How Bad is our Sanitary Sewer Infrastructure – Really?

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"The greatest enemy of knowledge is not ignorance, but the illusion of knowledge," - Daniel Boorstin

Our industry has become familiar with the infrastructure report cards published by the American Society of Civil Engineers (ASCE). According to these report cards, our wastewater infrastructure grade has hardly improved in the last ten years and persistently hovers around a grade D. Investment needs associated with replacing our aging sanitary sewer infrastructure are an important contributor to this grade.

Since 2014, the State of Michigan has been providing money to municipalities for performing condition evaluations and accompanying asset management programs. This program is being referred to as the Stormwater, Asset Management, and Wastewater (SAW) program. As part of this program, millions of linear feet of sanitary sewer systems have been condition assessed. Some of this information was utilized in the State wide Asset Management Pilot program, under the leadership of the previous administration (Pilot program report released in April of 2018).

It has been common practice in the industry that in the absence of more specific condition information, the age of a system, in comparison to its presumed useful life, i.e. its remaining useful life, is used as an indicator of the physical condition state of the infrastructure. The Environmental Protection Agency fact sheet for sewer collection systems (April 2002), for example, based its projections for the condition state of our sewer infrastructure on an assumed useful life of one hundred years. Several utilities in many states around the country use similar approaches when estimating the condition state of their aging infrastructure. However, there is growing evidence that, in many instances, the age of an infrastructure alone is not necessarily a good indicator of its physical condition state.

This paper presents the results of an analysis, including nearly 30 million feet of actual sanitary sewer inspection data throughout the country (inspections performed between the years of 2016 and 2018). Condition inspections were performed using the industry standard National Association of Sewer Service Companies (NASSCO) sanitary sewer physical condition inspection methodology referred to as the Pipeline Assessment Certification Program (PACP). The purpose was to:

- Use actual, observed physical condition state data in order to compare condition states of sewer pipes of various installation decades and
- Highlight some of the fallacies associated with the remaining useful life concept, thus suggesting that the remaining useful life concept in the industry, as identified above, may have reached its remaining useful life

This paper is Part I of a two-part series. The second part, building on the observations in this paper, lays out key recommendations for municipalities in assessing and prioritizing the condition state of their infrastructure as well as associated capital investment needs without the unquestioned reliance on a simplified but misleading remaining useful life concept.

Physical Attributes of Inspected Sewer Assets

The NASSCO sewer inspection program has become a nationally accepted means by which physical and operational condition states of linear sewer infrastructure are assessed. As part of this current paper, nearly 30 million linear feet of sanitary sewer, which was inspected with the NASSCO process, was collected from a variety of municipalities in different states throughout the country (Figure 1).

Figure 1: States from Where Sanitary Sewer Inspection Data was Collected

The inspected sewers ranged in diameter, material, and installation year. For example, sewers with pipe diameters as small as 6" and larger than 100" were part of the condition survey. However, sewers smaller

than 16" in diameter made up approximately 85% of the data. Out of the numerous sewer pipe material inspected (e.g. vitrified clay, concrete, PVC, asbestos cement), the vast majority (nearly 50%) included vitrified clay pipe, followed by PVC and concrete material pipes. These distributions in diameter and material type tend to make up the sewer pipes of many small to medium sized municipalities in our State. Lastly, the survey included sewer pipes older than nearly 125 years and as young as approximately 8 years, with infrastructure growths experienced after both world wars one and two. A noteworthy point of observation in the data, as it relates to pipe material, was that PVC pipe usage has increased substantially after the 1980's, suggesting that it may have replaced VCP. Even though asbestos cement (AC) pipe appears to have experienced a sharp increase after world war two, its usage appears to have declined significantly since.

Structural Condition State of Inspected Sewer Assets

The remaining useful life concept, as used and interpreted in the broader industry, is based on the premise that older infrastructure are in a worst structural state than younger infrastructure. Therefore, old infrastructure, especially ones that are older than a certain presumed useful life, e.g. 100 years, ought to be replaced. If this interpretation were correct, the condition inspection data would be expected to display such a trend as well. This premise has been put to test with physical inspection data collected in the field.

The NASSCO process allows for systematic, visual inspection and categorization of the physical and operational states of linear sanitary sewer assets. There are different ways by which the NASSCO process allows for the grading of sewer infrastructure assets. For example, some municipalities prefer to use what is referred to as the NASSCO quick scores when grading their sewer infrastructure assets. This is a four-digit score, identifying the observed two worst grades along with the number of defects associated with these two defect grades. For the purposes of this discussion, however, the overall, average grade score has been used. This represents an average of all the observed defects on a sanitary sewer pipe segment. For example, a grade of one (1) would imply an acceptable structural state of a sanitary sewer pipe that was condition assessed. A grade four (4) and higher (in this case, the highest NASSCO grade would be a five) would suggest a pipe that is likely to collapse in the foreseeable future or has already collapsed.

Figure 2 summarizes the results of the condition evaluation of the data. Several observations are noteworthy:

- Only approximately 30% of the sewer pipes that are nearly 120 years of age showed signs of near collapse (i.e. a defect grade of 4 an higher)
- Nearly 15% of pipes with ages less than 40 years showed signs of near collapse
- There were pipes less than approximately 10 years of age (approximately 5%), which indicated a state of near collapse

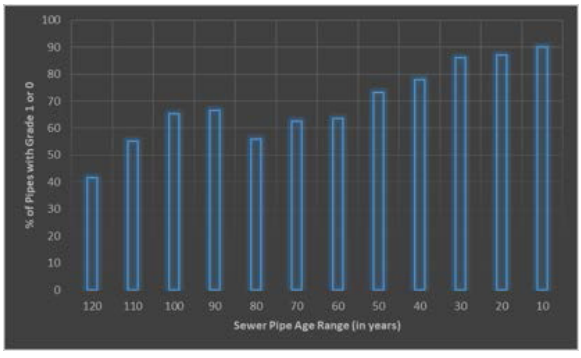

Figure 2: Percent of Pipes with Average Grade Defects of 4 and Higher in Comparison to Their Ages

Figure 3 below shows the same figure as above, but this time, displaying the percentage distribution of pipes in a good condition state (i.e. average structural grade scores of 1 or less).

As can be observed in this figure, the percentage of infrastructure that is nearly 100 years old and is in good condition, on average, appears to be the same as infrastructure that is 60 years old, for example.

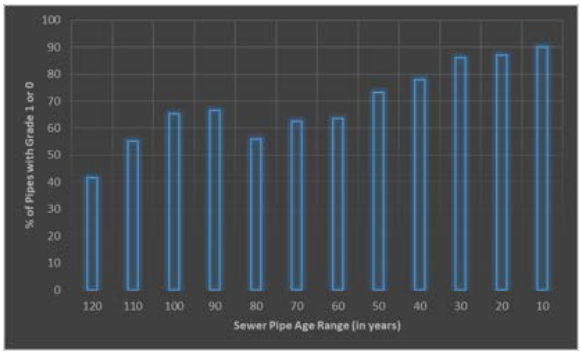

Figure 3: Percent of Pipes with Average Grade Defects of less than 1 in Comparison to Their Ages

Change in Paradigm

According to the principle of remaining useful life, with the assumption that sanitary sewers should only have 100 years of life in them, infrastructure that is older than 100 years old should be in a state of near collapse. However, as demonstrated in Figure 2, only about 6% of infrastructure of this age has

been observed to be in this condition state. In fact, amazingly, more than 60% of 100-year infrastructure can be classified as being in an "acceptable condition state" (i.e. a structural grade of 1 or 0). Yes, the data suggests that the percentage of near collapse states in infrastructure increases with age. However, as shown in Figure 2, this percentage, in a 110 year old pipe appears to be similar to a pipe that is only 40 years of age.

Conclusion

After analyzing the physical condition states of nearly 30 million feet of linear sanitary sewer infrastructure (inspections performed between 2016 and 2018), the data suggests that basing infrastructure condition states of assets, especially old ones, on a remaining useful life concept alone, which assumes a certain life span of an asset, can be significantly misleading. The second part of this article, building on the observations in this paper, lays out key recommendations for municipalities in assessing and prioritizing the condition state of their infrastructure as well as associated capital investment needs without the unquestioned reliance on a simplified but misleading remaining useful life concept.