



CHAPTER 11. CULVERTS AND BRIDGES
Design Checklist for Bridge Design

Yes	No	N/A	Design Requirements
I. GENERAL DESIGN GUIDELINES			
			A. Bridge design is in accordance with Bridges, Section 4.0 in the Hydraulic Structures chapter of the UDFCD Manual.
			B. Bridges are designed with flowrates that represent future, fully developed basin conditions for the drainageway in which the improvement is being made.
			C. All bridges are designed in accordance with UDFCD and County criteria and adhere to UDFCD requirements regardless of maintenance eligibility.
			D. All necessary local, State, and Federal permits required for a bridge crossing have been (or will be) applied for, including a County Floodplain Development Permit, if applicable.
			E. Aesthetics and Safety
			1. Structure geometry, materials, texture, patterning, and color blend with the adjacent landscape and provide an attractive appearance.
			2. Handrail /guardrail treatment is provided.
			F. Easement, Ownership, and Maintenance Requirements
			1. Appropriate measures to facilitate proper maintenance of the proposed bridge are included.
			2. Additional easement or right-of-way beyond the normal street right-of-way is provided as necessary to facilitate construction, operation and/or maintenance of proposed bridge.
			3. For a bridge not located within public right-of-way, easement, ownership and maintenance requirements are consistent with the requirements set forth for open channels. (See Section 12.5)
			G. Trail Coordination
			1. The proposed bridge has been coordinated with the County's Engineering and Open Space departments to determine if it is compatible with an existing or proposed trail plan.
			2. If a trail is deemed appropriate, a 12-foot minimum width bench is provided within the bridge.
			3. The culvert's height from the bench to the lowest point on the bridge is a minimum of 9 feet. Additional height is provided for trails with equestrian traffic.
			4. Low flow channels adjacent to the trail bench accommodate a minimum of the 2-year flow for a hydrograph shorter than 24 hours.
			5. Low flow channels adjacent to the trail bench accommodate a minimum of the 10-year flow for a hydrograph longer than 24 hours.

II. BRIDGE SIZING



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Yes	No	N/A	Design Requirements
			A. Bridge Constructed on Minor Drainageway
			1. The roadway's drainage classification was determined using Table 7-1 or 7-2.
			2. The minor and major storm event has been determined using Table 11-1.
			3. No overtopping occurs if a street has a raised median.
			B. Bridge Constructed on a Major Drainageway
			1. Bridges constructed on a major drainageway have no occurrences of overtopping. (Applies to all roadway drainage classifications)
			C. Sizing for Type A and B Streets when Overtopping is Allowed
			1. The future developed 100-year runoff was used to determine the allowable flow depth over the roadway by evaluating the roadway profile as a broad-crested weir.
			2. The difference between the 100-year flowrate and allowable flow overtopping the roadway was used to size the bridge opening size.
			3. The proposed bridge will convey the 10-year storm event without overtopping the roadway.

III. DESIGN STANDARDS FOR LOW WATER CROSSING/PEDESTRIAN BRIDGE

			A. Pedestrian bridge is designed to span the 100-year floodplain, where practical. (Design of a pedestrian bridge which does NOT span the 100-year floodplain must be approved by the County by variance.)
			B. At a minimum, pedestrian bridge is designed to convey the 10-year storm event.
			C. A minimum of 3-feet is provided from the channel invert to the lowest member of the pedestrian bridge.
			D. The design of the pedestrian bridge will withstand the forces of flows higher than the conveyance capacity, or the bridge will be tethered or restrained from being carried downstream.
			E. Pedestrian bridge is constructed with handrails per the criteria presented in Section 10.1.2.
			F. A maintenance plan has been developed for the pedestrian bridge to address concerns associated with debris accumulation, overtopping, etc.

IV. BRIDGE DESIGN GUIDANCE *(The following items are intended as Guidance only. Bridge design is specific to site conditions; it is the Engineer's responsibility to verify all aspects of the bridge design are considered.)*

			A. Location of Stream Crossing
			1. Bridge location was determined based on hydraulic considerations including floodplain width, channel flow distribution, stream type,



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			stream regime and stream controls.
			2. Bridge locations do not encroach on the FEMA regulated floodway unless otherwise approved.
			B. Structural Design
			1. At a minimum, bridge is designed to withstand HS-20 loading.
			2. Acceptable structural design method(s) have been verified with the County prior to design.
			C. Freeboard
			1. The preliminary design report discusses/recommends a freeboard requirement based upon the following channel properties: quantity of debris, channel/floodplain geometry, the availability of hydrologic data, etc.
			2. At a minimum, freeboard provisions meet requirements 1 and/or 2 outlined in Section 11.6.4.
			3. If a bridge is to be constructed on a continuous grade, freeboard is measured at the one-third point between the lowest and highest point on the low girder.
			4. The freeboard has been measured at the water surface elevation 50 to 100 feet upstream of the face of the bridge
			D. Flow Distribution
			1. The flow distribution has been evaluated at the proposed bridge location.
			2. The proposed bridge will not cause a significant change in the existing flow distribution or direction.
			E. Scour
			1. Bridge scour analysis includes an evaluation of flood history, channel hydraulics, and basic sediment transport analysis.
			2. FHWA publications HEC-18 and HEC-20 have been consulted for additional information on scour prediction methodologies.
			F. Deck Drainage
			1. A bridge is NOT placed on a sag vertical curve.
			2. A bridge is NOT placed at a superelevation transition.
			3. Bridge deck IS water tight.
			4. Stormwater is carried to drains (inlets) at the ends of the bridge; these drains have capacity for the minor storm, at a minimum.
			5. A rundown or an inlet/pipe system will be constructed at the end of the bridge guardrails (with asphalt curb roll) to convey drainage down the fill slope.
			G. Waterway Enlargement/Flood Channel
			1. The flow line elevation of the flood channel is set above the ordinary high water elevation.
			2. Flood channel extends upstream and downstream of the bridge as



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			necessary to achieve the desired flow regime.
			3. Flood channel design provides stabilization to prevent erosion, scour, and aggradation.
			H. Auxiliary Opening
			1. Determining a location for an auxiliary opening took into consideration the following: flow distribution, flow patterns, accommodation of large flow concentrations on the floodplain, avoiding floodplain flow along the roadway embankment for long distances, and accommodating the Colorado Division of Wildlife requests for minimal flows for wildlife.
			2. A thorough evaluation of the division of flow between the main structure and the auxiliary opening(s) has been completed.



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Bridge Construction Plans Checklist

Yes No N/A Construction Plan Requirements

I. BRIDGE PLAN VIEW, the following information is shown:

			A. Title block with project information, including a list of sheet revisions and an approval block
			B. Boundaries of project and plan sheet layout (key map)
			C. Existing and proposed roadways, sidewalks and other surface features
			D. Existing and proposed drainageways, irrigation ditches, culverts and storm sewer pipes
			E. Existing and proposed utilities (overhead and underground)
			F. Existing and proposed bridge(s)
			G. Existing and proposed contours
			H. Stationing along project control line
			I. Right-of-way and easement lines
			J. North arrow and scale bar
			K. Label locations of bridge pier(s) and abutments
			L. Erosion mitigation measures at bridge abutments and/or upstream/downstream of proposed bridge
			M. Label bridge approach slab
			N. Label locations of bridge drains (inlets)
			O. Label existing culvert or bridge to be removed

II. BRIDGE CROSS SECTION, the following information is shown:

			A. Title block with project information, including a list of sheet revisions and an approval block
			B. Horizontal and vertical scale bars
			C. Labels for length of bridge span(s), abutment locations, pier location(s), bridge approach slab, final elevation of bridge substructure(s) and bridge deck thickness.
			D. Depth of estimated scour for the design storm and the 500-year storm
			E. Erosion mitigation measures at the bridge abutments
			F. Existing and proposed ground along bridge alignment
			G. Existing and proposed utilities along bridge alignment

III. BRIDGE DETAILS, the following information is shown:

			A. Bridge substructure construction layout, cross sections and details
			B. Bridge superstructure construction layout, cross sections and details
			C. Bridge deck construction layout, cross sections and details.
			D. Elevation view, cross sections and details of abutments and



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			wingwalls
			E. Elevation view, cross sections, and details of pier(s)
			F. Cross sections and details of erosion mitigation measures
			G. Approach slab cross sections and details
			H. Pedestrian rail cross sections and details
			I. Any additional structure details or special connections that are not included in the Arapahoe County Standard Details or Colorado Department of Transportation M & S Standard Plans