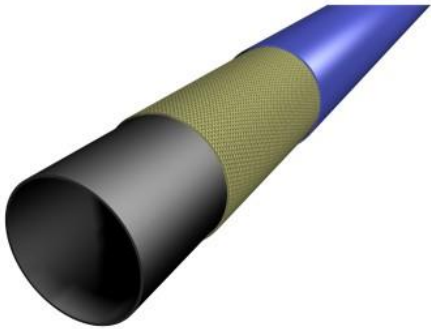
Trenchless Rehab & Replacement



Tennessee Association of Utility Districts

Vital for Tennessee's future

Underground Solutions®

An azuria Water Solutions Company

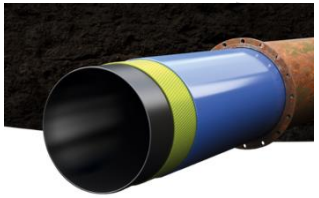
Trenchless Solutions

CIPP

Cured-in-place pipe

PRIMUS Line System

Flexible Fabric Reinforce Pipe (FFRP)



Pipeline Rehab Portfolio

Vylon Pipe

Gravity Sewer Segmented PVC

Fusible C900 PVC & TerraBrute CR

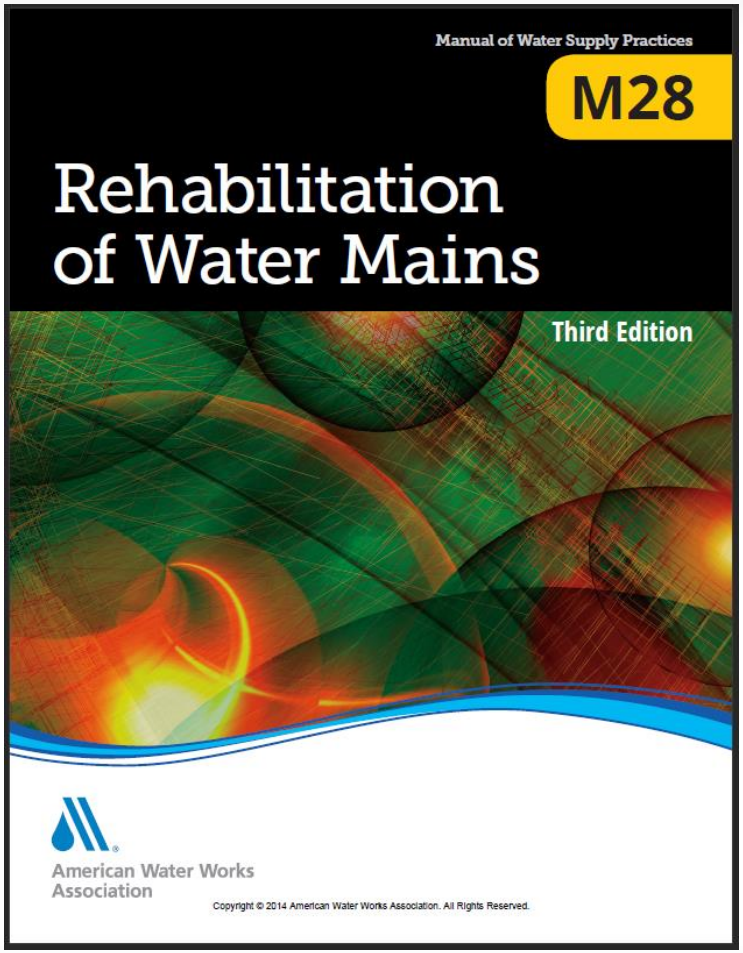
HDD, Pipe bursting, Sliplining, open-cut

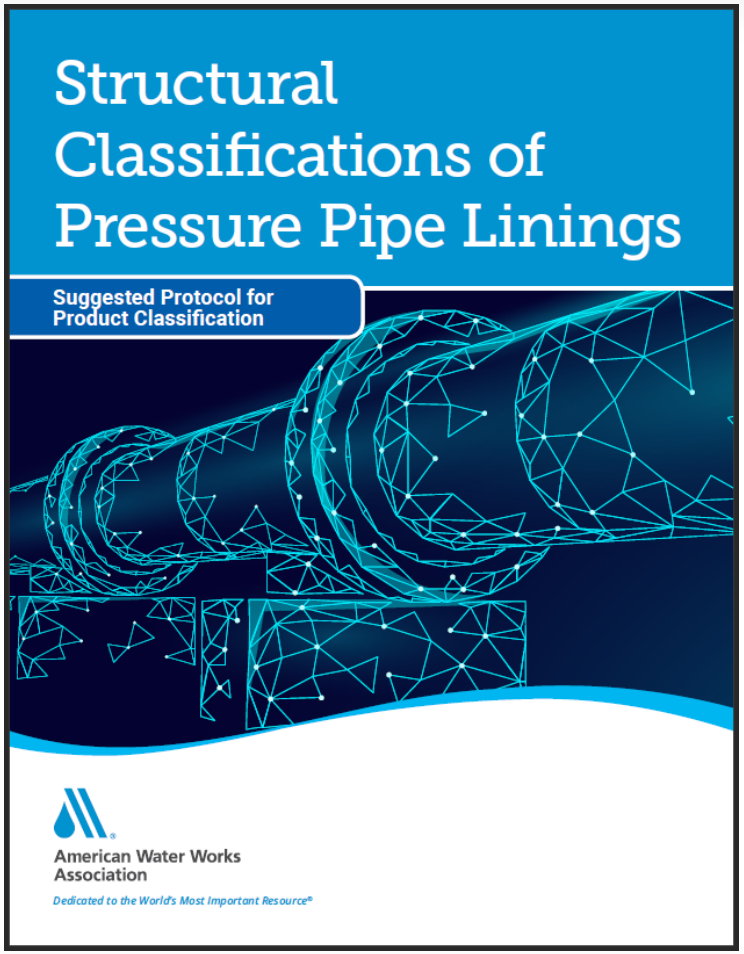
Presentation Outline

- AWWA Trenchless Structural Classifications
- Conventional Sliplining – Class IV
- Modified Sliplining – Class III
- HDD Replacement – Class IV
- Static Pipebursting – Class IV

AWWA Rehabilitation Structural Classifications

AWWA Publications

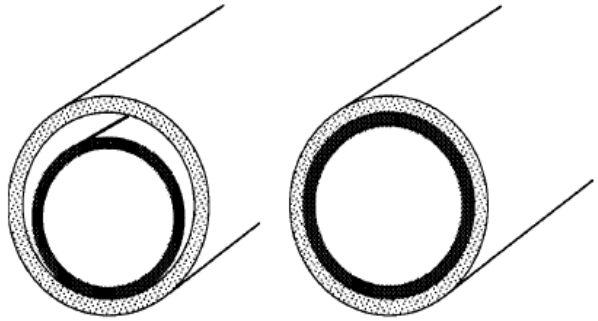




PRESSURE LINER CLASSIFICATIONS

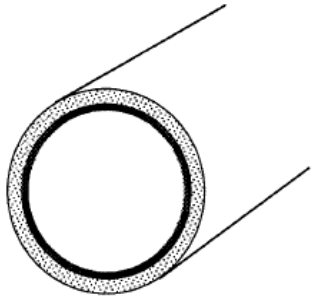
Two Categories of Pressure Pipe Liners:

- **Independent** – liner is designed for all applicable loads independent of the host pipe



INDEPENDENT
loose-fitting and close-fitting

- **Interactive** – liner relies on radial support from host pipe to handle internal loads without failing



INTERACTIVE

TRENCHLESS METHOD BY CATEGORY & CLASSIFICATION

Industry Classification	Non-Structural	Semi-Structural		Fully Structural
AWWA Classification	**Class I**	**Class II**	**Class III**	**Class IV**
Trenchless Products	Cement Mortar Lining Epoxy/ PU lining	CIPP Modified Epoxy Lining	CIPP Modified Sliplining	CIPP Sliplining Modified Sliplining

Trenchless Considerations vs. Open Cut

- Pipe Material - Structural Condition of Existing Pipe
- Fittings, Valves & Off-Sets
- Hydraulic capacity requirements (=, <, >, etc.)
- Soil type (sand, clay, silt, rock, etc.)
- Depth of existing pipe
- Existing utilities and structures
- Sub-aqueous crossings
- Bridge mounted WMs
- Bypass Considerations (hydrant locations, length, size, road crossings)
- Pit or open cut requirements (water table, dewatering, etc.)
- Site Restrictions (footprint, pipe layout, disruption, etc.)
- Traffic Control
- Site Restoration

Pre-construction Investigation and Preparation

- Site Visit
- As-builts
- Plans
- Operational Data
- CCTV
- Pipe Cleaning
- Point repairs

CONVENTIONAL SLIPLINING

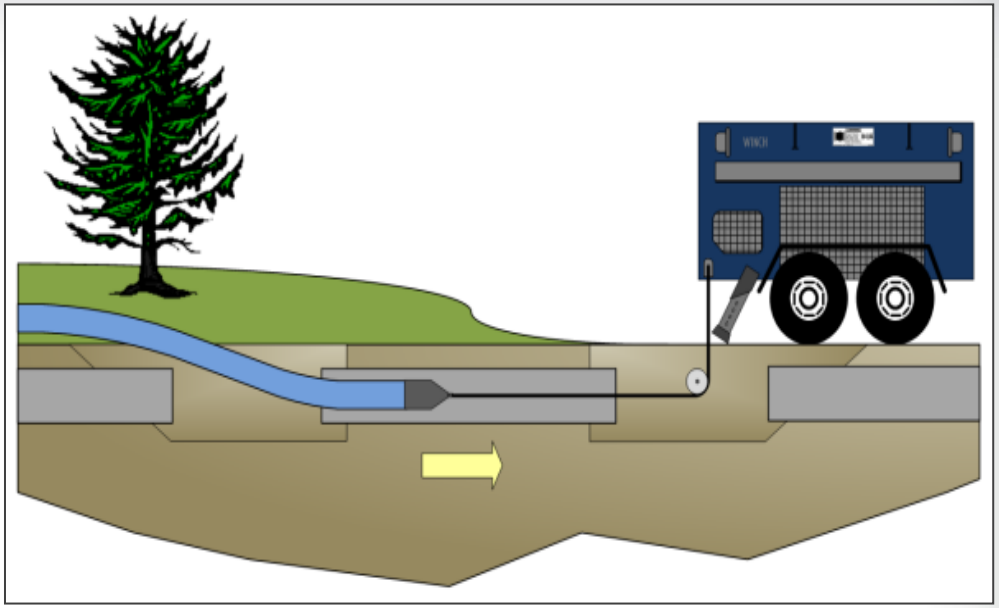
CLASS IV

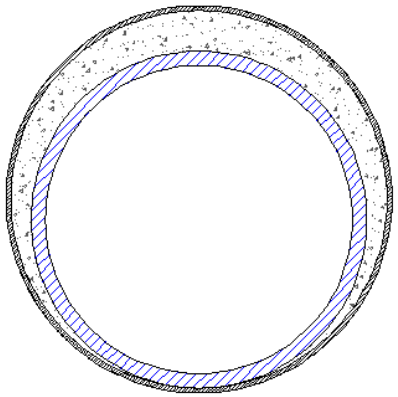
Fully – Structural Solution

Independent Liner – New Pipe inside Existing

Sliplining

- Provides maximum flow with an independent fully structural solution
- Results in a smaller ID than the host pipe
- Improvement in internal friction often minimizes flow loss – “C” factor
- 2” of annular space
- Grouting of the annular space between the existing and new pipe is usually required

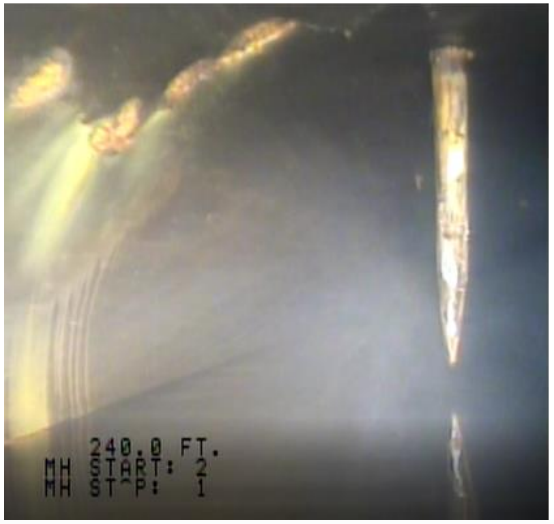




Constructability Considerations

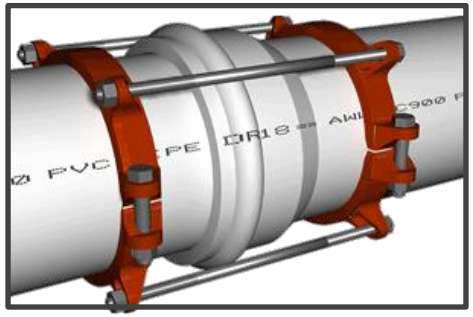
Sliplining

- Video inspection of host pipe – condition, deflections, vertical profiles and stranded appurtenances
- Ability to dig out connections before sliplining
- Layout area for fused pipe – as well as entrance pit constraints – possibility for “fuse & pull” or in pit fusion
- New carrier pipe material selection
- Pull proof piece – verify alignment
- Connections



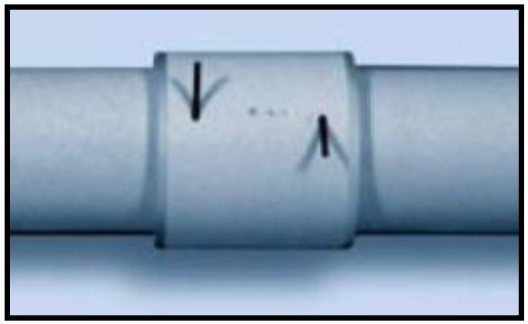
Cross Sectional Area & Deflection

12” C900 Restrained PVC



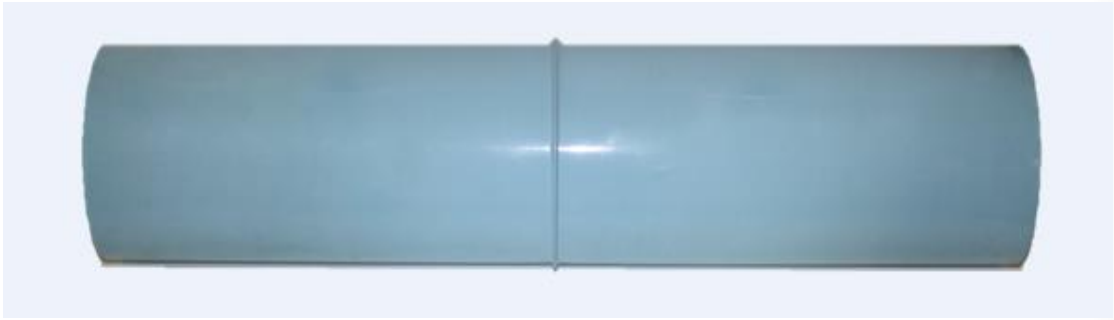
Barrel = 13.2”
Bell = 16.75”
Restraining Hardware = 19.45”

Bulldog Restraint
Barrel = 13.2”
Bell = 16.13” DR 18



Certa-Lok
Barrel = 13.2”
Bell = 15.83”

TerraBrute CR
Barrel = 13.2”
Bell = 16.36” DR 18



Fusible C900 PVC Pipe

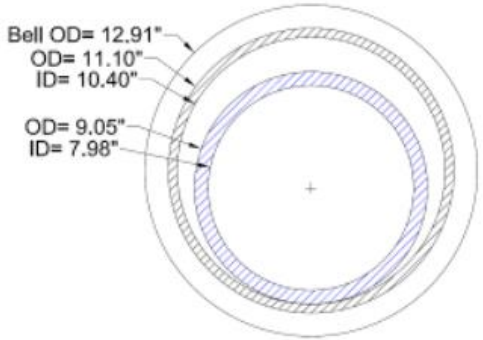
Barrel and Fused Joint Have Consistent O.D. = 13.2”

Elkton, TN – Elk River Water Line Crossing Repairs

Sliplining

SOUTH GILES UTILITY DISTRICT

8-inch DR 18 Fusible C-900® pipe inside 10-inch CL 350 ductile iron



- Original Casing/Carrier = 6” B&S PVC inside 10” DI
- New Carrier pipe = 680 linear feet of 8” DR18 Fusible PVC
- US31 HWY Bridge
- Fuse & install – 7 hrs
- Contractor – Williamson Construction
- Engineer – Goodwyn, Mills, and Cawood

Pipe pull-in with pull rods

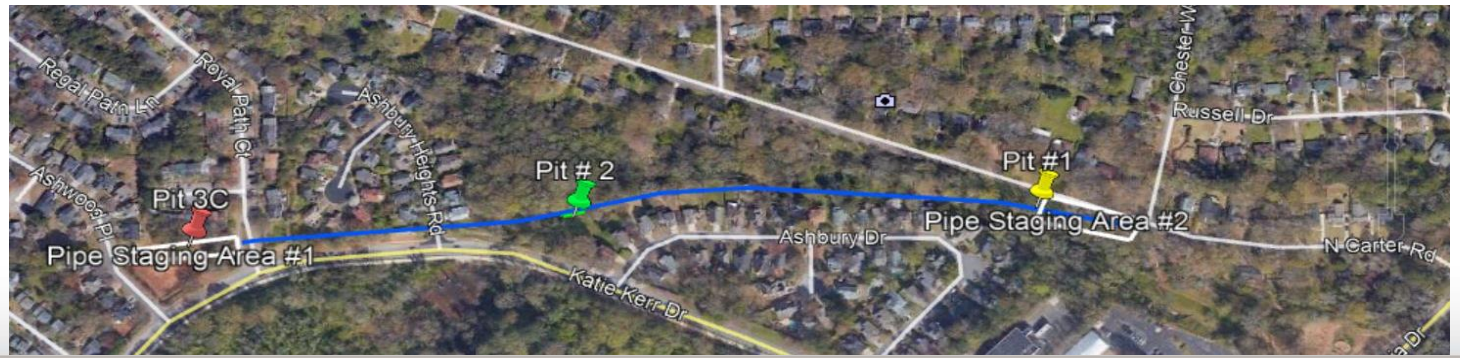
Fusible PVC® pipe in casing

New pipe string installation

Slipline

Metro Atlanta Slipline

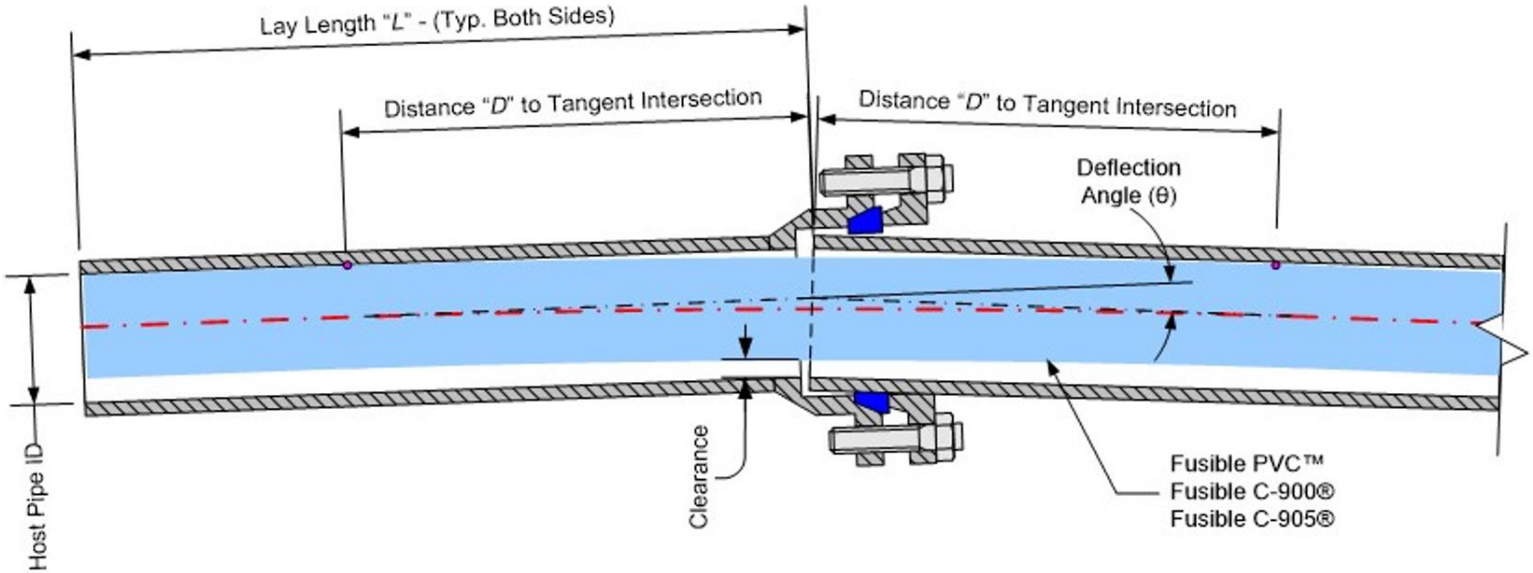
Project:	**Katie Kerr Rehab**
Location:	**Decatur, GA**
Length:	**2,250 LF**
Host Pipe:	**30” Steel**
Pipe Size:	**24” DR18 DIPS Fusible C-900® PVC pipe**
Pressure Test:	**200 psi**
Install:	**Static Pipe burst machine**



Dresser Coupling

underground SOLUTIONS®

Single Joint Deflection



Pipe Type	DIPS	
Nom. Dia.	24.00	in
Pipe OD	25.80	in
Bend Radius (R_B)	538.00	ft
Deflection Angle	4.00	degrees
Host Pipe ID	30.00	in
	2.50	ft
Lay Length (L)	500.00	ft

	ft.	in.
Distance (D)	18	9
Clearance	0	0.28

Disclaimer:
The values shown are based on minimum requirements of the selected FPVC™ pipe product.

La Brea Subarea GW Supply Project

Sliplining

City of Beverly Hills

- **Sliplined inside 1950s 18” & 24” Concrete pipe**
- **7,000-ft of 14” FPVC inside 18” on La Cienega**
- **2,300-ft of 16” FPVC inside 24” on Le Doux Rd**
- **Engineer – Hazen & Sawyer**
- **Contractor MNR Construction**

Charleston, SC – Wappoo Road WM Slipline

Sliplining

Charleston Water System

Charleston Water System

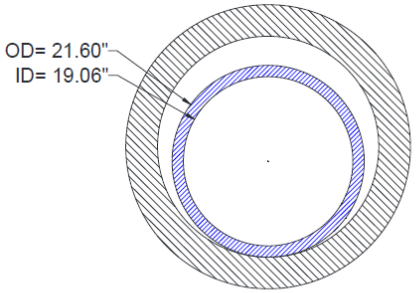
- 4,940’ linear feet of 8” DR18 Fusible PVC
- Sliplined inside 12” Cast Iron
- Engineer – Arcadis
- Contractor – Carroll Enterprises

Slipline – Rehab 30” Transmission WM

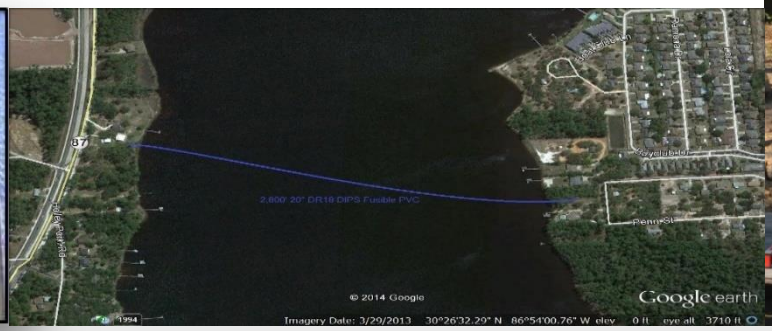
Sliplining

Fairpoint Regional Utility System
Navarre, FL

- 2,800’ 30” DR9 HDPE Water Transmission Main – Installed via HDD in 2004
- 2014 develop leak -Video Inspection revealed a gradual, spiraling, longitudinal crack - ~ 400’ from south end @ 55’ depth
- HDPE line was Sliplined with 2,800’ of 20” DR18 Fusible C-900 PVC
- HDD Pull-in method
- Completed & Pressure Test Feb ‘15



20" DR 18 Fusible C-905®
Inside Exist. 30" DR 9 HDPE



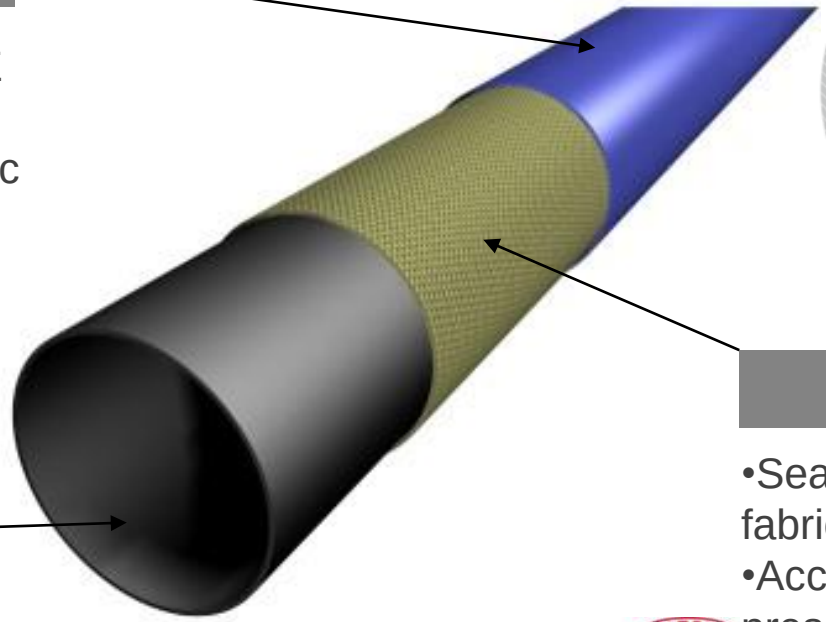
MODIFIED SLIPLINING

CLASS III
Semi – Structural Solution

Flexible Fabric Reinforced Pipe - Primus

External Layer

- Abrasion-resistant PE sheath
- Protection of the fabric during insertion



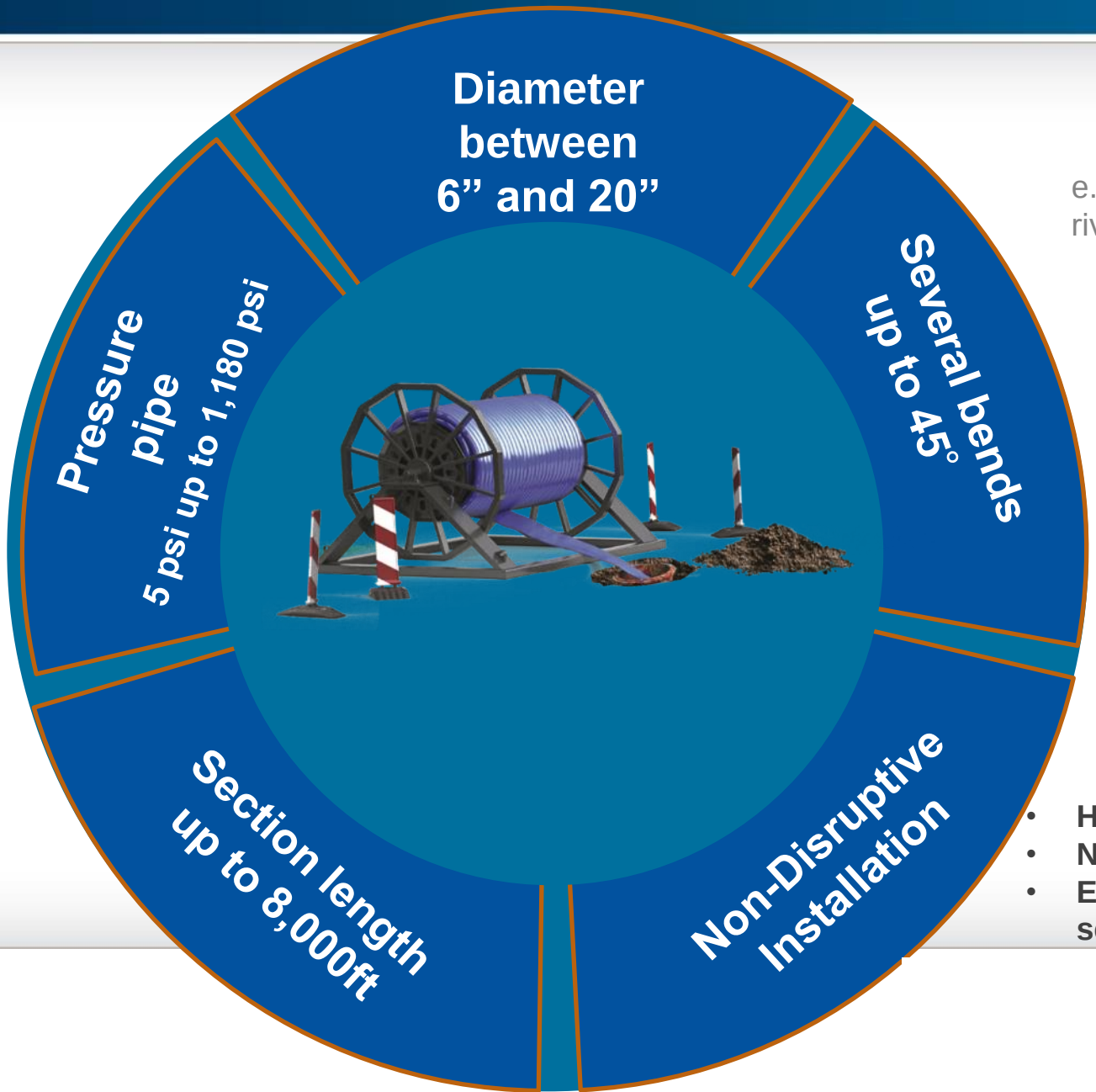
Kevlar®

- Seamless, woven aramid fabric
- Accommodates the operating pressure independently from host pipe
- Wall thickness of 6 mm
- Liner is not glued to host pipe (no steaming or curing processes)
- Installed with annulus space

Internal Layer

- Fluid specific
- Based on PE, TPU
- 15 potable water certifications (AS/NZS 4020:2005/NSF61)

Technical Envelope



e.g. Syphons, river crossings ….

- **High Traffic areas**
- **Nature parks**
- **Environmentally sensitive areas**

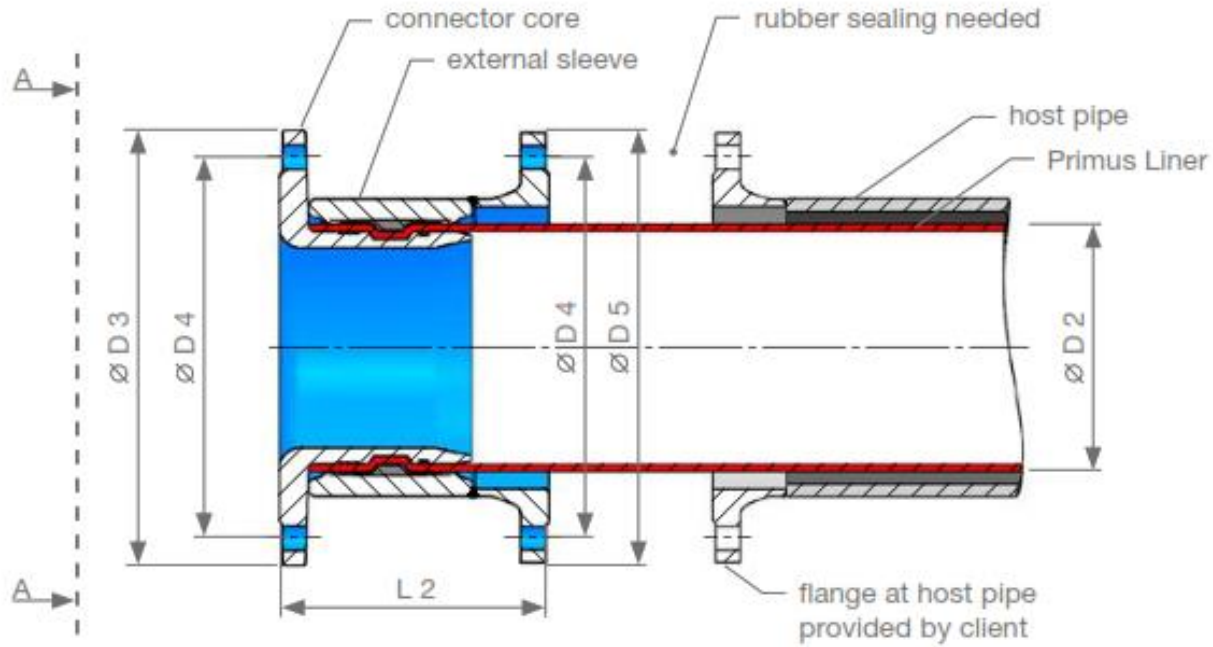
Installation Process

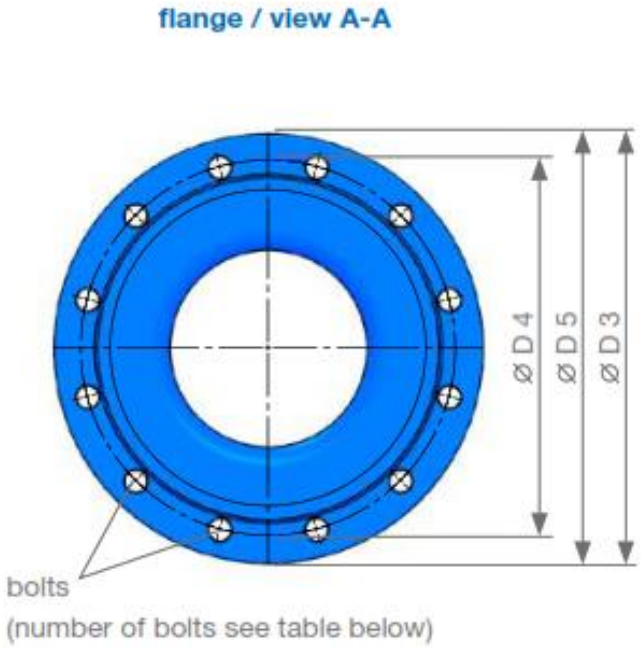
Insertion

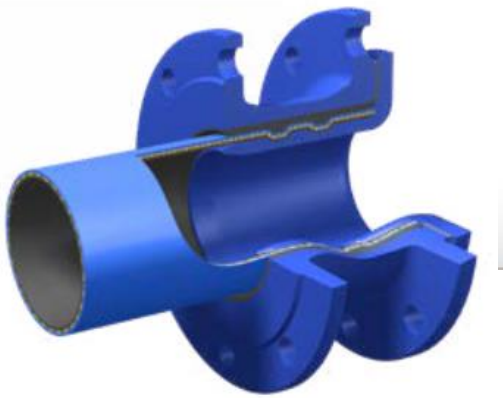
Pullback

Inflation

End Connections







HDD River Crossing Rehabiliation - FFRP

Project Description

- Pipe Material: 16” HDPE (HDD)
  - Two recent isolated failure locations @ fusion joints
- Length: ~1,100 LF
- Pressure: 80 psi
- Type: Potable water
- Adjacent to high-speed roadway

Bridge Water Main Rehabilitation - FFRP

Ductile Iron Bridge Crossing

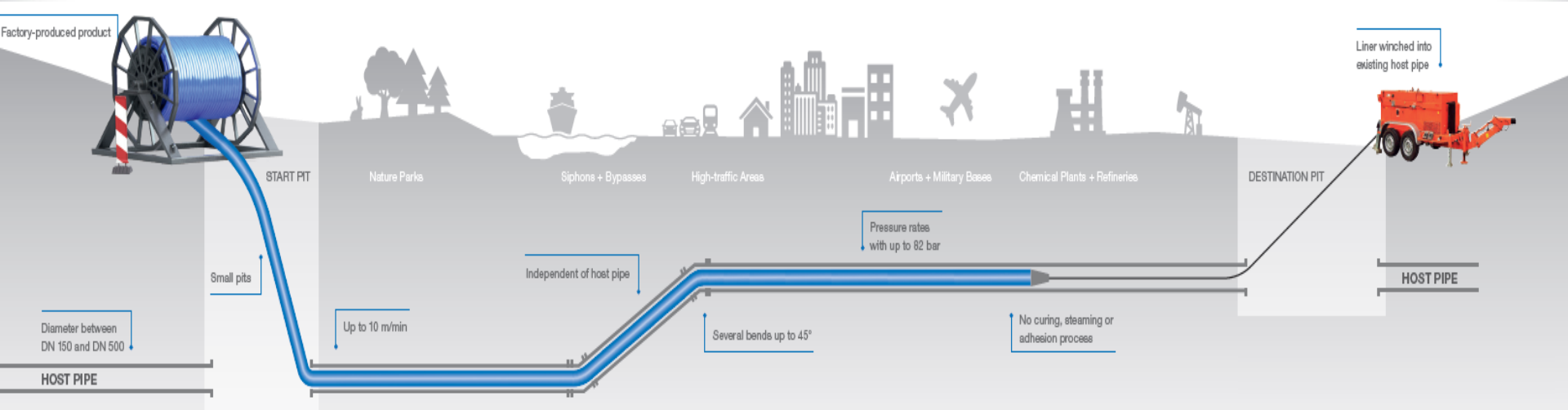
Project Description

- **Existing Pipe Material:** 12” DI
  - Hung from bridge
- **Length:** ~1,400 LF
  - 45 minute pull back (~30 ft/min)
- **Pressure:** 80+ psi
- **Type:** Potable water

Why use FFRP “modified sliplining” system for Class III?

- Minimal equipment / Personnel
- **Navigate Multiple bends up to 45 degrees**
- Fast install (33 ft/min or 1900 LF/hr)

- Small footprint
- Length of pulls >8000 LF
- Higher pressures and Low pressures
- No cure time liner cure time
- Emergency Rehab



Horizontal Directional Drilling

CLASS IV

Fully – Structural Solution

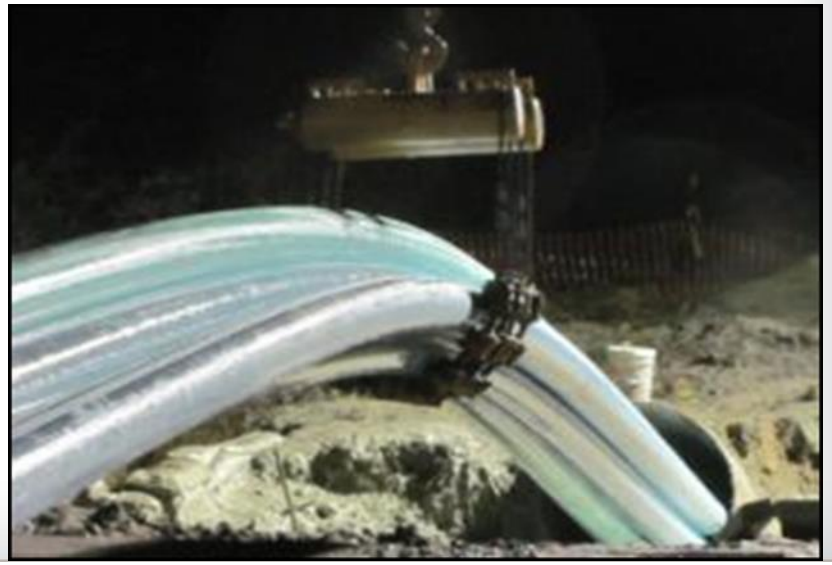
Where is Horizontal Directional Drilling utilized?

- Water, Wastewater, Casing, Gas, Comm., Conduit, etc.
  - Waterbody crossings, outfalls and shore approaches
  - Interstate, Highway, railroad crossings, county roads, driveway/parking lot crossings
  - Conflicting utilities - gas lines or storm drains
  - Congested areas where open cut is too expensive
  - relocation/replacement

Horizontal Directional Drilling

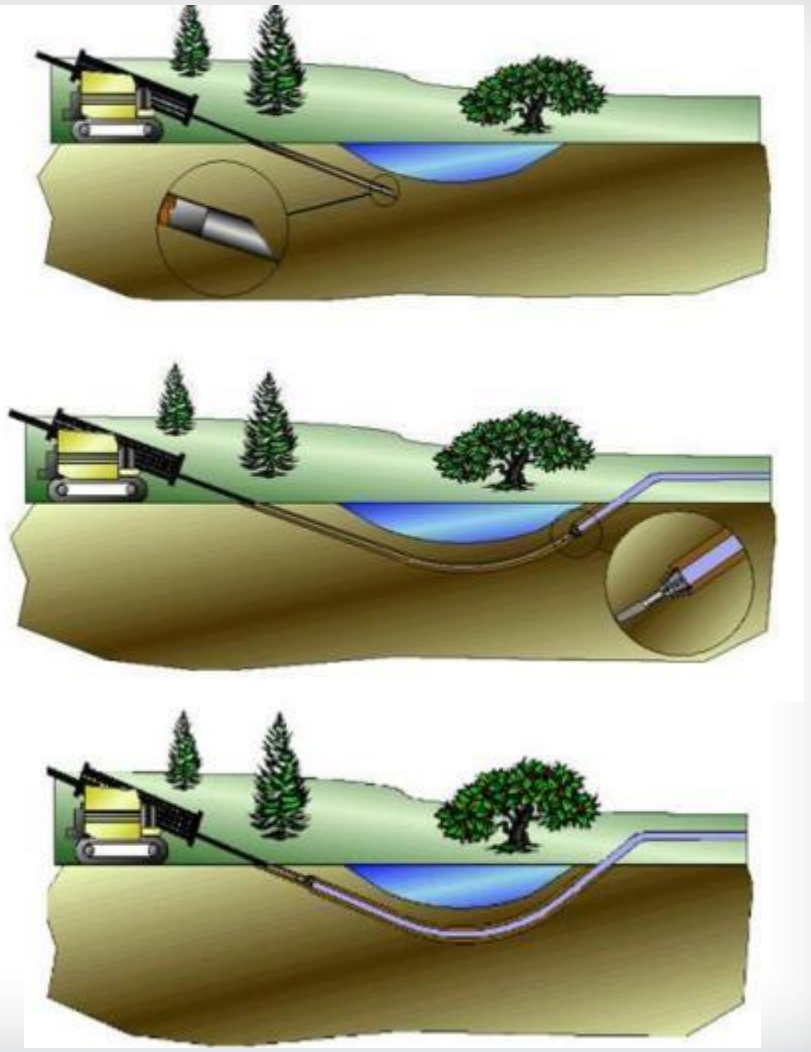
Project Considerations

- **Bore Alignment and Profile**
  - **Bend radius** of drill stem and product pipe
  - **Tracking / Bore path**
  - **Depth-** critical buckling pressure
- **Geotechnical information**
- **Insertion trench**
- **Pipe fusion and laydown area**
- **Drill Mud**
- **Pull Force**
  - **Water ballasting** and **rollers** to reduce drag
- **Reconnection**
- **Pressure test**

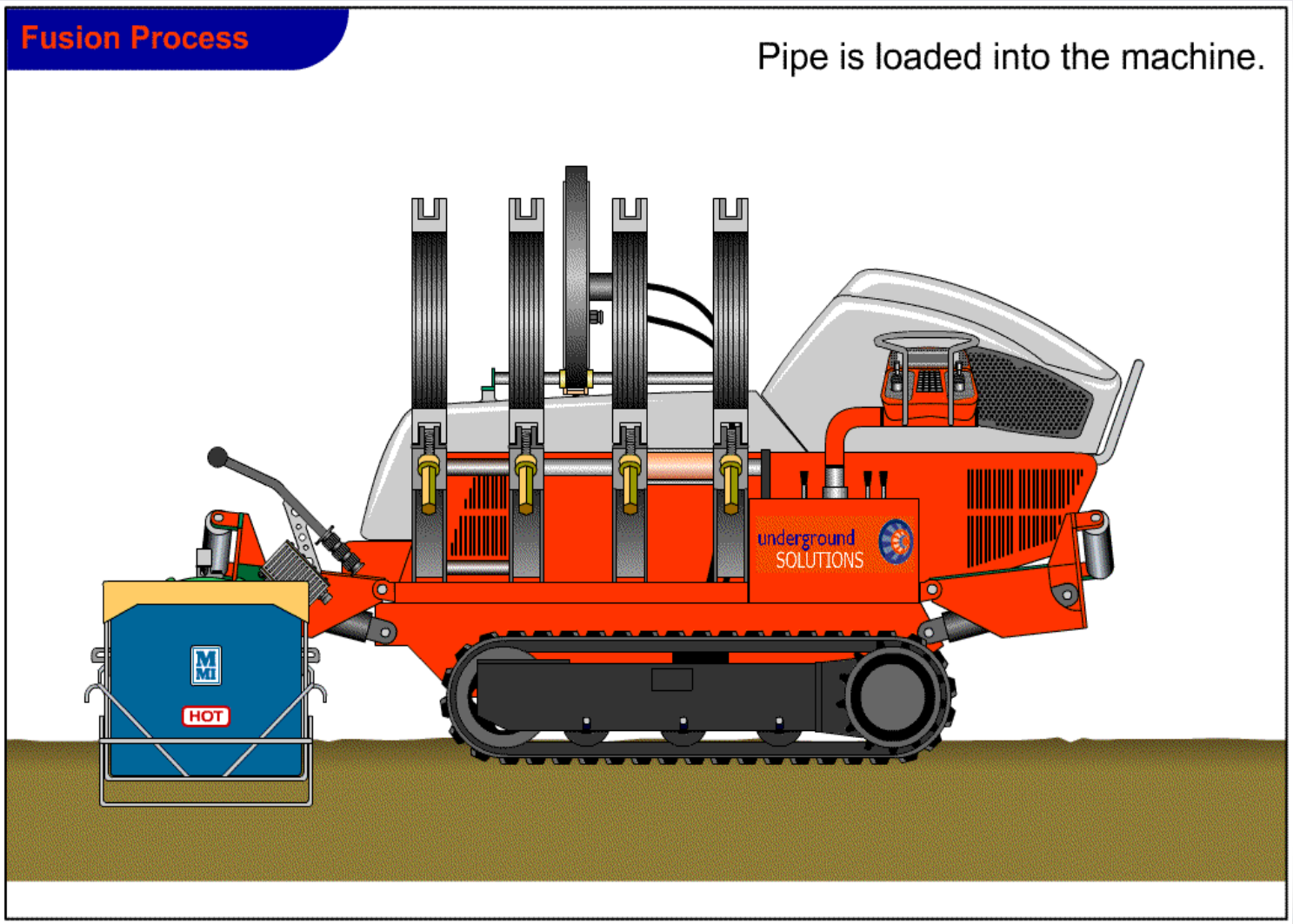


Basics of Horizontal Directional Drilling

- Guided pilot hole is drilled along a bore path
- Drilling fluids are injected into the hole to stabilize and lubricate
- Back reamer is used to enlarge the pilot hole
  - Multiple passes are required to accommodate pipe OD
  - Drilled bore hole is typically enlarged to 1.5 x OD of new pipe
- Product pipe is pulled through the bore hole



Fusion Process



PVC and HDPE Pipe Materials Properties

Property	Specification	PVC	HDPE 3608[1]	HDPE 4710[2]
Tensile Strength psi	ASTM D638	7,000	3,000	≤3,500
Density (Specific Gravity)	ASTM D1505	1.40	0.94	0.95
Hydrostatic Design Basis At 73° F, psi	ASTM D2837	4,000	1,600	1,600
Modulus of Elasticity psi (Short Term)	ASTM D638	400,000	110,000[3]	130,000[3]
Hardness (Rockwell R)	ASTM D785	117	52	NA
Coefficient of Linear Expansion In./In. deg F	ASTM D696	0.3×10^{-4} .36"/ 100'/ 10°F	1.2×10^{-4} 1.44"/ 100'/ 10°F	1.2×10^{-4} 1.44"/ 100'/ 10°F
Water Disinfectant Induced Oxidation		Highly Resistant	Low Resistance	Low Resistance
Hydrocarbon Permeation		Highly Resistant	Highly Permeable	Highly Permeable

1. HDPE 3608 also referred to as PE80
2. HDPE 4710 also referred to as PE100
3. PPI – PE Handbook – Long Term Modulus of Elasticity is 28,200 psi

Trenchless Pipe Material Options

- **Metal & Metal Reinforced Pipe** – Highest Tensile Strength, Limited Flexibility, Requires Corrosion Protection, Not Permeable (gaskets are permeable). Up to 18,000’ pull lengths.
- **Fusible PVC® Pipe** – Stronger than HDPE, More Flexible than Metal, No Galvanic Corrosion, No Water Disinfectant Oxidation, Permeation Resistant, Compatible with DI & Steel Pipe. Up to 7,600’ pull lengths.
- **Restrained Joint PVC Pipe** – Limited Deflection, No Water Disinfectant Oxidation, Permeation Resistant, Compatible with DI & Steel Pipe. Segmented assembly eliminates pipe layout challenges. Up to 2,000’ pull lengths.
- **Fusible HDPE Pipe** – Most Flexible, Lowest Tensile Strength & Stiffness, No Galvanic Corrosion, Requires Protection from Disinfectant Oxidation, Lowest Resistance to Hydrocarbon Permeation, Requires Transition Connections with DI & Steel Pipe. Up to 4,000’ pull lengths.

Eagleville, TN –River Crossings HDD

Horizontal Directional Drilling

CONSOLIDATED UTILITY DISTRICT
Rutherford County, Tennessee

Sliplining

- **Harpeth River Crossing HDD**
  - 320 linear feet of 12” DR25 blue Fusible PVC casing HDD
  - 320 linear feet of 8” DR18 blue Fusible PVC carrier Slipline
- **Stones River HDD – solid rock soils**
  - 600 linear feet of 12” DR25 blue Fusible PVC casing HDD
  - 600 linear feet of 8” DR18 blue Fusible PVC carrier Slipline

Recent USDA Projects

AL Water System Improvements

Clay County

- ~12000 LF of 6” & 8” Fusible C900 PVC
- >52 Horizontal Directional Drills for creeks, wetlands and roads

Perry County

- ~16,000 LF of 6-12” Fusible C900 PVC
- >59 Horizontal Directional Drills for creeks, wetlands and roads

Wilcox County

~15,000 LF of 6-8” Fusible C900 PVC

>60 Horizontal Directional Drills for creeks, wetlands and roads

Russell County

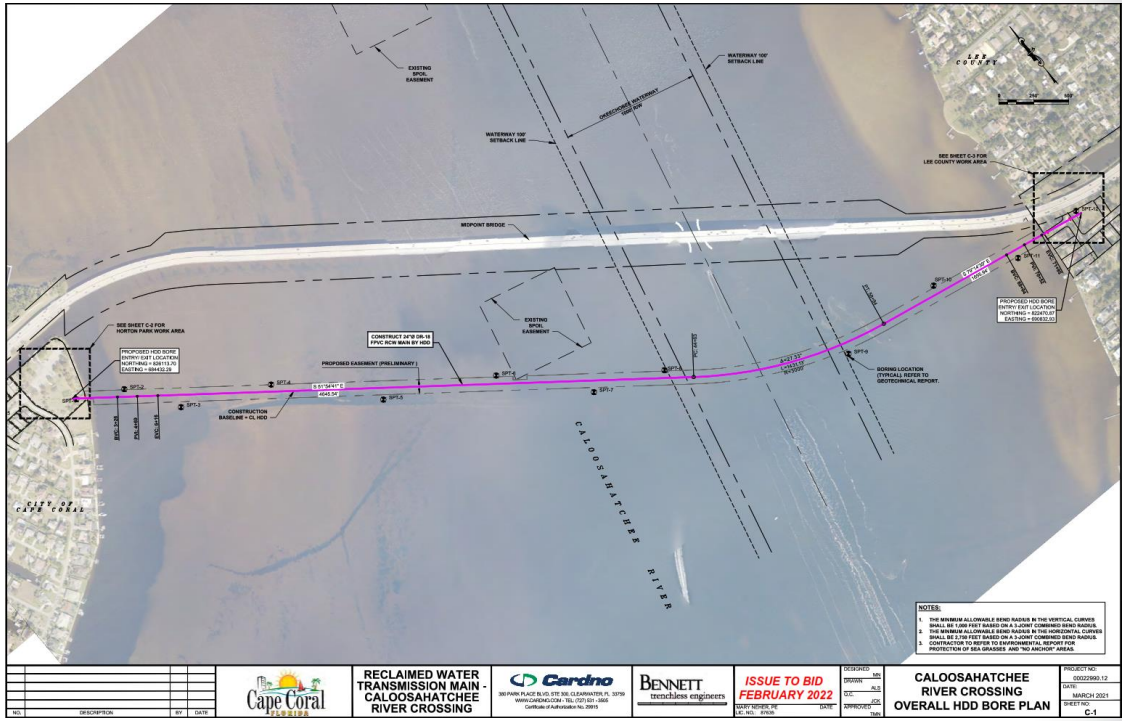
- ~5000 LF of 10” & 12” Fusible C900 PVC
- >12 Horizontal Directional Drills for creeks, wetlands and roads

Record Breaking HDD with 24” DR18 Fusible PVC® Pipe

Horizontal Directional Drilling

Caloosahatchee Connect RCW Transmission City of Cape Coral

- 7,630’ HDD of 24” DR18 Fusible PVC pipe
- 12MGD RCW from City of Ft. Myers to Cape Coral



Engineer – Stantec/Cardno, Bennett Trenchless
GC – Amici Engineering Contractors
HDD – Centerline Directional

Kiawah River HDD – South Carolina

Horizontal Directional Drilling

Kiawah Island Utility

- 7,000 linear feet of 16” DR14 Fusible PVC
- 85’ deep
- 1 intermediate – 4600’ & 2400’ segments
- Design Engineer – Thomas & Hutton
  Contractor - Mears Group, Houston, TX

Aerial approach for pipe entry

Johns Island, South Carolina

Horizontal Directional Drilling

St. Johns Water Company

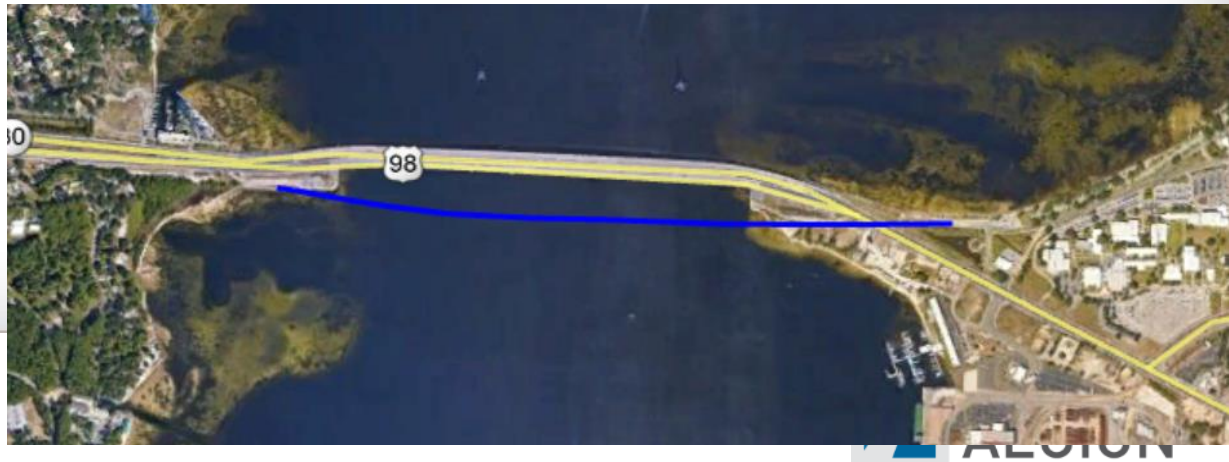
- 20,000’ 24” DR18 & DR25 Fusible C900 PVC
- 4,440’ in single HDD Stono River Crossing
- Wetlands, Marshland, Grand Live Oak Trees
- River Road
- Contractor – RH Moore

Panama City Beach, FL – 1 mile+ HDD

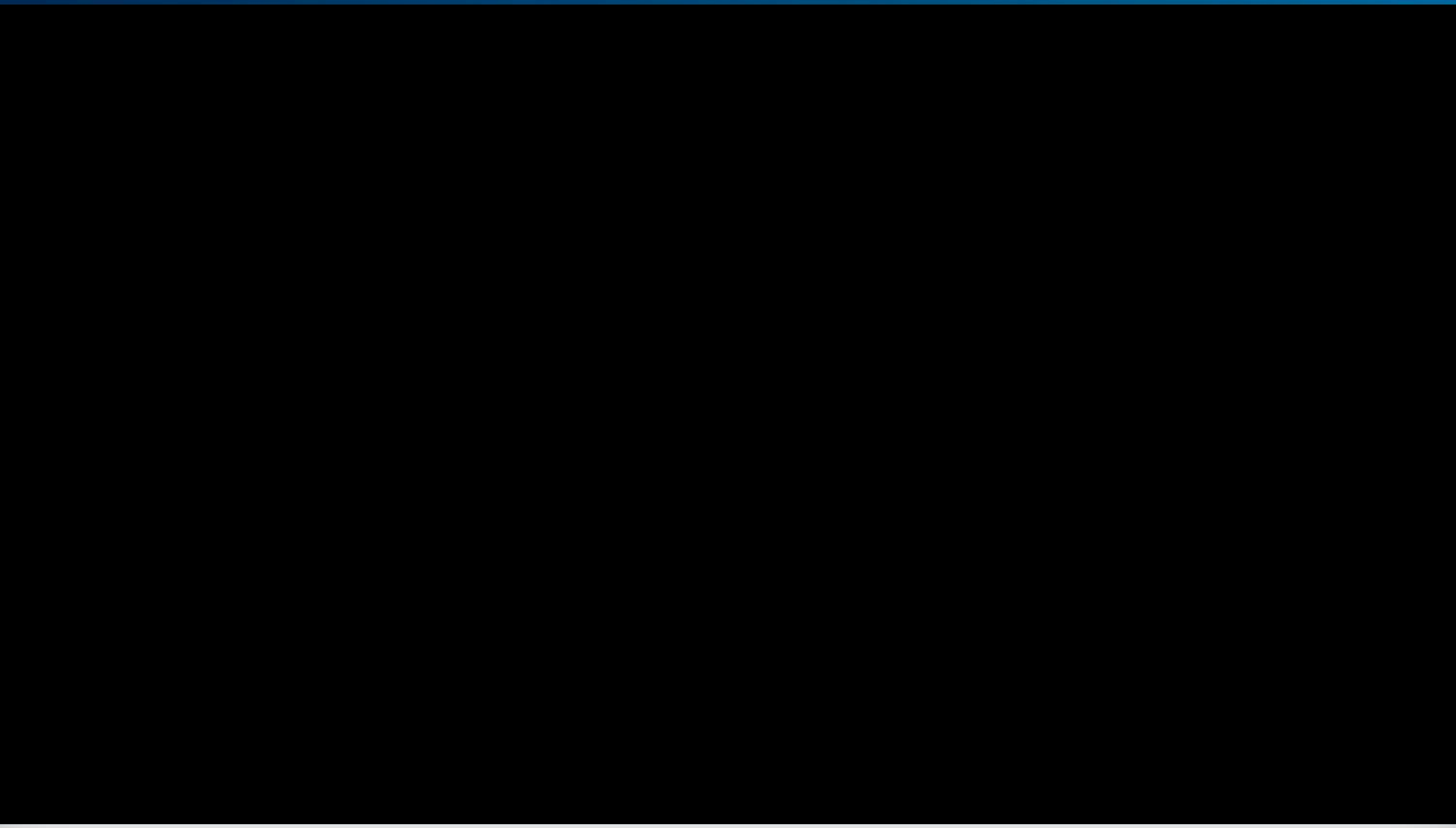
Horizontal Directional Drilling

Bay County - Hathaway Bridge

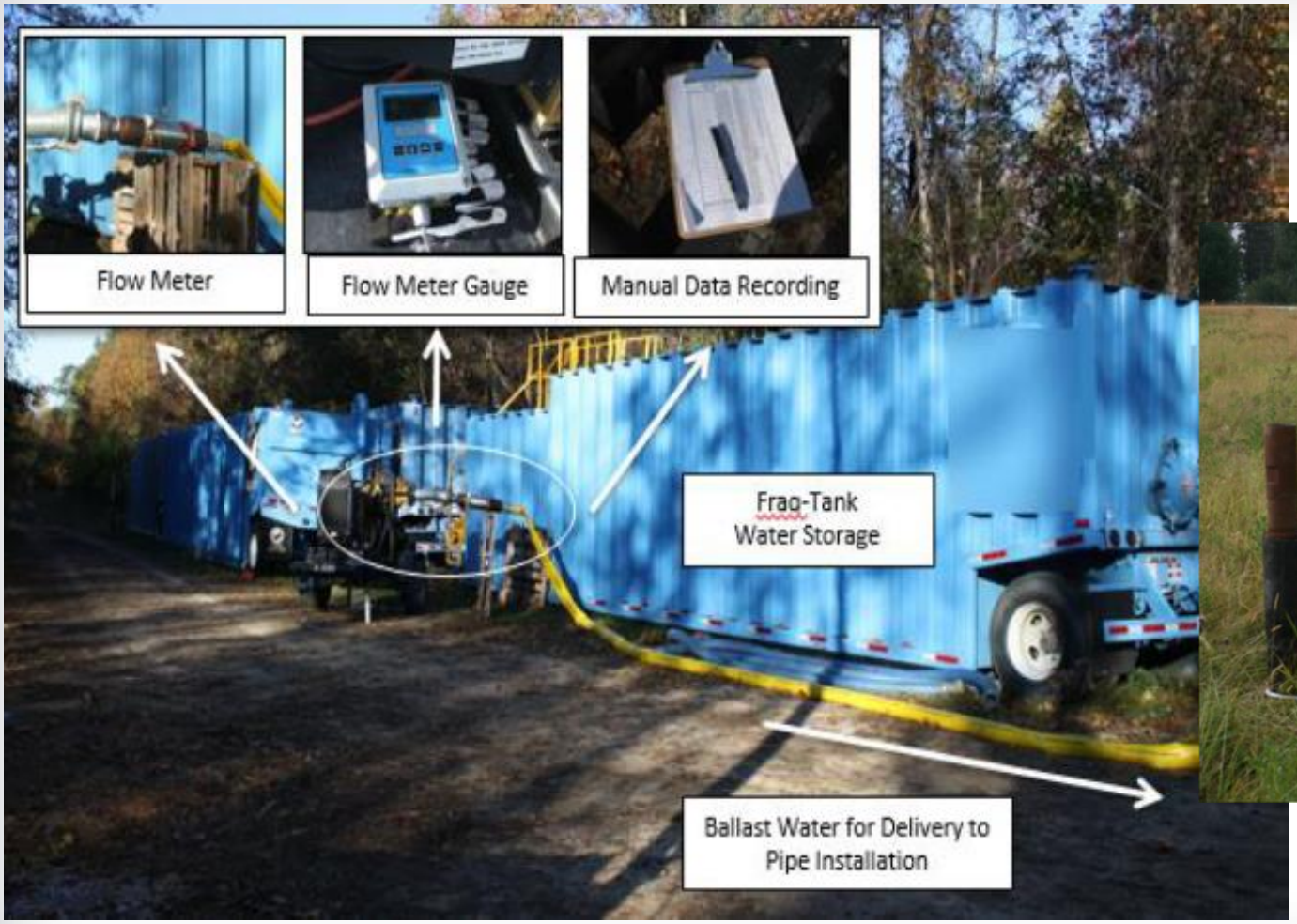
- 5400’ of 24” DR18 Fusible C-900 PVC
- Engineer – Dewberry
- GC – Marshall Brothers
-
- Inspector - MM
- HDD Sub Contractor – Mears Group



5,400 LF 24” DR 18 Fusible C900 HDD Crossing



Pipe Ballast Setup



PIPE BURSTING

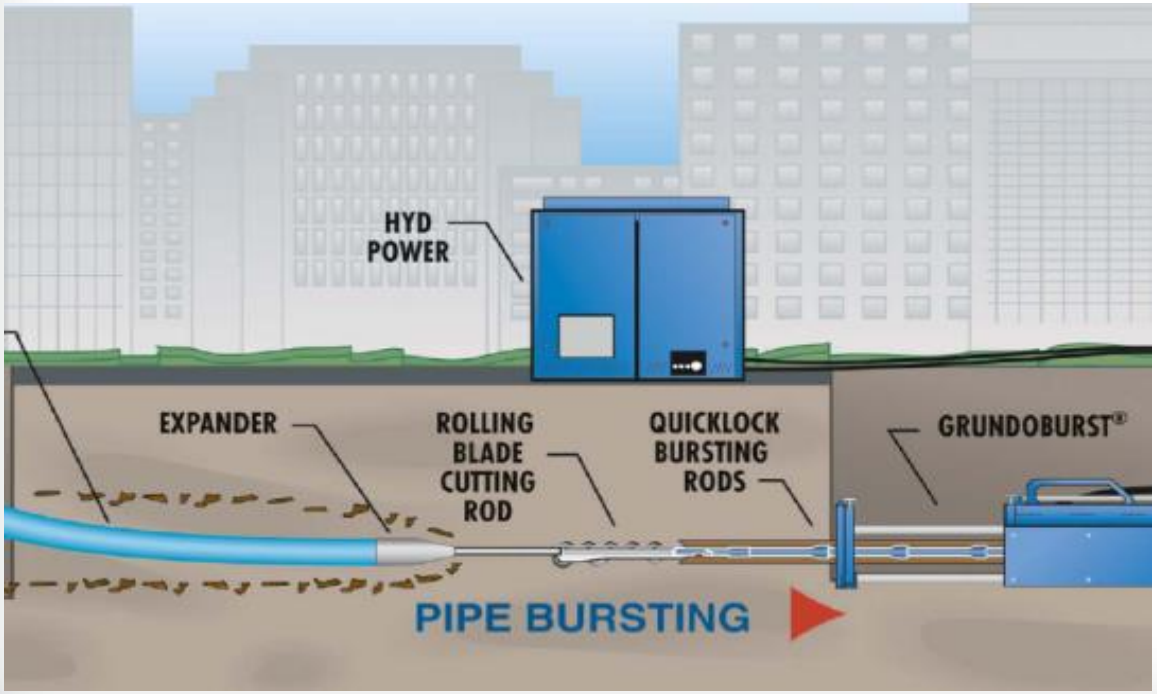
CLASS IV

Fully – Structural Solution

Pipe Replacement by Static Pipebursting

Pipe Bursting

- Static Hydraulic Method is used
- Burst head is pulled through existing line - fracturing or cutting the pipe
- Fractured or split pipe is pushed into the surrounding soil
- New pipe is pulled in immediately behind the burst head
- Typically done in 300 - 500’ increments (~1 hour pull-back)
- Utilizes existing alignment – less engineering cost to locate adjacent utilities
- Result in same or larger I.D. (upsizing) as old pipe



Pipebursting Process

- Pre TV Inspection
- Tool Selection
- Pit Locations
- Fittings, Valves, Off-Sets
- Service Locations
- Pipe Fusing
- Pipebursting/Pipe Installation
- Service Reconnections
- Restoration
- Post TV Inspection

Pipe Burst Host Pipe Materials

- **Fracturable Pipes** include cast iron (CI), clay (VCP), concrete (CP), asbestos cement (AC), RCP, and others.
- **Non-Fracturable Pipes** include ductile iron (DI), steel, galvanized iron, HDPE, PVC, and others.
  - Replaced by pipe splitting
- **Generally not good candidates-** Corrugated metal, corrugated plastic pipes, and brick

Static Machine Pit and Pipe Insertion

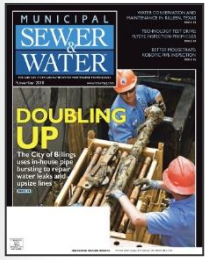
Tooling: Cutters, Linkage, and Expander

Insertion

Examples of Programmatic Pipe Bursting Water Mains Across the Country

End-users from East to West see advantages of pipe bursting programs

Billings, MT (pop. 110,000)



- Started in 2008
- Over 27,000 LF installed
- City does fusing and bursting

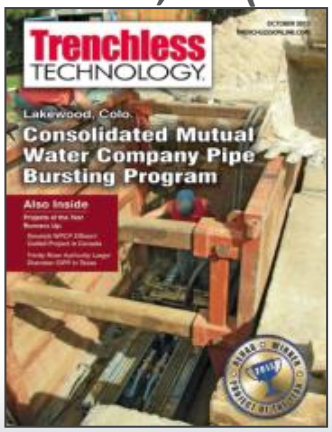
Lee's Summit, MO (pop. 91,000)

- Started in 2009
- Over 118,000 LF installed
- City bids specific projects

Monroe, NC (pop. 35,000)

- Started in 2014
- Over 50,000 LF installed
- City installs pipe

Denver, CO (CMW pop. 100,000)



- Started in 2010
- Over 230,000 LF installed
- City does fusing and bursting

Greensboro, NC (pop. 294,000)

- Started in 2009
- Over 72,000 LF installed
- City bids annual contracts

Water Distribution Replacement – Miller Street Water Main

Pipe Bursting

Client: City of Monroe, NC

- **Existing WM:**
- 10inch and 8inch existing Cast Iron
- **Replacement Material:**
- 1,485 LF: 10-inch Fusible C-900 PVC pipe
- 225 LF: 8-inch Fusible C-900 PVC pipe

- Contractor – KRG Utility

Ductile Iron Water Main Pipe Burst

Pipe Bursting

Client: CFPUA

- **Existing WM:**
- 20inch Ductile Iron

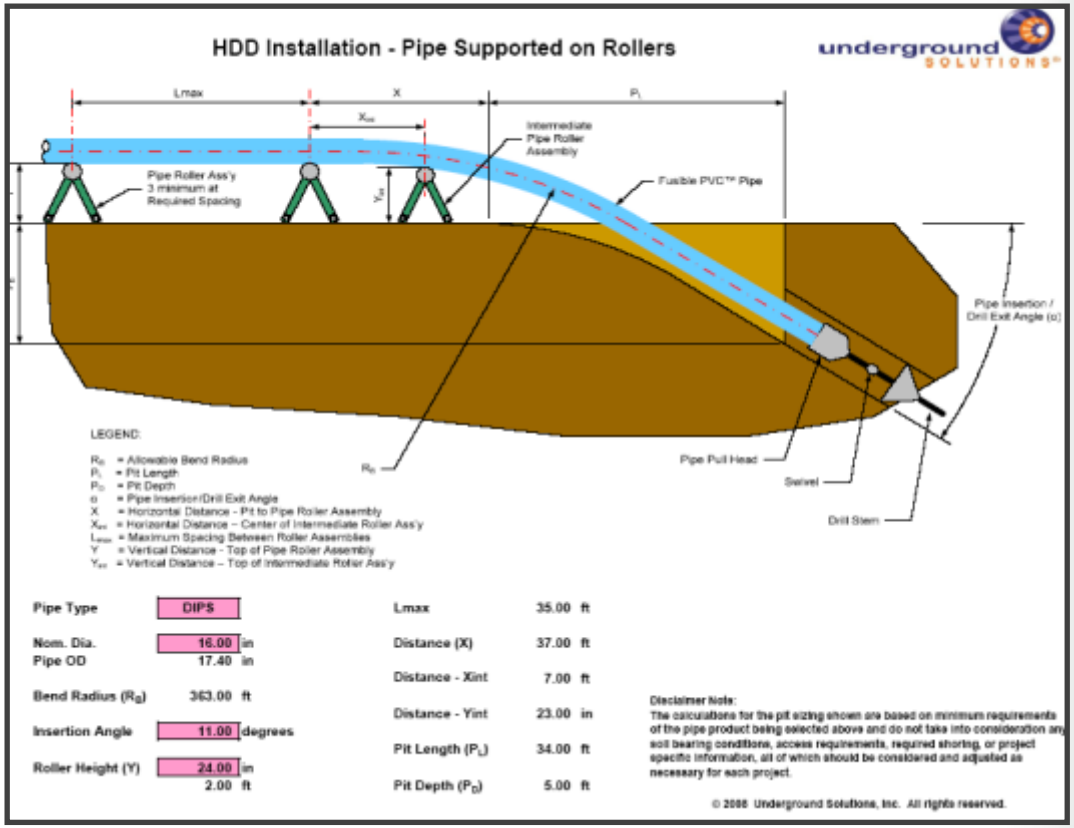
- **Replacement Material:**
- 5,039 LF: 20-inch DR18 Fusible C-900 PVC pipe

- GC – State Utility Contractors
- Contractor – KRG Utility

Technical Support

Project assistance includes:

- Seasoned industry construction managers to help “kick-off” projects with owners and contractors
- Calculation tools for planning HDD, Sliplining, Pipe Bursting and Open-Cut projects
- Handling instructions on “Quick Cards” for contractors in the field
- Project management and direct source of project information



QUESTIONS

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