



## Culvert hydraulics

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# The design process

#### The ideal culvert:

- > Capacity issues (flow, debris)
- > Self cleansing
- > No constrictions/bends
- > Construction and maintenance issues
- > Fish and wildlife issues
- > Safety
- > Appearance



# Some key issues

- > Full range of flows
- > Free or surcharged flow (free flow preferred)
- > Inlet or outlet control
- > Conveyance of sediment, trash and debris
- > Ease of construction
- > Safety and security
- > Ease of operation and maintenance
- > Environmental acceptability



# Culvert design - the parameters

Legend	Performance Criteria													
√ Direct impact														
Indirect impact	Hydrau	lic —		→ Environmental — — —					→ Operational — → Economic					
X Little or no impact					Τ,									
Note: 1. The impact of culvert slope will be dependent on head loss through the culvert	Flood flow capacity	Low flow performance	Flow velocity in culvert	(0	Trash/debris conveyance	Ponding of water u/s	Fish & wildlife migration	Scour of d/s channel	Leaka	Access for inspection	Safe			0
Foundation conditions may impact on these parameters	w сара	erforma	y in cul	Siltation risk	onveya	of water	e migra	l/s char	Leakage (in/out)	inspec	Safety/security	Durability	O&M costs	Capital cost
Design Parameters	city	nce	vert	risk	nce	s/m	tion	nel	out)	tion	ırity	oility	osts	cost
Culvert size	<b>/</b>	0	<b>V</b>	0	<b>V</b>	0	0	0	X	V	0	0	<b>V</b>	✓
Culvert shape (see note 2)	0	<b>V</b>	0	0	0	0	0	0	X	0	0	Х	0	0
Single or multiple barrels (see note 2)	0	V	0	0	V	0	0	0	0	V	0	0	V	0
Invert level(s) (see note 2)	х	0	0	V	0	V	0	V	0	0	0	х	0	0
Slope (see note 1)	0	0	<b>V</b>	V	0	0	V	<b>V</b>	x	0	0	x	0	0
Freeboard above design flood level	0	X	X	X	V	x	X	Х	x	0	0	х	0	✓
Provision of trash screen	<b>V</b>	0	X	0	<b>V</b>	0	<b>V</b>	х	X	1	V	X	V	V
Provision of security screen(s)	0	0	x	0	V	0	V	x	Х	V	1	X	0	V
Construction materials	х	Х	Х	X	X	X	X	х	V	X	0	V	V	/
Construction method (see note 2)	х	х	х	Х	X	Х	X	x	0	х	X	0	0	V



## Methodology

- > Data collection
- > Boundary conditions (flow and downstream water level)
- > Conceptual design
- > Detailed design
- > Detailing

#### **CULVERT DESIGN PROCEDURE** Stage 1 Collect design Data collection and data conceptual design Conceptual design Stage 2 Calculate flow Boundary conditions rate Calculate tailwater level Stage 3 Main analysis Surcharged design (If free flow is Free flow design not possible) Select culvert size Stage 4 **Detailed design** Detailing Section 6.7

Outline design procedure for new culverts

## PROCEDURE FOR ASSESSING THE **CAPACITY OF EXISTING CULVERTS** Stage 1 Collect site Data assembly data Initial flow estimate Calculate tailwater depth Stage 2 Main analysis Surcharged flow Free flow analysis analysis **Culvert capacity**

Outline design procedure for assessing existing culverts



# Outline (conceptual) design

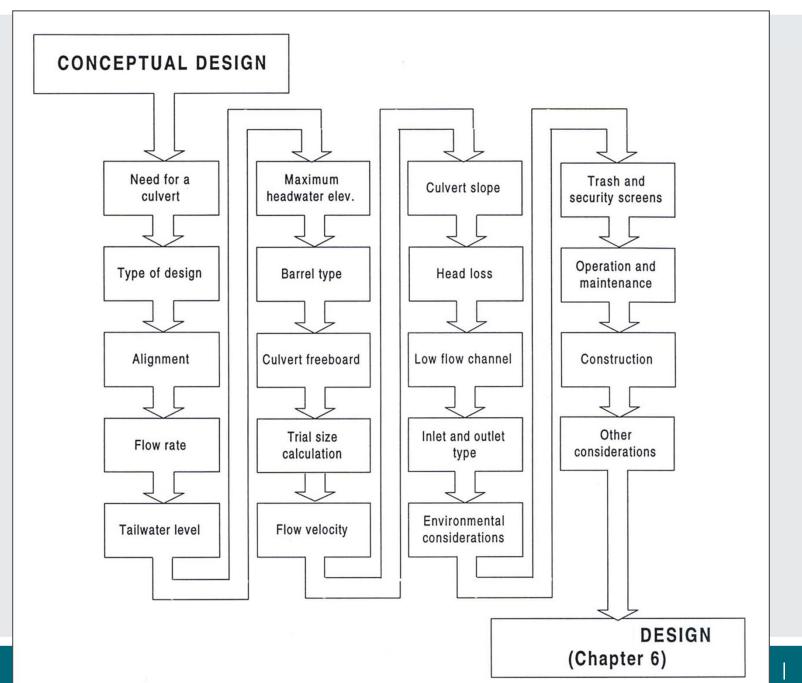
# Identification of all constraints Sketch design

Leading dimensions and levels

#### **Estimates of:**

- > barrel dimensions
- > design flow
- > tailwater & headwater elevations
- > inlet & outlet invert levels
- > other requirements (screens, maintenance, etc)









# Any questions?

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