

# PipeLine

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With the carrier pipe in place, workers installed a bundle of three 8-inch and three 4-inch pipes within the spacers.

## New Technology Leads to Successful Electric Transmission Project

Houston's population of 2.3 million makes it the fourth most populous city in the U.S. and the largest in Texas. Downtown Houston, the city's central business district, hosts the headquarters of many prominent companies. It is also home to Minute Maid Park, Toyota Center, George R. Brown Convention Center and a 17-block theater district just to name a few of its attractions.

CenterPoint Energy's electric transmission and distribution unit serves more than 2.1 million customers in a 5,000 square-mile area that includes Houston. With over 3,700 miles of transmission lines, 47,000 miles of distribution lines and 232 substations, CenterPoint Energy delivers electricity on behalf of 79 retail electric providers.

One of the underground transmission circuits serving the downtown Houston area is the 2.3 mile 138 kV Garrott to Midtown to Polk circuit. Its rating for continuous operation is 247 Mega Volt Amperes (MVA). CenterPoint Energy

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recommended upgrading the underground circuit by installing a new cable parallel with the existing one to increase the capacity of the circuit to a continuous rating of approximately 498 MVA. The existing line was a high-pressure fluid-filled (HPFF) pipe-type underground transmission system. After researching options,

the engineers decided to parallel bundle the HPFF system with an extruded cross-linked polyethylene (XPLE) underground cable system.

The existing 138 kV transmission line is located in an urban environment so installation of the new parallel line left no option other than trenchless methods. The project was awarded to Boyer, Inc. of Houston. They chose to build the new line with centrifugally cast, fiberglass reinforced, polymer mortar (CCFRPM) pipe.



**LEFT**  
The location of the project in the downtown area of Houston required a trenchless installation.

**RIGHT**  
Workers installed the 30-inch carrier pipe by jacking methods.



HOBAS Pipe USA supplied 7,000 feet of 30-inch, 230-ton jacking pipe to be used as casing for the conduit. HOBAS was selected for many reasons of which both its capability to be jacked long distances and its non-metallic properties stood out. "Non-metallic HOBAS pipe is manufactured of thermosetting resins which retain their properties better than thermoplastics when exposed to elevated temperatures," explained Rene Garcia, engineering supervisor, HOBAS Pipe USA.

Before construction began, Boyer performed a trial installation to ensure that the line would grout correctly. "Grouting on this project was important; you need complete coverage around the conduit because of the heat that is generated when the line is

energized," explained Barry Buse, project manager, Boyer, Inc.

The installation depth ranged from 20 to 30 feet. Boyer purchased an Akkerman 4812, Guided Boring Machine, built specially for this project. Customary tunneling and jacking machines use diesel motors, which generate loud noise when in use. Because of the project location, in an urban environment with noise pollution codes, Boyer needed an unobtrusive option. Akkerman built this particular unit to run electrically for noise reduction.

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Year of construction  
**2011 to 2012**  
Total length of pipe  
**7,000 feet**  
Diameter  
**30-inch**  
Stiffness class  
**230-ton**  
Installation method  
**Jacking**  
Application  
**Casing carrier for conduit**  
Client  
**CenterPoint Energy**  
Installer  
**Boyer, Inc.**  
Advantages  
**Non-metallic, high-strength**



# Emergency Repair in Lima, Ohio

Lima, a city with a population of roughly 40,000, located in Northwestern Ohio between Dayton and Toledo, boasts a rich manufacturing background.

Lima is notably the home of the Lima Army Tank Plant, built in 1941, which is the sole producer of the M1 Abrams. The M1 Abrams, a third-generation main battle tank produced in the United States is the principle battle tank of the United States Army and Marine Corps, as well as of the armies of Egypt, Kuwait, Saudi Arabia, Australia, and Iraq.

Ford Motor Company also calls Lima home with a 2,400,000 sq. ft. facility, which has about 1,600 total employees making its new all-aluminum, 3.5-liter Duratec 35 V6 engine. The plant was originally built in 1957 to manufacture V-8 engines for the Edsel.

Predating these manufacturing facilities are portions of the City's infrastructure.

Constructed in 1921, a 78-inch diameter clay tile lined sewer ranges in depth from 25 to 31 ft.

"The condition assessment was performed and found a deteriorating structural condition," stated Jack Huber, Utilities Department Field Service Division, City of Lima, Ohio. "To assist in determining a solution to rehabilitate the sewer, both a conventional CCTV and a digital laser survey were performed."

"The proposed rehabilitation system must restore structural integrity, be corrosion resistant and, as an annulus grouted composite, be sufficiently robust to deal with frequent surcharge as well as being back grouted to deal with possible

Year of Construction  
**2012**  
Total Length of Pipe  
**1,140 feet**  
Diameter  
**66-inch**  
Stiffness Class  
**71 psi**  
Installation method  
**Sliplining**  
Application  
**Sanitary Sewer**  
Client  
**City of Lima, OH**  
Installer  
**Midwest Mole**  
Advantages  
**Recovery of flow, ease of installation**



RIGHT  
**66-inch diameter segmental pipes were placed one at a time into the existing 78-inch diameter clay tile lined sewer.**

voids immediately outside the sewer," stated Ray Hutchinson, Vice President / Principal Engineer, MWH Atlanta, Georgia.

The survey revealed many obstacles that would need to be overcome. The max ovality of the existing sewer was 10.5% with the max deflection of 7%; several major encrustations existed as well as debris such as loose tiles. It was determined that a nominal 66-inch diameter Hobas pipe with an outside diameter of 69.2 inches could be successfully installed within the deteriorating line.

"Several remediation options were reviewed to restore the structural integrity to the existing sewer, however sliplining appeared to offer the ideal cost effective solution," noted Gary Sheely, Director of Utilities, City of Lima, Ohio.

HOBAS supplied 1,140 feet of centrifugally cast, fiberglass reinforced, polymer mortar (CCFRPM) pipe with a flush joint. Advantages of sliplining with CCFRPM included not needing to bypass; providing





a continuous smooth pipeline; optimizing capacity; chemical resistance; providing a structural solution and it was cost competitive.

Midwest Mole, headquartered in Greenfield, Indiana, was awarded the project and began work in May of 2012. Before installation began, one of the 20-foot long pipes delivered to the project was utilized as a mandrel. The success of the mandrel test, lead to the pipe installation from one shaft location. The downstream push of roughly 1,060 feet occurred over the course of 5 days. The upstream push and the pipes in the pit were subsequently installed.

“The liner was plugged at the downstream end and allowed to fill to counteract buoyancy while grouting the annular space between the host and the liner,” commented Huber. Cellular grout was placed in the annular space and flowable fill was placed in the pit area. Huber stated after project completion, “We just finished with CCTV; everything looked perfect.”

“The sewer is fully commissioned at this stage and the final inspection has been completed,” concluded Ray Hutchinson, Vice President/ Principal Engineer, MWH Global, Inc. 



**FAR LEFT**

A short section of HOBAS pipe was utilized as a push ring to facilitate the installation of the liner.

**LEFT**

The gasketed joints allowed for installation during live flow conditions and the flush configuration provided additional clearance.

# CCFRPM Pipe Gains Momentum in New England

Highlighted by three major projects in Massachusetts, the New England region has recently seen an increase in installations of centrifugally cast fiberglass reinforced polymer mortar (CCFRPM) pipe. One project involved sliplining portions of a four-mile-long reinforced concrete interceptor sewer. A second project consisted of pilot tube auger boring under a river to install 430 feet of 36-inch diameter CCFRPM pipe to contain electrical conduits. The third project involved microtunneling four runs of 48-inch and 57-inch diameter CCFRPM pipe at distances up to 837 feet.

The sliplining project took place in New Bedford, Mass., where the city's main interceptor sewer extends four miles from the city center, running along a waterfront to the wastewater treatment plant. Deteriorated concrete pipe segments and street flooding during rainfall identified the need to clean and repair the interceptor, which carries all of the city's wastewater. A major state highway, polychlorinated

biphenyl (PCB) contaminated grit deposits and irregular pipeline configurations all complicated the cleaning and repair of the horseshoe-shaped concrete conduit, according to CDM Smith's Shawn Syde, environmental engineer and project manager. CDM Smith is a global engineering and consulting firm based in Cambridge, Mass.

In December 2009, the city awarded a contract for grit removal and sewer rehabilitation to R. Zoppo Corp., in Stoughton, Mass. The final cost of cleaning and sliplining was \$13.7 million. Working under the direction of Zoppo, Brenford Environmental Systems of Pearland, Texas, cleaned the interceptor using a closed loop, non-odor-causing collection system for grit and debris.

The sliplining process was complicated by several problems located along the interceptor. It had turns, large deflection angles and in some cases S-curves with no manhole. The interceptor ranged in size from 84- by 92-inches to 63- by 69-inches, with some small sections of 72-inch circular pipe. Syde said that HOBAS pipe was selected because of the improved hydraulic performance, the ability to install the pipe live (without bypass pumping) and the ease of installation including lateral connections.

Year of construction  
**Hobas began supplying pipe to the New England region in 1994**

Hobas total footage in region  
**52,300 feet**

Diameter range  
**18- to 120-inch**

Installation method  
**Various including sliplining, jacking and aboveground**



LEFT  
**HOBAS pipe was selected for the New Bedford sliplining project because of its improved hydraulic performance and the ability to install the pipe live.**

OPPOSITE  
**Installation contractor R. Zoppo Corp. manufactured a test mandrel (foreground) to proof the line prior to installation of the HOBAS pipe (background).**

Because of the irregularities in the pipe and the S-curves that needed repair, CDM Smith developed a mandrel pull test to verify that the selected pipe diameter and length could be pushed through the interceptor. Contract documents required that the mandrel be one pipe size larger than the proposed liner pipe as a safety factor.

Zoppo installed the sliplining pipe using a hydraulic jack that was specially designed and built for the New Bedford project. While the total length of the cleaned interceptor was 18,950 feet,

Zoppo sliplined only portions of that. Sliplining totals were 1,697 feet of 54-inch, 894 feet of 63-inch and 454 feet of 72-inch pipe. The contractor pushed pipe from downstream to upstream, into the flow to stabilize the pipe. The pits were located at existing manholes or at bends in the pipe that could not be sliplined.

“In some cases there were bends that exceeded the limits of the pipe, so we needed to excavate a pit,” said Syde. “The lengths varied between 61 feet and 782 feet. We used a diver to assist during the sliplining where we needed one because of the collapsed portions of the old interceptor.

“We pushed around curves due to the proximity of a 16-inch high-pressure gas main that was constructed adjacent to and on top of the existing interceptor. That prevented us from needing to excavate a pit. We pushed the limit of technology for sliplining based on the information that was available about the existing bends. At the completion of the project, two joints were separated due to deflection within a reverse curve that was greater than the allowable joint deflection for the pipe as it was installed. However, no problems were observed during grouting.”

The city was completely satisfied with the project. “The rehabilitation of the city’s main interceptor by lining with HOBAS pipe was instrumental in providing a quality project in a timely manner to make a very difficult and complicated project successful for the city,” said Ronald H. Labelle, commissioner of the Department of Public Infrastructure, city of New Bedford, Mass.



#### World Record PTAB for Electrical Casing

Construction of the \$14 million Cambridge Park Drive Drainage Improvements project eliminated a combined sewer outfall near the public drinking water supply in Cambridge, Mass., minimized flooding in West Cambridge, and reduced the discharge of pollutants into the Little River. Part of the project involved relocating five utilities in order to build a wetland basin. The utilities crossing the Little River needed replacement using a suitable trenchless method, according to a technical paper by John J. Struzziery, PE, of the engineering firm of Kleinfelder, Cambridge, and Nick Strater, PG, of Brierly Associates LLC, Manchester, N.H.

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Horizontal directional drilling (HDD) was originally designed and bid as the preferred means of relocating the utilities for the river crossing. After the bid, however, the proposed length of the HDD bore could not be accommodated due to adjacent property restrictions that prevented the city from obtaining the needed rights-of-entry.

After a detailed review of alternative trenchless methods, pilot-tube guided auger boring (PTAB) was selected. The five utility crossings ranged in diameter from four inches to 36 inches. The most challenging reach, a 430-foot-long crossing for electrical conduit, with 36-inch-diameter HOBAS pipe, which people connected with the project believe set a new world record for the PTAB method.

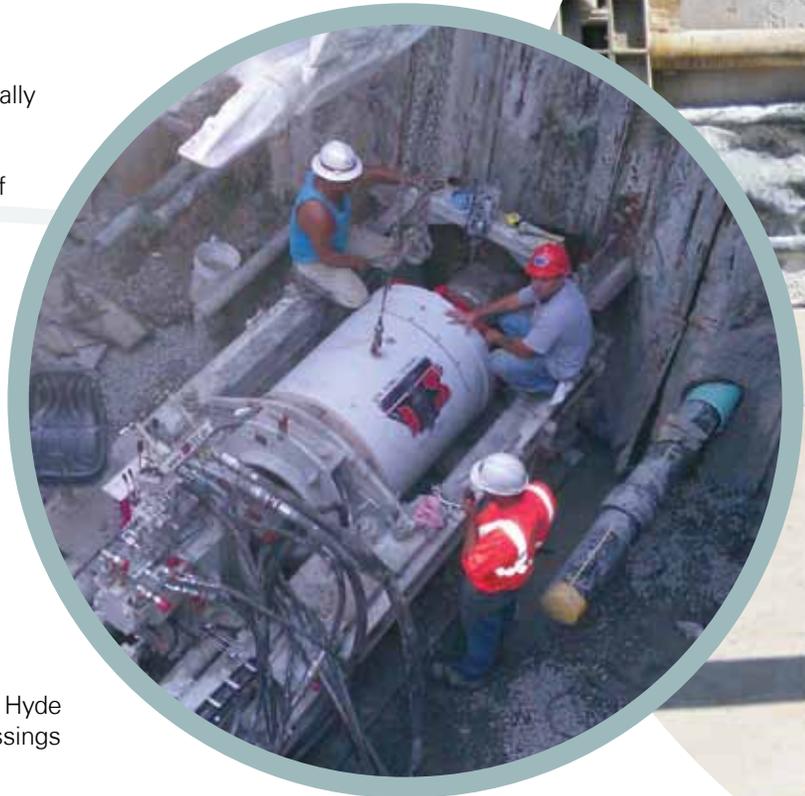
The general contractor, P. Gioioso & Sons, Inc., Hyde Park, Mass., subcontracted the trenchless crossings to Icon Tunnel Systems, East Brunswick, N.J.

The PTAB method is a multi-stage process that begins with jacking a series of pilot tube rods through the ground from a launching pit toward a receiving pit. The pilot tube rods and tube head simply displace the soil so no soil removal is required until later. "For guidance, the 5.5-inch-diameter pilot tube uses a theodolite camera that is mounted on the ground, or on the shaft along with the jacking machine," said David Crandall, vice president of Icon.

Once the pilot tube reaches the receiving pit, the line and grade for the bore are established. The next step is to jack in 16.5-inch temporary augers and casings. "Your pilot rods are removed as you're jacking," said Crandall. "As the casings and augers advance through the ground simultaneously, the pilot rods are removed and taken out through the reception pit until the casings reach the reception pit. Now the 16.5-inch casings and augers are in the ground following the path of the line and grade."

On the Cambridge project, Icon next attached a larger reaming extension kit to the pipe string in the jacking pit. A direct hydraulic drive motor was located inside the extension to excavate the overcut. The overcut of dirt was brought in through the extension, and then pushed back through the casings toward the reception pit.

The 36-inch HOBAS pipe fits behind the extension



using a jacking ring. "The only things inside the pipe at that point were the hydraulic lines, the water lines or bentonite lines that go directly to the back of the extension," said Crandall. "At this point you're just loading in your HOBAS pipe and pushing it forward. As the extension advances through the ground, the casings are removed in the reception pit. When your HOBAS pipe reaches the other side, your job is done."

According to John Struzziery, senior program manager for Kleinfelder, CCFRPM pipe was specified for this project because of its thermal properties – it does not conduct heat well. Six high-voltage electrical conduits were grouted inside the HOBAS pipe. "The HOBAS pipe provides insulation around the electrical conduits, so that heat doesn't escape beyond the casing," said Struzziery.

#### Largest Public Works Project for Brookline

The third New England project to use CCFRPM pipe was the Lower Beacon Street Sewer Separation Phase II in Brookline, Mass. According to BETA Group's website, the Town of Brookline engaged BETA to oversee and manage the construction of this \$18.1 million two-phase sewer separation project located in the easternmost



LEFT  
Corrosion resistant T-Base manholes were manufactured by HOBAS for the New Bedford sliplining project.

FAR LEFT  
The most challenging reach of the Cambridge Park Drive Drainage Improvements was a 430-foot-long crossing for electrical conduit and utilized 36-inch diameter HOBAS pipe.

project. P. Gioioso & Sons, Inc. was again the general contractor and subcontracted the microtunneling to Michels Corp., Brownsville, Wis.

The tunnel varied in depth to the pipe invert from 20 to 35 feet. Michels used two Akkerman microtunneling machines to bore through varied ground conditions including boulders, gravel, sand, silt and clay. The machines jacked 10 feet of 57-inch and 48-inch diameter Hobas pipe into place. A 57-inch diameter pipe with an allowable capacity of 425 US tons at a specified factor of safety of three was installed on a 498-foot run, while the 48-inch diameter pipe with an allowable capacity of 350 US tons at a specified safety factor of three was installed in three runs of 837, 639 and 529 feet.

Principals involved in the project agreed that there were no significant problems with the microtunneling and the HOBAS pipe went into place just as expected.

Acceptance and use of HOBAS CCFRPM pipe has grown in the New England region, with other projects including the Upper Neponset Sewer Project, a deep direct bury in West Roxbury, Mass., which included over 11,000 linear feet of 24-inch to 42-inch diameter CCFRPM. A Boston horse racing facility, Suffolk Downs, utilized 2,000 linear feet of 96-inch CCFRPM pipe to rehabilitate some drainage pipes in a tidal area. As well as being utilized for trenchless and direct bury projects, CCFRPM is being used above ground. Two penstock projects, one in Connecticut and another in New Hampshire, have utilized CCFRPM pipes. With the varied installation methods, corrosion resistance and long service life, more projects are likely on the horizon. 

urbanized areas of the town. The majority of the project is located along the congested Beacon Street corridor and adjoining neighborhood streets. This is the largest public works project ever commissioned by the town and is a joint and cooperative effort between the Town of Brookline and the Massachusetts Water Resources Authority (MWRA) as part of their Long-Term Combined Sewer Overflow (CSO) Control Plan.

The primary purpose of the project is to separate sanitary flows from an existing 110-year-old combined brick sewer system by installing new large diameter sewers that connect directly into the MWRA facilities. The existing combined sewer was then converted to a dedicated conduit for transporting storm drainage to the Charles River. Project benefits will reduce the amount of storm related flows entering the MWRA system, thereby reducing transport and treatment costs as well as MWRA CSO discharges to the Charles River.

Only HOBAS Pipe was specified for the project and was utilized for the six microtunneling runs on the

# Significant Pumping Cost Savings

## Introduction

A major cost in delivering fluids via a pipeline is the purchase and operation of the system's pumps. Because of differences in pipe hydraulic characteristics, a significant pumping cost savings may be achieved when smooth wall products are utilized in the pipeline. HOBAS pipes' exceptionally smooth interior surface and oversized ID combine to yield the greatest savings.

## Background

The flow of fluids through a pipeline is resisted by friction along the pipe interior. Smoother pipe wall surfaces cause less friction, resulting in less head (pressure) loss. This translates into reduced horsepower requirements, meaning smaller, less expensive pumps are needed (i.e. lower initial capital cost). The operation of the smaller pumps consumes less electricity, creating daily savings. The present value of the future power savings may be determined to permit meaningful comparisons of total life cycle costs.

## Pipe Characteristics

In pressure systems, the Hazen Williams flow factor (C) is often utilized in computations to calculate head loss due to friction. A water system operator with 30 miles of HOBAS pipes, measured head losses in his pipeline when it was 2 to 3 years old and determined an average C value of 155 for the Hobas portion. Typical Hazen Williams flow factors (C) for other materials are:

<b>Cement-lined</b>	<b>110 to 125</b>
<b>Steel (some tuberculation)</b>	<b>100 to 120</b>
<b>HOBAS CCFRPM</b>	<b>155</b>

## Pumping Cost Savings Calculation Procedure

### Step 1

Determine the flow volume, pipe ID(s) and Hazen Williams flow factor(s).

### Step 2

Calculate the flow velocity for each pipe:

$$V = Q \div (\pi D^2 / 4)$$

Where: V = flow velocity (ft/sec)  
Q = flow volume (cfs)  
D = ID (ft)

### Step 3

Compute the unit head loss for each pipe being compared:

$$S = [Q / (0.43222)(C)(D^{2.63})]^{1.852}$$

Where: S = head loss (ft/ft)  
C = Hazen Williams flow factor

### Step 4

Determine the total head loss savings:

$$H_{LS} = (S_1 - S_2)L$$

Where: H<sub>LS</sub> = head loss savings (ft)  
S<sub>1</sub> = head loss (ft/ft) in rougher pipe  
S<sub>2</sub> = head loss (ft/ft) in smoother pipe  
L = pipeline length (ft)

### Step 5

Calculate horsepower savings:

$$HPS = [(F)(H_{LS})(SG)] \div [3960(EFF)]$$

Where: HPS = horsepower savings  
F = flow volume (gal/min.)  
SG = specific gravity of pumped fluid  
EFF = pump efficiency (usually takes as 0.8)

### Step 6

Compute annual kilowatt-hour savings:

$$KWH/yr. = HPS (6532)$$

Where: KWH/yr. = kilowatt-hour savings per year

### Step 7

Figure annual power cost savings:

$$PCS = (KWH/yr.) (PR)$$

Where: PCS = annual power cost savings (\$)  
PR = power rate (\$/KWH)

### Step 8

Determine present value of future power cost savings:

Set: Discount rate (%)  
Inflation rate (%)  
Study period (years)

For no inflation (electricity cost), and 8% discount rate over 30 years:

$$PV = PCS (11.258)$$

Where: PV = present value of future power cost savings

**Example Calculation**

Pipe Materials	PCCP	HOBAS
Nominal diameter	48"	48"
ID	48"	48.5"
	4.00'	4.04'
Flow volume (F)	[ 50,000 gpm ]	
(O)	[ 111.40 cfs ]	
Flow velocity (ft/sec)	8.86	8.68
Hazen Williams (C)	120	155
Pipeline length	[ 16,000 ft. ]	
Fluid	[ Water (SG=1.0) ]	
Power Cost (\$/KWH)	[ \$0.07 / KWH ]	
Discount rate	[ 8% ]	
Inflation rate	[ 0% ]	
Study period	[ 30 years ]	

**Head Loss**

$$S = \left[ \frac{Q}{(0.43222)(C)(D^{2.63})} \right]^{1.852}$$

$$S_{PCCP} = \left[ \frac{111.4}{(0.43222)(120)(4.00)^{2.63}} \right]^{1.852}$$

= 0.0048125 ft/ft

$$S_{HOBAS} = \left[ \frac{111.4}{(0.43222)(155)(4.04)^{2.63}} \right]^{1.852}$$

= 0.0028541 ft/ft

**Head Loss Savings**

$$H_{LS} = (S_{PCCP} - S_{HOBAS})L$$

$$= (0.0019584)(16000)$$

$$= 31.33 \text{ ft}$$

**Horsepower Savings**

$$HPS = (F)(HLS)(SG)/(3960)(EFF)$$

$$= (50000)(31.33)(1.0)/(3960)(0.8)$$

$$= 494.5 \text{ HP}$$

**Annual Kilowatt-Hour Savings**

$$KWH/yr. = HPS(6532)$$

$$= (494.5)(6532)$$

$$= 3,230,074 \text{ KWH/yr.}$$

**Annual Power Cost Savings**

$$PCS = (KWH/yr.)(PR)$$

$$= (3,230,074)(\$0.07)$$

$$= \$226,105$$

**Present Value of Future Power Cost Savings**

$$PV = PCS(11.258)$$

$$= (\$226,105)(11.258)$$

$$= \$2,545,490$$



**Evaluation**

In order to evaluate the most economical piping alternative for a force main, both installed cost and pumping costs should be considered. As shown in the example calculation, HOBAS pipes will generate significant pumping cost savings compared to most other materials. Additionally, a reduced initial capital cost for pumps will also be realized due to the lower horsepower requirements. With the pumping cost savings included, HOBAS pipes will nearly always be the most economical large diameter force main piping alternative.

**Conclusion**

To save literally millions of dollars in pumping costs on your force main pipelines, specify and use corrosion resistant, smooth wall, centrifugally cast, fiberglass-reinforced polymer mortar pipes from HOBAS. HOBAS pipes have the lowest life cycle cost. 



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Boyer jacked the casing pipe in runs of 400 to 500 LF sections between pits. "We had high confidence in the quality of the HOBAS casing, despite it having to endure some pretty high crushing forces from the guided bore machine," stated Erich Schoennagel, manger - transmission project engineering, CenterPoint Energy.

Once the casing pipe was in place, their man, using a trolley system designed for the project, entered the pipe and installed a Unistrut rail system along the inside top of the pipe. With the casing pipe and Unistrut in place, Boyer installed a bundle of three 8-inch and three 4-inch PVC pipes in a spacer designed to support the weight of the product along with its accompanying grout and vent tubes. The owner insisted on conduits completely encased in thermal grout, so installers paid particular attention to the grouting process to ensure maximum grouting of the annular space inside the carrier pipe.

"The circuit was energized to the new capacity rating in late April 2012 and is performing well," Schoennagel said. 



ABOVE  
**Boyer, Inc.**  
designed the  
**Unistrut rail**  
**system, spacers**  
**and bundle configuration**  
specifically for this project.