BLOSSOM

CONSULTING & ENGINEERING

Predictive Decision Making

Interdisciplinary Forward-Thinking Approaches to Tidal Wetland Restoration, Floodplains, & Ephemeral Guts

Case Studies in “Design Scenarios”

The benefits (*and limitations*) of H & H modelling and its role in managing water resources and restoring floodplains in a variety of settings.

1) Tidal Wetland Mitigation: Forward thinking tidal wetland mitigation designed to adapt to rising tides

2) Beaver Creek Watershed Study: Watershed modelling to identify road overtopping for 100-year-old military facility

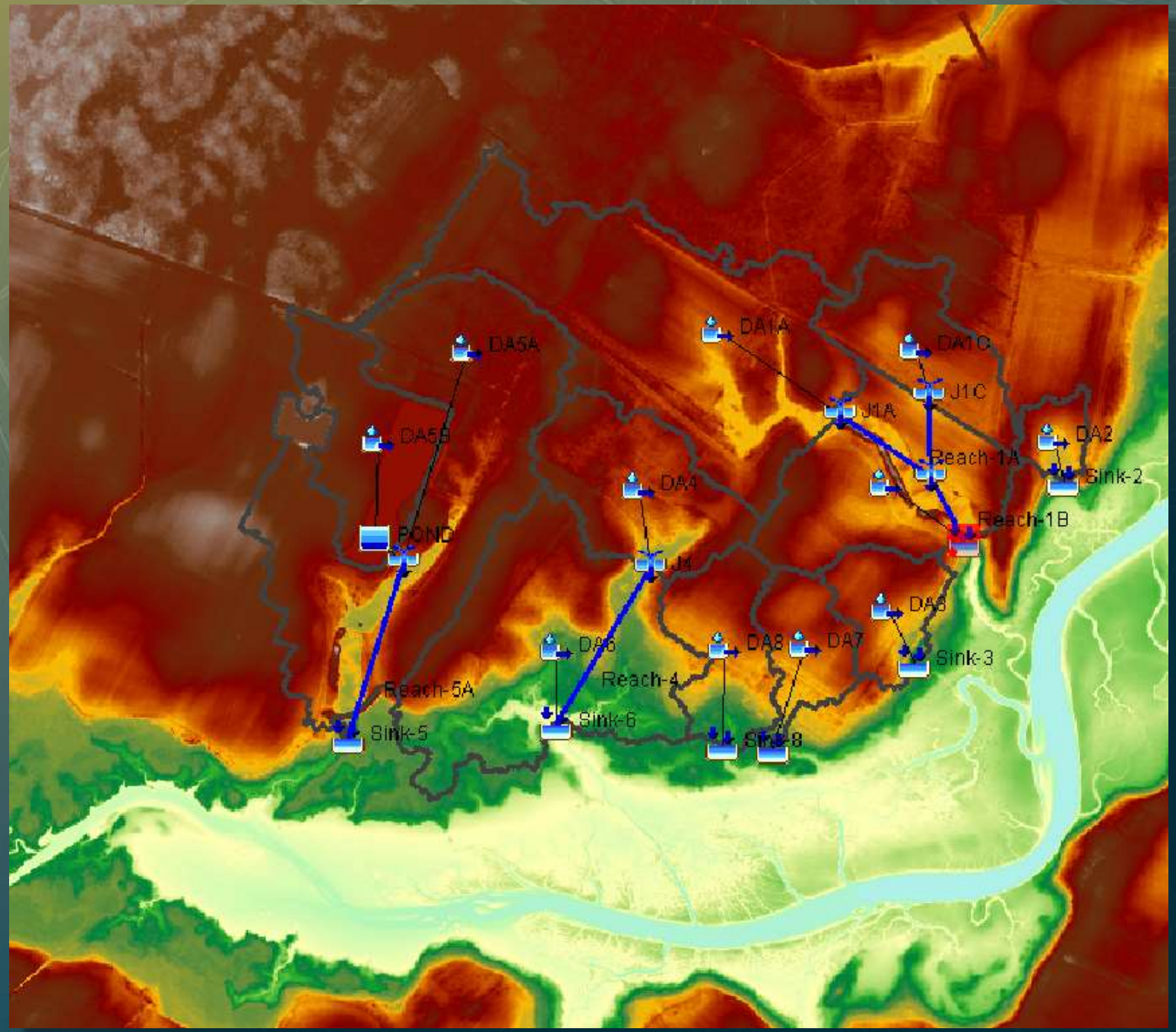
3) Cold Springs: Stream and floodplain restoration for nutrient crediting in the Shenandoah Valley

4) White Bay: Post hurricane stabilization in steep coastal island settings

5) Dam Safety: Comparison to the inundation mapping for hazard class and floodplains

Tidal Wetland Mitigation

Forward thinking tidal wetland mitigation designed to adapt to rising tides



Hydrologic Modeling

- USGS 1 Meter DEM converted to FT-MLW
- Evaluated in HEC-HMS 4.9 using Simple Canopy, SCS Curve Numbers and SCS Unit Hydrograph (Delmarva PRF-284)
- Automated watershed delineation using terrain preprocessing and user identified break points

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

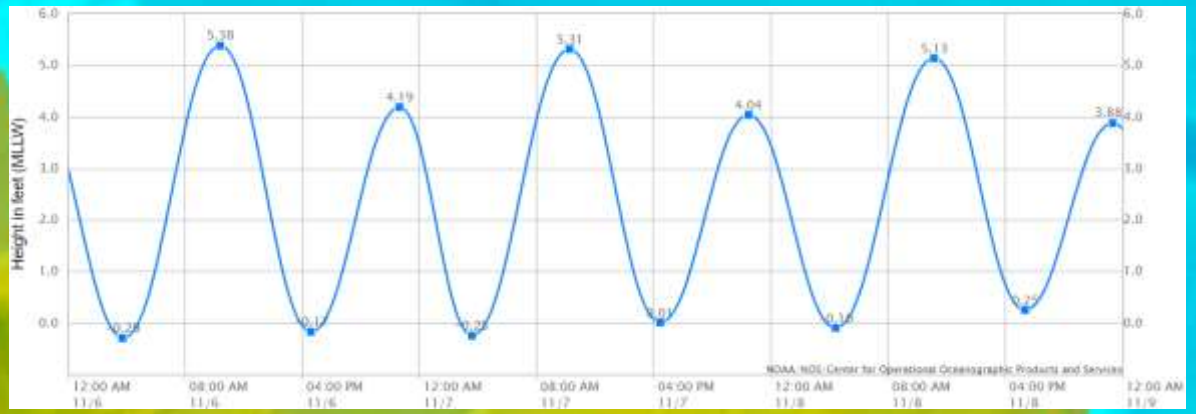
2D Hydraulic Modeling

- Evaluated in HEC-RAS 6.1
- Existing Conditions Terrain and 2D mesh created from USGS DEM (FT-MLW)
- Breakline system developed from existing tidal channels
- Downstream boundary condition developed using NOAA tide data

Existing Berm

Existing Berm

King Tide

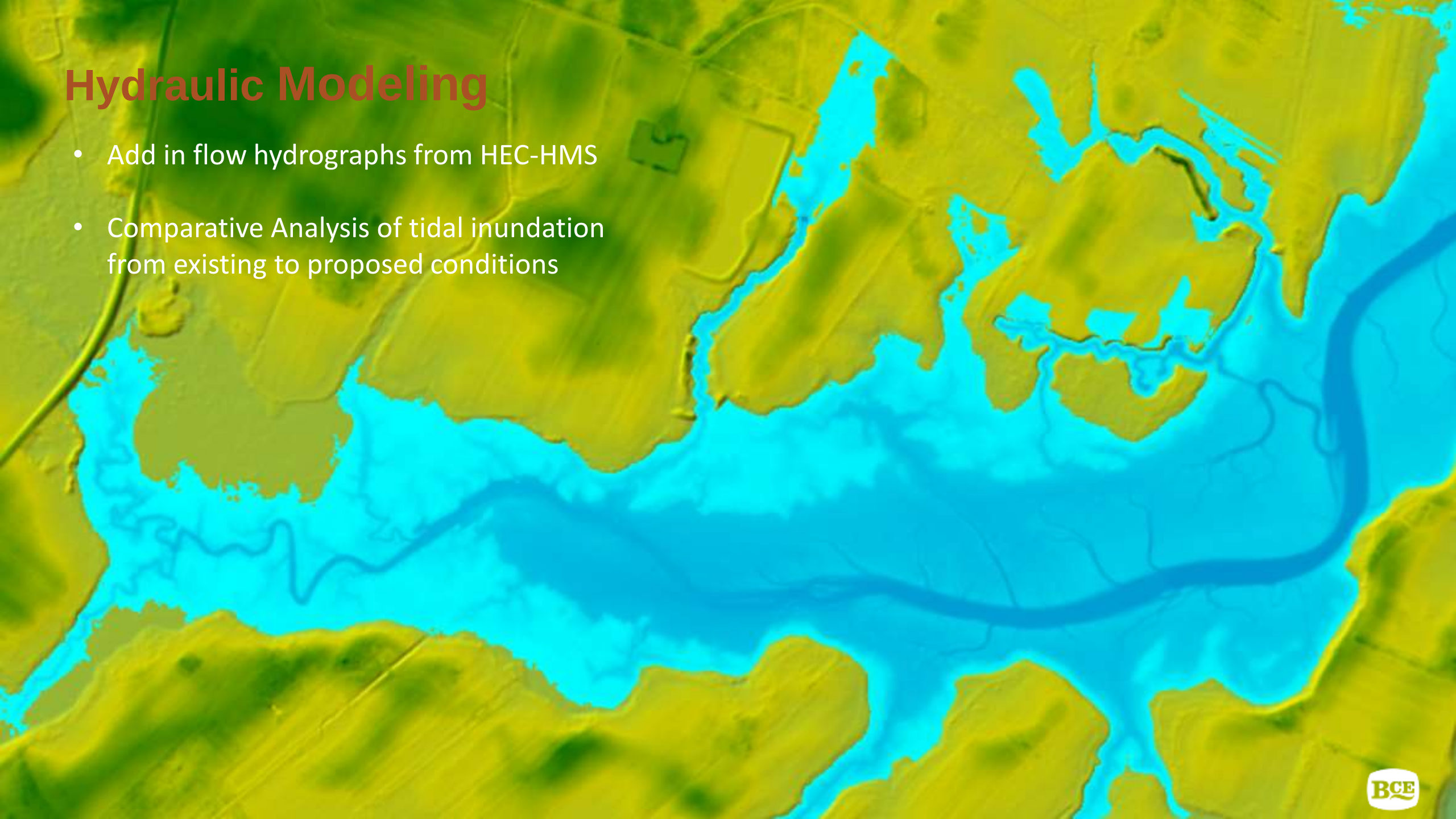


Reference Reach Analysis

- Similar Tidal Wetland Systems
- On Site Stable Sections

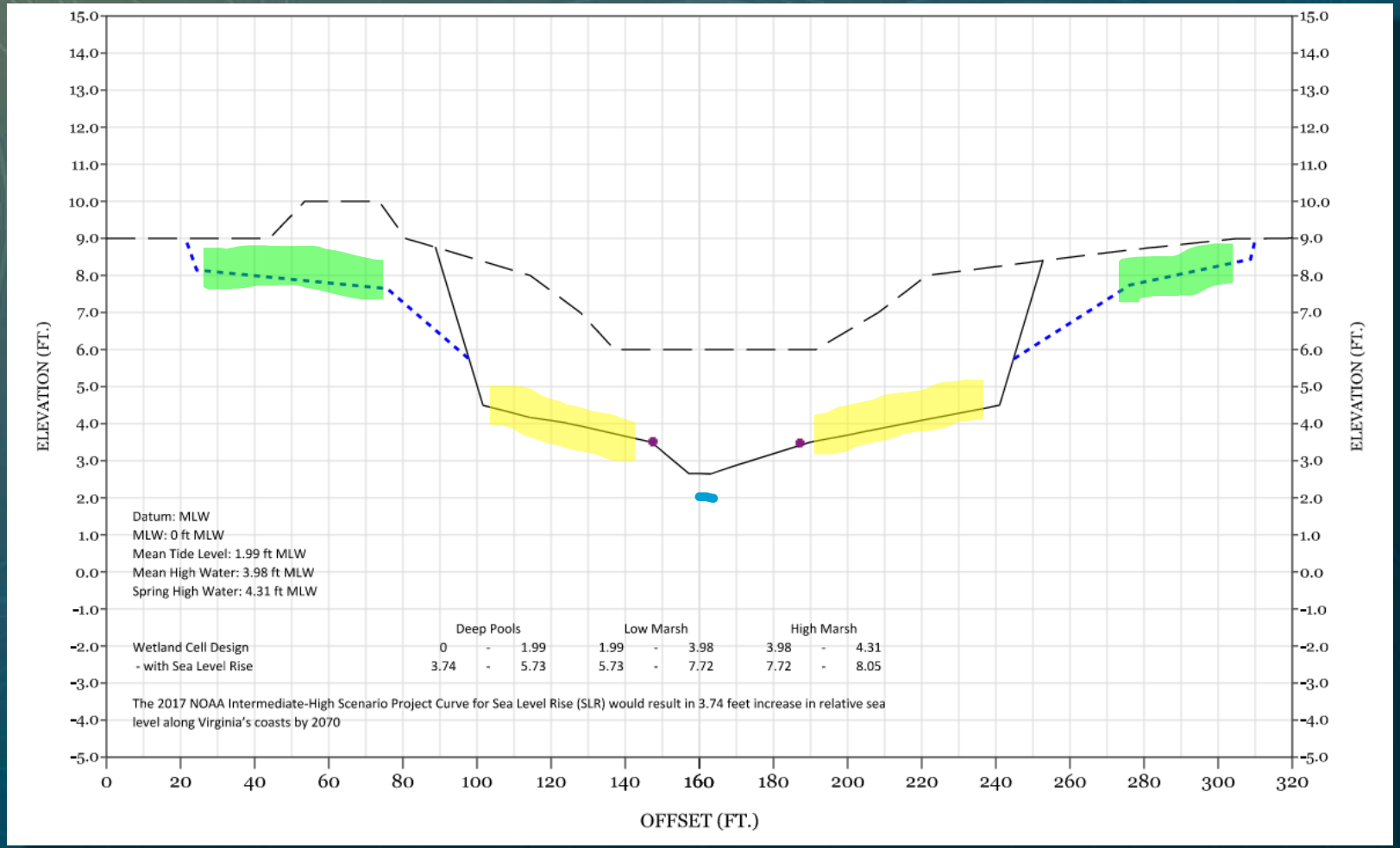
Hydraulic Modeling

- Add in flow hydrographs from HEC-HMS
- Comparative Analysis of tidal inundation from existing to proposed conditions



Sea Level Rise

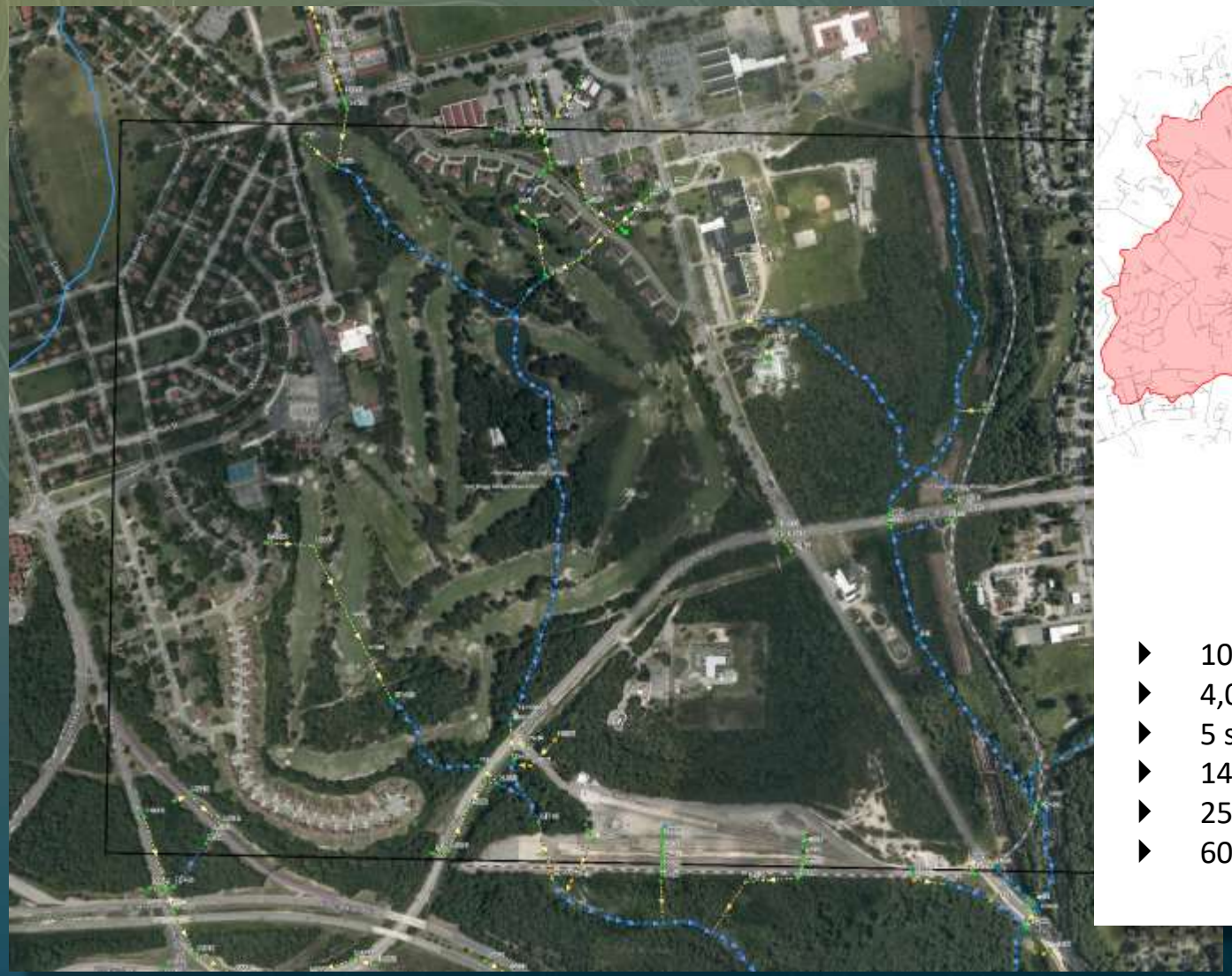
- Evaluate the impacts of Sea Level Rise on Low and High Marsh benches in created wetland systems
- Use the 2017 NOAA Intermediate-High Scenario Project Curve for Sea Level Rise (SLR)

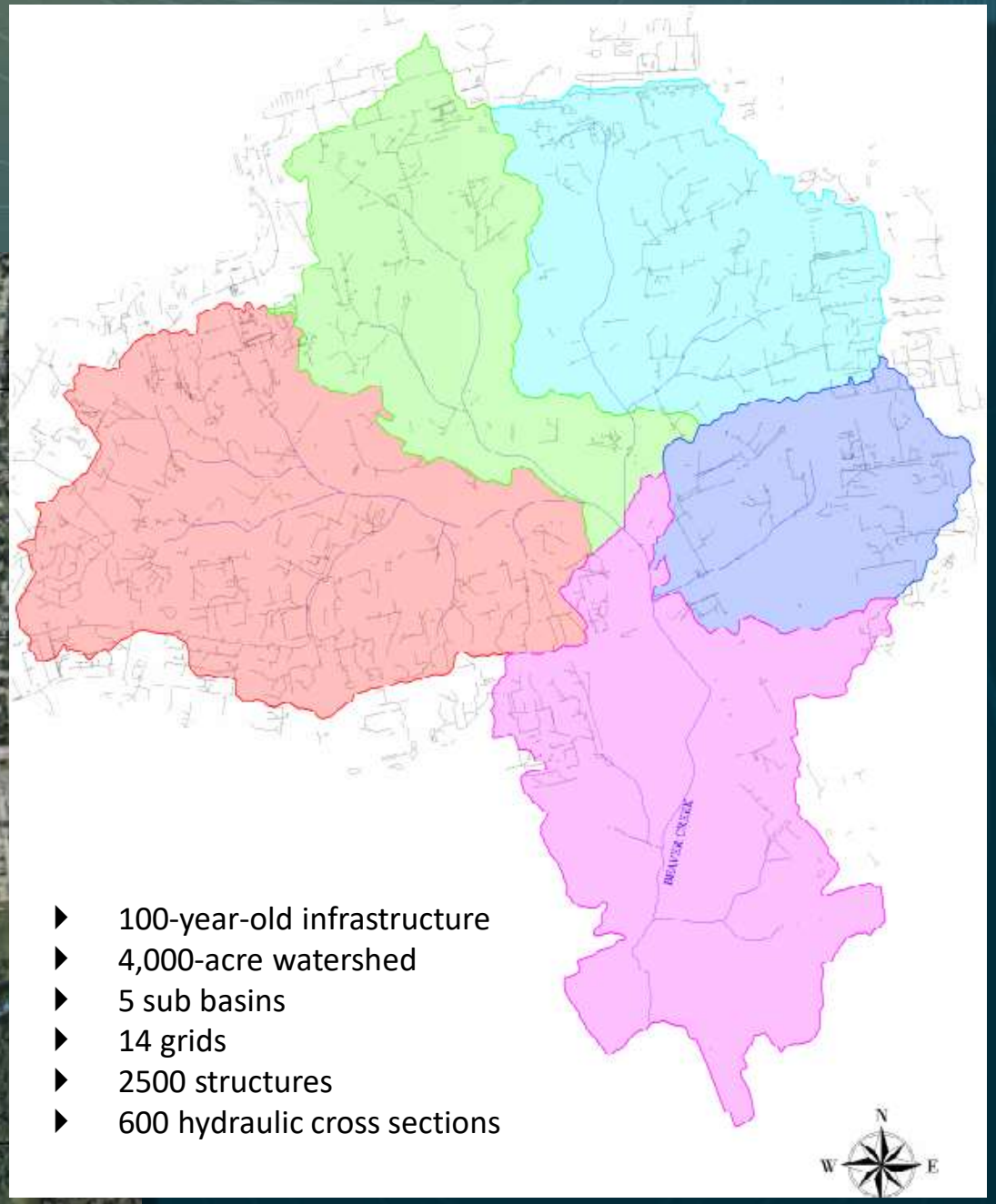


Beaver Creek

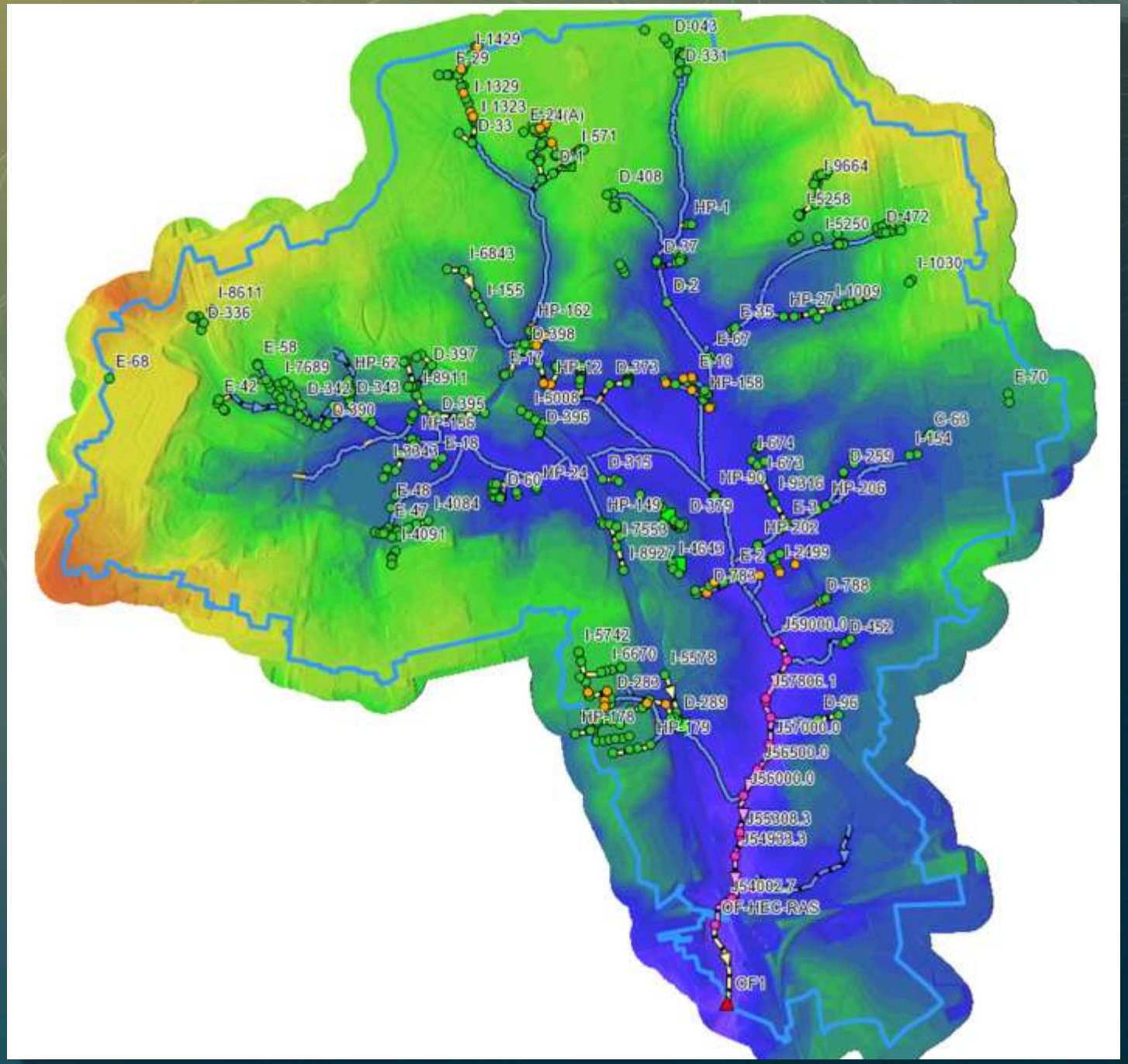
Watershed modelling to identify road overtopping for 100-year-old military facilities

In 2016, NC military base experienced significant flooding, erosion, road closures, and circulation issues during hurricane Mathew





- 100-year-old infrastructure
- 4,000-acre watershed
- 5 sub basins
- 14 grids
- 2500 structures
- 600 hydraulic cross sections

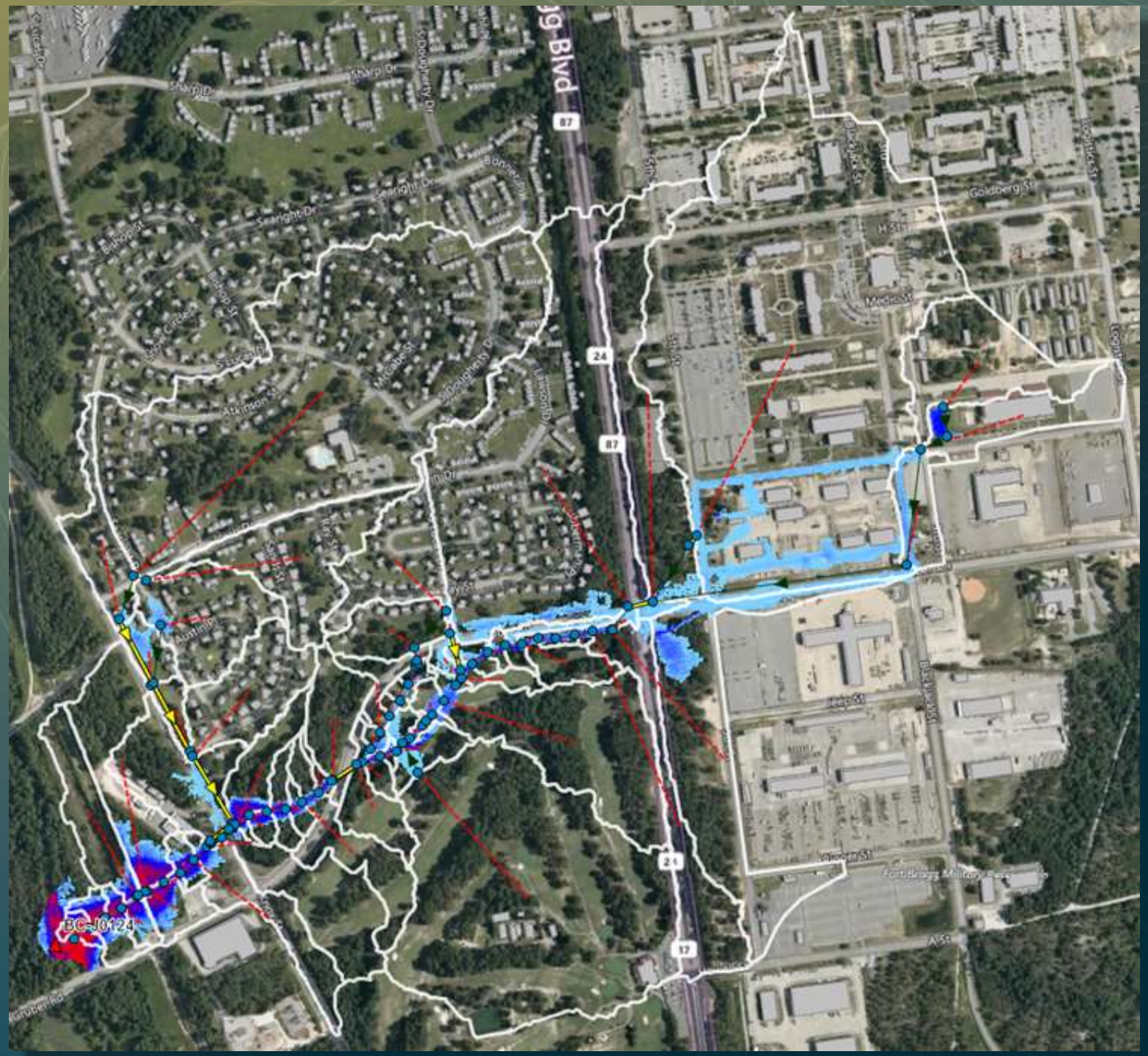


Design storms and scenarios

- 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

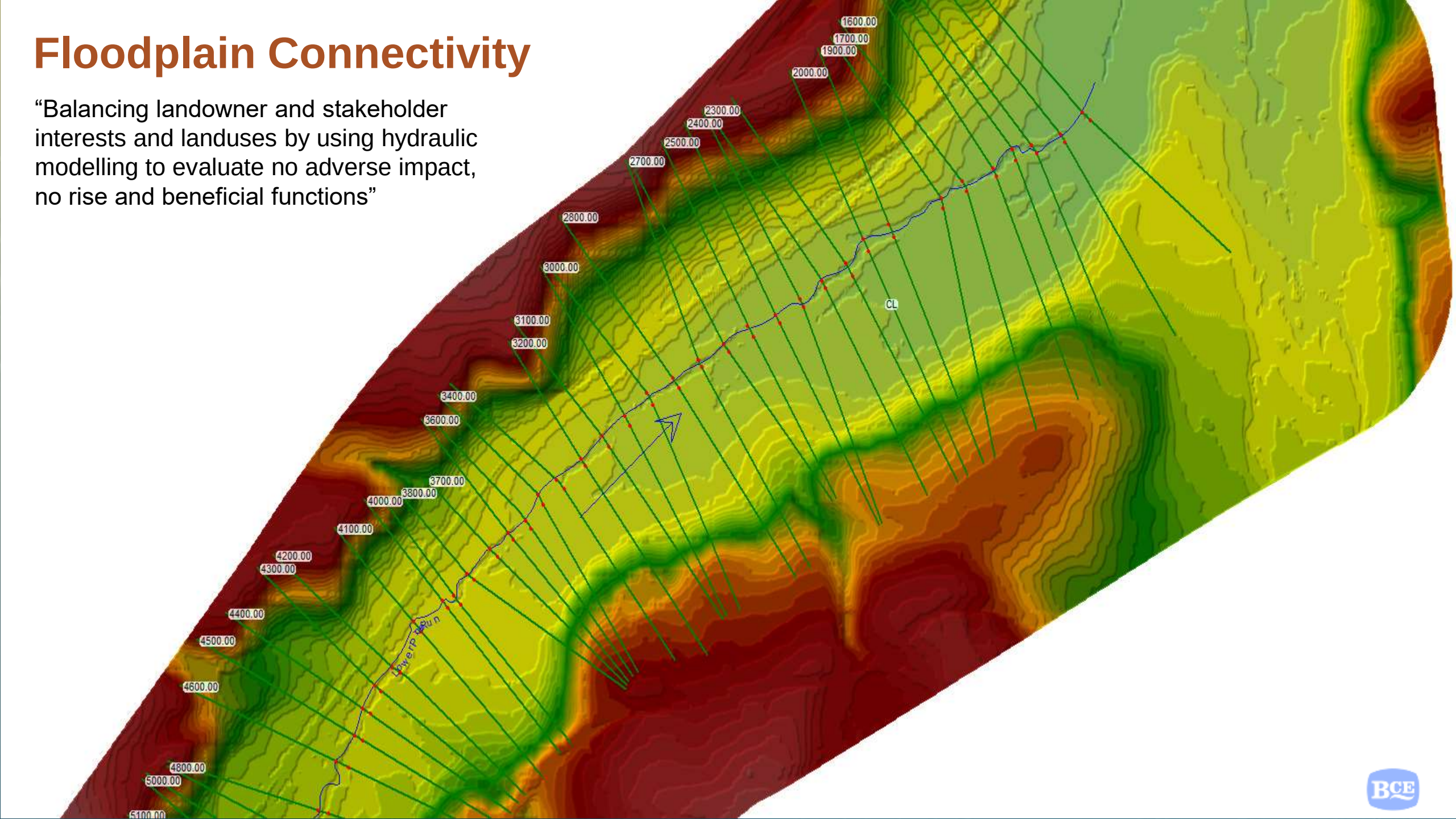
- - Road Elevation, Floodplain Culverts, Off Channel Storage, Restoration
-

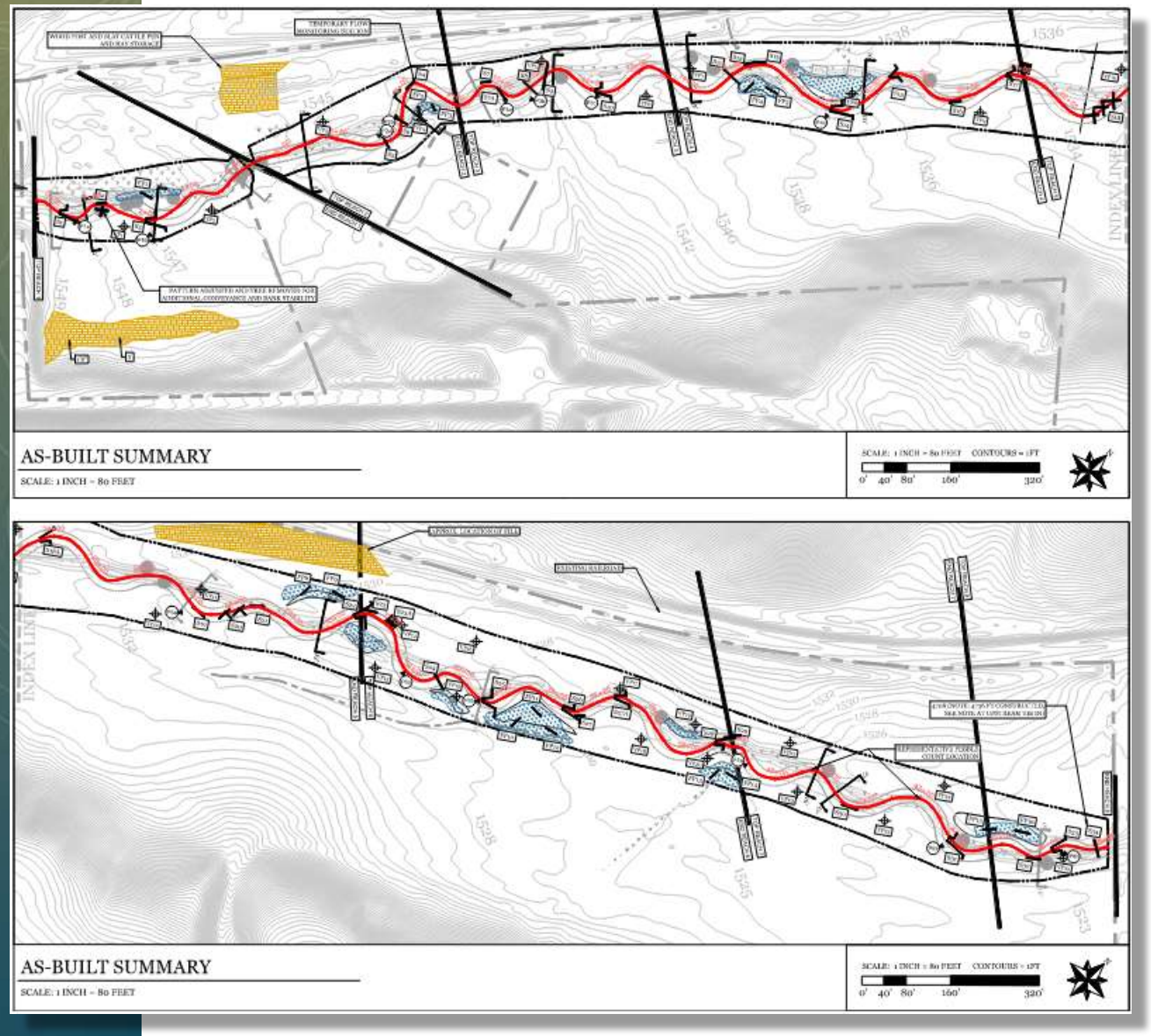
Cold Springs

Stream and floodplain restoration for nutrient crediting in the Shenandoah Valley

Floodplain Connectivity

“Balancing landowner and stakeholder interests and landuses by using hydraulic modelling to evaluate no adverse impact, no rise and beneficial functions”





Design Scenarios

- Perennial Flow Determination
- Wetland Mitigation
- Stream Restoration
- Adjacent Agriculture/Pasture
- No Rise, No Adverse Impact
- Downstream of Lofton Lake Dam (passes the probable maximum flood)

Return Event	Qpeak (CFS)
Bankfull	130
1-year	49
2-year	175
10-year	1,056
25-year	1,961
100-year	3,943

Increased conveyance downstream of road crossing, fencing to left, substation on right bank,– balance of stakeholder interests

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

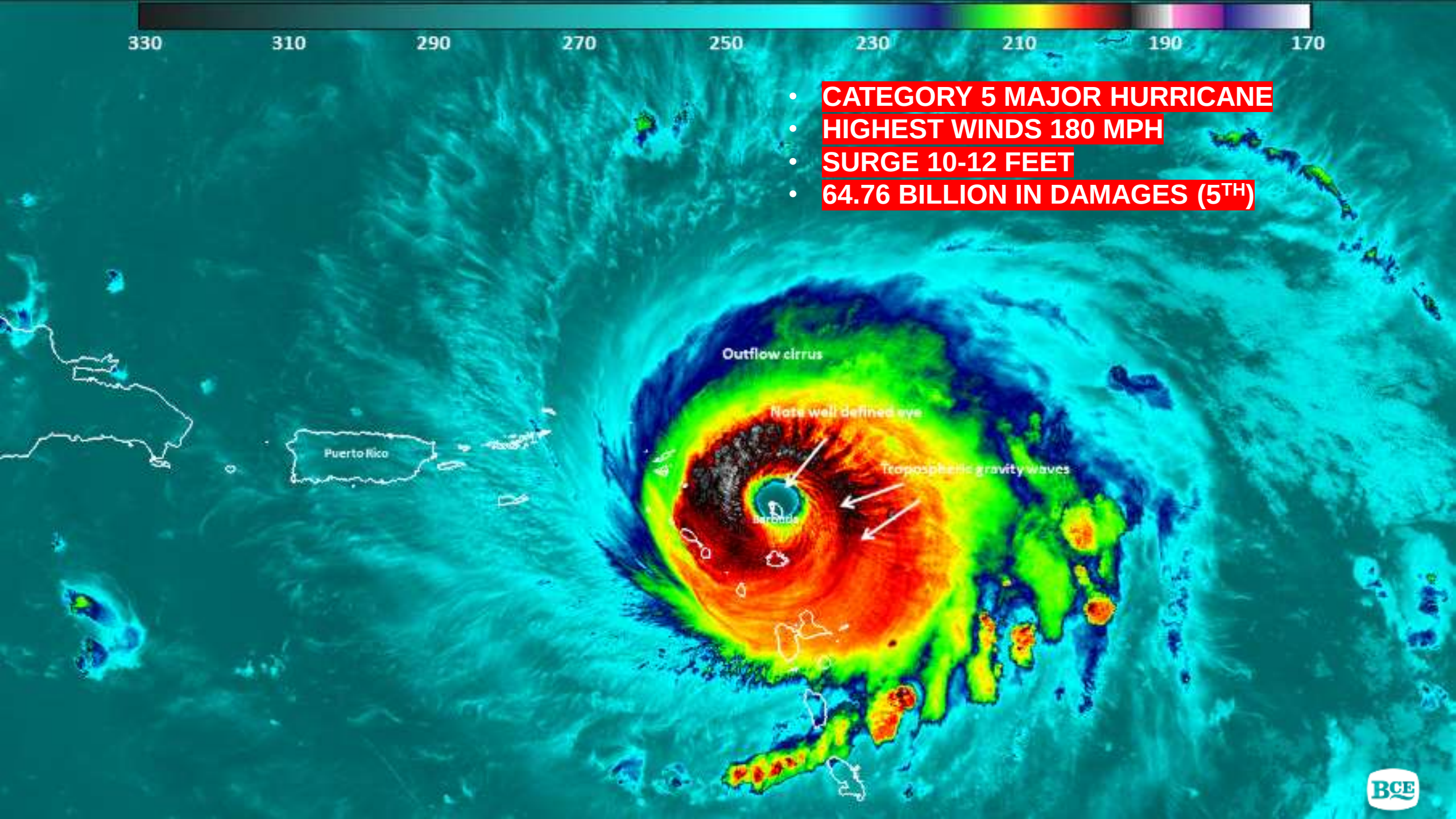
Looking upstream at constructed riffle and pool with toe wood.

Note bench/bar access on inner bend.

Note RR and Power line in valley.

White Bay

Post hurricane stabilization in steep coastal island settings



- CATEGORY 5 MAJOR HURRICANE
- HIGHEST WINDS 180 MPH
- SURGE 10-12 FEET
- 64.76 BILLION IN DAMAGES (5TH)

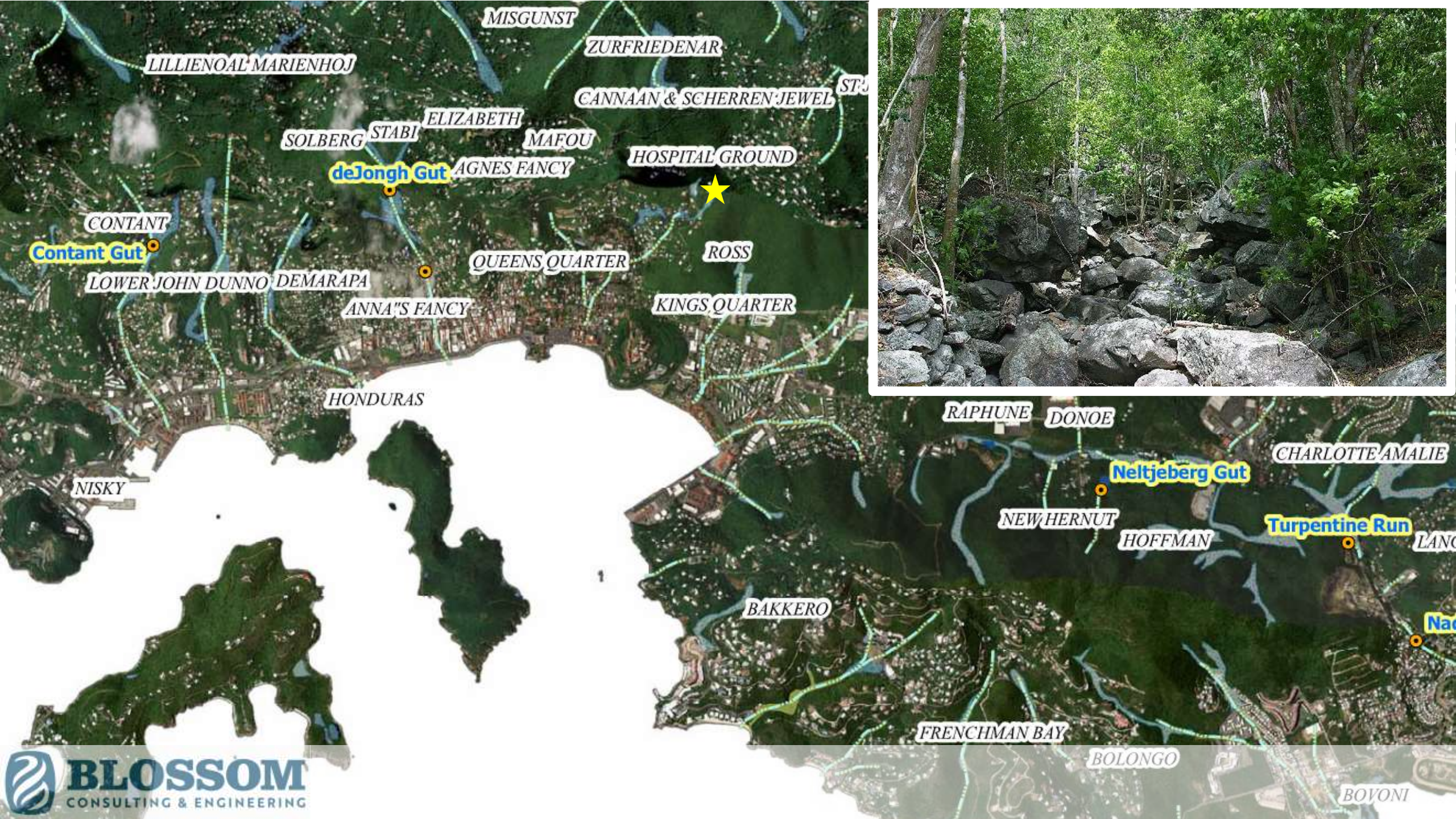

August 25
Tortola
Virgin Gorda
St. Thomas
St. John
September 10
10 km
BCE
N

RESTORATION PLAN FEATURES:

- RAINWATER HARVESTING
- STABILIZATION OF SLOPES, CONVEYANCE ROADSIDE SWALES AND GHUT
- DETENTION/RETENTION SALT POND
- PRETREATMENT/FOREBAY
- ROADWAY FILL
- STABILIZED BEACHSIDE CHANNEL WITH GRADE CONTROL
- HIDDEN STABILIZED EMERGENCY SPILLWAY(S) / VANES / SILLS / REVETMENT
- CORAL REEF RESTORATION

Modeling Strategy

- Atlas 14 Type III Storm
- Observed Water Surface Elevation Boundary Condition



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Urban Design Scenario, Virginia

SELECTED DESIGN FLOW = 53.5 CFS (1.5 YEAR RETURN INTERVAL, TR-55 OUTFALL RESULTS FOR BANKFULL

Regional Curve	Discharge (cfs)	Area (sq-ft)	Width (ft)	Depth (ft)
	Drainage Area (0.090 sq-mi)			
Virginia Piedmont (Rural) (USGS Report 2009-5206)	4.5	1.7	4.6	0.4
Virginia, Maryland (Coastal Plain) (USGS Report 2007-5162)	6.7	2.6	4.3	0.6
West Virginia, Virginia, and Maryland Valley (USGS Report 2005-5076)	6.4	2.2	4.4	0.5
North Carolina - Piedmont - Urban (Doll 2002, SRI)	67.4	12.6	11.0	1.1
North Carolina - Coastal Plain (Doll 2003, SRI)	2.9	3.0	4.6	0.6

BENTLEY SYSTEMS PONDPACK SUMMARY
(JAMES CITY COUNTY, VA, NOAA-C DISTRIBUTION)
(DA 1=58.7 AC, CN=76.6, TC=0.412 HRS)

STORM EVENT (YR)	PEAK DISCHARGE (CFS)	HYDROGRAPH VOLUME (AC-FT)
1	43.10	4.9
2	63.97	7.1
5	101.85	11.1
10	135.62	14.8
25	187.53	20.5
50	233.48	25.6
100	585.03	31.4

BENTLEY SYSTEMS PONDPACK SUMMARY
(JAMES CITY COUNTY, VA, NOAA-C DISTRIBUTION)
(OUTFALL=84.5 AC, CN=78.8, TC=0.412 HRS)
NOT ROUTED THROUGH JCC BMP YC021

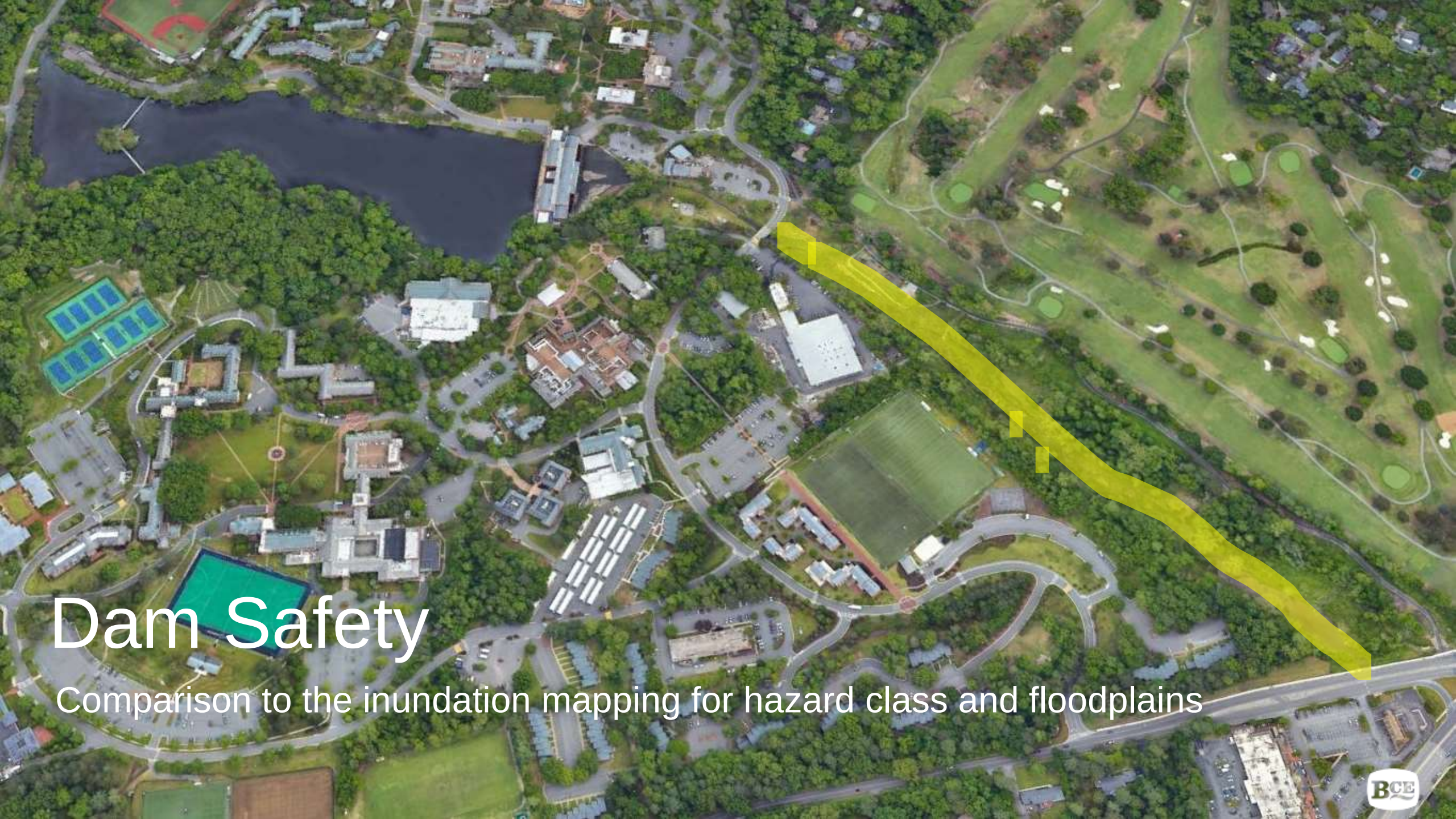
STORM EVENT (YR)	PEAK DISCHARGE (CFS)	HYDROGRAPH VOLUME (AC-FT)
1	62.68	7.0
2	91.18	10.0
5	142.39	15.5
10	187.76	20.4
25	256.99	28.1
50	318.00	35.0
100	386.26	42.7

Setting: Headwater Restoration, Urban Corridor, Utility Constraints

Goal: Increase Safety, Protect Infrastructure & Property

Technique: Increase Flood Prone Area Width, No Rise

Design Scenarios: Routed Flows for up to 10-year
Un-Routed 100-year analysis

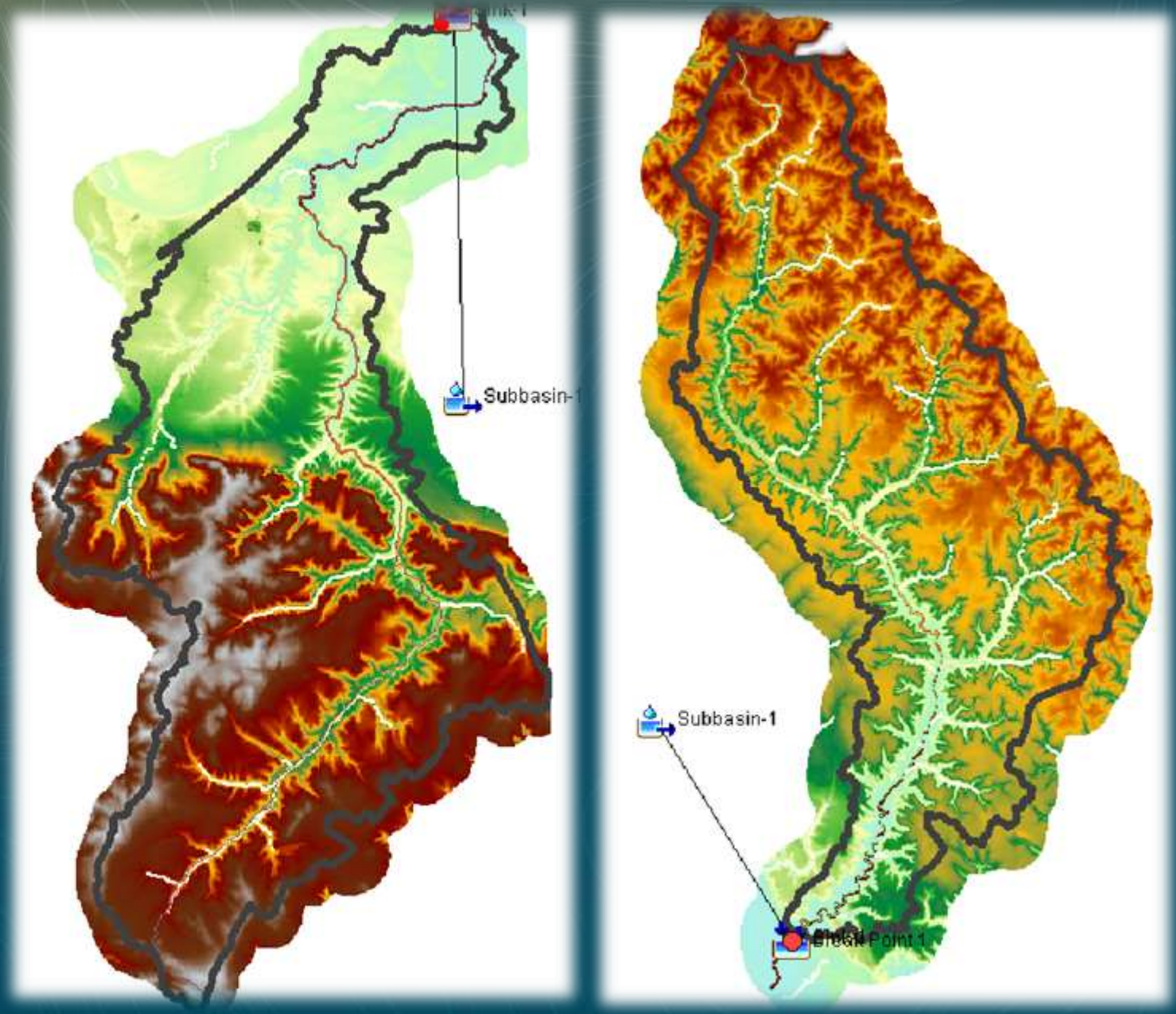


Dam Safety

Comparison to the inundation mapping for hazard class and floodplains

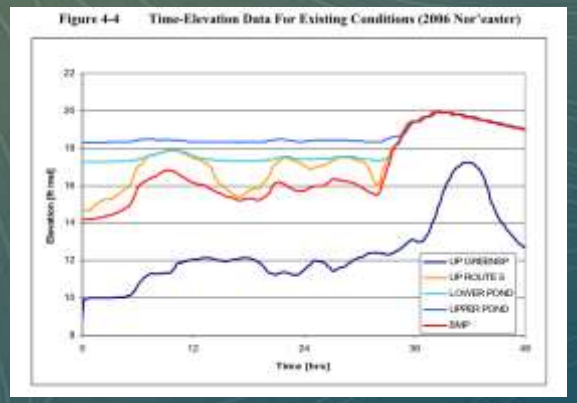
Modeling Strategy

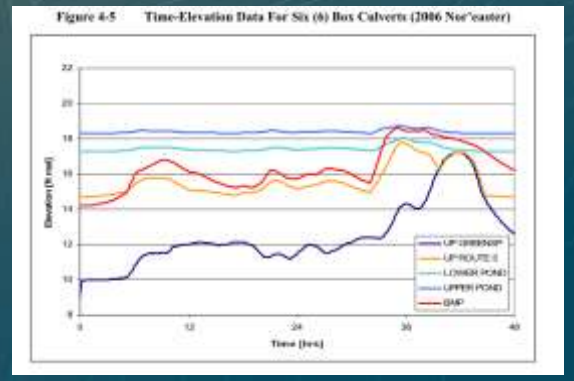
- USGS 1 Meter DEM converted to FT-(NAVD 88)
- Evaluated in HEC-HMS 4.9 to refine Drainage Areas and flow path for Dam Break Inundation Zone (DBIZ) determination
  - Sunny Day
  - PMF (w, w/o breach)
  - SDF (w, w/o breach)
- HEC-HMS used to develop breach unsteady state hydrograph for input into HEC-RAS



Putting It All Together

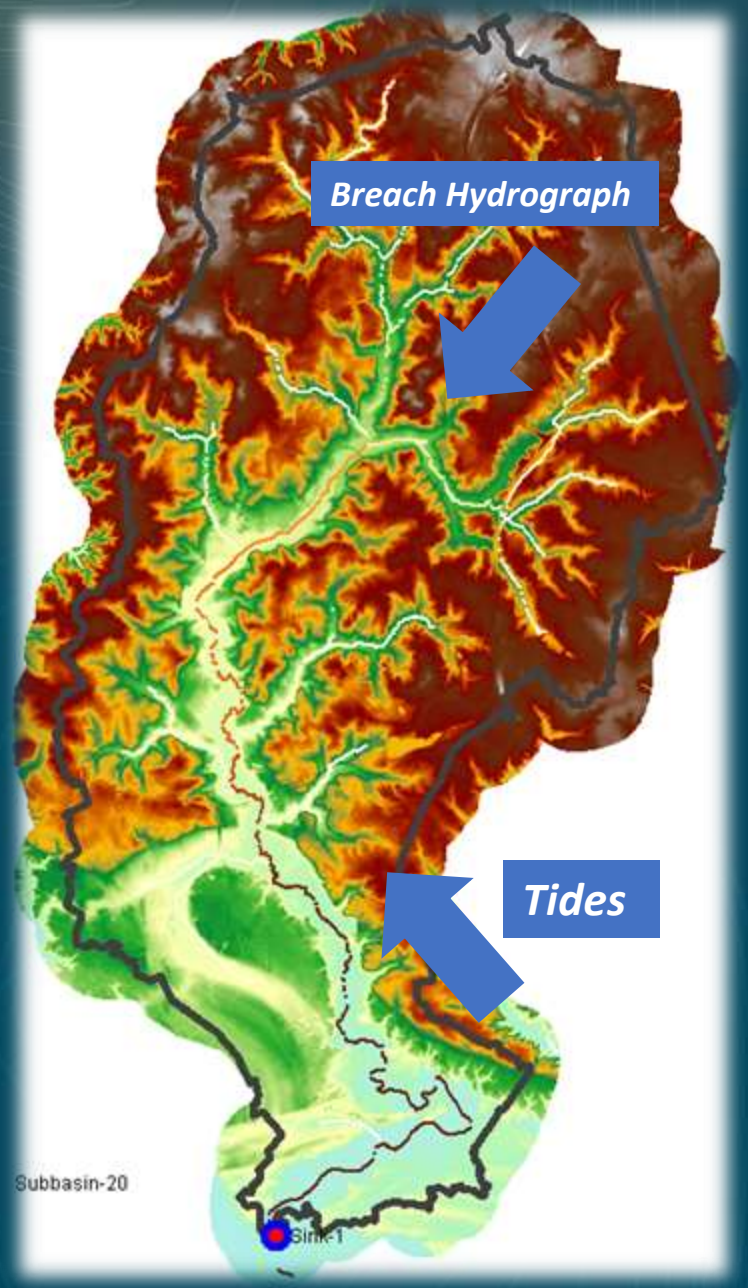
- Forward Thinking Modelling Approaches
  - Tidal Fluctuations
  - Breach Mapping
  - Interface of Riverine and Tidal
- ID Restoration/Mitigation Opportunities
- Improved Confidence for Risk Planning
- Improved Deployment
- Better Emergency Response





Emergency Water Line Repair

Hydraulic Modelling and No Rise Analysis AND consideration of natural tendency and river migration zones



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