

Waskada Unit No. 17
Waterflood Progress Report 2015
January 1st through December 31st 2015

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

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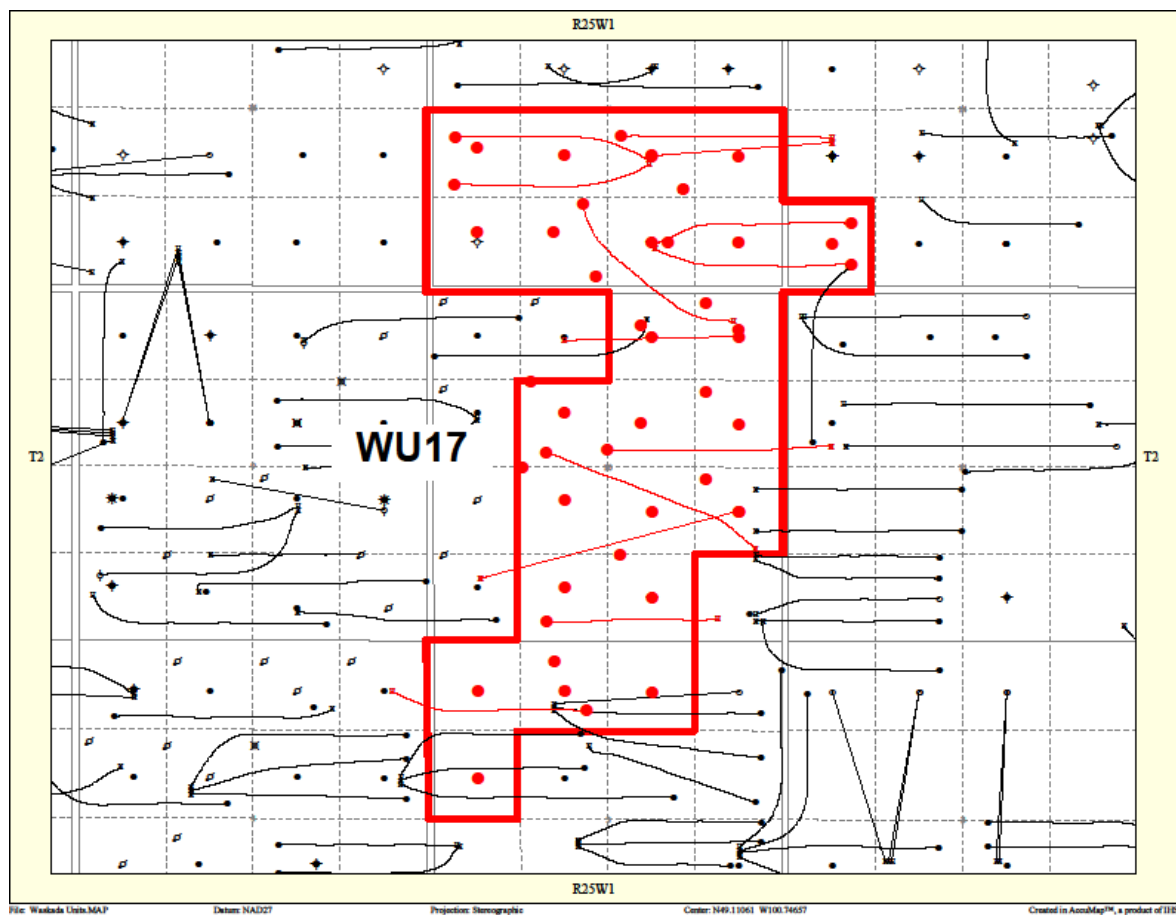
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INTRODUCTION

The Waskada Unit No.17 pressure maintenance project commenced water injection into the Lower Amaranth A pool in accordance with Manitoba Energy and Mines Order No. PM 66, dated October 1, 1991. Waskada Unit No. 17 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 red in [Figure 1](#), contains 47 wells over 23 LSDs in Township 2, Range 25W1 ([Table 1](#)).

Figure 1: Waskada Unit No. 17 Area Outline



PRODUCTION HISTORY

For the wells included in Waskada Unit No. 17, production started in December 1982 with the 00/15-10-002-25W1/00 well. From 1982 – 1990, 25 wells were drilled. Oil production peaked at 72.3 m³/d in September 1990. From 2012-2014, 11 new producers were added to the unit, resulting in a peak in oil production of 212.4 m³/d in November 2014. There are currently 19 producing wells in Waskada Unit No. 17. The average production for the unit was 82.3 m³/d of oil and 69.0 m³/d of water and the average WOR was 0.86 m³/m³ at the end of December 2015 (Table 4). The rates and WOR are presented in Figure 2.

Figure 2: Waskada Unit No. 17 Production/Injection Rates and WOR vs Time

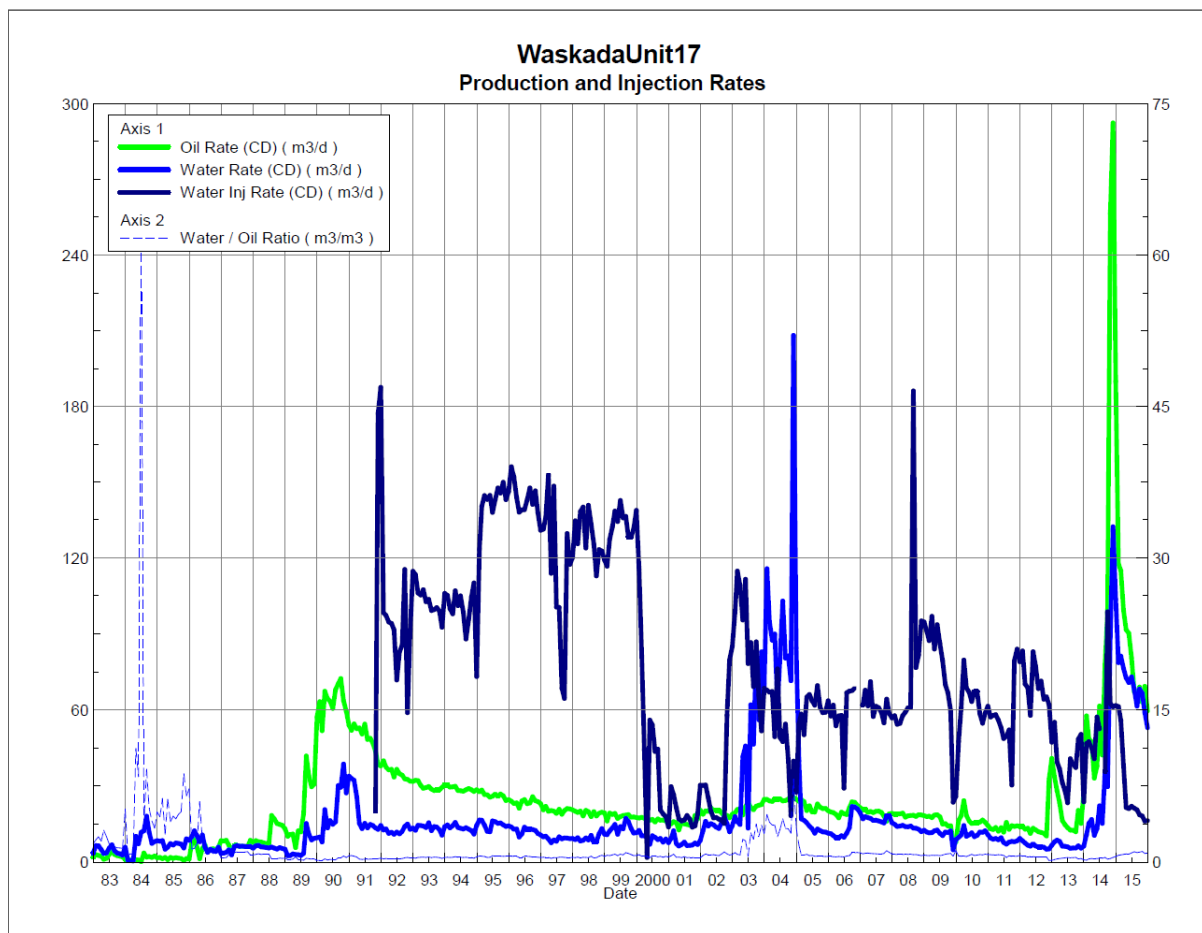
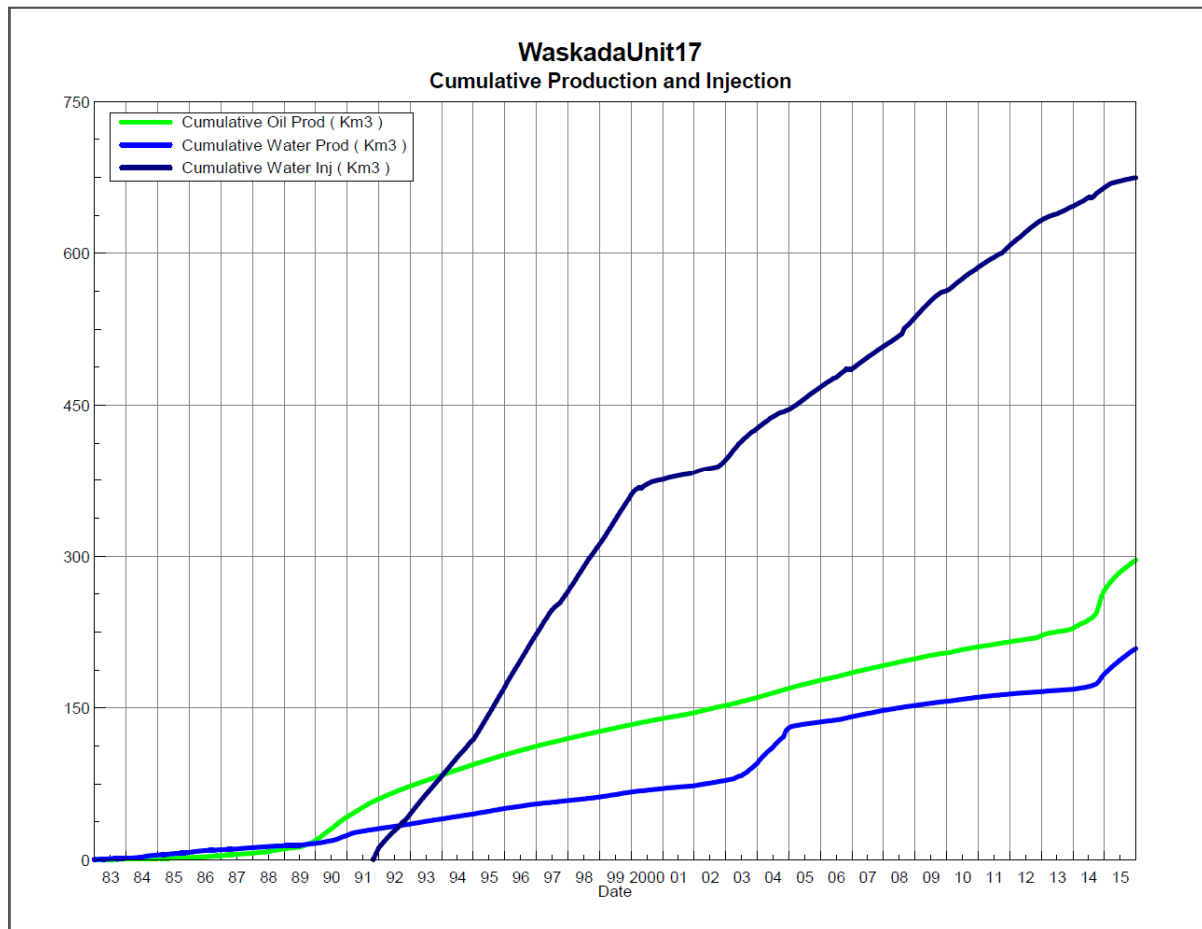


Figure 3 shows the cumulative production for Waskada Unit No. 17 to the end of December 2015 as 296.2 e³m³ of oil, and 208.7 e³m³ of water. The cumulative water injected is over 674.7 e³m³.

Figure 3. Waskada Unit No. 17 Cumulative Oil, Water and Water Injected vs. Time



WATERFLOOD HISTORY

Water injection commenced with 6 injector wells on October 1991. Two more injectors wells were added in November 2001 and 7 more in October 2002. Of the 14 injector wells operating in 2015, 11 were active at the end of 2014.

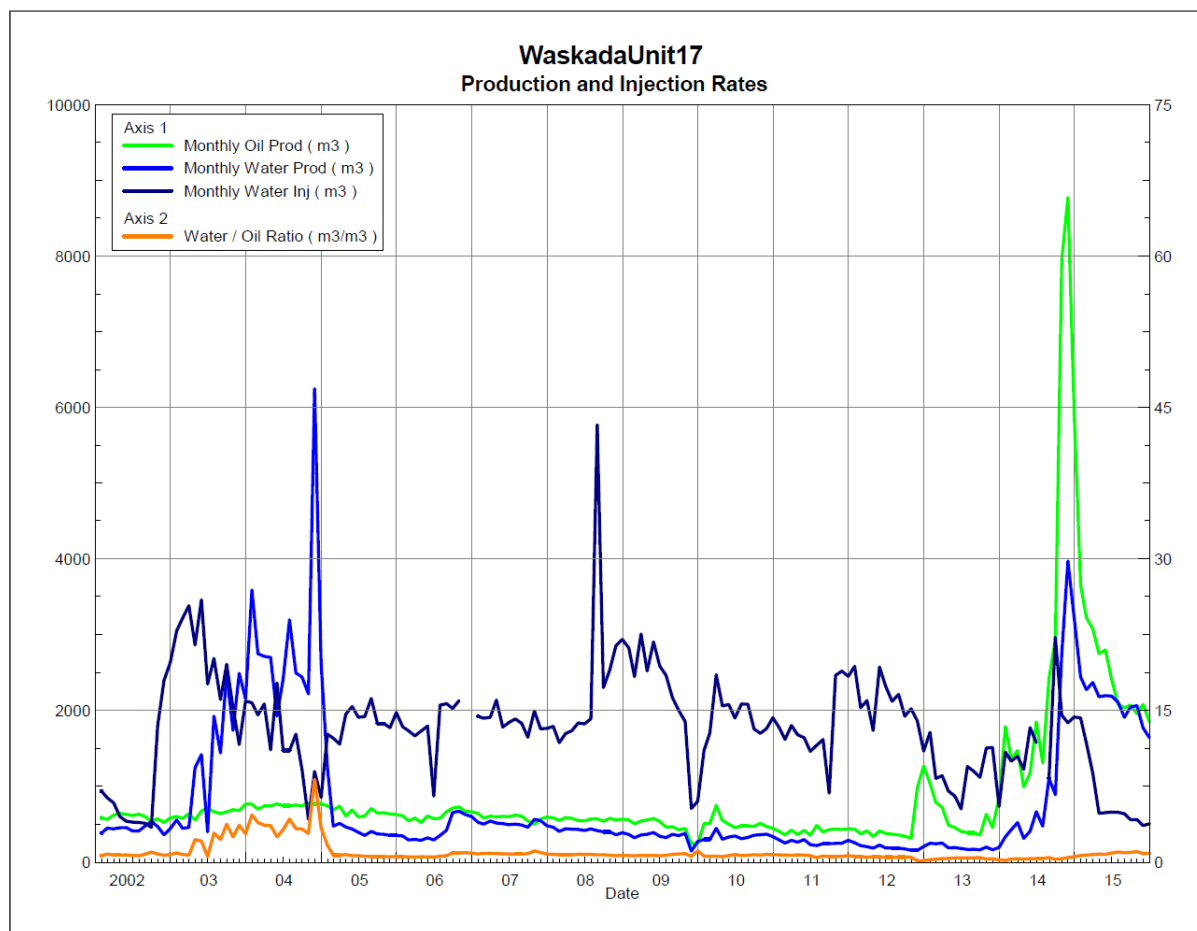
Any future revisions to the waterflood development or surveillance plan would be based on new production or performance response data, technical studies or observed reservoir behavior and reserves recovery interpretations.

WATERFLOOD PERFORMANCE

From January 1 to December 31 in 2015, Waskada Unit No. 17 produced 55,129 m³ of total fluids (29,958 m³ oil, 25,171 m³ water), and injected 10,006 m³ of source water, giving an annual oil and water voidage replacement ratio (VRR) of 0.168 for this reporting period. The cumulative VRR since injection commenced in October 1991 is presently at 1.228. The cumulative VRR reached 1.0 in 1995 and has maintained values of 1.35 – 1.64 since 1997. Table 2 summarizes the yearly and cumulative VRR for Waskada Unit No. 17.

In 2011, the injection rate was increased from approximately 1500 m³/month in January to 2300 m³/month in March. This increase resulted in a small increase in produced volumes (Figure 4). The injection rate was also increased in 2002, which also had a positive effect on the oil production. The increase in production in 2012-14 can be attributed to the addition of 11 new producers (1 in 2012, 2 in 2013 and 8 in 2014).

Figure 4. Waskada Unit No. 17 Production and Injection Rates From 2002-2015



INJECTION WELLHEAD PRESSURES

Individual injection pressure averages for 2015 can be found in **Table 5**.

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 17, so the effectiveness of the pressure maintenance program cannot be evaluated on the GOR.

WELL SERVICING

No well servicing was required for the wells in Unit 17 throughout 2015.

CORROSION AND SCALE PREVENTION

The facilities in Waskada Unit No. 17 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. 17. Tundra will maintain the current pressure maintenance program, and continue to monitor production and pressure performance. Plans for future injection conversions and well interventions to optimize the waterflood are currently being reviewed.

TABLE NO. 1: WASKADA UNIT NO. 17 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
100/12-03-002-25W1/0	Vertical	Producing	12/18/1989	5476.6	9780.9	12/31/2015		0.0	
100/13-03-002-25W1/0	Vertical	Pumping	7/19/1989	17598.1	1843.6	12/31/2015		0.0	
100/14-03-002-25W1/0	Vertical	Abandoned	11/22/1989	1141.3	204.9	8/31/1991	Oct-1991	68073.7	2/28/2005
102/14-03-002-25W1/0	Vertical	Injection	N/A	0.0	0.0		Oct-2002	5877.0	6/30/2015
103/14-03-002-25W1/0	Horizontal	Producing	9/17/2014	5170.0	1081.3	12/31/2015		0.0	
100/15-03-002-25W1/0	Vertical	Pumping	8/2/1990	4459.1	24893.5	12/31/2015		0.0	
100/02-10-002-25W1/0	Vertical	Abandoned	7/8/1990	3438.1	6493.1	3/31/2003		0.0	
1C0/02-10-002-25W1/0	Vertical	Injection	N/A	0.0	0.0		Oct-2002	5576.5	11/30/2014
100/03-10-002-25W1/0	Vertical	Producing	7/27/1989	12994.1	5223.8	12/31/2015		0.0	
102/03-10-002-25W1/0	Horizontal	Producing	11/8/2012	6559.9	1002.6	12/31/2015		0.0	
100/06-10-002-25W1/0	Vertical	Producing	8/5/1989	9137.7	8695.7	12/31/2015		0.0	
1C0/06-10-002-25W1/0	Vertical	Injection	N/A	0.0	0.0		Nov-2001	2466.8	12/31/2015
100/07-10-002-25W1/0	Vertical	Pumping	3/16/1990	17598.3	22917.9	12/31/2015		0.0	
100/08-10-002-25W1/0	Vertical	Injection	7/12/1990	570.1	175.7	9/30/1991	Oct-1991	63286.4	12/31/2015
103/08-10-002-25W1/0	Horizontal	Producing	10/22/2014	7276.7	2394.9	12/31/2015		0.0	
1C0/08-10-002-25W1/0	Vertical	Injection	N/A	0.0	0.0		Oct-2002	14339.2	12/31/2015
100/09-10-002-25W1/0	Vertical	Pumping	3/20/1990	21515.5	2749.4	12/31/2015		0.0	
1C0/09-10-002-25W1/0	Vertical	Injection	N/A	0.0	0.0		Oct-2002	28082.0	12/31/2015
100/10-10-002-25W1/0	Vertical	Pumping	12/12/1989	13845.8	1659.8	5/31/2015		0.0	
100/11-10-002-25W1/0	Vertical	Injection	7/8/1988	3313.7	96.5	10/31/1991	Oct-1991	76645.9	12/31/2015
103/11-10-002-25W1/0	Horizontal	Producing	3/24/2014	5051.7	1938.5	12/31/2015		0.0	
104/11-10-002-25W1/0	Horizontal	Producing	9/15/2014	6035.4	861.6	12/31/2015		0.0	
1C0/11-10-002-25W1/0	Vertical	Injection	N/A	0.0	0.0		Nov-2001	22209.7	11/30/2015
100/15-10-002-25W1/0	Vertical	Abandoned	12/9/1982	1737.6	7558.2	11/30/1989		0.0	
102/15-10-002-25W1/0	Vertical	Pumping	11/26/1989	10831.0	7896.5	12/31/2015		0.0	
100/16-10-002-25W1/0	Vertical	Pumping	12/15/1989	28925.1	7518.1	12/31/2015		0.0	
103/16-10-002-25W1/0	Horizontal	Producing	10/2/2014	3935.4	5421.3	12/31/2015		0.0	
1C0/16-10-002-25W1/0	Vertical	Injection	N/A	0.0	0.0		Oct-2002	16963.4	12/31/2015
100/04-14-002-25W1/0	Vertical	Injection	8/11/1989	3943.6	927.8	4/30/2014		322.8	12/31/2015
102/04-14-002-25W1/0	Horizontal	Producing	9/28/2014	5422.6	1620.7	12/31/2015		0.0	
103/04-14-002-25W1/0	Horizontal	Producing	9/29/2014	4746.2	887.1	12/31/2015		0.0	
100/01-15-002-25W1/0	Vertical	Abandoned Zone	2/24/1990	1138.2	164.5	10/31/1991	Oct-1991	77361.4	11/30/2003
100/02-15-002-25W1/0	Vertical	Abandoned	6/17/1983	521.9	1082.0	9/30/1984		0.0	
102/02-15-002-25W1/0	Vertical	Producing	7/21/1990	6396.2	34777.1	5/31/2012		0.0	
100/03-15-002-25W1/0	Vertical	Producing	7/9/1988	18324.5	3912.2	4/30/2014		0.0	
103/03-15-002-25W1/0	Horizontal	Producing	7/9/2014	5129.7	4156.5	12/31/2015		0.0	
1A0/03-15-002-25W1/0	Vertical	Abandoned	N/A	0.0	0.0		Oct-2002	10933.0	12/31/2004
102/04-15-002-25W1/0	Vertical	Injection	11/8/1987	1727.0	90.8	8/31/1991	Oct-1991	205775.3	3/31/2015
100/05-15-002-25W1/0	Vertical	Producing	1/10/1986	19983.3	13510.7	12/31/2015		0.0	
102/05-15-002-25W1/0	Horizontal	Producing	12/20/2013	3782.3	1615.3	12/31/2015		0.0	
103/05-15-002-25W1/0	Horizontal	Producing	9/29/2014	5028.3	13959.4	12/31/2015		0.0	
100/06-15-002-25W1/0	Vertical	Injection	8/9/1989	1818.2	71.0	10/31/1991	Oct-1991	69998.6	12/31/2015
100/07-15-002-25W1/0	Vertical	Pumping	12/19/1989	12611.7	1016.8	12/31/2015		0.0	
103/07-15-002-25W1/0	Horizontal	Producing	12/25/2013	4633.1	955.5	12/31/2015		0.0	
104/07-15-002-25W1/0	Horizontal	Producing	10/24/2014	4034.5	1331.5	12/31/2015		0.0	
1A0/07-15-002-25W1/0	Vertical	Injection	N/A	0.0	0.0		Oct-2002	7144.1	12/31/2015
100/08-15-002-25W1/0	Vertical	Injection	2/27/1990	10327.9	8226.2	12/31/2015		820.7	12/31/2015

TABLE NO. 2 - 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
1982	62	0.061	112	0.112	1.83		0.000	0.000	0.000
1983	886	0.948	1,740	1.852	1.96		0.000	0.000	0.000
1984	556	1.504	2,966	4.818	5.33		0.000	0.000	0.000
1985	527	2.031	2,639	7.457	5.01		0.000	0.000	0.000
1986	2,102	4.133	2,552	10.009	1.21		0.000	0.000	0.000
1987	2,458	6.591	1,953	11.962	0.79		0.000	0.000	0.000
1988	4,259	10.850	2,105	14.067	0.49		0.000	0.000	0.000
1989	8,384	19.234	2,264	16.331	0.27		0.000	0.000	0.000
1990	23,097	42.331	7,907	24.238	0.34		0.000	0.000	0.000
1991	17,649	59.980	6,610	30.848	0.37	11,761	11.761	0.437	0.118
1992	12,763	72.743	4,577	35.425	0.36	33,425	45.186	1.736	0.379
1993	10,847	83.590	4,935	40.360	0.45	37,546	82.732	2.157	0.606
1994	10,528	94.118	4,945	45.305	0.47	36,033	118.764	2.113	0.774
1995	9,584	103.702	5,395	50.700	0.56	51,942	170.707	3.164	1.004
1996	8,654	112.355	4,506	55.207	0.52	52,252	222.959	3.614	1.209
1997	7,445	119.800	3,355	58.562	0.45	42,058	265.017	3.529	1.350
1998	7,070	126.870	3,521	62.083	0.50	46,808	311.825	4.017	1.499
1999	6,604	133.474	4,835	66.918	0.73	48,343	360.168	3.889	1.634
2000	6,121	139.595	3,447	70.365	0.56	15,666	375.834	1.494	1.628
2001	5,773	145.368	2,812	73.177	0.49	7,294	383.127	0.772	1.594
2002	7,114	152.483	5,299	78.476	0.74	12,558	395.685	0.932	1.559
2003	7,876	160.359	16,751	95.227	2.13	31,446	427.130	1.218	1.527
2004	9,026	169.384	35,279	130.506	3.91	18,431	445.561	0.404	1.370
2005	7,951	177.335	5,725	136.231	0.72	22,256	467.817	1.497	1.375
2006	7,468	184.803	5,180	141.410	0.69	17,884	485.701	1.299	1.372
2007	7,078	191.881	6,141	147.551	0.87	22,355	508.056	1.565	1.380
2008	6,787	198.668	5,002	152.553	0.74	28,727	536.783	2.243	1.409
2009	5,576	204.244	3,991	156.544	0.72	26,267	563.050	2.525	1.438
2010	6,141	210.385	4,094	160.638	0.67	22,960	586.010	2.058	1.456
2011	4,951	215.336	3,127	163.765	0.63	21,464	607.474	2.433	1.477
2012	6,001	221.337	2,352	166.118	0.39	24,965	632.439	2.698	1.503
2013	6,978	228.315	2,372	168.490	0.34	13,790	646.228	1.326	1.499
2014	37,908	266.220	15,052	183.542	0.40	18,499	664.727	0.315	1.357
2015	29,958	296.180	25,171	208.713	0.84	10,006	674.733	0.168	1.228

TABLE NO. 3

**Tundra Oil and Gas
Waskada Unit No. 17
2015 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. 17 Total:				
	Jan-15	0	61.3	1,900
	Feb-15	0	55.9	1,566
	Mar-15	0	37.8	1,173
	Apr-15	0	21.5	646
	May-15	0	21.1	653
	Jun-15	0	22.0	660
	Jul-15	0	21.2	658
	Aug-15	0	20.6	638
	Sep-15	0	18.7	561
	Oct-15	0	18.2	563
	Nov-15	0	16.1	483
	Dec-15	0	16.4	507
2015 Group Totals:				10,006
Unit No. 17 Total:				
	1982	0	0.0	0
	1983	0	0.0	0
	1984	0	0.0	0
	1985	0	0.0	0
	1986	0	0.0	0
	1987	0	0.0	0
	1988	0	0.0	0
	1989	0	0.0	0
	1990	0	0.0	0
	1991	0	32.2	11,761
	1992	0	91.6	33,425
	1993	0	102.9	37,546
	1994	0	98.7	36,033
	1995	0	142.3	51,942
	1996	0	143.2	52,252
	1997	0	115.2	42,058
	1998	0	128.2	46,808
	1999	0	132.4	48,343
	2000	0	42.9	15,666
	2001	0	20.0	7,294
	2002	0	34.4	12,558
	2003	0	86.2	31,446
	2004	0	50.5	18,431
	2005	0	61.0	22,256
	2006	0	49.0	17,884
	2007	0	61.2	22,355
	2008	0	78.7	28,727
	2009	0	72.0	26,267
	2010	0	62.9	22,960
	2011	0	58.8	21,464
	2012	0	68.2	24,964
	2013	0	37.8	13,790
	2014	0	55.4	18,499
	2015	0	27.6	10,006
Group Totals:				674,732

TABLE NO. 4

**Tundra Oil and Gas
Waskada Unit No. 17
2015 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-15	17,496	117.53	3,643	78.64	2,438	0.67	24
Feb-15	16,728	114.93	3,218	81.19	2,273	0.71	25
Mar-15	17,952	99.15	3,074	76.30	2,365	0.77	24
Apr-15	18,072	91.58	2,748	72.66	2,180	0.79	25
May-15	18,456	90.17	2,795	70.75	2,193	0.78	25
Jun-15	16,464	80.49	2,415	73.00	2,190	0.91	23
Jul-15	16,992	67.16	2,082	68.02	2,109	1.01	23
Aug-15	15,696	65.56	2,032	61.53	1,907	0.94	21
Sep-15	15,768	69.00	2,070	68.20	2,046	0.99	22
Oct-15	17,088	63.10	1,956	66.53	2,063	1.05	23
Nov-15	16,944	69.28	2,078	58.88	1,766	0.85	24
Dec-15	16,128	59.58	1,847	52.93	1,641	0.89	22
	203,784		29,958		25,171		

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
1982	504	1.98	62	3.62	112	1.83	1
1983	12,816	2.43	886	4.77	1,740	1.96	2
1984	11,064	1.52	556	8.10	2,966	5.33	2
1985	8,112	1.44	527	7.23	2,639	5.01	1
1986	10,608	5.76	2,102	6.99	2,552	1.21	2
1987	9,480	6.73	2,458	5.35	1,953	0.79	3
1988	25,608	11.64	4,259	5.75	2,105	0.49	5
1989	54,192	22.97	8,384	6.20	2,264	0.27	15
1990	162,648	63.28	23,097	21.66	7,907	0.34	23
1991	177,888	48.35	17,649	18.11	6,610	0.37	23
1992	144,240	34.87	12,763	12.50	4,577	0.36	17
1993	146,736	29.72	10,847	13.52	4,935	0.45	17
1994	145,488	28.84	10,528	13.55	4,945	0.47	17
1995	143,928	26.26	9,584	14.78	5,395	0.56	17
1996	142,320	23.64	8,654	12.31	4,506	0.52	17
1997	139,008	20.40	7,445	9.19	3,355	0.45	17
1998	141,264	19.37	7,070	9.65	3,521	0.50	17
1999	138,792	18.09	6,604	13.25	4,835	0.73	17
2000	146,208	16.72	6,121	9.42	3,447	0.56	17
2001	137,592	15.82	5,773	7.70	2,812	0.49	17
2002	137,736	19.49	7,114	14.52	5,299	0.74	17
2003	134,928	21.58	7,876	45.89	16,751	2.13	17
2004	136,872	24.66	9,026	96.39	35,279	3.91	17
2005	135,000	21.78	7,951	15.68	5,725	0.72	17
2006	137,724	20.46	7,468	14.19	5,180	0.69	17
2007	135,744	19.39	7,078	16.82	6,141	0.87	17
2008	139,032	18.54	6,787	13.67	5,002	0.74	17
2009	120,408	15.28	5,576	10.93	3,991	0.72	17
2010	137,328	16.83	6,141	11.22	4,095	0.67	17
2011	127,440	13.56	4,951	8.57	3,127	0.63	17
2012	128,400	16.40	6,001	6.43	2,352	0.39	16
2013	122,520	19.12	6,978	6.50	2,372	0.34	18
2014	143,424	88.72	32,384	37.60	13,722	0.42	26
2015	203,784	82.29	29,958	69.05	25,171	0.86	23
	3,838,836		290,656		207,384		

TABLE NO. 5 - Average Injection Pressures

	00/04-14 Inj	00/06-15 Inj	00/08-10 Inj	00/08-15 Inj	00/11-10 Inj	02/04-15 Inj	02/14-03 Inj	A0/07-15 Inj	C0/02-10 Inj	C0/06-10 Inj	C0/08-10 Inj	C0/09-10 Inj	C0/11-10 Inj	C0/16-10 Inj
Year	Inj Pressure (kPa)	Inj Pressure (kPa)	Inj Pressure (kPa)	Inj Pressure (kPa)	Inj Pressure (kPa)	Inj Pressure (kPa)	Inj Pressure (kPa)	Inj Pressure (kPa)	Inj Pressure (kPa)	Inj Pressure (kPa)	Inj Pressure (kPa)	Inj Pressure (kPa)	Inj Pressure (kPa)	Inj Pressure (kPa)
2014	0.0	5000.0	4500.0	0.0	0.0	2600.0	0.0	0.0	0.0	5000.0	5000.0	3000.0	4546.9	5000.0
2015		4654.4	4735.8		3184.1	2241.4	3703.8	3802.7	0.0	4890.1	4998.6	4213.0	4765.7	4885.7