

***Waskada Unit No. 16***  
***Waterflood Progress Report 2014***  
***January 1<sup>st</sup> through December 31<sup>st</sup> 2014***

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

**Prepared by:**  
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**June 8, 2015**

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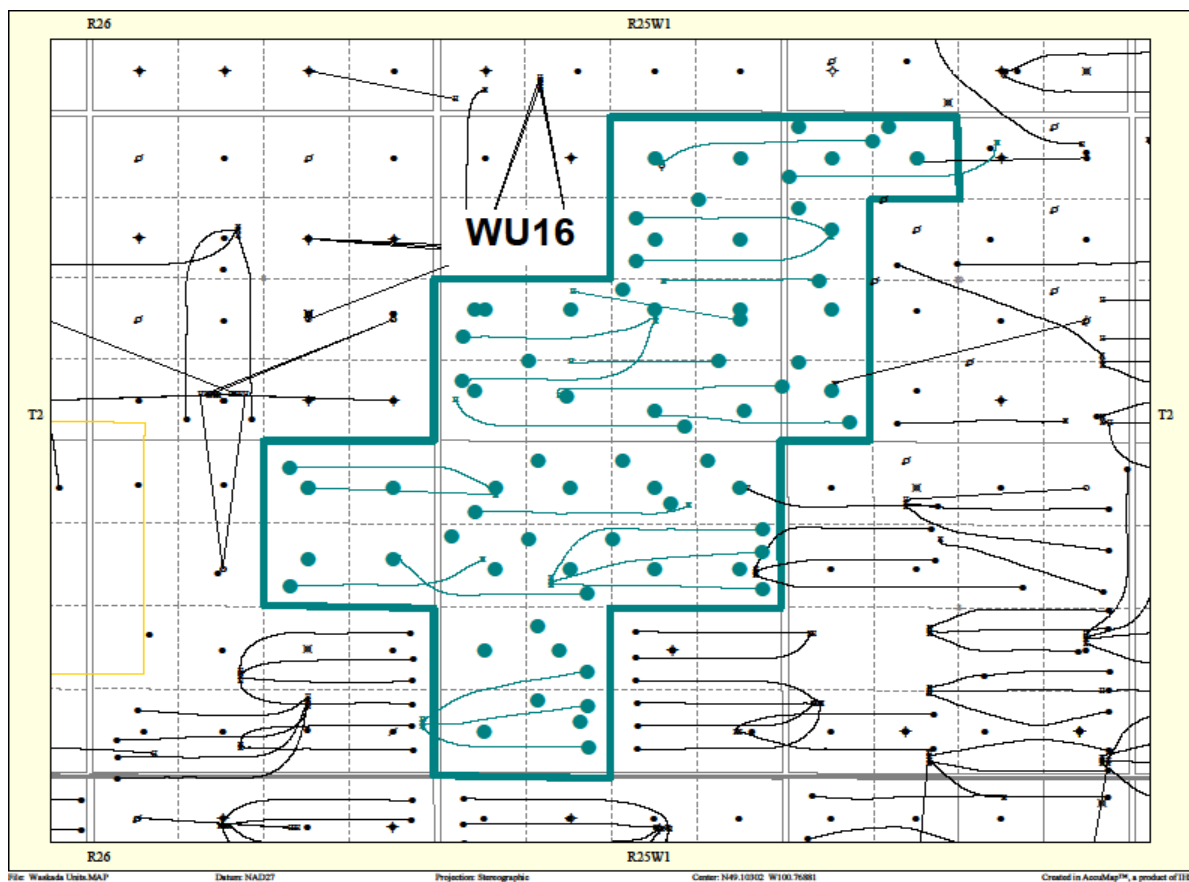
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## **INTRODUCTION**

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 (closing date December 1, 2014) with Tundra Oil and Gas (Tundra) as the new operator. THE EOR project area, outlined in green in **Figure 1**, contains 73 wells over 33 LSDs in Township 2, Range 25W1 (**Table 1**).

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



## **PRODUCTION HISTORY**

For the wells included in Waskada Unit No. 16, production started in July 1984 with the 00/04-09-002-25W1/00 well. From 1985 – 1989, 33 wells were drilled. Oil production peaked at 106.88 m<sup>3</sup>/d in April 1988. From 2012-2014, 18 new producers were added to the unit, resulting in a peak in oil production of 257.75 m<sup>3</sup>/d in October 2014. There are currently 35 producing wells in Waskada Unit No. 16. The

average production for the unit was 161.0 m<sup>3</sup>/d of oil and 127.9 m<sup>3</sup>/d of water and the average WOR was 0.79 m<sup>3</sup>/m<sup>3</sup> at the end of December 2014 (Table 4). The rates and WOR are presented in Figure 2.

**Figure 2: Waskada Unit No. 16 Production/Injection Rates and WOR vs Time**

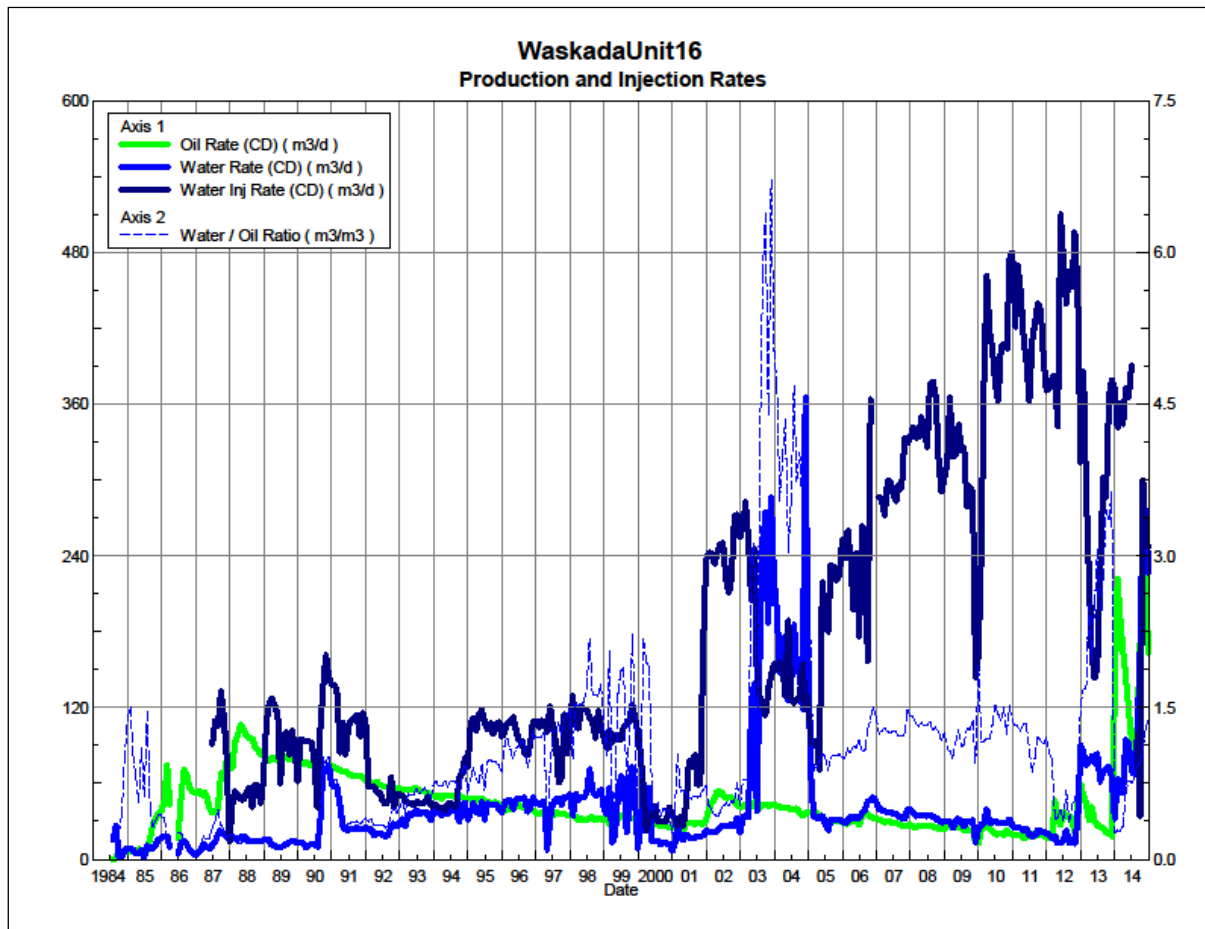
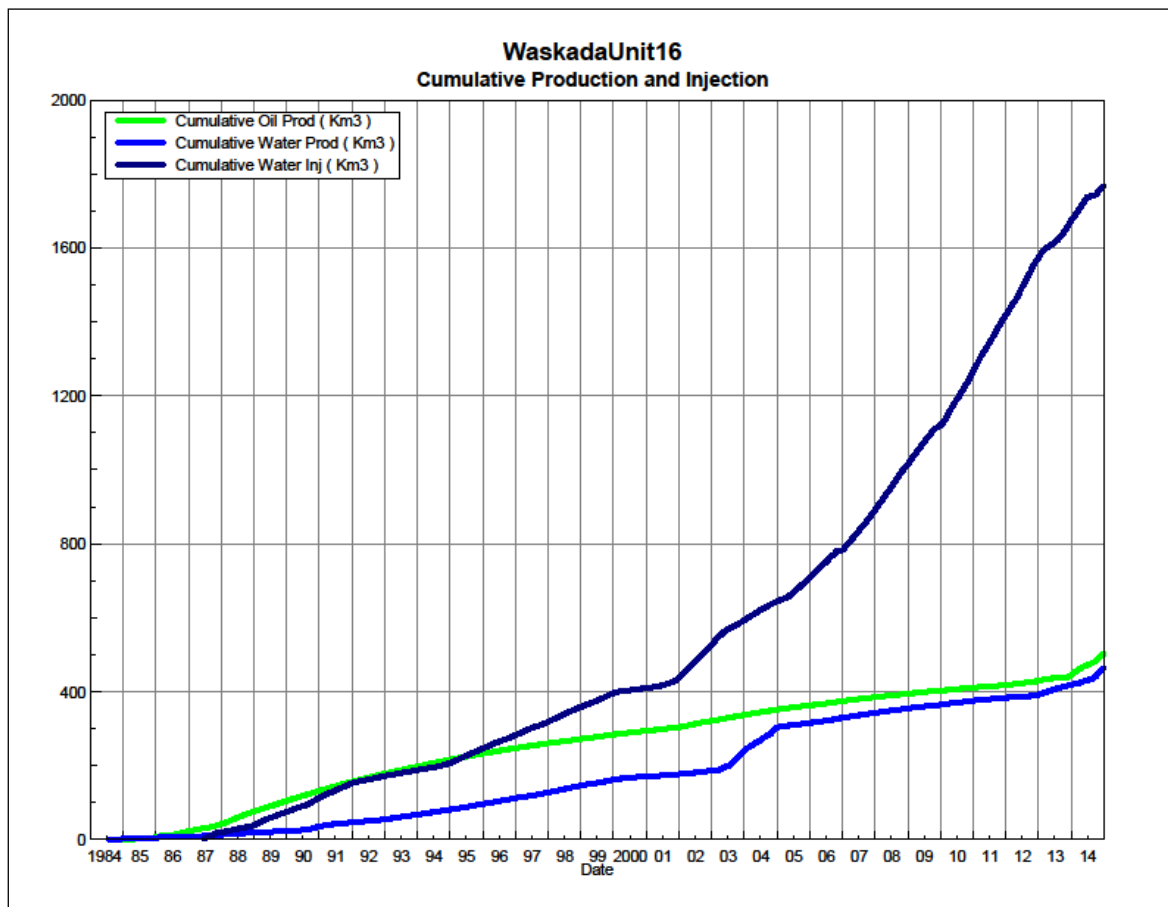


Figure 3 shows the cumulative production for Waskada Unit No. 16 to the end of December 2014 as 502.9 e<sup>3</sup>m<sup>3</sup> of oil, and 465.2 e<sup>3</sup>m<sup>3</sup> of water. The cumulative water injected is over 1768.0 e<sup>3</sup>m<sup>3</sup>.

**Figure 3. Waskada Unit No. 16 Cumulative Oil, Water and Water Injected vs. Time**



### **WATERFLOOD HISTORY**

Water injection commenced with 4 injector wells on June 1987. The unit was then enlarged and 5 more injection wells were added in December 1988. Fourteen injector wells were added in November 2001, and 3 more were added October 2002. Of the 22 injector wells operating in 2014, 17 were active at the end of 2014.

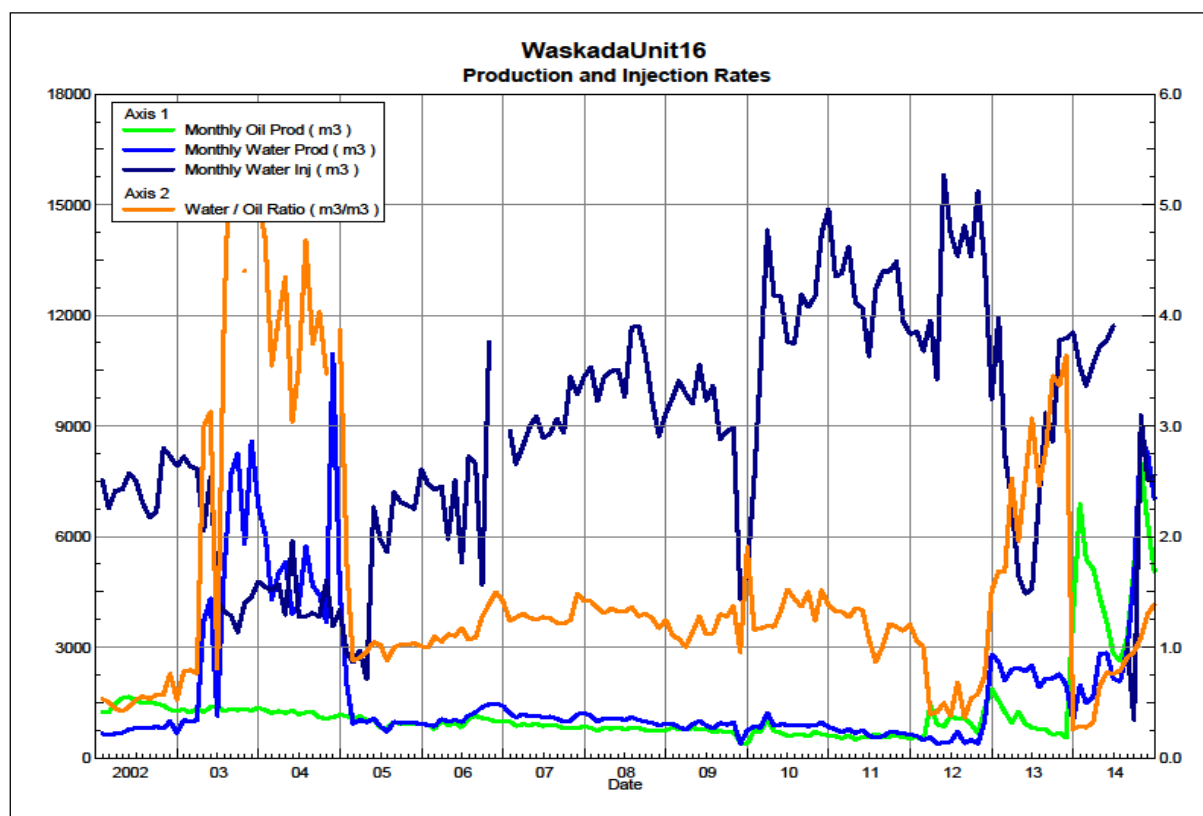
Any future revisions to the waterflood development or surveillance plan would be based on new production or performance response data, technical studies or observed reservoir behavior and reserves recovery interpretations.

## WATERFLOOD PERFORMANCE

From January 1 to December 31 in 2014, Unit No. 16 produced 105,527 m<sup>3</sup> of total fluids (58,702 m<sup>3</sup> oil, 46,825 m<sup>3</sup> water), and injected 94,154 m<sup>3</sup> of source water, giving an annual oil and water voidage replacement ratio (VRR) of 0.824 for this reporting period. The cumulative VRR since injection commenced in May 1987 is presently at 1.694. Table 2 summarizes the yearly and cumulative VRR for Waskada Unit No. 16.

Since 2007, the injection rate averaged 10,000 m<sup>3</sup>/d but has little effect on oil production, as can be seen in Figure 4. The injection rates have been steadily increased since 2002. There was an associated increase in oil and water production with the increase in injected water in 2002, but since then oil production has declined despite the increased injection rates. The increases in production in 2012-14 can be attributed to the addition of 18 new producers (3 in 2012, 4 in 2013 and 11 in 2014).

**Figure 4. Waskada Unit No. 16 Production and Injection Rates For 2002-2014**



### **INJECTION WELLHEAD PRESSURES**

Monthly injection wellhead pressures for 2014 are not in our database since Tundra acquired Waskada Unit No. 16 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 73 wells in Waskada Unit No. 16 in 2014.

### **CORROSION AND SCALE PREVENTION**

The facilities in Unit 16 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 a positive effect on oil production in Waskada Unit No. 16. 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. 16 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
100/03-04-002-25W1/0	Vertical	Producing	7/1/1986	7238.0	177.9	9/30/2014		0.0	
103/03-04-002-25W1/0	Horizontal	Producing	12/1/2013	4281.1	1941.1	12/31/2014		0.0	
104/03-04-002-25W1/0	Horizontal	Producing	12/1/2013	4287.0	2543.0	12/31/2014		0.0	
1C0/03-04-002-25W1/0	Vertical	Injection	N/A	0.0	0.0		10/1/2002	24753.5	12/31/2014
100/04-04-002-25W1/0	Vertical	Producing	2/1/1986	18482.8	5330.5	8/31/2011		0.0	
100/05-04-002-25W1/0	Vertical	Injection	8/1/1985	3887.5	303.9	4/30/1987	6/1/1987	109069.4	12/31/2014
100/06-04-002-25W1/0	Vertical	Producing	2/1/1986	25788.4	15470.8	6/30/2011		0.0	
103/06-04-002-25W1/0	Horizontal	Producing	7/1/2014	2200.4	4291.8	12/31/2014		0.0	
1C0/06-04-002-25W1/0	Vertical	Injection	N/A	0.0	0.0		10/1/2002	18539.4	12/31/2014
100/09-04-002-25W1/0	Vertical	Producing	8/1/1987	7883.1	358.2	7/31/2012		0.0	
102/09-04-002-25W1/0	Horizontal	Producing	1/1/2014	6738.4	726.2	12/31/2014		0.0	
103/09-04-002-25W1/0	Horizontal	Producing	12/1/2013	5203.0	451.9	12/31/2014		0.0	
104/09-04-002-25W1/0	Horizontal	Producing	11/1/2013	4908.8	1455.2	12/31/2014		0.0	
100/10-04-002-25W1/0	Vertical	Producing	8/1/1987	17267.4	356.1	12/31/2014		0.0	
1C0/10-04-002-25W1/0	Vertical	Abandoned	N/A	0.0	0.0		11/1/2001	1829.3	10/31/2003
100/11-04-002-25W1/0	Vertical	Injection	2/1/1986	755.1	34.0	4/30/1987	6/1/1987	26431.2	12/31/2014
103/11-04-002-25W1/0	Horizontal	Producing	9/1/2014	1761.9	2669.5	12/31/2014		0.0	
1C0/11-04-002-25W1/0	Vertical	Injection	N/A	0.0	0.0		11/1/2001	11512.1	12/31/2014
100/12-04-002-25W1/0	Vertical	Producing	2/1/1986	17340.1	6258.0	12/31/2014		0.0	
1C0/12-04-002-25W1/0	Vertical	Injection	N/A	0.0	0.0		10/1/2002	12435.6	10/31/2014
100/13-04-002-25W1/2	Vertical	Producing	9/1/1985	9938.9	11721.5	12/31/2014		0.0	
102/13-04-002-25W1/0	Horizontal	Producing	11/1/2012	7669.6	6517.1	12/31/2014		0.0	
100/14-04-002-25W1/0	Vertical	Producing	2/1/1986	13788.4	6015.4	4/30/2013		0.0	
1C0/14-04-002-25W1/0	Vertical	Injection	N/A	0.0	0.0		11/1/2001	24952.3	12/31/2014
100/15-04-002-25W1/0	Vertical	Injection	8/1/1985	391.5	48.7	4/30/1987	6/1/1987	32884.8	12/31/2014
102/15-04-002-25W1/0	Vertical	Producing	3/1/2006	2860.7	360.2	12/31/2014		0.0	
1C0/15-04-002-25W1/0	Vertical	Injection	N/A	0.0	0.0		11/1/2001	7128.7	12/31/2014
100/16-04-002-25W1/0	Vertical	Producing	9/1/1987	9981.3	2668.6	12/31/2014		0.0	
1C0/16-04-002-25W1/0	Vertical	Injection	N/A	0.0	0.0		11/1/2001	1522.7	10/31/2014
100/09-05-002-25W1/0	Vertical	Producing	11/1/1985	44067.4	5461.9	8/31/2014		0.0	
100/10-05-002-25W1/0	Vertical	Abandoned	12/1/1985	6507.8	112810.4	8/31/2003		0.0	
102/10-05-002-25W1/0	Horizontal	Producing	1/1/2014	8555.4	1332.4	12/31/2014		0.0	
100/15-05-002-25W1/0	Vertical	Abandoned Zone	12/1/1985	7401.5	708.3	9/30/2013		0.0	
102/15-05-002-25W1/0	Horizontal	Producing	3/1/2014	3103.1	8831.0	12/31/2014		0.0	
103/15-05-002-25W1/0	Horizontal	N/A	N/A						
100/16-05-002-25W1/0	Vertical	Injection	7/1/1985	1181.1	425.4	4/30/1987	6/1/1987	68870.6	8/31/2014
100/01-09-002-25W1/0	Vertical	Injection	8/1/1987	394.3	507.9	7/31/1988	12/1/1988	21984.6	12/31/2014
102/01-09-002-25W1/0	Horizontal	Injection	N/A	0.0	0.0		11/1/2001	12875.5	12/31/2014
103/01-09-002-25W1/0	Horizontal	Producing	9/1/2014	3907.6	1815.9	12/31/2014		0.0	
100/02-09-002-25W1/0	Vertical	Producing	7/1/1986	18408.6	1460.9	12/31/2014		0.0	
102/02-09-002-25W1/0	Horizontal	Producing	3/1/2012	7865.4	2024.8	12/31/2014		0.0	
100/03-09-002-25W1/0	Vertical	Producing	8/1/1987	37594.0	23746.3	2/28/2014		0.0	
1C0/03-09-002-25W1/0	Vertical	Injection	N/A	0.0	0.0		11/1/2001	9922.7	12/31/2014
100/04-09-002-25W1/2	Vertical	Producing	7/1/1984	11987.5	105862.5	11/30/2014		0.0	
102/04-09-002-25W1/0	Horizontal	Standing	N/A						
100/05-09-002-25W1/0	Vertical	Abandoned	2/1/1985	772.7	3250.5	2/28/1989		0.0	
102/05-09-002-25W1/0	Vertical	Pumping	11/1/1989	8102.5	1234.1	12/31/2014		0.0	
103/05-09-002-25W1/0	Horizontal	Producing	9/1/2014	1822.7	2197.1	12/31/2014		0.0	
100/06-09-002-25W1/0	Vertical	Injection	11/1/1987	850.5	40.0	8/31/1988	12/1/1988	47922.9	12/31/2014
100/07-09-002-25W1/0	Vertical	Producing	11/1/1987	27015.0	16683.2	3/31/2014		0.0	
1C0/07-09-002-25W1/0	Vertical	Injection	N/A	0.0	0.0		11/1/2001	11645.7	12/31/2014
100/08-09-002-25W1/0	Vertical	Abandoned Zone	2/1/1988	13546.1	5674.3	12/31/2012		0.0	
102/08-09-002-25W1/0	Horizontal	Standing	N/A						
100/09-09-002-25W1/0	Vertical	Producing	2/1/1988	25231.2	12158.3	7/31/2012		0.0	
1C0/09-09-002-25W1/0	Vertical	Abandoned	N/A	0.0	0.0		11/1/2001	20382.5	10/31/2004
100/10-09-002-25W1/0	Vertical	Abandoned	3/1/1986	1145.1	68.4	8/31/1988	12/1/1988	48805.8	8/31/2001
102/10-09-002-25W1/0	Horizontal	Producing	9/1/2014	2044.1	2624.5	12/31/2014		0.0	
103/10-09-002-25W1/0	Horizontal	Producing	9/1/2014	2578.3	2207.4	12/31/2014		0.0	
100/15-09-002-25W1/0	Vertical	Producing	1/1/1986	9292.1	307.9	12/31/2014		0.0	
100/16-09-002-25W1/0	Vertical	Injection	7/1/1985	3365.2	203.2	8/31/1988	12/1/1988	427172.0	6/30/2014
100/04-10-002-25W1/0	Vertical	Producing	10/1/1987	6295.2	687.3	12/31/2014		0.0	
103/04-10-002-25W1/0	Horizontal	Producing	9/1/2014	2011.8	600.5	12/31/2014		0.0	
1C0/04-10-002-25W1/0	Vertical	Injection	N/A	0.0	0.0		11/1/2001	2631.9	12/31/2014
100/05-10-002-25W1/0	Vertical	Injection	3/1/1988	338.8	32.8	8/31/1988	12/1/1988	721478.2	12/31/2014
102/05-10-002-25W1/0	Horizontal	Injection	N/A	0.0	0.0		11/1/2001	39040.9	12/31/2014
100/12-10-002-25W1/0	Vertical	Producing	3/1/1988	34567.3	50419.1	12/31/2014		0.0	
1C0/12-10-002-25W1/0	Vertical	Injection	N/A	0.0	0.0		11/1/2001	39817.8	8/31/2012
100/13-10-002-25W1/0	Vertical	Producing	2/1/1988	28150.4	2921.6	12/31/2014		0.0	
103/13-10-002-25W1/0	Horizontal	Producing	11/1/2012	568.2	25170.9	12/31/2014		0.0	
104/13-10-002-25W1/0	Horizontal	Producing	3/1/2014	3449.1	2483.6	12/31/2014		0.0	
1C0/13-10-002-25W1/0	Vertical	Injection	N/A	0.0	0.0		11/1/2001	2198.8	11/30/2014
100/14-10-002-25W1/0	Vertical	Producing	1/1/1986	8145.0	1505.2	12/31/2014		0.0	
1C0/14-10-002-25W1/0	Vertical	Injection	N/A	0.0	0.0		11/1/2001	22138.9	12/31/2014
				502918.4	465157.2				



TABLE NO. 2 - VRR Calculations

Date	Mth Oil Prod m3	Cum Oil Prod Km3	Mth Water Prod m3	Cum Water Prod Km3	Water Oil Ratio m3/m3	Mth Water Inj m3	Cum Water Inj Km3	VRR	Cum VRR
1984	774	0.774	1892	1.892	2.44		0.000	0.000	0.000
1985	5932	6.706	3258	5.150	0.55		0.000	0.000	0.000
1986	16130	22.836	3175	8.325	0.20		0.000	0.000	0.000
1987	19644	42.480	5006	13.331	0.25	19770	19.770	0.716	0.318
1988	33617	76.097	5787	19.118	0.17	18857	38.627	0.424	0.362
1989	29005	105.102	4528	23.647	0.16	36119	74.746	0.953	0.517
1990	27089	132.191	11703	35.349	0.43	38515	113.262	0.899	0.604
1991	24743	156.935	11364	46.713	0.46	39653	152.914	0.996	0.673
1992	21330	178.265	8289	55.002	0.39	18966	171.880	0.578	0.661
1993	19754	198.019	12744	67.746	0.65	16521	188.401	0.466	0.638
1994	18064	216.083	13597	81.343	0.75	18862	207.263	0.549	0.628
1995	16721	232.804	14658	96.001	0.88	38999	246.262	1.151	0.677
1996	14843	247.647	16507	112.508	1.11	36447	282.709	1.086	0.712
1997	13016	260.663	15408	127.916	1.18	35740	318.449	1.177	0.745
1998	11726	272.389	18486	146.402	1.58	40470	358.919	1.266	0.781
1999	11715	284.104	15011	161.413	1.28	37339	396.258	1.311	0.812
2000	10087	294.190	8957	170.370	0.89	14073	410.331	0.685	0.807
2001	10124	304.314	6718	177.088	0.66	28196	438.527	1.536	0.832
2002	17231	321.545	9116	186.203	0.53	88619	527.146	3.063	0.948
2003	15739	337.284	54464	240.667	3.46	66491	593.638	0.916	0.944
2004	14340	351.624	62663	303.331	4.37	51375	645.013	0.649	0.911
2005	11626	363.250	12251	315.582	1.05	64324	709.337	2.511	0.967
2006	11598	374.848	13838	329.420	1.19	72897	782.234	2.682	1.029
2007	10417	385.265	13376	342.796	1.28	109531	891.765	4.320	1.135
2008	9323	394.587	12196	354.992	1.31	123488	1015.253	5.388	1.255
2009	8347	402.934	10000	364.992	1.20	105691	1120.944	5.393	1.353
2010	8225	411.160	10834	375.826	1.32	146328	1267.272	7.211	1.493
2011	6795	417.955	8052	383.878	1.19	151409	1418.681	9.543	1.641
2012	12252	430.206	8620	392.498	0.70	154869	1573.550	6.820	1.774
2013	14010	444.216	25834	418.332	1.84	100244	1673.794	2.390	1.801
2014	45209	489.425	33928	452.261	0.75	94153	1767.948	0.824	1.694

TABLE NO. 3

**Tundra Oil and Gas  
Waskada Unit No. 16  
2014 Injection Volumes**

Well Location	Date	Hours On	H <sub>2</sub> O Inj Cal-d avg (m <sup>3</sup> /d)	Monthly Injected H <sub>2</sub> O (m <sup>3</sup> )
<b>Unit No. 16 Total:</b>				
	Jan-14	0	341.5	10586.10
	Feb-14	0	360.6	10096.60
	Mar-14	0	344.4	10677.20
	Apr-14	0	372.2	11165.70
	May-14	0	365.4	11327.90
	Jun-14	0	390.7	11720.20
	Jul-14	0	0.0	0.00
	Aug-14	0	99.0	3068.60
	Sep-14	0	34.0	1018.40
	Oct-14	0	299.6	9288.10
	Nov-14	0	251.6	7548.70
	Dec-14	0	247.0	7655.90
<b>2014 Group Totals:</b>				<b>94153.40</b>
<b>Unit No. 16 Total:</b>				
	1984	0	0.0	0.00
	1985	0	0.0	0.00
	1986	0	0.0	0.00
	1987	0	54.2	19,770.30
	1988	0	51.7	18,857.10
	1989	0	99.0	36,118.80
	1990	0	105.5	38,515.30
	1991	0	108.6	39,652.50
	1992	0	52.0	18,965.80
	1993	0	45.3	16,521.00
	1994	0	51.7	18,862.30
	1995	0	106.8	38,998.70
	1996	0	99.9	36,447.10
	1997	0	97.9	35,740.40
	1998	0	110.9	40,469.70
	1999	0	102.3	37,339.40
	2000	0	38.6	14,072.80
	2001	0	77.3	28,196.30
	2002	0	242.8	88,618.60
	2003	0	182.2	66,491.40
	2004	0	140.8	51,375.10
	2005	0	176.2	64,324.30
	2006	0	199.7	72,897.00
	2007	0	300.1	109,531.30
	2008	0	338.3	123,487.80
	2009	0	289.6	105,691.10
	2010	0	400.9	146,328.10
	2011	0	414.8	151,409.30
	2012	0	423.1	154,868.50
	2013	0	274.6	100,244.40
	2014	0	281.9	94,153.40
<b>Group Totals:</b>				<b>1,767,947.80</b>

TABLE NO. 4

**Tundra Oil and Gas  
Waskada Unit No. 16  
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	17,088	222.05	6,884	63.45	1,967	0.29	23
Feb-14	13,416	191.99	5,376	52.80	1,478	0.28	20
Mar-14	14,400	165.76	5,139	53.12	1,647	0.32	19
Apr-14	14,592	145.18	4,355	94.39	2,832	0.65	20
May-14	15,864	118.47	3,673	91.62	2,840	0.77	21
Jun-14	14,832	94.04	2,821	71.37	2,141	0.76	21
Jul-14	12,720	85.08	2,638	67.05	2,079	0.79	17
Aug-14	16,080	104.45	3,238	94.95	2,944	0.91	22
Sep-14	17,952	171.58	5,147	164.11	4,923	0.96	25
Oct-14	21,768	257.75	7,990	279.90	8,677	1.09	29
Nov-14	22,032	213.02	6,391	275.83	8,275	1.29	31
Dec-14	21,912	162.95	5,051	226.52	7,022	1.39	29
	202,656		58,703		46,825		

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
1984	3,600	4.21	774	10.28	1,892	2.44	1
1985	29,952	16.27	5,932	8.93	3,258	0.55	3
1986	94,440	44.19	16,130	10.45	3,175	0.20	13
1987	155,280	53.82	19,644	13.71	5,006	0.25	18
1988	222,336	92.00	33,617	15.81	5,787	0.17	25
1989	196,344	79.47	29,005	12.41	4,528	0.16	22
1990	207,408	74.22	27,089	32.06	11,703	0.43	24
1991	208,224	67.79	24,743	31.13	11,364	0.46	24
1992	208,632	58.28	21,330	22.65	8,289	0.39	24
1993	207,792	54.12	19,754	34.92	12,744	0.65	24
1994	205,104	49.49	18,064	37.25	13,597	0.75	23
1995	207,888	45.81	16,721	40.16	14,658	0.88	24
1996	205,032	40.55	14,843	45.10	16,507	1.11	23
1997	204,408	35.66	13,016	42.21	15,408	1.18	23
1998	206,256	32.13	11,726	50.65	18,486	1.58	24
1999	192,864	32.09	11,715	41.13	15,011	1.28	22
2000	198,696	27.56	10,087	24.47	8,957	0.89	23
2001	193,728	27.74	10,124	18.40	6,718	0.66	22
2002	198,600	47.21	17,231	24.97	9,116	0.53	23
2003	195,480	43.12	15,739	149.22	54,464	3.46	22
2004	193,368	39.18	14,340	171.21	62,663	4.37	22
2005	194,040	31.85	11,626	33.57	12,251	1.05	22
2006	204,283	31.78	11,598	37.91	13,838	1.19	23
2007	207,552	28.54	10,417	36.65	13,376	1.28	24
2008	209,304	25.47	9,323	33.32	12,196	1.31	24
2009	186,696	22.87	8,347	27.40	10,000	1.20	21
2010	207,000	22.54	8,225	29.68	10,834	1.32	24
2011	188,712	18.62	6,795	22.06	8,052	1.19	22
2012	165,432	33.47	12,252	23.55	8,620	0.70	19
2013	169,488	38.38	14,010	70.78	25,834	1.84	19
2014	202,656	160.83	58,703	128.29	46,825	0.80	23
	5,670,595		502,918		465,157		