

## Trenchless Sewer Rehabilitation

Rehabilitating the aging wastewater collection systems is increasing in importance. Cracks, sags, tree root intrusion and other structural defects develop over time in pipelines and other structures that comprise the wastewater collection system. These deteriorating conditions can increase the amount of inflow and infiltration (I/I) entering the system, especially during periods of wet weather. Increased I/I levels create an additional hydraulic load on the system and thereby decrease its overall capacity.

The traditional method of sewer repair is replacement or an additional parallel sewer using an open trench. Trenchless methods of rehabilitation use the existing pipe as a host for a new pipe or liner. Trenchless sewer rehabilitation techniques offer a method of correcting pipe deficiencies that requires less restoration and causes less disturbance and environmental degradation. Trenchless sewer rehabilitation methods include: Pipe Bursting, or In-Line Expansion; Slip-lining; Cured-In-Place Pipe; and Modified Cross Section Liner. These alternative techniques must be fully understood before they are applied. Below is a comparison of trenchless techniques.

Method	Diameter Range	Maximum Installation	Liner Material
Pipe Bursting	4-24 inches	750 feet	PE, PP, PVC, GRP
Slip-lining (Segmental, Continuous, Spiral Wound)	4-158 inches	1,000 feet	PE, PP, PVC, GRP
Cured-in-Place (Winched, Inverted)	4-108 inches	500-3,000 feet	Thermoset Resin/Fabric Composite
Modified Cross-Section (Deformed/Reformed)	4-15 inches	2,500 feet	HDPE
<b>Acronyms:</b> Polyethylene (PE), Polypropylene (PP), Polyvinyl Chloride (PVC), Glass-Fiber Reinforced Plastic (GRP), High Density Polyethylene (HDPE)			

### Advantages

- Reduces I/I levels
- Requires substantially less construction work than traditional open cut trench techniques
- Reduces surface disturbances, traffic and pedestrian detours, tree removal, construction noise and air pollution versus traditional methods

### Disadvantages

- Reduction in pipe diameter decreases the hydraulic capacity of the sewer, although the rehabilitated pipe may be less rough than the original
- Bypasses or diversion of flows are required
- Coordinating sewer lateral shutdowns is difficult and unpopular

### Costs

A cost comparison of trenchless and traditional sewer rehabilitation methods must consider the condition and site characteristics of the existing pipeline. Factors influencing the cost include:

- Pipe diameter
- Length of pipe to be rehabilitated
- Specific defects in the pipe (such as joint offsets, root intrusions, severe cracking, etc.)
- Depth of pipe to be replaced
- Location of other utilities that have to be avoided during construction
- Flow by-pass requirements
- Number of service connections that need to be reinstated

## Trenchless Sewer Rehabilitation (continued)

### Common Suppliers

National Rural Water Association Online Buyer's Guide - <http://nrwa.officialbuyersguide.net/>

### Source

- United States Environmental Protection Agency. Collection Systems O&M Fact Sheet September 1999, "Trenchless Sewer Rehabilitation" <https://www3.epa.gov/npdes/pubs/rehabl.pdf> [Online March 3, 2020]

### Other Links

- United States Environmental Protection Agency. Collection Systems O&M Fact Sheet "Sewer Cleaning and Inspection" <https://www3.epa.gov/npdes/pubs/sewcl.pdf> [Online March 3, 2020]

## Pipe Bursting

Pipe bursting, or in-line expansion, is a method by which the existing pipe is forced outward and opened by a bursting tool. The existing pipe is used as a guide for inserting the expansion head (part of the bursting tool). The expansion head, typically pulled by a cable rod and winch, increases the area available for the new pipe by pushing the existing pipe radially outward until it cracks. The bursting device pulls the new pipeline behind.

The expansion heads are categorized as static or dynamic. Static heads have no moving internal parts and expand the existing pipe through the pulling action only. Dynamic heads provide additional force by pulsating air pressure within the bursting tool. This is often required to penetrate difficult pipe materials and soils. The pipe bursting method is ideal for clay soil but is difficult to use in silty/sandy soils.

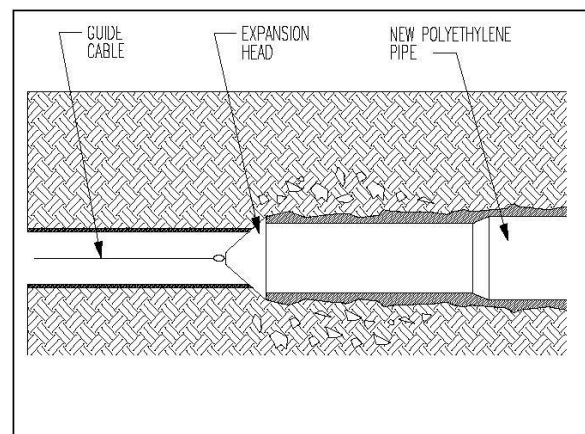
Manholes cannot function as access points to perform the rehabilitation and an insertion pit must be dug for each pipeline segment. Consequently, this method is not a completely trenchless technique. During the pipe bursting process, the rehabilitated pipe segment must be taken out of service by rerouting flows around it. After the pipe bursting is completed, laterals are re-connected, typically with robotic cutting devices.

### Advantages

- Increase in hydraulic capacity
- Can be used with both gravity and pressure pipeline
- Use of fusible pipe eliminates joints and benefits the structural integrity of the system

### Disadvantages

- Shallow installation has the potential of heaving paved roads and other surfaces
- May not be suitable for all materials
- Insertion pit is required
- Bypass or diversion of flow is required



### Costs

The rehabilitation costs for the pipe bursting method for pipelines 8-inches in diameter ranges from approximately \$75 to \$152 per linear foot (adjusted to January 2020 dollars). This cost includes a standard cleaning of the sewer line and inspection of the sewer before and after it has been rehabilitated.

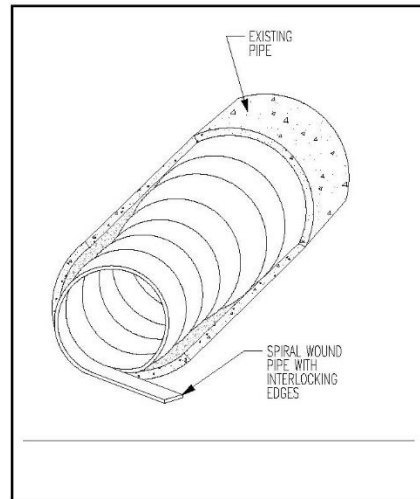
### Source

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## Slip-lining

The slip-lining method involves the process of installing a new liner of smaller diameter inside the larger diameter existing pipe. The space between the existing pipe and the new pipe is typically grouted to prevent leaks and to provide structural integrity. Although the diameter of the relined pipe is smaller than before, the smoother lining allows more efficient flow by decreasing the roughness coefficient. The common slip-lining materials include PVC and PE (polyethylene). Manholes cannot function as proper access points so an insertion pit must be dug for each pipeline segment. Methods of slip-lining include continuous, segmental and spiral wound. All three methods require laterals to be re-connected by excavation or by a remote-cutter.



### Advantages

- Existing flows do not have to be completely diverted
- Does not have to cure like cured-in-place pipe, making it ideal for larger diameter lines

### Disadvantages

- Installation is not practical for small diameter pipes
- Insertion pit is required
- Reduces pipe diameter, although the new pipe will general be smoother and have a lower roughness coefficient

### Costs

The rehabilitation costs for the slip-lining method for pipelines 21-inches in diameter ranges from approximately \$152 to \$323 per linear foot (adjusted to January 2020 dollars). This cost includes a standard cleaning of the sewer line and inspection of the sewer before and after it has been rehabilitated.

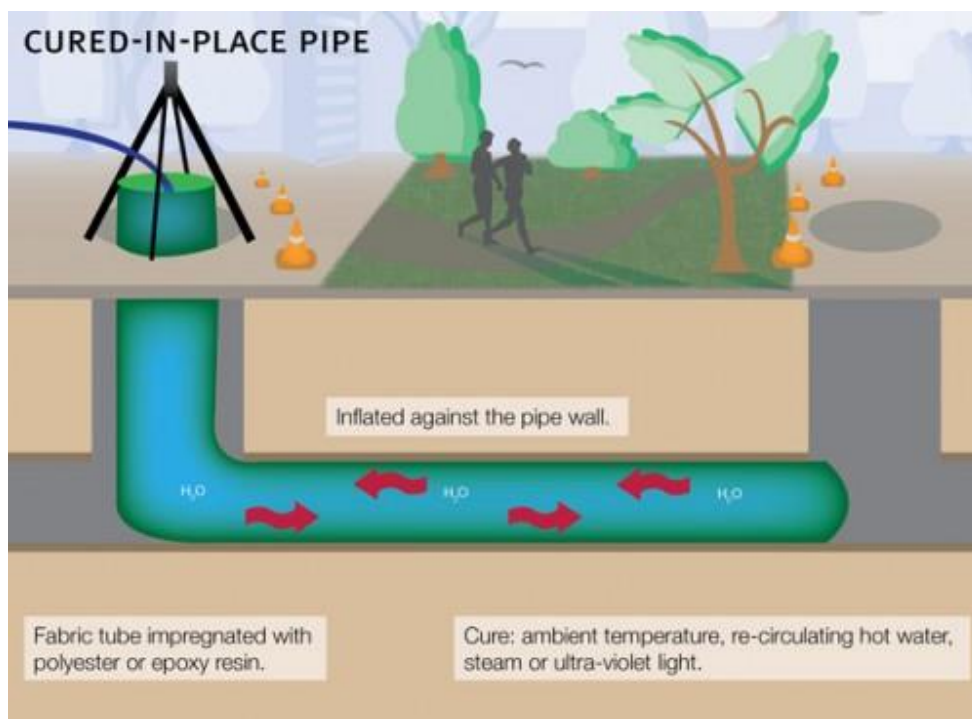
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## Cured-In-Place Pipe

The cured-in-place pipe (CIPP) rehabilitation technique consists of a flexible fabric liner, coated with a thermosetting resin. It is inserted into the existing pipeline and cured to form the newly lined pipe. The liner is typically inserted into the existing pipe through an existing manhole. Commonly manufactured resins include unsaturated polyester, vinyl ester, and epoxy, with each having distinct chemical resistance to domestic wastewater.

The CIPP method can rehabilitate pipelines with defects such as cracks, offset joints, and structurally deficient segments. The two primary methods of installing CIPP are winch-in-place and invert-in place. Laterals are typically reinstated with robotic cutting devices.



### Advantages

- Can be used with both gravity and pressure pipeline
- Liner is inserted into the existing pipe through existing manholes
- Thermosetting resin material bonds with the existing pipe material to form a tighter seal than most other trenchless techniques and provides structural support for the pipeline
- CIPP liners can act as a more permanent solution to the problem of root control within a pipeline

### Disadvantages

- Must allow adequate curing time
- Reduces pipe diameter, although the new pipe will general be smoother and have a lower roughness coefficient
- Bypass or diversion of flow is required

### Costs

The rehabilitation costs for the CIPP method for pipelines 8-inches in diameter ranges from approximately \$47 to \$125 per linear foot (adjusted to January 2020 dollars). This cost includes a standard cleaning of the sewer line and inspection of the sewer before and after it has been rehabilitated.



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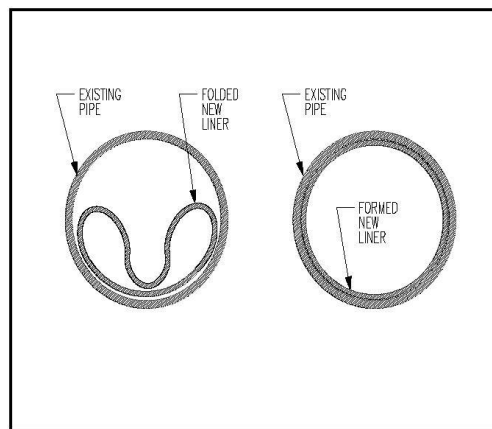
## Cured-In-Place Pipe (continued)

### Source

- United States Environmental Protection Agency – Collection Systems O&M Fact Sheet September 1999, “Trenchless Sewer Rehabilitation” <https://www3.epa.gov/npdes/pubs/rehabl.pdf> [Online March 3, 2020]

## Modified Cross-Section Lining

The modified cross section lining technique includes the deformed and reformed methods. These methods either modify the pipe's cross sectional profile or reduce its cross sectional area so that the liner can be extruded through the existing pipe. A new flexible pipe is deformed in shape and inserted into the host pipe. While the method of deforming the flexible pipe varies by manufacturer, with many processes referred to as fold and form methods, a typical approach is to fold the new liner into a "U" shape. After the liner is pulled through, the liner is heated and pressurized to conform to the original pipe shape. As with the CIPP method, laterals are reinstated with robotic cutting devices. Materials typically used for modified cross section linings include Polyvinyl Chloride (PVC) and High Density Polyethylene (HDPE).



### Advantages

- Does not have to cure like cured-in-place pipe
- Can be used with both gravity and pressure pipeline
- Liner is inserted into the existing pipe through existing manholes

### Disadvantages

- Liner does not provide structural support
- Infiltration may occur between the liner and the existing pipeline
- Reduces pipe diameter
- Bypass or diversion of flow is required

### Costs

The rehabilitation costs for the modified cross-section lining method for pipelines 8-inches in diameter ranges from approximately \$35 to \$96 per linear foot (adjusted to January 2020 dollars). This cost includes a standard cleaning of the sewer line and inspection of the sewer before and after it has been rehabilitated.

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