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SLIPLINING
Sewer Rehabilitation

Centrifugally Cast Fiberglass Reinforced Polymer Mortar Pipe

Bijan Khamaian

1/12/17

Seattle

NASTT PACIFIC NORTHWEST CHAPTER

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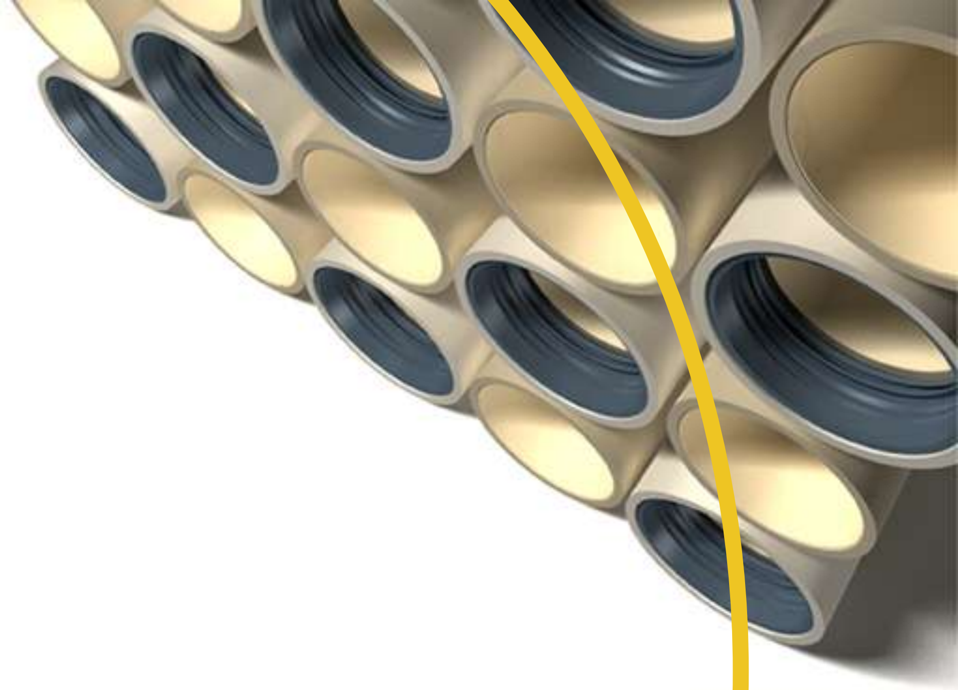

Agenda

- Introduction on Hobas
- Slipline Pipe Product details
- Features and benefits
- Case histories (Sliplining)
- Questions & answers

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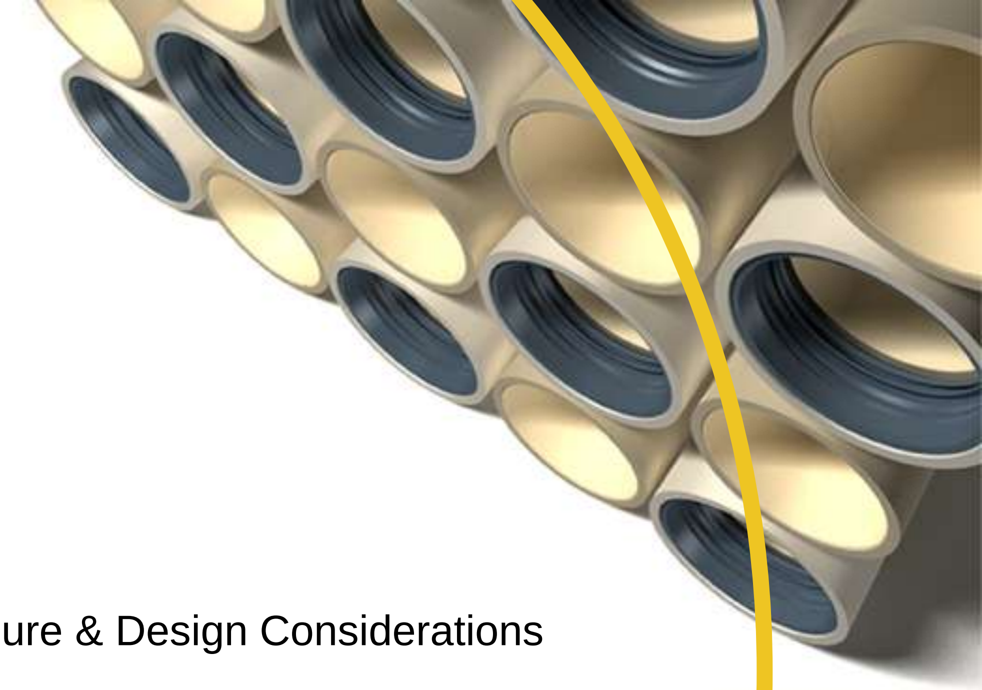

Agenda

- Overview of CCFRPM Product
- Overview of Sliplining with Basic Procedure & Design Considerations
  - Common Questions
    - What Pipe Will Fit?
    - Can I Maintain Capacity?
    - How Far Can I Push?
- Summary / Q & A

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Wietersdorfer
building solutions since 1893

Product

- Centrifugally Cast Fiberglass Reinforced Polymer Mortar (CCFRPM) Pipe
- Pipe, joints and fittings
- 18 inch to 126 inch diameter (450-3200 mm)
- Up to 20 foot section lengths (6 meter)

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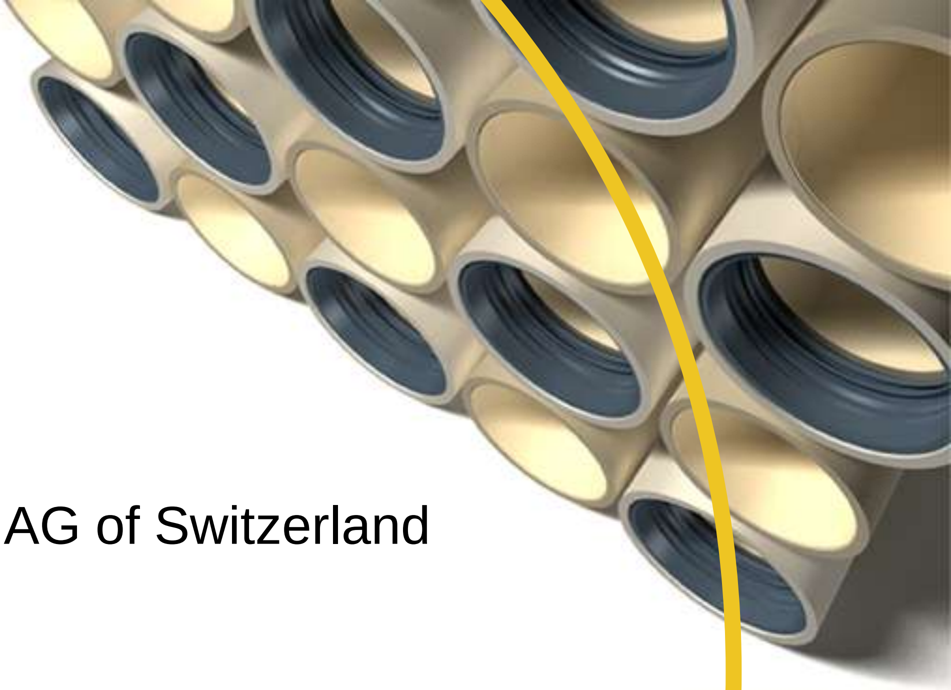

Company Information

- Licensee of HOBAS Engineering AG of Switzerland
- Worldwide organization
  - Over 36,000 miles (58,000 km)
  - Over 50 years
- Imported to the U.S. (early 1980‘s)
- Houston plant start-up (1987)
- U.S. installations = over 9.2 million feet (2,750,000 meters)

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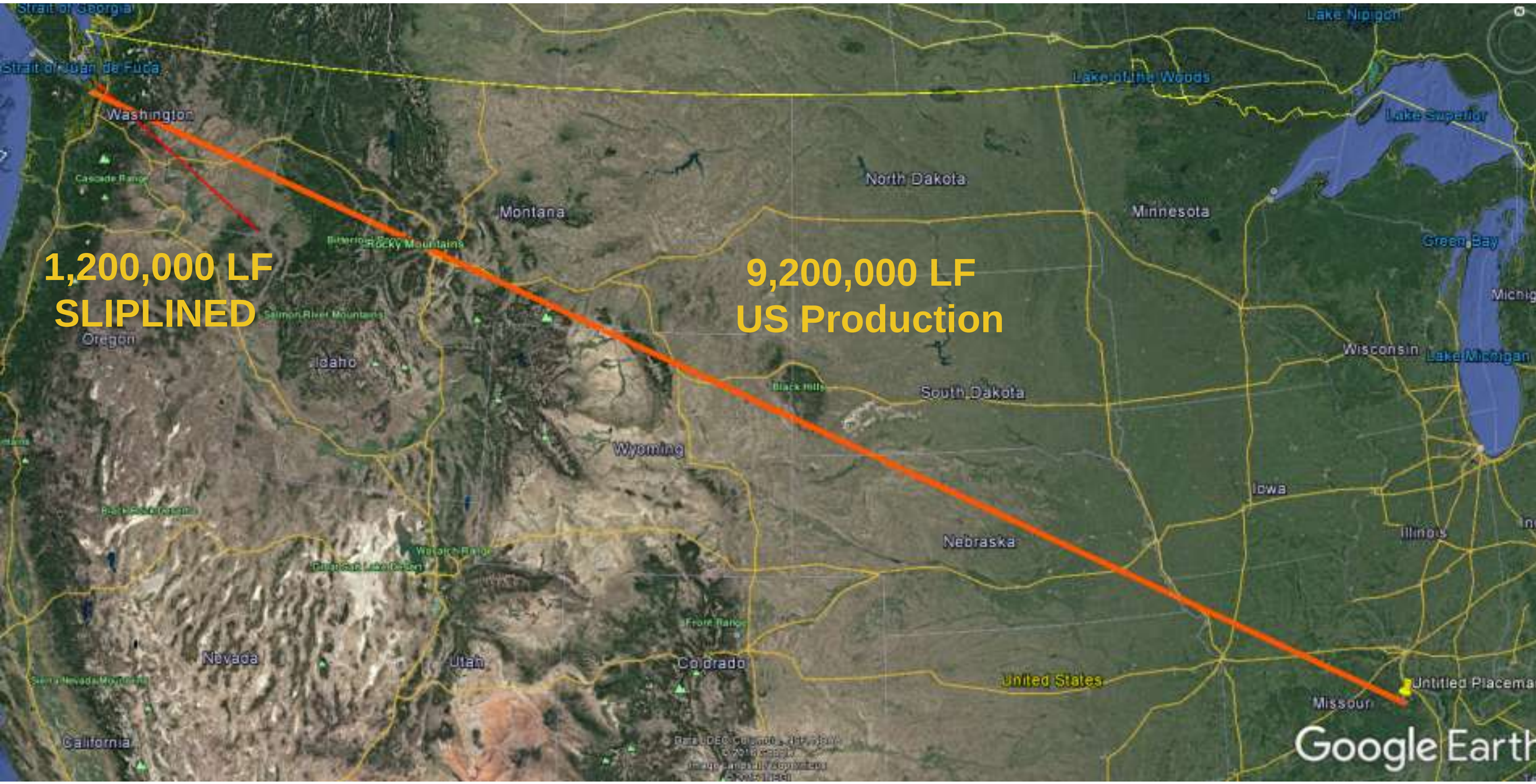
Hobas Pipe USA
Since 1987

30 years




ISTT
No-Dig
Award 2011
Winner
3000 mm (118”) Hobas Jacking Pipe
Warsaw, Poland
5,700 meters (18,700 LF) total length
930 meters (3,050 LF) single drive
Several Curved Drives

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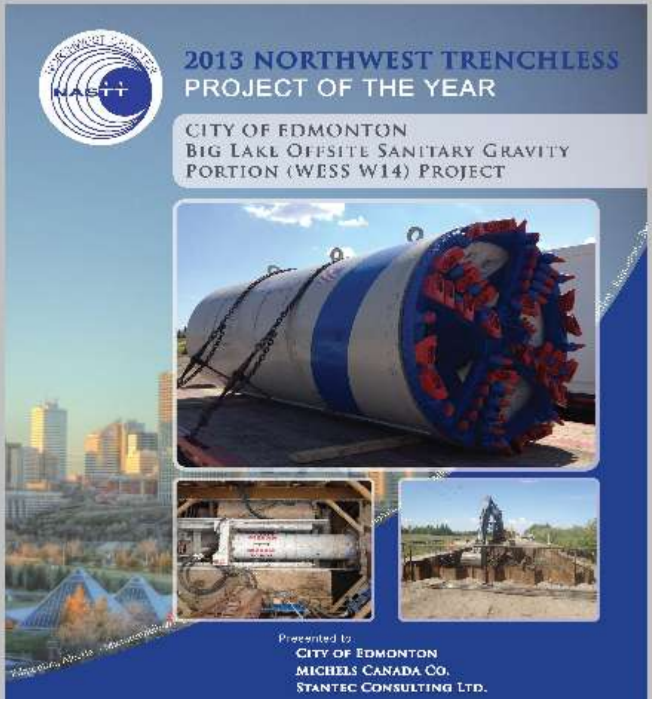
2,110 m
1,200 mm

North American Society for Trenchless Technology - Northwest Chapter

2013 Northwest Trenchless Project of the Year

Congratulations to the City of Edmonton, Michels Canada Co., and Stantec Consulting Ltd. for winning the 2013 Northwest Trenchless Project of the year!



Global Organization

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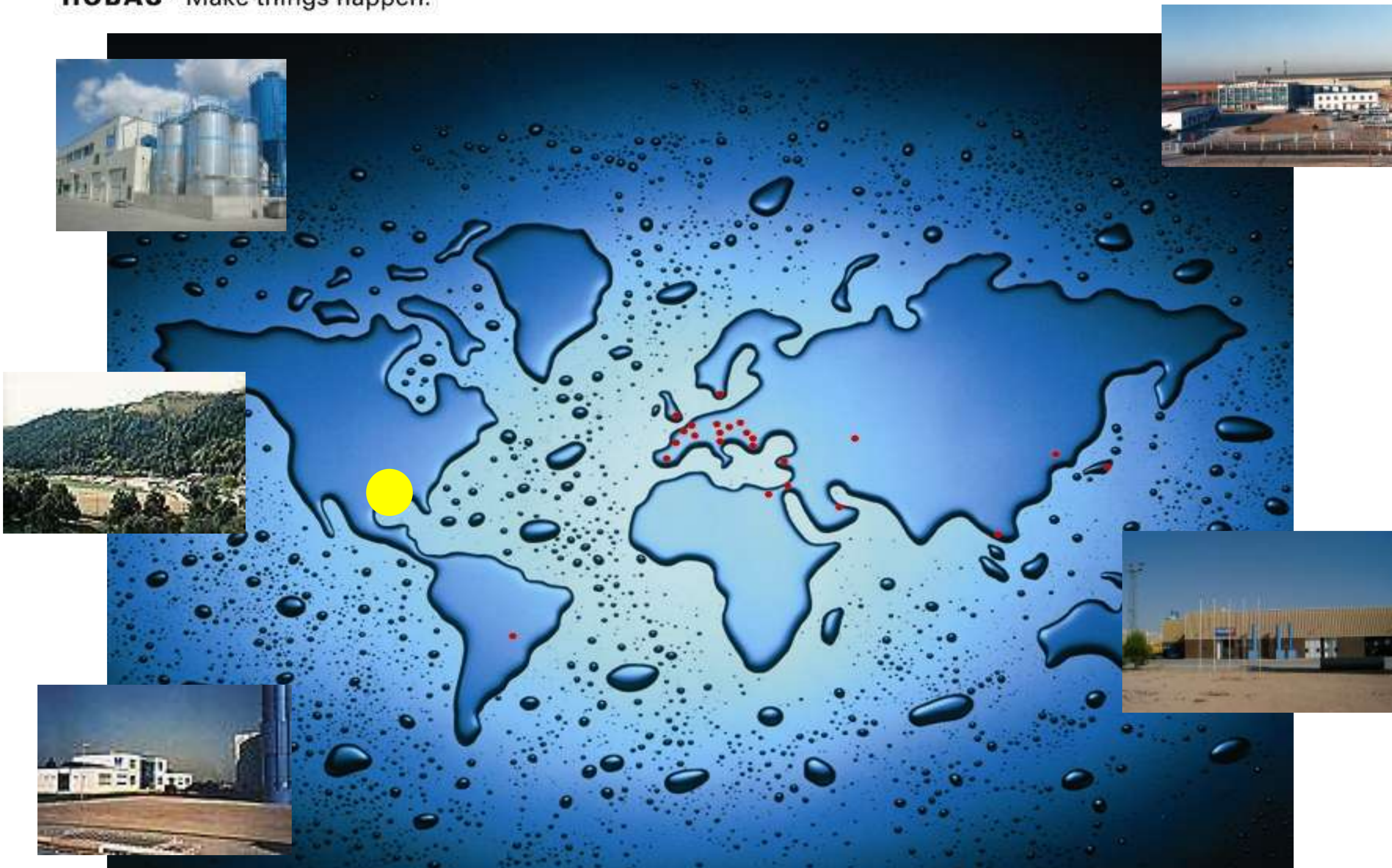

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Houston Factory

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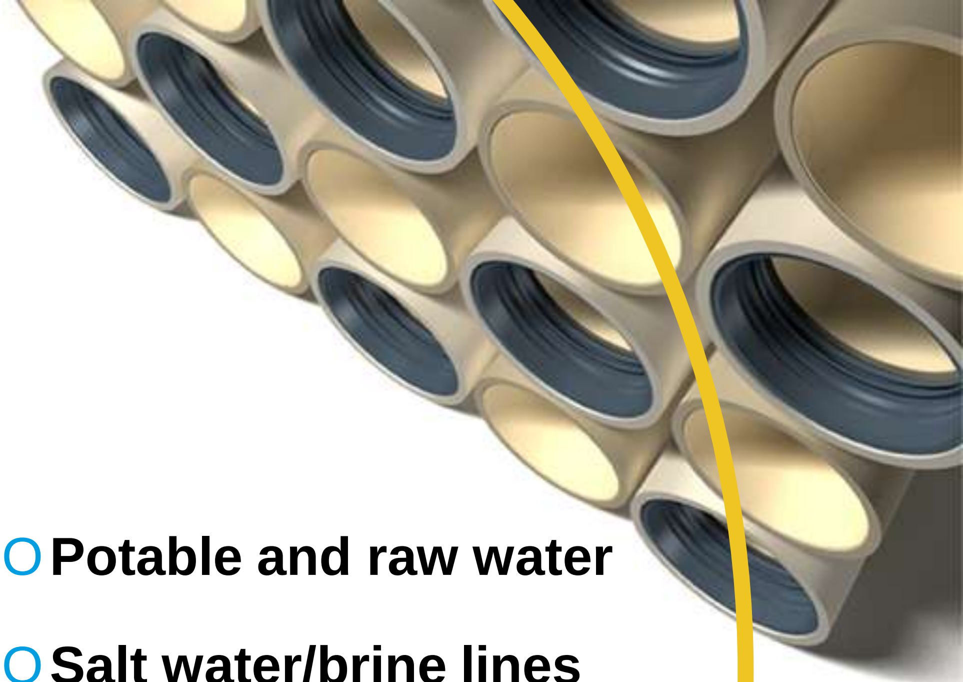

Applications

- **Gravity sewers**
- **Sewer force mains**
- **Industrial effluents**
- **Utility corridors**
- **WWTP piping**
  - Yard piping
  - Odor contol piping
- **Potable and raw water**
- **Salt water/brine lines**
- **Outfalls**
- **Cooling water**
- **Storm water segregation**
- **Penstocks**

Installation Methods

- Direct bury
- Microtunneling/Jacking
- Sliplining
- Above ground
- Tunnel carrier

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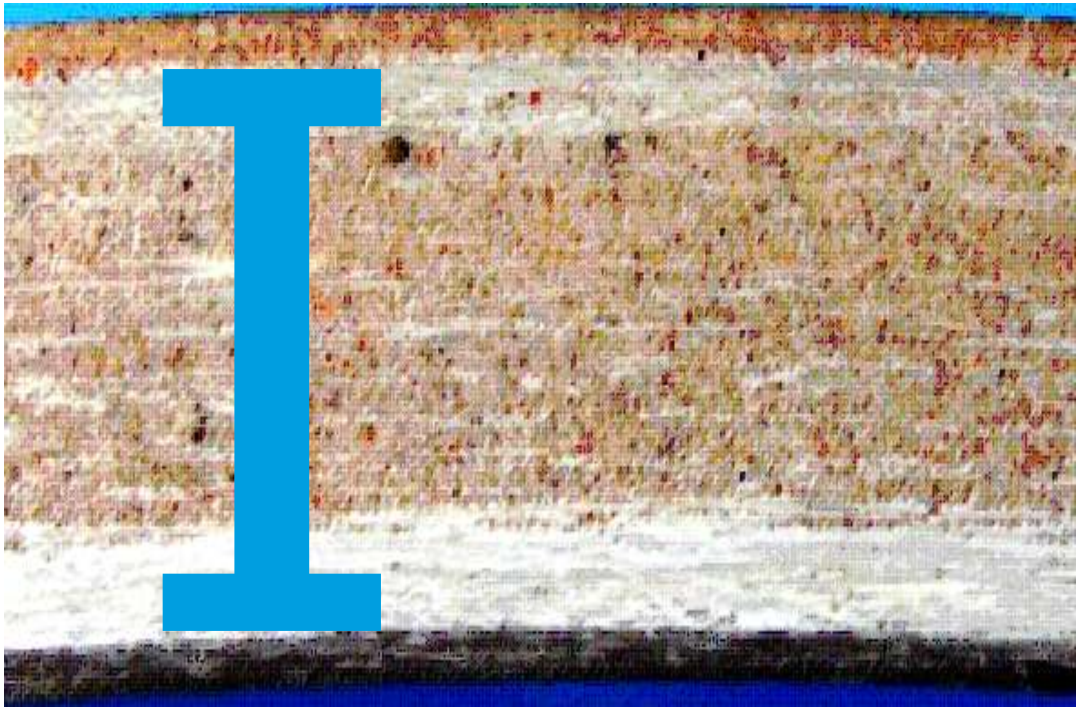
Materials

- High quality, commercial grade E-glass fibers
- Thermosetting resin
- Precisely graded aggregates

Wall Construction (I-beam principle)



Outer layer (sand and resin)

Heavily reinforced (chopped glass and resin)

Transition (glass, resin and mortar)

Core (polymer mortar)

Transition (glass, resin and mortar)

Heavily reinforced (chopped glass and resin)

Liner (high elongation resin)

HOBAS

Process

Process

ZERO energy to cure (very low carbon footprint process)

Process

Quality Control Lab

Lab Audits

-Raw materials

-Finished products

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Product Testing

- Pipe production is sampled per ASTM requirements
- Tests include stiffness, deflection characteristics and mechanical properties

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Long-term Performance

- Extended pressure and ring bending tests continue for a minumum of 10,000 hours
- Safe operating limits are established by following appropriate standards

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STRAIN CORROSION TEST RESULTS
(H_2SO_4 per ASTM D3262)

Deflection	Life Years
2%	681 Trillion
3%	247 Billion
4%	895 Million
5%	*11 Million*
6%	325 Thousand
7%	16 Thousand
8%	1 Thousand
9%	118

Lasts a bit more than 50 years!

$$\log(\text{time}) = -19.537 \log(\%\ \text{strain}) + 5.12$$

ZERTIFIKAT ◆ CERTIFICATE ◆ 認證證書 ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

TÜV SÜD

Management Service

CERTIFICATE

The Certification Body
of TÜV SÜD Management Service GmbH

certifies that

HOBAS®

HOBAS PIPE USA
1413 East Richey Road
Houston, TX 77073-3058
USA

has established and applies
an Environmental Management System for

Development, production, sales and
customer service of Centrifugally Cast Fiber-Reinforced
Polymer Mortar (CCFRPM) Pipe-Systems.

An audit was performed, Report No. **70772724**.

Proof has been furnished that the requirements
according to

ISO 14001:2004

are fulfilled. The certificate is valid from **2014-03-25** until **2017-03-24**.

Certificate Registration No. **12 104 40115 TMS**

Product Compliance Management
Munich, 2014-02-06

DAkkS
Deutsche
Akkreditierungsstelle
D-ZM-14143-01-04

ZERTIFIKAT ◆ CERTIFICATE ◆ 認証証書 ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

TÜV SÜD

Industrie Service

CONFIRMATION

The

TÜV SÜD Industrie Service GmbH
Westendstraße 199
80686 München/Germany

hereby declares that

HOBAS®

HOBAS PIPE USA
1413 E. Richey Road
Houston Texas 77073-3508

is a part of the HOBAS Group and capable to produce Centrifugally Cast Fiber Reinforced Polymer Mortar (CC-FRPM or CC-GRP) Pipes according to following FRP Piping Standards:

ASTM D 3262, ASTM D 3517, ASTM D 3754 and AWWA C-950

The design of Pipes, Joints and Fittings follows the guidelines of:

AWWA M45

Validity: This confirmation was checked during the ISO 9001 and ISO 14001 Audit in January 2014 and is valid until the next Re-Audit which is planned in January 2017.

The production an product monitoring is carried out every year.

Date of issue: February 21, 2014

TÜV SÜD Industrie Service GmbH
Institute for Plastics

Demetz

TÜV SÜD Industrie Service GmbH

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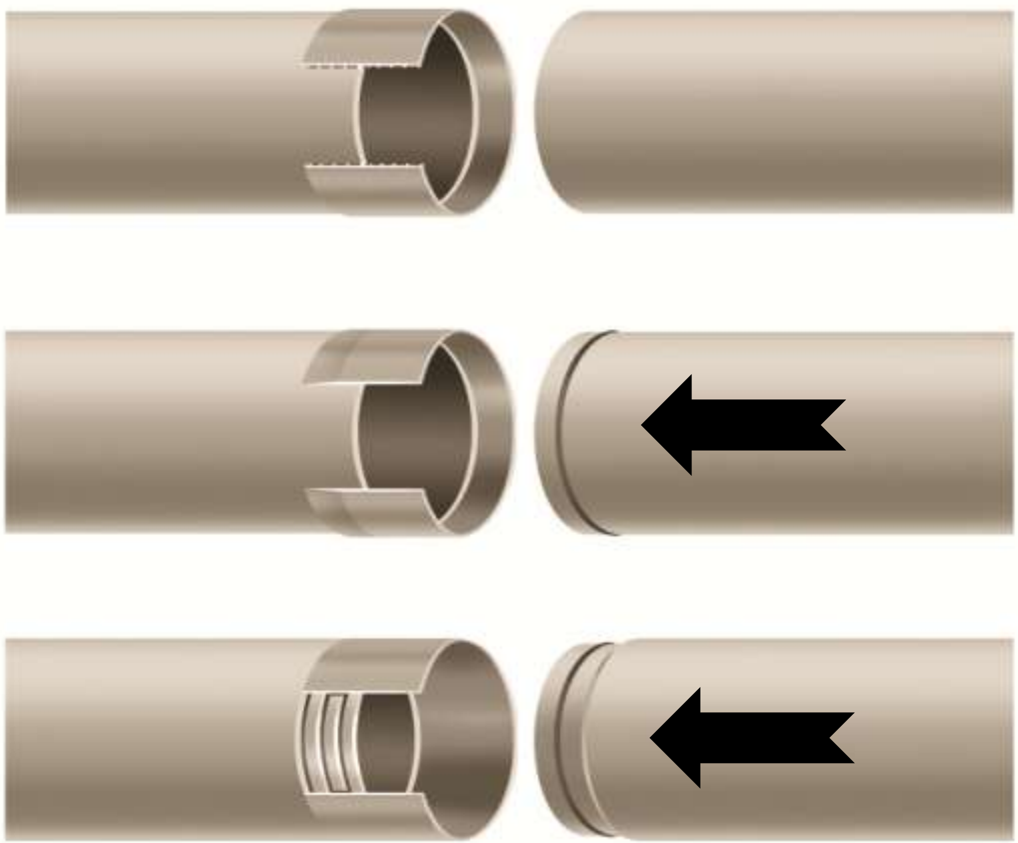
Joints / Couplings



FWC Coupling

Low Profile Bell-Spigot

Flush Bell-Spigot

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Flush Bell-Spigot

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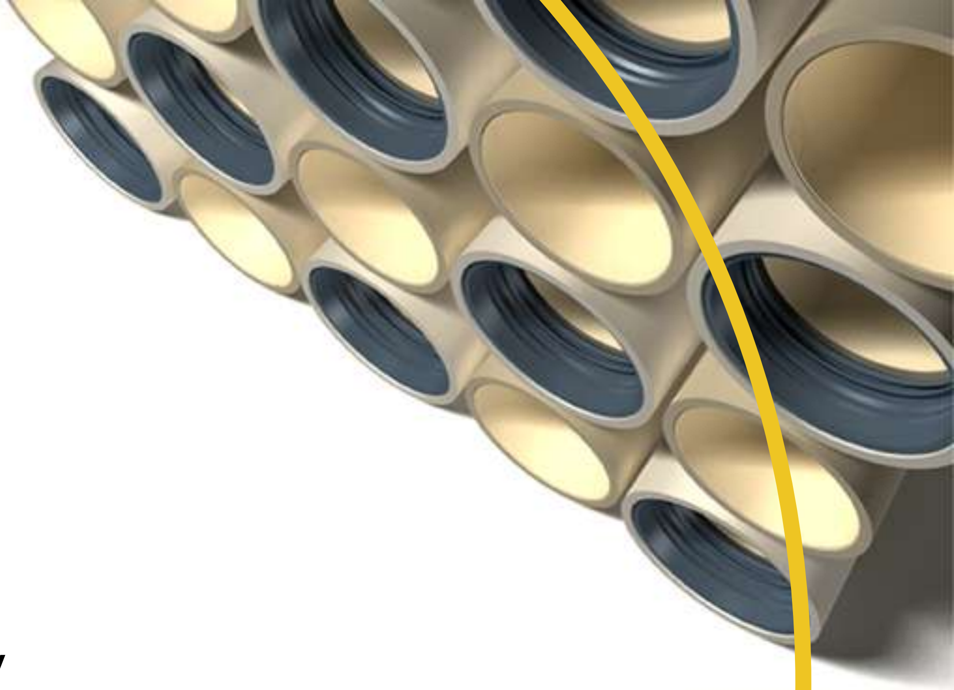
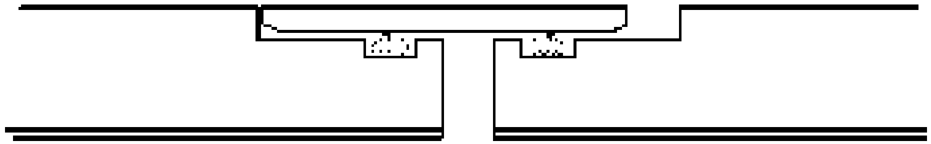


Flush Bell-Spigot

- Elastomeric gasket seal
- Push-together assembly
- Flush to pipe OD
- Excellent performance
    - 50 psi lab test
    - Zero leakage
    - 100 psi ext.



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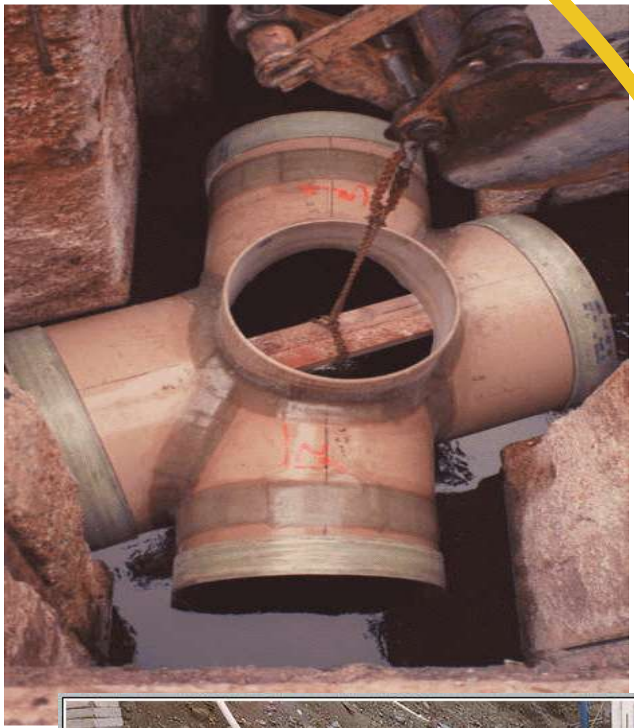
Fittings

- Elbows
- Reducers
- Flanges
- Tees
- Laterals
- Nozzles



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FIBERGLASS Manholes

- T bases
- Risers

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Standards

o **ASTM D3262**	**Gravity Sanitary Sewers**
o **ASTM D3754**	**Sewer Force Mains & Industrial**
o **AWWA C950**	**Water Pressure Mains**
o **AWWA M45**	**Fiberglass Pipe Design Manual**

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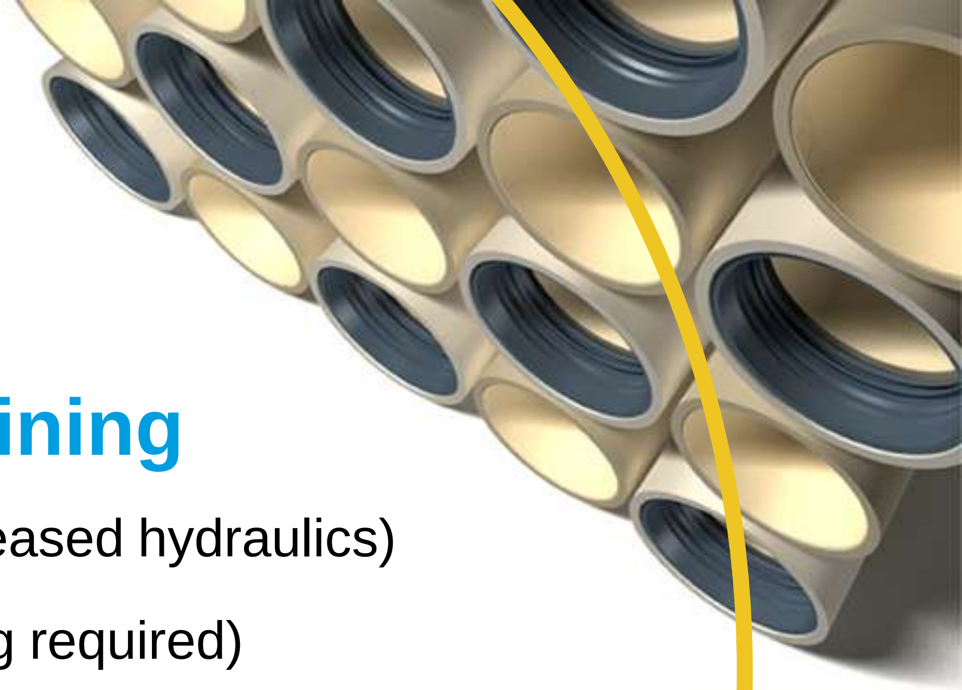

Advantages of Sliplining

- Improved flow capacity (increased hydraulics)
- Do live (no **BYPA$$** pumping required)
- Long pushes (fewer pits)
- Easy to grout with higher safety factors
- Elastomeric gasket push together joints
    - Smaller pits
    - Faster assembly

Sliplining Experience

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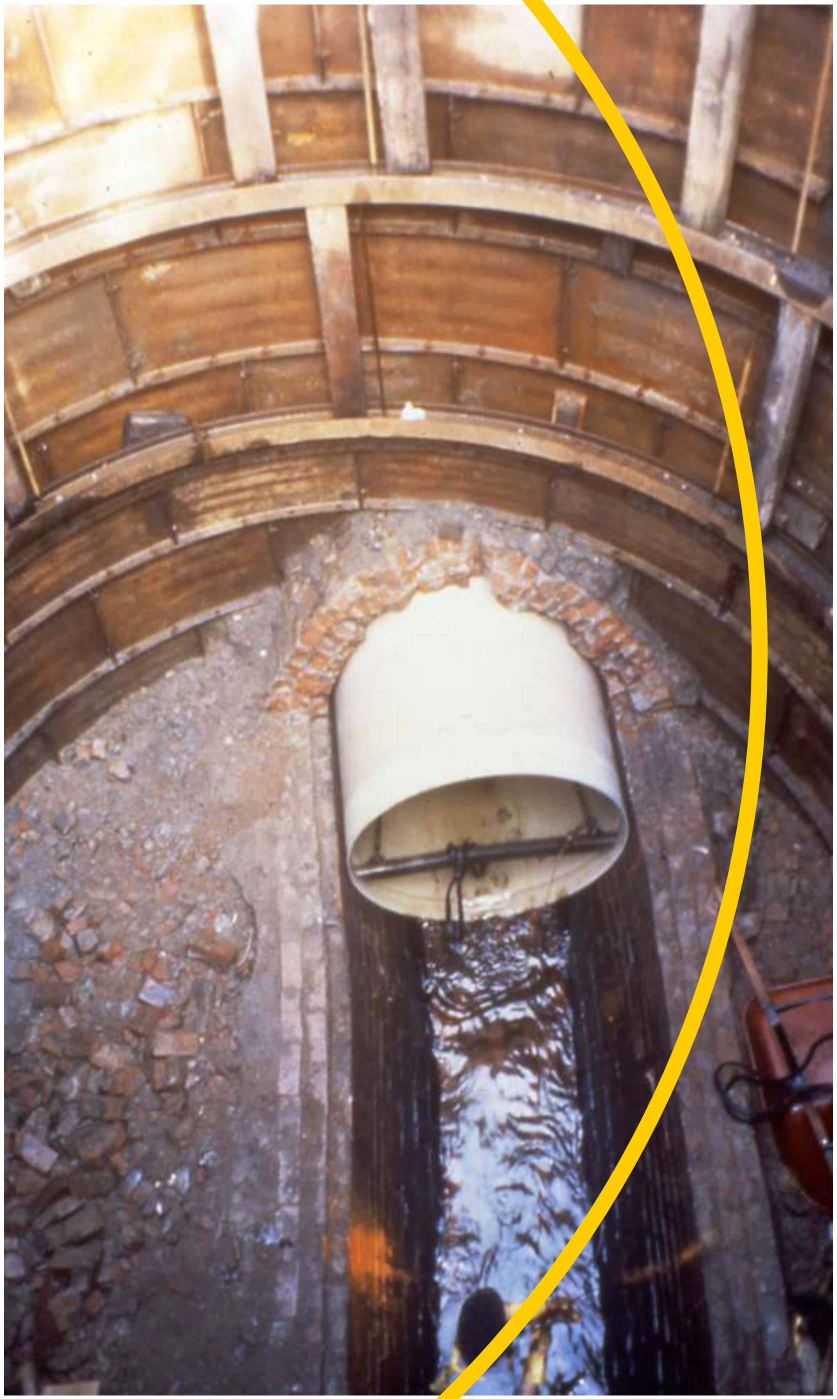
Sliplining

- Semi Trenchless Method (limited excavation)

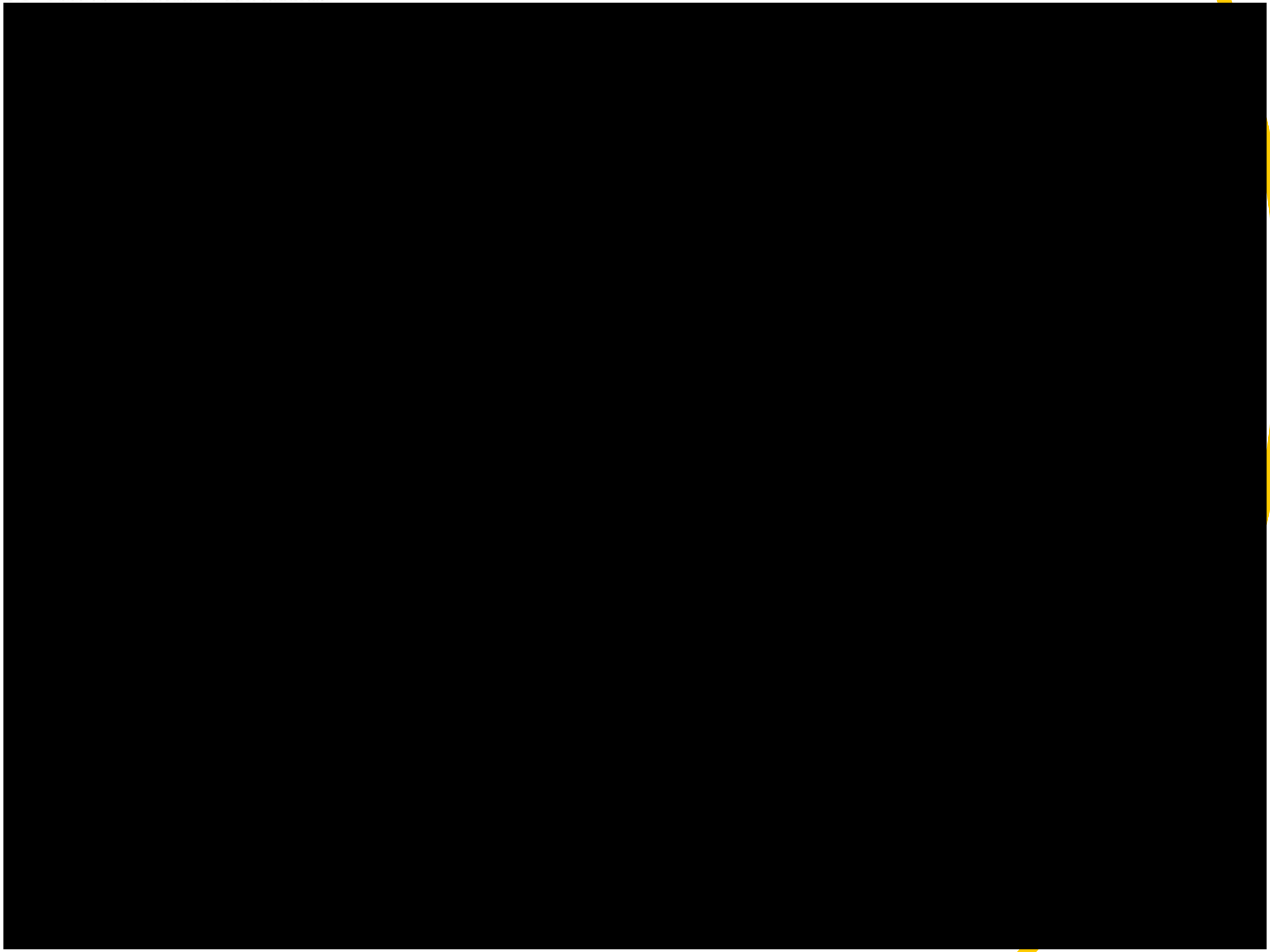
Sliplining

- New Factory Made Pipe Within An Old Pipe



Sliplining Experience

is this too fast?



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“Live”

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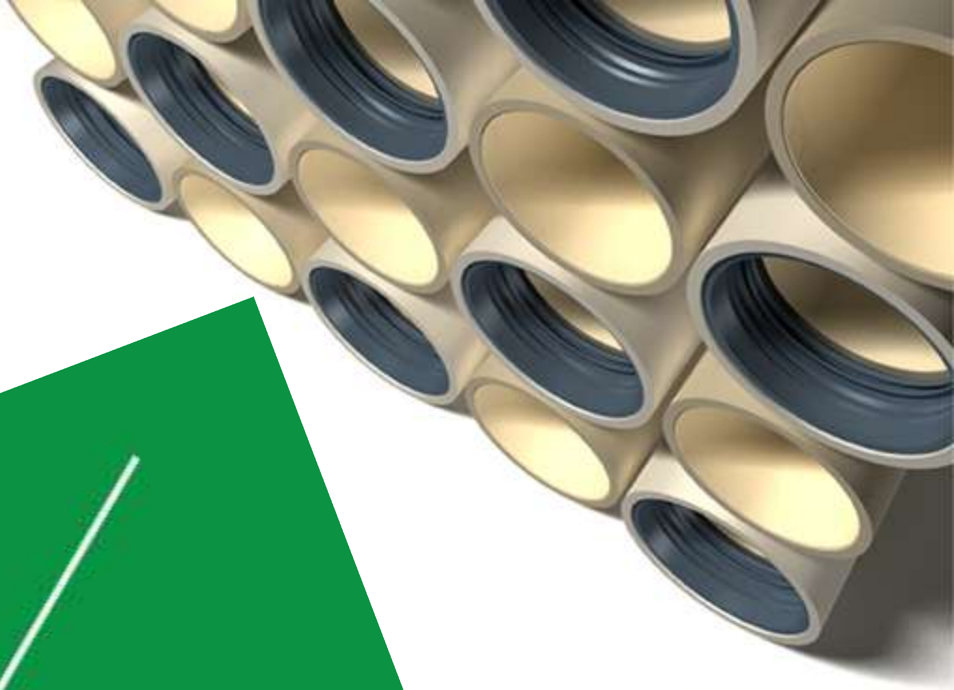
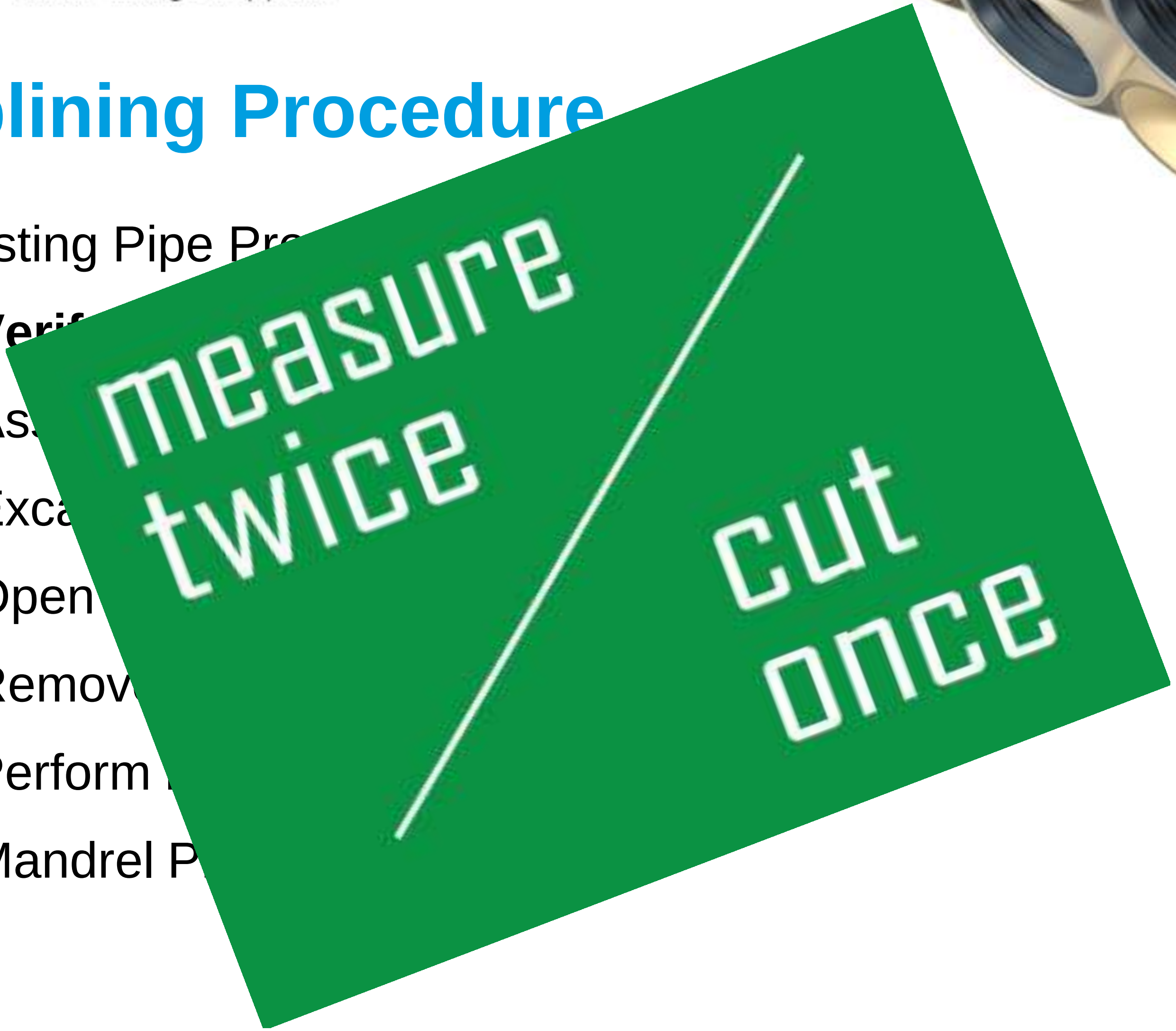


Sliplining Procedure

- Existing Pipe Pr
  - **Veri**
  - As
  - Exca
  - Open
  - Remov
  - Perform
  - Mandrel P



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Not Round,
Not a Problem!

Baudepartement Basel-Stadt

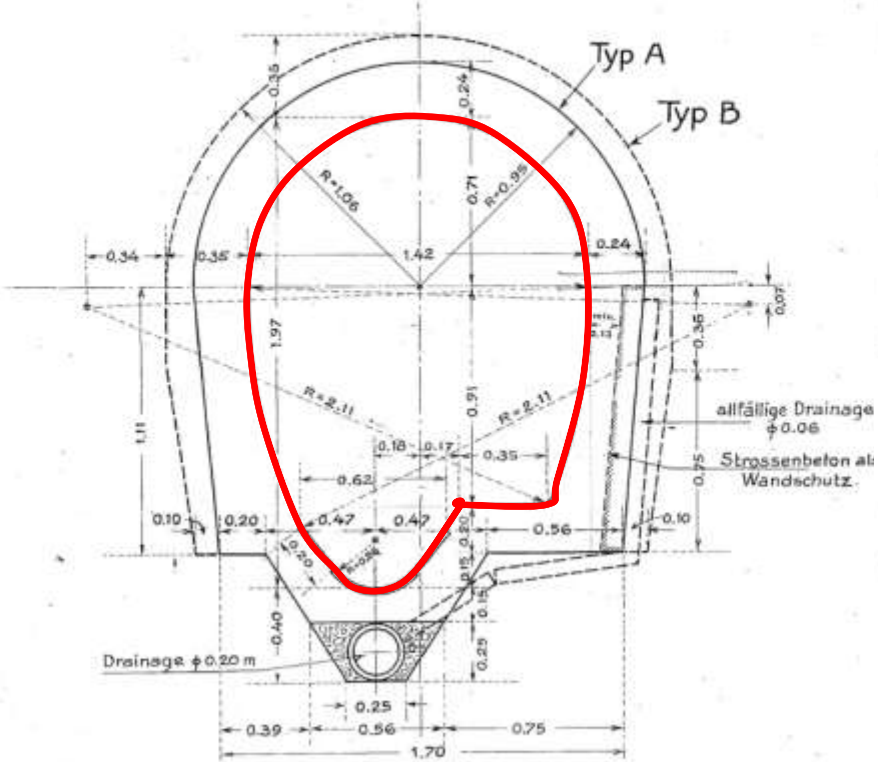
0345.1

Buss A-G. Basel
Ingenieurbureau für Tiefbauarbeiten

KANALISATION BRUDERHOLZ-ST JAKOB

NEUES NORMALPROFIL DER DOLE 1.42/1.97m.

1:20



Profilausmasse per m Dolenlänge.

	Mass	Typ A im Fels	Typ B im Kies
Verdrängte Erdmasse	m³	3.75	4.36
Beton inklusiv Verputz	m³	1.46	2.07
Aussenverputz (im offenen Graben)	m²	—	3.33
Innenverputz: Wände, d=1cm	m²	4.30	
Innenverputz: Bankett, d=2cm	m²	0.35	
Innere Steinzeugfläche	m²	0.82	
Kies für Drainage	m³	0.05	
Lichte Profilfläche	m²	2.16	
Lichter Profilumfang	m	5.47	

Buss A-G. Nº 10524a

Basel, 28.I.37. GB
abgeändert: 29.II.37

Baudepartement Basel-Stadt.

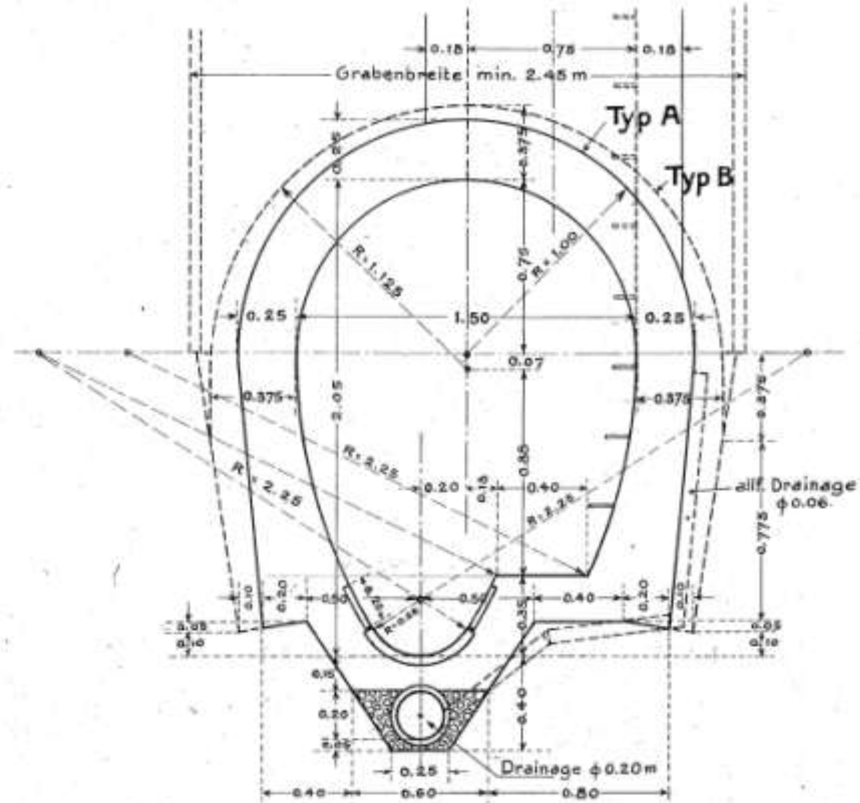
Buss A.-G. Basel
Ingenieurbureau für Tiefbauarbeiten.

KANALISATION BRUDERHOLZ-ST JAKOB

NORMALPROFIL DER DOLE 1.50/2.05 m

0634.1

1:20.



Profilausmasse per m Dolenlänge

	Mass	Typ A im Fels	Typ B im Kies
Verdrängte Erdmasse	m³	4.11	4.68
Beton inkl. Verputz	m³	1.52	2.10
Aussenverputz	m²	—	3.40
Innenverputz: Wände, d=1cm	m²	4.40	
Innenverputz: Bankett, d=2cm	m²	0.40	
Innere Steinzeugfläche	m²	0.93	
Kies für Drainage	m³	0.05	
Lichte Profilfläche	m²	2.45	
Lichter Profilumfang	m	5.73	

Buss A-G.
Nº 10349a

21. VIII. 36.

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Liner Sizes

Standalone Design

- **326 m**
  DN 1232x1800 GRP
  (25 mm wall)

- **672 m**
  DN 1302x1900
  (27 mm wall)

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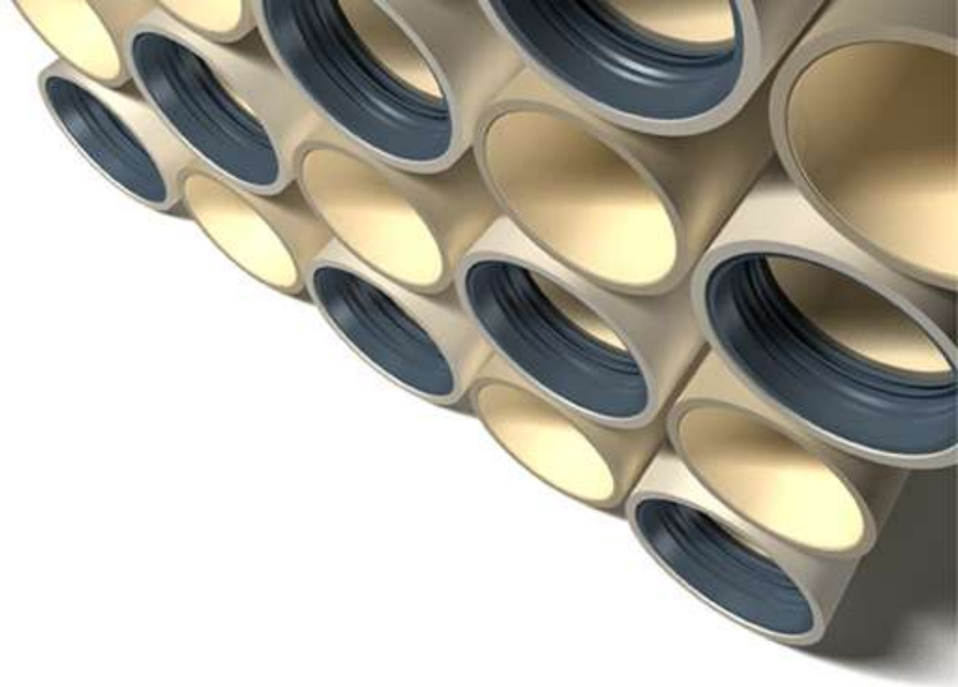
Sliplining Procedure



- Lining Process
  - Insert Liner Pipe
  - Confirm Successful Insertion (video)
  - Reinstate Any Laterals
  - Grout Annulus
  - Final Acceptance (video)

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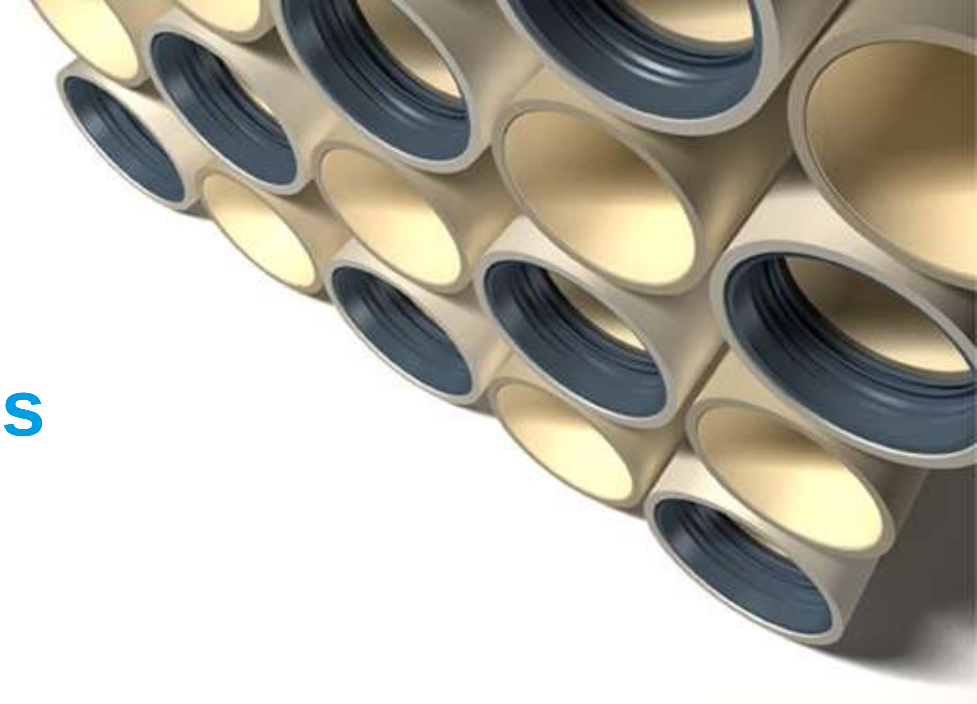

Design Considerations

- Liner
  - Corrosion Protection
  - Leak Prevention
  - Hydraulics
  - Structural Reinforcement
  - Installation

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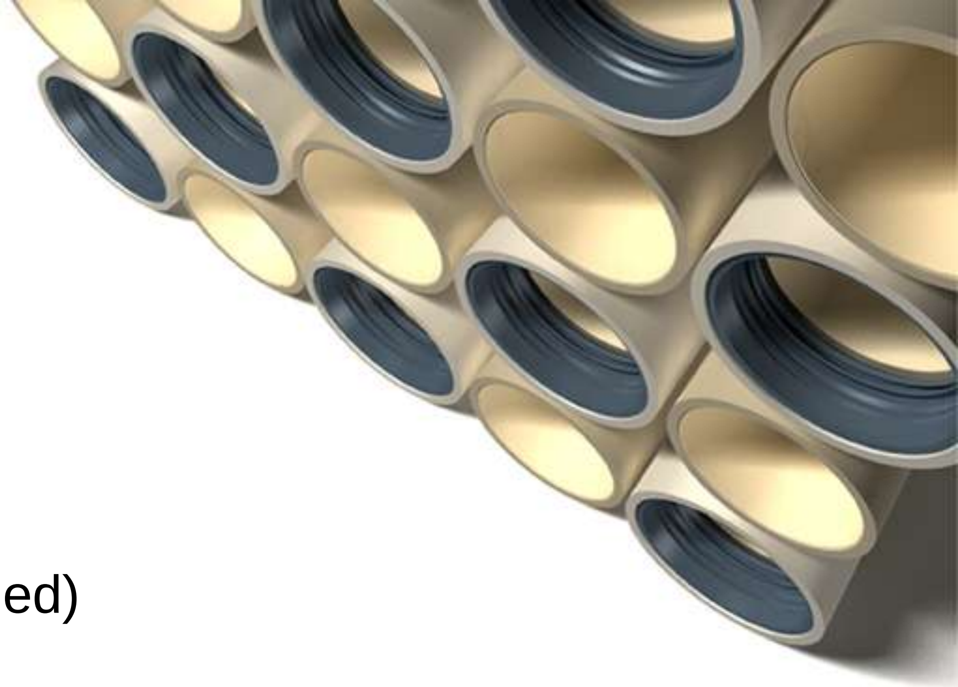

Sliplining Advantages – Segmental Pipes

- Segmented Systems (gasket sealed)
  - Live Insertion
  - Small Access Shafts
  - Fast Assembly
  - Quick Insertion

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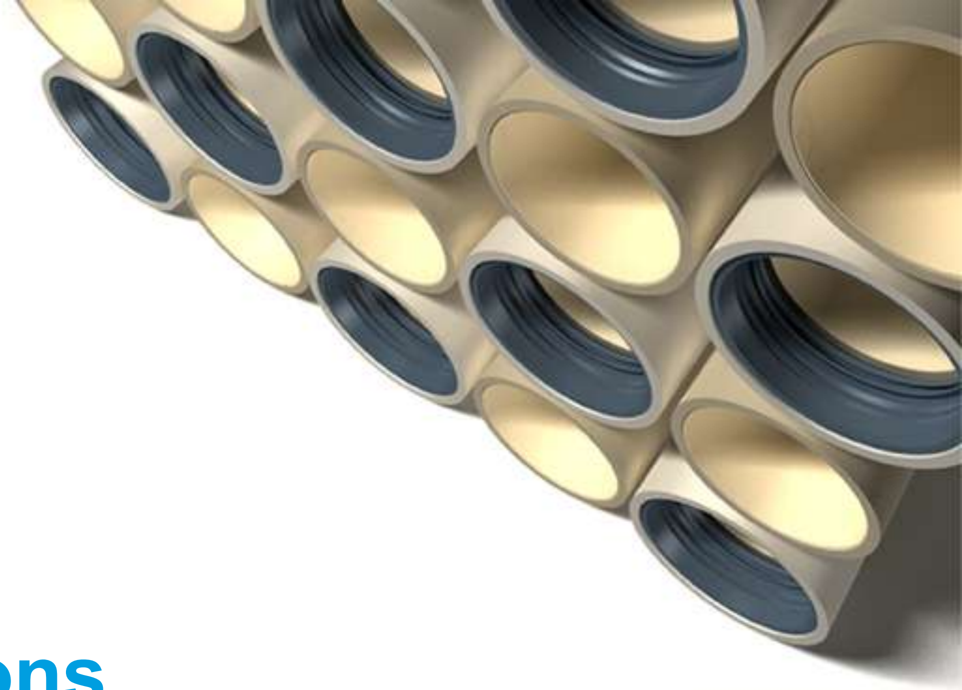

Most Common Questions…

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Q1 – What Pipe Will Fit?

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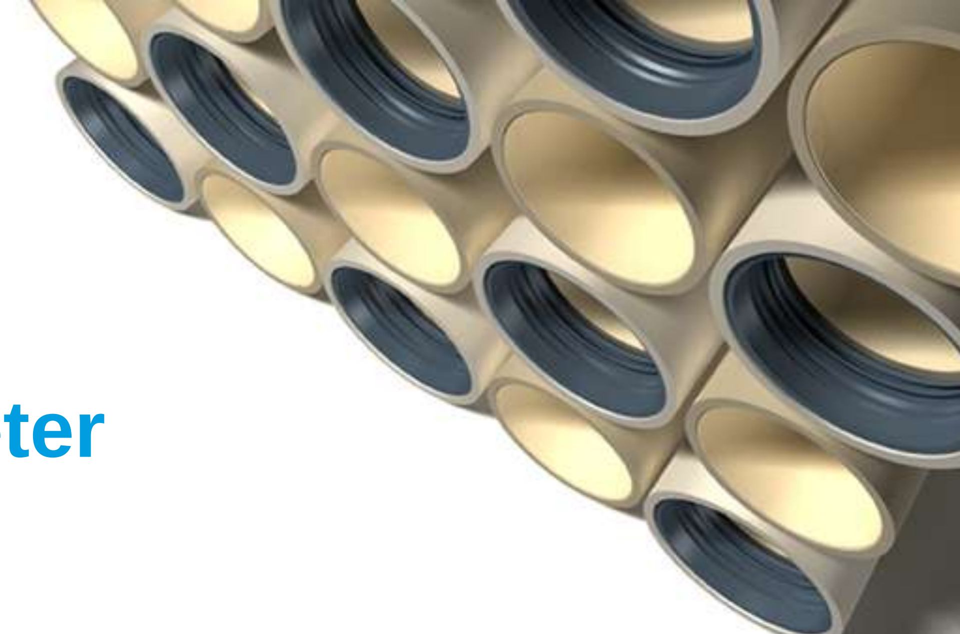

Determining The Diameter

- Diameter Differences
  - Generally a 5% Decrease in Diameter is Successful
  - Minimum of about 1” on R

26″ CCFRPM (28 OD) into 30″ (7%)

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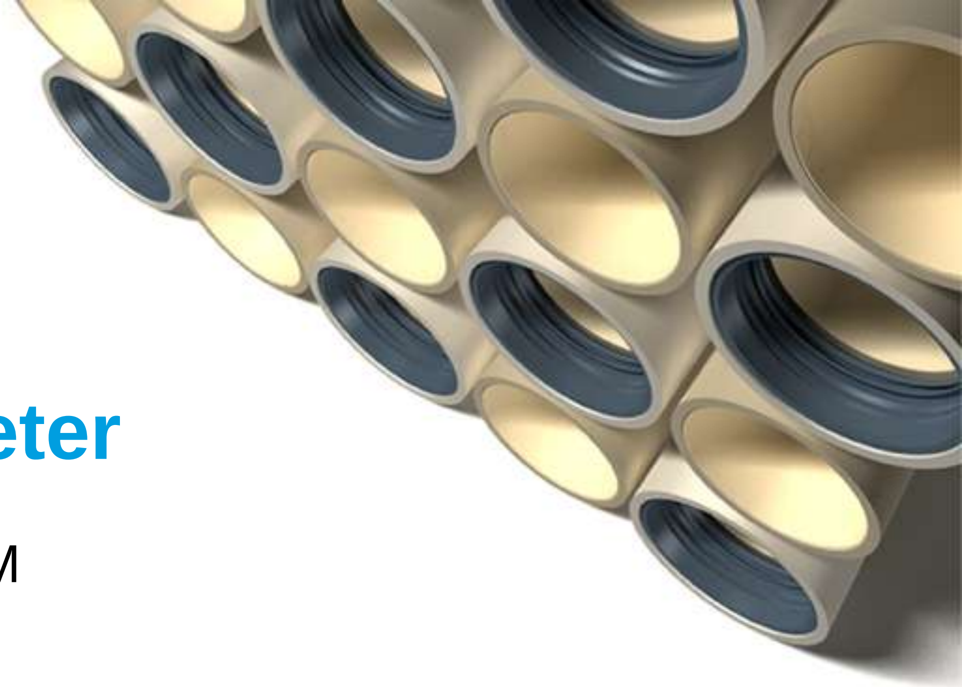

Determining the Diameter

- Tightest Fit Recorded w/ CCFRPM
  - Los Angeles, CA
  - 30” nominal, 32.0” OD, installed in 33” Clay (3%)
  - Existing Clay Pipes Were 4’ Joint Lengths, CCFRPM Pipes Were 10’ Joint Lengths
  - Total Installation ‘Run’ Was Only 400’

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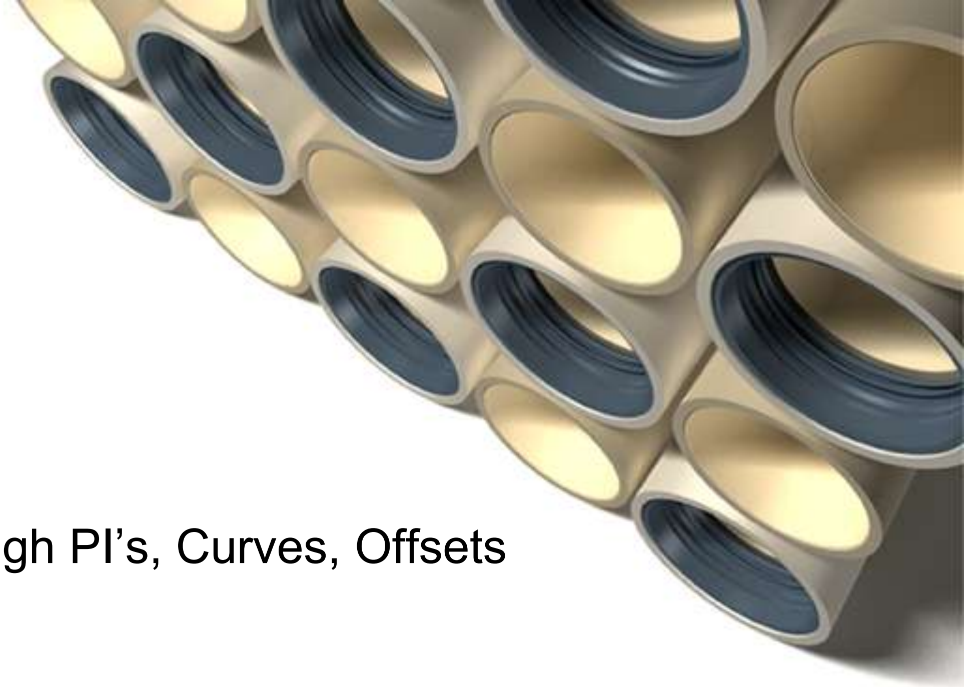

Non Straight Sections

- Determining if the pipes will pass through PI’s, Curves, Offsets
  - Accurate Survey
  - Pipe Dimensions (Raised or Flush Bell)
  - Simply Geometry
  - Mandrel “Proof”
- Determining if Pipes Will Seal if they pass
  - Worst Case if Liner Pipe Joints Occur at Host PI’s

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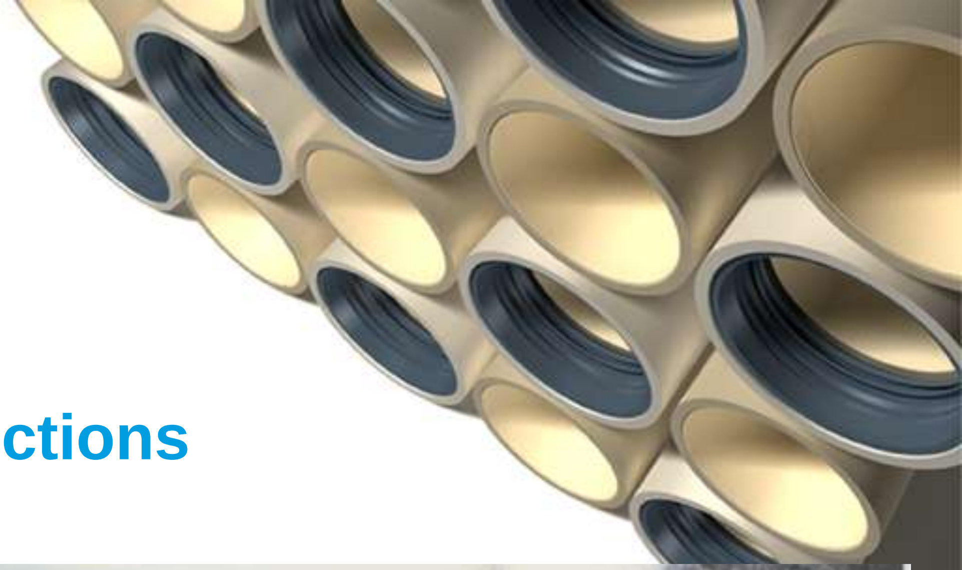

Solutions to Non Straight Sections

- Short Pipe Segments
  - Denver, CO
  - Rehab of Curved Above Ground Sewer by Joint Angular Deflection

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Short Pipe Segments

- Los Angeles, CA
- 57” & 63” RCP, with 51” & 57” CCFRPM
- Seventeen 2.5 ft Long Pipes At The Front Of A 3,500 ft. Push
- Three Curves Each of 45 Foot Radius
- Push Shafts Located so Curved Areas Were At The End Of The Drives

Solutions to Non Straight Sections

- Mitered Fittings at Shaft Locations

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Q2 – Can I Maintain Capacity?

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Maintaining Flow Capacity

Long Term
n=0.010

- Function of Diameters & Pipe Hydraulic Characteristics
- Even With A Diameter Reduction, Typically Improved Flow Capacity

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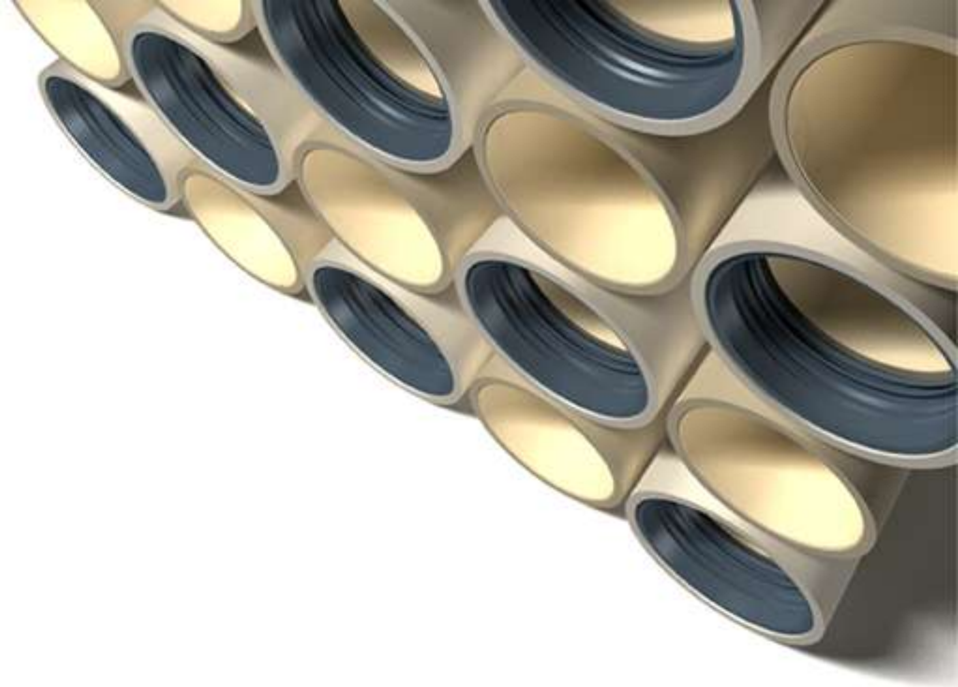

Manning’s

- $Q = (1.49/n)\ A\ R^{2/3}\ S^{1/2}$
- Reducing Two Simultaneous Equations On The Same Slope

$$Q_1 / Q_2 = (n_2/n_1) * (D_1/D_2)^{8/3}$$

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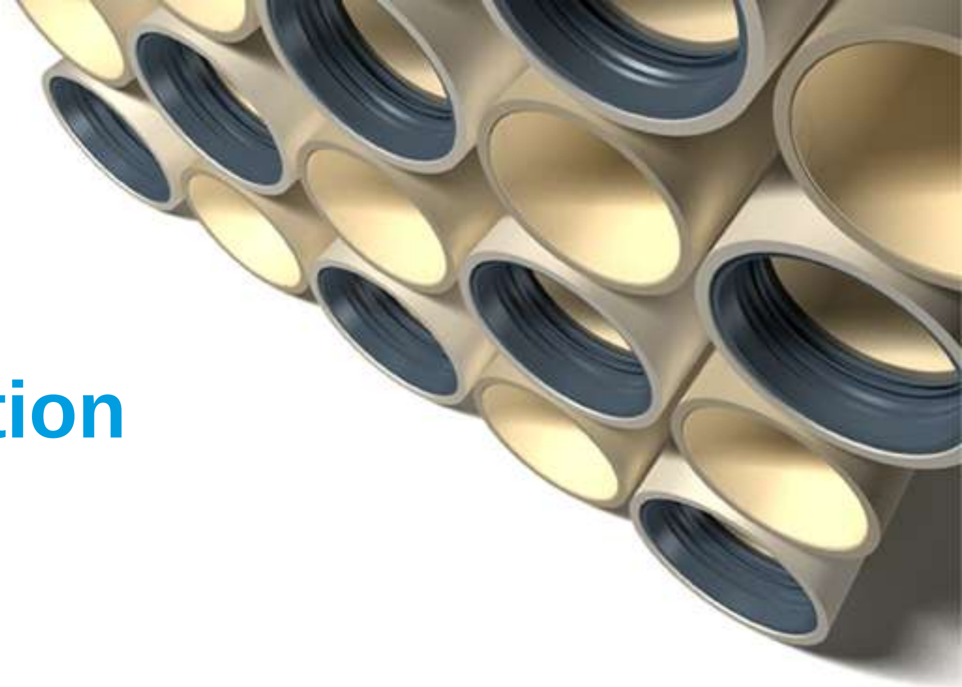

Liner Diameter Reduction

- 4 – 8 Inch Typical Step Down
- Depends On Wall "t" and Clearance

Liner Manning's "n"	Host Diameter for equal flow
0.009	13% Reduction vs. 0.013
0.011	13% Reduction vs. 0.016
	17% Reduction vs. 0.018

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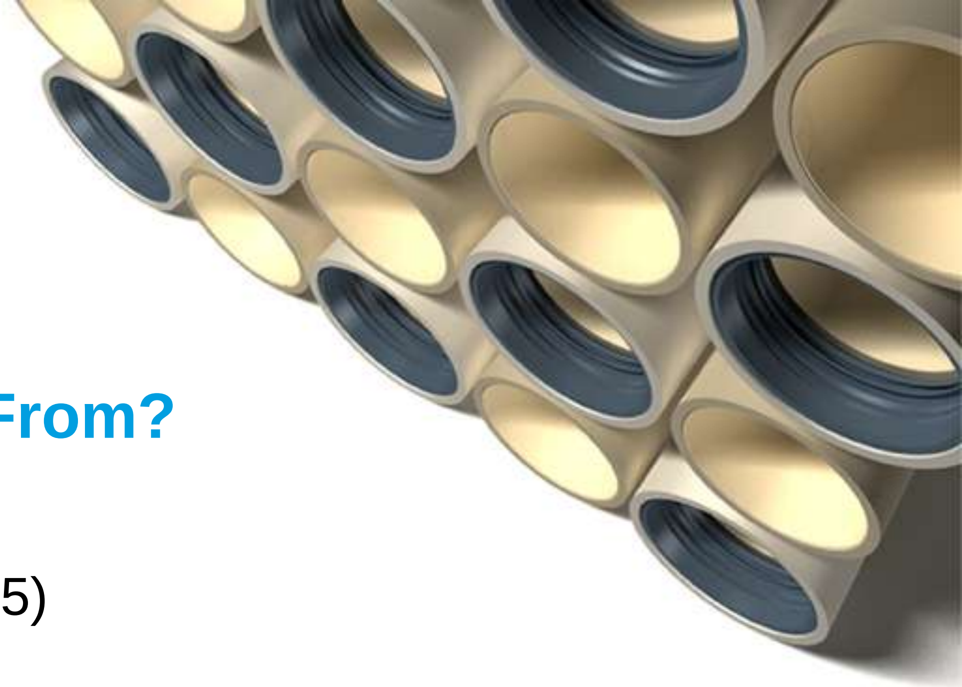
Capacity Change Scenarios

Material	Wall "t" vs. Dia.	Typ. Dia. Reduction	Flow Change
CCFRPM	2% - 3%	10%	>
PVC	3% - 4%	12%	>
HDPE - SW	4% - 5%	14%	=
HDPE - PW	6% - 8%	19%	<



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Where Did Flow Data Come From?

- West Texas (Hazen Williams C=155)
- LACSD (Manning's = 0.010)

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Q3 – How Far Can I Push?

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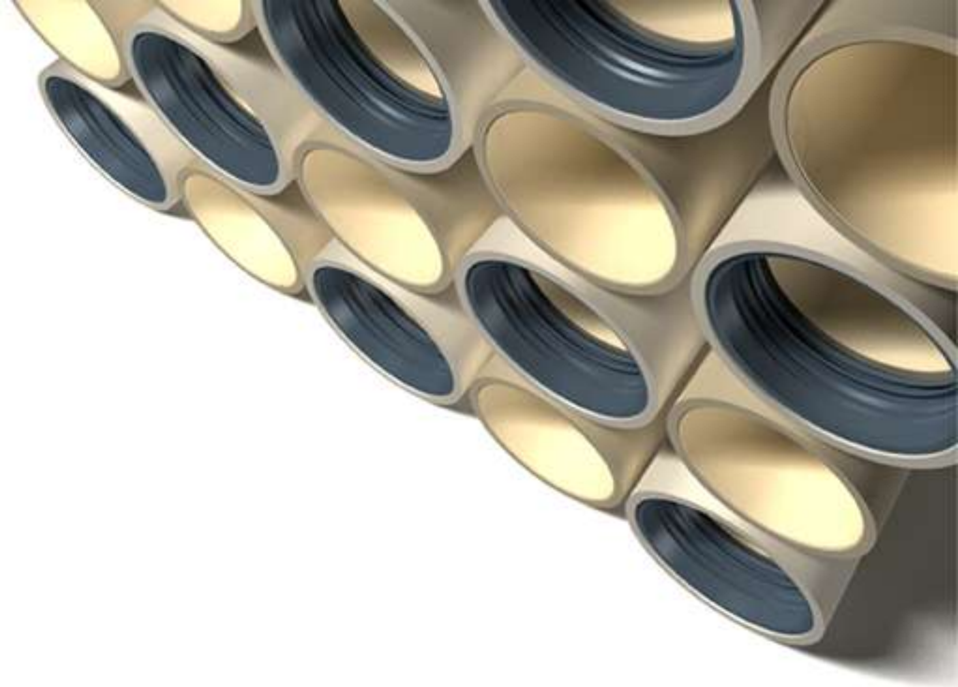
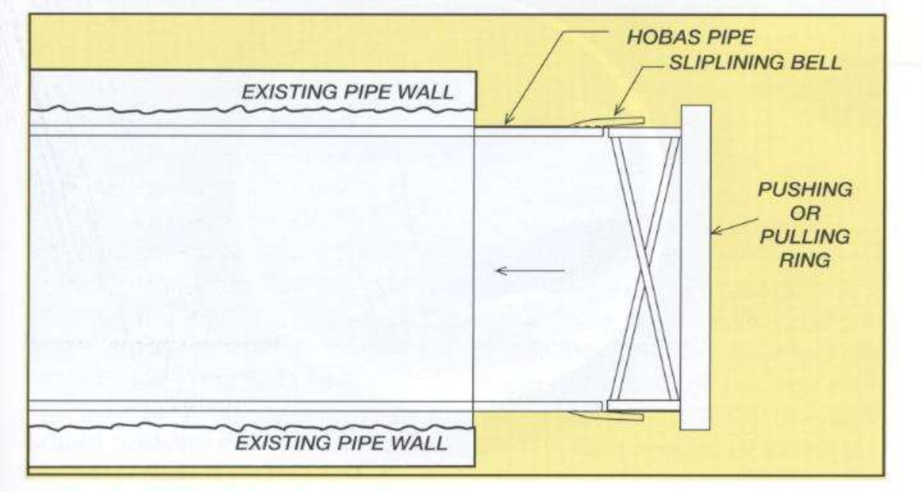


Pushing Distances

- Buoyancy
  - Flow Depth Control & Effects
- Equipment
- Friction
  - Pipe Weight



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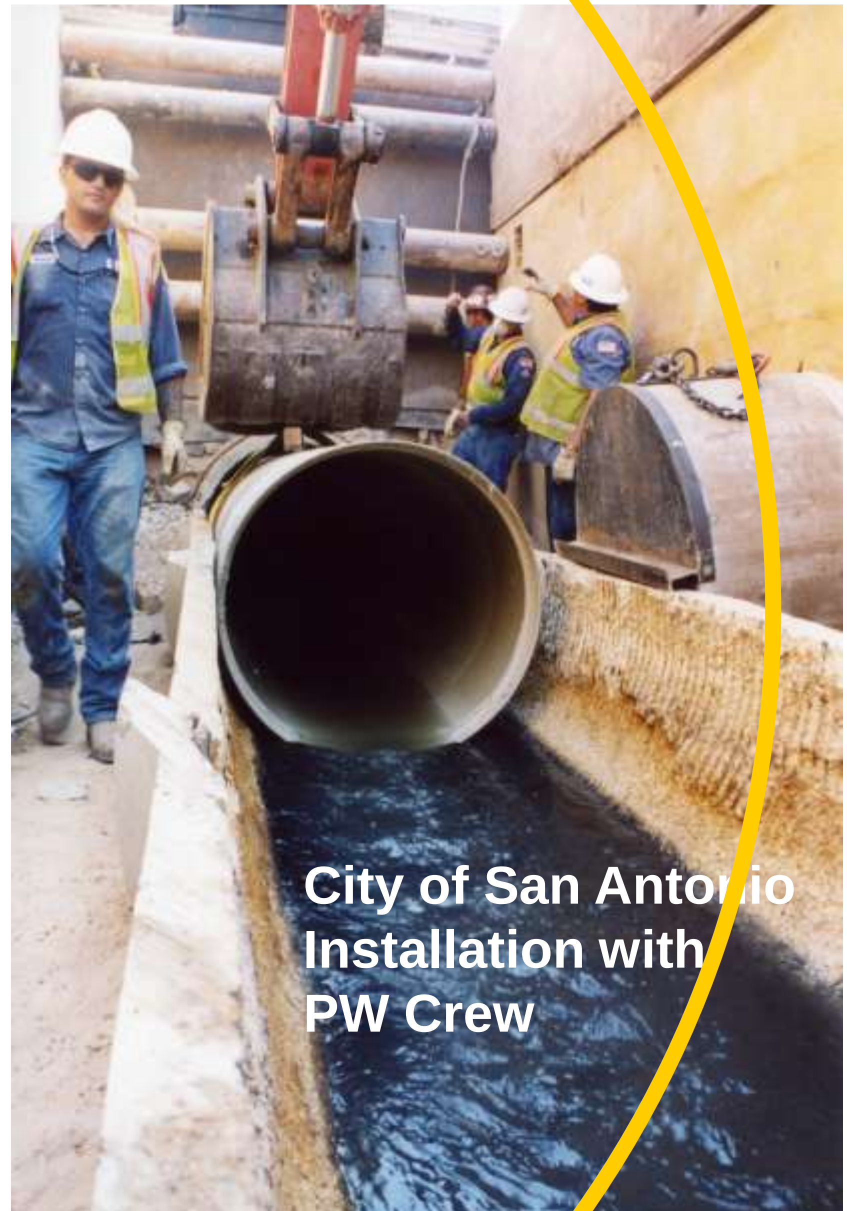
Uplift (Displaced Flow)

Flow in Liner

Pipe Weight



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Equipment

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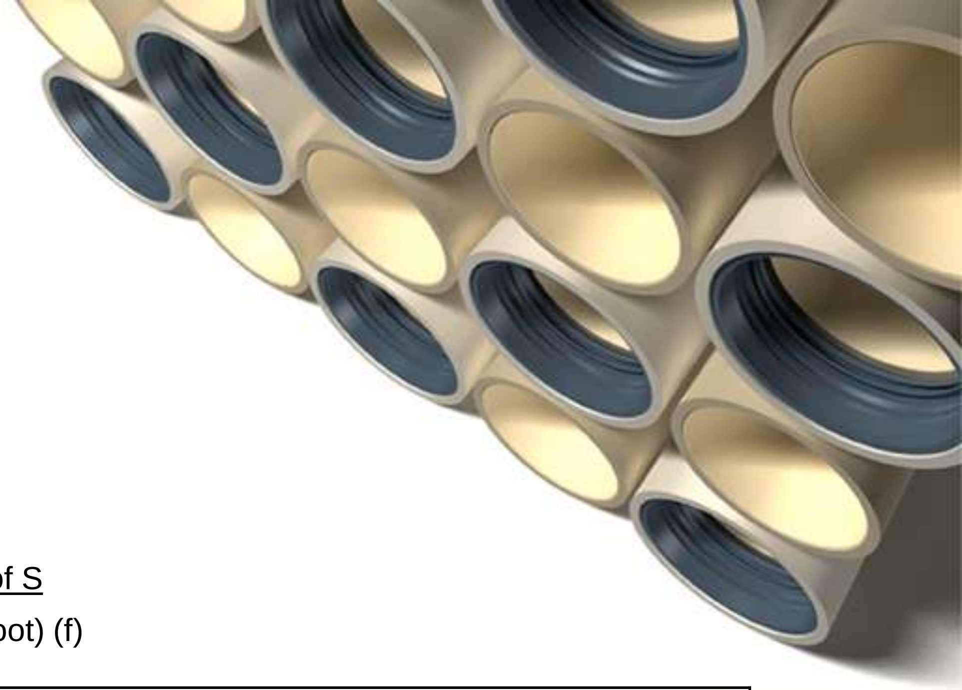

Friction

- Max. Safe Push Distance = Pipe Capacity / F of S ÷ (Pipe Weight per foot) (f)

Diameter (Inches)	Pipe Safe Load (Tons @ FS 3)	Pipe Weight (lb / ft)	Maximum Safe Pushing Distances (ft) for f =			
			0.2	0.4	0.6	1
24	39	39	10,000	5,000	3,333	2,000
36	82	82	10,000	5,000	3,333	2,000
48	**164**	**141**	**11,631**	**5,816**	**3,877**	**2,326**
60	271	213	12,723	6,362	4,241	2,545
72	448	302	14,834	7,417	4,945	2,967
96	844	520	16,231	8,115	5,410	3,246

* Stiffness 36, Low Profile Bell Configuration utilized in example

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Friction Example

- J.O. “B” 1C for LACSD
- 51” & 57” CCFRPM into 57” & 63” RCP
- Max Pushing Force About 100 Tons On All Drives Even In Curves, PI’s and Offsets
- Average Friction Factor Was 0.3, Range of 0.25 - 0.50

- **Max Push 5,600 ft**

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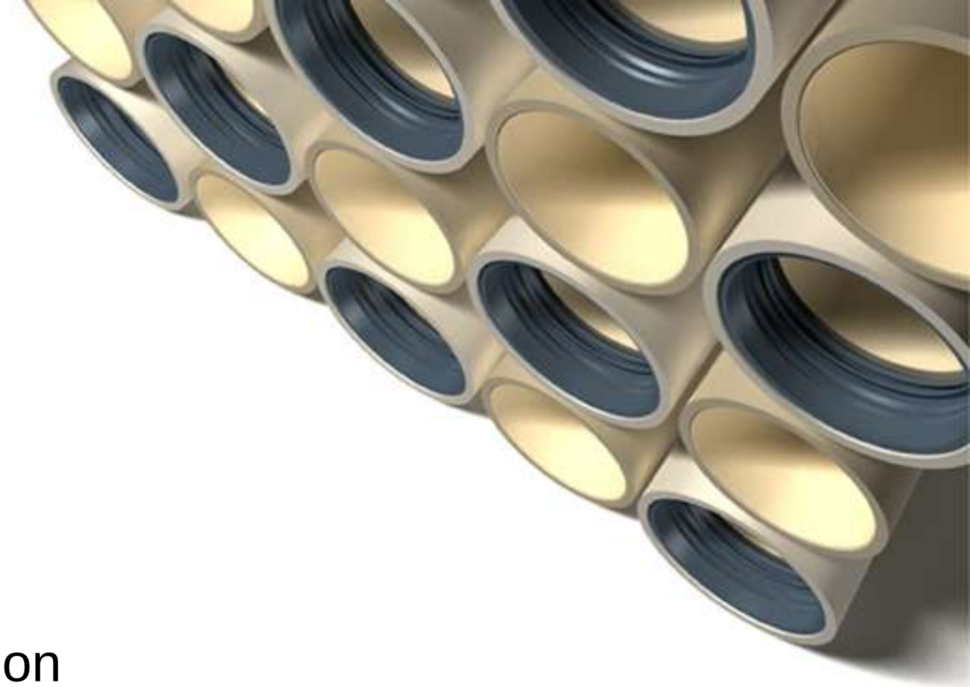
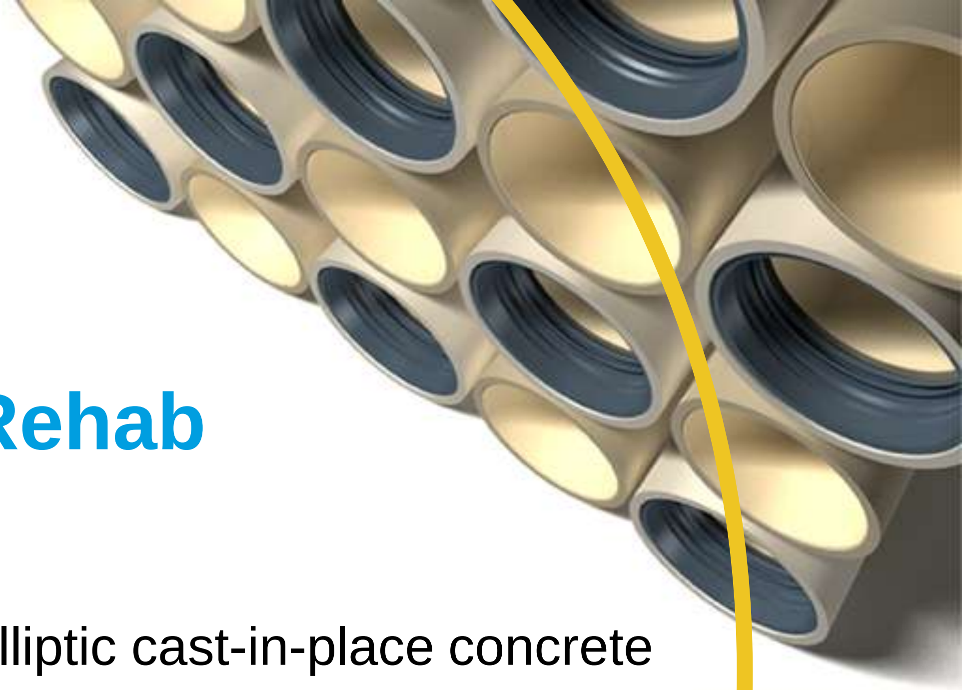


Sliplining Advantages

- Sliplining Can Provide:
  - Leak Free Service
  - Eliminate Corrosion Deterioration
  - Restore Structural Integrity
  - Only General Cleaning To Allow Liner Insertion
  - No Surface Cleaning or Dependence on Bond
- Preserving Capacity
- Long Insertion Pushes
  - Minimal Surface Disruption

Case Study: Sliplining

Over 1,200,000 LF in Service
(365,000 m)



Intercepting Sewer Rehab
Evanston, IL

- Deteriorating 120- inch semi-elliptic cast-in-place concrete sewer
- Needed to restore hydraulic and structural integrity

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Easy Installation

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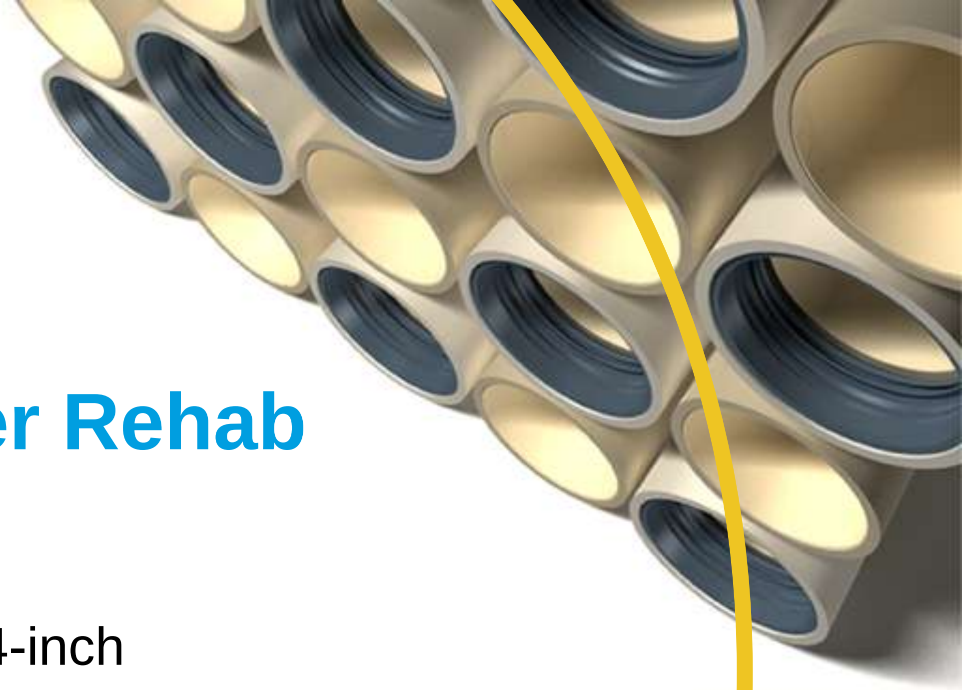

Intercepting Sewer Rehab
Evanston, IL

- 7,000 feet of 110- and 104-inch
- Flexible manufacturing allowed for a reduction in diameter after the job had started
- Only two shafts
- 10 foot sections were provided in addition to the 20 foot sections

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Lightweight Sections

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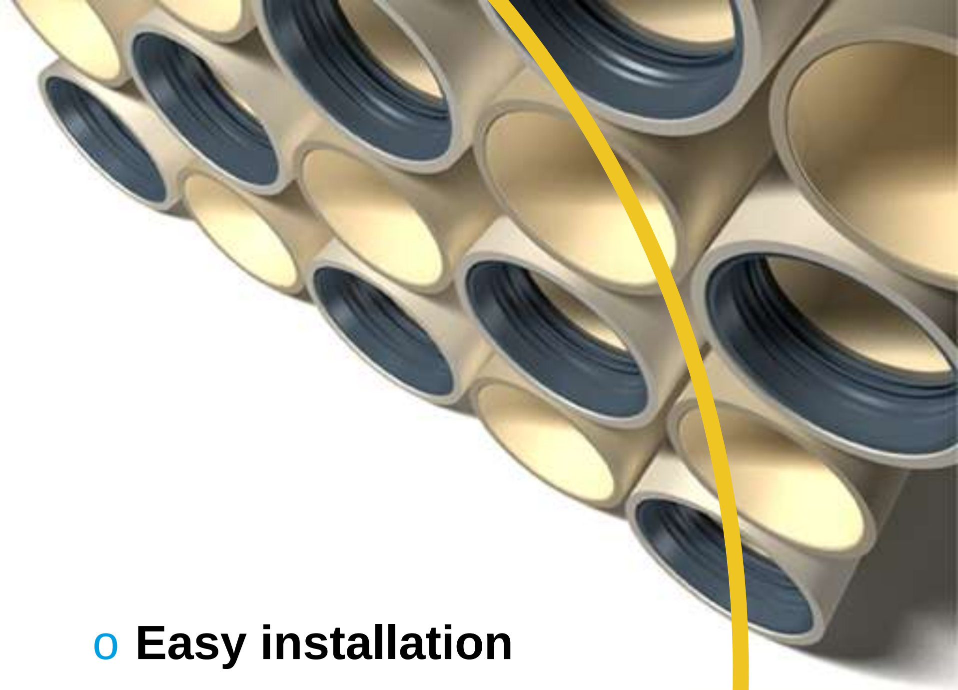

Summary

If you need....

- Corrosion resistance
- Long life
- Leak-free joints
- Structural reliability
- High flow capacity
- Easy installation
- Lower life cycle cost
- Consistent high quality
- Superior service

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Recent Local Project

EASTSIDE INTERCEPTOR SECTION 13 REHABILITATION PHASE I

CONTRACT NO. C00948C15

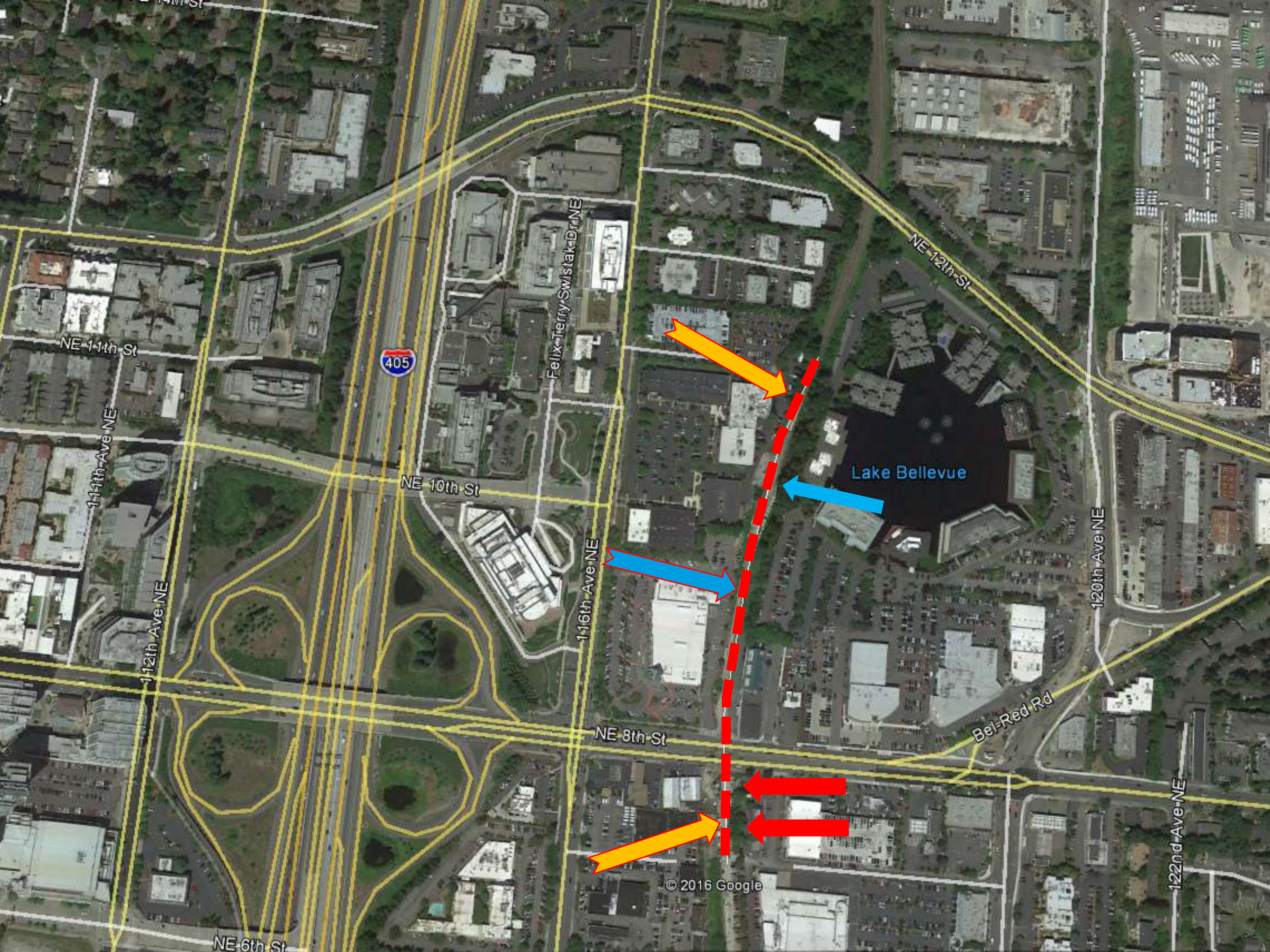
JULY 2015

KING COUNTY
Department of
Natural Resources and Parks
Wastewater Treatment Division

Eastside Interceptor Rehab

Bellevue, WA

72” Existing RCP
60” FRPM or HDPE Liner Specificed



NE 12th St
NE 11th St
NE 10th St
NE 8th St
NE 6th St
405
Felix Terry Swistak Dr NE
111th Ave NE
112th Ave NE
116th Ave NE
120th Ave NE
122nd Ave NE
Lake Bellevue
Bel-Red Rd
© 2016 Google

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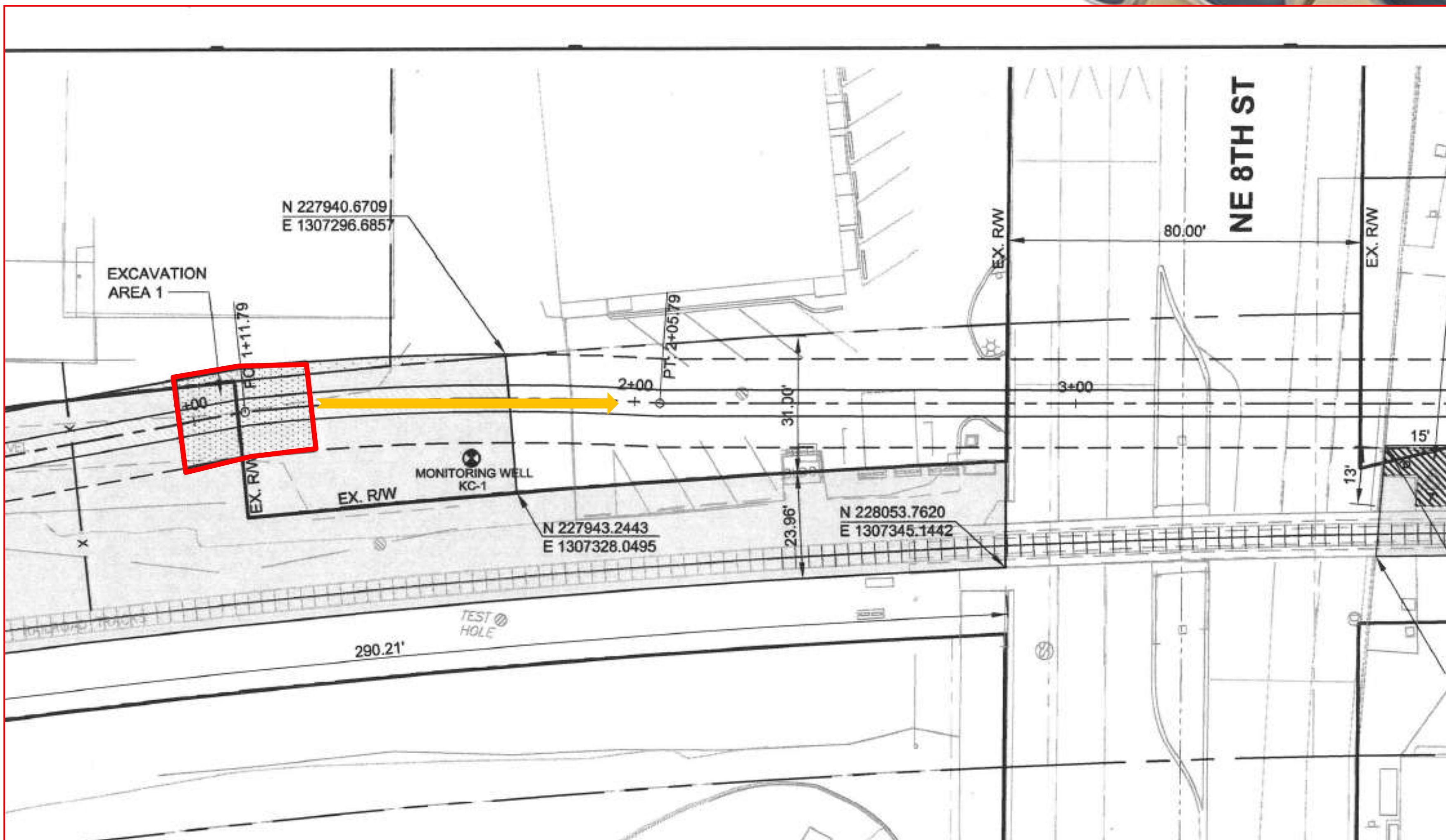
Pit #1 South of 8th Street



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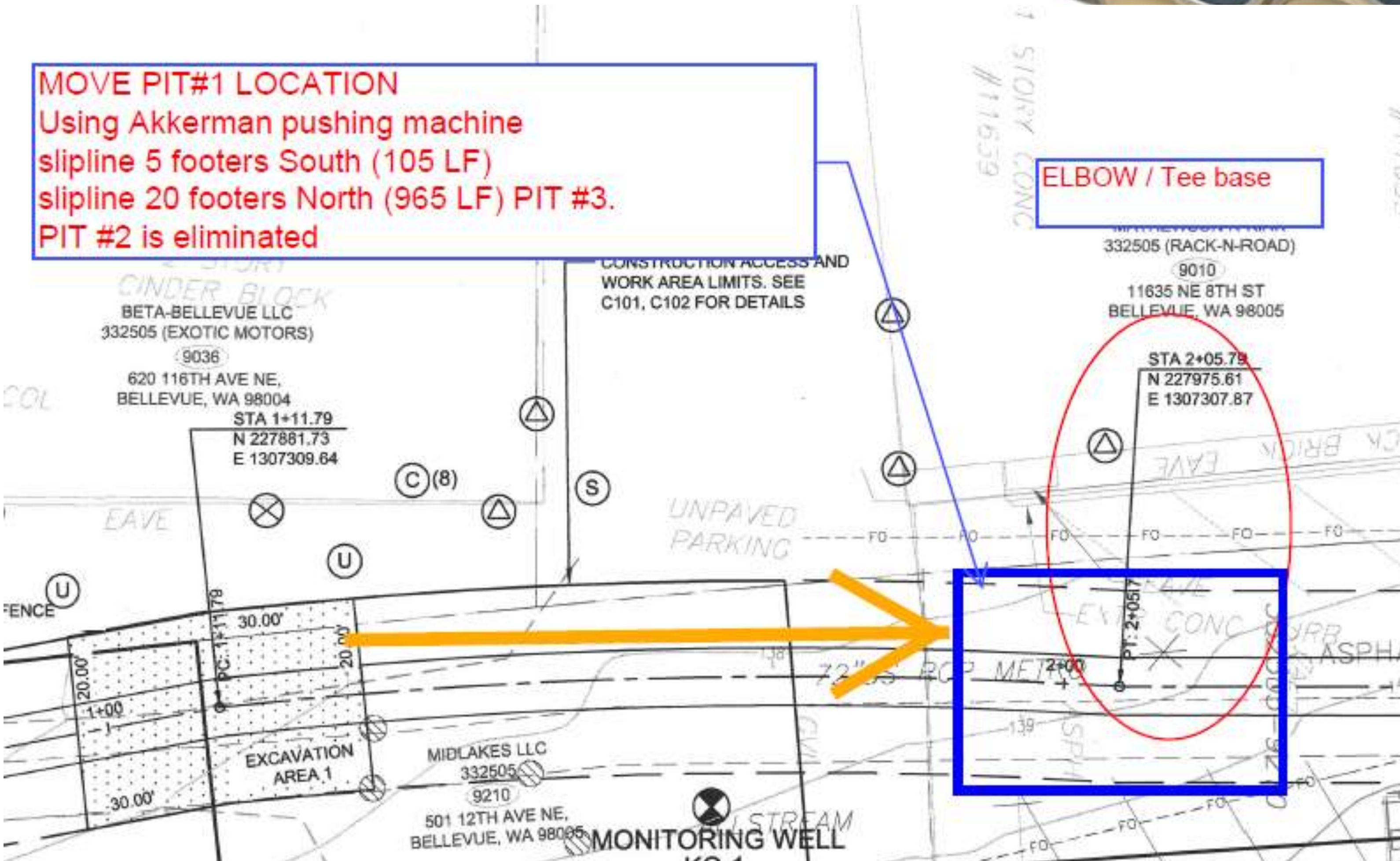
Pit #1 ALT



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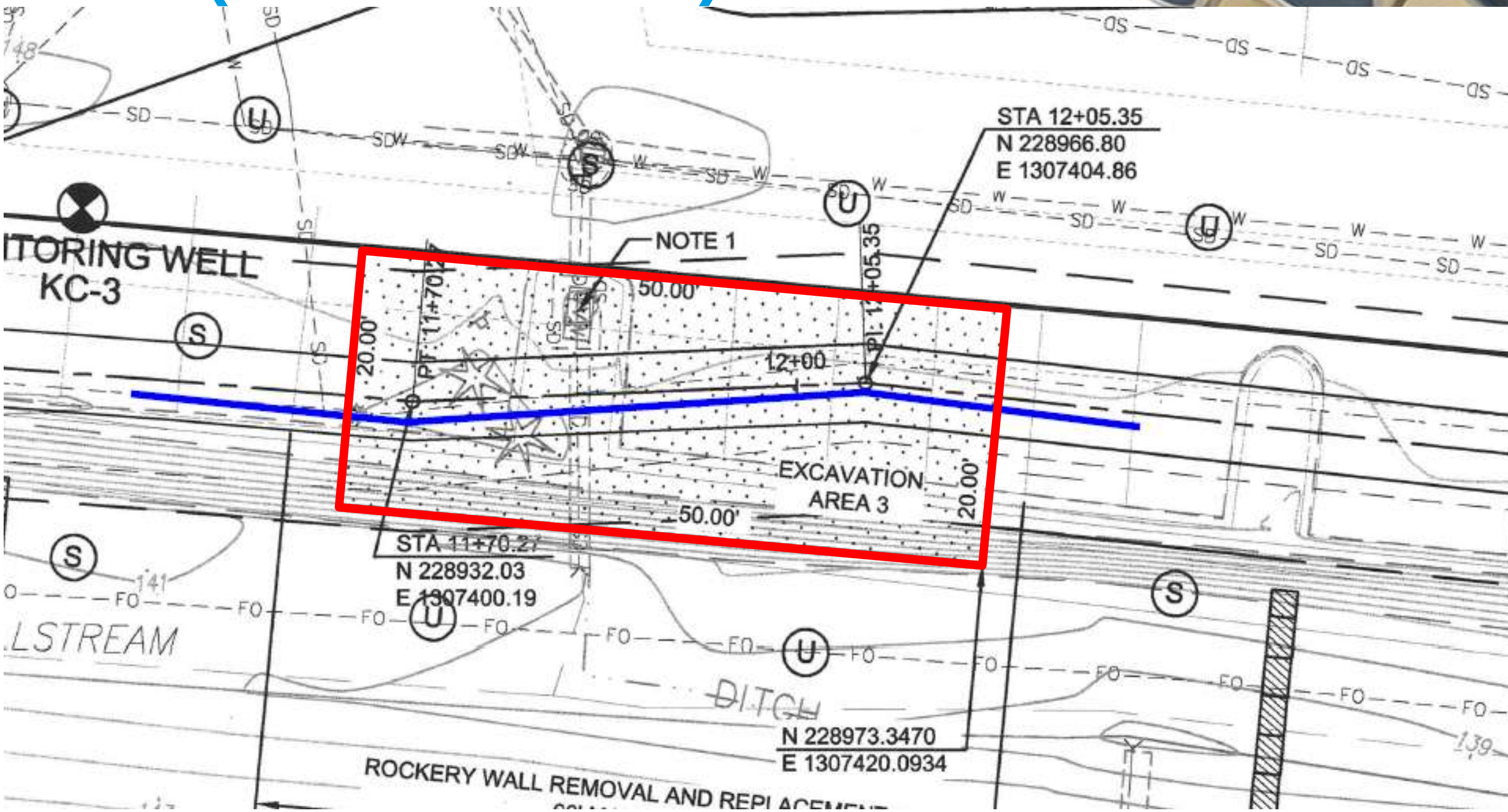
Pit #3 (never built $$)



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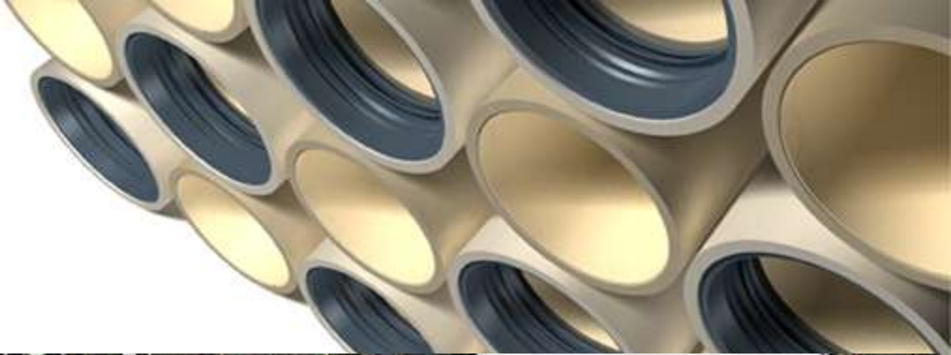

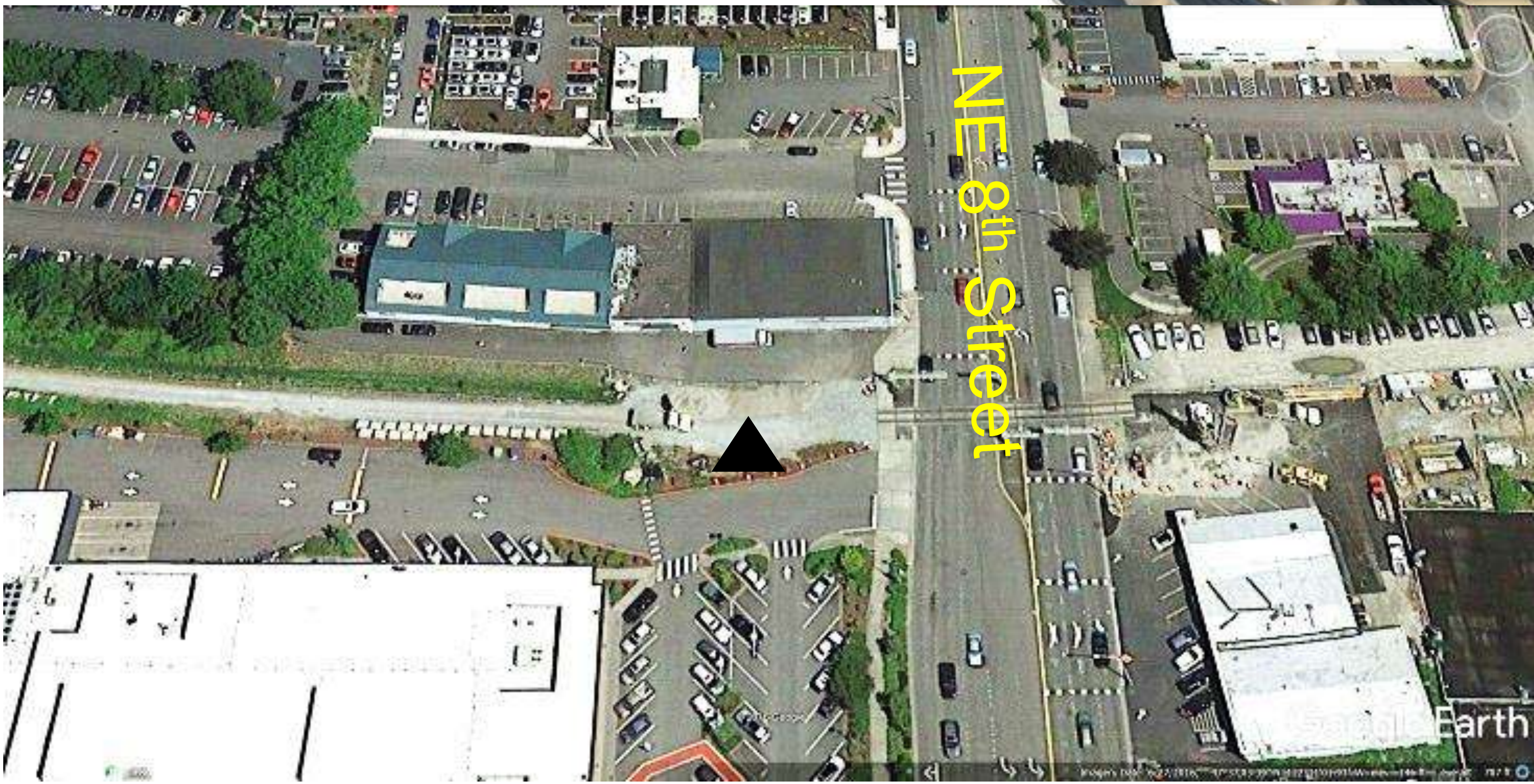

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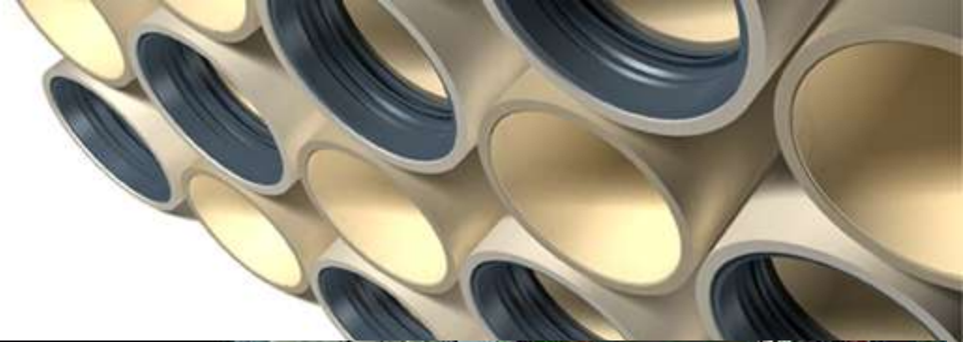

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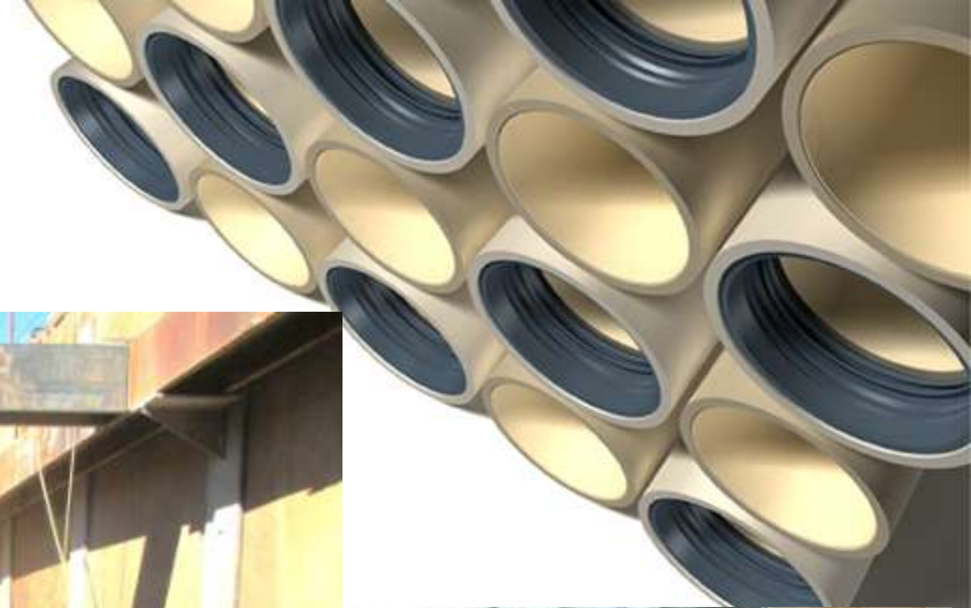

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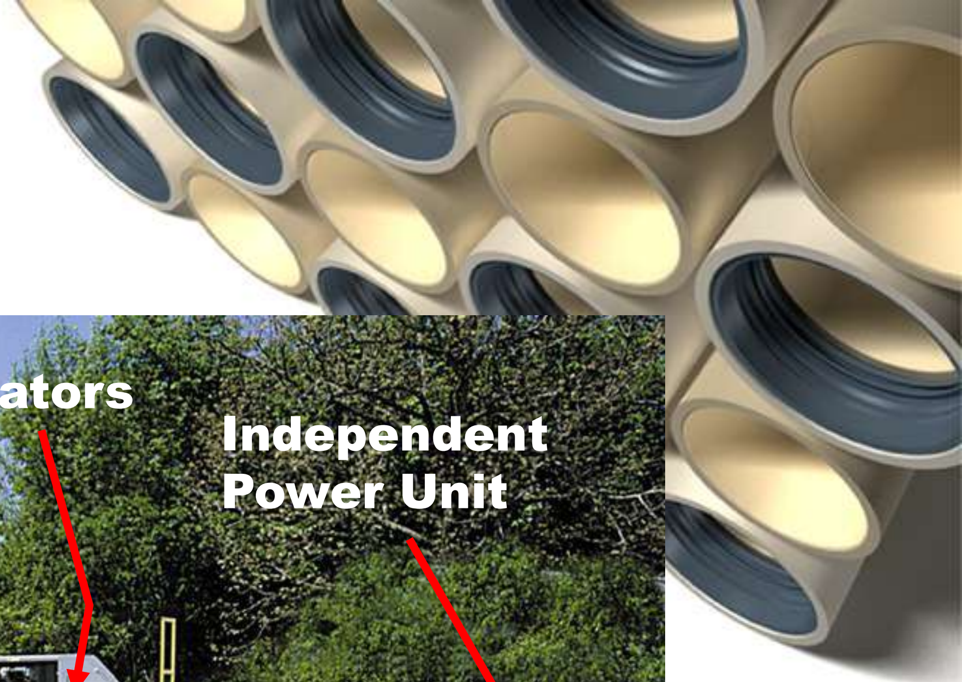
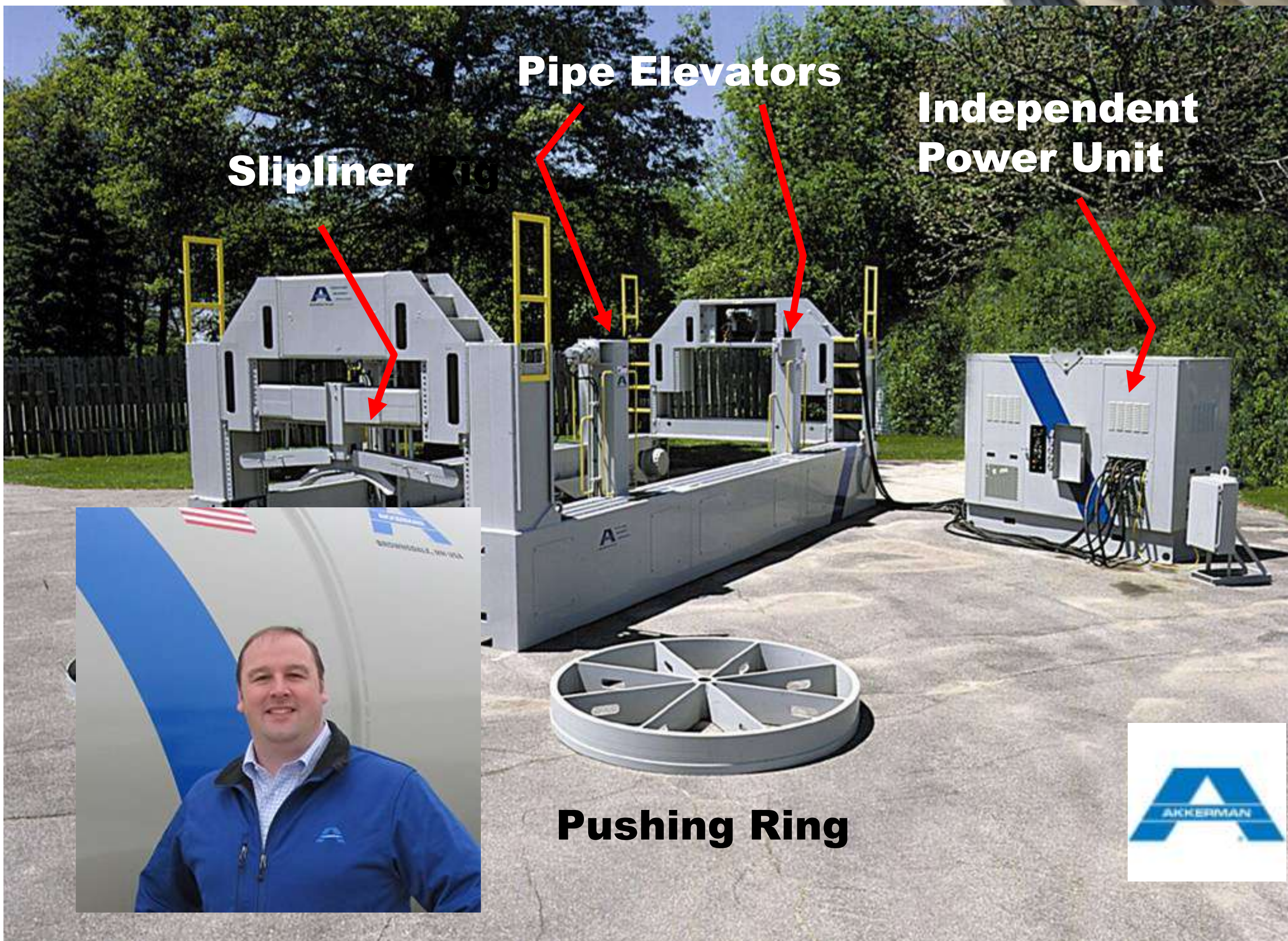
HOBAS® Make things happen.





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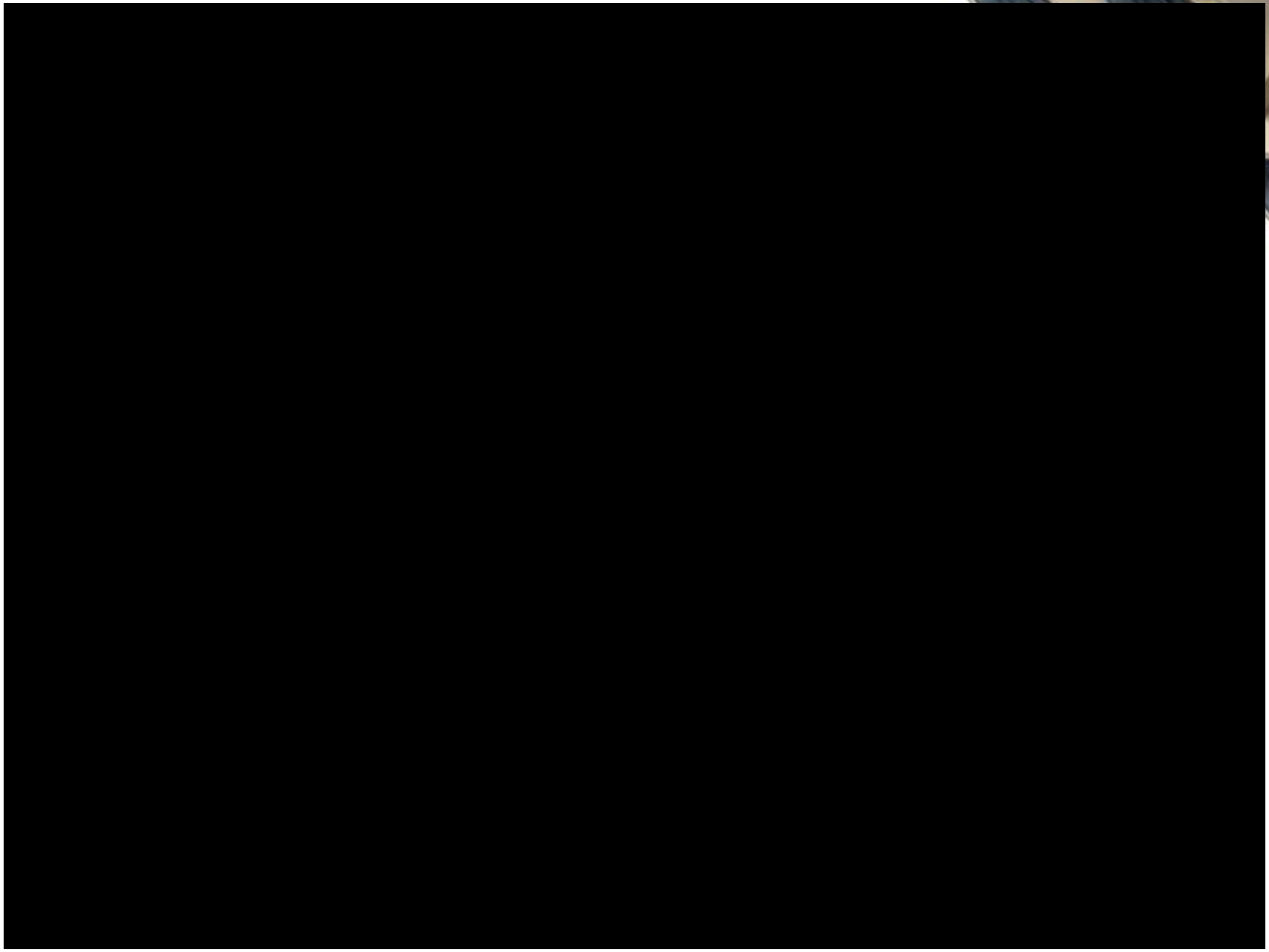
HOBAS® Make things happen.



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Lessons Learned

- Problems
  - Unknown Angle Points (Pit #1A - Requiring an Extra Pit $$
  - Poor Ground Conditions at Pit #3 – Difficult pit built $$
- Solutions
  - Provide a complete survey with the bid docs.
  - Provide a complete geo-tech report with the bid docs.

(OLD CREEK BEDS ARE NOT CONTRACTOR FRIENDLY)

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Leftover pipe, special tee and couplings

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HOBAS PIPES
are your best value

QUESTIONS AND ANSWERS