

ROAD VULNERABILITY AND ADAPTATION MATRIX

| Index | SLR | SS | PC | RR | Vulnerability | Questions to identify vulnerability | Primary Inspection element | Decision | Engineering Adaptation | Operations & Maintenance Adaptation | Resources |
|-------|-----|----|----|----|---|---|---|------------------------------------|--|---|---|
| 1 | SLR | SS | PC | RR | Approaches, embankments, and retaining structure undermining or washout | Unvegetated shoulders or embankments? Evidence of rills or mass soil failures? Exposure to SLR? SS? PC? RR? | scour/erosion at embankments and/or around retaining structures | Now Future No | Elevate approaches; provide extended wing walls; retrofit/improve roadside drainage systems | Add armoring (rip rap) to side slopes and embankments; increase frequency of inspections; consider continuous monitoring for high-risk, critical routes | Maryland Highway Drainage Manual; MDE Model Soil Erosion and sediment Control Ordinance (2018) |
| 2 | SLR | SS | PC | RR | Deterioration of pavement and subgrades due to inundation | Observed cracking or failure of pavement course? Exposure to SLR? SS? PC? RR? | pavement and subgrade condition (structural) | Now Future No | Elevate the pavement structure; increase design standards to withstand inundation/saturation | - | MDOT SHA Pavement Design Guide |
| 3 | SLR | SS | PC | RR | Sinkholes caused by subgrade inundation | Standing water in drainage conveyances? High water table? Exposure to SLR? SS? PC? RR? | standing water in drainage conveyances | Now Future No | Reevaluate geotechnical analysis to evaluate cause; consider additional geotechnical explorations; provide ground improvements where warranted | Consider groundwater monitoring in high-risk areas; apply grouting, geogrid reinforcement, underdrains, or improved subgrade | MDOT SHA Standard Specifications for Subsurface Explorations; FHWA NHI-16-072 |
| 4 | SLR | SS | PC | RR | Deteriorating roadside vegetation (salt exposure, inundation, drought) | Sparsely vegetated or unvegetated roadsides? Tidal exposure? Drought exposure? Exposure to SLR? SS? PC? RR? | vegetative cover of roadside | Now Future No | Consider alternative stabilizations (e.g., rip rap) within roadside conveyances | Retrofit with salt- and inundation-resistant vegetation; consider retrofitting with channel liners | Section 3.3.4 in Maryland Highway Drainage manual, Design channel linings following FHWA HEC 15: Design of Roadside channels with Flexible Lining |
| 5 | SLR | SS | PC | | Debris accumulation on roadways and clear zones | Expected high water elevation with respect to road elevation? Exposure to SLR? SS? PC? | observed debris | Now Future No | - | Station equipment for rapid debris removable | MDOT SHA Stormwater Management Facility Routine Maintenance Manual; MDOT SHA Highway Design Manual |
| 6 | SLR | SS | | | Salt impact to concrete pavement | Concrete composition? Expected high water elevation with respect to road elevation? Exposure to SLR? SS? | pavement structural condition | Now Future No | Increase rebar cover thickness | Apply protective coating; increase frequency of inspections/monitoring | MDOT SHA Standard Specifications for Construction Materials; MDOT SHA Pavement Design Guide |
| 7 | SLR | | PC | | Inundation of adjacent sag curves where previously flooding was not present | Expected high water elevation at adjacent sag curves? Maximum roadside ground elevation at crest between sags? Exposure to SLR? PC? | rills and/or flow pathways between adjacent culverts | Now Future No | Reevaluate hydraulic analysis; increase primary or adjacent culvert crossing sizes/capacities; improve roadside conveyances between crossings | Ensure culverts and ditches remain clear of debris, deterioration, and sedimentation | Maryland Highway Drainage Manual |

- Sea Level Rise
- Storm Surge
- Precipitation Change
- Rainfall Runoff