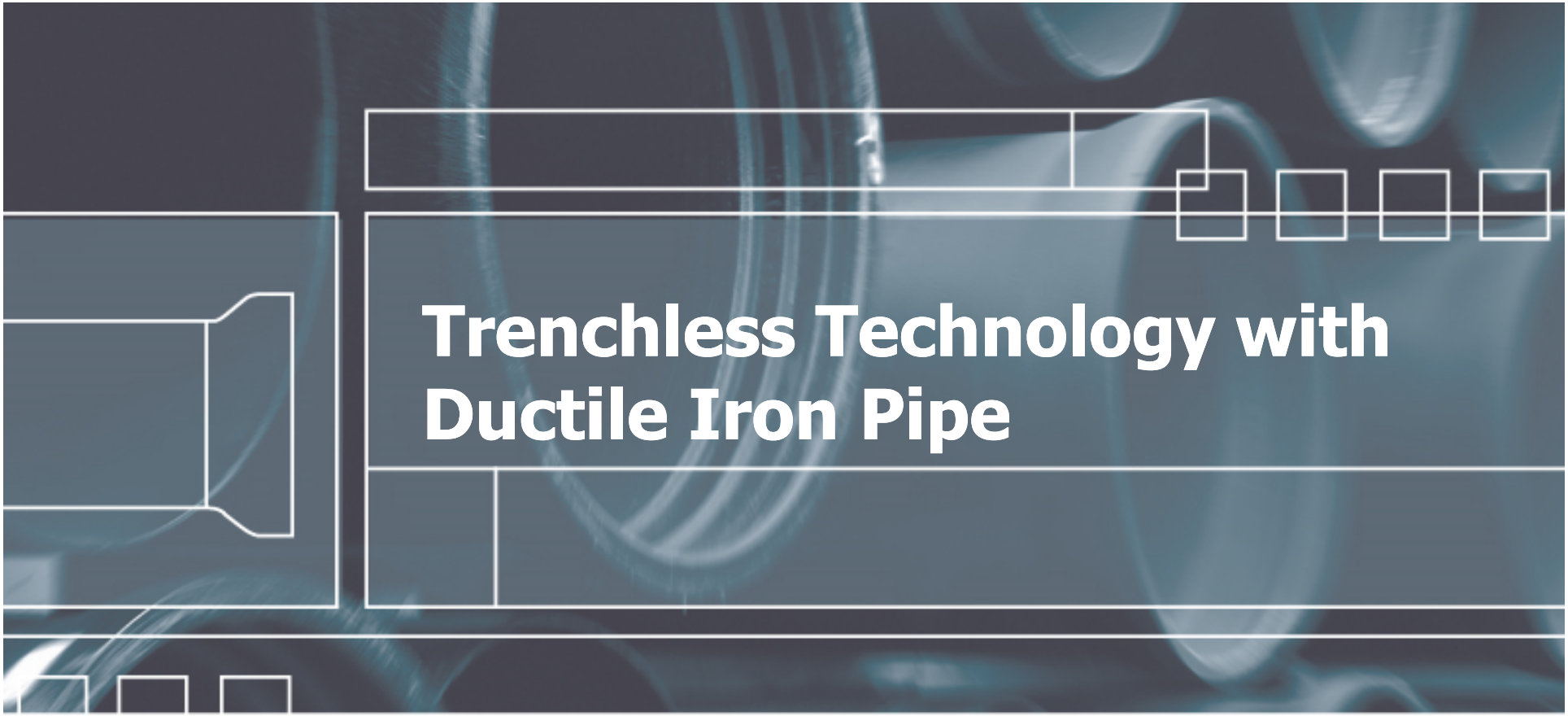

Trenchless Applications with Ductile Iron Pipe: Opportunities that began in 1992 for Water & Sewer Installations

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Agenda

- History
- Basic Knowledge
- Process & Procedures
- Use-full situations
- Case Studies
  - Riverwoods, IL
  - Atlanta, GA
  - Flipen, GA
- Closing Remarks

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Background

- Up and coming technology in the Water & Sewer industry
- 4" – 12" most common; 14" – 24" very practical
- 30" – 36" requires large equipment
- Pressure rated to 350 psi
- DI pipe used since 1992

Background

There are many off-shoots of Trenchless Technology:

- Pipe bursting
- Slip lining
- Cured In Place Piping (CIPP)
- Micro-tunneling (MT)
- Horizontal Directional Drilling…

Directional Drilling

- Much of the technology was developed from oil well experience.
  - Rock bits
  - Drilling mud
  - Advanced Geotechnical Surveys.
  - Steerable pilot drills

Advantages of HDD

- Trenchless Technology
- Little disruption to surface activities/Less Aesthetic factors
- Requires less working space
- May be performed more quickly than open cut methods
- Less noise pollution
- Less traffic disruption and public complaints
- Cost of restoration is much less-saves historic areas
- Very little environmental impact

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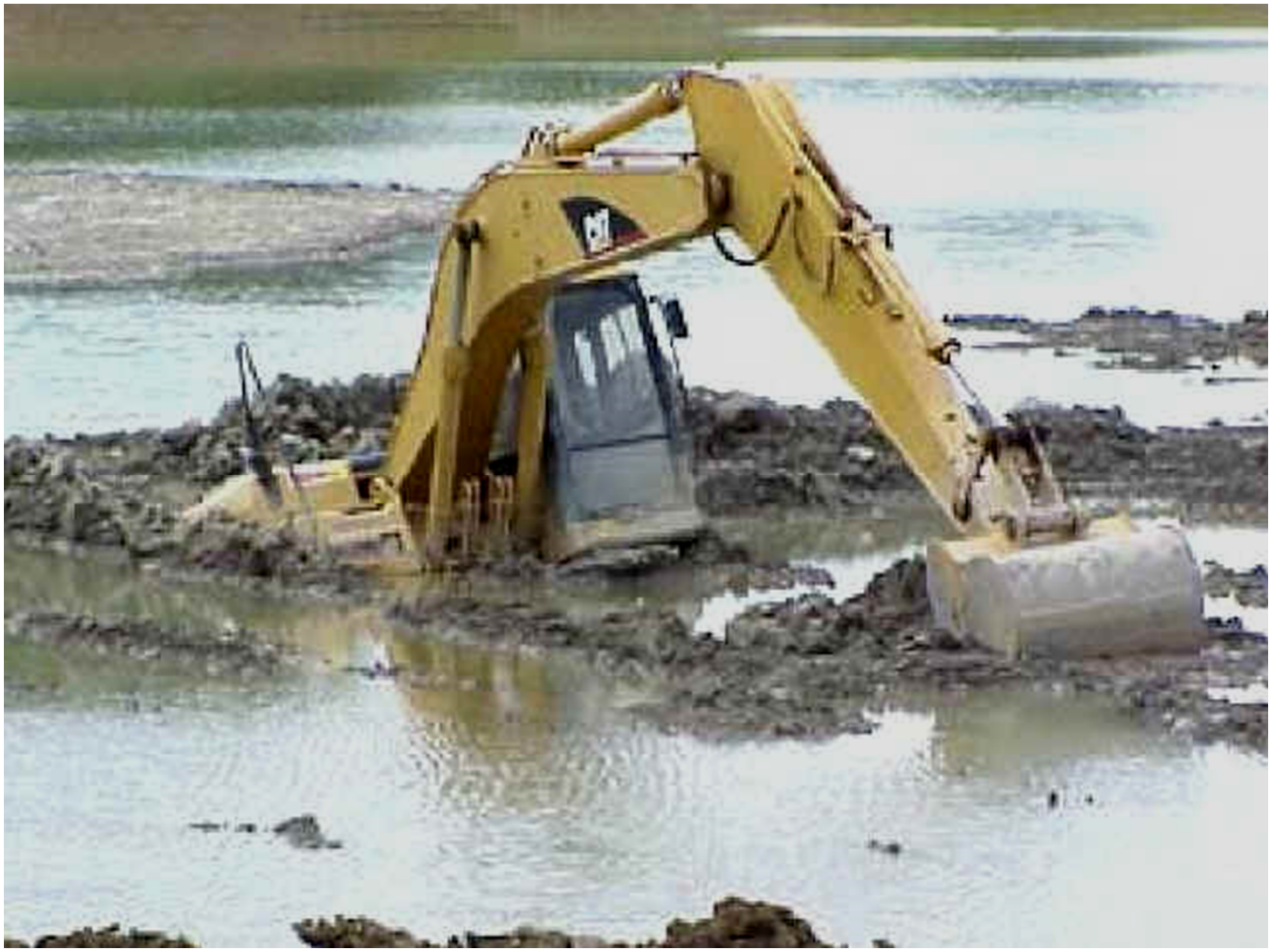
Why Go Trenchless?

- Many construction challenges can be bypassed:
  - High water table.
  - Unstable soils.
  - Proximity of other utilities.
  - Avert Wetlands
- Costs are coming down
  - Improvements in technology
  - Competition



Trenchless the hard way

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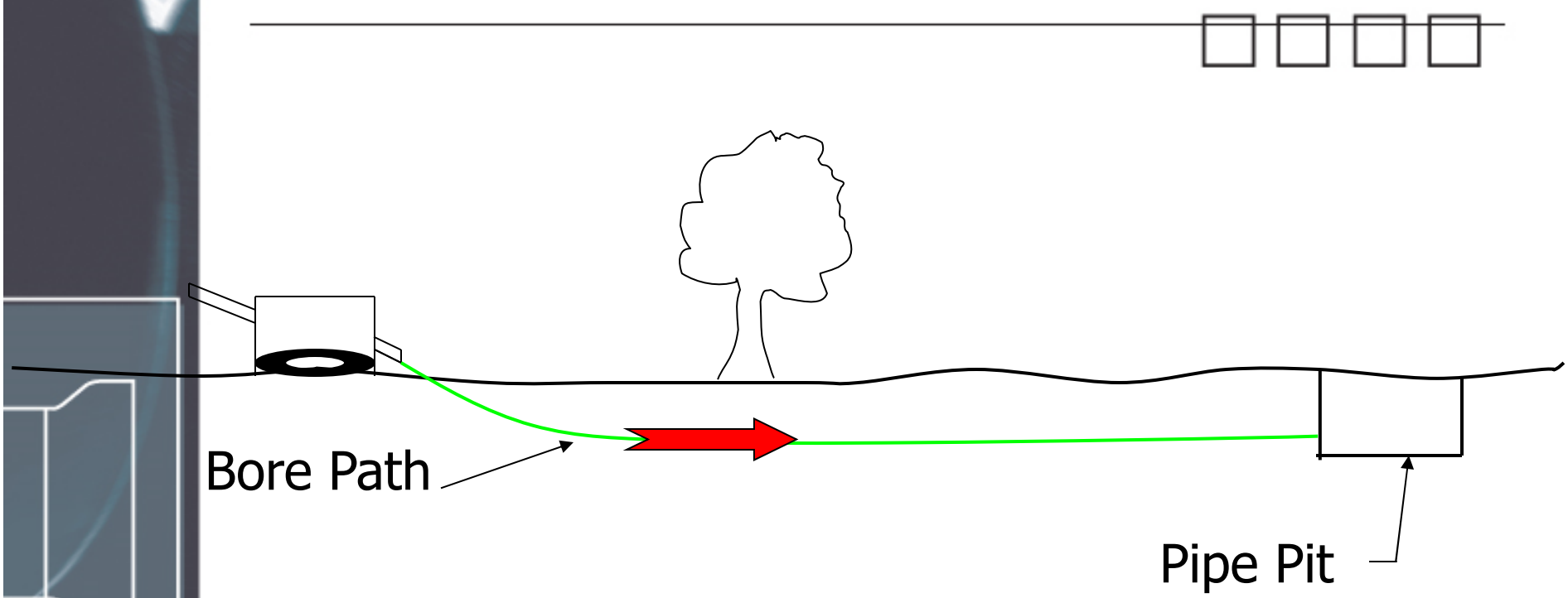
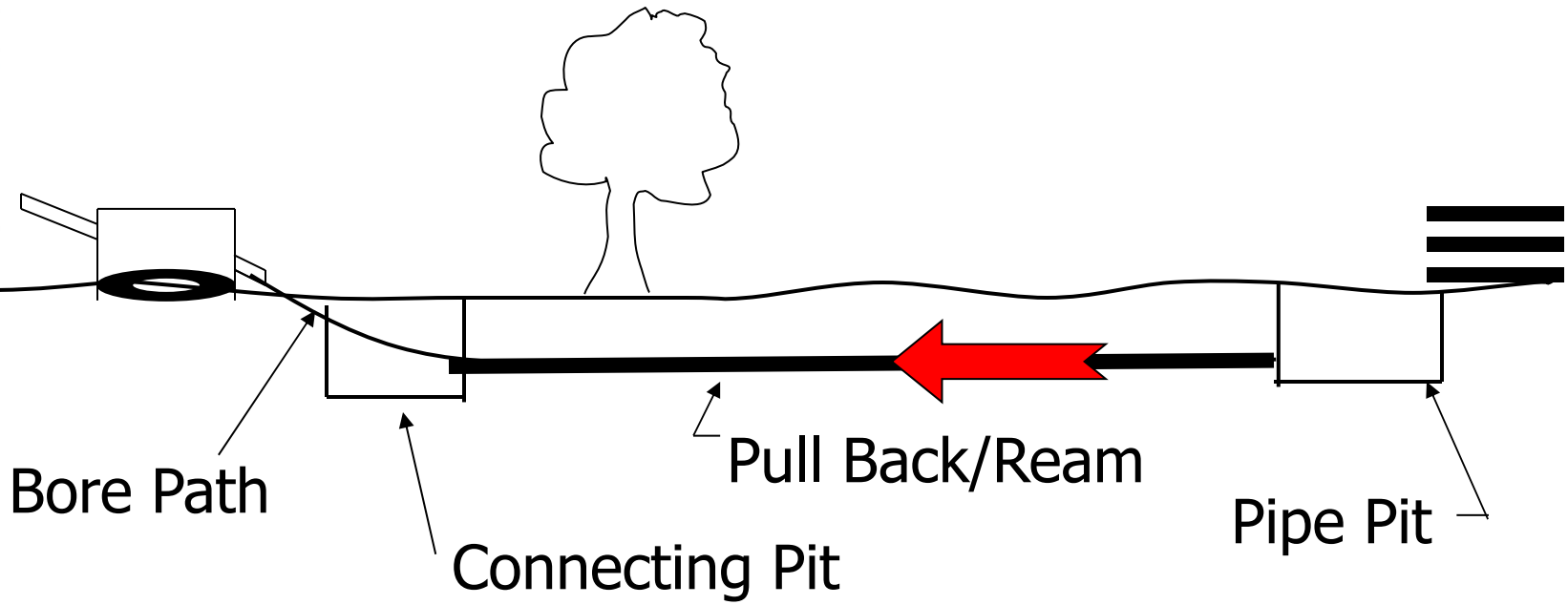
Boring



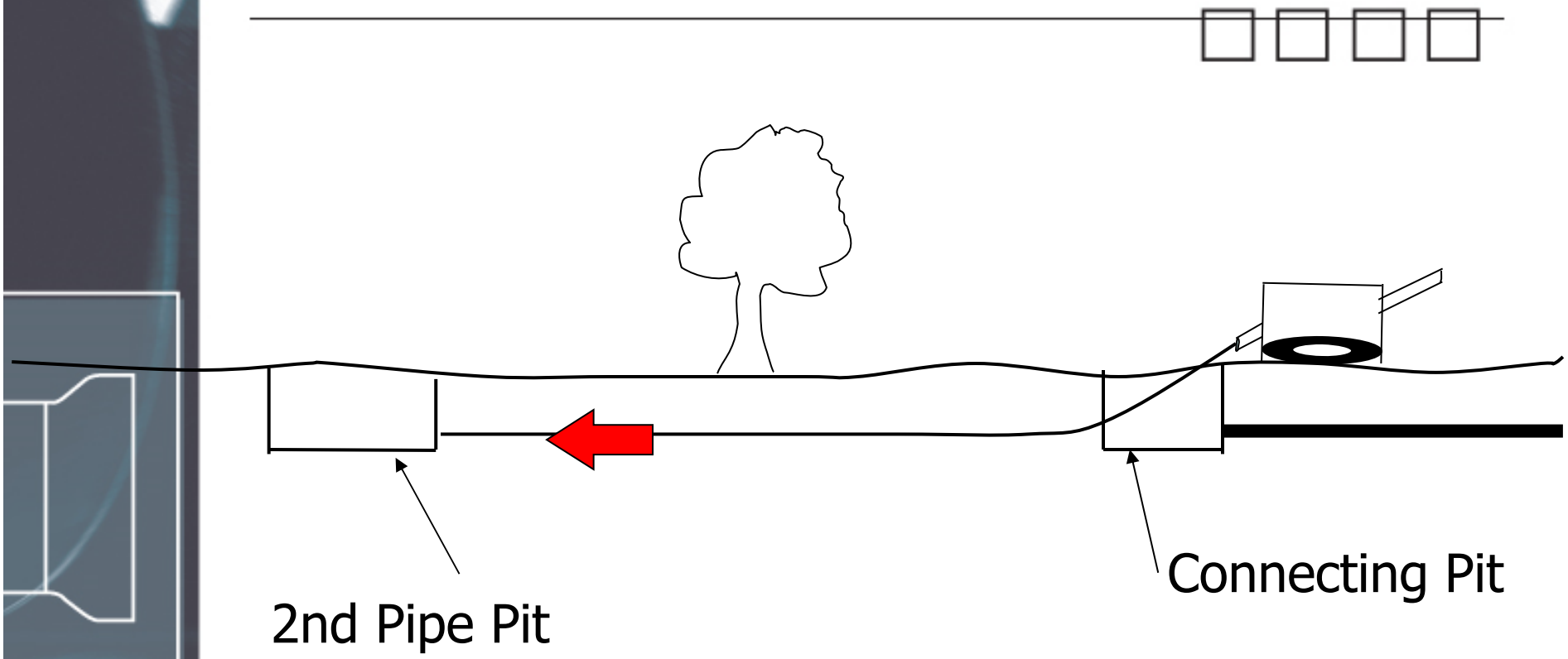
Pilot Bore to Pipe Pit

Boring



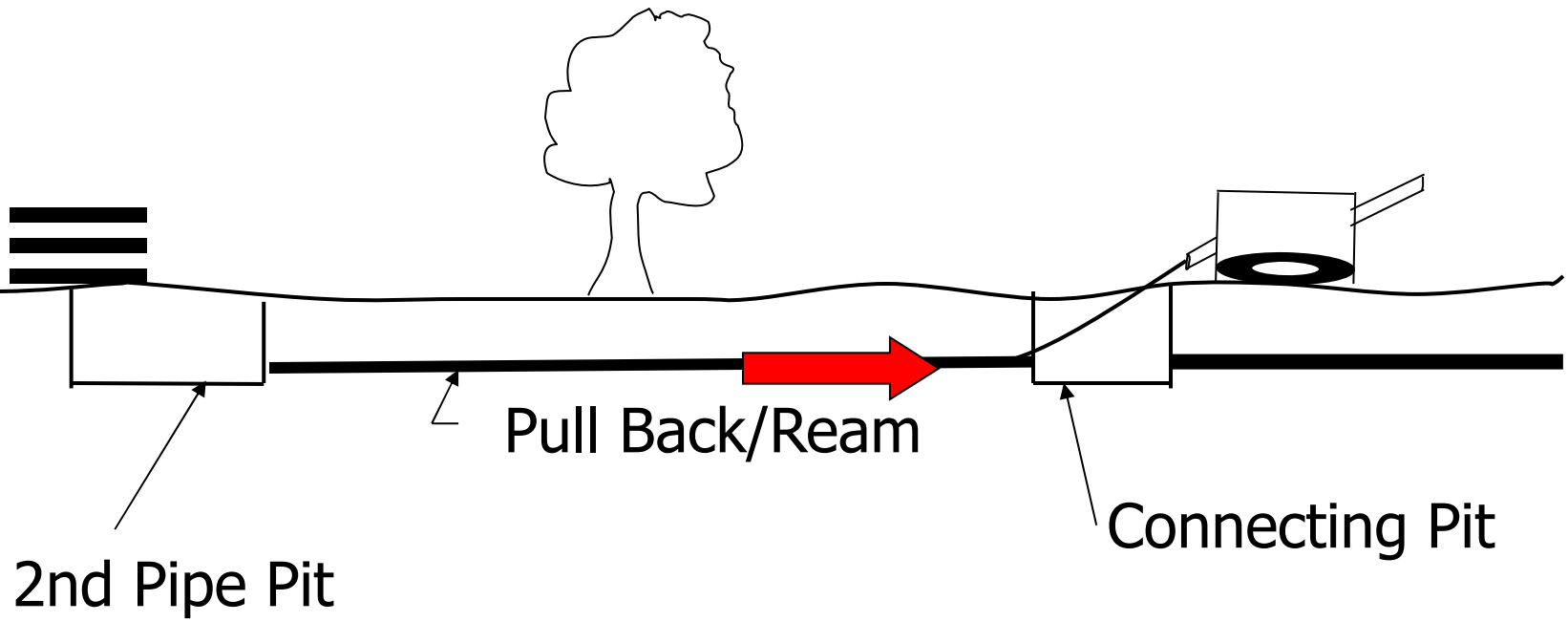
Pipe is assembled in pipe pit and pulled back

Boring



Boring Machine is turned around and pilot bore made to second pipe pit

Boring



The pipe is assembled, pulled back to the pipe pit and connected to the first installation

Methods of Assembly For Pipe

Cartridge & Assembly Line Methods

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Methods of Assembly

- 2 methods of Assembly
  - Cartridge Method
  - Assembly Line/ Ramp Method
- Drilling Operation is the same for both – Only the method of pipe installation is different

Cartridge Method

- Connecting the joints during installation one at a time is preferred in locations where right of ways or easements are limited. (urban areas)
- Ductile iron restrained joint systems can be quickly assembled as the drill string is retracted.
- During pull back the joint assembly normally requires little more time than it takes to disassemble the drill stem sections and store them on a rack.
- This method requires significantly less space or right of way requirements than the assembly line method.

Pipe Pit

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Pipe Pit

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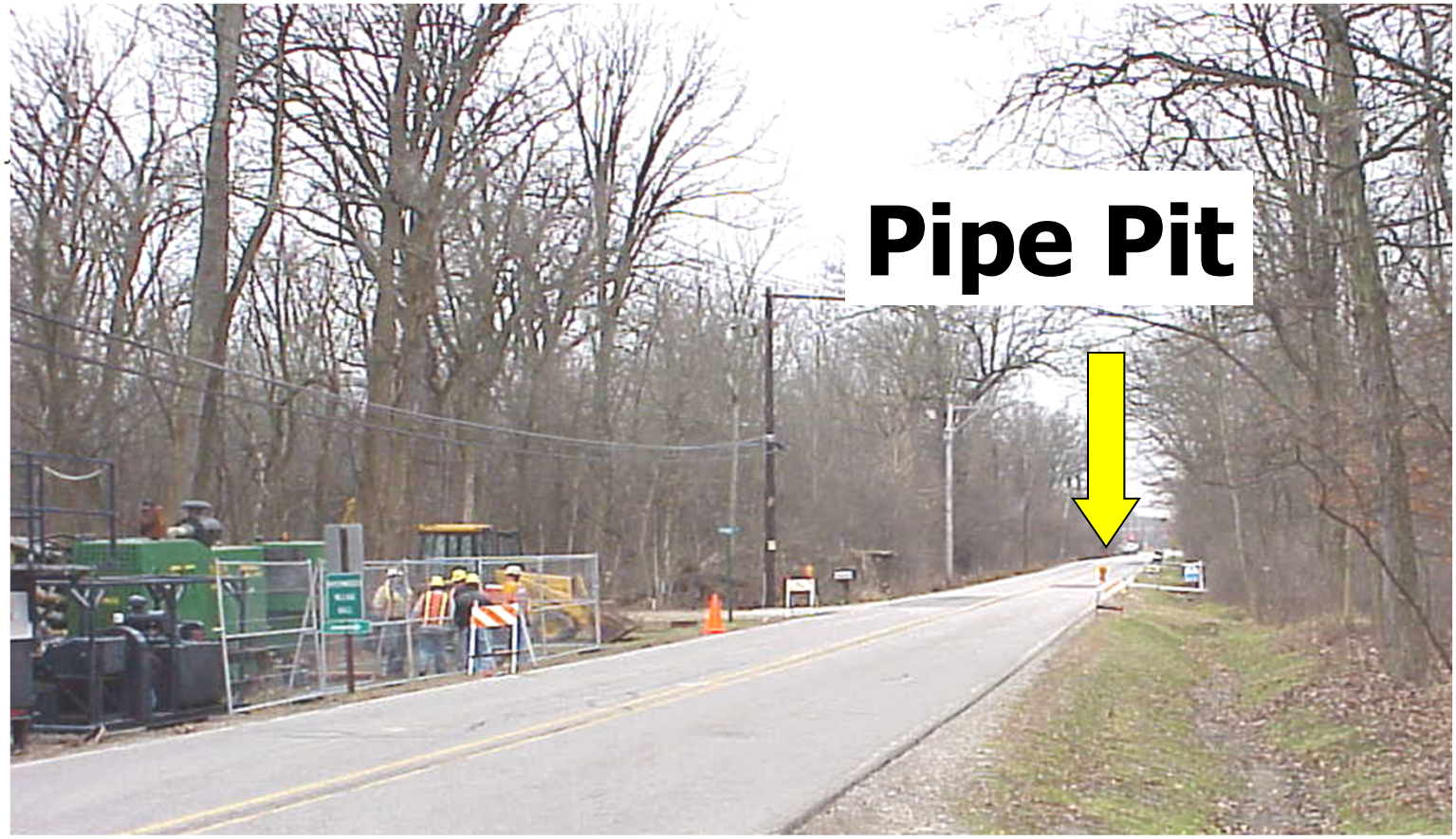

Riverwoods Project-12” TR-4520 Total feet

Accomplished in 3 Pulls with Lengths of 1100 ft, 1300 ft, and 2120 ft.

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Assembly Line Method

- The assembly-line method involves stringing out the connected pipe on the ground prior to pull-back.
- With this method it is necessary to have substantial space available to pre-string the pipe above the ground (generally on rollers) in direct alignment with the end of the drill path.
- This is normally the only option for welded steel or fusion joint polyethylene pipe.

Ramp Method-24”

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HDD Components-Rigs

- Drill Rigs

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Equipment Used

Drill Rig

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HDD Components – Drill Rig

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Equipment Used

Bentonite and or fluid additives are mixed in the unit then pumped to drill rig and through drill rod to pilot drill and to reamer on pull back. Pump regulates flow rate and pressure to pilot drill and reamer

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Equipment Used

Pilot Drill

Locator

Electronic sensor in pilot drill relays position, rotation angle and depth to a locator (held by crew personal) to direct bore.

Equipment Used

Reamer and Swivel

A 22” reamer diameter used for 12” pipe. Swivel has internal bearings and seals

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Equipment Used

Reamer

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Equipment Used

Reamer Jet Nozzles

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HDD Components – Support Equipment

- Material Handling
- Power Units
- Vacuum Equipment

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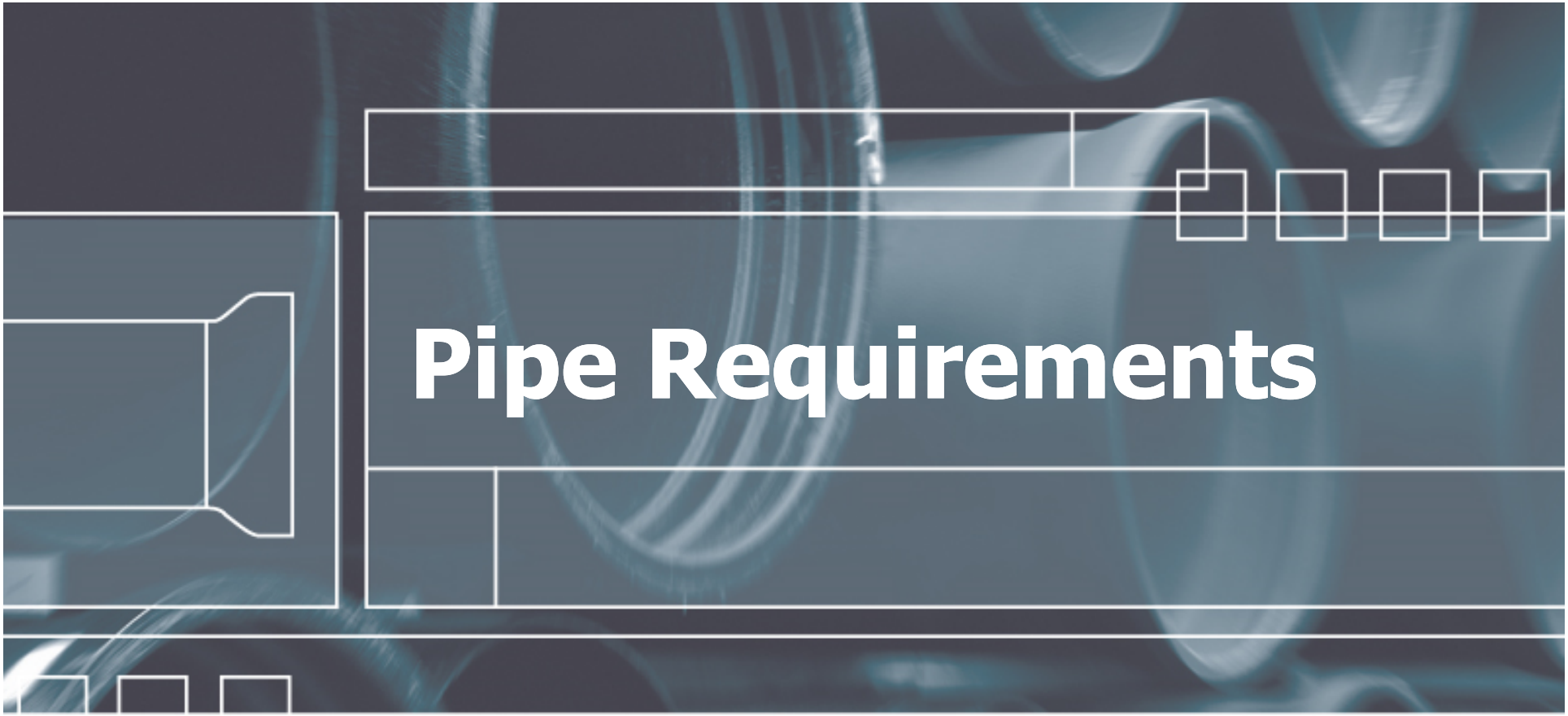

Restrained Joint Ductile-Iron Pipe

TR FLEX® Restrained Joint

HDSS ® Restrained Joint

HP LOK ® Restrained Joint

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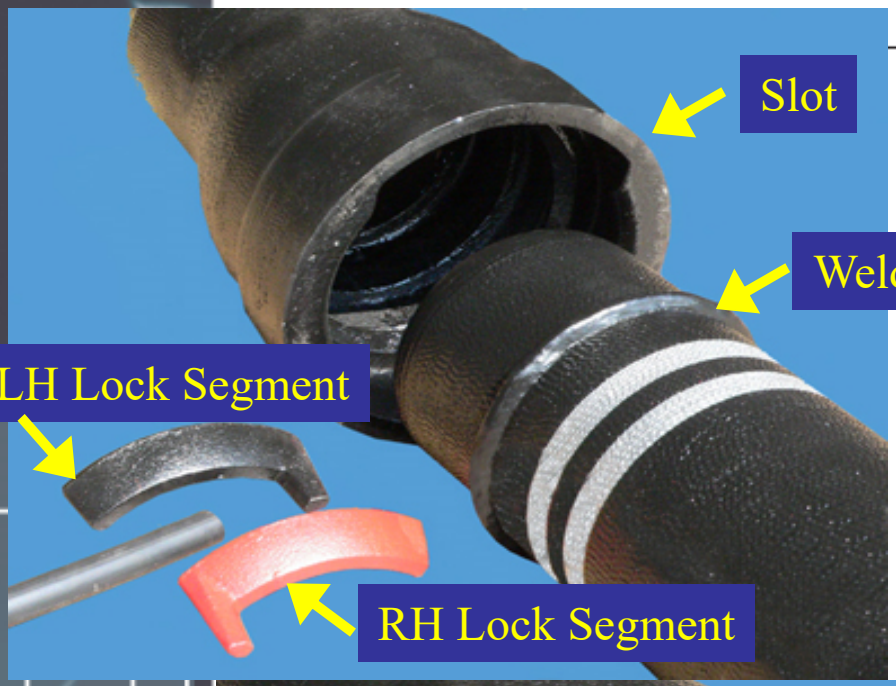
Joint Restraint Systems: US Pipe-TR FLEX®



Uses Standard TYTON® Gasket
4-20” Joint assemblies in 20 seconds or less.

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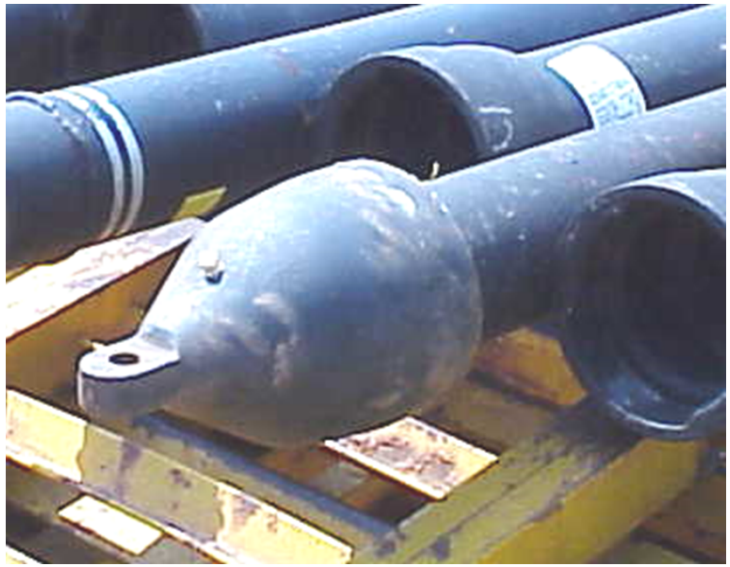
TR FLEX® Segment Restraint



TR FLEX® Pulling Heads- 4-36

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TR FLEX® Pulling Heads- 4-36

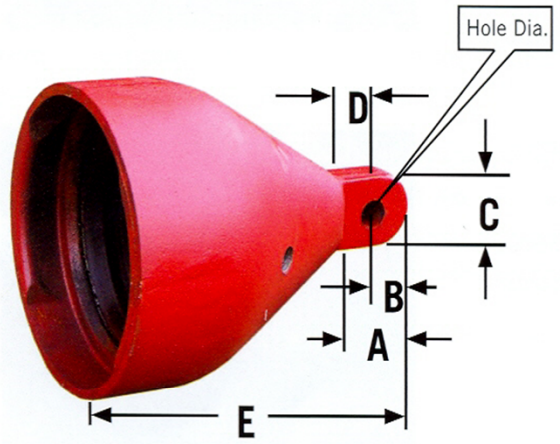

Table 2 – PULLING HEAD DIMENSIONS

SIZE	HOLE DIAMETER	A	B	C	D	E
			Inches			
4	.812	2.24	1.22	1.88	1.12	10.81
6	1.06	2.70	1.38	2.25	1.25	13.13
8	1.187	3.61	1.9	3.00	1.5	15.81
10	1.437	4.63	2.06	3.63	1.5	18.47
12	1.437	4.42	2.09	3.63	1.56	20.60
14	1.812	5.42	2.72	5.44	1.94	20.50
16	2.406	7.00	3.5	9.00	2.5	21.50
18	2.406	7.00	3.5	9.00	2.5	22.75
20	2.940	8.50	4.5	10.00	3.62	25.25
24	3.340	9.25	4.75	10.00	3.62	28.50
30*	5.00	13.30	8.00	16.25	6.50	43.28
36*	5.00	13.63	8.00	16.25	6.50	46.00

*Available soon

Notes:

- *Radius is based on Industry Standard of ½ of joints deflection capability – using 18 ft. lengths – a Tighter Radius can be achieved by using shorter length pipe. See Radius Calculator www.uspipe.com/trenchless*
- *30" and 36" are HP LOK™ Pipe.*
- *Industry Standards is 1.25 – 1.5 times bell Dia. For Straight Pulls and 1.5 or larger for Curved or Radius Pulls*
- *Pull loads are based on PC-350 Pipe – Contact your U.S. Pipe Sales Representative for lower PC pipe or higher pull loads if needed.*

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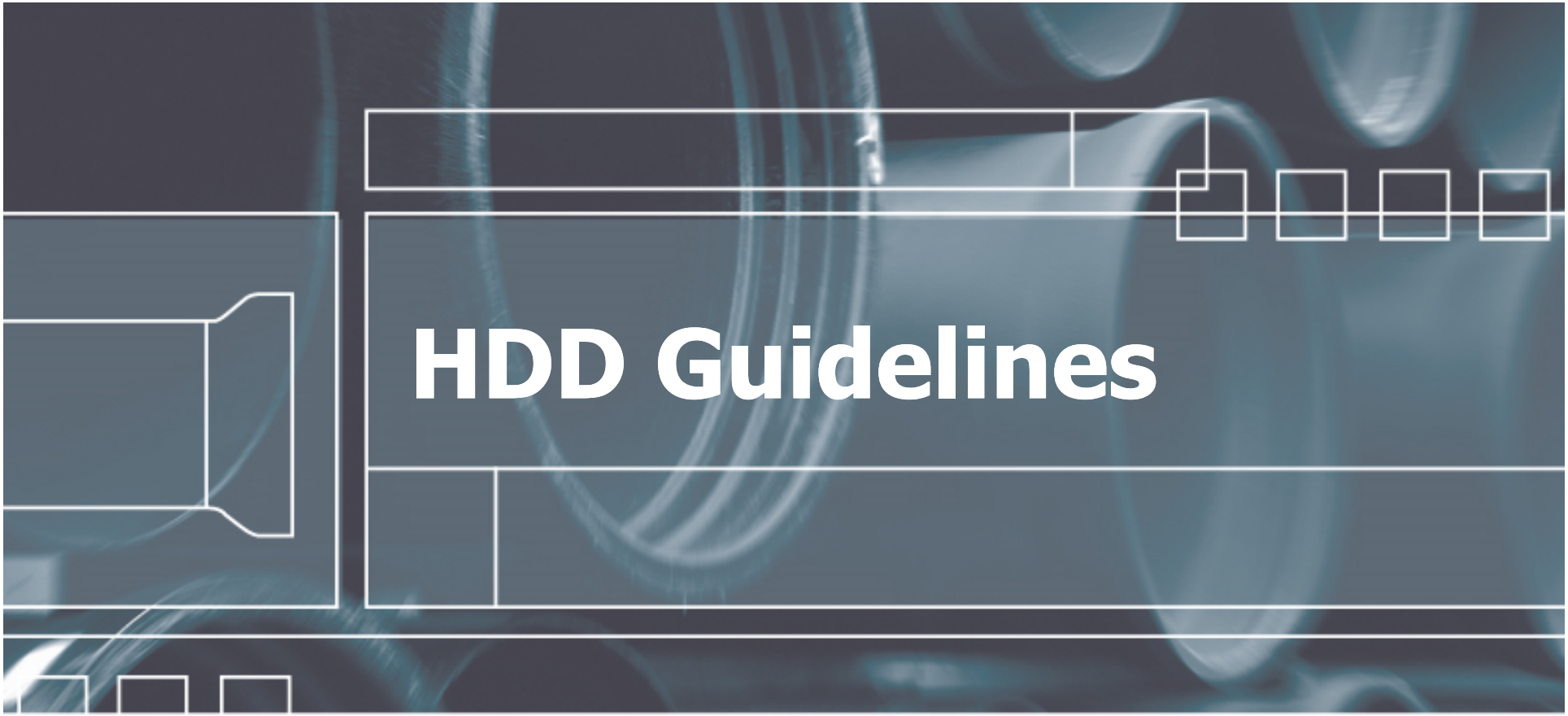

Polywrap, Bore Diameter-Radius, and Pulling

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Polywrap

- Corrosion studies have concluded that Bentonite is not corrosive to Ductile-Iron pipe. Therefore, poly-wrap is not necessary however, it is recommended that if the area of the proposed bore has a history of corrosive soils or a soil survey determines the soil is corrosive, then the pipe should be polyethylene encased with 8-mil polyethylene meeting the ANSI/AWWA C105/A21.5 *P.E. for Ductile-Iron Pipe Systems,* standard. Numerous dig-ups have found the poly is not damaged during the pulling operation.

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Poly-Wrap Pipe with Zip-tie and Ramp Method Pulled Into Bore Hole

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Pulling Head Installation with Tape Spiral Wound

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Poly-Wrap Installation with Tape Spiral Wound

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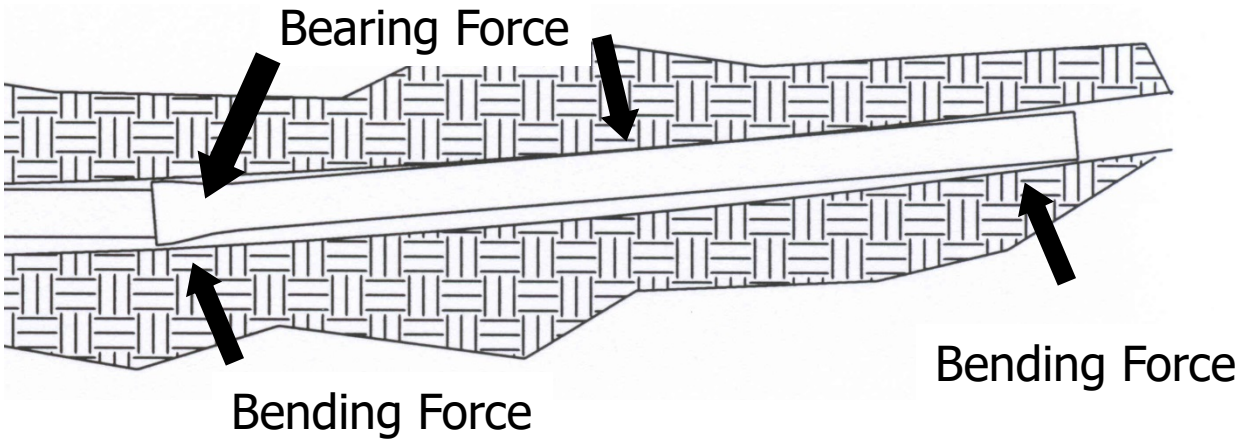
Guidelines For HDD Use

The Industry standard for a pull radius is to keep the curvature to ½ of the joints deflection capability and size the bore diameter to 1.5 x the bell diameter. The bore hole is sized so that the maximum deflection is not exceeded. Tighter radius's can be done with shorter lay-length pipe.

Diagram showing how bearing force is transmitted to pipe from trench bore. Can cause high pull loads and over-deflected joints if the proper Bore hole diameter is not used.



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Guidelines For HDD Use

Table 1 – HORIZONTAL DIRECTIONAL DRILLING WITH *TR FLEX*® PIPE

SIZE Inches	BELL O.D. Inches	BOREHOLE DIA @ 1.25 X BELL DIA (Rounded) Inches	BOREHOLE DIA @ 1.5 X BELL DIA (Rounded) Inches	ALLOWABLE JT. DEFLECTION Degrees	RADIUS @ 1/2 JT.-DEFLECT. – 18' PIPE Feet	PULL FORCE PC-350 PIPE Pounds	BUOYANCY (IN WATER) PIPE FULL OF AIR PC-350 PIPE (-)WILL NOT FLOAT Pounds/Foot
4	7.00	9	11	5	412	10,000	-5.5
6	9.27	12	14	5	412	20,000	-3.4
8	11.68	15	18	5	412	30,000	1.6
10	14.12	18	22	5	412	45,000	8.1
12	16.43	21	25	5	412	65,000	16.3
14	18.40	23	28	3.25	634	85,000	21.1
16	20.70	26	31	3.25	634	110,000	37.4
18	23.00	29	35	3	687	135,000	44.5
20	25.28	32	38	2.5	825	165,000	56.0
24	29.85	38	45	2.25	916	240,000	94.2
30-HP	36.38	46	55	.5	4125	365,000	157.8
36-HP	43.36	55	65	.5	4125	520,000	241.3

Pipe Bore Path Friction

Weight of Pipe

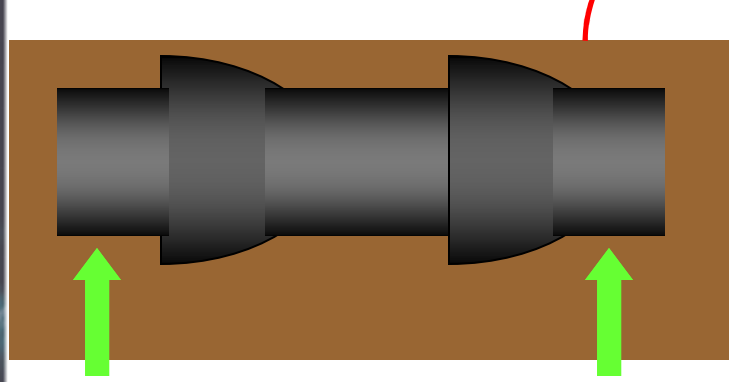
Ductile-Iron Pipe Bells only

Contact the bore hole every 18-ft= lower pull forces

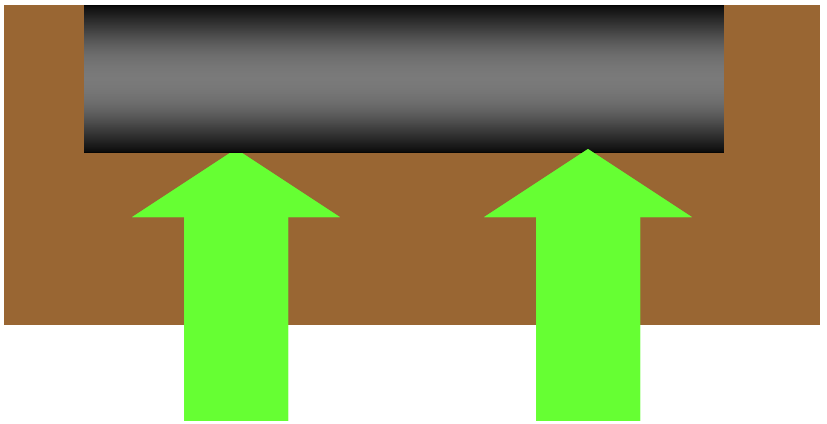
Bore Hole

Light Weight Pipe Material

Constant contact w/ bore hole, higher buoyancy force= more Drag-Higher pull forces



DIP Has Lower Buoyancy Force



Higher Buoyancy Force

Drillers experience lower pulling forces with Ductile Iron than other materials

Principle Functions Of Drilling Mud

1. Transporting drill cuttings to the surface by suspending and carrying them in the fluid stream flowing in the annulus between the bore wall and the drill pipe/product.
2. Lubricating to reduce the friction between the drill pipe/product and the bore wall.
3. Stabilizing the bore, especially in loose or soft soils by building a low permeability filter cake and exerting a positive hydrostatic pressure against the bore wall. The filter cake along with positive hydrostatic pressure reduces collapse of the bore and prevents formation fluids (groundwater) from flowing into the bore or drilling fluids from exiting the bore into the formation. Loss of circulation.
4. Cleaning build-up on drill bits or reamer cutters by directing fluid streams at the cutters
5. Cooling the down-hole tools and electronic equipment.
6. Keep the mud viscosity thin.

HDD and Pipe Bursting

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Case Studies

- Riverwoods, Illinois
- Atlanta, Georgia
- Flippen, Georgia

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Riverwoods Review-HDD

- 12” Ductile Iron
- Pull No.1-1100’ initial pull
- Pull No. 2-1300’
- Pull No.3-2120’
  - Longest known 12” single pull utilizing DIP for HDD
- Because of the success of this project, contractor (Tires and Tracks) was awarded an extra job in village for another 775’ of 12” DIP.
- Total Footage 5,295’

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Other Long Distance HDD-Projects

Riverwoods Project-12” TR-4520 Total feet-Accomplished in 3 Pulls with Lengths of 1100 ft, 1300 ft, and 2120 ft. (Longest known 12” single pull utilizing DIP for HDD)

Other Significant Projects:

June 06-Marysville,WA-1908-ft of 18” TR-one pull
April 07-San Antonio, TX-3 Pulls of 30”: 740 ft, 2 at 560 ft each

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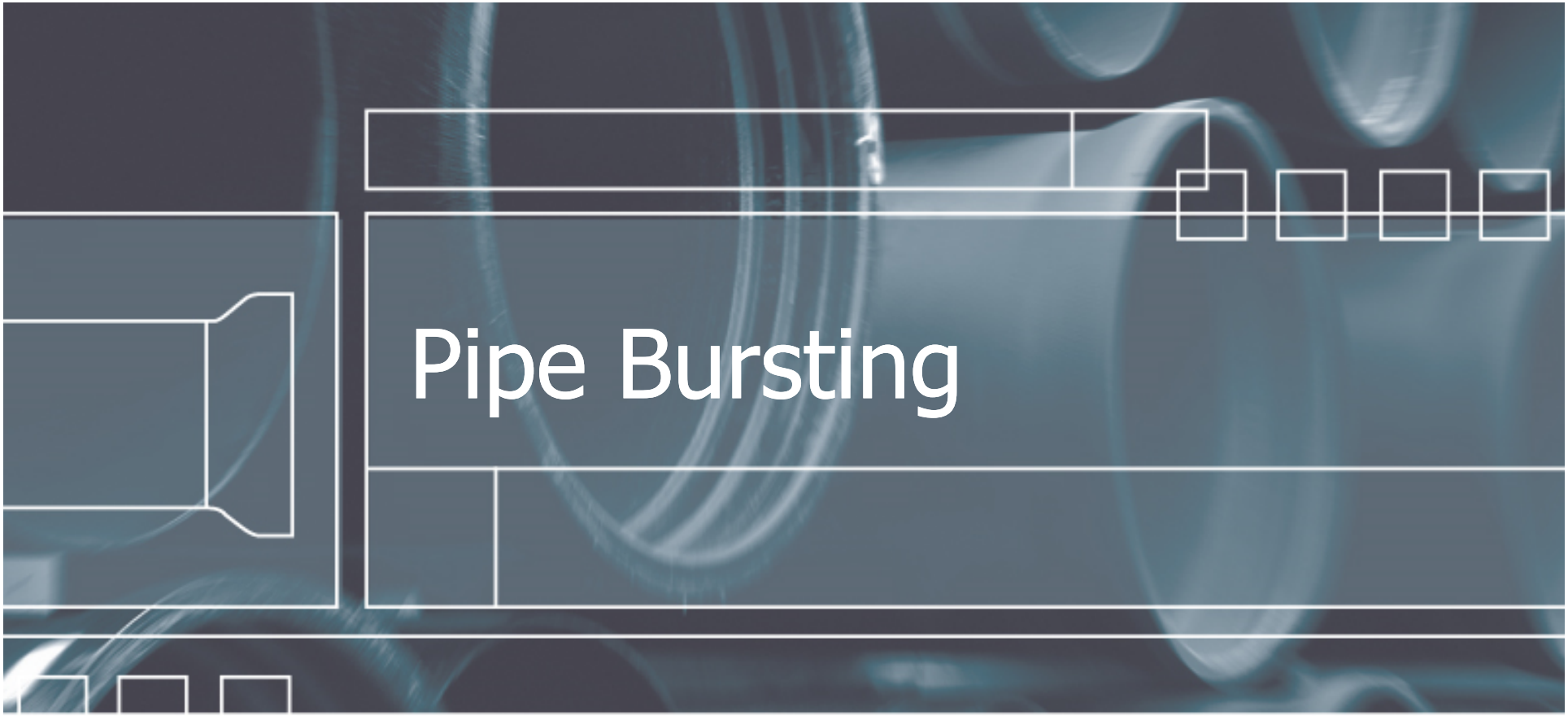

Pipe Bursting

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Pipe Bursting

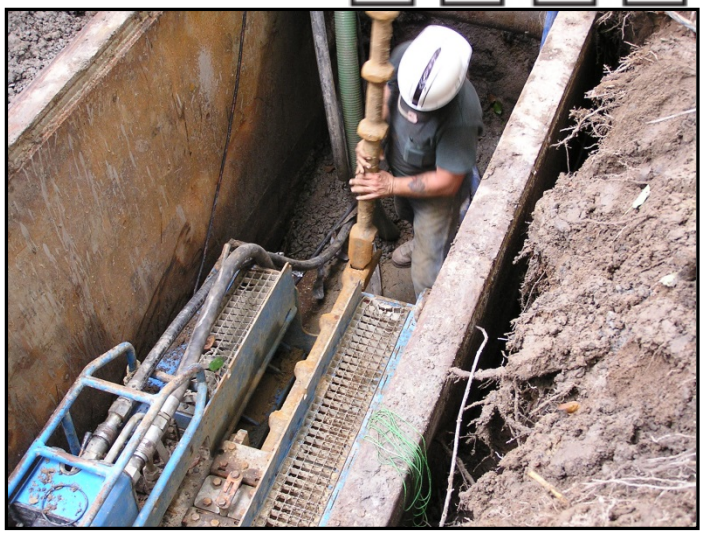
- Generally done manhole to manhole
- Rods are pushed thru existing pipe to pipe pit- to next manhole
- Cartridge method is used to insert pipe at pipe pit
- DI can be used to burst all other pipe materials
- CI can be burst w/DI-check Soil Resistivity-- => 2000 ohm-cm is recommended.

Atlanta, Georgia

- Lantern Lane Rehab
- Upsizing 8” Clay to 12” DIP
- Bury Depth—5-ft.
- 3 Burst of 200-feet each
- Fall of 2004

Atlanta, GA – Pipe Bursting

Pull Rods



Assembling Pull Rods

Pull Rod Joint

TR FLEX® Segment Restraint

- Cone inserts into 2’-lg TR bell with expander slid over pipe OD.
- Remainder of pipe is used in tie-in.
- Expander burst and expands existing pipe and soil as new pipe is pulled in to prevent the hole from collapsing.

TR FLEX® Pipe Bursting Head

Atlanta, GA – Pipe Bursting

TT Technologies, Inc.

Upsizing 8” Clay to 12” Ductile

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Atlanta, GA – Pipe Bursting

Pull Rods through Clay Pipe

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Atlanta, GA – Pipe Bursting

Upsizing 8” Clay to 12” Ductile

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Atlanta, GA – Pipe Bursting

Pipe pulled into expanded
Hole-low pulling force
Full length pipe keeps prices down

Pipe and Expander exiting pull pit

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Flippen,GA-Pipe Bursting

- Up-sizing 8″ DI to 10″ DI-Gravity Sewer-June-06
- 230 ft Pull
- 20-ft Bury Depth-Compacted Clay
- Time required to pull an 18-ft TR Pipe into the hole---3-4 minutes per 18-ft pipe. Total time of pull-under 45 min.
- Existing 8″ line had 3-DI tees

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Flippen,GA-Pipe Bursting

Flippen,GA-Pipe Bursting

DI Bursting has Cutter first, then Expander-Pipe is cut on bottom and spread to prevent debris from falling down.

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Flippen,GA-Pipe Bursting

Quick and Easy 10 sec. Pipe Assembly

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Flippen,GA-Pipe Bursting

Cartridge Method at 20-ft Pipe Pit Depth

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Flippen,GA-Pipe Bursting

Expander-head Exiting into Pull Pit

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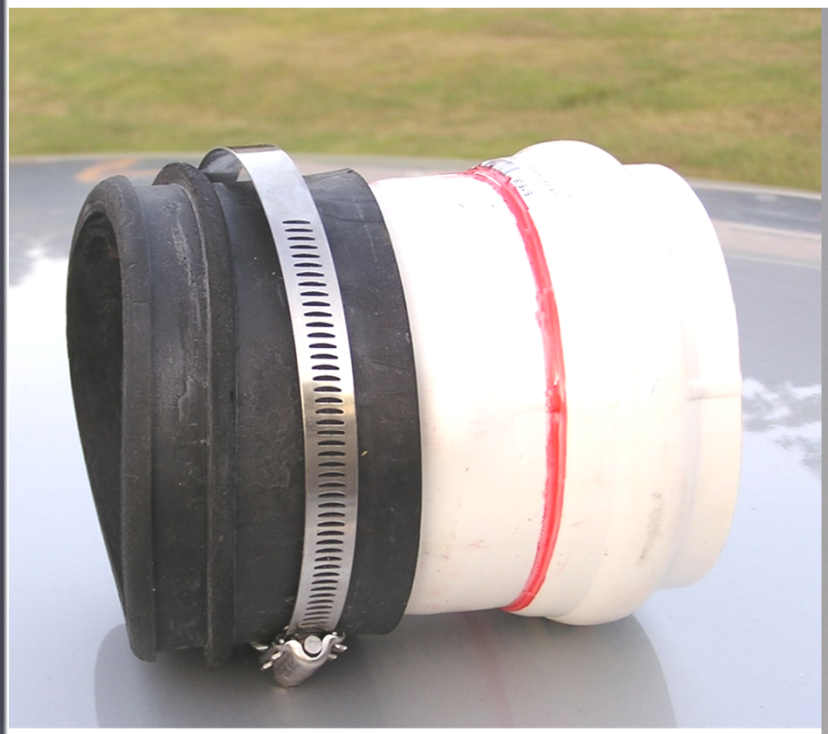
Flippen,GA-Pipe Bursting



Lateral Service Connections:In-Serta Tees for DI- Requires a Small Pit to install-Quick and Easy

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Pipe Bursting-Made Easy

- Accomplished with Standard PC-350 TR FLEX Restrained Joint Pipe. Pipe is stock with no long lead times or special machining.
- Cost effective-Much less than special bell-less pipe-Compare the price.
- 18-ft pipe= less handling, less joints.
- Sag's in existing lines can be limited w/ 18-ft pipe lengths
- Protecto 401 for aggressive Sewer applications
- Easy, fast and dependable joint assembly with leak free joints.
- In-Serta Tees for Service Connections

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Why Go Ductile?

- Pressure Ratings up to 350 PSI
- High allowable pulling forces
  - Material and Joint strength
- Low Pullback Forces
- Generous allowable joint deflections
- Quick and easy joint assembly
- "Cartridge" installation method
- Easy pipeline location
- Material strength not affected by time temperature
- No significant residual bending stresses
- Superior beam strength in trench loading conditions/bore holes
- Uses Standard, Stock Restrained Joint pipe

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Closing Remarks

Successful HDD installations have firmly established Restrained Joint Ductile Iron pipe as a viable, and in many instances a superior, trenchless pipe option.

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Questions-?

Thank You For This Opportunity

For More Information Contact:

Greg Key - 205-254-7954

Dick Rowell – 205-999-1008

Visit us at: www.uspipe.com

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