# A COMPARISON OF CONVENTIONAL AND NEW SANITARY SEWER REHABILITATION METHODS

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## ABSTRACT

In order to minimize sanitary sewer overflows and reduce inflow and infiltration, many municipalities spend a significant portion of their budgets on rehabilitation of sanitary sewer systems. There are a number of proven pipeline rehabilitation technologies with long track records, including cured in-place pipe (CIPP), sliplining, and pipe bursting, among others. One of the significant benefits of these technologies is that, in comparison with open cut, installation cost is lower and less disruptive. Many municipalities have become comfortable with the conventional sanitary sewer rehabilitation technologies. However, recent technology developments seek to provide rehabilitation methods that minimize life cycle costs and disruption even more than current conventional technologies. As an example, a CIPP hybrid has been developed in which glass fiber is cured with UV light. This technology provides a thinner, yet stronger liner material, with a longer lifespan than conventional CIPP liners. In addition, installation time is significantly reduced with the UV curing process. With traditional CIPP, the liner is cured with water, and with the discharge of the water following the curing process, there are potential negative environmental effects. The UV curing process eliminates these environmental effects, and minimizes public disruption due to the smaller footprint needed for installation as well as the shorter time period required for the curing process. Another technology that has been utilized in recent years in some locations is called spiral wound pipe. This technology is beneficial due to low mobilization costs and its close fit with various sizes and shapes of pipe. There are recent technologies associated with spiral wound pipe that seek to minimize the annular space between the spiral wound pipe and the host pipe, which would make this process more viable for smaller diameter pipes. These and other technological developments with sanitary sewer rehabilitation methods will be discussed and compared with conventional sanitary sewer rehabilitation methods in this paper and presentation. All North Carolina utilities with sanitary sewer rehabilitation programs can benefit from this paper and presentation. Sanitary sewer systems are such significant assets for wastewater utilities, with significant funds dedicated for rehabilitating these systems. Therefore, an understanding of the technologies which can minimize life cycle cost and disruption is important for all wastewater utilities to consider.

## INTRODUCTION

Rehabilitation of sanitary sewer systems has become increasingly important for wastewater utilities in the United States. Many sanitary sewer systems have reached an age where deterioration has occurred and the system no longer efficiently conveys wastewater as originally intended. Structural problems and increased infiltration in aged sanitary sewer systems can lead to increased flows and sanitary sewer overflows, both of which can have a high cost on wastewater utilities. Since the 70's, wastewater utilities have utilized cured-in-place pipe (CIPP) as a conventional method for rehabilitation of sanitary sewer systems. The CIPP method has proven to be a reliable, long-lasting rehabilitation method that many utilities continue to use today. However, there has been an acceleration of pipeline rehabilitation methods developed in recent years that, depending on the circumstances, may be more cost-effective than the conventional CIPP method. This paper provides a better understanding of the rehabilitation

methods that may be used in place of conventional CIPP, and under which circumstances these methods may be a better choice for cost-effective rehabilitation of sanitary sewer systems.

## METHODOLOGY

Just like any other type of infrastructure, sanitary sewer systems are in need of renewal at some point in time. There are generally three types of renewal, including repair, rehabilitation, and replacement. Repair is localized to a specific problem in a pipeline, and is likely a temporary fix that will undergo a more permanent fix at a future date with either rehabilitation or replacement. Sanitary sewer replacement typically has a higher capital cost when compared to rehabilitation. Rehabilitation of sanitary sewer, the focus of this paper, is a more permanent fix than a repair with typically a lower capital cost than replacement. Once it is determined that a pipeline will undergo rehabilitation, a decision must be made regarding the choice of the many sanitary sewer rehabilitation methods to utilize.

The following sanitary sewer rehabilitation methods have been analyzed:

- CIPP (conventional and UV-cured)
- Sliplining (continuous, segmented, and non-round fabricated)
- Spiral-Wound Lining
- Panel Lining
- Close-Fit Pipe (fold and form)
- Coatings

This paper seeks to help wastewater utility managers and their consultants make an informed decision regarding which sanitary sewer rehabilitation method to utilize, once the choice is made to move forward with pipeline rehabilitation versus repair or replacement. There are many variables that must be considered when choosing a pipeline rehabilitation method. The following variables have been analyzed for the various pipeline rehabilitation methods available:

- Bypassing considerations
- Pipeline shape
- Pipeline size
- Capability of handling changes in pipe diameter or obstructions
- Speed of installation
- Strength
- Pipeline hydraulics
- Site constraints
- Owner and contractor familiarity

## RESULTS

Following are the results of analyzing the various sanitary sewer rehabilitation methods in reference to the identified variables.

**CIPP** – Conventional CIPP is the pipeline rehabilitation method with the most history, and therefore has a high level of Owner and contractor familiarity. Bypassing is necessary with the CIPP method. This method is used to rehabilitate a wide range of shapes and sizes. The thermal curing process (with steam or water) can take a substantial amount of time. Therefore, bypassing costs may be expensive with this

method. In addition, this method can be more disruptive than other methods due to the longer period of installation. The UV-cured CIPP method utilizes a fiberglass material that is thinner and stronger than conventional CIPP material. In addition, UV-cured CIPP can be installed in less time than conventional CIPP. Therefore, while the UV-cured CIPP material is more expensive than conventional CIPP, installation labor costs and disruption can be lower, in addition to lower bypass pumping costs. Additionally, the thinner and stronger material can provide better pipeline hydraulics and more of a structural liner than the conventional CIPP method.

**Sliplining –** Sliplining is common with a high degree of familiarity with Owners and contractors. Bypassing may not be necessary with this option. Therefore, where bypass pumping will be expensive, sliplining should be evaluated to determine the most cost-effective rehabilitation method. However, there are some significant limitations with sliplining. There may be a significant annular space between the host pipe and the liner pipe which may substantially limit pipeline hydraulics. A large area may be needed for construction with pit excavations. Additionally, open cut construction may be necessary for laterals. Sliplining can be performed with a wide variety of pipe shapes and sizes. Continuous sliplining is typically performed with smaller diameter circular pipes, while segmental sliplining is performed with larger pipes. Additionally, non-round pipes can be fabricated for segmental sliplining. Sliplining is considered a structural pipeline rehabilitation method.

**Spiral-Wound Lining** - Spiral-wound lining rehabilitation is much less common than CIPP or sliplining. However, there are some distinct advantages of this method over the more conventional rehabilitation methods. This method utilizes PVC strips up to 12" wide that are on a roll and continuously fed into the host pipeline. The spiral-wound method can be performed in a small area with tight access. Additionally, this method can be utilized for pipes of various shapes and sizes. Similar to sliplining, the annular space can be large, causing hydraulic issues. Recent developments for spiral-wound lining for smaller pipelines seek to reduce the annular space, and therefore, reduce the effects of this method on small diameter pipeline hydraulics. Skilled expertise is necessary for construction of this liner. This method of lining can be used for structural or non-structural purposes and can be a relatively quick installation.

**Panel Lining** - Panel lining is limited to large pipelines since person-entry is required for installation. Bypass pumping is typically necessary if the panels are being installed on the full interior of the pipe. However, bypass pumping may not be required if the panels are being installed only on the upper portion of the pipe interior, where more corrosion typically takes place. Another advantage of this method is that it requires a smaller working area outside of the pipeline than other methods. Panel lining is a less common rehabilitation method and skilled workers are necessary to ensure a proper bond between the panels and the host pipe. The panel lining method provides a high strength with a thin material. Additionally, panel lining can be performed on a variety of pipeline shapes and can handle small changes in pipeline diameter or configuration.

**Close-Fit Pipe** – While there are several different forms of close-fit pipe, the one principally utilized in the United States is close-fit fold and form PVC liners. This method is limited to small to medium size pipelines (4 to 30 inch diameter). However, there are certain advantages this method has over other rehabilitation methods. The fold and form PVC liner provides a high strength, and rapid installation. The familiarity of this product is mixed, with substantial use in some areas and no use in other areas. The PVC fold and form liner is collapsed and coiled on a reel, and therefore requires a smaller working space than some rehabilitation methods. Bypassing is typically required for this method.

**Coatings** –Polymer-based coatings can be utilized in gravity sewer applications. However, their use is significantly limited to low corrosion sanitary sewers that are easy to clean and prepare. They can be sprayed in larger pipes (person-entry) or in smaller pipes (robotic spray). Coatings are more typical with

manhole applications or water main applications than sanitary sewer pipelines. However, this method can be a lower cost method of rehabilitation for gravity sewer pipelines that experience minimally corrosive environments.

## DISCUSSION

After analyzing the various sanitary sewer pipeline rehabilitation methods, it is clear that there a few important variables that need to be considered when selecting the most cost-effective, least disruptive, rehabilitation method.

**No bypass pumping** - If bypass pumping is going to be expensive, it may be prudent to consider sliplining or panel lining (for the top portion of the pipe). If sliplining is determined to be the most cost-effective option, a pipeline that is specially fabricated for the interior shape/size of the pipe may be best to limit the effect on pipeline hydraulics.

**Minimal Public Impact** – If minimal public impact is desired, a rehabilitation process with rapid installation and/or small working area could be the best choice for sanitary sewer rehabilitation. In this case, the UV-cured CIPP method may be utilized with its rapid curing process. Additionally, spiral-wound lining can be installed rapidly in a small working area, and has the added benefit of installation with various sizes and shapes of host pipe. Close-fit pipe can be utilized with minimal public impact as well, however, this method is limited to small to medium sized circular pipe.

**Structural Considerations** – Some rehabilitation methods provide corrosion resistance and reduction of infiltration. However, at times, it may be necessary to also provide structural rehabilitation. If CIPP is utilized, the UV-cured CIPP provides a stronger and thinner material than conventional CIPP for structural applications. Additionally, close-fit and sliplining provide high strength rehabilitation for structural purposes.

## CONCLUSIONS

If pipeline rehabilitation is chosen over pipeline repair or replacement, there are many rehabilitation methods to consider. Many wastewater utilities would benefit from lower capital and/or life cycle costs and possible from lower public impact, if additional analysis of the proper rehabilitation method is performed before construction. Although there are many variables to consider when choosing the proper rehabilitation method, there are certain criteria that can quickly eliminate certain methods so that a determination can be made in short period of time.

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