Research Note

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Don't let corrosion ruin your life expectancy: Choose the right culvert for your site

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Introduction

Galvanized steel (zinc coated) culverts have been used extensively as conduits for water management along resource roads. Practitioners have become accustomed to using galvanized culverts for many applications. There are, however, alternative coatings that may be better suited for local site and environmental conditions, thereby helping extend a culvert's expected life. Although abrasion, culvert wall thickness, and coatings are all important considerations for determining the life expectancy of a culvert, this research note focuses on the site parameters identified in water samples that can be used as indicators to help avoid corrosion.

Background

Corrosion can be an electrochemical action. Low electrical resistivity and high quantities of soluble salts generally indicate high corrosivity. There are easily measured site parameters, such as pH and water hardness, which can be used to help designers and planners choose the appropriate coating of a culvert for a given site. There is a correlation between resistivity and soluble salts. For this reason, resistivity is inferred by taking readings of water hardness and chlorides present. The hardness is an indicator of the amount of calcium carbonate ion ($CaCO_3$) dissolved in water, which can buffer the effects of acidic inputs (rainwater or weathering of parent material). Hard water containing ample $CaCO_3$ neutralizes acidity and forms a protective scale on the culvert's surface. A sulphate reducing anaerobic bacteria commonly found in naturally soft water may influence the corrosion of galvanized steel (not discussed in this research note). Chlorides from de-icing salts and some dust suppressants are highly soluble ions that contribute to low resistivity and promote corrosion of unprotected steel. Field personnel can take three simple measures to help determine steel culvert materials best suited for the site (Figure 1).

Figure 1. Test strips used to measure water properties have a colour reaction that is compared to a colour scale (photo on left shows total hardness reading); pH readings are collected in a similar manner. Titrator strips (right) are used for chloride readings. Test strips are inexpensive and available from www.HACH.com and www.CLEARTECH.ca.

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Culvert selection considerations

Depending on the readings obtained, there are a few common choices for culvert selection. For the purpose of this research note, the choices for culvert material coatings include galvanized, aluminized type 2 and polymer laminated. The bar graphs in Figure 2 were produced by the Corrugated Steel Pipe Institute. They show suggested culvert coatings compatible with the field measurements as well as a resistivity graph with units of ohm-cm, which could be measured with an electronic instrument. Where a galvanized culvert is not recommended, there is still a choice of aluminized type 2 or polymer laminate.

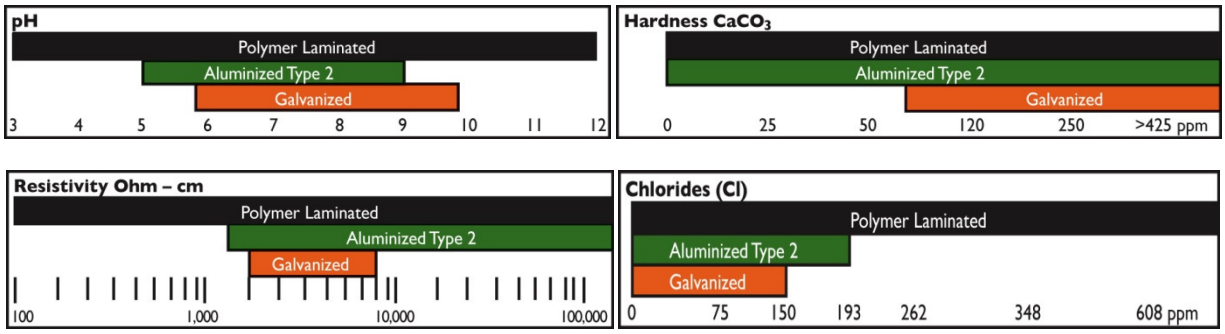

Figure 2. Four bar graphs showing reading levels associated with appropriate culvert coatings.

In order to accommodate culvert life expectancy, Figure 3 shows one graph for a design service life of 25 years and another for 50 years. Plot the pH and resistivity/total dissolved solids (TDS) for a given site in either graph, and read directly to the left for all appropriate coatings and thicknesses. TDS is reasonably represented by the sum of the two test strip readings (hardness and chlorides). Resistivity above 8000 indicates that few salt ions, protective or harmful, are present.

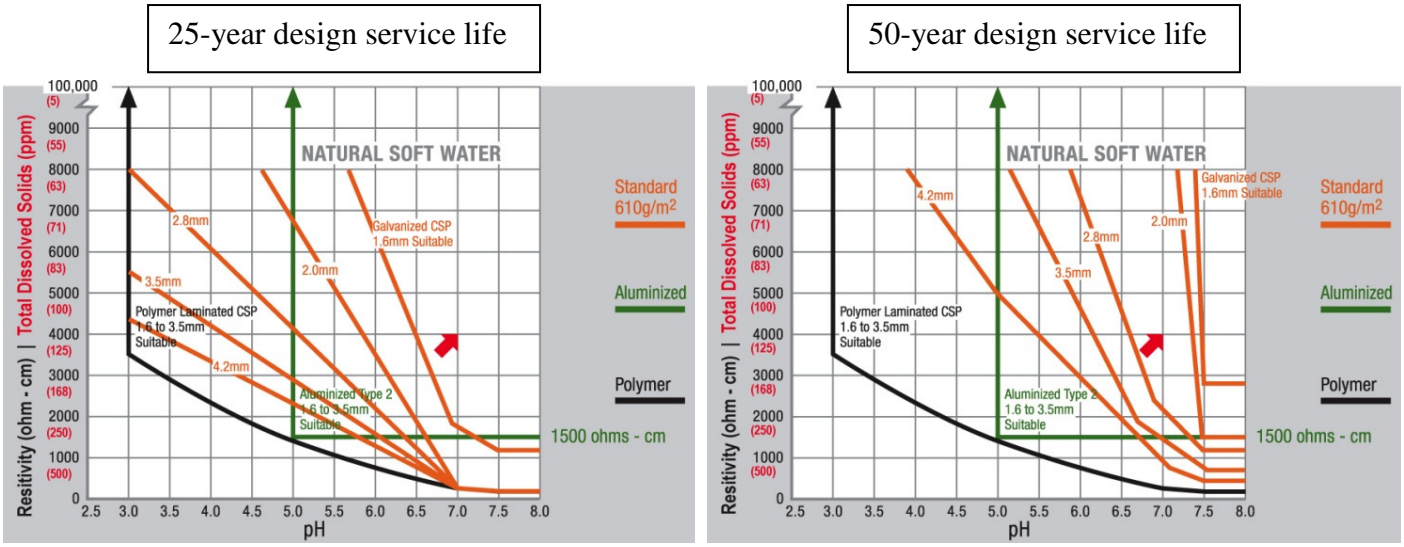

Figure 3. Each graph shows the coatings appropriate for given site conditions, plotted against pH and resistivity/TDS. The red arrow shows an example for a pH of 7 and a resistivity of 4000/TDS of 125. For a design service life of 25 years, all coatings and all galvanized steel thicknesses are appropriate (because all lie to the left of the arrow). For an expected life of 50 years, the two thinner (1.6 and 2.0 mm) galvanized steel culverts are not appropriate (they are to the right of the arrow), but all other coatings and thicknesses are appropriate.