1 INTRODUCTION

Rig owner intends to replace existing Choke and Kill lines of 6.75inh outer diameter (4.5 inch inner diameter). Lines of 6.25 inch outer diameter (4.0 inch inner diameter) are readily available. A study is conducted to determine the effect on the mud flow rate due to change in inner diameter. This documents presents the findings along with the methodology used for the flow rate evaluation.

2 SUMMARY

Due to change in inner diameter from 4.5 inch to 4.0 inch, the impact on the flow rate is as follows:

- Assuming same power/energy allocated for pumping through choke line (before and after change out), the maximum decrease in flow rate is approximately 26%. Analysis is conducted for varying flow rates up to 10 bbl/min;
- Assuming same flow rate is maintained for 4 inch ID, the friction losses increases by a factor of 1.75;
- Assuming constant friction energy loss, the 26% decrease in flow rate is conservative. Decrease in flow rate (and associated velocity) will also decrease friction loss in other regions (rig piping, annulus flow below mudline and downhole) and thus reallocates power utilized to overcome various friction sources. This reallocation of more power for C/K friction loss will tend to improve the flow rate. However, a more detailed annulus loss evaluation is recommended based on rig pump capacity, expected well depth, flow rates and other parameters;
- The pump power requirements to maintain the same flow rate in the 4 Inch ID pipe can also evaluated if required.

3 DESIGN BASIS AND METHODOLOGY

3.1 Design Data

The existing C/K pipe dimensions (ID of 4.5 inch) are shown in Figure 1 while the potential pipe dimensions (4.0 inch) are shown in Figure 2.

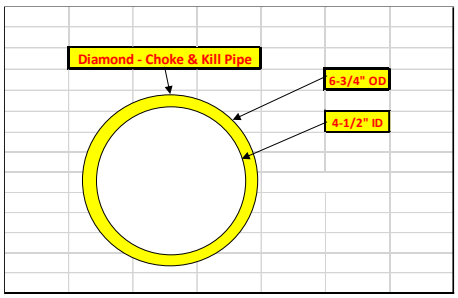

Figure 1 – Existing Pipe

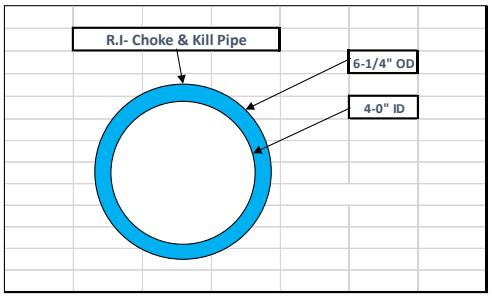

Figure 2 – Potential Pipe

The water depth, fluid properties and flow rate data considered for analysis is provided in Table 1.

Water Depth	Fluid Properties		Flow Rate
	Fluid Density	Fluid Viscosity	
500 ft	12.0 ppg	30.0 cP	0.2 bbl/min
2000 ft	13.0 ppg	40.0 cP	1.0 bbl/min
4000 ft	14.0 ppg	50.0 cP	2.0 bbl/min
6000 ft	15.0 ppg	60.0 cP	3.0 bbl/min
8000 ft			5.0 bbl/min
10000 ft			8.0 bbl/min
			10.0 bbl/min

Table 1 – Design Data Points

3.2 Flow Rate and Pressure Loss Calculation

The flow rate and pressure loss calculations are performed based on classical fluid mechanics internal flow through a pipe, [1]. The following outputs are evaluated

- The pressure (head) loss is determined in the C/K lines for various flow rate conditions;
- The increase in head loss due to change in inner diameter is also evaluated;
- The decrease in flow rate to ensure the head loss remains the same is also evaluated and presented;
- A detailed example calculation is provided in Appendix A.

3.3 Energy Allocation

The pumping energy is typically used in the following manner:

- Rig Piping

- Choke/Kill (C/K) or both lines
- Annulus Friction Pressure loss below mudline
- Downhole losses (if any)

With change in inner diameter of C/K lines, the other sources of pressure loss are assumed to remain the same. However, note that the energy consumed by other sources marginally decreases but is not evaluated and the results provided by the calculation are conservative.

Only one pipe (Choke line) circulation scenarios is considered for analysis. However, two pipe (choke/Kill) circulation flow rate and pressure loss trends are expected to be the same.

3.4 References

[1] Fluid Mechanics: Fundamentals and Applications, 2nd Edition, Yunus A. Cengel, John M. Cimbala, McGraw-Hill, 2010

4 RESULTS

Flow rate and pressure calculations are performed and the findings are provided below:

- The decrease in flow rate (> 3 bbl/min) for all conditions considered is approximately 26%. The flow rate decrease for 4000 ft water depth is shown in Figure 3.
- The increase in pressure loss requirements for all conditions considered is 75%. The increase in pressure loss for 4000 ft is shown in Figure 4.
- Analysis results for range of parameters considered is given in Appendix B.

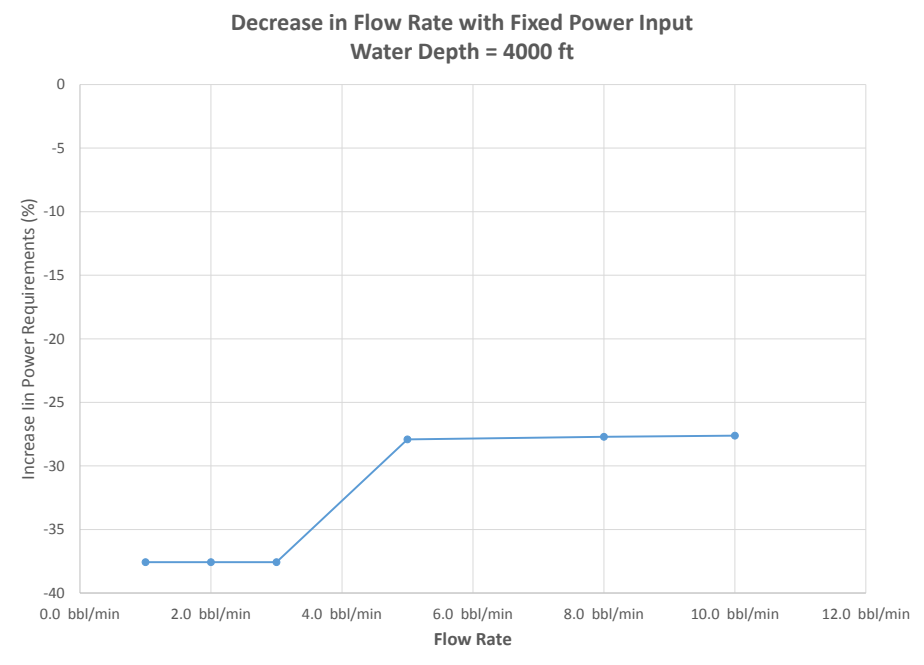

Figure 3 – Decrease in Flow Rate for 4000 ft Water Depth

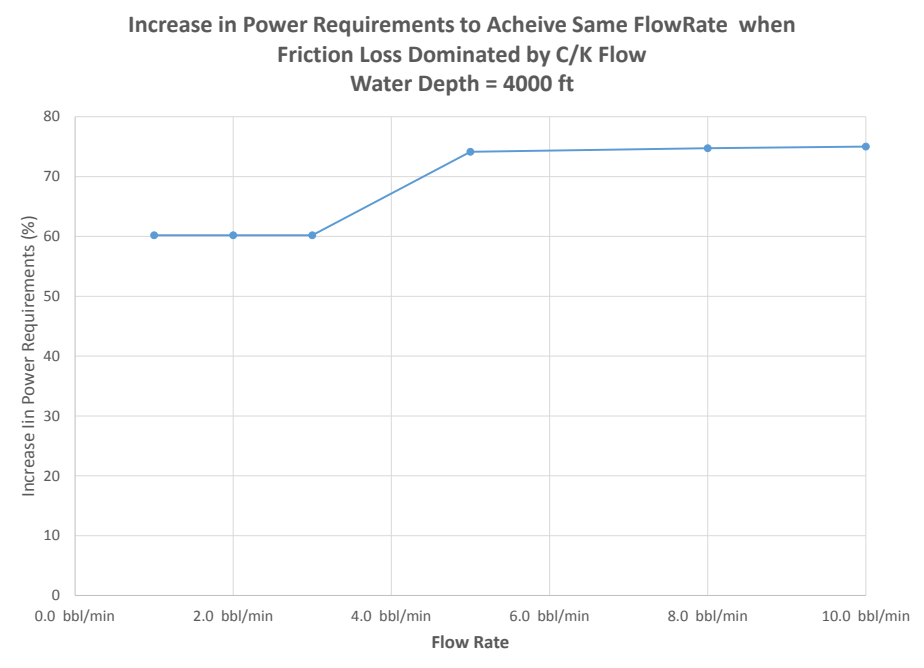

Figure 4 – Increase in Power Requirements for 4000 ft Water Depth

APPENDIX A – FRICTION LOSS AND FLOW RATE CALCULATION

Objective:	To quantify the friction loss in the a pipe due to mud flow					
Constants and Conversions	**Diamond**	**RI - Power**	**RI - Velocity**	**Comments**		
Acceleration due to gravity	9.81 m/s2	9.81 m/s2	9.81 m/s2			
Water Depth	10000 ft	10000 ft	10000 ft			
	3048 m	3048 m	3048 m			
Pipe Data						
Inner Diameter	4.50 inch	4.00 inch	4.00 inch			
Inner Diameter	0.114 m	0.102 m	0.102 m			
Internal Area	0.0103 m2	0.0081 m2	0.0081 m2			
Roughness - commercial steel, e	0.045 mm	0.045 mm	0.045 mm	Assumed		
	4.5E-05 m	4.5E-05 m	4.5E-05 m			
e/D	0.0004	0.0004	0.0004			
Fluid Properties						
Mud Weight	15.0 ppg	15.0 ppg	15.0 ppg	Parametrize		
Density	1797.4 kg/m3	1797.4 kg/m3	1797.4 kg/m3			
Dynamic (Absolute) Viscosity	60.0 cP	60.0 cP	60.0 cP	Parametrize		
	0.060 Pa.s	0.060 Pa.s	0.060 Pa.s			
Flow Parameters						
Flow rate	10.00 bbl/min	10.00 bbl/min	7.24 bbl/min	Parametrize	Typ. 1-4 bbl/min	
	0.026 m3/s	0.026 m3/s	0.019 m3/s			
U	2.6 m/s	3.3 m/s	2.4 m/s			
Reynolds Number	8.84E+03	9.95E+03	7.20E+03			
Type of Flow	**Turbulent**	**Turbulent**	**Turbulent**			
Friction Factor - Laminar	**0.0072**	**0.0064**	**0.0089**			
Friction Factor - Turbulent	**0.0324**	**0.0315**	**0.0343**	Explicit Haaland Equation, [1]		
Friction Loss, H_L	293.65 m	513.94 m	293.70 m	$\frac{1}{\sqrt{f}} \cong -1.8 \log\left[\frac{6.9}{\mathrm{Re}} + \left(\frac{\varepsilon/D}{3.7}\right)^{1.11}\right]$ Explicit Haaland equation		
	5.18 MPa	9.06 MPa	5.18 MPa			
% Increase in Friction Loss		**75.02**	0.02			
Kinetic Energy - Head	0.34 m	0.54 m	0.29 m			
Potential Energy - Head	3048 m	3048 m	3048 m			
Total - Head	3342 m	3562 m	3342 m			
% Max decrease in velocity with Constant power			**-27.6**			

APPENDIX B – SENSITIVITY ANALYSIS

Results for varying water depth, fluid properties, flowrate are given in this section.

Water Depth	Fluid Density	Fluid Viscosity	Basecase Flow Rate	Friction Loss	% increase in power requirements for C/K loss	% Max decrease in flow rate with Constant power
500 ft	12.0 ppg	30.0 cP	0.2 bbl/min	0.00 MPa	60.2	-37.6
500 ft	12.0 ppg	30.0 cP	1.0 bbl/min	0.00 MPa	60.2	-48.7
500 ft	12.0 ppg	30.0 cP	2.0 bbl/min	0.01 MPa	248.8	-37.6
500 ft	12.0 ppg	30.0 cP	3.0 bbl/min	0.02 MPa	74.1	-28.8
500 ft	12.0 ppg	30.0 cP	5.0 bbl/min	0.06 MPa	74.7	-27.0
500 ft	12.0 ppg	30.0 cP	8.0 bbl/min	0.12 MPa	75.3	-27.7
500 ft	12.0 ppg	30.0 cP	10.0 bbl/min	0.18 MPa	75.7	-27.5
500 ft	13.0 ppg	40.0 cP	0.2 bbl/min	0.00 MPa	60.2	-37.6
500 ft	13.0 ppg	40.0 cP	1.0 bbl/min	0.00 MPa	60.2	-48.7
500 ft	13.0 ppg	40.0 cP	2.0 bbl/min	0.01 MPa	60.2	-37.6
500 ft	13.0 ppg	40.0 cP	3.0 bbl/min	0.03 MPa	73.8	-22.7
500 ft	13.0 ppg	40.0 cP	5.0 bbl/min	0.06 MPa	74.5	-27.9
500 ft	13.0 ppg	40.0 cP	8.0 bbl/min	0.14 MPa	75.1	-27.8
500 ft	13.0 ppg	40.0 cP	10.0 bbl/min	0.21 MPa	75.4	-27.6
500 ft	14.0 ppg	50.0 cP	0.2 bbl/min	0.00 MPa	60.2	-37.6
500 ft	14.0 ppg	50.0 cP	1.0 bbl/min	0.00 MPa	60.2	-48.7
500 ft	14.0 ppg	50.0 cP	2.0 bbl/min	0.01 MPa	60.2	-37.6
500 ft	14.0 ppg	50.0 cP	3.0 bbl/min	0.01 MPa	260.6	-37.6
500 ft	14.0 ppg	50.0 cP	5.0 bbl/min	0.07 MPa	74.3	-27.7
500 ft	14.0 ppg	50.0 cP	8.0 bbl/min	0.16 MPa	74.9	-27.8
500 ft	14.0 ppg	50.0 cP	10.0 bbl/min	0.23 MPa	75.2	-27.6
500 ft	15.0 ppg	60.0 cP	0.2 bbl/min	0.00 MPa	60.2	-37.6
500 ft	15.0 ppg	60.0 cP	1.0 bbl/min	0.01 MPa	60.2	-37.6
500 ft	15.0 ppg	60.0 cP	2.0 bbl/min	0.01 MPa	60.2	-37.6
500 ft	15.0 ppg	60.0 cP	3.0 bbl/min	0.02 MPa	60.2	-37.6
500 ft	15.0 ppg	60.0 cP	5.0 bbl/min	0.08 MPa	74.1	-27.8
500 ft	15.0 ppg	60.0 cP	8.0 bbl/min	0.18 MPa	74.7	-27.8
500 ft	15.0 ppg	60.0 cP	10.0 bbl/min	0.26 MPa	75.0	-27.7
2000 ft	12.0 ppg	30.0 cP	0.2 bbl/min	0.00 MPa	60.2	-37.6
2000 ft	12.0 ppg	30.0 cP	1.0 bbl/min	0.01 MPa	60.2	-37.6
2000 ft	12.0 ppg	30.0 cP	2.0 bbl/min	0.02 MPa	248.8	-37.6
2000 ft	12.0 ppg	30.0 cP	3.0 bbl/min	0.09 MPa	74.1	-28.3
2000 ft	12.0 ppg	30.0 cP	5.0 bbl/min	0.22 MPa	74.7	-27.8

Water Depth	Fluid Density	Fluid Viscosity	Basecase Flow Rate	Friction Loss	% increase in power requirements for C/K loss	% Max decrease in flow rate with Constant power
2000 ft	12.0 ppg	30.0 cP	8.0 bbl/min	0.50 MPa	75.3	-27.5
2000 ft	12.0 ppg	30.0 cP	10.0 bbl/min	0.73 MPa	75.7	-27.5
2000 ft	13.0 ppg	40.0 cP	0.2 bbl/min	0.00 MPa	60.2	-37.6
2000 ft	13.0 ppg	40.0 cP	1.0 bbl/min	0.02 MPa	60.2	-37.6
2000 ft	13.0 ppg	40.0 cP	2.0 bbl/min	0.03 MPa	60.2	-37.6
2000 ft	13.0 ppg	40.0 cP	3.0 bbl/min	0.11 MPa	73.8	-22.7
2000 ft	13.0 ppg	40.0 cP	5.0 bbl/min	0.25 MPa	74.5	-27.9
2000 ft	13.0 ppg	40.0 cP	8.0 bbl/min	0.57 MPa	75.1	-27.6
2000 ft	13.0 ppg	40.0 cP	10.0 bbl/min	0.84 MPa	75.4	-27.6
2000 ft	14.0 ppg	50.0 cP	0.2 bbl/min	0.00 MPa	60.2	-37.6
2000 ft	14.0 ppg	50.0 cP	1.0 bbl/min	0.02 MPa	60.2	-37.6
2000 ft	14.0 ppg	50.0 cP	2.0 bbl/min	0.04 MPa	60.2	-37.6
2000 ft	14.0 ppg	50.0 cP	3.0 bbl/min	0.06 MPa	260.6	-37.6
2000 ft	14.0 ppg	50.0 cP	5.0 bbl/min	0.28 MPa	74.3	-27.7
2000 ft	14.0 ppg	50.0 cP	8.0 bbl/min	0.64 MPa	74.9	-27.7
2000 ft	14.0 ppg	50.0 cP	10.0 bbl/min	0.94 MPa	75.2	-27.6
2000 ft	15.0 ppg	60.0 cP	0.2 bbl/min	0.00 MPa	60.2	-37.6
2000 ft	15.0 ppg	60.0 cP	1.0 bbl/min	0.02 MPa	60.2	-37.6
2000 ft	15.0 ppg	60.0 cP	2.0 bbl/min	0.05 MPa	60.2	-37.6
2000 ft	15.0 ppg	60.0 cP	3.0 bbl/min	0.07 MPa	60.2	-37.6
2000 ft	15.0 ppg	60.0 cP	5.0 bbl/min	0.32 MPa	74.1	-27.8
2000 ft	15.0 ppg	60.0 cP	8.0 bbl/min	0.70 MPa	74.7	-27.7
2000 ft	15.0 ppg	60.0 cP	10.0 bbl/min	1.04 MPa	75.0	-27.7
4000 ft	12.0 ppg	30.0 cP	0.2 bbl/min	0.00 MPa	60.2	-37.6
4000 ft	12.0 ppg	30.0 cP	1.0 bbl/min	0.02 MPa	60.2	-37.6
4000 ft	12.0 ppg	30.0 cP	2.0 bbl/min	0.05 MPa	248.8	-37.6
4000 ft	12.0 ppg	30.0 cP	3.0 bbl/min	0.18 MPa	74.1	-27.9
4000 ft	12.0 ppg	30.0 cP	5.0 bbl/min	0.44 MPa	74.7	-27.7
4000 ft	12.0 ppg	30.0 cP	8.0 bbl/min	0.99 MPa	75.3	-27.5
4000 ft	12.0 ppg	30.0 cP	10.0 bbl/min	1.47 MPa	75.7	-27.5
4000 ft	13.0 ppg	40.0 cP	0.2 bbl/min	0.01 MPa	60.2	-37.6
4000 ft	13.0 ppg	40.0 cP	1.0 bbl/min	0.03 MPa	60.2	-37.6
4000 ft	13.0 ppg	40.0 cP	2.0 bbl/min	0.06 MPa	60.2	-37.6
4000 ft	13.0 ppg	40.0 cP	3.0 bbl/min	0.21 MPa	73.8	-22.7
4000 ft	13.0 ppg	40.0 cP	5.0 bbl/min	0.51 MPa	74.5	-27.9
4000 ft	13.0 ppg	40.0 cP	8.0 bbl/min	1.14 MPa	75.1	-27.6
4000 ft	13.0 ppg	40.0 cP	10.0 bbl/min	1.68 MPa	75.4	-27.5

Water Depth	Fluid Density	Fluid Viscosity	Basecase Flow Rate	Friction Loss	% increase in power requirements for C/K loss	% Max decrease in flow rate with Constant power
4000 ft	14.0 ppg	50.0 cP	0.2 bbl/min	0.01 MPa	60.2	-37.6
4000 ft	14.0 ppg	50.0 cP	1.0 bbl/min	0.04 MPa	60.2	-37.6
4000 ft	14.0 ppg	50.0 cP	2.0 bbl/min	0.08 MPa	60.2	-37.6
4000 ft	14.0 ppg	50.0 cP	3.0 bbl/min	0.12 MPa	260.6	-37.6
4000 ft	14.0 ppg	50.0 cP	5.0 bbl/min	0.57 MPa	74.3	-27.9
4000 ft	14.0 ppg	50.0 cP	8.0 bbl/min	1.27 MPa	74.9	-27.7
4000 ft	14.0 ppg	50.0 cP	10.0 bbl/min	1.88 MPa	75.2	-27.6
4000 ft	15.0 ppg	60.0 cP	0.2 bbl/min	0.01 MPa	60.2	-37.6
4000 ft	15.0 ppg	60.0 cP	1.0 bbl/min	0.05 MPa	60.2	-37.6
4000 ft	15.0 ppg	60.0 cP	2.0 bbl/min	0.09 MPa	60.2	-37.6
4000 ft	15.0 ppg	60.0 cP	3.0 bbl/min	0.14 MPa	60.2	-37.6
4000 ft	15.0 ppg	60.0 cP	5.0 bbl/min	0.63 MPa	74.1	-27.9
4000 ft	15.0 ppg	60.0 cP	8.0 bbl/min	1.41 MPa	74.7	-27.7
4000 ft	15.0 ppg	60.0 cP	10.0 bbl/min	2.07 MPa	75.0	-27.6
6000 ft	12.0 ppg	30.0 cP	0.2 bbl/min	0.01 MPa	60.2	-37.6
6000 ft	12.0 ppg	30.0 cP	1.0 bbl/min	0.03 MPa	60.2	-37.6
6000 ft	12.0 ppg	30.0 cP	2.0 bbl/min	0.07 MPa	248.8	-37.6
6000 ft	12.0 ppg	30.0 cP	3.0 bbl/min	0.28 MPa	74.1	-27.9
6000 ft	12.0 ppg	30.0 cP	5.0 bbl/min	0.66 MPa	74.7	-27.7
6000 ft	12.0 ppg	30.0 cP	8.0 bbl/min	1.49 MPa	75.3	-27.5
6000 ft	12.0 ppg	30.0 cP	10.0 bbl/min	2.20 MPa	75.7	-27.5
6000 ft	13.0 ppg	40.0 cP	0.2 bbl/min	0.01 MPa	60.2	-37.6
6000 ft	13.0 ppg	40.0 cP	1.0 bbl/min	0.05 MPa	60.2	-37.6
6000 ft	13.0 ppg	40.0 cP	2.0 bbl/min	0.09 MPa	60.2	-37.6
6000 ft	13.0 ppg	40.0 cP	3.0 bbl/min	0.32 MPa	73.8	-22.7
6000 ft	13.0 ppg	40.0 cP	5.0 bbl/min	0.76 MPa	74.5	-27.8
6000 ft	13.0 ppg	40.0 cP	8.0 bbl/min	1.71 MPa	75.1	-27.6
6000 ft	13.0 ppg	40.0 cP	10.0 bbl/min	2.51 MPa	75.4	-27.5
6000 ft	14.0 ppg	50.0 cP	0.2 bbl/min	0.01 MPa	60.2	-37.6
6000 ft	14.0 ppg	50.0 cP	1.0 bbl/min	0.06 MPa	60.2	-37.6
6000 ft	14.0 ppg	50.0 cP	2.0 bbl/min	0.12 MPa	60.2	-37.6
6000 ft	14.0 ppg	50.0 cP	3.0 bbl/min	0.17 MPa	260.6	-37.6
6000 ft	14.0 ppg	50.0 cP	5.0 bbl/min	0.85 MPa	74.3	-27.9
6000 ft	14.0 ppg	50.0 cP	8.0 bbl/min	1.91 MPa	74.9	-27.7
6000 ft	14.0 ppg	50.0 cP	10.0 bbl/min	2.81 MPa	75.2	-27.6
6000 ft	15.0 ppg	60.0 cP	0.2 bbl/min	0.01 MPa	60.2	-37.6
6000 ft	15.0 ppg	60.0 cP	1.0 bbl/min	0.07 MPa	60.2	-37.6

Water Depth	Fluid Density	Fluid Viscosity	Basecase Flow Rate	Friction Loss	% increase in power requirements for C/K loss	% Max decrease in flow rate with Constant power
6000 ft	15.0 ppg	60.0 cP	2.0 bbl/min	0.14 MPa	60.2	-37.6
6000 ft	15.0 ppg	60.0 cP	3.0 bbl/min	0.21 MPa	60.2	-37.6
6000 ft	15.0 ppg	60.0 cP	5.0 bbl/min	0.95 MPa	74.1	-27.9
6000 ft	15.0 ppg	60.0 cP	8.0 bbl/min	2.11 MPa	74.7	-27.7
6000 ft	15.0 ppg	60.0 cP	10.0 bbl/min	3.11 MPa	75.0	-27.6
8000 ft	12.0 ppg	30.0 cP	0.2 bbl/min	0.01 MPa	60.2	-37.6
8000 ft	12.0 ppg	30.0 cP	1.0 bbl/min	0.05 MPa	60.2	-37.6
8000 ft	12.0 ppg	30.0 cP	2.0 bbl/min	0.09 MPa	248.8	-37.6
8000 ft	12.0 ppg	30.0 cP	3.0 bbl/min	0.37 MPa	74.1	-27.9
8000 ft	12.0 ppg	30.0 cP	5.0 bbl/min	0.88 MPa	74.7	-27.7
8000 ft	12.0 ppg	30.0 cP	8.0 bbl/min	1.99 MPa	75.3	-27.5
8000 ft	12.0 ppg	30.0 cP	10.0 bbl/min	2.94 MPa	75.7	-27.5
8000 ft	13.0 ppg	40.0 cP	0.2 bbl/min	0.01 MPa	60.2	-37.6
8000 ft	13.0 ppg	40.0 cP	1.0 bbl/min	0.06 MPa	60.2	-37.6
8000 ft	13.0 ppg	40.0 cP	2.0 bbl/min	0.12 MPa	60.2	-37.6
8000 ft	13.0 ppg	40.0 cP	3.0 bbl/min	0.43 MPa	73.8	-22.7
8000 ft	13.0 ppg	40.0 cP	5.0 bbl/min	1.01 MPa	74.5	-27.8
8000 ft	13.0 ppg	40.0 cP	8.0 bbl/min	2.27 MPa	75.1	-27.6
8000 ft	13.0 ppg	40.0 cP	10.0 bbl/min	3.35 MPa	75.4	-27.5
8000 ft	14.0 ppg	50.0 cP	0.2 bbl/min	0.02 MPa	60.2	-37.6
8000 ft	14.0 ppg	50.0 cP	1.0 bbl/min	0.08 MPa	60.2	-37.6
8000 ft	14.0 ppg	50.0 cP	2.0 bbl/min	0.15 MPa	60.2	-37.6
8000 ft	14.0 ppg	50.0 cP	3.0 bbl/min	0.23 MPa	260.6	-37.6
8000 ft	14.0 ppg	50.0 cP	5.0 bbl/min	1.14 MPa	74.3	-27.9
8000 ft	14.0 ppg	50.0 cP	8.0 bbl/min	2.55 MPa	74.9	-27.7
8000 ft	14.0 ppg	50.0 cP	10.0 bbl/min	3.75 MPa	75.2	-27.6
8000 ft	15.0 ppg	60.0 cP	0.2 bbl/min	0.02 MPa	60.2	-37.6
8000 ft	15.0 ppg	60.0 cP	1.0 bbl/min	0.09 MPa	60.2	-37.6
8000 ft	15.0 ppg	60.0 cP	2.0 bbl/min	0.19 MPa	60.2	-37.6
8000 ft	15.0 ppg	60.0 cP	3.0 bbl/min	0.28 MPa	60.2	-37.6
8000 ft	15.0 ppg	60.0 cP	5.0 bbl/min	1.26 MPa	74.1	-27.9
8000 ft	15.0 ppg	60.0 cP	8.0 bbl/min	2.82 MPa	74.7	-27.7
8000 ft	15.0 ppg	60.0 cP	10.0 bbl/min	4.14 MPa	75.0	-27.6
10000 ft	12.0 ppg	30.0 cP	0.2 bbl/min	0.01 MPa	60.2	-37.6
10000 ft	12.0 ppg	30.0 cP	1.0 bbl/min	0.06 MPa	60.2	-37.6
10000 ft	12.0 ppg	30.0 cP	2.0 bbl/min	0.12 MPa	248.8	-37.6
10000 ft	12.0 ppg	30.0 cP	3.0 bbl/min	0.46 MPa	74.1	-27.9

Water Depth	Fluid Density	Fluid Viscosity	Basecase Flow Rate	Friction Loss	% increase in power requirements for C/K loss	% Max decrease in flow rate with Constant power
10000 ft	12.0 ppg	30.0 cP	5.0 bbl/min	1.10 MPa	74.7	-27.7
10000 ft	12.0 ppg	30.0 cP	8.0 bbl/min	2.48 MPa	75.3	-27.5
10000 ft	12.0 ppg	30.0 cP	10.0 bbl/min	3.67 MPa	75.7	-27.5
10000 ft	13.0 ppg	40.0 cP	0.2 bbl/min	0.02 MPa	60.2	-37.6
10000 ft	13.0 ppg	40.0 cP	1.0 bbl/min	0.08 MPa	60.2	-37.6
10000 ft	13.0 ppg	40.0 cP	2.0 bbl/min	0.15 MPa	60.2	-37.6
10000 ft	13.0 ppg	40.0 cP	3.0 bbl/min	0.53 MPa	73.8	-22.7
10000 ft	13.0 ppg	40.0 cP	5.0 bbl/min	1.26 MPa	74.5	-27.8
10000 ft	13.0 ppg	40.0 cP	8.0 bbl/min	2.84 MPa	75.1	-27.6
10000 ft	13.0 ppg	40.0 cP	10.0 bbl/min	4.19 MPa	75.4	-27.5
10000 ft	14.0 ppg	50.0 cP	0.2 bbl/min	0.02 MPa	60.2	-37.6
10000 ft	14.0 ppg	50.0 cP	1.0 bbl/min	0.10 MPa	60.2	-37.6
10000 ft	14.0 ppg	50.0 cP	2.0 bbl/min	0.19 MPa	60.2	-37.6
10000 ft	14.0 ppg	50.0 cP	3.0 bbl/min	0.29 MPa	260.6	-37.6
10000 ft	14.0 ppg	50.0 cP	5.0 bbl/min	1.42 MPa	74.3	-27.9
10000 ft	14.0 ppg	50.0 cP	8.0 bbl/min	3.19 MPa	74.9	-27.7
10000 ft	14.0 ppg	50.0 cP	10.0 bbl/min	4.69 MPa	75.2	-27.6
10000 ft	15.0 ppg	60.0 cP	0.2 bbl/min	0.02 MPa	60.2	-37.6
10000 ft	15.0 ppg	60.0 cP	1.0 bbl/min	0.12 MPa	60.2	-37.6
10000 ft	15.0 ppg	60.0 cP	2.0 bbl/min	0.23 MPa	60.2	-37.6
10000 ft	15.0 ppg	60.0 cP	3.0 bbl/min	0.35 MPa	60.2	-37.6
10000 ft	15.0 ppg	60.0 cP	5.0 bbl/min	1.58 MPa	74.1	-27.9
10000 ft	15.0 ppg	60.0 cP	8.0 bbl/min	3.52 MPa	74.7	-27.7
10000 ft	15.0 ppg	60.0 cP	10.0 bbl/min	5.18 MPa	75.0	-27.6