

**Waskada Unit No. 19**

**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:**

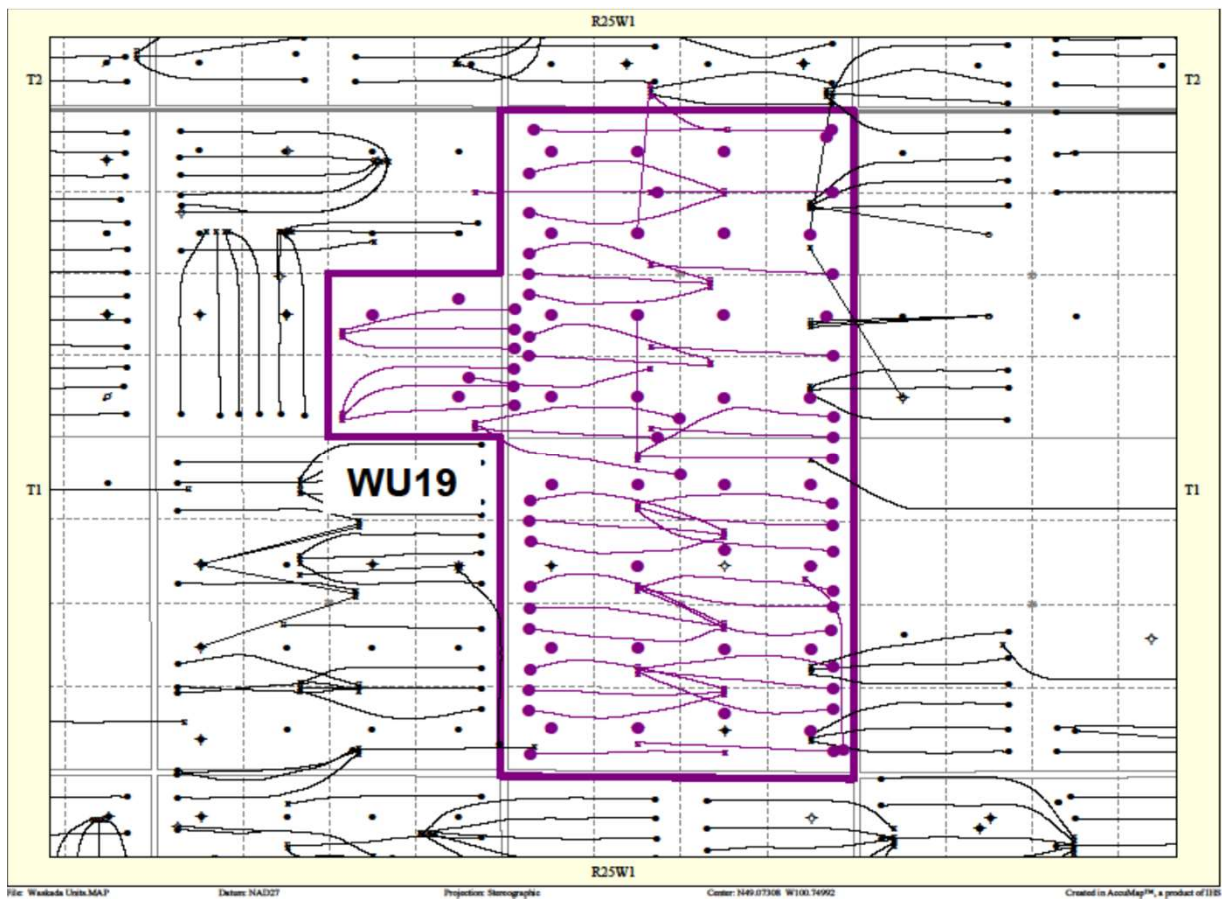
**Tundra Oil and Gas**

**June 27, 2019**

## INTRODUCTION

The Waskada Unit No. 19 pressure maintenance project commenced water injection into the Lower Amaranth A pool in accordance with Manitoba Energy and Mines Order No. PM 14, dated August 1, 2003. Waskada Unit No. 19 was acquired from EOG Resources Canada Inc. effective October 1, 2014 (closing date December 1, 2014) with Tundra Oil and Gas (Tundra) as the new operator. THE EOR project area, outlined in purple in Figure 1, contains 85 wells over 36 LSDs in Township 1, Range 25W1.

**Figure 1: Waskada Unit No. 19 Area Outline**



## Waskada Unit No. 19

Tundra Oil and Gas (Tundra), as the operator of the Waskada Unit No. 19 Enhanced Oil Recovery (EOR) project hereby submits the 2018 EOR report as per section 73 of the Drilling and Production Regulations.

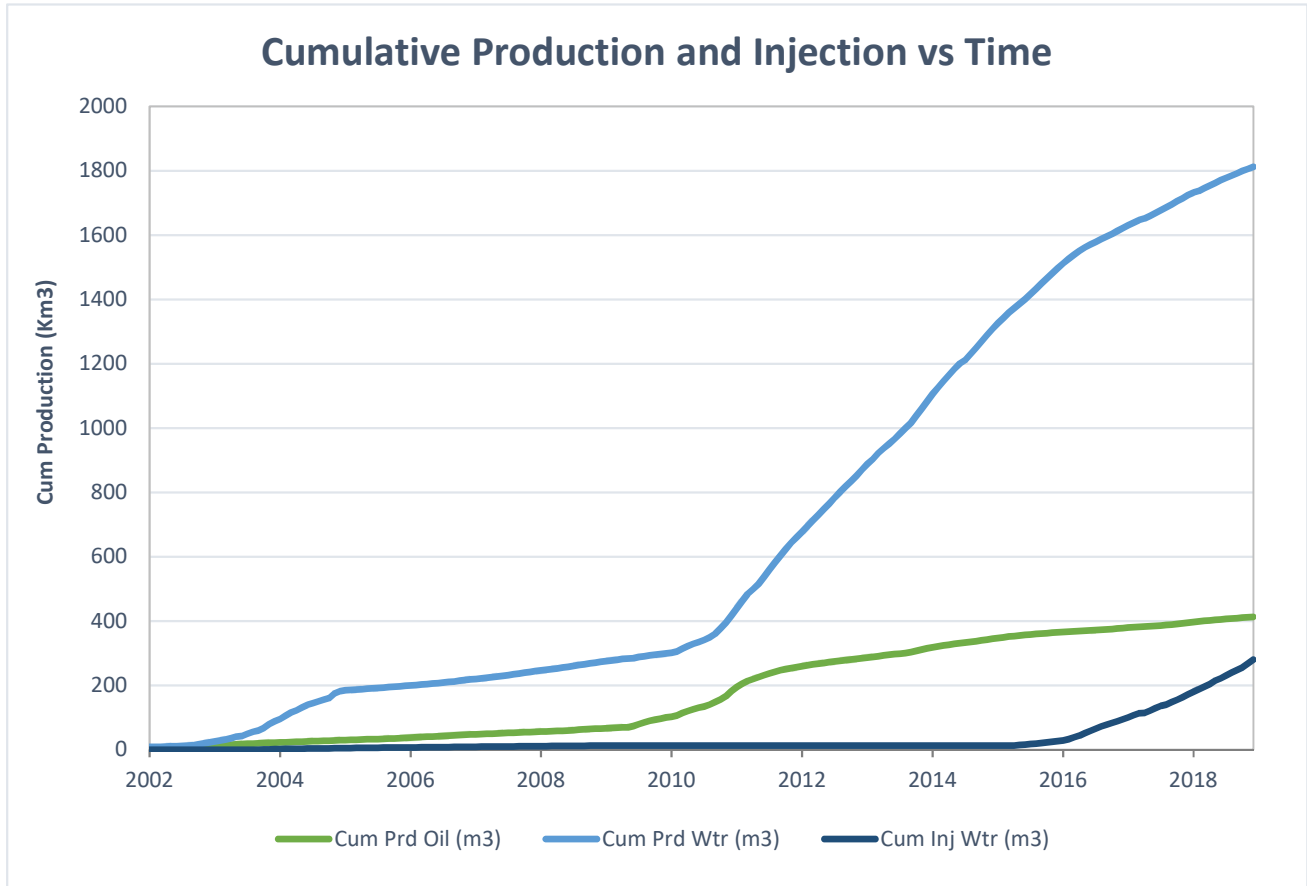
**a) Monthly oil and water production rates, injection rate, GOR and WOR**

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	65.58	243.95	517.39	3.72	8.31
Feb-2018	59.69	192.45	502.31	3.22	21.66
Mar-2018	65.91	280.11	533.43	4.25	17.08
Apr-2018	56.34	264.10	536.93	4.69	20
May-2018	48.08	244.43	531.23	5.08	21.87
Jun-2018	40.43	291.56	468.46	7.21	28.11
Jul-2018	46.25	242.51	554.10	5.24	23.71
Aug-2018	48.02	235.91	543.19	4.91	21.29
Sep-2018	42.99	220.25	479.66	5.12	21.79
Oct-2018	39.65	238.21	501.88	6.01	24.4
Nov-2018	38.87	217.07	666.31	5.59	25.73
Dec-2018	43.02	201.52	661.46	4.68	21.59

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

2018 PRODUCTION	
Produced Oil (m <sup>3</sup> )	18,082
Produced Gas (m <sup>3</sup> )	371
Produced Water (m <sup>3</sup> )	87,464
Fluid Injected (m <sup>3</sup> )	107,832
CUMULATIVE PRODUCTION	
Produced Oil (m <sup>3</sup> )	412,817
Produced Water (m <sup>3</sup> )	1,812,197

## Waskada Unit No. 19



c) Monthly wellhead injection pressure for each injection well

	00/06-27 Inj		00/14-27 Inj		00/02-34 Inj		00/04-27 Inj		00/10-34 Inj		02/12-34 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	4000	0.0	0	0.0	4850	0.0	0	0.0	4800	541.4	3978
Feb-2018	0.0	4000	0.0	0	0.0	4850	0.0	0	0.0	4800	429.7	2902
Mar-2018	0.0	4000	0.0	0	0.0	4850	0.0	0	0.0	4800	815.0	3969
Apr-2018	0.0	4000	0.0	0	0.0	4850	0.0	0	0.0	4800	826.6	4644
May-2018	0.0	4000	0.0	0	0.0	4850	0.0	0	0.0	4800	776.6	4777
Jun-2018	0.0	4000	0.0	0	0.0	4850	0.0	0	0.0	4800	569.4	4810
Jul-2018	0.0	4000	0.0	0	0.0	4850	0.0	0	0.0	4800	806.1	4794
Aug-2018	0.0	4000	0.0	0	0.0	4850	0.0	0	0.0	4800	779.7	4824
Sep-2018	0.0	4000	0.0	0	0.0	4850	0.0	0	0.0	4800	716.6	4784
Oct-2018	0.0	4000	0.0	0	0.0	4850	0.0	0	0.0	4800	711.9	4807
Nov-2018	0.0	4000	0.0	0	0.0	4850	0.0	0	0.0	4800	680.7	4878
Dec-2018	0.0	4000	0.0	0	0.0	4850	0.0	0	0.0	4800	684.4	4909
<b>Total</b>	0.0		0.0		0.0		0.0		0.0		8338.1	
<b>Avg Inj P</b>		4000		0		4850		0		4800		4506

	00/08-34 Inj		04/12-27 Inj		03/05-34 Inj		02/09-27 Inj		04/09-27 Inj		02/14-34 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	4800	853.0	3981	688.4	3981	922.6	300	1123.8	2946	1095.3	2205
Feb-2018	0.0	4800	732.1	3982	555.3	4449	800.0	1665	991.4	2922	1076.7	2478
Mar-2018	0.0	4800	779.4	3982	729.2	4283	900.9	1345	1089.4	2969	1201.1	2505
Apr-2018	0.0	4800	723.2	3980	790.0	4798	859.4	2719	1037.7	2986	1179.5	2485
May-2018	0.0	4800	786.7	5578	671.2	4805	772.6	2992	1077.3	3101	1216.6	2561
Jun-2018	0.0	4800	832.6	4834	510.3	4877	454.4	510	1166.3	3522	875.4	2511
Jul-2018	0.0	4800	809.0	4967	630.0	4941	605.3	495	1209.1	3711	1208.3	2435
Aug-2018	0.0	4800	760.6	4876	559.3	4912	600.0	749	1228.8	3653	1190.4	2504
Sep-2018	0.0	4800	693.4	4702	184.8	3718	346.8	676	939.3	3191	1133.0	2475
Oct-2018	0.0	4800	676.3	4861	150.3	3198	322.1	941	1172.0	3710	1144.9	2504
Nov-2018	0.0	4800	653.5	4837	844.1	4877	462.2	2925	1192.4	3896	1184.0	2567
Dec-2018	0.0	4800	655.3	4894	618.5	4940	453.7	2981	1234.7	5259	1226.9	2583
<b>Total</b>	0.0		8955.1		6931.4		7500.0		13462.1		13732.1	
<b>Avg Inj P</b>		4800		4623		4482		1525		3489		2484

c) Monthly wellhead injection pressure for each injection well

	00/07-27 Inj		02/03-34 Inj		03/04-27 Inj		02/04-34 Inj		03/16-34 Inj		02/16-34 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	307.6	1667	902.1	2798	950.2	3980	635.2	3985	0.0	0	0.0	0
Feb-2018	277.9	1701	829.1	2946	782.5	3982	557.6	3915	0.0	0	0.0	0
Mar-2018	307.5	1661	915.1	3012	886.3	3980	644.3	4032	0.0	0	0.0	0
Apr-2018	296.8	1609	889.0	3175	839.6	3981	612.2	3941	0.0	0	0.0	0
May-2018	304.1	1566	909.9	3264	892.1	4128	826.9	4245	0.0	0	3118.0	0
Jun-2018	297.2	1502	653.7	2517	1012.7	4766	655.0	4444	0.0	0	0.0	0
Jul-2018	302.4	1529	905.4	3217	998.1	4964	910.6	4297	408.5	-17	0.0	0
Aug-2018	300.1	1502	889.9	3376	952.3	4906	859.8	4264	597.1	-93	0.0	0
Sep-2018	279.5	1315	839.2	3426	897.0	4698	806.3	4115	568.9	-92	149.1	408
Oct-2018	293.0	1435	871.7	3606	926.9	4911	846.3	4124	668.7	-89	525.9	-93
Nov-2018	297.5	1391	892.5	3745	880.8	4811	894.1	4560	692.6	-90	595.4	-94
Dec-2018	308.2	1406	924.2	3824	907.8	4862	927.0	4788	926.5	617	616.8	-94
<b>Total</b>	3571.7		10421.8		10926.3		9175.3		3862.3		5005.1	
<b>Avg Inj P</b>		1523		3242		4497		4226		20		11

	02/09-34 Inj		02/13-34 Inj		03/01-34 Inj		03/13-27 Inj		02/08-34 Inj		WU19	
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	0	0.0	0	0.0	0	0.0	0	0.0	0	8019.6	3017
Feb-2018	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	7032.3	3087
Mar-2018	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	8268.2	3137
Apr-2018	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	8054.0	2942
May-2018	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	11352.0	3082
Jun-2018	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	7026.8	2930
Jul-2018	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	8792.8	2988
Aug-2018	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	8717.9	2996
Sep-2018	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	7553.9	2881
Oct-2018	0.0	0	0.0	0	44.5	363	44.7	-24	43.7	-30	8442.9	2572
Nov-2018	495.4	311	505.3	-84	578.4	-13	580.1	-93	578.4	-92	12007.3	2469
Dec-2018	616.4	-91	617.7	-92	614.3	-92	616.5	56	615.8	-93	12564.6	2570
<b>Total</b>	1111.8		1123.0		1237.2		1241.3		1237.9		107832.5	
<b>Avg Inj P</b>		18		-15		22		-5		-18		2889

**c) Monthly wellhead injection pressure for each injection well**

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>	8019.6	7032.3	8268.2	8054.0	11352.0	7026.8	8792.8	8717.9	7553.9	8442.9	12007.3	12564.6
<b>Daily (m<sup>3</sup>/d)</b>	258.70	251.16	266.72	268.47	366.19	234.23	283.64	281.22	251.80	272.35	400.24	405.31

2018 AVG. ANNUAL DAILY INJECTION = 295.00 m3/d
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CUMULATIVE INJECTION TO Dec 31, 2017 = 172,331 m3
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TOTAL 2018 ANNUAL INJECTION = 107,832 m3
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CUMULATIVE INJECTION TO Dec 31, 2018 = 280,163 m3
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**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
102.01-27-001-25W1.00	Pump Change	3/17/2018
102.01-27-001-25W1.00	Pump Change	9/11/2018
102.05-34-001-25W1.00	Pump Change	3/12/2018
102.05-34-001-25W1.00	Cemented Liner Clean Out	7/23/2018
102.08-34-001-25W1.00	WIW Conversion	8/14/2018
102.09-34-001-25W1.00	WIW Conversion	8/16/2018
102.16-34-001-25W1.00	WIW Conversion	8/18/2018
103.03-34-001-25W1.00	Pump Change	11/23/2018
103.12-34-001-25W1.00	Cemented Liner Clean Out	7/5/2018
103.13-34-001-25W1.00	Cemented Liner Clean Out	6/25/2018
104.05-34-001-25W1.00	Cemented Liner Clean Out	7/12/2018
104.12-34-001-25W1.00	Cemented Liner Clean Out	8/14/2018

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	2033.1	396.77	7562.6	1732.30	8019.6	180.35	0.807	0.082
Feb-2018	1671.3	398.44	5388.7	1737.68	7032.3	187.38	0.958	0.085
Mar-2018	2043.3	400.48	8683.3	1746.37	8268.2	195.65	0.747	0.088
Apr-2018	1690.3	402.17	7923	1754.29	8054.0	203.71	0.813	0.092
May-2018	1490.4	403.66	7577.3	1761.87	11352.0	215.06	1.218	0.096
Jun-2018	1212.9	404.88	8746.8	1770.61	7026.8	222.08	0.691	0.099
Jul-2018	1433.7	406.31	7517.9	1778.13	8792.8	230.88	0.956	0.102
Aug-2018	1488.7	407.80	7313.3	1785.45	8717.9	239.59	0.963	0.106
Sep-2018	1289.7	409.09	6607.4	1792.05	7553.9	247.15	0.931	0.109
Oct-2018	1229.3	410.32	7384.6	1799.44	8442.9	255.59	0.957	0.112
Nov-2018	1166.0	411.48	6512.2	1805.95	12007.3	267.60	1.524	0.117
Dec-2018	1333.7	412.82	6247	1812.20	12564.6	280.16	1.609	0.122

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>
100/01-27-001-25W1/0	Vertical	Abandoned Zone	-
102/01-27-001-25W1/0	Horizontal	Producing	-
103/01-27-001-25W1/0	Horizontal	Producing	-
104/01-27-001-25W1/0	Horizontal	Producing	-
100/03-27-001-25W1/0	Vertical	Abandoned	-
100/04-27-001-25W1/0	Vertical	Injection	-
102/04-27-001-25W1/0	Horizontal	Producing	-
103/04-27-001-25W1/0	Horizontal	Injection	-
100/05-27-001-25W1/0	Vertical	Abandoned Zone	-
102/05-27-001-25W1/0	Horizontal	Producing	-
103/05-27-001-25W1/0	Horizontal	Abandoned Zone	-
104/05-27-001-25W1/0	Horizontal	Abandoned Zone	-
100/06-27-001-25W1/0	Vertical	Injection	-
100/07-27-001-25W1/0	Vertical	Injection	-
100/08-27-001-25W1/0	Vertical	Abandoned Zone	-
102/08-27-001-25W1/0	Horizontal	Abandoned Zone	-
103/08-27-001-25W1/0	Horizontal	Producing	-
104/08-27-001-25W1/0	Horizontal	Producing	-
100/09-27-001-25W1/0	Vertical	Abandoned	-
102/09-27-001-25W1/0	Horizontal	Injection	-
103/09-27-001-25W1/0	Horizontal	Producing	-
104/09-27-001-25W1/0	Horizontal	Injection	-
102/10-27-001-25W1/0	Vertical	Abandoned	-
100/11-27-001-25W1/0	Vertical	Abandoned Zone	-
100/12-27-001-25W1/0	Vertical	Abandoned	-
102/12-27-001-25W1/0	Horizontal	Producing	-
103/12-27-001-25W1/0	Horizontal	Producing	-
104/12-27-001-25W1/0	Horizontal	Injection	-
100/13-27-001-25W1/0	Vertical	Abandoned Zone	-
102/13-27-001-25W1/0	Horizontal	Producing	-
103/13-27-001-25W1/0	Horizontal	Producing	-
100/14-27-001-25W1/0	Vertical	Injection	-
102/14-27-001-25W1/0	Horizontal	Producing	-
100/15-27-001-25W1/0	Vertical	Abandoned Zone	-
100/16-27-001-25W1/0	Vertical	Producing	-
102/16-27-001-25W1/0	Horizontal	Suspended	-
103/16-27-001-25W1/0	Horizontal	Producing	-
104/16-27-001-25W1/0	Horizontal	Producing	-
100/01-33-001-25W1/0	Vertical	Abandoned Zone	-
100/07-33-001-25W1/0	Vertical	Pumping	-
100/08-33-001-25W1/0	Vertical	Abandoned	-
100/01-34-001-25W1/0	Vertical	Pumping	-
102/01-34-001-25W1/0	Horizontal	Abandoned Zone	-
103/01-34-001-25W1/0	Horizontal	Producing	-
104/01-34-001-25W1/0	Horizontal	Drilled & Cased	-

## j) Well List

## Waskada Unit No. 19 Well List

<i><b>UWI</b></i>	<i><b>Type</b></i>	<i><b>Status</b></i>	<i><b>Future Plans</b></i>
100/02-34-001-25W1/0	Vertical	Injection	-
100/03-34-001-25W1/0	Vertical	Pumping	-
102/03-34-001-25W1/0	Horizontal	Injection	-
103/03-34-001-25W1/0	Horizontal	Producing	-
100/04-34-001-25W1/0	Vertical	Abandoned Zone	-
102/04-34-001-25W1/0	Horizontal	Injection	-
103/04-34-001-25W1/0	Horizontal	Producing	-
104/04-34-001-25W1/0	Horizontal	Producing	WIW Conversion
105/04-34-001-25W1/0	Horizontal	Producing	-
100/05-34-001-25W1/0	Vertical	Abandoned Zone	-
102/05-34-001-25W1/0	Horizontal	Producing	-
103/05-34-001-25W1/0	Horizontal	Injection	-
104/05-34-001-25W1/0	Horizontal	Producing	-
105/05-34-001-25W1/0	Horizontal	Producing	-
106/05-34-001-25W1/0	Horizontal	Suspended	-
107/05-34-001-25W1/0	Horizontal	Producing	-
100/06-34-001-25W1/0	Vertical	Producing	-
100/07-34-001-25W1/0	Vertical	Pumping	-
100/08-34-001-25W1/0	Vertical	Injection	-
102/08-34-001-25W1/0	Horizontal	Producing	-
103/08-34-001-25W1/0	Horizontal	Producing	-
100/09-34-001-25W1/0	Vertical	Producing	-
102/09-34-001-25W1/0	Horizontal	Producing	-
103/09-34-001-25W1/0	Horizontal	Producing	-
100/10-34-001-25W1/0	Vertical	Injection	-
100/11-34-001-25W1/0	Vertical	Abandoned Zone	-
100/12-34-001-25W1/0	Vertical	Abandoned Zone	-
102/12-34-001-25W1/0	Horizontal	Injection	-
103/12-34-001-25W1/0	Horizontal	Producing	-
104/12-34-001-25W1/0	Horizontal	Producing	-
100/13-34-001-25W1/0	Vertical	Abandoned Zone	-
102/13-34-001-25W1/0	Horizontal	Producing	-
103/13-34-001-25W1/0	Horizontal	Producing	-
100/14-34-001-25W1/0	Vertical	Abandoned Zone	-
102/14-34-001-25W1/0	Horizontal	Injection	-
100/15-34-001-25W1/0	Vertical	Pumping	-
100/16-34-001-25W1/0	Vertical	Abandoned	-
102/16-34-001-25W1/0	Horizontal	Producing	-
103/16-34-001-25W1/0	Horizontal	Injection	-
104/16-34-001-25W1/0	Horizontal	Drilled & Cased	-

**k) Discussion**

Water injection commenced with 4 injector wells on October 2003. Four more injectors were added in November 2003. **In 2011, EOG received permission to convert 3 Spearfish injection wells into Mississippian SWD wells. The wells converted were 00/06-27, 00/14-27 and 02/02-27-001-25W1.**