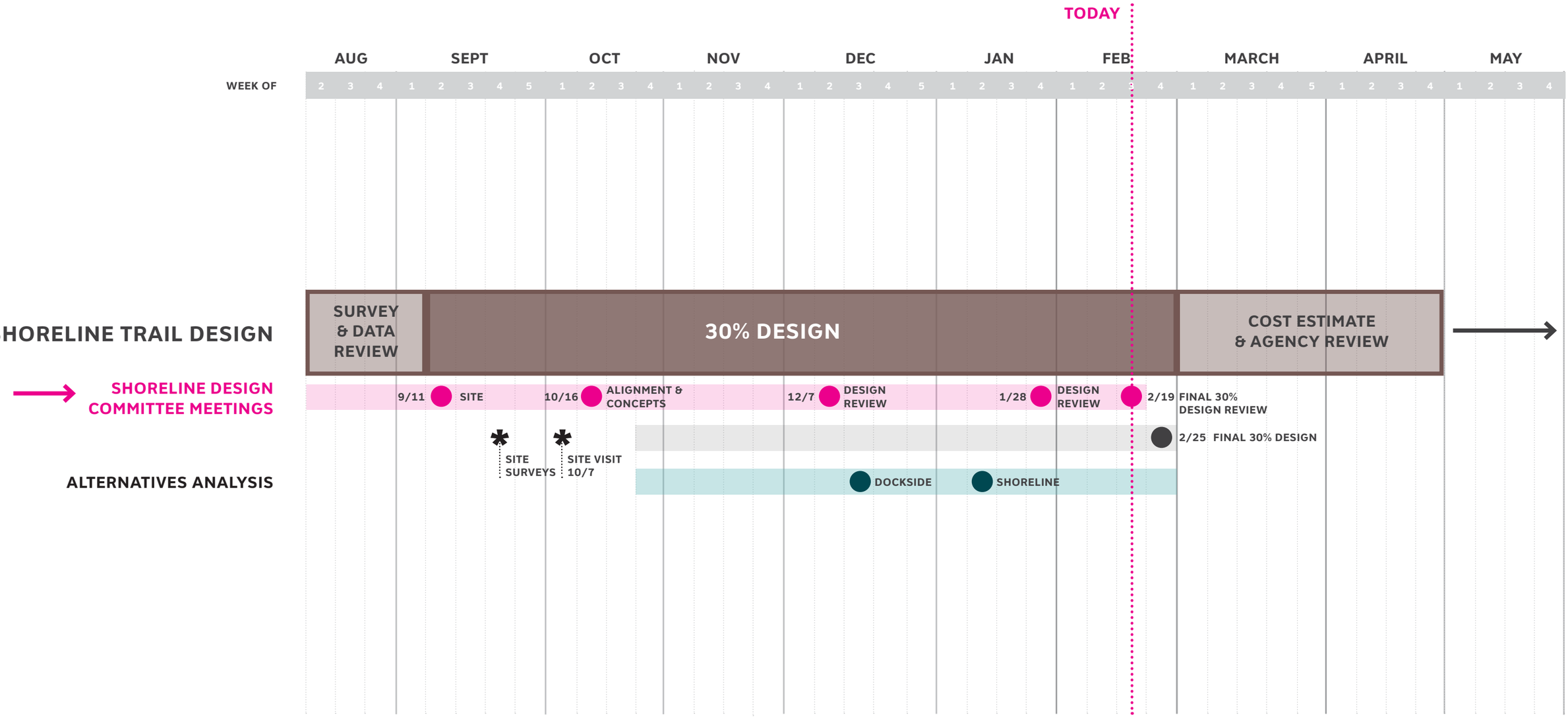
SHORELINE TRAIL

SHORELINE DESIGN COMMITTEE MTG #5

2/19/2021

PROJECT TIMELINE



AGENDA

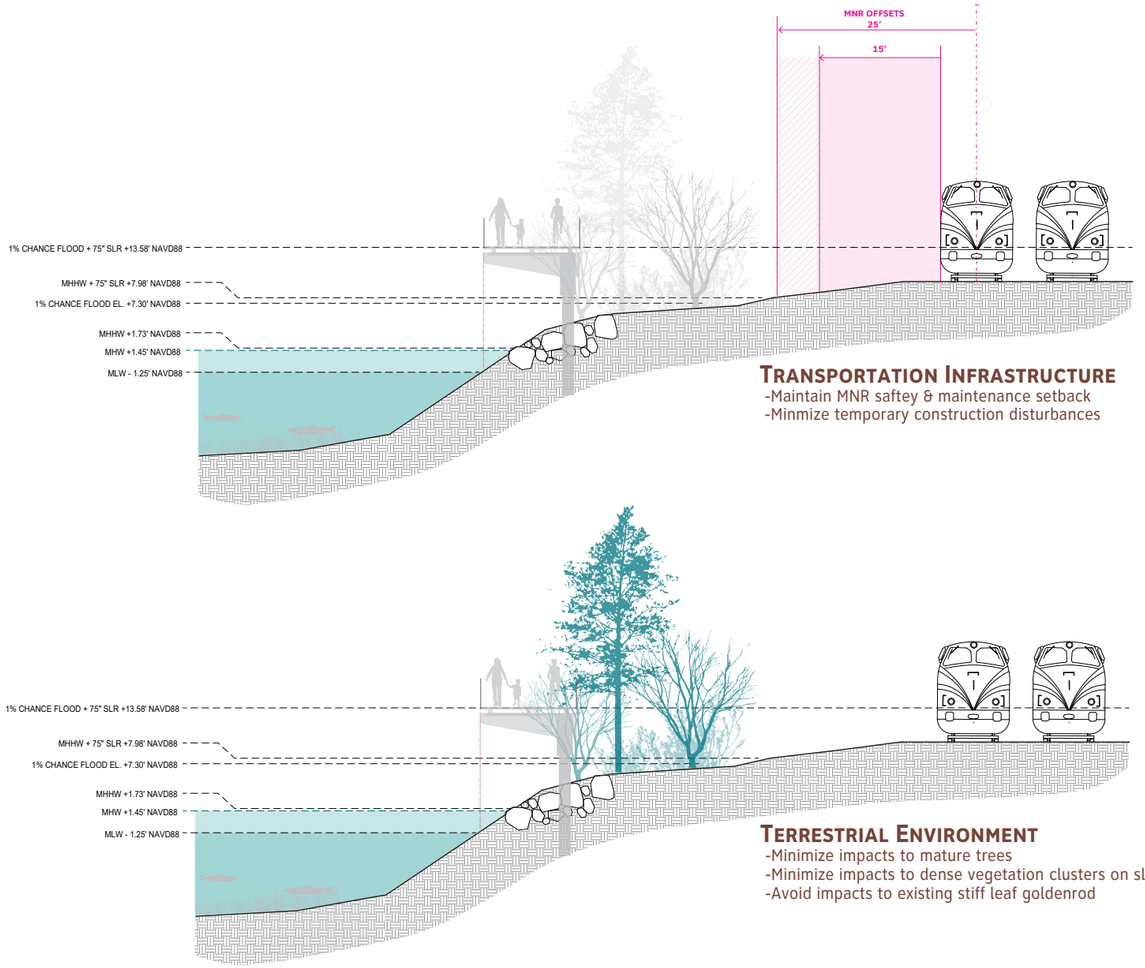
DESIGN REVIEW

- Mtg #1: Review Design Parameters
- Mtg #3: Review Criteria for Developing a Successful Shoreline
- Mtg #2 - 4: Review Alignment & Design
- Mtg #4 - Review the Lower Overlook

DESIGN UPDATE

- 30% Design Alignment
- Dockside Alignment Design
- Design Summary and Next Steps

DESIGN PARAMETERS

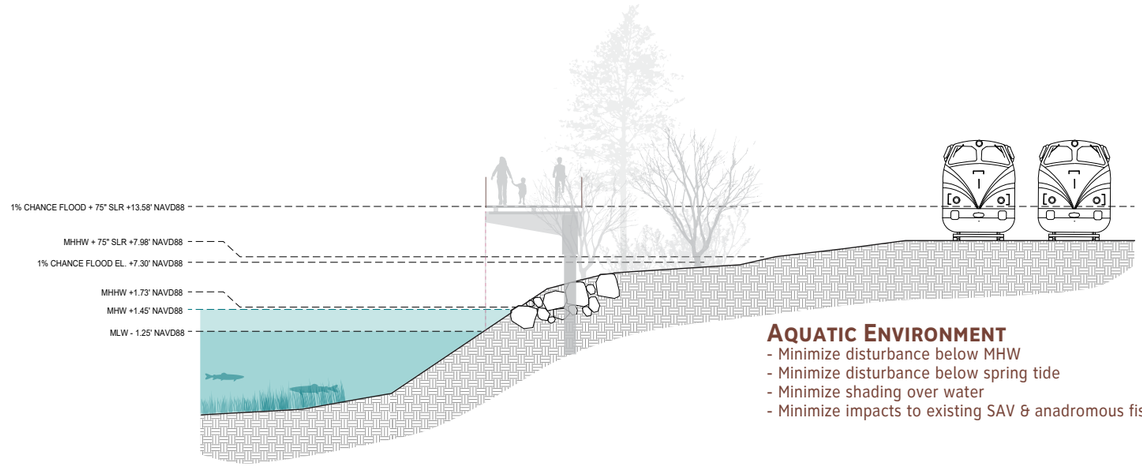


Transportation Infrastructure

-Maintain MNR saftey & maintenance setback
-Minmize temporary construction disturbances

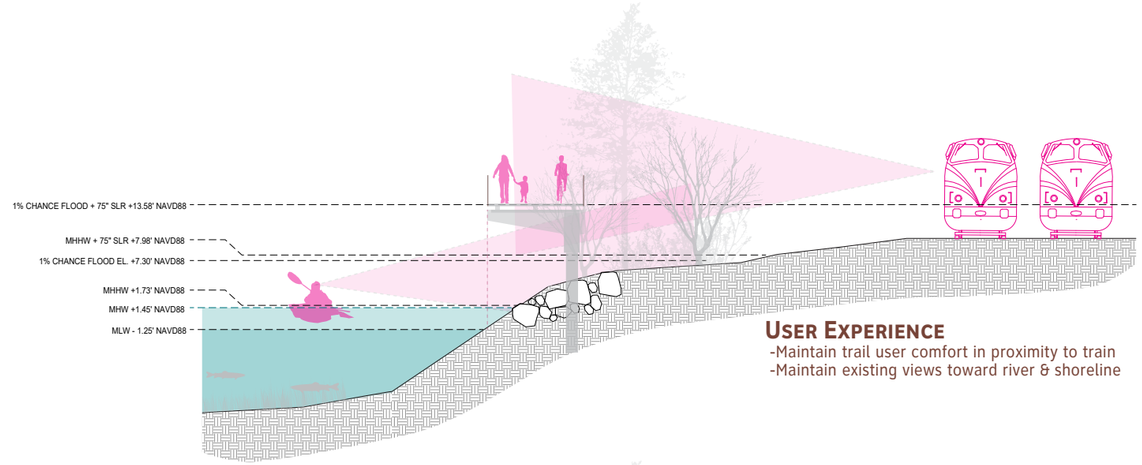
Terrestrial Environment

-Minimize impacts to mature trees
-Minimize impacts to dense vegetation clusters on slc
-Avoid impacts to existing stiff leaf goldenrod



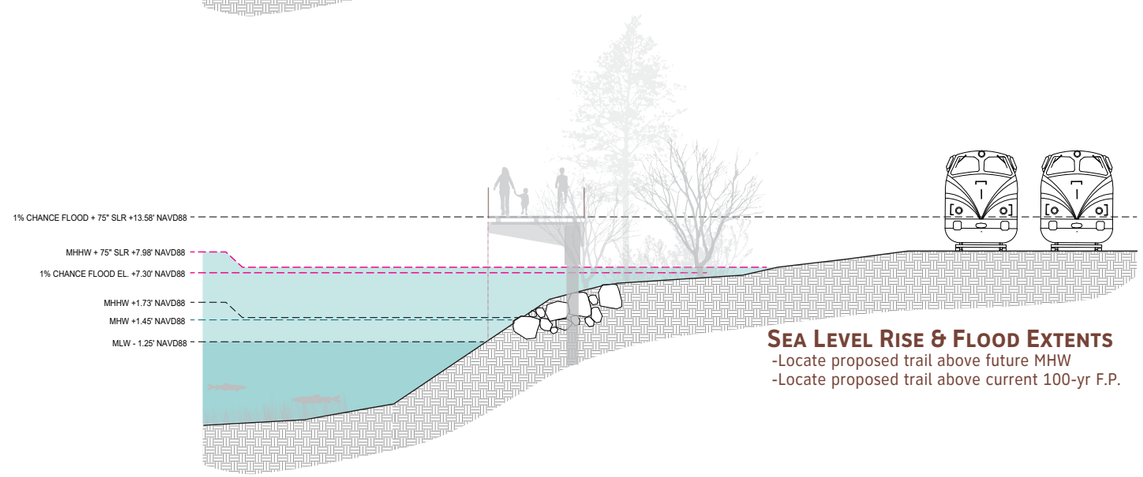
Aquatic Environment

- Minimize disturbance below MHW
- Minimize disturbance below spring tide
- Minimize shading over water
- Minimize impacts to existing SAV & anadromous fish



User Experience

-Maintain trail user comfort in proximity to train
-Maintain existing views toward river & shoreline



Sea Level Rise & Flood Extents

-Locate proposed trail above future MHW
-Locate proposed trail above current 100-yr F.P.

CRITERIA FOR DEVELOPING A SUCCESSFUL SHORELINE

SHORELINE STABILITY

- Visual evidence of erosion, causes to be determined
- Washout
- Vegetation cover, type, quantity, root exposure
- Level of exposure to environmental impacts
- Misalignment, settlement, bulging

ECOLOGICAL INTEGRITY

- Robust upland provides shoreline stability and habitat
- SAV protects soft sediments and critical fish habitat
- Vegetations provides cover for juvenile fish to escape predation and supports invertebrates that are an important food source for fish
- SAV beds act as a carbon sink
- Surface hydrology and sediment processes are a natural condition of Hudson River ecology
- Driftwood pile-up provides habitat

CLIMATE CHANGE VULNERABILITY

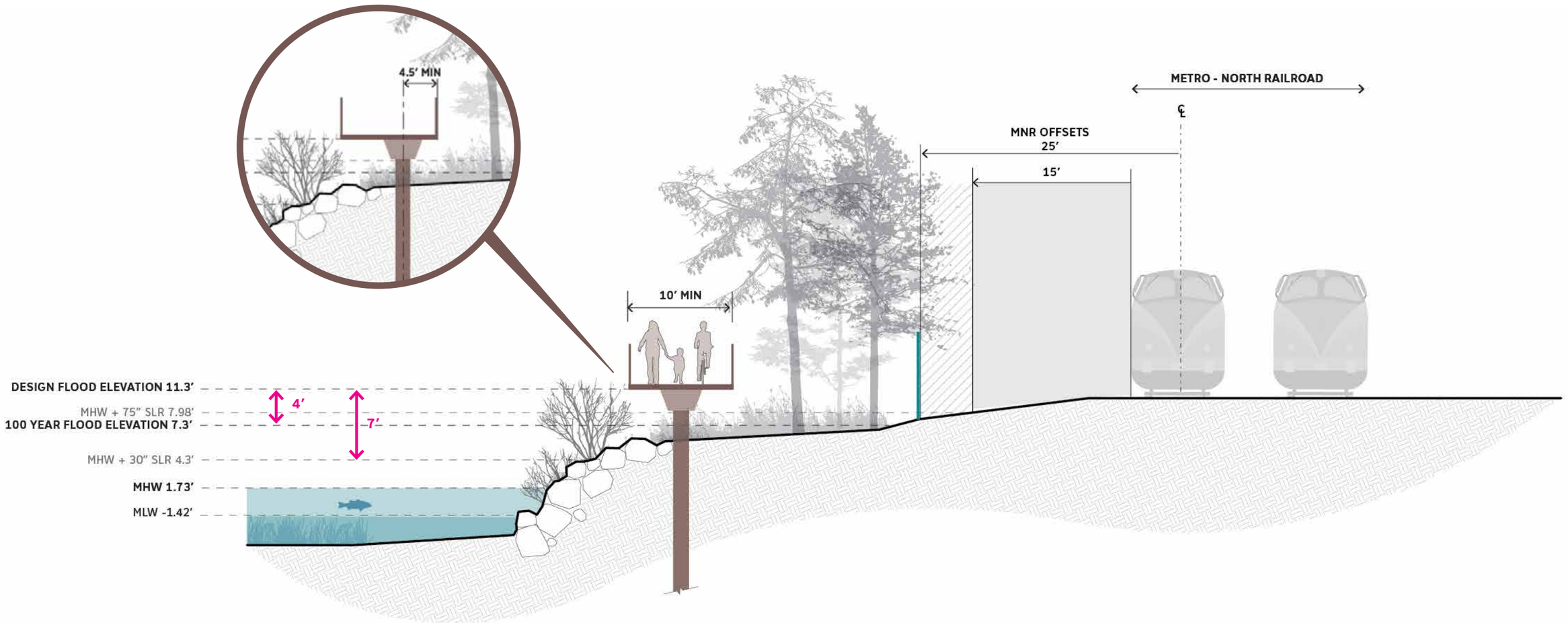
- Balance current shoreline vulnerability with sea level rise planning
- Identify areas of the shoreline more vulnerable to sea level rise
- Sea level rise will impact vegetation
- Sea level rise will increase ice scour and erosion along the shoreline

ELEVATED TRAIL DESIGN

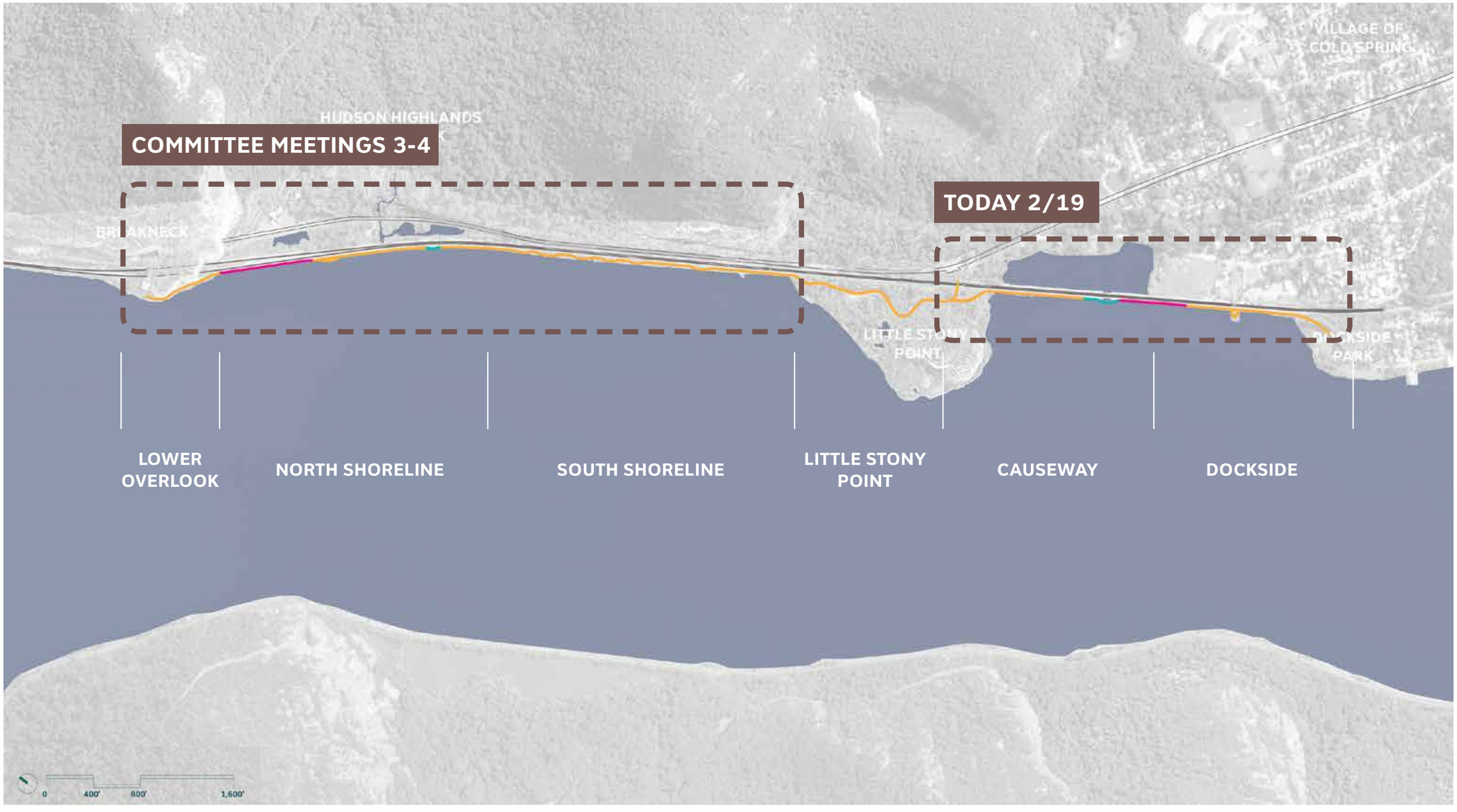
- **Bottom of trail deck designed with 4’ of freeboard above the FEMA 100 YR Base Flood Elevation**
- **Bottom of trail deck provides 7’ of freeboard above MHW with 30” SLR** *(5’ of freeboard + additional 2’ for future rip rap maintenance)*
- **Trail structure above MHW in 75” of SLR**

Time Interval	Low Projection	Low-Medium Projection	Medium Projection	High-Medium Projection	High Projection
2020s	2 inches	4 inches	6 inches	8 inches	10 inches
2050s	8 inches	11 inches	16 inches	21 inches	30 inches
2080s	13 inches	18 inches	29 inches	39 inches	58 inches
2100	15 inches	22 inches	36 inches	50 inches	75 inches

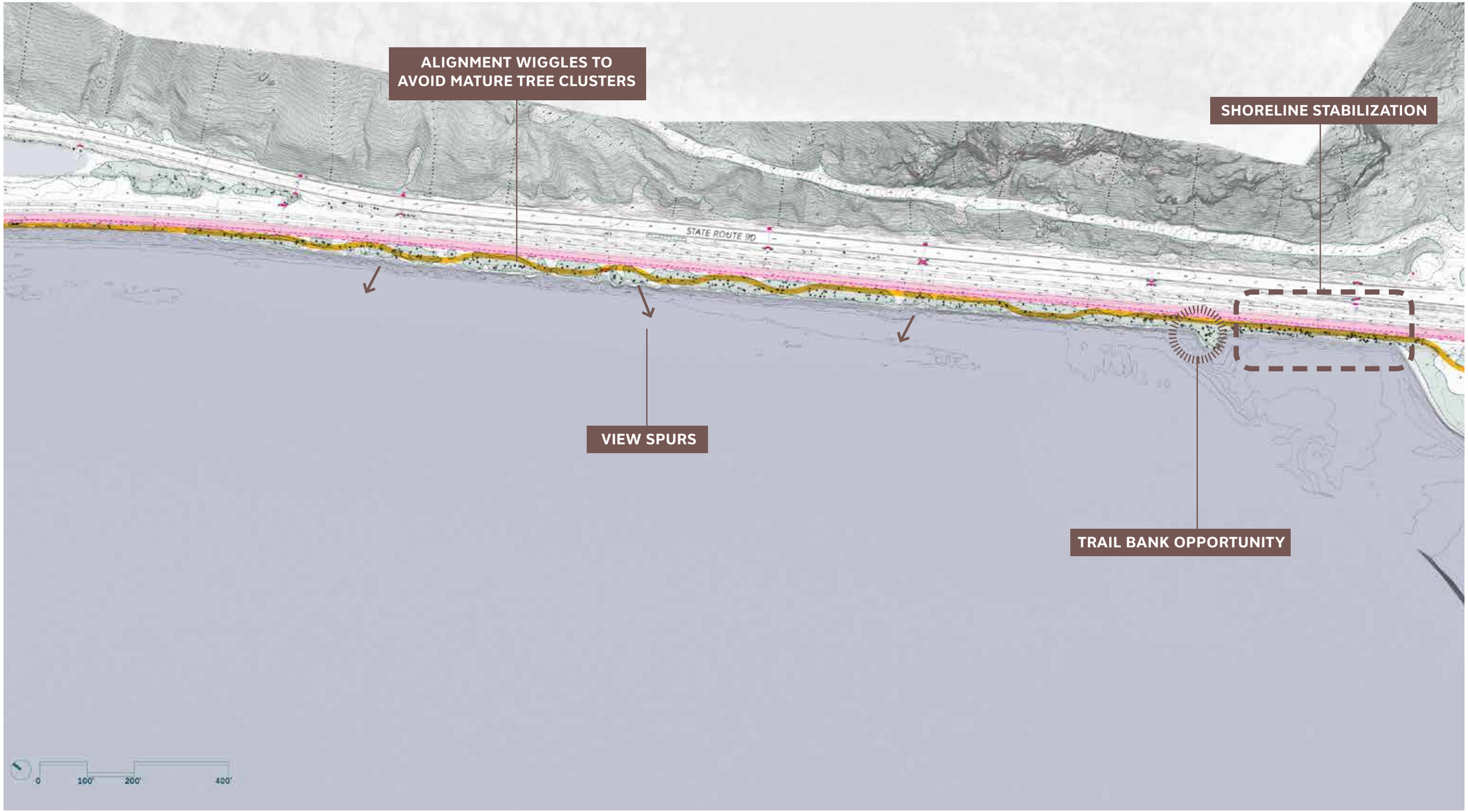
CANTILEVERED SECTION



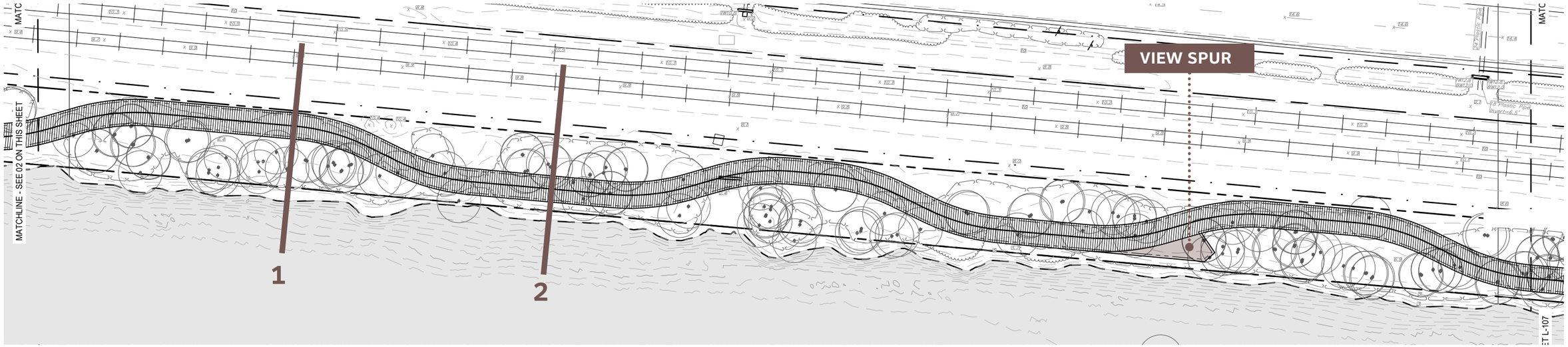
30% DESIGN ALIGNMENT

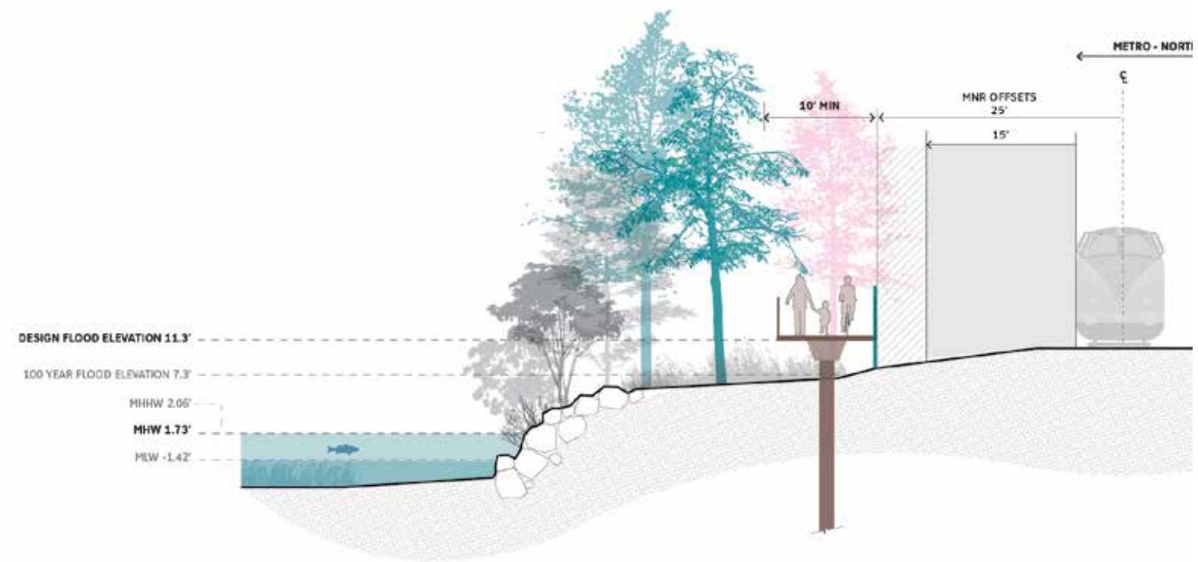


SOUTH SHORELINE ALIGNMENT



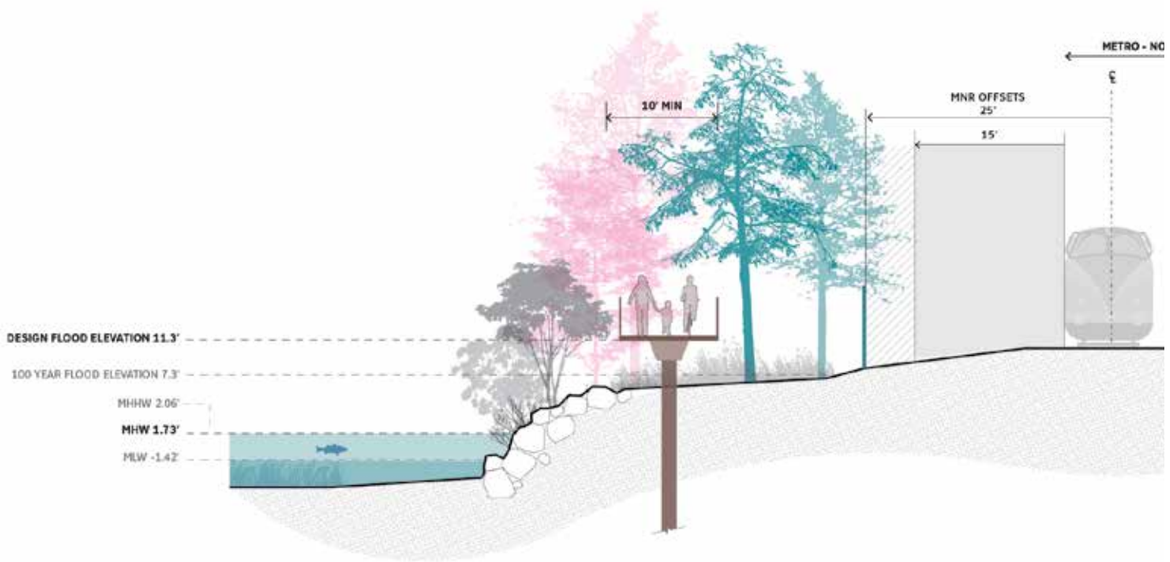
TYPICAL WIGGLE STRATEGY: AVOID MATURE TREE CLUSTERS





ELEVATED TRAIL AT 25' SETBACK FROM MNR

- **Trail meets minimum setback requirements at MNR railroad**
- **Preserves mature tree clusters that are closer to the shoreline**



ELEVATED TRAIL AT TOP OF BANK

- **Trail meets minimum setback requirements at MNR railroad**
- **Trail pile located at top of bank**
- **Preserves mature tree clusters closer to MNR railroad**

HOLLOW TRAIL BANKS / SPURS

IMAGE FROM HHFT MASTERPLAN

BREAKNECK RIDGE

UGAR LOAF MOUNTAIN

HUDSON HIGHLANDS STATE PARK

COLD SPRING

MT. TAURUS QUARRY

BREAKNECK RIDGE TRAIL

WASHBURN TRAIL

CORNISH ESTATE TRAIL

P

P

BREAKNECK POINT

MNR

LITTLE STONY POINT

CAUSEWAY BRIDGE + UTILITY OFFSET

DOCKSIDE PARK

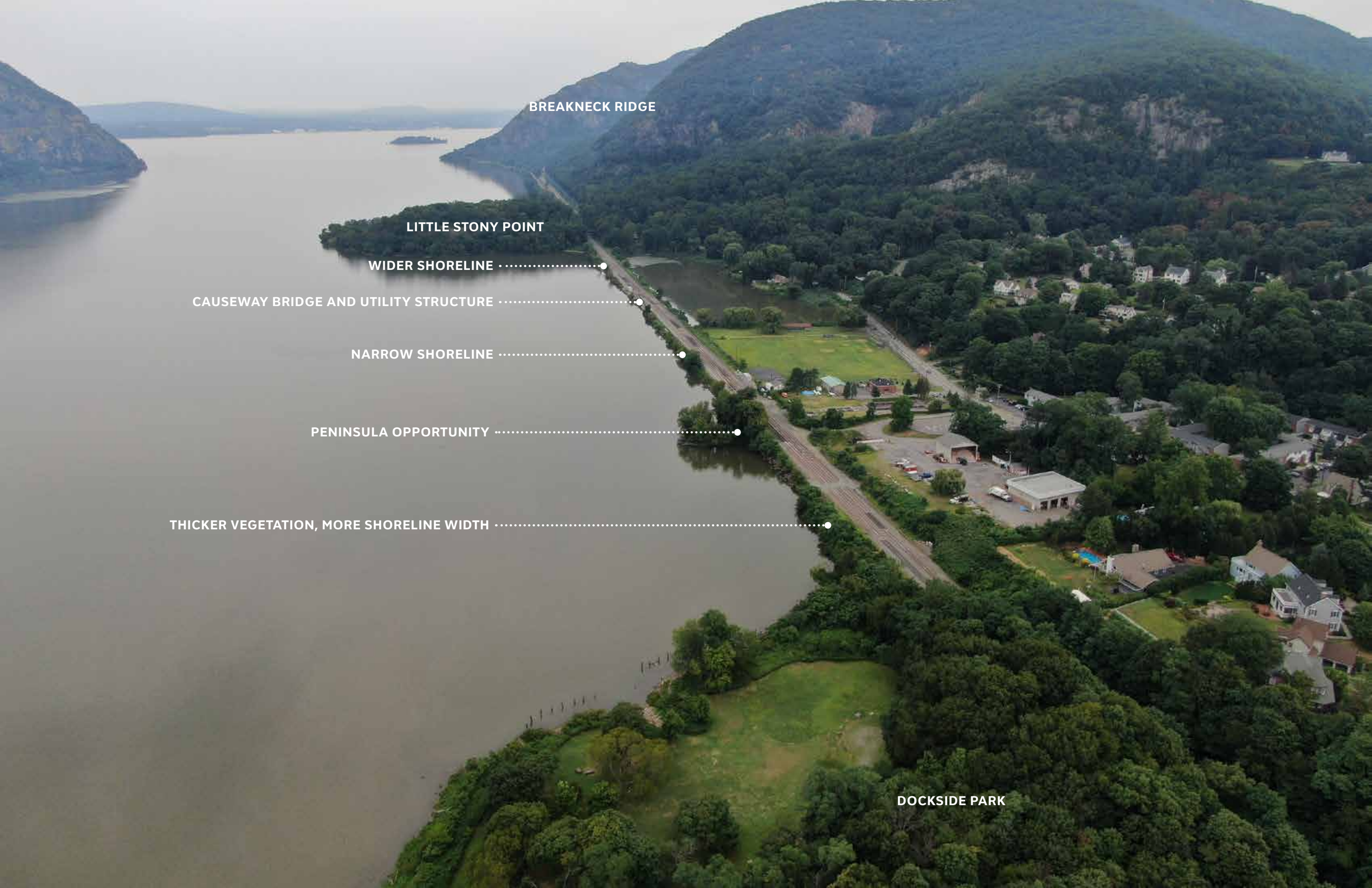
DOCKSIDE TO LITTLE STONY POINT

HUDSON RIVER

STORM KING MOUNTAIN

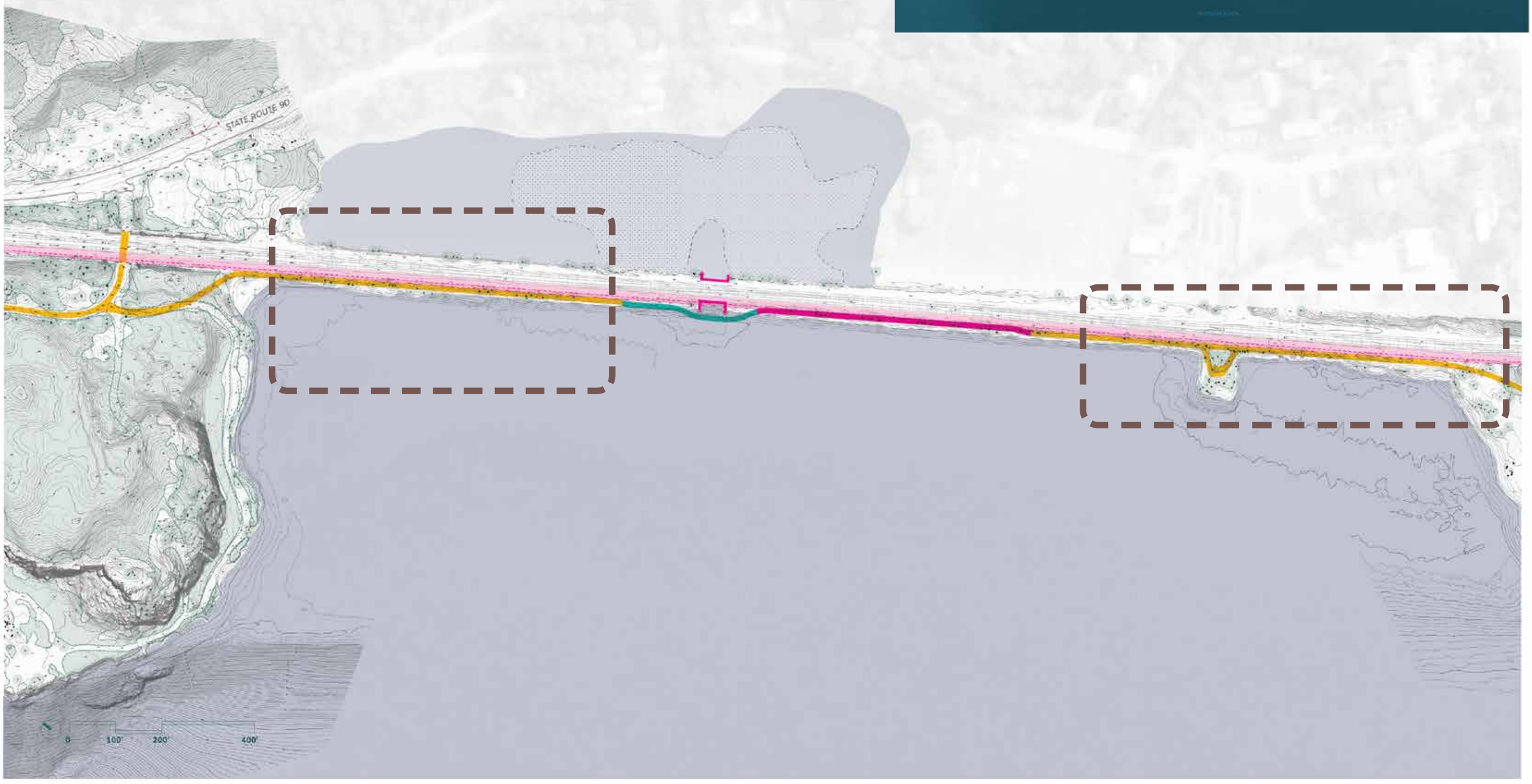
LEGEND

- SHORELINE TRAIL
- BREAKNECK CONNECTOR
- CONNECTOR TRAILS
- ACCESS POINTS
- ROUTE 9D
- METRO - NORTH RAIL
- DOCUMENTED SUBMERGED AQUATIC VEGETATION


BREAKNECK RIDGE
LITTLE STONY POINT
WIDER SHORELINE
CAUSEWAY BRIDGE AND UTILITY STRUCTURE
NARROW SHORELINE
PENINSULA OPPORTUNITY
THICKER VEGETATION, MORE SHORELINE WIDTH
DOCKSIDE PARK

DOCKSIDE ALIGNMENT

DOCKSIDE ALIGNMENT: TYPICAL STRATEGIES

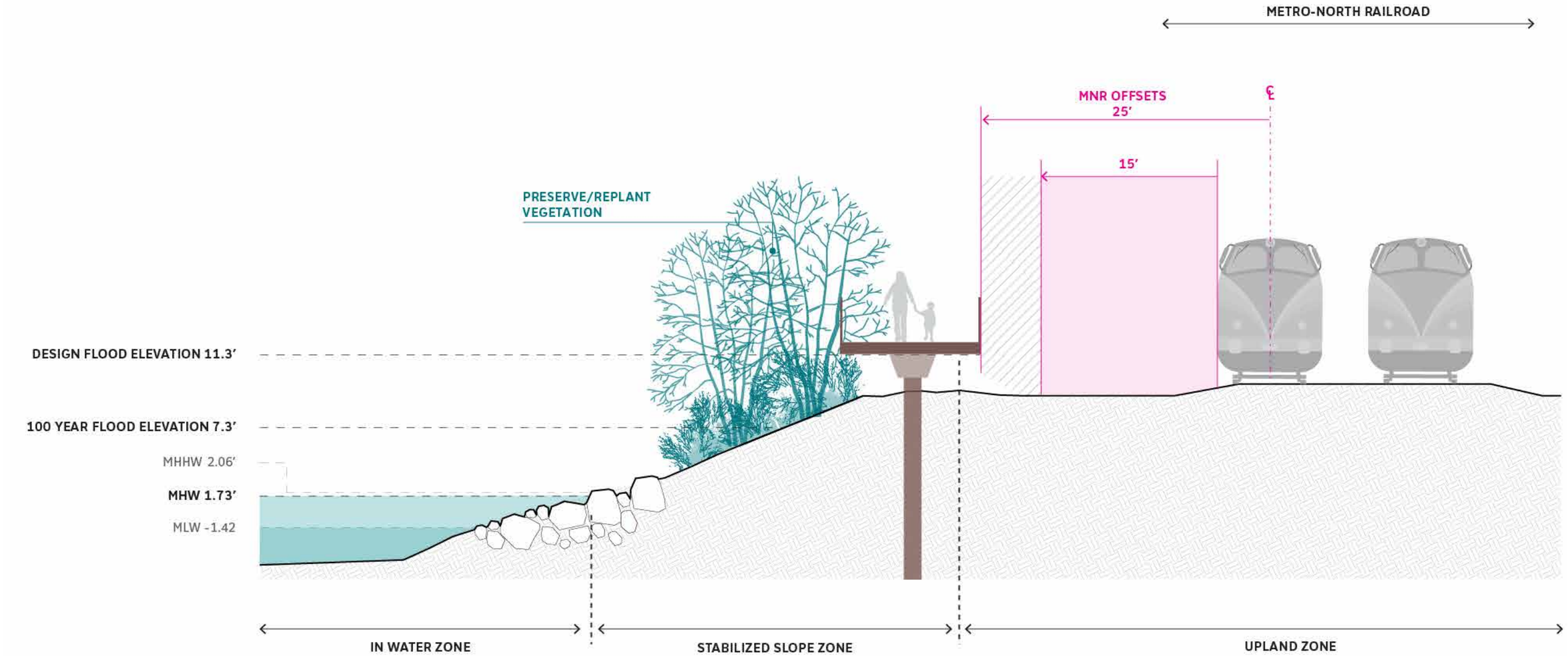



WIDER SHORELINE
LAND PROTRUSION


THICK, LOW WOODY VEGETATION

TRAIL AT 25’ OFFSET

- MAXIMIZES PRESERVATION OF VEGETATION
- TRAIL CLOSER TO MNR RAIL

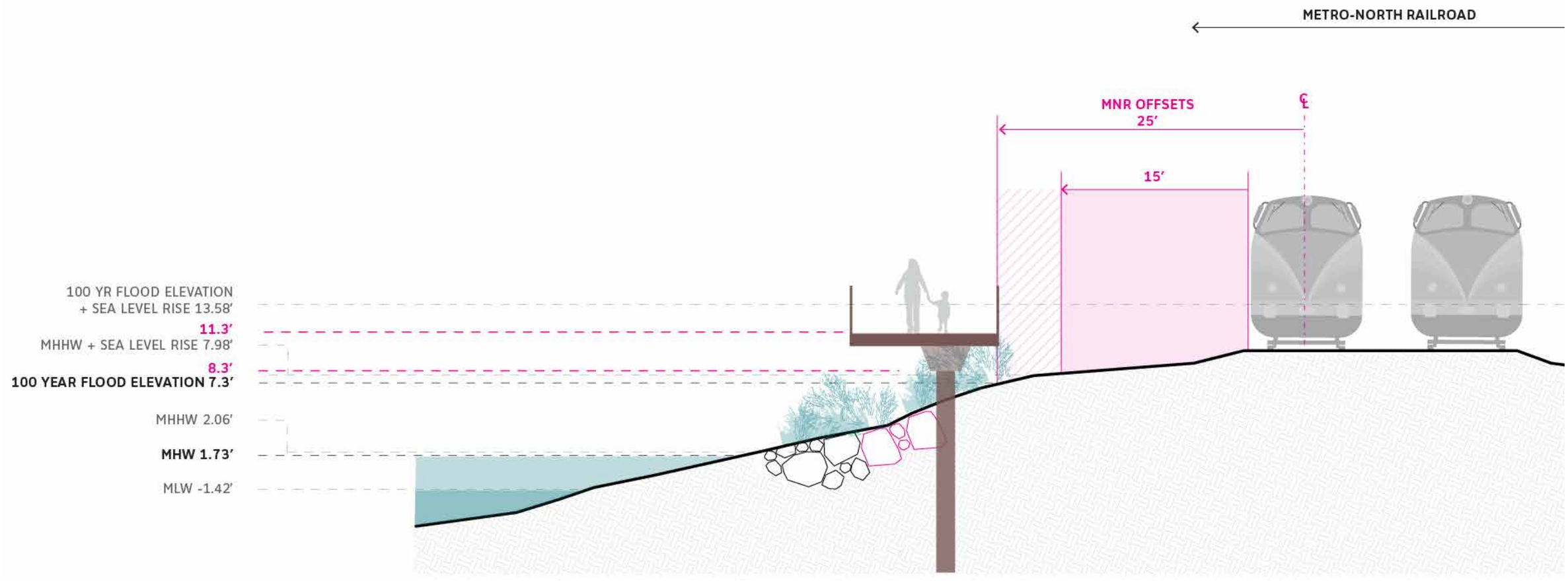



WIDER SHORELINE

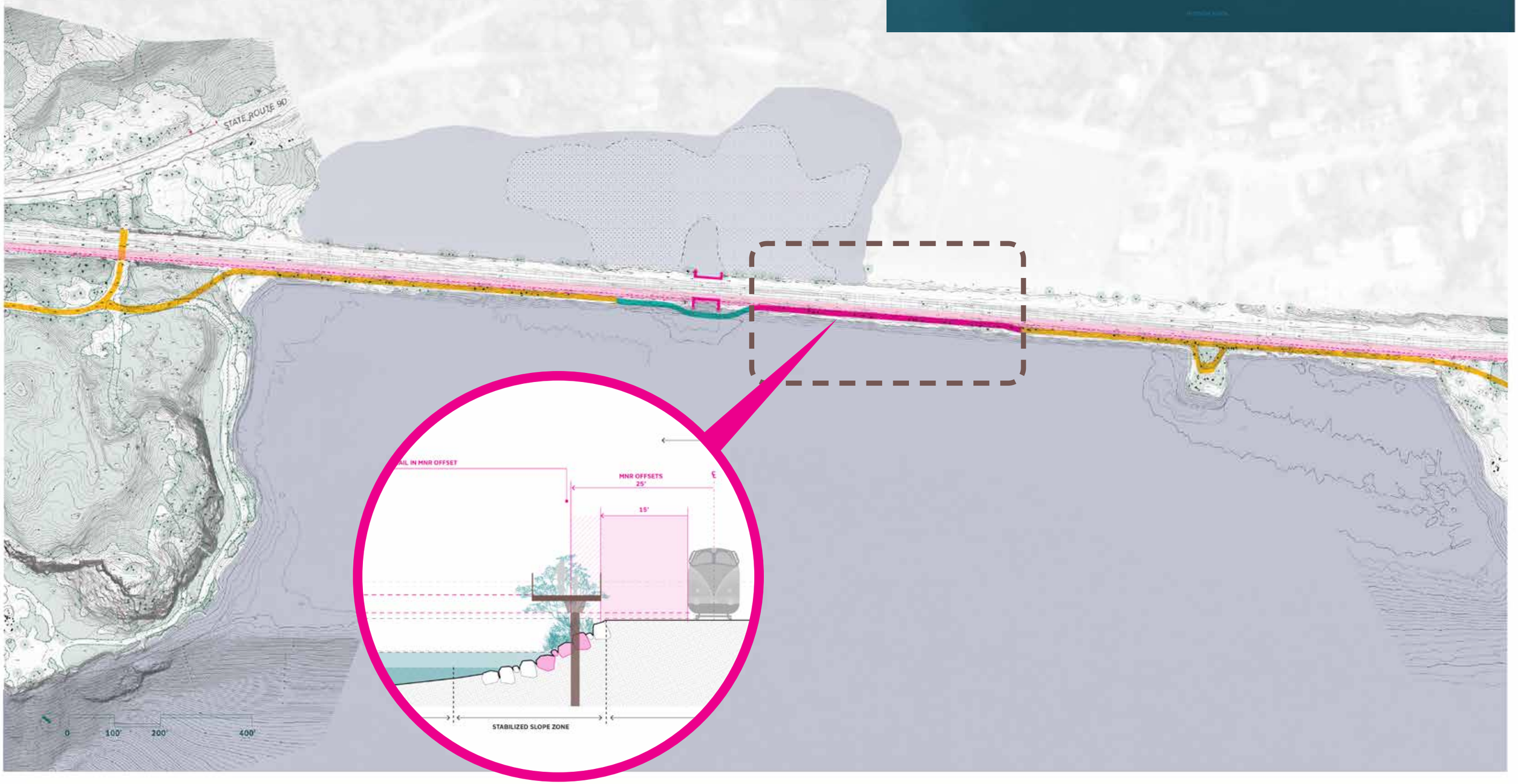

SCATTERED TREES
WIDER SHOULDER
LOW SHRUB EDGE

SECTION AT WIDER REVETMENT

- TRAIL MAINTAINS 25’ CLEARANCE FROM METRO-NORTH RAILROAD
- PILES REMAIN ABOVE MHW



DOCKSIDE: PINCH POINTS

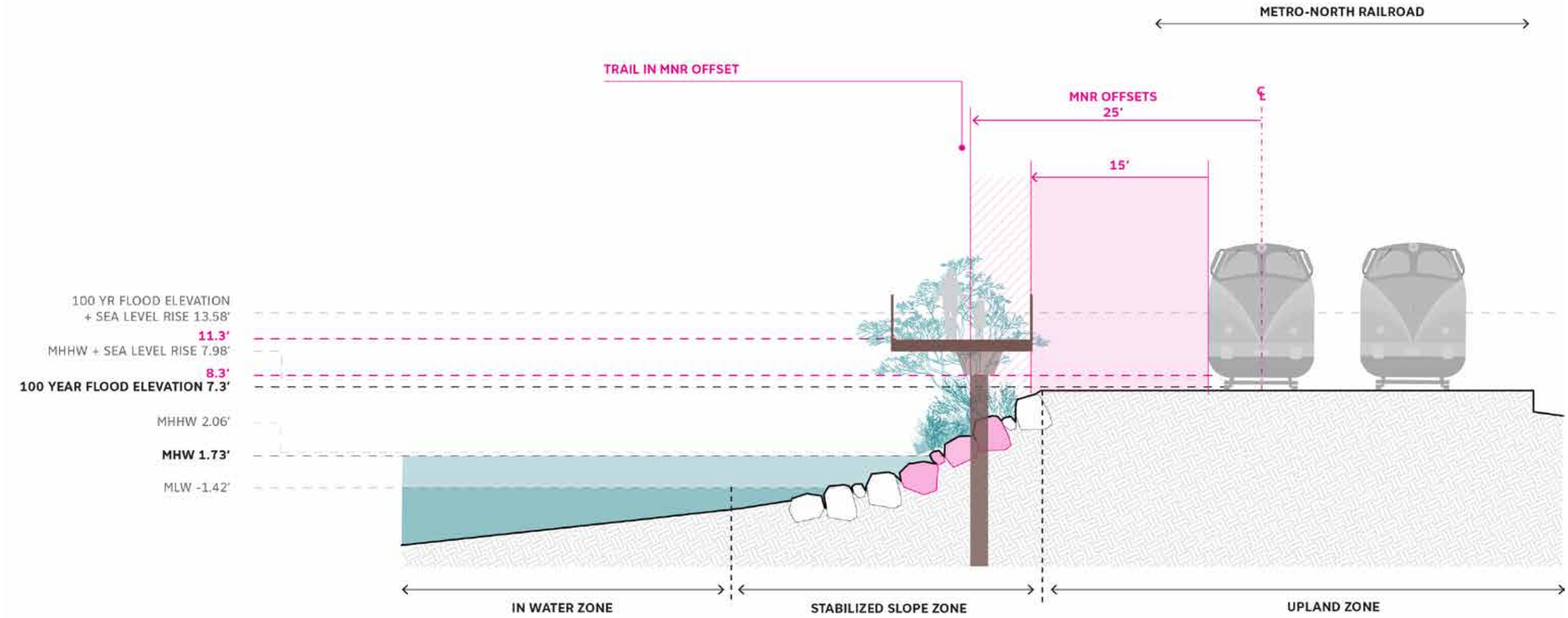



NARROW SHORELINE
SMALL BRIDGE
UTILITY STRUCTURE

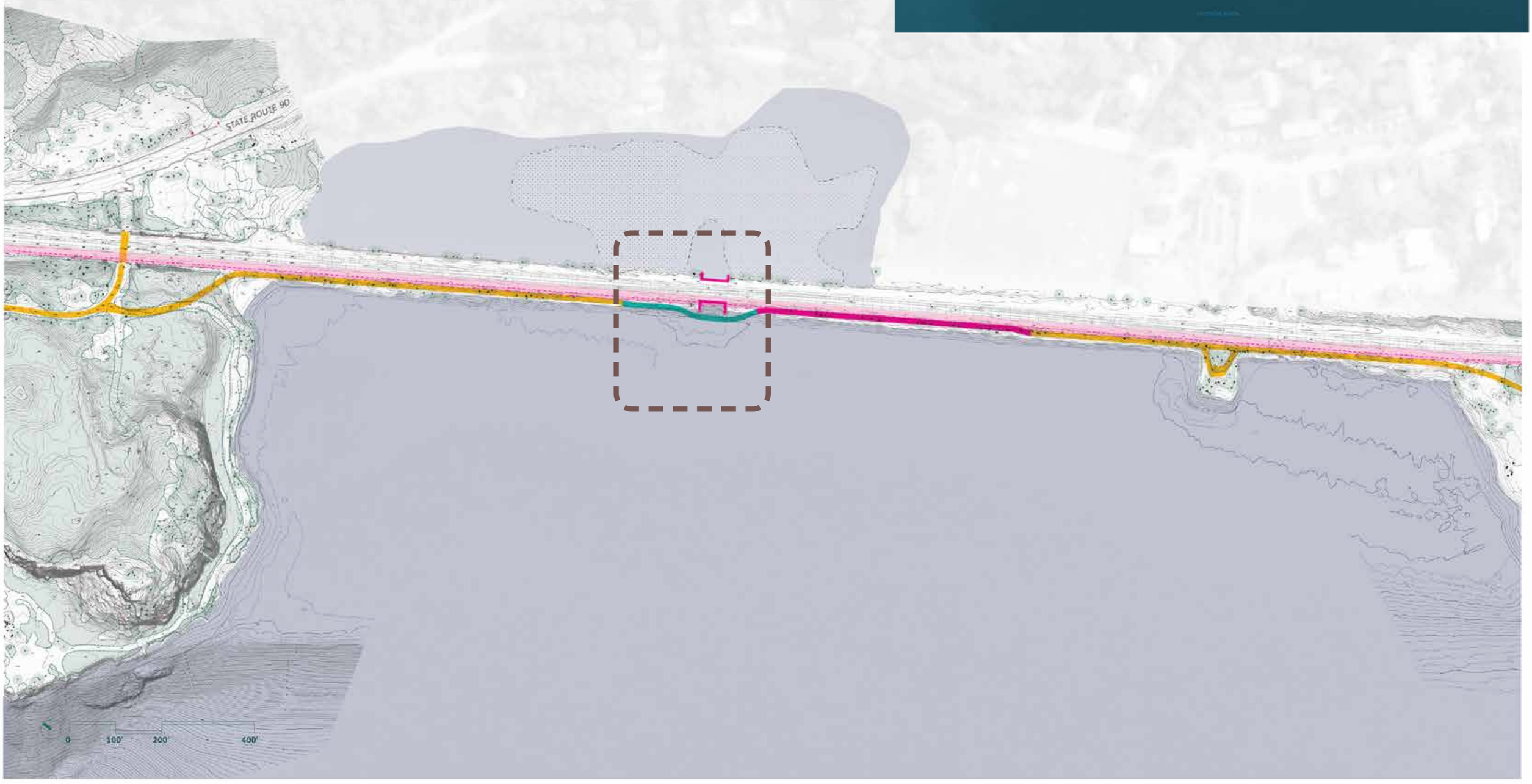

SCATTERED TREES
NARROW SHORELINE

CANTILEVERED TRAIL AT NARROW REVETMENT

- CANTILEVERED SECTION KEEPS PILE ABOVE MHW
- NARROW REVETMENT CREATES A PINCH POINT ALONG THE RAILROAD

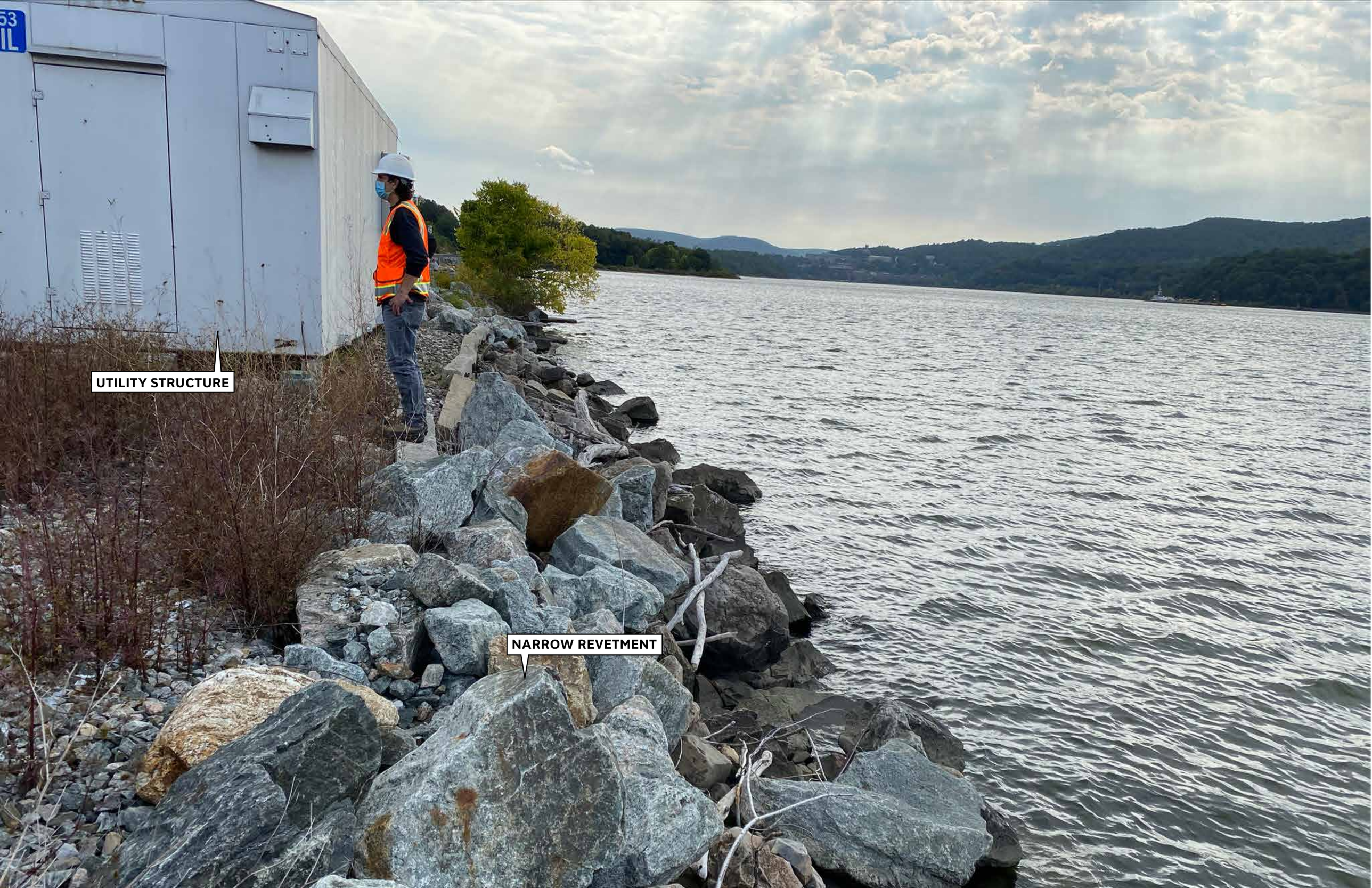


DOCKSIDE: IN- WATER SECTION

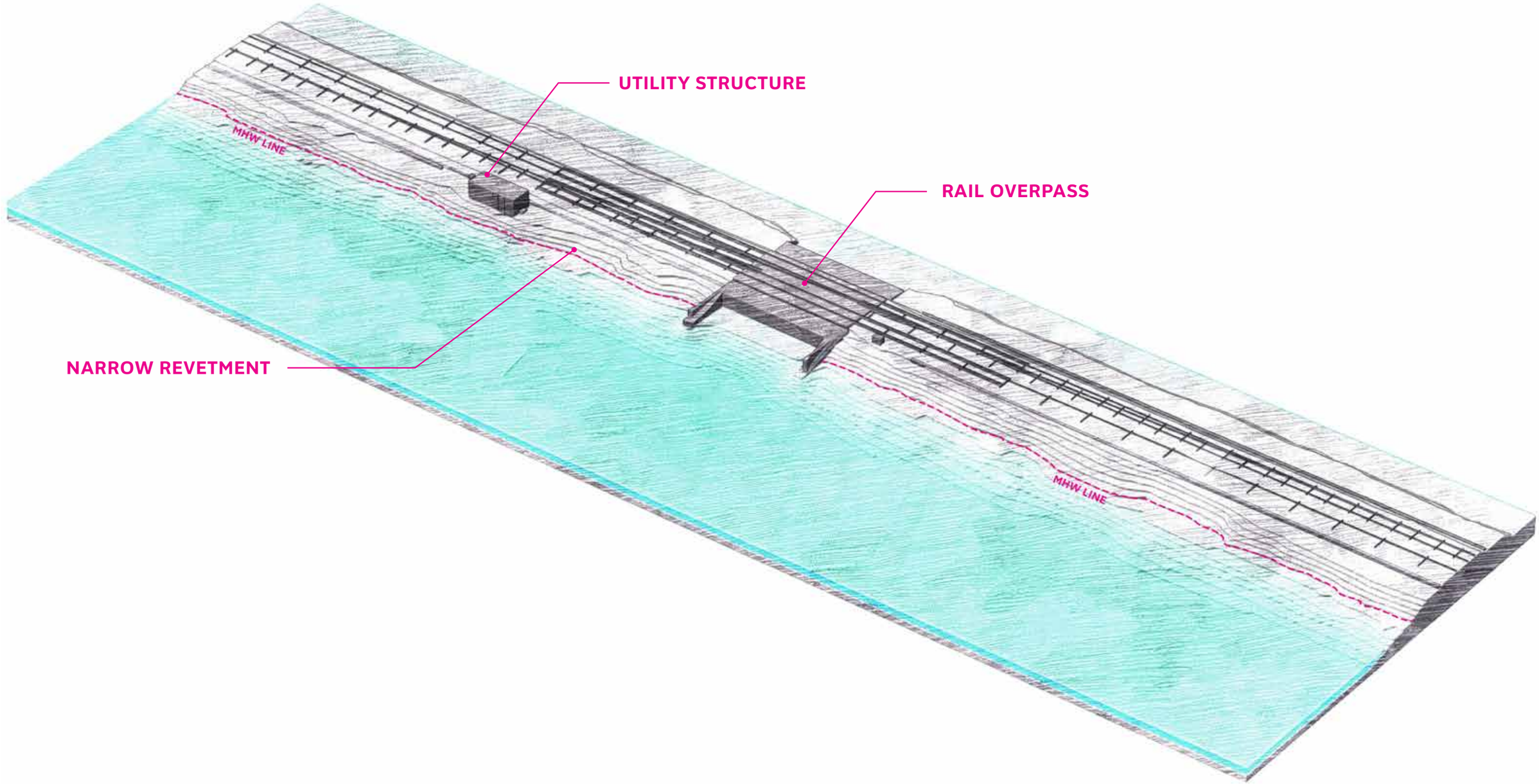


NARROW REVETMENT

BRIDGE STRUCTURE

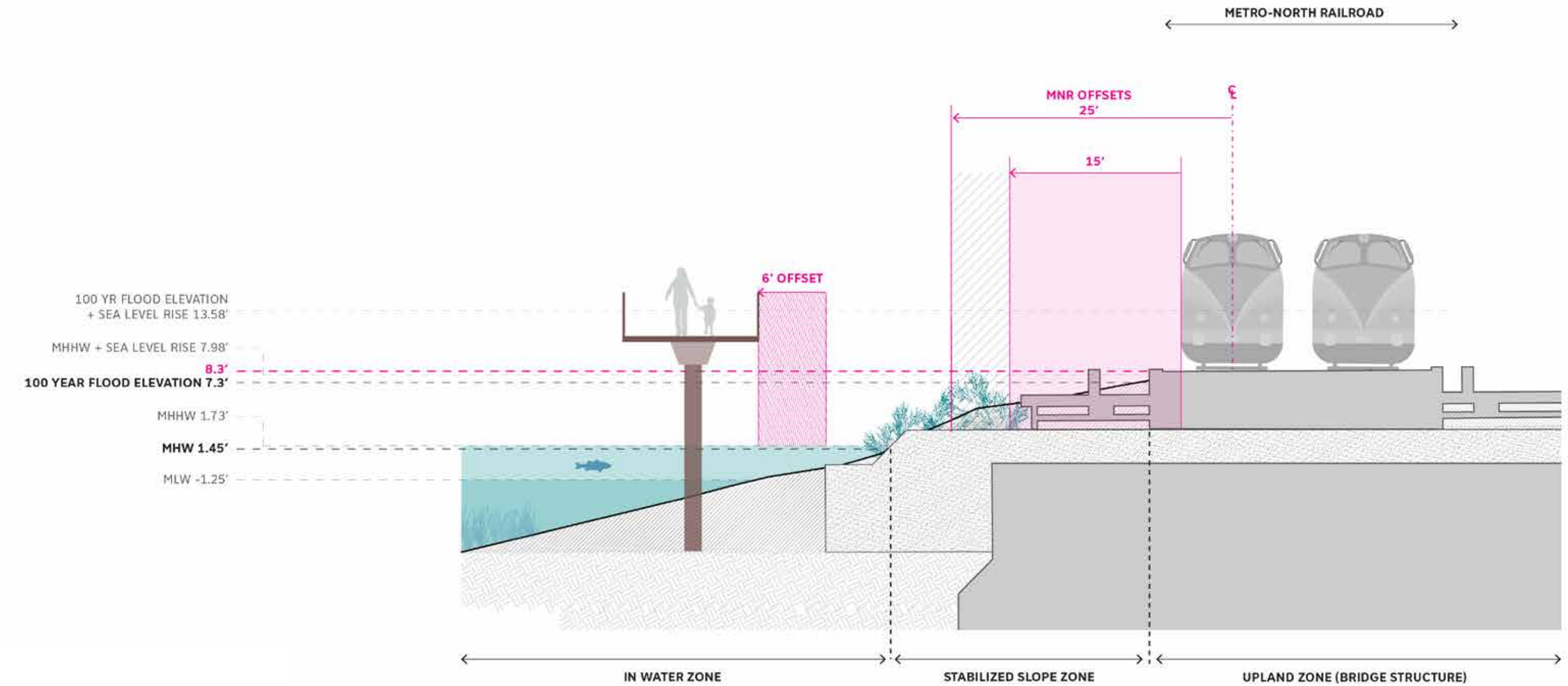

UTILITY STRUCTURE
NARROW REVETMENT

EXISTING CONDITIONS



BASELINE: PILES IN WATER

- RIVER BOTTOM AT RISK OF SCOURING AROUND PILES
- MINIMIZES RIVER BOTTOM DISTURBANCE



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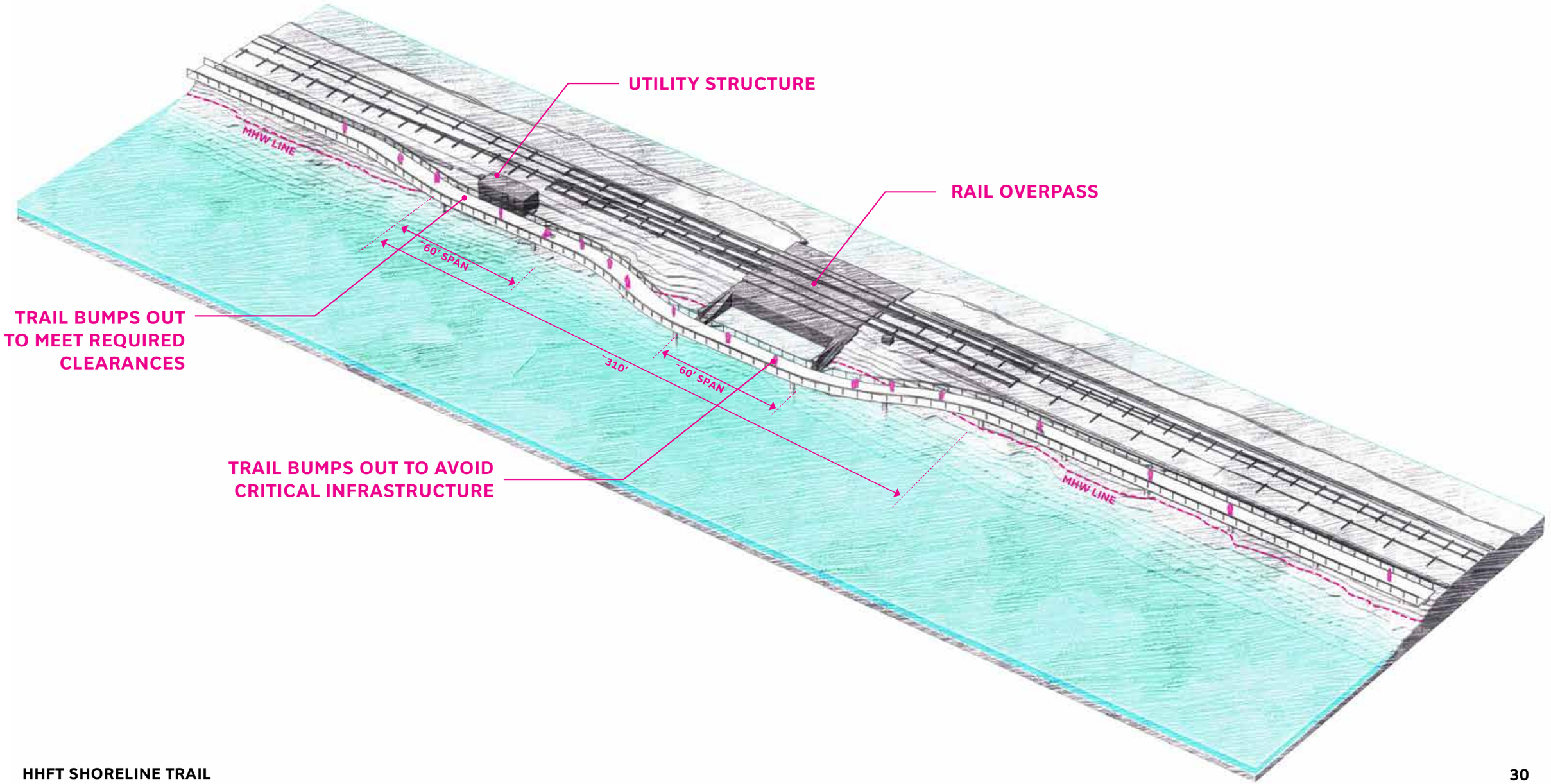
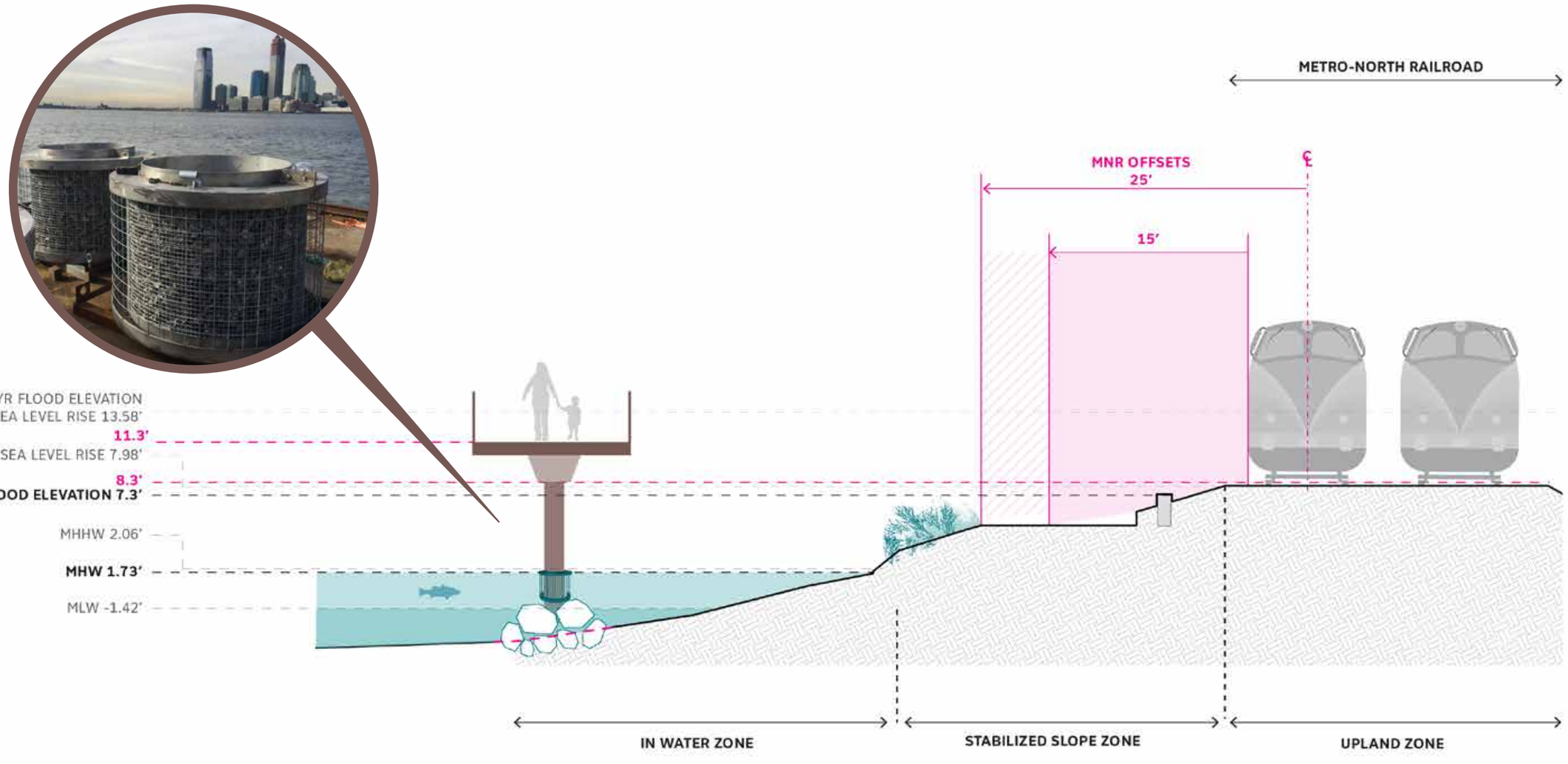


OPT 1: VERTICAL PILE ENHANCEMENTS

- MINIMIZES RIVER BOTTOM DISTURBANCE
- REDUCE SCOUR AND INCREASE RIVER BOTTOM STABILITY AROUND PILE
- PROVIDE VERTICAL ECOLOGICAL ENHANCEMENTS THAT DO NOT DISPLACE RIVER BOTTOM HABITAT



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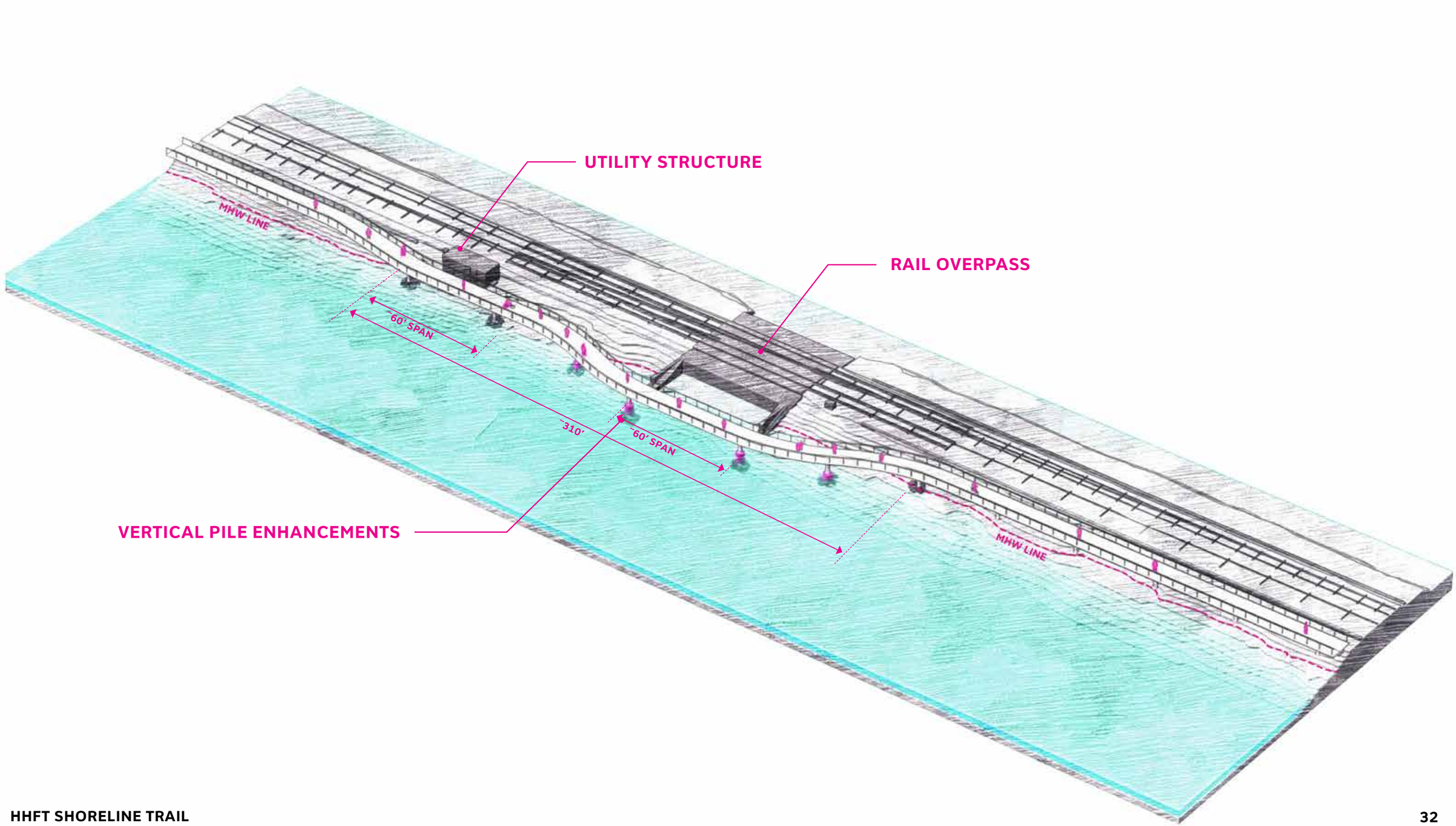
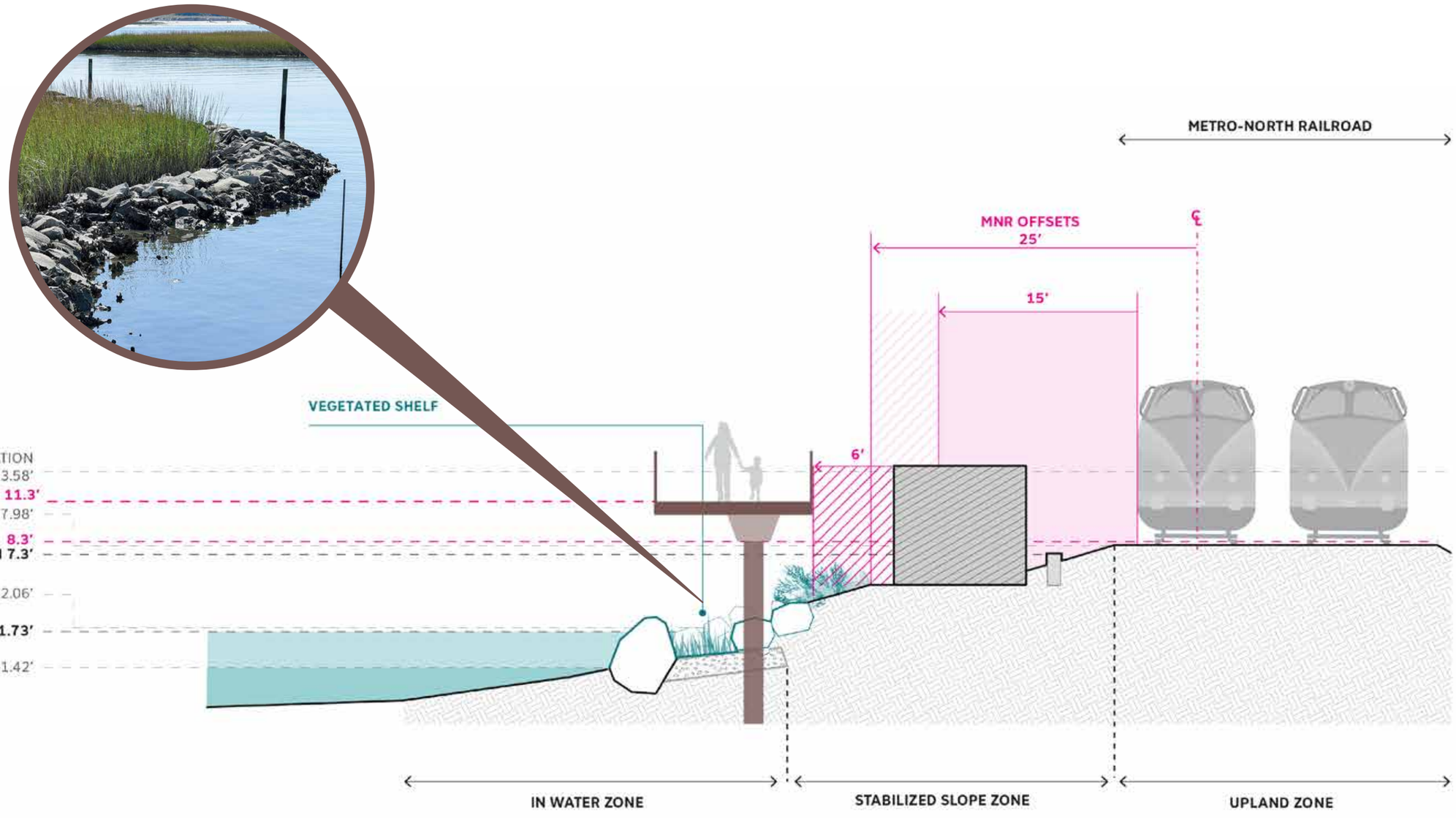
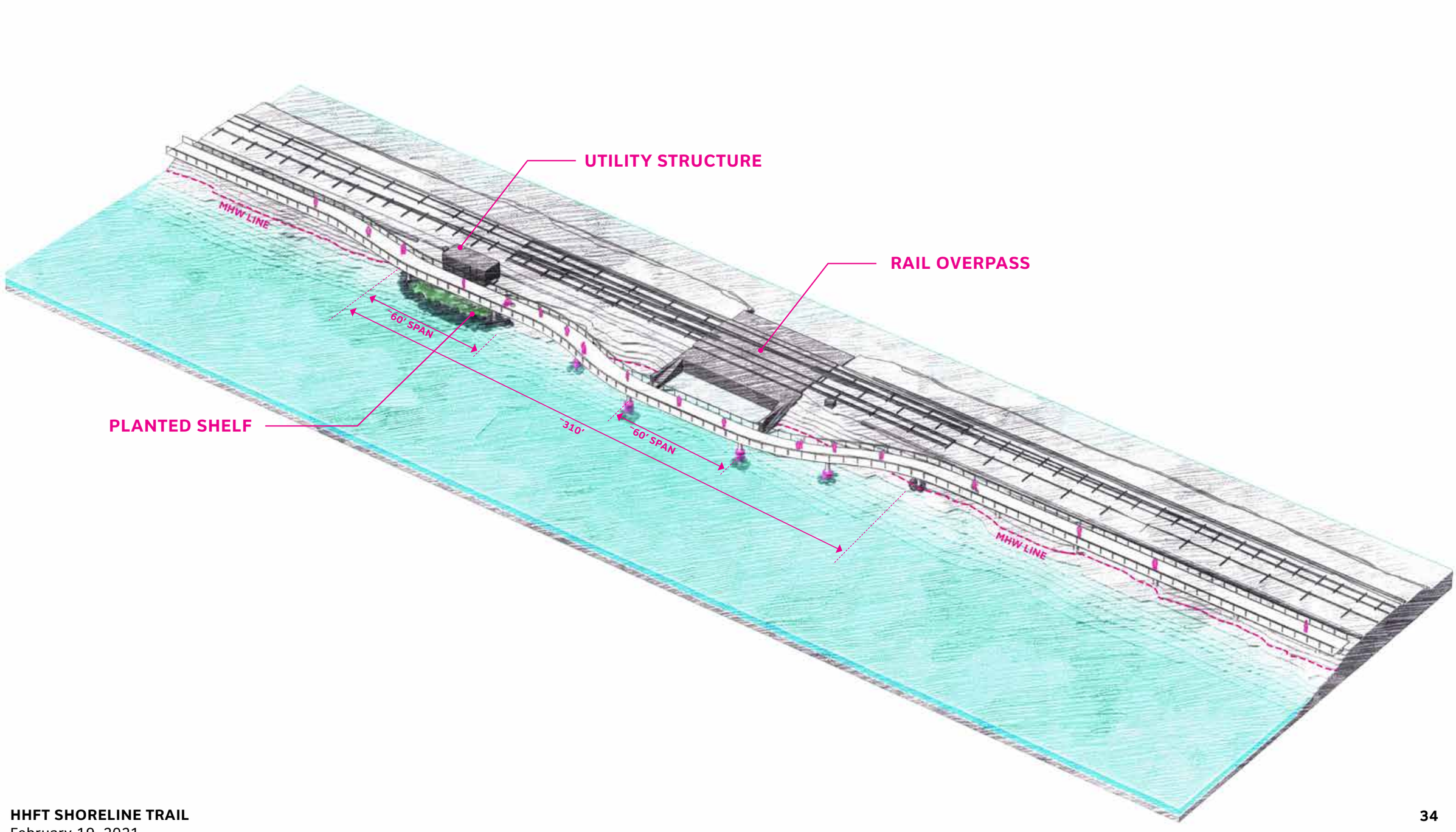


OPT 2: PLANTED SHELF AT UTILITY STRUCTURE

- PROVIDES MORE SHORELINE STABILITY AT CRITICAL RAIL INFRASTRUCTURE
- MAINTAINS REQUIRED CLEARNANCES FROM RAIL UTILITIES
- PROVIDES HABITAT

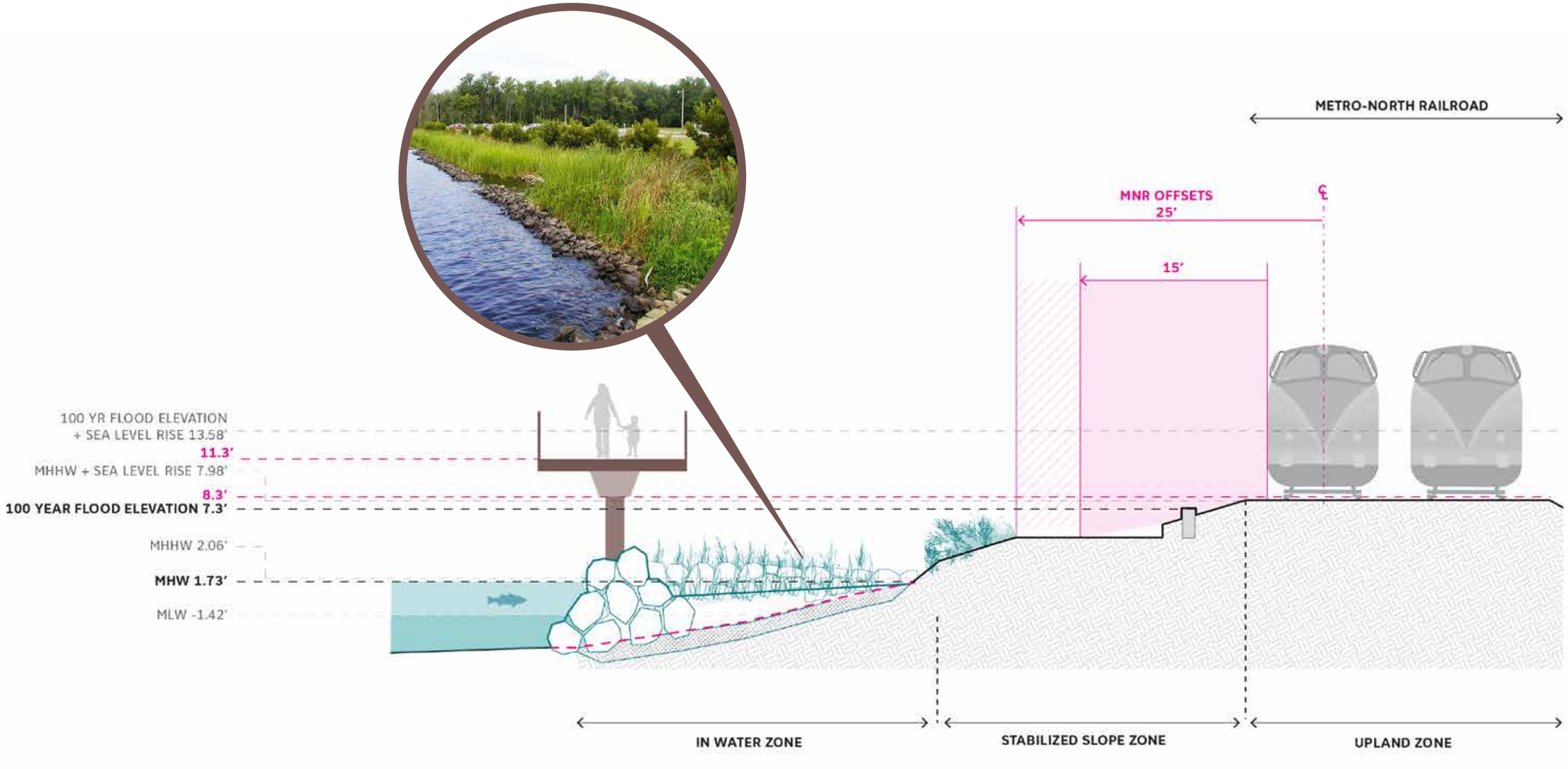


OPT 2: PLANTED SHELF AT UTILITY STRUCTURE



OPT 3: LIVING SHORELINE

- **EXPANDS HABITAT BENEFITS FROM OPTION 3**
- **OPPORTUNITY TO INCREASE STABILITY AROUND IN-WATER PILES AND SHORELINE STABILITY AT CRITICAL RAIL INFRASTRUCTURE**



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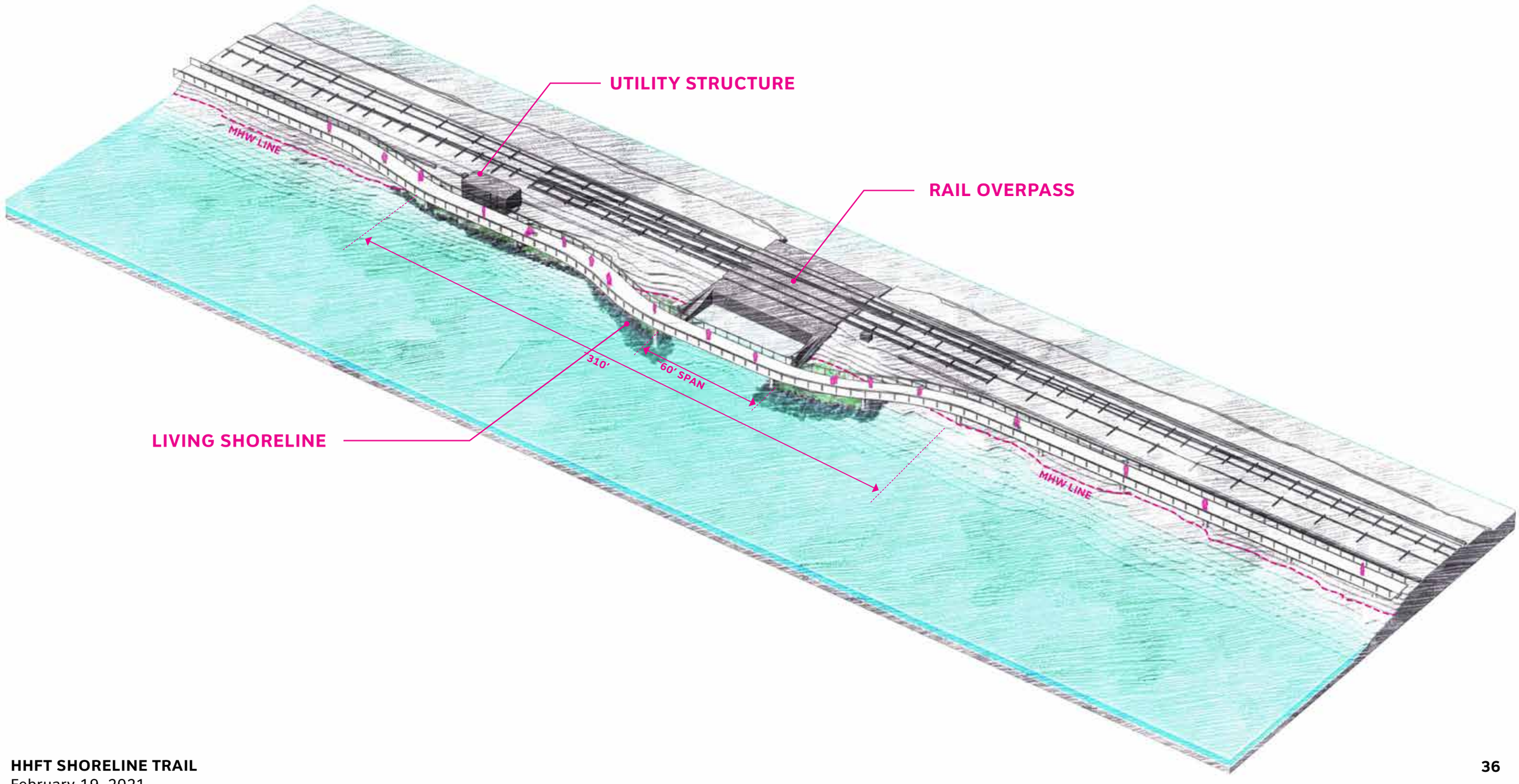
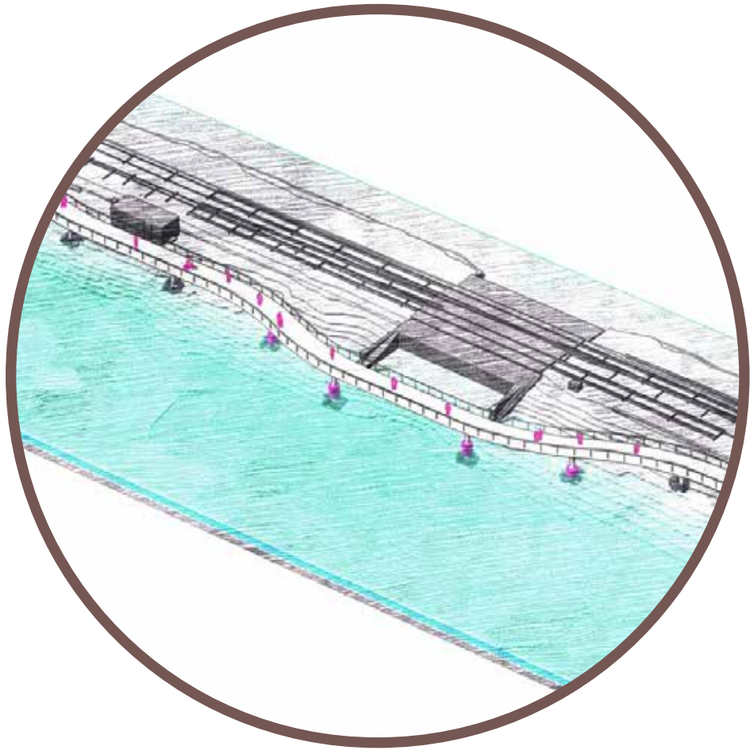
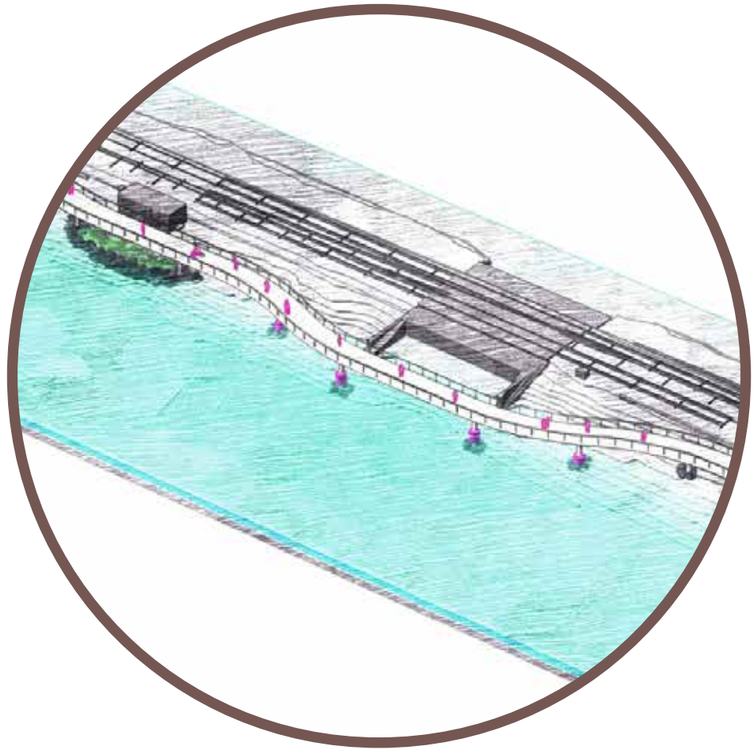


OPTIONS REVIEW



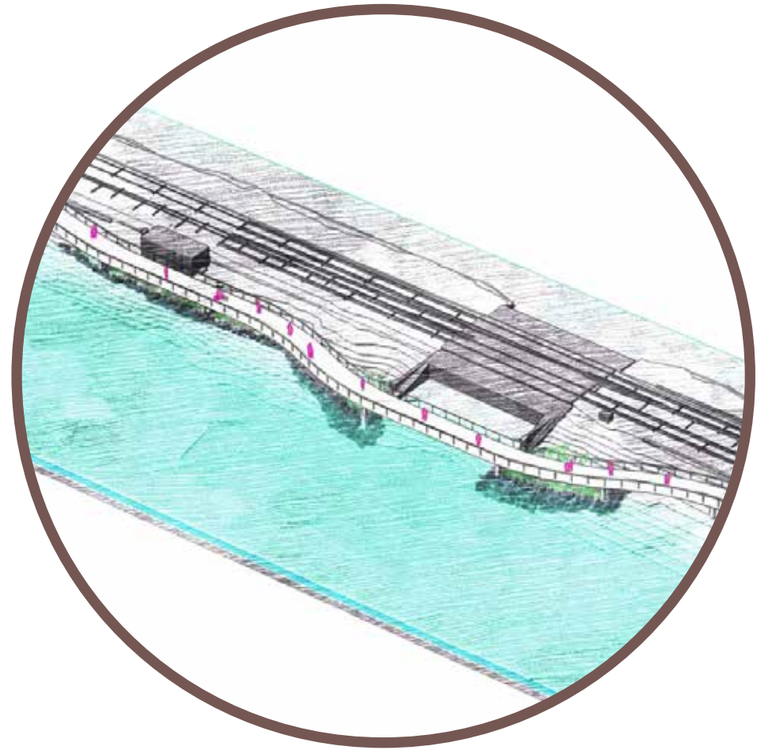
OPT 1: VERTICAL PILE ENHANCEMENTS

- MINIMIZES RIVER BOTTOM DISTURBANCE
- REDUCE SCOUR AND INCREASE RIVER BOTTOM STABILITY AROUND PILE
- PROVIDE VERTICAL ECOLOGICAL ENHANCEMENTS THAT DO NOT DISPLACE RIVER BOTTOM HABITAT



OPT 2: PLANTED SHELF AT UTILITY STRUCTURE

- PROVIDES MORE SHORELINE STABILITY AT CRITICAL RAIL INFRASTRUCTURE
- MAINTAINS REQUIRED CLEARNANCES FROM RAIL UTILITIES
- PROVIDES HABITAT



OPT 3: LIVING SHORELINE

- EXPANDS HABITAT BENEFITS FROM OPTION 3
- OPPORTUNITY TO INCREASE STABILITY AROUND IN-WATER PILES AND SHORELINE STABILITY AT CRITICAL RAIL INFRASTRUCTURE

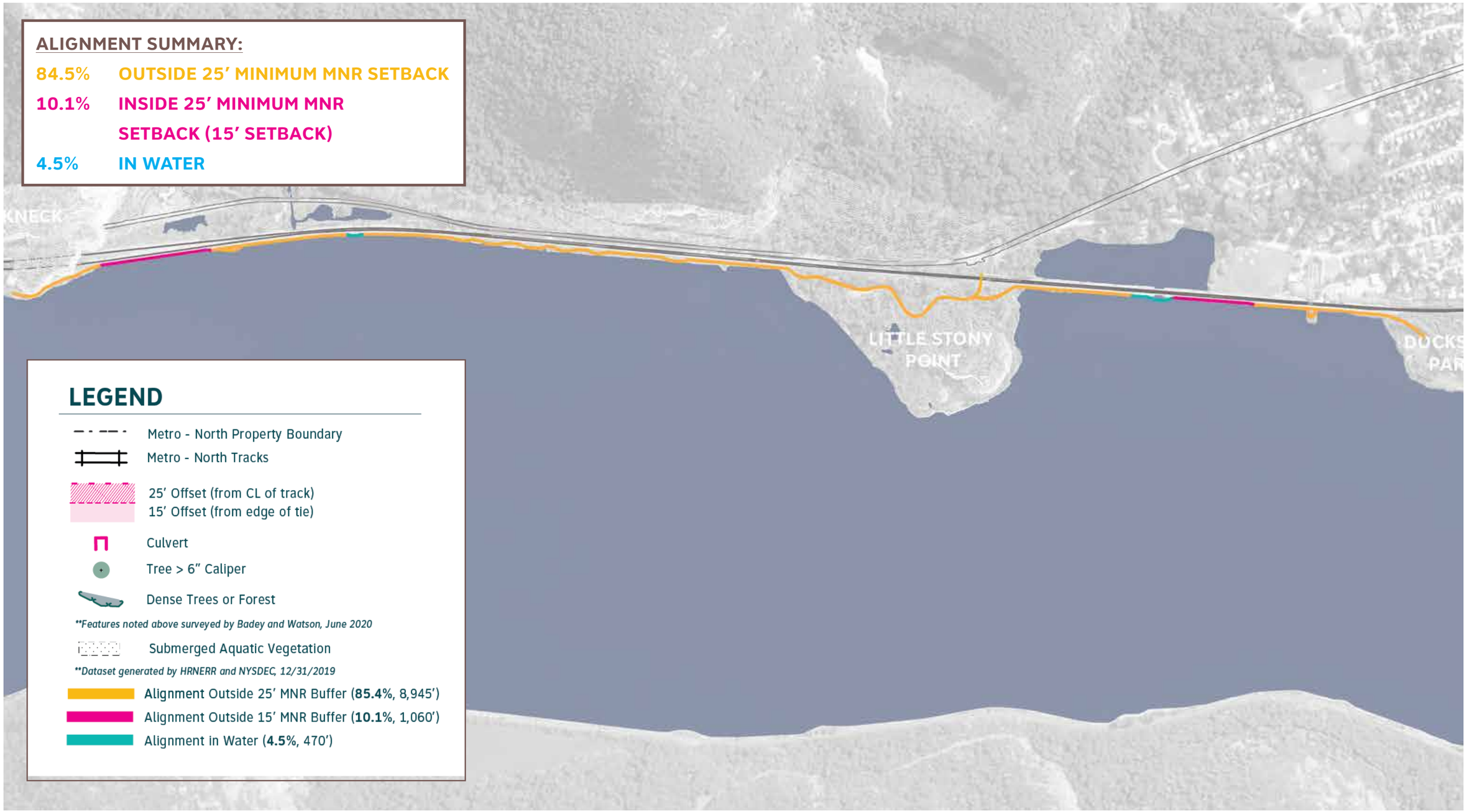
30% DESIGN SUMMARY

30% DESIGN ALIGNMENT

RELATIONSHIP TO METRO-NORTH RAILROAD

ALIGNMENT SUMMARY:

84.5%	OUTSIDE 25’ MINIMUM MNR SETBACK
10.1%	INSIDE 25’ MINIMUM MNR SETBACK (15’ SETBACK)
4.5%	IN WATER



LEGEND

- Metro - North Property Boundary
- Metro - North Tracks
- 25’ Offset (from CL of track)
  15’ Offset (from edge of tie)
- Culvert
- Tree > 6” Caliper
- Dense Trees or Forest

***Features noted above surveyed by Badey and Watson, June 2020*

- Submerged Aquatic Vegetation

***Dataset generated by HRNERR and NYSDEC, 12/31/2019*

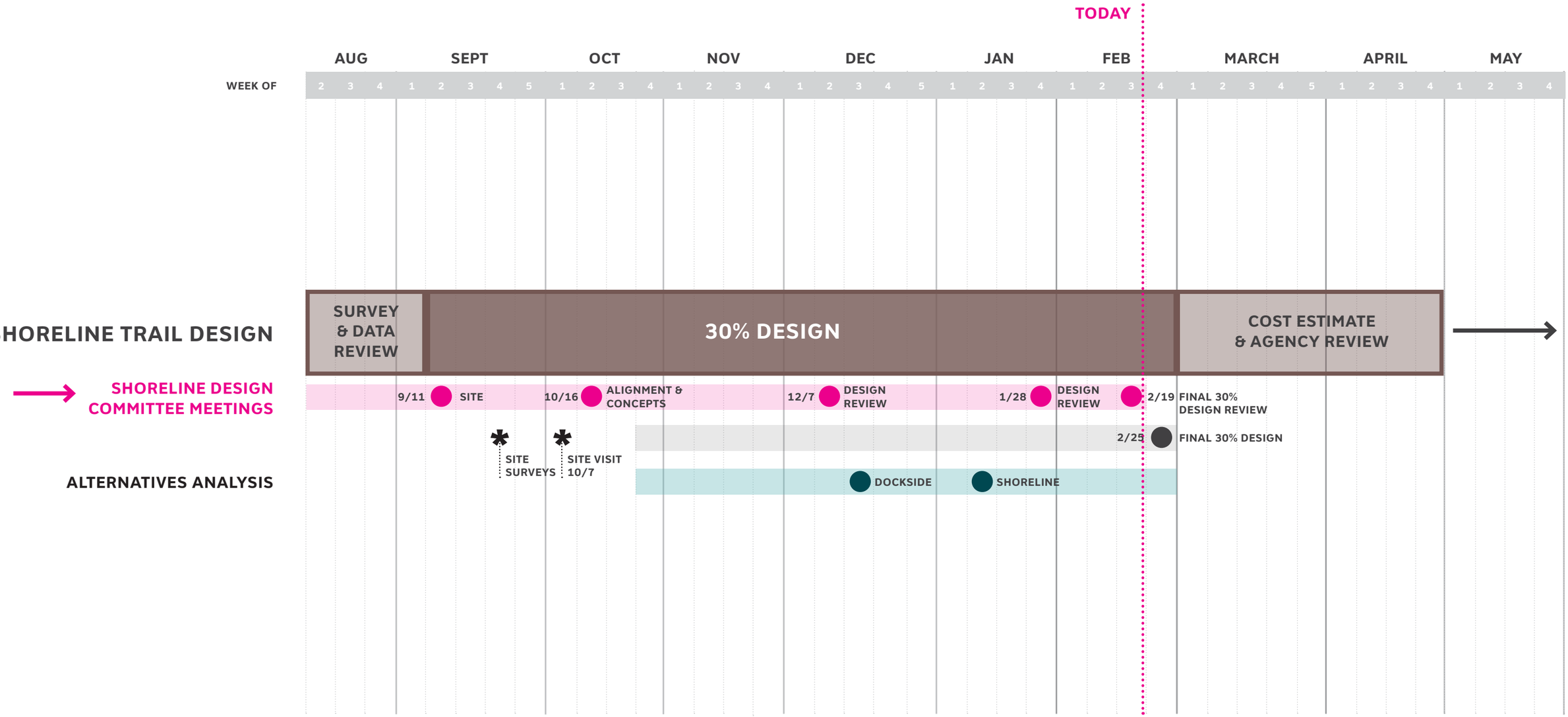
- Alignment Outside 25’ MNR Buffer (**85.4%**, 8,945’)
- Alignment Outside 15’ MNR Buffer (**10.1%**, 1,060’)
- Alignment in Water (**4.5%**, 470’)

30% DESIGN ALIGNMENT

LOCATION ON SHORELINE

NEXT STEPS

NEXT STEPS


TODAY
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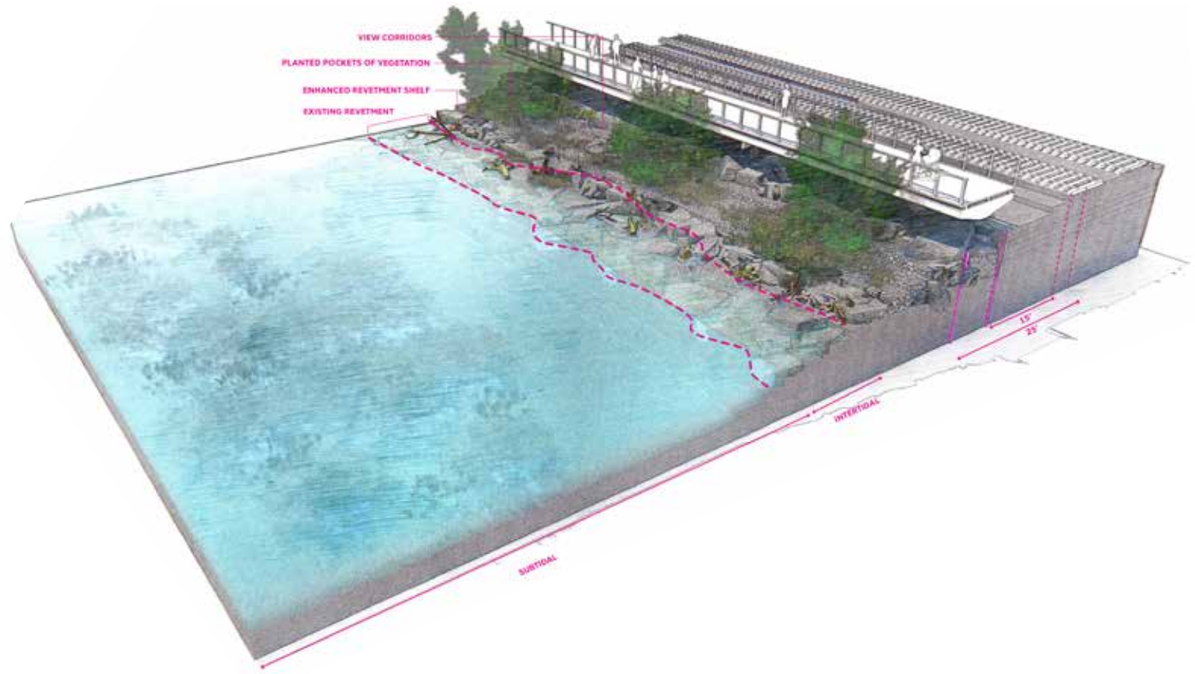
2 3 4 1 2 3 4 5 1 2 3 4 1 2 3 4 1 2 3 4 5 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
SHORELINE TRAIL DESIGN
SURVEY & DATA REVIEW
30% DESIGN
COST ESTIMATE & AGENCY REVIEW
SHORELINE DESIGN COMMITTEE MEETINGS
9/11 SITE
10/16 ALIGNMENT & CONCEPTS
12/7 DESIGN REVIEW
1/28 DESIGN REVIEW
2/19 FINAL 30% DESIGN REVIEW
2/25 FINAL 30% DESIGN
ALTERNATIVES ANALYSIS
SITE SURVEYS
SITE VISIT 10/7
DOCKSIDE
SHORELINE

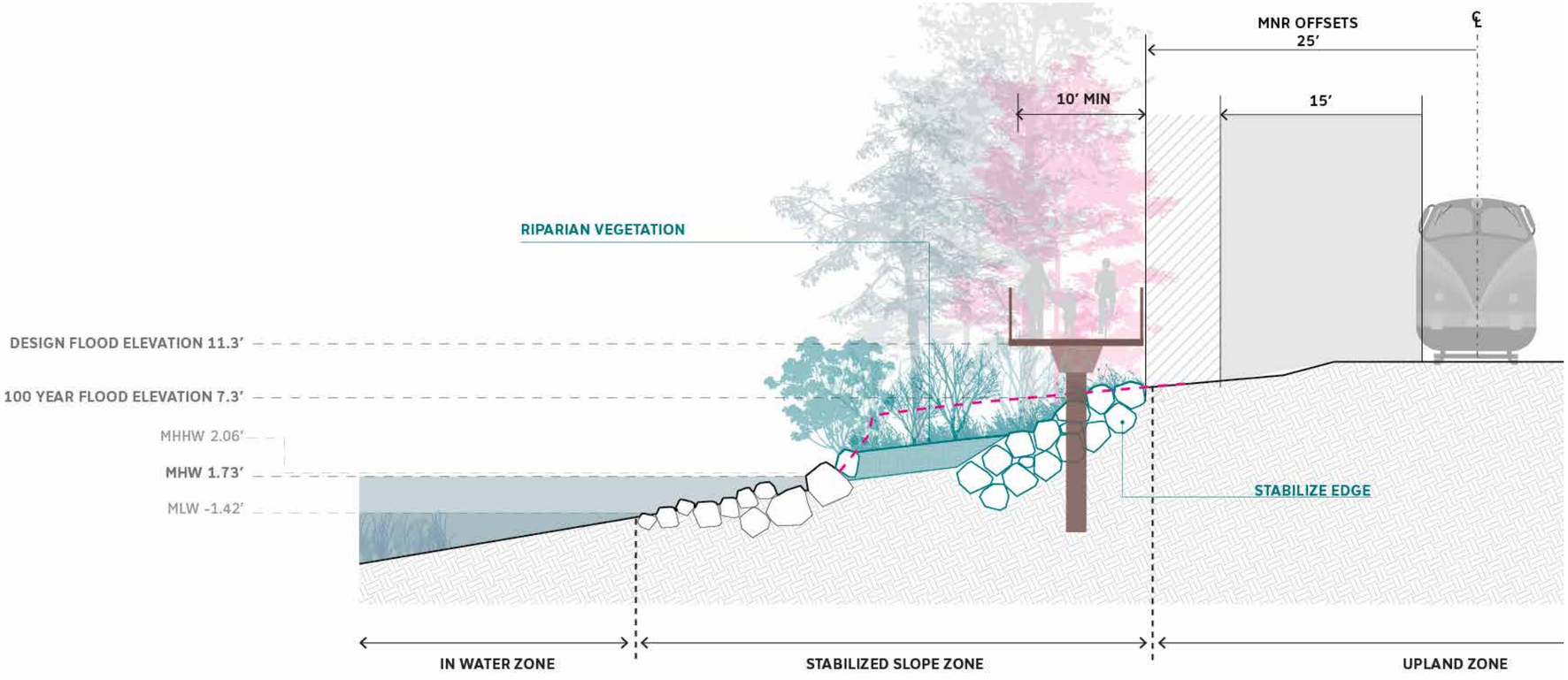
THANK YOU!

SLIDE APPENDIX

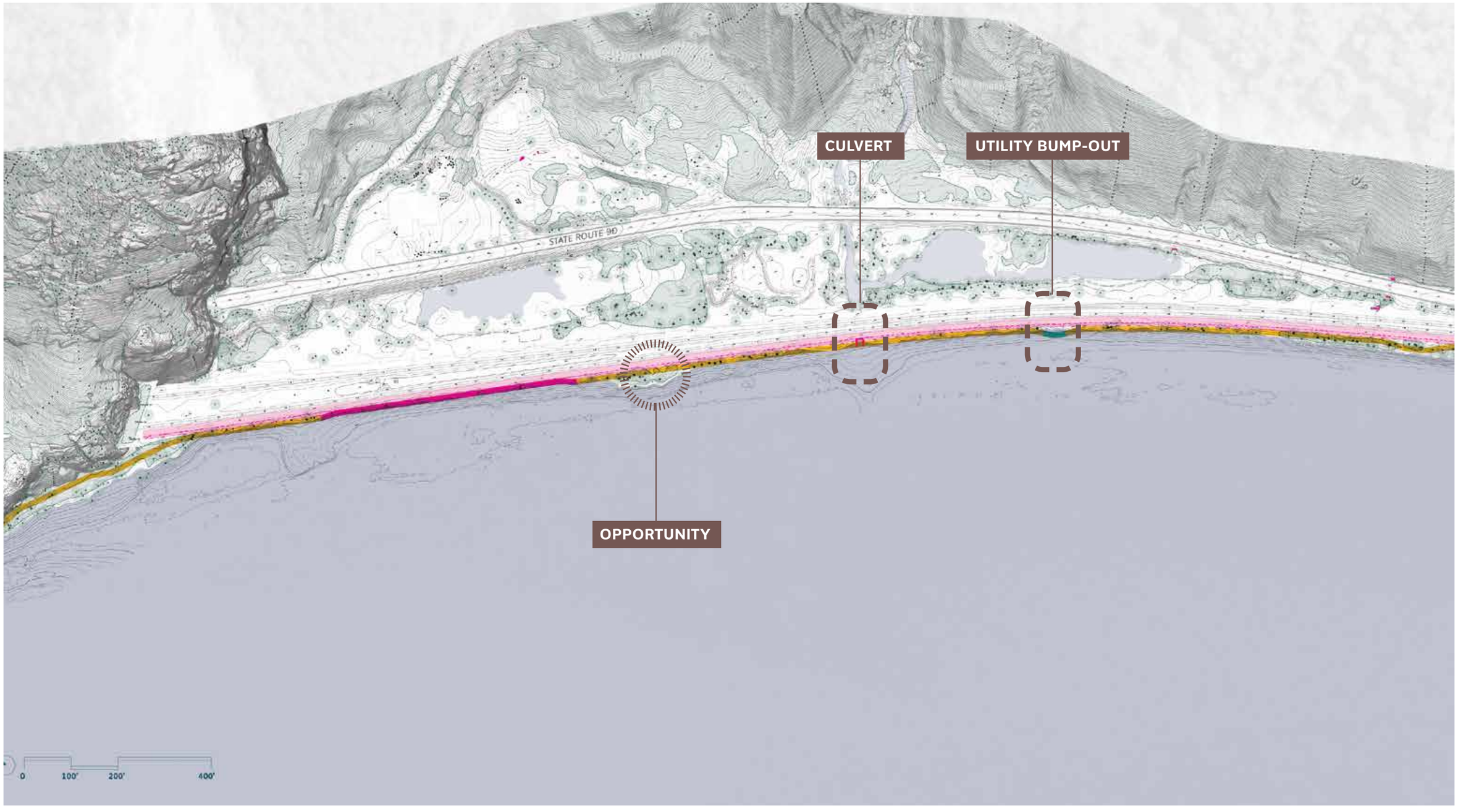
SHORELINE STABILIZATION: PLANTED SHELF

- **Provides shoreline stability**
- **Planted shelf provides additional habitat**
- **Allows for shallow water habitat migration under future SLR conditions**

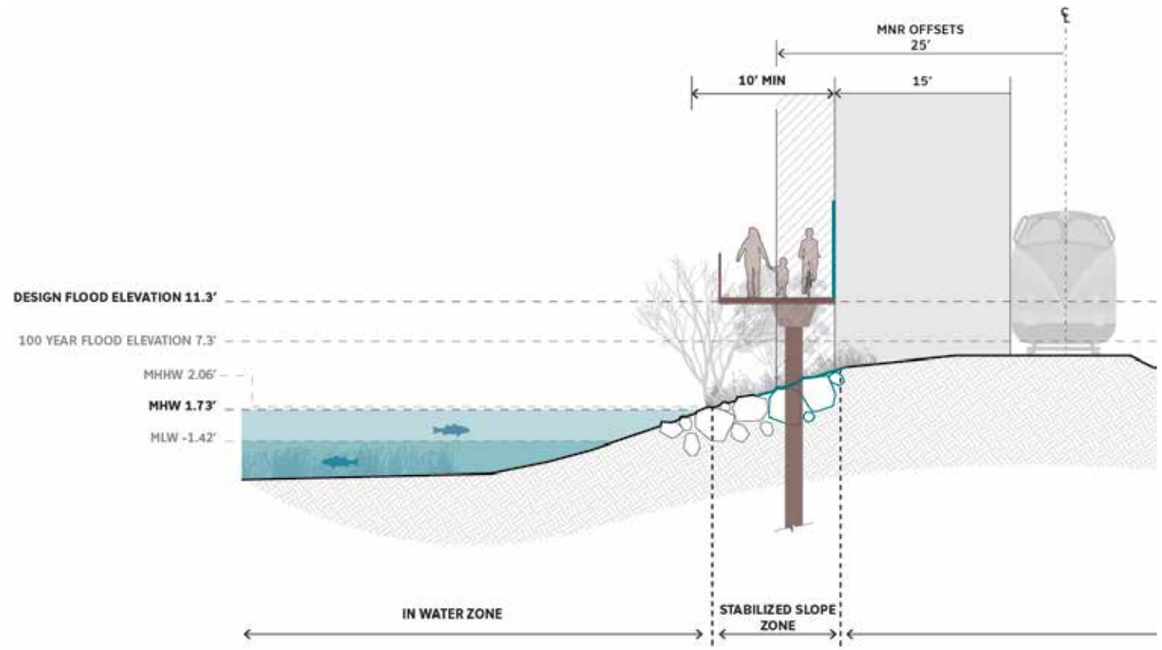




NORTH SHORELINE ALIGNMENT

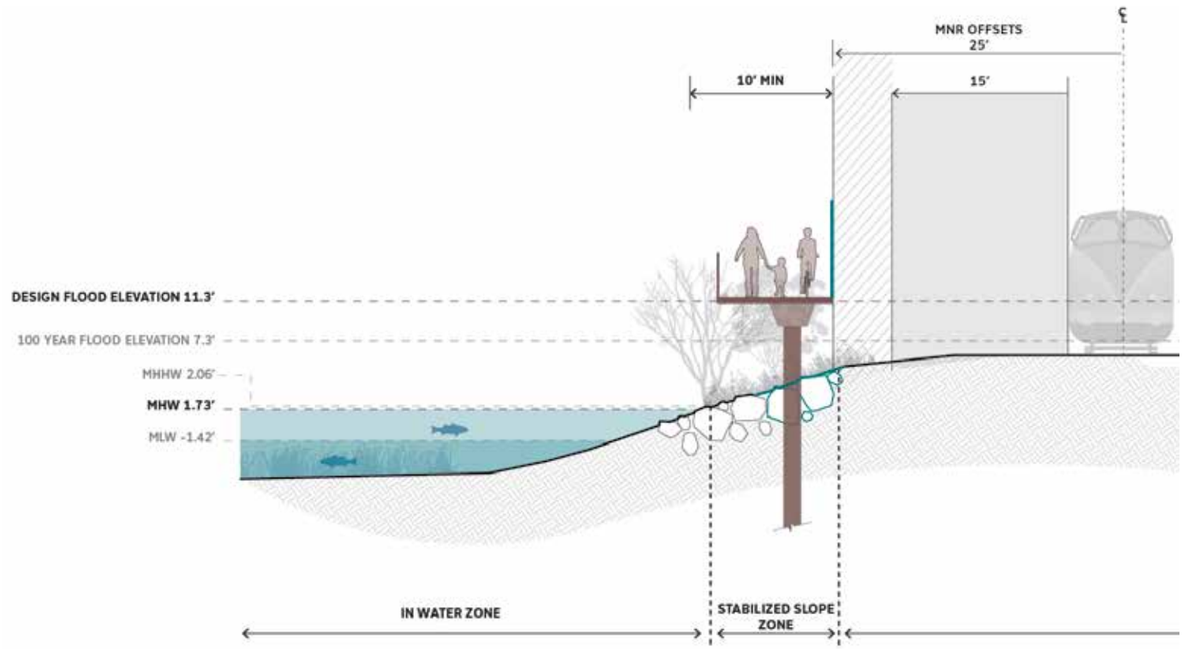


TYPICAL NORTH SHORELINE SECTIONS



CANTILEVERED TRAIL AT 15' MNR SETBACK (PINCH POINTS ONLY)

- Cantilever section keeps pile disturbance above MHW
- Required in areas with narrow revetments

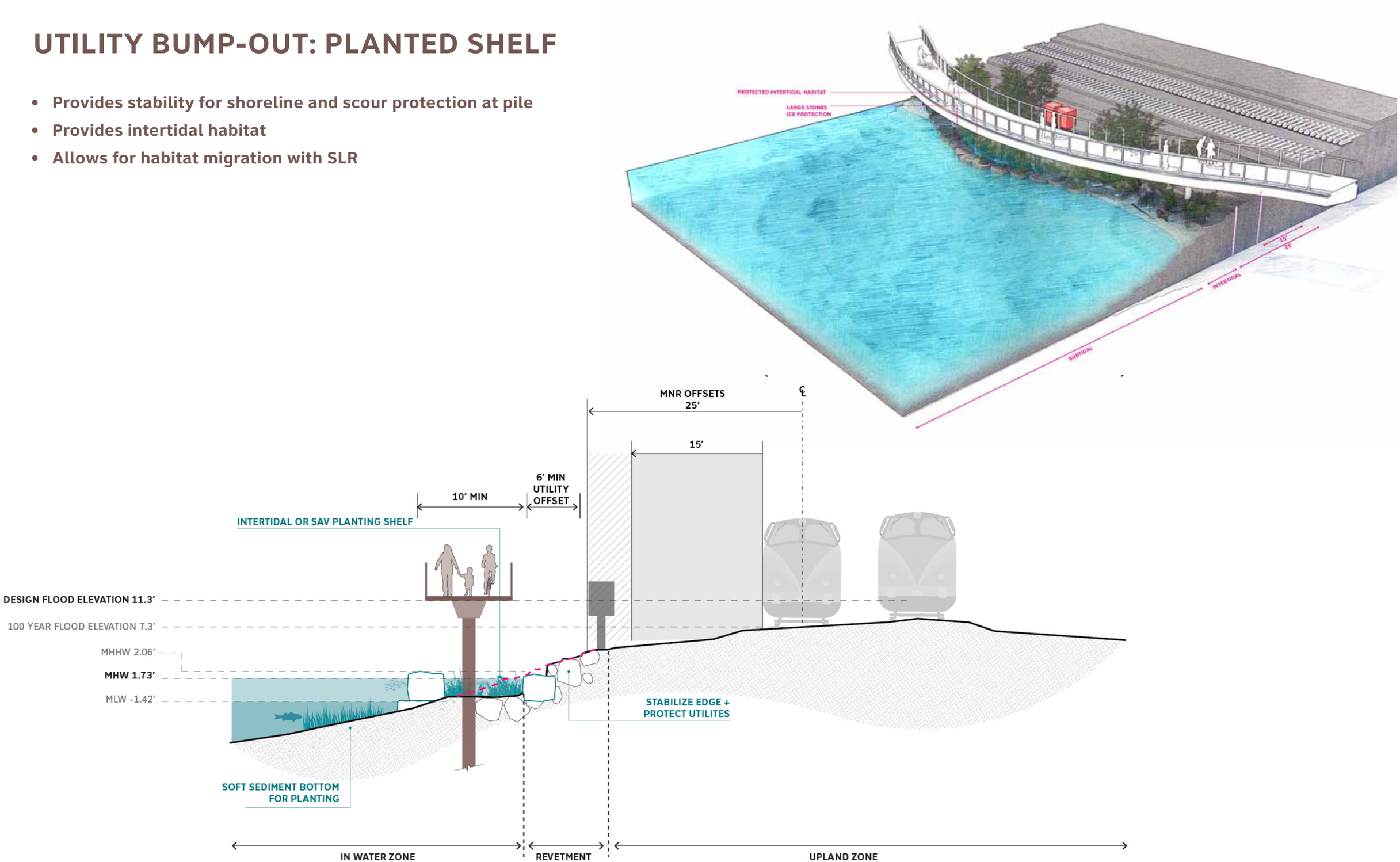


CANTILEVERED TRAIL AT 25' MNR SETBACK

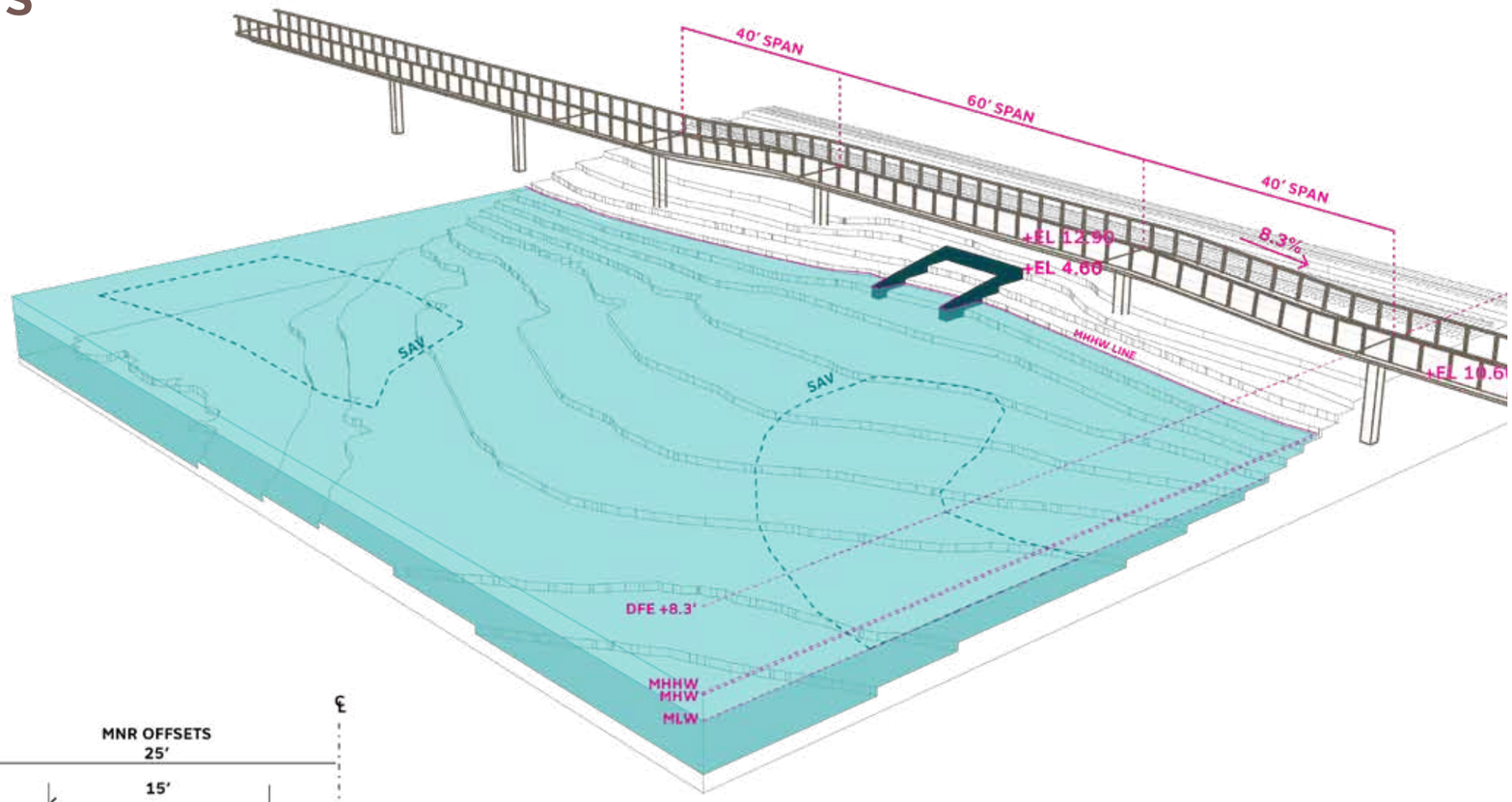
- Cantilevered section keeps pile disturbance above MHW
- Trail maintains 25' minimum required setback where revetment is wider

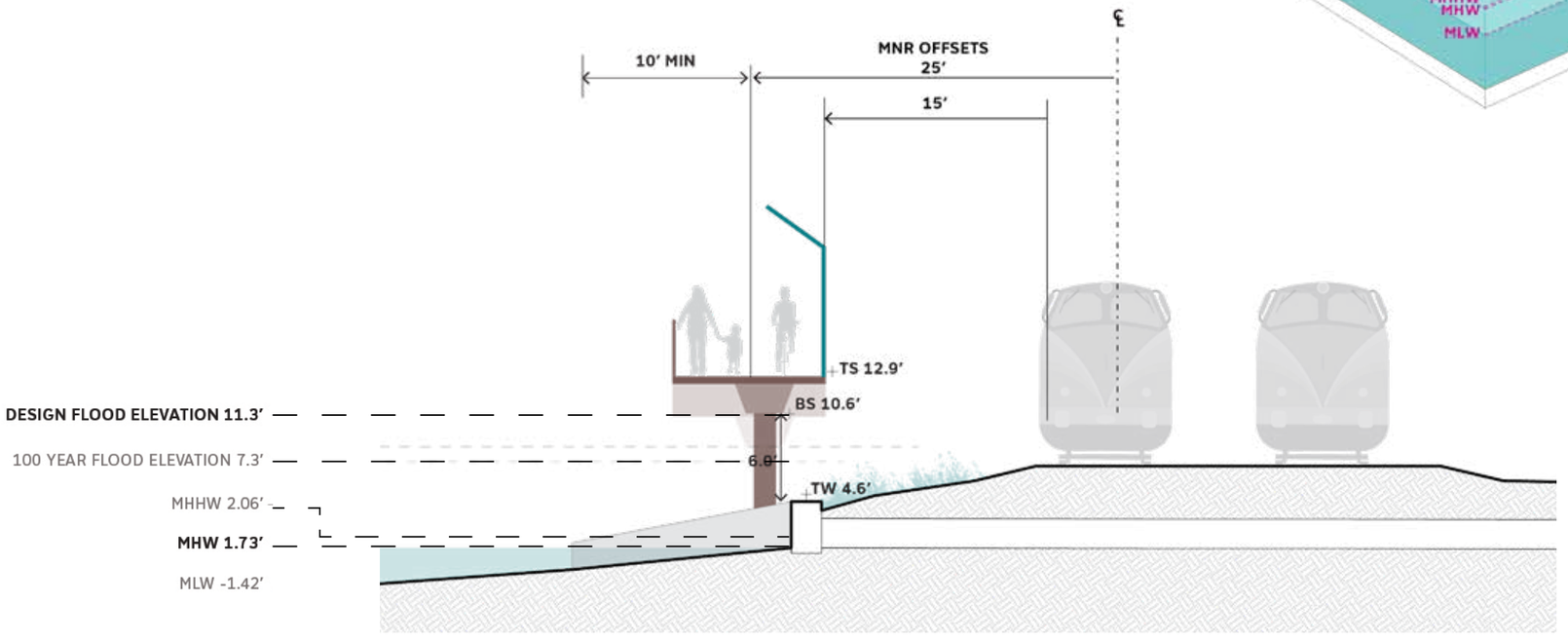
UTILITY BUMP-OUT: PLANTED SHELF

- Provides stability for shoreline and scour protection at pile
- Provides intertidal habitat
- Allows for habitat migration with SLR



TYPICAL STRATEGY AT CULVERTS






LOWER OVERLOOK
BOULDER EDGE
EXPANDED OVERLOOK
SHORELINE ACCESS
ELEVATED SHORELINE TRAIL
PREVIOUSLY DOCUMENTED SAV BEDS
(Data represents a combination of layers from the 1997, 2002, 2007, 2014, 2016, & 2018 data sets, representing a culmination of all areas where SAV habitat has been documented.)
MEAN HIGH WATER (APPROX.)
MHW
HUDSON RIVER
A
B
C
D
0'
5'
N
0
50'
100'

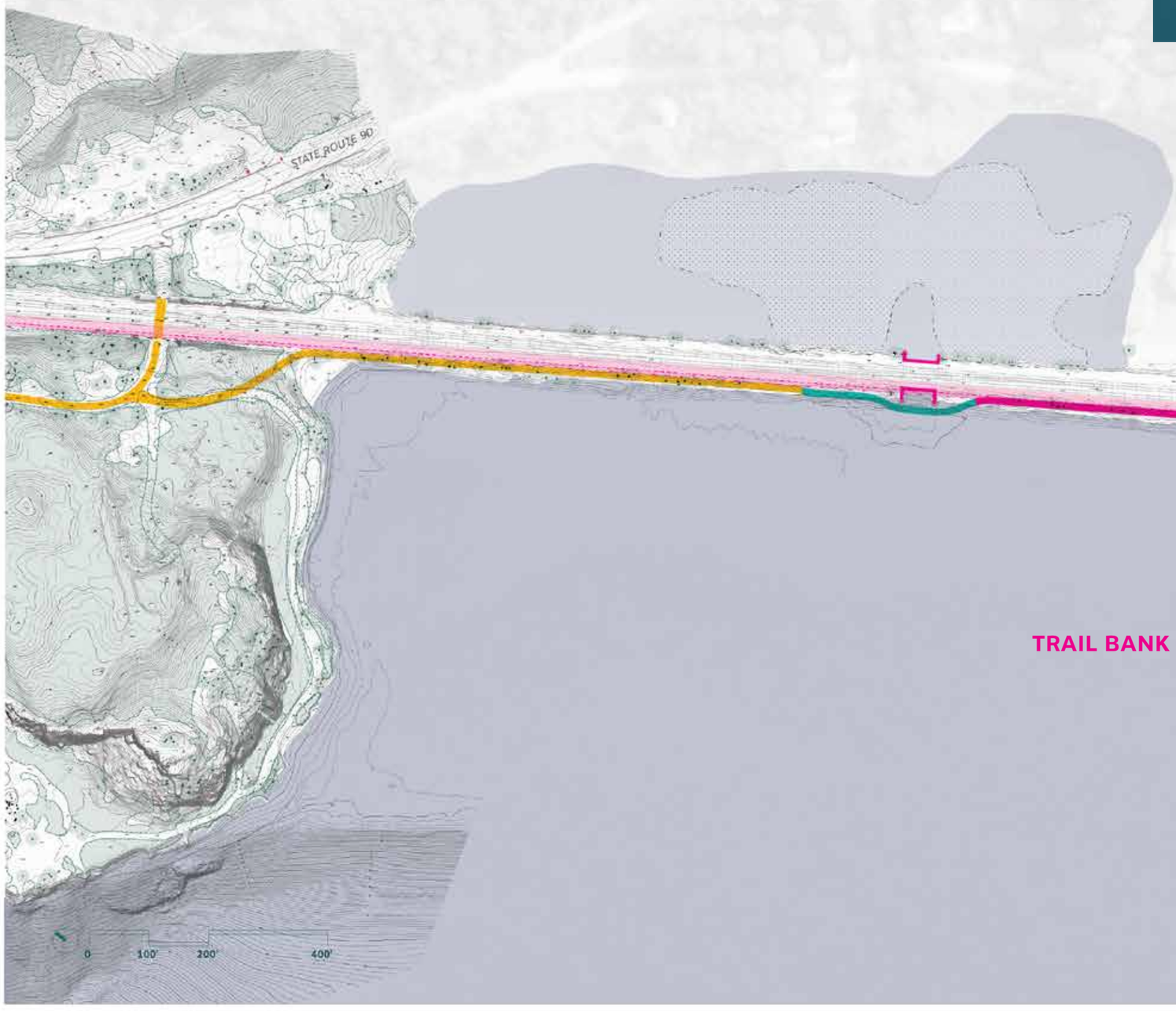
THE LOWER OVERLOOK ALTERNATIVES

PREFERRED OPTION PENDING GEOTECHNICAL INFORMATION

OPT 1: ON-GRADE

OPT 2: ON-STRUCTURE

PENINSULA: TRAIL BANK OPPORTUNITY




COMPLEXITY AT EDGE


MAKESHIFT TRAIL BANK
EMERGENT, DRY GROUND

RESTORATION OPPORTUNITIES?

ECOLOGICAL INTEGRITY

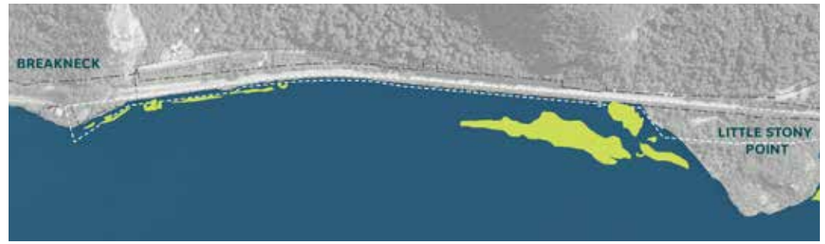
- ROBUST UPLAND PROVIDES SHORELINE STABILITY AND HABITAT
- SAV PROTECTS SOFT SEDIMENTS AND CRITICAL FISH HABITAT
- VEGETATION PROVIDES COVER FOR JUVENILE FISH TO ESCAPE PREDATION AND SUPPORTS INVERTEBRATES THAT ARE AN IMPORTANT FOOD SOURCE FOR FISH
- SAV BEDS ACT AS A CARBON SINK
- SURFACE HYDROLOGY AND SEDIMENT PROCESSES ARE A NATURAL CONDITION OF HUDSON RIVER ECOLOGY
- DRIFTWOOD PILEUP PROVIDES HABITAT

MATURE TREES

EMERGENT AND SUBMERGED VEGETATION

SOFT SHORELINES

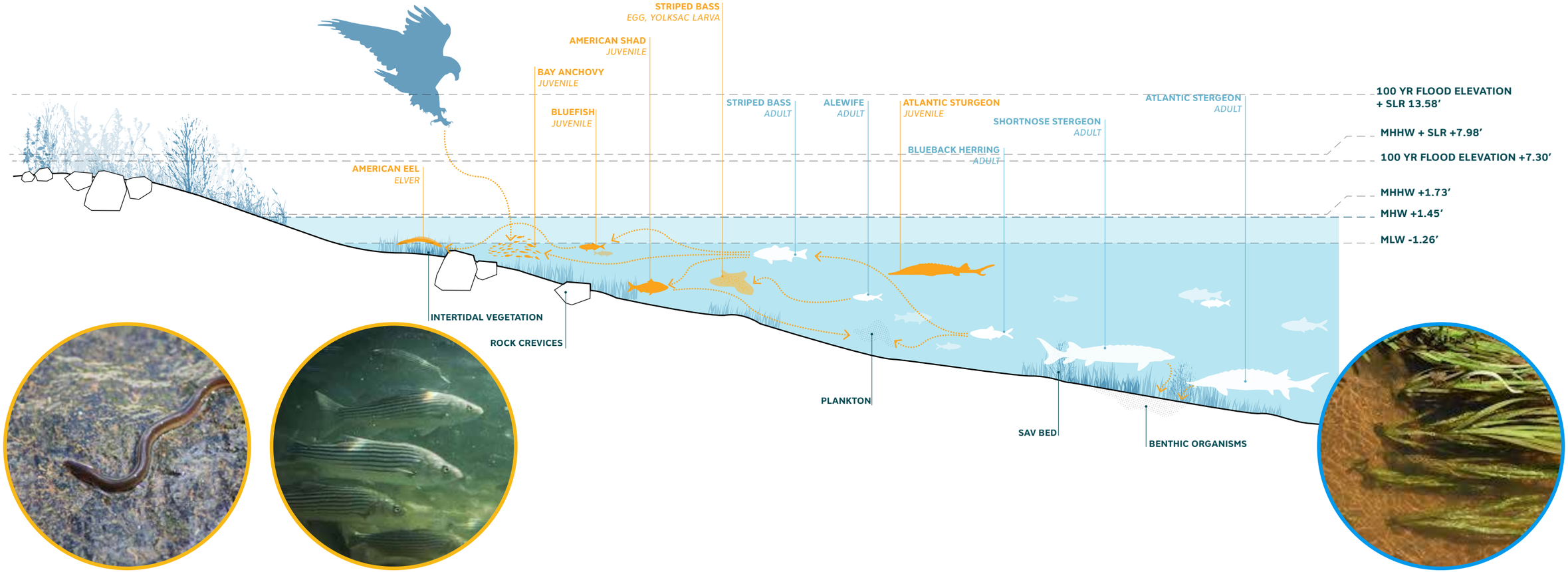
SHALLOW WATER HABITAT



"THE NURSERY"
SHALLOW WATER HABITAT

SUB-TIDAL HABITAT

DEEP SUB-TIDAL HABITAT



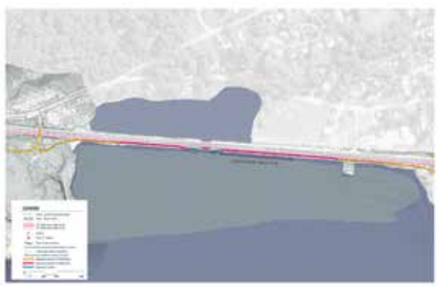
YOUNG OF YEAR EELS

JUVENILE STRIPED BASS

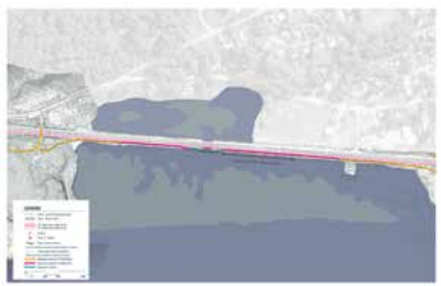
VALLISNERIA AMERICANA

DOCKSIDE - SAV OPPORTUNITY???

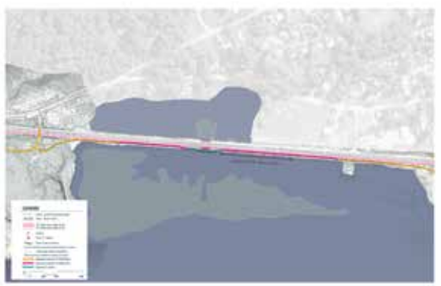
2018



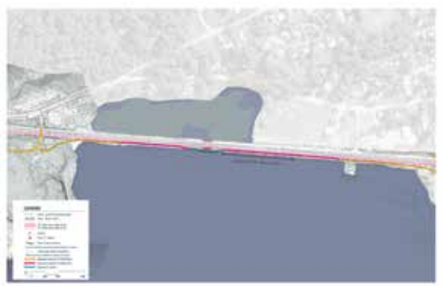
1997



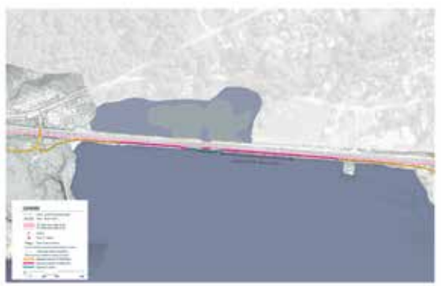
2002



2007



2014



2016