

**PennWest**

# Waskada Unit No.14

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Waterflood Progress Report

**January 1<sup>st</sup> – December 31<sup>st</sup>, 2014**

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## **INTRODUCTION**

The Waskada Unit No.14 pressure maintenance project commenced water injection into the Lower Amaranth designed and in accordance with Manitoba Energy and Mines Approval No. PM 58.

Please refer to Attachment 1 – Area Map.

**PRESSURE MAINTENANCE:** Governed by Board Order No. PM 58

## **UNIT INFORMATION**

**UNITIZED ZONE:** Lower Amaranth  
Original Unit, February 1, 1988 Board Order - Voluntary

**POOL:** Waskada Lower Amaranth A (03 292A)

This report documents the performance of the Waskada Unit No.14 pressure maintenance project for the period of January 1 to December 31, 2013. The Unit had production from 6 wells and no injection in 2014.

Unit # 14 is part of the main Waskada field. The Waskada field is situated on the northeast rim of the Williston Basin in southern Manitoba. It comprises a large portion of Township 1 and 2, Ranges 25 and 26 W1.

## **GEOLOGY**

The Waskada Fields produce light density crude (approximately 36° API), predominantly from the Lower Amaranth formation. This is an interlaminated, shallow marine to subtidal succession of sandstones, siltstones, and shale progressively onlaps the Mississippian unconformity surface from basin center, up dip to the north and eastern basin limits in Saskatchewan and Manitoba. The fine grained reservoir rock has a complex reservoir characterization with 13 to 16 % porosity and permeability on the order of 0.5 to 15 md. The Lower Amaranth, the oldest Mesozoic unit, is a clastic red bed sequence lying directly on the Paleozoic erosional surface. It consists of a series of dolomitic siltstones and sandstones interbedded with argillaceous siltstones and shales. The section is usually subdivided into a lower sandy unit and an overlying shale unit. The lower sequence is the oil production zone. The bulk of pay is found in the laminated sandstone/siltstone facies.

The Lower Amaranth has been classified into four general lithological types:

1. Interbedded shale/siltstone/sandstone by grain size, color and texture
2. Siltstone – This lithology occurs in distinct intervals up to two or three metres in thickness. It is generally light green in color and dolomitic.
3. Laminated sandstone – This occurs in distinct sandy intervals with a wide range of grain sizes and primary sedimentary structures.

4. Massive sandstone – This lithology occurs in thin intervals and usually associated with the laminated sandstones facies. Beds are usually light grey to reddish grey in color and coarse to medium – grained.

## **DISCUSSION**

### **Production and Injection Performance**

Board Order No. PM 58 provided for pressure maintenance operations in Waskada Unit No.14. From the startup of injection in 1988, injection rates fluctuated to the same degree in each injector, making it difficult to link any production responses to any injector. The Unit includes 3 injection wells, none are currently active, and 6 active producers. Pressure maintenance by water injection ceased in February 2000.

Please refer to Attachment 2 – A spreadsheet of the Unit Well List and History.

Please refer to Attachment 3 – A Production and Injection plot of the Unit.

Please refer to Attachment 4 – A spreadsheet of Unit Annual Volumes and Rates.

Please refer to Attachment 5 – A Cumulative Production and Injection plot of the Unit.

### **Voidage Replacement Ratio Calculation:**

The Cumulative VRR from production start reached a maximum of 0.82 in 1997 and has declined in the last 3 years to 0.48. The Cumulative VRR from injection start stabilized at 1.7 and has declined in the last 3 years to 0.7. The decline in both Cumulative VRR's in the last 3 years is coincident with no injection from February 2000, no production from January 2004 and the startup of horizontal producers in 2012. Currently there are no active injectors in this Unit and PennWest has no plans to reactivate at this time any of the old injectors.

Please refer to Attachment 6 – A Unit Voidage Replacement Ratio Plot.

Please refer to Attachment 7 – Individual Injection Well Performance Plots.

### **Pressure Surveys:**

No pressure surveys were conducted in 2014.

### **Corrosion and Scale Prevention Program:**

Scale corrosion programs are implemented throughout the field. Wells and pipelines have mitigation measures in place.

## **SUMMARY AND RECOMMENDATIONS**

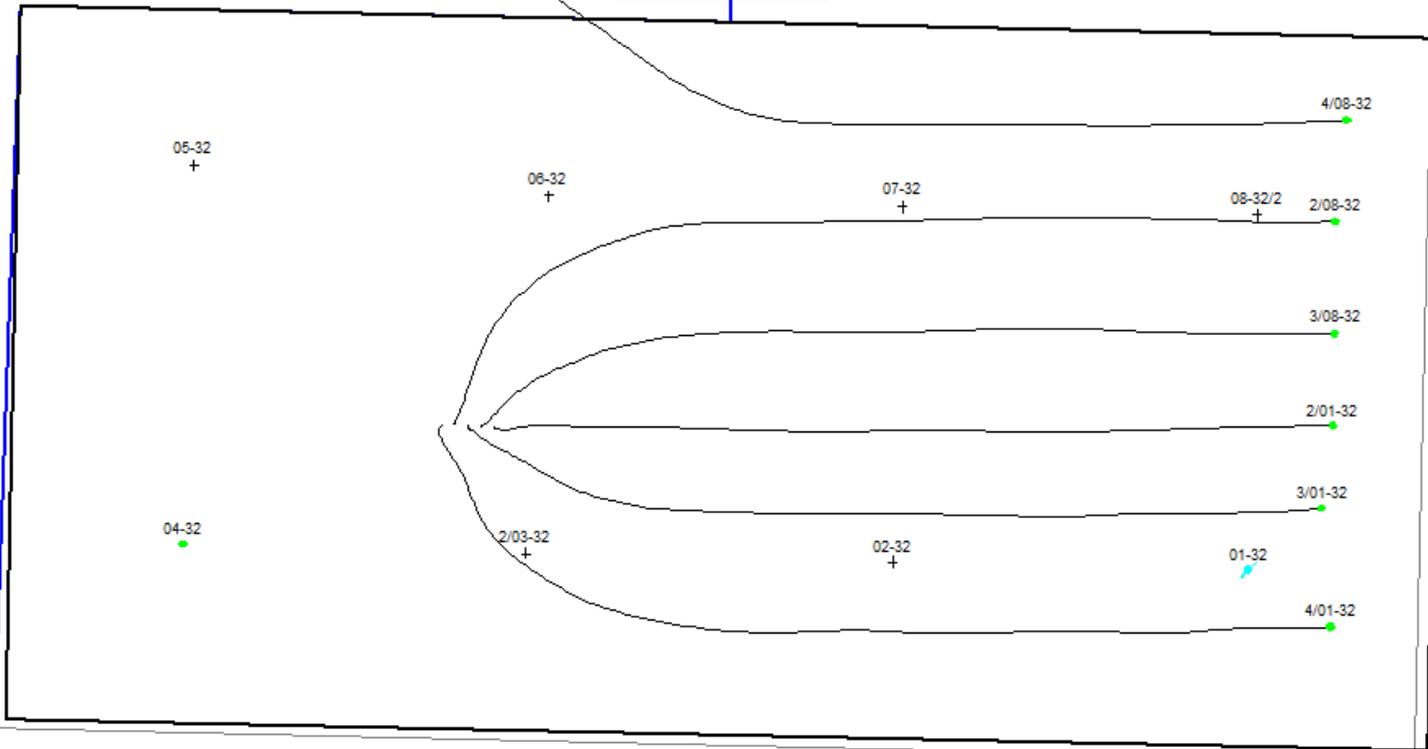
The behavior of Waskada Unit 14 producers are indicated by good initial oil productivity, rapidly declining to low decline rates, with almost no discernible water flood response. This behavior can be explained by drops in the reservoir pressure from initial, approximately 8700 kPa, to above the bubble point, about 4200 kPa, followed by solution gas breakout. It is also believed that fracture stimulation treatments, performed on these wells prior to initiation of water injection, “broke through” into the higher productivity Mississippian and that the majority of injected water to date has entered this zone. This is one of the major explanations for lack of waterflood response to date and the continued decline in oil productivities.

**ATTACHMENT 1 – UNIT AREA MAP**

**PENN WEST EXPLORATION**

**OFM 2012 WASKADA**

- Oil Producer
- + Plugged & Abandoned
- ↗ Water Injector



## ATTACHMENT 2- UNIT HISTORY

Unit History : Waskada -Unit#14

UWI	Completion Date	Operator	Status	New Drills	Kb Elevation	Total Depth	First prd Date	Cum Oil Prd	Cum Water Prd	Last Prd Date	First Inj Date	Cum Water Inj	Cum Gas Inj	Last Inj Date
					m	m		m3	m3			m3	scm	
00/01-32-001-25W1/0	10/20/1985	PENN_WEST	WTR-INJ	<N/A>	475.60	958.00	11/1/1985	697.90	3912.70	10/1/1992	11/1/1992	22263.60	0.00	2/1/2000
00/02-32-001-25W1/0	9/9/1985	OMEGA_HY DROC	ABD-OIL	<N/A>	474.80	952.00	11/1/1985	526.90	2699.70	5/1/1989		0.00	0.00	
00/04-32-001-25W1/0	6/16/1984	PENN_WEST	OIL	<N/A>	473.80	954.00	6/1/1984	5526.70	15707.60	3/1/2001		0.00	0.00	
00/05-32-001-25W1/0	6/11/1984	PENN_WEST	ABD-OIL	<N/A>	475.30	950.70	6/1/1984	5294.70	14178.20	2/1/1988	2/1/1988	22951.00	0.00	4/1/1993
00/06-32-001-25W1/0	12/13/1984	PENN_WEST	ABD-OIL	<N/A>	474.40	955.00	1/1/1985	5073.10	6310.00	10/1/2002		0.00	0.00	
00/07-32-001-25W1/0	8/17/1985	PENN_WEST	ABD-OIL	<N/A>	474.80	937.00	9/1/1985	605.70	249.70	2/1/1988	2/1/1988	25631.40	0.00	4/1/1993
00/08-32-001-25W1/2	6/23/1984	PENN_WEST	ABD-OIL	<N/A>	475.60	950.00	2/1/1985	6625.00	5556.50	1/1/2004		0.00	0.00	
02/01-32-001-25W1/0	11/27/2011	PENN_WEST	OIL	<N/A>	476.20	1737.00	2/1/2012	1650.80	7842.40	1/1/2015		0.00	0.00	
02/03-32-001-25W1/0	11/8/1982	PENN_WEST	ABD-OIL	<N/A>	474.10	939.00	11/1/1982	4052.00	9047.10	9/1/1996		0.00	0.00	
02/08-32-001-25W1/0	11/6/2011	PENN_WEST	OIL	<N/A>	476.00	1832.00	2/1/2012	2278.10	6631.50	1/1/2015		0.00	0.00	
03/01-32-001-25W1/0	11/13/2011	PENN_WEST	OIL	<N/A>	476.00	1762.00	2/1/2012	2145.80	7579.90	1/1/2015		0.00	0.00	
03/08-32-001-25W1/0	11/20/2011	PENN_WEST	OIL	<N/A>	476.20	1760.00	2/1/2012	2294.20	6238.20	1/1/2015		0.00	0.00	
04/01-32-001-25W1/0	10/31/2011	PENN_WEST	OIL	<N/A>	475.70	1830.00	2/1/2012	3843.70	8416.00	1/1/2015		0.00	0.00	
04/08-32-001-25W1/0	2/18/2012	PENN_WEST	OIL	<N/A>	475.50	1699.00	8/1/2012	2772.60	3945.50	1/1/2015		0.00	0.00	

# ATTACHMENT 3 – UNIT PRODUCTION AND INJECTION PLOT

PENN WEST

UNIT: WASKADA\_UNIT\_NO\_14\_-\_PM\_58

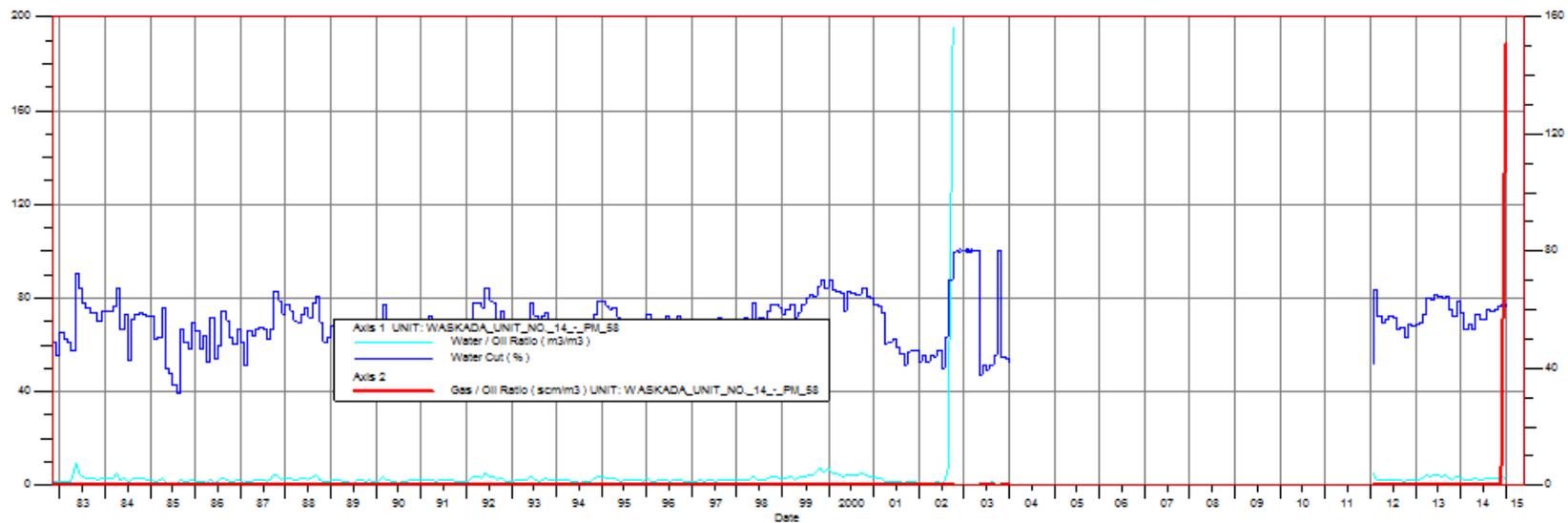
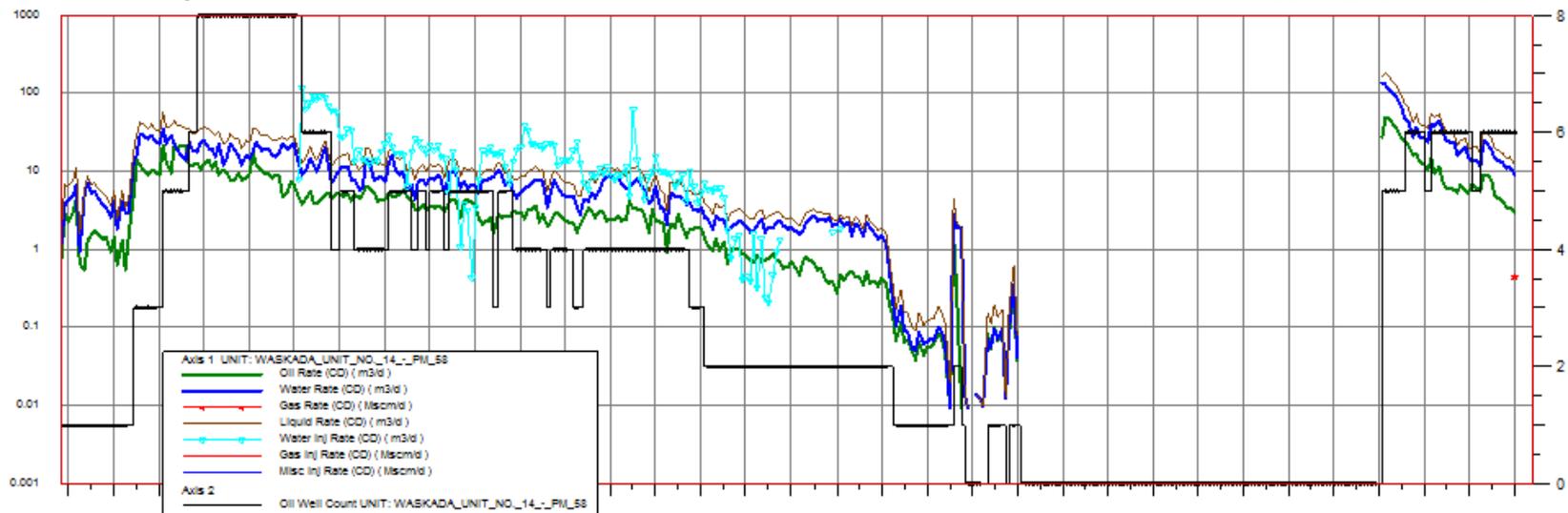
Last Prod/Inj Date: 201501

Cumulative Water Prod : 98.32 Mm3

Cumulative Oil Prod : 43.39 Mm3

Cumulative Gas Prod : 0.01 MMscm

Cumulative Gas Inj : 0.00 MMscm  
Cumulative Water Inj : 70.85 Mm3  
Cumulative Misc Inj : 0.00 MMscm



**ATTACHMENT 4 –UNIT ANNUAL VOLUMES AND RATES**

<i>Unit : Waskada - Unit #14 --PM58</i>								
<i>Rates and Volume History</i>								
<i>Date</i>	<i>Annual Oil Prd</i>	<i>Annual Oil Rate</i>	<i>Annual Water Prod</i>	<i>Annual Water Prod Rate</i>	<i>Annual Water Inj</i>	<i>Annual Water Inj Rate</i>	<i>Annual Gas Inj</i>	<i>Annual Gas Inj rate</i>
	<i>m3</i>	<i>m3/d</i>	<i>m3</i>	<i>m3/d</i>	<i>m3</i>	<i>m3/d</i>	<i>Mscm</i>	<i>Mscm/d</i>
1/1/1981	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00
1/1/1982	114.90	0.31	152.00	0.42	0	0.00	0.00	0.00
1/1/1983	626.00	1.72	1657.10	4.54	0	0.00	0.00	0.00
1/1/1984	2367.60	6.47	5649.90	15.44	0	0.00	0.00	0.00
1/1/1985	5679.10	15.56	8079.20	22.13	0	0.00	0.00	0.00
1/1/1986	3714.40	10.18	6567.40	17.99	0	0.00	0.00	0.00
1/1/1987	3407.30	9.34	6876.80	18.84	0	0.00	0.00	0.00
1/1/1988	1771.70	4.84	4788.10	13.08	24636	67.31	0.00	0.00
1/1/1989	1847.80	5.06	3453.20	9.46	7335	20.10	0.00	0.00
1/1/1990	1606.40	4.40	3182.60	8.72	7078	19.39	0.00	0.00
1/1/1991	1372.40	3.76	2875.00	7.88	4108	11.25	0.00	0.00
1/1/1992	965.90	2.64	2698.90	7.37	5196	14.20	0.00	0.00
1/1/1993	1014.80	2.78	2351.00	6.44	8285	22.70	0.00	0.00
1/1/1994	933.40	2.56	1877.50	5.14	4441	12.17	0.00	0.00
1/1/1995	1057.20	2.90	2460.50	6.74	4881	13.37	0.00	0.00
1/1/1996	725.30	1.98	1512.90	4.13	3138	8.57	0.00	0.00
1/1/1997	412.80	1.13	861.10	2.36	1419	3.89	0.00	0.00
1/1/1998	270.80	0.74	734.00	2.01	223	0.61	0.00	0.00
1/1/1999	211.50	0.58	798.00	2.19	53	0.14	0.00	0.00
1/1/2000	155.00	0.42	710.60	1.94	54	0.15	0.00	0.00
1/1/2001	50.20	0.14	126.00	0.35	0	0.00	0.00	0.00
1/1/2002	73.00	0.20	221.00	0.61	0	0.00	0.00	0.00
1/1/2003	23.30	0.06	27.40	0.08	0	0.00	0.00	0.00
1/1/2004	1.20	0.00	1.30	0.00	0	0.00	0.00	0.00
1/1/2005	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00
1/1/2006	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00

1/1/2007	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00
1/1/2008	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00
1/1/2009	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00
1/1/2010	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00
1/1/2011	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00
1/1/2012	9627.70	26.31	24535.90	67.04	0	0.00	0.00	0.00
1/1/2013	3129.80	8.57	10277.60	28.16	0	0.00	0.00	0.00
1/1/2014	2136.00	5.85	5557.00	15.22	0	0.00	0.00	0.00
Sum	43295.50		98032.00		70846			

# ATTACHMENT 5 – UNIT CUMULATIVE PRODUCTION AND INJECTION PLOT

PENNWEST

UNIT: WASKADA\_UNIT\_NO.\_14\_-\_PM\_58

Cumulative Water Prod : 98.32 Mm3

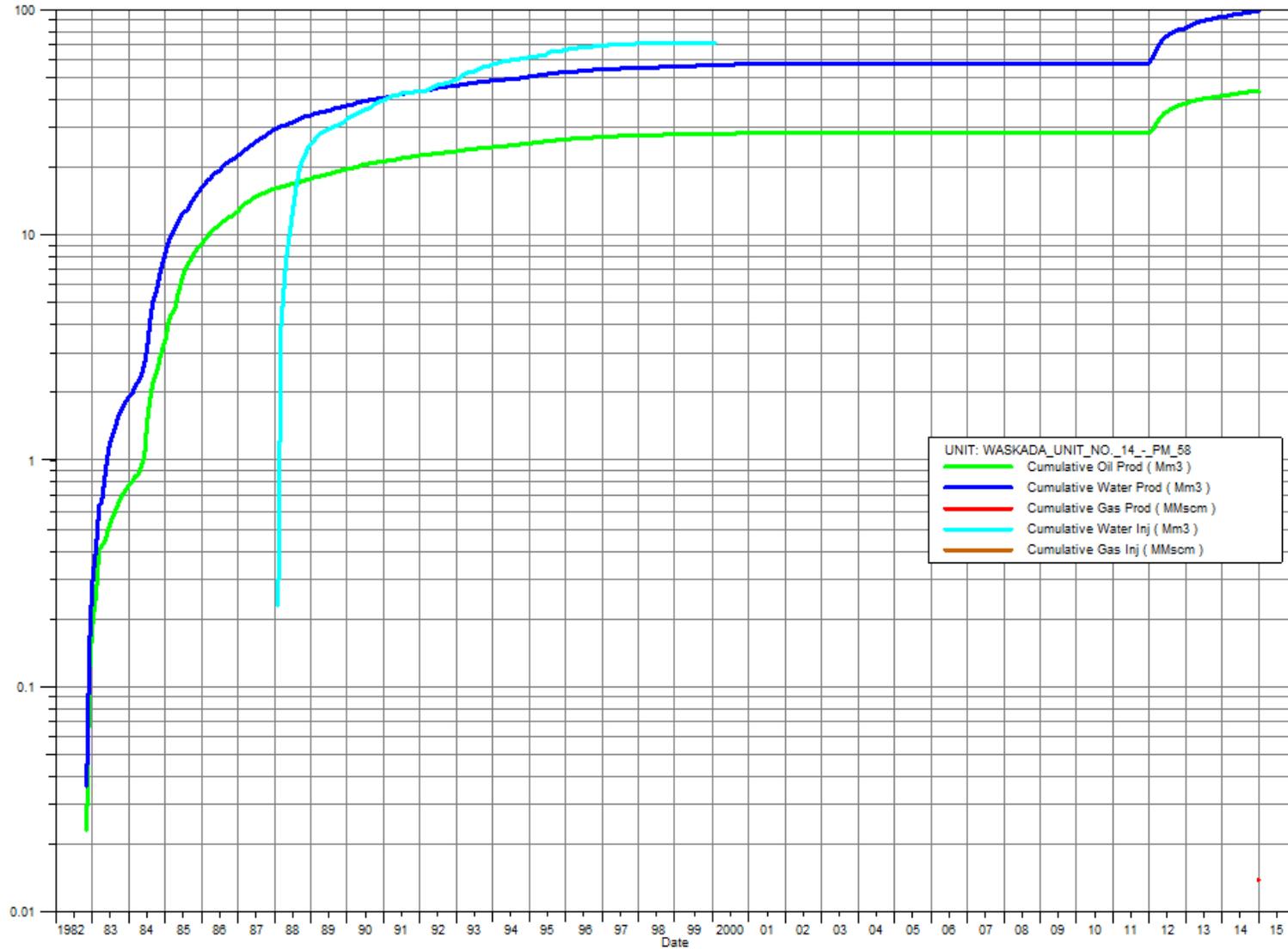
Cumulative Oil Prod : 43.39 Mm3

Cumulative Gas Prod : 0.01 MMscm

Cumulative Gas Inj : 0.00 MMscm

Cumulative Water Inj : 70.85 Mm3

Last Prod/Inj Date: 201501



# ATTACHMENT 6 – UNIT VOIDAGE REPLACEMENT RATIO PLOT

PENNWEST

UNIT: WASKADA\_UNIT\_NO.\_14\_-\_PM\_58

Cumulative Water Prod : 98.32 Mm3

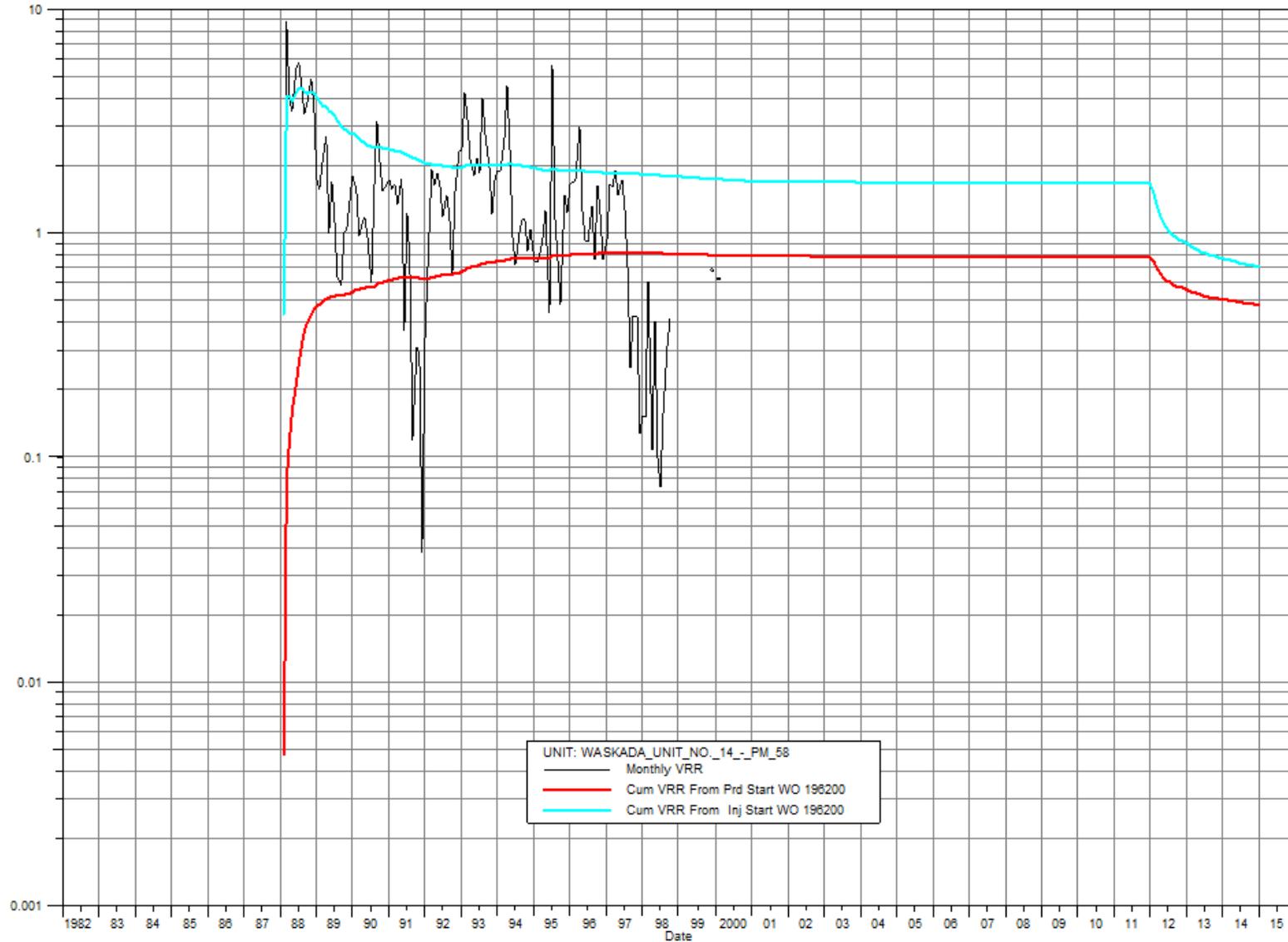
Cumulative Oil Prod : 43.39 Mm3

Cumulative Gas Inj : 0.00 Mm3cm

Cumulative Water Inj : 70.85 Mm3

Last Prod/Inj Date: 201501

Cumulative Gas Prod : 0.01 Mm3cm



# ATTACHMENT 7 – INDIVIDUAL INJECTION WELL PERFORMANCE PLOTS (3 WELL)

Status: WTR-INJ

Unit: WA SKADA\_UNIT\_NO\_14\_-\_PIL\_68

Zone: LOWER\_AMARANTH\_A

Operator: PENN\_WEST Approval: Amaranth

PENNWEST EXPLORATION

00/01-32-001-25W1/0

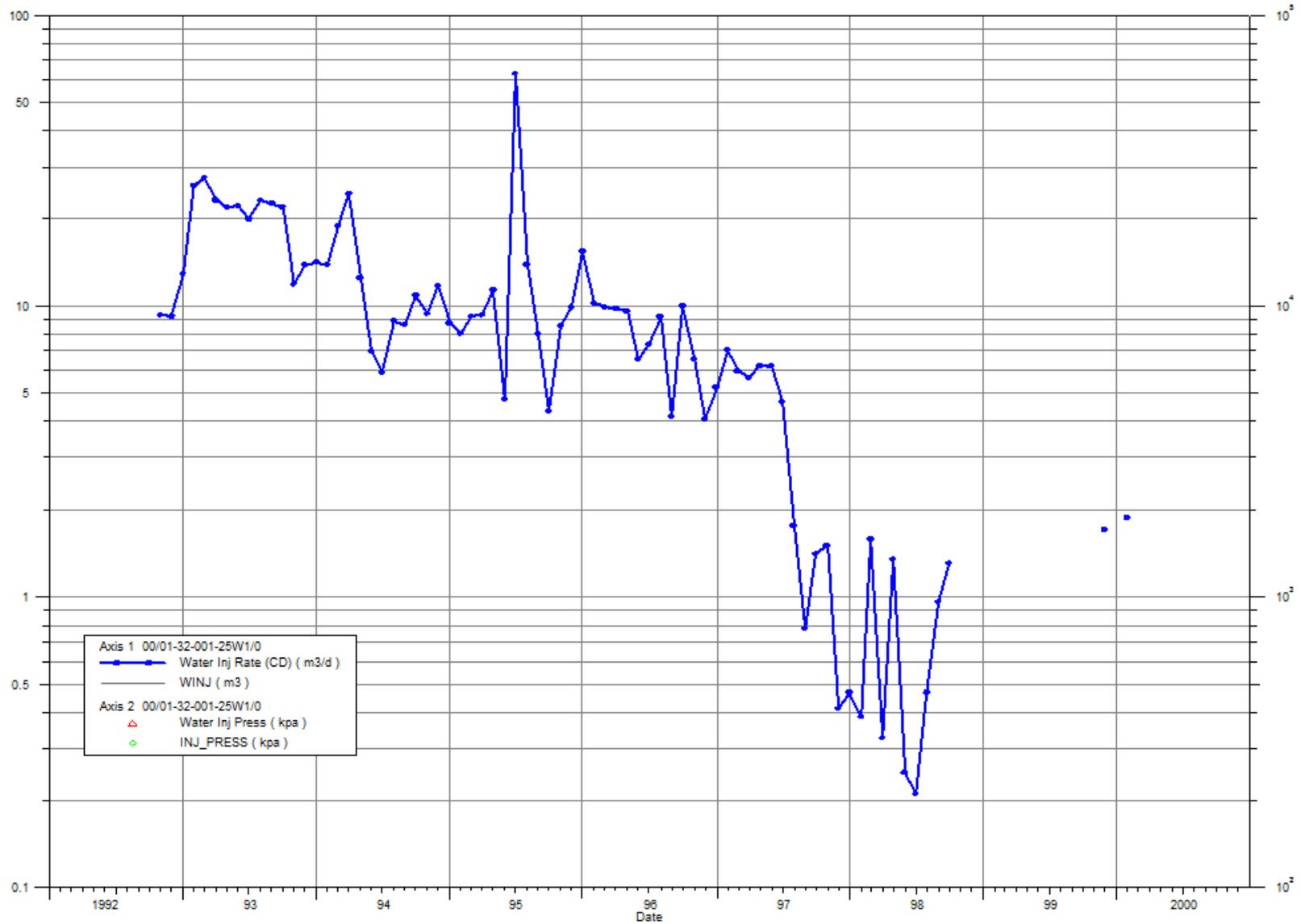
Cumulative Gas Inj : 0.00 MMscm

Cumulative Water Inj : 22.26 Mm3

Cumulative Water Prod : 3.91 Mm3

Cumulative Oil Prod : 0.70 Mm3

Cumulative Gas Prod : 0.00 MMscm



Status: ASD-OIL

Unit: WASKADA\_UNIT\_NO\_14\_-\_PM\_68

Zone: LOWER\_AMARANTH\_A

Operator: PENN\_WEST Approval: Amaranth

PENNWEST EXPLORATION

00/05-32-001-25W1/0

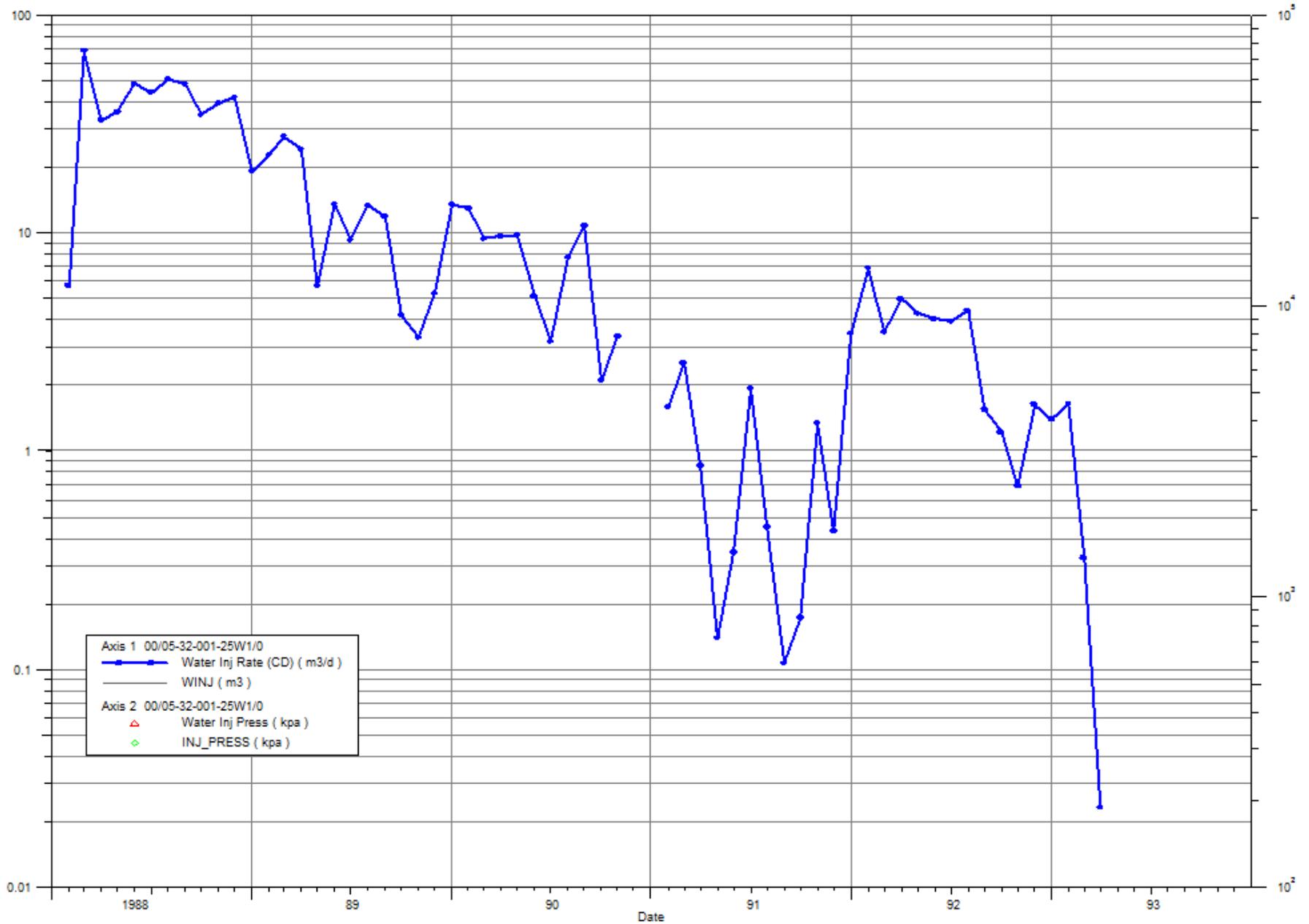
Cumulative Gas Inj : 0.00 MMscm

Cumulative Water Inj : 22.95 Mm3

Cumulative Water Prod : 14.18 Mm3

Cumulative Oil Prod : 5.29 Mm3

Cumulative Gas Prod : 0.00 MMscm



Status: ABD-OIL

PENNWEST EXPLORATION

Cumulative Gas Inj : 0.00 MMscm

Cumulative Water Inj : 25.63 Mm3

Unit: WASKADA\_UNIT\_NO\_14\_-\_PM\_68

Cumulative Water Prod : 0.25 Mm3

Zone: LOWER\_AMARANTHA

00/07-32-001-25W1/0

Cumulative Oil Prod : 0.61 Mm3

Operator: PENN\_WEST Approval: Amaranth

Cumulative Gas Prod : 0.00 MMscm

