE SCHOOL RD
Deep Creek
Deep Creek

12/2013

1/2022

Balance of Energy

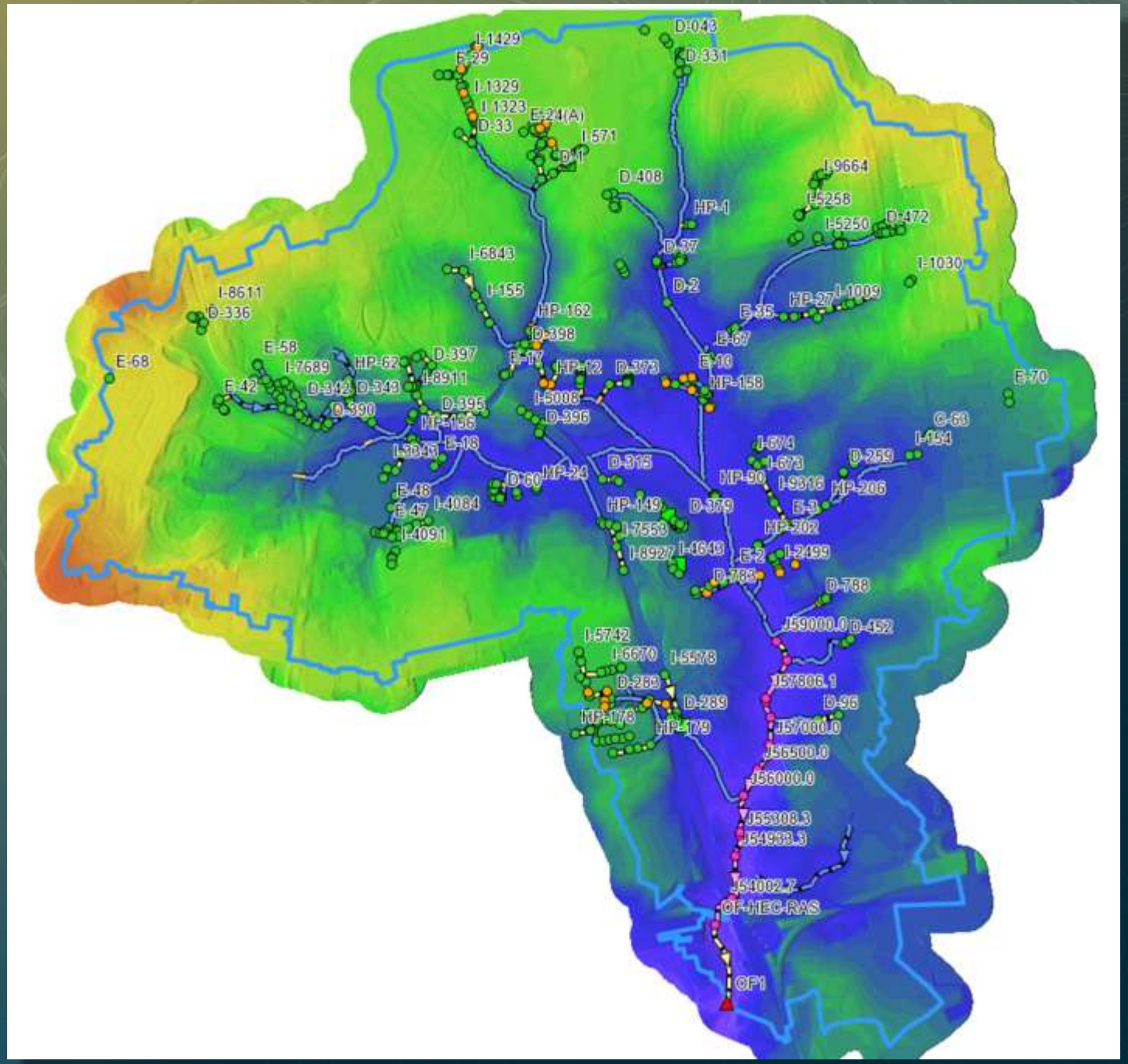
- Deliver/Transmit Energy
- Interrelationship of Power and Water
- Stormwater management that is based on maintaining the pre-development durations of exceedances of the threshold discharge for streambed mobilization (Q critical) or the erosion potential
- Regional or watershed hydrologic models that site developers would need to use for stormwater management (this would allow for continuous simulation modeling, predictive climate models, greater accounting of hydrograph coincidence/overlapping from subwatersheds, etc.),



* Virginia preliminary stormwater management considerations for future regulations

Beaver Creek

Watershed modelling to identify road overtopping for 100-year-old military facilities

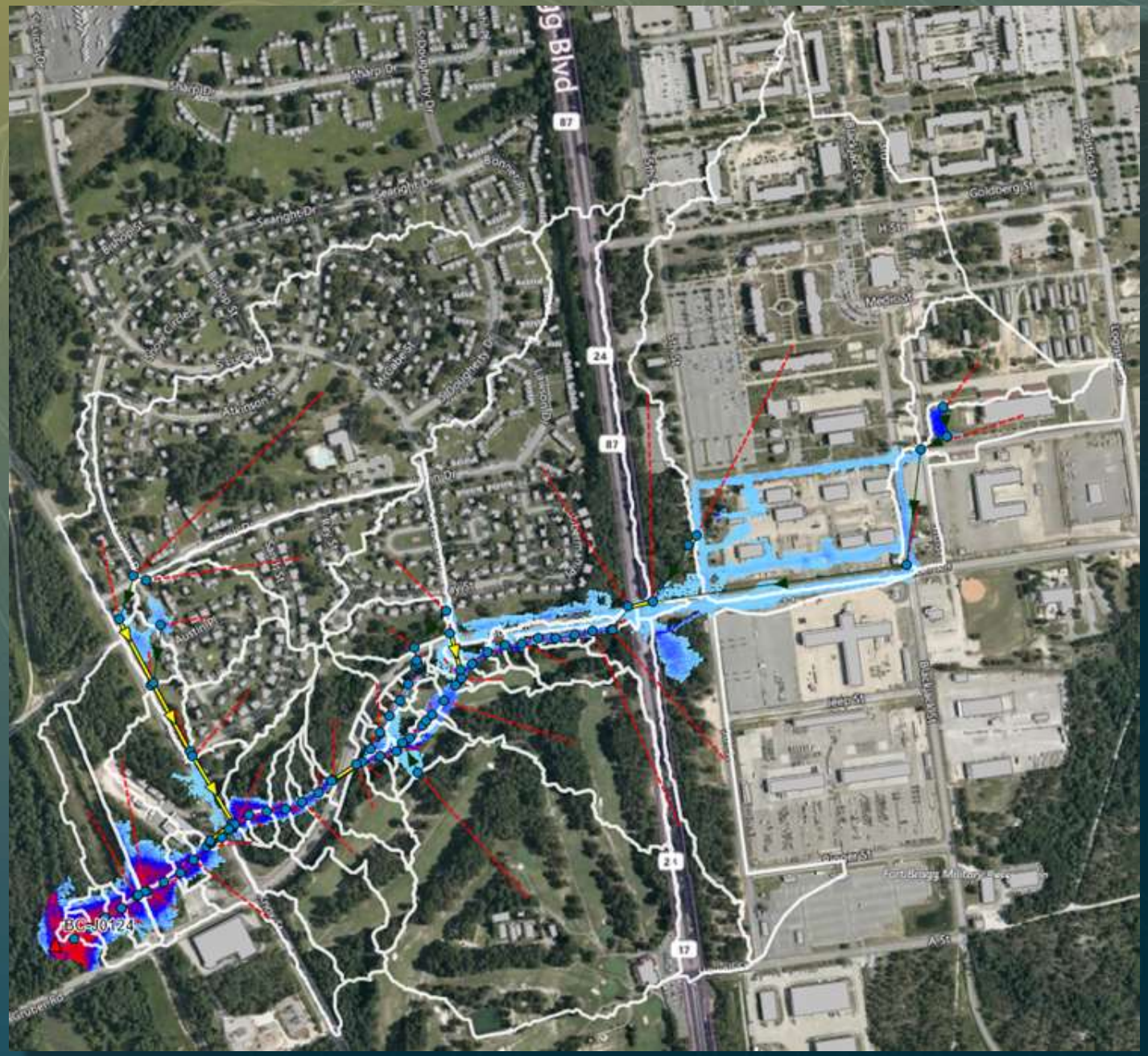


Design storms and scenarios

- NOAA, NCDC Climate Data File
- Simulation of a 10- and 50-year, 24-hour depth precipitation event following an equal event 7 days prior
- Simulation of a 200-year, 24-hour depth precipitation event
- 15 second interval 40-year precipitation data long term record

Tributary	Qpeak (CFS)		
	10-year	50-year	200-year
Main Stem	987	1494	1971
Red	580	776	958
Green	226	300	364
Cyan	467	567	1073
Blue	295	675	926

- Standardization across bases / regions



Tasks Complete

- Forecasting and predictive analysis for improved circulation and protection of resources/assets during extreme events.

- Conveyance success analysis at primary and secondary roads.

- 2D modelling for proposed solutions as it relates to sub watershed response.

Critical Steps

- Gage installation
- Monitoring stations for alerts
- Emergency action planning

Future Solutions

- - Road Elevation, Floodplain Culverts, Off Channel Storage, Restoration

Cold Springs

Stream and floodplain restoration for nutrient crediting in the Shenandoah Valley

TABLE 2: RELEASE SCHEDULE TABLE for Cold Springs Nutrient Bank

			Current Bank Credits released				Cummulative Bank Credits released		
Credit Release Period	Delivery Method	% Of Credits Released	TP lbs/yr (0.85 Delivery Factor Applied)	TN lbs/yr (0.56 Delivery Factor Applied)	SED lbs / yr (0.56 Delivery Factor Applied)	Cumulative % Release	TP lbs/yr	TN lbs/yr	SED lbs / yr
	Protocol 1 (Default Efficiency)	25%	88.88	166.27	145,853.40	25%	88.88	166.27	145,853.40
	Protocol 2 (Default Bulk Density)	25%		112.56		25%		112.56	
	Land Conversion	100%	13.04	81.28	7,056.76	100%	13.04	81.28	7,056.76
Construction Release			**101.92**	**360.09**	**152,910.16**		**101.92**	**360.09**	**152,910.16**
	Protocol 1 (Default Efficiency)	25%	88.88	166.27	145,853.40	50%	177.76	332.55	291,706.80
	Protocol 2 (Default Bulk Density)	25%		112.56		50%		225.12	
Monitoring Year 1 Credit Release			**88.88**	**278.83**	**145,853.40**		**190.80**	**638.93**	**298,763.56**
	Protocol 1 (Default Efficiency)	25%	88.88	166.27	145,853.40	75%	266.64	498.82	437,560.20
	Protocol 2 (Default Bulk Density)	25%		112.56		75%		337.68	
Monitoring Year 2 Credit Release			**88.88**	**278.83**	**145,853.40**		**279.68**	**917.76**	**444,616.96**
	Protocol 1 (Default Efficiency)	25%	88.88	166.27	145,853.40	100%	355.52	665.10	583,413.60
	Protocol 2 (Default Bulk Density)	25%		112.56		100%		450.24	
*Assuming 65% efficiency achieved to illustrate credit release**	Protocol 1 -from exceeding 50% efficiency	100%	106.66	199.53	175,024.08	100%	106.66	199.53	175,024.08
Monitoring Year 3 Credit Release	Protocol 1 from exceeding 50% efficiency** and Protocol 2	100%	**195.54**	**478.36**	**320,877.48**		**475.22**	**1396.12**	**765,494.44**

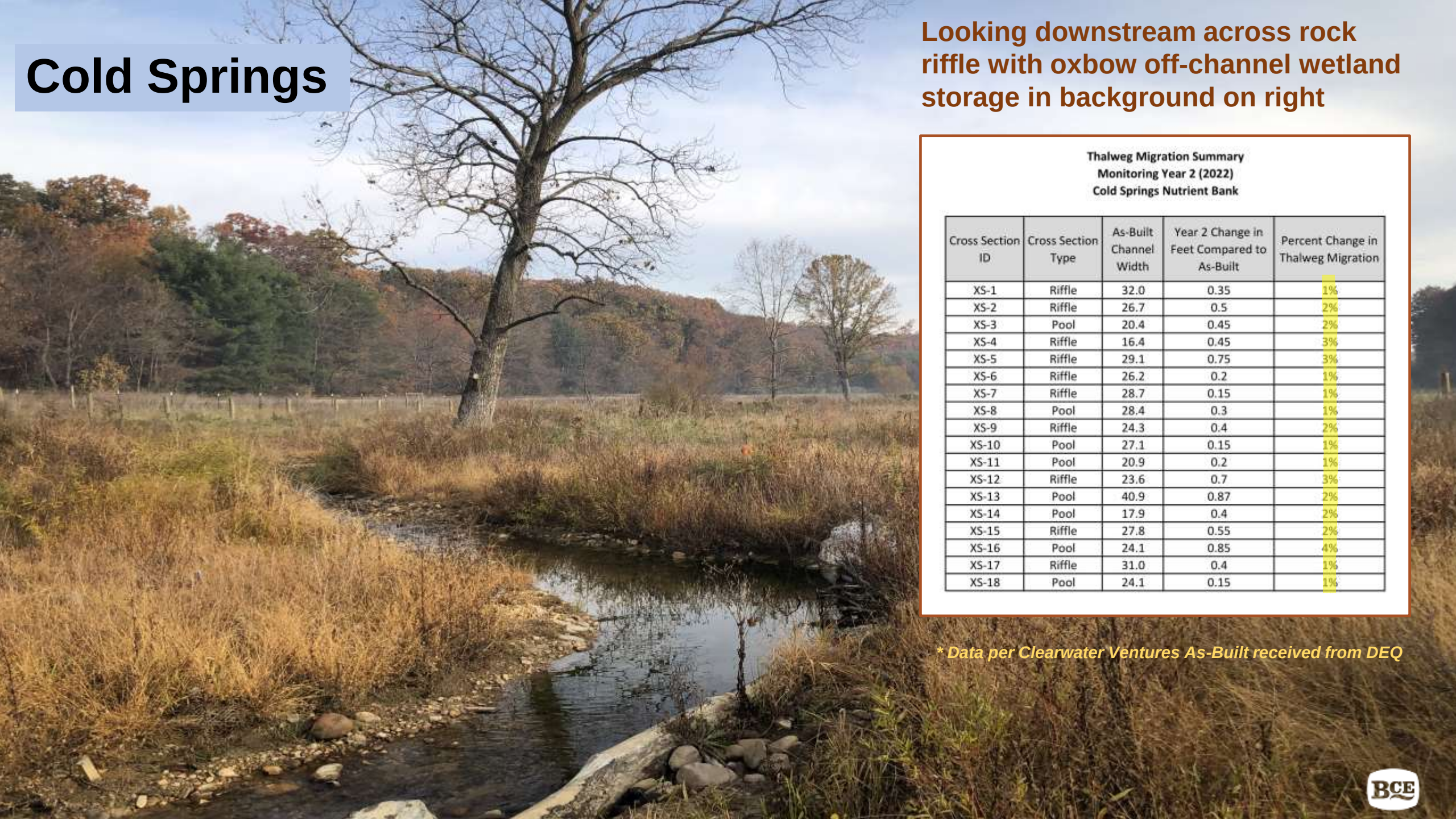
* 65% minimum used for planning purposes. Higher efficiency may be demonstrated via monitoring, and credits adjusted accordingly.

** For additional clarity, in the event that the project achieves 80% Efficiency rate the 3rd year monitoring release would be 302.19 lb TP, 677.88 lb TN, 445,301.36 lbs SED.

Also bringing the cumulative project releases to 581.87 lb TP, 1,595.65 lb TN, 940,518.52 lbs SED.

NOTE: see Appendix G for additional detail.

Cold Springs



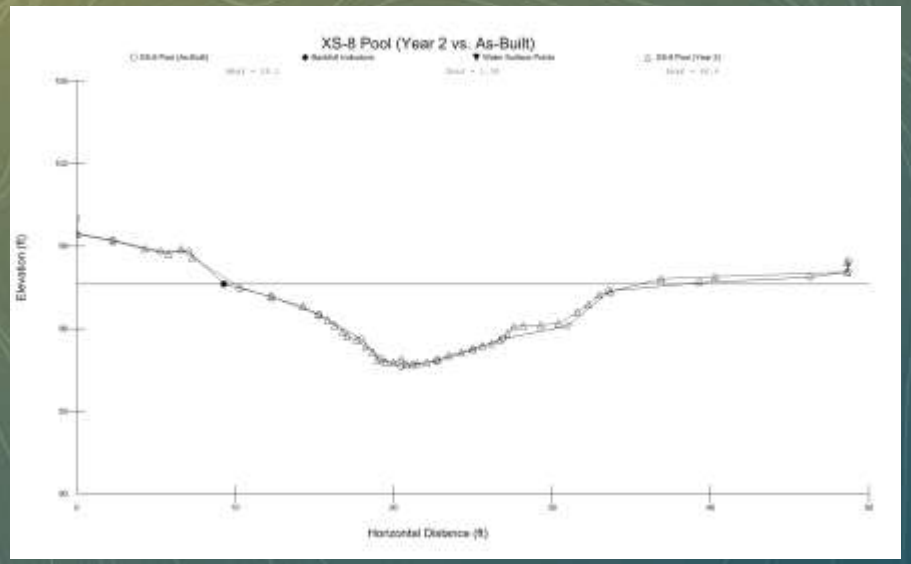
Looking downstream across rock riffle with oxbow off-channel wetland storage in background on right

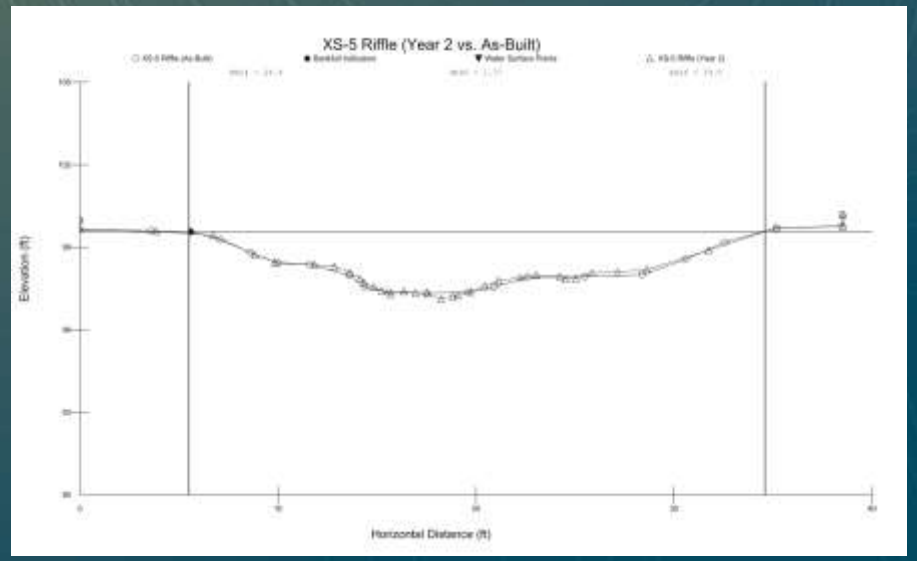
Thalweg Migration Summary
Monitoring Year 2 (2022)
Cold Springs Nutrient Bank

Cross Section ID	Cross Section Type	As-Built Channel Width	Year 2 Change in Feet Compared to As-Built	Percent Change in Thalweg Migration
XS-1	Riffle	32.0	0.35	1%
XS-2	Riffle	26.7	0.5	2%
XS-3	Pool	20.4	0.45	2%
XS-4	Riffle	16.4	0.45	3%
XS-5	Riffle	29.1	0.75	3%
XS-6	Riffle	26.2	0.2	1%
XS-7	Riffle	28.7	0.15	1%
XS-8	Pool	28.4	0.3	1%
XS-9	Riffle	24.3	0.4	2%
XS-10	Pool	27.1	0.15	1%
XS-11	Pool	20.9	0.2	1%
XS-12	Riffle	23.6	0.7	3%
XS-13	Pool	40.9	0.87	2%
XS-14	Pool	17.9	0.4	2%
XS-15	Riffle	27.8	0.55	2%
XS-16	Pool	24.1	0.85	4%
XS-17	Riffle	31.0	0.4	1%
XS-18	Pool	24.1	0.15	1%

** Data per Clearwater Ventures As-Built received from DEQ*

Stability Rating





Width Depth Ratio Stability Summary
Monitoring Year 2 (2022)
Cold Springs Nutrient Bank

Cross Section ID	Cross Section Type	As-Built	Year 1	Year 2	Width/Depth Ratio Stability Rating (Year 2 vs As-Built)
XS-1	Riffle	30.7	33.8	33.9	1.1
XS-2	Riffle	30.3	32.5	33.1	1.1
XS-4	Riffle	11.8	12.3	11.1	0.9
XS-5	Riffle	21.1	22.7	21.5	1.0
XS-6	Riffle	23.8	22.7	22.9	1.0
XS-7	Riffle	20.7	20.2	22.1	1.1
XS-9	Riffle	19.6	19.4	20.0	1.0
XS-12	Riffle	17.1	19.6	17.3	1.0
XS-15	Riffle	27.7	28.3	29.5	1.1
XS-17	Riffle	29.0	29.8	29.7	1.0

**** Data per Clearwater Ventures As-Built received from DEQ***

Year 2 Vegetation Monitoring

- Platanus occidentalis / American sycamore
- Acer negundo / Boxelder
- Salix nigra / Black willow
- Acer rubrum / Red maple
- Quercus rubra / Northern red oak
- Juglans nigra / Black walnut
- Hamamelis virginiana / American witch-Hazel

** Data per Clearwater Ventures As-Built received from DEQ*

Looking upstream at constructed riffle and pool with toe wood.

Note bench/bar access on inner bend.

Note RR and Power line in valley.

Woody Stems

Date:	7/21/22	Woody Stems														
Project Name:	Cold Springs Nutrient Bank - Year 2 (2022)															
Indicator	Scientific Name / Common Name	VP-01	VP-02	VP-03	VP-04	VP-05	VP-06	VP-07	VP-08	VP-09	VP-10	VP-11	VP-12	VP-13	VP-14	VP-15
Native / Non-Invasvie																
OBL	Cephalanthus occidentalis / Common buttonbush															
OBL	Rosa palustris / Swamp rose															
OBL	Salix nigra / Black willow												6		4	
FACW	Cornus amomum / Silky dogwood															
FACW	Quercus michauxii / Swamp chestnut oak							1								
FACW	Quercus palustris / Pin oak													1		
FACW	Betula nigra / River birch															
FACW	Fraxinus pennsylvanica / Green ash															
FACW	Platanus occidentalis / American sycamore	3	7	2	1	3			6	2	2	3		6		6
FACW	Ulmus americana / American elm															
FAC	Acer negundo / Boxelder	4	2	5	1	1	2	1		1		2	1			1
FAC	Acer rubrum / Red maple			1			1	1	2		1	1				
FAC	Asimina triloba / Common pawpaw															
FAC	Carpinus caroliniana / American hornbeam															
FAC	Diospyros virginiana / Common persimmon											1				
FAC	Liquidambar styraciflua / Sweetgum															
FAC	Nyssa sylvatica / Blackgum															
FAC	Quercus phellos / Willow oak															
FAC	Viburnum dentatum / Southern arrow-wood															
FACU	Celtis occidentalis / Common hackberry															
FACU	Cercis canadensis / Redbud															
FACU	Hamamelis virginiana / American witch-hazel															
FACU	Juglans nigra / Black walnut						1	1								
FACU	Juniperus virginiana / Eastern red-cedar															
FACU	Liriodendron tulipifera / Tuliptree															1
FACU	Morus rubra / Red mulberry															
FACU	Quercus rubra / Northern red oak			1				2		1		1	1			
FACU	Rhus copallinum / Winged sumac															
UPL	Rhus aromatica / Fragrant sumac															
FAC	Lindera benzoin / Northern Spicebush	1														
NI	Pinus virginiana / Virginia pine							1								
NI	Quercus velutina / Black oak								1							
NI	Sambucus nigra / American black elderberry															
Woody Species Richness		3	2	4	2	2	3	6	3	3	2	5	3	2	1	3
Woody Stem Height (ft)		2.75	3.75	2.25	3.5	1.75	2	2	1	1.5	1.5	2	4	2.75	5	2.5
Total Woody Cover (%)		12	13	10	4	3	3	6	5	2	2	10	10	6	5	7
Total Stems per Plot		8	9	9	2	4	4	7	9	4	3	8	8	7	4	8
Estimated Stems Per Acre		871	980	980	218	436	436	762	980	436	327	871	871	762	436	871
Success Criteria: Greater than 400 Stems per Acre		yes	yes	yes	no	yes	yes	yes	yes	yes	no	yes	yes	yes	yes	yes
Average Species Richness														3		
Average Woody Stem Height (ft)														2.6		
Average Woody Cover (%)														7		
Average Stems Per Plot														7		
Average Estimated Stems Per Acre														775		

** Data per Clearwater Ventures As-Built received from DEQ*

Year 2 Vegetation Monitoring

- Platanus occidentalis / American sycamore
- Acer negundo / Boxelder
- Salix nigra / Black willow
- Acer rubrum / Red maple
- Quercus rubra / Northern red oak
- Juglans nigra / Black walnut
- Hamamelis virginiana / American witch-Hazel
- Quercus michauxii / Swamp Chesnut Oak

Herbaceous Cover

VP-9 North

(07/19/22, G. Kouri)

VP-9 South

(07/19/22, G. Kouri)

VP-9 East

(07/19/22, G. Kouri)

VP-9 West

(07/19/22, G. Kouri)

- Solidago canadensis / Canada goldenrod
- Erigeron annuus / Annual fleabane
- Chamaecrista fasciculata / Partridge pea
- Monarda fistulosa / Oswego-tea
- Oenothera biennis / King's-Cureall
- Daucus carota / Queen Anne's-Lace
- Verbena urticifolia / White vervain

International Concepts

- Alps to the Adriatic Sea

Tagliamento River

- Model Ecosystem for Large European Rivers
- Morphologically Intact Gravel Bed
- 120 inches rainfall/year
- Braided Meandering Channels
- Floodplain Management

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