Horizontal Directional Drilling & Trenchless Construction Capabilities

AECOM

CONVEYANCE PLANNING, DESIGN, AND CONSTRUCTION PHASE SERVICES

OIL & GAS TRANSMISSION | OFFSHORE WIND | POWER TRANSMISSION | TELECOM

SCOPE OF TRENCHLESS PLANNING, DESIGN AND CONSTRUCTION PHASE SERVICES:

- HDD – Shore Approach and Conventional
- Microtunneling, Conventional Boring
- Conduit Installation and Operational Stress Analyses
- Borehole Stability Analysis and Other Specialty Analyses
- Construction Risk Profile and Mitigation Options
- Routing Studies
- Permitting Support and Documentation – FERC, State, and Local
- Site Access, Temporary/Permanent Easement and Staging Options
- Construction Inspection, Monitoring, As-Built Documentation

EXPERIENCE HIGHLIGHTS

- Over 2,500 Trenchless Designs Completed To Date
- Offshore Power Landfalls, Water Body Crossings, Wetlands, Roadways, Railroads, Utilities, Airport Runways and Similar Natural and Man-made Obstacles; Each With Unique Spatial and Geotechnical Characteristics.
- Longest HDD – 7,100' ¦ Conduit Diameters 4" – 60" ¦ Compound Curves ¦ Shore Approaches and Outfalls ¦ Intersect Method

COORDINATION WITH CONTRACTORS AND SUBCONTRACTORS

- AECOM has worked with all NATIONAL HDD/Trenchless Contractors and many Regional and Local Drillers
- Typical Subcontracted Services - Surveying, Bathymetry, Geophysics
- Geotechnical Drilling Services - In-house and Locally Subcontracted

Project Example – Shore Landings (Confidential Offshore Wind Client)

❖ **HDD and Trenching Landing Options for HVDC Marine Cable/Fiber Optic**
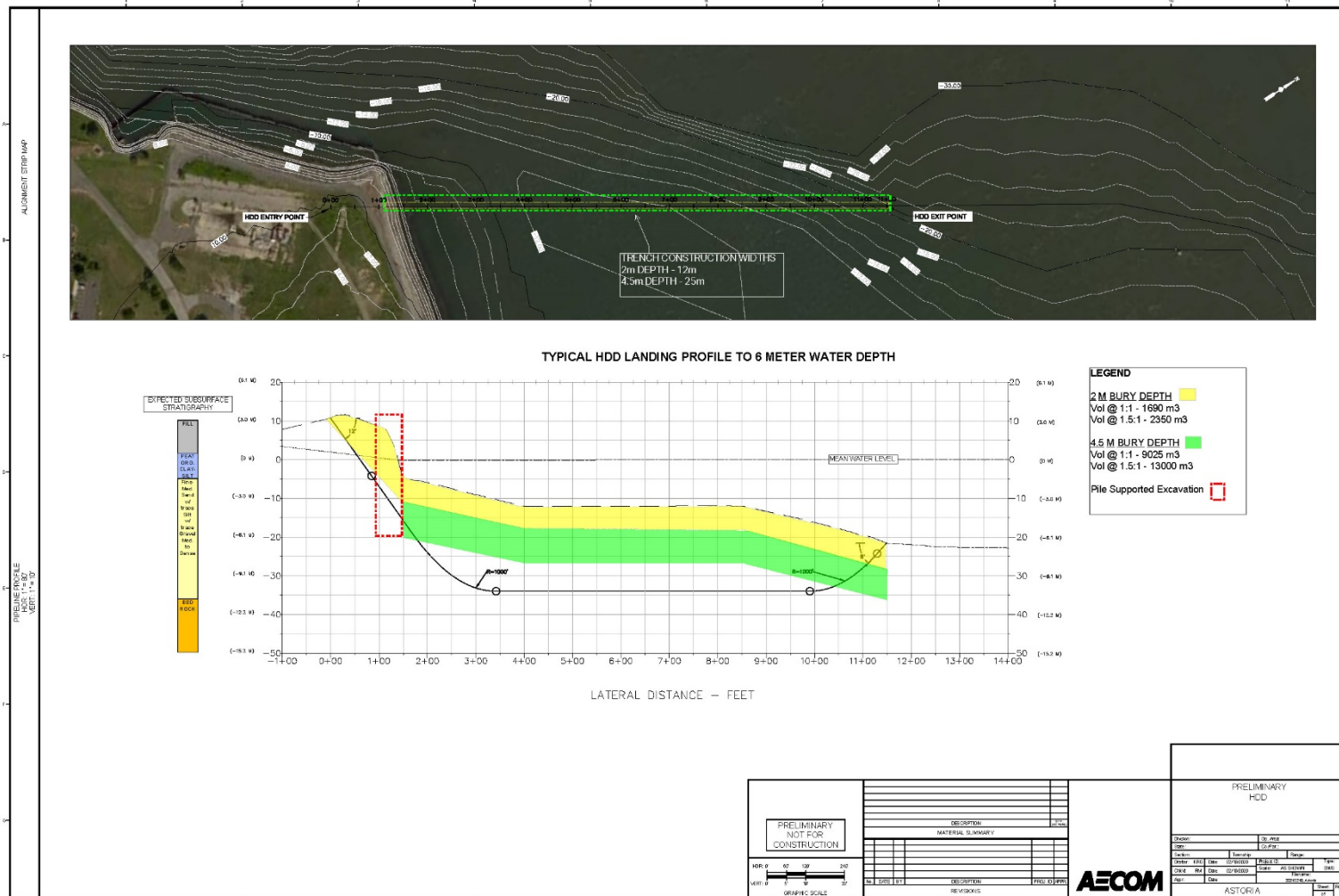
Project Example - Dominion Virginia Gas 230kV, 600 MW U/G Transmission Lines
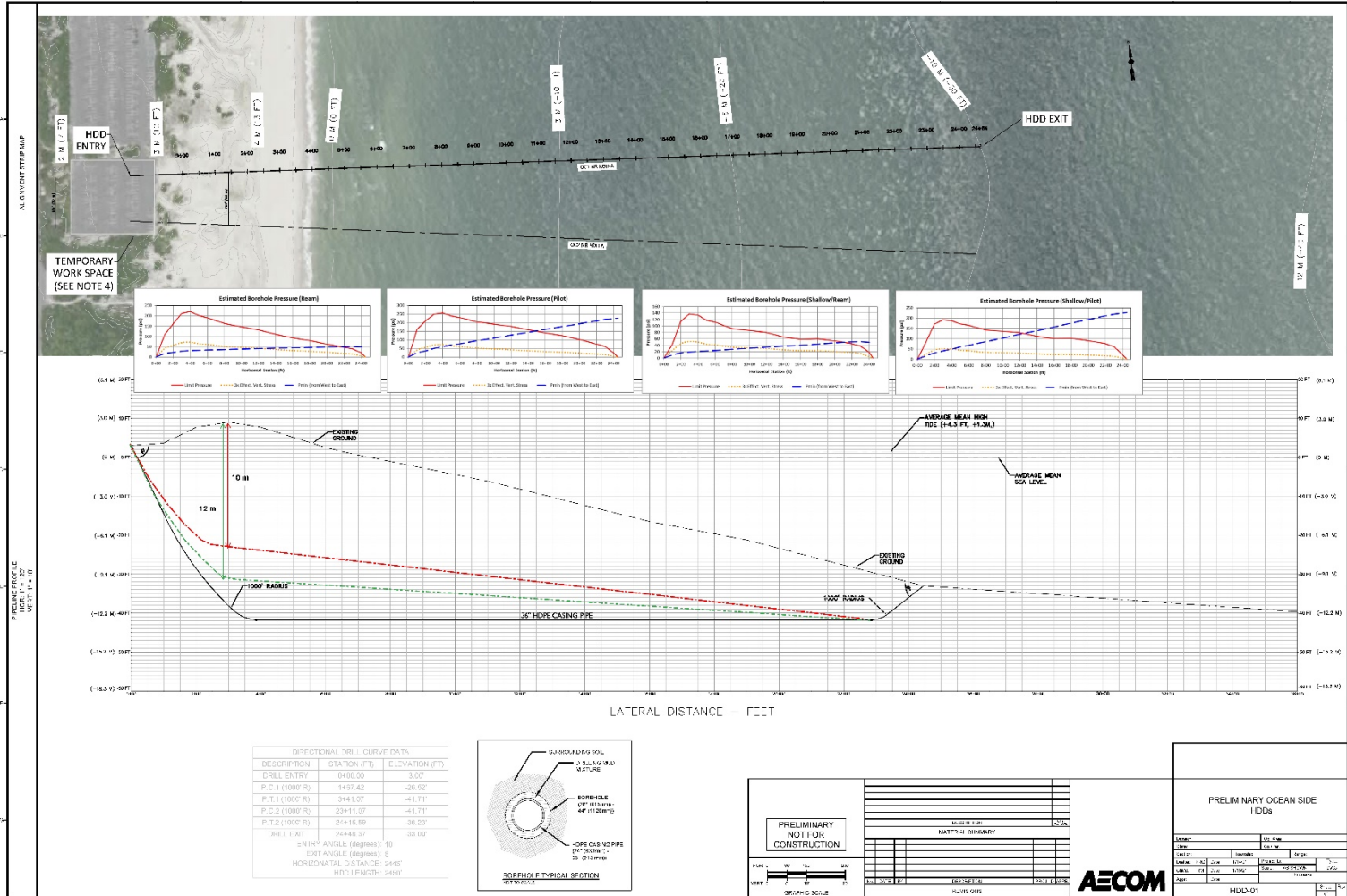
- Full-Time Construction Monitoring Services (MEARS)
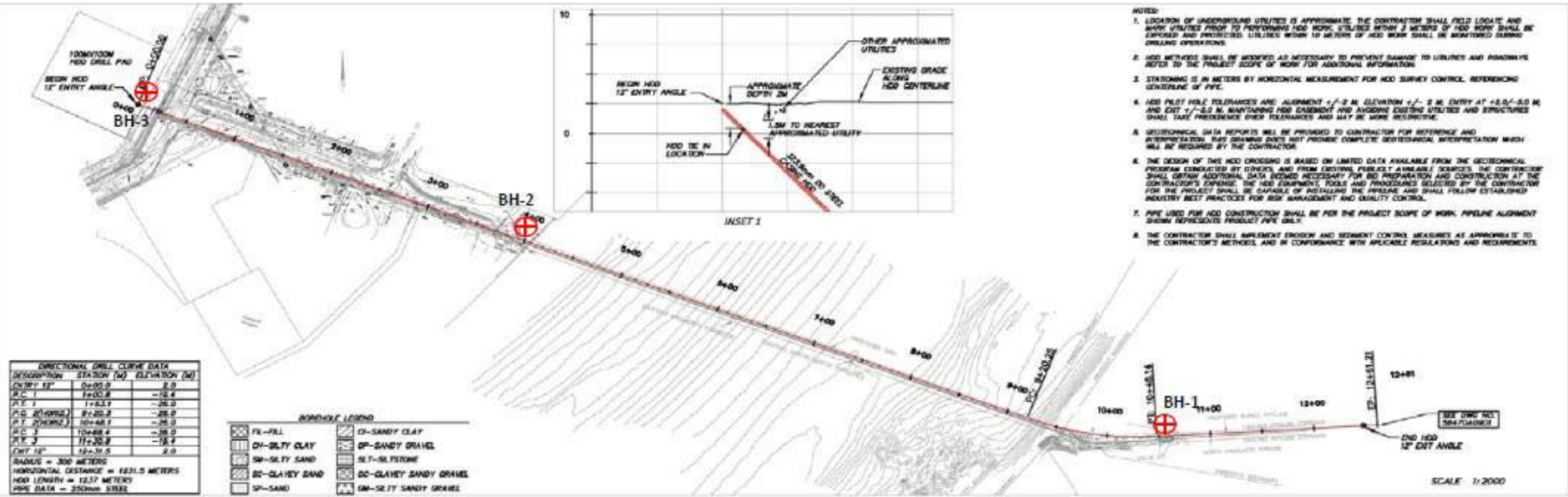- Total of 17,000 FT HDD across York River – 3 Segments

- North Section = 6000 FT
- Central = 7500 FT
- South Section = 3500 FT
- Twin 8-inch lines
- Fixed Platforms in River

Project Example – Shore Landings (Confidential Offshore Wind Client)

❖ **Conceptual HDD Designs for Marine Cable Landings**

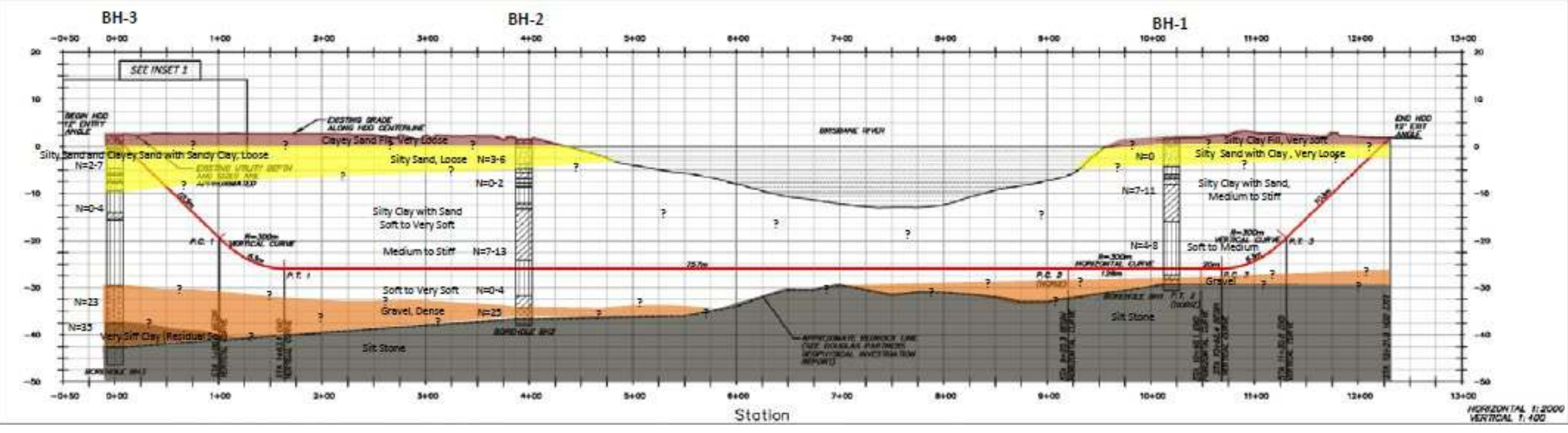# Project Example - Brisbane River & Runway Crossing Crossing Crossing

Project Example - Pearl Harbor P534 Crossing
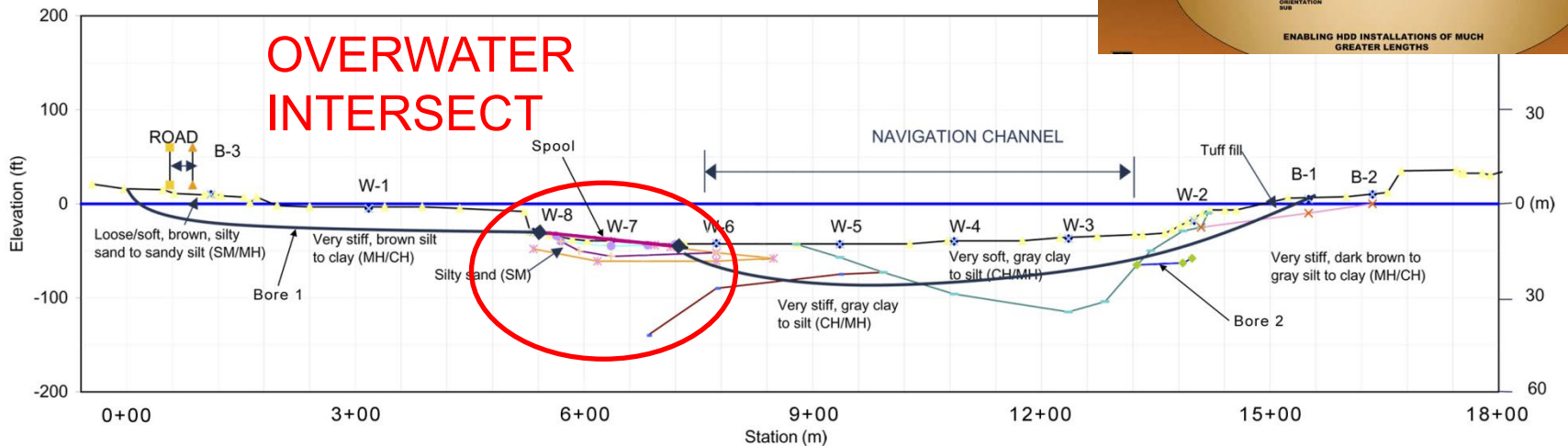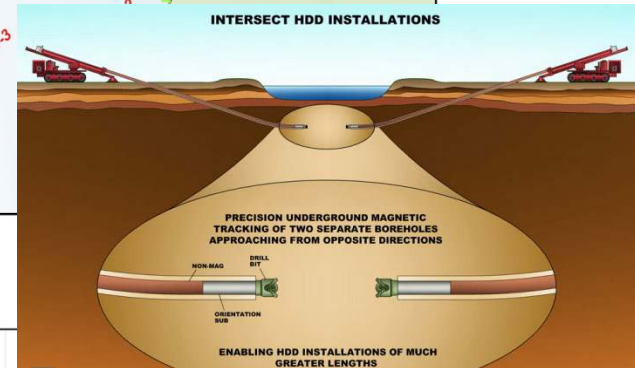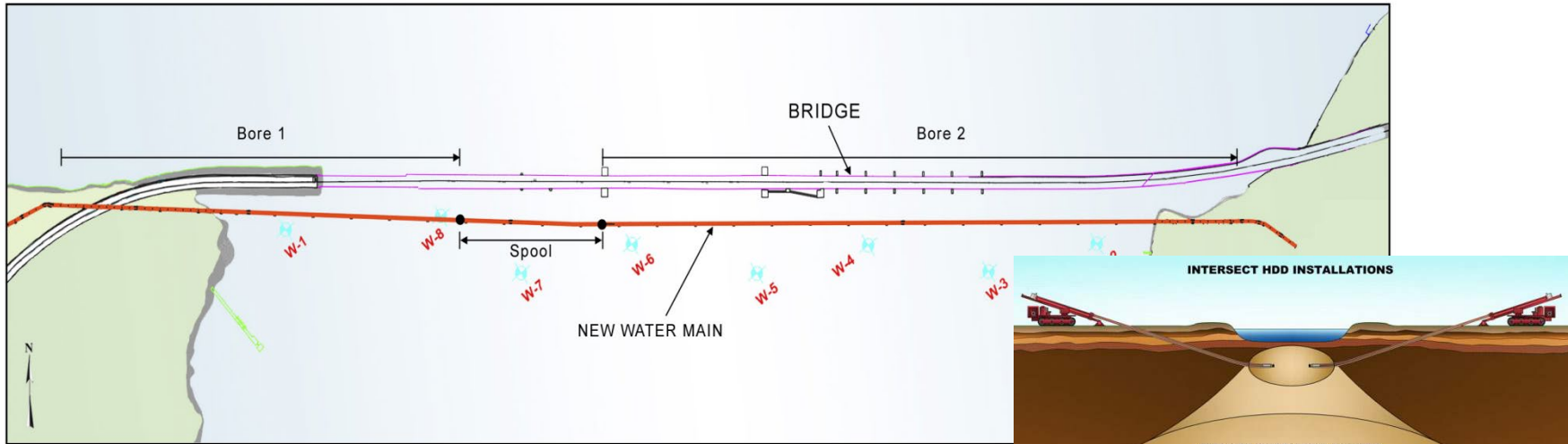
Project Example - Brisbane River & Runway Crossing Crossing Crossing

- In House Programs for Pipe Stress Analysis, Borehole Stability, and Inadvertent Mud Returns

- Full Risk/Mitigation Profile in FS

ANALYSIS OF INSTALLATION LOADS AND STRESSES - PRCI METHOD
10 In. (250mm) Nominal Steel - X-42 (.365" wall) - Brisbane River - HDD
URS Virginia Beach — Monday, March 10, 2014

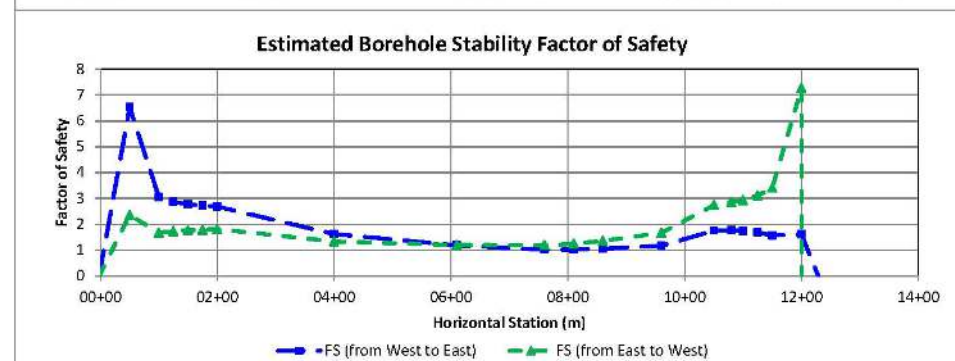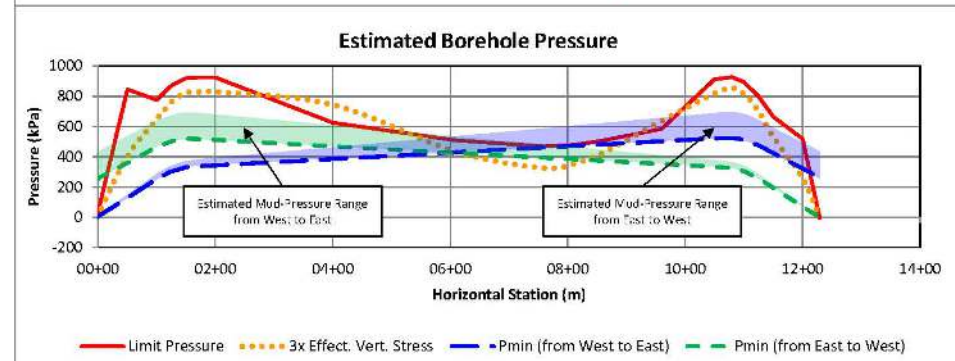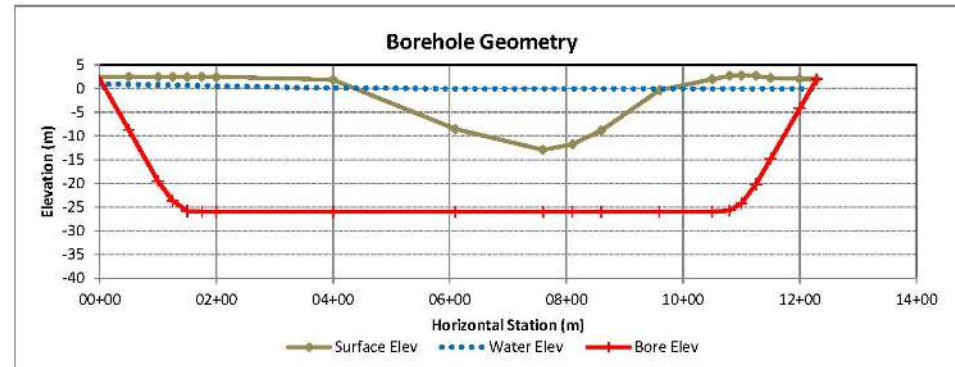| Pipe Material Properties			
Pipe Outside Diameter (D):	10.00	in	
Minimum Wall Thickness (t):	0.365	in	
Modulous of Elasticity (E):	2.9E+07	psi	
Spec. Min. Yield Strength (SMYS):	42,000	psi	
Bending Moment of Inertia (I):	128.21	in⁴	
Poisson's Ratio (v):	0.30	steel	
Dia. to Wall Thickness Ratio (D/t):	27.40		
Coefficent of Thermal Expansion:	6.5E+06	in/in/F	
Empty Pipe Weight:	37.56	lb/ft	
Pipe Interior Volume:	0.47	ft³/ft	
Pipe Exterior Volume:	0.55	ft³/ft	

Installation Properties			
Coefficent of Friction (μ_{soil}):	0.30		
Fluid Drag Coefficient (μ_{mud}):	0.06	psi	
Drilling Mud Density (γ_{mud}):	89.80	lb/ft³	
Water Density (γ_{wa}):	62.40	lb/ft³	
Ballast Weight (W_b):	29.25	lb/ft	
Displaced Mud Weight (W_m):	48.98	lb/ft	
Effective Wgt Ballasted (W_e):	17.83	lb/ft	
Effective Wgt Submerged (W_s):	-11.42	lb/ft	
Above Ground Load (W_p):	30,484	lb	
Allowable Pull Force :	1.86E+06	Newton
Pipe Face Area (A):	11.05	in²
Hydrokinetic Pressure (p):	10.00	psi
Hydrokinetic Force (F_{HK}):	1178.10	lb

Drilled Path Input			
Sta. Drill Entry:	000+00		
Elev. Drill Entry:	6.56		
Elev. Bottom:	-85.22		
Sta. Drill Exit:	040+40		
Elev. Drill Exit:	6.56		
Elev. Obstacle:	-45.54		
Clearance Check:	OK >5'		
Horizontal Curve?:	YES		

Drill Entry Angle:	12	°	
Entry Tangent:	338	ft	
Radius Entry Curve:	984	ft	
Bottom Tangent:	2,970	ft	
Radius Exit Curve:	984	ft	
Exit Tangent:	338	ft	
Drill Exit Angle:	12	°	
Horizontal Curve Radius:	984	ft	
Horizontal Curve Entry Angle:	15	°	
Horizontal Curve Exit Angle:	15	°	

Drilled Path Geometry								
	Entry	VPC1	VPT1	HPC1	HPT1	VPC2	VPT2	Exit
Elevation	6.56	-63.71	-85.22	-85.22	-85.22	-85.22	-63.71	6.56
Station	0000+00	0003+31	0005+35	0030+16	0033+73	0035+05	0037+10	0040+40
Total Drill Length	0.00	338.00	544.09	3016.08	3373.39	3514.09	3720.18	4058.19

Pull Back Forces (SI Units)									
	Above Ground Load	Frictional Drag	Fluidic Drag	Axial Segment Weight	Bending Frictional Drag	Assumed Tension	Average Tension	Section Pull Back	Total Pullback (Newton)
Point 1	135,601	5,038	34,009	3,570	\	0	0	178,218	183,459
Point 2	\	\	20,736	1,094	19,950	200,170	204,349	41,780	225,239
Point 3	\	2,097	14,156	\	\	0	0	16,253	241,493
Point 4	\	\	35,952	4,698	11,567	262,445	267,601	52,216	293,709
Point 5	\	37,669	248,723	\	\	0	0	286,392	580,101
Point 6	\	\	20,736	-1,094	47,553	609,406	613,698	67,195	647,296
Point 7	\	5,038	34,008	-3,570	\	0	0	35,477	682,773

Borehole Geometry

Estimated Borehole Pressure

Estimated Borehole Stability Factor of Safety

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