HDD EXECUTION PLAN

Client: Trans Mountain Corporation

Project: Trans Mountain Expansion Project – Spread 5A

Crossing: Jacko Hill HDD Crossing

Table of Contents

1.0 Jacko Hill HDD 3
1.1 Project Description 3
1.2 Equipment 3
1.3 Workspace / Access 3
1.4 Construction Methodology 4
1.4.1 Geotechnical Data Review 4
1.4.2 Drilling Prognosis 6
1.5 Construction Methodology 8
1.5.1 Surface Casing 8
1.5.2 Pilot Hole Navigation 8
1.5.3 Reaming 9
1.5.4 Pipe Pull 9
1.5.5 Demobilization 9

Appendix A – Drawings & Layouts

Appendix B – Drilling Details

Appendix C – Execution Details

Appendix D – Plans

Appendix E – IFC Design Drawing

HDD EXECUTION PLAN

1.0 JACKO HILL HDD

1.1 PROJECT DESCRIPTION

Trans Mountain Corporation (TMC) is proposing to construct the Trans Mountain Expansion Pipeline, an NPS 36 pipeline running from Edmonton, Alberta to Burnaby, British Columbia. Spread 5A of the project includes a Horizontal Directional Drilling (HDD) Crossing of Jacko Hill. The construction period for this crossing is approximately 34 days and is expected to begin in September 2023.

1.2 EQUIPMENT

For the primary rig (entry/Northeast) side, The Crossing Company Incorporated (TCC) proposes to provide Rig 10. Rig 10 is an American Augers DD-625 drilling rig capable of providing 625,000 lbs of push/pull and 80,000 ft-lbs of rotary torque. Rig 10 will include a 60 m3 drilling fluid mixing system with one (1) Derrick FLC-504 shaker, one (1) F-800 drilling fluid pump, and one (1) Alfa Laval Lynx 40 centrifuge. Rig 10 will be equipped with 6-5/8" S-135 drill pipe.

Please see the Equipment Inventory Drawings located in Appendix A and the attached Execution Plan Technical Details in Appendix C for more information.

Rig 10 will also come equipped with the PASON Electronic Drill Recorder (EDR) for real-time info and traces for various aspects of drilling operations. Please see the list of standard TCC PASON traces in Appendix A for more information.

1.3 WORKSPACE / ACCESS

For the entry (Northeast) side, the workspace detailed looks suitable, provided the area is flat, matted, and available for TCC to use. This is also assuming that the centerline of the microtunnel alignment does not interfere with the placement of buildings on site. The archeological site looks to not interfere with the placement of buildings, assuming it is as depicted in the IFC drawing no. 01-13283-M002-XD00162 Rev 0.

A pre-job meeting will be held between TCC, the General Contractor, and TMC prior to beginning construction activities.

Please see the Entry Side Layout Drawing located in Appendix A for more information.

1.4 CONSTRUCTION METHODOLOGY

1.4.1 Geotechnical Data Review[1]

Borehole SH21-5A-19-TEL-JL-KP851+931 (Approximately 15 m Northwest of the entry point (Northeast)):

Depth From Surface (m)	Approximate Elevation (m)	SPT (N)	Classification	Other Notes
0.0. – 0.2	943.5 – 943.3	-	Topsoil	- **Trace sand, trace gravel, dark brown, occasional rootlets**
0.2 – 0.8	943.3 – 942.7	-	Clay	- **Trace sand, low to medium plastic, brown, occasional oxides**
0.8 – 2.2	942.7 – 941.3	-	Sand & Gravel	- **Silty, trace clay, brown, trace oxides**
2.2 – 2.6	941.3 – 940.9	>50	Silt	- **Very dense, greenish grey to brown**
2.6 – 4.6	940.9 – 938.9	>50	Sand	- **Silty, gravelly, trace clay, very dense, grey**

[1]Source: Spread 5A – Geotechnical Assessment KP852 Trenchless Crossing (Jacko Hill) Rev 0, TMEP Doc No. 01-13283-S5A-M002-PL-MEM-0243 Rev 0, Prepared by Thurber Engineering Ltd. for Trans Mountain Pipeline L.P, June 15, 2023

4.6 – 35.3	938.9 – 908.2	R4 – 5	Diorite	- **Strong, slightly weathered, fine to medium grained, grey to greenish grey, quartz, epidote, & calcite veins throughout** - Trace clay infill, 6.5 m bgl - Broken core, 6.5 – 6.6 m bgl - Broken core, 7.0 – 7.1 m bgl - Brecciated zones, 7.4 – 9.3 m bgl - Broken core, 7.8 – 7.9 m bgl - Broken core, 8.2 – 8.4 m bgl - Strong to very strong, fresh, below 8.9 m bgl - Slickensides noted on joint surfaces, 9.1 – 10.3 m bgl - Iron oxide staining noted on joint faces, 10.3 – 11.9 m bgl - Broken core, 10.6 – 10.7 m bgl - Broken core, 12.0 – 12.1 m bgl - Broken core, 13.4 – 13.6 m bgl - Broken core, 15.7 – 15.8 m bgl - Drill bit stuck, 19.5 m bgl - Broken core, 19.5 – 20.4 m bgl - Slightly weathered, below 21.1 m bgl - Broken core, 21.0 – 21.1 m bgl - Broken core, 21.8 – 22.1 m bgl - Broken core, 22.5 – 22.6 m bgl - Fresh, below 22.6 m bgl - Broken core, 22.7 m bgl - Broken core, 23.2 – 23.3 m bgl - Broken core, 23.3 – 23.4 m bgl - Broken core, 25.8 – 25.9 m bgl - Broken core, 27.1 – 27.2 m bgl - Broken core, 28.9 m bgl - Broken core, 29.5 – 29.6 m bgl - Broken core, 30.1 – 30.4 m bgl - Broken core, 31.7 – 31.8 m bgl

Borehole SH21-5A-19-TEL-JL-KP852+390 (Approximately 21 m Southeast of the exit point (Southwest)):

Depth From Surface (m)	Approximate Elevation (m)	SPT (N)	Classification	Other Notes
0.0 – 0.5	936.0 – 935.5	-	Clay (Fill)	- **Sandy, black, occasional rootlets**
0.5 – 7.8	935.5 – 928.2	40 – >50	Clay	- **Trace fine sand, trace gravel, brown, hard, occasional oxides** - Some fine sand, below 2.4 m bgl - Seepage noted, 4.6 m bgl - Diorite fragments noted, 5.3 m bgl - Very hard, below 6.1 m bgl

7.8 – 55.4	928.2 – 880.6	R3 – 5	Diorite	- **Strong, fresh, greenish grey, massive, epidote noted throughout, trace calcite & quartz veins noted throughout, iron oxide staining & clay infill noted at joint surfaces** - Medium strong, slightly weathered, 9.3 – 9.8 m bgl - Broken core, 9.4 m bgl - Broken core, 10.4 m bgl - Broken core, 11.2 m bgl - Broken core, 13.9 – 14.0 m bgl - Broken core, 14.6 m bgl - Broken core, 15.1 m bgl - Grey, epidote, & hornblende noted, 15.9 m bgl - Broken core, 19.1 – 19.2 m bgl - Broken core, 20.4 – 20.6 m bgl - Broken core, 27.3 – 27.4 m bgl - Brecciated hornblende noted, 28.0 m bgl - Strong to very strong, below 32.6 m bgl - Broken core, 35.6 – 35.7 m bgl - Becomes brecciated, below 36.9 m bgl - Broken core, 38.4 – 38.5 m bgl - Medium strong to strong, below 40.2 m bgl - Broken core, 41.2 – 41.3 m bgl - Olivine noted, 41.7 m bgl - Pyrite noted, below 47.8 m bgl - Broken core, 54.4 m bgl - Clay infill laong joint surfaces, 54.7 – 54.8 m bgl

1.4.2 Drilling Prognosis

0 m to 23.0 m Measured Depth (MD)

The geotechnical report indicates the initial section of the borepath is expected to be contained in clay, sand & gravel, silt, and sand. The clay is described as low to medium plastic and containing trace sand. The sand & gravel is described as silty and containing trace clay. The silt is described as very dense. The sand is described as silty, gravelly, very dense, and containing trace clay. SPT (N) values in this zone were noted as greater than 50. Soils with SPT blow counts of less than 15 can be prone to sagging under their own weight and can create an increased risk of a fluid to surface event or loss of circulation (LOC). Additionally, when drilling fluid interacts with sand or gravel it can cause the formation to become unconsolidated, increasing the risk of the borehole sloughing in or over excavation. This may result in the borehole bridging shut and preventing drilling fluid from returning to the entry point, increasing the risk of drilling fluid to surface or LoC. To ensure a stable hole at entry, 1524 mm (60") OD surface casing will be installed to a depth of 23 m MD. The surface casing is intended to ensure borehole stability for the duration of the project at the entry point and will provide additional anchoring points for the rig. More information regarding the casing installation and procedure is located in section 1.5.1 below.

23.0 m to 399.0 m MD

The geotechnical report indicates this section of the borepath is expected to be contained in diorite. The diorite is described as medium to very strong, fresh to slightly weathered, fine to medium grained, and containing quartz, epidote, and calcite throughout.

A large portion of the borepath is expected to be contained within strong to very strong rock. Drilling within formations like this can lead to increased drilling times, increase the wear on the BHA, and have an affect on the efficiency of downhole tooling.

Broken core samples were noted within the geotechnical report. Broken cores may indicate potential fractures within the formation, which can provide a preferential path for drilling fluid to travel through. The product Uniq-Pac is used to help form a strong, thin, low-permeability filter cake against the borehole wall. The filter cake is intended to strengthen the formation by preventing fluid movement across the borehole wall and thereby minimize the formation degradation that often results.

An annular pressure sensor will also be installed in the drilling bottom hole assembly (BHA). The annular pressure sensor will be used to measure the pressure that is created while drilling the pilot hole. The measured pressure will be compared to the modelled annular pressure (see Annular Pressure Graph in Appendix B) which represents the expected annular pressure assuming a free and clear hole (no bridging). Discrepancies between the modeled and actual annular pressure will help to indicate if the annulus is being restricted due to the overburden soils sloughing, sagging, or bridging. If the annulus is being restricted, TCC could trip back to mechanically clean the hole which may clear up restrictions in the annulus.

If a fluid to surface event does occur, TCC will react in accordance with the Environmental Management Plan located in TCC's HDD Environmental Execution Plan and TMEP's Site Specific IFR Clean-Up Plan.

399.0 m to 455.2 m MD

The geotechnical report indicates the final section of the borepath is expected to be contained in clay and clay fill. The clay is described as hard to very hard and containing trace fine sand, trace gravel, and trace diorite fragments. The clay fill is described as sandy and containing occasional rootlets.

Although not noted in the geotechnical report, medium and high plastic clays may be prone to water absorption and swelling, which can lead to poor hole cleaning, high annular pressure, and LoC. To reduce the risks of swelling and water absorption the Project Specific Drilling Fluid Program (PSDFP) recommends the use of UniPam 530, a partly hydrolyzed polyacrylamide that encapsulates the clay cuttings to reduce water absorption, swelling, and dispersion. In addition, the PSDFP also recommends the use of ZAN HD, a xanthan based viscosifier, which will improve the hole cleaning capability of the drilling fluid without the addition of clays or solids. Additional information about the recommended drilling fluid additives is available in the PSDFP attached in Appendix B. Additionally, the PSDFP recommends using Uniq Pac, a polyanionic cellulose which is intended to help form a strong, thin, low-permeability filter cake against the borehole wall. The filter cake is intended to increase the stability of the borehole wall and reduce fluid migration. This will reduce the risk of sloughing or inflow from the formation, as well as reducing the depth of invasion of drilling fluid into the formation. In this way, the filter cake can also reduce hydration and swelling of reactive clays in the surrounding formation.

1.5 CONSTRUCTION METHODOLOGY

1.5.1 Surface Casing

For the entry (Northeast) side, TCC proposes to install 1524 mm (60") OD surface casing to a target depth of 23 m. A Pipe Rammer will be used to drive the casing into the ground by repeated percussive blows using the methodology described below.

TCC will survey an alignment based upon the provided plan and TMC provided survey monuments, including an entry point and an approximate termination of the casing that is to be dug in. Welding and hoisting support to be provided by the General Contractor. A trench will be dug, using the onsite excavator, from the entry point towards the front of the workspace along the Entry to Exit alignment. TMC will be notified when casing installation begins and updated on its progress. The excavation will be properly sloped to provide wall stability based on OH&S regulations. With the aid of the onsite excavator, the drive shoe will be set in the trench and rechecked for alignment, both horizontally and vertically. Once the shoe is set, the excavator will backfill around it. Once backfilling is completed, a joint of the casing will be welded to the drive shoe using an approved welding procedure. The pipe rammer will be seated into the back of the casing and will drive the casing into the ground using repeated percussive blows. The pipe is installed open ended which allows the soil to enter the pipe as a soil plug develops. Once a length of casing pipe has been driven down, the hammer is removed, and another length casing is welded in place. Upon completion of welding the next pipe is driven down and the process is repeated until the casing has reached the desired depth. In between hammering and welding, the casing may need to be cleaned out in order to continue advancing it. To clean the casing, TCC will use an auger in conjunction with Rig 10. The flighting on the auger will be turned into the soil inside the casing and then pulled to the surface, thus removing the material from inside the casing. Hammering and auguring operation will alternate until the casing has reached the desired length or refusal and no further hammering is required. Casing installation to refusal will be interpreted jointly between TMC and The Crossing Company. Once the casing is deemed to be set, an additional 2 meters will be augured outside of the casing to confirm soil conditions. A leak test of the casing will be performed by TCC by filling the casing with drilling fluid and observing if any losses occur.

Following the surface casing installation, TCC would install a 16" flanged centralizer in each section of surface casing. The centralizer will be installed approximately to 1m outside of the casing and will be used to ensure that the drill string is in the center of the casing and laying at the bottom. This is intended to mitigate the risk of tooling getting caught on the bottom of the casing during reaming and line pull operations. All stages of the crossing will involve the utilization of the centralizer, from pilot hole, reaming, and the duration to completion of the product line pull.

1.5.2 Pilot Hole Navigation

The crew will drill a 311.2 mm (12-1/4”) pilot hole from the entry (Northeast) side to the exit (Southwest) side) of Jacko Hill along the drill path trajectory as shown on drawing 01-13283-M002-XD00162 Rev 0. Prior to the commencement of pilot hole drilling, TCC will supply a predrill profile to TMC for review and approval. Steering data during pilot operations will be provided on a per shift basis and when requested.

The pilot hole BHA used will house a Vector Magnetics steering tool guided with Paratrack 2. The steering tool will be used to determine the position of the drilling assembly at the bottom of each length of drill pipe (approximately every 9.5m) using the earth’s geomagnetic and gravitational fields. A secondary locating system comprising of surface-mounted electromagnetic coils will also be used to determine the position of the drilling assembly. To form the electromagnetic coil, the crew will run insulated copper wire on the surface to form the coils outlined by the Wire Plan in Appendix A.

It should be noted that coordination between TMC and all stakeholders will need to be made in advance for access to land for coil layouts. Please refer to the Coil Layout Sketch in Appendix A for more details.

1.5.3 Reaming

Following completion of the pilot hole and approval from TMC regarding the as-built pilot hole profile, a 609.6 mm (24") TCI reamer assembly will be added in the drill string at the entry point. The 609.6 mm reamer assembly will be pushed from entry to exit. As the reamer assembly is pushed, 6-5/8" drill pipe will be added on entry side while 6-5/8" drill pipe are removed on exit side. An excavator and operator (supplied by TCC) will be used on exit side to apply tension to the drill string and make/break pipe.

Following completion of the 609.6 mm reaming pass, the reamer assembly will be removed at the exit point and a 914.4 mm (36") TCI reamer assembly will be added in the drill string at the entry point. The 914.4 mm reamer assembly will be pushed from entry to exit. As the reamer assembly is pushed, 6-5/8" drill pipe will be added on entry side while 6-5/8" drill pipe are removed on exit side. An excavator and operator (supplied by TCC) will be used on exit side to apply tension to the drill string and make/break pipe.

Following completion of the 914.4 mm reaming pass, the reamer assembly will be removed at the exit point and a 1,219.2 mm (48") TCI reamer assembly will be added in the drill string at the entry point. The 1,219.2 mm reamer assembly will be pushed from entry to exit. As the reamer assembly is pushed, 6-5/8" drill pipe will be added on entry side while 6-5/8" drill pipe are removed on exit side. An excavator and operator (supplied by TCC) will be used on exit side to apply tension to the drill string and make/break pipe.

Following completion of the 1219.2 mm reaming pass, the reamer assembly will be removed, reversed, and added to the drill string at the exit point. The reamer assembly will be pulled from exit to entry as a cleaning pass. The results of the cleaning pass will be reviewed with TMC prior to product line pull.

For each ream pass, joints will be worked when required as dictated by hole conditions. Additional mechanical trips will be done as required based on the conditions encountered in the hole.

1.5.4 Pipe Pull

Following completion of the cleaning pass, the 1,219.2 mm reamer assembly will be removed at the entry point. Prior to completion of the cleaning pass, TCC will install the buoyancy line within the product pipeline and the pullhead (Max Pull Force = 1,100,000 lbs) will be attached to the product line (pull head supplied by TCC, attached by pipeline contractor). The product pipeline will be attached to the 6-5/8" drill string with a 500 ton-swivel and reamer directly in front of it. The pipe will then be pulled into the prepared borehole. The pipeline will be supported by others during the pulling operation.

1.5.5 Demobilization

Following completion of the Jacko Hill HDD crossing, TCC will demobilize Rig 10 from site and extract the surface casing.

Appendix A – Drawings & Layouts

Contents

Coil Layout Drawing

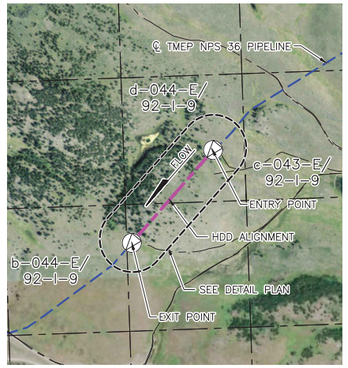
Rig 10 Inventory Drawing

Spread Layout - Entry

Rig Anchor Drawing

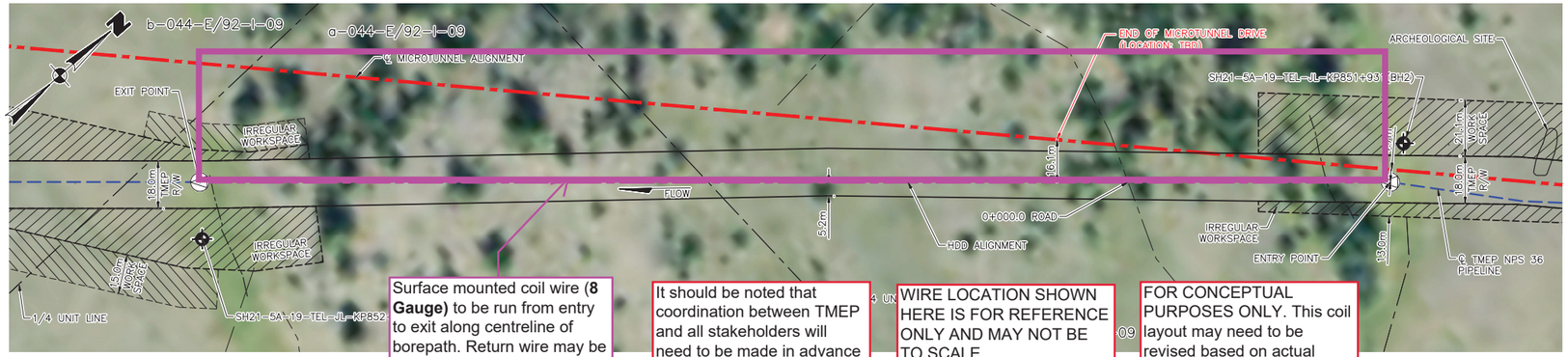
PASON Electronic Drilling Recorder - TCC Standard Traces

Pullhead Drawing



LOCATION PLAN

SCALE 1:10000
d–044–E/92–I–9
CITY OF KAMLOOPS
NAD83 UTM ZONE 10N
APPROX. TMEP KP 852.3

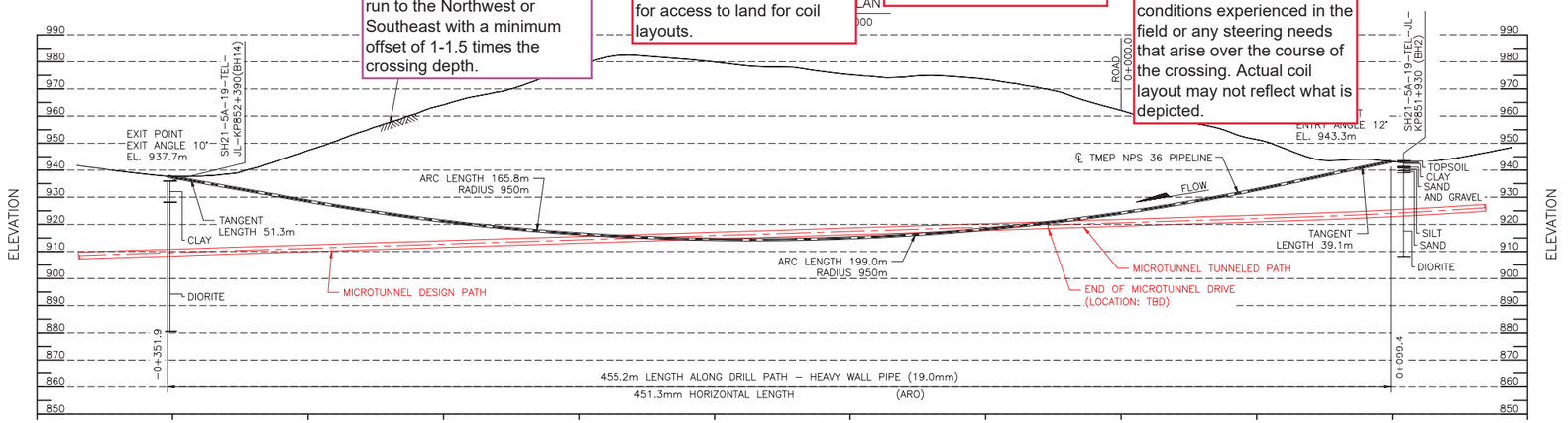


Surface mounted coil wire (**8 Gauge)** to be run from entry to exit along centreline of borepath. Return wire may be run to the Northwest or Southeast with a minimum offset of 1-1.5 times the crossing depth.

It should be noted that coordination between TMEP and all stakeholders will need to be made in advance for access to land for coil layouts.

WIRE LOCATION SHOWN HERE IS FOR REFERENCE ONLY AND MAY NOT BE TO SCALE.

FOR CONCEPTUAL PURPOSES ONLY. This coil layout may need to be revised based on actual conditions experienced in the field or any steering needs that arise over the course of the crossing. Actual coil layout may not reflect what is depicted.



PROFILE ALONG DITCHLINE

SCALE 1:1000

GENERAL NOTES

A1. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES UNLESS OTHERWISE SHOWN. ALL ELEVATIONS ARE GEODETIC. ALL CHAINAGES ARE HORIZONTAL.
A2. DRAWING SCALES ARE ONLY CORRECT WHEN PLOTTED AT FULL SIZE (A1).
A3. ALL WORK IN CLOSE PROXIMITY TO POWER LINES MAY BE SUBJECT TO ELECTROSTATIC AND ELECTROMAGNETIC INDUCED VOLTAGES. CONTRACTOR SHALL BE RESPONSIBLE FOR MONITORING AND IMPLEMENTING MITIGATION PROCEDURES. CONTRACTOR SHALL IMPLEMENT THESE PRECAUTIONS AS WELL AS THOSE SPECIFIED BY TRANS MOUNTAIN REPRESENTATIVE.
A4. THE CONTRACTOR SHALL ENSURE ALL UTILITIES ARE PROTECTED AND MAINTAINED THROUGH THE CONSTRUCTION PROCESS.
A5. THE CONTRACTOR SHALL ENSURE THAT COPIES OF THE CROSSING AGREEMENTS ARE KEPT ON SITE FOR THE FULL DURATION OF THE CONSTRUCTION ACTIVITIES. CONTRACTOR SHALL ADHERE TO ALL REQUIREMENTS OF THE CROSSING AGREEMENTS.
A6. SURVEYED BASE PLANS ARE BASED ON BASE PLAN 38290–BASE–92I9E R5 DATED MAY 31, 2022, PROVIDED BY GEOVERRA SURVEY (BC) LTD. PARTNERSHIP. THE GROUND PROFILE WAS BASED ON SURVEY DWG 01–13283–M002–XD0510101.DWG DATED MAY 18, 2022, PROVIDED BY ADIT ENGINEERING. THE IMAGERY IS SUPPLIED BY AEROQUEST MAPCON, DATED 2019.
A7. CONSTRUCTION SHALL BE COMPLETED IN ACCORDANCE WITH CSA Z662 (CURRENT VERSION), AND THE MOST RECENT VERSIONS OF ALL PROVINCIAL AND FEDERAL REGULATIONS, ENVIRONMENTAL PROTECTION PLAN (EPP), CONTRACT DOCUMENTS, AND THE AUTHORITIES HAVING JURISDICTION.
A8. THE CONTRACTOR SHALL SUPPLY AND ADHERE TO THE CONTRACTOR SUPPLIED AND APPROVED DRILLING EXECUTION PLAN.
A9. AS PER 01–13283–SG–M002–PL–DCN–0005, THE PIPELINE WILL BE TESTED AND OPERATED BASED ON POINT–SPECIFIC MAXIMUM OPERATING PRESSURE (BASED ON THE APPROVED FINAL HYDROSTATIC TEST). MINIMUM TEST PRESSURE WILL BE BASED ON ELEVATION PROFILES BETWEEN PUMP STATIONS.

CONSTRUCTION NOTES

B1. CONSTRUCTION METHOD FOR THIS CROSSING IS THE HORIZONTAL DIRECTIONAL DRILL METHOD (HDD). FOR HDD CONSTRUCTION SPECIFICATIONS REFER TO THE CONTRACT DOCUMENTS.
B2. THE CONTRACTOR SHALL VERIFY ALL TOPOGRAPHICAL SURVEY INFORMATION AND CONFIRM THE DEPTH AND LOCATION OF ALL BURIED FACILITIES IN THE FIELD PRIOR TO CONSTRUCTION.
B3. THE CONTRACTOR SHALL SUPPLY A DRILL RIG WITH A MINIMUM OF 400,000 LBF (1,779kN) PUSH/PULL WITH APPROPRIATE ASSOCIATED EQUIPMENT AS OUTLINED IN THE SPECIFICATIONS. THE THEORETICAL PULL FORCE FOR THIS CROSSING IS 320,000 LBF (1,423 kN) WITHOUT BUOYANCY CONTROL AND 260,000 LBF (1,157 kN) WITH 100% BUOYANCY CONTROL.
B4. THE CONTRACTOR SHALL SUPPLY AN ELECTRONIC DRILLING RECORDER (EDR) TO MONITOR AT A MINIMUM, TANK/PIT VOLUME, FLOW (PUMP AND RETURN), PRESSURE (ANNULAR/STANDPIPE), RATE OF PENETRATION, PUSH/PULL FORCE, ROTARY TORQUE, AND ROTATIONAL SPEED. PROVIDE THIS ELECTRONIC INFORMATION TO TRANS MOUNTAIN REPRESENTATIVE AND ALSO SUBMIT AS A PART OF THE AS–BUILT RECORDS REQUIRED AT THE END OF THE PROJECT.
B5. THE CONTRACTOR SHALL SUPPLY AND USE AN APPROVED ANNULAR PRESSURE TOOL WITH THE CONTRACTOR SUPPLIED ANNULAR PRESSURE MODEL.
B6. ALL EQUIPMENT SHALL BE SUPPLIED IN GOOD WORKING ORDER MAINTAINED AND SERVICED. ANY EQUIPMENT NOT OPERATIONAL OR FULFILLING THE REQUIREMENTS OUTLINED IN THE CONTRACT DOCUMENTS SHALL BE REPAIRED OR REPLACED.
B7. SURFACE CASING, IF REQUIRED TO ASSIST/SECURE DRILLING FLUID CIRCULATION OR TO PREVENT HOLE COLLAPSING NEAR THE SURFACE, SHOULD BE DETERMINED BY CONTRACTOR AND APPROVED BY TRANS MOUNTAIN REPRESENTATIVE.
B8. THE CONTRACTOR SHALL SUPPLY A CASING PLAN (IF REQUIRED) WHICH SHALL INCLUDE SIZE OF CASING, INSTALLATION METHOD, CLEANOUT PROCEDURE, REMOVAL PROCEDURE, AND A DESCRIPTION OF THE CENTRALIZING CASING TO BE USED.
B9. THE PILOT HOLE SHALL BE INSTALLED AS CLOSE AS PRACTICAL TO THE PROPOSED DESIGN DRILL PATH WITH THE DESIGN INFORMATION SHOWN ON THE DRAWING. HORIZONTAL DEVIATION GREATER THAN ±2.0 m SHALL BE APPROVED BY TRANS MOUNTAIN REPRESENTATIVE PRIOR TO COMPLETION OF DRILL. DRILL PATH VERTICAL DEVIATION SHALL BE WITHIN ±2.0 m RADIAL DISTANCE OF THE DESIGN DRILL PATH. UNDER NO CIRCUMSTANCES SHALL THE PIPELINE BE INSTALLED OUTSIDE THE LEGAL PIPELINE EASEMENT.
B10. MINIMUM DEPTH OF COVER TO BE THE GREATER OF THIS DRAWING OR AS SPECIFIED IN CROSSING AGREEMENTS.
B11. THE DESIGN RADIUS FOR THE CROSSING IS 950 m. THE PILOT HOLE SHALL ADHERE TO THE FOLLOWING TOLERANCES:
– THE SINGLE JOINT RADIUS SHALL NOT BE LESS THAN 600.0 m.
– THE THREE JOINTS RADIUS SHALL NOT BE LESS THAN 800.0 m.
B12. THE MAKE–UP SECTION WILL LIKELY BE PLACED ON EXIT SIDE.

ENVIRONMENTAL NOTES

C1. DISPOSAL OF DRILLING FLUID AND CUTTINGS WILL BE CONDUCTED IN A MANNER THAT ADHERES TO BRITISH COLUMBIA OIL AND GAS HANDBOOK – DRILLING WASTE MANAGEMENT CHAPTER.
C2. TO MINIMIZE THE POTENTIAL FOR INADVERTENT FLUID RELEASE TO SURFACE, CONTRACTOR SHALL ENSURE THAT MUD PRESSURE IS KEPT TO THE MINIMUM REQUIREMENT FOR CUTTINGS RETURN AND FOR MAINTAINING A CLEAN HOLE AND IN ACCORDANCE WITH THE CONTRACTOR SUPPLIED ANNULAR PRESSURE MODEL.
C3. FRAC WALKS SHALL BE CONDUCTED EVERY 4 HOURS (AS A MINIMUM), OR IMMEDIATELY AFTER A LOSS OF FLUID EVENT.
C4. SUITABLE EMERGENCY SPILL KITS ARE REQUIRED TO BE MAINTAINED ON SITE AT ALL TIMES.

GEOTECHNICAL INFORMATION

D1. GEOTECHNICAL BOREHOLE DATA ON THE DRAWING IS PROVIDED FOR INFORMATIONAL PURPOSES ONLY. FOR COMPLETE SOIL INFORMATION AND GROUNDWATER CONDITIONS, THE CONTRACTOR SHALL REFER TO GEOTECHNICAL REPORT 01–13283–S5A–M002–PL–MEM–0243 REV 0, FOR TRANS MOUNTAIN EXPANSION PROJECT – SPREAD 5A – GEOTECHNICAL ASSESSMENT KP852 TRENCHLESS CROSSING (JACKO HILL), DATED JUNE 15, 2023. ALL GEOTECHNICAL INFORMATION PROVIDED BY THURBER ENGINEERING LTD.

LEGEND

- ℄ TMEP NPS 36 PIPELINE
- ℄ HDD ALIGNMENT
- ℄ MICROTUNNEL ALIGNMENT
- GEOTECHNICAL BOREHOLE

HDD FEATURE COORDINATES
(NAD83 UTM ZONE 10N)

	EASTING	NORTHING
ENTRY	682818.4	5611026.0
0+000	682752.9	5610951.2
EXIT	682521.3	5610686.4

BOREHOLE LOCATION
(NAD83 UTM ZONE 10N)

BOREHOLES	EASTING	NORTHING
SH21–5A–19–TEL–JL–KP851+931(BH2)	682810.6	5611039.4
SH21–5A–19–TEL–JL–KP852+390(BH14)	682538.1	5610672.8

PROJECT PIPE SPECIFICATIONS

PRODUCT	LOW VAPOUR PRESSURE (LVP) LIQUID HYDROCARBONS	
CLASS LOCATION DESIGNATION	N/A	
DESIGN PRESSURE	9,930 kPa	
MAXIMUM OPERATING PRESSURE	VARYING POINT–SPECIFIC PRESSURE (SEE NOTE A9)	
MINIMUM TEST PRESSURE	VARYING POINT–SPECIFIC PRESSURE (SEE NOTE A9)	
MINIMUM OPERATING TEMPERATURE	5 °C	
MAXIMUM OPERATING TEMPERATURE	38 °C	
PIPELINE DATA	CARRIER PIPE	
	LINE PIPE	HEAVY WALL PIPE
OUTSIDE DIAMETER OF PIPE (mm)	914.4 (NPS 36)	914.4 (NPS 36)
PIPE WALL THICKNESS (mm)	–	19.0
MINIMUM YIELD STRENGTH (MPa)	483	483
PIPE MATERIAL	STEEL, CSA Z245.1 (GRADE 483, CAT II)	
COATING	FUSION BOND EPOXY (FBE), ABRASION RESISTANT OVERCOAT (ARO)	
CATHODIC PROTECTION	IMPRESSED CURRENT	

PROFESSIONAL ENGINEER
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Z. ZHANG
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June 22, 2023. Rev. 0

PERMIT TO PRACTICE
UPI PROJECTS CANADA LTD.
PERMIT NUMBER: 1001209
THE ASSOCIATION OF PROFESSIONAL ENGINEERS AND GEOSCIENTISTS OF THE PROVINCE OF BRITISH COLUMBIA

UPI DWG. No.: 19731–505–HDW–00162

CLIENT ACCEPTANCE

NO.	DATE	REVISION	ACC
0	23/06/22	ISSUED FOR CONSTRUCTION, AFE 01–13283	bk

NO.	REFERENCE DRAWING TITLE	REFERENCE DRAWING NO.	NO	DATE	REVISION	DRN	CHK	ENG	APPR
1	ALIGNMENT SHEET	M002–PA0311701	0	23/06/22	ISSUED FOR CONSTRUCTION, AFE 01–13283	XW	RGR	PL	HB

TRANSMOUNTAIN

DRAWN BY BF	TRANS MOUNTAIN EXPANSION PROJECT PLANS AND PROFILES JACKO HILL d–044–E/92–I–9	SHEET SIZE A1
CHECKED BY RGR		SCALE AS SHOWN
APPROVED BY HB		DATE 23/05/11

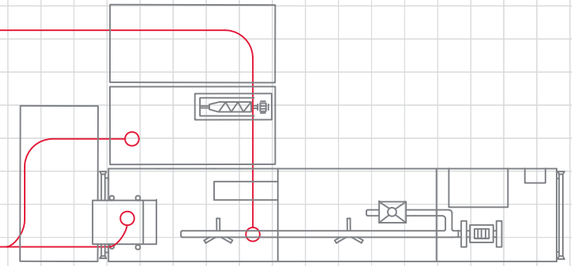
PROJECT CODING	DRAWING NUMBER			
AFE	FACILITY ID	DOCUMENT NO	SHT NO	REV
01–13283	M002	XD00162	01	0

P:\19731 - Kinder Morgan TMX\81 Drafting\505 Pipeline Drawings\HDW - Horizontal Directional Drill\Spread 5A\M002-XD00162\01.dwg, 6/22/2023 10:52:05 AM, xiule.wang

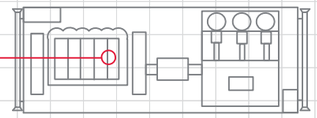
THE CROSSING COMPANY

RIG No.10 RIG INVENTORY

FLUID CIRCULATION SYSTEM
5' X 6' 60HP Electric Motor
Venturi Mixing Hopper
Electric Agitators
3' Mud Guns
6' Bridge Gates
Shale Shaker Tank 21.3m³ Capacity
Settling Tank 21.3m³ Capacity
Mix Tank 21.3m³ Capacity
16.3m x 3.5m x 3.7m
Weight 22,727 kg

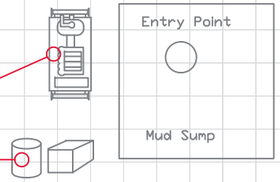


SOLIDS CONTROL SYSTEM
1 - Derrick FLC-504 Shale Shaker
1 - Alfa Laval Lynx 40 Centrifuges (Hydraulic Rating 2176 lpm)
2 - Pair 3' 60watt Fluorescent Bulbs c/w All Weather Housing
2 - 400watt Maxlight Halogen Bulbs



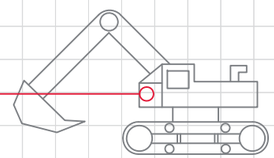
PUMP BUILDINGS
CAT 379 Motor
F-800 Pump
1.9 m³/min Capacity
Circulated Steam Heating
11.6m x 3.8m x 3.5m
Weight 37,954 kg
2 - Pair 3' 60watt Fluorescent Bulbs c/w All Weather Housing
2 - 400watt Maxlight Halogen Bulbs

GORMAN
Detroit Diesel 85hp @ 2600rpm
6' Centrifugal Pump

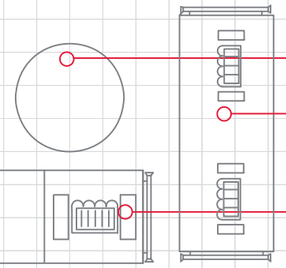


SPILL/FRAC CONTAINMENT KIT
1 - 4x25 ft Silt Fence
50 - Sandbags
1 - Small Hand Shovel
1 - 8 kg Organic Oil Absorbent
1 (each) - 8, 6, 3 ft Absorbent Snake
1 - Bag Diaper

EXCAVATOR
150 or Larger



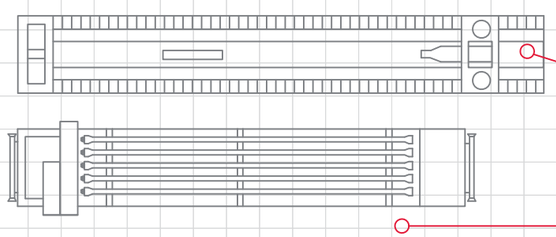
ENVIRO WASTE DISPOSAL BIN
Oil, Fuel, Hydraulic, and Filters Disposal
Metal Scrap Container
Recycle Container
Plastic and Non-Recyclable Container



WATER STORAGE
60m³ Water Capacity
3' Centrifugal Pump

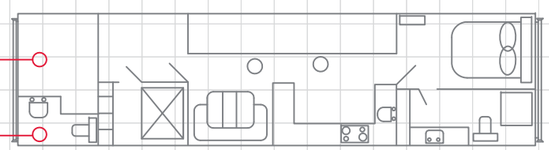
POWER UNITS
2 - CAT C-15 DIT ATAAC Turbo Diesel
2 - 525hp @ 2100rpm
13.7m x 3m x 3m
Weight 21,969 kg

COMMAND CENTER
Drilling Console
PASON Electric Drilling Recorder
Generator CAT 3306 210kw Motor
11.3m³ Fuel Tank
15.3m x 3.2m x 3.3m
Weight 18,909 kg
12 - Pair 3' 60watt Fluorescent Bulbs c/w All Weather Housing
4 - 400watt Maxlight Halogen Bulbs



AMERICAN AUGERS DD-625
625,000 ft-lb Push/Pull Capacity
Rotary High 80,000 ft-lb @ 0-33rpm
Rotary Low 33,000 ft-lbs @ 0-90rpm
Vice 212,000 ft-lb Breakout
Drill Angle 8 - 18 Degrees
15.2m x 2.4m x 3.8m

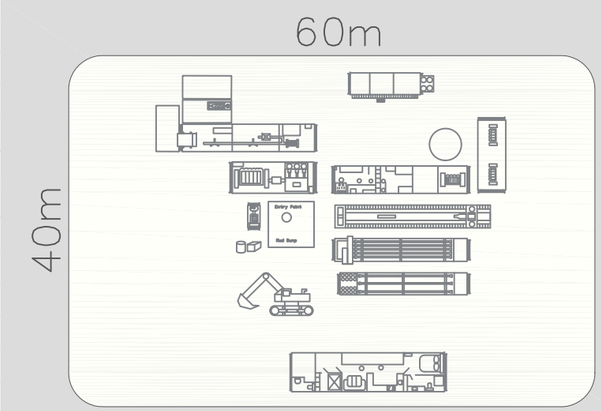
TUBULARS/TOOLING TUB
090 HIAB Knuckle Crane
12.3m x 2.4m x 3.4m
Weight 25,000 kg

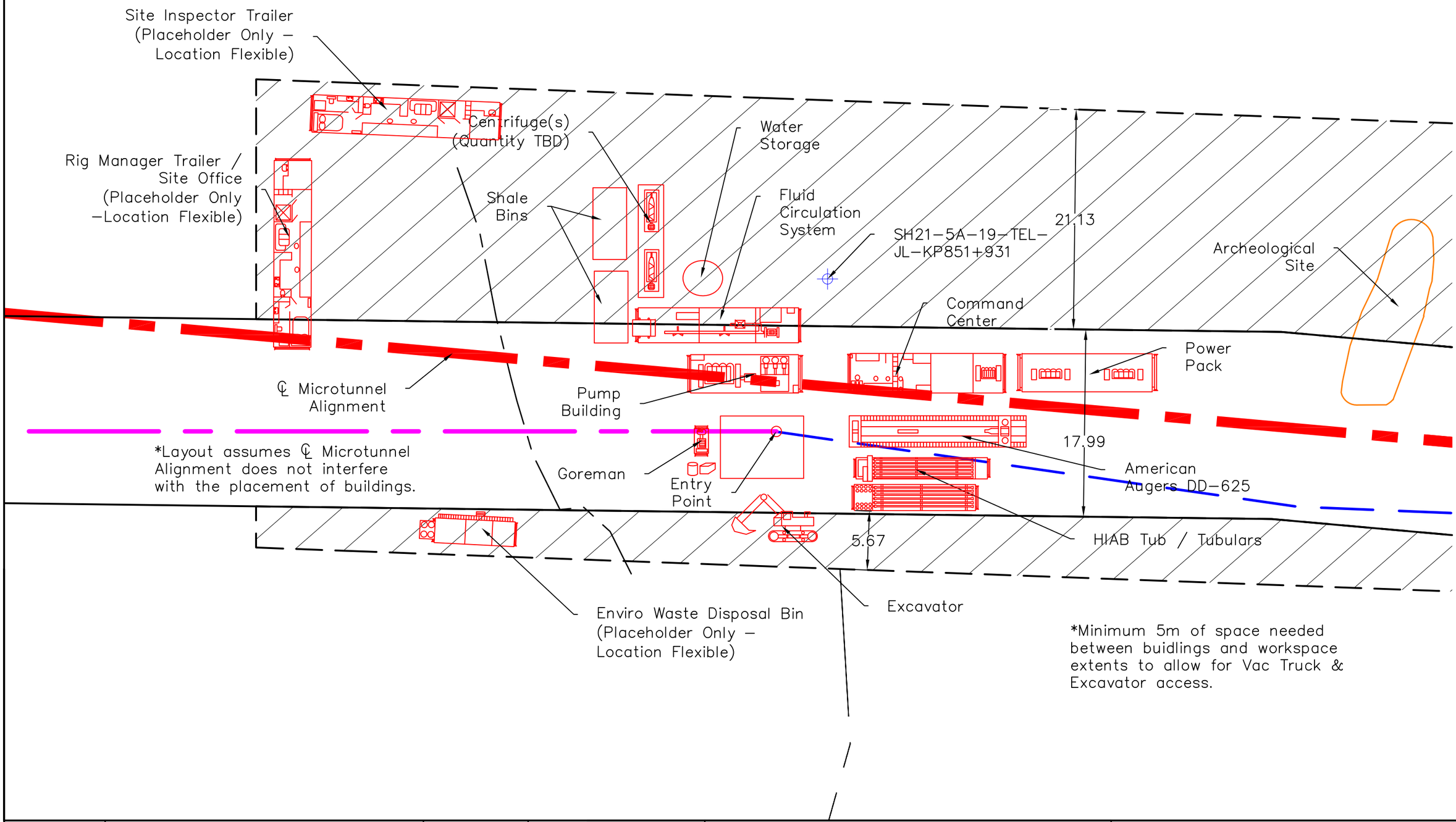


SITE OFFICE (If Required)
Rig Manager Office/Living Quarters
18.3m x 3.9m x 3.7m
Weight 9,545 kg

ISOLATED CREW WASHROOM

RIG WORK PAD LAYOUT



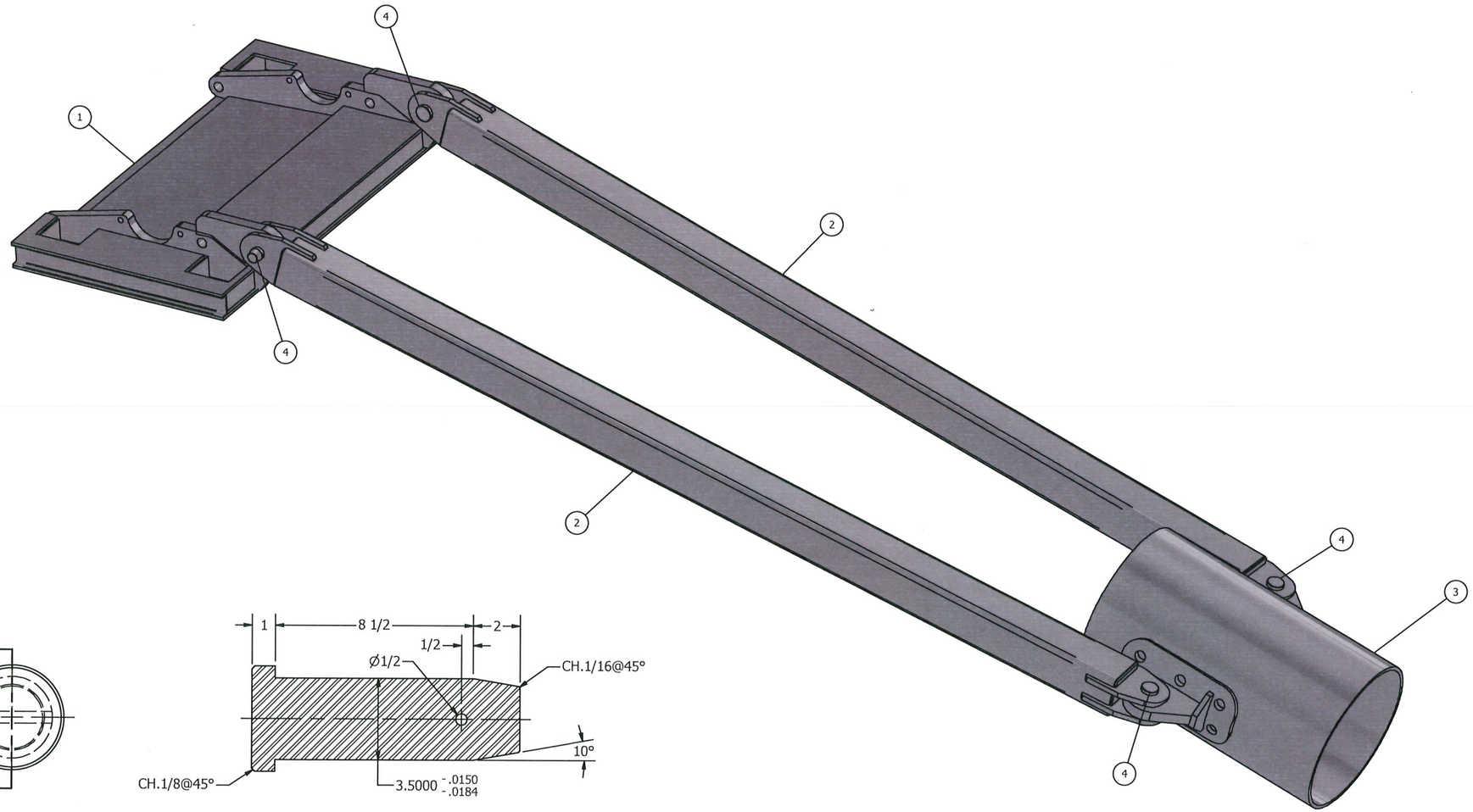


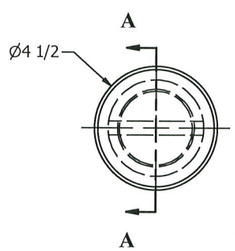
Client:	Trans Mountain Corporation		Rig Number:	10
Project:	Trans Mountain Expansion Project		Crossing	Jacko Hill (Entry, NE Side)
Note: All dimensions in metres.			Scale:	NTS
			Drawn By:	Alex Ronaldson
			Date Issued:	August 1, 2023

THE CROSSING COMPANY INC.

NOTES:
1. WORKING LOAD LIMIT 5340 kN (1,200,000 LBS) TOTAL ANCHOR FORCE, 1.5x LOAD FACTOR.
2. ALL STEEL IN ACCORDANCE WITH CSA G40.20/G40.21, GRADES AS NOTED IN ITEM LIST.
3. WELD USING SMAW E7018-1 ELECTRODE, FLAT OR HORIZONTAL POSITION. USE CSA W59-18 PREQUALIFIED PARTIAL JOINT PENETRATION GROOVE WELDS AND FILLET WELDS AS DETAILED.
4. INSPECT COMPLETED WELDS USING MAGNETIC PARTICLE TECHNIQUE MINIMUM 48 HOURS AFTER WELD COMPLETION.

ITEM	QTY	DESCRIPTION	MATERIAL	WT (LBS)
1	1	ANCHOR FOOT (VARIES BY RIG)		
2	2	ANCHOR ARM ASSEMBLY, SEE DRAWING 211403-2		2378.3
3	1	CASING LUG ATTACHMENT, SEE DRAWING 211403-3		3479.4
4	4	3.5 DIA PIN, 4340HTSR Fymin=140ksi, SEE ITEM DETAIL r1	4340HTSR	31.9





ITEM DETAIL r1
FOUR (4) REQ'D, 4340 HTSR Fymin=140ksi

SECTION A-A

PROFESSIONAL ENGINEER ALBERTA
CHAD M. SKAARE

2021-01-21

REV	DATE	DESCRIPTION	DRW	CHK	APP

THIRD ANGLE PROJECTION:

UNLESS NOTED OTHERWISE
DIMENSIONS IN INCHES
DO NOT SCALE DRAWAING

DECIMAL	FRACTIONAL
.X ±.1	XX' - X X/X" ±1/4"
.XX ±.03	X' - X X/X" ±1/8"
.XXX ±.015	X X/X" ±1/16"

DRAWN: cms	2021-01-20	
CHECKED: as	2021-01-20	
MFG:		
APPROVED: cms	2021-01-20	

CLIENT: THE CROSSING COMPANY

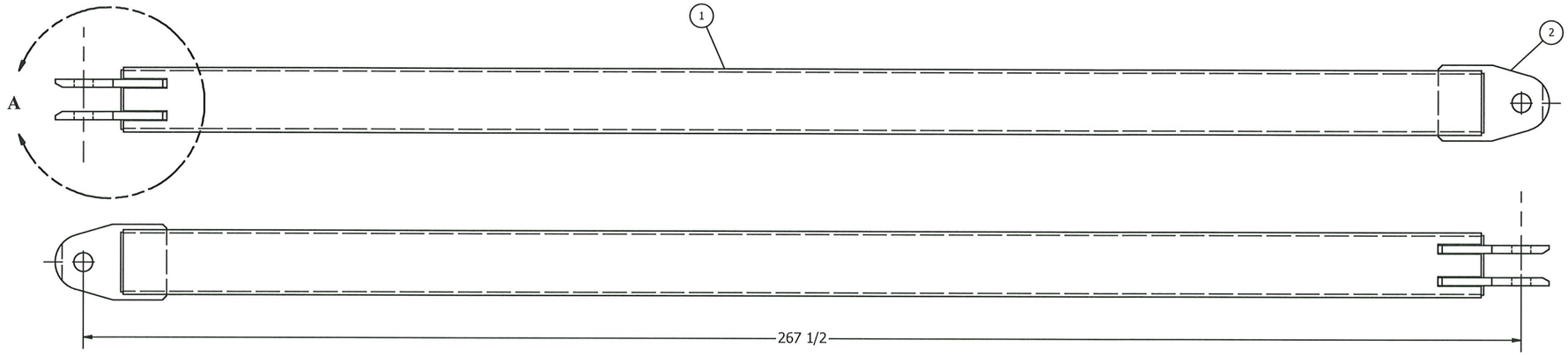
TITLE: CASING ANCHOR INSTALLATION
RIG RATINGS OVER 660 kip TO 1,200 kip

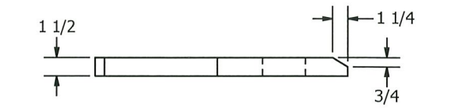
CS ENGINEERING INC.
PO Box 1406, Camrose AB T4V 1X3 | (780)672-4920 | info@cseng.ca

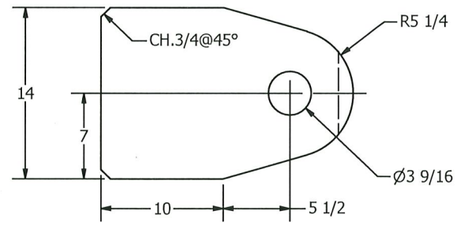
SHEET:	DATE:	SCALE:	DRAWING NO.:	SIZE:	REV:
1 OF 1	2021-01-20	NONE	211403-1	B	0

NOTES:
1. ALL STEEL IN ACCORDANCE WITH CSA G40.20/G40.21, GRADES AS NOTED IN ITEM LIST.
2. WELD USING SMAW E7018-1 ELECTRODE, FLAT OR HORIZONTAL POSITION. USE CSA W59-18 PREQUALIFIED PARTIAL JOINT PENETRATION GROOVE WELDS AND FILLET WELDS AS DETAILED.
3. INSPECT COMPLETED WELDS USING MAGNETIC PARTICLE TECHNIQUE MINIMUM 48 HOURS AFTER WELD COMPLETION.

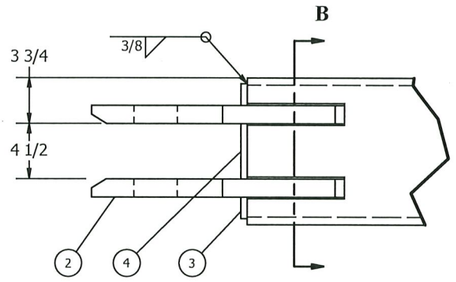
ANCHOR ARM, TWO REQ'D, QTY'S FOR 1 UNIT				
ITEM	QTY	DESCRIPTION	MATERIAL	WT (LBS)
1	1	12 x 12 x 5/8 HSS, SEE ITEM DETAIL t1	50W	1944.5
2	4	1.5 PL., SEE ITEM DETAIL p1	50W	102.2
3	4	1/2 PL., 1 3/4 x 11	44W	2.7
4	2	1/2 PL., 4 1/2 x 11	44W	7



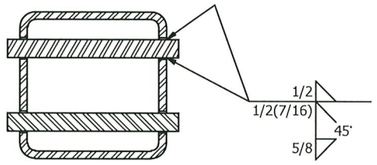




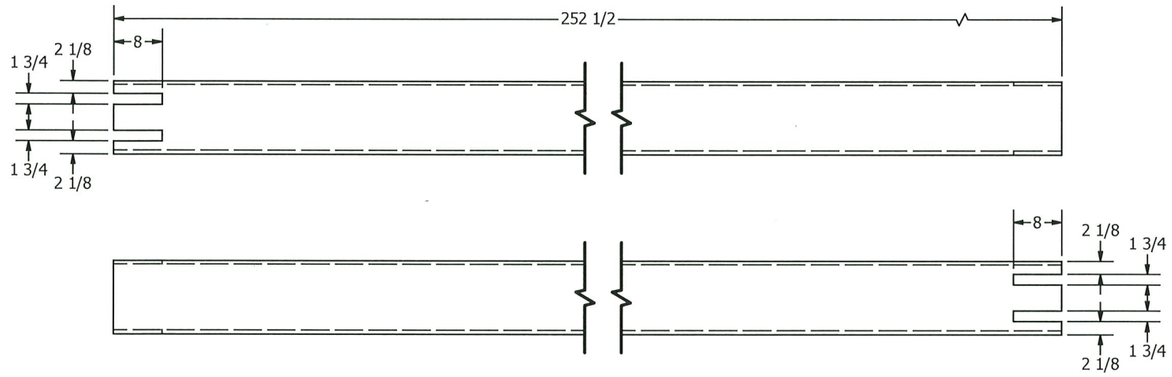
ITEM DETAIL p1
EIGHT (8) REQ'D, 1.5 PL.



DETAIL A



SECTION B-B



ITEM DETAIL t1
TWO (2) REQ'D, 12 x 12 x 5/8 HSS

PROFESSIONAL ENGINEER ALBERTA CHAD M. SKARET

2021-01-21

REV	DATE	DESCRIPTION	DRW	CHK	APP

THIRD ANGLE PROJECTION:

UNLESS NOTED OTHERWISE
DIMENSIONS IN INCHES
DO NOT SCALE DRAWAING

DECIMAL	FRACTIONAL
.X ± .1	XX' - X X/X" ± 1/4"
.XX ± .03	X' - X X/X" ± 1/8"
.XXX ± .015	X X/X" ± 1/16"

DRAWN: cms	2021-01-20	
CHECKED: as	2021-01-20	
MFG:		
APPROVED: cms	2021-01-20	

CLIENT: THE CROSSING COMPANY

TITLE: CASING ANCHOR ARMS
RIG RATINGS OVER 660 kip TO 1,200 kip

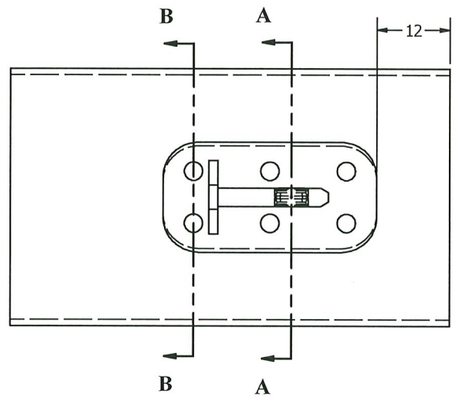
SHEET:	DATE:	SCALE:
1 OF 1	2021-01-20	NONE

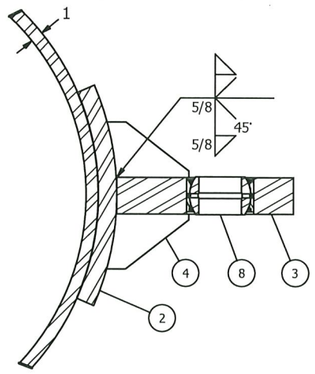
CS ENGINEERING INC.
PO Box 1406, Camrose AB T4V 1X3 | (780)672-4920 | info@cseng.ca

DRAWING NO.:	SIZE:	REV:
211403-2	B	0

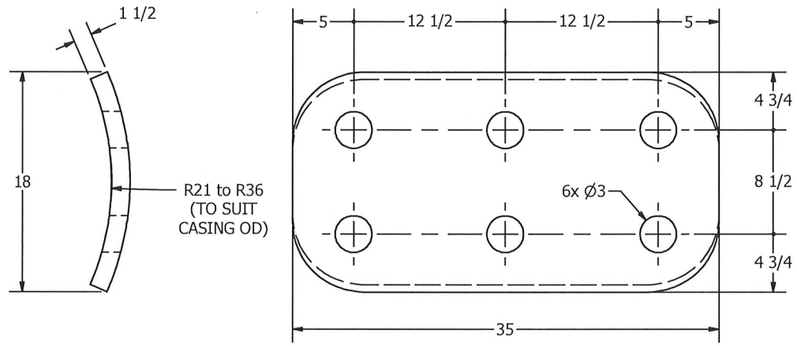
NOTES:
1. ALL STEEL IN ACCORDANCE WITH CSA G40.20/G40.21, GRADES AS NOTED IN ITEM LIST.
2. WELD USING SMAW E7018-1 ELECTRODE, FLAT OR HORIZONTAL POSITION. USE CSA W59-18 PREQUALIFIED PARTIAL JOINT PENETRATION GROOVE WELDS AND FILLET WELDS AS DETAILED.
3. INSPECT COMPLETED WELDS USING MAGNETIC PARTICLE TECHNIQUE MINIMUM 48 HOURS AFTER WELD COMPLETION.

ITEM	QTY	DESCRIPTION	MATERIAL	WT (LBS)
1	1	CASING, 42 DIA to 72 DIA x 1" W.T. MIN		
2	2	1.5 PL., SEE ITEM DETAIL p2	44W	234.9
3	2	3 PL., SEE ITEM DETAIL p3	50W	156.7
4	2	1.5 PL., SEE ITEM DETAIL p4	50W	22.8
8	2	IKO SBB 56-2RS SPHERICAL PLAIN BEARING		10.1

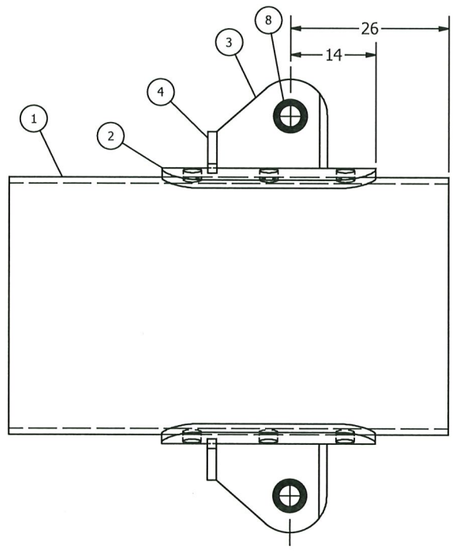


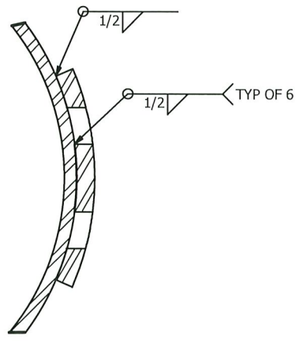


SECTION A-A

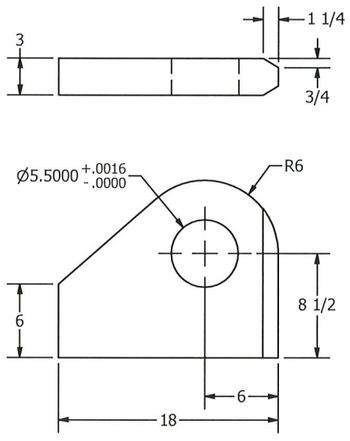


ITEM DETAIL p2
TWO (2) REQ'D, 1.5 PL.

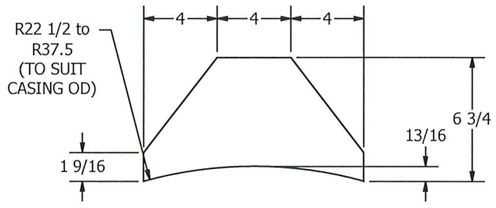




SECTION B-B



ITEM DETAIL p3
TWO (2) REQ'D, 3 PL.



ITEM DETAIL p4
TWO (2) REQ'D, 1.5 PL.

2021-01-21

REV	DATE	DESCRIPTION	DRW	CHK	APP

THIRD ANGLE PROJECTION:

UNLESS NOTED OTHERWISE
DIMENSIONS IN INCHES
DO NOT SCALE DRAWAING

DECIMAL	FRACTIONAL
.X ± .1	XX' - X X/X" ± 1/4"
.XX ± .03	X' - X X/X" ± 1/8"
.XXX ± .015	X X/X" ± 1/16"

DRAWN: cms	2019-02-05	
CHECKED: as	2019-02-06	
MFG:		
APPROVED: cms	2019-02-06	

CLIENT: THE CROSSING COMPANY

TITLE: CASING ANCHOR LUG INSTALLATION
RIG RATINGS OVER 660 kip TO 1,200 kip

CS ENGINEERING INC.
PO Box 1406, Camrose AB T4V 1X3 | (780)672-4920 | info@cseng.ca

SHEET:	DATE:	SCALE:	DRAWING NO.:	SIZE:	REV:
1 OF 1	2019-02-05	NONE	211403-3	B	0

TCC STANDARD EDR TRACES

1.0 Rig Operation

(a)	Carriage Push / Pull	psi (rig specific conversion charts available)
(b)	Rate of Penetration	m/min (calculated)
(c)	Hole Depth	meters
(d)	Rotary Torque	psi (rig specific conversion charts available)
(e)	Rotary Speed	rpm

1.1 Drilling Fluid Pressure

(a)	Standpipe Pressure	kPa
(b)	Differential Pressure	kPa (calculated)
(c)	Annular Pressure (Pilot Hole Only)	kPa
(d)	Drill Pipe Pressure (Pilot Hole Only)	kPa

1.2 Drilling Fluid System Operation

(a)	Tank Volume (Suction Tank)	m^3
(b)	Pump Speed (each pump)	strokes per minute
(c)	Pump Rate (each pump & total)	m^3/min (calculated)
(d)	Pump Displacement	m^3 (calculated)

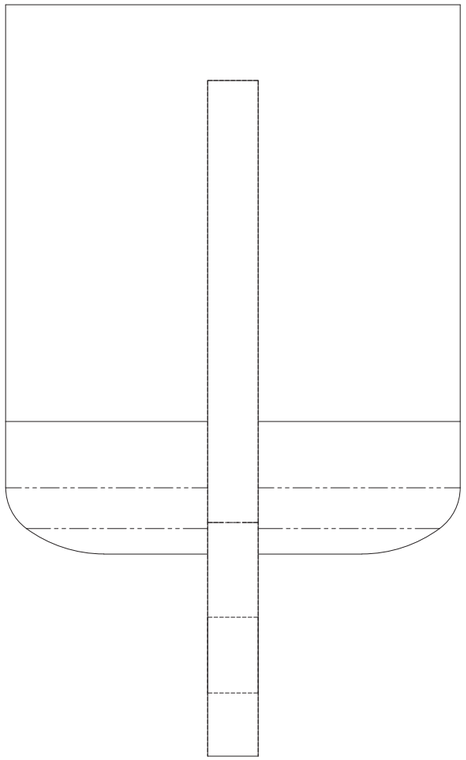
BLUEFOX
ENGINEERING

THE CROSSING GROUP
FRASER RIVER HDD
NPS 36 PULLHEAD

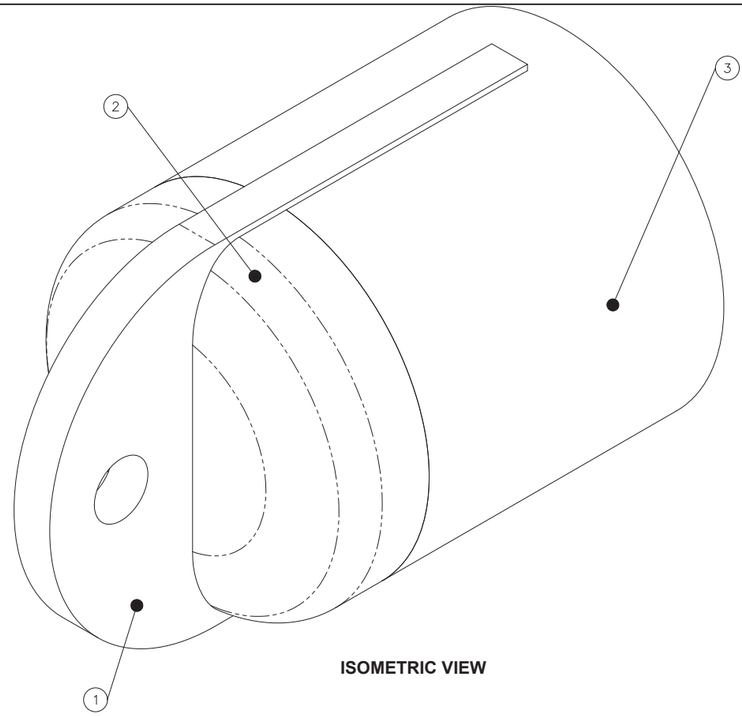
DRAWING INDEX				
SHEET	REVISION	ISSUE	SIZE	NOTES
1	0	IFC	NPS 36	PULLHEAD OVERVIEW
2	0	IFC	NPS 36	PULLHEAD ITEMS 1-3 DETAIL

THE CROSSING GROUP

JUNE 23, 2022
22542-00-PH01-0

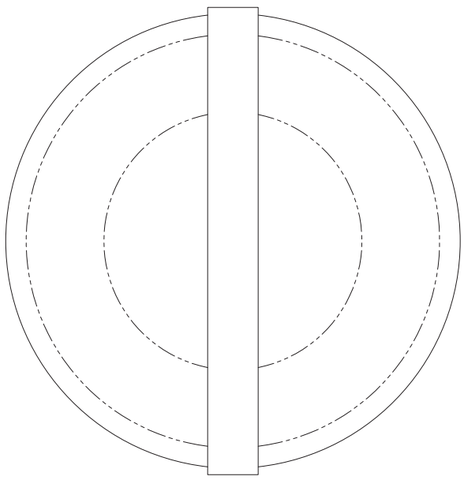


TOP VIEW

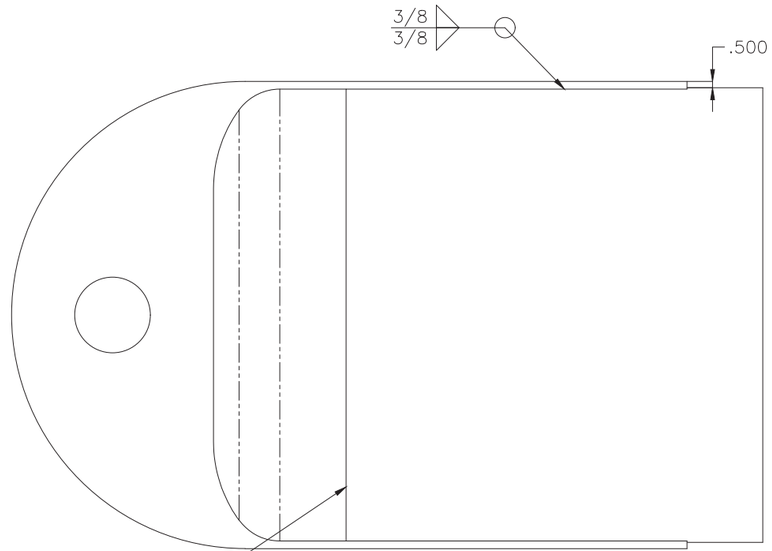


ISOMETRIC VIEW

BILL OF MATERIALS		
ITEM	QUANTITY	DESCRIPTION
1	1	53.500 X 37.000 X 4.000 STEEL PLATE - CSA G40.21-QT100
2	1	NPS 36 STEEL PIPE CAP - MIN. 12.7mm WT, MIN. GR 241MPa
3	1	33.000 X NPS 36 STEEL PIPE - 18.8mm WT GR 483MPa



FRONT VIEW



SIDE VIEW

NOTES

1. ALL DIMENSIONS IN INCHES UNLESS OTHERWISE STATED.
2. THIS DRAWING IS APPROXIMATELY HALF SCALE WHEN PRINTED ANSI B (LEDGER SIZE).
3. STRUCTURAL WELDING TO BE COMPLETED IN ACCORDANCE WITH THE LATEST W59 STANDARD USING E110XX ELECTRODES OR EQUIVALENT.
4. PIPE TO CAP WELDING TO BE COMPLETED AS PER LINE PIPE PROCEDURE.
5. MAX PULL FORCE 1,100,000LBS.
6. DESIGN BASED ON CONNECTION TO DCD 00508-1501 SWIVEL.

PIPE SPECIFICATIONS	
QUANTITY	1
SIZE	NPS 36 (914mm)
WT	18.8mm
GRADE	483MPa

INSTALLATION SPECIFICATIONS	
MAXIMUM PULL FORCE	1,100,000 LBS

REVISION LIST					
REV.	DATE	DESCRIPTION	DSG.	RVR.	APPR.
0	23-JUN-2022	ISSUED FOR CONSTRUCTION	BS	BV	BS

APPROVAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — B. S. SKIBSTED # 55677

Rev 0
2022-06-23
Permit 1003191

PREPARED BY: BLUEFOX ENGINEERING

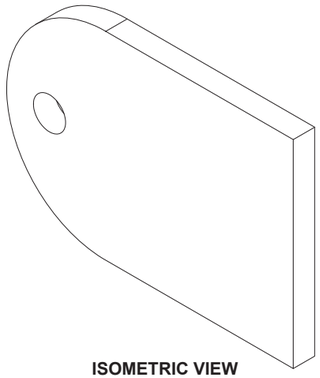
PREPARED FOR: THE CROSSING GROUP

PULLHEAD OVERVIEW

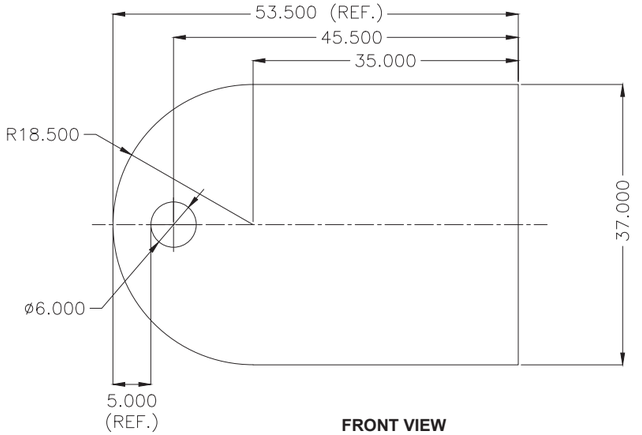
THE CROSSING GROUP
FRASER RIVER HDD
NPS 36 PULLHEAD

SHEET SIZE > ANSI D	SCALE > 1:6	SHEET NO. > 1/2	
DRAWING NO. > 22542-00-PH01		REV. NO. > 0	

TOP VIEW



ISOMETRIC VIEW



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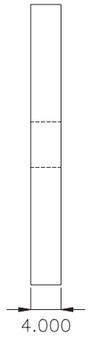

SIDE VIEW

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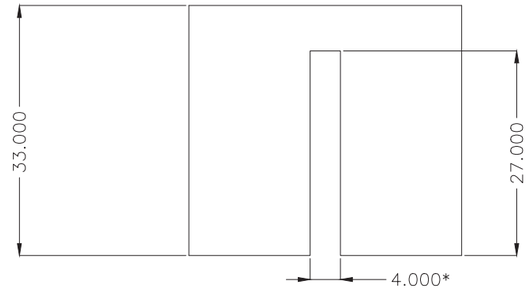
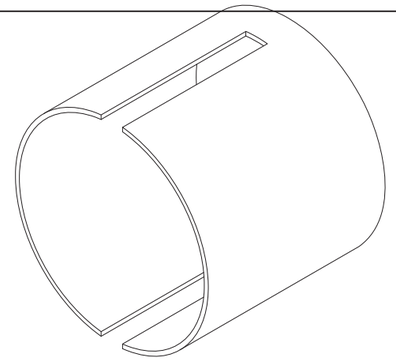


TOP VIEW



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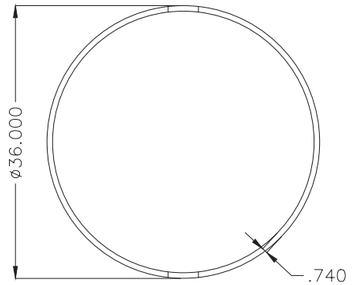

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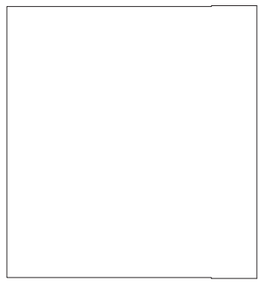

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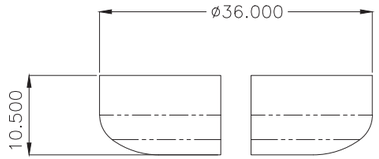
ITEM #2
QUANTITY: 1



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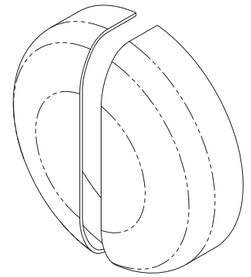

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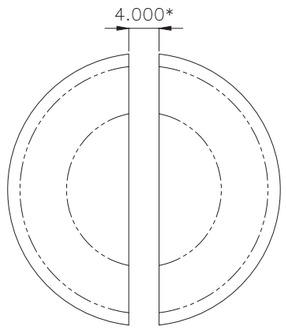

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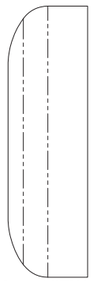


SIDE VIEW

* DIMENSION PLUS TOLERANCE. SLOT TO FIT.

PIPE SPECIFICATIONS	
QUANTITY	1
SIZE	NPS 36 (914.4mm)
WT	18.8mm
GRADE	483MPa

INSTALLATION SPECIFICATIONS	
MAXIMUM PULL FORCE	1,100,000 LBS

REVISION LIST

REV.	DATE	DESCRIPTION	DSG.	RVR.	APPR.
0	23-JUN-2022	ISSUED FOR CONSTRUCTION	BS	BV	BS

APPROVAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA
B. S. SKIBSTED
55677
2022-06-23
Rev 0
Permit 1003191

PREPARED BY:
BLUEFOX ENGINEERING

PREPARED FOR:
THE CROSSING GROUP

PULLHEAD ITEMS 1-3
THE CROSSING GROUP
FRASER RIVER HDD
NPS 36 PULLHEAD

SHEET SIZE > ANSI D	SCALE > 1:10	SHEET NO. > 2/2
DRAWING NO. > 22542-00-PH01		REV. NO. > 0

Appendix B – Drilling Details

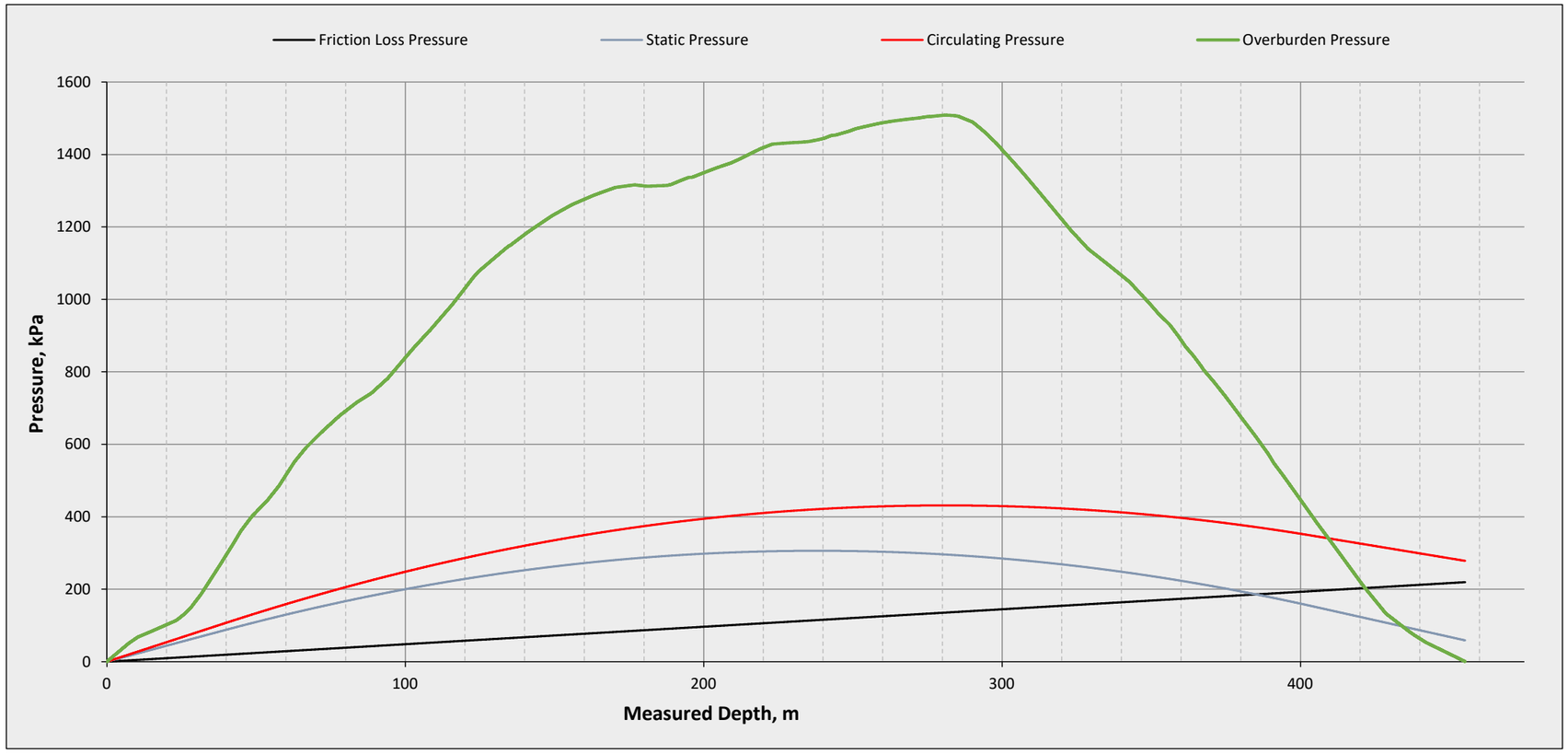
Contents

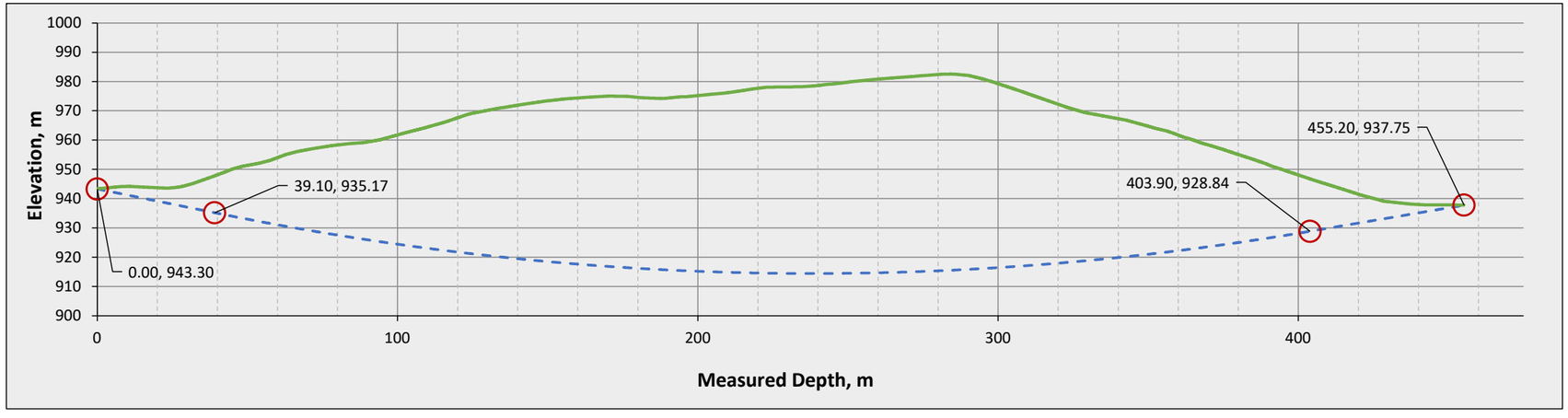
TCC Annular Pressure Graph Drilling

Prognosis Summary Table

Project Specific Drilling Fluid Program

Annular Pressure Graph





Project Information

Trans Mountain Corporation

Trans Mountain Expansion Project

Jacko Hill HDD Crossing

Notes

Based on client drawing
01-13283-M002-XD00162 Rev 0

Drilling from Entry to Exit (Northeast to Southwest).

Drilled Pilot Hole Depth (m):	***0***

Model Fluid Properties

600	74
300	54
200	45
100	38
6	22
3	21
Fluid Density (kg/m3)	1080.00
Flowrate (m3/min)	1.50
Hole Diameter (in.)	12.25
Pipe Diameter (in.)	6.625

THE CROSSING COMPANY

DRILLING PROGNOSIS SUMMARY TABLE - JACKO HILL HDD CROSSING
Based on Drawing No. 01-13283-M002-XD00162 Rev 0

MD	Joint #	Approximate Elevation (Rounded Value, Estimate Only)	Expected Geotech Layer	Borehole Referenced	Segment of Borepath	SPT / Mpa	Notes	Potential Risks
0	0	943.30	Topsoil	SH21-5A-19-TEL-JL-KP851+931	Entry Tangent		Trace sand, trace gravel, occasional rootlets	Contained Within 23 m MD of NPS 60 Surface Casing
9.5	1	941.33	Clay / Sand & Gravel				Clay: Trace sand, low-med. plast., occasional oxides Sand & Gravel: Silty, trace clay, occasional oxides	
19	2	939.35	Silt / Sand			>50	Silt: Very dense Sand: Silty, gravelly, trace clay, very dense	
28.5	3	937.38	Diorite			R4	Strong, slightly weathered, fine-med. grained, quartz, epidote, & calcite veins throughout	
38	4	935.41					Trace clay infill, 937.0 m elev. Broken core segments, 937.0 - 935.1 m elev. Brecciated zones, 936.1 - 934.2 m elev.	Risk of LoC to formation
47.5	5	933.47			Build Section	R4 - 5	Strong - very, fresh, below 934.6 m elev.	Risk of increased wear on down hole tooling
57	6	931.62					Broken core, 932.9 - 932.8 m elev.	Risk of LoC to formation
66.5	7	929.87					Broken core, 931.4 - 929.9 m elev.	
76	8	928.21						
85.5	9	926.64					Broken core, 927.8 - 927.7 m elev.	Risk of LoC to formation
95	10	925.17						
104.5	11	923.79					Broken core, 924.0 - 923.1 m elev.	Risk of LoC to formation
114	12	922.50						
123.5	13	921.31					Slightly weathered, below 922.4 m elev. Broken core segments, 922.4 - 920.0 m elev.	Risk of LoC to formation
133	14	920.22					Fresh, below 920.9 m elev.	
142.5	15	919.22						
152	16	918.31						
161.5	17	917.50					Broken core segments, 917.7 - 916.3 m elev.	Risk of LoC to formation
171	18	916.78						
180.5	19	916.15						
190	20	915.63						
199.5	21	915.19						
209	22	914.85						
218.5	23	914.61						
228	24	914.46					Broken core segments, 914.6 - 914.5 m elev.	Risk of LoC to formation
237.5	25	914.41		SH21-5A-19-TEL-JL-KP852+390		R4	Strong, fresh, massive, epidote noted throughout, trace calcite & quartz veins noted throughout	
247	26	914.45						
256.5	27	914.59						
266	28	914.82						
275.5	29	915.15						
285	30	915.57					Broken core segments, 915.4 - 915.5 m elev.	Risk of LoC to formation
294.5	31	916.08						
304	32	916.69						
313.5	33	917.40					Broken core segments, 916.8 - 916.9 m elev.	Risk of LoC to formation
323	34	918.20						
332.5	35	919.10						
342	36	920.09						
351.5	37	921.17					Broken core segments, 920.8 - 922.0 m elev.	Risk of LoC to formation
361	38	922.35						
370.5	39	923.62						
380	40	924.98					Broken core segments, 924.8 - 926.6 m elev.	Risk of LoC to formation
389.5	41	926.45				R3	Med. strong, slightly weathered, 926.2 - 926.6 m elev.	
399	42	928.00						
408.5	43	929.64	Clay		Exit Tangent	>50	Trace fine sand, trace gravel, hard, occasional oxides	Risk of deflection/steering difficulties
418	44	931.29					Very hard, below 929.9 m elev. Diorite fragments, 930.6 m elev.	
427.5	45	932.94				40	Seepage noted, 931.4 m elev.	Risk of LoC to formation
437	46	934.59				46	Some fine sand, below 933.6 m elev.	
446.5	47	936.23						
455.2	48	937.74	Clay (Fill)				Sandy, black, occasional rootlets	

Drilling Fluids Plan

Trans Mountain Expansion Project
Jacko Hill HDD Crossing

UNIQENERGY SOLUTIONS

Attention:	Alex Ronaldson	
UES Contact:	Devon Hanson	403-969-3701
	Josh Lord	587-435-0613
Date:	August 1, 2023	
Warehouse:	Nisku, AB	

August 1st 2023
The Crossing Company
1807 8th St
Nisku Alberta
T9E 7S8

Attention: Alex Ronaldson,

Subject: Drilling Fluids Plan - Jacko Hill HDD Crossing

Drilling Fluids Program Overview

The purpose of the drilling fluid is to provide optimal wellbore stability, and appropriate hole cleaning in a cost effective and environmentally friendly. In order to design the tailored fluid system for the Jacko Hill HDD Crossing the hole configuration and expected lithology's of the formations to be drilled were reviewed. The Geo Technical report indicated the potential to encounter faults and fractures on this specific crossing have been identified as moderate to high. Despite not encountering losses on offsetting boreholes managing fluid loss and density will help mitigate issues that can arise from encountering fractures and faults.

Table 1: Project Specifications

Project	Bore Length
Jacko Hill HDD Crossing	451m

Potential Problems identified in the Geology and Wellbore Geometry

1. **Faults and Fractures:** The Geo Technical report indication of encountering highly fractured zones, faults, and joints emphasizes the importance of addressing potential drilling challenges. Maintaining wellbore stability and preventing fluid losses are crucial objectives. Two key considerations in this context are maintaining a tight filter cake and managing fluid density.

    - **Tight Filter Cake:** Creating and maintaining a tight filter cake is essential to seal faults and fractures and prevent fluid invasion into the formation. A well-formed filter cake helps reduce fluid losses, stabilizes the wellbore, and enhances drilling efficiency in such complex geological conditions.

    - **Fluid Density Management:** Properly managing drilling fluid density is crucial to avoid issues related to fluid invasion into fractures. The drilling fluid's density must be carefully controlled to strike a balance between preventing lost circulation and avoiding wellbore instability.

    - **Low Fluid Density:** If the drilling fluid density is too low, it may lead to fluid invasion into the fractures, causing lost circulation or wellbore instability. This can hinder drilling progress and pose challenges in maintaining wellbore stability.

    - **High Fluid Density:** Conversely, if the drilling fluid density is too high, it can induce wellbore breakout or fault slip, leading to wellbore instability and potential drilling problems.

2. **Losses:** Given the potential for losses due to the presence of faults and fractures, UES recommends having additional LCM and Grouting material on location in the event it is required. Please see the sample pill recipes if losses occur. In addition a MMO system may be spotted in the event losses occur. UniqEnergy can provide a one sack product to allow for easy additions and cost effectiveness.

3. **Clays:** Despite not being as prevelant on the offsetting boreholes, it is recommend to use a moderately inhibited system depending on the respective lithology. Reactive clays can cause reduced borehole size due to swelling as well as can create mud rings. In addition dispersed clays in the system can cause high densities and the potential for pressure issues.

Drilling Fluid Design for the Jacko Hill HDD Crossing

It is recommended to use the following products a low concentration of High Yield Bentonite, Soda Ash, UniPam 530, Zan HD, and Uni-Pac LVD. The High Yield Bentonite is chosen for its cost-effectiveness and quick development of rheology, which helps with efficient hole cleaning during drilling. Additionally, the inclusion of Zan HD further improves low-end rheology, optimizing hole cleaning. Zan HD's inert nature to almost all contaminants ensures that the drilling fluid's rheological properties remain unaffected, maintaining its effectiveness in hole cleaning. By combining these additives, the drilling fluid can efficiently remove cuttings and debris, enhancing overall drilling performance in challenging formations with faults and fractures. UniPac LVD's tight filter cake formation is crucial for reducing the depth of drilling fluid invasion into the formation. This is essential in stabilizing the wellbore while drilling through faults and fractures. By sealing faults and fractures, the drilling fluid's invasion is minimized, preventing fluid losses and maintaining wellbore integrity. Stabilizing the wellbore is vital for successful drilling operations and mitigating potential challenges associated with fractured formations. Despite the presence of Clay not being overly prevalent on this crossing additions of UniPam 530 are still recommended to encapsulate the reactive shales to prevent swelling and dispersion; additions of UniPam 530 will also provide additional filter cake integrity.

Table 6: Additives for the Jacko Hill HDD Crossing

Product	Concentration	Function	Microtox Threshold
Soda Ash	0.25 kg/m3	pH and Calcium Control	18.40 kg/m3
High Yield Bentonite	30.00 kg/m3	Viscosity	100.00 kg/m3
UniPac LVD	2.00 kg/m3	Fluid Loss Control	20.00 kg/m3
Zan HD	2.00 kg/m3	Low End Rheology	5.00 kg/m3
UniPam 530	1.50 kg/m3	Clay Control	3.10 kg/m3

Product	Product Weight (kg)	Concentration Required (kg/m3)	Volume (m3)	Sacks required
High Yield Bentonite	22.68	30.00	10.00	13.23
UniPac LVD	22.68	2.00	10.00	0.90
Zan HD	25.00	2.00	10.00	0.80
UniPam 530	25.00	1.50	10.00	0.60

Mixing Instructions

Into10m3 mix:

- Mix the required amount of Soda Ash determined by the calcium check. Only a very small amount is required. We would like to keep a pH of below 8
- Mix 1.0 sack of UniPac LVD at 30 mins per sack
- Mix 1.0 sack of Zan HD at 4 hours per sack
- Mix 1.0 sack of UniPam 530 at 4 hours per sack
- All three products can be mixed at the same time. Allow this to mix for 6 + hours (the longer the better). You will see rheology from both the UniPac LVD and Zan HD.
- Once Polymers are hydrated, add 13 sacks of Gel High Yield Bentonite

Please note sacks additions have been rounded to the nearest whole sack for ease of mixing

Lost Circulation Procedure

Option A: Mix 2-3 sacks of sawdust and Magma Fiber per single or every 30 mins to slow / stop losses. This would be mixed continuously as losses were experienced.

Option B: Set a loss circulation pill, below is a list of a number of pill options. Please note the severity of the losses, the lithology of the thief zone, the drilling activity and the drilling fluid properties should all be taken into account prior to pill selection. Each pill varies in cost, and aggressiveness.

Pill 1: For mild losses (Aggressive level: Low)

- Mix 10-15m3 of drilling fluid into the tank and increase the viscosity to 150 sec/L
- Mix in 55 kg/m3 of sawdust and 55 kg/m3 of Magma Fiber
- Pump into the thief zone and allow to set up for 2-4 hours

Pill 2: For mild to moderate losses (Aggressive level: Low to moderate)

- Mix 10-15m3 of drilling fluid into the tank and increase the viscosity to 150 sec/L
- Mix in 55 kg/m3 of sawdust and 55 kg/m3 of Magma Fiber
- Also Mix 25 kg/m3 of Kwik Seal and 25 kg/m3 of Cellophane
- Pump into the thief zone and allow to set up for 2-4 hours

Pill 3: For moderate to severe losses (Aggressive level: moderate to high)

- Mix 10-15m3 of drilling fluid into the tank and increase the viscosity to 150 sec/L
- Mix in 55 kg/m3 of sawdust and 55 kg/m3 of Magma Fiber
- Mix 25 kg/m3 of Kwik Seal and 25 kg/m3 of Cellophane
- Mix 10-15 kg/m3 of Enviroplug just before you pump
- Pump into the thief zone and allow to set up for 2-4 hours

Pill 4: For severe losses (Aggressive level: high)

- Mix 10-15m3 of drilling fluid into the tank and increase the viscosity to 150 sec/L
- Mix in 55 kg/m3 of sawdust and 55 kg/m3 of Magma Fiber
- Mix 35 kg/m3 of Kwik Seal and 35 kg/m3 of Cellophane
- Mix 10-15 kg/m3 of Enviroplug and 20 kg/m3 of Clearex just before you pump
- Pump into the thief zone and allow to set up for 2-4 hours

Pill 5: For severe / total losses (Aggressive level: Very high)

- Mix 10-15m3 of drilling fluid into the tank and increase the viscosity to 150 sec/L
- Mix in 55 kg/m3 of sawdust and 55 kg/m3 of Magma Fiber
- Mix 35 kg/m3 of Kwik Seal and 35 kg/m3 of Cellophane
- Mix 10-15 kg/m3 of Enviroplug, and 40 kg/m3 of Clearex just before you pump
- Pump into the thief zone and allow to set up for 2-4 hours

- Note: All of the pill listed above are suggestions. Please contact the drilling fluids engineer Devon Hanson (403-969-3701) and the rig manager for selection.

Table 7: Initial Water Quality Testing Requirements

Ions	Test Method
Calcium	Titration
Sodium	Meter
Potassium	Titration
Chloride	Titration
Bicarbonate	Titration
Carbonate	Titration
Bacteria	Dipslide
pH	Strips

Table 8: Drilling Fluid tests that can be performed by The Crossing Company

Property	Measurement Method	Measurement and definition
Density	Scale	The Density should be maintained as low as possible
Fluid Loss	Fluid Loss Cell	A higher fluid loss will allow more water to enter the formation potentially causing instability. Also, as more fluid is lost to the wellbore the filter cake thickness will increase. This is measured using a filter press pressured up to 500 psi
Yield Point	6 speed Rheometer	The Yield point is a measurement of the chemical interactions between the polymer molecules and/ or the bentonite present in the system
Plastic Viscosity	6 speed Rheometer	The Plastic Viscosity is a measurement of the solids (both drilled and barite) in the system
MBT	MBT Kit	The methylene Blue Test is a measurement of reactive clays in the system
PHPA	Material Balance	This is partially hydrolyzed polyacrylamide. It will coat the shales and stop hydration

Note: All tests are done to API standards and will be performed as the hole dictates.

Recommended Properties

One of the optimization techniques used by The Crossing Company is daily review and recommendations of the drilling fluid reports. This along with morning discussions of drilling related problems and solutions allows the Crossing Company to optimize their mud program as dictated by the wellbore, as opposed to having set recommended properties regardless of what is happening during the drill.

This method will provide a tailored mud system for each bore to ensure the optimal properties and additives are being constantly utilized. This will provide, increased ROP optimal hole cleaning, and added wellbore stability to reduce the overall risk of the project.

Drilling Fluid Products and Function

1. **High Yield Bentonite**: This is a high quality bentonite based product that will provide solids suspension and carrying capacity. The chemical interaction of the gel will create a non-Newtonian or thixotropic environment that will get thick when the fluid is not in motion and prevent the solids from settling and will thin once the fluid is being pumped to allow for optimal hole cleaning. The goal of these mechanisms is to reduce the cutting beds, in the wellbore wall which can cause pipe drag and elevated annular pressures. Also, it is important that the fluid will carry out the solids on the first pass to maintain a larger particle size to allow them to be removed on surface.

2. **Soda Ash:** The chemical formula of soda ash is Na_2CO_3. This product will maintain a pH level of 9 allowing for the bentonite and polymers the appropriate environment to hydrate. Also, it will precipitate out any calcium contamination in the make up water.

3. **UniPam 530:** This is a powdered PHPA (Partly hydrolyzed poly acrylamide) that will provide shale stabilization through the reactive clays. This long chain polymer will bond to the negative edges of the clay platelets and wrap around the shale unit. This will prevent water from penetrating the clay layers and causing swelling and dispersion.

4. **Zan HD:** This is a xanthan based viscosifier that will provide extremely high low end rheology without the addition of clays or solids. This product will provide optimal hole cleaning dramatically improving the 6 and 3 values.

5. **UniPac LVD:** This is a polyanionic cellulose that will provide a filter cake on the wellbore wall to reduce the fluid loss and thus the depth of invasion of the drill fluid. In summary It will provide the following: A tight filter cake to reduce the amount of fluid that enters the formation. Resulting in less fluid encountering the reactive shales thus eliminating them from swelling and dispersing. This will also help with annular velocities and hole cleaning as the hole will be gauge. Will provide a "skin" to allow for a potential of wellbore strengthening as well as will give the fluid something to "push" against. Will reduce the amount of solids present in the fluid system if the formations are protected.

6. **Lignite:** is a naturally occurring coal product that will reduce the amount of swelling and dispersion of the formation clay and create a tight filtercake.

Contingency Products for Elimination of Mud Rings

1. **Disperse 72:** This is a liquid based polymer thinner that will act as a rheology control agent by reducing viscosity and gel strengths.

2. **Sawdust:** This is a cellulose based product that is used primarily as a loss circulation material. It can also be used to eliminate mud rings and bit balling.

Contingency Products in the Event of Instability due to Gravel, Boulders, Cobbles or Flowing Sand

1. **Calcium Carbonate:** is a sized inert (to water) particle that is used as a bridging material in grout pills and loss circulation environments.

2. **Gilsonite:** is a sized particle that will adhere to the coal surface and seal up the fractures / cleat system of the coal.

Contingency Products in the Event of Loss Circulation

1. **Kwikseal:** is an engineered blend of particles which: .Contains high strength granules, flakes and fibers with a definite particle size distribution. Seals effectively under both high and low differential pressure conditions. Is equally effective in unconsolidated formations and fractures or vugs in hard formations.

2. **Celloflake:** is a clear multi-sized flakes of poly cellulose, with an average size of 9.5mm (3/8").

3. **EnviroPlug 8:** is a high-swelling Wyoming Bentonite in granular form. The unique molecular structure allows it to absorb five times its weight of water and swell to a volume of 12-16 times its dry bulk, making it an ideal sealant. Applied dry or in a pumpable slurry, these fine granules expand against casings and formations to create a very low permeability flexible grout seal.

4. **Magma Fiber:** This is a spun mineral fiber, which acts as a plugging and bridging agent in voids, fractures, and all types of permeable formations

5. **Spectra HD:** This is a high quality fiber product that has a larger particle size distribution then Magma Fiber. Also, it has a mild affinity for itself helping it to seal up formation by creating a webbing.

6. **Clearex:** Is a water swell-able bead in a partly hydrolyzed polyacrylamide.

7. **MMO:** If severe losses are encountered a Mix Metal Oxide pill can be ran through the loss zone. In addition an entire MMO system can be used.

Appendix C – Execution Details

Contents

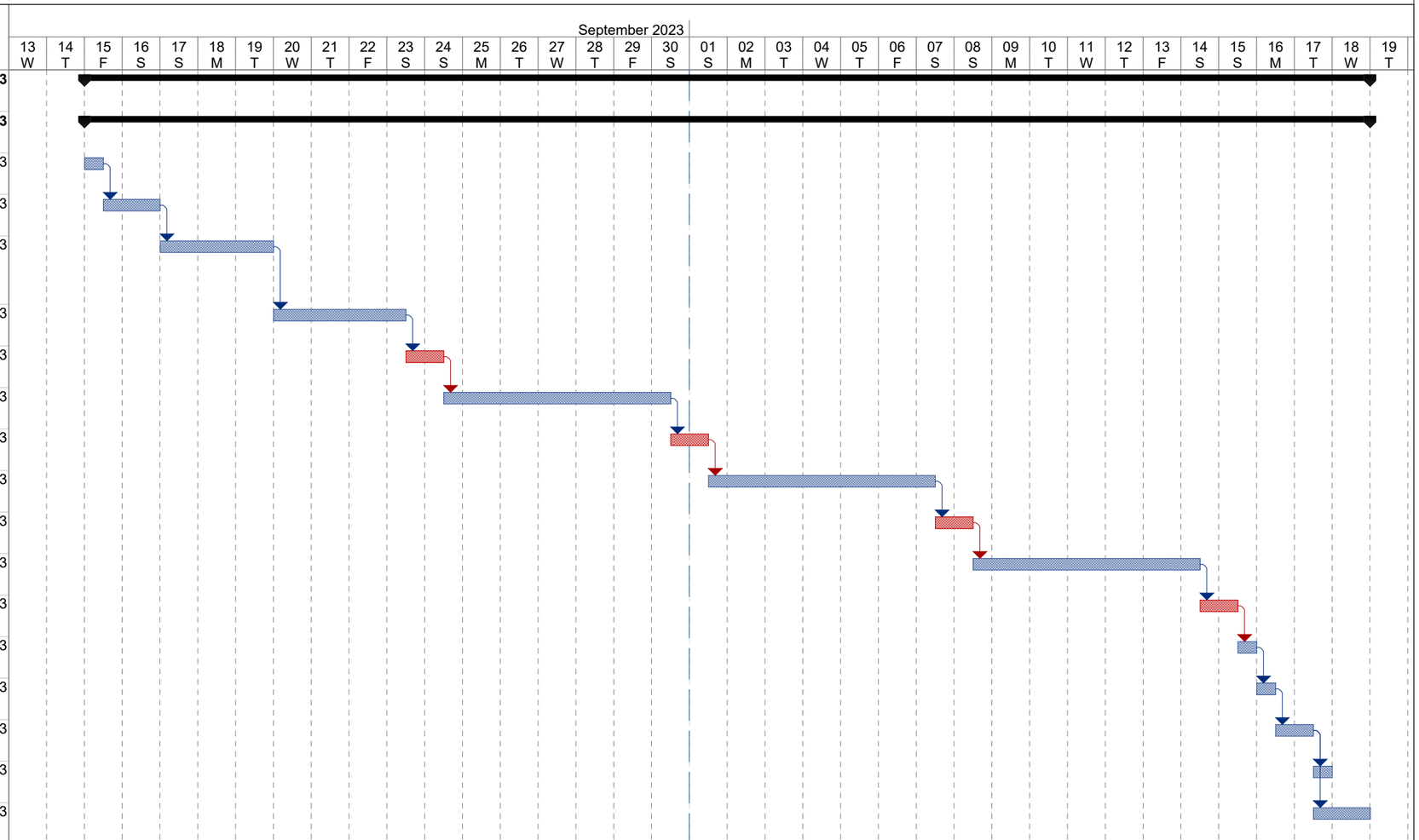
TCC Construction Schedule

Execution Plan Technical Details

Proposed Construction Schedule
Trans Mountain Corporation - Jacko Hill HDD Crossing

The Crossing Company Inc.
24 Hour Schedule
rB
08.01.2023

ID	Task Name	Duration	Start	Finish
1	**Jacko Hill HDD Crossing**	**34 days**	**Fri 9/15/23**	**Thu 10/19/23**
2	**Primary Rig**	**34 days**	**Fri 9/15/23**	**Thu 10/19/23**
3	Mobilization	0.5 days	Fri 9/15/23	Fri 9/15/23
4	Rig Up	1.5 days	Fri 9/15/23	Sun 9/17/23
5	Install Surface Casing - 22.6 m of 1,524 mm (60") (Assumes 24 hr Operations)	3 days	Sun 9/17/23	Wed 9/20/23
6	Drill 311 mm (12-1/4") Pilot Hole - 463.6 m MD	3.5 days	Wed 9/20/23	Sat 9/23/23
7	Tripping to Clean Hole	1 day	Sat 9/23/23	Sun 9/24/23
8	Ream 610 mm (24")	6 days	Sun 9/24/23	Sat 9/30/23
9	Tripping to Clean Hole	1 day	Sat 9/30/23	Sun 10/01/23
10	Ream 914 mm (36")	6 days	Sun 10/01/23	Sat 10/07/23
11	Tripping to Clean Hole	1 day	Sat 10/07/23	Sun 10/08/23
12	Ream 1219 mm (48")	6 days	Sun 10/08/23	Sat 10/14/23
13	Tripping to Clean Hole	1 day	Sat 10/14/23	Sun 10/15/23
14	Cleaning Pass	0.5 days	Sun 10/15/23	Mon 10/16/23
15	Pull Product: (1) 914.4 mm pipeline - no insulation	0.5 days	Mon 10/16/23	Mon 10/16/23
16	Rig Out	1 day	Mon 10/16/23	Tue 10/17/23
17	Demobilization	0.5 days	Tue 10/17/23	Wed 10/18/23
18	Extract Surface Casing	1.5 days	Tue 10/17/23	Thu 10/19/23



EXECUTION PLAN TECHNICAL DETAILS

Project **Trans Mountain Expansion Project – Spread 5A – Jacko Hill HDD**
Location **d-044-E/92-I-9**

Equipment	Rig 10	American Augers DD-625 Push/Pull Force: 625,000 lbs Rotary Torque: 80,000 ft-lb		
Geometry	Length Entry/Exit Angle Minimum radius as per owner specifications subject to ground conditions.	455.2 m 12° / 10°	Client Dwg No. Design Radius	01-13283-M002-XD00162 Rev 0 950 m
Conductor Pipe	Entry	23 m of 1,524 mm (60") (Proposed)		
Pilot Hole	Pilot Hole Drilling Assembly	(1) 311 mm (12-1/4") TCI drill bit (1) 203 mm (8") mud motor (1) 171.4 mm (6-3/4") orienting sub (1) 171.4 mm (6-3/4") x 9 m non-magnetic drill collar 168 mm (6-5/8") S-135 Drill Pipe, inspected within one year, may be used since last inspection Required cross-over subs		
	Annular Pressure Sensor	Vector Magnetics Pressure Module annulus pressure 0-1000 PSI full scale drill pipe pressure 0-5000 PSI full scale		
	Guidance System	Vector Magnetics Steering Tool c/w 3 axis accelerometer (accuracy: +/- 0.10°) 3 axis magnetometer (accuracy: +/- 0.4°) ParaTrack (surface electromagnetic AC coils)		
Reaming	Reaming Assembly	(1) 609.6 mm (24") Inrock TCI Reamer (1) 914.4 mm (36") Inrock TCI Reamer (1) 1,219.2 mm (48") Inrock TCI Reamer 168 mm (6-5/8") S-135 Drill Pipe, inspected within one year, may be used since last inspection Required cross-over subs		
Product Pull	Product Line Pulling Assembly	(1) Pull head welded to line pipe (1) Swivel: 550 ton (1) Hole Opener (Previously Run) 168 mm (6-5/8") S-135 Drill Pipe, inspected within one year, may be used since last inspection Required cross-over subs		
	Expected Line Pipe	(1) 914.4 mm OD Pipeline - no insulation		
Drilling Fluid	Drilling Fluid Composition	High Yield Gel: 2,942 sacks estimated Soda Ash: 36 sacks estimated Uniq PAC: 149 sacks estimated Zan HD: 135 sacks estimated Uni-PAM 530: 127 sacks estimated		
	Cleaning Equipment	(1) Linear Motion Shakers (see Rig Inventory) (1) Lynx 40 (or equivalent) Decanting Centrifuge: 1,665 l/min		
	Estimated Volumes	Water Use 1,700 m^3	Fluids Disposal 1,150 m^3	Solids Disposal 800 m^3
Schedule	Duration	Approx. 34 days (see Construction Schedule)		

Appendix D – Plans

Contents

Sample Buoyancy Control Plan

Site Specific Frac Contingency Plan

THE CROSSING COMPANY

Rev 00

03.19.2015

BUOYANCY CONTROL PLAN

Project:	SAMPLE
Crossing:	SAMPLE

Table of Contents

1.0 Material 3
1.1 Supplied by The Crossing Company 3
1.2 Supplied by OWNER/PIPELINER 3
2.0 Preparation and Pipe Pull 3
3.0 Buoyancy Control Attachments 5

BUOYANCY CONTROL PLAN

1.0 Material

1.1 Supplied by The Crossing Company

A. 50' sticks 6" HDPE (6.63" OD 6.193" ID SDR11)
B. Steel cable and rope to pull the HDPE into the product line
C. (1) Water meter, valve and tee assembly
D. (1) Battery powered tow tractor
E. (1) Snatch block
F. (1) 6" steel pipe to be used as anchor (if unable to be used as an anchor, an excavator will need to be provided as an anchor)
G. Third party fusing services

1.2 Supplied by OWNER/PIPELINER

A. 400bbl water storage tanks, complete with interconnect hoses/hardware. All heated water required for the buoyancy control procedure.
B. Supply and disposal of buoyancy control water as required
C. (2) Excavators for HDPE installation/extraction support.
D. (2) 6" or larger water pump with to 6" inlet and outlet (one as backup)

2.0 Preparation and Pipe Pull

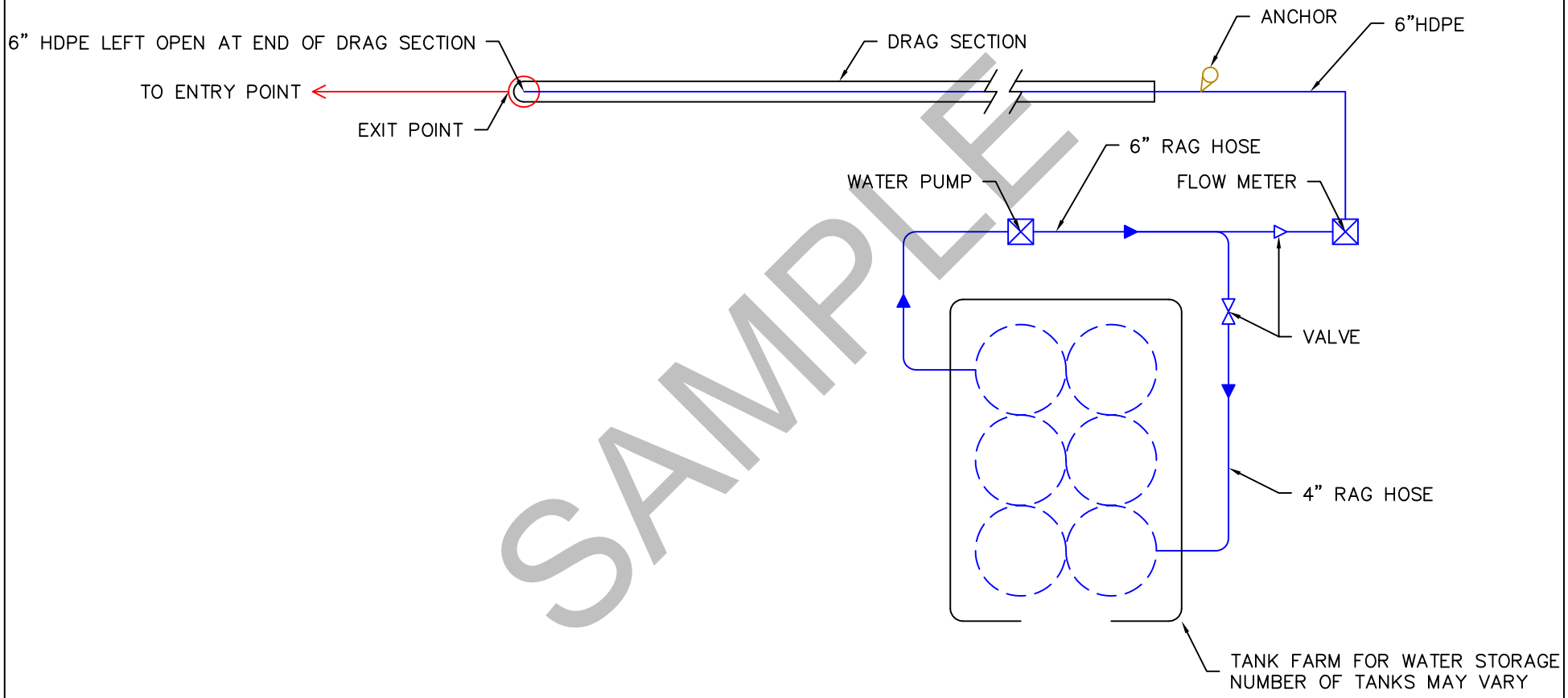
1. PIPELINER will layout one section of product pipe along the Right-of-Way on the exit side of the crossing.
2. The pipe will have one length of 6" DR11 HDPE installed inside of it to prior to line pull. The HDPE line will extend beyond the end of the pipe by a few meters to allow for connection to the water source and anchoring of the HDPE.
3. The length of the pipe will be measured and verified before installing the HDPE. If the length is different from what is listed on the drawing, the length of the HDPE will be adjusted accordingly so that the correct length of HDPE protrudes from the end of the pipe. Likewise, all measurements will be confirmed in the field prior to executing this plan.
4. The process used to install the HDPE will be as follows:

    a. TCC will run a battery powered tow tractor connected to a reel of rope through the section of pipe.
    b. TCC will attach 5/8" steel cable to the rope and will pull the rope through the drag section of pipe, resulting in the 5/8" steel cable laying through the entirety of the pipe
    c. A pull head will be fused onto the HDPE. The 5/8" steel cable will be attached to the pull head that is fused onto the HDPE.
    d. A snatch block will be attached to an excavator near the front end of the pipe. The steel cable will be routed through the snatch block and attached to an excavator. A second excavator will drive along the ROW, pulling the HDPE into the pipe.
    Note: To install the HDPE in one section TCC will require the equivalent length of the drag section of workspace away from the drag section. This space would be used to fuse together the pipe in one section to be pulled into the product pipe.

5. A tank farm will be positioned as close to the far side of the product line as possible. The tank farm will be made up of 60m^3 tanks full water. The required volume of water for buoyancy control operations will be calculated by The Crossing Company.
6. A 6" centrifugal pump (and one back up pump) will be positioned near the tanks. The HDPE surface fill line will be attached to a valve/meter assembly that will in turn be attached to the 6" centrifugal pump. A 6" line will run from one 60m^3 water tank to the inlet of the pump. A 6" line will run from the outlet of the pump to a Y valve. One 6" line will run from the Y valve to the HDPE fill line while another 4" line will run from the Y valve back to the 60m3 water tank. This configuration will allow circulation back to the 60m^3 water tank when water is not being fed into the pipe (see attached sketch for typical layout).
7. At time of product pull, PIPELINER will position the pipe in front of the exit point ready for installation.
8. TCC will run an HDPE surface fill line from the tank farm to the end of the product line. TCC will attach a softener in between the edge of the product line and the HDPE to protect the HDPE from damage during pull back operations.
9. A 6" steel pipe anchor will be installed by PIPELINER approximately 5m behind the west end of the drag section to hold the HDPE in place as the line is pulled. The anchor will be vertically driven if possible. If not, a piece of equipment (ie excavator, CAT, etc.) will be used as an alternative anchor.
10. Once all preparations for line pull have been made, the drilling rig will pull one joint of drill pipe out of the hole at a time advancing the pipe an average of 9.5m per joint.
11. After the product line has been pulled 19m downhole (two drill pipe joints in) TCC will use slings to connect the HDPE to the anchor. As each 9.5m of pipe is pulled in, 9.5m of HDPE will slide out of the product line. After the line pull is complete, approximately 19m of HDPE will need to be extracted from the product line.
12. When the pullhead reaches a calculated elevation below exit the operator will begin to flow a calculated volume of water into the pipe for every joint pulled (see typical Buoyancy Control Volume Worksheet attached).
13. This process will continue until the pull head is at an elevation calculated by The Crossing Company's Project Engineer. The valve/meter operator will stop adding water to the pipe at this point to prevent water from spilling out from the back side of the product line.
14. After completion of the product pull, PIPELINER will extract HDPE and TCC will cut up the HDPE, and remove it from site.

3.0 Buoyancy Control Attachments

BUOYANCY CONTROL TYPICAL LAYOUT SKETCH



NOTES:
1) LAYOUT TO BE SET UP AS PER BUOYANCY CONTROL PLAN.
2) PUMP IS ALWAYS CIRCULATING WATER THROUGH 400bbl TANKS WHEN NOT FLOWING WATER INTO PIPE

Dwn By:	CT
Date:	05/02/2019
File:	BUOYANCY CONTROL SKETCH

The Crossing Company Inc

Job Name/Number: SAMPLE
Location: SAMPLE
Date Of Pull: SAMPLE

Joint Off	MD	Planned Water to Add (m^3)	Planned Total Water (m^3)	Recorded Total Water From Flow Meter (m3)	Minimum Water Required	Recorded Total Water From 400bbl Tank	Comments

Trans Mountain Corporation	Rev. A	08.01.2023

SITE SPECIFIC FRAC CONTINGENCY PLAN

Client: Trans Mountain Corporation

Project: Trans Mountain Expansion Project

Crossing: Jacko Hill HDD Crossing

Contents

SITE SPECIFIC FRAC CONTINGENCY PLAN 3

01. MONITORING 3

02. FRAC CONTAINMENT AND RECOVERY 3

ZONE A (ENTRY): RIG ENTRY (0M AWAY) – EDGE OF ROAD (99M AWAY) 3
ZONE B: EDGE OF ROAD (99M AWAY) – RIG EXIT (451M AWAY) 3

03. LOST CIRCULATION PILLS 4

SITE SPECIFIC FRAC CONTINGENCY PLAN

01. MONITORING

The Crossing Company Inc. (TCC) will monitor the return flow of drilling fluid from the borehole, the annular/standpipe pressure, and the tank/pit volumes to determine if there is a loss of circulation. Additionally, regular frac walks will be performed by TMEP/the Pipeline Contractor every four (4) hours. In the event that there is a loss of circulation detected, TCC will stop the forward advancement of the drilling assembly and complete a frac walk in order to locate any potential frac. This procedure will continue for the duration of the project. The bore path and 50m offset each way will be divided up into a grid search pattern. The frac walkers will be in contact with the driller at the rig by means of two-way radios. In the event of fluid being discovered on surface, the frac walkers will immediately notify the driller who will cease pumping and shut off the rig, as well as immediately notify the Owner drilling inspector and Environmental Inspector (EI). In consultation with the Owner drilling inspector and Environmental inspector, the crew will enact the protocols outlined in the Environmental Management Plan (EMP), located in TCC's HDD Environmental Execution Plan, and the TMEP Site Specific IFR Clean Up Plan, and proceed to contain and if possible, recover any drilling fluid found on surface.

02. FRAC CONTAINMENT AND RECOVERY

In the event of a surface frac out, TCC will follow the protocols outlined in the supplied EMP. The equipment and materials required will vary depending on the terrain in the area and type of recovery.

All zones are identified from entry point.

Zone A (Entry): Rig Entry (0m away) – Edge of Road (99m away)

This zone is defined by terrain that is accessible from the rig. Any fracs discovered in this zone can be accessed, contained, and pumped back to the entry side rig using equipment readily available. Containment structures made of sandbags/silt fence will be built by TCC and the fluid will be pumped back to the rig by the Pipeline Contractor.

TCC will be responsible to provide:

- 50 m of silt fence & stakes
- 50 m thick plastic (6mm or better) for wrapping around sandbags or fence as a barrier
- 100 sand bags
- Filter cloth
- T-bar posts & post pounders
- Assorted Shovels, axes, and other hand tools

Pipeline Contractor will be responsible to provide:

- Any Emergency Response Materials not noted above, from the list outlined within document no. 01-13283-GG-0000-CHE-RPT-0006 (Environmental Protection Plan for the Trans Mountain Pipeline ULC Trans Mountain Expansion Project) – Appendix B – 3.0

Zone B: Edge of Road (99m away) – Rig Exit (451m away)

If a frac occurs in this zone, drilling fluid can be contained but may need to be recovered and transported back to entry (using a vac truck/pump) by the Pipeline Contractor. Depending on the location of the frac, temporary containment pits can be erected utilizing a combination of silt fence and sandbags by TCC. Once the frac is contained, the fluid will then need to be pumped/transported from the frac by the Pipeline Contractor to the entry location or to an area where a sump will need to be constructed to contain the fluid. If a sump is constructed to contain the drilling fluid, the fluid will need to be transported back the rig side by means of vac trucks. Additional materials that

may exceed the materials listed in the TCC EMP may be required to aid in transporting fluid to a point that vac trucks can access.

TCC will be responsible to provide:

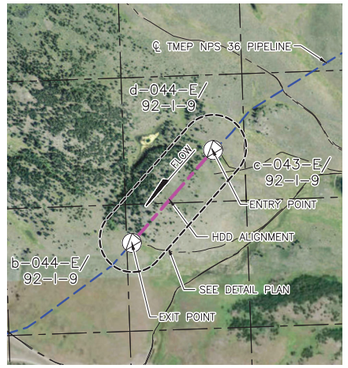
- 50 m of silt fence & stakes
- 50 m thick plastic (6mm or better) for wrapping around sandbags or fence as a barrier
- 100 sand bags
- Filter cloth
- T-bar posts & post pounders
- Assorted Shovels, axes, and other hand tools

Pipeline Contractor will be responsible to provide:

- Any Emergency Response Materials not noted above, from the list outlined within document no. 01-13283-GG-0000-CHE-RPT-0006 (Environmental Protection Plan for the Trans Mountain Pipeline ULC Trans Mountain Expansion Project) – Appendix B – 3.0

03. LOST CIRCULATION PILLS

In the event of lost circulation, TCC may propose to use a process involving spotting lost circulation material (LCM) pills consisting of a high viscosity bentonite slurry, Sawdust, and Magma Fiber. The pill will be spotted over the lost circulation zone. Once the pill is spotted, the BHA will be tripped back 2-3 joints from the loss zone and the LCM pill will be allowed to hydrate and set for 3 hours. Once the pill has set, the BHA will be run to bottom at a reduced pump rate and the next joint will be drilled at full pump rate. Once the next joint has been drilled down, the procedure can be repeated if necessary. This procedure may be repeated as many times are required to ensure fluid returns to the rig and wellbore stability are maintained. If a stronger pill is required, the LCM pill composition can be created by consulting with an Uniq Energy Drilling Fluid Expert if requested by Owner. Additional information regarding lost circulation pills can be found in the Project Specific Drilling Fluid Program.

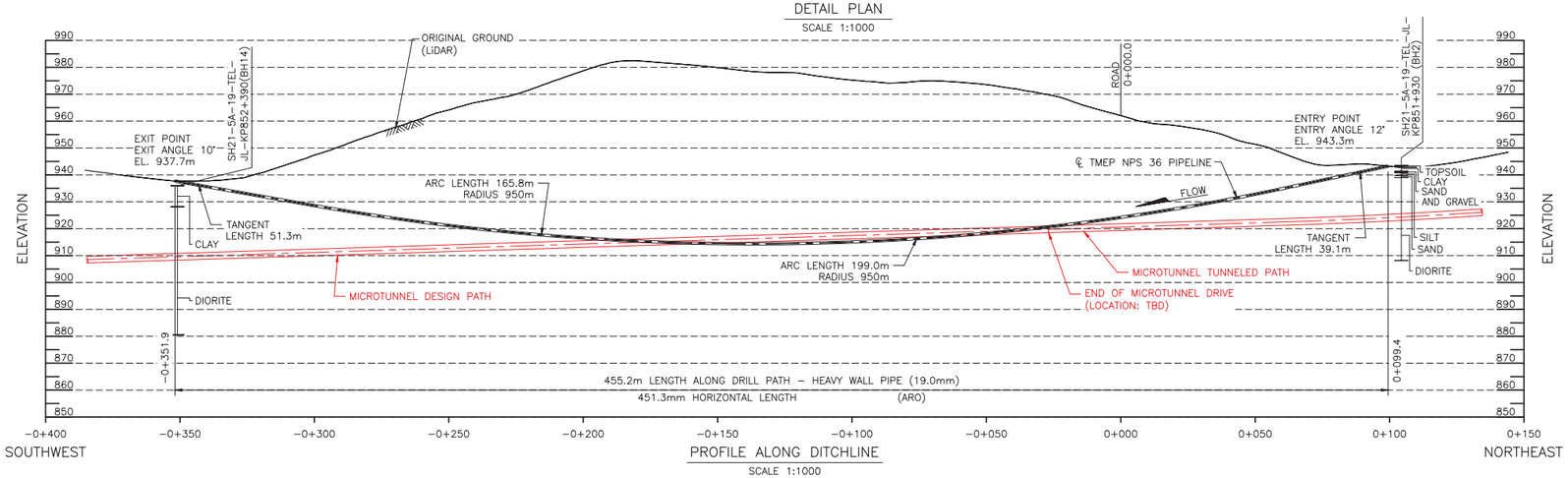


LOCATION PLAN

SCALE 1:10000
d-044-E/92-I-9
CITY OF KAMLOOPS
NAD83 UTM ZONE 10N
APPROX. TMEP KP 852.3

DETAIL PLAN

SCALE 1:1000



PROFILE ALONG DITCHLINE

SCALE 1:1000

GENERAL NOTES

A1. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES UNLESS OTHERWISE SHOWN. ALL ELEVATIONS ARE GEODETIC. ALL CHAINAGES ARE HORIZONTAL.
A2. DRAWING SCALES ARE ONLY CORRECT WHEN PLOTTED AT FULL SIZE (A1).
A3. ALL WORK IN CLOSE PROXIMITY TO POWER LINES MAY BE SUBJECT TO ELECTROSTATIC AND ELECTROMAGNETIC INDUCED VOLTAGES. CONTRACTOR SHALL BE RESPONSIBLE FOR MONITORING AND IMPLEMENTING MITIGATION PROCEDURES. CONTRACTOR SHALL IMPLEMENT THESE PRECAUTIONS AS WELL AS THOSE SPECIFIED BY TRANS MOUNTAIN REPRESENTATIVE.
A4. THE CONTRACTOR SHALL ENSURE ALL UTILITIES ARE PROTECTED AND MAINTAINED THROUGH THE CONSTRUCTION PROCESS.
A5. THE CONTRACTOR SHALL ENSURE THAT COPIES OF THE CROSSING AGREEMENTS ARE KEPT ON SITE FOR THE FULL DURATION OF THE CONSTRUCTION ACTIVITIES. CONTRACTOR SHALL ADHERE TO ALL REQUIREMENTS OF THE CROSSING AGREEMENTS.
A6. SURVEYED BASE PLANS ARE BASED ON BASE PLAN 38290-BASE-92I9E R5 DATED MAY 31, 2022, PROVIDED BY GEOVERRA SURVEY (BC) LTD. PARTNERSHIP. THE GROUND PROFILE WAS BASED ON SURVEY DWG 01-13283-M002-XD0510101.DWG DATED MAY 18, 2022, PROVIDED BY ADIT ENGINEERING. THE IMAGERY IS SUPPLIED BY AEROQUEST MAPCON, DATED 2019.
A7. CONSTRUCTION SHALL BE COMPLETED IN ACCORDANCE WITH CSA Z662 (CURRENT VERSION), AND THE MOST RECENT VERSIONS OF ALL PROVINCIAL AND FEDERAL REGULATIONS, ENVIRONMENTAL PROTECTION PLAN (EPP), CONTRACT DOCUMENTS, AND THE AUTHORITIES HAVING JURISDICTION.
A8. THE CONTRACTOR SHALL SUPPLY AND ADHERE TO THE CONTRACTOR SUPPLIED AND APPROVED DRILLING EXECUTION PLAN.
A9. AS PER 01-13283-SG-M002-PL-DCN-0005, THE PIPELINE WILL BE TESTED AND OPERATED BASED ON POINT-SPECIFIC MAXIMUM OPERATING PRESSURE (BASED ON THE APPROVED FINAL HYDROSTATIC TEST). MINIMUM TEST PRESSURE WILL BE BASED ON ELEVATION PROFILES BETWEEN PUMP STATIONS.

CONSTRUCTION NOTES

B1. CONSTRUCTION METHOD FOR THIS CROSSING IS THE HORIZONTAL DIRECTIONAL DRILL METHOD (HDD). FOR HDD CONSTRUCTION SPECIFICATIONS REFER TO THE CONTRACT DOCUMENTS.
B2. THE CONTRACTOR SHALL VERIFY ALL TOPOGRAPHICAL SURVEY INFORMATION AND CONFIRM THE DEPTH AND LOCATION OF ALL BURIED FACILITIES IN THE FIELD PRIOR TO CONSTRUCTION.
B3. THE CONTRACTOR SHALL SUPPLY A DRILL RIG WITH A MINIMUM OF 400,000 LBF (1,779kN) PUSH/PULL WITH APPROPRIATE ASSOCIATED EQUIPMENT AS OUTLINED IN THE SPECIFICATIONS. THE THEORETICAL PULL FORCE FOR THIS CROSSING IS 320,000 LBF (1,423 kN) WITHOUT BUOYANCY CONTROL AND 260,000 LBF (1,157 kN) WITH 100% BUOYANCY CONTROL.
B4. THE CONTRACTOR SHALL SUPPLY AN ELECTRONIC DRILLING RECORDER (EDR) TO MONITOR AT A MINIMUM, TANK/PIT VOLUME, FLOW (PUMP AND RETURN), PRESSURE (ANNULAR/STANDPIPE), RATE OF PENETRATION, PUSH/PULL FORCE, ROTARY TORQUE, AND ROTATIONAL SPEED. PROVIDE THIS ELECTRONIC INFORMATION TO TRANS MOUNTAIN REPRESENTATIVE AND ALSO SUBMIT AS A PART OF THE AS-BUILT RECORDS REQUIRED AT THE END OF THE PROJECT.
B5. THE CONTRACTOR SHALL SUPPLY AND USE AN APPROVED ANNULAR PRESSURE TOOL WITH THE CONTRACTOR SUPPLIED ANNULAR PRESSURE MODEL.
B6. ALL EQUIPMENT SHALL BE SUPPLIED IN GOOD WORKING ORDER MAINTAINED AND SERVICED. ANY EQUIPMENT NOT OPERATIONAL OR FULFILLING THE REQUIREMENTS OUTLINED IN THE CONTRACT DOCUMENTS SHALL BE REPAIRED OR REPLACED.
B7. SURFACE CASING, IF REQUIRED TO ASSIST/SECURE DRILLING FLUID CIRCULATION OR TO PREVENT HOLE COLLAPSING NEAR THE SURFACE, SHOULD BE DETERMINED BY CONTRACTOR AND APPROVED BY TRANS MOUNTAIN REPRESENTATIVE.
B8. THE CONTRACTOR SHALL SUPPLY A CASING PLAN (IF REQUIRED) WHICH SHALL INCLUDE SIZE OF CASING, INSTALLATION METHOD, CLEANOUT PROCEDURE, REMOVAL PROCEDURE, AND A DESCRIPTION OF THE CENTRALIZING CASING TO BE USED.
B9. THE PILOT HOLE SHALL BE INSTALLED AS CLOSE AS PRACTICAL TO THE PROPOSED DESIGN DRILL PATH WITH THE DESIGN INFORMATION SHOWN ON THE DRAWING. HORIZONTAL DEVIATION GREATER THAN ±2.0 m SHALL BE APPROVED BY TRANS MOUNTAIN REPRESENTATIVE PRIOR TO COMPLETION OF DRILL. DRILL PATH VERTICAL DEVIATION SHALL BE WITHIN ±2.0 m RADIAL DISTANCE OF THE DESIGN DRILL PATH. UNDER NO CIRCUMSTANCES SHALL THE PIPELINE BE INSTALLED OUTSIDE THE LEGAL PIPELINE EASEMENT.
B10. MINIMUM DEPTH OF COVER TO BE THE GREATER OF THIS DRAWING OR AS SPECIFIED IN CROSSING AGREEMENTS.
B11. THE DESIGN RADIUS FOR THE CROSSING IS 950 m. THE PILOT HOLE SHALL ADHERE TO THE FOLLOWING TOLERANCES:
- THE SINGLE JOINT RADIUS SHALL NOT BE LESS THAN 600.0 m.
- THE THREE JOINTS RADIUS SHALL NOT BE LESS THAN 800.0 m.

B12. THE MAKE-UP SECTION WILL LIKELY BE PLACED ON EXIT SIDE.

ENVIRONMENTAL NOTES

C1. DISPOSAL OF DRILLING FLUID AND CUTTINGS WILL BE CONDUCTED IN A MANNER THAT ADHERES TO BRITISH COLUMBIA OIL AND GAS HANDBOOK – DRILLING WASTE MANAGEMENT CHAPTER.
C2. TO MINIMIZE THE POTENTIAL FOR INADVERTENT FLUID RELEASE TO SURFACE, CONTRACTOR SHALL ENSURE THAT MUD PRESSURE IS KEPT TO THE MINIMUM REQUIREMENT FOR CUTTINGS RETURN AND FOR MAINTAINING A CLEAN HOLE AND IN ACCORDANCE WITH THE CONTRACTOR SUPPLIED ANNULAR PRESSURE MODEL.
C3. FRAC WALKS SHALL BE CONDUCTED EVERY 4 HOURS (AS A MINIMUM), OR IMMEDIATELY AFTER A LOSS OF FLUID EVENT.
C4. SUITABLE EMERGENCY SPILL KITS ARE REQUIRED TO BE MAINTAINED ON SITE AT ALL TIMES.

GEOTECHNICAL INFORMATION

D1. GEOTECHNICAL BOREHOLE DATA ON THE DRAWING IS PROVIDED FOR INFORMATIONAL PURPOSES ONLY. FOR COMPLETE SOIL INFORMATION AND GROUNDWATER CONDITIONS, THE CONTRACTOR SHALL REFER TO GEOTECHNICAL REPORT 01-13283-S5A-M002-PL-MEM-0243 REV 0, FOR TRANS MOUNTAIN EXPANSION PROJECT – SPREAD 5A – GEOTECHNICAL ASSESSMENT KP852 TRENCHLESS CROSSING (JACKO HILL), DATED JUNE 15, 2023. ALL GEOTECHNICAL INFORMATION PROVIDED BY THURBER ENGINEERING LTD.

LEGEND

- ℄ TMEP NPS 36 PIPELINE
- ℄ HDD ALIGNMENT
- ℄ MICROTUNNEL ALIGNMENT
- GEOTECHNICAL BOREHOLE

HDD FEATURE COORDINATES
(NAD83 UTM ZONE 10N)

	EASTING	NORTHING
ENTRY	682818.4	5611026.0
0+000	682752.9	5610951.2
EXIT	682521.3	5610686.4

BOREHOLE LOCATION
(NAD83 UTM ZONE 10N)

BOREHOLES	EASTING	NORTHING
SH21-5A-19-TEL-JL-KP851+931(BH2)	682810.6	5611039.4
SH21-5A-19-TEL-JL-KP852+390(BH14)	682538.1	5610672.8

PROJECT PIPE SPECIFICATIONS

PRODUCT	LOW VAPOUR PRESSURE (LVP) LIQUID HYDROCARBONS	
CLASS LOCATION DESIGNATION	N/A	
DESIGN PRESSURE	9,930 kPa	
MAXIMUM OPERATING PRESSURE	VARYING POINT-SPECIFIC PRESSURE (SEE NOTE A9)	
MINIMUM TEST PRESSURE	VARYING POINT-SPECIFIC PRESSURE (SEE NOTE A9)	
MINIMUM OPERATING TEMPERATURE	5 °C	
MAXIMUM OPERATING TEMPERATURE	38 °C	
PIPELINE DATA	CARRIER PIPE	
	LINE PIPE	HEAVY WALL PIPE
OUTSIDE DIAMETER OF PIPE (mm)	914.4 (NPS 36)	914.4 (NPS 36)
PIPE WALL THICKNESS (mm)	–	19.0
MINIMUM YIELD STRENGTH (MPa)	483	483
PIPE MATERIAL	STEEL, CSA Z245.1 (GRADE 483, CAT II)	
COATING	FUSION BOND EPOXY (FBE), ABRASION RESISTANT OVERCOAT (ARO)	
CATHODIC PROTECTION	IMPRESSED CURRENT	

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
Z. [illegible]
35516
June 22, 2023. Rev. 0

PERMIT TO PRACTICE
UPI PROJECTS CANADA LTD.
PERMIT NUMBER: 1001209
THE ASSOCIATION OF PROFESSIONAL ENGINEERS AND GEOSCIENTISTS OF THE PROVINCE OF BRITISH COLUMBIA

UPI DWG. No.: 19731-505-HDW-00162

CLIENT ACCEPTANCE

NO.	DATE	REVISION	ACC
0	23/06/22	ISSUED FOR CONSTRUCTION, AFE 01-13283	bk

NO.	REFERENCE DRAWING TITLE	REFERENCE DRAWING NO.	NO	DATE	REVISION	DRN	CHK	ENG	APPR
1	ALIGNMENT SHEET	M002-PA0311701	0	23/06/22	ISSUED FOR CONSTRUCTION, AFE 01-13283	XW	RGR	PL	HB

TRANSMOUNTAIN

DRAWN BY BF	TRANS MOUNTAIN EXPANSION PROJECT PLANS AND PROFILES JACKO HILL d-044-E/92-I-9	SHEET SIZE A1
CHECKED BY RGR		SCALE AS SHOWN
APPROVED BY HB		DATE 23/05/11

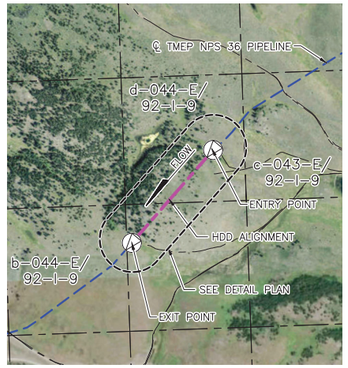
PROJECT CODING	DRAWING NUMBER			
AFE	FACILITY ID	DOCUMENT NO	SHT NO	REV
01-13283	M002	XD00162	01	0

P:\19731 - Kinder Morgan TMX\81 Drafting\505 Pipeline Drawings\HDW - Horizontal Directional Drill\Spread 5A\M002-XD00162\01.dwg, 6/22/2023 10:52:05 AM, xiule.wang

Appendix E – IFC Design Drawing

Contents

Issued For Construction Design Drawing

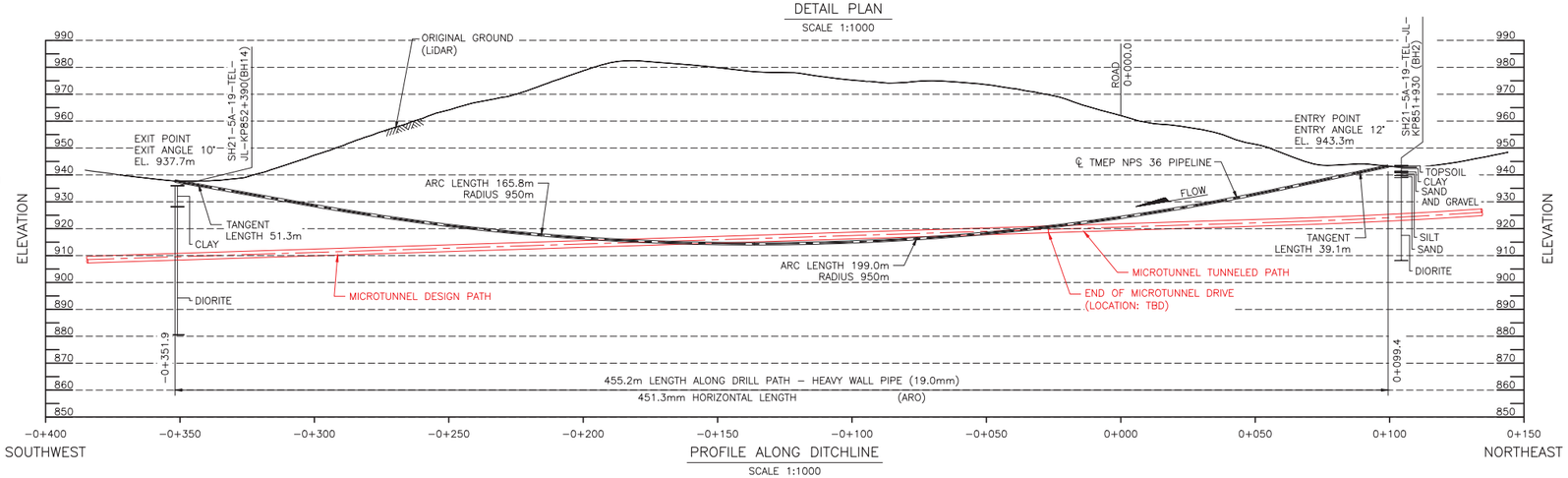


LOCATION PLAN

SCALE 1:10000
d–044–E/92–I–9
CITY OF KAMLOOPS
NAD83 UTM ZONE 10N
APPROX. TMEP KP 852.3

DETAIL PLAN

SCALE 1:1000



PROFILE ALONG DITCHLINE

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A4. THE CONTRACTOR SHALL ENSURE ALL UTILITIES ARE PROTECTED AND MAINTAINED THROUGH THE CONSTRUCTION PROCESS.
A5. THE CONTRACTOR SHALL ENSURE THAT COPIES OF THE CROSSING AGREEMENTS ARE KEPT ON SITE FOR THE FULL DURATION OF THE CONSTRUCTION ACTIVITIES. CONTRACTOR SHALL ADHERE TO ALL REQUIREMENTS OF THE CROSSING AGREEMENTS.
A6. SURVEYED BASE PLANS ARE BASED ON BASE PLAN 38290–BASE–92I9E R5 DATED MAY 31, 2022, PROVIDED BY GEOVERRA SURVEY (BC) LTD. PARTNERSHIP. THE GROUND PROFILE WAS BASED ON SURVEY DWG 01–13283–M002–XD0510101.DWG DATED MAY 18, 2022, PROVIDED BY ADIT ENGINEERING. THE IMAGERY IS SUPPLIED BY AEROQUEST MAPCON, DATED 2019.
A7. CONSTRUCTION SHALL BE COMPLETED IN ACCORDANCE WITH CSA Z662 (CURRENT VERSION), AND THE MOST RECENT VERSIONS OF ALL PROVINCIAL AND FEDERAL REGULATIONS, ENVIRONMENTAL PROTECTION PLAN (EPP), CONTRACT DOCUMENTS, AND THE AUTHORITIES HAVING JURISDICTION.
A8. THE CONTRACTOR SHALL SUPPLY AND ADHERE TO THE CONTRACTOR SUPPLIED AND APPROVED DRILLING EXECUTION PLAN.
A9. AS PER 01–13283–SG–M002–PL–DCN–0005, THE PIPELINE WILL BE TESTED AND OPERATED BASED ON POINT–SPECIFIC MAXIMUM OPERATING PRESSURE (BASED ON THE APPROVED FINAL HYDROSTATIC TEST). MINIMUM TEST PRESSURE WILL BE BASED ON ELEVATION PROFILES BETWEEN PUMP STATIONS.

CONSTRUCTION NOTES

B1. CONSTRUCTION METHOD FOR THIS CROSSING IS THE HORIZONTAL DIRECTIONAL DRILL METHOD (HDD). FOR HDD CONSTRUCTION SPECIFICATIONS REFER TO THE CONTRACT DOCUMENTS.
B2. THE CONTRACTOR SHALL VERIFY ALL TOPOGRAPHICAL SURVEY INFORMATION AND CONFIRM THE DEPTH AND LOCATION OF ALL BURIED FACILITIES IN THE FIELD PRIOR TO CONSTRUCTION.
B3. THE CONTRACTOR SHALL SUPPLY A DRILL RIG WITH A MINIMUM OF 400,000 LBF (1,779kN) PUSH/PULL WITH APPROPRIATE ASSOCIATED EQUIPMENT AS OUTLINED IN THE SPECIFICATIONS. THE THEORETICAL PULL FORCE FOR THIS CROSSING IS 320,000 LBF (1,423 kN) WITHOUT BUOYANCY CONTROL AND 260,000 LBF (1,157 kN) WITH 100% BUOYANCY CONTROL.
B4. THE CONTRACTOR SHALL SUPPLY AN ELECTRONIC DRILLING RECORDER (EDR) TO MONITOR AT A MINIMUM, TANK/PIT VOLUME, FLOW (PUMP AND RETURN), PRESSURE (ANNULAR/STANDPIPE), RATE OF PENETRATION, PUSH/PULL FORCE, ROTARY TORQUE, AND ROTATIONAL SPEED. PROVIDE THIS ELECTRONIC INFORMATION TO TRANS MOUNTAIN REPRESENTATIVE AND ALSO SUBMIT AS A PART OF THE AS–BUILT RECORDS REQUIRED AT THE END OF THE PROJECT.
B5. THE CONTRACTOR SHALL SUPPLY AND USE AN APPROVED ANNULAR PRESSURE TOOL WITH THE CONTRACTOR SUPPLIED ANNULAR PRESSURE MODEL.
B6. ALL EQUIPMENT SHALL BE SUPPLIED IN GOOD WORKING ORDER MAINTAINED AND SERVICED. ANY EQUIPMENT NOT OPERATIONAL OR FULFILLING THE REQUIREMENTS OUTLINED IN THE CONTRACT DOCUMENTS SHALL BE REPAIRED OR REPLACED.
B7. SURFACE CASING, IF REQUIRED TO ASSIST/SECURE DRILLING FLUID CIRCULATION OR TO PREVENT HOLE COLLAPSING NEAR THE SURFACE, SHOULD BE DETERMINED BY CONTRACTOR AND APPROVED BY TRANS MOUNTAIN REPRESENTATIVE.
B8. THE CONTRACTOR SHALL SUPPLY A CASING PLAN (IF REQUIRED) WHICH SHALL INCLUDE SIZE OF CASING, INSTALLATION METHOD, CLEANOUT PROCEDURE, REMOVAL PROCEDURE, AND A DESCRIPTION OF THE CENTRALIZING CASING TO BE USED.
B9. THE PILOT HOLE SHALL BE INSTALLED AS CLOSE AS PRACTICAL TO THE PROPOSED DESIGN DRILL PATH WITH THE DESIGN INFORMATION SHOWN ON THE DRAWING. HORIZONTAL DEVIATION GREATER THAN ±2.0 m SHALL BE APPROVED BY TRANS MOUNTAIN REPRESENTATIVE PRIOR TO COMPLETION OF DRILL. DRILL PATH VERTICAL DEVIATION SHALL BE WITHIN ±2.0 m RADIAL DISTANCE OF THE DESIGN DRILL PATH. UNDER NO CIRCUMSTANCES SHALL THE PIPELINE BE INSTALLED OUTSIDE THE LEGAL PIPELINE EASEMENT.
B10. MINIMUM DEPTH OF COVER TO BE THE GREATER OF THIS DRAWING OR AS SPECIFIED IN CROSSING AGREEMENTS.
B11. THE DESIGN RADIUS FOR THE CROSSING IS 950 m. THE PILOT HOLE SHALL ADHERE TO THE FOLLOWING TOLERANCES:
– THE SINGLE JOINT RADIUS SHALL NOT BE LESS THAN 600.0 m.
– THE THREE JOINTS RADIUS SHALL NOT BE LESS THAN 800.0 m.
B12. THE MAKE–UP SECTION WILL LIKELY BE PLACED ON EXIT SIDE.

ENVIRONMENTAL NOTES

C1. DISPOSAL OF DRILLING FLUID AND CUTTINGS WILL BE CONDUCTED IN A MANNER THAT ADHERES TO BRITISH COLUMBIA OIL AND GAS HANDBOOK – DRILLING WASTE MANAGEMENT CHAPTER.
C2. TO MINIMIZE THE POTENTIAL FOR INADVERTENT FLUID RELEASE TO SURFACE, CONTRACTOR SHALL ENSURE THAT MUD PRESSURE IS KEPT TO THE MINIMUM REQUIREMENT FOR CUTTINGS RETURN AND FOR MAINTAINING A CLEAN HOLE AND IN ACCORDANCE WITH THE CONTRACTOR SUPPLIED ANNULAR PRESSURE MODEL.
C3. FRAC WALKS SHALL BE CONDUCTED EVERY 4 HOURS (AS A MINIMUM), OR IMMEDIATELY AFTER A LOSS OF FLUID EVENT.
C4. SUITABLE EMERGENCY SPILL KITS ARE REQUIRED TO BE MAINTAINED ON SITE AT ALL TIMES.

GEOTECHNICAL INFORMATION

D1. GEOTECHNICAL BOREHOLE DATA ON THE DRAWING IS PROVIDED FOR INFORMATIONAL PURPOSES ONLY. FOR COMPLETE SOIL INFORMATION AND GROUNDWATER CONDITIONS, THE CONTRACTOR SHALL REFER TO GEOTECHNICAL REPORT 01–13283–S5A–M002–PL–MEM–0243 REV 0, FOR TRANS MOUNTAIN EXPANSION PROJECT – SPREAD 5A – GEOTECHNICAL ASSESSMENT KP852 TRENCHLESS CROSSING (JACKO HILL), DATED JUNE 15, 2023. ALL GEOTECHNICAL INFORMATION PROVIDED BY THURBER ENGINEERING LTD.

LEGEND

- ℄ TMEP NPS 36 PIPELINE
- ℄ HDD ALIGNMENT
- ℄ MICROTUNNEL ALIGNMENT
- GEOTECHNICAL BOREHOLE

HDD FEATURE COORDINATES
(NAD83 UTM ZONE 10N)

	EASTING	NORTHING
ENTRY	682818.4	5611026.0
0+000	682752.9	5610951.2
EXIT	682521.3	5610686.4

BOREHOLE LOCATION
(NAD83 UTM ZONE 10N)

BOREHOLES	EASTING	NORTHING
SH21–5A–19–TEL–JL–KP851+931(BH2)	682810.6	5611039.4
SH21–5A–19–TEL–JL–KP852+390(BH14)	682538.1	5610672.8

PROJECT PIPE SPECIFICATIONS

PRODUCT	LOW VAPOUR PRESSURE (LVP) LIQUID HYDROCARBONS	
CLASS LOCATION DESIGNATION	N/A	
DESIGN PRESSURE	9,930 kPa	
MAXIMUM OPERATING PRESSURE	VARYING POINT–SPECIFIC PRESSURE (SEE NOTE A9)	
MINIMUM TEST PRESSURE	VARYING POINT–SPECIFIC PRESSURE (SEE NOTE A9)	
MINIMUM OPERATING TEMPERATURE	5 °C	
MAXIMUM OPERATING TEMPERATURE	38 °C	
PIPELINE DATA	CARRIER PIPE	
	LINE PIPE	HEAVY WALL PIPE
OUTSIDE DIAMETER OF PIPE (mm)	914.4 (NPS 36)	914.4 (NPS 36)
PIPE WALL THICKNESS (mm)	–	19.0
MINIMUM YIELD STRENGTH (MPa)	483	483
PIPE MATERIAL	STEEL, CSA Z245.1 (GRADE 483, CAT II)	
COATING	FUSION BOND EPOXY (FBE), ABRASION RESISTANT OVERCOAT (ARO)	
CATHODIC PROTECTION	IMPRESSED CURRENT	

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
Z. ZHANG
39516
June 22, 2023. Rev. 0

PERMIT TO PRACTICE
UPI PROJECTS CANADA LTD.
PERMIT NUMBER: 1001209
THE ASSOCIATION OF PROFESSIONAL ENGINEERS AND GEOSCIENTISTS OF THE PROVINCE OF BRITISH COLUMBIA

UPI DWG. No.: 19731–505–HDW–00162

CLIENT ACCEPTANCE

NO.	DATE	REVISION	ACC
0	23/06/22	ISSUED FOR CONSTRUCTION, AFE 01–13283	bk

NO.	REFERENCE DRAWING TITLE	REFERENCE DRAWING NO.	NO	DATE	REVISION	DRN	CHK	ENG	APPR
1	ALIGNMENT SHEET	M002–PA0311701	0	23/06/22	ISSUED FOR CONSTRUCTION, AFE 01–13283	XW	RGR	PL	HB

TRANSMOUNTAIN

DRAWN BY BF	TRANS MOUNTAIN EXPANSION PROJECT PLANS AND PROFILES JACKO HILL d–044–E/92–I–9	SHEET SIZE A1
CHECKED BY RGR		SCALE AS SHOWN
APPROVED BY HB		DATE 23/05/11

PROJECT CODING	DRAWING NUMBER			
AFE	FACILITY ID	DOCUMENT NO	SHT NO	REV
01–13283	M002	XD00162	01	0

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