

Appendix C: Reservoir Characteristics & Recovery

Appendix C, Figure 1: Estimate Oil Reserves

Estimate of Oil Reserves

(as at)

Property

Field

Reservoir

Display Name

SOUTH HALF OF SECTION 8-2-28W1M

Well Name

Analysis Name

Analysis 1

Classification

General Formation Data

Top Formation (TVD)		ft(KB)		m(KB)
Btm Formation (TVD)		ft(KB)		m(KB)
Gas/Oil Contact (TVD)		ft(KB)		m(KB)
Oil/Water Contact (TVD)		ft(KB)		m(KB)

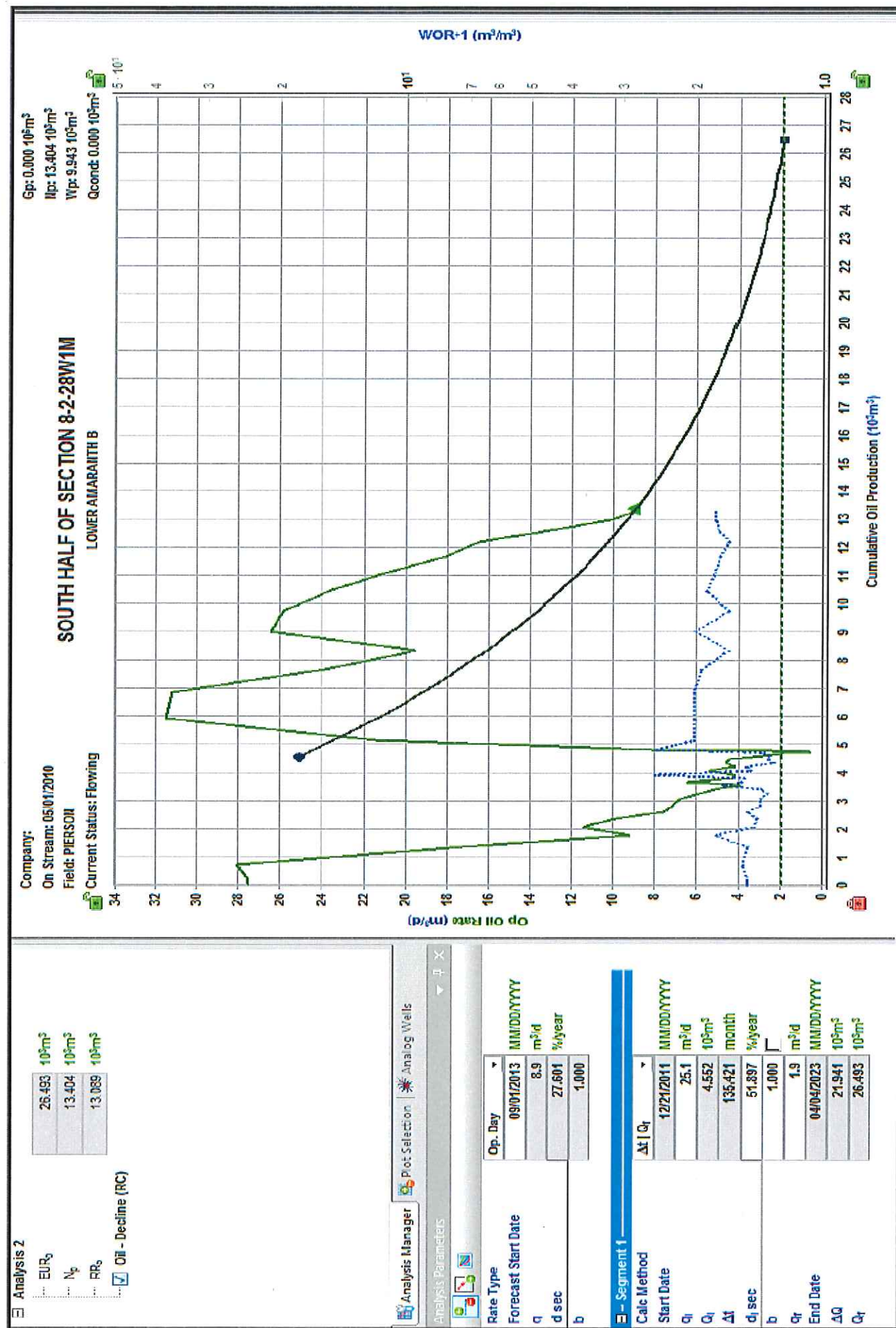
Reservoir Parameters

Total Porosity	14.0	%	14.0	%
Initial Oil Saturation	50.0	%	50.0	%
Initial Water Saturation	50.0	%	50.0	%
Initial Pressure	1247	psi(a)	8598	kPa(a)
Reservoir Temperature	102	°F	39	°C
Shrinkage	0.9346		0.9346	
R _s	104.435	scf/bbl	18.507	m ³ /m ³
Drainage Area	316	acres	128.0	ha
Net Pay	25.2	ft	7.7	m
Rock Volume	7977	acre-ft	984.00	ha-m
Original Oil-In-Place	4048.9	Mstb	643.7	10 ³ m ³
Oil Recovery Factor	4.1	%	4.1	%
Ultimate Recoverable Oil	166.8	Mstb	26.5	10 ³ m ³
Cumulative Oil Production	84.3	Mstb	13.4	10 ³ m ³
Remaining Recoverable Oil	82.5	Mstb	13.1	10 ³ m ³

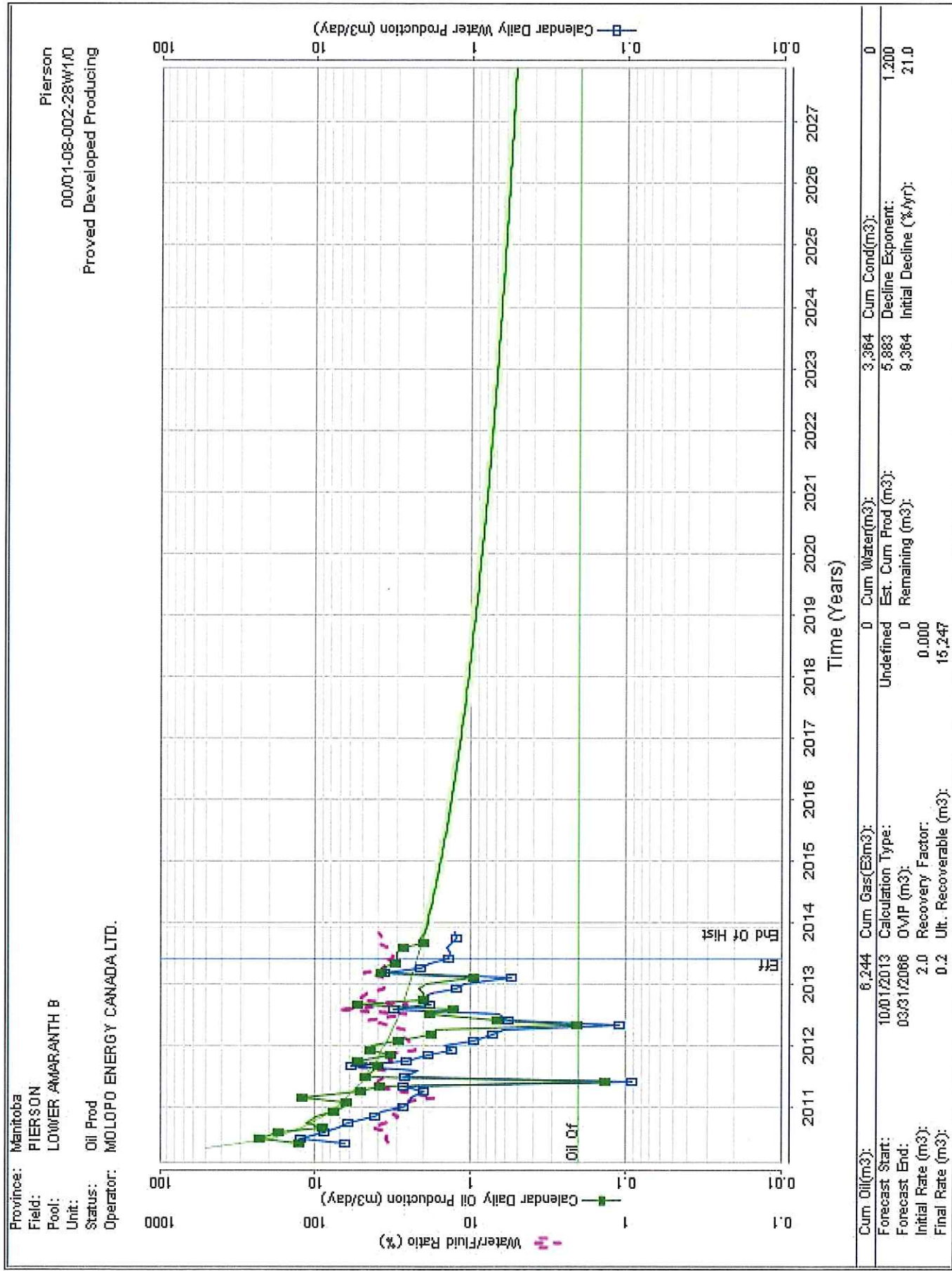
Oil Properties

Oil Gravity	35.00	°API	0.850	
Bubble Point Pressure	363	psi(a)	2500	kPa(a)

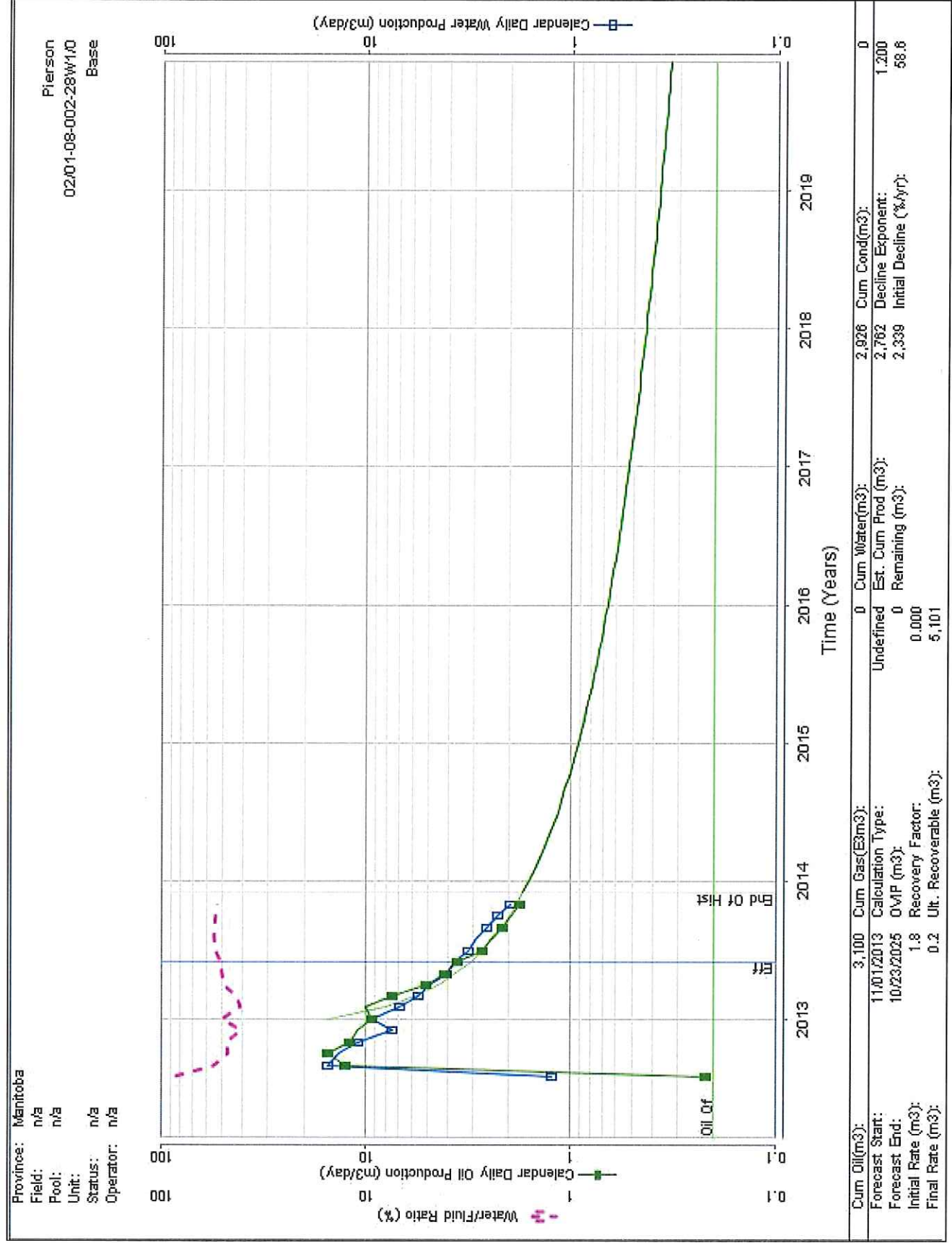
Appendix C, Figure 2: South half of 08-002-28W1 Group Production Plot



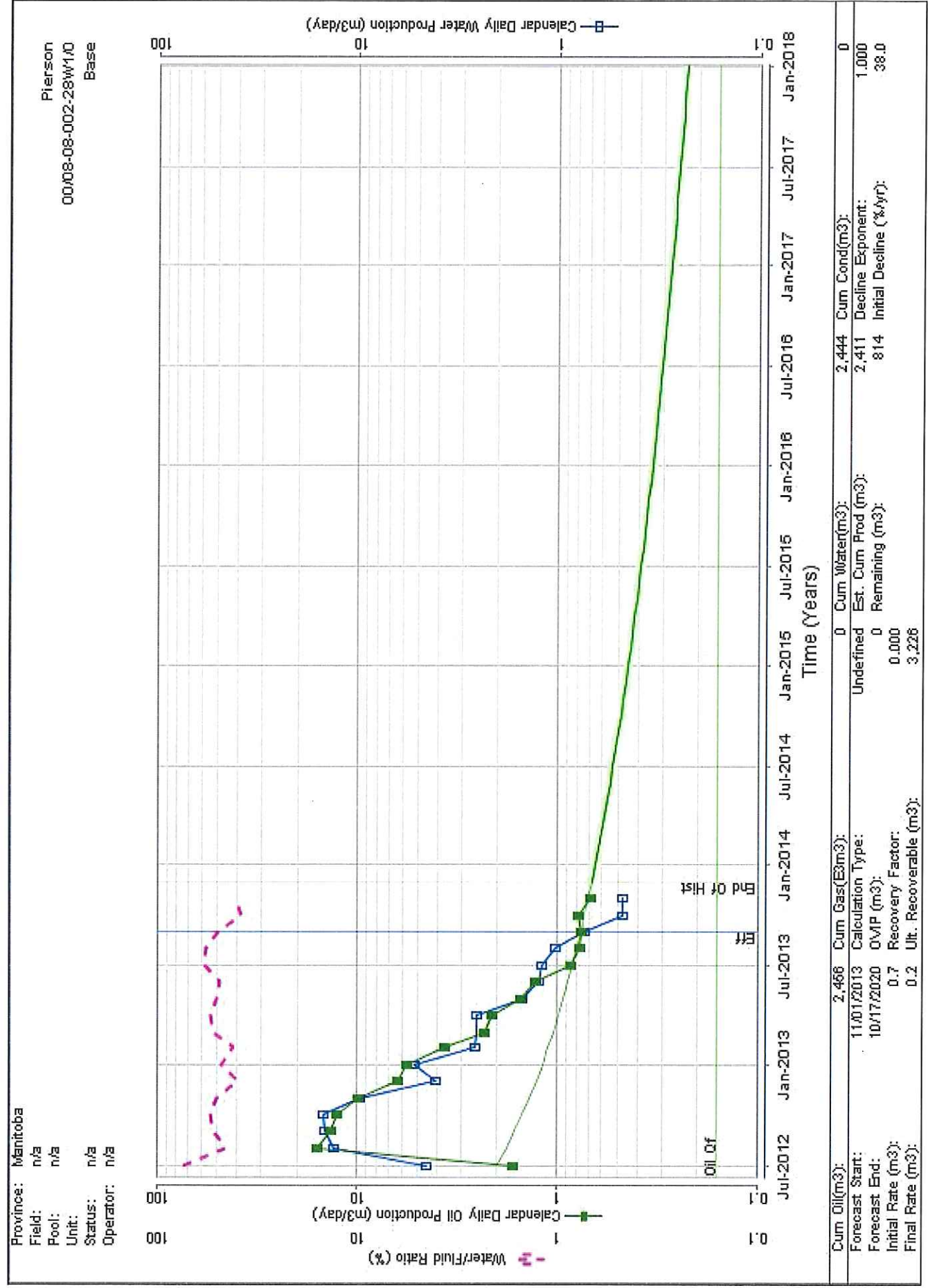
Appendix C, Figure 3: 00/01-08-002-28W1 Production Plot



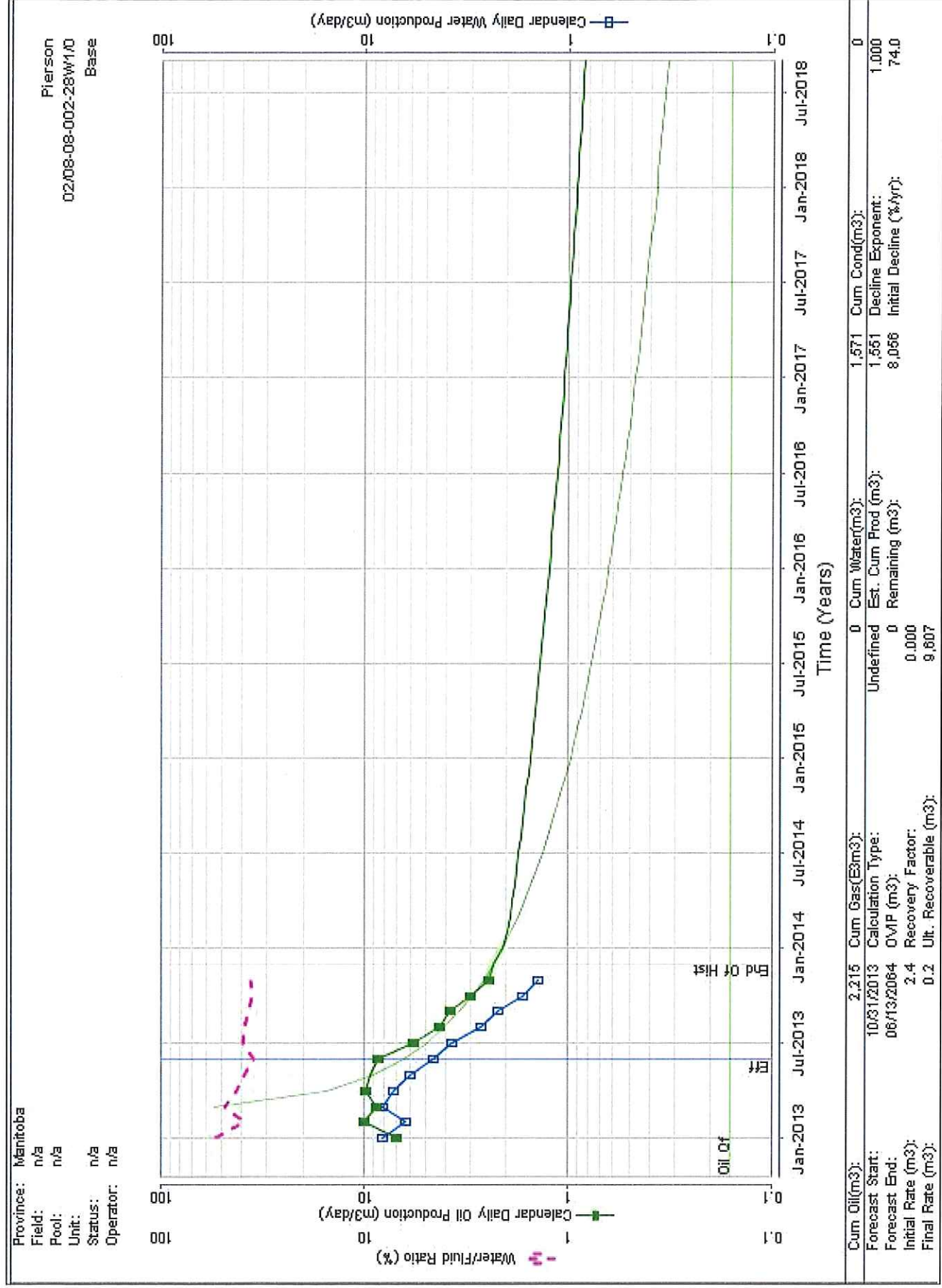
Appendix C, Figure 4: 02/01-08-002-28W1 Production Plot



Appendix C, Figure 5: 00/08-08-002-28W1 Production Plot

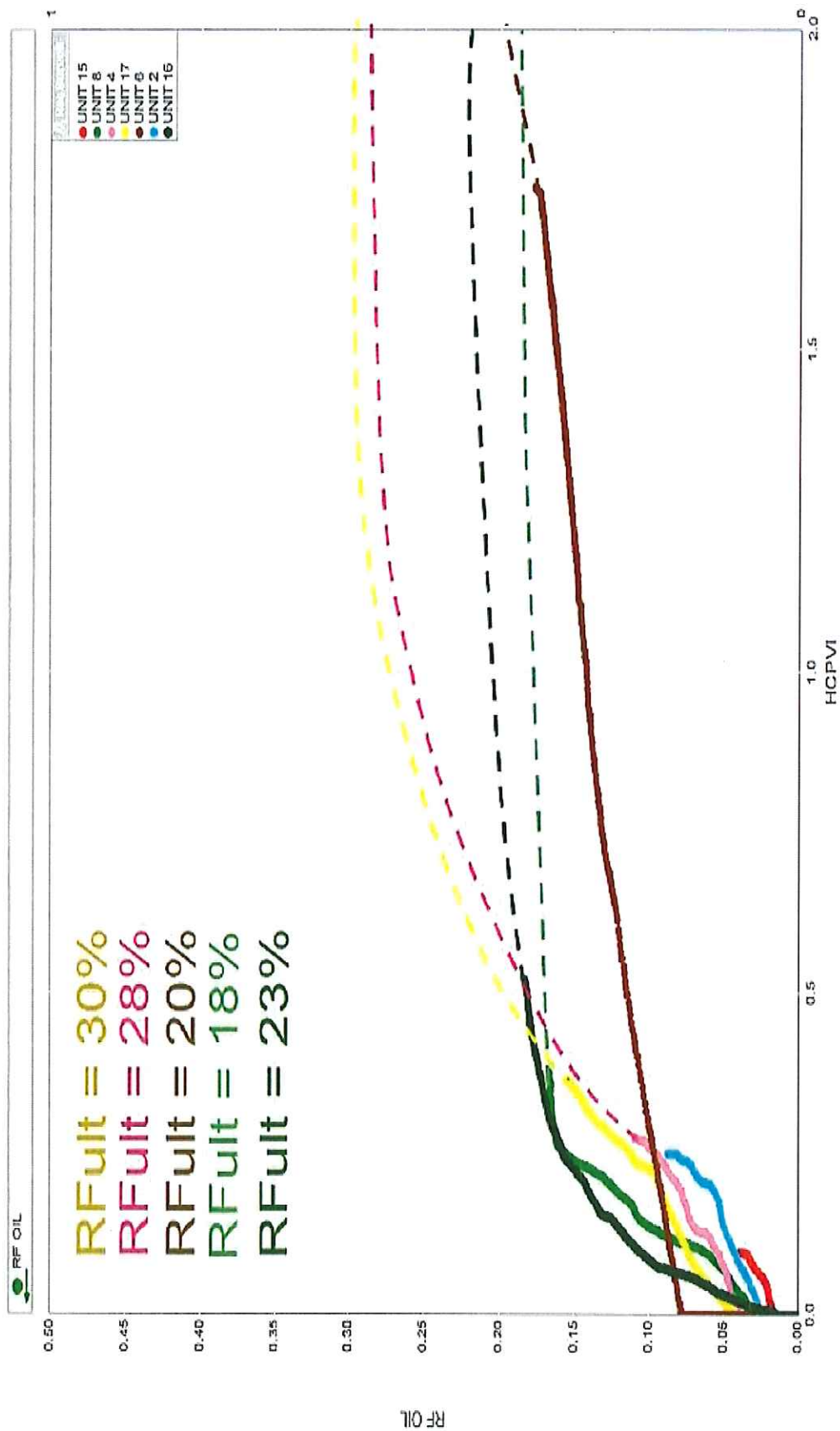


Appendix C, Figure 6: 02/08-08-002-28W1 Production Plot



Appendix C, Figure 7: Waterflood Recoveries within the Pierson field

**Gaffney,
Cline &
Associates**



Appendix C, Figure 8: Build-Up Test Results 100/08-08-002-28W1M

00/08-08-002-28W1/0
LEGACY PIERSON HZNTL 8-8-2-28
Lower Amaranth
November, 2013

Model Results

Number of Stages (n_s)	31	Reservoir Length (X_e)	1365.0 m
Number of Perforation Clusters (n_p)	1	Reservoir Width (Y_e)	200.0 m
No. of Fractures (n_f)	31	Single Stage Length (X_s)	44.0 m
Permeability x-direction (k_x)	0.1602 mD	Well Location in X-direction (X_w)	682.5 m
Permeability y-direction (k_y)	0.1369 mD	Well Location in Y-direction (Y_w)	100.0 m
Permeability z-direction (k_z)	mD	Well Location in Z-direction (Z_w)	3.5 m
Fracture Half Length (Y) ($(x_f)_y$)	15.6 m		
Dimensionless Fracture Conductivity (F_{CD})	1.503		
Effective Horizontal Well Length (X) (L_{ex})	1365.0 m		

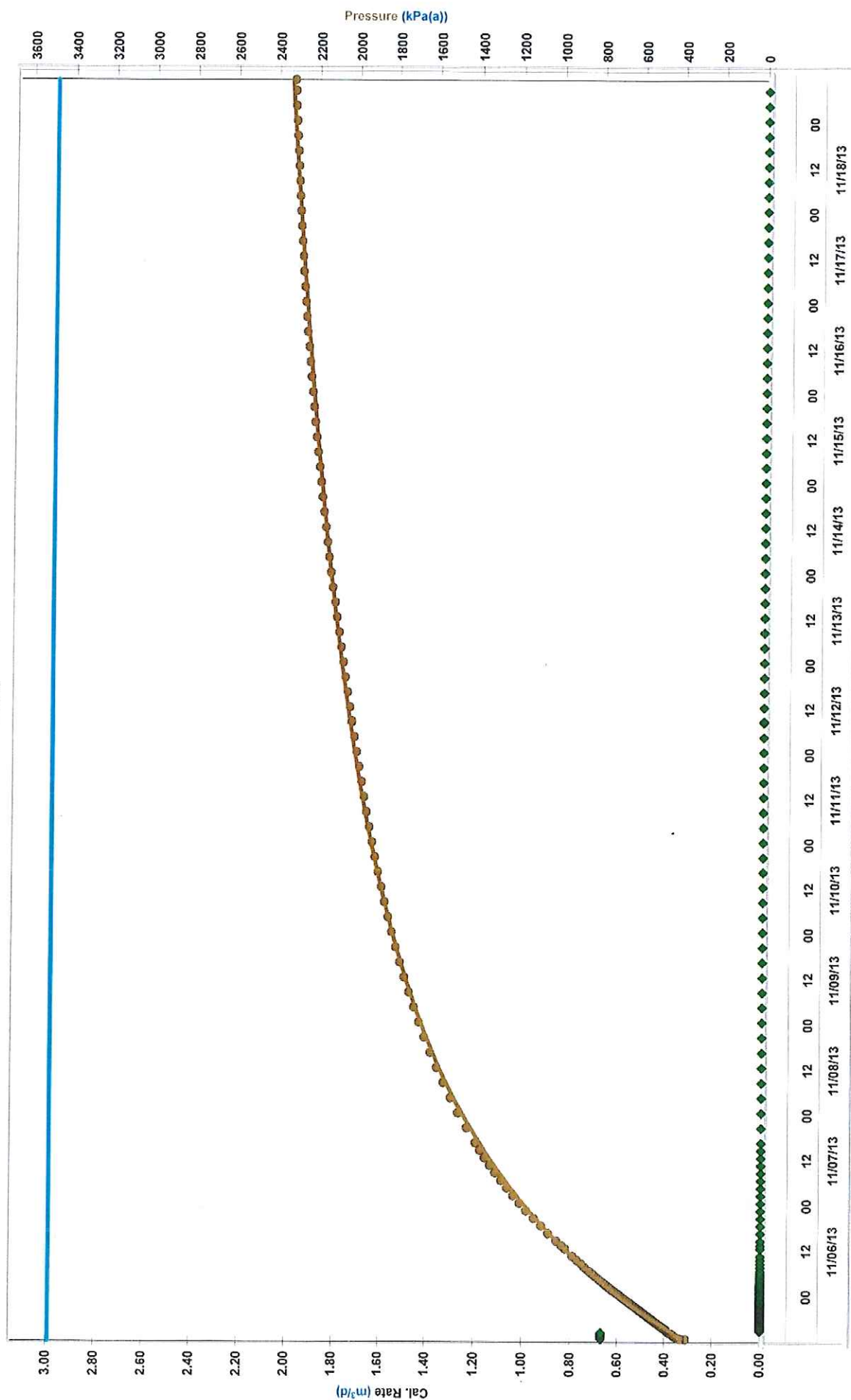
Reservoir Parameters

Initial Pressure (p_i)	8600.0 kPa(a)	Net Pay (h)	7.0 m
Reservoir Temperature (T_R)	38.0 °C	Total Porosity (ϕ_t)	14.00 %
		Wellbore Radius (r_w)	0.091 m
Dimensionless Storage 1 (C_D)	80409.4	Drainage Area (A)	27.3 ha
Dimensionless Storage 2 (C_{aD})	0.0		
Dimensionless Storage Parameter (C_{pD})	0.549	Original Oil-In-Place (OOIP)	127.980 10 ³ m ³
Turbulence Factor (D)	1/10 ³ m ³ /d		
Storativity Ratio (ω)		Gas Saturation (S_g)	0.00 %
Interporosity Coefficient (λ)		Oil Saturation (S_o)	50.00 %
Interporosity Skin ($s_{d\phi}$)		Water Saturation (S_w)	50.00 %
		Formation Compressibility (c_f)	6.1331e-07 1/kPa
		Total Compressibility (c_t)	9.8275e-07 1/kPa
		Gas Compressibility (c_g)	1.3447e-04 1/kPa
		Water Compressibility (c_w)	4.4610e-07 1/kPa
		Oil Compressibility (c_o)	2.9278e-07 1/kPa

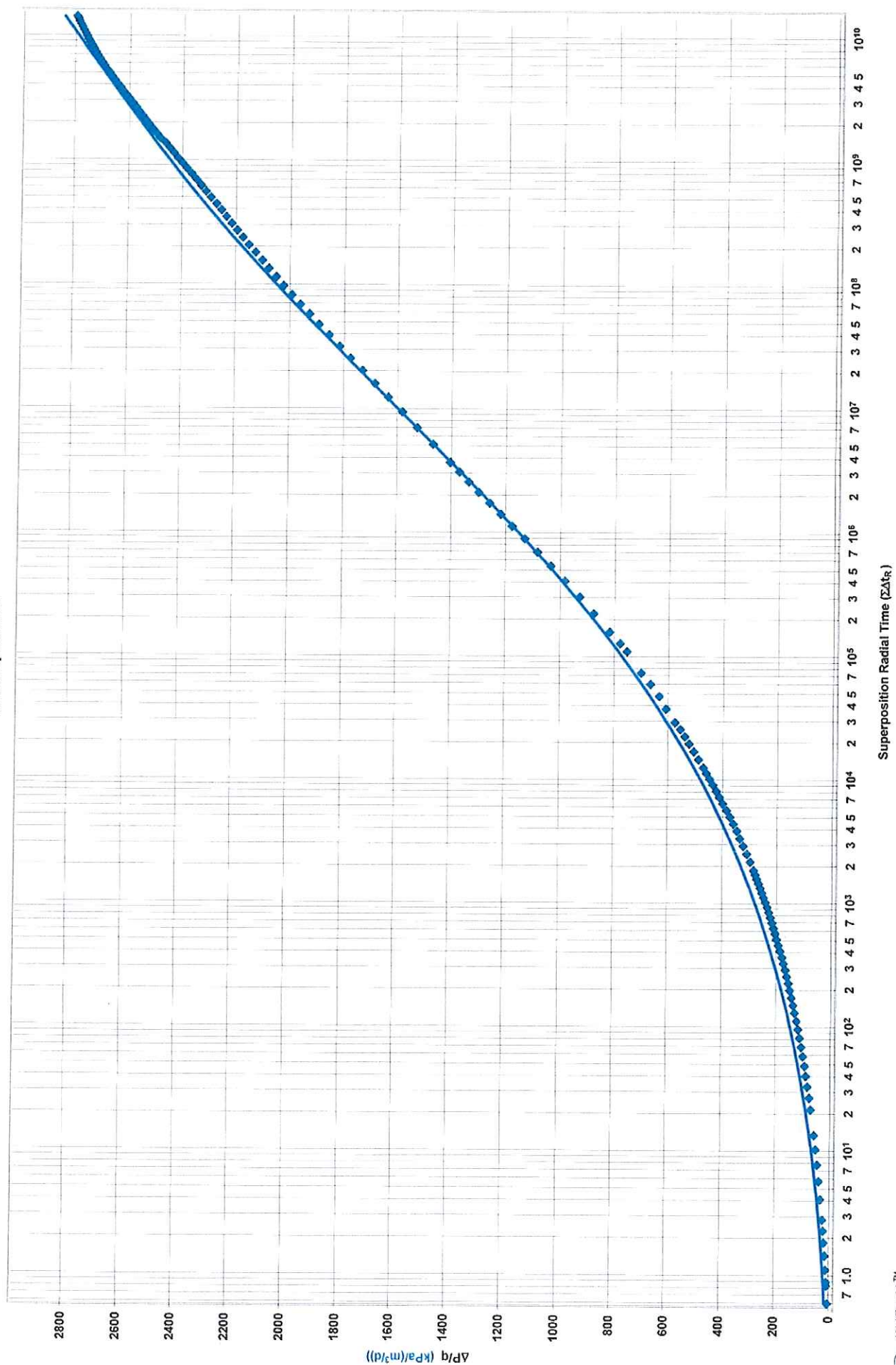
Fluid Properties

Reservoir Temperature (T_{resv})	38.0 °C
Reservoir Pressure (p_{resv})	2481 kPa(a)
Gas Gravity (γ_g)	0.650
N ₂	0.00 %
CO ₂	0.00 %
H ₂ S	0.00 %
Critical Temperature (T_c)	206.3 K
Critical Pressure (p_c)	4604 kPa(a)
Gas Formation Volume Factor (B_g)	4.1793e-02 m ³ /m ³
Gas Viscosity (μ_g)	11.3 µPa.s
Gas Compressibility (c_g)	4.2508e-04 1/kPa
Gas Compressibility Factor (z)	0.948
Gas Correlation	B.W.R. (Table)
Gas Viscosity Correlation	Carr et al

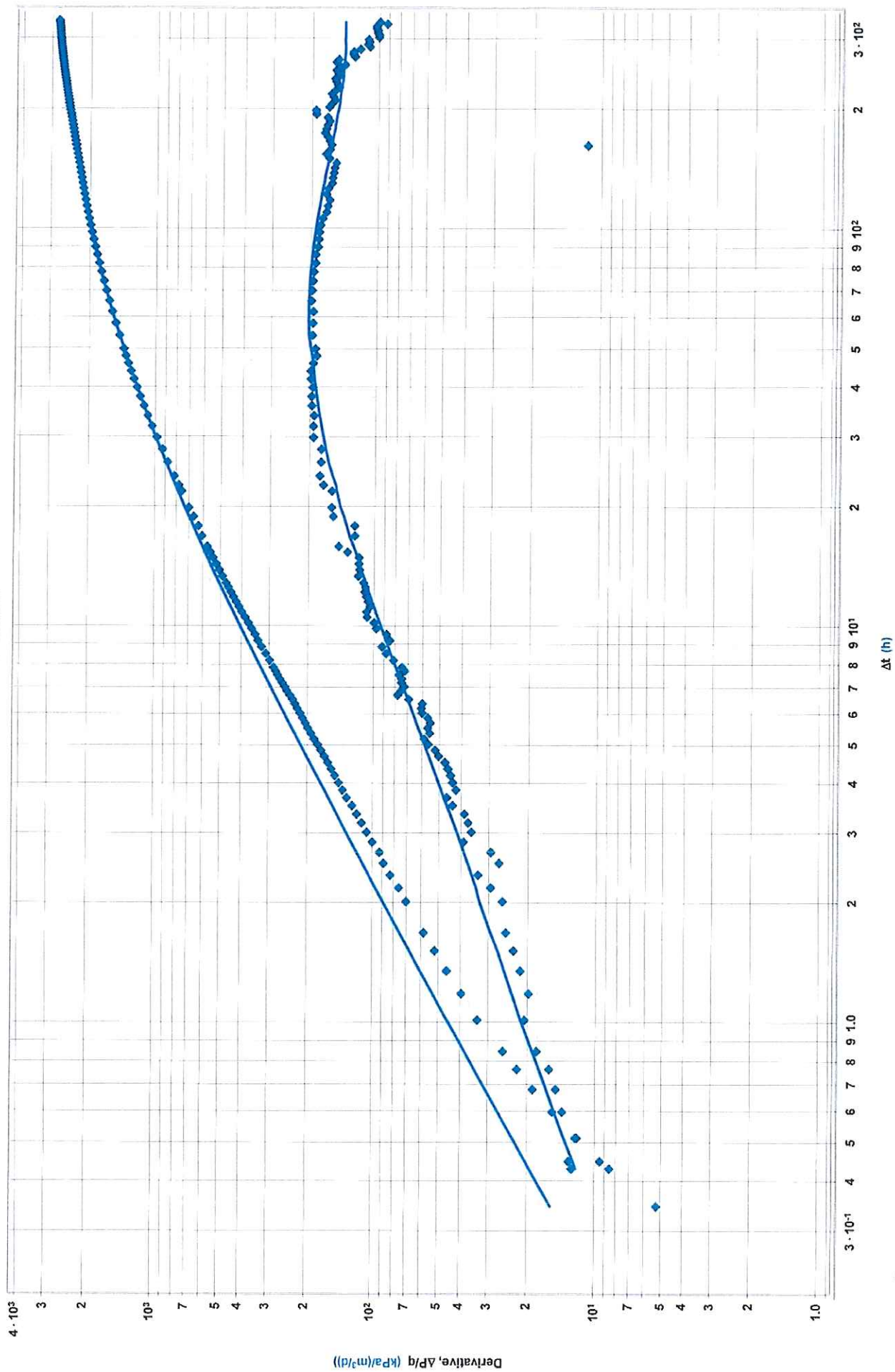
Oil AM-Multifrac-Repeating Pattern History



Oil AM-Multifrac-Repeating Pattern Radial Specialized



Oil AM-Multifrac-Repeating Pattern WellTest Derivative



Appendix C, Figure 9:

PVT Parameters for the Spearfish Formation from correlations and Gaffney, Cline and Associates Waterflood Pilot Feasibility Study prepared for Surge Energy on the Waskada Lower Amaranth Unit #15.

Pressure (kpa)	B_o (m^3/m^3)	B_g (m^3/m^3)	R_s (m^3/m^3)	Z	$1/B_g$ (m^3/m^3)	μ_o (mPa.s)
100	1.015	1.552	0.56	0.999	0.64	8.79
1000	1.045	0.110	9.65	0.995	9.06	5.47
1400	1.060	0.077	14.39	0.993	12.97	4.55
1800	1.076	0.059	19.40	0.991	16.89	3.86
2200	1.093	0.051	24.61	0.990	19.51	3.32
2600	1.110	0.043	30.01	0.989	23.44	2.90
3000	1.128	0.037	35.57	0.987	27.39	2.56
3400	1.146	0.032	41.26	0.986	31.35	2.29
3800	1.165	0.028	47.09	0.985	35.31	2.07
4200	1.184	0.025	53.03	0.984	39.28	1.88
4600	1.184	0.023	53.18	0.982	43.26	1.88
5000	1.183	0.021	53.18	0.981	47.24	1.89
5400	1.182	0.020	53.18	0.980	51.23	1.90
5800	1.181	0.018	53.18	0.979	55.22	1.91
6200	1.180	0.017	53.18	0.979	57.89	1.92
6600	1.179	0.016	53.18	0.978	61.89	1.92
7000	1.178	0.015	53.18	0.977	65.89	1.93
7400	1.177	0.014	53.18	0.976	69.90	1.94
7800	1.176	0.014	53.18	0.976	73.91	1.95
8200	1.175	0.013	53.18	0.975	77.92	1.96
8600	1.174	0.012	53.18	0.974	81.93	1.97