Session 2 – Concurrent Presentations

Resilient Structures

Location: Room 2

Evaluating Coastal Pavement Performance and Adaptation under Sea Level Rise in New Hampshire – *Wei Sun (UNH)*

Climate Resilient Stream Crossings: Are We There Yet? – *Polly Perkins (NHDES) and Patrick Jackson (Underwood Engineers)*

Building Resilience can be Fun and Engaging at a Vulnerable Living History Museum – *Rodney Rowland (Strawbery Banke Museum)*

Evaluating Coastal Pavement Performance and Adaptation under Sea Level Rise in New Hampshire

Wei Sun, Ph.D. | University of New Hampshire
NCCOS Effects of Sea Level Rise Program
Project PI: Jo Sias, Ph.D. | University of New Hampshire

May 21st, NH Coastal Climate Summit 2026

What This Presentation Connects

A high-level view of several project pieces, translated for planning and community resilience.

1 Coastal exposure

Where and how long roads may experience flooding as sea level rises.

2 Groundwater rise

How the water table moves upward under and near coastal roads.

3 Pavement performance

How moisture changes the support beneath traffic and shortens pavement service life.

4 Adaptation options

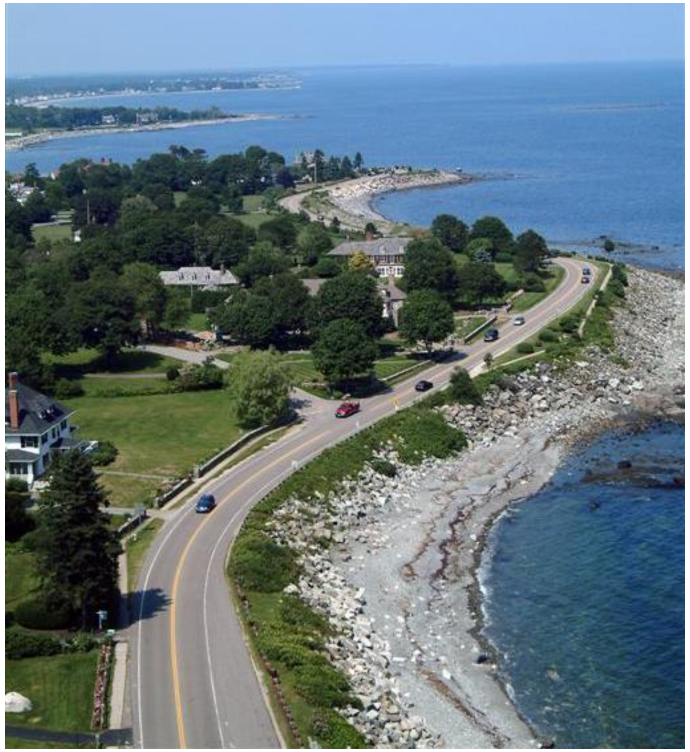
How coastal infrastructure and NNBF can reduce exposure or consequences.

5 Decision support

How the toolkit helps users compare scenarios and alternatives.

Why coastal pavements matter

Roads are the visible part of a larger coastal resilience system.



Community access

Coastal roads connect homes, businesses, schools, emergency routes, and recreation areas.

Hidden vulnerability

Damage can begin below the road surface before the pavement looks visibly distressed.

Long-term cost

More frequent wet conditions can increase maintenance needs and shorten the useful life of pavement.

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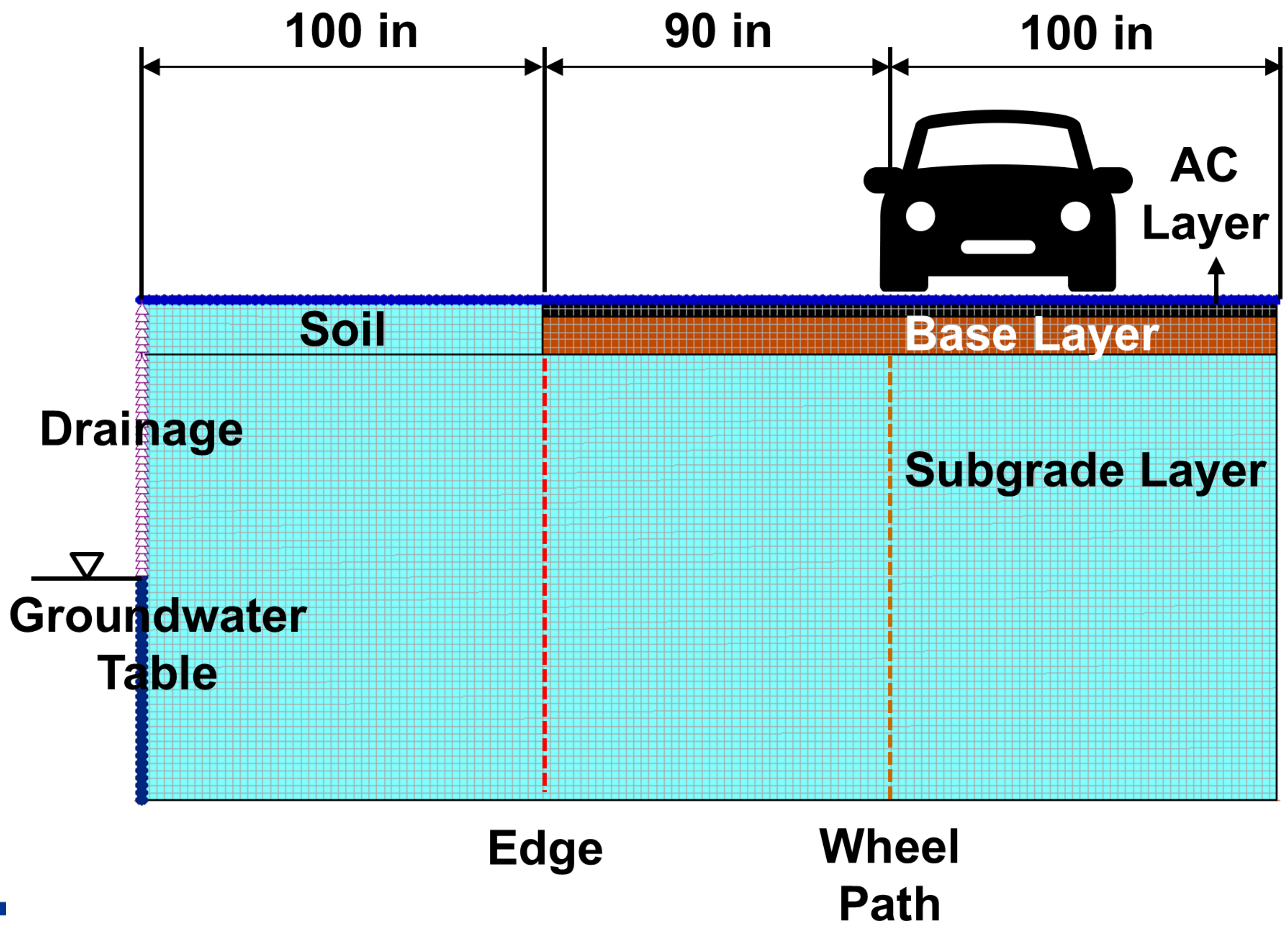
What sea level rise changes beneath a road



1. More water reaches the road system

Storm surge, high tides, rainfall, and future sea levels can increase wet periods.

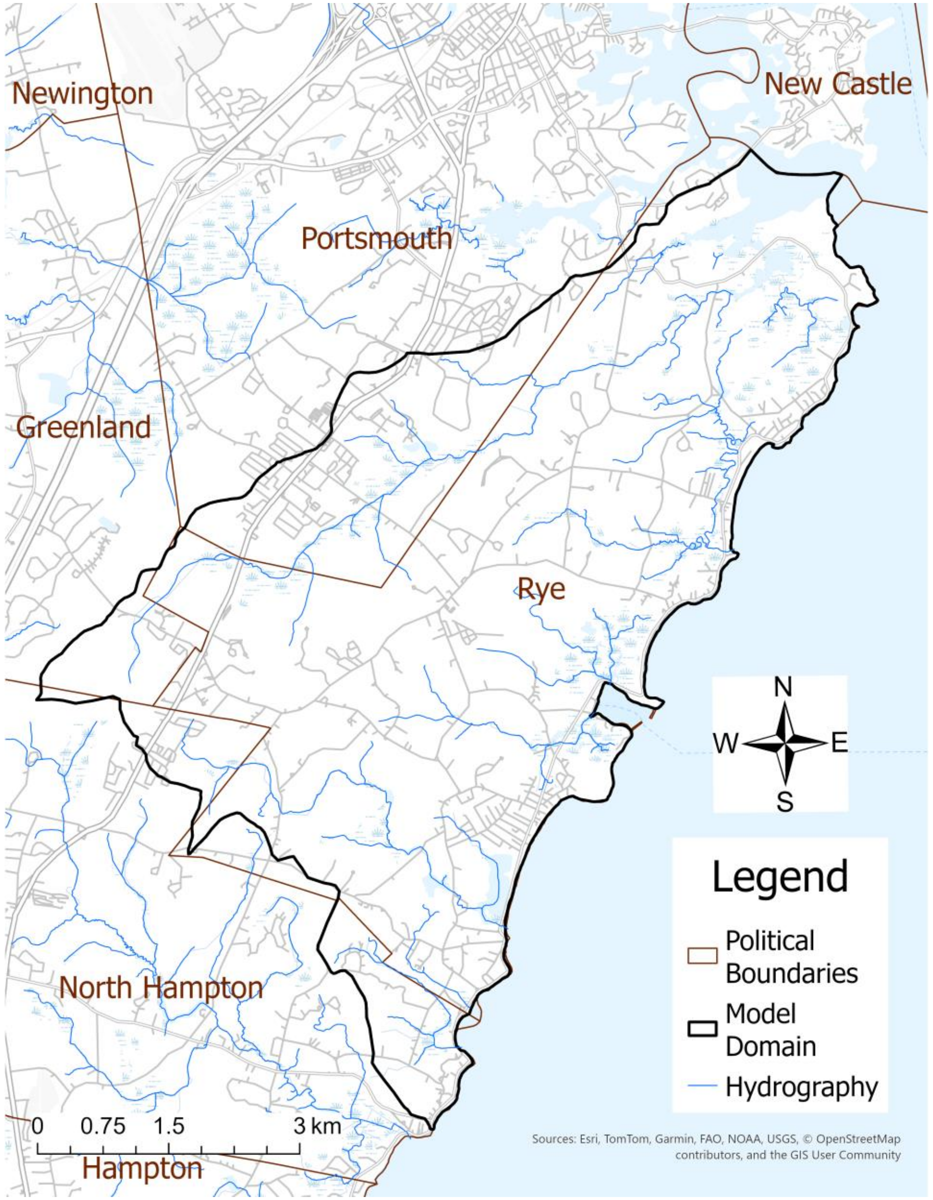
2. Soil support can weaken

When subgrade soils stay wet, they can carry traffic loads less effectively.

3. Recovery can take time

The pavement may need time to drain and regain support after flooding ends.

Study focus in New Hampshire



Roadway setting

The project focuses on coastal road segments where flooding, groundwater rise, shoreline exposure, and pavement condition interact.

Inputs

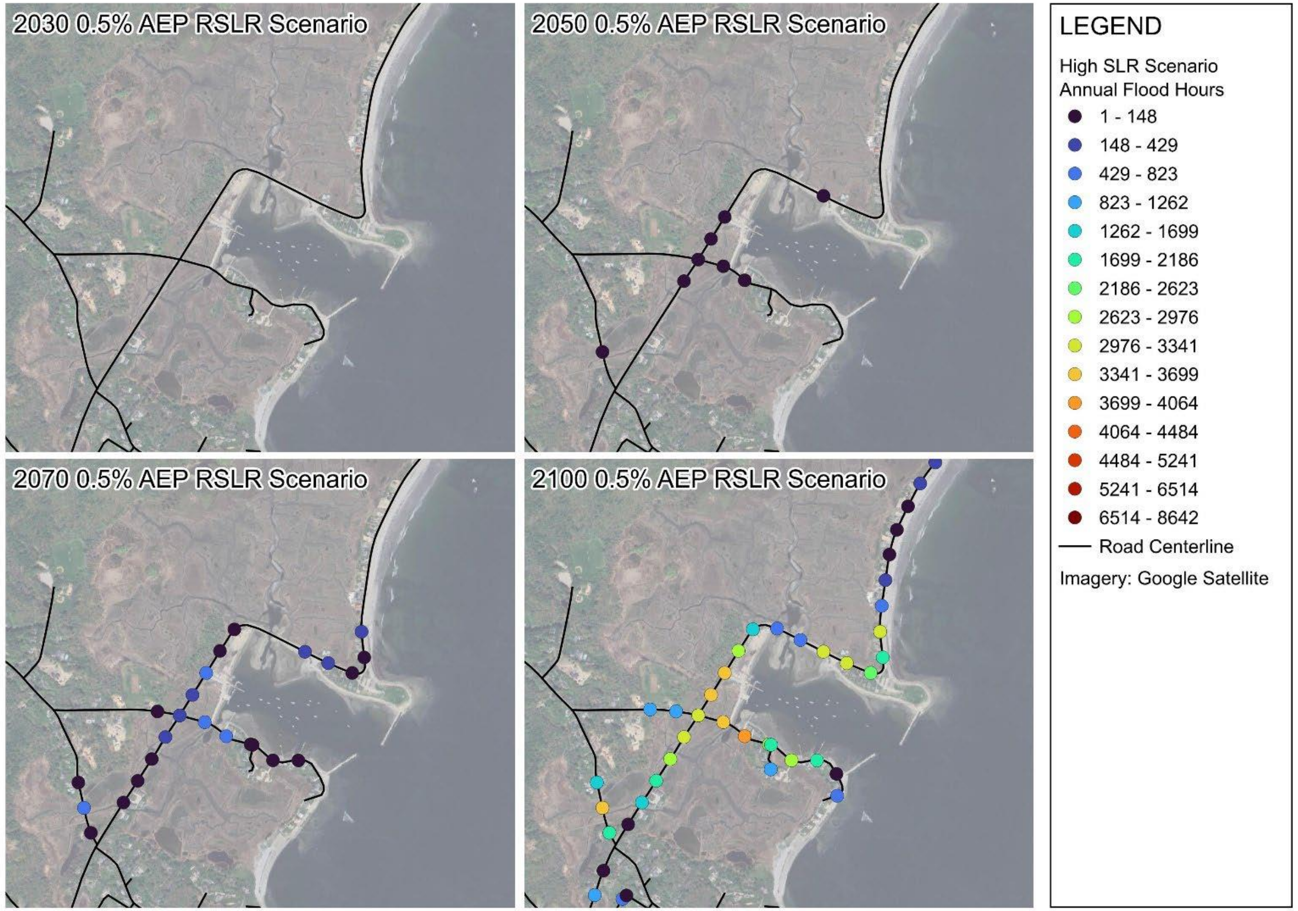
Sea level rise scenarios
Flood days and duration
Groundwater depth
Pavement structure
Traffic volume

Outputs

Service-life curves
Vulnerability maps
Washout and bearing risk
Adaptation comparison

Move from “a road might flood” to “which segments are vulnerable, why, and what options could reduce risk.”

Surface Inundation: How Often Roads are Wet from Above



How many days per year?

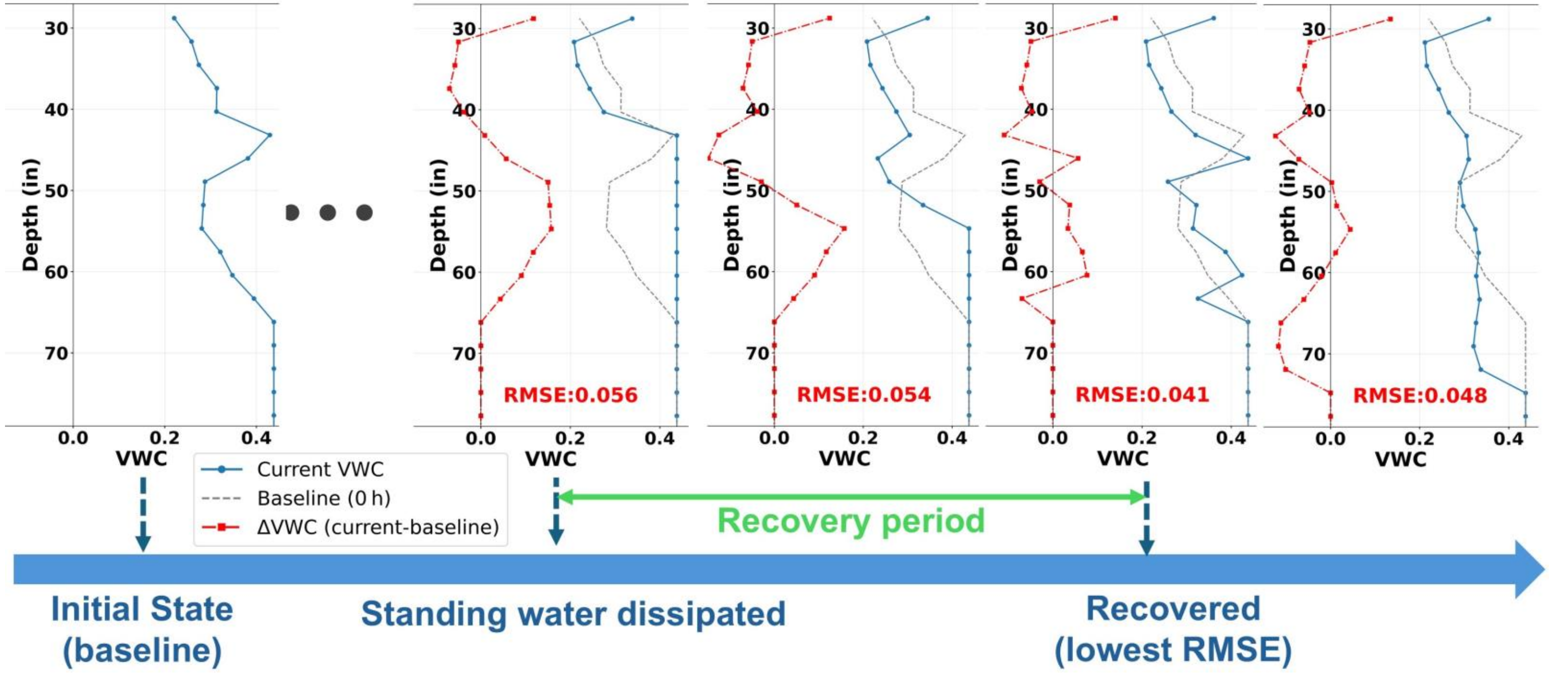
How long is each inundation event?

Which roads are more exposed?

What SLR scenario are considered?

For pavement performance, exposure duration matters because longer wet periods can increase moisture in the pavement system

After Surface Flooding: the Road May Still be Recovering



Recovery period

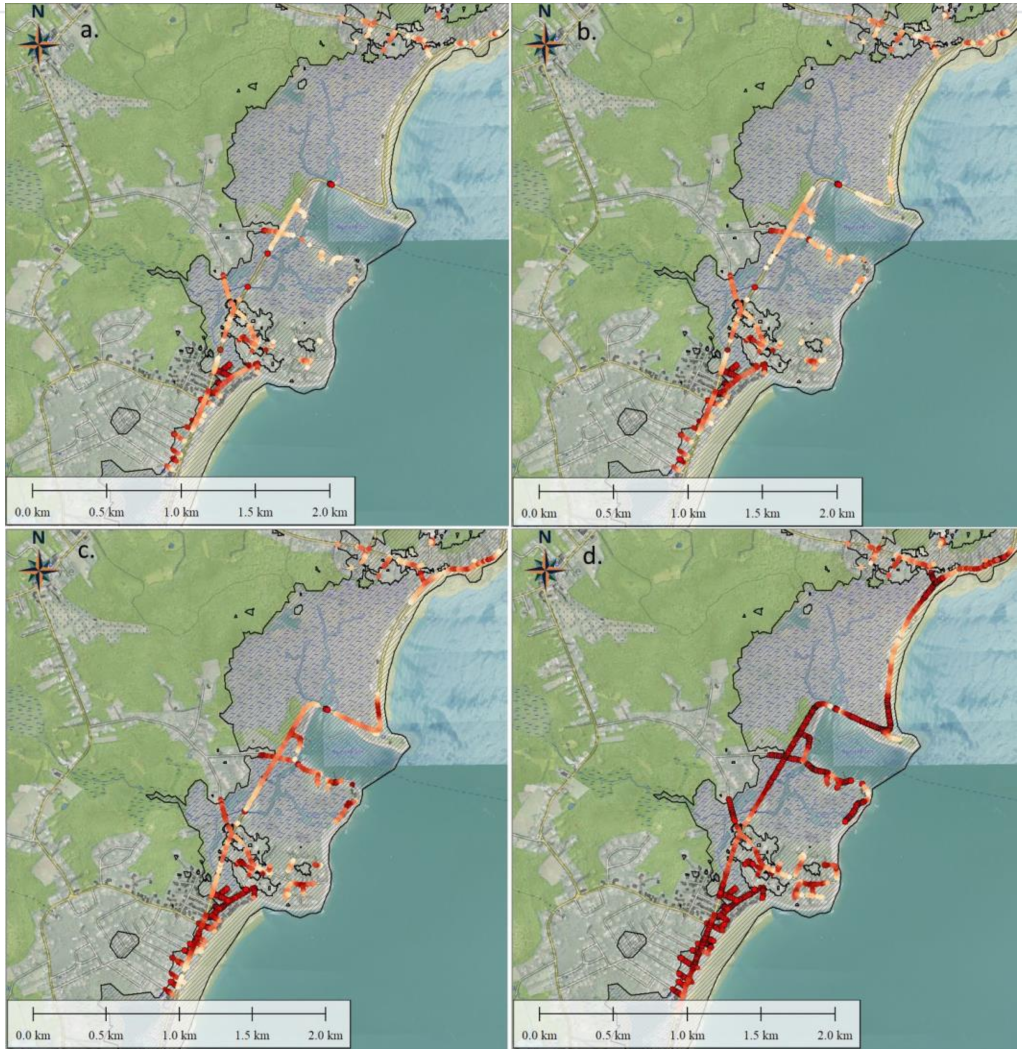
The time after flood water leaves the surface, while moisture inside the pavement system is still returning toward normal.

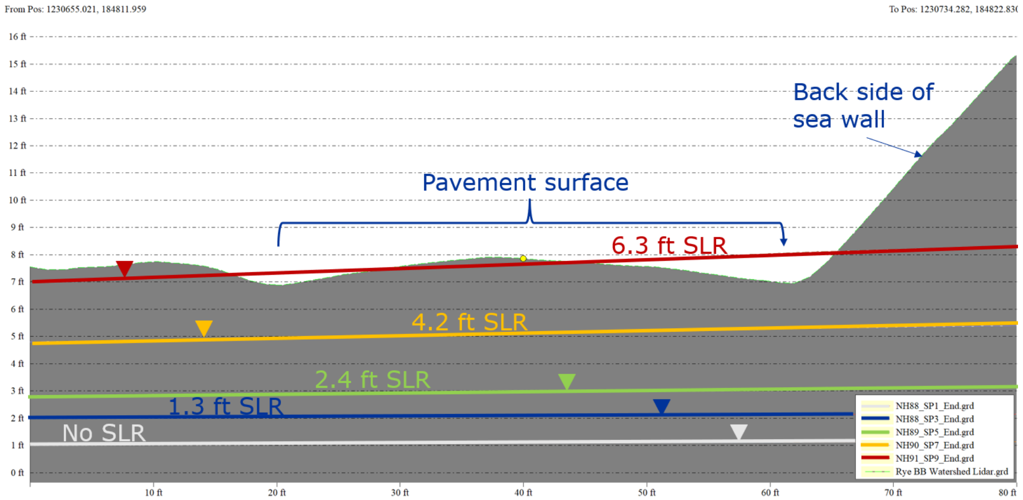
1 During flood → 2 Surface clears → 3 Traffic resumes → 4 Subsurface drains

Planning implication

Maintenance and reopening decisions may need to consider hidden weakening, not only visible water depth.

Rising groundwater is a hidden pathway





Why this matters

A road section can be affected even when there is no standing water on the pavement surface.

What the model provides

Projected groundwater elevations that can be linked to pavement structure and performance.

The color of the dots from white to dark red represents a projected water table depth from 5.5 feet (1.7 m) to less than 2.5 feet (0.8 m), respectively, for (a) 1.3 feet (0.4 m) SLR, (b) 2.4 feet (0.7 m) SLR, (c) 4.2 feet (1.3 m) SLR, and (d) 6.3 feet (1.9 m) SLR. Road sections with red dots are vulnerable to premature failure from shallow groundwater.

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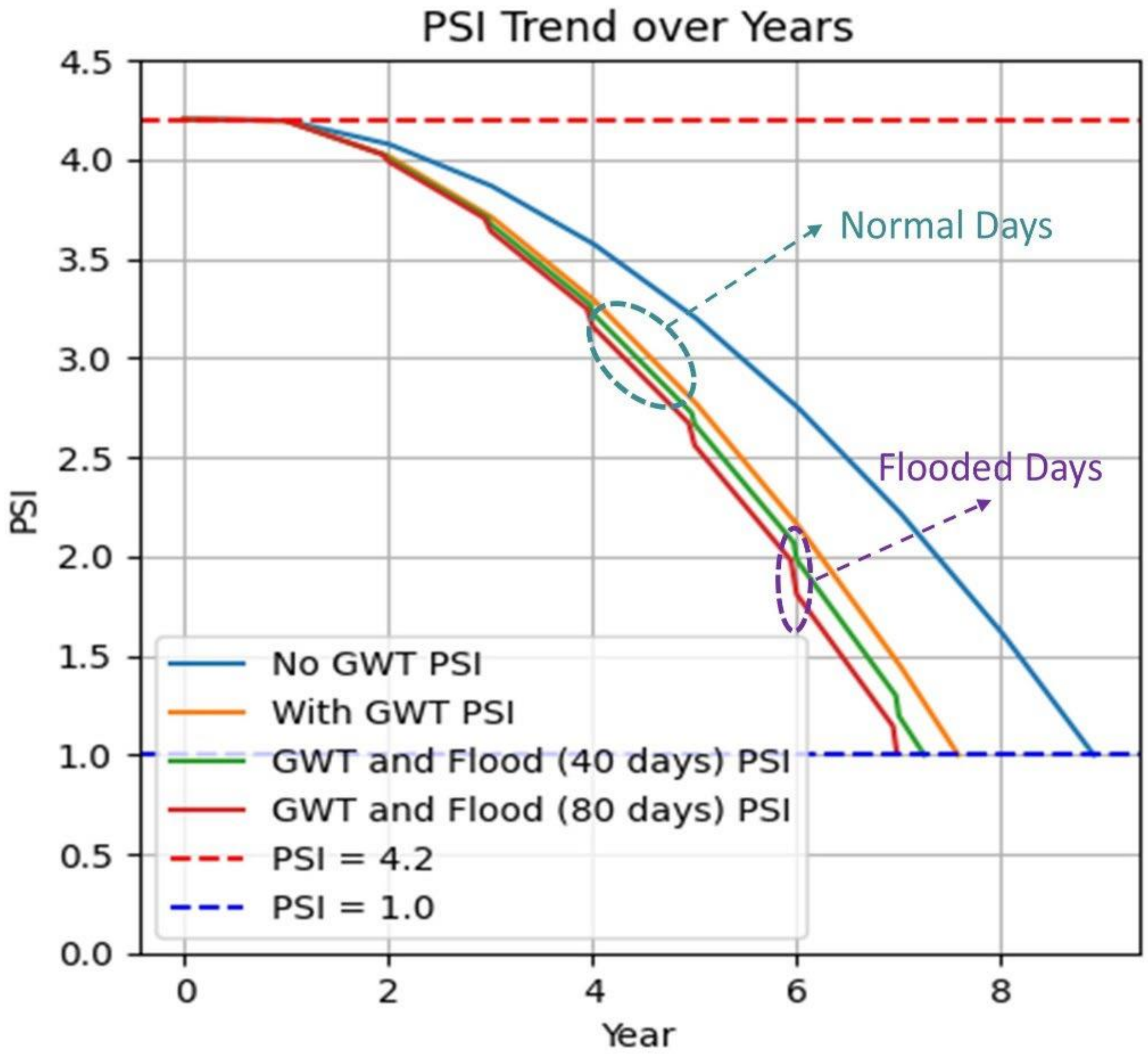
Pavement Life Curves Translate Impacts into Service Life



What is PSI?

Pavement Serviceability Index, a simple way to represent pavement condition or ride quality over time.

What the curve shows

As wet days increase and groundwater rises, the curve can drop faster and the road reaches terminal condition earlier.

Why it helps

A curve gives a common language for comparing baseline conditions, future climate scenarios, and adaptation options.

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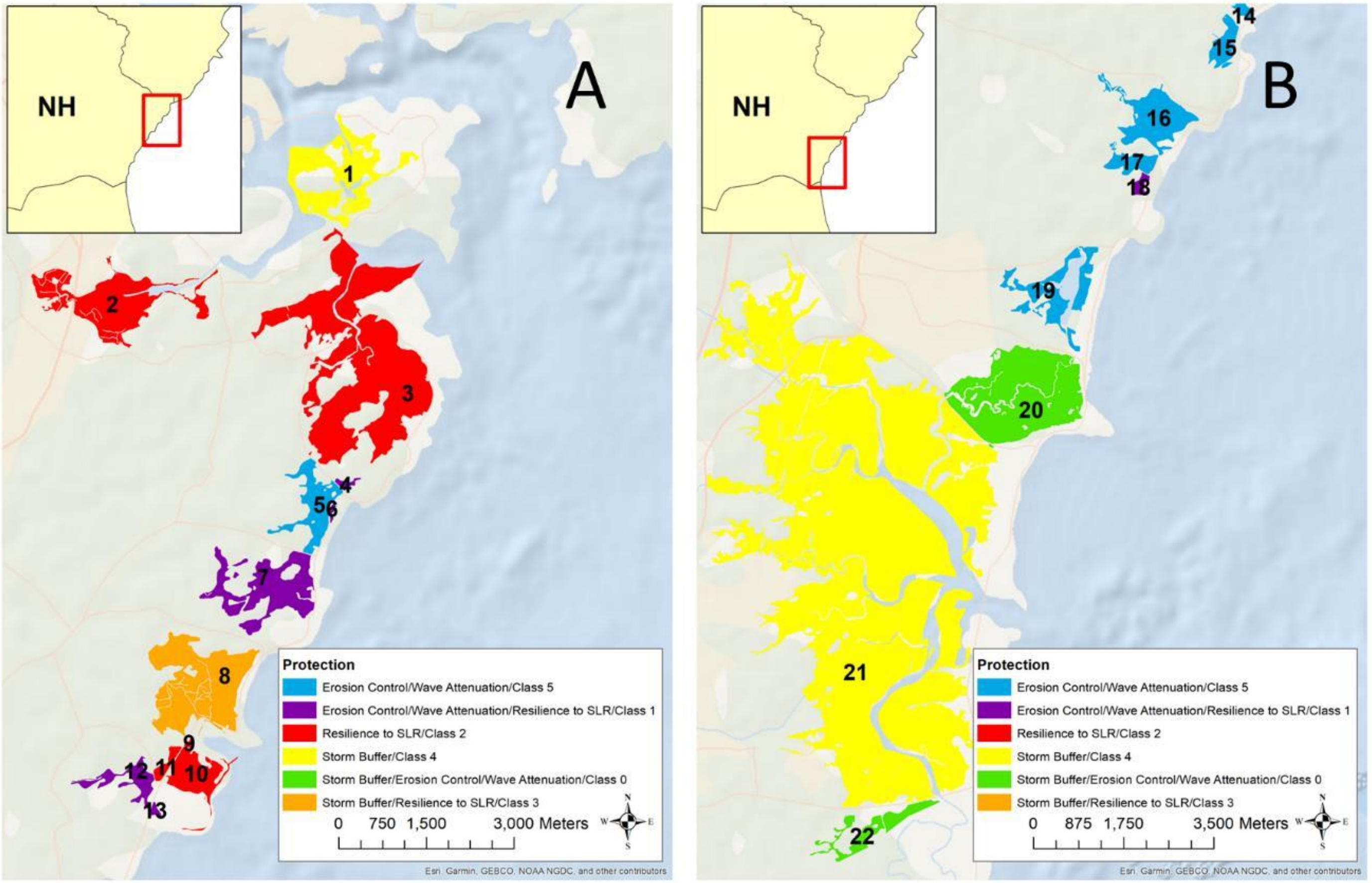
Adaptation Includes Existing Natural Protection and Future Options



Gray infrastructure

Road elevation
Drainage upgrades
Seawalls and revetments
Armored shoulders

NNBF

Salt marshes
Beaches
Dunes
Living shorelines

Operations

Traffic routing
Temporary closures
Monitoring
Maintenance timing

Tradeoffs

Performance
Cost
Environmental benefit
Long-term uncertainty

NNBF evaluation connects natural features to protective functions such as storm buffering, wave attenuation, erosion control, and resilience to sea level rise.

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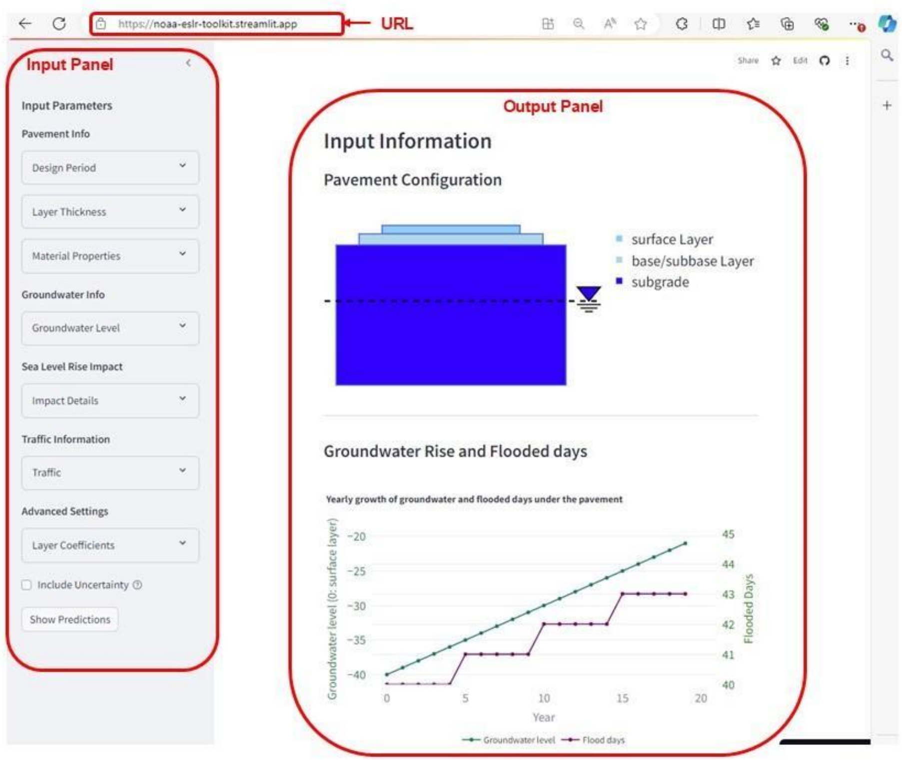
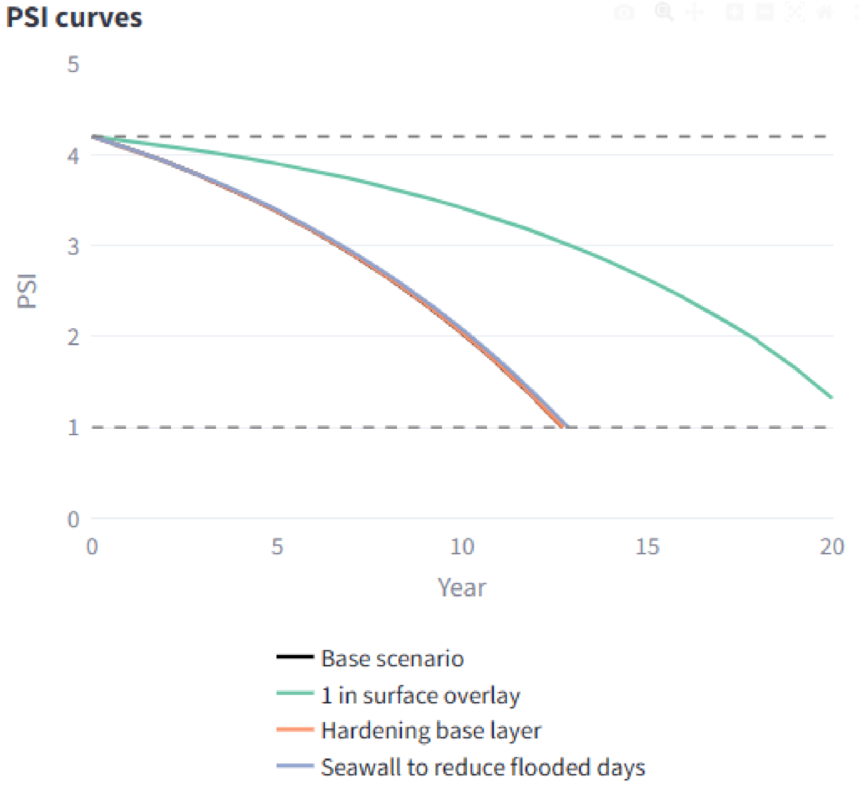
Toolkit as a Bridge from Models to Planning





What users change

Pavement, traffic, groundwater, flooding, and adaptation assumptions.

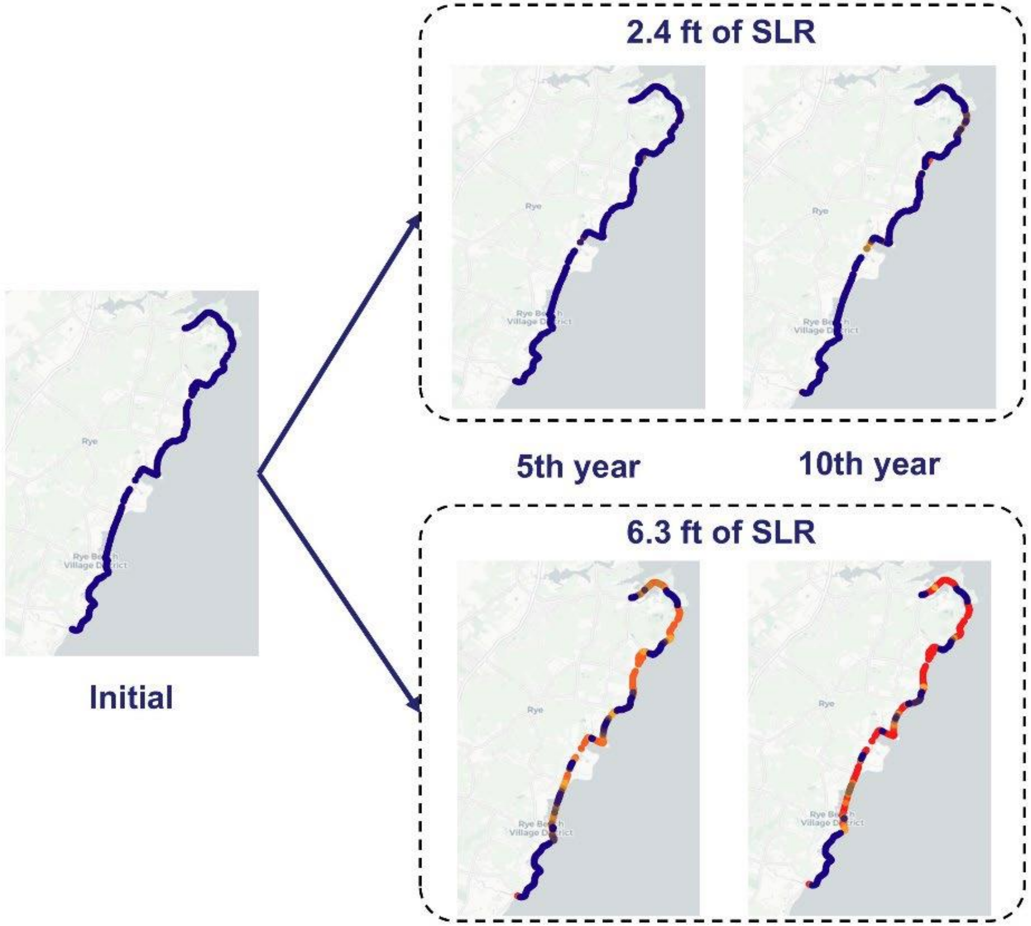
What users compare

Projected life curves and scenario differences for screening decisions.

Toolkit Demo

U.S. Department of Transportation Federal Highway Administration

Mapped Pavement Condition: Rye Harbor Example



Why this map

It shows where the road condition changes along the corridor, not only a single curve or summary bar.

What the result suggests

Under 2.4 ft SLR, most segments remain stable through year 5, with localized degradation by year 10.

High SLR scenario

Under 6.3 ft SLR, more segments show accelerated deterioration by year 5 and widespread damage by year 10.

spatial outputs help identify vulnerable segments that need earlier maintenance, phased upgrades, or adaptation evaluation.

How the pieces support decisions

Climate and coastal exposure
Flooding, water levels, storm conditions

→

Groundwater and pavement response
Hidden weakening, recovery, service life

→

Vulnerability and risk
Which road segments need attention

→

Adaptation comparison
Gray, green, operational options

→

Planning output
Priorities, communication

Practical planning questions the toolkit can help frame

Which segments are most exposed?
Which mechanisms matter most?
Which alternatives may reduce vulnerability?
What additional data should be collected?

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Key takeaways

1. Climate impacts reach below the road surface.
2. Flood recovery time matters for pavement performance.
3. Adaptation can combine engineered structures and NNBF.
4. The toolkit helps translate research into planning information.

Thanks for your attention, and Questions?

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Climate Resilient Culverts: Are We There Yet?

Patrick Jackson | Underwood Engineers | Project Engineer

Polly Perkins | NHDES | Coastal Program | Watershed Management Specialist

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

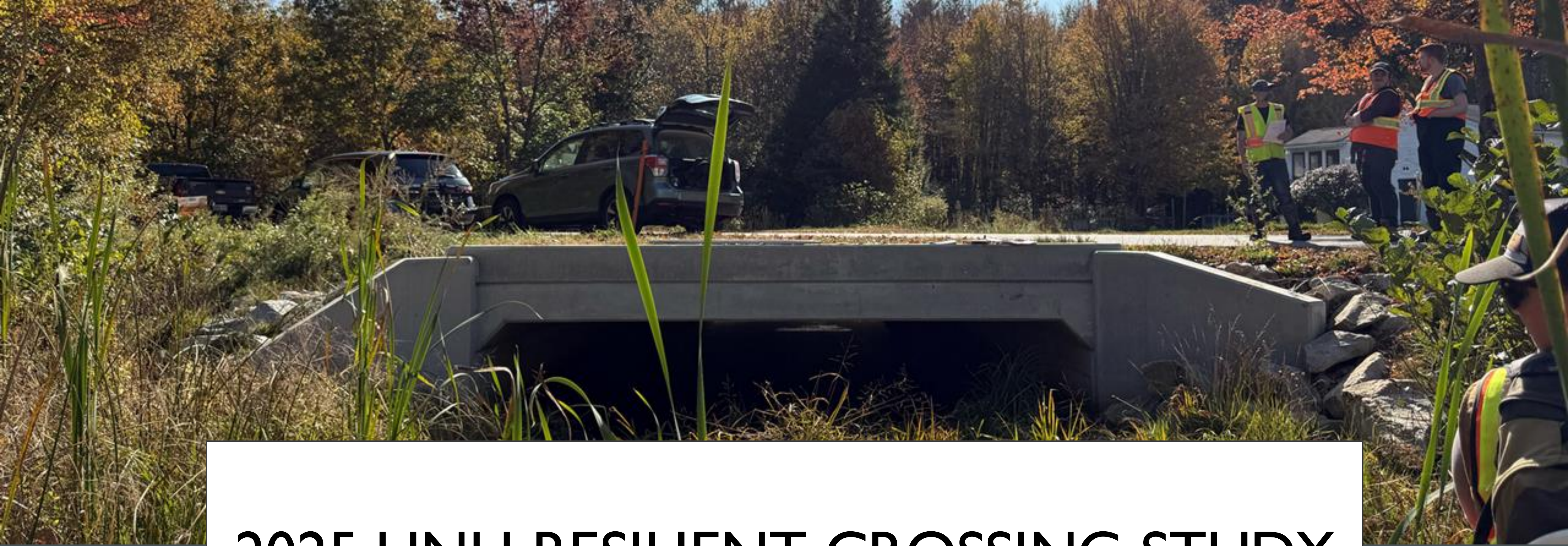
5.21.2026

TODAY'S PRESENTATION

UNH Resilient Crossing Study

Resilient Crossing Implementation

Crossing Capacity Pilot Pipeline



2025 UNH RESILIENT CROSSING STUDY

DRIVING QUESTIONS

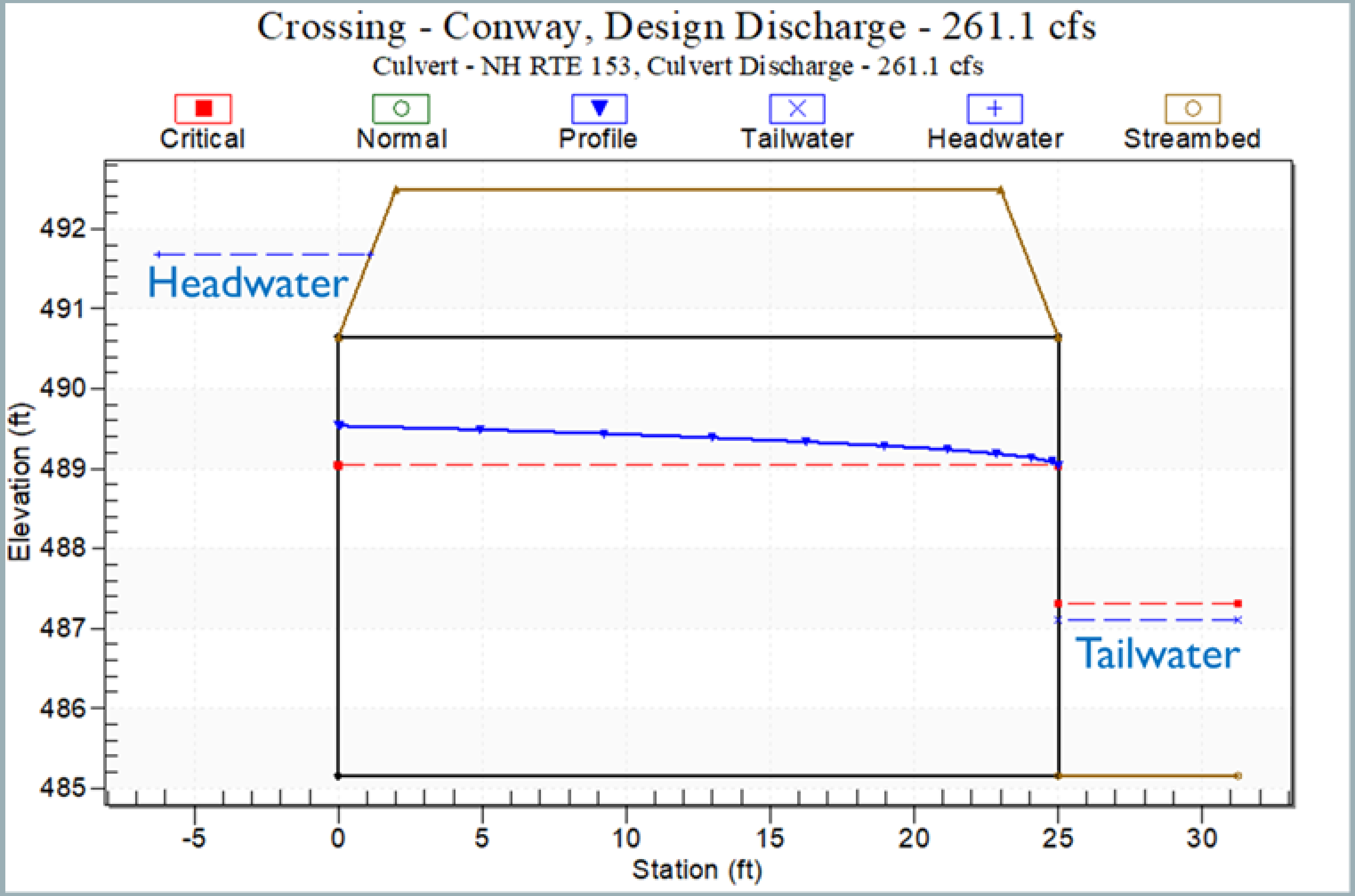
Are stream crossing regulations and guidelines accounting for the effects of rapid climate change?

If not, what is the cost of redesigning to address the effects of climate change?

PROJECT SCOPE

- Review 20 municipal and NHDOT crossings built in the past 5 years
- Create hydraulic models to determine if they can manage future storms
- Cost analysis

HYDRAULIC MODELING



- To account for the effects of climate change by the year 2100 the inlet flowrates for each crossing were increased by 15%
- Model quality assurance with Professional Engineers Joel Ballestero (Streamworks) and Nick Messina (CMS Engineers)

NHDOT FINDINGS

Site	Hydraulic Vulnerability	Inlet or Outlet Control	Length	Original Span	Alternative Design Span Increase (ft)	Original Cost	New Cost	Cost Increase
Wakefield	Pass	Inlet	40	7	0	$252,000	$252,000	0.00%
Acworth	Pass	Inlet	34	6	0	$183,600	$183,600	0.00%
Alton	**Overtops**	**Inlet**	**70**	**6**	**1**	**$420,000**	**$490,000**	**14.29%**
Auburn	**Overtops**	**Inlet**	**45**	**9**	**1.5**	**$364,500**	**$425,250**	**14.29%**
Conway	**Overtops**	**Inlet**	**25**	**5**	**1**	**$112,500**	**$135,000**	**16.67%**
Eaton	Overtops	Outlet	36	8	N/A	$259,200	$259,000	0.00%
Hancock	Overtops	Outlet	60	8	N/A	$432,000	$432,000	0.00%
Jefferson	**Overtops**	**Inlet**	**45**	**20**	**1**	**$900,000**	**$945,000**	**4.76%**
Springfield	Overtops	Outlet	82	20	N/A	$984,000	$984,000	0.00%
Meredith	Overtops	Outlet	30	4	N/A	$72,000	$72,000	0.00%

CONCLUSIONS

- 55% of crossings required a span increase to be resilient to 2100
- 18% average increase in total project cost to design crossings to storms of 2100 (ranged from 5% to 36%)
- Increasing crossing service life and level of service
- Is it economically feasible to design stream crossings to the end of the century?

RESILIENT
CROSSINGS

Lubberland Creek

Bay Rd, Newmarket, NH

Project Period:	2015 - 2019
Cost:	~$400K
Partners:	NHDES, TNC, Newmarket
Sizing:	3.74' SLR & 100yr of 2100

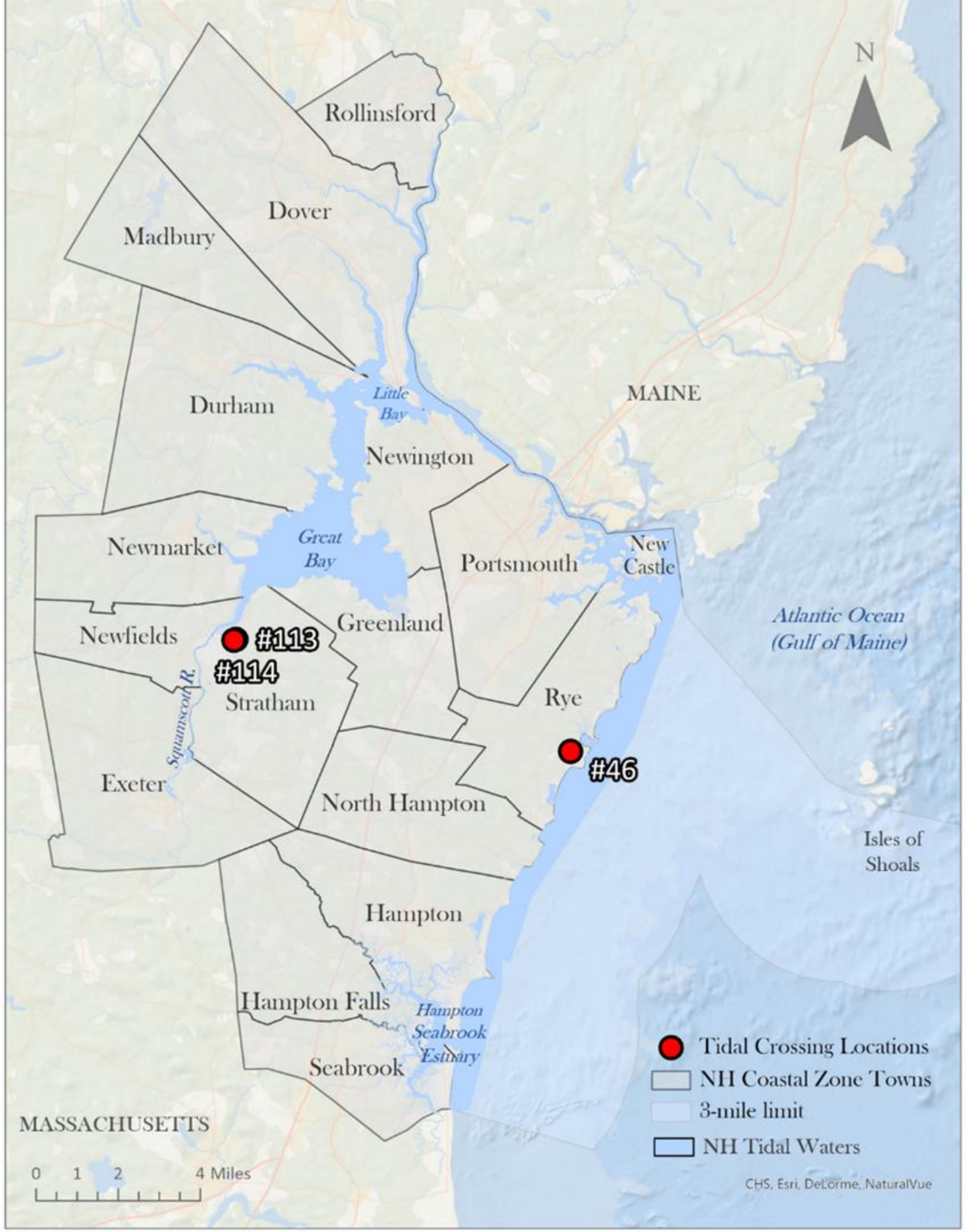
Oyster River
Topaz Dr, Barrington, NH

Project Period:	2009-2023
Cost:	~$1M
Partners:	NHDES, TNC, HOA
Sizing:	geomorphically compatible

CURRENT RESILIENT PIPELINE

Rye | Spring 2027

Stratham East & West | Fall 2026

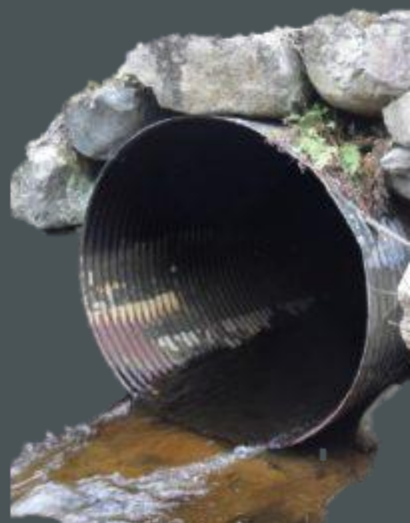


CROSSING
CAPACITY
PILOT
PIPELINE

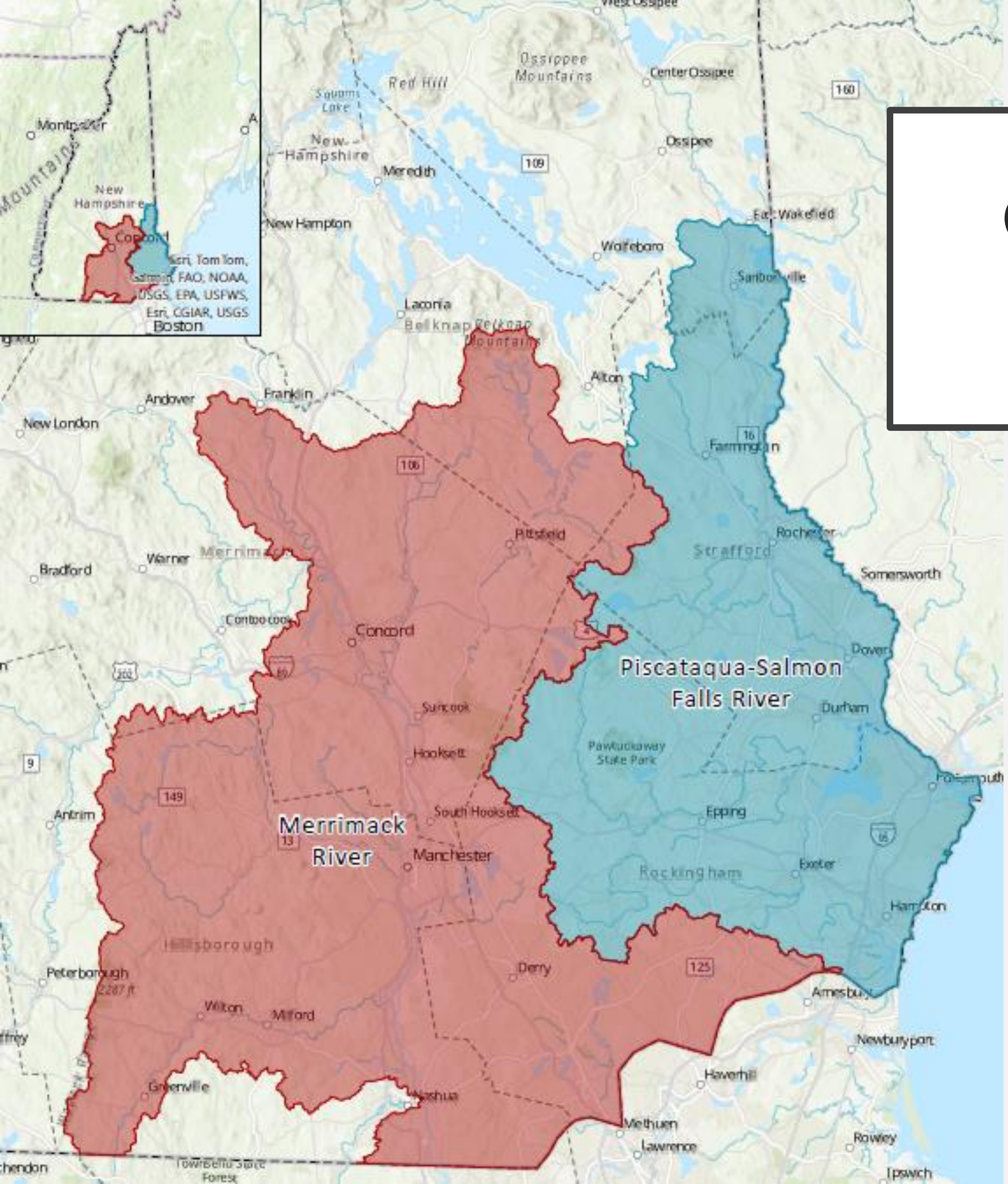
CROSSING PROGRAM GOAL:

STREAMLINE CROSSING IMPLEMENTATION!

(PUN INTENDED)



COASTAL WATERSHED PILOT AREA



Check out the searchable map!

https://arcg.is/1S5D1G

NFWF NCRF

Budget: $997,685

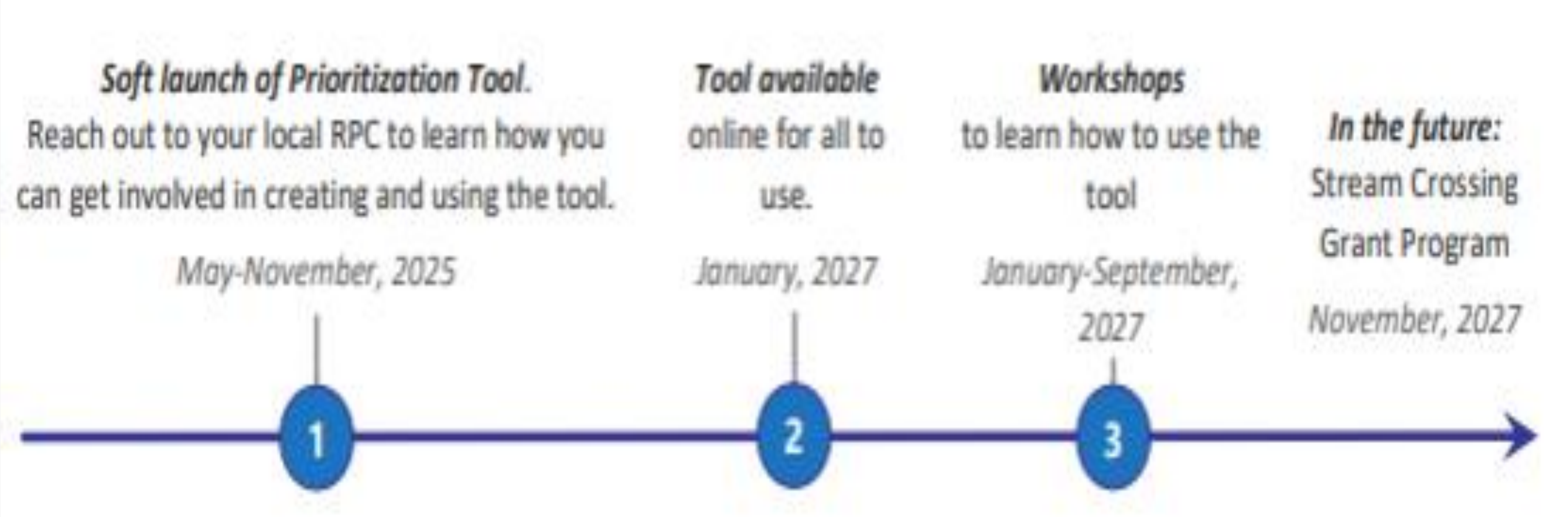
Timeline: June 2025 – Dec 2027

Empower transportation, wildlife, and environmental stakeholders to create a robust, equitable, and multi-benefit ***pipeline of stream crossing projects*** in NH's coastal watersheds. Project will result in a pipeline of at least 10 restoration projects ***sized to manage the 100-year storm of 2100.***

WHAT WE'LL BE OFFERING

- ❑ Staffing capacity at local RPCs, **"Stream Crossing Navigators"** for project development
- ❑ **Crossing Prioritization Tool** and associated trainings
- ❑ Crossing **Planning How-To Guides**
- ❑ **Engineering** technical assistance

PROJECT TIMELINE



THANK YOU!

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

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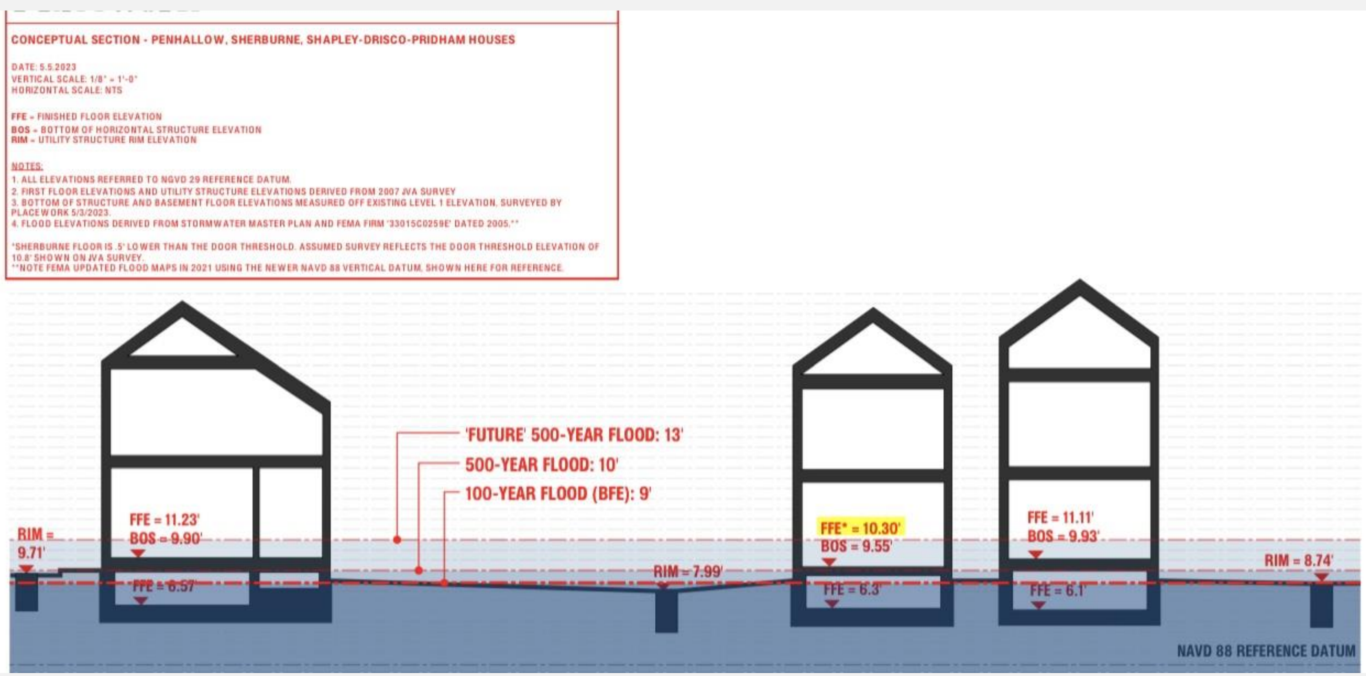
STRAWBERY BANKE PORTSMOUTH NEW HAMPSHIRE

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Strawbery Banke Museum: Building Resiliency In and Fun and Engaging Way


CONCEPTUAL SECTION - PENHALLOW, SHERBURNE, SHAPLEY-DRISCO-PRIDHAM HOUSES
DATE: 5.5.2023
VERTICAL SCALE: 1/8" = 1'-0"
HORIZONTAL SCALE: NTS
FFE = FINISHED FLOOR ELEVATION
BOS = BOTTOM OF HORIZONTAL STRUCTURE ELEVATION
RIM = UTILITY STRUCTURE RIM ELEVATION
NOTES:
1. ALL ELEVATIONS REFERRED TO NGVD 29 REFERENCE DATUM.
2. FIRST FLOOR ELEVATIONS AND UTILITY STRUCTURE ELEVATIONS DERIVED FROM 2007 JVA SURVEY
3. BOTTOM OF STRUCTURE AND BASEMENT FLOOR ELEVATIONS MEASURED OFF EXISTING LEVEL 1 ELEVATION, SURVEYED BY PLACEWORK 5/3/2023.
4. FLOOD ELEVATIONS DERIVED FROM STORMWATER MASTER PLAN AND FEMA FIRM '33015C0259E' DATED 2005.**
*SHERBURNE FLOOR IS .5' LOWER THAN THE DOOR THRESHOLD. ASSUMED SURVEY REFLECTS THE DOOR THRESHOLD ELEVATION OF 10.8' SHOWN ON JVA SURVEY.
**NOTE FEMA UPDATED FLOOD MAPS IN 2021 USING THE NEWER NAVD 88 VERTICAL DATUM, SHOWN HERE FOR REFERENCE.
'FUTURE' 500-YEAR FLOOD: 13'
500-YEAR FLOOD: 10'
100-YEAR FLOOD (BFE): 9'
RIM = 9.71'
FFE = 11.23'
BOS = 9.90'
FFE = 6.57'
RIM = 7.99'
FFE* = 10.30'
BOS = 9.55'
FFE = 6.3'
FFE = 11.11'
BOS = 9.93'
FFE = 6.1'
RIM = 8.74'
NAVD 88 REFERENCE DATUM


DOWNTOWN PORTSMOUTH
PISCATAQUA RIVER
PRESCOTT PARK
COURT STREET
ATKINSON STREET
MARCY STREET
PUDDLE LANE
WASHINGTON STREET
HANCOCK STREET
1
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Image Slide Example 2

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Image Slide Example 2

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- Bullet 1
- Bullet 2
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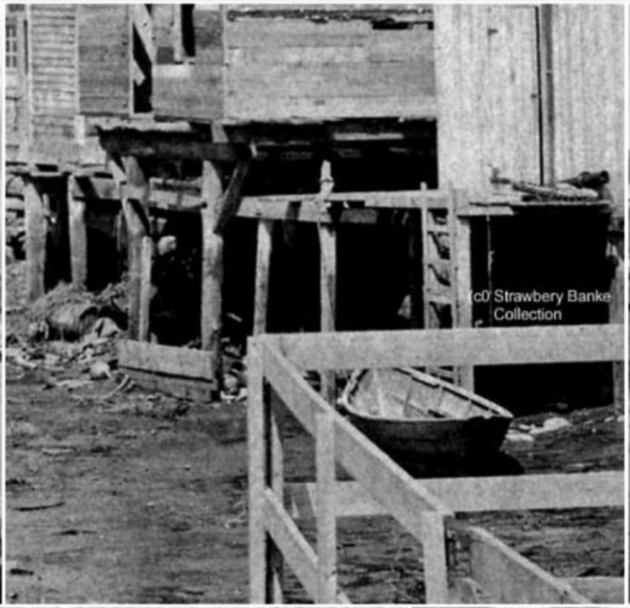
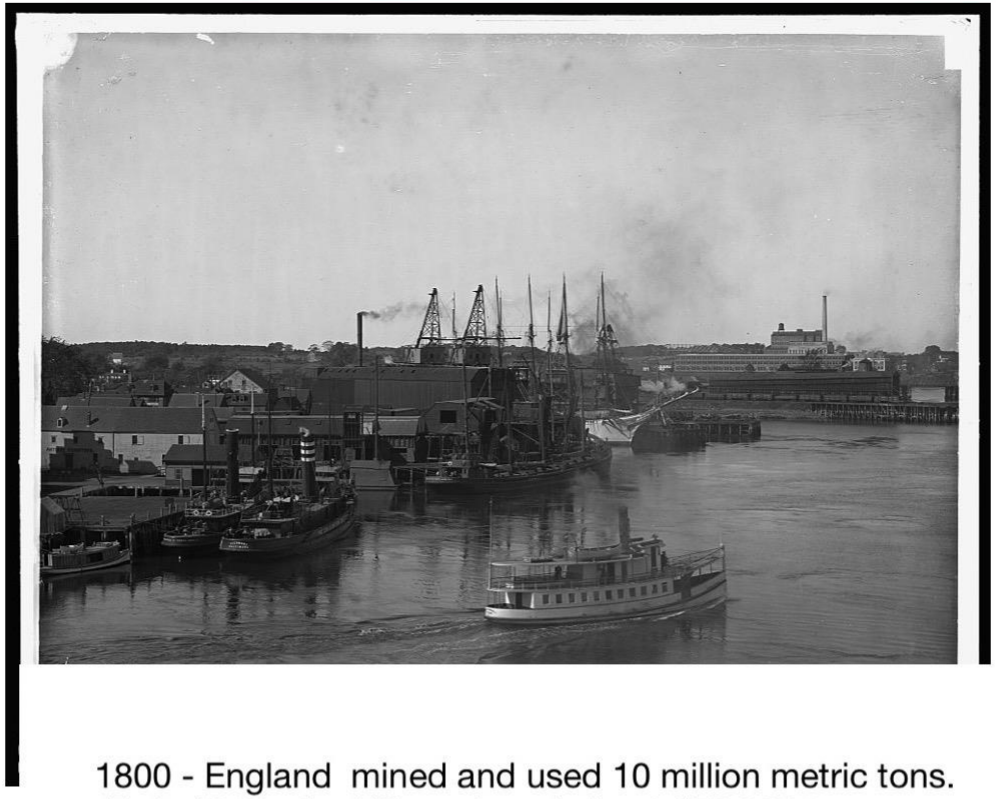
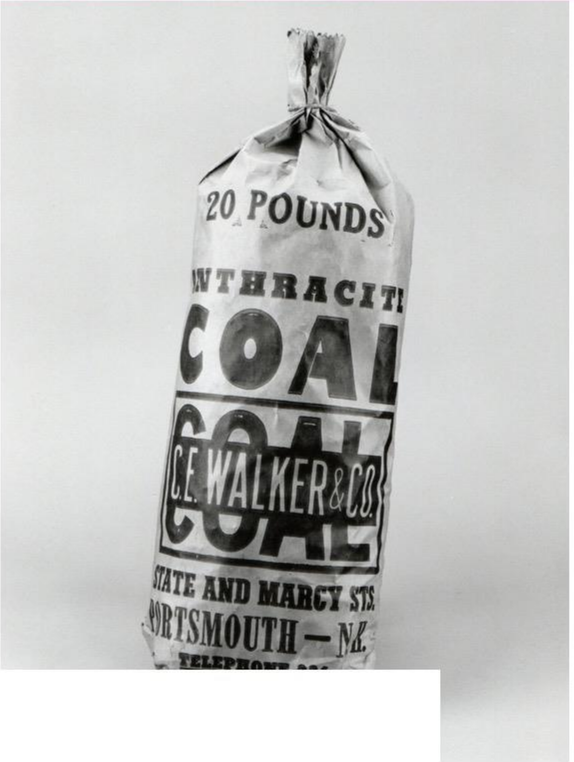
Context: Our Past

Context: Our Past



Context: Our Past

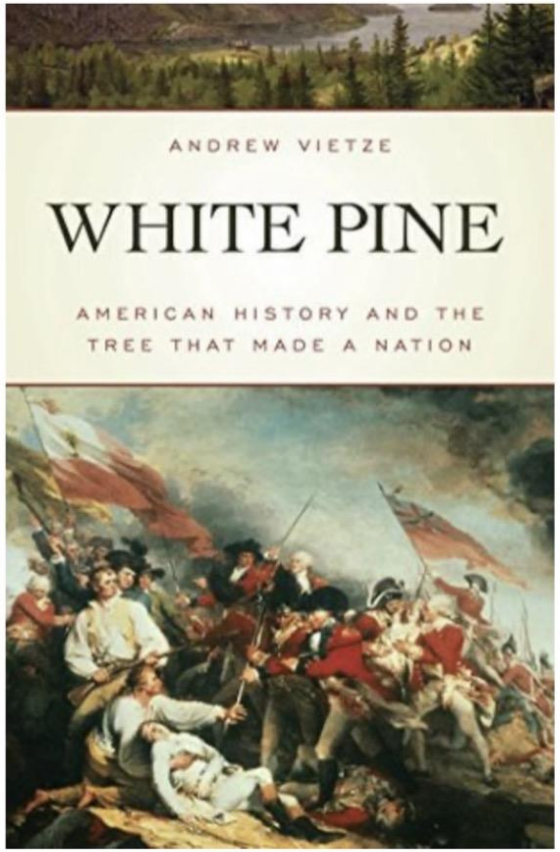




Walker Coal Bag
Ca. 1930-50
Strawbery Banke Museum
Gift of Cameron Russell Holt-Corti

1800 - England mined and used 10 million metric tons.
Early 1800s the US produced about 178,000 tons.
The amount of carbon in the atmosphere worldwide stood at 280 parts per trillion.
1850, US coal production had grown to 8.4 million tons.
1918 that had grown to 604 million tons.
1932 the US produced 360 million tons –
The atmospheric carbon registered 310 parts per trillion.
Since then, US production is at 775 million tons.
The atmospheric carbon is a 413 ppt – and rising.

Context: Our Past




PARKING/EVENT/ICESKATES
SHADE HARDSCAPE + ICE
EXIT
GRADING/ADDITIONL STORAGE
ELV. 8 FLOODING
BUS PARKING
BIO / WATER
AREA
ENTRANCE
ELV9.
PUDDLE
LANE
(PRIVATE)
MAST LANE

Potential Adjustments

REDUCING IMPERVIOUS SURFACE SF

1 - Reduce parking spots

(129 existing; 107 max used; 133-26 proposed)

EXPANDING STORMWATER CAPTURE CAPACITY

2 - Eliminate raised landform to expand basin

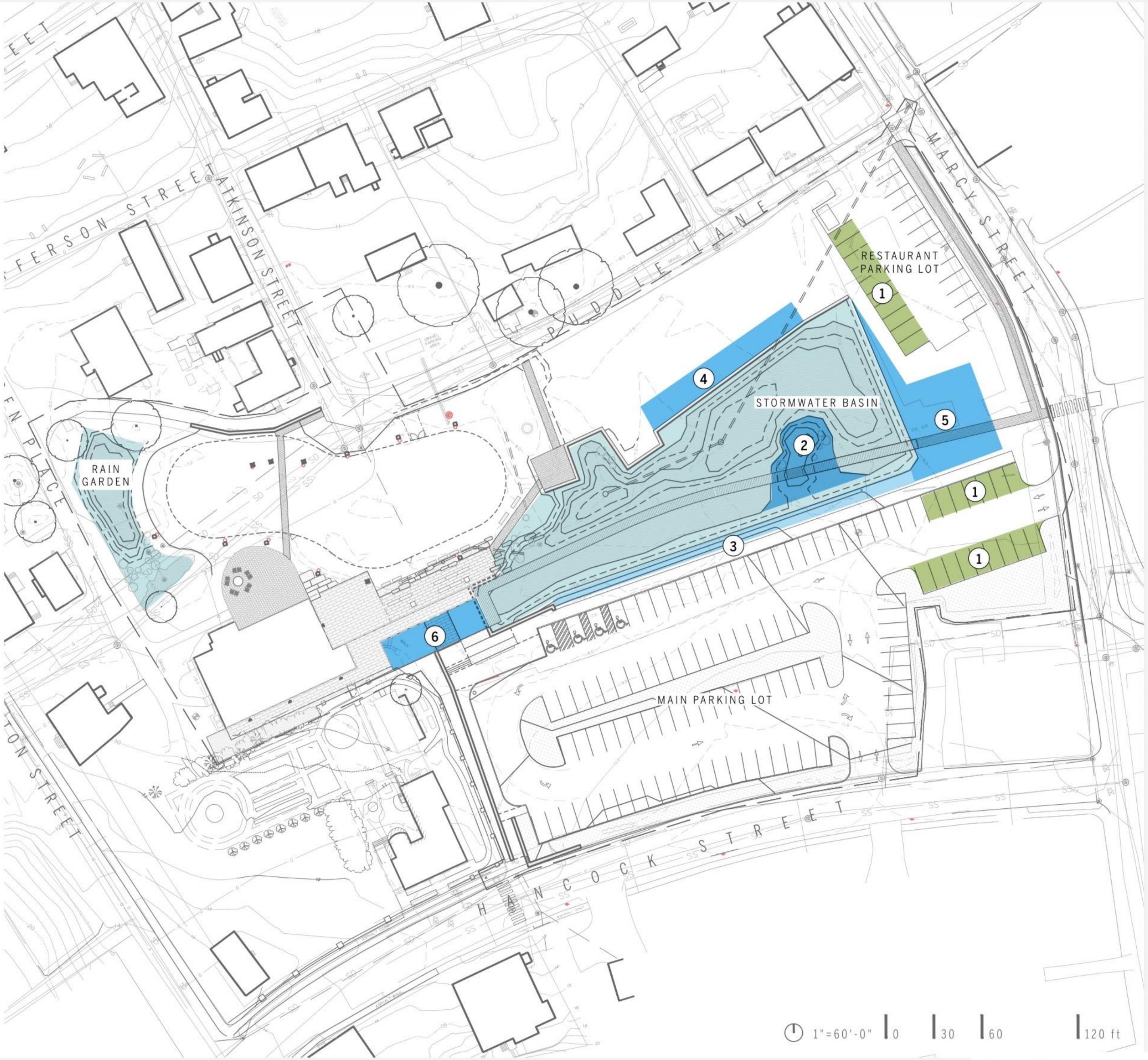
3 - Use wall (gabion) in lieu of slope to expand basin

4 - Expand basin north into event lawn area

(limit: archaeological features)

5 - Expand basin east toward Marcy St

6 - Put pavilion on piers to expand basin underneath



Site Constraints & Project Goals

(Blue items new for Schematic Design phase)

Design Implications

(A) PARKING LOTS

1 - Maximize parking capacity

129 existing; 107 max used; 133 proposed

2 - Meet fire truck and bus access requirements

3 - Raise grades to fit soils excavated from basin

4 - Maintain access to Marcy St and Hancock St

- Main Lot footprint has grown northward
- NW corner of Main Lot is located to allow fire hose access (100' to hookup)

(B) LAWNS

5 - Maximize event tent capacity

6 - Do not infringe on archaeological sites

- Lawn areas are graded to be level with retaining walls at basin that trace archaeological site shapes

(C) RINK AREA

7 - Maintain rink size

13,200sf existing; 12,840sf proposed (99%)

8 - Maintain relationship to existing buried infrastructure as possible

Header, light poles

9 - Improve rink access from Visitor Center

10 - Meet rink installation and maintenance requirements

- Rink shape is based on its current location
- Rink elevation is raised to meet maximum accessible slopes from Visitor Center. Keeping rink level requires retaining walls
- ~10ft buffer is shown around rink footprint for installation
- New Zamboni shed and access are shown north of rink

(D) ARRIVAL & PAVILION

11 - Locate pavilion near Visitor Center to create massing

12 - Provide covered shelter, room for events, group visitors

13 - Reference historic dock character

14 - Provide ADA accessible access from parking lot and Marcy St

15 - Relocate fire pit

16 - Maintain existing terrace

- Parking lot connection to entry happens closer to the Visitor Center, which is at a lower grade (limits parking lot elevations)
- New terraces and roofs create a cohesive arrival space between a new pavilion and the Visitor Center
- Boardwalk connects arrival terrace to Marcy St

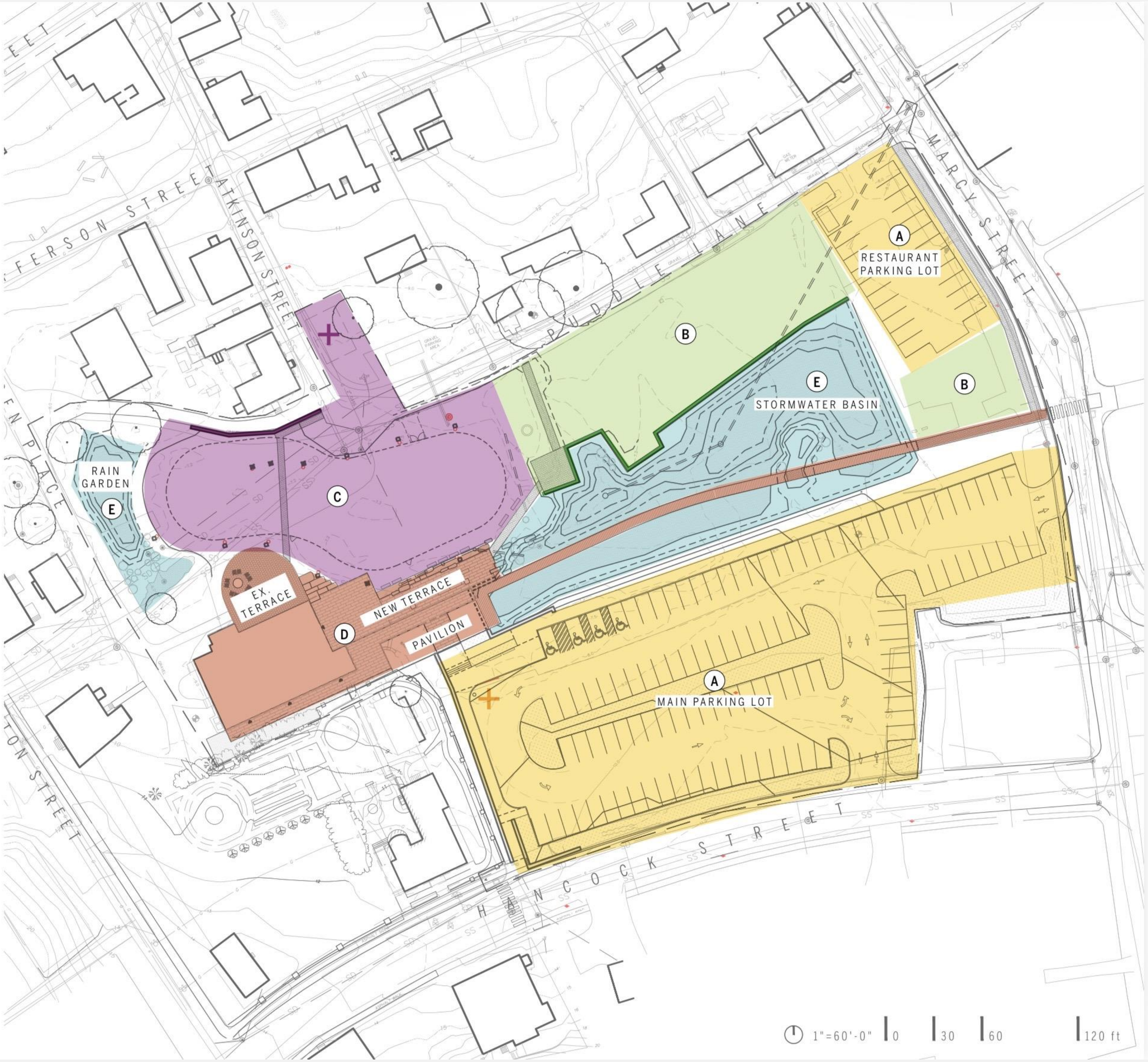
(E) STORMWATER

17 - Based on new survey, expand stormwater capture capacity to mitigate site flooding for current and projected storm events from multiple sources: rainfall on Puddle Dock area and from overall site runoff

18 - Limit excavation to -2ft below existing grades

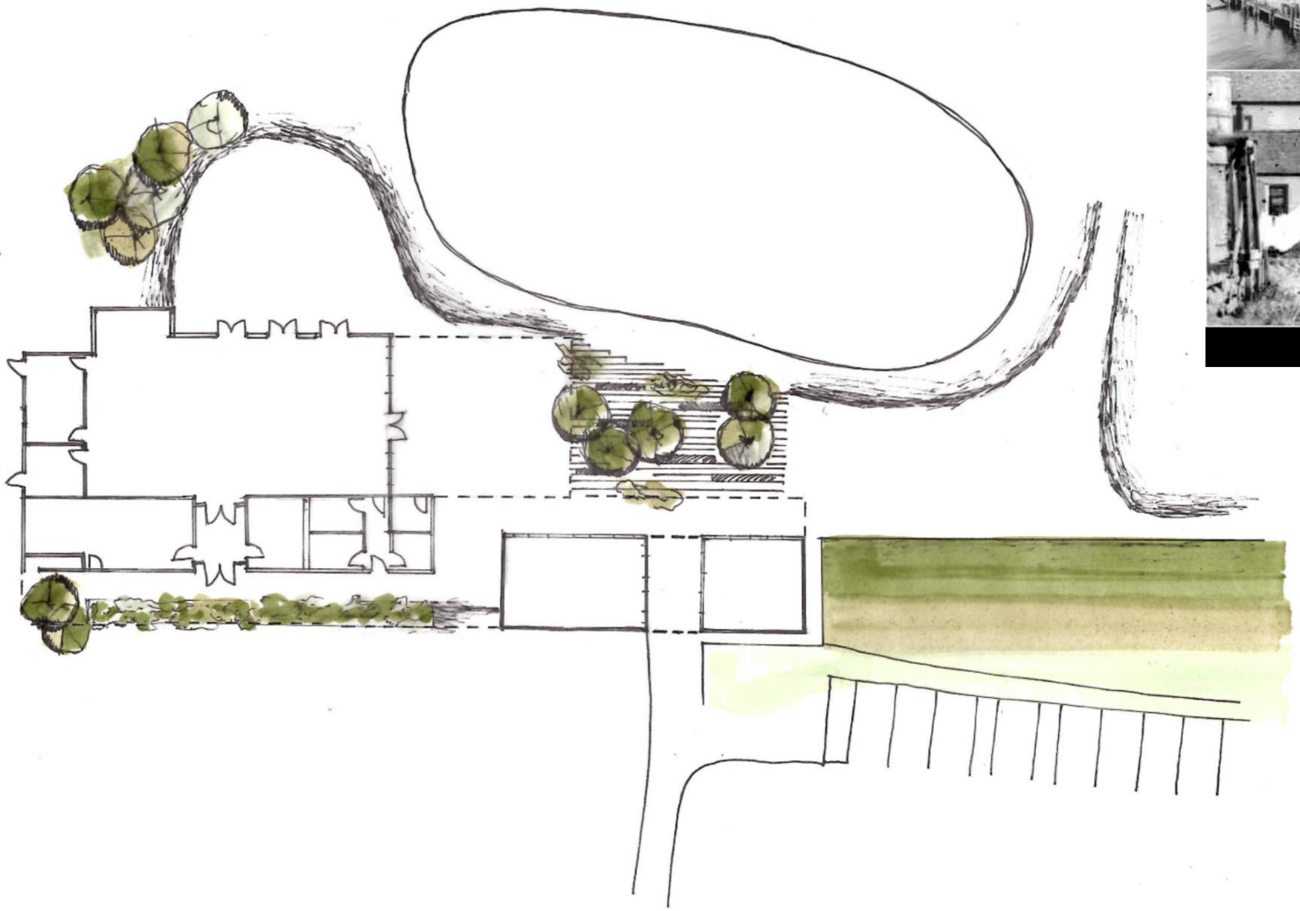
19 - Keep all excavated soils on site

- Stormwater basin and rain garden footprints are maximized while maintaining required program areas



Historic Wharf Vernacular

plan



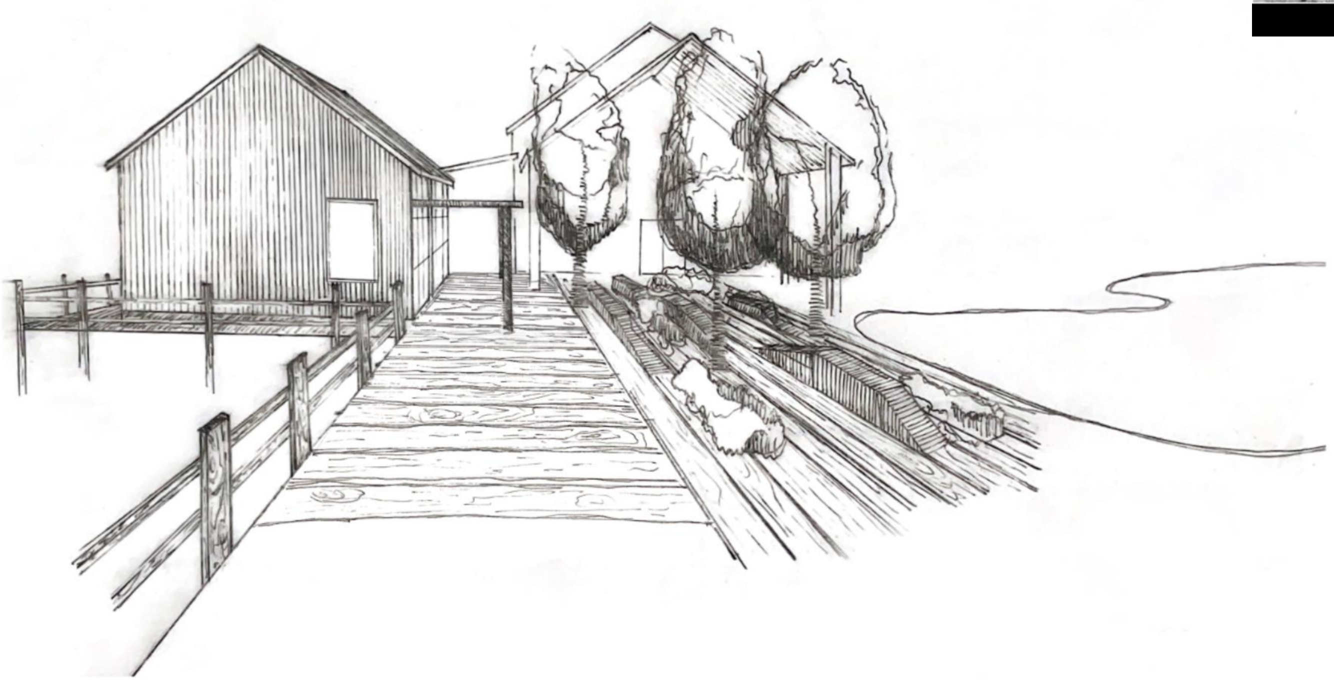
Placework

STRAWBERY BANKE MUSEUM
PORTSMOUTH, NH

N

Historic Wharf Vernacular

dock-inspired pavilion + landscape



FOX POINTE
STORMWATER RUNOFF
A Bio-Retention Basin Can Reduce Runoff Pollutants
Monarch
Painted Lady
Tiger Swallowtail
12-Spotted Skimmer
WILDLIFE WELCOME!
The native plants in this Bio-Retention Basin create a prairie in miniature. Prairie plants have root systems that extend far down into the soil. Deep roots help the plants grow taller and absorb more water and nutrients from the soil. They also offer habitat for small wildlife like butterflies, dragonflies, amphibians and songbirds.
Big Bluestem
This native prairie grass towers above most other plants, reaching 4–8 feet. It is also called "Turkey Foot" because its seed spikes often branch to resemble a bird's foot.
VILLAGE OF LANSING
Plants are crucial to our pollution reduction practices. Bio-retention Basins planted with native trees, shrubs, forbs, grasses, and sedges that you see here adjacent to the parking lot filter contaminated rainwater run-off from the parking lot.
During heavy rains, some water flows across the parking lot, washing pollution into the Bio-Retention Basin.
Pollutants remain trapped but don't damage the plants.
Overflow Drain, excess water flows down this pipe.
Maximum water level.
Parking Lot with curb drain into Basin.
Parking Lots can be a big source of water pollution if stormwater runoff is allowed to flow directly into the storm sewer unfiltered. This Parking Lot directs its polluted runoff into a Bio-Retention Basin for filtering before entering the storm sewer and then river system.
Soil Filter Mix. Supports plant growth. Pollutants get trapped in plant roots, stems and soil before moving on to next layer.
Aggregate Drainage Layer. Large gravel allows filtered water to drain more quickly.
Filtered water flows through the aggregate drainage layer to a perforated draining pipe.
Cleaner rainwater leaves the bio-retention basin and enters the storm sewer.
This Bio-Retention Basin was Designed per Metropolitan Water Reclamation District of Greater Chicago Standards.
Prairie Cord Grass
Swamp Mallow
Tall Coreopsis
Swamp Milkweed
Switch Grass
Spotted Joe-pye Weed
WHAT IS A BIO-RETENTION BASIN?
The planted depression planted next to this parking lot is known as a "Bio-Retention Basin." It was put here to help keep our environment cleaner and healthier. Every time it rains, grime, oil, grass clippings and fertilizers are washed off the parking lot. The plants catch and filter out these water contaminants rather than funneling them straight through a storm pipe and into the lake and river. Deep-rooted plants eat up excess algae-growing nutrients and help water to be re-absorbed back into the soil. The result is a cleaner, healthier environment for you to enjoy.
THE BENEFITS INCLUDE:
Increase the amount of water that filters into the ground which recharges aquifers.
Help protect against flooding and drainage problems.
Help protect streams and lakes against pollutants carried by stormwater—fertilizer, car fluids, salt, and pesticides.
Improves water quality through the removal of pollutants.
Northern Cardinal


Think Blue! What can YOU do?
See how many of these suggestions from the City of Portsmouth DPW Water-Stormwater Division you can adopt!
START HERE
•Replace your toilet with a new, water-efficient one. Many places, like Portsmouth, offer rebates. Save 10 gals per day.
•Install low-flow showerheads. Take showers instead of baths and keep them under 5 minutes. Save 50 gals per day.
•Turn off the water while brushing your teeth, shaving and while lathering your hands. Save 7 gals a day.
•Avoid over-fertilization that increases plants' need for water and adds nitrogen to stormwater runoff.
•Use mulch around plants to retain water, repel weeds, moderate temperature and avoid erosion.
•Run only full loads of laundry. Invest in a high-efficiency washing machine. Many places like Portsmouth offer rebates. Save 10 gals per day. Save 27 gals per load.
•Add a rain barrel to your gutter downspout and use rainwater for watering. Save 55 gals a day.
•Create a rain garden! Rain gardens are great ways to improve both your landscape and water quality.
•Run only full loads in the dishwasher. Save 2,000 gals per year.
•When washing dishes by hand, fill the sink with soap and water instead of running the water. Rinse in a basin of clear water.
•Compost. Add organic waste from your kitchen to a compost pile that forms a nutrient-rich soil to add to your garden.
•Wash car at car wash that recycles their water Save 100 gals.
•Take the pledge to "Scoop the Poop" at Stateofourestuaries.org/everydrop/petpledge
•Step on your grass. If it bounces back, you don't need to water. Water your yard in the morning or evening to avoid losing water to evaporation. Save 96 gals.
•Rake it or Leave it. Do not dump leaves or clippings in or near storm drains or water bodies/wetlands. Use leaves as mulch and compost or collect in a paper bag for proper disposal.
•Don't dump waste in storm drains. Dispose of household hazardous waste properly at your town's collection day events.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GARDEN
This property fulfills the principles of landscape sustainability
Select appropriate plants. Nurture the soil. Practice responsible pest management. Protect wildlife. Conserve water and protect water quality. Conserve energy and protect air quality. Reduce waste.
www.MasterGardenerSD.org
MASTER GARDENER ASSOCIATION
SAN DIEGO COUNTY


BAD IDEAS
WE ALL HAVE THEM

Rodney Rowland

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