

# Stream crossing design

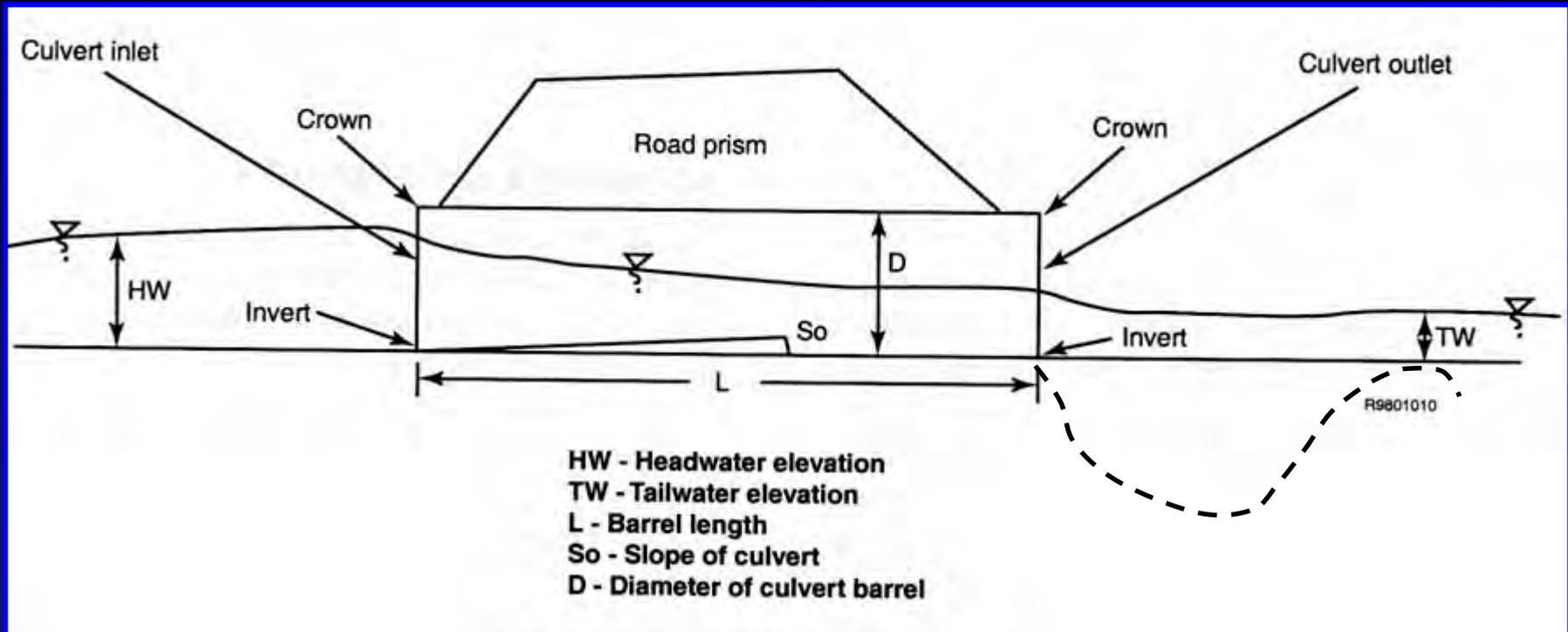


Mark Fedora, hydrologist, Ottawa National Forest  
Dale Higgins, retired, hydrologist, US Forest Service

# Overview

- Culvert Hydraulics
- Culvert Design Methods
- Hydrology
- Site Assessment
- Alignment and Profile
- Bed and Banks
- Structure
- Sediment Mobility and Stability

# Culvert hydraulics terms



- Invert, Headwater (HW), Tailwater (TW)
- Headwater/Depth Ratio (HW/D):  $HW / \text{pipe diameter or depth}$
- Supercritical Flow: high velocity, shallow water
- Subcritical Flow: low velocity, deep water

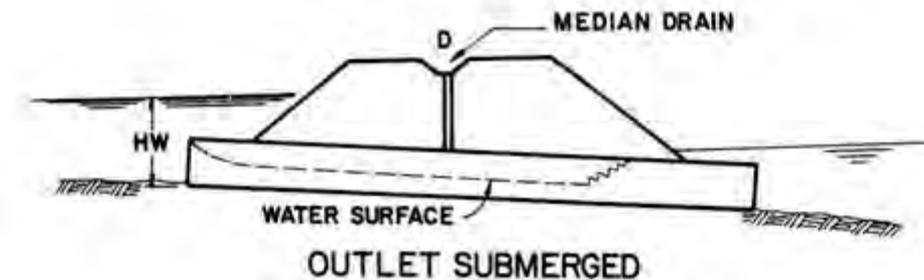
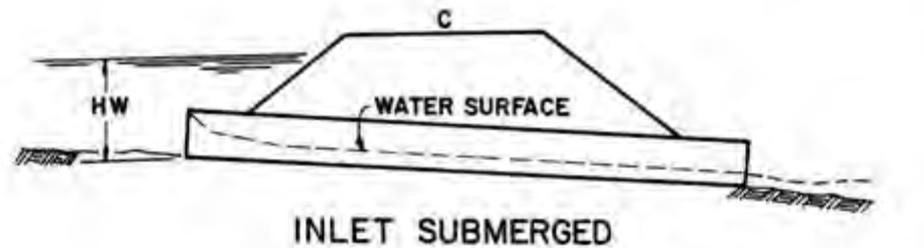
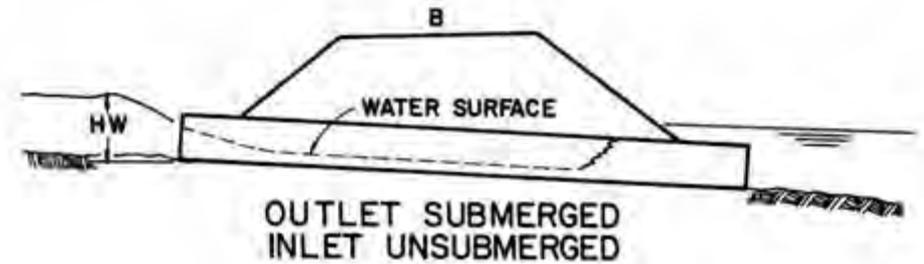
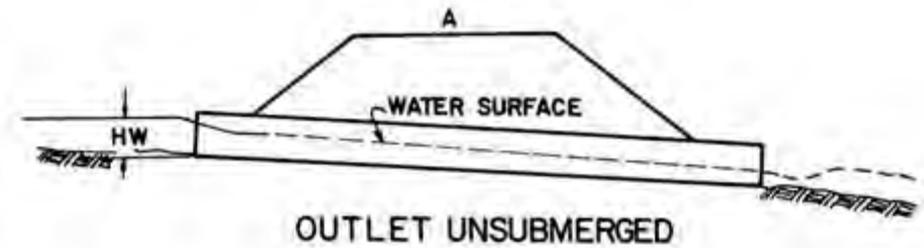
# Inlet control



Culvert geometry at inlet controls flow

- Flow determined by HW elev and inlet characteristics
- Flow in culvert is supercritical
- Culvert can convey more flow than inlet will accept

# Inlet control

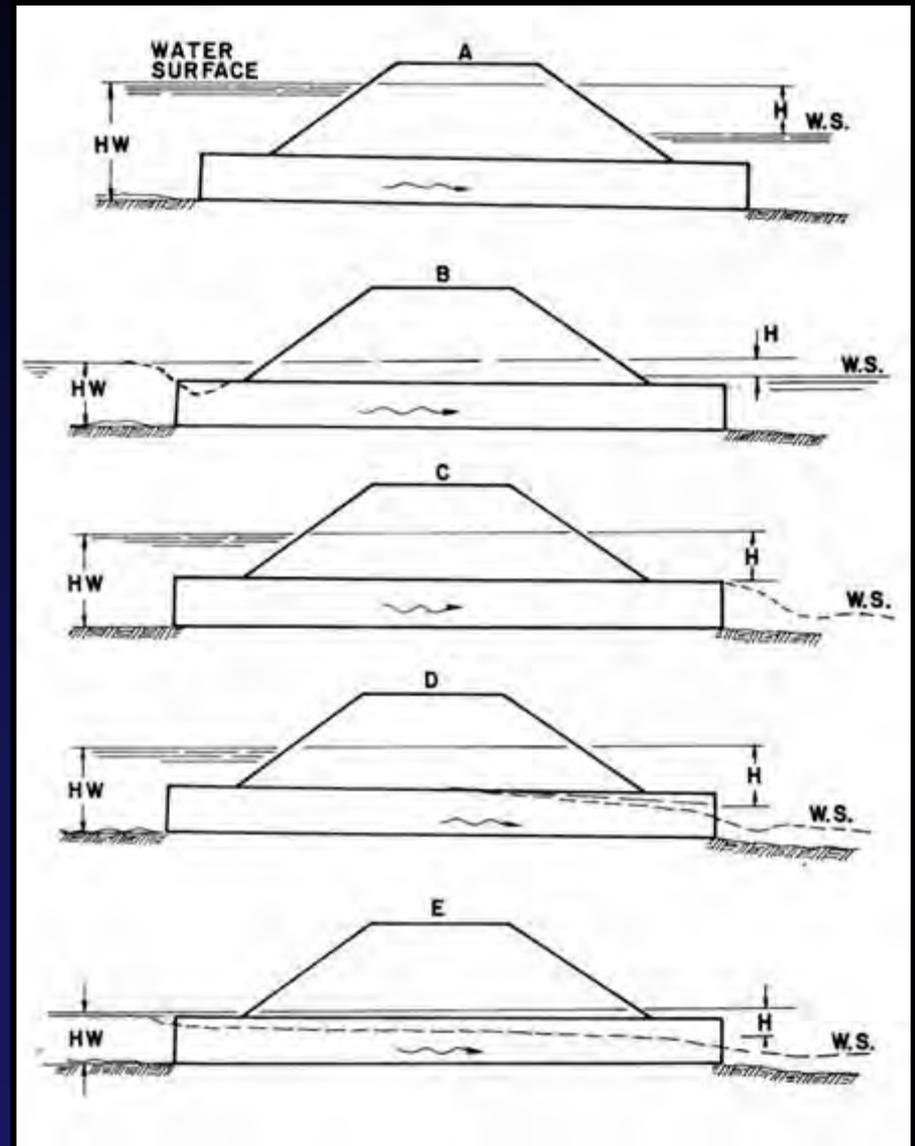


# Outlet control



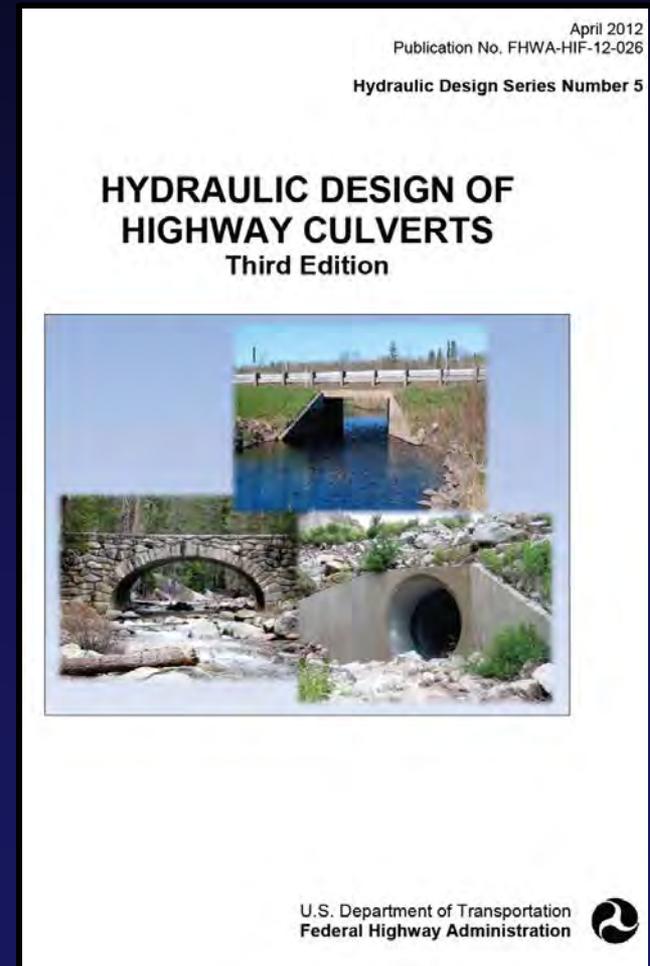
- Tailwater, culvert inlet and barrel characteristics (slope, length, roughness) control flow
- Flow in culvert is subcritical or under pressure
- Culvert inlet can convey more flow than barrel

# Outlet control

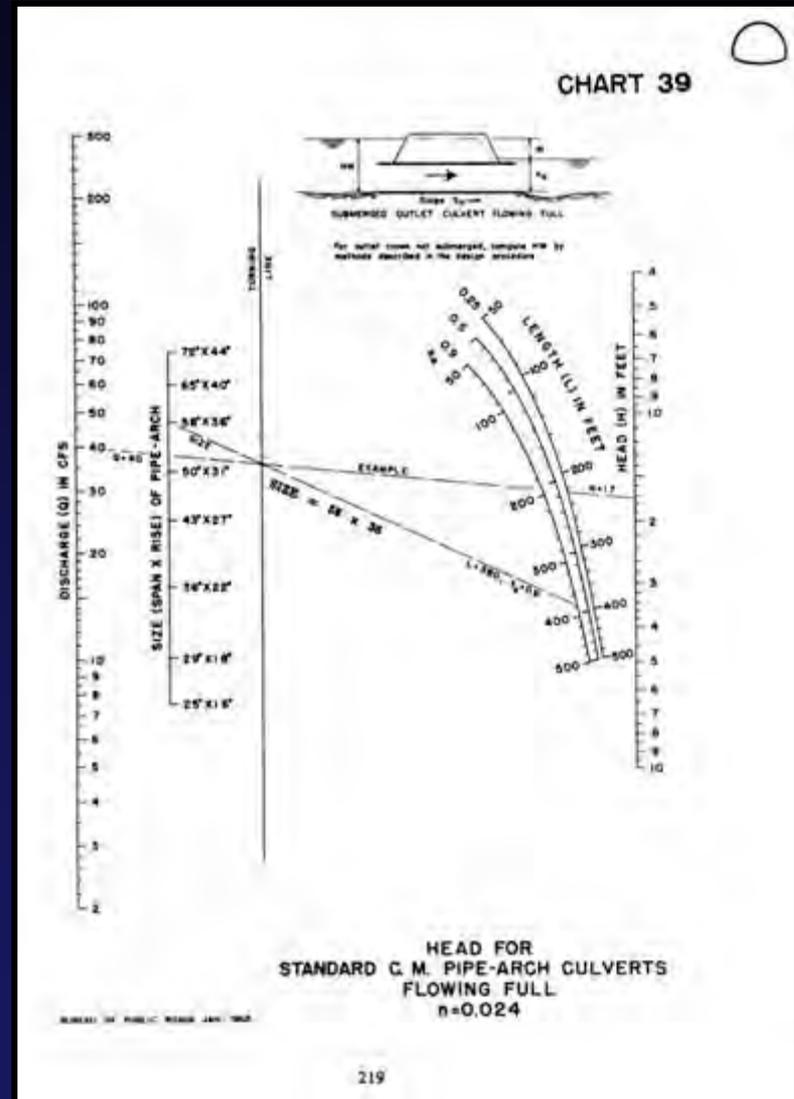
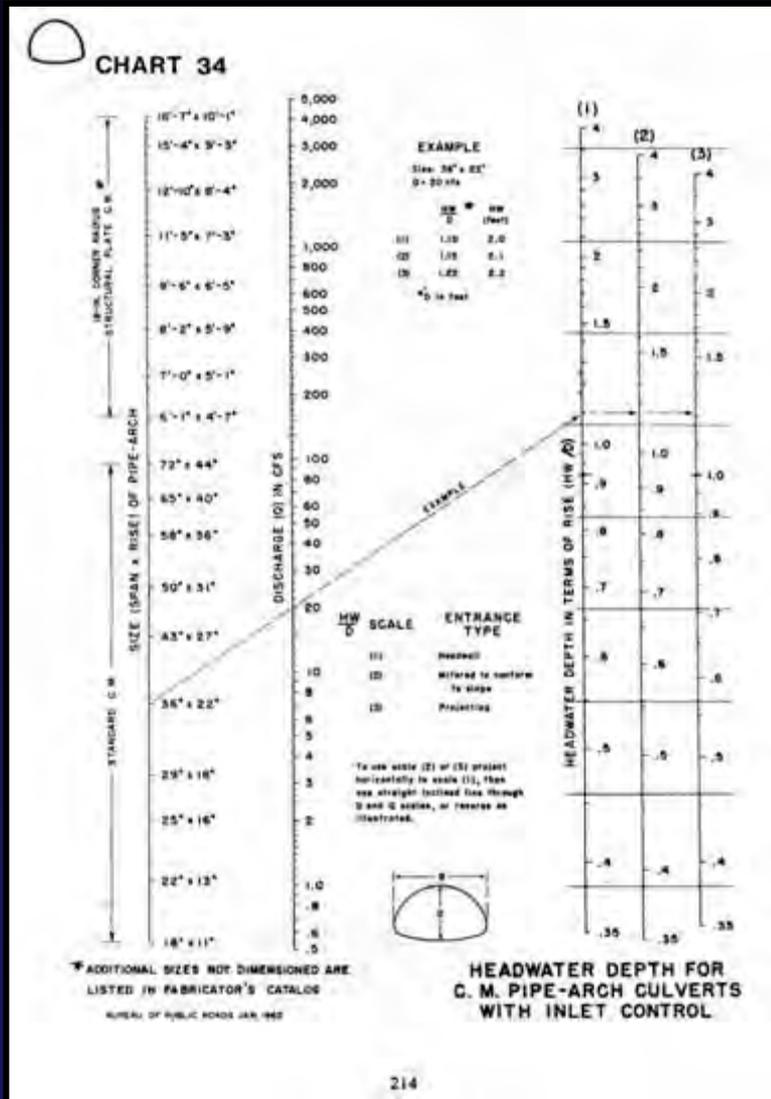


# Hydraulic analyses for culverts

- HDS-5 Nomographs
- Computer Models:
  - HEC-RAS
  - HY-8 FHA
  - HydroCAD



# Hydraulic analyses for culverts



# Hydraulic analyses for culverts

**HEC-RAS 4.0**

File Edit Run View Options Help

Project: Brookside Cr at Brookside Road C:\...\brookside\_cr\_brookside\_rd\HEC-RAS\BrooksideCratBro.prj

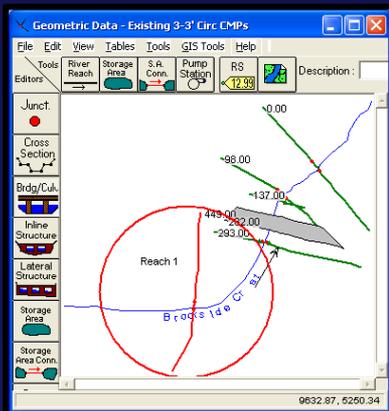
Plan: Existing 3-3' Circ CMPs C:\...\brookside\_cr\_brookside\_rd\HEC-RAS\BrooksideCratBro.p01

Geometry: Existing 3-3' Circ CMPs C:\...\brookside\_cr\_brookside\_rd\HEC-RAS\BrooksideCratBro.g01

Steady Flow: 500-yr, 100-yr, 1.5-yr, Hfpf, Lfpf C:\...\brookside\_cr\_brookside\_rd\HEC-RAS\BrooksideCratBro.f01

Unsteady Flow:

Description: US Customary Units



**Steady Flow Data - 500-yr, 100-yr, 1.5-yr, Hfpf, Lfpf**

Enter/Edit Number of Profiles (25000 max): 5 Reach Boundary Conditions... Apply Data

River: Brookside Cr at Add Multiple...

Reach: Reach 1 River Sta.: 449.00 Add A Flow Change Location

Flow Change Location			Profile Names and Flow Rates				
River	Reach	RS	500-yr (449 cfs)	100-yr (381 cfs)	1.5-yr (78 cfs)	Hfpf (13.7 cfs)	Lfpf (0.2 cfs)
1	Brookside Cr at Reach 1	449.00	474	381	78	19.6	0.2

Edit Steady flow data for the profiles (cfs)

**Steady Flow Analysis**

Plan: Existing 3-3' Circ CMPs Short ID: Existing 3-3' Cir

Geometry File: Existing 3-3' Circ CMPs

Steady Flow File: 500-yr, 100-yr, 1.5-yr, Hfpf, Lfpf

Flow Regime:  
 Subcritical  
 Supercritical  
 Mixed

Plan Description:

COMPUTE

Enter to compute water surface profiles