CMA Engineers

Wherever the tides takes us

Designing culverts in tidal settings

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CMA is working on replacement plans for culverts like this one in Rye.

The design of resilient infrastructure is a critical part of planning in coastal New Hampshire. Considerations for climate change adaptation apply, in addition to conventional designs for traditional infrastructure, including bridges and culverts.

In a unique collaboration between the N.H. Department of Transportation, N.H. Department of Environmental Services, the N.H. Coastal Program and The Nature Conservancy, CMA Engineers completed the planning and preliminary design of culvert replacements on state highways in Rye and Stratham (Ocean Boulevard and Squamscott Road, respectively).

The structures were chosen in a review of all coastal crossings in New Hampshire because they are under state highways, in particularly sensitive tidal settings, and have poor existing structural conditions. Both sites have culverts with daily tidal flows through the culverts, as well as conventional fresh stormwater flows.

Two important climate change impacts will affect these and other tidal structures:

• Increasing sea levels and storm surge elevations.

• Increasing intensity and duration of precipitation events.

Both are critical in the design of tidal crossings.

Comprehensive and complex hydrologic/hydraulic evaluations were developed for each site that modeled both tidal and stormwater flows under both existing and future scenarios incorporating climate change.

Sea level rise was considered based on relative vulnerability for each site, which ranged from 3.8 feet at Stratham to 5.3 feet at Rye by the year 2100, based on the latest NHDES guidance.

The design of inland culverts is primarily driven by hydraulic capacity and matching channel geometry. Unlike inland culverts, in tidal crossings, water flows in both directions — inland during the incoming tides and storm surges, and in the opposite direction on the outgoing tide and during rain events.

The alternatives in this project were evaluated considering several metrics unique to tidal settings: hydraulic capacity in both directions, matching channel geometry, aquatic organism passage, salt marsh migration potential, and flooding impacts. Developing salt marsh habitat is a high priority due their role in flood mitigation and supporting biodiversity.

Projects that use traditional grey infrastructure (bridges, culverts) to promote green infrastructure (salt marsh for flood storage, rain gardens) are considered critical for maximizing resiliency.

The selected preferred alternatives are a result of leveraging the perspectives of the project stakeholders to produce a design that satisfies multiple environmental criteria. Preferred alternatives included significant increases in culvert widths, from 3.5 feet to 15 feet at Rye and from 1.5 feet to 8 feet at two culverts in Stratham.

Future roadway elevations were considered for sea level rise, and structural accommodation for possible future decisions to raise roadways was accommodated. The culvert designs reflect a high level of understanding and accommodation of the changing conditions coming with climate change and aim to maximize resiliency.