Culvert components and good design practice

- Culvert barrel
- Inlet structure
- Outlet structure
- Other design considerations
> Materials and types

> Constant cross-section and avoid obstructions, bends, etc

> Reasons for selecting single or multiple barrels

> Depress invert below bed level

> Sediment management

> Environmental considerations (fish, wildlife, amenity value)

> Operation and maintenance (access, desilting, etc)
Typical culvert?
<table>
<thead>
<tr>
<th>TYPE</th>
<th>SHAPE</th>
<th>MATERIALS</th>
<th>SIZE RANGE (dia or B x D) in metres</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>MINIMUM</td>
</tr>
<tr>
<td>Pipe</td>
<td></td>
<td>Concrete</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Corrugated Steel</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Plastic</td>
<td>0.45(1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other</td>
<td>n/a</td>
</tr>
<tr>
<td>Box</td>
<td></td>
<td>Pre-cast concrete</td>
<td>1.0 x 0.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>In-situ concrete</td>
<td>See notes (2) and (6)</td>
</tr>
<tr>
<td>Arch</td>
<td></td>
<td>Corrugated steel</td>
<td>1.8 x 0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Brick/Masonry/Concrete</td>
<td>B&gt;1.5</td>
</tr>
<tr>
<td>Pipe arch</td>
<td></td>
<td>Corrugated Steel (3)</td>
<td>0.8 x 0.6</td>
</tr>
<tr>
<td>Complex</td>
<td></td>
<td>In-situ concrete</td>
<td>See note (2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pre-cast with in-situ addition(4)</td>
<td></td>
</tr>
</tbody>
</table>

Notes:

(1) Minimum recommended diameter for any culvert.
(2) In-situ concrete minimum sizes limited by construction practicalities.
(3) Corrugated steel structures are available in a wide range of shapes and sizes.
(4) Pre-cast units are often supplied with features, such as low flow channel, incorporated.
(5) All shapes can be used in combination to form a multi-barrelled structure (see section 4.12).
(6) Standard culverts can be tall and narrow as well as short and wide (B<D) although this does not match channel hydraulics well.

Figure 4.3 Culvert barrel size range
<table>
<thead>
<tr>
<th>Criteria</th>
<th>Plastic Pipe</th>
<th>Concrete Pipe</th>
<th>Concrete Box</th>
<th>Corrugated Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small temporary structures</td>
<td></td>
<td>○</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Aggressive groundwater conditions</td>
<td>○</td>
<td>●</td>
<td>●</td>
<td>○</td>
</tr>
<tr>
<td>Low headroom</td>
<td>○</td>
<td>○</td>
<td>●</td>
<td>○</td>
</tr>
<tr>
<td>Steep streams carrying heavy loads of coarse sediment</td>
<td>X</td>
<td>○</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Rapid construction important</td>
<td>●</td>
<td>●</td>
<td>X</td>
<td>●</td>
</tr>
<tr>
<td>Long term durability paramount</td>
<td>X</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Multiple barrels required</td>
<td>○</td>
<td>○</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Low costs very important (large culvert)</td>
<td>X</td>
<td>○</td>
<td>○</td>
<td>●</td>
</tr>
<tr>
<td>Low costs very important (small culvert)</td>
<td>●</td>
<td>●</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Thrust boring/jacking required</td>
<td>X</td>
<td>●</td>
<td>X</td>
<td>●</td>
</tr>
</tbody>
</table>

**Legend**
- ● Good/appropriate
- ○ May be appropriate
- X Do not use/not applicable

**Notes:**
1. Will require additional protection of invert.
2. Costs will increase if large volumes of material have to be imported to develop soil/pipe interaction.

**Figure 4.6** Culvert selection checklist
Single barrel generally preferred, but multiple barrels offer the following advantages:

- Low flow channel can be provided
- Lower headroom possible
- Inspection and maintenance easier
- Wildlife migration route
- Better hydraulic performance
Twin barrels
Figure 4.4  Culvert barrel options (not to scale)

(a) Pipe

(b) Box

Note
Bed of culvert can be lined with gravel to improve the aquatic environment in low flows

(c) Pipe arch (corrugated steel)

Note
The invert up to the normal flow waterline can be concrete lined to provide erosion resistance and/or form a low flow channel

(d) Multiple barrels

Ledge for wildlife/pedestrian/maintenance access

Flood flow
Moderate flow
Low flow
Wildlife provision
Why is an inlet structure needed?

- Provide smooth transition into culvert
- Accommodate scour
- Facilitate installation of trash or security screens
- House monitoring devices
- Accommodate bed level drop
- Facilitate maintenance (e.g., stoplog grooves)
- Maintain upstream water levels
- Possible need for a sediment trap upstream
Why is an inlet structure needed?
Figure 4.10 Basic inlet/outlet options (continued over)
Inlet structure
Inlet screen

> Exclude trash or prevent unauthorised access
> Avoid wherever possible (risk of blockage)
> Large smooth straight culvert preferred
> Recommendations for screen design
Drawing X.05 TRASH SCREEN OR SECURITY SCREEN

FOR FURTHER DETAILS REFER TO DRAWING X.06
Trash screens
Trash screens
Trash screens
Why is an outlet structure needed?

> Provide a transition to the channel downstream

> Energy dissipation

> Erosion prevention

> Flap gates

> Security screen
Any questions?

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