

# **Corrugated Metal Pipe Inspection Policy**

**Delaware Department of Transportation  
Bridge Management Section**



**Policy for Inspection and Load Posting of Corrugated Metal Culverts**

**Introduction**

As of January 2008, there were 270 Corrugated Metal Culverts, which represents 18.4% of the inventory of 1,469 bridges that are maintained by DelDOT. The total number includes steel and aluminum pipes and arches. There are 113 National Bridge Inventory (NBI) length structures included in the list. An NBI length structure is a structure that is greater than 20' in length. These structures are potentially eligible for federal funding through the FHWA Highway Bridge Program. Bridges eligible for this funding must be structurally deficient or functionally obsolete, and have a sufficiency rating of 80 or less.

DelDOT has utilized the Pontis Bridge Management System to store element level bridge inspection data since 1994. The preservation modeling capabilities of Pontis were implemented in 2005. These preservation models are updated annually based on cost changes and experience gained through the use of the Pontis program. In March 2006, Bridge Management Section created a Deficiency Formula for use in managing bridge preservation activities. The Deficiency Formula assigns points to each bridge based on several factors, such as health index, Pontis benefit to cost ratio, structural deficiency, load capacity, roadway functional class, truck traffic volume, detour length, and historic significance. The points are added for each bridge and the bridges are ranked in order of the Deficiency Points. This ranking is used to prioritize work for the Bridge Design Program and the District Structure Maintenance Program.

The Deficiency Formula was created in such a way that a structurally deficient pipe culvert would rise to the top of the priority list, regardless of the roadway characteristics. However, it became evident that the culverts that were identified as structurally deficient were in very poor condition and near the end of their service life. Given the three-year timeline to initiate, design, obtain environmental permits, and construct a project, these culverts need to remain in service for at least three years after being identified as a priority. Also, DelDOT does not have a policy for restricting truck traffic on pipe culverts in poor condition. The soil around these culverts is distributing the traffic loads in a way that cannot be determined with simple analytical methods. In order to assure public safety, several of these culverts

were placed on a monthly watch list to closely monitor their condition and close the road as necessary. As of January 2008, there were four metal culverts on the monthly watch list.

Bridge Management Section identified two areas of improvement in our policies and procedures. First, the Pontis and NBI inspection rating criteria need to be modified such that deficiencies are identified earlier and replacement projects are programmed before these culverts reach critical condition. Second, a load posting policy needs to be created in order to restrict heavy vehicles on pipe culverts that are in poor condition. Representatives from DelDOT Bridge Management and Bridge Design Sections, and FHWA met to create a policy regarding these two areas.

## Inspection Criteria

All pipe culverts are inspected using Pontis and NBI criteria. Pontis utilizes an element level approach, dividing each linear foot of the culvert into its appropriate condition state, whereas the NBI rating provides an overall characterization of the general condition of the entire culvert.

## Pontis Ratings

There is some overlap in the current condition state language for Condition States 3 and 4. Holes in the barrel were listed in both states, and there was no clear definition of significant corrosion. The new rating criteria removes “holes” from Condition State 3. The new rating criteria identify significant corrosion in Condition State 3 as that which allows easy perforation with a hammer. The Pontis condition states were defined as follows:

240 Steel Culvert (L.F.)

244 Steel Culvert - Major (L.F.)

<u>Condition State</u>	<u>Description</u>
1.	The element shows little or no deterioration. Some discoloration or surface corrosion may exist but there is no metal pitting. There is little or no deterioration or separation of seams. ~ <i>Surface Corrosion</i> <ul style="list-style-type: none"><li>- Do nothing</li></ul>
2.	There may be minor to moderate corrosion and pitting, cannot easily perforate with hammer. Little or no distortion exists. There may be minor deterioration and/or separation of seams. ~ <i>Minor corrosion</i> <ul style="list-style-type: none"><li>- Do nothing</li></ul>
3.	Significant corrosion, deep pitting, or flaking which allows easy perforation exists. Minor to moderate distortion and deflection may exist. Minor cracking or abrasion of the metal may exist. There may be considerable deterioration and/or separation of seams. ~ <i>Moderate corrosion</i> <ul style="list-style-type: none"><li>- Do nothing</li></ul>
4.	Major corrosion, perforations and/or holes exist. Major distortion, deflection, or settlement may be evident. Major cracking or abrasion of the metal may exist. Major separation of seams may have occurred. ~ <i>Major corrosion</i> <ul style="list-style-type: none"><li>- Do nothing</li><li>- Replace</li></ul>

Note: Concrete footings are not part of this element, any necessary repair actions should be noted in the inspection report. If 30% or more of the culvert is in Condition State 4, or if 75% or more is in CS 3 or CS 4, then the bridge is Structurally Deficient.

## NBI Ratings

The NBI rating criteria was not modified. However, the following procedure will be use to “translate” Pontis condition states into NBI ratings. Photos are included as general illustrative examples.

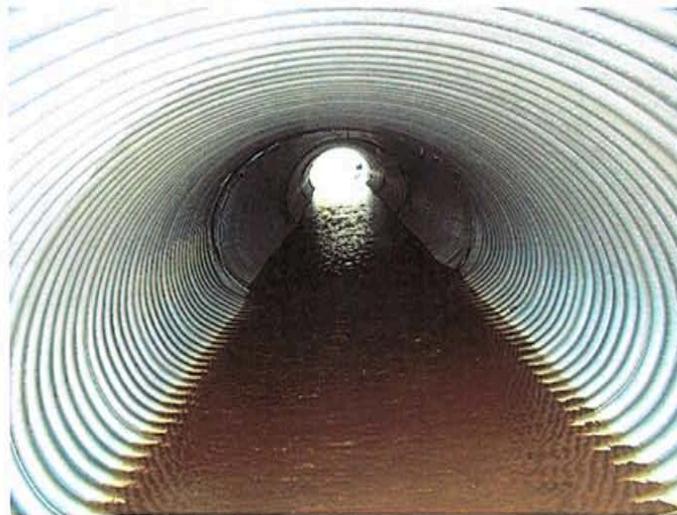
### Item 62 - Culverts

<u>Code</u>	<u>Description</u>
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N	Not applicable. Use if structure is not a culvert.
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9	No deficiencies.
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Pontis Equivalent: 100% of the quantity is in Condition State 1. This coding shall only be used for a newly inventoried culvert.



8	No noticeable or noteworthy deficiencies which affect the condition of the culvert. Insignificant scrape marks caused by drift.
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Pontis Equivalent: 100% of the quantity is in Condition State 1. This coding shall only be used for a culvert that has been previously inspected, and exhibits no corrosion.



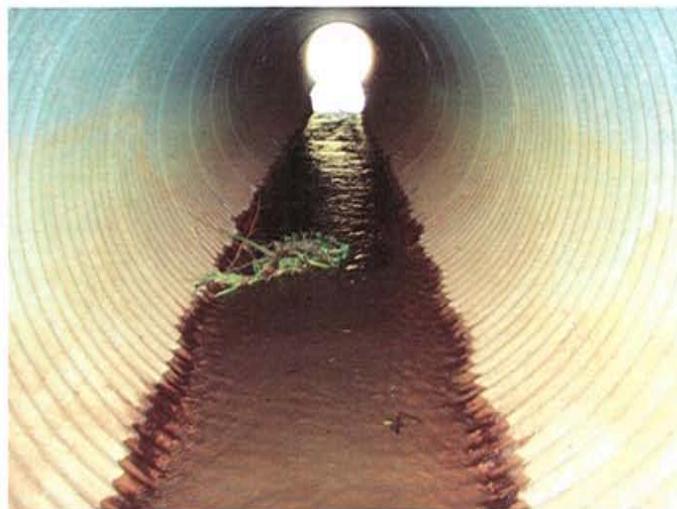
- 7 Shrinkage cracks, light scaling, and insignificant spalling which does not expose reinforcing steel. Insignificant damage caused by drift with no misalignment and not requiring corrective action. Some minor scouring has occurred near curtain walls, wingwalls, or pipes. Metal culverts have a smooth symmetrical curvature with superficial corrosion and no pitting.

Pontis Equivalent: 100% of the quantity is in Condition State 1. Portions of the culvert exhibit surface corrosion with no pitting.



- 6 Deterioration or initial disintegration, minor chloride contamination, cracking with some leaching, or spalls on concrete or masonry walls and slabs. Local minor scouring at curtain walls, wingwalls, or pipes. Metal culverts have a smooth curvature, non-symmetrical shape, significant corrosion or moderate pitting.

Pontis Equivalent: There is some quantity in Condition State 2, but none in Condition States 3 or 4.



- 5 Moderate to major deterioration or disintegration, extensive cracking and leaching, or spalls on concrete or masonry walls and slabs. Minor settlement or misalignment. Noticeable scouring or erosion at curtain walls, wingwalls, or pipes. Metal culverts have significant distortion and deflection in one section, significant corrosion or deep pitting.

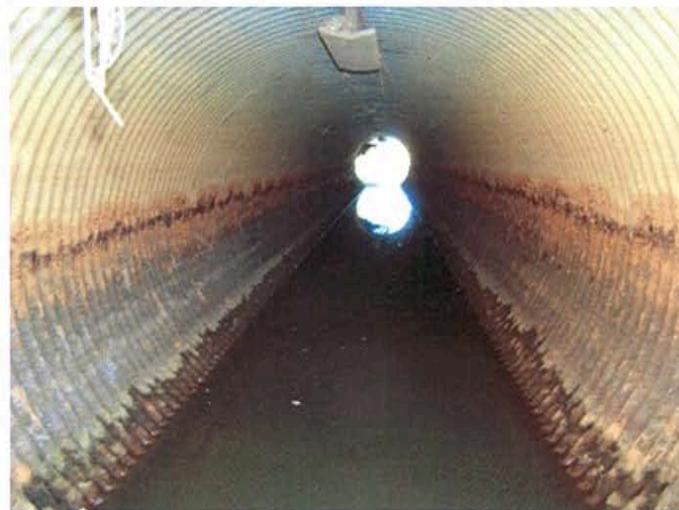
Pontis Equivalent: The combined quantity in Condition States 3 and 4 is less than 75%, and the

quantity in Condition State 4 is less than 30%.



- 4 Large spalls, heavy scaling, wide cracks, considerable efflorescence, or opened construction joint permitting loss of backfill. Considerable settlement or misalignment. Considerable scouring or erosion at curtain walls, wingwalls or pipes. Metal culverts have significant distortion and deflection throughout, extensive corrosion or deep pitting.

Pontis Equivalent: The combined quantity in Condition States 3 and 4 is greater than 75%. The quantity in Condition State 4 is less than 30%



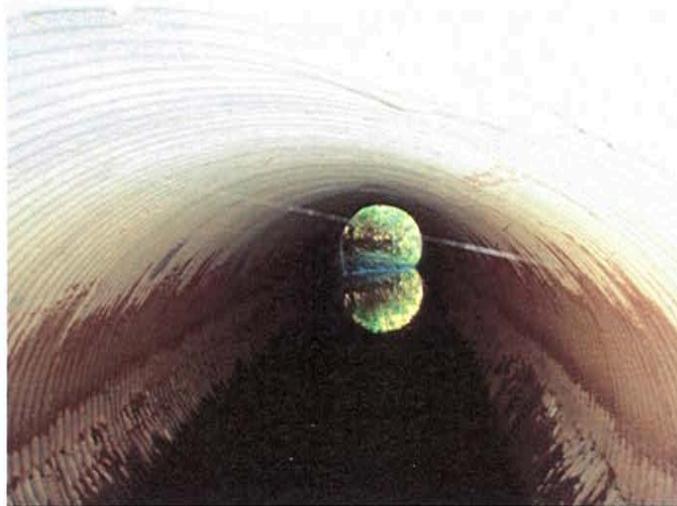
- 3 Any condition described in Code 4 but which is excessive in scope. Severe movement or differential settlement of the segments, or loss of fill. Holes may exist in walls or slabs. Integral wingwalls nearly severed from culvert. Severe scour or erosion at curtain walls, wingwalls or pipes. Metal culverts have extreme distortion and deflection in one section, extensive corrosion, or deep pitting with scattered perforations.

Pontis Equivalent: The quantity in Condition States 4 is greater than 30%. There is no deflection, settlement, loss of backfill, kinking, or separation of the culvert.



- 2 Integral wingwalls collapsed, severe settlement of roadway due to loss of fill. Section of culvert may have failed and can no longer support embankment. Complete undermining at curtain walls and pipes. Corrective action required to maintain traffic. Metal culverts have extreme distortion and deflection throughout with extensive perforations due to corrosion.

Pontis Equivalent: The quantity in Condition States 4 is greater than 30%. There is loss of backfill, or kinking, but no separation with displacement of the culvert.



- 1 Bridge closed. Corrective action may put back in light service.

Pontis Equivalent: The quantity in Condition States 4 is greater than 30%. There is separation with displacement of the culvert.



0 Bridge closed. Replacement necessary. (This code is normally not used)

### Load Posting and Road Closure

Corrugated metal culverts develop their strength through the interaction of the soil backfill with the metal structure. As metal culverts deteriorate to serious and critical condition, there is no analytical method to determine the remaining strength of the system. It is desirable to reduce or eliminate heavy vehicle loads when metal culverts reach this deteriorated state. The NBI ratings will be utilized to define the level of load posting or the need for closure of the road. The following chart summarizes the criteria:

NBI Rating	Load Posting
9 - 4	None
3	15 Tons
2	3 Tons
1	Road Closure
0	Road Closure

### Impact on the Bridge Inventory

A comparison was made between current NBI ratings and the new “translated” NBI ratings. Existing Pontis ratings were used for the new NBI ratings. The following chart summarizes the comparison:

<b>NBI Rating</b>	<b>Existing # of Bridges</b>	<b>New # of Bridges</b>
9 - 7	105	64
6	86	97
5	64	33
4	14	62
3	1	9
2	0	3
1	0	2
0	0	0

The comparison reveals that 61 additional bridges would be classified as structurally deficient, and would rise to the top of the priority list for work. Twelve of the bridge would require load posting and two of the bridges would be closed. It should be noted that the two bridges that would require closure are on the monthly watch list.

### **Implementation**

The new inspection and load posting criteria for metal culverts will be implemented with the 2008 Bridge Inspection season. Training will be provided for inspection staff prior to the inspection season. The following guide will be used by the inspectors in the field:

<b>Corrugated Metal Culvert Inspection Guide</b>					
	<b>Pontis Condition State</b>				
<b>NBI Rating</b>	<b>CS1</b>	<b>CS2</b>	<b>CS3</b>	<b>CS4</b>	<b>Load Posting</b>
9	100% (new)				N/A
8	100% (w/ no corrosion)				N/A
7	100% (w/ surface corrosion)				N/A
6		> 0%		0%	N/A
5				> 0%	N/A
4				> 75%	N/A
3				> 30%	15 Tons
2				> 30% (w/ loss of fill, or kinking)	3 Tons
1				> 30% (w/ separation)	Road Closure
0					Road Closure