

Waskada Unit No. 18
Waterflood Progress Report 2014
January 1st through December 31st 2014

Prepared for:
Manitoba Industry, Economic Development and Mines
Petroleum Branch

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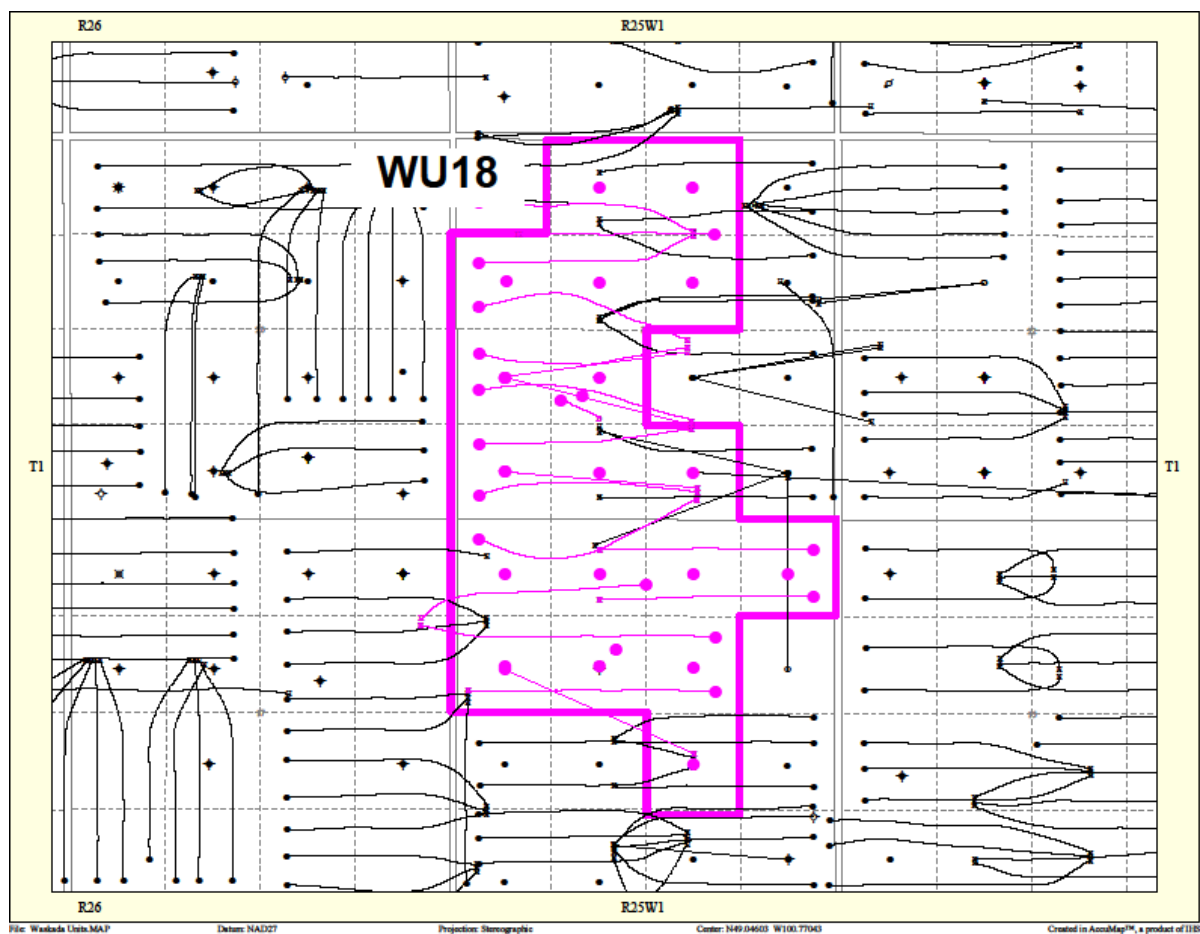
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INTRODUCTION

The Waskada Unit No. 18 pressure maintenance project commenced water injection into the Lower Amaranth A pool in accordance with Manitoba Energy and Mines Order No. PM 68, dated October 1, 1991. Waskada Unit No. 18 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 pink in [Figure 1](#), contains 35 wells over 18 LSDs in Township 1, Range 25W1 ([Table 1](#)).

Figure 1: Waskada Unit No. 18 Area Outline



PRODUCTION HISTORY

For the wells included in Waskada Unit No. 18, production started in November 1989 with the 02/11-16-001-25W1/00 well. From 1989 – 1991, 18 wells were drilled. Oil production peaked at 47.56 m³/d in March 1991. From 2007-2011, 14 new producers were added to the unit, resulting in a peak

in oil production of 190.73 m³/d in January 2011. There are currently 21 producing wells in Waskada Unit No. 18. The average production for the unit was 15.12 m³/d of oil and 43.32 m³/d of water and the average WOR was 2.86 m³/m³ at the end of December 2014 (Table 4). The rates and WOR are presented in Figure 2.

Figure 2: Waskada Unit No. 18 Production/Injection Rates and WOR vs Time

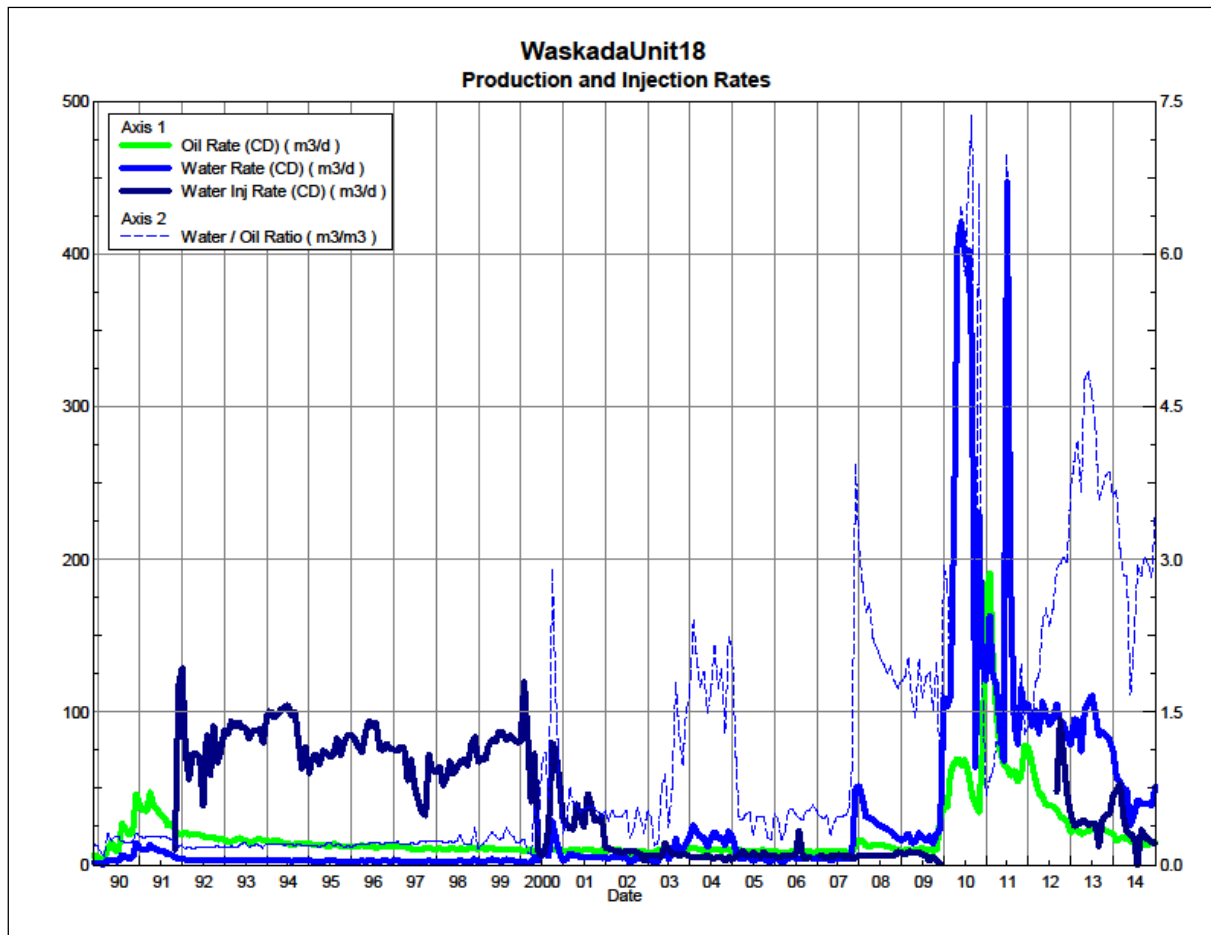
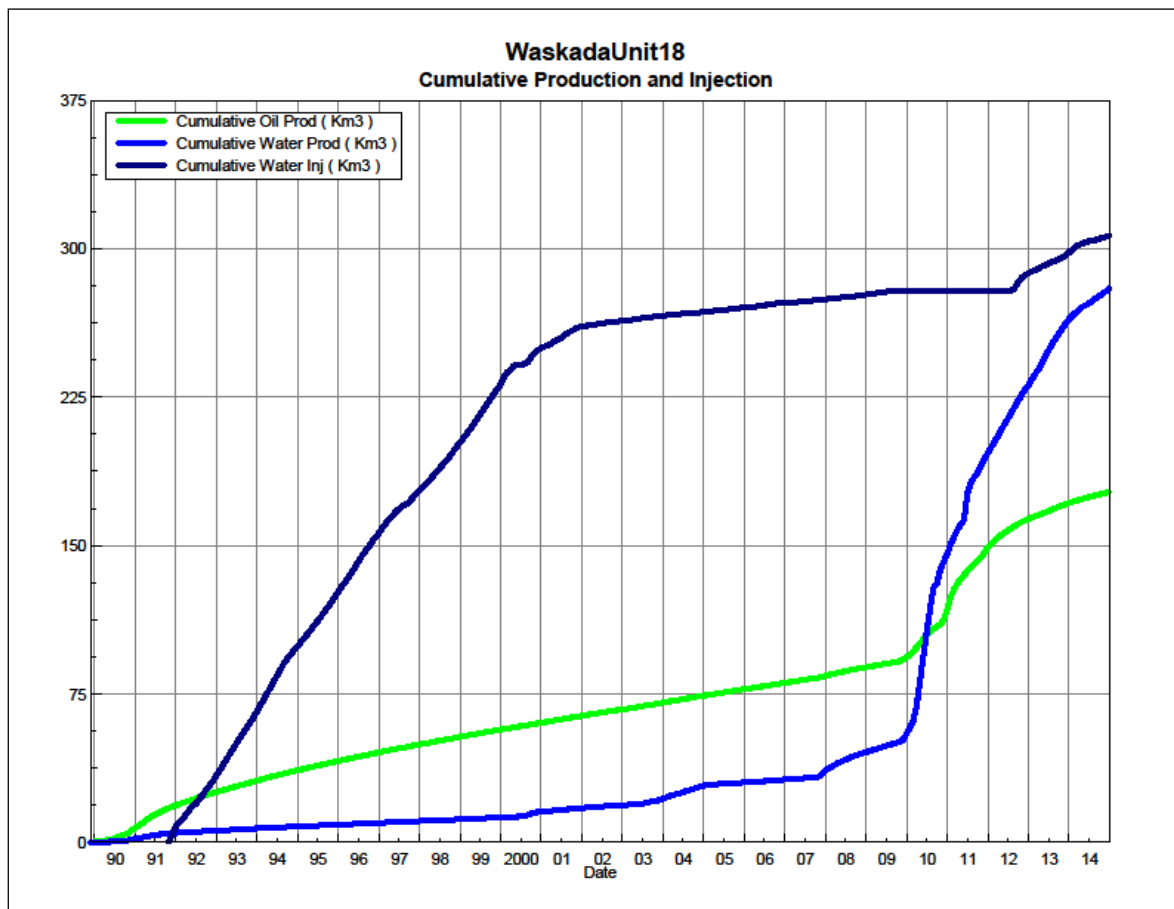


Figure 3 shows the cumulative production for Waskada Unit No. 18 to the end of December 2014 as 177.1 e³m³ of oil, and 280.2 e³m³ of water. The cumulative water injected is over 306.5 e³m³.

Figure 3. Waskada Unit No. 18 Cumulative Oil, Water and Water Injected vs. Time



WATERFLOOD HISTORY

Water injection commenced with 4 injector wells on October 1991. Two more injectors were added in March 2001. In 2011, EOG received permission to convert 3 Spearfish injection wells into Mississippian SWD wells. As of the end of December 2014, there is only 1 active Spearfish injection well.

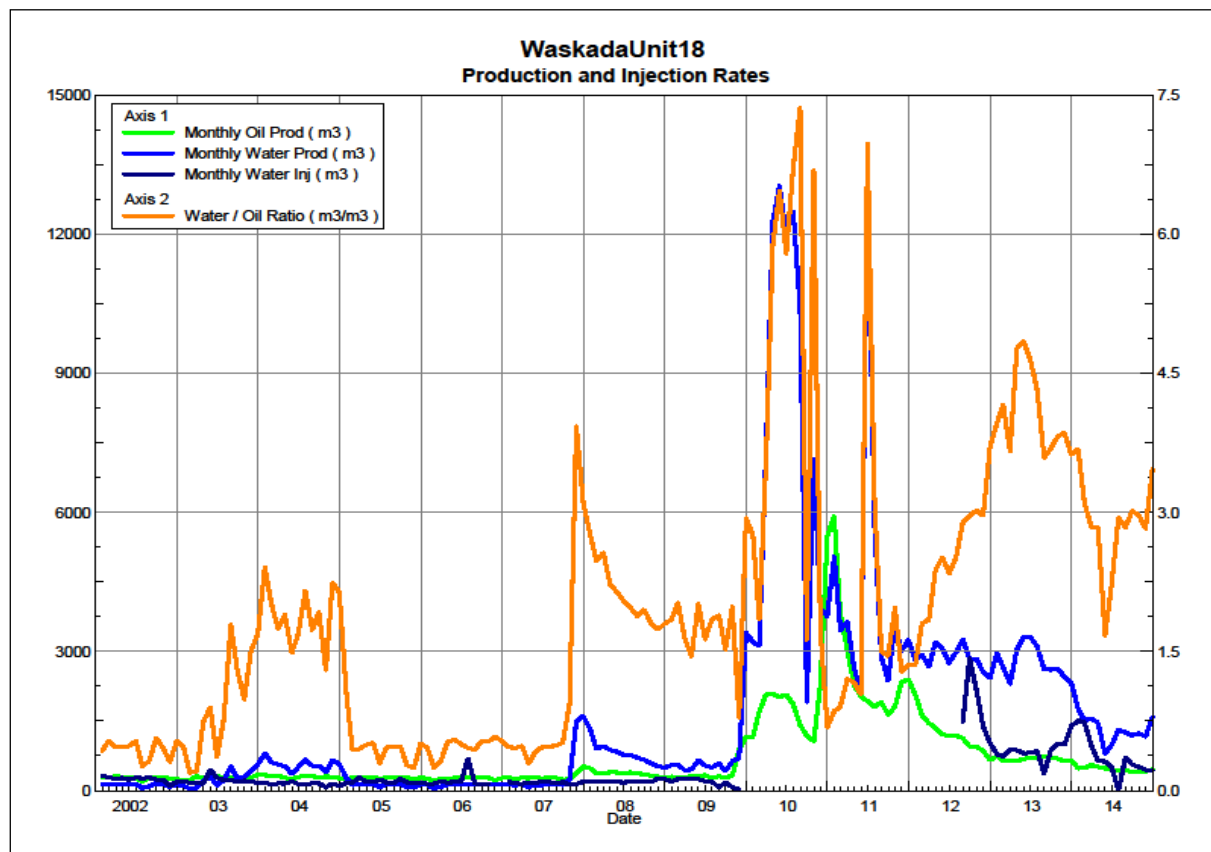
Any future revisions to the waterflood development or surveillance plan would be based on new production or performance response data, technical studies or observed reservoir behavior and reserves recovery interpretations.

WATERFLOOD PERFORMANCE

From January 1 to December 31 in 2014, Waskada Unit No. 18 produced 21,334 m³ of total fluids (5,520 m³ oil, 15,814 m³ water), and injected 8,407 m³ of source water, giving an annual oil and water voidage replacement ratio (VRR) of 0.367 for this reporting period. The cumulative VRR since injection commenced in May 1987 is presently at 0.613. Table 2 summarizes the yearly and cumulative VRR for Waskada Unit No. 18.

When water injection commenced in 1991, there was no effect on production. In 2002, water injection rates fell off sharply as wellhead injection pressures increased. In 2009, the amount of water that could be injected vertically was insignificant. Injection was halted in 2010. In 2011, EOG received permission to convert 3 of the Spearfish injection wells to Mississippian disposal wells. The wells converted were 00/10-21, 00/15-16 and 03/11-16-001-25W1. In August 2012, EOG converted the 02/12-21-001-25W1 horizontal producer to an injection well to observe if horizontal injection is more effective than vertical injection at increasing production.

Figure 4. Waskada Unit No. 18 Production and Injection Rates From 2002-2014



INJECTION WELLHEAD PRESSURES

Monthly injection wellhead pressures for 2014 are not in our database since Tundra acquired Waskada Unit No. 18 in October 2014. Individual injection rates can be found in [Table 3](#).

RESERVOIR PRESSURE

There have been no pressure surveys done on the reservoir.

Gas volumes from the field are measured at the 15-9-2-25W1M battery. There is no individual well gas volume measurement. It is not possible to separate out the gas production from only the wells in Unit 16, so the effectiveness of the pressure maintenance program cannot be evaluated on the GOR.

WELL SERVICING

No maintenance was required on the 35 wells in Waskada Unit No. 18 in 2014.

CORROSION AND SCALE PREVENTION

The facilities in Unit 18 are currently using cathodic protection and chemicals to protect against corrosion and scale. All facilities are monitored every 3 months to assess the corrosion and ensure that proper electrical current is being supplied. There have been no issues with corrosion or scale to date.

Biocide chemical is added to the injection water to prevent any sulfide producing bacteria from forming.

CONCLUSION

The current pressure maintenance program is having little effect on oil production in Waskada Unit No. 18. Tundra will maintain the current pressure maintenance program, and continue to monitor production and pressure performance. Plans for future injection conversions and acid treatments to improve unit performance are being considered for 2015.

TABLE NO. 1: WASKADA UNIT NO. 18 WELL SUMMARY

UWI	Type	Status	On Prod Date	Cum Prd Oil (m3)	Cum Prd Water (m3)	Last Prod Date	On Inj Date	Cum Inj Water (m3)	Last Inj Date
100/07-16-001-25W1/0	Vertical	Pumping	7/1/1990	6,851	404	5/31/2012		0	
100/10-16-001-25W1/0	Vertical	Producing	11/1/1990	8,848	916	12/31/2014		0	
102/10-16-001-25W1/0	Horizontal	Producing	11/1/2009	9,805	12,038	12/31/2014		0	
103/10-16-001-25W1/0	Horizontal	Producing	2/1/2010	8,891	28,020	12/31/2014		0	
102/11-16-001-25W1/0	Vertical	Abandoned	11/1/1989	1,894	236	9/1/1991	10/1/1991	75,629	6/30/2006
103/11-16-001-25W1/0	Vertical	Injection	N/A	0	0		3/1/2001	3,768	6/30/2009
100/12-16-001-25W1/0	Vertical	Producing	11/1/1990	4,999	876	8/31/2012		0	
100/13-16-001-25W1/0	Vertical	Producing	2/1/1991	4,173	3,470	12/31/2014		0	
102/13-16-001-25W1/0	Horizontal	Producing	11/1/2010	5,374	10,090	12/31/2014		0	
100/14-16-001-25W1/0	Vertical	Pumping	7/1/1990	6,721	1,050	12/31/2014		0	
102/14-16-001-25W1/0	Horizontal	Producing	11/1/2011	4,845	2,437	12/31/2014		0	
100/15-16-001-25W1/0	Vertical	Injection	3/1/1990	1,462	591	10/31/1991	10/1/1991	61,938	9/30/2009
100/16-16-001-25W1/0	Vertical	Pumping	2/1/1991	5,580	14,325	12/31/2014		0	
102/16-16-001-25W1/0	Horizontal	Producing	12/1/2009	1,102	77,371	7/31/2011		0	
103/16-16-001-25W1/0	Horizontal	Producing	10/1/2009	8,288	40,801	12/31/2014		0	
100/02-21-001-25W1/0	Vertical	Pumping	7/1/1990	6,683	599	12/31/2014		0	
100/03-21-001-25W1/0	Vertical	Producing	3/1/1990	9,198	7,597	12/31/2014		0	
100/04-21-001-25W1/0	Vertical	Abandoned	10/1/1990	3,219	2,477	11/30/2000		0	
102/04-21-001-25W1/0	Horizontal	Producing	11/1/2010	6,168	2,964	12/31/2014		0	
103/04-21-001-25W1/0	Horizontal	Producing	12/1/2010	5,144	13,030	12/31/2014		0	
100/05-21-001-25W1/0	Vertical	Producing	2/1/1991	7,333	2,602	12/31/2014		0	
102/05-21-001-25W1/0	Horizontal	Producing	12/1/2010	6,718	9,150	12/31/2014		0	
103/05-21-001-25W1/0	Horizontal	Producing	12/1/2010	5,591	2,013	12/31/2014		0	
100/06-21-001-25W1/0	Vertical	Abandoned	11/1/1990	501	216	10/31/1991	10/1/1991	74,313	3/31/2001
102/06-21-001-25W1/0	Vertical	Abandoned	N/A	0	0		3/1/2001	3,055	11/30/2001
103/06-21-001-25W1/0	Dir/Dev	SWD	N/A	0	0				
100/10-21-001-25W1/0	Vertical	Injection	10/1/1990	841	210	10/31/1991	10/1/1991	60,103	11/30/2009
100/11-21-001-25W1/0	Vertical	Pumping	7/1/1990	6,438	1,237	12/31/2014		0	
100/12-21-001-25W1/0	Vertical	Pumping	10/1/1990	7,690	3,224	12/31/2014		0	
102/12-21-001-25W1/0	Horizontal	Injection	12/1/2010	3,785	1,275	3/31/2012	8/1/2012	27,717	12/31/2014
103/12-21-001-25W1/0	Horizontal	Producing	12/1/2010	5,040	1,558	12/31/2014		0	
102/13-21-001-25W1/2	Horizontal	Producing	12/1/2010	3,379	1,685	12/31/2014		0	
100/14-21-001-25W1/0	Vertical	Pumping	3/1/1991	8,889	1,114	12/31/2014		0	
100/15-21-001-25W1/0	Vertical	Producing	11/1/1990	6,363	751	2/28/2013		0	
102/15-21-001-25W1/0	Horizontal	Producing	10/1/2007	5,318	35,910	7/31/2013		0	
				177,129	280,236				
								306,522	

TABLE NO. 2 - Waskada Unit No. 18 VRR Calculations

Date	Monthly Oil Prod m3	Cum Oil Prod Km3	Monthly Water Prod m3	Cum Water Prod Km3	Water Oil Ratio m3/m3	Monthly Water Inj m3	Cum Water Inj Km3	VRR	Cum VRR
1989	339	0.339	66	0.066	0.19		0.000	0.000	0.000
1990	6,979	7.318	1,784	1.850	0.26		0.000	0.000	0.000
1991	11,355	18.673	2,943	4.793	0.26	7,816	7.816	0.488	0.298
1992	6,805	25.477	1,169	5.962	0.17	25,867	33.683	2.876	0.955
1993	5,779	31.256	1,087	7.049	0.19	32,427	66.109	4.194	1.538
1994	5,221	36.478	1,032	8.081	0.20	32,903	99.013	4.676	1.979
1995	4,618	41.096	875	8.956	0.19	27,508	126.520	4.447	2.251
1996	4,438	45.534	920	9.877	0.21	29,853	156.373	4.955	2.512
1997	3,981	49.515	868	10.745	0.22	21,457	177.831	3.940	2.627
1998	3,820	53.335	886	11.630	0.23	24,241	202.071	4.592	2.769
1999	3,685	57.020	989	12.620	0.27	29,328	231.399	5.610	2.959
2000	3,465	60.485	2,836	15.456	0.82	18,424	249.823	2.701	2.939
2001	3,491	63.976	1,927	17.383	0.55	10,860	260.683	1.828	2.866
2002	3,290	67.266	1,486	18.868	0.45	2,940	263.623	0.558	2.740
2003	3,371	70.638	3,130	21.998	0.93	2,633	266.256	0.376	2.579
2004	3,543	74.180	6,738	28.737	1.90	1,707	267.962	0.158	2.350
2005	3,297	77.477	1,561	30.297	0.47	2,344	270.306	0.438	2.264
2006	3,135	80.612	1,492	31.789	0.48	2,155	272.461	0.423	2.189
2007	3,555	84.167	4,409	36.198	1.24	2,023	274.484	0.238	2.064
2008	4,386	88.552	9,403	45.601	2.14	2,398	276.882	0.166	1.878
2009	5,031	93.584	9,428	55.029	1.87	1,924	278.805	0.126	1.714
2010	24,369	117.952	90,614	145.643	3.72		278.805	0.000	0.991
2011	30,880	148.833	51,152	196.796	1.66		278.805	0.000	0.749
2012	14,610	163.443	34,324	231.120	2.35	8,927	287.733	0.154	0.669
2013	8,167	171.609	33,303	264.422	4.08	10,382	298.115	0.220	0.624
2014	5,520	177.129	15,814	280.236	2.86	8,407	306.522	0.367	0.613

TABLE NO. 3

**Tundra Oil and Gas
Waskada Unit No. 18
2014 Injection Volumes**

Well Location	Date	Hours On	H ₂ O Inj Cal-d avg (m ³ /d)	Monthly Injected H ₂ O (m ³)
Unit No. 18 Total:				
	Jan-14	0	48.6	1,508
	Feb-14	0	52.8	1,477
	Mar-14	0	31.3	971
	Apr-14	0	21.4	641
	May-14	0	20.2	627
	Jun-14	0	17.3	520
	Jul-14	0	0.0	1
	Aug-14	0	22.9	710
	Sep-14	0	18.8	563
	Oct-14	0	16.4	509
	Nov-14	0	15.0	448
	Dec-14	0	13.9	432
2014 Group Totals:				8,407

Unit No. 18 Total:

1989	0	0.0	
1990	0	0.0	
1991	0	21.4	7,816
1992	0	70.9	25,867
1993	0	88.8	32,427
1994	0	90.1	32,903
1995	0	75.4	27,508
1996	0	81.8	29,853
1997	0	58.8	21,457
1998	0	66.4	24,241
1999	0	80.3	29,328
2000	0	50.5	18,424
2001	0	29.8	10,860
2002	0	8.1	2,940
2003	0	7.2	2,633
2004	0	4.7	1,707
2005	0	6.4	2,344
2006	0	5.9	2,155
2007	0	5.5	2,023
2008	0	6.6	2,398
2009	0	5.3	1,924
2010	0	0.0	0
2011	0	0.0	0
2012	0	24.4	8,927
2013	0	28.4	10,382
2014	0	23.2	8,407
			306,522

TABLE NO. 4

**Tundra Oil and Gas
Waskada Unit No. 18
2014 Production Volumes**

Date	Hours On	Oil Rate (CD) m3/d	Monthly Oil Prod m3	Water Rate (CD) m3/d	Monthly Water Prod m3	Water Oil Ratio m3/m3	Well Count
Jan-14	12,192	15.45	479	56.87	1,763	3.68	21
Feb-14	12,576	17.38	487	53.90	1,509	3.10	21
Mar-14	14,136	17.68	548	50.29	1,559	2.84	21
Apr-14	13,464	17.11	513	48.49	1,455	2.83	21
May-14	13,488	15.46	479	25.83	801	1.67	21
Jun-14	12,792	14.76	443	32.70	981	2.22	21
Jul-14	13,152	14.36	445	42.26	1,310	2.94	21
Aug-14	14,136	14.30	443	40.58	1,258	2.84	21
Sep-14	13,632	13.19	396	39.76	1,193	3.02	21
Oct-14	14,112	13.40	415	39.70	1,231	2.96	21
Nov-14	13,296	13.75	412	38.84	1,165	2.83	21
Dec-14	14,352	14.80	459	51.28	1,590	3.46	21
	161,328		5,520		15,814		

Date	Hours On	Oil Rate (CD) m3/d	Monthly Oil Prod m3	Water Rate (CD) m3/d	Monthly Water Prod m3	Water Oil Ratio m3/m3	Well Count
1989	1,296	0.93	339	0.18	66	0.19	1
1990	46,848	19.12	6,979	4.89	1,784	0.26	6
1991	141,504	31.11	11,355	8.06	2,943	0.26	17
1992	121,032	18.64	6,805	3.20	1,169	0.17	14
1993	118,320	15.83	5,779	2.98	1,087	0.19	14
1994	118,704	14.30	5,221	2.83	1,032	0.20	14
1995	117,072	12.65	4,618	2.40	875	0.19	14
1996	120,240	12.16	4,438	2.52	920	0.21	14
1997	119,712	10.91	3,981	2.38	868	0.22	14
1998	120,360	10.47	3,820	2.43	886	0.23	14
1999	116,472	10.10	3,685	2.71	989	0.27	14
2000	114,096	9.49	3,465	7.77	2,836	0.82	14
2001	110,280	9.56	3,491	5.28	1,927	0.55	13
2002	107,448	9.01	3,290	4.07	1,486	0.45	13
2003	94,152	9.24	3,371	8.58	3,130	0.93	13
2004	109,944	9.71	3,543	18.46	6,738	1.90	13
2005	109,368	9.03	3,297	4.28	1,561	0.47	13
2006	107,508	8.59	3,135	4.09	1,492	0.48	13
2007	113,875	9.74	3,555	12.08	4,409	1.24	13
2008	118,440	12.02	4,386	25.76	9,403	2.14	14
2009	118,368	13.78	5,031	25.83	9,428	1.87	15
2010	146,808	66.76	24,369	248.26	90,614	3.72	19
2011	197,928	84.60	30,880	140.14	51,152	1.66	26
2012	179,232	39.92	14,610	93.78	34,324	2.35	23
2013	164,232	22.37	8,167	91.24	33,303	4.08	21
2014	161,328	15.12	5,520	43.32	15,814	2.86	21
	3,094,567		177,129		280,236		