

**Waskada Unit No. 16**

**Waterflood Progress Report 2018**

**January 1<sup>st</sup> through December 31<sup>st</sup> 2018**

**Prepared for:**

**Manitoba Industry, Economic Development and Mines**

**Petroleum Branch**

**Prepared by:**

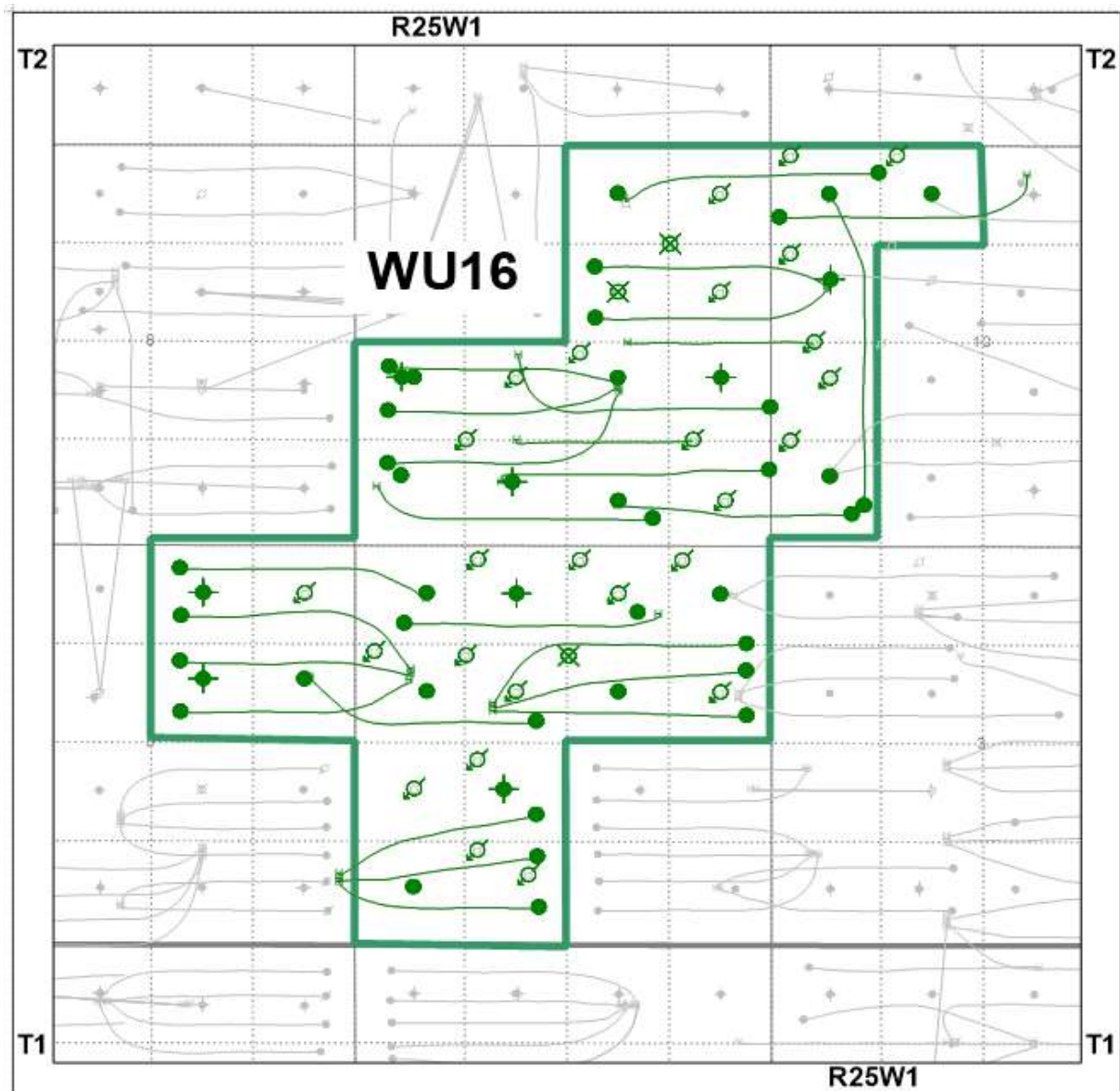
**Tundra Oil and Gas**

**June 17, 2019**

## INTRODUCTION

The Waskada Unit No.16 pressure maintenance project commenced water injection into the Lower Amaranth A pool in accordance with Manitoba Energy and Mines Order No. PM 57, dated May 1, 1987. This unit was enlarged on October 1, 1988 to its current boundary. Waskada Unit No. 16 was acquired from EOG Resources Canada Inc. effective October 1, 2014 with Tundra Oil and Gas (Tundra) as the new operator. THE EOR project area, outlined in green in Figure 1, contains 76 wells over 33 LSDs in Township 2, Range 25W1.

**Figure 1: Waskada Unit No. 16 Area Outline**



## Waskada Unit No. 16

Tundra Oil and Gas (Tundra), as the operator of the Waskada Unit No. 16 Enhanced Oil Recovery (EOR) project hereby submits the 2018 EOR report as per section 73 of the Drilling and Production Regulations.

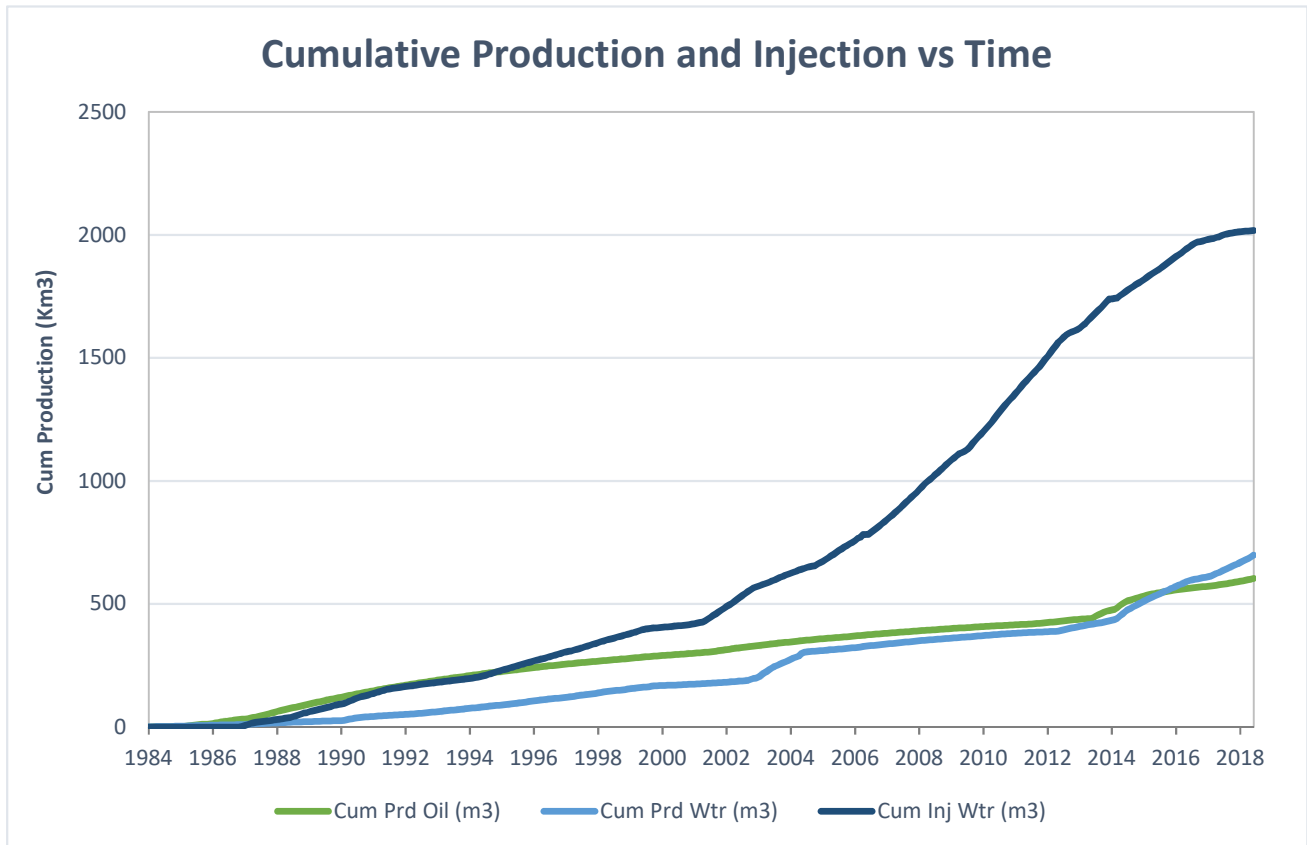
**a) Monthly oil and water production rates, injection rate, GOR and WOR**

MONTH	Cal Dly Oil m <sup>3</sup> /day	Cal Dly Wtr m <sup>3</sup> /day	Cal Inj Wtr m <sup>3</sup> /day	WOR m <sup>3</sup> /m <sup>3</sup>	GOR m <sup>3</sup> /m <sup>3</sup>
Jan-2018	51.52	177.35	137.47	3.44	0
Feb-2018	54.58	155.56	108.97	2.85	0
Mar-2018	65.45	180.86	69.60	2.76	0
Apr-2018	68.33	166.07	61.72	2.43	0
May-2018	64.00	158.74	55.67	2.48	0
Jun-2018	61.64	158.30	45.50	2.57	0
Jul-2018	65.63	184.42	40.98	2.81	0
Aug-2018	64.14	186.48	40.88	2.91	0
Sep-2018	71.31	175.51	39.97	2.46	0
Oct-2018	77.44	171.31	53.66	2.21	0
Nov-2018	71.49	202.95	57.27	2.84	0
Dec-2018	87.21	218.94	58.17	2.51	0

**b) Cumulative volume of oil, gas and water produced and fluid injected**

2018 PRODUCTION	
Produced Oil (m <sup>3</sup> )	24,449
Produced Gas (m <sup>3</sup> )	0
Produced Water (m <sup>3</sup> )	65,061
Fluid Injected (m <sup>3</sup> )	20,742
CUMULATIVE PRODUCTION	
Produced Oil (m <sup>3</sup> )	603,597
Produced Water (m <sup>3</sup> )	698,077

## Waskada Unit No. 16



c) Monthly wellhead injection pressure for each injection well

	C0/12-10 Inj		00/16-09 Inj		C0/16-04 Inj		C0/03-04 Inj		00/05-10 Inj		00/06-09 Inj	
MONTH	Inj Water (m <sup>3</sup> )	Avg Inj P (kPa)	Inj Water (m <sup>3</sup> )	Avg Inj P (kPa)	Inj Water (m <sup>3</sup> )	Avg Inj P (kPa)	Inj Water (m <sup>3</sup> )	Avg Inj P (kPa)	Inj Water (m <sup>3</sup> )	Avg Inj P (kPa)	Inj Water (m <sup>3</sup> )	Avg Inj P (kPa)
Jan-2018	20.9	4923	0.0	0	18.7	5000	222.4	0	0.0	2200	107.5	5000
Feb-2018	12.4	4979	0.0	0	18.5	5000	225.8	0	0.0	2200	31.4	5000
Mar-2018	0.0	5000	0.0	0	14.1	5000	68.1	0	0.0	2200	0.0	5000
Apr-2018	0.0	5000	0.0	0	0.0	5000	0.0	0	0.0	2200	0.0	5000
May-2018	0.0	5000	0.0	0	0.0	5000	0.0	0	0.0	2200	0.0	5000
Jun-2018	0.0	5000	0.0	0	0.0	5000	0.0	0	0.0	2200	0.0	5000
Jul-2018	0.0	5000	0.0	0	0.0	5000	0.0	0	0.0	2200	0.0	5000
Aug-2018	0.0	5000	0.0	0	0.0	5000	0.0	0	0.0	2200	0.0	5000
Sep-2018	0.0	5000	0.0	0	0.0	5000	0.0	0	0.0	2200	0.0	5000
Oct-2018	0.0	5000	0.0	0	0.0	5000	0.0	0	0.0	2200	0.0	5000
Nov-2018	0.0	5000	0.0	0	0.0	5000	0.0	0	0.0	2200	0.0	5000
Dec-2018	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
<b>Total</b>	33.3		0.0		51.3		516.2		0.0		138.9	
<b>Avg Inj P</b>		4575		0		4583		0		2017		4583

	00/16-05 Inj		C0/06-04 Inj		00/15-04 Inj		C0/13-10 Inj		C0/14-04 Inj		C0/15-04 Inj	
MONTH	Inj Water (m <sup>3</sup> )	Avg Inj P (kPa)	Inj Water (m <sup>3</sup> )	Avg Inj P (kPa)	Inj Water (m <sup>3</sup> )	Avg Inj P (kPa)	Inj Water (m <sup>3</sup> )	Avg Inj P (kPa)	Inj Water (m <sup>3</sup> )	Avg Inj P (kPa)	Inj Water (m <sup>3</sup> )	Avg Inj P (kPa)
Jan-2018	353.4	834	347.9	2684	0.0	0	470.3	600	244.4	5000	12.8	5000
Feb-2018	307.1	820	319.1	3382	0.0	0	198.7	600	221.6	5000	13.5	5000
Mar-2018	318.4	800	333.5	3500	0.0	0	0.0	600	247.9	5000	8.7	5000
Apr-2018	300.3	780	364.7	3225	0.0	0	0.0	600	248.6	5000	0.0	5000
May-2018	271.0	590	423.9	2319	0.0	0	0.0	600	85.6	5000	0.0	5000
Jun-2018	252.5	555	383.9	4165	0.0	0	0.0	600	0.0	5000	0.0	5000
Jul-2018	245.8	594	339.0	3131	0.0	0	0.0	600	0.0	5000	0.0	5000
Aug-2018	224.7	600	345.3	3039	0.0	0	0.0	600	0.0	5000	0.0	5000
Sep-2018	211.1	600	330.6	3100	0.0	0	0.0	600	0.0	5000	0.0	5000
Oct-2018	155.5	578	183.4	2477	0.0	0	0.0	600	0.0	5000	0.0	5000
Nov-2018	96.7	93	178.0	1113	0.0	0	0.0	600	0.0	5000	0.0	5000
Dec-2018	303.0	306	301.1	2235	0.0	0	0.0	0	0.0	0	0.0	0
<b>Total</b>	3039.3		3850.2		0.0		669.0		1048.0		35.0	
<b>Avg Inj P</b>		596		2864		0		550		4583		4583

c) Monthly wellhead injection pressure for each injection well

	C0/03-09 Inj		C0/04-10 Inj		00/11-04 Inj		02/05-10 Inj		C0/14-10 Inj		00/05-04 Inj	
MONTH	Inj Water (m <sup>3</sup> )	Avg Inj P (kPa)	Inj Water (m <sup>3</sup> )	Avg Inj P (kPa)	Inj Water (m <sup>3</sup> )	Avg Inj P (kPa)	Inj Water (m <sup>3</sup> )	Avg Inj P (kPa)	Inj Water (m <sup>3</sup> )	Avg Inj P (kPa)	Inj Water (m <sup>3</sup> )	Avg Inj P (kPa)
Jan-2018	0.0	5000	498.7	89	0.0	0	223.8	5000	163.5	5000	219.1	48
Feb-2018	0.0	5000	327.0	50	0.0	0	0.0	5000	68.9	5000	227.0	682
Mar-2018	0.0	5000	0.0	50	0.0	0	0.0	5000	0.0	5000	173.9	800
Apr-2018	0.0	5000	0.0	50	0.0	0	0.0	5000	0.0	5000	0.0	800
May-2018	0.0	5000	0.0	50	0.0	0	0.0	5000	0.0	5000	0.0	800
Jun-2018	0.0	5000	0.0	50	0.0	0	0.0	5000	0.0	5000	0.0	800
Jul-2018	0.0	5000	0.0	50	0.0	0	0.0	5000	0.0	5000	0.0	800
Aug-2018	0.0	5000	0.0	50	0.0	0	0.0	5000	0.0	5000	0.0	800
Sep-2018	0.0	5000	0.0	50	0.0	0	0.0	5000	0.0	5000	0.0	800
Oct-2018	0.0	5000	0.0	50	0.0	0	0.0	5000	0.0	5000	0.0	800
Nov-2018	0.0	5000	0.0	50	0.0	0	0.0	5000	0.0	5000	0.0	800
Dec-2018	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
<b>Total</b>	0.0		825.7		0.0		223.8		232.3		620.1	
<b>Avg Inj P</b>		4583		49		0		4583		4583		661

	C0/12-04 Inj		00/01-09 Inj		C0/11-04 Inj		02/01-09 Inj		C0/07-09 Inj		00/09-04 Inj	
MONTH	Inj Water (m <sup>3</sup> )	Avg Inj P (kPa)	Inj Water (m <sup>3</sup> )	Avg Inj P (kPa)	Inj Water (m <sup>3</sup> )	Avg Inj P (kPa)	Inj Water (m <sup>3</sup> )	Avg Inj P (kPa)	Inj Water (m <sup>3</sup> )	Avg Inj P (kPa)	Inj Water (m <sup>3</sup> )	Avg Inj P (kPa)
Jan-2018	123.4	5000	74.0	5000	374.0	3497	216.8	5000	174.7	4966	201.4	4677
Feb-2018	108.3	5000	99.5	5000	329.4	3800	194.5	5000	52.8	4950	169.8	4952
Mar-2018	118.6	5000	111.6	5000	357.4	3798	216.0	5000	0.0	4950	175.9	4751
Apr-2018	115.9	4980	110.3	5043	345.9	3750	205.1	5043	0.0	4950	160.7	4738
May-2018	136.0	4890	102.1	5000	347.9	3566	202.8	5000	0.0	4950	156.6	4744
Jun-2018	118.8	4850	0.0	5000	289.6	3900	181.4	5000	0.0	4950	138.8	4977
Jul-2018	39.8	4148	0.0	5000	351.2	4363	163.9	6445	0.0	4950	130.8	4919
Aug-2018	23.2	5053	0.0	5000	370.7	4685	177.1	5000	0.0	4950	126.2	4871
Sep-2018	18.2	5000	0.0	5000	357.4	4700	166.4	5000	0.0	4950	115.5	4878
Oct-2018	9.1	4932	0.0	5000	269.4	4697	112.7	4911	0.0	4950	101.6	4827
Nov-2018	0.0	4900	0.0	5000	176.0	3487	290.2	4977	0.0	4950	118.1	4901
Dec-2018	0.0	4900	0.0	0	151.7	3200	104.4	5000	0.0	0	41.5	4111
<b>Total</b>	811.2		497.6		3720.5		2231.2		227.5		1637.0	
<b>Avg Inj P</b>		4888		4587		3954		5115		4539		4779

c) Monthly wellhead injection pressure for each injection well

	00/03-04 Inj		00/09-09 Inj		WU16	
MONTH	Inj Water (m <sup>3</sup> )	Avg Inj P (kPa)	Inj Water (m <sup>3</sup> )	Avg Inj P (kPa)	Inj Water (m <sup>3</sup> )	Avg Inj P (kPa)
Jan-2018	0.0	749	193.9	4630	4261.6	3073
Feb-2018	0.0	749	125.9	5000	3051.1	3160
Mar-2018	0.0	749	13.5	5000	2157.4	3161
Apr-2018	0.0	749	0.0	5000	1851.6	3150
May-2018	0.0	749	0.0	5000	1725.8	3095
Jun-2018	0.0	749	0.0	5000	1365.0	3184
Jul-2018	0.0	749	0.0	5000	1270.4	3190
Aug-2018	0.0	749	0.0	5000	1267.3	3177
Sep-2018	0.0	749	0.0	5000	1199.1	3178
Oct-2018	0.0	749	0.0	5000	831.7	3170
Nov-2018	0.0	749	0.0	5000	859.0	3217
Dec-2018	0.0	0	0.0	0	901.6	3292
<b>Total</b>	0.0		333.3		20741.5	
<b>Avg Inj P</b>		687		4552		3171

MONTH	Jan-2018	Feb-2018	Mar-2018	Apr-2018	May-2018	Jun-2018	Jul-2018	Aug-2018	Sep-2018	Oct-2018	Nov-2018	Dec-2018
<b>Total m3</b>	4261.6	3051.1	2157.4	1851.6	1725.8	1365.0	1270.4	1267.3	1199.1	831.7	859.0	901.6
<b>Daily (m<sup>3</sup>/d)</b>	137.47	108.97	69.59	61.72	55.67	45.50	40.98	40.88	39.97	26.83	28.63	29.08

2018 AVG. ANNUAL DAILY INJECTION = 57.11 m3/d

CUMULATIVE INJECTION TO Dec 31, 2017 = 1,996,821 m3

TOTAL 2018 ANNUAL INJECTION = 20,742 m3

CUMULATIVE INJECTION TO Dec 31, 2018 = 2,017,563 m3

d) Summary of the result of any survey of reservoir pressure conducted in 2018. N/A

e) **Date and type of any well servicing.**

Well	Service Description	Date
1C0.15-04-002-25W1.00	Acid Stimulation - Rigless	1/23/2018
103.09-04-002-25W1.00	Cemented Liner Clean Out	1/27/2018
104.03-04-002-25W1.00	Broken Polished Rod	2/5/2018
103.15-05-002-25W1.00	Broken Rod / Pump Change	2/11/2018
103.10-09-002-25W1.00	Cemented Liner Clean Out	2/22/2018
102.10-09-002-25W1.00	Cemented Liner Clean Out	3/15/2018
100.13-04-002-25W1.00	Pump Change / Acid Job	3/15/2018
103.05-09-002-25W1.00	Pump Change	6/28/2018
102.10-09-002-25W1.00	Pump Change	9/10/2018
102.15-05-002-25W1.00	CO Cemented Liner Casing & Pressure Test	10/29/2018
100.04-10-002-25W1.00	Pump Change / Acid Job	11/26/2018
100.12-04-002-25W1.00	BHP change / Acid Job	11/29/2018
103.01-09-002-25W1.00	Cemented Liner Cleanout	12/2/2018
102.08-09-002-25W1.00	Spearfish Cemented Liner Cleanout	12/8/2018

f) **Calculations of voidage replacement ratio on a monthly and cumulative basis**

**VOIDAGE CALCULATIONS**

OIL FORMATION VOLUME FACTOR (Rm3/Sm3) = 1.17

MONTH	Mth Oil Prod (m3)	Cum Oil Prod (Km3)	Mth Water Prod (m3)	Cum Water Prod (Km3)	Mth Water Inj (m3)	Cum Water Inj (Km3)	VRR	Cum VRR
Jan-2018	1597.2	580.75	5497.9	638.51	4261.6	2001.08	0.579	1.518
Feb-2018	1528.1	582.27	4355.7	642.87	3051.2	2004.13	0.497	1.514
Mar-2018	2029.0	584.30	5606.7	648.48	2157.6	2006.29	0.270	1.506
Apr-2018	2049.8	586.35	4982	653.46	1851.6	2008.14	0.251	1.499
May-2018	1984.1	588.34	4920.8	658.38	1725.9	2009.87	0.238	1.492
Jun-2018	1849.3	590.19	4749	663.13	1365.0	2011.23	0.197	1.486
Jul-2018	2034.5	592.22	5716.9	668.85	1270.5	2012.50	0.157	1.478
Aug-2018	1988.3	594.21	5780.9	674.63	1267.2	2013.77	0.156	1.470
Sep-2018	2139.4	596.35	5265.3	679.89	1199.2	2014.97	0.154	1.463
Oct-2018	2400.6	598.75	5310.5	685.20	831.7	2015.80	0.102	1.455
Nov-2018	2144.6	600.89	6088.4	691.29	859.0	2016.66	0.100	1.446
Dec-2018	2703.6	603.60	6787.1	698.08	901.6	2017.56	0.091	1.437

g) **An outline of the method used for quality control and treatment of the injected fluid**

The injected fluid is treated by filtration.

h) **A report of any unusual performance problems and remedial measures taken or being considered. N/A**

i) **Any other information necessary to evaluate the project**



<i>UWI</i>	<i>Type</i>	<i>Status</i>	<i>Future Plans</i>
100/03-04-002-25W1/0	Vertical	Injection	-
103/03-04-002-25W1/0	Horizontal	Producing	-
104/03-04-002-25W1/0	Horizontal	Producing	WIW Conversion
1C0/03-04-002-25W1/0	Vertical	Injection	-
100/04-04-002-25W1/0	Vertical	Producing	-
100/05-04-002-25W1/0	Vertical	Injection	-
100/06-04-002-25W1/0	Vertical	Abandoned Zone	-
103/06-04-002-25W1/0	Horizontal	Producing	-
1C0/06-04-002-25W1/0	Vertical	Injection	-
100/09-04-002-25W1/0	Vertical	Injection	-
102/09-04-002-25W1/0	Horizontal	Producing	-
103/09-04-002-25W1/0	Horizontal	Producing	WIW Conversion
104/09-04-002-25W1/0	Horizontal	Producing	-
100/10-04-002-25W1/0	Vertical	Producing	-
1C0/10-04-002-25W1/0	Vertical	Abandoned	-
100/11-04-002-25W1/0	Vertical	Injection	-
103/11-04-002-25W1/0	Horizontal	Producing	-
1C0/11-04-002-25W1/0	Vertical	Injection	-
100/12-04-002-25W1/0	Vertical	Producing	-
1C0/12-04-002-25W1/0	Vertical	Injection	-
100/13-04-002-25W1/2	Vertical	Producing	-
102/13-04-002-25W1/0	Horizontal	Producing	-
100/14-04-002-25W1/0	Vertical	Abandoned Zone	-
1C0/14-04-002-25W1/0	Vertical	Injection	-
100/15-04-002-25W1/0	Vertical	Injection	-
102/15-04-002-25W1/0	Vertical	Producing	-
1C0/15-04-002-25W1/0	Vertical	Injection	-
100/16-04-002-25W1/0	Vertical	Producing	-
1C0/16-04-002-25W1/0	Vertical	Injection	-
100/09-05-002-25W1/0	Vertical	Producing	-
100/10-05-002-25W1/0	Vertical	Abandoned	-
102/10-05-002-25W1/0	Horizontal	Producing	-
103/10-05-002-25W1/0	Horizontal	Producing	WIW Conversion
100/15-05-002-25W1/0	Vertical	Abandoned Zone	-
102/15-05-002-25W1/0	Horizontal	Producing	WIW Conversion
103/15-05-002-25W1/0	Horizontal	Producing	-
100/16-05-002-25W1/0	Vertical	Injection	-
100/01-09-002-25W1/0	Vertical	Injection	-
102/01-09-002-25W1/0	Horizontal	Injection	-
103/01-09-002-25W1/0	Horizontal	Producing	-
100/02-09-002-25W1/0	Vertical	Producing	-
102/02-09-002-25W1/0	Horizontal	Producing	-
100/03-09-002-25W1/0	Vertical	Abandoned Zone	-
1C0/03-09-002-25W1/0	Vertical	Injection	-
100/04-09-002-25W1/2	Vertical	Producing	-

## j) Well List

## Waskada Unit No. 16 Well List

<i><b>UWI</b></i>	<i><b>Type</b></i>	<i><b>Status</b></i>	<i><b>Future Plans</b></i>
102/04-09-002-25W1/0	Horizontal	Producing	WIW Conversion
100/05-09-002-25W1/0	Vertical	Abandoned	-
102/05-09-002-25W1/0	Vertical	Pumping	-
103/05-09-002-25W1/0	Horizontal	Producing	-
104/05-09-002-25W1/0	Horizontal	Producing	WIW Conversion
100/06-09-002-25W1/0	Vertical	Injection	-
100/07-09-002-25W1/0	Vertical	Producing	-
1C0/07-09-002-25W1/0	Vertical	Injection	-
100/08-09-002-25W1/0	Vertical	Abandoned Zone	-
102/08-09-002-25W1/0	Horizontal	Producing	-
100/09-09-002-25W1/0	Vertical	Injection	-
1C0/09-09-002-25W1/0	Vertical	Abandoned	-
100/10-09-002-25W1/0	Vertical	Abandoned	-
102/10-09-002-25W1/0	Horizontal	Producing	-
103/10-09-002-25W1/0	Horizontal	Producing	-
100/15-09-002-25W1/0	Vertical	Producing	-
100/16-09-002-25W1/0	Vertical	Injection	-
100/04-10-002-25W1/0	Vertical	Producing	-
102/04-10-002-25W1/0	Horizontal	Producing	-
103/04-10-002-25W1/0	Horizontal	Producing	-
1C0/04-10-002-25W1/0	Vertical	Injection	-
100/05-10-002-25W1/0	Vertical	Injection	-
102/05-10-002-25W1/0	Horizontal	Injection	-
100/12-10-002-25W1/0	Vertical	Abandoned Zone	-
1C0/12-10-002-25W1/0	Vertical	Injection	-
100/13-10-002-25W1/0	Vertical	Producing	-
103/13-10-002-25W1/0	Horizontal	Producing	-
104/13-10-002-25W1/0	Horizontal	Producing	-
1C0/13-10-002-25W1/0	Vertical	Injection	-
100/14-10-002-25W1/0	Vertical	Producing	-
1C0/14-10-002-25W1/0	Vertical	Injection	-