155 East Broad Street
20th Floor
Columbus, Ohio, 43215

o: 614-222-1330
f: 614-222-1337

December 4, 2020

Ms. Tanowa M. Troupe
Ohio Power Siting Board
PUCO Docketing Division
180 East Broad Street, 11th Floor
Columbus, OH 43215-3716

Re: Case No. 16-253-GA-BTX
Staff Report Condition No. 24 – Inadvertent Return Contingency Plan

Dear Ms. Troupe:

Please find attached the Inadvertent Return Contingency Plan for the Central Corridor Pipeline project.

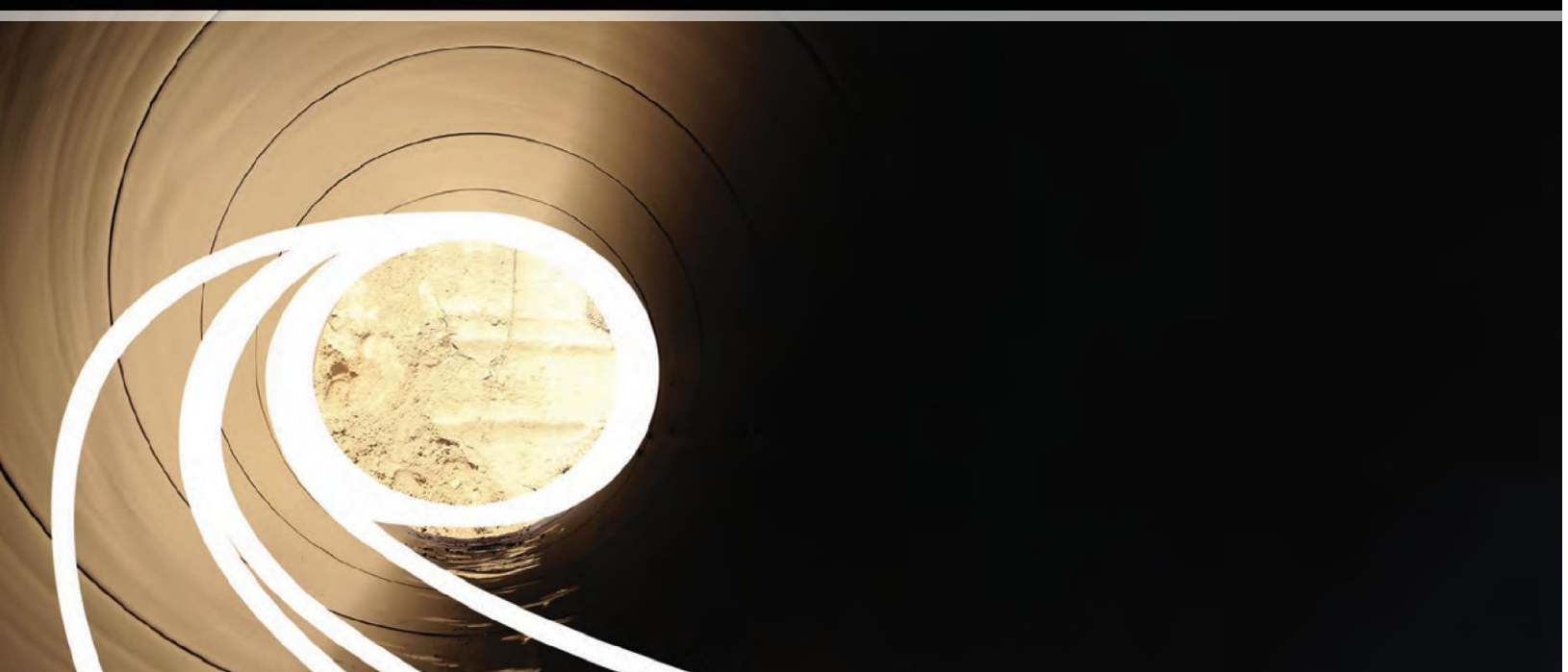
Duke Energy Ohio sets forth this communication to certify its adherence with Condition No. 24 of the OPSB's Opinion, Order and Certificate pertaining to Case No. 16-253-GA-BTX.

Please contact me if you have any questions.

Sincerely,

Emily A. Olive, CP
Paralegal

Duke Energy Central Corridor Project
Inadvertent Return Contingency Plan



Title: DUKE ENERGY CENTRAL CORRIDOR IR PLAN **Author:** JOHN SEIBERT

Date: 12/03/2020

1.0 Scope and Application

Provide for a timely detection of an Inadvertent Return (IR's). Ensure an organized, timely, and "minimum impact" response in the event of an Inadvertent Return.

2.0 Objective

The objective of this method and procedure is to inform and educate outside sources on the process of pre planning for, detection of and controlling Inadvertent Returns associated with the three HDDs on this project.

3.0 Equipment and Material-

3.1 Containment Material- Used to contain drilling fluids that inadvertently reach the surface.

- 3.1.1 **Straw bales:** 20 EA
- 3.1.2 **Silt fence:** 500 LF
- 3.1.3 **Plastic sheeting and/or geo-textile fabric:** 2,000 SF
- 3.1.4 **Pre-filled sandbags:** 100 EA
- 3.1.5 **Turbidity curtain:** Staged for large water bodies
- 3.1.6 **Composite silt sock:** 8" OD, 240 LF

3.2 Equipment- Used to cleanup IR's.

- 3.2.1 Vacuum truck- On Site 24/7
- 3.2.2 Frac tanks
- 3.2.3 Pumps and hoses
- 3.2.4 Shovels, buckets, brooms, and other appropriate hand tools
- 3.2.5 Excavators to get containment and pumps into position.

4.0 Process

4.1 Pre-Planning- Prior to construction on site, the plans and google earth alignment will be examined to assess overall IR risk and potential area of release. The areas of concern are shown below. Once the HDD rig is mobilized, the crew will walk the drill alignment to confirm all areas of concern have been identified before drilling commences. Any areas not previously identified will then be addressed.

4.1.1 Kemper Road HDD: The HDD design provides adequate cover under the drainage swale. Potential releases into the wetland and drainage swale are of concern. Additionally, parking lots, roads and building that are along the HDD alignments can also be damaged by IR releases to the surface. Overall IR risk is low on this HDD.

4.1.2 Mill Creek HDD: The HDD design provides adequate cover under the creek and drainage swale. Potential releases into the creek and drainage swale are of concern.

Additionally, parking lots, roads and building that are along the HDD alignments can also be damaged by IR releases to the surface. Overall IR risk is low on this HDD.

4.1.3 **Mill Creek 2 HDD:** The HDD design provides adequate cover under the creek. Potential releases into the creek are of concern. Additionally, building that are along the HDD alignments can also be damaged by IR releases to the surface. Overall IR risk is low on this HDD.

4.1.4 **Areas of Concern:** See below

4.1.5 **Staging of Materials and Equipment**- Materials and Equipment to contain and control an IR will be stored at the project site in an accessible area and in a position to be immediately employed. (Locations show below)

4.1.6 **Pump Back/Access-** The best route for pumping fluid back from the identified high risk or environmentally sensitive areas will be determined once personnel are on site.

4.1.7 **Fluid Program**: A fluid program has been developed specifically for this project. It outlines the additives and fluid properties we feel are best suited for the ground conditions present. All additives will be NSF-60. (See below)

4.2 **Monitoring**- Means that will be employed to monitor for IR's.

4.2.1 **Walk Over Monitoring-** The drill route will be routinely monitored by walking the route and visually inspecting for drilling fluid that has escaped to the surface. Additional monitoring will be employed when operating with fluid loss.

4.2.2 **Fluid Returns to the Drill Rig-** The mud holding pits will be visually monitored to assure that drilling fluid is being returned back through the drilled hole and into the mud holding system.

4.2.3 **Mud System:** The mud system operator will monitor fluid level and alert the driller if fluid loss is occurring.

4.2.4 **Pressure Tooling-** Downhole annular pressure will be monitored to help detect fluid loss and reduce over pressuring. (Pilot hole only).

4.3 **Loss of Returns Detected –** If partial or full loss of returns is detected the following actions will take place.

4.3.1 **Up to 25% Loss of Fluid –** Customer will be notified of partial loss of returns. Drilling operations will continue with heightened monitoring for IR along the HDD alignment. Amount of lost fluid will be tracked and provided to the customer daily.

4.3.2 **25% Or Greater Loss of Fluid-** Customer will be notified of significant loss of returns. AEI can utilize the following to regain returns.

- Install wash-over or temporary conductor casing to convey fluid back to the rig.
- Pump a "pill" thick mix of mud downhole.
- Pump LCM's (loss circulation material) downhole.
- Trip back and completely or partially re-drill pilot.
- Conduct downhole grouting operations to seal fractures causing fluid loss.
    - Various proprietary grout mixes.

- Drill relief hole and pump fluid back to the rig on the surface.
- Drill with partial to full loss of returns. Constant monitoring of the HDD alignment will be done to detect IR's.

4.4 Inadvertent Return Detected – If an IR is detected all drilling operations will immediately cease. Project specific chain of command will be notified. Containment measures will be put in place and a conveyance system will be installed to divert in a controlled manner drilling fluid at the IR location back to entry or exit.

4.4.1 Containment Measures- Will be carried by hand and/or with heavy equipment to the area of the IR. The measures will be installed around the IR completely encapsulating it.

4.4.2 Vac Trucks- If the IR is minor a vac trucks will be used to remove the fluid from the IR and haul it back to entry of exit.

4.4.3 Conveyance System- If the use of vac trucks is not possible or cannot keep up with the flow of the IR, HDPE pipe will be placed from the area of the IR back to entry or exit. Intermediate pumping stations may be needed to pump drill fluid back to entry or exit.

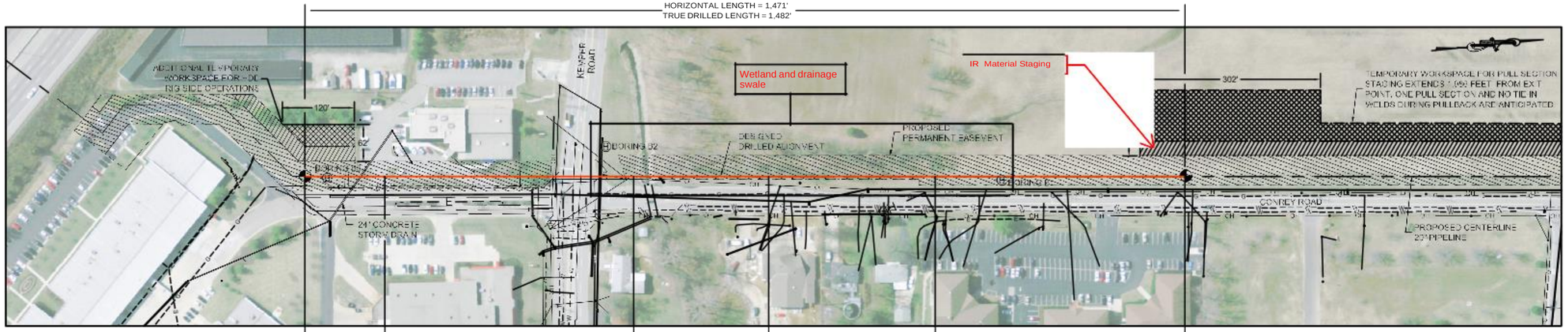
4.5 Commencement of Drilling- Drilling operation will only commence once containment system is in place and go ahead is given from the customer to start drilling again.

4.6 Clean Up – Once the HDD crossing is complete any fluid left in the containment devices will be cleaned up. The containment devices will be removed.

Revision Register:

Date	Revision Description	Initials

HAMILTON COUNTY, OHIO



PLAN

SCALE: 1"=100'

ENTRY POINT @ 12°
0+00.00, 860.00
N 471597.41, E 1441858.32

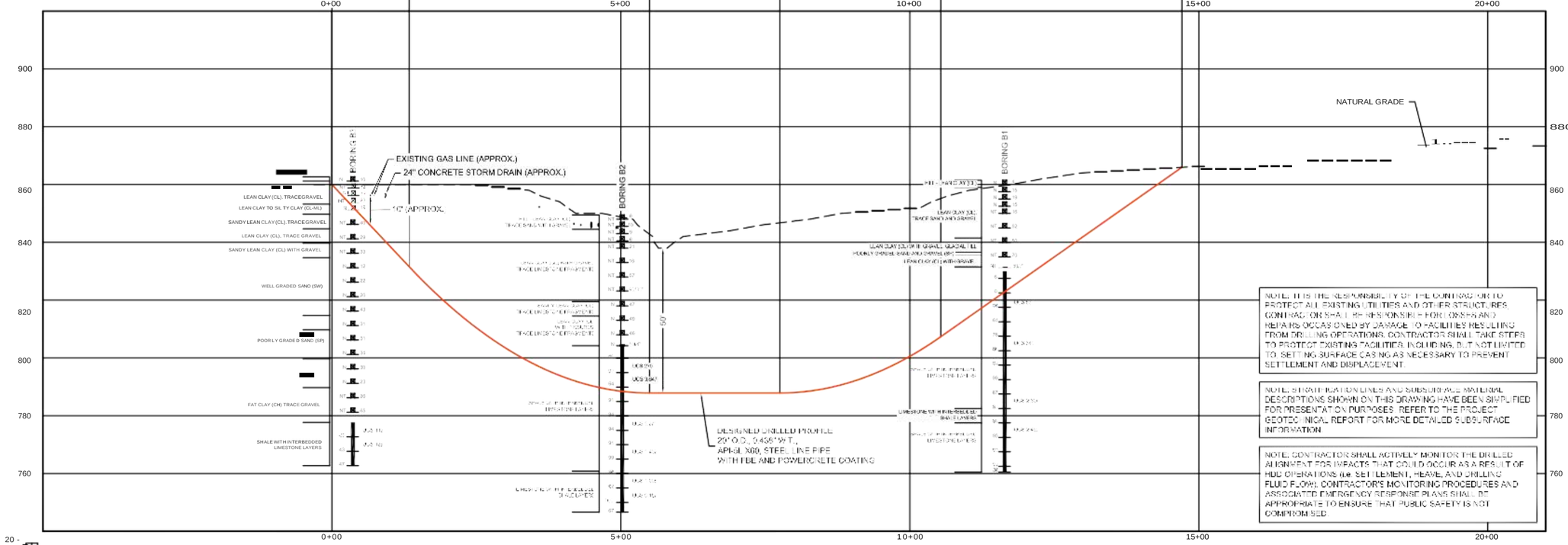
P.C. 12° SAG BEND
1+33.71, 831.58
RADIUS = 2,000'

P.T. 12° SAG BEND
5+49.54, 787.87

P.C. 8° SAG BEND
7+75.17, 787.87
RADIUS= 2,000'

P.T. 8° SAG BEND
10+53.52, 807.34

EXIT POINT @ 8"
14+70.75, 865.98
N 473061.02, E 1442003.02



PROFILE

SCALE: 1"=100' HORIZONTAL
1"= 20' VERTICAL

0 50 100 200

GENERAL LEGEND

S DRILLED PATH ENTRY/EXIT POINT

GEOTECHNICAL LEGEND

@ BORING LOCATION

SPLIT SPOON SAMPLE

53 JI 23 — PENETRATION RESISTANCE IN BLOWS PER FOOT FOR A 140 POUND HAMMER FALLING 30 INCHES
PERCENTAGE OF GRAVEL BY WEIGHT FOR SAMPLES CONTAINING GRAVEL

CORE BARREL SAMPLE

53 I ucs 6,250 - UNCONFINED COMPRESSIVE STRENGTH (PSI)
6 - MOHS HARDNESS
ROCK QUALITY DESIGNATION (PERCENT)

GEOTECHNICAL NOTES

1. GEOTECHNICAL DATA PROVIDED BY TERRACON CONSULTANTS, INC, CINCINNATI, OHIO. REFER TO THE PROJECT GEOTECHNICAL REPORT DATED APRIL 13, 2017, FOR MORE DETAILED SUBSURFACE INFORMATION.
2. THE LETTER "N" TO THE LEFT OF A SPLIT SPOON SAMPLE INDICATES THAT NO GRAVEL WAS OBSERVED IN THE SAMPLE.
   THE LETTERS "NT" INDICATE THAT GRAVEL WAS OBSERVED BUT NO GRADATION TEST WAS PERFORMED.
3. THE GEOTECHNICAL DATA IS ONLY DESCRIPTIVE OF THE LOCATIONS ACTUALLY SAMPLED. EXTENSION OF THIS DATA OUTSIDE OF THE ORIGINAL BORINGS MAY BE DONE TO CHARACTERIZE THE SOIL CONDITIONS, HOWEVER, COMPANY DOES NOT GUARANTEE THESE CHARACTERIZATIONS TO BE ACCURATE. CONTRACTOR MUST USE HIS OWN EXPERIENCE AND JUDGMENT IN INTERPRETING THIS DATA

TOPOGRAPHIC SURVEY NOTES

1. TOPOGRAPHIC SURVEY DATA PROVIDED BY XP-RS, LLC, OVERLAND PARK, KANSAS.
2. NORTHINGS AND EASTINGS ARE IN U.S. SURVEY FEET REFERENCED TO OHIO STATE PLANE COORDINATES, SOUTH ZONE, NAO 83.
3. ELEVATIONS ARE IN FEET REFERENCED TO NAVO 88.

DRILLED PATH NOTES

1. DRILLED PATH STATIONING IS IN FEET BY HORIZONTAL MEASUREMENT AND IS REFERENCED TO CONTROL ESTABLISHED FOR THE DRILLED SEGMENT.
2. DRILLED PATH COORDINATES REFER TO CENTERLINE OF PILOT HOLE AS OPPOSED TO TOP OF INSTALLED PIPE.

PILOT HOLE TOLERANCES

THE PILOT HOLE SHALL BE DRILLED TO THE TOLERANCES LISTED BELOW. HOWEVER, IN ALL CASES, RIGHT-OF-WAY RESTRICTIONS AND CONCERN FOR ADJACENT FACILITIES SHALL TAKE PRECEDENCE OVER THESE TOLERANCES.

1. ENTRY POINT: AT THE STAKED LOCATION
2. ENTRY ANGLE: INCREASE ANGLE UP TO 1-DEGREE (STEEPER), BUT NO DECREASE IN ANGLE ALLOWED
3. EXIT POINT: UP TO 5 FEET SHORT OR 10 FEET LONG RELATIVE TO THE DESIGNED EXIT POINT; UP TO 3 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT
4. EXIT ANGLE: NO INCREASE IN EXIT ANGLE. DECREASE UP TO 2-DEGREES (FLATTER)
5. ELEVATION: UP TO 2 FEET ABOVE AND 10 FEET BELOW THE DESIGNED PROFILE
6. ALIGNMENT: UP TO 5 FEET RIGHT, 0 FEET LEFT OF THE DESIGNED ALIGNMENT FROM STA 0+00 TO 5+00. UP TO 5 FEET RIGHT OR LEFT BEYOND STA. 5+00
7. CURVE RADIUS: NO LESS THAN 1,200 FEET BASED ON A 3-JOINT AVERAGE

PROTECTION OF EXISTING FACILITIES

CONTRACTOR SHALL UNDERTAKE THE FOLLOWING STEPS PRIOR TO COMMENCING DRILLING OPERATIONS:

1. CONTACT THE UTILITY LOCATION/NOTIFICATION SERVICE FOR THE CONSTRUCTION AREA.
2. POSITIVELY LOCATE AND STAKE ALL EXISTING UNDERGROUND FACILITIES. ANY FACILITIES LOCATED WITHIN 10 FEET OF THE DESIGNED DRILLED PATH SHALL BE EXPOSED.
3. MODIFY DRILLING PRACTICES AND DOWNHOLE ASSEMBLIES AS NECESSARY TO PREVENT DAMAGE TO EXISTING FACILITIES.

PRELIMINARY - NOT FOR CONSTRUCTION

MATERIAL ; (2)1,482' ;
MAS/MAO 500 PSIG

JD. HAIR & ASSOCIATES, INC.
STATE LICENSE# GOA 05060

PROFESSIONAl ENG'MCH STAMP

NO.	DATE	REVISION ($) DESCRIPTION	BY	CHK	APPD
A	06/17/20	IS S U E D FO R 90% REVIEW	JMS	C N S	JMS
B	07/24/20	ISSUED FOR BID	JMS	CNS	JMS

DESCRIPTION	
AREA CODE	
ACCOUNT NUMBER	03680
OJECT NUMBER	1880115
DRAWING BY	JMS
STATION ID	C350
ECKER INITIALS	CNS

APPROVALS

DATE	INITIALS	
		REGIONAL ENGINEER
DATE	NITIALS	MGR TECH REC & STD
D ATE	NITIALS	PRINCIPAL ENGINEER

DUKE ENERGY. Piedmont Natural Gas

REF. DWG(S) PNG-C-350-0001182 PNG-B-350-0001008 PNG-C-350-0001183 PNG-B-350-0001009

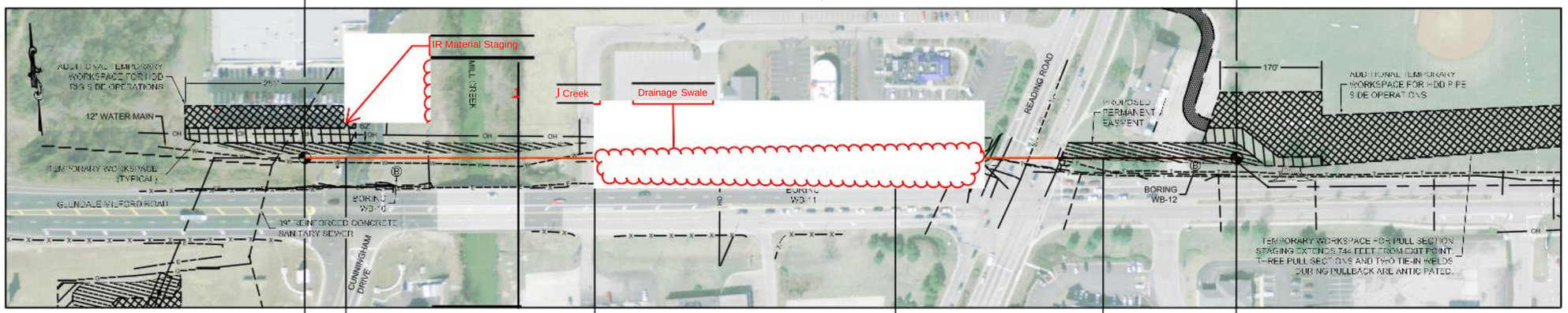
C350 PROJECT
KEMPER RD HOD ALIGNMENT SHEET
HAMILTON COUNTY, OHIO

H A M IL TON C O U N T Y , OHIO

SHEET(S) 1 OF 4 | DWG SCALE AS NOTED
DWG DATE 09/05/18 | SUPERSEDED
DRAWING NUMBER: PNG-C-350-0001272 | REVISION: B
C/HAMILTON COUNTY/C350

HAMILTON COUNTY, OHIO

HORIZONTAL LENGTH= 1,558'
TRUE DRILLED LENGTH = 1,567'



PLAN

SCALE: 1" = 100'

ENTRY POINT @ 12°
0+00.00, 567.65
N 462764.96, E 1422952.60

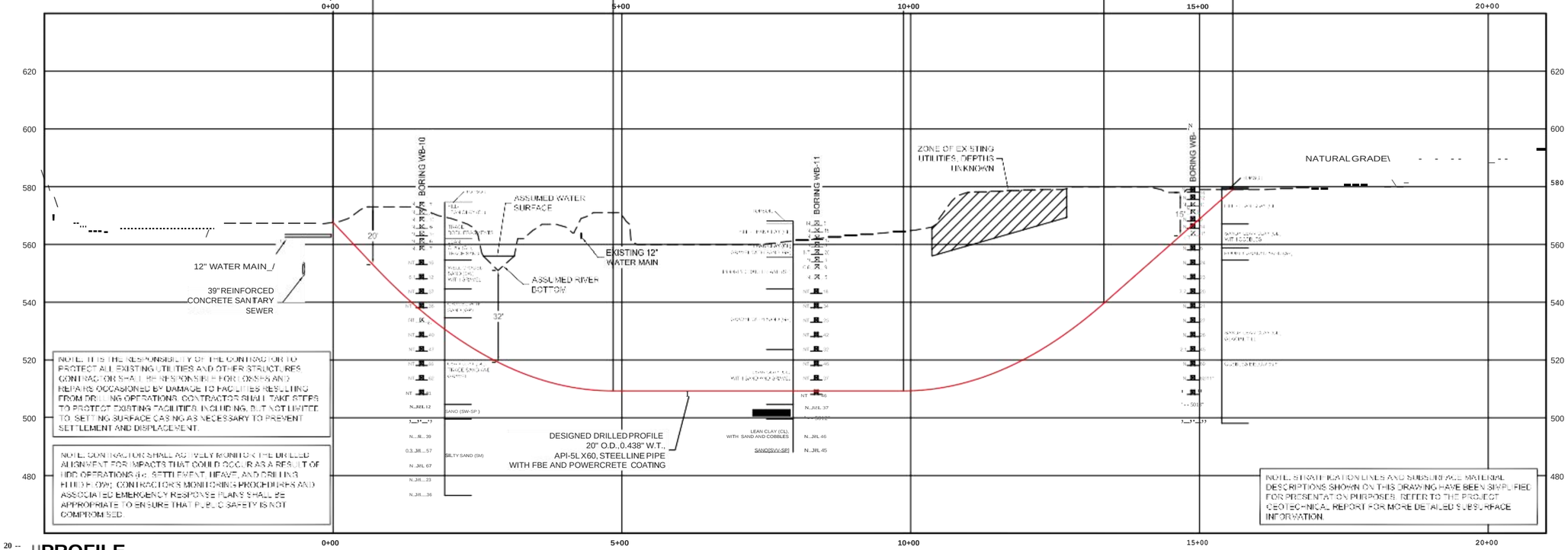
P.C. 12° SAG BEND
0+68.94 , 553.00
RADIUS = 2,000'

P.T. 12° SAG BEND
4+84.76, 509.30

P.C. 10° SAG BEND
9+87.39 , 509.30
RADIUS = 2,000'

P.T. 10° SAG BEND
13+34.69, 539.68

EXIT POINT @ 10°
15+57.69 , 579.00
N 462593.64, E 1424500.84



PROFILE

SCALE: 1"=100' HORIZONTAL
1"= 20' VERTICAL

20 --
10 ---
0 -
0 50 100 200

PRELIMINARY - NOT FOR CONSTRUCTION

MATERIAL
CLASS / MAOP
500 PSIG

i- @1,567' 7

GENERAL LEGEND

S DRILLED PATH ENTRY/EXIT POINT

GEOTECHNICAL LEGEND

@ BORING LOCATION

SPLIT SPOON SAMPLE
53 JI 23 / 1 -
PENETRATION RESISTANCE IN BLOWS PER FOOT FOR **A 140 POUND HAMMER FALLING 30 INCHES**
PERCENTAGE OF GRAVEL BY WEIGHT FOR SAMPLES CONTAINING GRAVEL

CORE BARREL SAMPLE
53 I 6 / 1
UCS 6,250 - **UNCONFINED COMPRESSIVE STRENGTH (PSI)**
MOHS HARDNESS
ROCK QUALITY DESIGNATION (PERCENT)

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7. CURVE RADIUS: NO LESS THAN 1,200 FEET BASED ON A 3-JOINT AVERAGE

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J.D. HAIR & ASSOCIATES, INC.
STATE LICENSE # GOA 05060
PROFESSIONAL ENG/ARCH STPMP

NO.	DATE	REVISION(S) DESCRIPTION	BY	CHK	APP
A	06/17/20	ISSUED FOR 90% REVIEW	JMS	CNS	JMS
B	07/24/20	ISSUED FOR BID	JMS	CNS	JMS

DESCRIPTION	
AREA CODE	
ACCOUNT NUMBER	03680
PROJECT NUMBER	1880115
DRAWING BY	JMS
STATION ID	C350
CHECKER INITIALS	CNS

APPROVALS	DATE	INITIALS
REGIONAL ENGINEER		
MGR TECH REC & STD		
PRINCIPAL ENGINEER		

REF. DWG(S) PNG-C-350-0001208 PNG-B-350-0001013 PNG-C-350-0001209 PNG-B-350-0001014

SHEET(S) 2 OF 4 | DWG SCALE AS NOTED

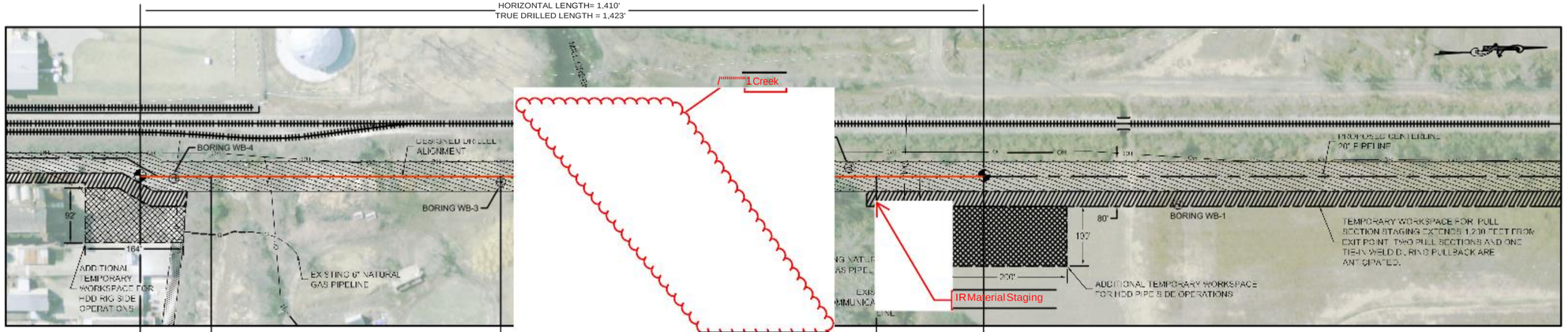
DWG DATE 09/05/18 | SUPERSEDED

C350 PROJECT
MILL CREEK 1 HOD ALIGNMENT SHEET
HAMILTON COUNTY, OHIO
HAMILTON COUNTY, OHIO

DRAWING NUMBER: **PNG-C-350-0001273** | REVISION: **B**

C/HAMILTON COUNTY/C350

HAMILTON COUNTY, OHIO



PLAN

SCALE: 1"=100'

ENTRY POINT@ 14"
0+00.00, 585.00
N 456249.35, E 1420124.73

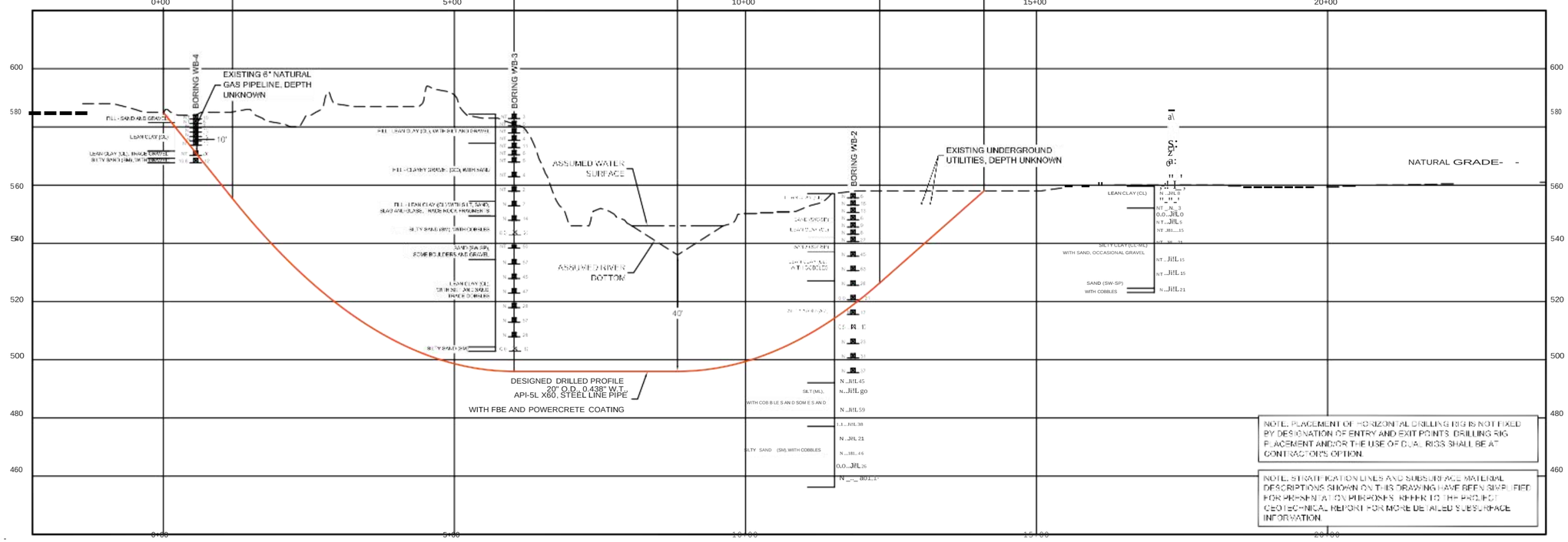
P.C. 14" SAG BEND
1+18.68, 555.41
RADIUS = 2,000'

P.T. 14" SAG BEND
6+02.53, 496.00

P.C. 10" SAG BEND
8+83.28, 496.00
RADIUS = 2,000'

P.T. 10" SAG BEND
12+30.57, 526.39

EXIT POINT@ 10"
14+09.87, 558.00
N 457656.42, E 1420213.73



PROFILE

SCALE: 1"=100' HORIZONTAL
1"= 20' VERTICAL

0 50 100 200

GENERAL LEGEND

S DRILLED PATH ENTRY/EXIT POINT

GEOTECHNICAL LEGEND

@ BORING LOCATION

SPLIT SPOON SAMPLE
53 JI 23 — PENETRATION RESISTANCE IN BLOWS PER FOOT FOR A 140 POUND HAMMER FALLING 30 INCHES
1 - PERCENTAGE OF GRAVEL BY WEIGHT FOR SAMPLES CONTAINING GRAVEL

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53 ucs 6,250 - UNCONFINED COMPRESSIVE STRENGTH (PSI)
6 - MOHS HARDNESS
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PROTECTION OF EXISTING FACILITIES

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PRELIMINARY - NOT FOR CONSTRUCTION

MATERIAL (2)1.423
1.ASS/M.A.Q 500 PSIG

J.D. HAIR & ASSOCIATES, INC.
STATE LICENSE# COA 05060

PROFESS/ONALENGIARCHSTAMP

NO.	DATE	REVISION(S) DESCRIPTION	BY	CHK	APPO
A	06/17/20	ISSUED FOR 90% REVIEW	JMS	CNS	JMS
B	07/24/20	ISSUED FOR BID	JMS	CNS	JMS

DESCRIPTION	
AREA CODE	-
ACCOUNT NUMBER	03680
OJECT NUMBER	1880115
AWING BY	JMS
ATION ID	C350
ECKER INITIALS! CNS	

APPROVALS

	DATE	INITIALS	
REGIONAL ENGINEER			
MGR TECH REC & STD			
PRINCIPAL ENGINEER			

REF. DWG(S) PNG-C-350-0001216 PNG-B-350-0001010 PNG-C-350-0001217 PNG-B-350-0001011

SHEET(S) 3 OF 4 | DWG SCALE AS NOTED

DWG DATE 09/05/18 | SUPERSEDED

C350 PROJECT
MILL CREEK 2 HOD ALIGNMENT SHEET
HAMILTON COUNTY, OHIO

HAMILTON COUNTY, OHIO

DRAWING NUMBER **PNG-C-350-0001274** REVISION **B**

C/HAMILTON COUNTY/C350

Location: Hamilton County, OH
Project: Duke Energy Central Corridor Project

Overview

All products are developed to provide the best value and ease of use. Products are designed to address a wide range of soil and rock geologies, thus providing stable well bores while removing and suspending drill cuttings during drilling/reaming processes.

From dry and readily dispersible dry products to more concentrated liquid products, the goal is to stay within budget and increase productivity.

With the advancement of new HDD steering and drilling techniques, longer and larger diameter HDD crossings are becoming a reality. An important part of these advancements is the use of drilling fluids that can carry more cuttings faster, across longer distances without allowing them to disperse and/or settle in the flow stream. Thus, annular pressures are minimized while a maximum area is established to accommodate the pipeline.

The drilling fluid should provide excellent hole cleaning, cuttings suspension and bore stability. Entry soils are very unconsolidated, and sandstone is possibly permeable. The fluid should be thickened for entry soils and can be maintained at lower viscosity when drilling bedrock.

Running a full mud system will ensure cuttings are quickly removed from the bore and to not accumulate in the bore hole.

The bentonite-based mud system is designed to address the varying soil conditions to be encountered during the crossing. MAX GEL/SUPER GEL X (Average 20 - 30 lbs./100 gal) will be used as a base along with PLATINUM PAC for fluid loss control and bore stability, DRILPLEX for cuttings suspension, POLY PLUS used to control clays from hydrating, and SODA ASH for pH control. Bentonite selection will be per operator and RTS.

As a preventive measure to combat inadvertent returns (IR) the use of DRILL SEAL should be used during pilot. Drill Seal can be used on various unconsolidated, fractured, and fragile soils to stop major losses of mud and fluids. Based on Drill Seal's unique design it can be pumped through a mud motor or jetting assembly. It should be mixed at a ratio of 1 to 2 bags per 50 gallons.

Should seepage or full losses be encountered, a blend of specially sized loss of circulation materials (LCM) can be used in a "pill" to provide maximum coverage and effectiveness in regaining full returns. These include HDD Defense and Drill Seal. In a small volume using a Star Plex enhanced base fluid, these materials have a very good success rate in regaining circulation to reduce costs to the operator and potential releases of fluid to the environment.

In some cases, bore stability and loss of circulation require the application of a high-solids bentonite grout product. The grout mixture is designed to permeate highly unconsolidated zones and provide a temporary matrix to the local geology while allowing for drilling and reaming to progress.

Geology

Mainly SAND and GRAVEL.

Drilling Fluid System

MAX GEL/SUPER GEL X

MAX GEL/SUPER GEL X viscosifier is a premium Wyoming bentonite blended with special extenders, producing a product that will yield more than twice as much viscosity as API Wyoming bentonite. MAX GEL/SUPER GEL X is an easily mixed bentonite for freshwater and extended bentonite systems. It is used to rapidly build mud viscosity and provide superior hole cleaning, as well as to help control lost circulation, formation sloughing and promote hole stability in unconsolidated formations. It is typically used between 15 and 35 lbs./gal as required.

Yields much faster than API-standard bentonite
Non-toxic and proven suitable for use in all drilling applications
requirements as compared to API bentonite

SODA ASH

SODA ASH is used to condition and soften make-up water and raise pH, allowing drilling fluid additives to mix more efficiently. SODA ASH treats out hardness due to calcium in make-up water and raises pH.

PLATINUM PAC

PAC L FORCE polyanionic cellulose is a high-quality, readily dispersible water-soluble polymer designed to control fluid loss, with a minimal increase in viscosity in water-base drilling fluids. PAC L FORCE is used where fluid loss control is required, without affecting the beneficial rheological properties of the drilling fluid. PAC L FORCE is also effective in flooded reverse drilling where low viscosity fluids are required.

Disperses quickly and produces minimal viscosity increase while providing fluid loss control
Encapsulates shale particles to inhibit swelling and dispersion
Resists bacterial attack, requiring no biocides or preservatives
Functions over a wide range of salinity, hardness and pH levels in most mud systems
Effective in low concentrations for controlling fluid loss and building viscosity
Environmentally acceptable

POLY PLUS

POLY-PLUS polymer is a high-molecular-weight, anionic liquid designed to provide cuttings encapsulation and shale stabilization. POLY-PLUS additive also acts as a viscosifier, friction reducer and cuttings flocculant. POLY-PLUS polymer can be used in mud systems using makeup waters from freshwater to saltwater.

Effective at concentrations as low as 0.25% by volume
Water soluble
Helps prevent bit-balling on BHA and tooling by coating and lubricating solids
Environmentally friendly

DRILPLEX HDD

DRILPLEX HDD is a specialty product used to enhance the gel strengths of bentonite. DRILPLEX HDD viscosifier is an inorganic chemical viscosifier for water-base bentonite drilling fluids.

DRILLPLEX HDD viscosifier allows the formulation of fluids with exceptional shear-thinning properties, resulting in a drilling fluid with both excellent dynamic and static carrying capacity for solids. This is indicated by high-yield point and low plastic-viscosity readings. When not circulating, the mud instantly reverts to a gelled state and results in high suspending capacity indicated by high, non-progressive gel strength readings.

High rate of penetration
Excellent cuttings transport
Excellent cuttings suspension
Borehole stabilization through “gel locking” in the formation

Lost Circulation

HDD Defense

HDD Defense is a blend of environmentally safe sealants and swellable materials designed to remediate inadvertent return events in HDD applications. Designed to be applied at the onset of inadvertent returns, HDD Defense should be spotted as a pill on bottom (in the inadvertent return zone), with typical concentrations varying from 1 – 1.5 lbs./gallon.

Effectively bridges across loss zones
Can be pumped through mud motors
Environmentally safe and non-toxic

APPLICATION

At the onset of inadvertent returns, pumping should be stopped while mixing the HDD Defense pill. Isolate a mixing tank suitable of holding the desired finished volume, and fill with fresh mud. Add the required HDD Defense through the mixing hopper. Once the pill is mixed, the entire pill should be picked up and pumped down the drill pipe. Chase the pill with active mud until the tail of the pill is outside of the bit. Stop pumping and pull pipe out of the hole to position the bit behind the tail of the pill. Begin circulating at a slow rate while monitoring returns. Stage the pumps up slowly and circulate behind the pill for 1-2 hours to allow the material to create a seal. Wash and ream to bottom pumping sweeps with Drill-Seal as needed to prevent further inadvertent returns.

DRILL-SEAL

DRILL-SEAL is a blend of natural plant fibers. These deformable and compressible particles conform to the shape of pores and fractures to provide a bridge and a primary seal against loss of drilling mud. DRILL-SEAL can be used as a standalone product or in conjunction with HDD Defense lost circulation materials to combat lost circulation / inadvertent returns.

Sealing various types of unconsolidated and fragile soil
Stopping major losses of mud and fluids in fractured formation
Deformable and compressible particles conform to the shape of pores and fractures

APPLICATION

Pills may be used in sweep fashion or spotted downhole to create a lasting seal. Typical concentrations range from 1 – 2 sacks per 50 gallons.

SEAL FORCE

SEAL FORCE is a swelling copolymer for lost circulation that expands over 200 times its volume in freshwater. SEAL FORCE is a lost circulation material used to seal fractures. It can also be spotted in caving zones to consolidate loose formations. After placing SEAL FORCE pills, pull up above the problem zone to prevent stuck pipe. Hydration occurs in 20 to 30 minutes. Circulate with mud and LCM to fill the voids between the spotted pill.

Can be hydrated prior to spotting
Will accumulate in a variety of fracture sizes due to its swelling capacity and particle size distribution

Loss of Circulation Materials (LCM)

LCM pills and sweeps incorporate fibrous and granular products to effectively block the paths of the seepage or whole loss. Magma Fiber will mesh across loss zones and provide a foundation for the blockage where sawdust will further incorporate itself into the structure. High viscosity base bentonite/Star Plex fluid will further slow the migration of drilling fluid into loss zones and form extremely high gel strengths around the loss zone. Swell Star, an insoluble and flexible LCM, can swell up to 200 times its volume in fresh water. Swell Star can be added at connections, dry or pre-hydrated for seepage losses, or incorporated in the LCM pill at various points of mixing to improve the blocking potential.

Recommended properties and maintenance

As mud engineering is not confirmed for this project, drilling fluids monitoring and maintenance will depend on the experience of the drilling foreman, driller, and tank hands, as well as available testing equipment on location. Wherever possible, API RP 13B-1 should be followed when monitoring drilling fluid parameters. An application guide is provided for field personnel with additions for each section of the bore. All drilling fluid additive concentrations must be maintained for fresh water added, including make-up volume for disposed fluids.

Viscosity

The funnel viscosity of the drilling fluid will depend on the diameter of the section of hole being drilled or reamed and the nature of the drilled cuttings being removed. It is a simple measurement that indicates how much thicker the fluid is in relation to water (26 seconds/quart). Crews can monitor the funnel viscosity of the fluid to maintain recommended mud properties and determine if the formation being drilled is contributing to an increase in viscosity. As a result, clay control additives can be adjusted to further improve clay and shale stability.

Similarly, in unconsolidated formations like sand, silt and gravel, viscosity increases will improve cuttings transport and suspension. Continuous monitoring of the funnel viscosity in these formations will ensure the drilling fluid maintains optimum performance.

Sand Content

Sand content is normally maintained below 1 %. Excessive sand in the drilling fluid can cause premature wear on circulating pumps, piping, and mud motors. Periodic sand content tests by crews can effectively determine formation (geology) changes as well as deficiencies in the cleaning system. Holes in shaker screens and plugged hydrocyclones can cause rapid increases in the sand content and should be repaired immediately.

Density (mud weight)

The mud density should be maintained as low as possible. Continuous mud density monitoring by tank hands can expose deficiencies in the circulating system such as holes in shaker screens, plugged hydrocyclones and poor centrifuge performance. Excess density will increase hydrostatic pressure and could cause inadvertent losses into weak formations. Excess solids due to higher mud weight can also affect the rate of penetration.

Fluid Loss (API Filtrate)

High yield bentonite on its own does provide some fluid loss control but often additives are required for unconsolidated formations or reactive clay formations demonstrating a higher dispersion potential. PAC LV provides fluid loss control and crews can monitor fluid loss if there is a filter press on location. Maintaining acceptable parameters for fluid loss can prevent hole collapse and clay/shale hydration.

pH, Hardness & Chlorides

Testing the make-up water before mixing drilling fluid products will determine compatibility and

potential contamination. Recommended drilling fluid additives are designed to mix efficiently in any make-up water but there are exceptions. Very high hardness levels can restrict bentonite and additive hydration and salt content over 5000 ppm can reduce the hydration potential of bentonite products. Soda ash or sodium bicarbonate is normally to treat contaminated hard water sources. Higher salt content may require the use of specialty additives if the source water cannot be replaced. Resulting pH and hardness following mixing can also be determined by the filtrate from the fluid loss test (API filtrate).

Rheology

Crews are often trained on the use of electric and hand crank viscometers and additional fluid properties can be checked during the shift. Increases in plastic viscosity are often an indication of increases in mud weight due to excess solids and low gravity solids dissolution. Maintaining the mud weight as low as possible will result in a lower plastic viscosity. Slight changes in additive concentrations may better consolidate cuttings and reduce sloughing and swelling in HDD bores.

Yield point and low-end rheology (6/3 RPM) properties determine the ability of the fluid to efficiently clean cuttings from the borehole by maintaining the appropriate flow regime for HDD bore path lengths and angles. Elevated properties may provide solutions to reduce torque, drag, annular pressures, and seepage losses.

Gel strengths (10 sec/10 min) indicate the ability of the drilling fluid to “stiffen” and provide a matrix for effective cuttings suspension. Gel strengths should be higher and flatter in HDD fluids to provide immediate suspension and reduce the tendency of cuttings to form beds. These cuttings beds may accumulate as annular blockages that can affect fluid flow and annular pressures.

These tests are normally performed by mud engineers. We recommend mud engineering on all crossings.

Crossing Specifications and Mud Volumes (Multiple Crossings)

Length:	**3,229 ft**
Pilot:	10-5/8 inches
Casing:	NA
Product:	20" STEEL
Reaming Stages:	30-inch, Swab Pass
Formation:	SAND – SILT – GRAVEL
Mud Motor:	8 INCH
Rig:	160 K +
Tank Volume:	8000 gal.
Total Fluid:	235,074 gal.

INSERT BORE PROFILE

Mud Volume Calculations for Each Pass

10-5/8” Pilot Bore (INCLUDES ALL 3 CROSSINGS)	
Hole Volume per Foot:	5 gallons/foot
Recommended Pump Rate:	400 GPM
Hole Volume:	15,019 gallons
Mud to Pump:	820,063 gallons
Mud Lost (4%):	32,803 gallons
Total Mud to Pump (losses, tanks, hole vol.):	852,866 gallons

Ream Pass 1: 30” Diameter (INCLUDES ALL 3 CROSSINGS)	
Hole Volume per Foot:	37 gallons/foot
Recommended Pump Rate:	600 GPM
Hole Volume:	118,616 gallons
Mud to Pump:	1,845,143 gallons
Mud Lost (3%):	55,354 gallons
Total Mud to Pump (losses + increases in hole vol.):	1,900,487 gallons

Swab Pass: 30” Diameter (INCLUDES ALL 3 CROSSINGS)	
Hole Volume per Foot:	37 gallons/foot
Recommended Pump Rate:	600 GPM
Hole Volume:	118,616 gallons
Mud to Pump:	615,048 gallons
Mud Lost (2%):	12,301 gallons
Total Mud to Pump (losses + increases in hole vol.):	627,349 gallons

Additive Concentrations (INCLUDES ALL 3 CROSSINGS)

Stage	PLATINUM PAC	DRILPLEX HDD	SODA ASH	POLY PLUS
Pilot	**223 – 335 lbs. or 2 – 3 lbs. per joint**	**223 – 335 lbs. or 2 – 3 lbs. per joint**	**140 – 279 lbs. or 1 – 3 lbs. per joint**	**56 – 112 Gal. or .5 – 1 Gal. per joint**
Ream 30”	**668 – 1,002 lbs. or 7 - 10 lbs. per joint**	**668 – 1,002 lbs. or 7 - 10 lbs. per joint**	**417 – 835 lbs. or 4 – 8 lbs. per joint**	**167 – 334 Gal. or 2 – 3 Gal. per joint**
Swab Pass	**74 lbs.**	**74 lbs.**	**62 lbs.**	**25 GAL.**

NOTE: 1 vis cup is approximately 2 lbs. of additive
NOTE: When building the initial mud, hydrate the bentonite, add the powder additives, mix, then add the liquids.

Batch Mixing per 5000 Gallons

Stage	MAX GEL	PLATINUM PAC	DRILPLEX HDD	SODA ASH	POLY PLUS
5000 gal.	**20 – 30 BAGS**	**20 – 30 lbs. (10 – 15 VIS CUPS)**	**20 – 30 lbs. (10 – 15 VIS CUPS)**	**12.5 – 25 lbs. (6 – 12 VIS CUPS)**	**5 – 10 GAL.**

NOTE: Adjust water pH first with SODA ASH. pH level needs to be 8.5 – 10
NOTE: Mix MAX GEL 2nd and let hydrate for 5 minutes
NOTE: Add PLATINUM PAC followed by DRILL PLEX HDD
NOTE: Lastly add POLY PLUS

Properties

Stage	Stage Funnel Viscosity (sec/qt)	Mud Weight (lb/gal)	Sand Content (%)	Plastic Viscosity (CP)	Yield Point (lb/100 ft2)	Fluid Loss (mL)	Hardness (ppm)	pH
Pilot	**60 - 70**	**8.8 - 10**	**<1 %**	**9 - 15**	**18 -32**	**<15**	**< 100**	**8.5 - 10**
Ream	**80 - 90**	**8.8 - 10**	**<1 %**	**9 - 15**	**35+**	**<15**	**< 100**	**8.5 - 10**
Swab Pass	**80 - 90**	**8.8 - 10**	**<1 %**	**9 - 15**	**35+**	**<15**	**< 100**	**8.5 - 10**

Additive Concentrations

Product Name	Quantity	Units	Pallets
Bentonite	**47,015 – 70,522 LBS.**	**940 – 1410 bags**	**14 – 20 (70/PALLET)**
SODA ASH	**588 – 1175 LBS.**	**12 – 24 buckets**	**½ - 1 (32/PALLET)**
PLATINUM PAC	**940 - 1410 LBS.**	**38 - 56 buckets**	**1 – 2 (36/PALLET)**
DRILPLEX HDD	**940 - 1410 LBS.**	**38 - 56 buckets**	**1 – 2 (36/PALLET)**
POLY PLUS	**235 – 470 GAL.**	**47 – 94 buckets**	**2 – 3 (32 PALLET)**