VIRGINIA DEPARTMENT OF TRANSPORTATION

LOCATION AND DESIGN DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: CULVERT DESIGN	NUMBER: IIM-LD-214.2
SPECIFIC SUBJECT: COUNTERSINKING AND LOW FLOW CONSIDERATIONS FOR SINGLE AND MULTIPLE BARREL CULVERTS	DATE: July 27, 2006
	SUPERSEDES: IIM-LD-214.1
DIVISION ADMINISTRATOR APPROVAL: Mohammad Mirshahi, P.E. State Location and Design Engineer Approved July 27, 2006	

EFFECTIVE DATE

- This memorandum is effective upon receipt. Shading has been omitted.

1.0 DEFINITIONS

1.1 Stream Bed – The substrate along the length of a stream, which lies below the ordinary high water elevation. The substrate may consist of organic matter, bedrock or inorganic particles that range in size from clay to boulders, or a combination of materials. Areas contiguous to the stream bed, but above the ordinary high water elevation, are not considered part of the stream bed.

1.2 Culvert – A culvert is generally defined as an enclosed structure that is used to convey surface waters from one side of an embankment to the other. For the purposes of this IIM there is no distinction between temporary and permanent culvert installations.

2.0 POLICY

2.1 The District Environmental staff will determine if the culvert impacts a jurisdictional stream bed (US Army Corps of Engineers) and will notify the appropriate project authority and the Hydraulic Engineer when the below requirements must be incorporated into the design.

2.2 Culverts constructed in jurisdictional stream beds are required to have the upstream and downstream inverts set (countersunk) below the natural stream bed elevation to stimulate natural stream bed establishment within the culvert and to meet the requirements of the environmental permitting process. The countersinking requirement does not apply to floodplain culverts or extensions or maintenance of existing structures where the existing structure will remain in service.

2.3 When performing the hydraulic analysis for any culvert installation that is to be countersunk, the analysis shall either:

1) Consider the hydraulic opening as being that above the countersunk portion of the culvert, or
2) Determine the required hydraulic opening (size) based on no countersinking; then specify the next larger size structure (3” or 6” greater height as appropriate) with the additional opening installed below the steam bed.

2.4 When performing a hydraulic analysis for any multiple barrel culvert crossing, it is appropriate to consider the natural channel and flood plain configuration as projecting through the crossing, the same as if it were a bridge spanning a flood plain. For the purpose of determining the hydraulic capacity of the crossing, any culvert area that is outside the natural channel area and below the flood plain elevation will be considered obstructed and, therefore, not available for hydraulic conveyance.

2.5 Culverts will be adequately sized to allow for the passage of ordinary high water with the countersinking, invert and flood plain restrictions taken into account.

2.6 If the culvert is greater than 24” (or equivalent) in diameter, the inlet and outlet ends shall be countersunk a minimum of 6” below the natural stream bed. If the culvert is 24” (or equivalent) or less in diameter, the inlet and outlet ends shall be countersunk a minimum of 3” below the natural stream bed.

3.0 MULTIPLE BARREL CULVERTS

3.1 When multiple barrel culverts are used, the 6" countersink requirement may only be needed for one barrel. The Hydraulic Engineer should determine whether it is appropriate and/or feasible to countersink one barrel or all of the barrels considering the following:

3.1.1 Width of Normal Stream - The width of the culvert barrel(s) receiving the low flow should approximate the width of the normal stream to avoid accelerating velocities (at normal flow) through the culvert.

3.1.2 Width of Floodplain - Narrow and constricted floodplains may necessitate all barrels being at the lowest possible elevation. Wide floodplains with significant over bank areas may permit one barrel to be countersunk and the remaining barrels to be either at the floodplain elevation or at an elevation slightly higher than the natural stream bed.

3.1.3 Pipe Culverts – Pipe Culverts may be designed to have barrels at different invert elevations. However, special provisions are needed to ensure proper bedding and backfill. Special Design Endwalls will be required. These considerations may negate any potential cost savings associated with not countersinking all barrels a like amount.

3.1.4 Box Culverts - Precast box culverts may be designed to have barrels at different invert elevations. In doing so, the installation is usually configured with the top of all barrels at the same elevation. This will require the same special considerations for bedding, backfill and endwall design as noted in Section 3.1.3. Cast in place box culverts usually have all barrels of the same size and elevation in order to construct the box culvert using standard details.

3.2 Multiple barrel culverts that are constructed with all barrels countersunk shall provide measures for directing the low flow through one or more barrels that approximate the width of the normal stream.

3.2.1 If the normal stream width is approximately equal to the total span of all barrels, low flow diversion measures normally should not be needed. If the Hydraulic Engineer elects not to utilize a low flow diversion structure, the District Environmental Manager shall be notified of the decision and be provided justification in order to advise the environmental review agencies during the permitting process.

3.2.2 When low flow diversion measures are needed, they shall be constructed to permit the stream to continue the natural meander or moving process normally associated with flood flows. The low flow diversion structures shall be constructed of rip rap, or other similar material. The rip rap material used should be small enough to allow movement during flood events (i.e., Class I Dry Rip Rap).

See Standard Insertable Sheet isd1588.dgn "Low Flow Diversion for Multiple Line Culvert Installations" for standard low flow diversion details.

3.2.3 Other methods of achieving the desired low flow conditions may also be employed. These shall be reviewed and approved by the District Environmental Manager.

4.0 SPECIAL CULVERT INSTALLATIONS

4.1 Culverts on Bedrock: If the bedrock prevents countersinking, evaluate the use of a three-sided structure to cross the waterway or evaluate alternative locations for the new culvert that will allow for countersinking. If none of these alternative measures are practicable, the Hydraulic Engineer shall submit documentation to the District Environmental Manager, including the cost, engineering factors, and site conditions that prohibit countersinking the culvert, and shall coordinate the evaluation of options to minimize disruption of the movement of aquatic life. Options that must be considered include partial countersinking (such as less than 3" of countersinking, or countersinking of only one end of the culvert), constructing stone step pools and low rock weirs downstream of the culvert, or other measures that provide for the movement of aquatic life.

NOTE: Blasting of bedrock stream bottoms through the use of explosives is not acceptable as a means of providing for countersinking of pipes on bedrock.

4.2 Culverts on Steep Terrain: Culverts on steep terrain (slope of 5% or greater) may generate flow velocities that cause excessive scour at the outlet and may prevent the establishment of a natural bed of material through the culvert. Should this situation present itself, the Hydraulic Engineer shall coordinate the evaluation of alternatives to countersinking. These include partial countersinking of the inlet end and implementation of measures to minimize any disruption of the movement of aquatic life, constructing a stone step/pool structure, using river rock/native stone rather than riprap or constructing low rock weirs to create a pool or pools.

Stone structures should be designed with sufficient-sized stone to prevent erosion or washout and should include keying-in as appropriate. These structures should be designed both to allow for aquatic life passage and to minimize scour at the outlet. The Hydraulic Engineer shall submit documentation to the District Environmental Manager, including the cost, engineering factors, and site conditions that prohibit countersinking the culvert, and shall coordinate the evaluation of options to minimize disruption of the movement of aquatic life.

4.3 Culverts at the Confluence of Two Streams: The outlet end of culverts that discharge a tributary directly into another stream must be countersunk below the natural stream bed at the discharge point. If this measure is not practicable, the Hydraulic Engineer shall submit documentation to the District Environmental Manager, including the cost, engineering factors, and site conditions that prohibit countersinking the culvert, and shall coordinate the evaluation of options to minimize disruption of the movement of aquatic life.

4.4 Other unusual circumstances that prohibit countersinking shall be evaluated on a case-by-case basis. The Hydraulic Engineer shall submit documentation to the District Environmental Manager, including the cost, engineering factors, and site conditions that prohibit countersinking the culvert, and shall coordinate the evaluation of options to minimize disruption of the movement of aquatic life.

4.5 Proposed culverts that do not include countersinking are subject to environmental agency review and approval and may require additional documentation or evaluation of other alternative measures.