

Delaware Floodplain: Impacts of Severe Storms on Infrastructure in a Low Lying State

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Executive Order 41

- Requires State Agencies to plan and design projects for flooding and sea level rise (SLR)
- Requires State Agencies to prepare Adaptation Recommendations
- Directs the state to set a Greenhouse Gas Mitigation Goals
- Creates Cabinet Committee on Climate and Resiliency



EO 41 – Workgroups

- **Adaption**

- Develop agency specific, actionable recommendations for improving Delaware's preparedness and resilience to climate impacts.

- **Flood Avoidance**

- Established to develop flood avoidance and design guidance to incorporate measures for adapting to increased flood heights and sea level rise.

EO 41 – Workgroups (cont.)

- **Mitigation**

- Examine GHG emissions, regulations, programs, and policies that influence GHG emissions, use best data available to establish a GHG mitigation target, and develop an implementation plan to guide Delaware toward its goal
 - Mitigation target of 30% greenhouse gas reduction from a 2008 baseline by 2030

DelDOT Bridge Design Manual

104.3.4.6

Sea Level Rise

In accordance with Executive Order 41, all state agencies shall incorporate measures for adapting to increased flood heights and sea level rise in the siting and design of projects for construction of new structures and reconstruction of substantially damaged structures and infrastructure. Such projects shall be sited to avoid and minimize flood risks that would unnecessarily increase state liability and decrease public safety.

Construction projects shall also incorporate measures to improve resiliency to flood heights, erosion, and sea level rise using natural systems or green infrastructure to improve resiliency wherever practical and effective; if the structures are within an area mapped by DNREC as vulnerable to sea level rise inundation the projects shall be designed and constructed to account for sea level changes anticipated during the lifespan of the structure, in addition to FEMA flood levels; and all state agencies shall consider and incorporate the sea level rise scenarios set forth by the DNREC Sea Level Rise Technical Committee into appropriate long-range plans for infrastructure, facilities, land management, land-use, and capital spending.

DelDOT Project Development Manual – *Proposed Language*

5.15.13 Sea Level Rise

Climate change and associated sea level rise and flooding has become an issue that needs to be addressed for transportation facilities in coastal states, like Delaware. These issues, as related, but limited to, future roadway and bridge elevations, roadway and roadside materials, and overall system planning for future transportation facilities, should be addressed as part of planning and design activities.

Setting the Stage: Moving from generalization to specifics....

Problem Statement: What would be the cost of upgrading states currently existing roadway network to resist SLR levels (+1.5 m) predicted to develop by 2100?

Methodology: To develop engineering-based estimates that reflect the project cost to raise all DelDOT-owned roads and bridges to 1.5 meter SLR resistance based upon roads and bridges identified using the 'bathtub' model method in GIS.



Total Cost Estimates to Raise All DelDOT-Owned Assets

<i>COUNTY</i>	<i>Roads</i>	<i>Bridges</i>	<i>TOTAL</i>
New Castle	\$293,142,890	\$51,670,169	\$344,813,059
Kent	\$207,867,192	\$11,583,599	\$219,450,792
Sussex	\$838,394,344	\$51,155,453	\$889,549,798
<i>TOTAL</i>	\$1,339,404,428	\$114,409,222	\$1,453,813,650

Results & Further Study Needs

- ✓ Cost to raise all DelDOT-owned assets to resist 1.5 m sea level rise = **\$1.45 Billion**
- ✓ Cost to raise Priority 1 & 2 assets = \$946.1M
- ✓ Roadways make up 90% of the costs
- ✓ Sussex County has the largest amount of vulnerable assets, a majority of which are local roads
- ✓ Coastal Route 1 is the most at-risk of all state routes (\$158M to raise), followed by Route 9 (\$74M)
- ✓ Need combined storm surge/SLR model to determine maximum vulnerability



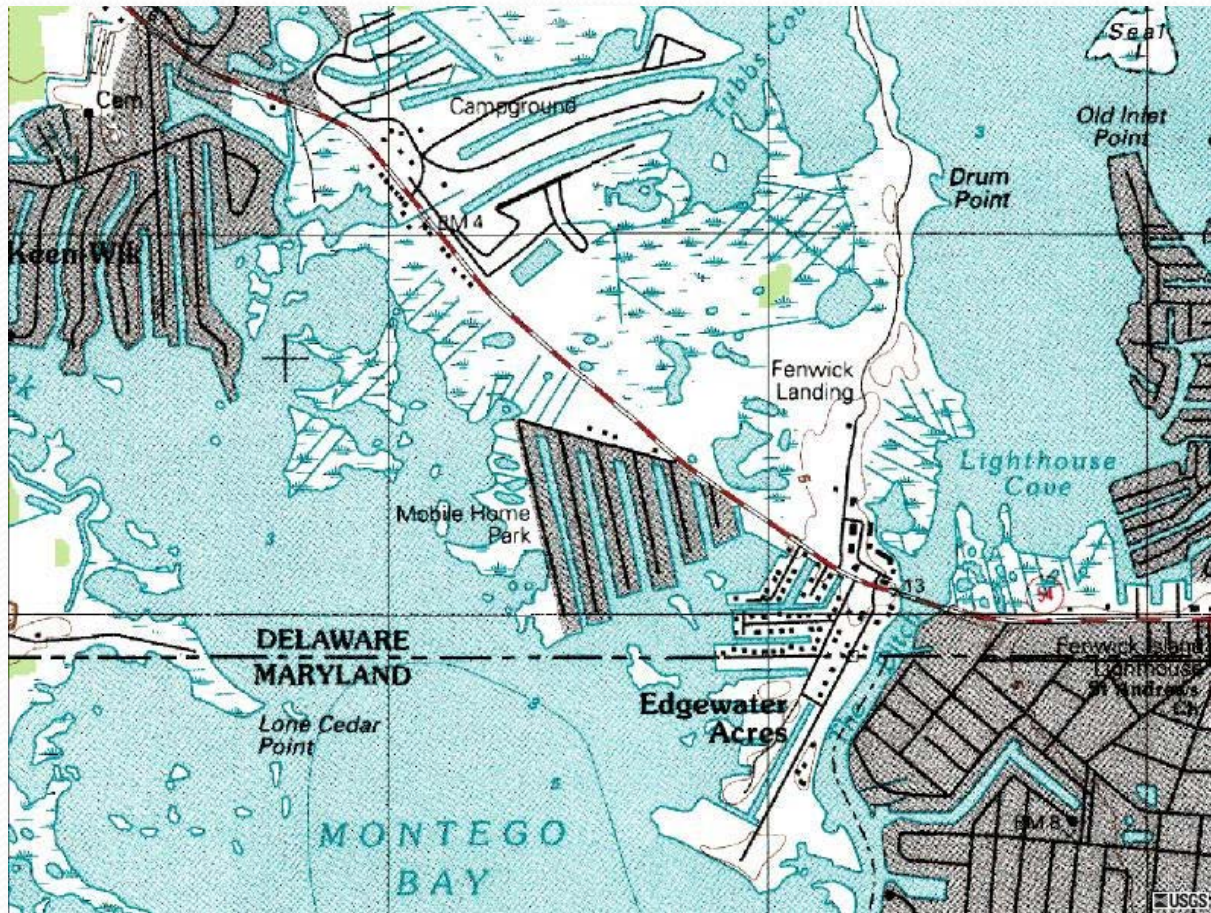
Case Studies:

Elevate, Harden or Abandon?

Where is this?



Example - Elevating



SR54 East of Fenwick

Example - Elevating



SR54 East of Fenwick

Example - Elevating

➤ Solution

- Construct viaduct over low marshy areas to raise road above flooding elevation
- Could not simply raise roadway using fill because of adjacent wetland impacts
- Viaduct consists of two separate structures a total of 2400' long and cost \$16M in 2001.
- Elevating the roadway is not cheap.

Example - Elevating



Rendering of SR54 Viaduct

Example - Elevating



Elevation View of SR54 Viaduct From Old SR54 Alignment

Where is this?



Example - Hardening



Looking South down the Center of SR 1 after Hurricane Sandy

Example - Hardening



Erosion of the Approach Embankments to SR 1

Example - Hardening

➤ Solution

- Construct Sheet Pile Seawall so that we don't lose SR 1 in the event of the next storm
- Wall was 800' long and had 65 tie backs
- The work was added to the IRIB approach roadway project and cost \$1.4M
- **Hardening the roadway is not cheap.**

Example - Hardening



Construction of Sheet Pile Sea Wall

Example - Hardening



Final Product

Where is this?



Old Corbitt Road



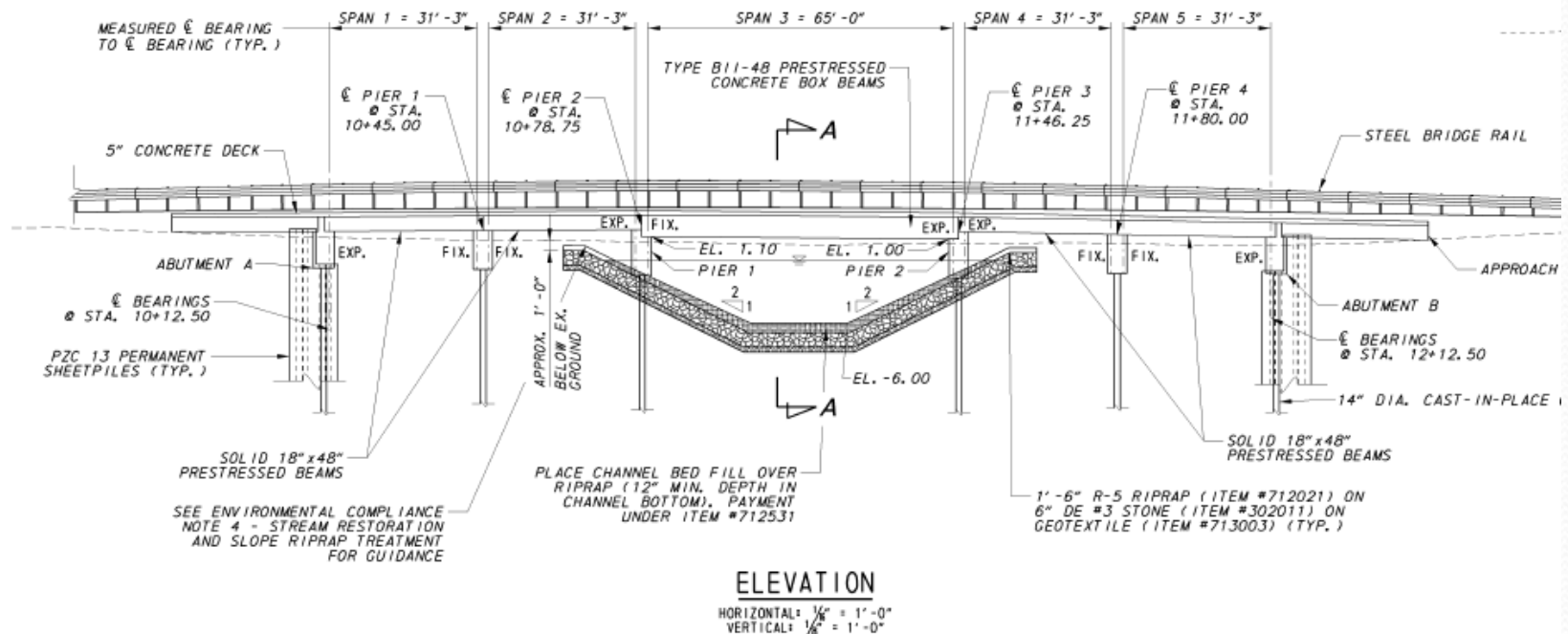
Old Corbitt Road

- Road abandonment?
- 340 ADT is the result of the automatic traffic recorder counts.
- Overtops daily due to tides
- Traveling time will be slightly increased by approximately 2 to 3.5 minutes.



Old Corbitt Road

- Abandon or elevate?
- Proposed bridge is a 5 span 250' long concrete structure and is estimated to cost \$2.5M.
- Is this the best way to spend our limited State resources? ... Stay tuned!



Summary

- ✓ DelDOT has been and continues to be challenged by the affects of SLR
- ✓ DelDOT currently makes decisions about SLR on a case-by-case basis
- ✓ DelDOT needs to develop policies on how we will spend our capital to protect and maintain assets affected by SLR
- ✓ DelDOT's policies need to line up with Statewide policies for all agencies
- ✓ State government needs political support for policies as we move forward.