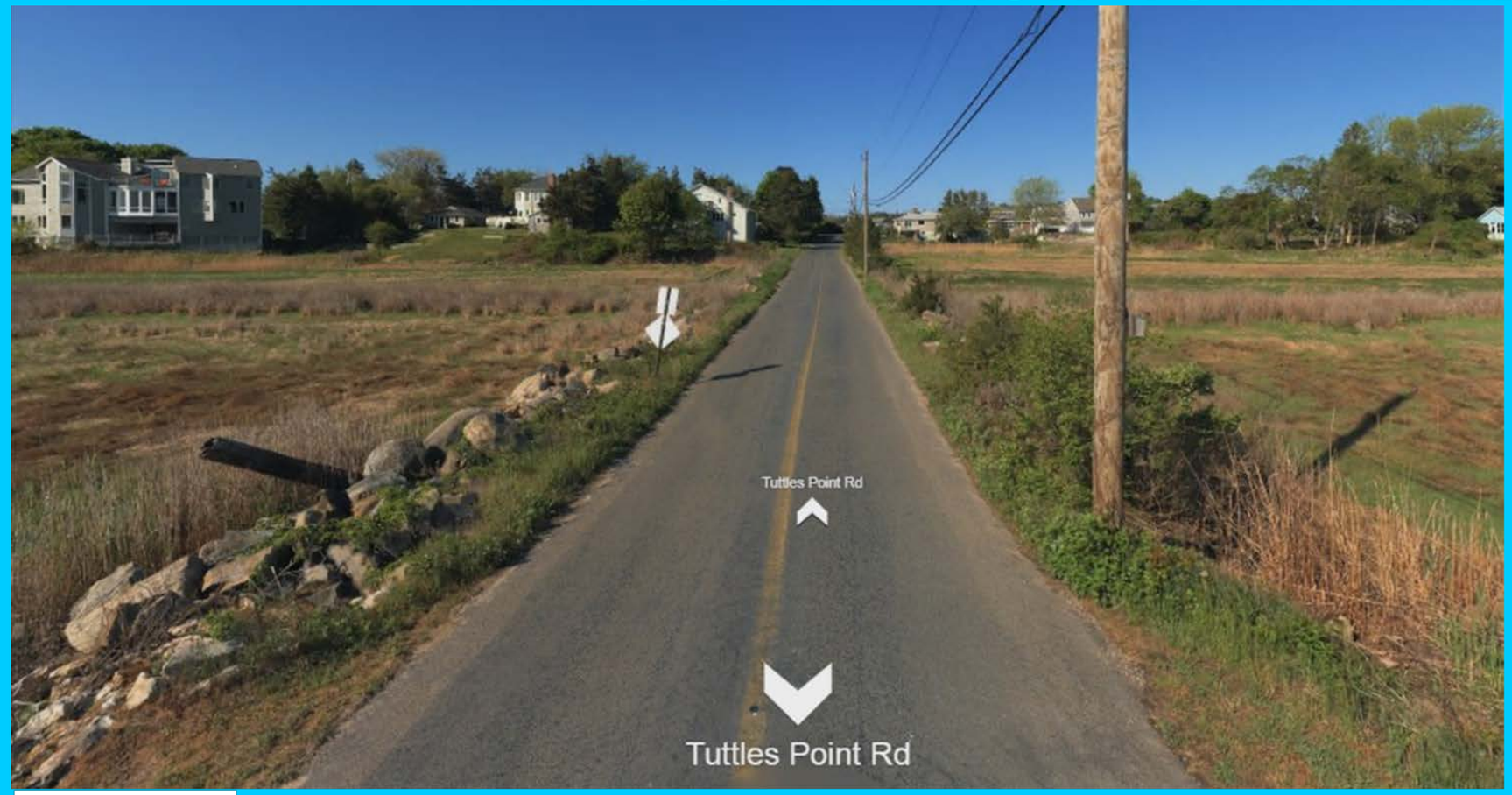
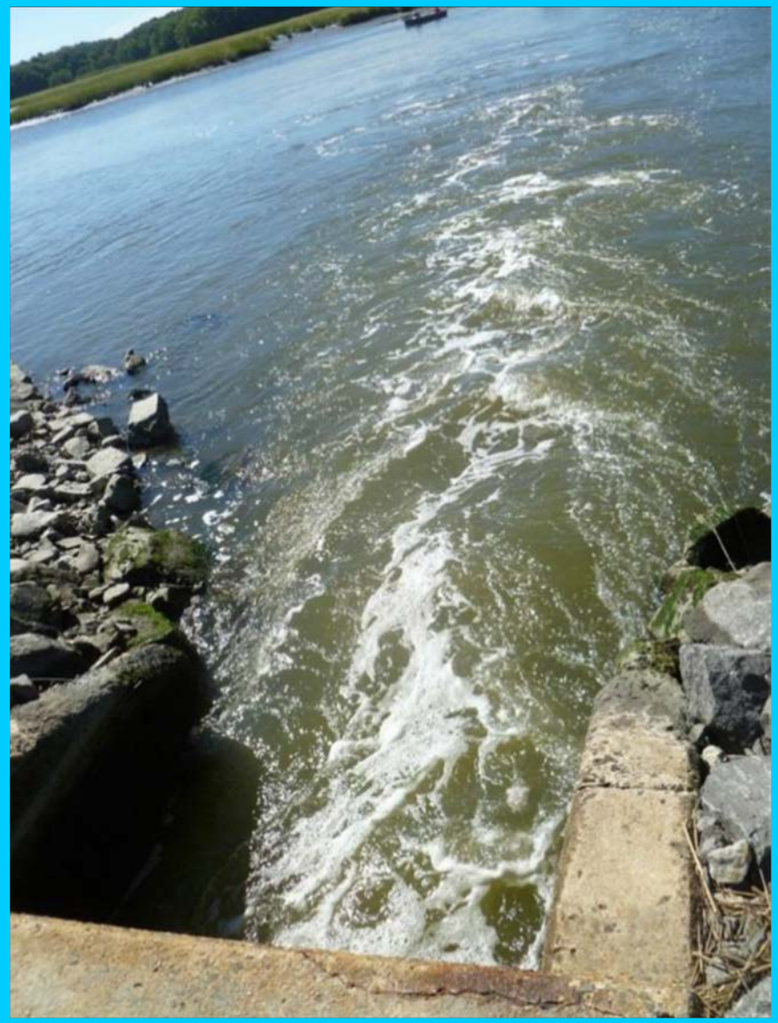
ELEVATING ROADS IN RESPONSE TO CLIMATE CHANGE & SLR: IMPACTS AND HOW TO MINIMIZE THEM





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Perched culverts under I-95 block fish passage (Noroton River).

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  - Commonly observed methods & structures, such as:
    - Causeways
    - Culverts
    - Pile-supported Bridges
    - Tide Gates
  - Resource impacts associated with each
- Road Elevation in Response to SLR
  - What to watch out for
  - Dos & Don’ts


Aerial
United States · CT · New London Co.
250 feet
50 m
© 2019 HERE
Barn Island WMA,
Stonington
marsh, Clinton
Marsh, Westbrook
Google
Money Point
Boulder Rd

INLAND / FRESHWATER SYSTEMS TOO

CT Rt. 11, Salem

EXISTING ROADS & ROAD ELEVATION - Resource Impacts

- **Depends on the nature of the work being done**
  - Commonly observed methods & structures, such as:
    - Causeways
    - Single-span bridges, incl. box culverts, or bridge with 2 abutments
    - Pile-Supported Bridges, multi-span bridges with 2 abutments + 1 or more piers
    - Roads crossing tidal wetlands
    - Roads crossing inland, non-tidal wetlands
    - Roads crossing rivers / streams (both tidal and non-tidal)
  - Associated water control structures may help, or make things worse:
    - Culverts & Tide Gates (including SRTGs)
    - Box Culverts (see above)

RESOURCE IMPACTS – Culverts & Tide Gates

RESOURCE IMPACTS – Culverts & Tide Gates

Photos: CT Fund for the Environment / Save The Sound

Photos: CT Fund for the Environment / Save The Sound

RESOURCE IMPACTS – Culverts & Tide Gates
Commonly Associated Risks and Impacts

- Impede the flow of water (intentionally or not)
  - Culverts / pipes installed to pass water, but may be undersized or installed at wrong elevation
  - Tide gates installed to block flow of water, but leaky and easily broken

- Both commonly result in negative impacts to natural resources
  - Could be the sole cause, or working in conjunction with one another, or with a road
  - Blocking tidal flow / stormwater drainage is not good for tidal marshes / inland wetlands
  - Backing up tidal water also not good for tidal marshes

***Basically any problems that arise with these kinds of structures could very likely lead to road flooding / residential flooding, or possibly wash out a road
  - Problems such as culverts collapsing, filling in, rusting, designed / installed 100+ years ago (does not meet today's needs); tide gates rotting, rusting, hinges rusting / breaking, ice damage, wooden or concrete framework no longer serviceable, **unqualified people messing with tide gate management**

ROAD ELEVATION – Tide Gates & Culverts / Pipes

When elevating a road with existing TGs, new structures usually must be installed. There is no getting out of it, because…

If a bridge or culvert still has tide gates on it, then there is probably a very good reason for it. If elevating a road associated with tide gates, then these will have to be replaced or there will be some very unhappy people living or driving around upstream of your project. Many of these structures are very old, and they leak. New tide gates must also be designed and installed to match the volume of water that leaked through prior to construction in order to remain consistent with state and federal statutes.

Unfortunately, people do sometimes mess around with tide gates. They like to think they understand how they work but many people don't and…

ROAD ELEVATION – Tide Gates & Culverts / Pipes

…they mistakenly refer to them as flood control gates

Waverly Park Road, Branford, now floods frequently – whenever a tide gate on the Sybil Creek bridge falls into disrepair, or when someone decided to mess with the gates.

ROAD ELEVATION – Tide Gates & Culverts / Pipes

This structure is not for flood control. Flap gates of this variety break easily and need frequent and costly repairs.

Tide gates also interrupt the flow of sediment into marsh systems, may cause excessive panne formation, and block fish passage.

Photo: CT Fund for the Environment – Save the Sound

Photo: Janice Plaziak

ROAD ELEVATION – Tide Gates & Culverts / Pipes

Pipes, fortunately, are simpler – no moving parts, no temptation for people to mess with them.
But metal, or concrete, they do age and deteriorate

ROAD ELEVATION – Tide Gates & Culverts / Pipes

Photo: Janice Plaziak

ROAD ELEVATION – Tide Gates & Culverts / Pipes

Pipes also tend to get clogged, depending on a wide variety of factors:

- sand
- mud
- leaves
- vegetation (eelgrass, seaweed, Phragmites stems)
- size
- elevation
- straight vs. curved (flow volume & velocity)

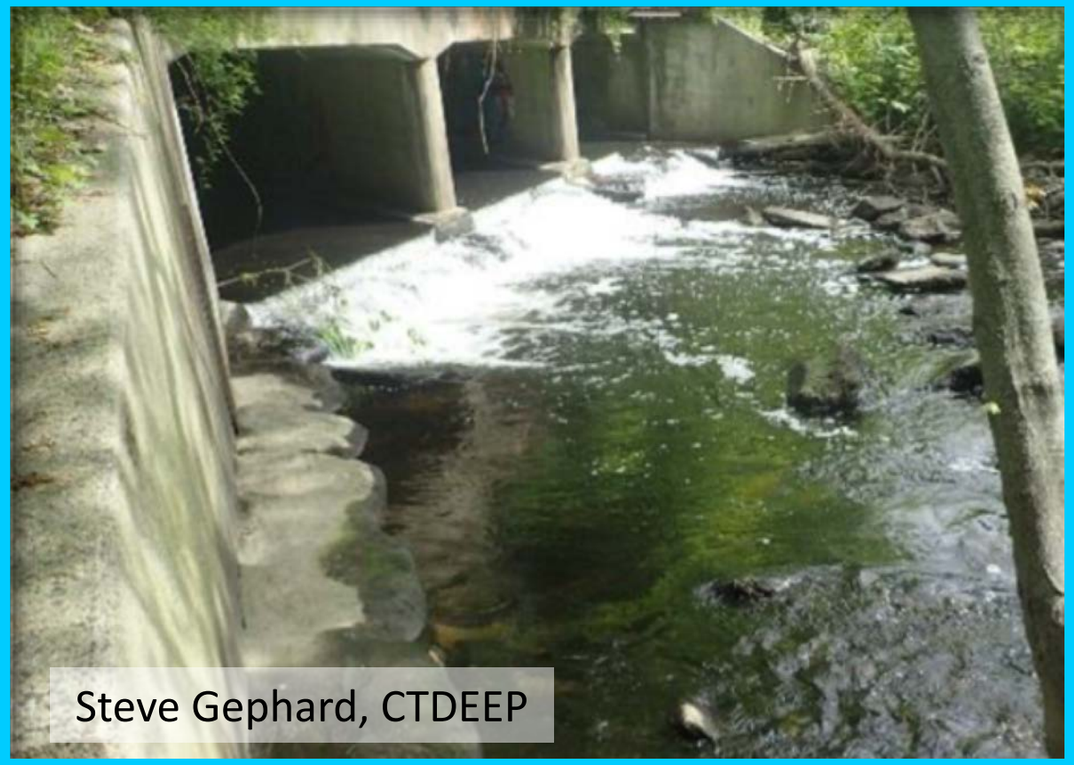
Photo: Steve Gephard, DEEP Fisheries

Cranberry Pond marsh, Waterford

ROAD ELEVATION – Tide Gates & Culverts / Pipes

Like tide gates, culverts & pipes can also hinder fish passage

- **may act as a complete physical barrier if perched or just too small**
- **long, narrow-diameter pipes are dark – will prevent some species from entering**
- **pipes can create velocity barriers and thermal barriers**
- **can cause erosion (plunge pools), sedimentation, and shoaling, altering the streambed and causing loss of feeding / spawning habitat**



Steve Gephard, CTDEEP

When elevating roads, it is important to avoid creating this condition (perched box culverts). Fish passage is important in both coastal and non-coastal areas; could negatively impact movement of migratory and riverine fish species.

ROAD ELEVATION – Tide Gates & Culverts / Pipes

*When elevating roads with existing pipes or TGs, new structures usually must be installed. The hydrology should be studied to determine correct size and invert elevation of your pipe(s) to prevent flooding and safely pass tidal water and stormwater

When elevating a road associated with pipes, must design to pass tidal water and stormwater without increasing risk of flooding, and while minimizing impacts to natural resources

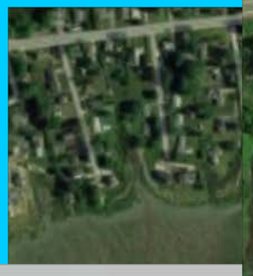
When designing road elevation projects (or road construction/repairs in general) engineer them with climate change / SLR in mind, not just minimal standards for today's conditions. Both inland and coastal systems – climate researchers are calling for possibility of increased precipitation! So not just SLR – not just a coastal issue

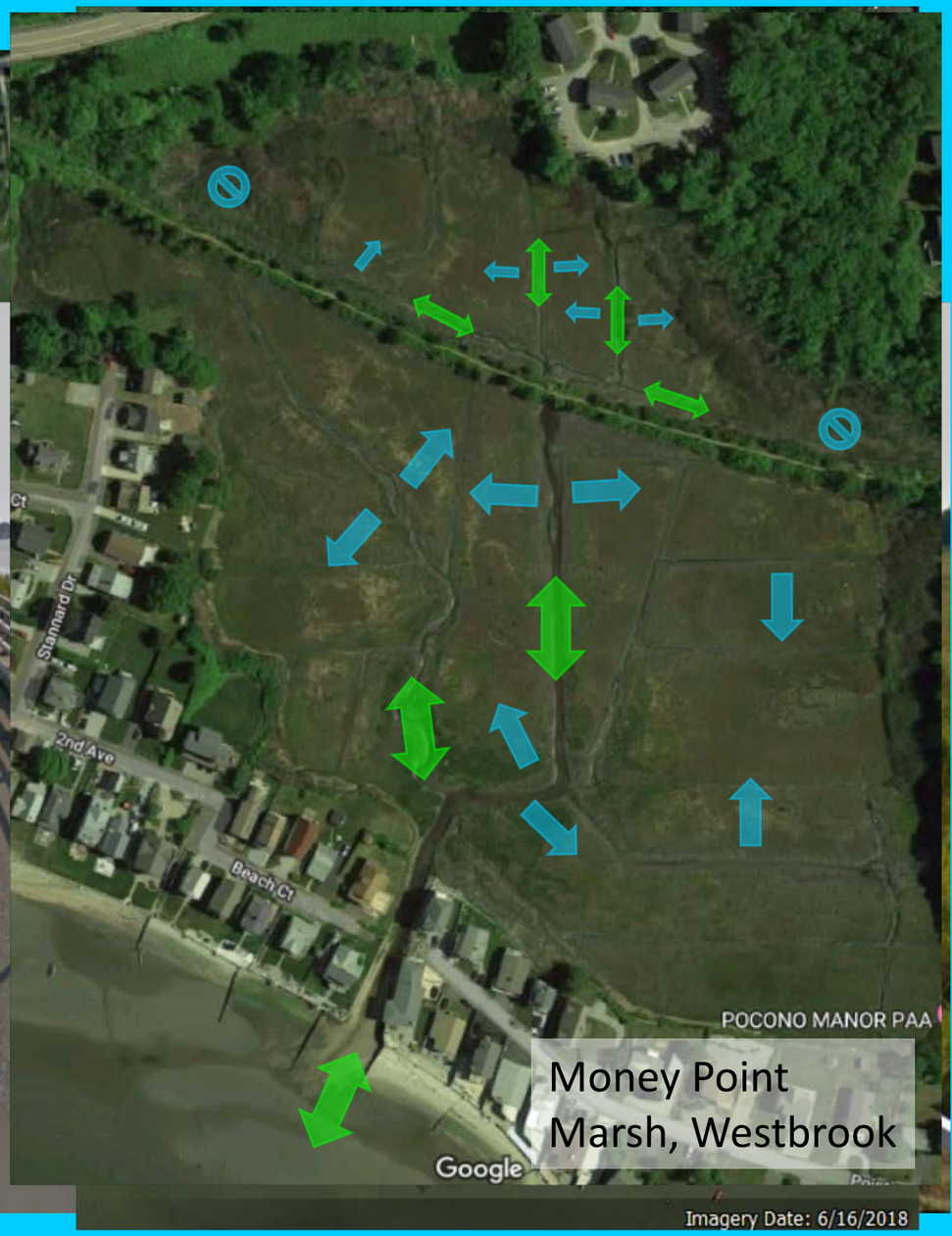
*Also true for general road repairs & maintenance

RESOURCE IMPACTS - Causeways

Stone / dirt fill roadbed, paved, placed right over the top of wetlands, other tidal / subtidal resource

- Usually associated with some form of pipe to allow the flow of water to pass through
- Sometimes associated with tide gates
- Impacts include:
  - Immediate and total loss of all resources below the road bed (wetlands, intertidal flats, oyster beds, eelgrass beds, etc)
  - Disruption of tidal flow into or within a tidal marsh system, or estuarine embayment habitat
  - Altered hydrology can suppress high tide level, increase low tide level, or both, impacting marsh plant species composition, abundance, and distribution, as well as the movement and survival of marsh species - - except mosquitos



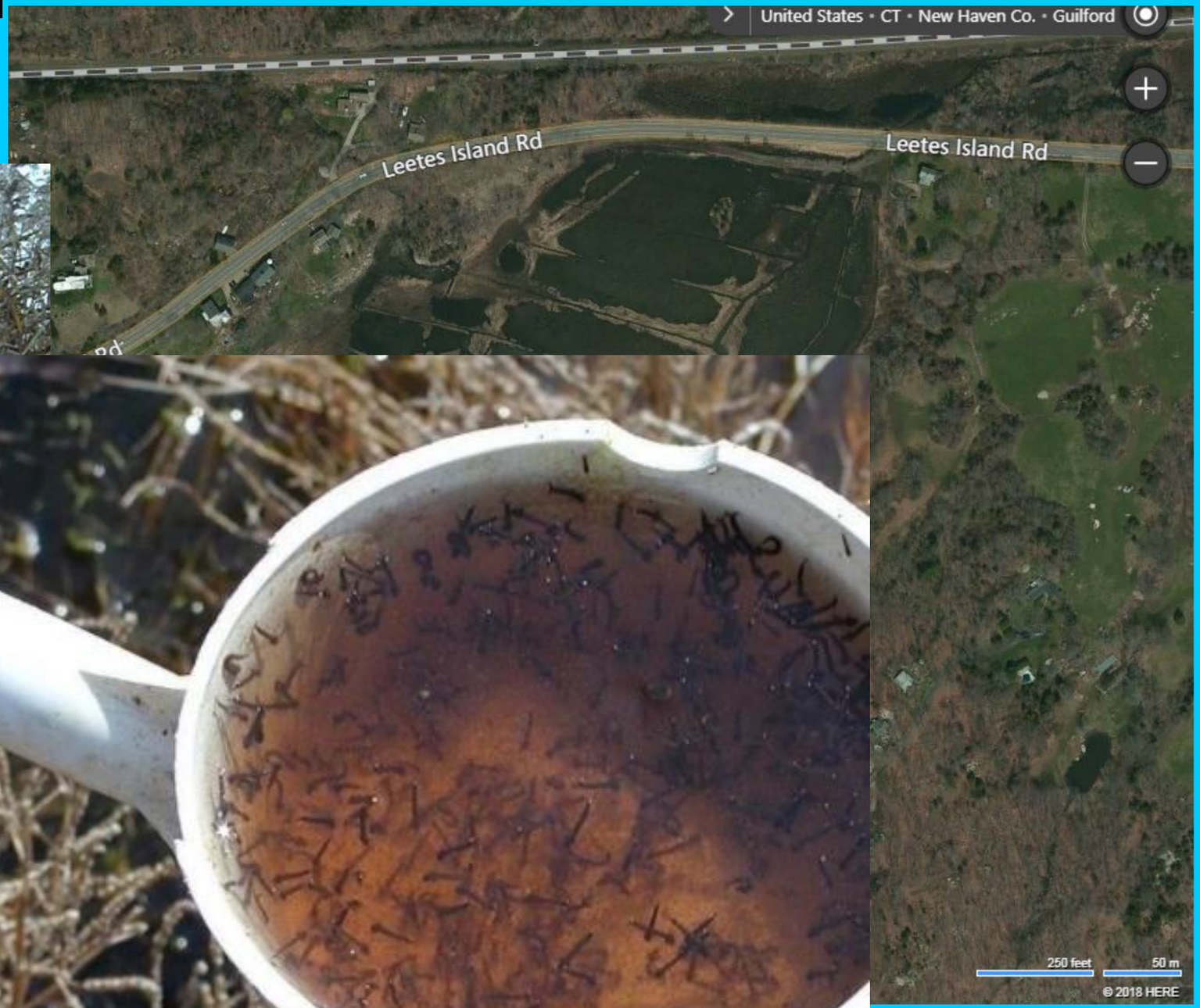


Money Point Marsh, Westbrook

www.ncfishes.com

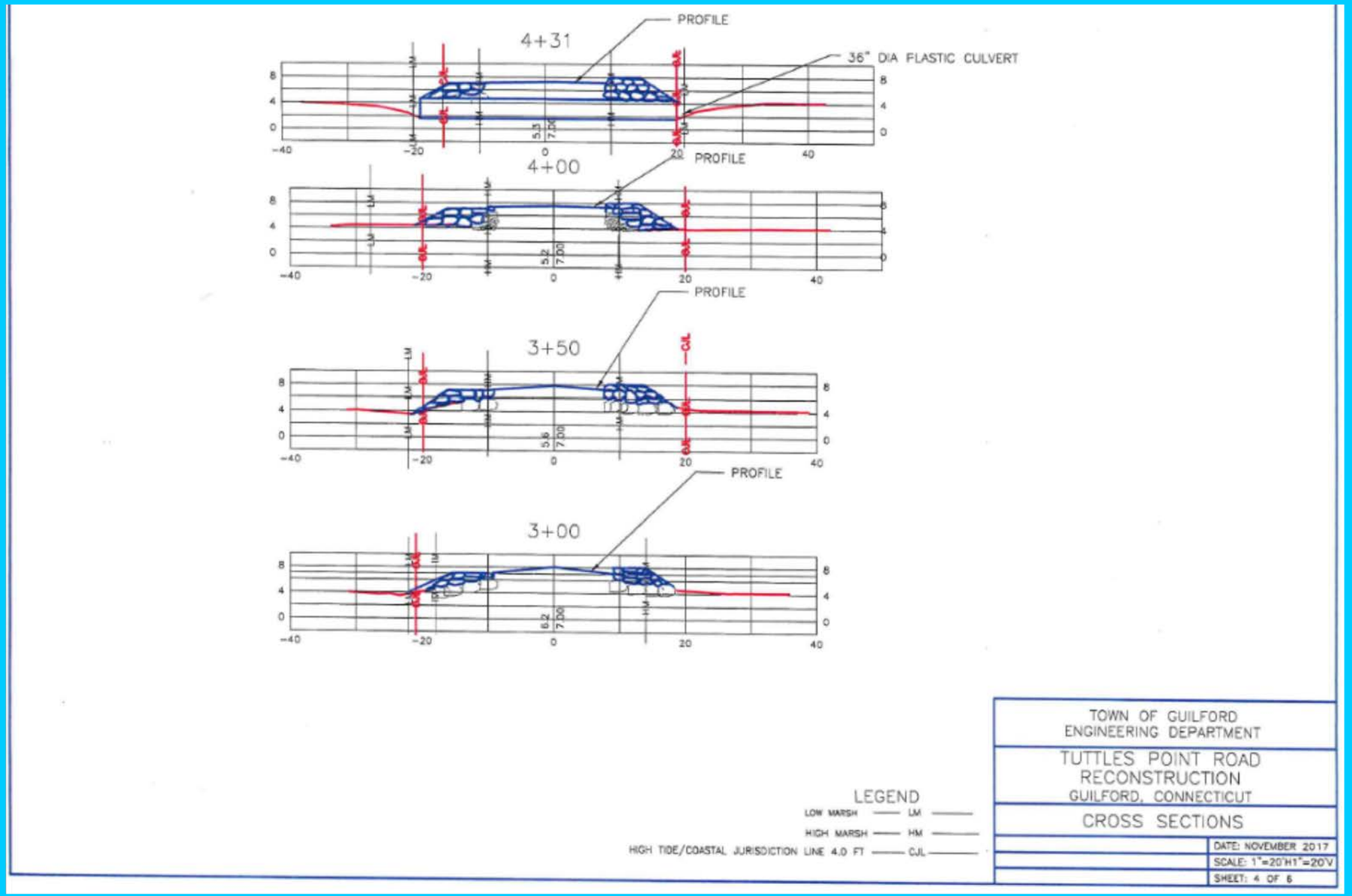
RESOURCE IMPACTS - Causeways

After decades (or longer) of interrupted tidal flow, many of our obstructed marshes look like this:

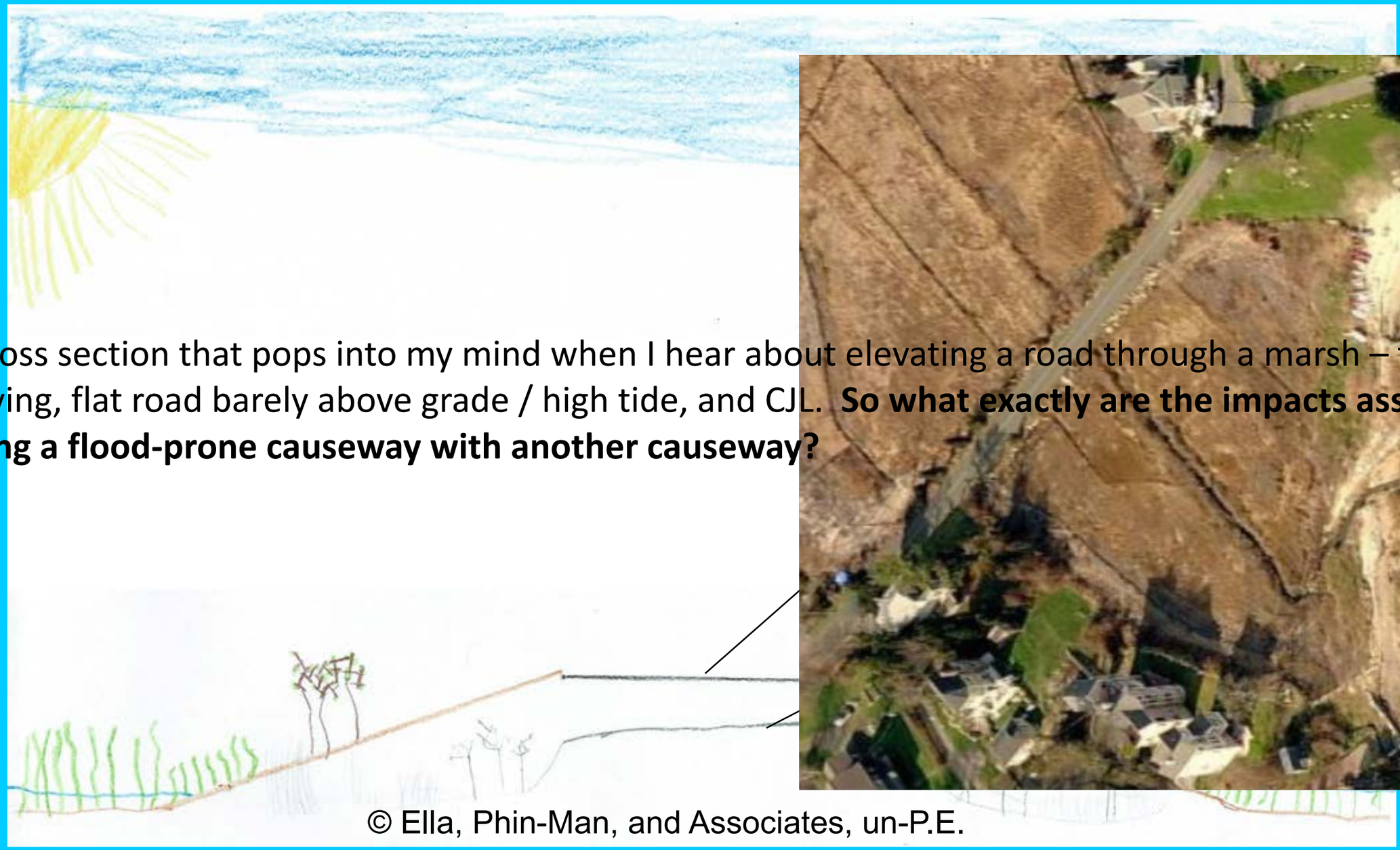


ROAD ELEVATION – Causeways

- Classic, low-lying & flat road whose surface is barely above grade / high tide / CJL



ROAD ELEVATION – Causeways



This is the cross section that pops into my mind when I hear about elevating a road through a marsh – this classic low-lying, flat road barely above grade / high tide, and CJL. **So what exactly are the impacts associated with replacing a flood-prone causeway with another causeway?**

ROAD ELEVATION – Causeways

Case Study: Tuttles Point Rd, Guilford. The area of marsh lost recently due to elevating this road approximately 2 feet above its lowest point is about double the area of the pre-existing road & side slopes – elevating the road required widening the roadbed.

**This is a total loss of tidal marsh resources within the footprint of the project, not just minor impact that the marsh could recover from over time, with or without intervention.

– BUT…project was authorized by state and federal regulators – "necessary authorized impacts"

- A new road construction project in 2019 must meet modern and very strict safety standards, hence the wider road bed with gentler (and longer) slopes

Permitting process aims to minimize the losses / impacts to natural resources prior to construction

Conditions of the permit include compensatory mitigation requirements to offset authorized impacts

- Ideally, on-site and in-kind mitigation (ie, restore tidal marsh habitat within this marsh system)
- if not possible, look for marsh restoration opportunities elsewhere / preferably nearby
- finally, look for opportunities to restore other habitat types either on or off-site.


Tuttles Point R
Guilford, Connec
Whitetop Ln
Tuttles Point Rd
Tuttles Point Rd
Tuttles Point Rd
Chittenden
Park
a problem

ROAD ELEVATION – Smaller Bridges

Single-span bridges, incl. box culverts, or bridge with 2 abutments & no supporting piers

Sybil Creek
marsh, Branford

Hammock River
marsh, Clinton

ROAD ELEVATION – Smaller Bridges

No work proposed at any of the Hammock River road crossings that I am aware of

Case Study (almost): CT DOT is in design stages for replacing Route 146 bridge over Sybil Creek, but NOT ELEVATING the road – surrounding level of development just does not allow for this.

- Specific to this project, Impacts are primarily associated with restricted tidal flow to upstream side of bridge
- Is the box culvert large enough quickly drain stormwater and prevent upstream road flooding?

In general….

- some loss of TW resources would be necessary if elevating; approaches also must be elevated and sloped widely & gently enough to meet modern construction standards; slopes will narrow approaching the bridge span

- In inland systems, sloping and encroaching into adjacent wetlands also unavoidable; and
- Can water control structures (pipes, etc) pass stormwater quickly enough to prevent road flooding?

- Less likely to cause a tidal restriction / back-up stormwater with a larger box culvert in place
  - pipe invert elevation is key, must be low enough to drain water at low tide, or pass all the stormwater in a relatively short amount of time.
  - BUT, too large and tidal water could flood low-lying areas upstream (or stormwater flooding downstream)

Compensatory mitigation most likely required by state and federal permits

- exact nature of the compensation depends on extent of impacts to natural resources

ROAD ELEVATION – Larger Bridges

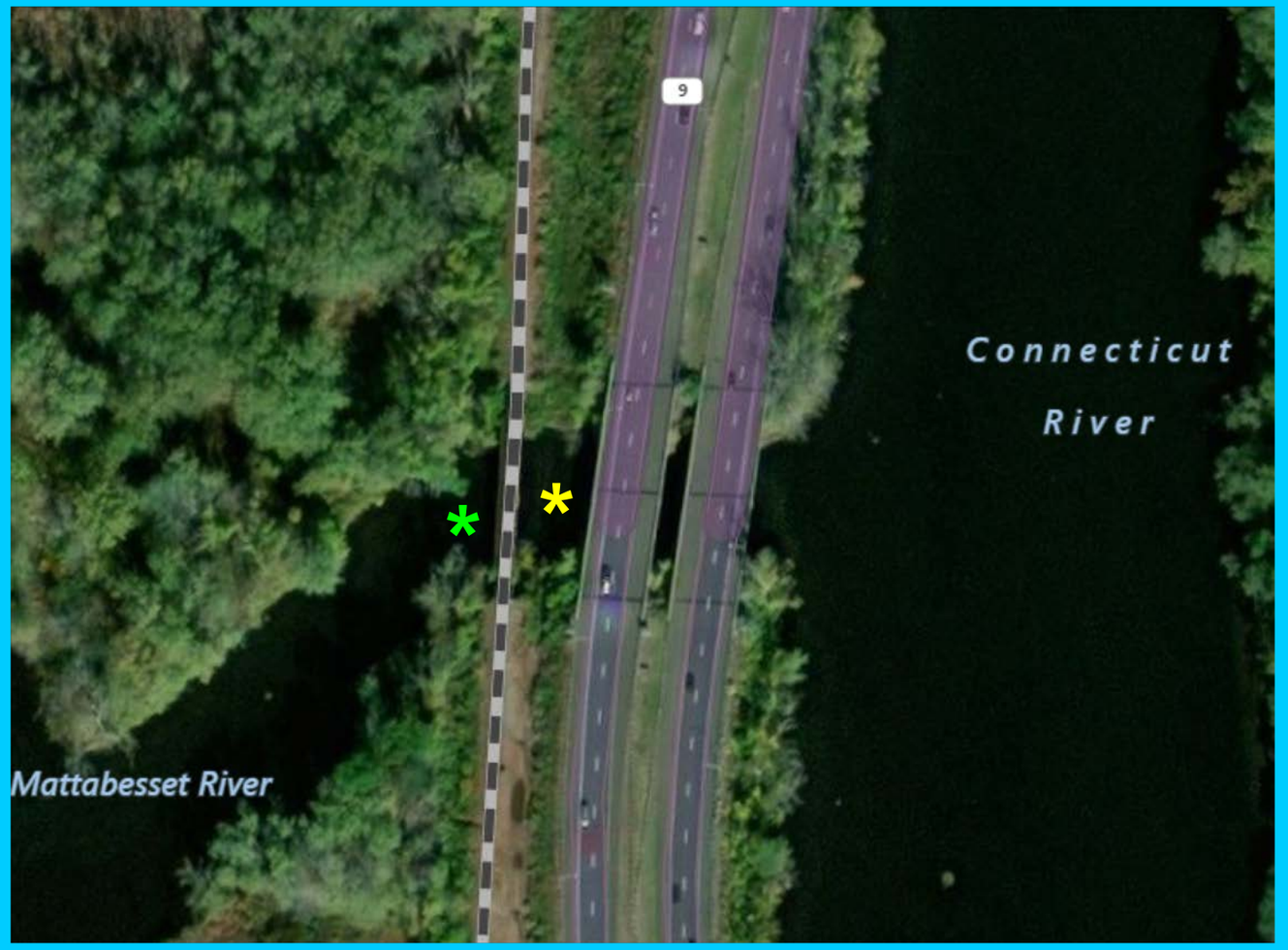
Taller bridges, usually with 2 or more spans; may be pile-supported, or bridges with 2 abutments & 1 or more supporting (central) piers

No tidal restrictions here! Ignoring the extraneous structures around the bridge, impacts are primarily: Footprint of the bridge supports, resources buried under fill required by design, altered currents / eddies which could lead to scour and sedimentation (until equilibrium), and **shading impacts**

ROAD ELEVATION – Larger Bridges

Shading can impact the growth / survival of eelgrass & other species of submerged aquatic vegetation found in fresh and brackish water

Shading impacts tend to be worse underneath bridges with an E-W orientation; amount of time spent in shade is considerably less for any one particular spot beneath N-S oriented bridges



ROAD ELEVATION – Larger Bridges

Case Study: Leetes Island Rd (CT Rt. 146), Guilford, between Lost Lake and Great Harbor Marsh

ROAD ELEVATION – Larger Bridges

Case Study: Leetes Island Rd (CT Rt. 146), Guilford, between Lost Lake and Great Harbor Marsh

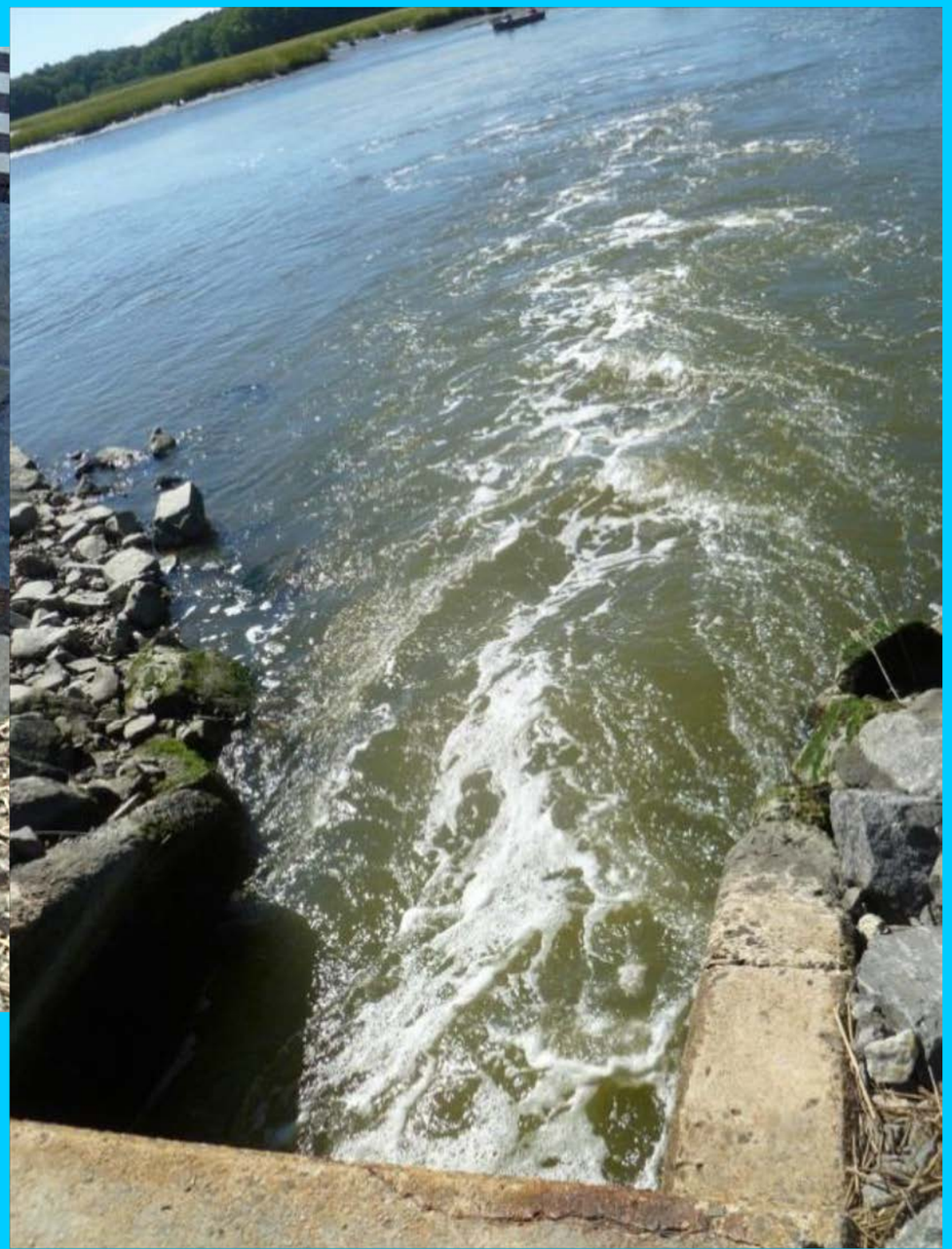
- CT DOT is in design for elevating this stretch of road by about 15+ feet above its lowest point
- Due to the nature of these taller, pier-supported bridges, there is no need to widen the road bed. In fact, there will not be a road bed.
- Primary impacts will include shading (E-W orientation) but there are no SAVs in this area to be concerned about. Recovery of marsh vegetation in shaded area may be slow.
- Resources within the footprint of abutments & piers were already lost to the road bed many years ago, and will not recover, but area is small (sqft instead of acres); **BUT** areas in between piers and abutments should recover

***Very unusual for a construction project of this scope: outcome expected to yield net positive environmental benefits as opposed to significant negative impacts. Perfect opportunity for on-site compensatory mitigation as well

- much of the road bed ***could*** be converted back to tidal marsh; and some marsh will be restored, however, some may be converted to a **coastal public access** spot for fishing, crabbing, and launching canoes/kayaks

ROAD ELEVATION – Larger Bridges

Case Study: Leetes Island Rd (CT Rt. 146), Guilford, between Lost Lake and Great Harbor Marsh



FINAL THOUGHTS

A Little More On Compensatory Mitigation

- On-site and in-kind is preferred
- Amount of area to be restored depends upon the types of impacts to resources from your project, resources / habitat type(s) affected, and areal extent of impacts
- Herbiciding and mowing Phragmites-dominated marshes is never suitable compensation for the long-term impacts or permanent losses of natural resources
- Design roads, bridges, other construction projects (and associated pipes, etc) to meet today's conditions, but also to withstand potential impacts of climate change and SLR

****Don't under-engineer your restoration projects** → off-site compensation projects, or stand alone habitat restoration or living shorelines, or similar work that is directly integrated with your road work…

ACKNOWLEDGEMENTS

Janice Plaziak, Town of Branford Engineering (formerly)

Janice Plaziak, Town of Guilford Engineering (currently)

Crack team of un-Professional Engineers at Ella, Phin-Man, and Associates

QUESTIONS???

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Questions??
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