

Rehabilitation Technology

This chapter describes the rehabilitation technology database developed for the pilot projects and includes a brief description of the major rehabilitation technologies that were considered by designers.

4.1 Rehabilitation Technology Database

Prior to the I/I pilot project design, a database of sewer rehabilitation technologies and products was developed to identify trenchless technologies requiring minor or no excavation. The database includes information on rehabilitation products for sewer mains, manholes, and lateral and side sewers. The purpose of compiling the database was to provide an overview of commercially available rehabilitation technologies that could be included during subsequent design of the pilot projects.

The initial collection of rehabilitation technology information was obtained from work done in Miami-Dade County in 1999. Additional sources of database information included product brochures, videos, samples, phone interviews, seminars, venter meetings, and Web sites.

The database includes information on:

- Installation requirements (for example, cure times, substrate conditions, how a product is applied)
- Application (pipe size, pipe material, pipe shape)
- Contact information (manufacturer, local representative, local installer)
- Installation costs (provided by the manufacturer, local representative, or installer)
- Warranty
- List of local installations
- Life expectancy

The database is organized into three rehabilitation categories: pipes (sewer mains), manholes, and laterals and side sewers (see Table 4-1). In general, the products reviewed reduce infiltration. One exception is “lid sealing” for manhole repair, which corrects or reduces inflow.

Table 4-1. Database Categories

Rehabilitation Category	Sub-category
Pipes (sewer mains)	Spiral Wound PVC Liner
	Slip Lining
	Point Repair
	Pipe Bursting
	Lining (Other)
	Groutin
	Fold and Form
	Cured-In-Place (CIP)
	Coating
	CIP Point Repair
Point Repair (Other)	
Manholes	Liner
	Lid Sealer
	Grouting
	External Sealant
	Coating
Laterals and Side Sewers	Slip Lining
	Pipe Bursting
	Lining (Other)
	Grouting
	Fold and Form
	Cured-in-Place (CIP)
	Coating
	CIP Point Repair
Point Repair (Other)	

4.2 Rehabilitation Technologies

Following is a brief description of the major rehabilitation technologies that were considered by designers for use on the pilot projects. Designers found these technologies through a product database; standards for sewer construction; review of trade publications; discussions with contractors, suppliers, and manufacturers of rehabilitation technologies; and their own knowledge or experience of trenchless technologies. While an extensive information search was conducted, it is likely that some rehabilitation technologies were missed.

4.2.1 Pipes (Sewer Mains)

Cured-In-Place Pipe

Cured-in-place pipe (CIPP) is a rehabilitation technology where a fabric liner saturated with a liquid resin is placed inside the existing sewer main, inflated, and then cured. The technology is used to provide a lining inside a host pipe to prevent infiltration through defects in the pipe, or it may be used to form a structurally sound new pipe. The process may be used on an entire segment of sewer main between manholes, or in specific locations of a sewer main as a spot repair.

Changing the resin type, fabric type, installation method, cure method, and design condition will vary CIPP. Resin types are typically epoxy, vinylester, or polyurethane. Fabric types are typically polyester felt or fiberglass. The liner is pulled in (usually with a cable) or inverted in the host pipe. Cure method is usually by steam, hot water, ultraviolet light, or ambient air. The design condition is for fully or partially deteriorated pipe.

Pipe Bursting

Pipe bursting is used to replace an entire segment of sewer main between manholes. The process involves replacing an existing pipe by pulling in a new high-density polyethylene (HDPE) pipe and simultaneously bursting the old pipe into fragments with a steel- bursting head. The broken pipe fragments remain in place in the surrounding soil.

Pipe bursting installation techniques are static, pneumatic, or hydraulic. In static pipe bursting, the bursting head is attached to a pulling device (usually a chain, cable, or threaded rods) and is pulled by force of the pulling device. In pneumatic pipe bursting, the bursting head may be attached to a pulling device or not, but receives most of the force by a pneumatic device in the bursting head. In hydraulic pipe bursting, the bursting head has an expansion device that compresses surrounding soil by means of hydraulic jacking prior to the pull into that area.

Pipe Reaming

Pipe reaming is used to replace an entire segment of sewer main between manholes. The process involves a directional drill used with a rotating head to grind the existing pipe into small pieces while pulling in a new pipe of the same or larger diameter.

Chemical Grouting

Chemical grouting of sewer mains is a process where acrylamide grout is pressure-injected into a crack, joint, or lateral connection in a sewer main. A remotely operated grout packer delivers the grout to the selected location. The grout packer is similar to a pipe plug that uses air to inflate bladders at each end of the plug. The grout is then injected under pressure into the annular space between the plug and the sewer main, and then migrates into the cracks and open joints. The

flexible and non-cohesive grout remaining on the pipe wall when the grout packer is removed is pulled out, leaving grout in the joint spaces of the pipe.

Sliplining

Sliplining is typically used to line an entire length of sewer main between manholes, although it can be used in shorter portions of the sewer main. Sliplining involves pulling or pushing a smaller diameter pipe or liner into place inside an existing pipe. The sliplined pipe material is typically HDPE or fiberglass, although some other materials may be used. The pipe is typically grouted at the ends or over the length of the pipe.

Spiral Wound Pipe

Spiral wound pipe is a type of pipe used to slipline an existing pipe. This pipe is formed by spirally winding a continuous strip of some material into a pipe by means of a machine placed in the excavation or manhole. Strips can be made of polyvinyl chloride (PVC), HDPE, or steel. The strips are typically 2 to 6 inches wide and have a locking mechanism such that the strips “lock” into adjacent portions of the strip. Spiral wound pipe comes in two types: (1) those which are “wound” to the diameter required for sliplining, and (2) those which are “wound” in a smaller diameter, then twisted to expand the pipe to the host pipe diameter after the wound pipe is in place. There may also be steel wire or rebar placed in the strips to add structural support.

Deformed/Reformed HDPE

Deformed/reformed HDPE is a method for installing a new HDPE pipe or liner inside an existing sewer main. The HDPE pipe is pulled through a die to fold the pipe into a smaller diameter. The pipe is secured with breakaway plastic straps in the deformed position. The pipe is pulled into the sewer main and reformed either by plugging and pressurizing the main or by running a rounding device through the line to break the straps and allow it to form within the existing pipe.

Swage Lining

Swage lining is a method for installing a new HDPE pipe inside an existing sewer main. The HDPE pipe is pulled through a die or set of rollers to neck-down the pipe to a smaller diameter. This method relies on the property of polymeric materials to retain a memory of their original shape. The smaller diameter pipe is then pulled into the host pipe and pressurized to allow it to revert to the original diameter.

Fold and Formed PVC

Fold and formed PVC is a method for installing a new PVC pipe inside the entire segment of sewer main between manholes. The PVC pipe is heated and then folded into a smaller diameter at the factory. Then, after it is pulled into the sewer main, the PVC pipe is heated and pressurized to unfold and form to the shape of the host pipe. The PVC pipe is then cooled to form a rigid

pipe inside the host pipe. This process relies on the property of PVC that allows it to be rigid at normal temperatures and flexible at higher temperatures.

4.2.2 Manholes

Interior Cementitious Coatings

Cementitious coatings are applied with a trowel, sprayed on, or poured, and are used to seal cracks on all or portions of the interior of the entire manhole. These coatings typically contain a mix of cement and chopped fibers. The coatings may be sprayed directly on the wall, over a wire mesh, or poured into an HDPE form with rebar. The coatings often contain calcium aluminate as an additive, which provides additional corrosion resistance for the concrete.

Cured-In-Place Fiberglass Manhole Liners

Fiberglass manhole liners are used to line all or portions of the interior surface of the manhole. The liners consist of a fabric liner saturated with a liquid resin. The liner is placed inside the manhole, inflated, and then cured. The fabric typically consists of layers of woven fiberglass bonded to a non-porous membrane, the resin is epoxy, and the curing method is steam. Ladder rungs are removed during installation and may or may not be re-installed.

Paving Rings

A WHIRLyGIG (manufactured by the Whirlygig Company) is a concrete form and cutting gig designed to allow concrete to be poured. It is used to replace the chimney section of the manhole. The WHIRLyGIG has a rigid rubber form that sits on the top of the cone and makes up the interior of the chimney. Concrete is poured around the WHIRLyGIG to the edge of the excavation, and this concrete becomes the new chimney.

Leveling Ring Boots

Leveling ring boots are intended to seal the inside of the chimney section of the manhole. They are made of a circular heavy-ribbed rubber that is held in place with expanding interior stainless steel rings. The boots are installed by simply opening the cover, so no excavation is required. The boots need to be fit around any ladder rungs located in the chimney or the ladder rungs may be removed.

Manhole Pans

Manhole pans fit under the manhole cover and are intended to prevent inflow through holes in the manhole cover. The pans are either HDPE or stainless steel.

Reset Frame and Raise to Grade

Resetting the frame is a method intended to adjust a frame that has moved horizontally and/or to raise the cover above grade to prevent inflow, mostly in non-paved areas (for example, when a cover is located in a slight depression where ponding of water occurs). The installation involves minimal excavation – only enough to allow replacement of damaged concrete leveling rings and addition of new rings to bring the top of the frame above grade.

Cement Patching Grouts

Cement patching grouts are hand-applied grout mixtures used to seal cracks on all or portions of the interior of the manhole. There are many different compositions of these grouts.

Interior Epoxy Coatings

Epoxy coatings are applied as a spray and are used to coat the interior of the entire manhole to form a water/vapor barrier. These coatings are two-part epoxy, typically 100- percent solids by volume. They require abrasive blasting or high-pressure water cleaning for surface preparation.

Interior Polyurethane Coatings

Polyurethane coatings are applied as a spray and are used to coat all or portions of the interior of the entire manhole to form a water/vapor barrier. These coatings are made of urethane resin. They require abrasive blasting or high-pressure water cleaning for surface preparation.

Exterior Coatings

Exterior coatings are used on all or portions of the barrel, cone, and chimney sections of manholes. These coatings are unique in that they require less of a bond than interior coatings, due to the fact that the backfilled soil holds them in place and any groundwater presses the coating onto the manhole. These coatings come in different types: spray-on cementitious, epoxy, or polyurethane; shrink-wrap plastic; and/or adhesive rubber tapes. These coatings require excavation around the manhole.

PVC Manhole Liners

PVC manhole liners are used to line all or portions of the interior surface of the manhole. They are made of sheets of PVC and are mechanically or adhesively connected to the manhole. Mechanical connection is either by: (1) protruding locking shapes of the PVC material which is embedded into grout applied to the interior of the manhole, or (2) by attachment to the manhole by stainless steel anchors with a PVC cap welded over the top of the anchor. Adhesive connection is by a polymer applied to the concrete manhole, which is then bonded to the PVC with an activator.

Pre-Formed Fiberglass or HDPE Manhole Liners

Pre-formed fiberglass or HDPE manhole liners are rigid shapes fabricated at a plant to match the interior size of the manhole. They are used to line the interior surface of the manhole in the base, barrel, cone, and sometimes in the chimney sections. The liner is installed by excavating and removing the manhole cone section. Then the liner is inserted and the cone section replaced. For installations in portions of the manhole, the edges of the liners are grouted to form a seal with the manhole surface.

Chimney Barriers

The I/I Barrier (manufactured by Strike Products) is one proprietary product considered a chimney barrier. It is used to rehabilitate the chimney section of the manhole. The I/I Barrier consists of a rigid medium-density polyethylene riser with a thick base that sits on top the cone section of the manhole. The concrete manhole rings are then stacked on the thick base on the outside of the riser. The riser becomes a barrier to I/I entering the chimney section.

Manhole Covers

Gasketed manhole covers are steel covers with an inset gasket either in the frame or placed between the frame and cover. They are intended to prevent inflow from around the manhole cover.

Solid manhole lids without holes are available, as are plugs for the holes.

HDPE Leveling Rings

HDPE plastic leveling rings are meant to replace concrete leveling rings. The leveling rings are not solid HDPE; rather, they are hollow with support ribs.

New Concrete Leveling Rings

New concrete leveling rings are used to repair the chimney section where existing brick or concrete chimneys have worn out. The leveling rings may be sealed with non-shrink cement grout, a rubber gasket, or butyl rubber mastic. Likewise, the frame may be sealed to the chimney by the use of a rubber gasket or butyl rubber mastic.

Pipe Penetration Repairs

Kor-N-Seal® boots are a proprietary product consisting of a rubber boot that uses an interior stainless steel band to seal to the manhole core drill and an outer stainless steel band to seal to the sewer main. In existing manholes, a remote core drill must be performed to allow use of this gasket.

LCT™ gaskets are a proprietary product consisting of a rubber gasket that can be cast into new manholes and sealed around the sewer main.

Sand collars are a short section of the bell end of a PVC pipe with a gasket. The collar has sand embedded on the outside for grout adhesion. The sand collars are grouted into manhole openings for pipe penetrations.

New Concrete Manholes

New concrete manholes are used to replace existing manholes. The new manholes are typically installed with rubber gaskets between barrel sections. Cement patching grout is typically used on all joints between base, barrel, cone, chimney, and frame sections.

Fiberglass Manholes

Fiberglass manholes are used to replace the base, barrel, cone, and in some cases the chimney portions of existing manholes. The manholes are typically pre-fabricated to ship to the site in one unit. The fiberglass manholes require excavation and full installation, as is required for new concrete manholes.

HDPE Manholes

HDPE manholes are used to replace the base, barrel, cone, and in some cases the chimney portions of existing manholes. The manholes are typically pre-fabricated to ship to the site in one unit. The HDPE manholes require excavation and full installation, as is required for new concrete manholes.

4.2.3 Laterals and Side Sewers

Cured-In-Place Pipe

CIPP installation and products for laterals and side sewers are similar to and in some cases the same as for sewer mains. A fabric liner saturated with a liquid resin is placed inside the existing pipe, inflated, and then cured. The intent is to prevent infiltration through defects in the pipe, or CIPP may be used to form a structurally sound new pipe. The method may be used on all or portions of the lateral or side sewer. A cleanout or excavation is required at some location on the lateral or side sewer to allow access for insertion of the liner.

Pipe Bursting

Pipe bursting is used to replace all or a portion of the lateral and side sewer between the house and sewer main. The process involves replacing an existing pipe by pulling in a new HDPE pipe and simultaneously bursting the old pipe into fragments with a steel bursting head. The broken

pipe fragments remain in place in the surrounding soil. A cleanout is usually placed where the pipe-burst lateral connects to existing pipe, either at the house or at the property line.

Pipe bursting of laterals is usually done by the static method due to the lower force required to burst the smaller diameter laterals.

Chemical Grouting

Chemical grouting of laterals and side sewers is a process where a crylamide grout is pressure-injected into a joint or lateral connection point of a lateral or side sewer. The grout is delivered remotely to the location by a mechanism that has two sealing devices; the grout is injected into the entire space between the two. The flexible and non-cohesive grout is pulled out of the pipe in the area between the sealing devices, leaving grout in the joint spaces of the pipe. Where used to seal the connection between the sewer main and lateral, three devices are used, two in the main and one in the lateral.

Service Connection Rehabilitation Liners (SCLs)

The service connection liner (SCL) is a cured-in-place liner used to seal the service connection between the sewer main and lateral. The SCL, installed by remote device, typically consists of a fiberglass fabric and polyester resin. A portion of the liner seals around the opening of the lateral in the sewer main, and a portion (usually 2 to 6 inches in length) is located in the lateral. The SCL is held in place either by an epoxy that forms a bond at the interface between sewer main and lateral, or by mechanical friction between the SCL and the lateral.

Service Connection and Lateral Liners (SCLLs)

The SCLL is a cured-in-place liner used to seal the service connection between the sewer main and lateral and some portion of the lateral and/or side sewer. The SCLL, installed by remote device, typically consists of a felt fabric and polyester resin. A short portion of liner is placed in the sewer main around the full diameter, and a second portion is located a defined distance up the lateral and/or side sewer. The two pieces are attached. Some products can be used for lining more than 80 feet up the lateral. Tees and fittings can sometimes be lined through; however, they are usually excavated to allow for reconnection.