

Mokapu CIPP Case Study & Innovations in Trenchless Technologies for Wastewater System Rehabilitation

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Insituform Technologies, Inc.*



Trenchless v. Dig and Replace



What is CIPP?

- Developed in 1971, cured-in-place pipe (CIPP) is a trenchless technology developed by Insituform
- The end product is a jointless, seamless, pipe-within-a-pipe that protects against spills, breaks and pipeline leakage
- Insituform has installed over 90 million feet of CIPP and has been the industry leader for over 35 years



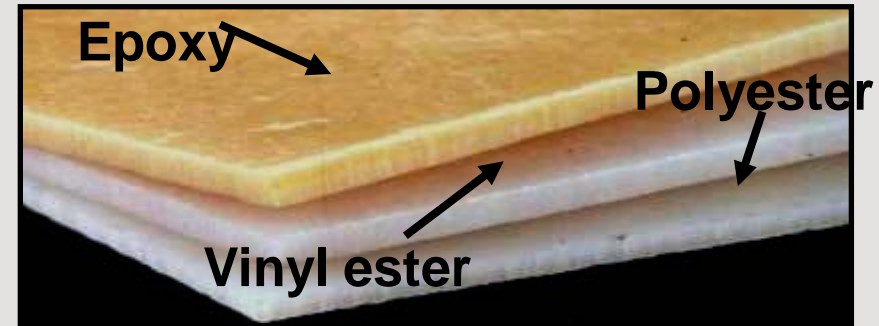
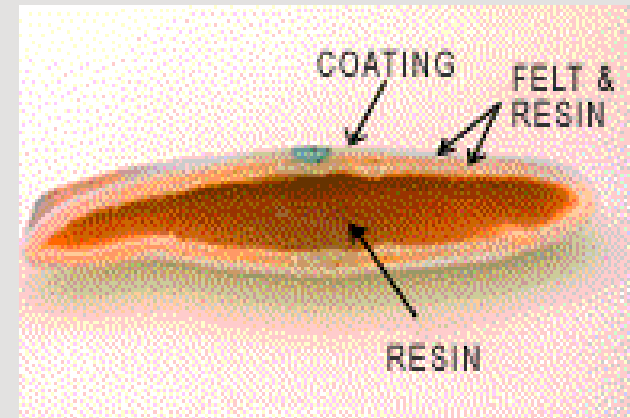
Benefits

- Eliminate infiltration and exfiltration
- Restore structural integrity
- Eliminate joints, root intrusion and leaks
- Prevent sinkholes and surface settlement
- Suitable for irregularly shaped pipes and changes in pipe diameter
- Increase flow capacity
- Protect pipes from corrosion
- Reduce maintenance
- Minimal traffic disruption
- Fewer social costs to open-cut



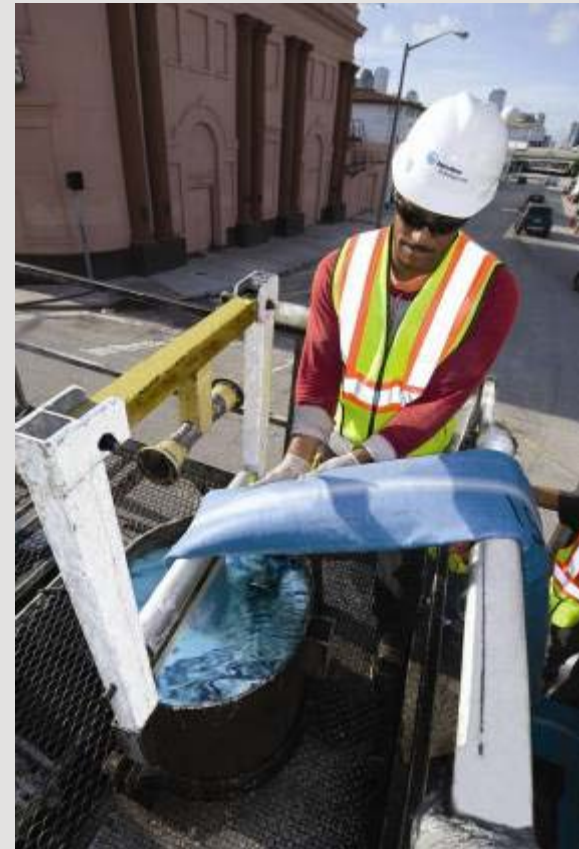
Materials

- Felt material:
 - Custom made to hold resin in place until cure has been achieved
 - Ensures proper pipe thickness
- Exterior coating allows for serial vacuum impregnation and prevents resin loss during installation and cure.
- Thermosetting resin retains its shape with no residual memory.



Water-Inversion Water-Cure

- Tubes are inverted using water pressure
- Water is heated to cure the inverted tube
- Final product is a brand new, jointless, pipe-within-a-pipe
- Tried and true method used for over 35 years

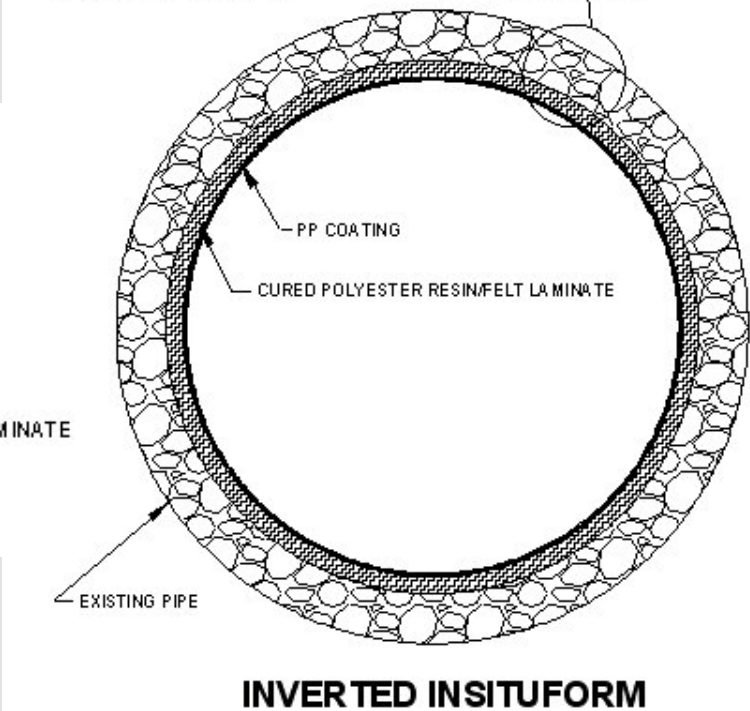
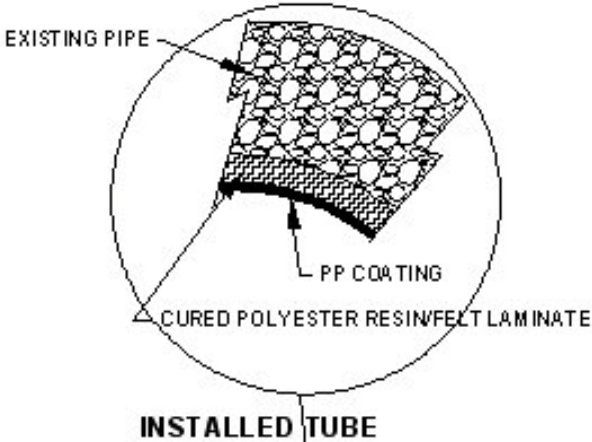
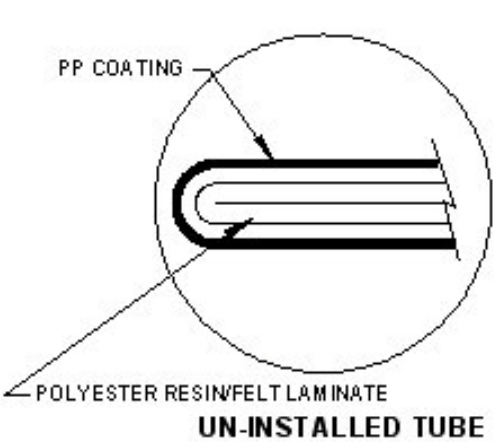


Air-Inversion Steam-Cure

- High quality end product
- Short installation cycle
- Specialized installation equipment minimize footprint
- Specially engineered resin and coatings used for AISC
- Diameters 6 to 96 inches
- 15,000 separate AISC installations in 2008 alone – almost 3.5 million feet
- Uses 95% to 98% less water
- 50% reduction in energy usage
- Virtually eliminates discharge of process water into sewers
- No grade limitations
- Shorter cool-down allows lateral reinstatement to take place sooner



Insituform Tube

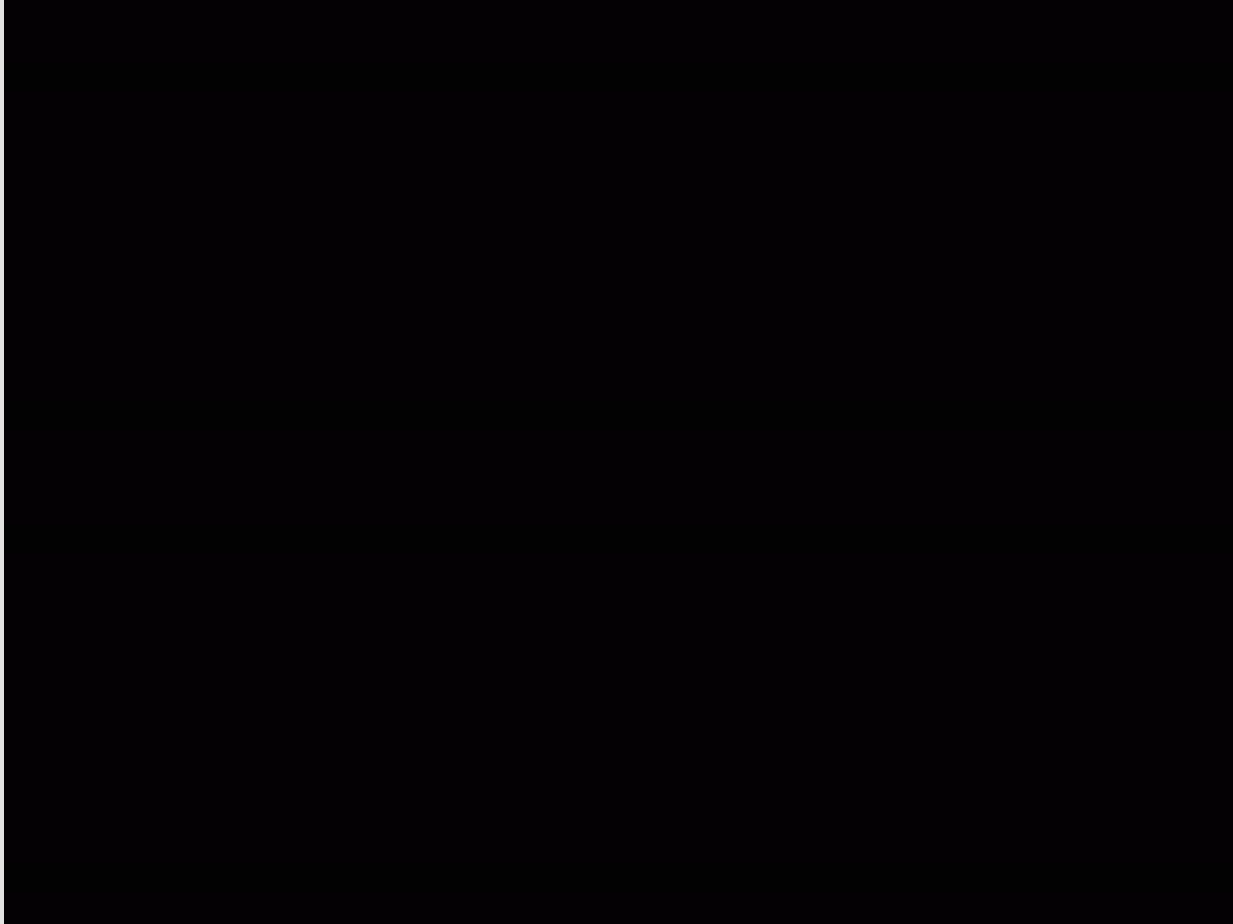


CIPP Installation

- Thermosetting resin is injected into a felt tube
- The tube is inserted into an existing host pipeline by either pull-in or inversion (water/air)
- The tube is inflated to the size of the host pipe
- The CIPP tube is cured using hot water or steam
- Ends are cut and the final product is a fully-functional pipe-within-a-pipe



Installation Animation



CIPP Technical Envelope

Diameter Range	6 to 96 inches
pH Range	.5 to 10.5
Effluent Temperature	Up to 140
Fully Deteriorated Pipe Condition	Yes
Partially Deteriorated Pipe Condition	Yes
Bends	Yes
Offset Joints	Yes
Diameter Changes	Yes, without manhole access
Thickness Changes	Yes, without manhole access
Typical Shot Length	200 ft. to 1,000 ft.
Host Pipe Shape	All Shapes
Host Pipe Material	All Materials

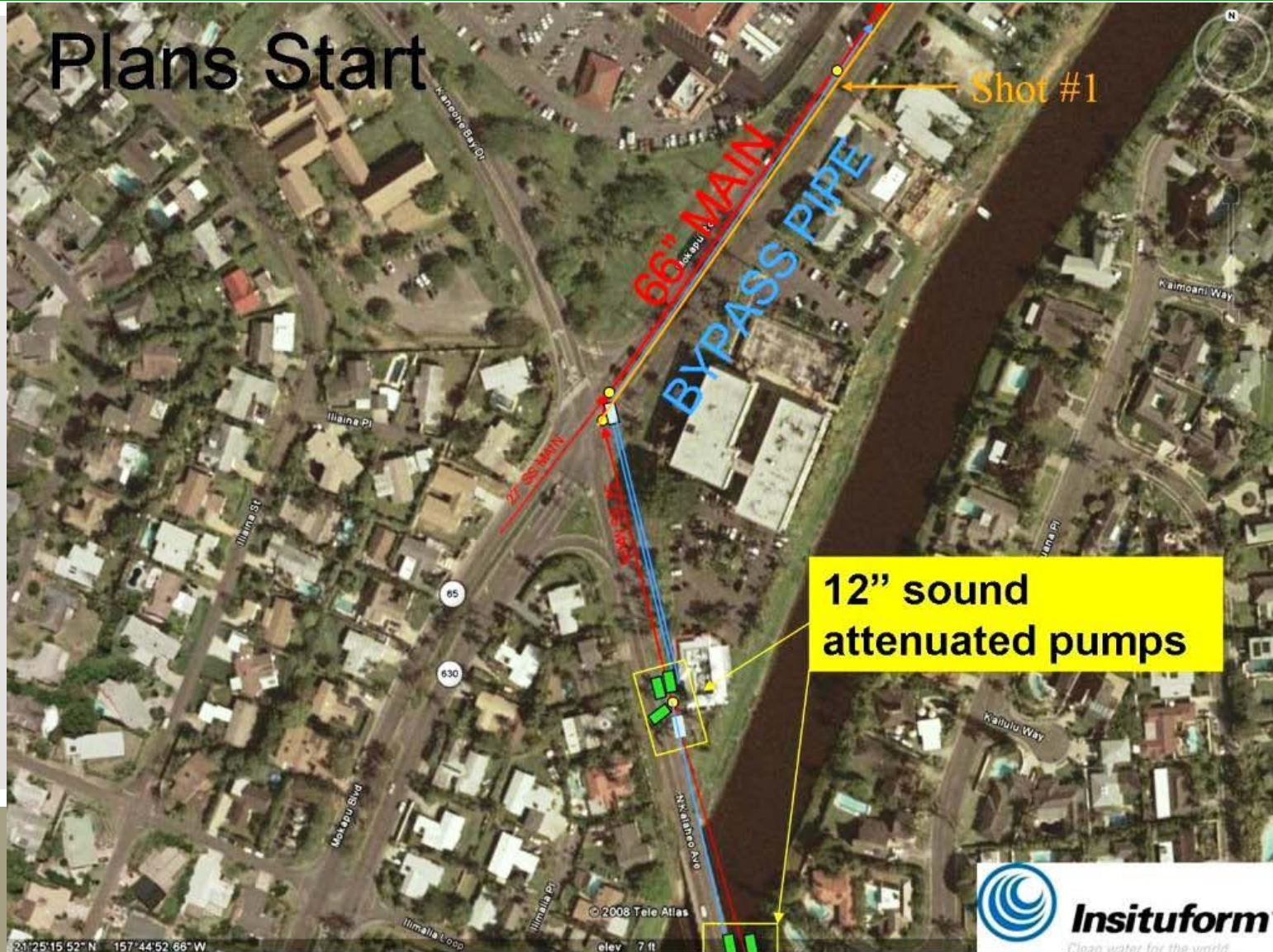
Mokapu Case Study

- Deteriorated with a chance of collapse, the pipe runs along Kalaheo Avenue and Mokapu Road in the Aikahi Loop area.
- A 3400-foot section of reinforced concrete pipe was rehabilitated as part of Honolulu's ongoing capital improvement program.
- As groundwater infiltration and a high water table around the job site made controlling water during any open cut work extremely challenging, cured-in-place pipe (CIPP) was chosen as the best option.



Project Setup

Plans Start



Project Setup

Plans Middle



Special project characteristics

- Bypass pumps were operated 24 hours/day
- Wooded boxes were constructed and placed over 4" trash pumps to reduce the operating noise levels.
- The boxes were constructed of 1/4" plywood and had cut-outs to facilitate hose connections and fueling requirements.
 - Similar methodology was used on a project in Maui, which received no any noise complaints.



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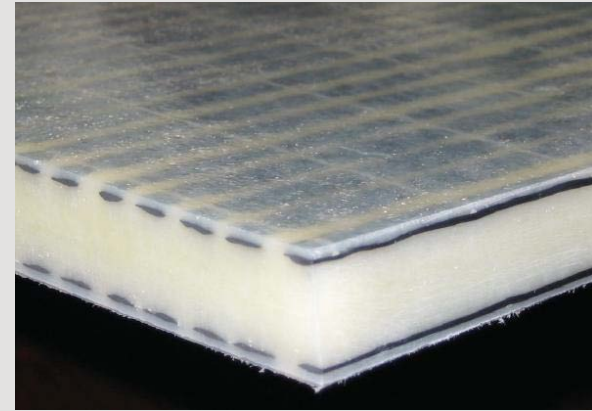
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Innovations in CIPP

- Pull-in installation – iPlus Infusion®
- Fiber-reinforced CIPP – iPlus® Composite
- CIPP for potable water and pressure pipes – InsituMain™



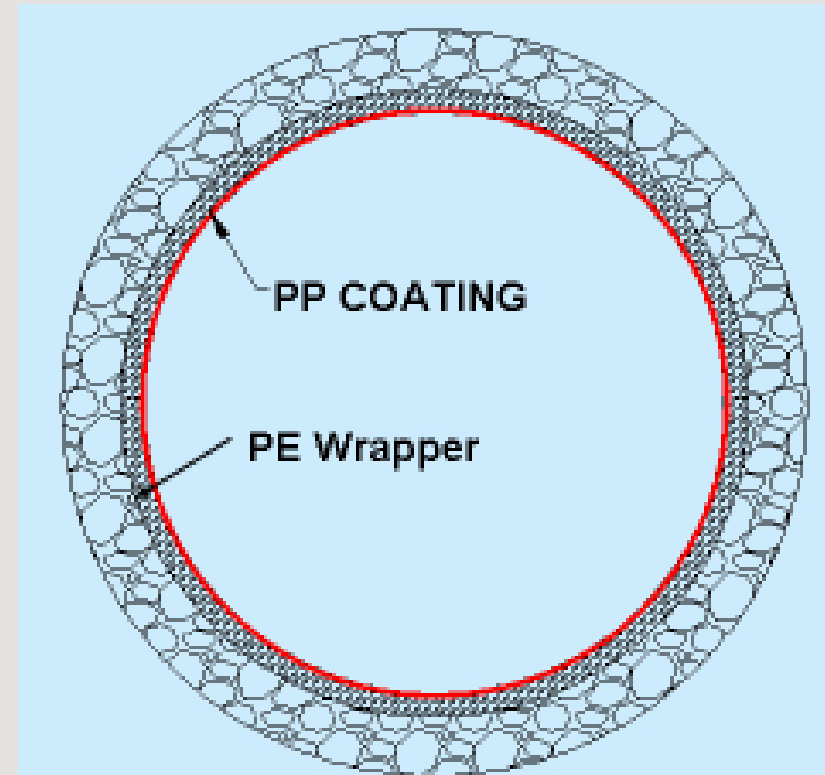
Pull-in Steam-Cure

- Small installation footprint minimizes disruption
 - Boiler truck can be located 250 ft from MH
 - Ideal for small backyard easements
 - Minimal traffic disruption
 - Reduced equipment on street
- 700+ ft installations
- Shorter installation time
 - Shorter sewer outage



Tube Construction

- Protects tube during installation
- Allows for better resin impregnation
- Minimizes resin washout
- Reduces occurrence of resin slugs in lateral



Pull-in Installation

- Tubes wet-out using specialized controlled resin impregnation system
- Resin-saturated tube is pulled into damaged pipe
- Air is used to inflate the tube and steam is used to cure the resin
- Service laterals are restored internally



Reduced Equipment Requirements

- Smallest jobsite footprint of any CIPP process
- Portable equipment
- Ideal for off-road installations
- Minimal traffic disruption
- Reduces stress on tube
- Shot lengths up to 700 feet
- Meets or exceeds the physical properties set forth in ASTM F1743



Technical Envelope

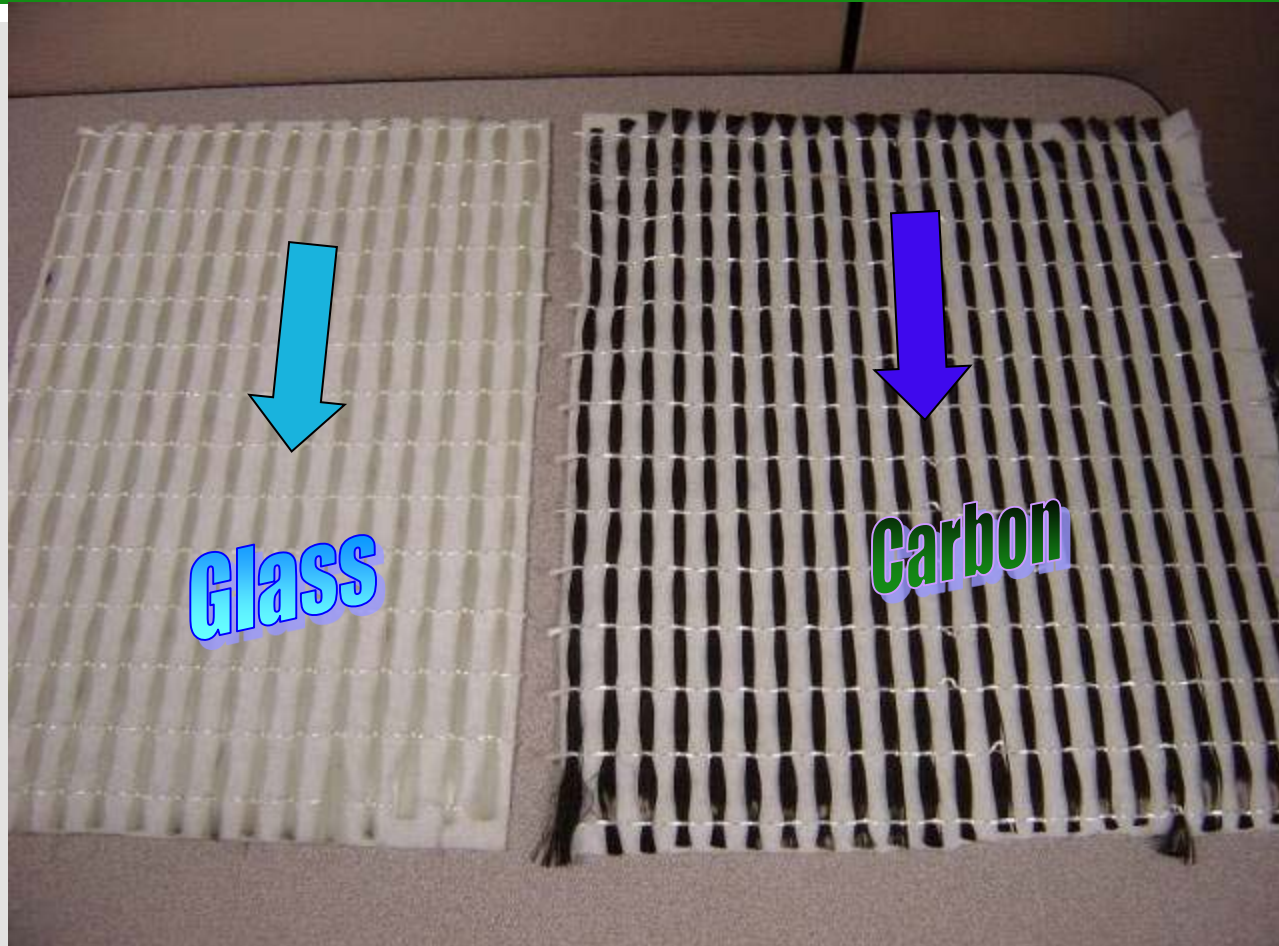
Diameter Range	6 – 12 in.
pH Range	.5 – 10.5
Effluent Temperature	Up to 140 F
Fully Deteriorated	Yes
Partially Deteriorated	Yes
Bends	No
Offset Joints	Yes
Shot Length	Up to 700 ft
Host Pipe Material	All, except truss

iPlus™ Composite

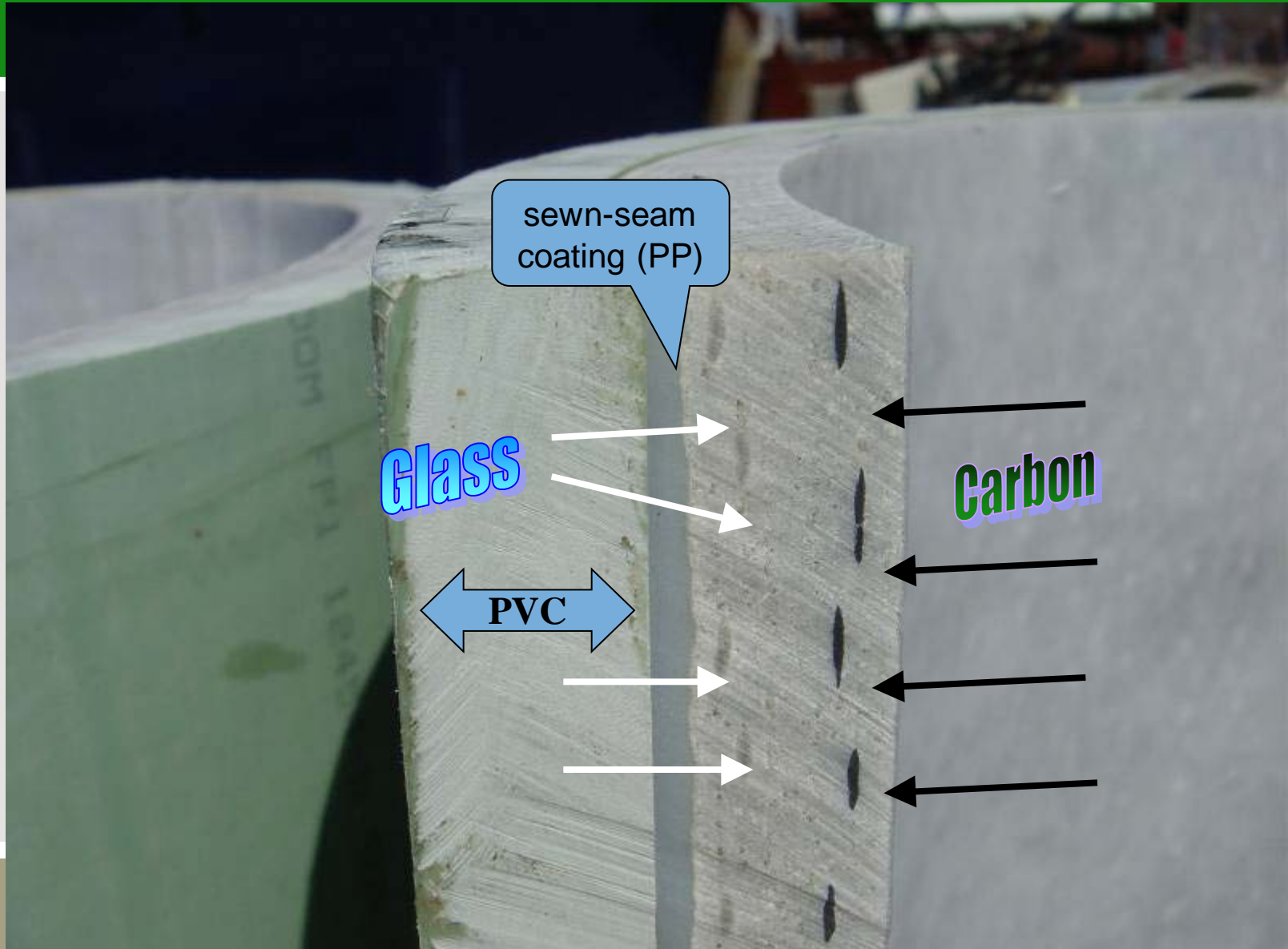
- High-strength, fiber-reinforced composite CIPP for rehabilitation of medium- to large-diameter pipes.
- Fiber reinforcement provides maximum stiffness which results in thinner tube walls
 - Carbon
 - Glass
- Composite sandwich technology



iPlus™ Composite



iPlus™ Composite



iPlus™ Composite Benefits

- Design flexibility – thickness is no longer the only variable
- High strength and modulus → thinner walls
- Larger finished pipe inside diameter
 - Better flow capacity
- Less weight to transport
 - Fewer on-site wet outs
- Easier to handle and install
 - Expedites jobsite activities
 - Reduces project risk



Technical Envelope

Diameter Range	24 to 96 inches
pH Range	.5 to 10.5
Pipe Condition – Fully Deteriorated	Yes
Pipe Condition – Partially Deteriorated	Yes
Bends	Yes
Offset Joints	Yes
Host Pipe Shape	All Shapes
Host Pipe Material	All Materials

Completed iPlus™ Composite



30-inch iPlus® Composite installation at a service location. Service connection opened using diamond or carbide cutter.

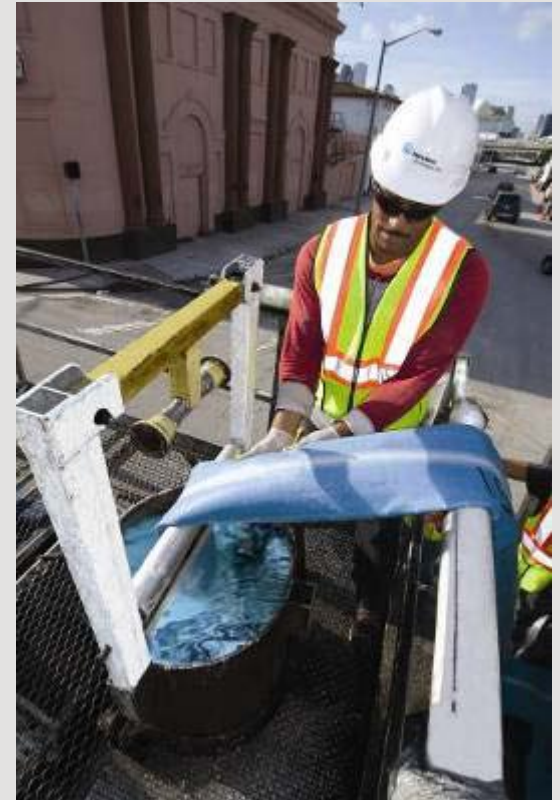
CIPP for Pressurized Lines

- AWWA Class III or Class IV rating
- Can be a structural solution
- Corrosion-resistant
- Small jobsite footprint
- Typically reinforced with materials such as fiberglass



What is Cured-In-Place Pipe?

- Developed in 1971 by Insituform, cured-in-place pipe (CIPP) is a trenchless technology
 - Initially used in sewers
 - Modified properties made it suitable for the drinking water market
 - End product is a jointless, pipe-within-a-pipe that protects against spills, breaks and pipe leakage
- Over 25,000 miles of CIPP have been installed in the last 38 years by CIPP contractors



Product Development

- The InsituMain™ system
 - Recently-introduced CIPP product for pressure pipelines
 - Utilizes proven CIPP technology
 - Extension of existing pressure pipe lining products available since 1995



InsituMain™ Product Characteristics

- Designed as fully structural, independent of host pipe
- Jointless, continuous pipe lining
- Tight fit maximizes flow capacity
- Materials inhibit further corrosion or internal buildup
- Bond to host pipe eliminates need for specialty fittings
- Certified to ANSI/NSF Standard 61
- Manufactured and installed under ISO:9000 certified quality management system



InsituMain™ Technical Envelope

Diameter Range	6 to 36 inches
Effluent Temperature	Up to 120 F
Internal Pressure Capability	150 psi
Bends	Up to 22.5
Host Pipe Material	All Materials
Mechanical Properties	Exceeds ASTM F1216 and ASTM F1743

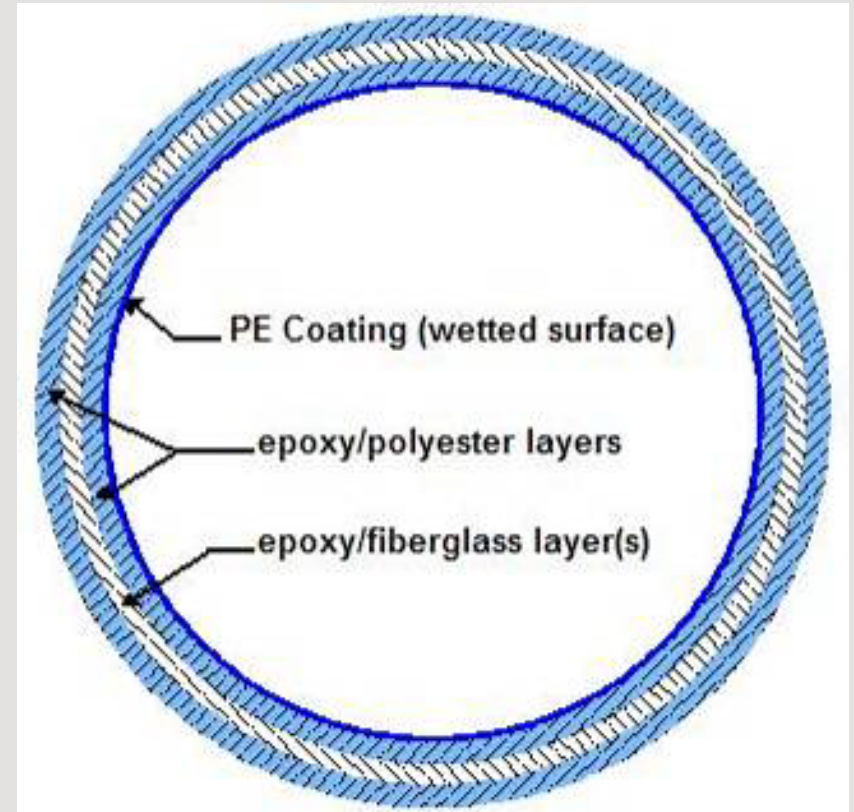
InsituMain™ Applications

- The system is suitable for the following applications:
 - Distribution and transmission mains
 - Cooling water lines
 - Fire water mains
 - Industrial pressure applications
 - Sewage force mains



InsituMain™ Composite Structure

- Epoxy/fiberglass structure
 - Provides high tensile strength
 - Number of layers vary depending on diameter and internal pressure
- Epoxy/polyester felt structure
 - Provides for external load capacity
 - Layer thickness can be varied depending on loading conditions
- PE coating
 - Water contact surface
 - Coating also provides water barrier for installation processes



InsituMain™ Design

- Internal pressure standalone design of 150 psi
 - Hydrostatic burst tested up to 1300 psi
 - Custom designs possible
- External loading design accounts for:
 - Soil
 - Groundwater loads
 - Traffic
 - Other live loads



InsituMain™ Manufacturing



- Custom manufactured glass reinforced tube
- Tube impregnated with epoxy resin – regional facility or near jobsite
- Typically transported to job site in refrigerated trucks

Installation Process – Bypass and Pipeline Access

- Bypass is set up pre-installation for potable water pipelines and for non-potable pipelines as needed
- Disinfection per AWWA/owner standards ensures continuous supply of safe drinking water
- Pits are dug to access lines



Pre-Installation – Cleaning

- Pipeline is cleaned using drag scrapers, high pressure water jetting, pigs or other similar equipment, as needed



Plugging of Services

- Pipeline is inspected by CCTV before lining
- Any service connections are temporarily plugged using CCTV and robotics
- Plugs prevent resin migration into the service connection



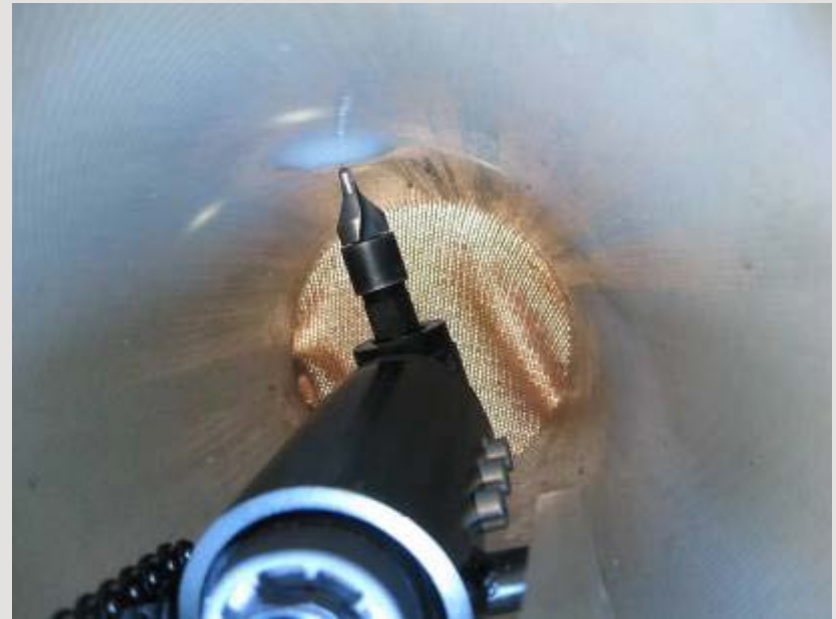
InsituMain™ Installation

- InsituMain is installed utilizing the inversion or pull-in process
- Liner is formed under pressure utilizing hot water or air/steam
- Lengths of 500 ft to 750 ft typical
- Longer lengths possible depending on site conditions
- Hydrostatic pressure testing follows lining, as required
- ASTM F1216 or F1743



Service Connection Reinstatement

- Using a robotic cutting device and CCTV, operator enters the lined pipe and cuts out each service connection
- Process allows services to be abandoned and/or replaced externally, as required



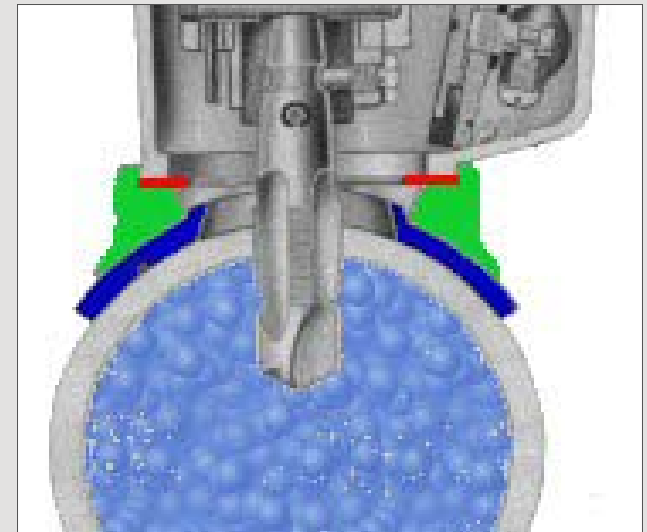
Restoring Service

- Lined pipe disinfected per AWWA/owner requirements prior to reconnecting to system
- Standard fittings (MJ, etc.) are installed to reconnect the lined pipe section with existing system



Future Connections

- Typical maintenance equipment can be used on InsituMain™
- Any time after lining, the Owner can add fittings (valves, tees, ARV's, repair spool pieces, etc.) with standard equipment
- Capability to perform hot taps using standard off-the-shelf equipment
- Eliminates the need for specialty fittings



Potable Water Case Study

- Water main renewal
- 600 linear feet
- 8-inch diameter
- 80-year-old steel host pipe
- Depth of pipe: 15 feet deep
- Three installations



Non-Potable Case Study

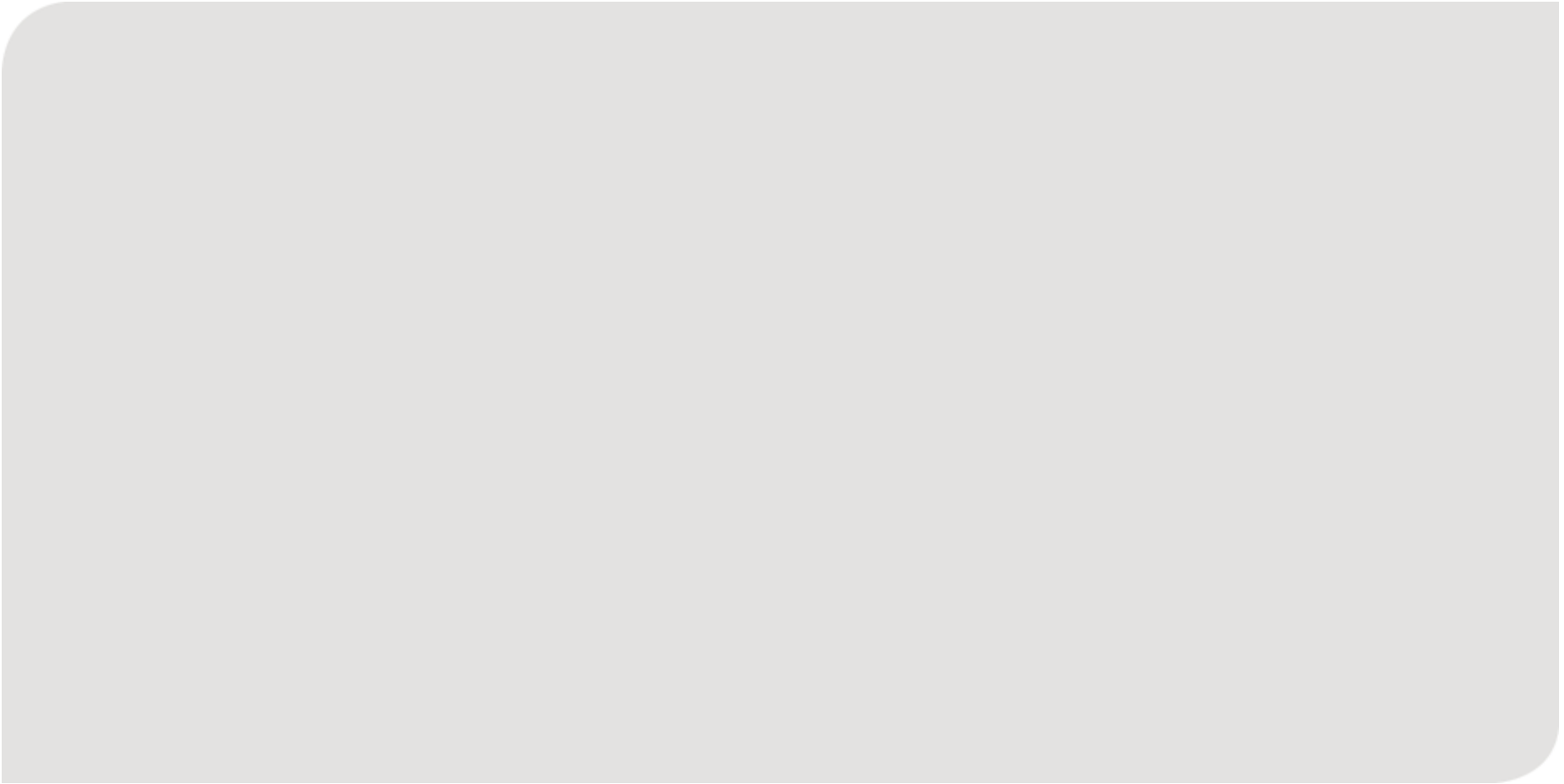
- Sewage Treatment Plant
- 6-inch diameter
- Cement-mortar lined DIP
- Three pipes connecting two main clarifiers
- 90 psi operating pressure
- Deteriorating due to wear and abrasion



InsituMain™ Product Benefits

- Utilizes proven CIPP technology
- Provides a fully structural, independent pipe lining system
 - Handles both internal and external load requirements
- Small footprint and excavations minimize social costs
- Eliminates the need for specialized fittings





Questions?

Thank you.

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