

Small Structure

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Agenda

- **Definition**
- **Surveys**
- **Serviceability**
- **Sump Requirements**
- **Replacement Options and Sizing**
- **Questions**



Definition

- **Federal Highway Administration (FHWA) – span of 20 ft or less**
(IDM Fig 203-2A)
- **Minimum Pipe Sizes**
(IDM Fig. 203-2B)

Structure Application	Minimum Circular-Pipe Size	Minimum Deformed-Pipe Area
Drive	15 in.	1.1 ft ²
Mainline or Public-Road Approach (2 lanes)	15 in.	1.1 ft ²
Mainline or Public-Road Approach (≥ 3 Lanes)	36 in.	6.7 ft ²



Surveys

- Any PE or LS can provide a relative survey
- Relative Surveys should have a definite “benchmark”
 - Outlet or pavement grade, etc.
- Survey sheet provided on [Hydraulics Website](#) as Field Data Form



Hydraulics Field Data Form (rev. 6/10/16)

Des #: _____

Site Location:

Route: _____ RP: _____ Distance to intersection: _____

Stream Crossing: _____ County: _____

Hydrology Information:

Drainage Area: _____ Discharge: _____ Legal Drain (Y/N) _____

Flow direction: N-S __ S-N __ E-W __ W-E __ (if flow is SE for example, check N-S & W-E)

Culvert Data:

Type: _____ Size: _____ Length: _____

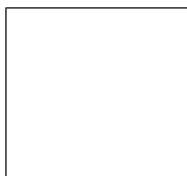
End Treatment: _____ Scour: Outlet _____ Inlet _____

Photos? Yes* _____ No _____ Skew _____

*Photo Sequence: Outlet, Scour, ~~Downstream~~ Area, Highway & Ditches, ~~Upstream~~ Area, Inlet, Inside Pipe, Water level restrictions (i.e. building, crops, and personal property), observed utilities

Field Notes: _____

Attendees: _____



PE sign. _____ Date: _____

*PE is certifying the *field data* collected at the specified site above. Hydrology information is to be determined by the designer.

Field Data: Distance from structure to surveyed cross section _____

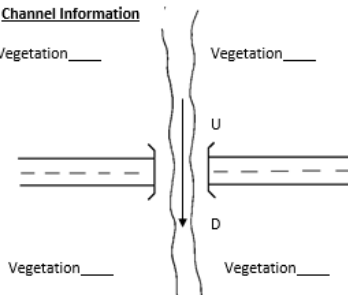
Profile Grade _____ Outlet _____ Inlet _____

Channel Cross Section - Field Survey

Data Points	Tape Distance	Rod Reading	Constraints	Tape Distance	Rod Reading
1			I.E.: Crops,	<i>US Constraints</i>	
2			house,		
3			bridge,		
4			culvert,		
5			parking lot,		
6			barn, shed,		
7			yard,		
8			business,		
9			etc.		
10				<i>DS Constraints</i>	
11			I.E.: Another		
12			culvert,		
13			pond WS,		
14			Scour Hole		
15			Size, etc.		
16					
17					
18					

Channel Information

Vegetation _____

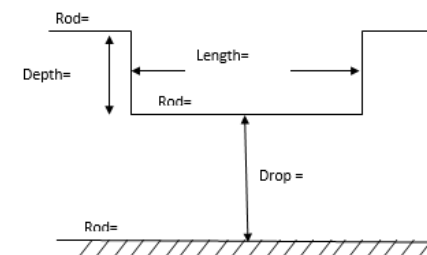


Vegetation _____

Channel n = _____
 Skew = _____
 Culvert Length = _____

Weir Information

US or DS



Surveys

- **Station ruler should be relatively taught for cross section**
- Outside of Scour Hole
- Measure Pipe Sizes
- Inlet and outlet
- Pavement grade
- Upstream structures and restrictions
- Downstream Restrictions
- Weirs and Dams
- Signs of Overtopping



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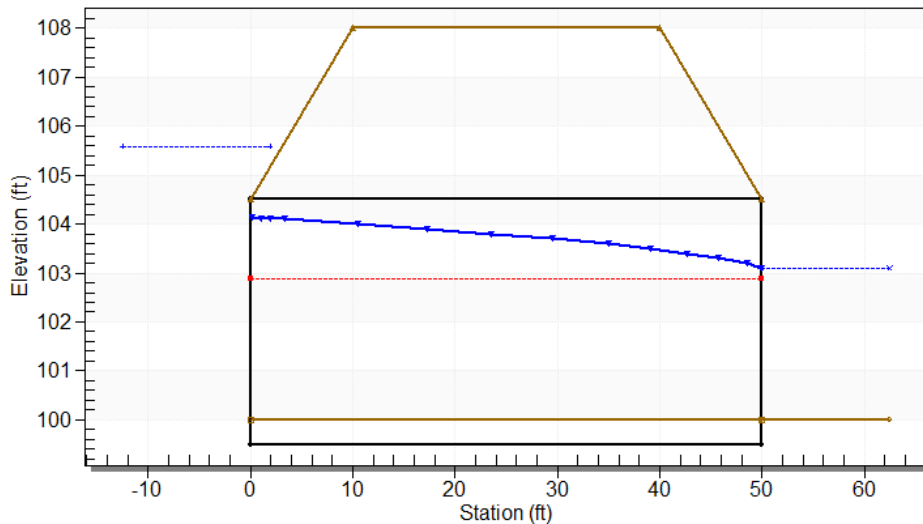
Trapezoidal vs Irregular

- $Q = 125$ cfs
- 2:1 slopes
- 0.0012 channel slope
- $n_{\text{channel}} = 0.035$
 - Woods and crops on outer banks
- 5' cmp w/ 6" sump thin edge
- 8' channel bottom

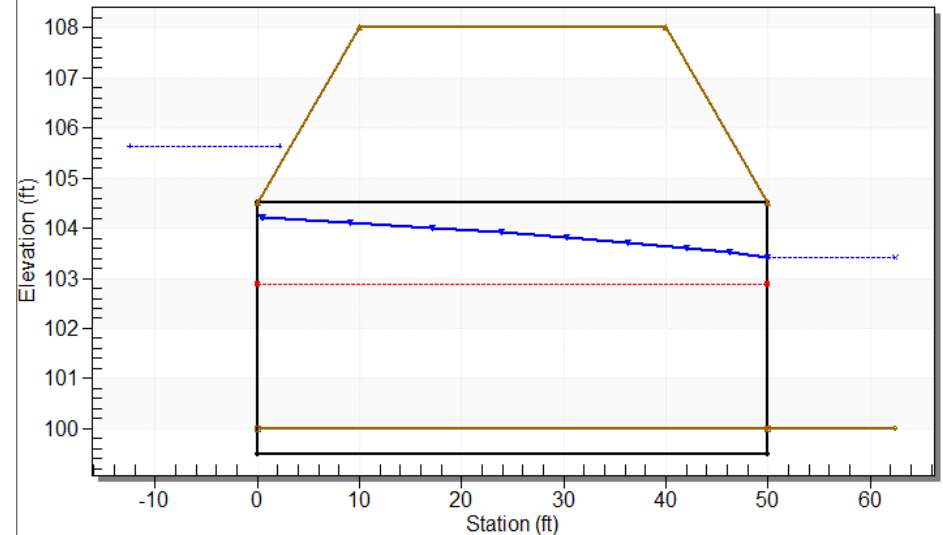


Trapezoidal vs Irregular

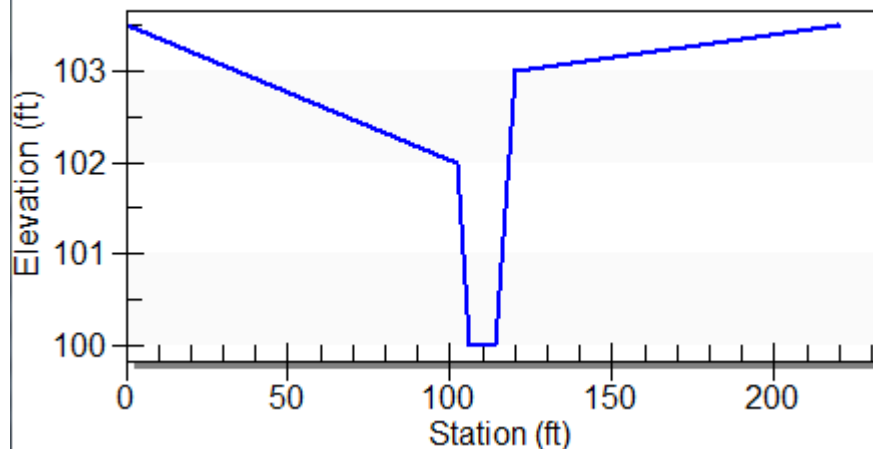
Crossing - Irregular channel, Design Discharge - 125.0 cfs
Culvert - Culvert 1, Culvert Discharge - 125.0 cfs



Crossing - Trapezoidal Channel, Design Discharge - 125.0 cfs
Culvert - Culvert 1, Culvert Discharge - 125.0 cfs



Tailwater/Channel Cross Section



TW depths:

Irreg. = 3.10 ft

Trap. = 3.41 ft

HW elevations

Irreg. = 105.57 ft

Trap. = 105.64 ft

BW depths

Irreg. = 2.47 ft

Trap. = 2.23 ft



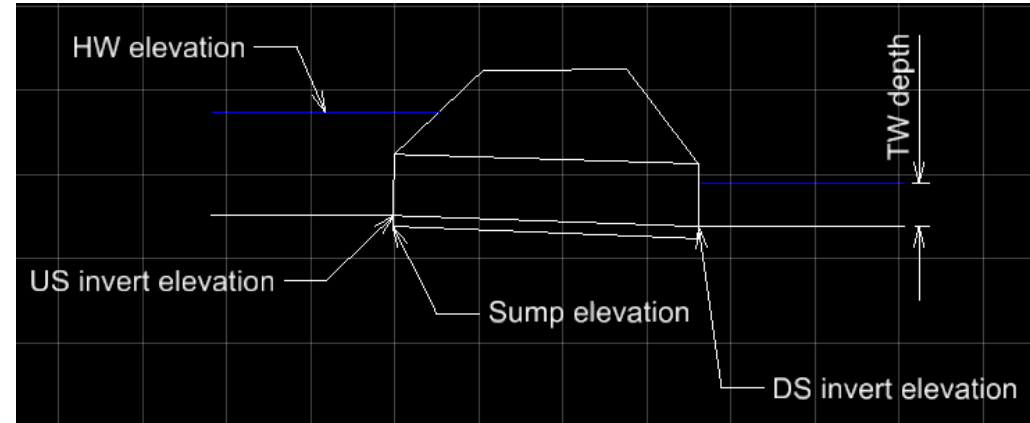
Serviceability

Functional Classification	Allowable Backwater, Annual EP	Roadway Serviceability, Annual EP	Service-ability Freeboard *	Bridge, Allowable Velocity, Annual EP	Culvert, Allowable Velocity, Annual EP
Freeway	1%	1%	2 ft	1%	2%
Ramp	1%	1%	0 ft	1%	2%
Non-Freeway, 4 or More Lanes	1%	1%	2 ft	1%	2%
Two-Lane Facility, AADT > 3000	1%	1%	1 ft	1%	2%
Two-Lane Facility, 1000 < AADT ≤ 3000	1%	4%	0 ft	1%	4%
Two-Lane Facility, AADT ≤ 1000	1%	10%	0 ft	1%	10%
Drive	1%	10%	0 ft	1%	10%



Serviceability

Functional Classification	Allowable Backwater, Annual EP
Freeway	1%
Ramp	1%
Non-Freeway, 4 or More Lanes	1%
Two-Lane Facility, AADT > 3000	1%
Two-Lane Facility, 1000 < AADT ≤ 3000	1%
Two-Lane Facility, AADT ≤ 1000	1%
Drive	1%



$$BW = HW - (US_{\text{invert}} + TW_{\text{exist}})$$

$$BW_{\text{prop}} = BW_{\text{exist}} + (HW_{\text{prop}} - HW_{\text{exist}})$$

Serviceability

Functional Classification	Roadway Serviceability, Annual EP
Freeway	1%
Ramp	1%
Non-Freeway, 4 or More Lanes	1%
Two-Lane Facility, AADT > 3000	1%
Two-Lane Facility, 1000 < AADT ≤ 3000	4%
Two-Lane Facility, AADT ≤ 1000	10%
Drive	10%



Serviceability

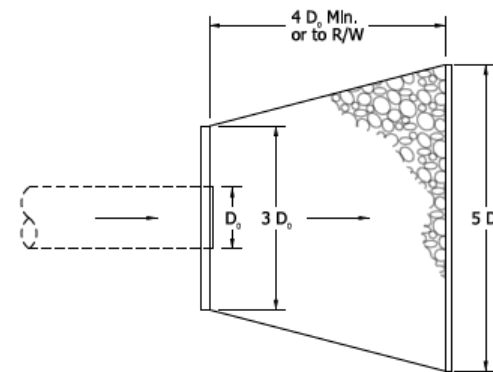
Functional Classification	Service-ability Freeboard *
Freeway	2 ft
Ramp	0 ft
Non-Freeway, 4 or More Lanes	2 ft
Two-Lane Facility, AADT > 3000	1 ft
Two-Lane Facility, 1000 < AADT ≤ 3000	0 ft
Two-Lane Facility, AADT ≤ 1000	0 ft
Drive	0 ft



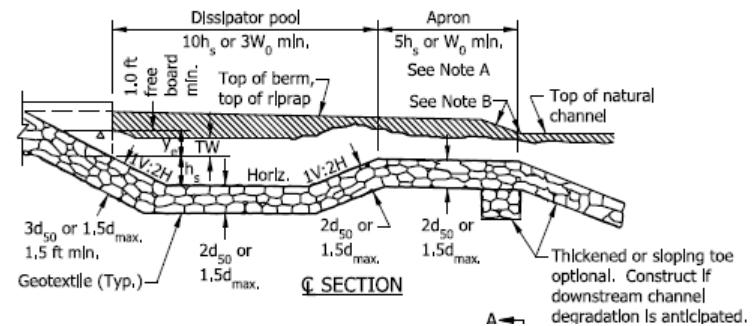
Serviceability

Functional Classification	Culvert, Allowable Velocity, Annual EP
Freeway	2%
Ramp	2%
Non-Freeway, 4 or More Lanes	2%
Two-Lane Facility, AADT > 3000	2%
Two-Lane Facility, 1000 < AADT ≤ 3000	4%
Two-Lane Facility, AADT ≤ 1000	10%
Drive	10%

Erosion-Protection Method	Velocity, v (ft/s)
Revetment Riprap	≤ 6.5
Class 1 Riprap	$6.5 < v < 10$
Class 2 Riprap	$10 \leq v \leq 13$
Energy Dissipator	> 13



D_o = Outside Diameter of structure



Sump Requirements

Structure Diameter or Span, S (ft)	Sump Required for Stream Bed of Sand (in.)	Sump Required for Stream Bed of Other Soil (in.)	Sump Required for Stream Bed of Rock or Till (in.)
< 4	6	3	3
$4 \leq S < 12$	12	6	3
$12 \leq S < 20$	18	12	3

PIPE- OR BOX-STRUCTURE SUMP REQUIREMENT

Figure 203-2E



Pipe Sizing

1. Prefer Circular

- Smooth, Semi-smooth, Corrugated



Pipe Sizing

2. CMPA, R.C. Elliptical, and Box options

- Corrugated Aluminum Boxes = Special Provision



Pipe Sizing



3. Mega Box, 3-Sided Structures, and Arches

- Prefer Single Span Structures
- Open Bottom Metal Arches typically not used

Pipe Sizing

- **Check n-values**
- **Use inner dimensions**
- **Include haunches**
- **Inlet Configurations**
 - Concrete structures get headwall
 - All others are thin edge projecting
 - There are smooth pipes that are metal.
- **Match span and open area of existing**
- **Include more than one option**
- **No Drop at outlet unless designed as such**
- **Channel invert = outlet invert + sump**
- **Use irregular cross sections not trapezoidal**
- **Existing CMPA's should not be modeled as Elliptical**



Questions?

