Culvert corroded? Question conditions

"Corrosion is a pretty complex and variable mechanism."

The Culvert Selection Standard, 13-1-15 of the ***WisDOT Facilities Manual*** is accessible online if you have a Wisconsin user ID. Choose FDM, then select the Drainage chapter at http://www.dot. wisconsin.gov/library/publications/format/manuals.htm.

Or request a print copy from the TIC.

Experimental Culvert Pipe, STH 80 Juneau and Wood Counties, Wisconsin, Final Report, WisDOT WI/FEP-09-96, November 2003, 33 pp.

Describes field tests of corrosion resistant culvert pipes, water and soil characteristics, and related research. Available from the WisDOT Technology Advancement Unit, 608-243-5989.

WHEN EROSION on the shoulder or a new dip in the blacktop tells you a culvert has failed, do some detective work before you order a replacement. Find out the culvert's age, consider the water flow pattern, and look at nearby land uses. If it is steel, look at the type and location of corrosion. Depending on your area in the state (see map), gather soils and water information.

Age will tell you if the culvert failed prematurely. If there are no paper records, ask nearby landowners if they recall when it was installed. Metal culvert pipe of any type should last at least 20 years before perforation occurs. Premature failure indicates that you should look further to pinpoint sources and causes.

Corrosion primarily on a culvert bottom that should be normally dry suggests constant contact with water. Evaluate the pitch and water flow through the pipe and its connecting ditches. A faulty design or incorrect installation may be trapping water in the culvert.

Most corrosion is primarily scale: flat pieces that flake off in layers. Scale is most directly related to low pH or low electrical resistivity in the soil or water at the culvert site. It is most common where the pH is less than 6 and where the electrical resistance is less than 4000 ohm/cm.

Effluent or runoff could also be a cause. Barnyards or feedlots generally produce effluent with very low electrical resistance. Effluent from cheese factories can have a very low pH and can even dissolve the cement in concrete. Runoff from cultivated fields can contain fertilizer, herbicides, or pesticides that can also be very corrosive to metal. Look for these or other possible sources nearby, especially when soil and water tests are negative.

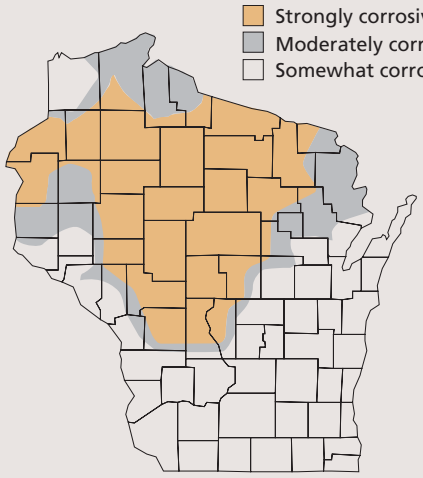
If corrosion takes the form of nodules, and small discrete holes the size of a dime appear, bacteria are likely the cause. Bacterial corrosion will tend to concentrate along the flow line where water flow is variable. These bacteria (called anaerobic sulfate reducing bacteria) do not attack the steel directly but create an environment favorable to corrosion. They thrive primarily in the north central part of Wisconsin where water alkalinity is low and are most active at sites of flowing water where the alkalinity is less than 120 ppm and the pH is 5 to 7.

Bacterial corrosion related to the soil also occurs where the soil is organic and poorly drained, with a pH range near neutral. This corrosion can occur anywhere in Wisconsin and is characterized by rust stained soil adhering to the outside of the pipe. Placing clean, inorganic fill around the pipe can reduce soil side corrosion.

"Based on research completed by my predecessor, Bob Patenaude, WisDOT developed an overview map of the state showing the potential for bacterial corrosion related to water at the site," says Dan Reid, a WisDOT geologist. "The highest potential is in the central and northwestern counties. We frequently find very low pH and alkalinity in those areas because of the bedrock." The map appears in the WisDOT Facilities Development Manual along with recommended corrosion resistant culvert types. You may be able to get information about the corrosive characteristics of a site's soil or water from district soils or maintenance records.

The state DOT has evaluated and tested several corrosion resistant pipe materials: concrete, aluminum, aluminized steel, polymer coated steel, and polyethylene. Recent ongoing improvements in plastic pipe make it a good potential alternative, but experience with it is relatively short. If you are considering aluminum, it should be protected from road salt that can move down through the soil and corrode it from the top.

Poor installation left this culvert lower than the ditches. Constant standing water quickly rusted through the bottom.



Potential for bacterial corrosion of zinc galvanized steel culvert pipe

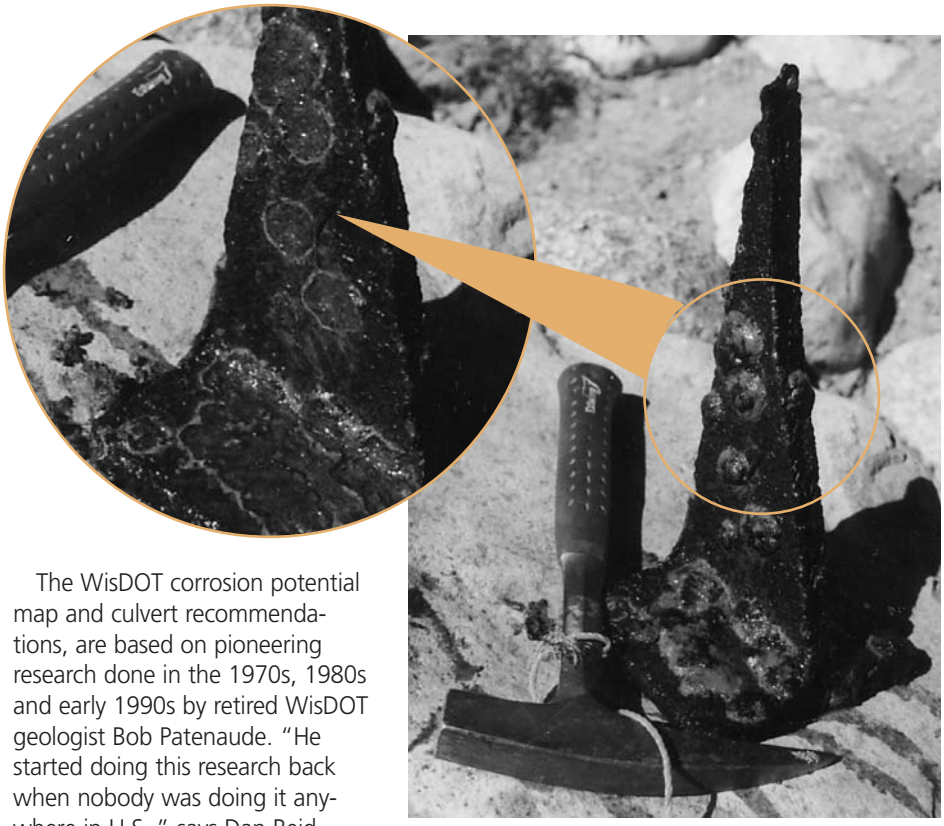
Inspect culverts regularly

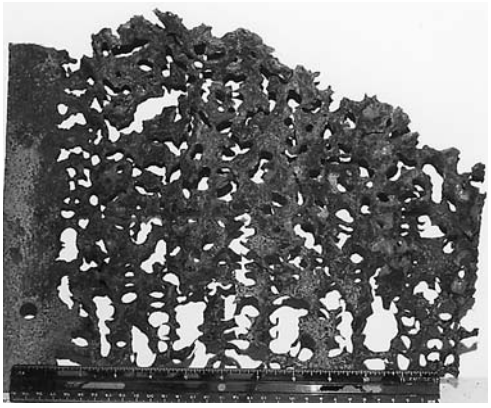
It's a good idea to routinely inspect culverts, allowing you to plan and budget for their replacement. The following rating scale for zinc galvanized steel pipe may be helpful.

Corrosion Ratings for Zinc Galvanized Steel Pipe

RATING	CONDITION OF PIPE
0	No corrosion. Galvanizing or cladding intact.
1	Staining or surficial oxidation. No pitting.
2	Moderate rusting. Rust flakes tight. Possible nodules. Minor pitting.
3	Fairly heavy rusting. Some scale. Nodules. Some pitting.
4	Heavy rusting. Rust scale easily removed. Deep pitting but metal is sound.
5	Heavy scale. Deep pitting. Unsound areas easily penetrated with pick end of geology hammer.
6	Small perforations in pipe.
7	Large perforations in pipe.
8	Invert gone from pipe.

These ratings attempt to reflect both scale and nodules, Wisconsin's two principal corrosion modes. They can be used as a gross estimate of remaining service life. For example, if a pipe has a C.R. of 4 and has been in service for 20 years, the rate of corrosion is 5 years per C.R., and with 2 C.R. ratings to perforation, the remaining service life would be estimated as 10 years.





Bacterial corrosion severely perforated this 10-gauge pipe arch invert. Nodules have dried and fallen off the metal.

LEFT Corrosion in the form of nodules was likely caused by bacteria. In closeup, nodules have been removed revealing underlying pits.

The WisDOT corrosion potential map and culvert recommendations, are based on pioneering research done in the 1970s, 1980s and early 1990s by retired WisDOT geologist Bob Patenaude. "He started doing this research back when nobody was doing it anywhere in U.S.," says Dan Reid.

Patenaude studied a lot of corroded pipe in his many years with the state. His research on state highway 80 in Juneau and Wood counties helped solve a long-standing culvert failure mystery and explain the mechanisms of bacterial corrosion.

"Corrosion is a pretty complex and variable mechanism," says Patenaude. "The causes of corrosion at an individual site can be unique to that situation." So when a culvert fails too soon, take a hard look at it and check the variables—water and soil characteristics, local land uses, and original design and installation—before you replace it.