

Culvert Inspection and Ratings

Culvert Inspection and Rating



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Culvert Inspection and Ratings

Introduction

- Bridge sized culverts have an equivalent diameter of 1500mm or greater
- Bridge site that requires a 1500 mm pipe due to hydraulic discharge
- Will routinely inspect smaller culverts if there are several (low level crossing)
- May also inspect if multiple small culverts are equivalent in hydraulic capacity to bridge-sized (2-1200mm)
- May inspect certain other non-bridge sized culverts (3 - 900mm)



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Introduction

- Many different types of culverts – refer to Table 1.1 in Manual
- Vast majority are CSP or SPCSP in various shapes - round, arch pipe, horizontal ellipse
- Three culvert forms (Cul1, CulE, CulM)
- Same forms used for all types of culverts
- Timber pipe (TP) culverts exception
 - Use TT form



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Form Types

- CUL1
 - Single culvert or single culvert extended with same material and size
- CULM
 - Two or more culverts (MP, SP or BP etc.)
 - Includes 1 Upstream & 1 Downstream End section for each Barrel section
 - Exception is Concrete Boxes (BP) where single U/S and single D/S sections for all barrel sections
 - Includes 2 cell box extended with single steel
- CULE
 - Single culvert extended with different material and/or size
 - One Upstream & Downstream section, Barrel sections for all cells and/or pipes



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Inventory Information

Bridge Culvert Information								
Pipe #	Barrel	Span	Rise (or Dia.)	Type	Length	Corr. Profile	PI/Slab Thickness	Shape
1	MAIN	1800		MP	33	125X26	2.8	ROUND
Special Features Comment								

- Extracted from BIS
- Span/rise is original design shape
- If round then only rise is recorded
- Span types – refer to Table 1.1 and Sec. 13.2.3
- Corrugation Profile and Plate Thickness selected from Table 13.1 and 13.2 (p.13.5 in manual)
- Specific information is provided for all pipes
 - a culvert extended with same material and size is considered to be one culvert (Cul1)




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Culvert Span Types



March 3, 2008

FORM TYPE	DESCRIPTION	SPAN TYPE
TH	Through Trusses	TH
PT	Flange Trusses	PT
RS	Roller Beams	RS/RC
RS	Riveted Plate Girders	RG
RS	Welded Girders	WG
RS	Steel Rigid Frames	RF
OS	Other Trusses & Arches	OS/SS/ISA/SSS/SF/SSC
DT	Deck Trusses	DT
TT	All Timber Bridges	TT/UT/AT/TP
PCB	Standard Precast Bridges	HE/HG/UN/PQ/GK/FE/PA/PS/MM/HCO/RGO/HND/PA/PCS/PE/VE/DM/SAC/SC/SCC/SMD/VSD/SCM/SL/SLC
PSR	Regular Prestress Bridge	PG/PC/UF/PM/MM/PE/DE/FG/PQ/PMD/DM/LP/PM/SM/PJ/NJ/CBT/DNC/CRG/PCD/PO
CCB	All Cast in Place Concrete Bridge	CA/CB/CF/CP/CK/CC/CCP
CCB	Corrosion Free Steel Bridges	CS
CUL 1	Single Culverts	SP/SF/SM/SR/SR/CP/SP/AP/SR/MS
CUL 2	Multiple Culverts	RFB/CFA/CPE/SPE
CUL 3	Culverts extended with different material and/or size	PCB/RFA/RS/RSR/SRS/SCA/SCS/SCP/SPF/SRA/SRA/MS
SD2	Span-Through Bridges	S
THFT	Through Trusses with Timber Approaches	
THPCS	Through Trusses with Standard Precast Approaches	
THPSR	Through Trusses with Regular Precast Approaches	
THSG	Through Trusses with Steel Girder Approaches	
THFT	Through Trusses with Flange Truss Approaches	
PTFT	Flange Trusses with Timber Approaches	
PTPCS	Flange Trusses with Standard Precast Approaches	
SGTT	Steel Beams with Timber Approaches	
SGPCS	Steel Beams with Standard Precast Approaches	
PSRPCS	Regular Prestress with Standard Precast Approaches	
SSSG	Special Steel with Steel Girder Approaches	
DTSG	Deck Truss with Steel Girder Approaches	

Table 1.1 - BIM Report Index




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Numbering and Identification

- Where the culvert does not carry flow determine “upstream” and “downstream”
 - Look in direction of increasing chainage
 - (to north or east)
 - Left is “upstream” (end 1)
 - Right is “downstream” (end 2)
 - Keep same choice for each subsequent inspection

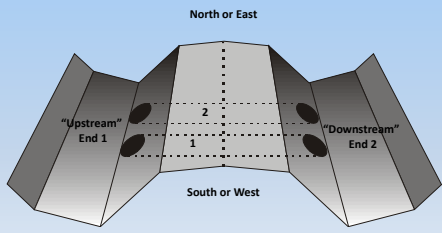



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Numbering and Identification






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Numbering and Identification

- Primary span is the largest span at the site
- Secondary span is the smaller span
- Multiple culverts of same dimension are numbered in order of increasing chainage (from south to north or west to east)
- Multiple culverts also have same Ring numbering system (R1, R2, R3, etc.)




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Ends - General

- Individual rating sections for the Upstream and Downstream ends
- Single upstream and downstream end sections for the CUL1, CULE forms
- Separate Upstream and Downstream ends for each Barrel section on CULM forms - except Concrete Boxes
- Upstream and Downstream sections are identical
- Items are inspected and rated the same way for both ends




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Ends - General

Culvert Component	Downstream End		
	Last	Now	Explanation of Condition
Direction	S		
End Treatment (Concrete, Steel, Others, None)	STEEL		
Headwall	X	X	
Collar	X	X	
Wingwalls	X	X	
(Shape :)			
Cutoff Wall	X	X	
Bevel End		8	8
Heaving (mm)	0		
Invert Above/Below Stream Bed	BELOW		
Above/Below (mm)	200		
Scour Protection		8	8
(Type : RIP RAP)			
(Avg. Rock Size(mm) : 300)			
Scour/Erosion		8	8
Beavers (Y/N)	No		
Downstream End General Rating		8	8




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Ends - End Treatment

- Purpose:
 - Improve aesthetics
 - Improve hydraulic performance
 - Prevent undermining due to scour
 - Prevent scour of the embankment
 - Reduce piping along or under the culvert
 - Resist uplift due to buoyancy forces
 - Shorten the culvert
 - Stiffen the ends



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End Treatment -Types

- Steel:
 - Most common
 - Bevel end with no concrete treatment
- Concrete
 - Presence of any or all of: Headwall, Collar, Wingwall, Cutoff Wall
- Other
 - Timber Culvert with Timber End Treatment
- None
 - Square end – no Bevel present

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Bevel Ends – End Treatment Type is “Steel”



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Bevel Ends with Full Concrete End Treatment - Type is “Concrete”



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Bevel End with Full Concrete End Treatment - Type is “Concrete”




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End Treatment - Headwall

Culvert Component	Downstream End		
	Last	Now	Explanation of Condition
Headwall			

- Located over the crown
- Usually attached to the barrel
- Purpose:
 - Aesthetics
 - Strengthen end
 - Resist buoyancy force
 - Retaining walls




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End Treatment - Headwall

- Look for:
 - Signs of movement or tilting
 - Loose connections
- Rate according to condition of material and functionality of component
- Condition affecting functionality rate 4 or less



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End Treatment - Collar / Slope Protection

Culvert Component	Downstream End		
	Last	Now	Explanation of Condition
Collar/Concrete Slope Protection			

- Located along the beveled slopes of flexible culverts between headwall and cutoff wall
- Usually constructed from concrete
- Usually used with and connected to headwall and cutoff walls
 - May be used alone




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End Treatment - Collar / Slope Protection

- Purpose:
 - Aesthetics
 - Stiffen the bevel
 - Resist buoyancy force
 - Improve hydraulic efficiency of end
 - protect against scour / erosion
 - reduces piping potential
 - Concrete slope protection




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End Treatment - Collar / Slope Protection

- Look for:
 - Evidence of piping or scour / erosion
 - Loose connections
 - Voids underneath or settlement
- Rate according to condition of material and functionality of component
- If piping, rate 4 or less:
 - Also rated under bevel end and barrel



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End Treatment - Wingwalls

Wingwalls	5	5	Both wings pushing towards streambed. North wall is 100 mm at top and 65 mm away from barrel worst of all four corners.
<small>(Shape: FLARE)</small>			

- Generally found at culverts that do not have bevels
- Shape is either Parallel or Flared to culvert axis
- Main difference from Bevel is Wingwall is not attached to the barrel
- Usually constructed from concrete or steel
- Purpose
 - Improve hydraulic efficiency
 - Retain embankment fill




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End Treatment - Wingwalls

- Record Shape as “Parallel” or “Flare” (to culvert axis)
 - Parallel wingwall
 - Req’ less scour protection between walls
 - Flared wingwalls
 - more hydraulic efficient
- May have a reinforced concrete slab between
 - Prevents undermining of wingwalls due to scour
 - Act as struts for greater stability
 - If present rate with wingwalls




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End Treatment - Wingwalls

- Look for:
 - Evidence of movement
 - Loose connections (gap at barrel)
 - Scour / erosion at toe or behind wingwall
- If wingwall is unstable rate 4 or less
- Separation losing fill rate 4 or less
- Includes rating of wingwall floor slab





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End Treatment – Flared Wingwalls





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End Treatment - Cutoff Wall

Culvert Component	Downstream End		
	Last	Now	Explanation of Condition
Cutoff Wall			

- Located at the end of the culvert
- Vertical wall extending down below the bottom of the culvert
- Depth exceeds the depth of the riprap or concrete apron
- Usually constructed from concrete or steel
- Purpose:
 - Reduce potential for undermining of end of culvert
 - Minimize possibility of piping
 - Resist buoyancy force




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End Treatment - Cutoff Wall

- Look for evidence of:
 - Undermining
 - Piping
 - Uplift
 - Loose connections
- Usually not possible to inspect since they are submerged or covered with ice or debris
 - If not visible rate “N”
 - If certain not present rate “X”
- If piping, rate 4 or less
 - May also affect Bevel End and Barrel Rating



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Ends - Bevel End

Culvert Component	Downstream End		Explanation of Condition
	Last	Now	
Bevel End			
Heaving (mm)			
Invert Above/Below Stream Bed			
Above/Below (mm)			

- Sloped section at the end of the culvert
- Permanently attached to the barrel
- Generally parallel to the culvert axis
- Bevel types
 - Full bevel
 - Step bevel



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Ends - Bevel End

- Compared to projecting ends, bevel ends are more:
 - Aesthetic
 - Economical
 - Hydraulically efficient
- Compared to projecting ends, bevel ends on corrugated steel culverts are more flexible and susceptible to:
 - Deform due to lateral earth pressure
 - Uplift due to buoyancy
 - Heave due to frost action



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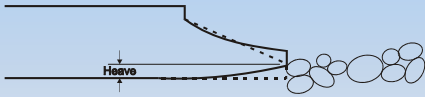


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Ends - Bevel End


- Measure or estimate heaving of bevel and record amount



- Often best place to estimate is from inside barrel looking back to Bevel
- Use waterline as level
- Some heave is tolerable as long as water is entering Bevel



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Ends - Bevel End

- If possible, measure or estimate height above or depth below streambed and record amount in mm. (may not be able to measure or confirm measurements in high water or winter).
- Normally "Below" as designed to be buried ¼ diameter below streambed.
- If invert is "at streambed" record Above/Below as 0mm.
- Find a representative natural streambed location
 - Discount presence of localized scour hole or deposits (aggrading) at end of culvert



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Ends - Bevel End

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Ends - Bevel End

- Look for:
 - Piping
 - Deformation
 - Impact damage
 - Corrosion that affect strength
 - Abrasion
- If piping, rate 4 or less
 - Also rated under End Treatment if present
- Defects/deformations not affecting function rate 6 or less (un-supported bevel - no heave)
- Severe corrosion affecting strength (perforations) rate 4 or less – otherwise corrossions should not affect rating
- If no bevel, rate “X”
 - Underpasses often have square ends

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Ends - Bevel End

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Ends - Scour Protection

Scour Protection	8	
(Type : RIP RAP)		
(Avg. Rock Size(mm) : 600)		

- Usually heavy rock riprap
- The current version of Std. Drawing S-1418 shows the minimum requirements for riprap
 - Coverage
 - Size
 - Minimum thickness
 - Gradation
- <http://www.transportation.alberta.ca/index.htm>


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Ends - Scour Protection

- Purpose is to prevent scour and erosion at culvert ends which may:
 - Undermine the culvert
 - Undermine the sideslopes
 - Cause the formation of sand bars




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Ends - Scour Protection

- Record the type of Scour Protection
 - If none exists and none is required, record type as “NATURAL”
 - If none exists and some is required, record type as “NONE”
- Estimate and record the average size (rock only)
- Look for:
 - Durability of riprap - e.g. sandstone is not acceptable
 - Shape – flat rocks not desirable
 - Displacement or movement
 - Scour
 - Current standards on S- 1418




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Ends - Scour Protection Ratings

- No scour/erosion or displacement rate 7 or more
- If none exists and none is required record type as “NATURAL” and rate 7 or more
- If none exists but is required record type as “NONE” and rate 4 or less (also make recommendation)
- Generally not rated higher than Scour rating – especially when Scour is 4 or less
- Protected area is smaller than required or rock gradation or quality is inadequate rate 4 or less
- Concrete protection with excessive settlement or undermining rate 4 or less
- Cattlepasses that handle drainage rate – otherwise X



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Ends - Scour / Erosion

Culvert Component	Downstream End		
	Last	Now	Explanation of Condition
Scour/Erosion			

- Removal of material from the streambed, banks or sideslopes by the action of flowing water and/or constrictions or obstructions (refer to Section 16.2 in manual).
- Effects:
 - Undermine the culvert
 - Undermine the sideslopes
 - Impede fish passage
 - Alter culvert hydraulics




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Ends - Scour / Erosion

- Two types:
 - General – uniform lowering of original stream
 - Local – occurring at specific locations
- Look for:
 - Scour holes, especially at downstream ends
 - Undermining of culvert end or sideslopes
 - Slumping of sideslope or banks
 - Areas where flow impinges on banks, sideslopes or protection systems
 - Areas susceptible to high velocities and undermining
 - culvert footings
 - ends or bottoms of wingwalls and cutoff walls
 - sides of collars
 - ends or bottoms of ends of protection systems



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Ends - Scour / Erosion

- Rate the presence and extent of scour and adverse effects on culvert, embankment, streambed and banks
- If culvert and embankment are not affected, rate 5 or more
- Scour/erosion affecting culvert, rate 4 or less




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Ends - Scour / Erosion






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Ends - Scour / Erosion





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Ends - Beaver Activity

	Structure Usage		Explanation of Condition
	Last	Now	
Channel (U/S and D/S)	5	5	
Alignment			
Bank Stability	5	5	
HWM (m below Top of Culvert)			(High water 1.2m above streambed @ outlet.) No visible HWM.
Drift (Y/N)	Yes		Drift on floor of R1-R4
Channel Bottom Degradation/Regrading		DEGRADING	
Beavers (Y/N)	Yes		At D/S only Beavers at both U/S and D/S
(Fish Compensation Measure 1 : NONE)			
(Fish Compensation Measure 2 : NONE)			
Channel General Rating	5	5	

- Beavers frequently construct dams at inlet or inside culverts
- Effects:
 - reduced flow capacity
 - Flooding upstream
 - Scour
 - Ponding of water inside culverts preventing inspection




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Ends - Beaver Activity

- Indicate the presence of beaver dams in or near the culvert by **Yes** or **No**
- If “yes”, provide comment
- No rating required but may affect
 - End General Rating
 - Scour
 - Waterway Adequacy in Barrel section




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Ends - General Rating

- Governing elements: (Refer to 1.10.7 & 13.5.10)
 - Headwall
 - Collar
 - Wingwall
 - Cutoff Wall
 - Bevel end
 - Scour protection
 - If all are rated “X” then provide rating based on general condition of culvert end




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Barrel - Rigid Types

- Made from concrete or timber
- Designed to carry loads without deflection (Rise and Span measurements normally not necessary).
- Culvert carries entire load with no reliance on surrounding fill for support.
- Generally more expensive but more durable, last longer and require less structural maintenance.




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Barrel - Flexible Types

- Made from corrugated steel
- Low strength
- Dependent on surrounding backfill for support
- Culvert deflects under load until the backfill picks up the stress
- Entire load carrying system cannot be inspected directly (I.e. can inspect culvert but not backfill)
- Flexible culverts more susceptible to failure by:
 - Change in shape due to excessive deflection
 - Defective joints - cracks, open joints, cusped seams, etc.
 - Severe corrosion
 - Uplift of ends due to buoyancy forces




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Bridge Culvert Barrel			
Culvert Component	Last	Now	Explanation of Condition
<i>Pipe # : 1, Primary Span, Location Code: MAIN, Span (mm): 2325, Rise (mm): 2644, Type: SPE</i>			
Barrel Last Accessible Date	06-Jul-2015		Plates from bottom are 6N, 5N, 5N, 6N.
Special Features			
Special Feature	7	7	Struts installed in 1997. 3.5 heavy wall steel struts on 6" x 6" TT.
(Type - VERT STEEL STRUTS)			
Special Feature		X	
(Type -)			
Roof			
Measured Rise (mm)	2170	3	Rating due to deflection.
Measured At Ring No.	9		
Sag (mm)	374		
Percent Sag	15		
Sidewall			
Measured Span (mm)	2670	2	Where bolted correctly sidewalls are crimping & cracked @ R11, 13, 15.
Measured At Ring No.	9		Cracked seams.
Deflection (mm)	345		
Percent Deflection	15		
Floor			
Bulge (mm)	200	4	(Rating due to floor bulge, 02-Sep-2011)
Measured At Ring No.	6		Could not confirm bulge due to depth of water.
Abrasion (Y/N)	No		
Circumferential Seams			
Separation (mm)	0	4	Bulbs pulled through @ 4 rings.
Longitudinal Seams			
Total No. of Cracked Rings	9	2	Cracks in both W & E sidewalls at R2-5 and R7.
Total No. of Rings with Two Cracked Seams	5		
Min. Remaining Steel Between Cracks (mm)	25		R11 is cracked where bolted correctly at W side.
Proper Lap (Y/N)	No		At ring 6, E sidewall.
Longitudinal Spacing (Y/N)	Yes		
Coating			
Corrosion By Soil (Y/N)	Yes		Corrosion with pitting.
Corrosion By Water (Y/N)	Yes		
Coating POLYETHYLENE	NEG		
Ponding (Y/N)	No		
Fish Passage Adequacy			
Baffle	X	X	
(Type -)			
Waterway Adequacy			
Sill (Y/N)	No	3	Drift on floor of R1-14.
Sill (Y/N)	No		
Drift (Y/N)	Yes		
Barrel General Rating	3	3	1 point increase for struts.



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Barrel - General

Bridge Culvert Barrel			
Culvert Component	Last	Now	Explanation of Condition
Barrel Last Accessible Date			

- If barrel is accessible provide current date
- Not accessible explain why & retain previous date
- Rate elements **N** if not visible
- Previous comments are retained and dated
- If more than one barrel indicate location (west) or span number



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Barrel - Special Features

Special Features			
Special Feature	7	7	Struts installed in 1997. 3.5 heavy wall steel struts on 6" x 6" TT.
(Type - VERT STEEL STRUTS)			
Special Feature		X	
(Type -)			

- Cannot be rated under another component
- May be temporary or permanent
- Must be visible to inspect
 - Special design features not usually inspectable (ribs, thrust blocks, etc.)




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Barrel - Special Features

- Examples
 - Struts
 - Shotcrete beams
 - Abrasion plates
 - Concrete Floor
 - Storm Drains
- Record type
- Provide additional information in Explanation of Condition
 - Description
 - Location
 - Dimensions
 - Inspection procedures
- Provide rating based on condition /functionality




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Barrel - Special Features Shot-crete Beam






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Barrel - Special Features Struts – Rated 3





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Barrel - Deformation

Roof					
Measured Rise (mm)	2170	3	3	Rating due to deflection.	
Measured At Ring No.	9				
Sag (mm)	374				
Percent Sag	15				
Sidewall		2	2	Where bolted correctly sidewalls are crimping & cracked @ R11, 13, 15.	
Measured Span (mm)	2670				
Measured At Ring No.	9				Cracked seams.
Deflection (mm)	345				
Percent Deflection	15				
Floor		4	4	(Rating due to floor bulge. 02-Sep-2011)	
Bulge (mm)	200				Could not confirm bulge due to depth of water.
Measured At Ring No.	6				
Abrasion (Y/N)	No				
Circumferential Seams		4	4	Bolts pulled through @ 4 rings.	
Separation (mm)	0				
Longitudinal Seams		2	2	Cracks in both W & E sidewalls at R2-5 and R7.	
Total No. of Cracked Rings	9				
Total No. of Rings with Two Cracked Seams	5				
Min. Remaining Steel Between Cracks (mm)	25				R11 is cracked where bolted correctly at W side.
Proper Lap (Y/N)	No				At ring 6, E sidewall.
Longitudinal Stagger (Y/N)	Yes				



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Barrel - Ring

- Different elements make up a complete ring:
 - Roof
 - Sidewall
 - Floor
 - Bolted or riveted seams
 - Circumferential seams (bolted (SPCSP) or external coupler (CSP))
- Purpose:
 - Carry water flow or traffic
 - carry loads and transmit to surrounding soil
 - Prevent infiltration of fill



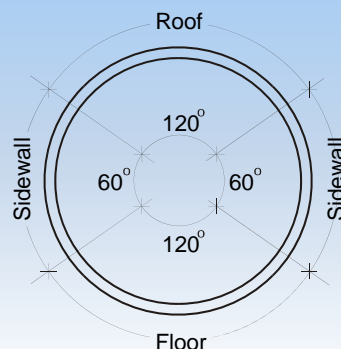
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Barrel - Ring

- For round culverts, use approximate arcs shown
 - Use longitudinal seam if close



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Barrel – Ring Defects

- Flexible Steel culverts look for:
 - Deformation (measure crest to crest)
 - Localized crimping or buckling
 - Longitudinal seam problems
 - Corrosion
 - Abrasion on floor
- Rigid Timber culverts look for :
 - Material defects – rot decay
- Rigid Concrete culverts look for :
 - Structural problems - cracking
 - Material defects - corrosion, scaling, freeze-thaw damage



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Culvert Inspection and Ratings

Barrel - RoofFlexible Culverts:

- Record lowest measured Rise in mm (crest-crest). Mark in culvert for future reference.
- Record Ring number measurements taken.
- If floor bulge occurs at same location add bulge to measured rise and explain in comments.
- Calculate and record Sag in mm (design –measured rise).
- Calculate and record % Sag.
- Rate Roof based on % Sag (Table 13.3) or other visual defects.
- If not able to measure Rise due to ice, silt, concrete floor, etc. a Roof rating is still required based on visual evidence and estimated sag.



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Culvert Inspection and Ratings

Barrel – Roof RatingsFlexible culverts - continued

- Presence of temporary repairs has no influence.
- Sag within 5% , no corrosion - rate 7
- Sag within 7% , no pitting - rate 5
- Sag within 10%, corrosion pitting – rate 4
- Sag 11-15%, isolated perforations – rate 3
- Sag >15%, roof flattening, reverse curvature , extensive perforations – rate 2.
- Reverse curvature in flat HE or round under low cover, severe perforations – rate 1.
- Consider Longitudinal Seam rating if in Roof.

Rigid Culverts:

- Rate Roof based on visual evidence, defects
- Measurements not required



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Culvert Inspection and Ratings

**Barrel – Roof Ratings
Reverse Curvature-Rated 2**

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Culvert Inspection and Ratings

Barrel - SidewallFlexible Culverts:

- Record greatest measured Span in mm. (crest-crest). Mark in culvert for future reference.
- Record Ring number measurements taken.
- Calculate and record Deflection in mm (measured rise - design).
- Calculate and record % Deflection.
- Rate Sidewall based on % Deflection (Table 13.3) or other visual defects.
- If not able to measure Span due to size, ice, etc. a Sidewall rating is still required based on visual evidence and estimated deflection.



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Culvert Inspection and Ratings

Barrel – Sidewall Ratings

- Deflection within 5% , no corrosion - rate 7
- Deflection within 7% , no pitting - rate 5
- Deflection within 10%, corrosion pitting – rate 4
- Deflection 11-15%, crimping or buckling, isolated perforations – rate 3 or less.
- Deflection >15%, crimping/buckling with plate shear, extensive perforations – rate 2 or less.
- Consider Longitudinal Seam rating if in Sidewall (e.g. - Longitudinal Seam in Sidewall rated 2 governs Sidewall rating).

Rigid Culverts:

- Rate Sidewall based on visual evidence, defects
- Measurements are not required






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Culvert Inspection and Ratings

Barrel – Sidewall Inward Movement – Rated 2




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Culvert Inspection and Ratings

Barrel – Sidewall Buckling – Rated 3 or less






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Culvert Inspection and Ratings

Barrel - Floor



- Check timber floors for rot, missing sections.
- Check concrete floors for cracking, spalling, missing sections.
- Check steel floors for cracks, crimping/buckling, defective seams, corrosion, abrasion.
- Measure or estimate floor bulge and record ring number.
- For flexible culverts - If greatest floor bulge is occurring in same ring as worst roof deflection add bulge to measured Rise
- Indicate abrasion on floor by Yes or No. if yes provide comment.


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Culvert Inspection and Ratings

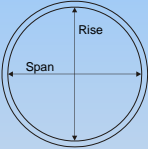
Barrel - Floor

- Rate flexible culvert floors as per Table 13.3:
 - Isolated perforations rate 4
 - Extensive perforations rate 3
 - Severe perforations rate 2
 - <5% bulging, minor abrasion and corrosion, no buckling or seam defects rate 6 or more
 - Seam rating may govern if located in floor

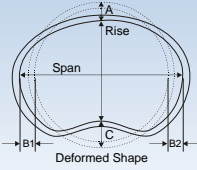

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Culvert Inspection and Ratings

Barrel - Ring




Design Shape




Deformed Shape

A = Roof Sag
 B1 + B2 = Sidewall Deflection
 C = Floor Bulge



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Culvert Inspection and Ratings


Barrel - Circumferential Seams

Bridge Culvert Barrel			
Culvert Component	Last	Now	Explanation of Condition
Circumferential Seams			
Separation (mm)			

- Refers to seams joining individual rings or sections of culvert
- Found on most types of culverts
 - Bolted seams on SPCSP
 - Couplers on CSP or Riveted pipes
 - Joints in precast concrete
 - Construction joints in cast-in-place concrete




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Culvert Inspection and Ratings

Barrel - Circumferential Seams

- Purpose**
 - Join rings
 - Prevent infiltration of backfill
- Most common problems are separation caused by settlement or corrosion of couplers
 - Especially CSP and precast concrete (settlement)
- Potential for safety problem if void develops in fill
- Look for:
 - Separation
 - Loose or missing couplers (corrosion)
 - Bent or broken edges on the rings
 - Misalignment of rings
 - Infiltration of backfill
 - Voids in surrounding fill




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Culvert Inspection and Ratings

Barrel - Circumferential Seams

- Record width of worst separation.
- Gap but no soil infiltration - rate 4.
- Gap with minor soil infiltration - rate 3.
- Void from loss of material due to soil infiltration - rate 2.
- Severe loss of material due to soil infiltration - rate 1.
- Cracking from over torqueing of bolts but no growth or problems – rate 5.
- Cracking due to roof sag rate 4 or less.
- May affect Roof, Sidewall or Floor rating if severe (2 or less).

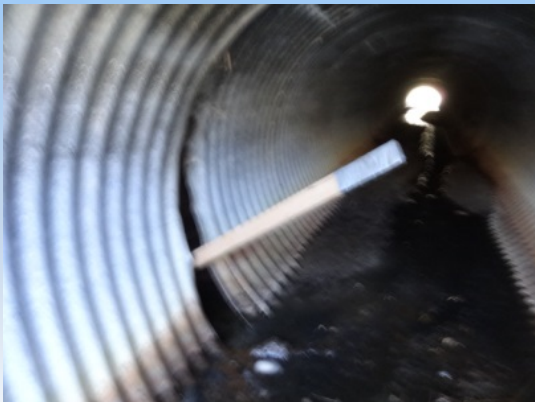



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Culvert Inspection and Ratings

Barrel - Circumferential Seam Void Rated 2







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Culvert Inspection and Ratings

Barrel - Circumferential Seam – Material Loss and Voids Rated 2





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Culvert Inspection and Ratings


Barrel - Longitudinal Seams

Longitudinal Seams		2	2	Cracks in both W & E sidewalls at R0-5 and R7.
Total No. of Cracked Rings	9			
Total No. of Rings with Two Cracked Seams	5			R11 is cracked where bolted correctly at W side.
Min. Remaining Steel Between Cracks (mm)	25			At ring 6, E sidewall.
Proper Lap (Y/N)	No			
Longitudinal Stagger (Y/N)	Yes			

- Applies to SPCSP and CSP riveted culverts
- All others, Rate "X"




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Culvert Inspection and Ratings

Barrel - Longitudinal Seams

- Purpose
 - Join individual plates in ring
 - Transmit loads between plates
 - Approx. 75% bending strength of plates
- Indicate if all seams properly lapped by Yes or No
 - If No, provide comment
- Indicate if seams staggered by Yes or No
 - Within same arc only
 - At change of arc should not be staggered
 - If No provide comment
 - Most common problem is cracking
 - Especially on improperly lapped seams



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Culvert Inspection and Ratings


Barrel - Longitudinal Seams

- Typical longitudinal seams

INCORRECT LAP

CORRECT LAP



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Culvert Inspection and Ratings

Typical longitudinal seams

Cracked Seam



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Culvert Inspection and Ratings

Barrel - Longitudinal Seams Cracked Seams

- Record and comment on number of rings with cracked seams
- Record and comment on number of rings with 2 or more cracked seams (may cause catastrophic failure)
- Record least remaining steel between cracks and record location in comments ("At R9")
- Mark and date ends of worst cracks – pencil is best
- Properly lapped seam has bolt in valley nearest visible edge of plate



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Culvert Inspection and Ratings

Barrel - Longitudinal Seams Other Problems

- Poorly nested plates
 - Improper fabrication and/or poor assembly
- Cusping
 - Sharp break or discontinuity in curvature
 - Occurs most often at longitudinal seams
 - Improper fabrication , poor assembly/plate rotation during torquing
 - Improper backfill
- Bolt tipping
 - High ring compression causing plate slippage and/or hole elongation
- Plate distortion
 - High ring compression, improper assembly and backfill
- Corrosion



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Culvert Inspection and Ratings

Barrel - Longitudinal Seams Rating

- Rate as per Table 13.3
- All seams properly lapped and no defects rate 9
- If seams are not properly lapped but in otherwise excellent condition - rate 7
- >100mm remaining steel between cracks rate 4
- 50 – 100mm remaining steel between cracks - rate 3
- <50mm remaining steel between cracks rate 2
- Two cracked seams in same Ring – rate 2
- Rating for longitudinal seams may also affect Roof, Sidewall and Floor ratings
- Rate riveted longitudinal seams in CSP




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Bridge Inspection and Maintenance


Culvert Inspection and Ratings

Barrel – Wrong Lap - Cracked Longitudinal Seam - <50mm Remaining Steel-Rated 2






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Bridge Inspection and Maintenance


Culvert Inspection and Ratings

Barrel – Cracked Longitudinal Seam and Wrong Lap





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Bridge Inspection and Maintenance

Culvert Inspection and Ratings


Barrel - Coating

Culvert Component		Bridge Culvert Barrel		Explanation of Condition
Last	Now	Span (mm)	Rise (mm)	
(Pipe #: , Primary/Secondary Span, Location Code : , Span (mm) : , Rise (mm) : , Type :)				
Coating				
Corrosion By Soil (Y/N)				
Corrosion by Water (Y/N)				

- Applicable to steel culverts only
- Applies mainly to zinc or aluminized coating
 - Can include other types - bituminous
- Purpose is to protect the steel from corrosion
 - Zinc & aluminum protect by sacrificial action



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Bridge Inspection and Maintenance


Culvert Inspection and Ratings

Barrel - Coating

- Corrosion can occur on soil or water side of culvert
- Soil side corrosion is generally visible above waterline and most common at seams
 - Can lead to perforations
 - Difference in backfill resistivity
 - Corrosive chemicals in backfill or water in fill
- Water side corrosion usually occurs in lower areas
 - Abrasion can remove protective coating
 - Water may have low pH or contain corrosive chemicals
 - Anaerobic bacteria may live in stagnant water



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Bridge Inspection and Maintenance


Culvert Inspection and Ratings

Barrel - Coating

- Look for:
 - Fabrication or installation defects or damage
 - Loss of coating - Corrosion
 - Rust stains from bolt holes or seams
 - Perforations
- Record if corrosion is on SOIL and/or WATER side – provide comment if Yes
- Rate according to Table 13.3
- Superficial corrosion no pitting – rate 5 or 6
- Corrosion with pitting in roof or sidewall rate 4
- Isolated perforations in roof or sidewall, extensive perforations in floor - rate 3
- Extensive perforations in roof or sidewall, severe perforations in floor - rate 2
- Severe perforations in roof or sidewall - rate 1
- Rating of Coating may affect other elements ratings




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Bridge Inspection and Maintenance


Culvert Inspection and Ratings

Barrel Coating – Sidewall Perforations and Separation






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Culvert Inspection and Ratings

Barrel Coating – Floor Severe Perforations





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Culvert Inspection and Ratings


Barrel - Camber

Bridge Culvert Barrel			
Culvert Component	Last	Now	Explanation of Condition
Camber POS/ZERO/NEG			

- Refers to longitudinal gradeline of invert
- No rating is required
- If water line is level can be used to determine camber
- Record whether camber is POSITIVE, Zero (0), or NEGATIVE
- If significantly POSITIVE or NEGATIVE provide Explanation

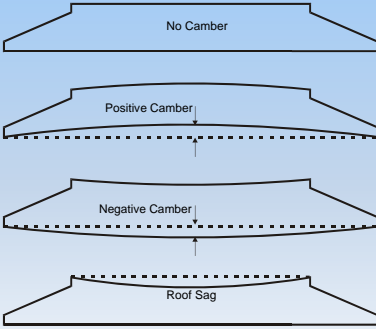



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Culvert Inspection and Ratings

Barrel - Camber





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Culvert Inspection and Ratings


Barrel - Ponding

Bridge Culvert Barrel			
Culvert Component	Last	Now	Explanation of Condition
Ponding (Y/N)			

- Refers to ponded water which adversely affects the culvert
 - Especially underpasses
- Does not refer to normal amounts of ponded water
 - Buried ¼ dia. below SB so expect standing water
 - Normal water level in stream
 - Invert normally set below streambed
- No rating required
- Indicate presence of ponding by Yes or No
- If “yes”, explain



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Culvert Inspection and Ratings


Barrel - Fish Passage Adequacy

Bridge Culvert Barrel			
Culvert Component	Last	Now	Explanation of Condition
Fish Passage Adequacy			
Baffle (Type :)			

- Inspector should assume ALL culverts are fish bearing even when dry
- Refers to ability of culvert to accommodate fish passage U/S and D/S
- May have fish baffles to:
 - provide rest areas
 - reduce velocities
 - provide minimum water levels

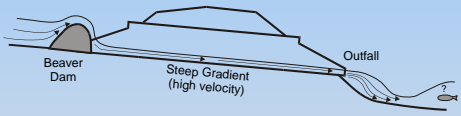


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Culvert Inspection and Ratings

Barrel - Fish Passage Adequacy



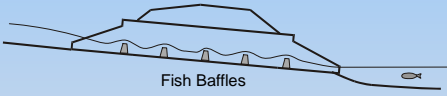
Beaver Dam Steep Gradient (high velocity) Outfall

Fish Baffles

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Culvert Inspection and Ratings

Barrel - Fish Passage Adequacy



Fish Baffles

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Culvert Inspection and Ratings

Barrel - Fish Passage Adequacy

- Types of baffles
 - Spoilers
 - Concrete or steel projections
 - Large boulders
 - Weirs
 - Extend fully across floor
 - May have notches
 - Bolted to floor to prevent displacement

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Culvert Inspection and Ratings

Barrel - Fish Passage Adequacy


- Record type of baffle or NONE
- Look for:
 - Excessive velocities
 - Scour
 - Silt deposition downstream
 - Steep gradient in culvert
 - Drops at ends of culvert
 - Anything which could block flow or affect water levels
 - Dirt
 - Beaver dams
 - Condition and functionality of baffles including anchorages

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Culvert Inspection and Ratings

Barrel - Fish Passage Adequacy

- Culverts used as Animal/Cattle passes Rate X unless also designed to handle flows
- Rate whether flowing or dry
- If in line with or below streambed rate 5 or more
- U/S or D/S ends above streambed rate 4 or less



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Culvert Inspection and Ratings


Barrel - Waterway Adequacy

Bridge Culvert Barrel			
Culvert Component	Last	Now	Explanation of Condition
Waterway Adequacy			
Icing (Y/N)			
Siltting (Y/N)			
Drift (Y/N)			

- Refers to the ability of the culvert to safely pass the design flow
 - Maintain Freeboard
 - Pass drift without damage
 - No damage from backwater created




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Culvert Inspection and Ratings

Barrel - Waterway Adequacy

- Adequately sized culvert may be affected by:
 - Ice build up
 - Silt deposition
 - Drift accumulation
 - Beaver dams
 - Ponding
 - Repair or rehabilitation work
 - Shotcrete beams
 - Struts




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Culvert Inspection and Ratings

Barrel - Waterway Adequacy

- Indicate presence of ice build up (icing) by Yes or No if Yes explain
 - Not normal freezing of ponded water
 - Results from active springs which freeze and causes layers of ice to build up
 - If previously Yes - leave and retain comments adding date of previous inspection
- Indicate presence of silt build up (Siltting) by Yes or No, if Yes explain
 - Invert normally below streambed
 - Minor accumulation of silt expected
- Indicate presence of drift in Barrel by Yes or No
- If “yes”, explain



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Culvert Inspection and Ratings

Barrel - Waterway Adequacy

- Look for:
 - High water marks (not normal flow lines)
 - Potential damage from backwater
 - Potential for drift
 - Evidence of high velocities
 - Scour
 - Silt deposition downstream
 - Presence and effect of items which can affect adequacy

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Culvert Inspection and Ratings


Barrel - Waterway Adequacy

- Rate "X" if not a drainage culvert
- Adequate opening rate 5
- HWM above crown, 4 or less
- Culvert blockage 50% or more rate 3 or less

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Culvert Inspection and Ratings


Barrel - Waterway Adequacy-100% Blockage



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Culvert Inspection and Ratings

Barrel - Waterway Adequacy - 50% Blockage



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Culvert Inspection and Ratings

Barrel - General Rating

- Governed by the following element ratings : (refer to 1.10.8 and 13.6.14)
 - Roof
 - Sidewalls
 - Longitudinal seams
 - Circumferential seam rating of 2 or less
 - Corrosion rating of 2 or less
- Barrel not accessible - rate barrel elements "N"
- If previous Barrel General Rating was 4 or less then carry over previous General Rating rating and provide Explanation of Condition ("carried forward")
- If previous Barrel General Rating was 5 or more rate current General Rating "N"



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Culvert Inspection and Ratings

Effects of Struts on Barrel General Rating

- Inspector may increase General Rating by 1 or 2 points but not exceed rating of 4.
- Rating Conditions
 - struts in place more than 2 years
 - struts rated 5 or more
 - 1 permanent reference for monitoring
 - struts inspected after any significant event
 - consider culvert size and depth of cover (failure of large diameter culvert under high fill may not be as serious as under low fill)
 - does not apply when deflections >30% or cracked seams with less than 25mm remaining steel
 - applied to general rating only, element ratings remain unchanged



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Culvert Inspection and Ratings

Questions??

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