ENERGY DISSIPATERS

Plastic Culvert Overview Flowchart
Structural Defects Flowchart (Plastic)
Bedding Deficiencies Flowchart (Plastic)
Hydraulic Capacity Flowchart (Plastic)

1. SUMMARY

Energy dissipaters reduce the flow velocity in a culvert and thus abrasion related wear of culvert. General types of energy dissipaters include hydraulic jump, forced hydraulic jump, impact, drop structure, stilling well, and riprap.

FHWA's HEC 14 (Thompson and Kilgore, 2006) described various energy dissipaters, including their design, applicability and limitations.

Energy dissipaters can be external (located outside of the culvert barrel) and internal (located within the culvert barrel). Internal dissipaters are intended to form the hydraulic jump within the culvert, thus eliminating costly outlet structures. One type of internal energy dissipaters are circular rings spaced along the pipe at the downstream end (Figure 1), described in HEC 14 (Thompson and Kilgore, 2006), and Wiggert and Erfle (1972).

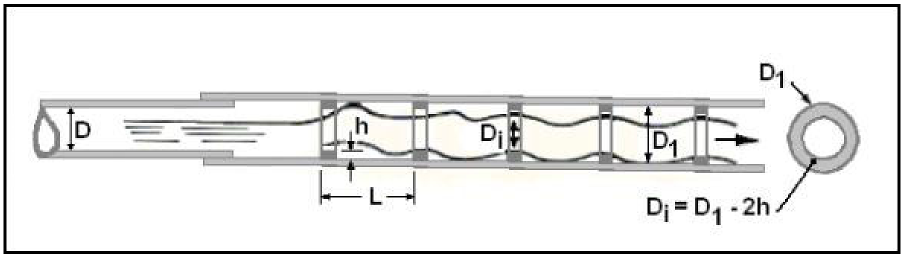

Figure 1 Circular rings inside the barrel (Thompson and Kilgore, 2006)

One type of external energy dissipaters are stilling basins, characterized by some combination of chute blocks, baffle blocks, and sills designed to trigger a hydraulic jump in combination with a required tailwater condition.

Drop structures are commonly used for flow control and energy dissipation. Changing the channel slope from steep to mild, by placing drop structures at intervals along the channel reach, changes a continuous steep slope into a series of gentle slopes and vertical drops. Instead of slowing down and transferring high erosion producing velocities into low non-erosive velocities, drop structures control the slope of the channel in such a way that the high, erosive velocities never develop. A grate or series of rails forming a "grizzly" may be used in conjunction with drop structures. The incoming flow is divided into a number of jets as it passes through the grate (Thompson and Kilgore, 2006).

Stilling wells can be used in channels with moderate to high concentrations of sand or silt and where debris is not a serious problem (Thompson and Kilgore, 2006).

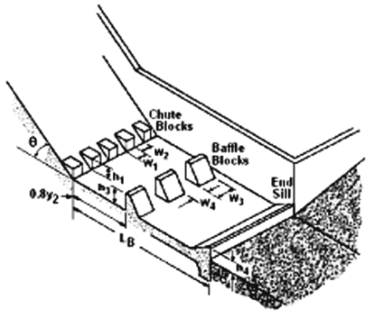

Figure 2. USBR type III stilling basin (Thompson and Kilgore, 2006)

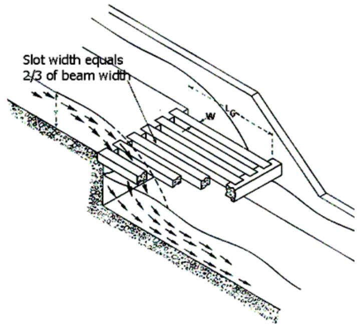

Figure 3. Drop structures (Thompson and Kilgore, 2006)

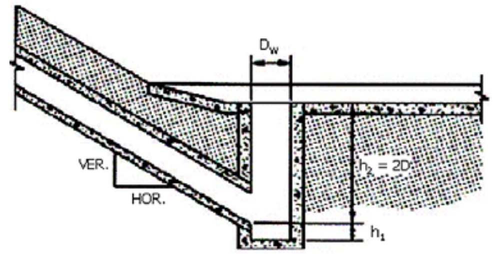

Figure 4. Stilling well (Thompson and Kilgore, 2006)

Riprap basin energy dissipaters can be based on armoring a pre-formed scour hole (Figure 5) or they can be made as riprap aprons that provide a flat armored surface. Both types were developed by U.S. Army Corps of Engineers (Bohan, 1970; Fletcher and Grace, 1972). Riprap energy dissipaters are adaptable to regions where riprap in the required sizes, gradation, and quantity is readily and economically available.

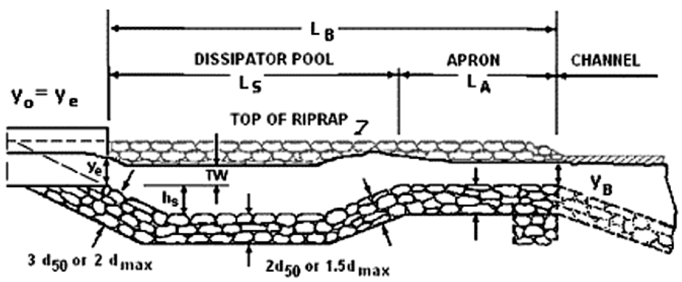

Figure 5. Riprap basin energy dissipators (Thompson and Kilgore, 2006)

Figure 6. Riprap at culvert outlet (Watershed Steward Demonstration Site Examples, downloaded www.livestockandland.org/Demonstration_Sites/pilot_site.html on June 17, 2010)

Limitations for different dissipater types are summarized in Table 1, which can be used to determine what alternative types to consider in particular situations (CDOT, 2004). Various energy dissipaters and stilling basins are described in other publications, e.g., City of Knoxville (2010).

Table 1: Limitations for different energy dissipater types (after CDOT, 2004)

Internal dissipaters	Natural scour holes	External dissipaters	Stilling Basins
▪ The scour hole at the culvert outlet is unacceptable ▪ The right-of-way is limited ▪ Debris is not a problem; and ▪ Moderate velocity reduction is needed	▪ Undermining of the culvert outlet will not occur or it is practicable to be checked by a cutoff wall ▪ The expected scour hole will not cause costly property damage; and ▪ There is no nuisance effect.	▪ The outlet scour hole is not acceptable ▪ Moderate amount of debris is present; and ▪ The culvert outlet velocity is moderate and corresponding Fr < 3.	▪ The outlet scour hole is not acceptable; ▪ Debris is present; and ▪ The culvert outlet velocity is high, and corresponding Fr > 3.•

2. REFERENCES

Bohan, J. P., 1970. *Erosion and Riprap Requirements at Culvert and Storm-Drain Outlets*, Research Report H-70-2, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS, 56p

City of Knoxville, 2010. *Best Management Practices (BMP) Manual*, *Section 3: Erosion and Sediment, 2010*, City of Knoxville, TN, http://www.ci.knoxville.tn.us/engineering/bmp_manual/

CDOT, 2004. *Drainage Design Manual*, Chapter 11: Energy Dissipators, Colorado Department of Transportation, 30p.

Fletcher, B. P., and Grace, J. L., Jr. 1972. *Practical Guidance for Estimating and Controlling Erosion at Culvert Outlets*, Final report, H-72-5, May 1972, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, MS, 45p

Thompson, P.H. and R.T. Kilgore, 2006. *Hydraulic Design of Energy Dissipators for Culverts and Channels, HEC 14*, Third Edition, FHWA-NHI-06-086, July 2006, 286p

Wiggert, J.M. and P.D. Erfle, 1972. "Culvert Velocity Reduction by Internal Energy Dissipators," Concrete Pipe News, Oct. 1972, American Concrete Pipe Association, Arlington, VA, pp. 87-94

Plastic Culvert Overview Flowchart

Structural Defects Flowchart (Plastic)

Bedding Deficiencies Flowchart (Plastic)

Hydraulic Capacity Flowchart (Plastic)