

Ellicott City Safe & Sound Extended North Tunnel



The Why, The What, and the How of
Stormwater Conveyance Tunnel Design

June 9, 2023



Presenters



Chris Nelsen, PE, ENV SP
Project Engineer
Delve Underground



Chris Brooks, PE
Director, Water Resources
McCormick Taylor



Zach Hollenbeck, AIA
Deputy Chief, Bureau of Facilities
Howard County Maryland
Department of Public Works

Why

- Flash Flooding History & Background
- *EC Safe and Sound* Program Background
- Adjacent Projects

What

- Hydrology and Flood Modeling
- North Tunnel Alignment and Profile

How

- Diversion and tunnel hydraulics
- Full-scale modeling
- Transients and other hydraulic considerations
- Non-technical challenges
- Special considerations

The Why



MAY 27, 2018

6/27/2023



4:20 p.m.

2016 Storm Damage



2016 Storm Damage



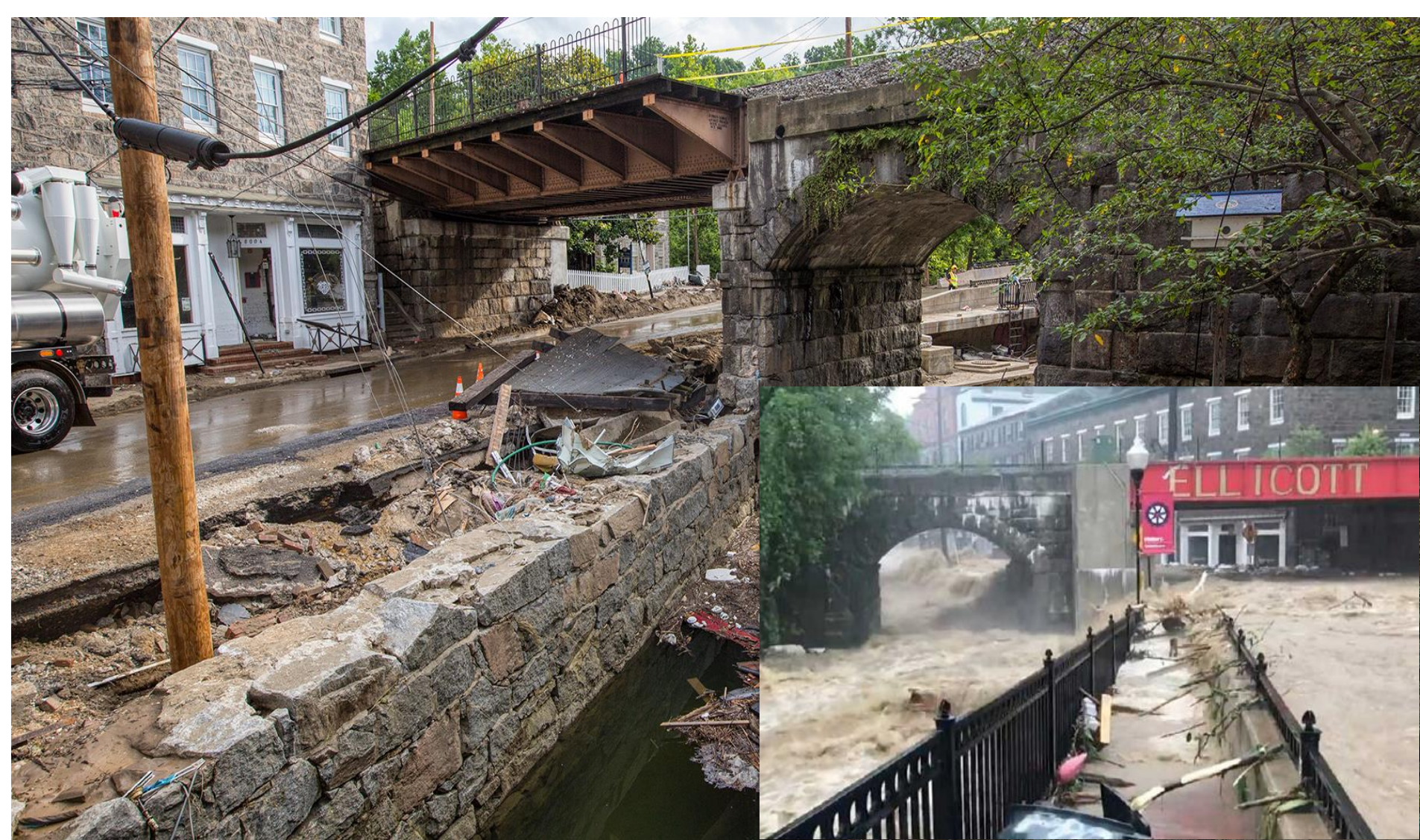
NEWEA
WORKING FOR WATER QUALITY



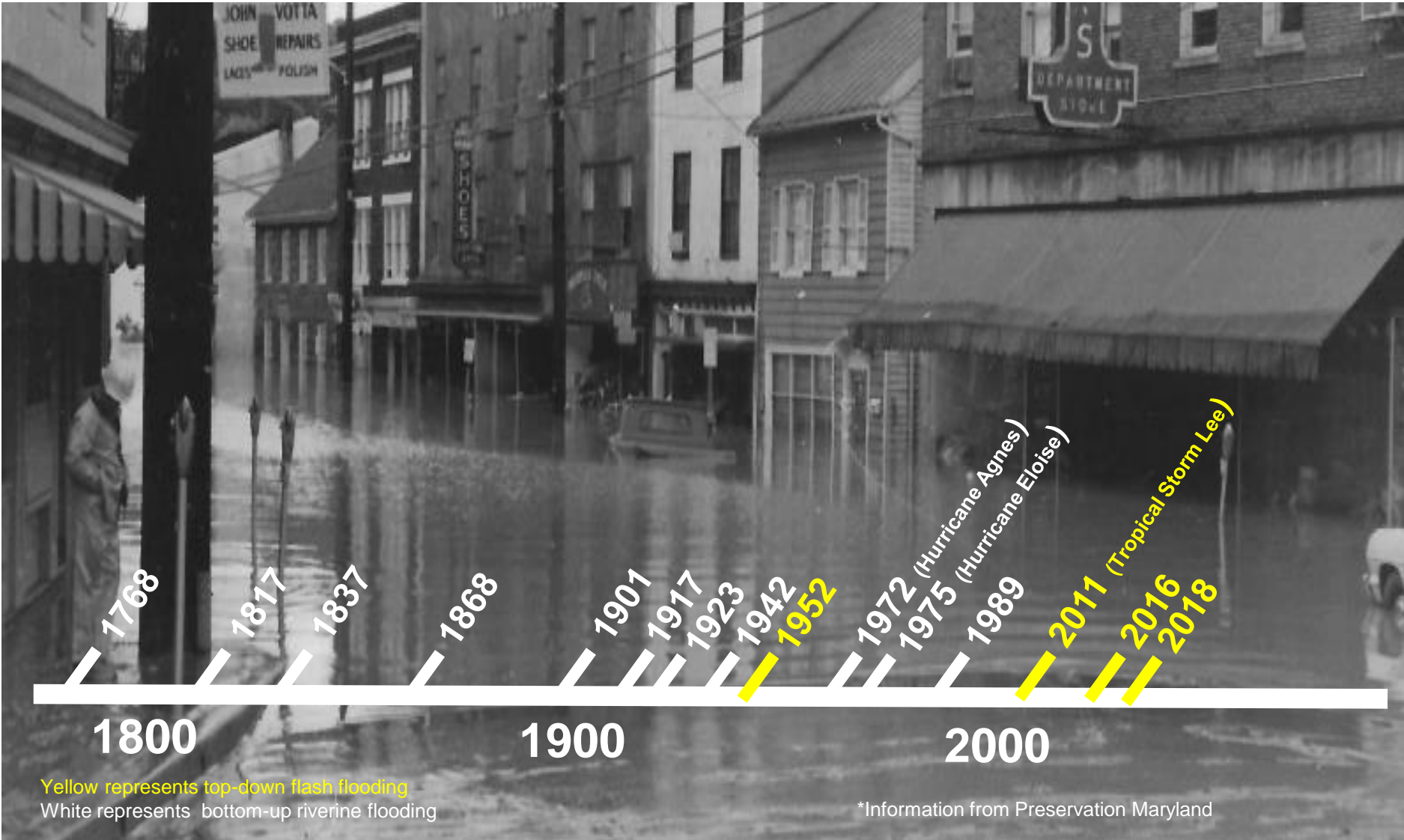
2016 Storm Damage



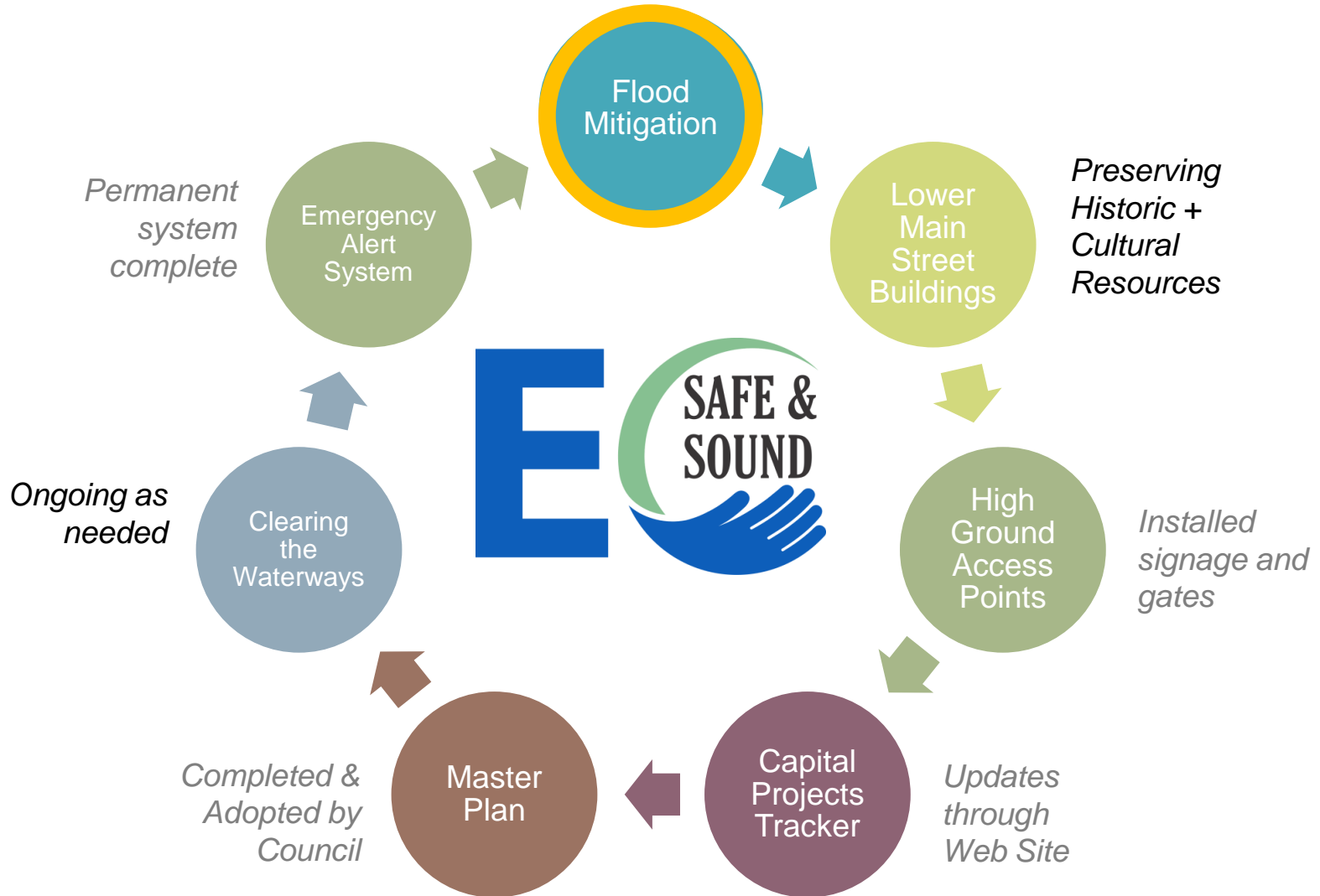
NEWEA
WORKING FOR WATER QUALITY



Timeline of Past Flooding



EC Safe & Sound Program

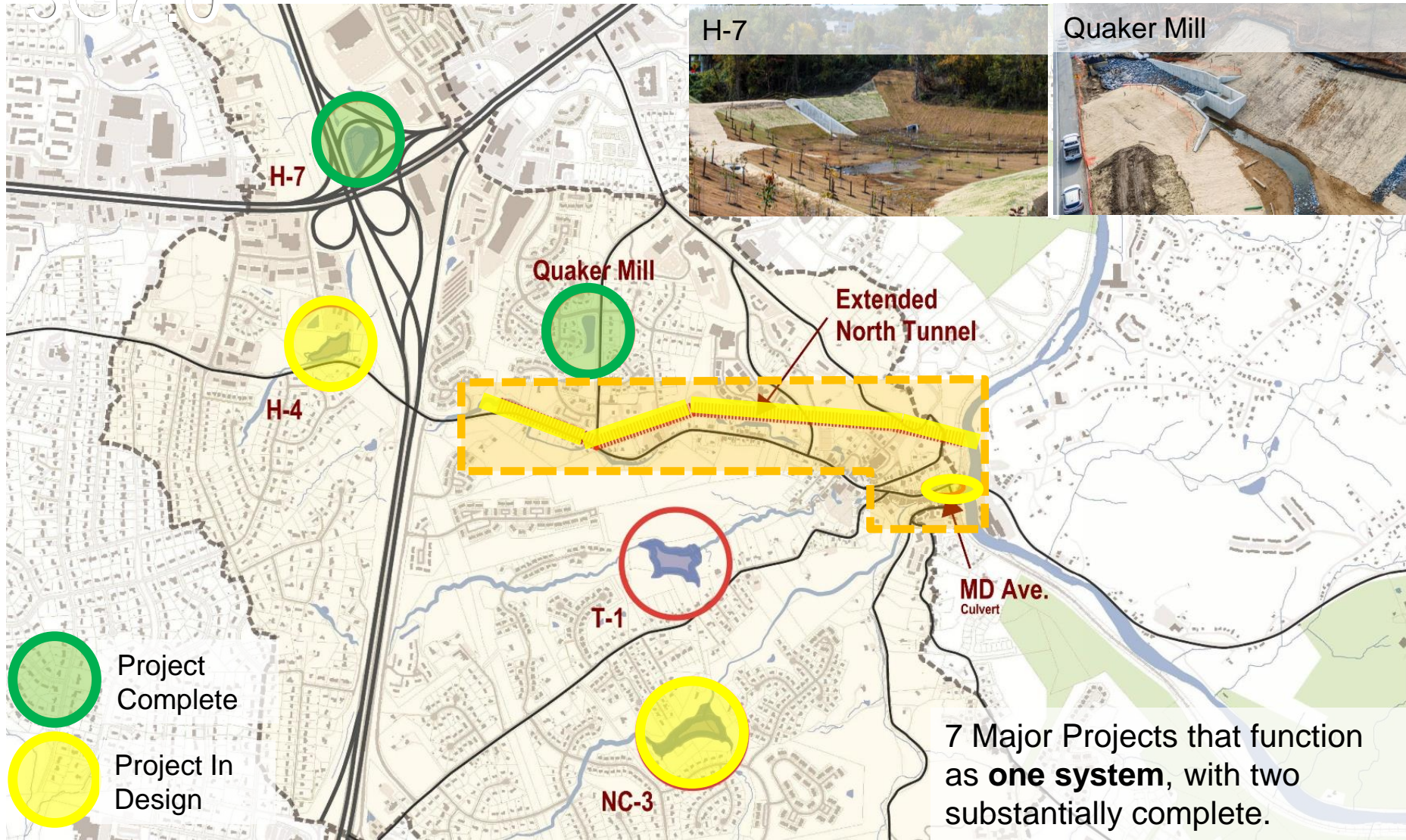


EC Safe & Sound -

3G7.0



NEWEA
WORKING FOR WATER QUALITY

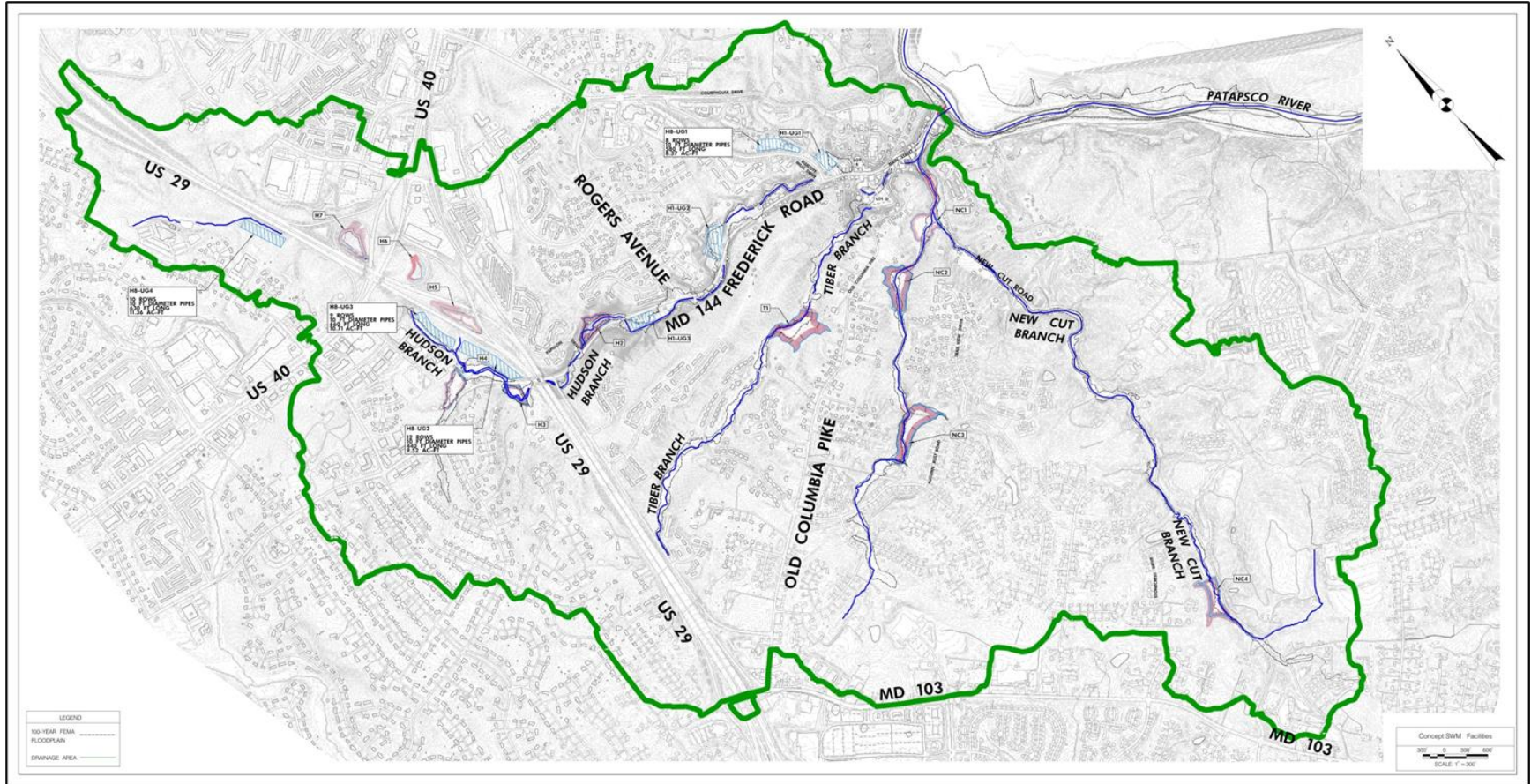


7 Major Projects that function as **one system**, with two substantially complete.

The What



Flood Mitigation Plan - Hydrology



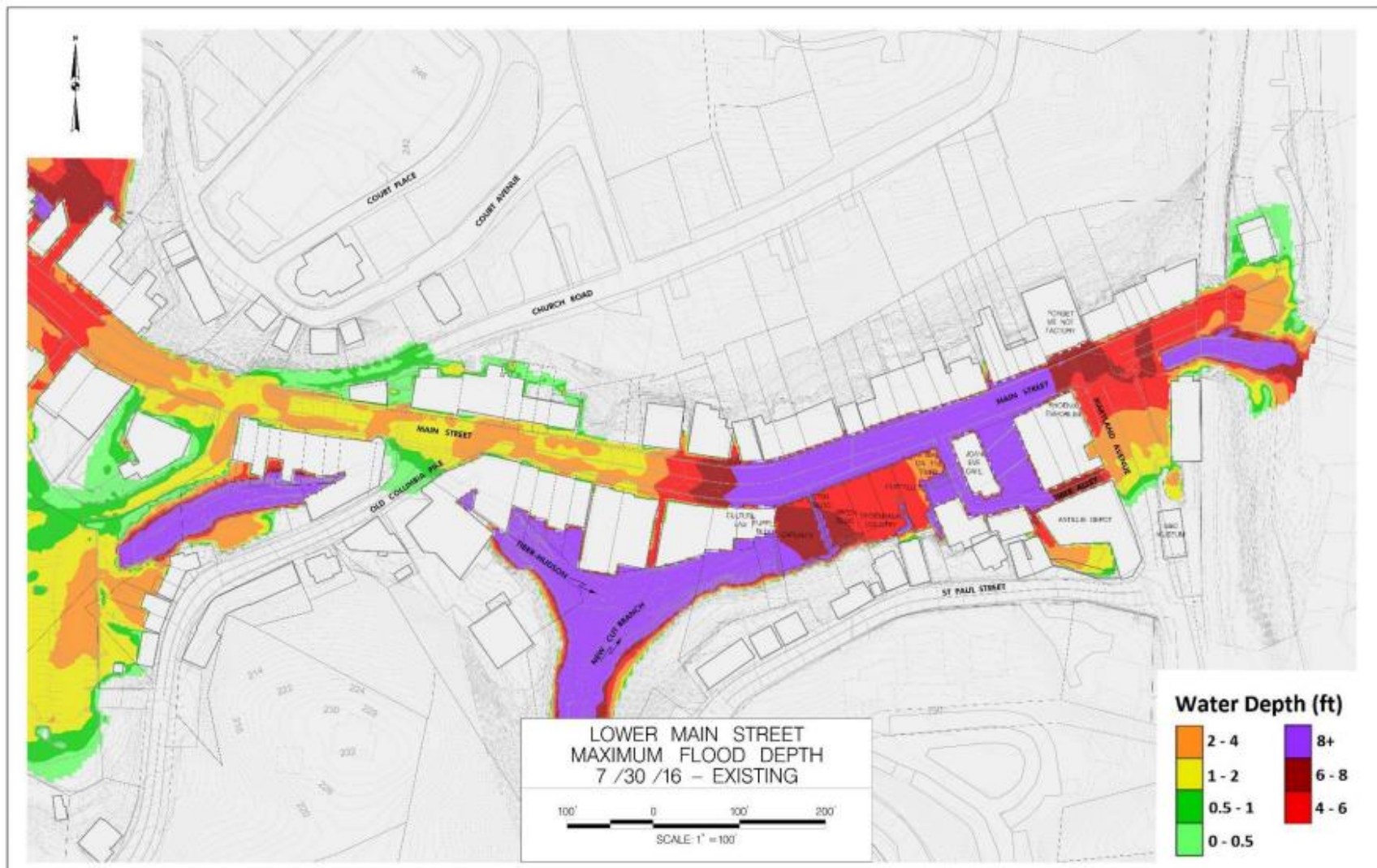
Shape of watershed is key reason for flood severity

Baseline modeling development was first step in mitigation approach

Flood Mitigation Plan - Hydraulics



NEWEA
WORKING FOR WATER QUALITY

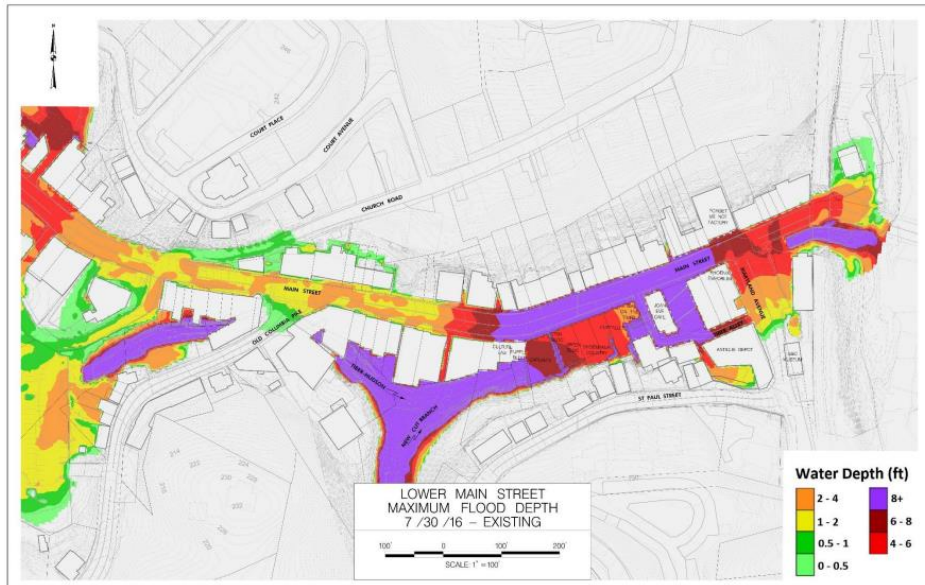


July 2016 Storm Event

Flood Mitigation Plan

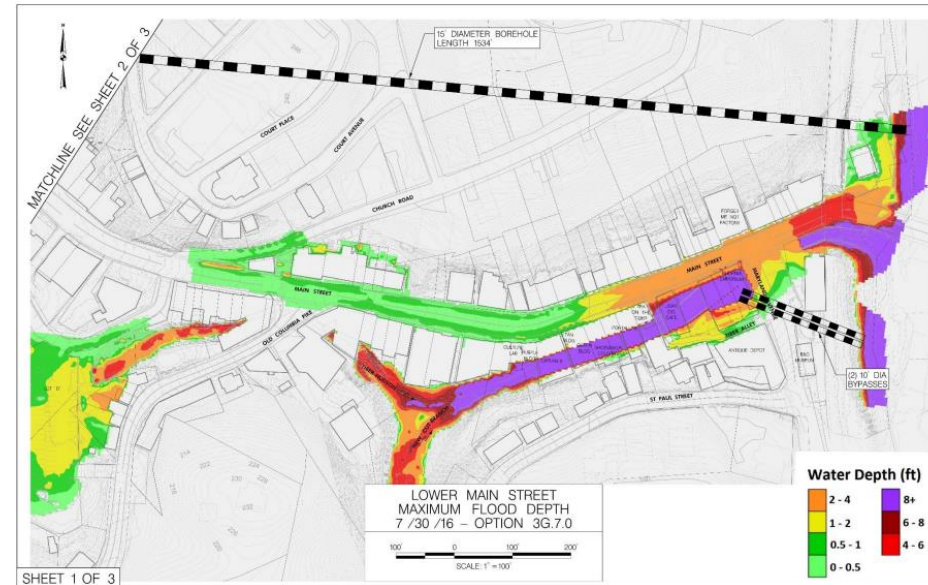


NEWEA
WORKING FOR WATER QUALITY



July 2016 Storm Event

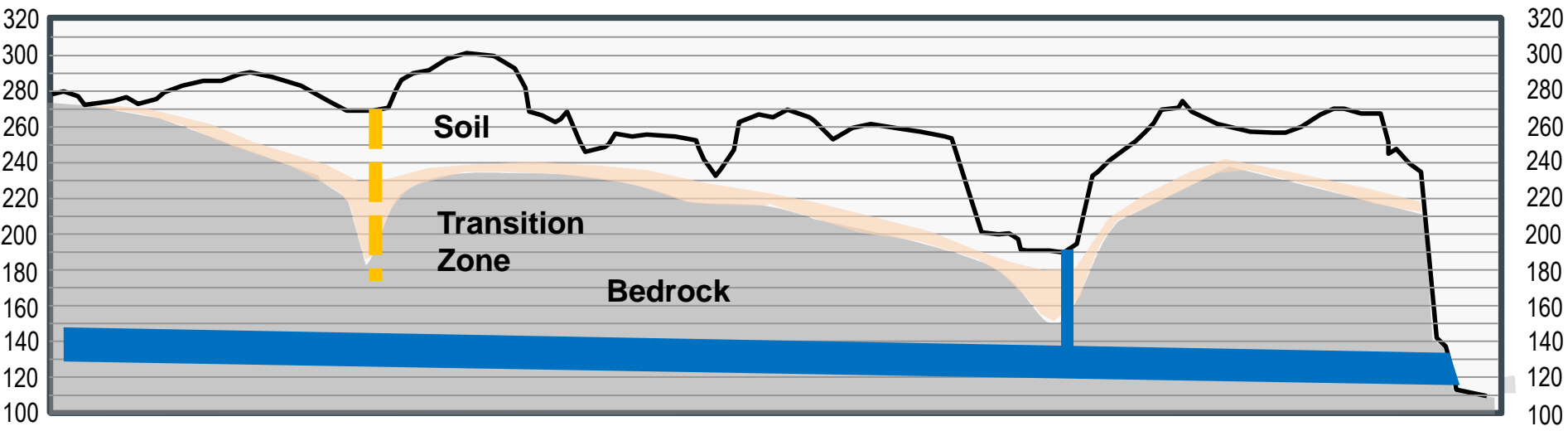
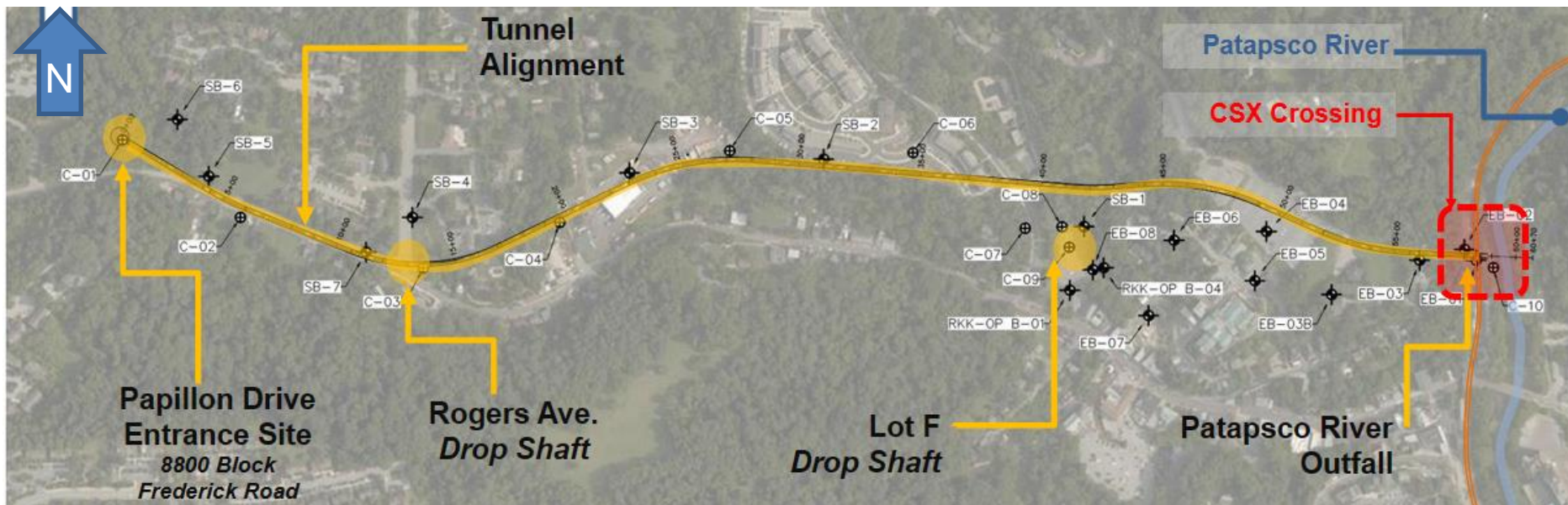
- Goal of reducing depths and velocities as much as possible.
- All projects work together as a system to accomplish this goal.



*Simulating July 2016 Storm Event
With 3G7.0 implemented*

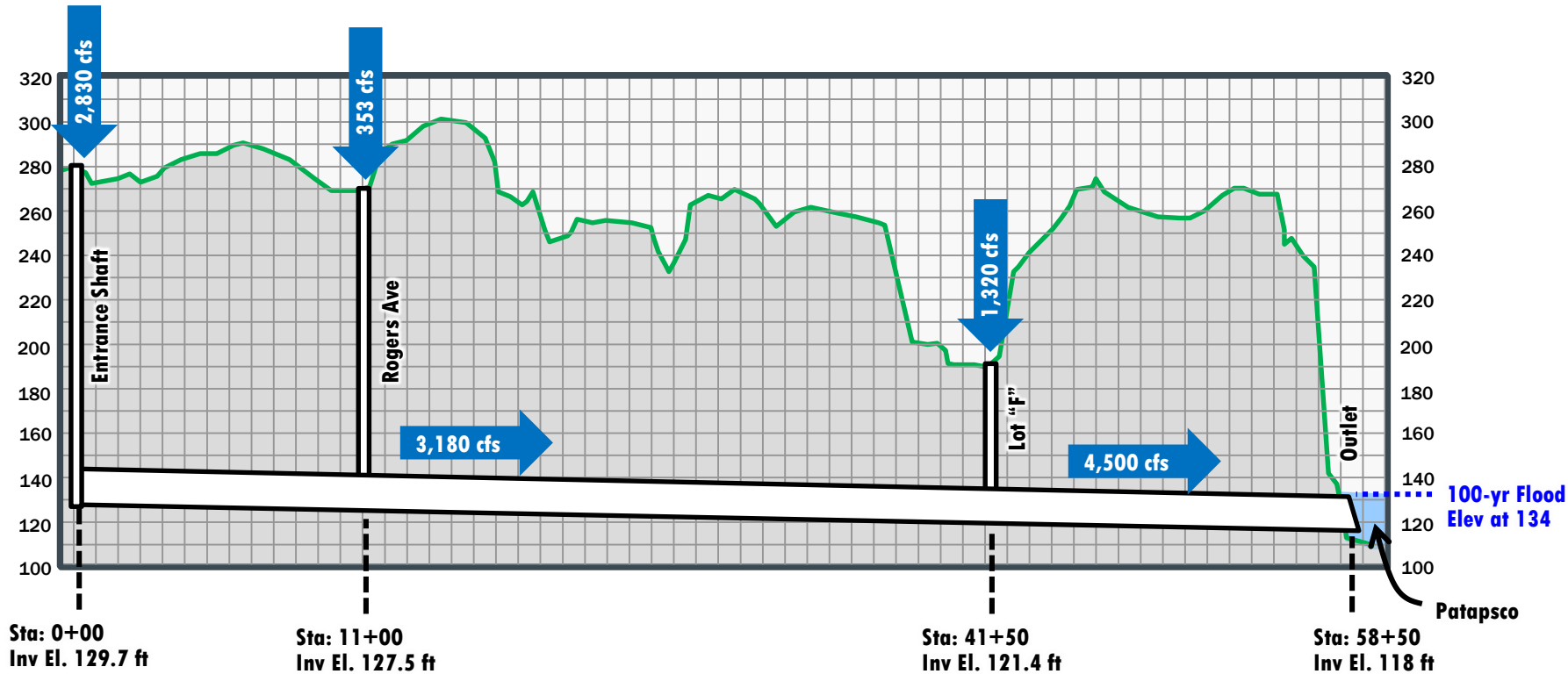
- Reduction in street-level flooding to 3 feet or less a priority in support of non-structural flood proofing
- Reduction in flood velocities down to 5 feet/second (or below) are a priority in support of non-structural flood proofing

North Tunnel Alignment



Tunnel Profile and Peak Design Flows

7/30/2016 Storm



Note: Peak design flows are based on the hydrology after the implementation of the other Safe and Sound Projects and a 1.2 safety factor

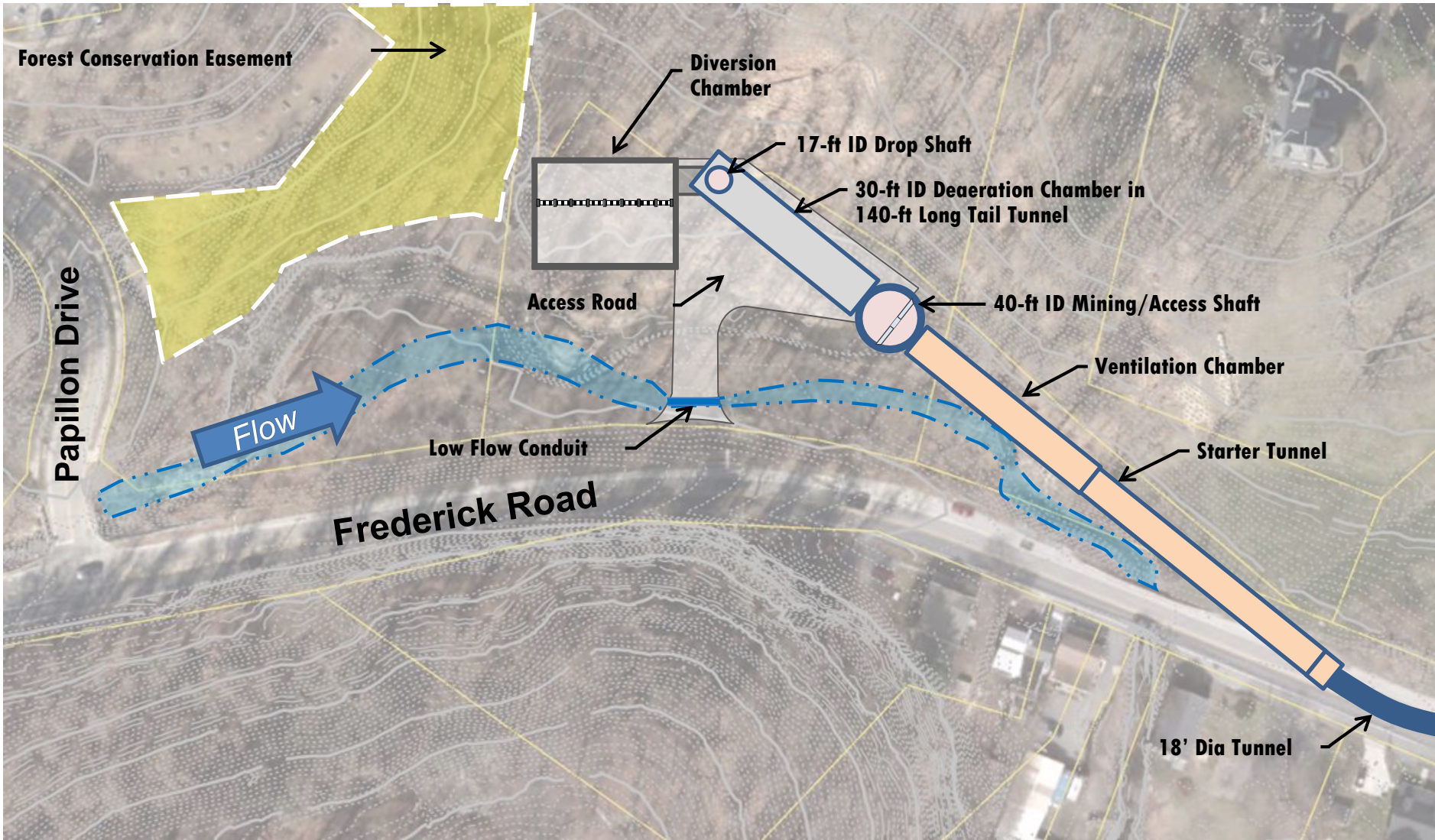
The How



NEWEA
WORKING FOR WATER QUALITY



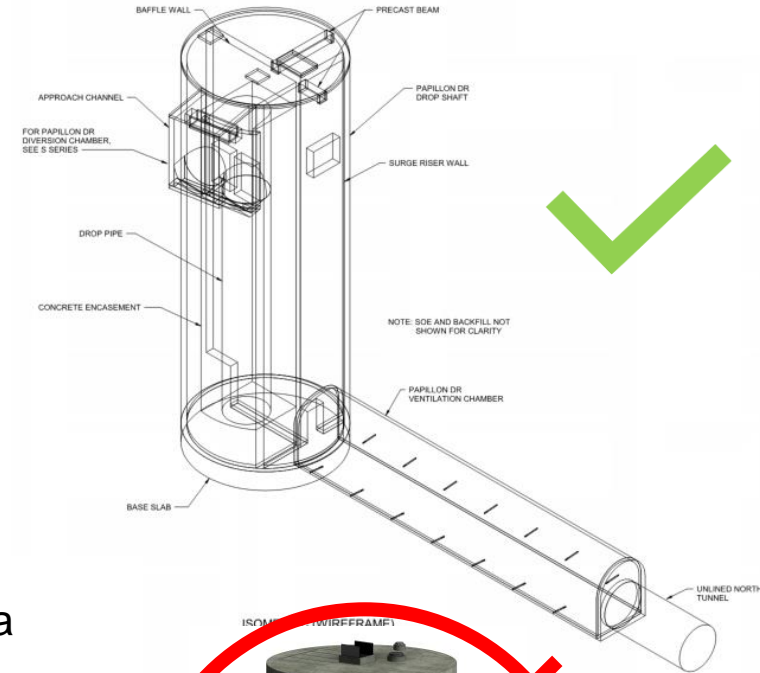
Papillon Drive Site Layout



Drop Shaft @ Papillion Drive

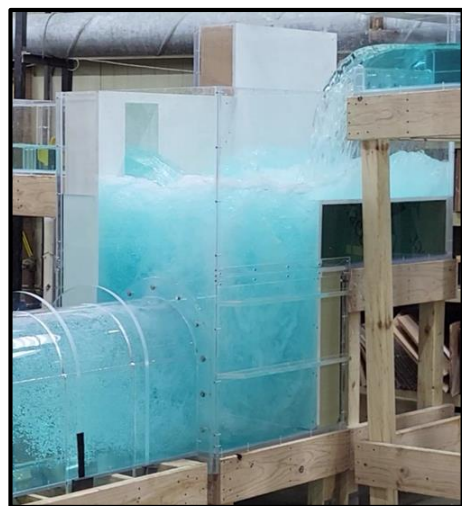
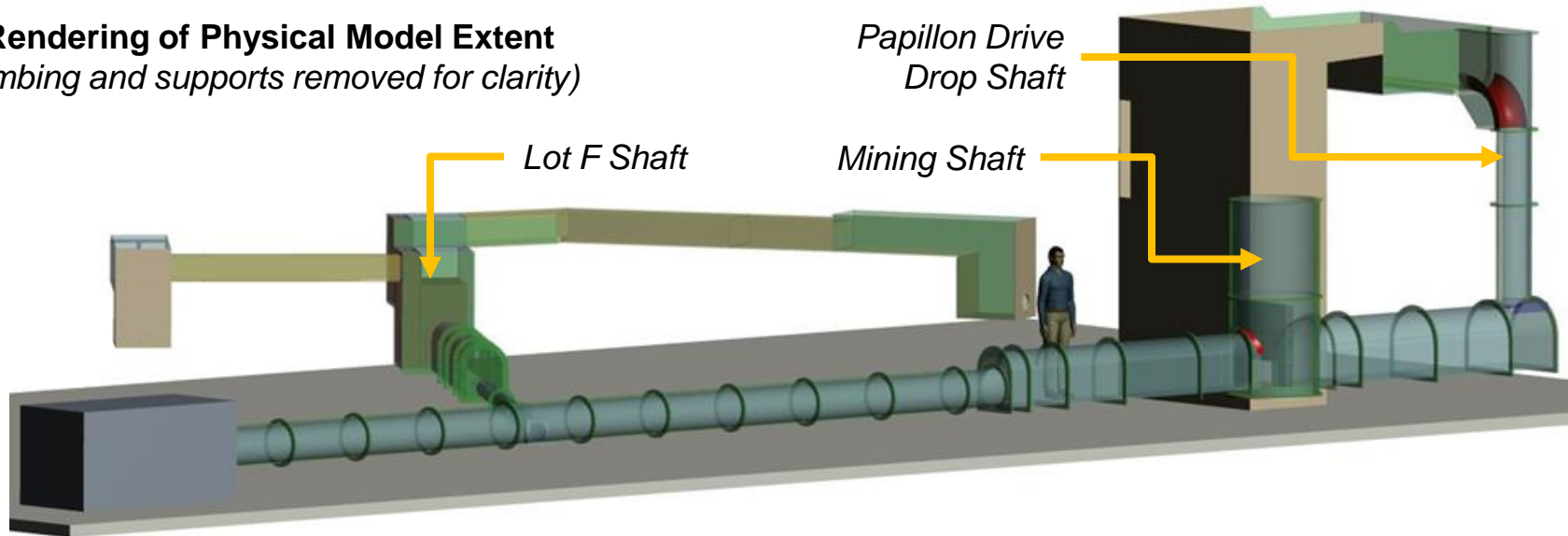


- VE Concept - Plunge Drop Shaft
 - Significantly lower risk of clogging compared to Milwaukee Vortex Drop Structure
 - Will entrain more air than Milwaukee Vortex Drop Structure
- Goal to use one shaft for mining / deaeration
- Initial Papillon Drive Deaeration Chamber Size
 - Length at 140-ft
 - Diameter at 30-ft ID
 - (Traditional Milwaukee Deaeration Chamber has a length of 180-ft and diameter at 25-ft ID)
- Physical modeling is required
 - Determine the diameter of the Deaeration Chamber with a Plunge Drop Shaft
 - Verify Deaeration Chamber performance during tunnel surcharging



Physical Model Construction

3D Rendering of Physical Model Extent
(plumbing and supports removed for clarity)

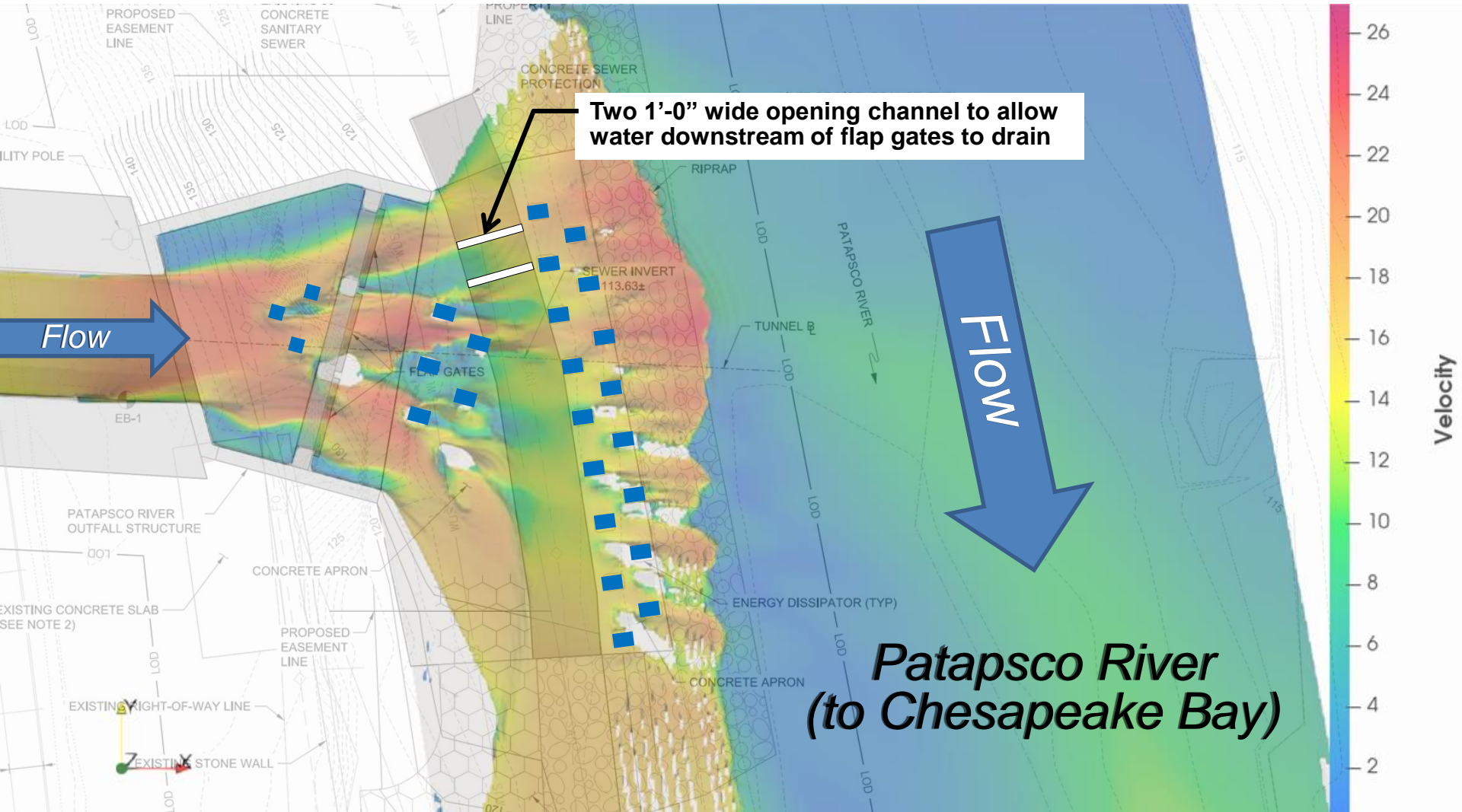


Physical Model: Papillon Drive



Papillon Drive Plunge Drop Shaft and Deaeration Chamber

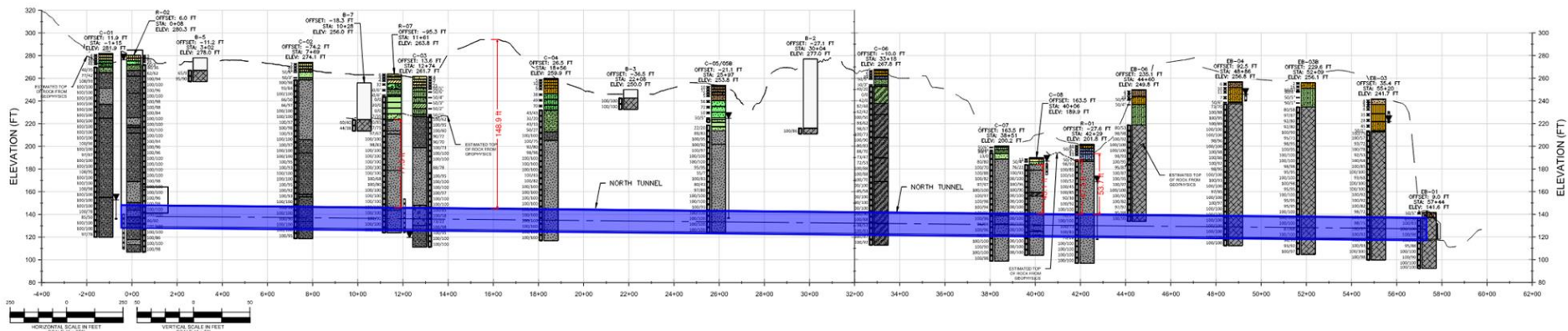
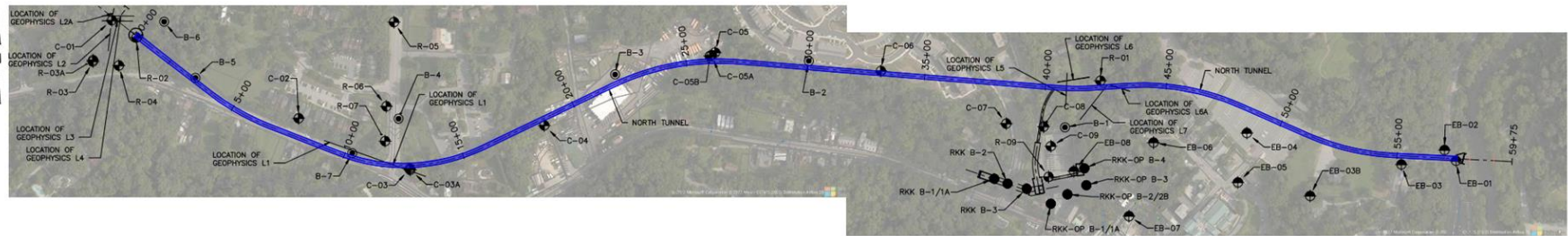
Outfall Hydraulics



Geologic Profile



NEWEA
WORKING FOR WATER QUALITY



- **Bedrock includes granodiorite and granite with gneissic inclusions**
 - Unconfined compressive strength: ~15 ksi average, ~25 ksi max
 - Highly to extremely abrasive
 - Generally good to excellent quality, with zones of very poor to poor quality
 - Avoided low elevation saprolite zones
 - Low cover CSX crossing at outfall site

Non-Technical Challenges

Acquisitions



- Fee Simple vs. Subterranean Easement
- CSX Crossing

Design



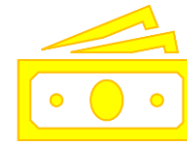
- Expedited Delivery
- Value Engineering
- CMAR Pre-Construction Engagement

Permitting



- Early Engagement
- Section 106 Process
- Community Outreach

Funding



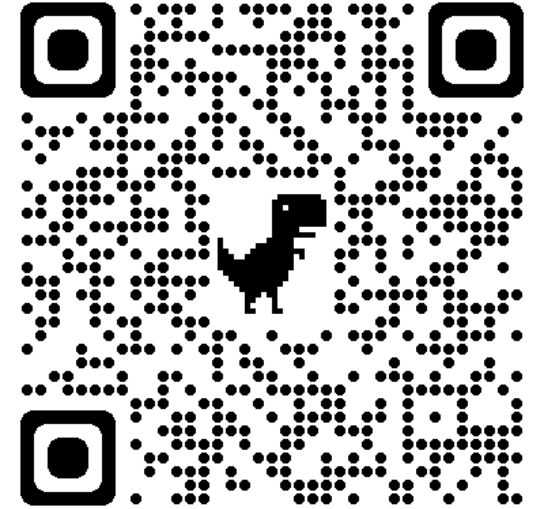
- WIFIA Loan (EPA)
- Escalation
- Project Cost Drivers

Construction



- Construction Manager @ Risk (CMAR)
- Mitigating impact to historic resources & community

Thank you!



ecsafeandsound.org

Facebook: @SaferEC

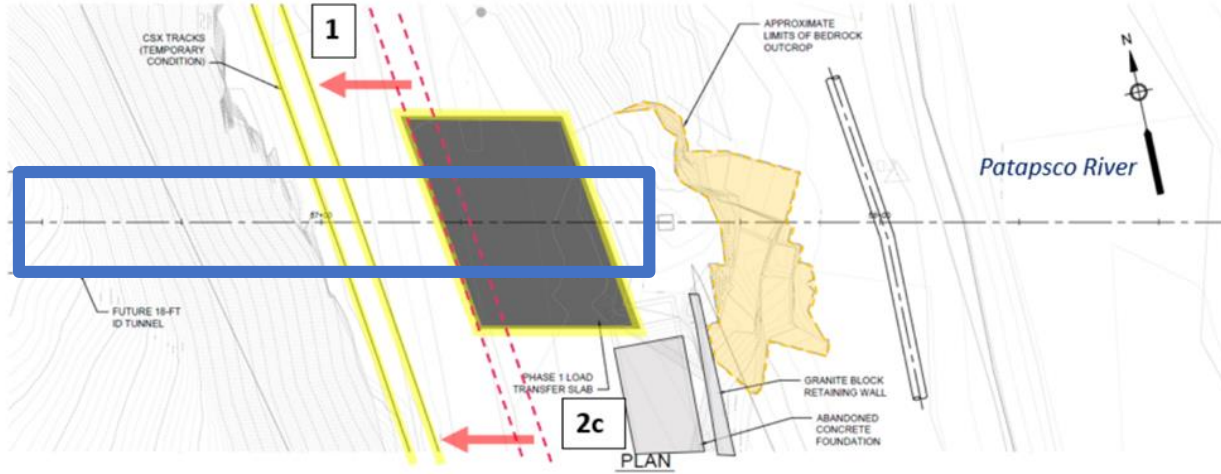
ecsafeandsound@howardcountymd.gov



Extra Slides

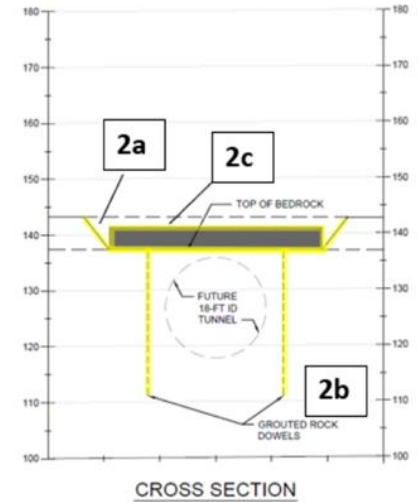
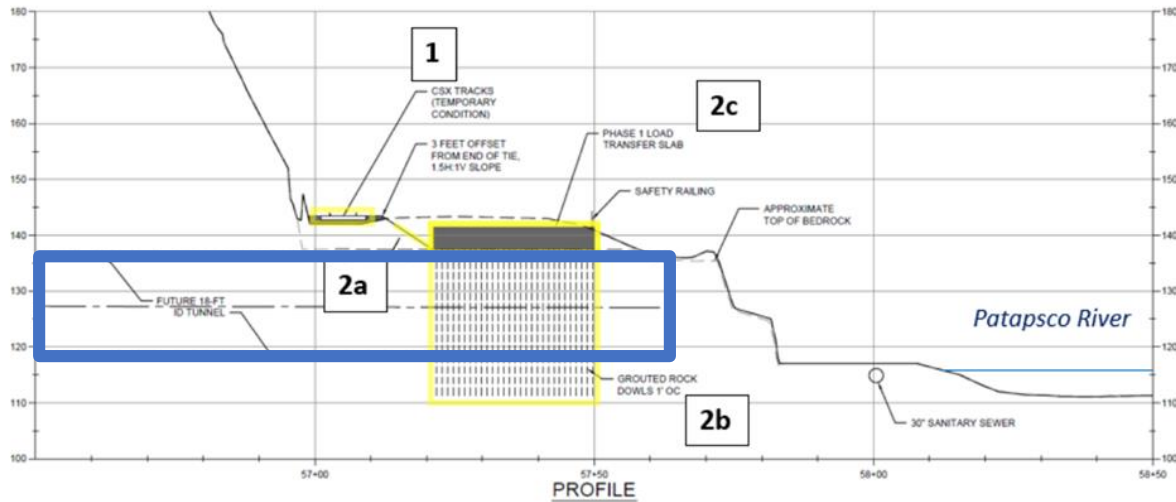


CSX Crossing

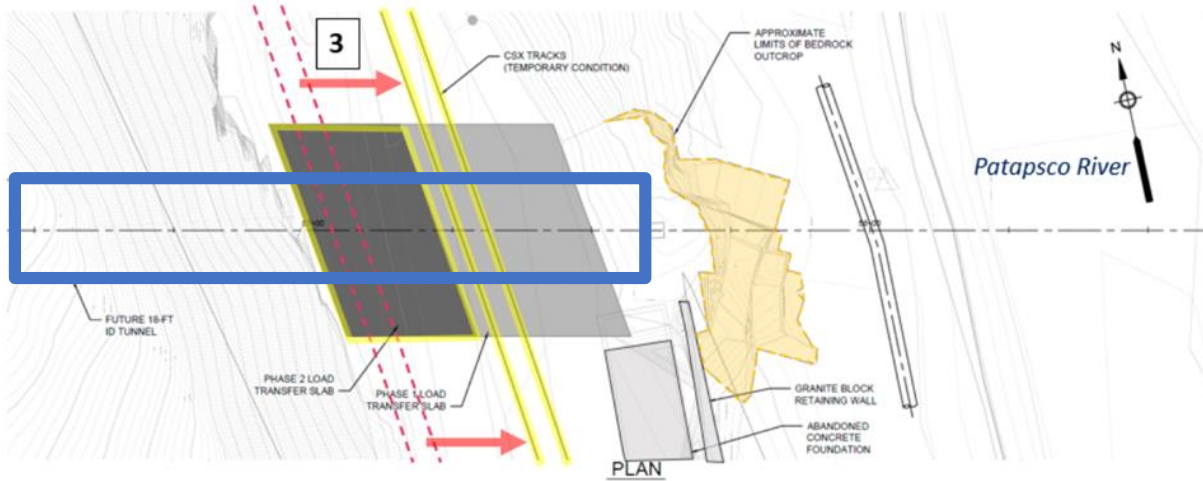


Steps

- 1** Temporarily Relocate Track to the West
- 2a** Excavate to Top of Rock While Protecting Relocated Track
- 2b** Install Rock Reinforcement
- 2c** Construct East Portion of Load Transfer Slab

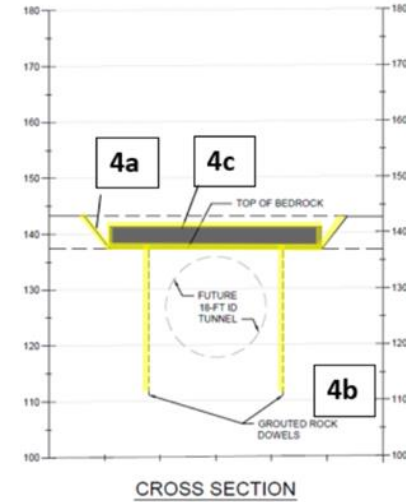
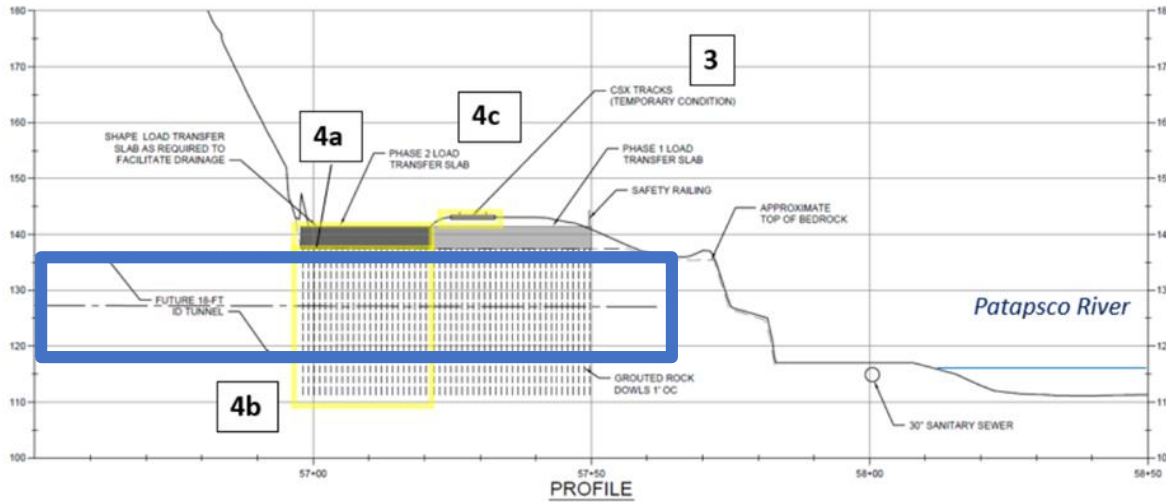


CSX Crossing

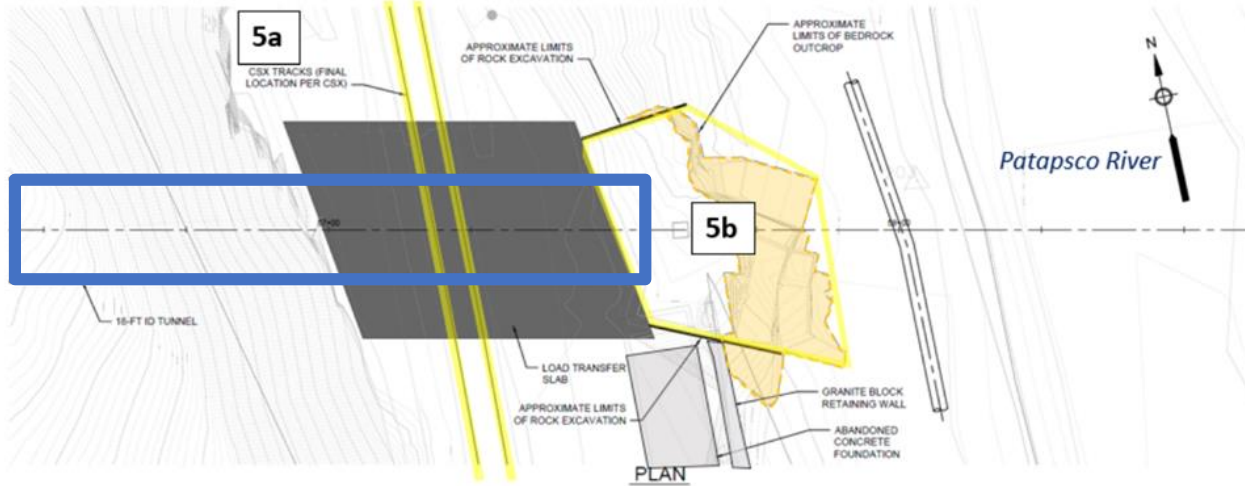


Steps

- 3** Temporarily Relocate Track to the East
- 4a** Excavate to Top of Rock While Protecting Relocated Track
- 4b** Install Rock Reinforcement
- 4c** Construct West Portion of Load Transfer Slab



CSX Crossing



Steps

- 5a** Relocate Track to Permanent Position
- 5b** Excavate Rock with Non-Explosive Method(s)
- 5c** Excavate Tunnel with TBM

