As one of the lowest lying states in the country, Delaware is particularly vulnerable to the consequences of climate change. Delaware’s Department of Transportation (DelDOT) partnered with state, federal, and non-profit stakeholders to study transportation vulnerabilities along Coastal Highway/SR1 in southern Delaware. The team developed concept designs that incorporate green infrastructure techniques for two sites. DelDOT will use these sites to develop design standards to apply to other vulnerable locations in the state.

The Problem & Context

Transportation located in coastal areas can be vulnerable to flooding, wave energy and storm surges. Sea level rise is expected to exacerbate these vulnerabilities. By the end of this century, a projected 8-11% of Delaware will be inundated by sea level rise. DelDOT already manages coastal roads that experience habitual flooding, a term that, in some cases leads to routine closures. Because of the state’s vulnerability it is critical to address this issue and increase the state’s resilience to flooding to ensure the health, safety and economic well-being of residents for years to come.

Delaware’s Coastal Highway/SR1 is an important economic driver for the state and also functions as an important evacuation/emergency route. Linking Dewey Beach in the north to Fenwick Island to the south, this 17-mile, 4 lane highway is critical for the state’s tourism industry, which employs 40,000 people and contributes approximately $2.1 billion annually to the state’s gross domestic product. Nearly 7.1 million people visit the area annually, most of whom rely on Coastal Highway/SR1 to arrive at their destination.

The vulnerability assessment and site selection were performed using GIS-based online tools to consider a number of factors – e.g., coastal management opportunities, sea level rise scenarios, areas of coastal vulnerability and flooding impacts. The team also assessed Coastal Highway/SR1’s storm resiliency by considering structural characteristics of the road and adjacent vegetation, e.g., position relative to water bodies, use of sand berms and vegetative areas associated with flooding events. Because Coastal Highway/SR1 is vulnerable to both coastal and inland flooding, both were considered in the analysis. Inland flooding is caused by insufficient management of precipitation, whereas coastal flooding occurs when water enters the uplands from nearby tidal waterbodies.

The initial screening effort involved review of existing data sets and interviews with agencies/local officials. The team referred to local historic aerial photography, LIDAR data, as-built drawings of the roadway, and spotwater infrastructure plans. For the sea level rise scenarios, the team used the National Oceanic and Atmospheric Administration’s (NOAA’s) Sea Level Rise Viewer and the Delaware Department of Natural Resources & Environmental Control (DNREC’s) SLR Tool. Flooding information was obtained from Delaware’s Flood Risk Adaptation Map (FRAM) online mapper, the NOAA Coastal Flood Exposure Maps and a flood insurance study for Sussex County.

Modeling was performed along the entire 17-mile corridor to evaluate flood volume, the wave energy contacting the roadway, and the extent of marsh buffer. Formulas were developed to estimate the minimum marsh platform width that would be required to dampen wave energy to a non-destructive size.

Natural buffers perform a critical role for Coastal Highway/SR1’s resiliency. On the east side, the dune system protects the road from all modeled storm events. Along the western bay side, the marshes dampen wave energy, but their ability to do so is dependent on the height, extent and health of the plant community. Over the past fifty years, the marshes along this stretch of road have lost an average of 0.63 acres per year due to various factors e.g., sea level rise, wave energy, anthropogenic activities).

Throughout the corridor there are unfavorable conditions for retention-based stormwater management due to shallow groundwater depths. Because there are limiting conditions for green stormwater infrastructure, it was determined that a multi-faceted approach would work best. Extended detention should be considered for those areas where the soils or groundwater depth is not conducive to retention-based approaches. Work in upland areas that do not have these limiting conditions should also be explored.

Site selection was performed to identify locations that both had good potential for adaptation and that presented common challenges in the area. They were identified based on stormwater management opportunities and coastal vulnerability. A rating system was developed based on these considerations and five locations were selected for further investigation. Two of these sites were selected to have a concept design developed based on consideration of all of the factors (flooding, wave energy, buffer protection and stormwater management): (1) Read Street site, (2) National Guard site.

Each site is located in a different area and reflects a different type of challenge. The Read Street project presents issues that are common in urban areas, where there are substantial site constraints and buffer protection is limited. The National Guard site poses a problem that is common throughout the Coastal Highway/SR1 corridor – the challenge of maintaining sufficient drainage on roads that are adjacent to tidal marshes.