



2018 NORTHEAST ANNUAL UTILITY CONFERENCE

Trenchless Technology – Horizontal Directional Drilling (HDD)
Brad Eifert – Michels Corporation
January 24, 2018

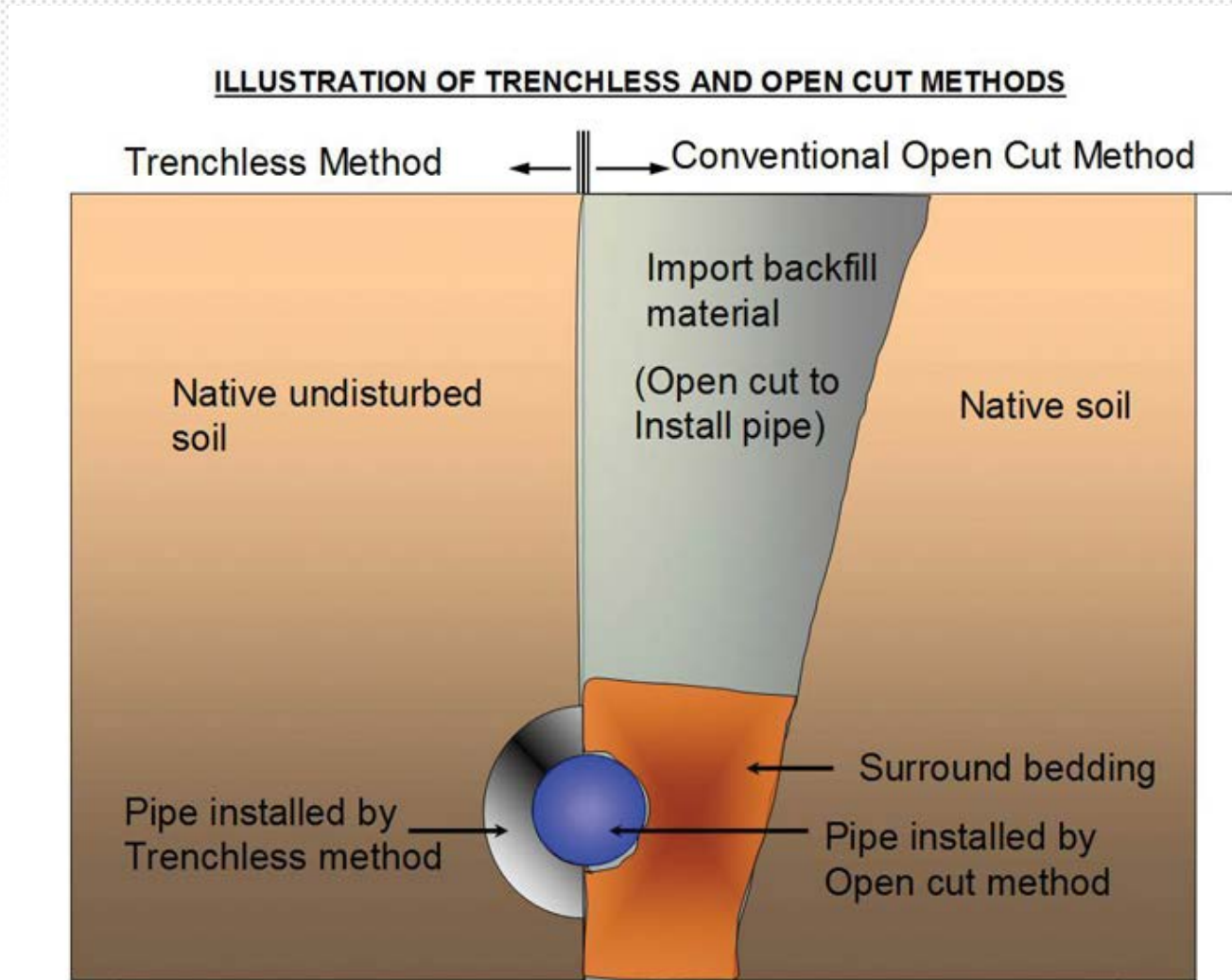
Topics

- Open cut vs. trenchless (definition of terms)
- Pros/Cons, limitations and applications of different trenchless methods, advances in technology, industry capabilities.
- HDD basics and equipment (above ground, below ground)

Topics

- HDD steering, tracking
- Drilling mud
- HDD case study example
- Questions (as time allows)

Open Cut vs Trenchless



Open Cut vs Trenchless Methods

Typical Underground Utility Installation Methods

1. Direct Installation
 - a) Trenched or Open-cut
 - b) Cable Plow

2. Trenchless
 - a) Jack & Bore/Auger Bore
 - b) HDD (Horizontal Directional Drilling)
 - c) Microtunneling
 - d) Direct Pipe
 - e) Pipe Bursting, CIPP, etc. (less common)

Direct Installation

Trenched/Open-Cut



Plow



Direct Installation

Trenched/Open-Cut

- Typically cheapest cost per foot overall
- Can install any pipe size or material - versatile
- Large number of contractors able to perform work
- Potential for environmental concerns
- High surface impact, high public impact in urban areas

Direct Installation

Plow

- Highly efficient
- Only can install small diameter conduit, pipes or cable
- Large number of contractors can perform work
- Less environmental concerns than trenching
- High surface impact, high public impact in urban areas

Trenchless – Jack & Bore Auger Bore

- Typically larger diameter installations
- Short distance capabilities (~250' max)
- Not often used for waterbody crossings (water table requires dewatering)
- High per foot cost
- Not all contractors can perform
- Low surface impact



Trenchless – HDD



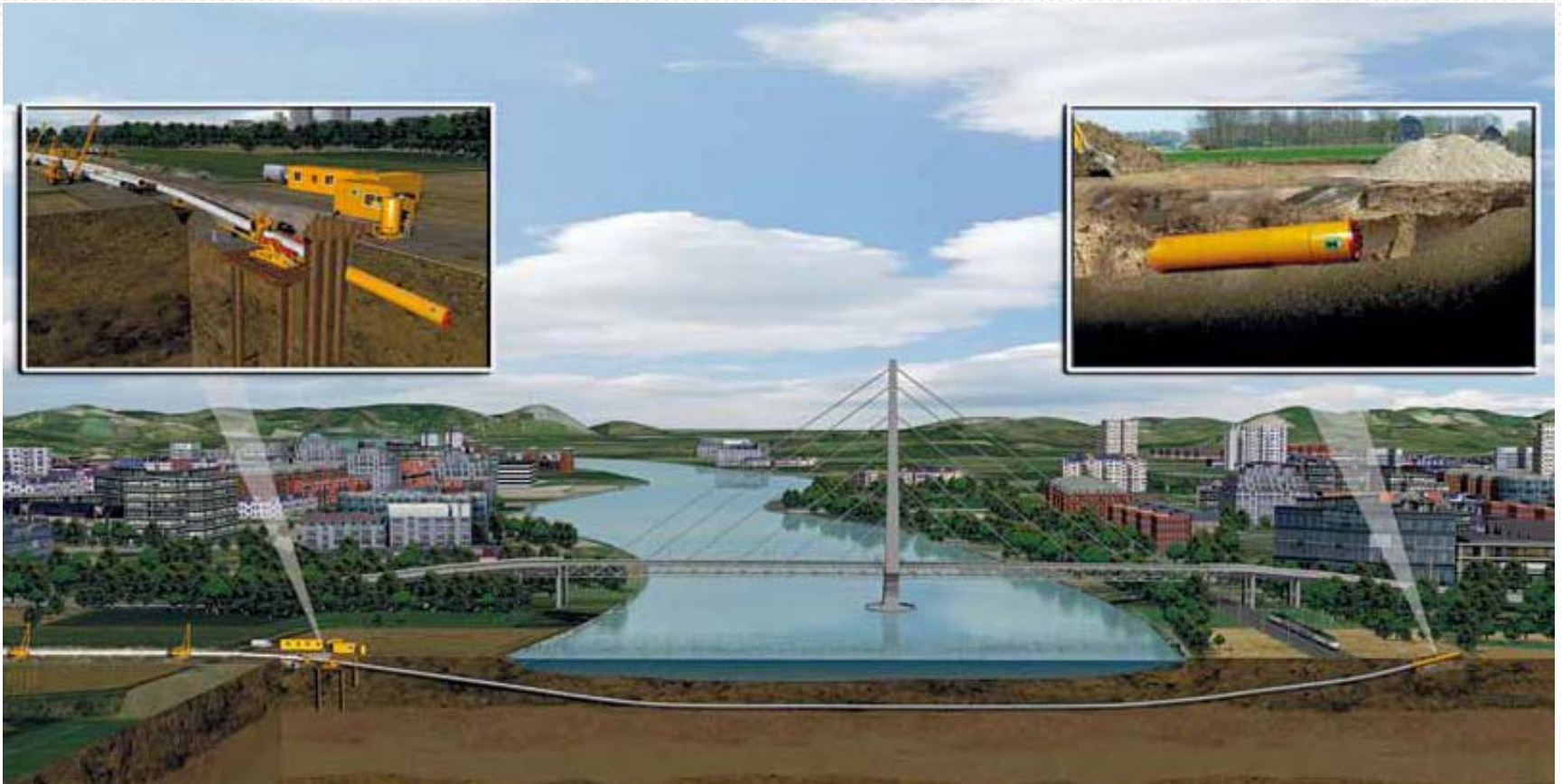
- Pipe up to 60” in diameter.
- Installations up to 13,000’ +
- Need specialized and competent contractor
- Poor soils can present risks and environmental concerns
- Higher per foot cost
- Very low surface impact
- Inadvertent Return risk

Trenchless – Microtunneling

- Large diameter pipes (typically 36” and above)
- As pipe size increases so does potential max length.
- Maximum installation length shorter than HDD
- Can handle poor soils without risk or environmental concerns
- Very high per foot cost
- Very low surface impact
- Very specialized contractor
- Virtually no risk of inadvertent return



Direct Pipe Installation



Trenchless – Direct Pipe



- New Technology
- Typically only 36”-48” pipe sizes
- As pipe size increases so does potential max length.
- Maximum installation length shorter than HDD
- Can handle poor soils without risk or environmental concerns
- Very high per foot cost
- Very low surface impact
- Very specialized contractor
- Virtually no risk of inadvertent return

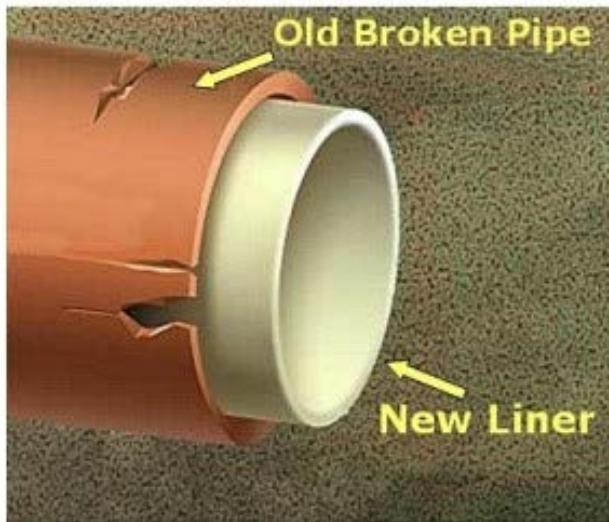
Compare Direct Pipe to HDD

DIRECT PIPE	HORIZONTAL DIRECTIONAL DRILLING
One-pass pipe installation	Multiple Passes – Pilot, Ream, Swab, Pull
Smaller borehole diameter – 3” larger than product pipe	Borehole Diameter - 1.5 times or 12 inches larger than product pipe
Permanent borehole support.	Hole support from drilling fluid.
Entry Side Workspace and Exit Side shaft only	Working room on entry and exit required
Surface Launch or only shallow shafts at entry and exit	Surface to Surface
Lower mud pressure and mud volume.	Geology needs to be able to support annular pressure and high fluid volumes
Less overburden needed typically 2-3 times product OD	Deeper cover to support annular pressure
Minimal disposal of cuttings	Disposal cuttings typically 1.75 to 2 times hole volume.



Trenchless – Cured in Place Pipe (CIPP)

- Rehabilitates old pipes
- Water and sewer only
- No surface impact
- Option to only line damaged area if desired
- Typically lower overall replacement cost
- Easy to obtain permits



Trenchless – Pipe Bursting



- Rehabilitates old pipes
- Can increase finished pipe size diameter
- No surface impact
- Typically lower overall replacement cost
- Easy to obtain permits

HDD – In depth



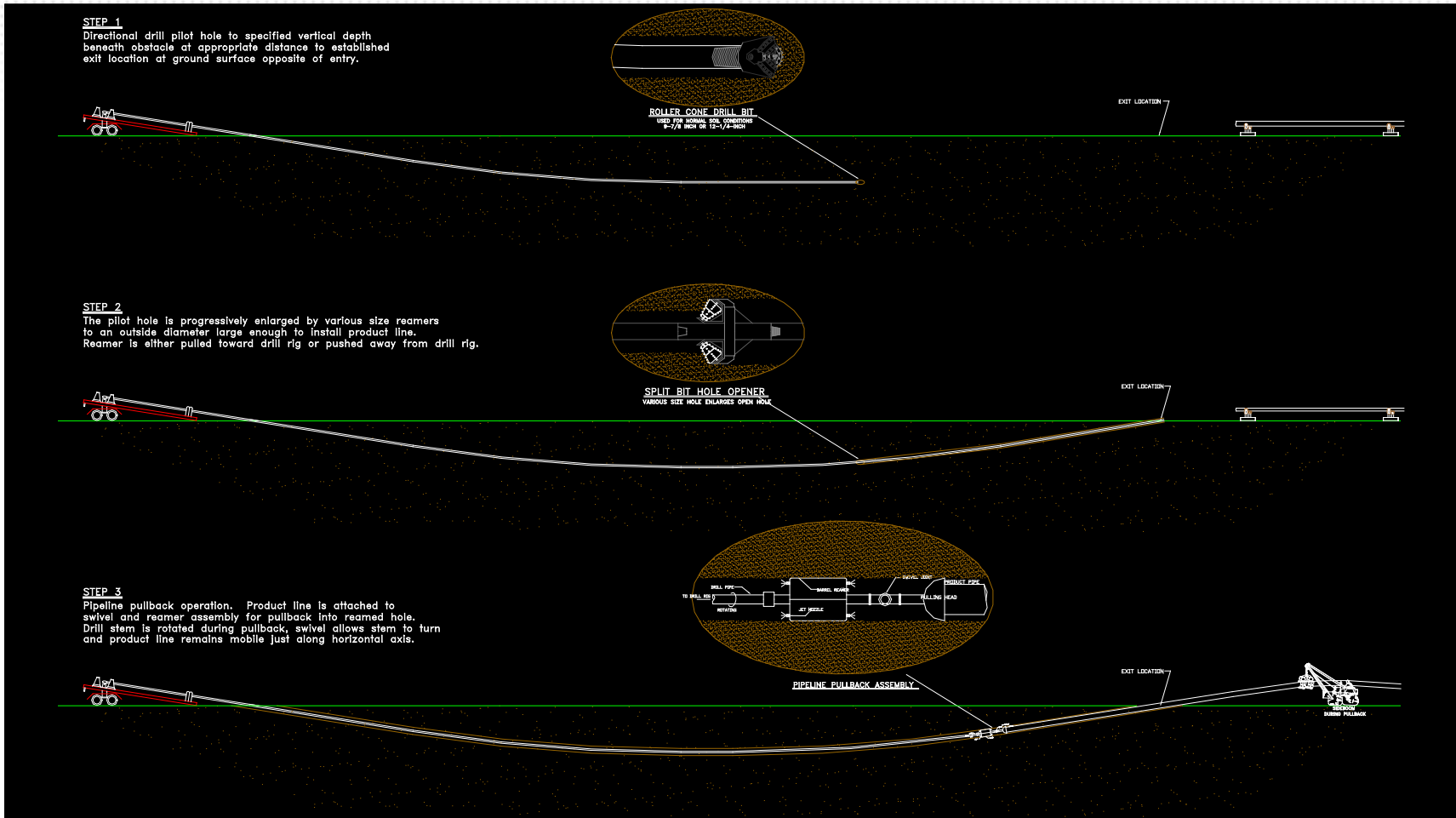
SUPPORT EQUIPMENT



HDD Rig Size Classification

- Mini (Typical less than 50,000 pounds of thrust/pullback capacity)
- Mid Size (Typical 50,000 pounds to 150,000 pounds of thrust/pullback capacity)
- Large (Typical 150,000 to 550,000 pounds of thrust/pullback capacity)
- Maxi (Typically greater than 550,000 pounds)

Phases of HDD Construction



HDD Tracking Systems

- Primary
 - Walkover (no secondary)
 - MGS –Magnetic Guidance System
- Secondary
 - Tru-Tracker – requires surface coil
 - Para-Tracker – surface coil or solenoid
- Gyroscopic
 - Both primary and secondary in one
 - No surface coil required
 - Not affected by interference
 - Hard rock limitations

HDD Tracking Systems

Walkover

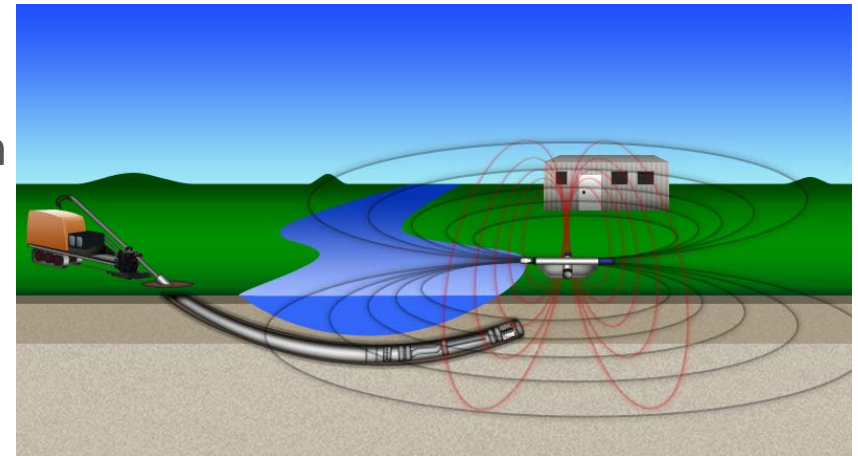
- Typically for small drill rigs
- Limited precision
- Limited depth
- Can only track where there is foot access



HDD Tracking Systems

Wireline

- Tru-tracker, Para-track or Tensteer
- Virtually unlimited depth and length capabilities
- Requires surface cable



HDD Tracking Systems

Gyroscope

- Latest Technology
- More expensive
- Can have availability concerns
- No surface cable required
- Requires exacting preliminary design and coordinates to be determined as a target.



Computer Wireline Tracking

RivCross Version: 3.0.8.29165, Job: Military Canal, Last day to use tool: 5/5/2011

File Edit View Log Windows Help

Paratrack 2 Input Shot Summary Survey Summa Plan View Vertical Section Pressure Dials

Shot Summary

MD	Joint	Shot #	Type	Final Shot	Tool In	InclAz	Az Cor	Final Az	Meas Az	Meas
474.30	15	111	P2	No	83.96	5.80	41.20	46.99	447.56	
474.30	15	112	AVG	No	83.97	5.80	41.20	47.00	447.57	
506.30	16	113	P2	No	84.23	5.51	41.20	46.71	479.25	
506.30	16	114	P2	No	84.25	5.51	41.20	46.71	479.40	
506.30	16	115	AVG	Yes	84.24	5.51	41.20	46.71	479.33	
538.10	17	116	P2	No	85.46	5.31	41.20	46.50	511.12	
538.10	17	119	P2	No	85.47	5.34	41.20	46.54	511.13	
538.10	17	120	AVG	Yes	85.47	5.32	41.20	46.52	511.13	
569.90	18	121	P2	No	85.46	4.89	41.20	46.38	542.80	
569.90	18	122	P2	No	85.46	4.89	41.20	46.39	542.84	
569.90	18	123	AVG	Yes	85.46	4.89	41.20	46.39	542.82	
601.70	19	124	P2	No	86.10	5.00	41.20	46.20	574.61	
601.70	19	126	P2	No	86.10	5.02	41.20	46.21	574.58	
601.70	19	127	AVG	Yes	86.10	5.01	41.20	46.21	574.59	
633.60	20	128	P2	Yes	86.88	5.57	41.20	46.76	606.51	-73.66
665.40	21	130	P2	No	87.66	5.99	41.20	47.18	638.34	-75.47
665.40	21	131	P2	No	87.66	5.99	41.20	47.19	638.35	-75.25
665.40	21	132	AVG	Yes	87.66	5.99	41.20	47.19	638.34	
697.40	22	133	P2	No	88.53	6.48	41.20	47.67	670.40	
697.40	22	134	P2	No	88.53	6.49	41.20	47.68	670.39	
697.40	22	135	AVG	Yes	88.53	6.48	41.20	47.68	670.40	
729.30	23	136	P2	Yes	88.44	6.05	41.20	47.25	702.23	
762.50	24	138	P2	No	88.01	5.33	41.20	46.53	735.34	
762.50	24	139	P2	No	88.01	5.28	41.20	46.48	735.35	
762.50	24	140	AVG	Yes	88.01	5.31	41.20	46.51	735.35	
791.90	25	141	P2	No	88.55	5.29	41.20	46.49	764.82	
791.90	25	142	P2	Yes	88.54	5.37	41.20	46.56	764.82	
5.10	0	143	ST	No	89.75	264.53	0.00	264.53		
5.10	0	144	P2	No	89.76	264.57	0.00	264.57		-21.36
5.10	0	145	AC	No	89.74	264.50	0.00	264.50		-308.32

Pressure Dials

Plan View - Job# 011511a

Paratrack 2 Input

Tool Position
 Tool is at end of rod # 0 | 5.10 | 5.10 ft
 Additional distance + 0 ft
 Baseline Az 46 Measured Distance 5.10 ft

Steering Tool Orientation
 Tool Azimuth 262.44 Corrected Az 262.44
 Az Correction 0.00 Inclin 89.36
 Gtotal 1.0361 Tool Face Offset (deg) 97.88
 Angle High Side to Tool Face 77.55

Vertical Section View

Survey Summary - First Bore

Joint	Hd	Incl	Az	Away	Elev
12	380.30	85.99	47.39	354.45	-46.64
13	412.10	85.65	47.42	386.16	-48.95
14	445.30	85.72	47.51	419.25	-51.45
15	474.30	84.99	48.05	448.14	-53.80
16	506.30	84.24	46.71	479.99	-56.80
17	538.10	85.47	46.52	511.66	-59.66
18	569.90	85.46	46.09	543.36	-62.17
19	601.70	86.10	46.21	575.07	-64.51
20	633.60	86.88	46.76	606.91	-66.96
21	665.40	87.66	47.19	638.67	-67.98
22	697.40	88.53	47.68	670.64	-69.04
23	729.30	88.44	47.25	702.52	-69.89
24	762.50	88.01	46.51	735.70	-70.91
25	791.90	88.54	46.56	765.09	-71.80

Magnetic Data

BTotal 43895 nT
 Dip 73.88 deg
 HTotal 68 uA/m
 Filtering: 4 second filter
 Wire Current (Amps p-p) 2.51
 Averaging: 150
 Active Wire: Copy of C:\Documents and Settings\Michels\Desktop
 Cals Received High Gain

Pressure
 Pipe 817
 Annulus 72
 Temp (F) 68.96
 Volts 46.25

Tool Face

Vertical Section View

Section View - Job# 011511a

E 0
 R 0
 Arc Len 0
 Init Dir 0
 Final Dir 0

Line Options
 Cursor
 Survey
 Show all shots

Print
 Rotate

90
 180
 270

Edit Baseline Az 46



Tracking Form and Calculations



PROJECT: _____
 LOCATION: _____
 JOB #: _____
 SHEET #: _____

CASING DEPTH: _____
 BIT MANUF: _____
 MOTOR MAKE: _____
 MD IN: _____

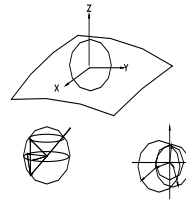
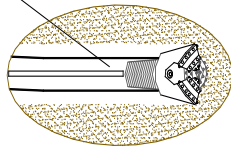
CASING SIZE: _____
 BIT SIZE: _____
 SETTING: _____
 GPM: _____

DATE	SURVEY #	MD	INC	FINAL AZI	HTOTAL	DIP	P2 ELEV	P2 RT	CALC STATION	CALC ELEV	CALC RIGHT	3 JOINT INC RADIUS	3 JOINT AZI RADIUS



Pilot Hole Intersect

PARA-TRACK GUIDANCE PROBE



DRILL RIG-1

Directional drill pilot hole to specified vertical depth utilizing Par-Track downhole guidance system

DRILL RIG-2

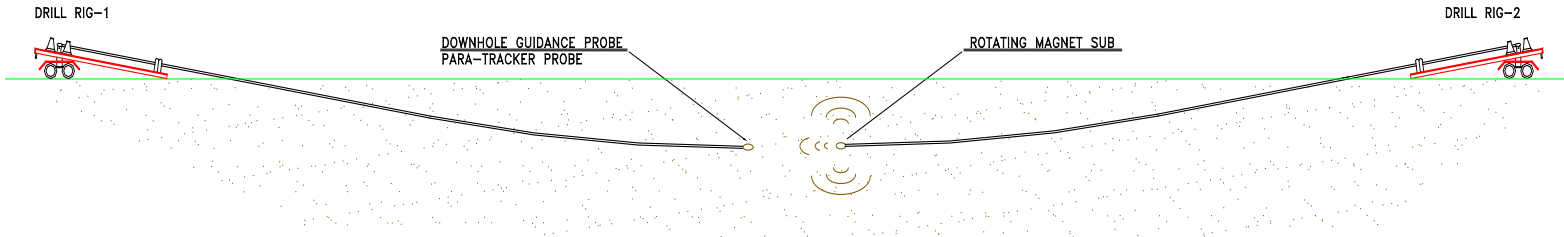
Directional drill pilot hole to specified vertical depth utilizing rotating magnet sub. Drill rig one will advance drill bit & probe toward signal emitted by rotating magnet.

DRILL RIG-1

DOWNHOLE GUIDANCE PROBE
PARA-TRACKER PROBE

ROTATING MAGNET SUB

DRILL RIG-2



Pilot Hole Intersect Advantages

- Reduced downhole pressures
- Less time to complete the crossing
- Increased pipe side tolerance
- Surface casing on both sides of the crossing
- Increases potential length limits of HDD

Drilling Fluid



QUIK-GEL®

Viscosifier

Description QUIK-GEL is an easy-to-mix, finely ground (200-mesh), premium-grade, high-yielding Wyoming sodium bentonite. QUIK-GEL imparts viscosity, fluid loss control and gelling characteristics to freshwater-based drilling fluids.

Applications/Functions

- Mix with fresh water to form a low-solids drilling fluid for general drilling applications
- Viscosity water-based drilling fluids
- Reduce filtration by forming a thin filter cake with low permeability
- Improve hole-clearing capability of drilling fluids
- Mix with foaming agents to make "gel-foam" drilling fluids for airfoam drilling applications

Advantages

- ANSINSE Standard 60 certified
- Single-sack product and cost effective
- Provides lubricity for drilling fluids
- Mixes easily and quickly reaches maximum viscosity
- Yields more than twice as much mud of the same viscosity as an equal weight of API oilfield grades of bentonite

Typical Properties

- Appearance Grey to tan powder
- Bulk density, lb/ft³ 68 to 72 (compacted)
- pH (3% solution) 8.9

Recommended Treatment Mix slowly through a jet mixer or sift slowly into the vortex of a high-speed stirrer.

Approximate Amounts of QUIK-GEL Added to Freshwater			
Application/Desired Result	lb/100 gal	lb/bbl	kg/m ³
Normal Drilling Conditions	15-25	6-10	18-30
Unconsolidated Formations	35-50	15-21	42-60
Make-Up For Gel-Foam Systems	12-15	5-7	14-18

• 1 bbl = 42 U.S. gallons

Additional Information Note:

- For optimum yield, pre-treat make-up water with 1-2 pounds of soda ash per 100 gallons of water (1.2-2.4 kg/m³).

© Copyright 2007 Harco, a Halliburton PSL

QUIK-GEL is a registered trademark of Halliburton Energy Services, Inc.

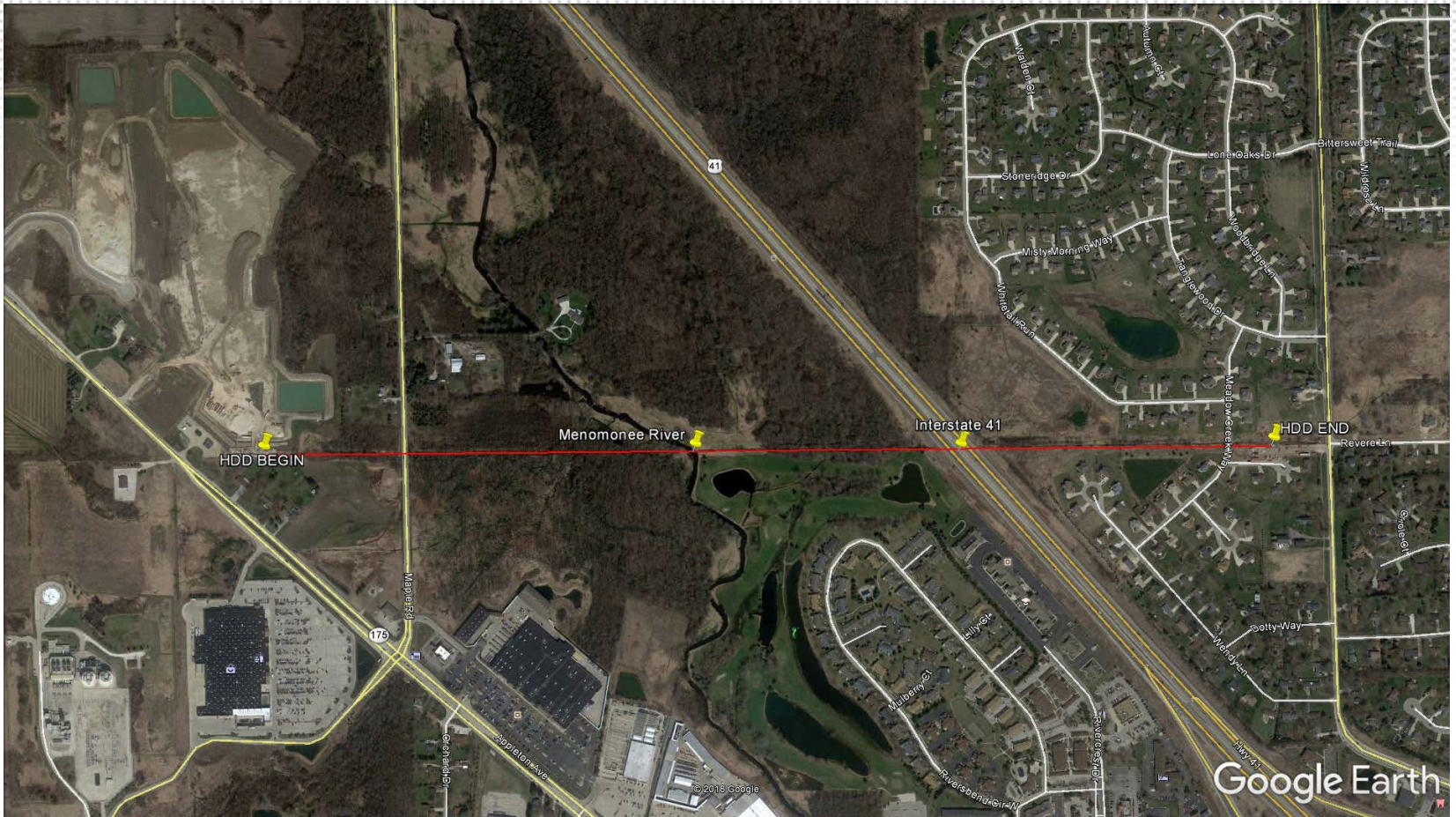
Rev. 02/07 03P-008

Because the conditions of use of this product are beyond the seller's control, Harco suggests that the purchaser make its own test to determine the suitability for the particular application. Harco makes no warranty, either expressed or implied, as to the quality, quantity, or performance of this product. This product will be supplied as delivered in accordance with the product label and instructions, unless otherwise indicated on the product label. EXCEPT AS EXPRESSLY PROVIDED HEREON, THIS PRODUCT IS PROVIDED "AS IS," WITHOUT WARRANTIES, EITHER EXPRESS OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY, ACCURACY OF DATA, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT.



HDD case study example

- WE Energies 24” diameter gas line installed in 2017
- 5,762’ long under Interstate 41 near Germantown, WI
- Limestone rock at 50-70’ deep
- Pipe Installed ~140’ below Interstate
- Pilot Hole Intersect Method was used



Residential Setting



Residential Setting



Second rig over a mile away



Second Rig



Pipe laydown 5,700' of 24" steel pipe



Pipe staged in sections



Thank you and questions

