Design Checklist for Culvert Design

Yes	No	N/A	Design Requirements
			I. GENERAL DESIGN GUIDELINES
			A. Culvert design is in accordance with the Culverts chapter of Volume 2 of the UDFCD Manual for additional design guidelines.
			B. Culverts are designed with flowrates that represent future, fully developed basin conditions for the drainageway in which the improvement is being made.
			C. All culverts are designed in accordance with UDFCD and County criteria and all culverts adhere to UDFCD requirements regardless of maintenance eligibility.
			D. All necessary local, State, and Federal permits required for a drainageway 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. The potential for pedestrian and recreational uses near structures has been evaluated and handrail treatments are included where deemed appropriate.
			F. Easement, Ownership, and Maintenance Requirements
			1. Appropriate measures (i.e. access road) are included to facilitate proper maintenance of the proposed culvert.
			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 culvert.
			3. For a culvert 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 culvert 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 culvert.
			3. The culvert's height from bench to the lowest point on the culvert is a minimum of 9 feet. Additional height is provided for trails with equestrian traffic.
			4. Low flow channels adjacent to the trail bench are designed to accommodate a minimum of the 2-year flow for a hydrograph shorter than 24 hours.
			5. Low flow channels adjacent to the trail bench are designed to accommodate a minimum of the 10-year flow for a hydrograph longer

Yes	No	N/A	Design Requirements
			than 24 hours.

Design Checklist for Culvert Design

Yes	No	N/A	Design Requirements
			II. CULVERT SIZING
			A. Culvert Constructed on Minor Drainageway
			1. The roadway's drainage classification has been determined using Table 7-1 or 7-2.
			2. The allowable overtopping in 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. Culvert Constructed on a Major Drainageway
			1. Culverts constructed on a major drainagway 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 the allowable flow overtopping the roadway was used to determine the culvert size.
			3. The proposed culvert will convey the 10-year storm event without overtopping the roadway.
			D. Allowable Headwater
			1. For Type A and B roads, the maximum headwater to depth ratio for the 100-year design flows is 1.5 times the culvert opening height.
			2. For Type C roads, the maximum headwater to depth ratio for the 100-year design flows is 1.2 times the culvert opening height.
			III. CULVERT DESIGN STANDARDS
			A. Construction Material
			1. All culverts shall be constructed of reinforced concrete in round, elliptical, or box shapes. (Concrete box culverts may be cast-in-place or supplied in precast sections.)
			2. Corrugated metal pipe is used in rural areas **if approved by the County**. All corrugated metal pipe shall be galvanized or aluminized steel or aluminum pipe.
			B. Minimum Pipe Size
			1. Culverts within public right-of-way have a minimum of 24-inches in diameter, or a minimum cross sectional area of 3.3 ft^2.

			2. Box culverts have a minimum inside height dimension of 3-feet.

Design Checklist for Culvert Design

Yes	No	N/A		Design Requirements
			C.	Culvert Capacity
			1.	The culvert capacity charts and nomographs provided in the Culverts chapter of the UDFCD Manual were used to determine culvert capacity.
			D.	Velocity
			1.	Minimum flow velocity in culvert for frequently occurring storms is 4 fps. Velocities have been checked for a flow depth in the culvert equal to 25% of the culvert diameter.
			2.	Velocity in culvert for the 100-year event will not exceed 15 fps.
			E.	Structural Design
			1.	At a minimum, culvert is designed to withstand HS-20 loading.
			F.	Alignment
			1.	Culvert is aligned with the natural channel.
			G.	Minimum Cover
			1.	Minimum cover over culvert is 1.5-feet from roadway subgrade to the outside top of the pipe.
			H.	Trash Rack/Safety Grate
			1.	Table 11-2 has been used for guidance on conditions where a trash/safety rack is or is not appropriate.
			2.	Trash/safety rack meets the criteria listed in Section 11.3.12.
IV. DRIVEWAY CULVERTS				
			A.	Construction Material
			1.	Culverts within County right-of-way are concrete or galvanized corrugated metal.
			B.	Minimize Pipe Size
			1.	Culverts are sized to pass the 5-year flow in a ditch without overtopping the driveway.
			2.	Driveway culverts have a minimum of 18-inches in diameter, or a minimum cross sectional area of 1.8 ft^2.
			C.	Minimum Cover
			1.	Cover over culvert must meet minimum cover recommended by the pipe structural design requirements or 1-foot, which ever is greater
			D.	End Treatment
			1.	Proposed culverts are designed to be constructed with flared end sections or headwall/wingwalls as appropriate.
			E.	Minimum Slope
			1.	Culvert slopes are a minimum of 2% or are the result of a minimum flow velocity in culvert for frequently occurring storms of 4 fps. Velocity shall be checked for a flow depth in the culvert equal to 25% of the culvert diameter.

Design Checklist for Culvert Design

Yes	No	N/A	Design Requirements		
			F.	Driveway Culvert Permit	
				1.	Culverts located in County right-of-way will have a Right-of-Way Use Permit.

Culvert Construction Plans Checklists

Yes	No	N/A	Construction Plan Requirements
			I. CULVERT PLAN VIEW, the following information shall 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 and storm sewer pipes.
			E. Existing and proposed utilities (overhead and underground)
			F. Existing and proposed culvert(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 size (diameter) and material of proposed culvert pipe
			L. Label location(s) of proposed culvert entrance and exit end treatment
			M. Label existing culvert(s) to be removed or plugged
			II. CULVERT PROFILE / 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 culvert length, slope, diameter, material and upstream and downstream pipe inverts
			D. Existing and proposed ground along culvert alignment
			E. Existing and proposed utilities along culvert alignment
			F. Station and offset from upstream and downstream end of culvert to project control line
			G. Proposed culvert entrance and exit end treatment
			III. CULVERT DETAILS, the following information is shown:
			A. Include any structure details or special connections that are not included in the Arapahoe County Standard Details or Colorado Department of Transportation M & S Standard Plans