

Fact Sheet 1.0: Roads

The mitigation objective of this Fact Sheet is to introduce mitigation strategies for roadways, bridges and associated support infrastructure needed for transportation and societal lifelines to reduce their vulnerability to flooding, storm surge and wind hazards.

Hurricane and Flood Impacts

Damage to roads and highways from hurricanes and floods exceeds millions and sometimes billions of dollars annually. Roadways through low-lying areas commonly are built on earthen embankments with one or more culverts extending through the embankments to handle normal drainage, runoff and flood flow. When flows are greater than expected, the capacity of culverts and drainage infrastructure to carry the additional flows can be exceeded. Consequently, the road surface can become flooded or the road embankment can act as a dam, creating flood conditions upstream of the embankment.

Similarly, bridges could flood if the volume of water in the flood flow is greater than the volume of water that can reasonably pass underneath or around the bridge at ordinary velocities. Flood-borne debris, such as trees or other barriers, can wedge in bridge openings, which causes a damming effect that can result in floodwaters washing over the bridge deck. Debris also can strike bridge piers and abutments, causing structural damage. Uplift forces may even lift the bridge deck from its supports.

Other impacts associated with hurricanes also can damage road infrastructure. Storm surge and wave action from hurricanes can erode roadways and embankments that are close to the shoreline. High wind and windborne debris may damage traffic signals, streetlights and signs, causing breakage, blow-down, or collapse of supports. Debris from these events can land in the roadway, blocking traffic flow.

Mitigation Fact Sheets

Roadway-related infrastructure is grouped into five fact sheets in this Handbook, each corresponding to different components of a roadway (Figure 1.0.1). The five roadway-related fact sheets are:

1. **Road Surfaces**—The portion of roads designed to carry traffic. Roads are paved or unpaved. Other public facilities may include bike paths, pedestrian ways, sidewalks and maintained trails.
2. **Road Shoulders and Embankments**—Road shoulders provide side support for pavement or unpaved surface layers and create a space at the edge of the roadway for stopped vehicles, emergency use, and out-of-control vehicles. Road shoulders also can be an essential part of the road surface drainage system. The road shoulder may be located on an embankment, where the embankment is also a structural support, in some cases supporting land next to a river or stream or supporting other raised land with a natural, stable slope.



3. **Culverts and Drainage Infrastructure**—Culverts are pipes or other structures crossing through an embankment under a road. Culverts move water from the road surface, road shoulders, roadside ditches and any other basins through or past the road itself. Roadside drainage ditches or swales collect and channel water away from the road surface for vehicle safety and protect the integrity of the roadway. Stormwater drainage systems around buildings, parking lots, railroads, airports and other facilities use similar features as road drainage.
4. **Bridges**—Bridge decks support the road and are connected to it at bridge approaches. Bridges span over roads, water bodies, railroads or unstable soils such as those in wetland areas. Bridge structures consist of piers, footings, headers, girders, the bridge deck and a wall or guardrail. Bridge abutments protect the area under the bridge approach. Embankments sometimes are supported with additional retaining structures called wing walls.
5. **Lights, Poles, and Signage**—Other roadway accessories include traffic control and safety structures, such as traffic signals, streetlighting and signs. Many of these structures are controlled electronically, and the controller box may be positioned next to the road on the ground. Traffic signals and signs are raised to be visible to travelers, making them vulnerable to high winds.

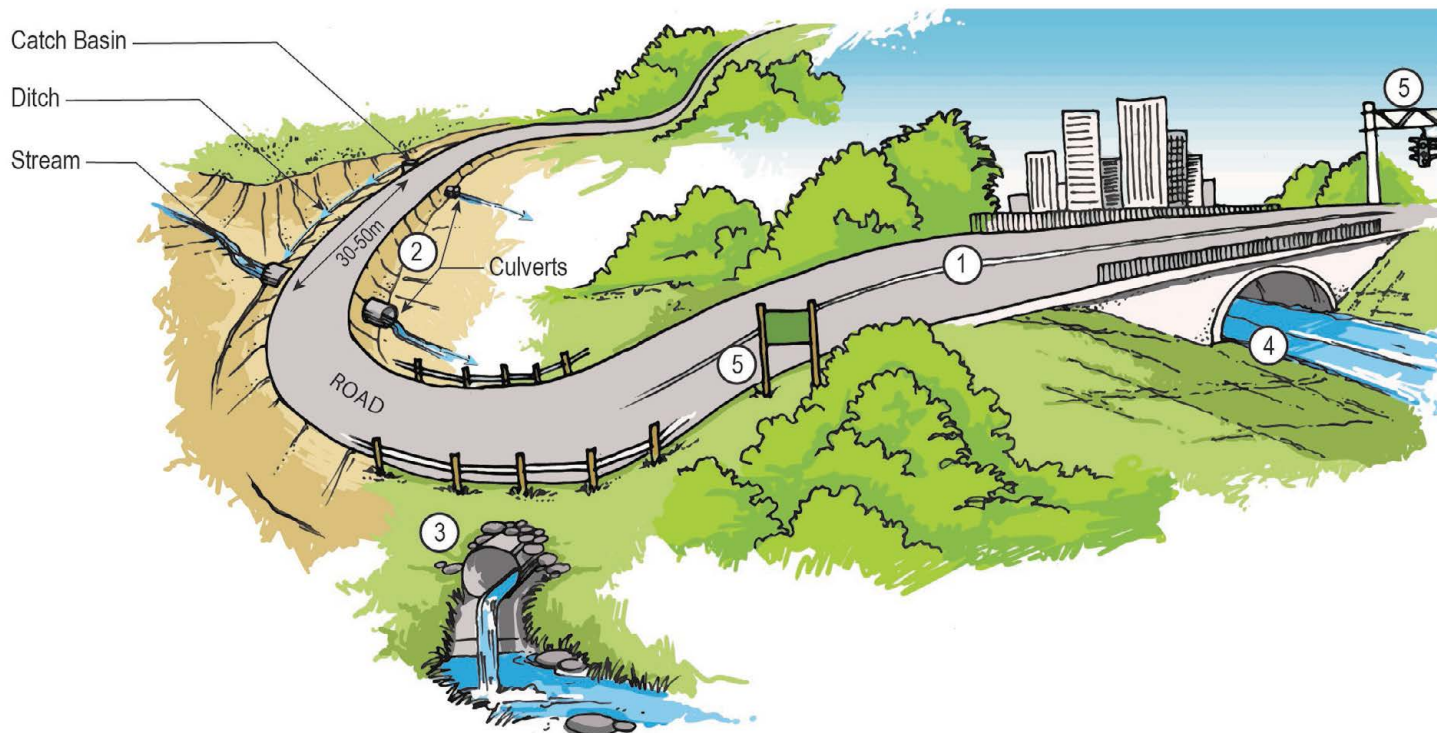


Figure 1.0.1. Road System Components.

Mitigation Solutions

Roadways are important facilities that must remain usable during and immediately after a natural disaster so that needed services can continue to function. Decreasing the likelihood of flooding, reducing damage and controlling erosion can improve the resilience of roadways. The methods used will depend on many factors, including cost, physical limitations, and environmental requirements. Possible strategies are detailed in the fact sheets that follow, including:

- Elevating roadways
- Improving drainage
- Strengthening underlying soils
- Installing erosion control measures
- Realigning roads and structures
- Strengthening support structures
- Decreasing debris damage
- Armoring vulnerable structures and embankments
- Moving electronic controls and equipment up off the ground
- Providing a source of standby power







NOTE:

Roadway and highway drainage and culvert systems to reduce future damage are tied to roadway classifications, such as interstates and primary and secondary roadway categories. State Department of Transportation manuals outline drainage standards.

Icons

The fact sheets include points to consider about developing and implementing each option. Icons represent these common considerations, which are summarized in Table 1.0.1 below.

Table 1.0.1. Icons Used to Represent Considerations about Hazard Mitigation Strategies

Icon	Considerations about Hazard Mitigation Strategies
	Cost – The cost to carry out the mitigation option may be high, which could make using the option cost prohibitive.
	Engineering – A qualified engineer would likely need to design the mitigation option.
	Environmental and Historic Preservation – The mitigation option likely will need to comply with local, state and/or federal environmental and historic preservation requirements.
	Floodplain Management – Carrying out the mitigation option might impact the floodplain, triggering compliance with floodplain management requirements.
	Operations and Maintenance – The mitigation option might require additional operations and maintenance activities beyond those currently being performed.
	Permitting – Evaluate the local, state or federal permits required to carry out the mitigation option.

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- State Department of Transportation Geotechnical Manuals.
- State Department of Transportation Traffic Sign Design Manuals.