

# **WASKADA UNIT NO. 12**

## **WATERFLOOD PROGRESS REPORT**

**January 1, through December 31, 2012**

### **PennWest Exploration**

**Prepared by:  
Siros Mahmody, P.Eng.  
Senior Waterflood Exploitation Engineer**

## **TABLE OF CONTENTS**

	<u>Page</u>
<b>INTRODUCTION</b>	<b>3</b>
<b>UNIT HISTORY</b>	<b>4</b>
<b>DISCUSSION</b>	<b>5</b>
• Production Performance	
• Voidage Replacement Ratio Calculation	
• Corrosion and Scale Prevention Program	
<b>SUMMARY &amp; RECOMMENDATIONS</b>	<b>6</b>
<b>TABLE</b>	<b>9</b>
• Table 1 - Rates History	
• Table 2 – Pressure Survey	
<b>APPENDICES</b>	
• Appendix A – Area Map	
• Appendix B – Production and Injection History plot	
• Appendix C – Voidage replacement Ratio VRR	
• Appendix D – Production and Injection Profiles (Individual wells)	

## **INTRODUCTION**

The Waskada Unit No.12 pressure maintenance project commenced water injection into the Mission Canyon designed and in accordance with Manitoba Energy and Mines Approval No. PM 48. (See Appendix A – Area Map)

PRESSURE MAINTENANCE: Governed by Board Order No. PM 48

UNIT INFORMATION:

UNITIZED ZONE: Mission Canyon

Original Unit: April.1, 1986 – Board Order, Voluntary

POOL: Waskada Mission Canyon 3a A (03 43A)

This report documents the performance of the Waskada Unit No.12 pressure maintenance project for the period of January 1 to December 31, 2012.

Unit # 12 is part of main Waskada. 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 (WPM).

The Waskada Fields produce light density crude (approximately 36° API), predominantly from the Lower Amaranth formation. The interlaminated, shallow marine to subtidal succession of sandstones, silstones, 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 founded 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 meters 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.

## **UNIT HISTORY**

### **Waskada Unit # 12 (Unit History)**

<b>CPA Pretty Well ID</b>	<b>Date Well Spudded</b>	<b>On Prod YYYY/MM/DD</b>	<b>Org Operator Name</b>	<b>Ground Elevation (m)</b>	<b>TVD (m)</b>
100/01-23-001-26W1/02	6/29/1982	5/1/1989	NCE Petrofund Corp	466.3	953
100/07-23-001-26W1/00	9/18/1982	12/1/1982	Omega Hydcbns Ltd	466.4	947
100/08-23-001-26W1/00	8/30/1982	12/1/1982	Omega Hydcbns Ltd	466.2	956
1A0/08-23-001-26W1/02	2/25/1991	7/1/1992	NCE Petrofund Corp	463.8	963
102/09-23-001-26W1/00	7/14/1983	4/1/1984	Omega Hydcbns Ltd	464.4	951
100/10-23-001-26W1/00	8/25/1982	1/1/1983	Omega Hydcbns Ltd	465.2	952
102/15-23-001-26W1/00	7/10/1983	8/1/1983	Omega Hydcbns Ltd	464.3	950
100/01-24-001-26W1/00	1/10/1981	2/1/1981	Omega Hydcbns Ltd	464.2	957
100/08-24-001-26W1/00	10/23/1981	11/1/1981	Omega Hydcbns Ltd	467.8	955
100/09-24-001-26W1/00	11/28/1981	2/1/1982	Omega Hydcbns Ltd	468.8	944
100/12-24-001-26W1/00	11/3/1981	11/1/1981	Omega Hydcbns Ltd	463.9	952
100/13-24-001-26W1/00	11/7/1981	4/1/1982	Omega Hydcbns Ltd	465.8	952
100/03-25-001-26W1/00	7/14/1981	7/1/1981	Omega Hydcbns Ltd	467	955
102/03-25-001-26W1/00	9/5/1982	12/1/1982	Omega Hydcbns Ltd	466.5	952
100/04-25-001-26W1/00	8/17/1981	9/1/1981	Omega Hydcbns Ltd	466.6	963
100/01-26-001-26W1/00	9/14/1981	10/1/1981	Omega Hydcbns Ltd	466.1	960
102/01-26-001-26W1/00	7/8/1994	7/1/1994	Omega Hydcbns Ltd	467.5	930
100/02-26-001-26W1/02	11/17/1981	7/1/1989	NCE Petrofund Corp	463.1	952

## Waskada Unit #12 (Production & Injection History)

CPA Pretty Well ID	First Prod YYYY/MM	On Inject. YYYY/MM/DD	Last Prod. YYYY/MM	Cumulative OIL Prod. (m3)	Cumulative WTR Prod. (m3)	Last Inject. YYYY/MM
100/01-23-001-26W1/02	1989/05		2002/06	404	507	
100/07-23-001-26W1/00	1982/12		1983/11	223	2486	
100/08-23-001-26W1/00	1982/12		1996/06	5623	44452	
1A0/08-23-001-26W1/02	1992/07		1992/10	16	78	
102/09-23-001-26W1/00	1984/04	6/1/1987	1984/09	115	1485	1993/03
100/10-23-001-26W1/00	1983/01		1993/10	2608	3424	
102/15-23-001-26W1/00	1983/08	5/1/1986	1990/08	313	2527	1988/03
100/01-24-001-26W1/00	1981/02	4/1/1986	1986/03	3802	474	1988/11
100/08-24-001-26W1/00	1981/11		2012/10	10999	25883	
100/09-24-001-26W1/00	1982/02		1991/12	839	465	
100/12-24-001-26W1/00	1981/11		2012/10	2529	5992	
100/13-24-001-26W1/00	1982/04		1990/07	2925	12238	
100/03-25-001-26W1/00	1981/07		1982/12	1690	1035	
102/03-25-001-26W1/00	1982/12		2011/08	11047	23022	
100/04-25-001-26W1/00	1981/09		2012/09	1986	4398	
100/01-26-001-26W1/00	1981/10		1990/11	293	1341	
102/01-26-001-26W1/00	1994/07		2010/01	6784	16288	
100/02-26-001-26W1/02	1989/07		1991/09	318	494	

### **DISCUSSION:**

#### **Production Performance**

The Waskada MC3a A Pool was discovered in January, 1981 with the completion of the well Omega Waskada 1-24-1-26 (WPM) in the Mission Canyon 3a zone, the Pool has since developed was unitized in early 1986. Currently included in the Unit Area are 4 active producers, with 12 suspended or abandoned wells, and 2 abandoned injectors. (see Appendix D for oil, water and injection rates). The Mission Canyon 3a zone is the lower porous unit of the Mission Canyon 3 Member. Table No. 1 illustrates the severity of the primary production decline in the Waskada MC3a A Pool and emphasizes the need for pressure maintenance operations. The Table lists average daily oil production in the first month which each well produced at least 20 days and the corresponding rate for March, 1986 (or earlier, if shut-in) for each well. In April and May 1986, waterflooding began in

the Pool. The average length of production prior to water injection is about 25 months, but over this time, oil rates have declined to 36% of the initial rates. Appendix B shows the production history of the unit wells.

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

Upon review of the voidage replacement ratio (VRR) for the Waskada Unit # 12 area, it was shown that the area has been under injected. This is shown by instantaneous and cumulative VRR for the Waskada Unit # 12 (Please see the Appendix C). Currently there is no active injector in this unit, and PennWest has no plan to re-activate any of the old injectors.

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

We currently inject ScalCor down all the new horizontal wells. Plus, PennWest will be installing cathodic protection on the wells. Also, the new gathering system is Fiberglass and as such is not susceptible to corrosion.

### **SUMMARY AND RECOMMENDATIONS**

#### **Producers:**

##### **Current Producing Wells**

1. 00/08-24-001-26W1/0
2. 00/12-24-001-26W1/0 (Commingled)

##### **Current Suspended Producing Wells**

1. 00/01-23-001-26W1/2 (since 2002/07)
2. 02/03-25-001-26W1/0 (since 2011/09)
3. 00/04-25-001-26W1/0 (since 2012/10)
4. 00/02-26-001-26W1/2 (since 1991/10)

##### **Abandoned Producing Wells**

1. 00/07-23-001-26W1/0 (since 1983/12)
2. 00/08-23-001-26W1/0 (since 1996/07)
3. A0/08-23-001-26W1/2 (since 1992/11)
4. 00/10-23-001-26W1/0 (since 1993/11)
5. 02/15-23-001-26W1/0 (since 1990/09)
6. 00/09-24-001-26W1/0 (since 1992/01)
7. 00/13-24-001-26W1/0 (since 1990/08)
8. 00/03-25-001-26W1/0 (since 1983/01)
9. 00/01-26-001-26W1/0 (since 1990/12)
10. 02/01-26-001-26W1/0 (since 2010/02)

### **Injectors**

#### **Current Injecting Wells**

None

#### **Current Suspended Injection Wells**

None

#### **Abandoned Injection Wells**

1. 02/09-23-001-26W1/0 (since 1993/04)
2. 00/01-24-001-26W1/0 (since 1988/12)

The behavior of a Lower Amaranth Unit 1 producers are indicated by examining the oil rate versus time plots (see Appendix B). It exhibited relatively high initial oil productivity (most of the wells drilled in the past were verticals), rapidly declining to flat/low decline rates, with almost no discernible water flood response. This behavior can be explained by drop in the reservoir pressure from initial (approximately 8700 kPag) to above in some wells or below in others bubble point pressure (about 4200 kPag) followed by solution gas breakout which adversely affected the relative permeability to oil. (see Table # 2)

Also, it is believed that fracture stimulation treatments, performed on these wells prior to initiation of water injection, “broke” through into the higher productivity Mississippian and that 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.

Currently, there are only four active producers and no injection well in this unit; we do not have any plan for this unit other than monitoring the producers. PennWest Exploration’s plan is to concentrate on Lower Amaranth Formation for now.



## **TABLES**

### **Waskada Unit #12**

**Table 1: Rate History**

Production Data						
Date	Oil		Water		Injection Water	
Year	m3/year	m3/day	m3/year	m3/day	m3/year	m3/day
1982	746	2.04	116	0.32	0	0.00
1982	5,337	14.62	2,460	6.74	0	0.00
1983	5,126	14.04	6,662	18.25	0	0.00
1984	3,811	10.44	4,872	13.35	0	0.00
1985	2,901	7.95	5,065	13.88	0	0.00
1986	3,067	8.40	8,584	23.52	24,010	65.78
1987	2,789	7.64	9,856	27.00	21,950	60.14
1988	2,055	5.63	6,597	18.07	7,842	21.49
1989	2,454	6.72	8,797	24.10	346	0.95
1990	1,807	4.95	7,577	20.76	554	1.52
1991	1,772	4.85	5,500	15.07	5,719	15.67
1992	1,552	4.25	7,107	19.47	4,596	12.59
1993	869	2.38	8,489	23.26	1,232	3.38
1994	2,016	5.52	6,304	17.27	0	0.00
1995	1,279	3.50	7,184	19.68	0	0.00
1996	1,162	3.18	4,552	12.47	0	0.00
1997	1,125	3.08	3,227	8.84	0	0.00
1998	937	2.57	3,105	8.51	0	0.00
1999	897	2.46	3,119	8.55	0	0.00
2000	899	2.46	2,896	7.93	0	0.00
2001	809	2.22	2,798	7.67	0	0.00
2002	802	2.20	2,010	5.51	0	0.00
2003	807	2.21	2,222	6.09	0	0.00
2004	757	2.07	2,548	6.98	0	0.00
2005	846	2.32	2,399	6.57	0	0.00
2006	1,052	2.88	2,836	7.77	0	0.00
2007	1,186	3.25	4,600	12.60	0	0.00
2008	848	2.32	4,867	13.33	0	0.00
2009	616	1.69	3,633	9.95	0	0.00
2010	464	1.27	1,777	4.87	0	0.00
2011	431	1.18	2,363	6.47	0	0.00
2012	224	0.61	1,593	4.36	0	0.00

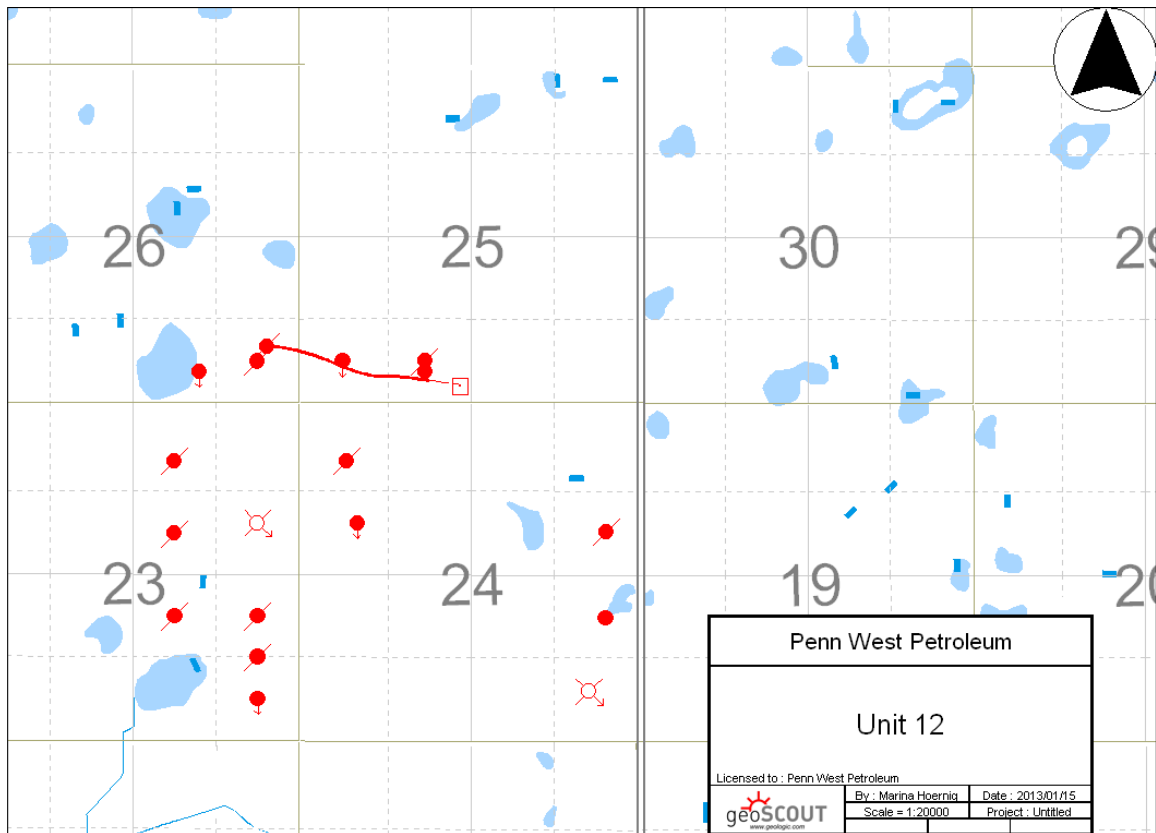
## Waskada Unit #12

Table 2: Pressure Surveys

Location	Shut In Date	Date of Survey	Type of Survey	Pressure @ Datum Depth (kPa)
00/08-23-001-26W1/0	Mar-91	(7 days)	Static Gradient	3989
00/13-24-001-26W1/0	Nov-89	(6 days)	Static Gradient	9035
02/03-25-001-26W1/0	11-Dec-06	19-Dec-06	Acoustic Build Up	922

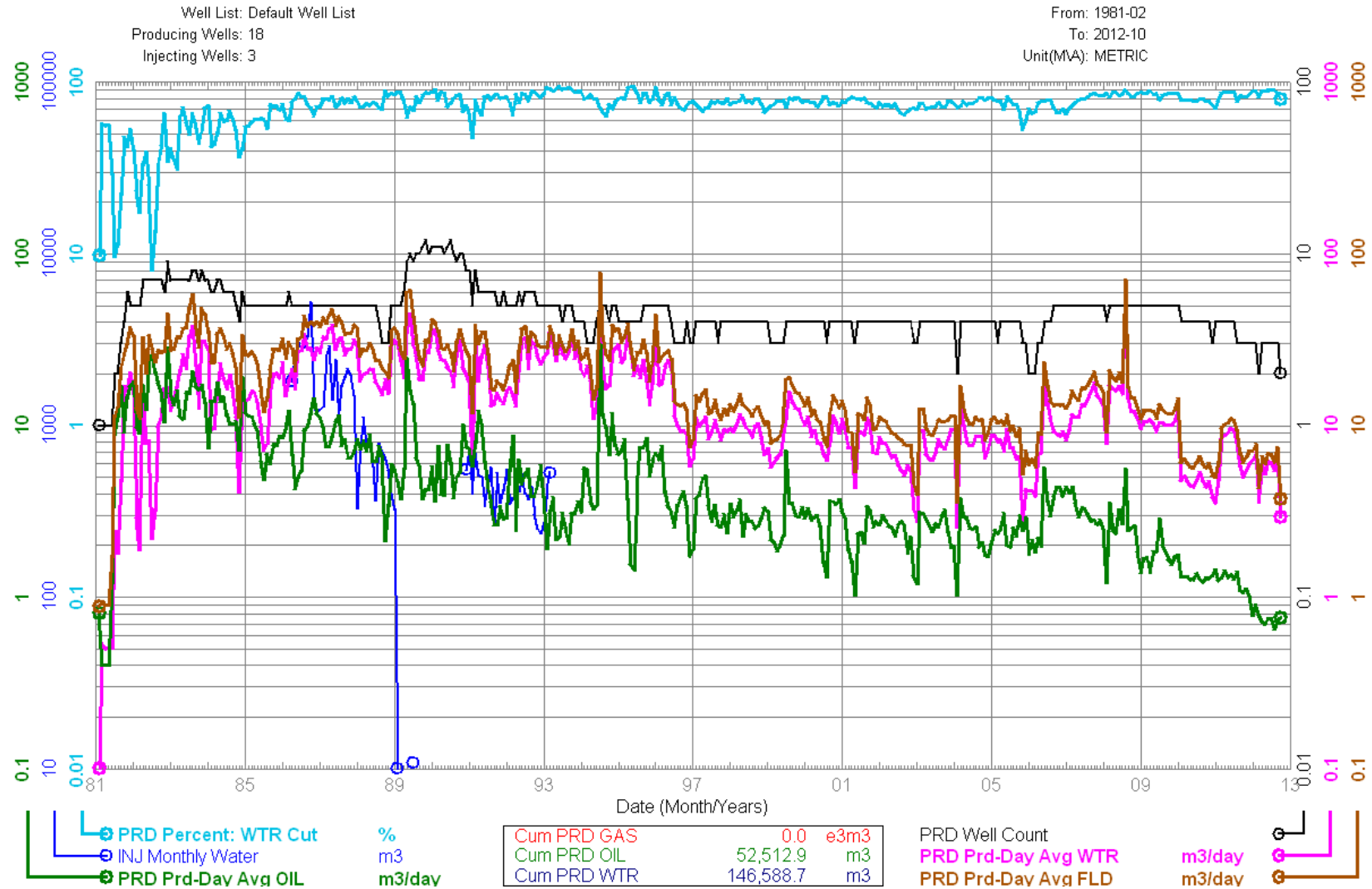
## **APPENDIX A**

## Appendix A – Area Map



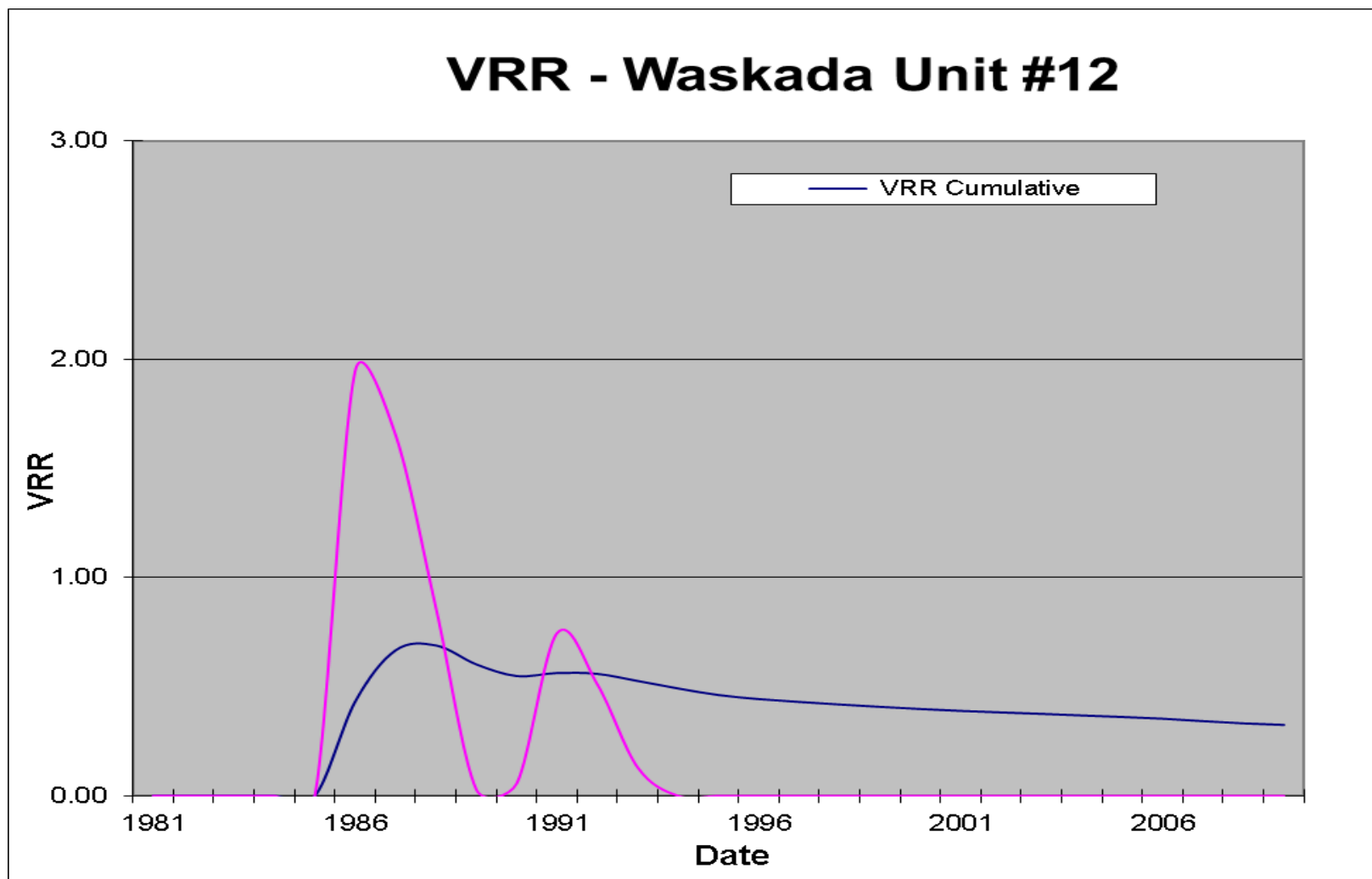
## **APPENDIX B**

## Appendix B – Production and Injection History plot



## **APPENDIX C**

**Appendix C – Voidage Replacement Ratio VRR**





## **APPENDIX D**

## Appendix D – Production and Injection Profiles

Data As Of: 2012-10 (MB)

From: 1983-08

To: 1990-08

102/15-23-001-26W1/00

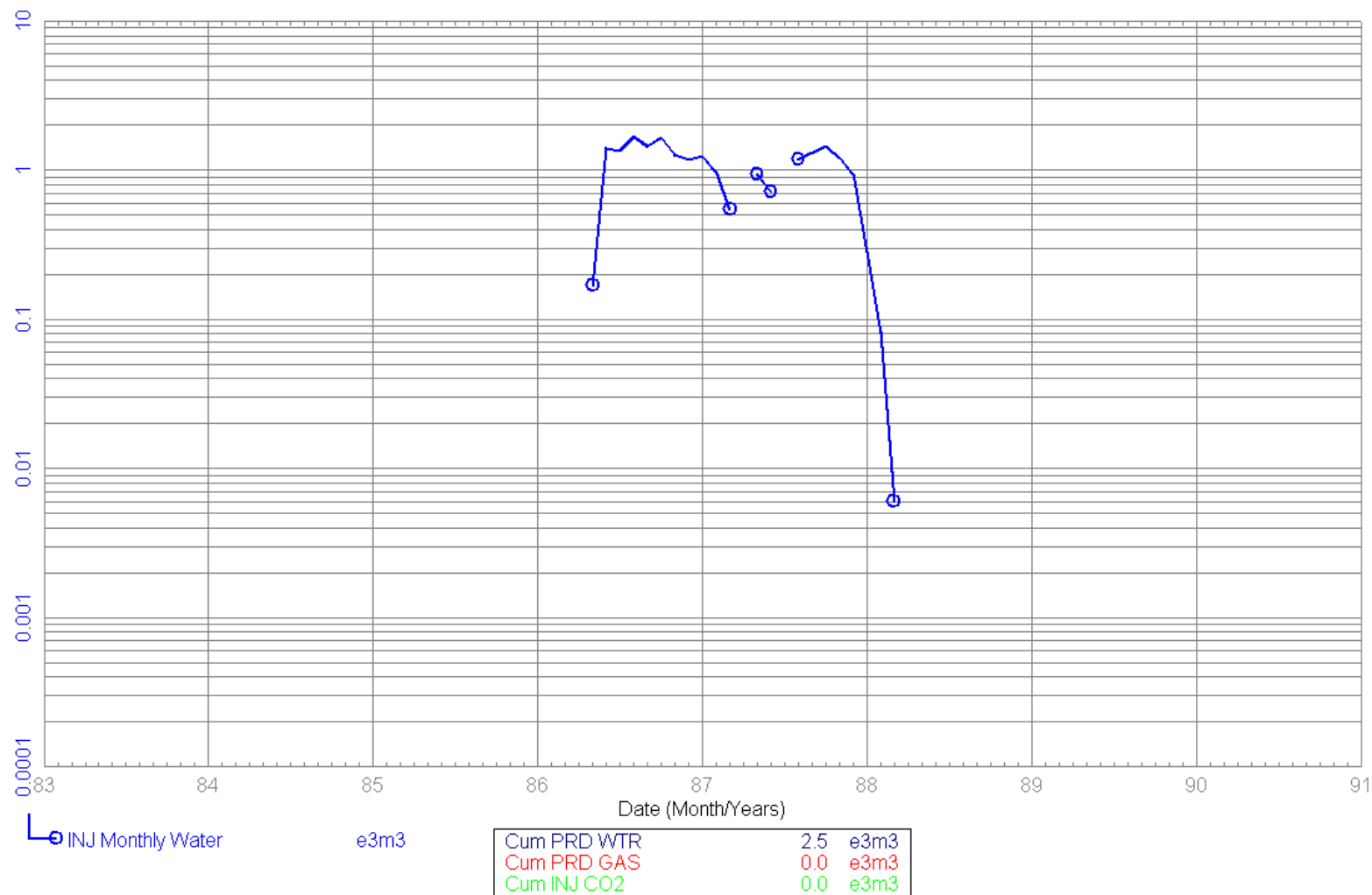
Waskada Unit No. 12

Abandoned Producer

Field: WASKADA (03)

Pool: WASKADA MISSION CANYON 3A- A (43A)

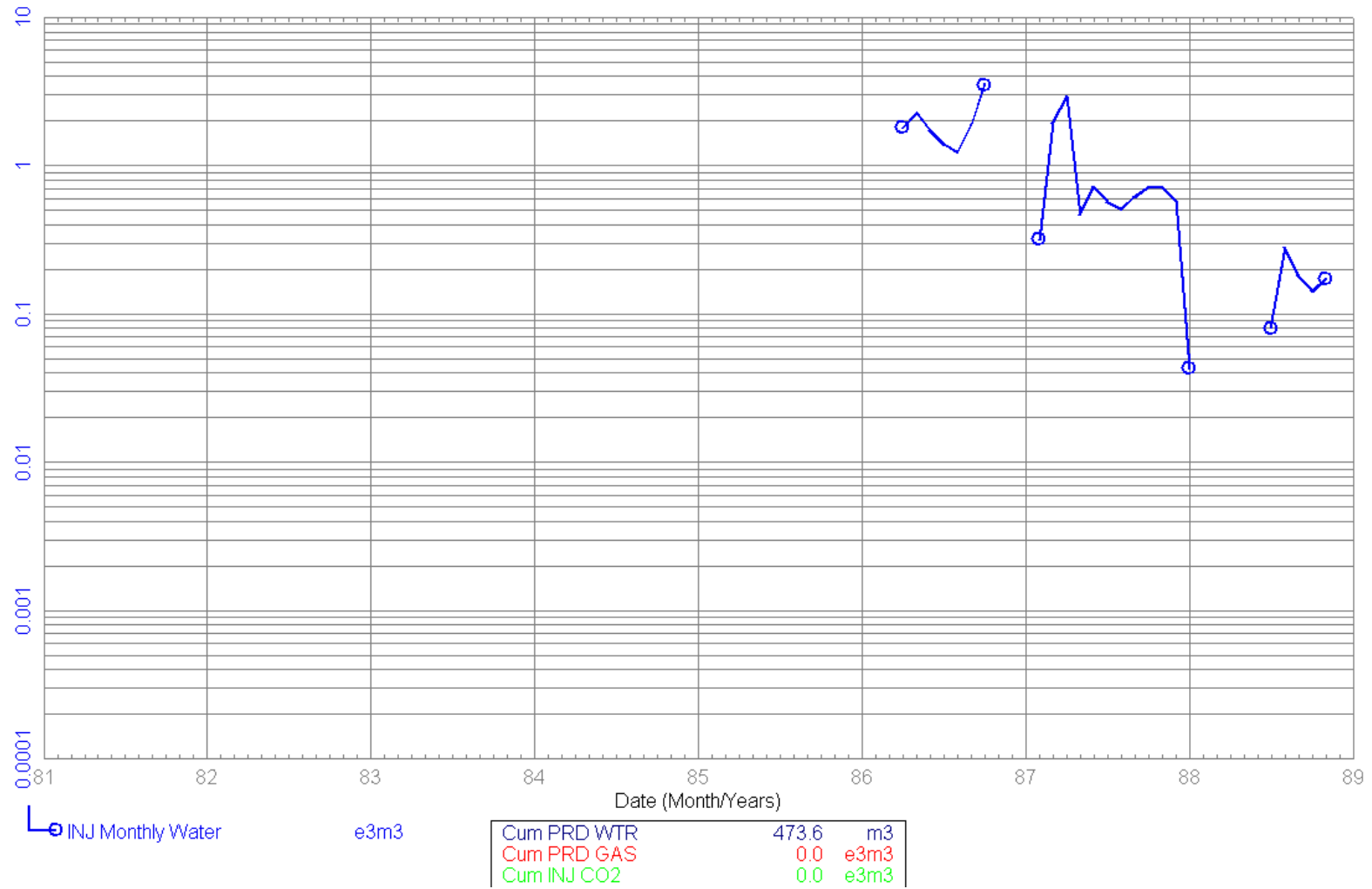
Unit: WASKADA UNIT NO. 12



Data As Of: 2012-10 (MB)  
From: 1981-02  
To: 1986-03

100/01-24-001-26W1/00  
Waskada Unit No. 12 Prov. WW  
Abandoned Water Inj Well

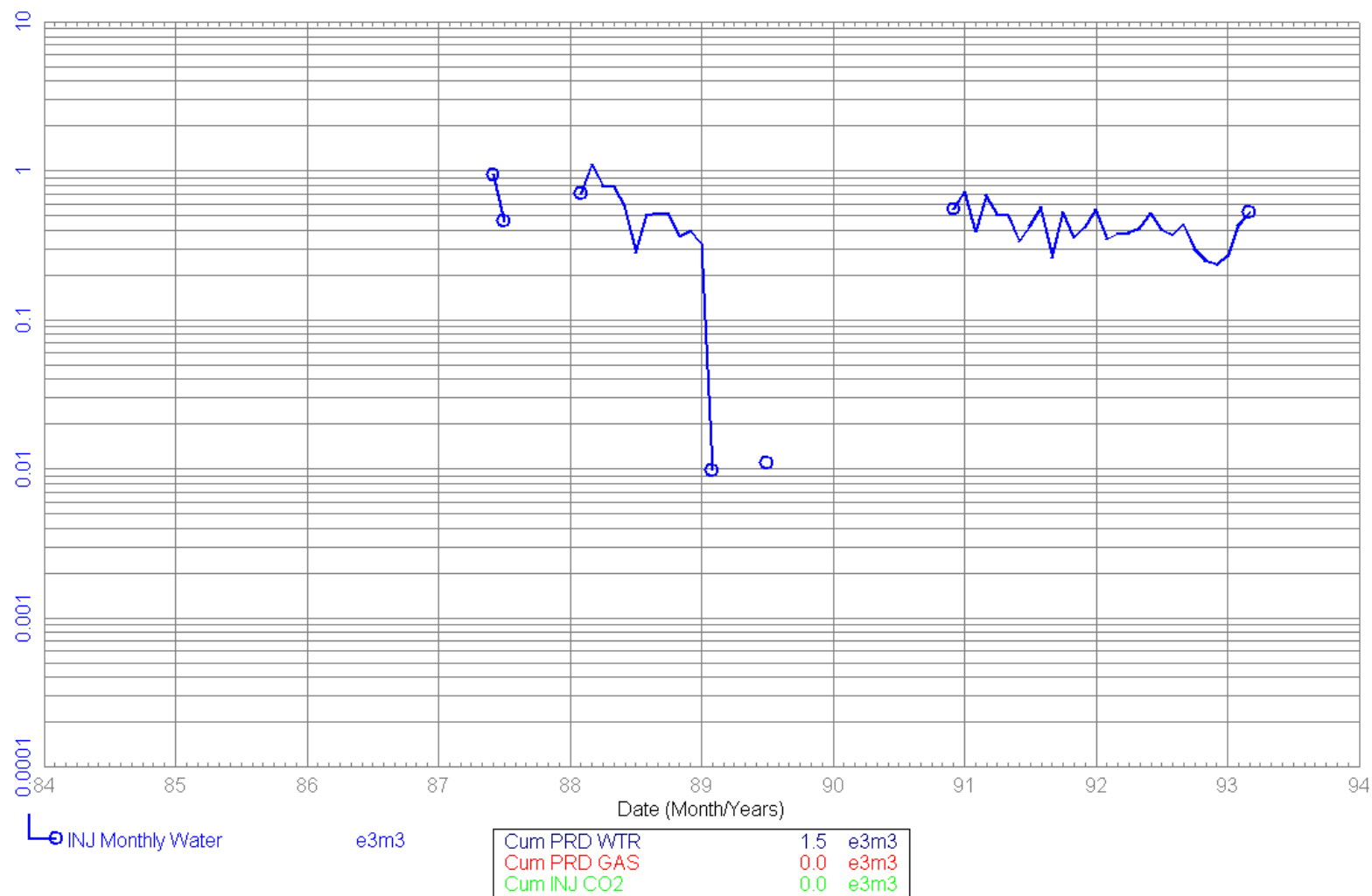
Field: WASKADA (03)  
Pool: WASKADA MISSION CANYON 3A A (43A)  
Unit: WASKADA UNIT NO. 12



Data As Of: 2012-10 (MB)  
From: 1984-04  
To: 1984-09

102/09-23-001-26W1/00  
Waskada Unit No. 12 WW  
Abandoned Water Inj Well

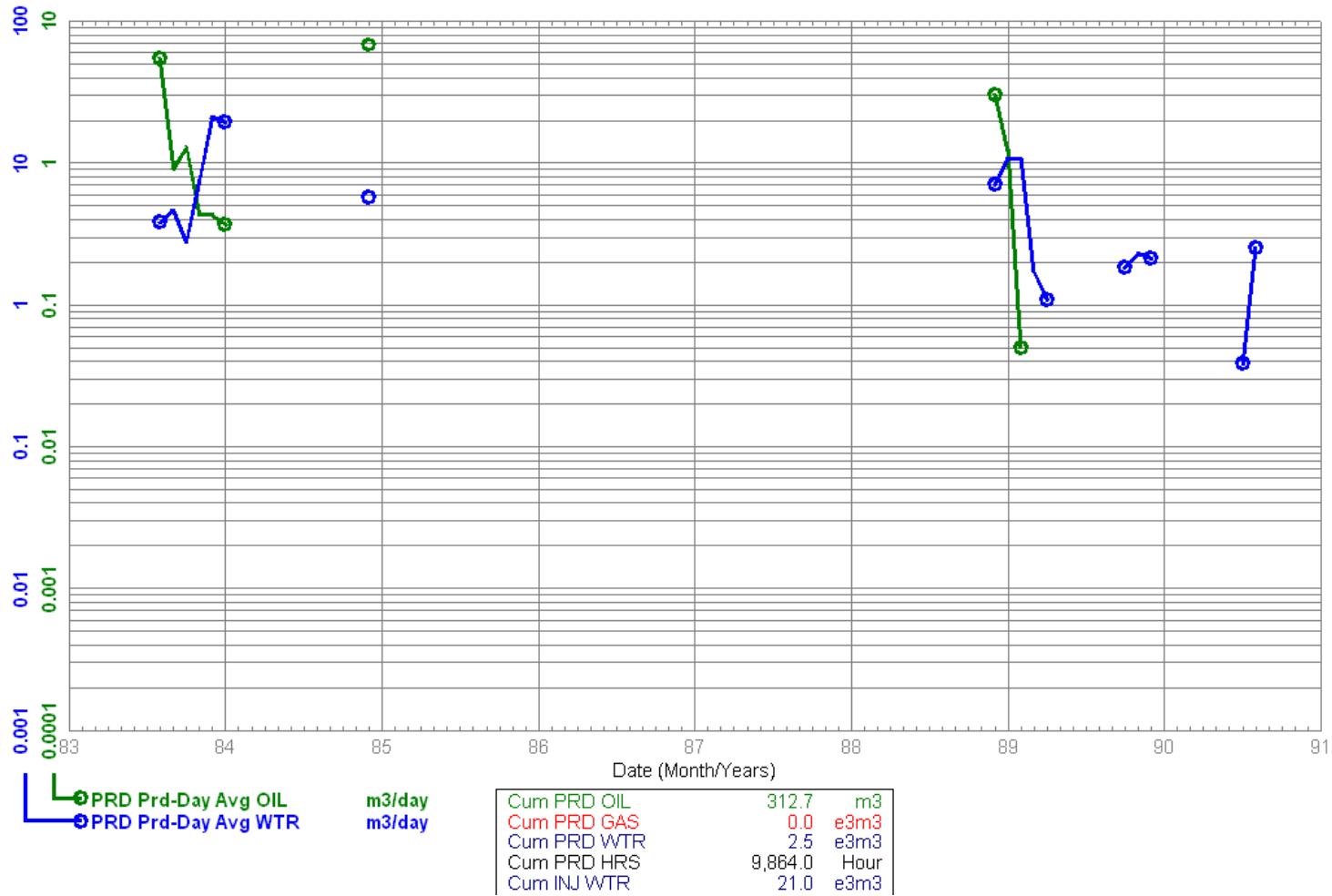
Field: WASKADA (03)  
Pool: WASKADA MISSION CANYON 3A A (43A)  
Unit: WASKADA UNIT NO. 12



Data As Of: 2012-10 (MB)  
 From: 1983-08  
 To: 1990-08

102/15-23-001-26W1/00  
 Waskada Unit No. 12  
 Abandoned Producer

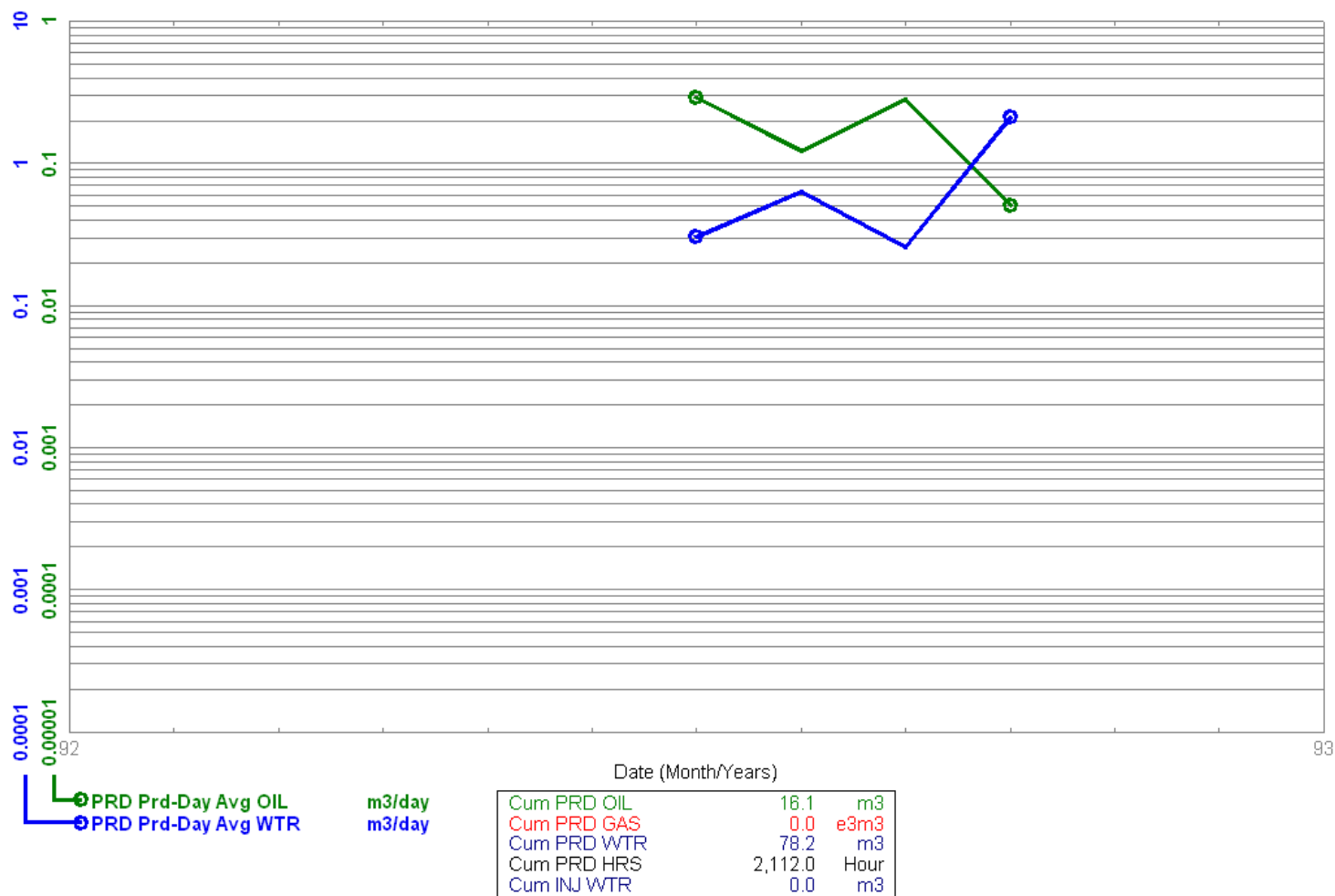
Field: WASKADA (03)  
 Pool: WASKADA MISSION CANYON 3A A (43A)  
 Unit: WASKADA UNIT NO. 12



Data As Of: 2012-10 (MB)  
 From: 1992-07  
 To: 1992-10

1A0/08-23-001-26W1/02  
 Waskada Unit No. 4  
 Abandoned Producer

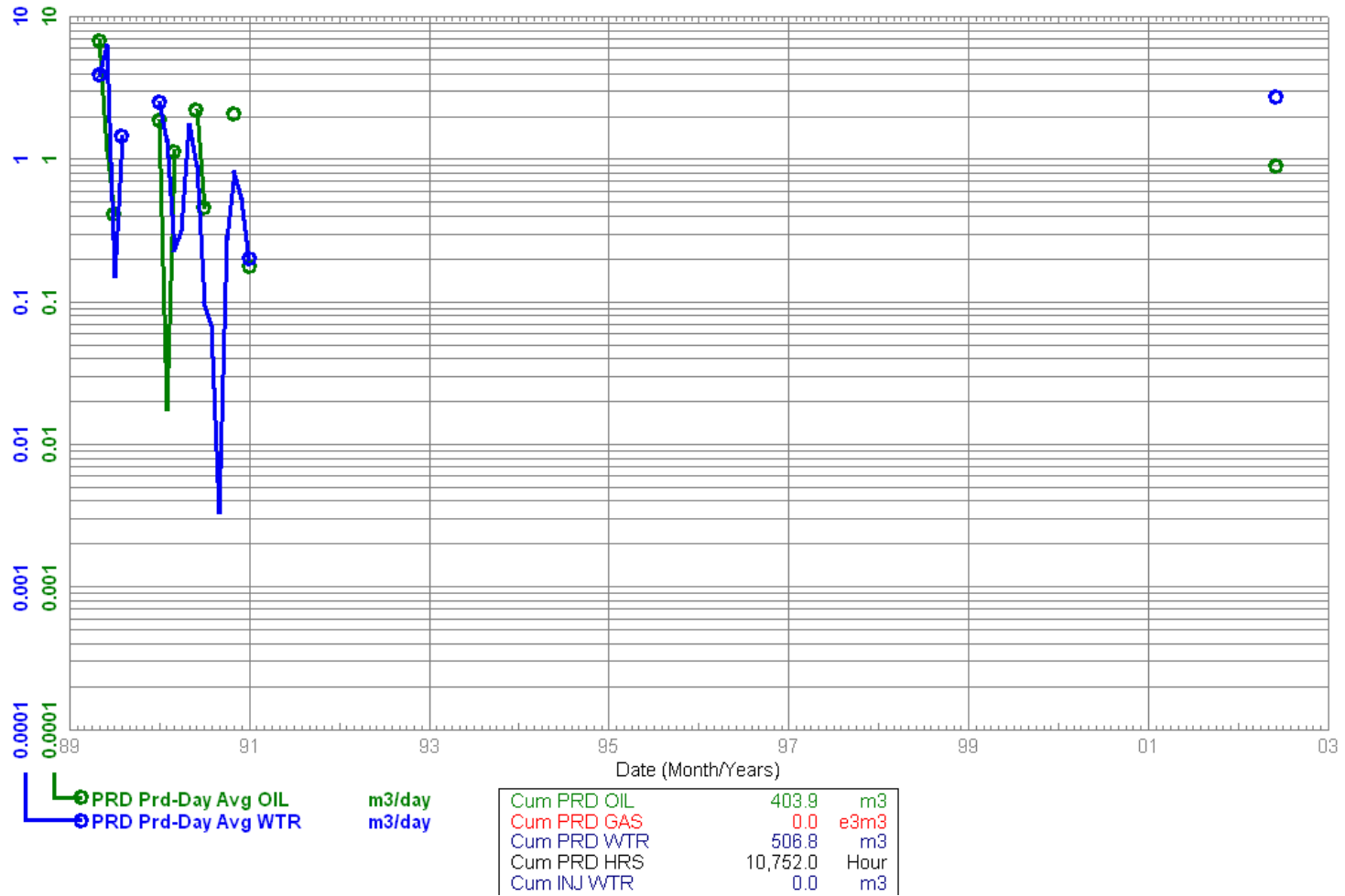
Field: WASKADA (03)  
 Pool: WASKADA MISSION CANYON 3A A (43A)  
 Unit: WASKADA UNIT NO. 12



Data As Of: 2012-10 (MB)  
 From: 1989-05  
 To: 2002-06

100/01-23-001-26W1/02  
 Waskada Unit No. 4 COM  
 Comingled

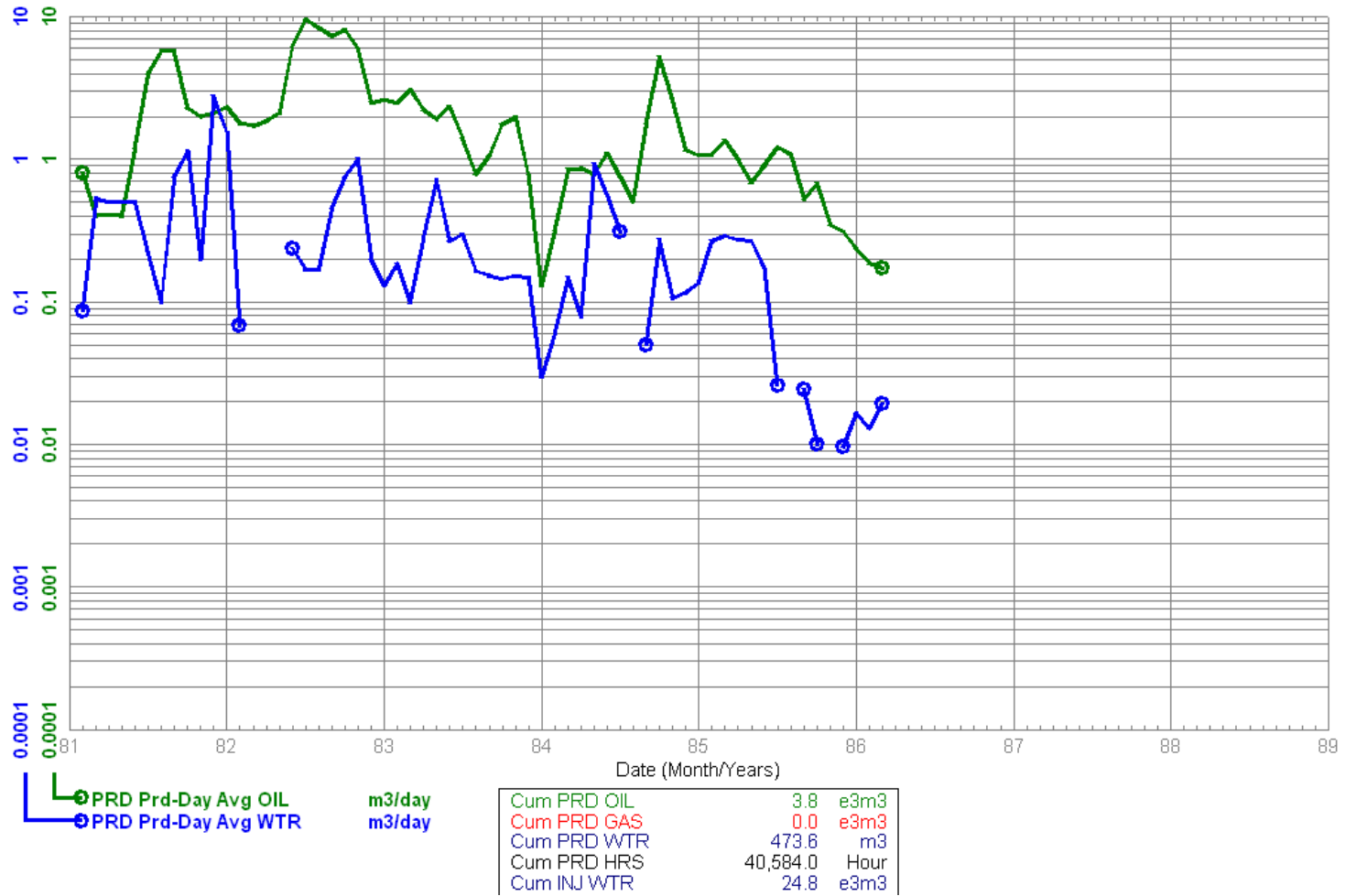
Field: WASKADA (03)  
 Pool: WASKADA MISSION CANYON 3A A (43A)  
 Unit: WASKADA UNIT NO. 12



Data As Of: 2012-10 (MB)  
 From: 1981-02  
 To: 1986-03

100/01-24-001-26W1/00  
 Waskada Unit No. 12 Prov. WW  
 Abandoned Water Inj Well

Field: WASKADA (03)  
 Pool: WASKADA MISSION CANYON 3A A (43A)  
 Unit: WASKADA UNIT NO. 12

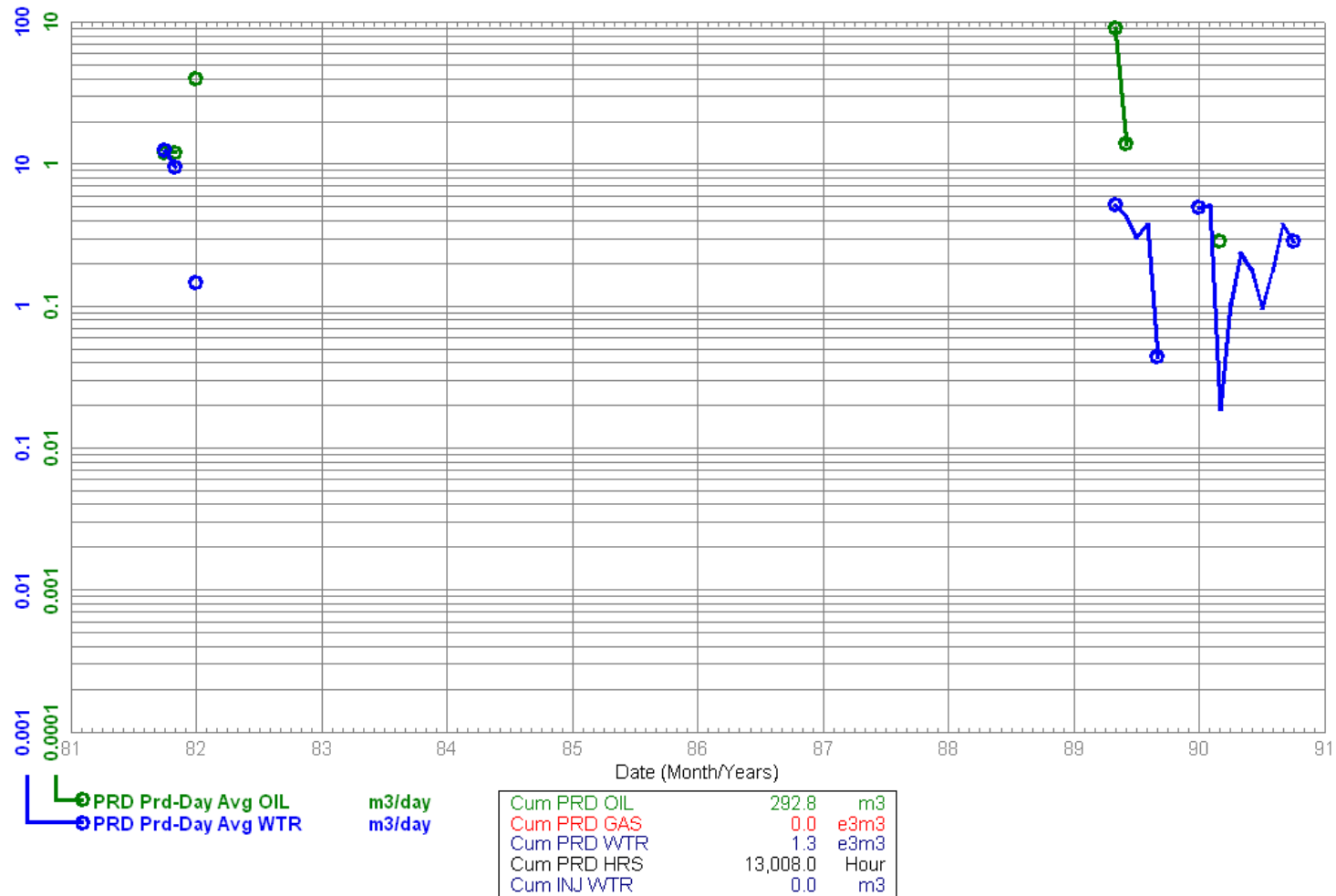




Data As Of: 2012-10 (MB)  
 From: 1981-10  
 To: 1990-11

100/01-26-001-26W1/00  
 Waskada LAm Unit No. 1  
 Abandoned Producer

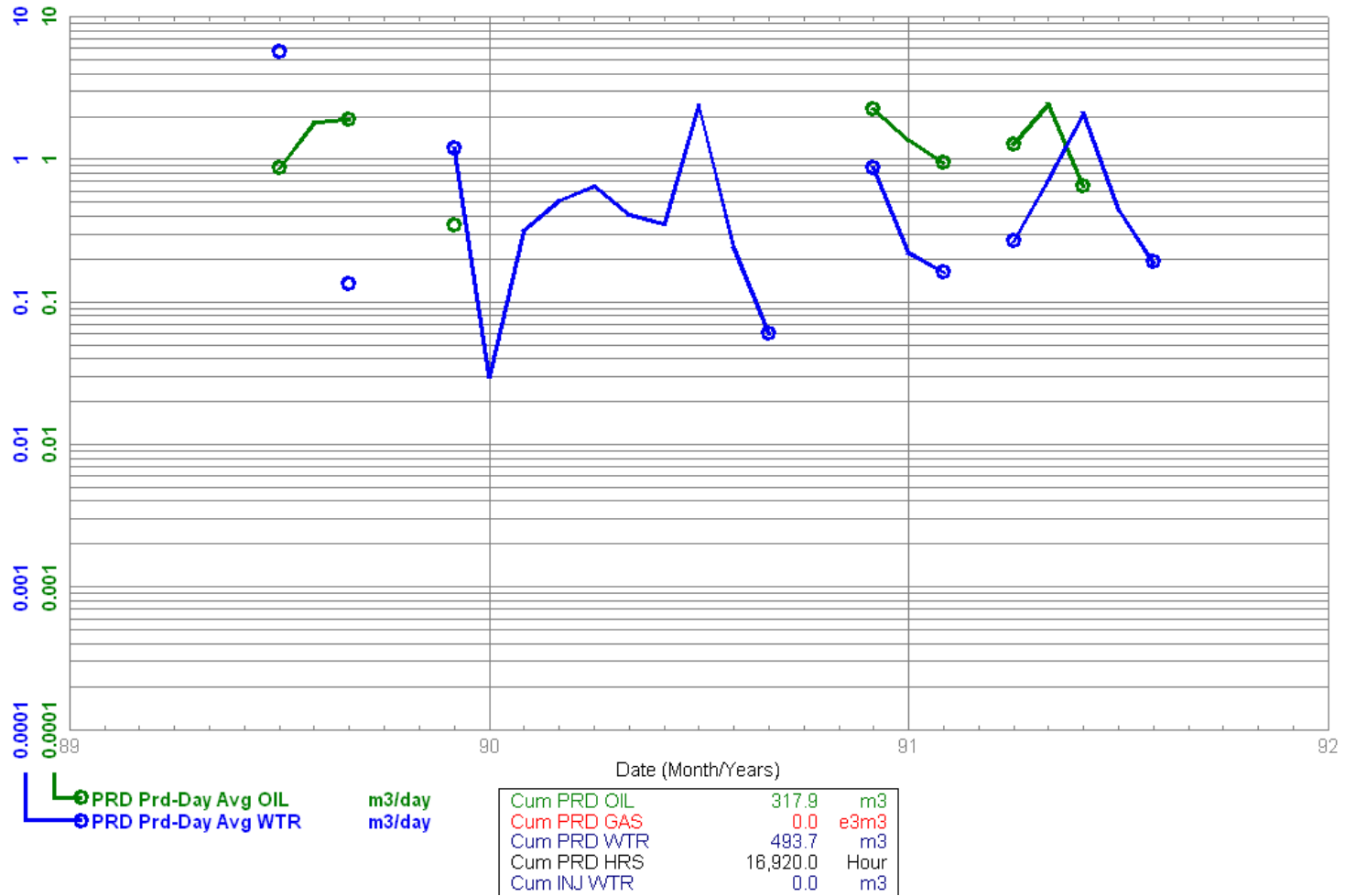
Field: WASKADA (03)  
 Pool: WASKADA MISSION CANYON 3A A (43A)  
 Unit: WASKADA UNIT NO. 12



Data As Of: 2012-10 (MB)  
 From: 1989-07  
 To: 1991-09

100/02-26-001-26W1/02  
 Waskada LAm Unit No. 1 COM  
 Comingled

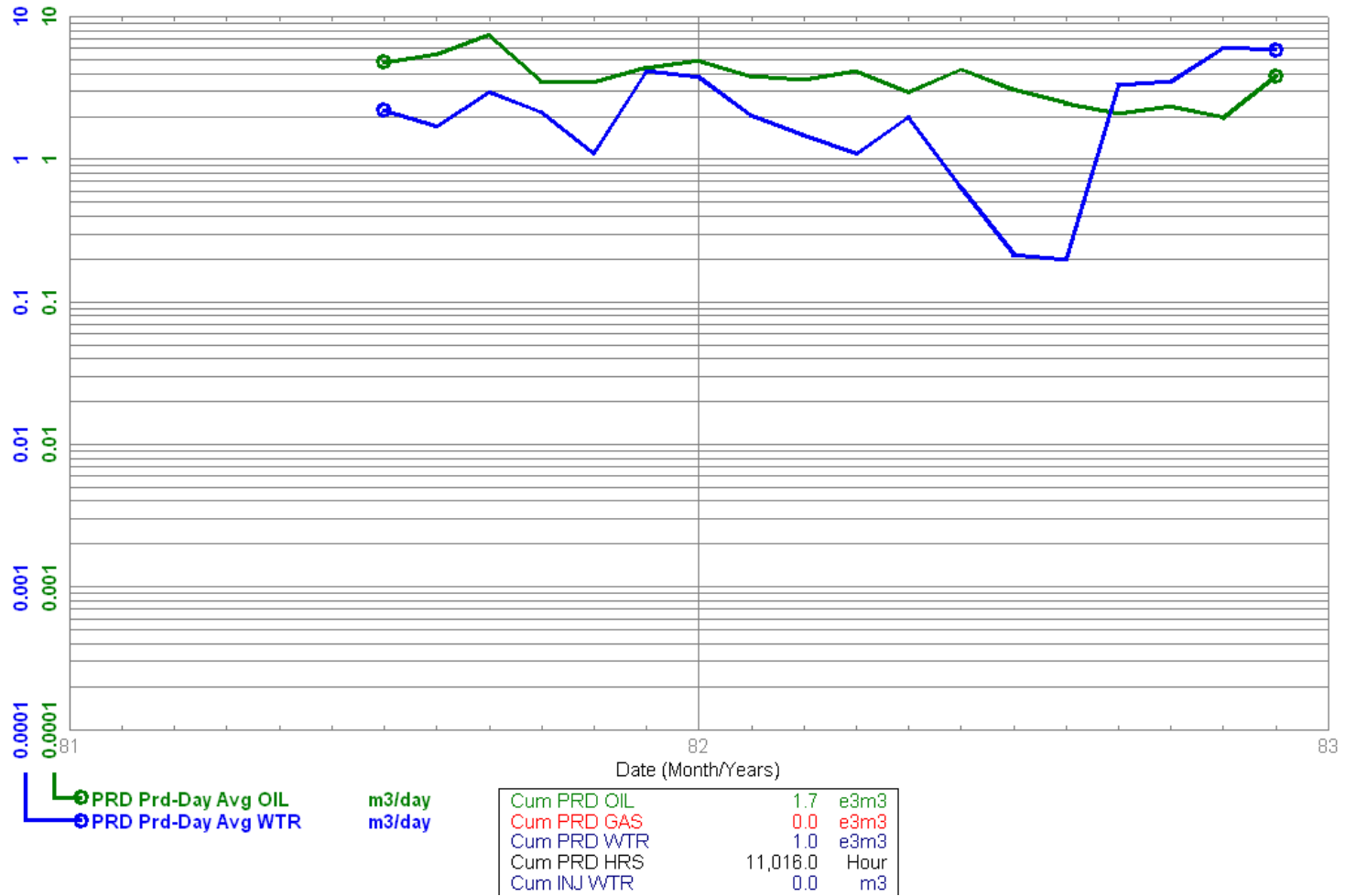
Field: WASKADA (03)  
 Pool: WASKADA MISSION CANYON 3A A (43A)  
 Unit: WASKADA UNIT NO. 12



Data As Of: 2012-10 (MB)  
 From: 1981-07  
 To: 1982-12

100/03-25-001-26W1/00  
 Waskada LAm Unit No. 1  
 Abandoned Producer

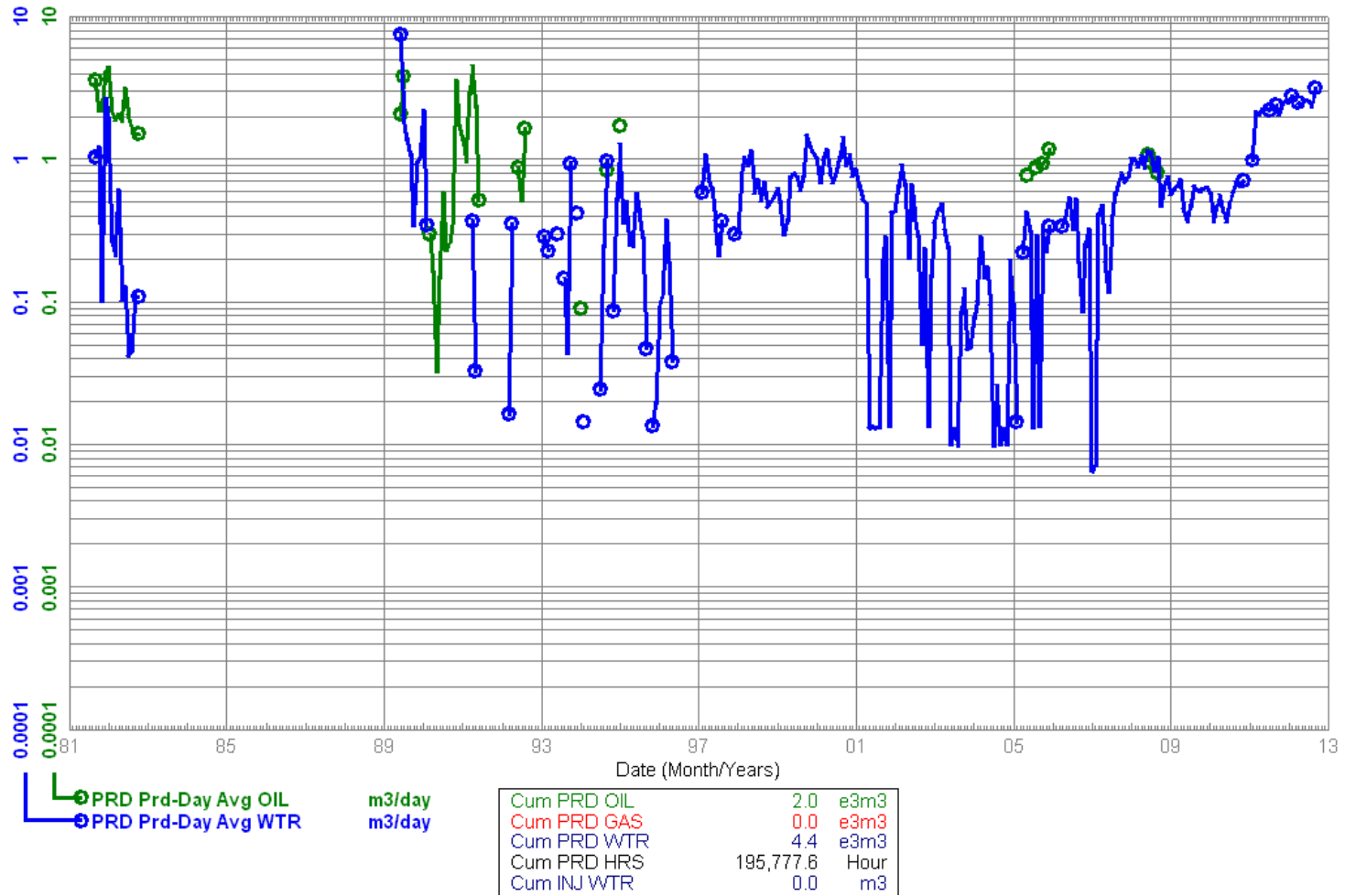
Field: WASKADA (03)  
 Pool: WASKADA MISSION CANYON 3A A (43A)  
 Unit: WASKADA UNIT NO. 12



Data As Of: 2012-10 (MB)  
 From: 1981-09  
 To: 2012-09

100/04-25-001-26W1/00  
 Waskada Unit No. 12 COM  
 Comingled

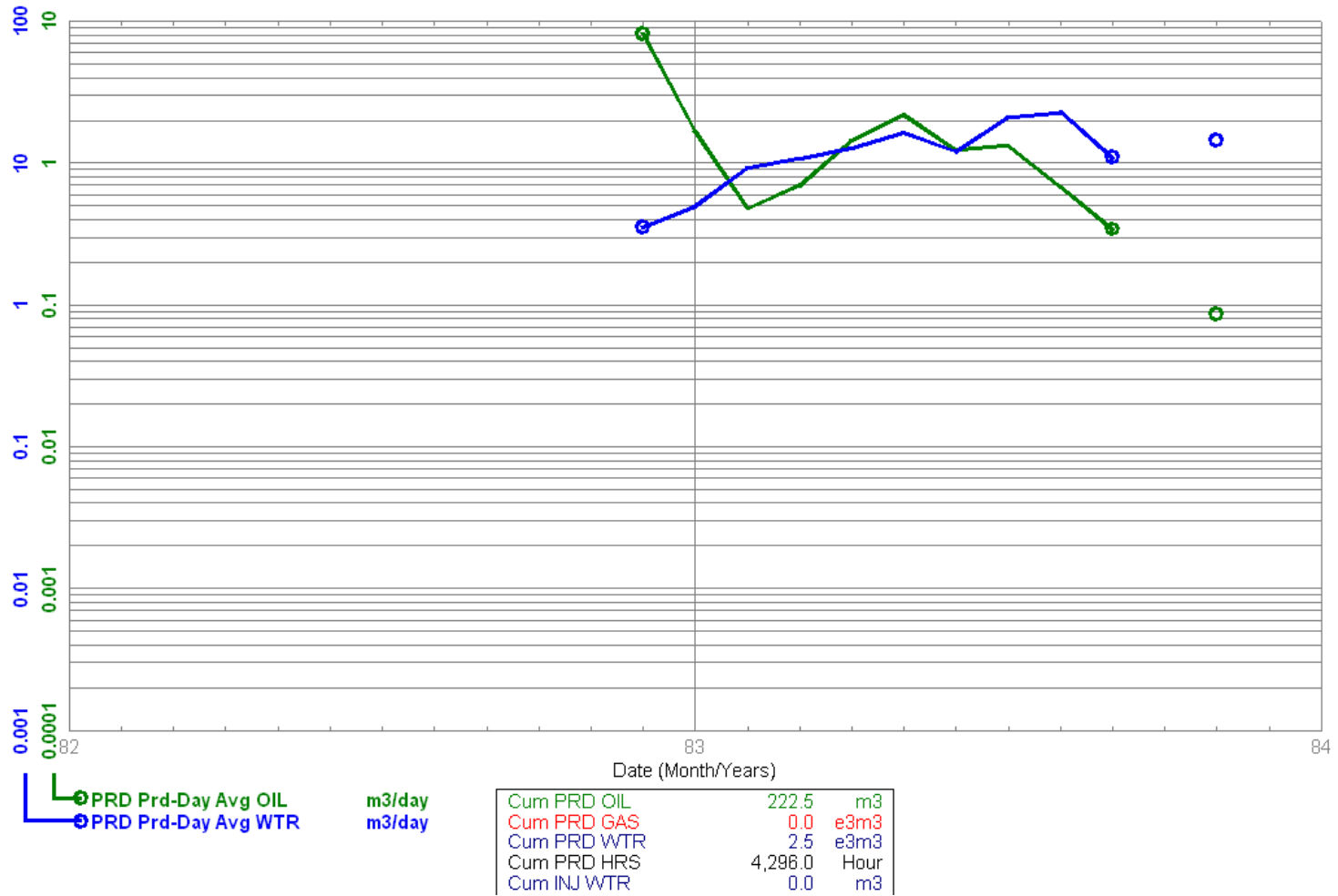
Field: WASKADA (03)  
 Pool: WASKADA MISSION CANYON 3A A (43A)  
 Unit: WASKADA UNIT NO. 12



Data As Of: 2012-10 (MB)  
 From: 1982-12  
 To: 1983-11

100/07-23-001-26W1/00  
 Waskada Unit No. 4 W1W  
 Abandoned Producer

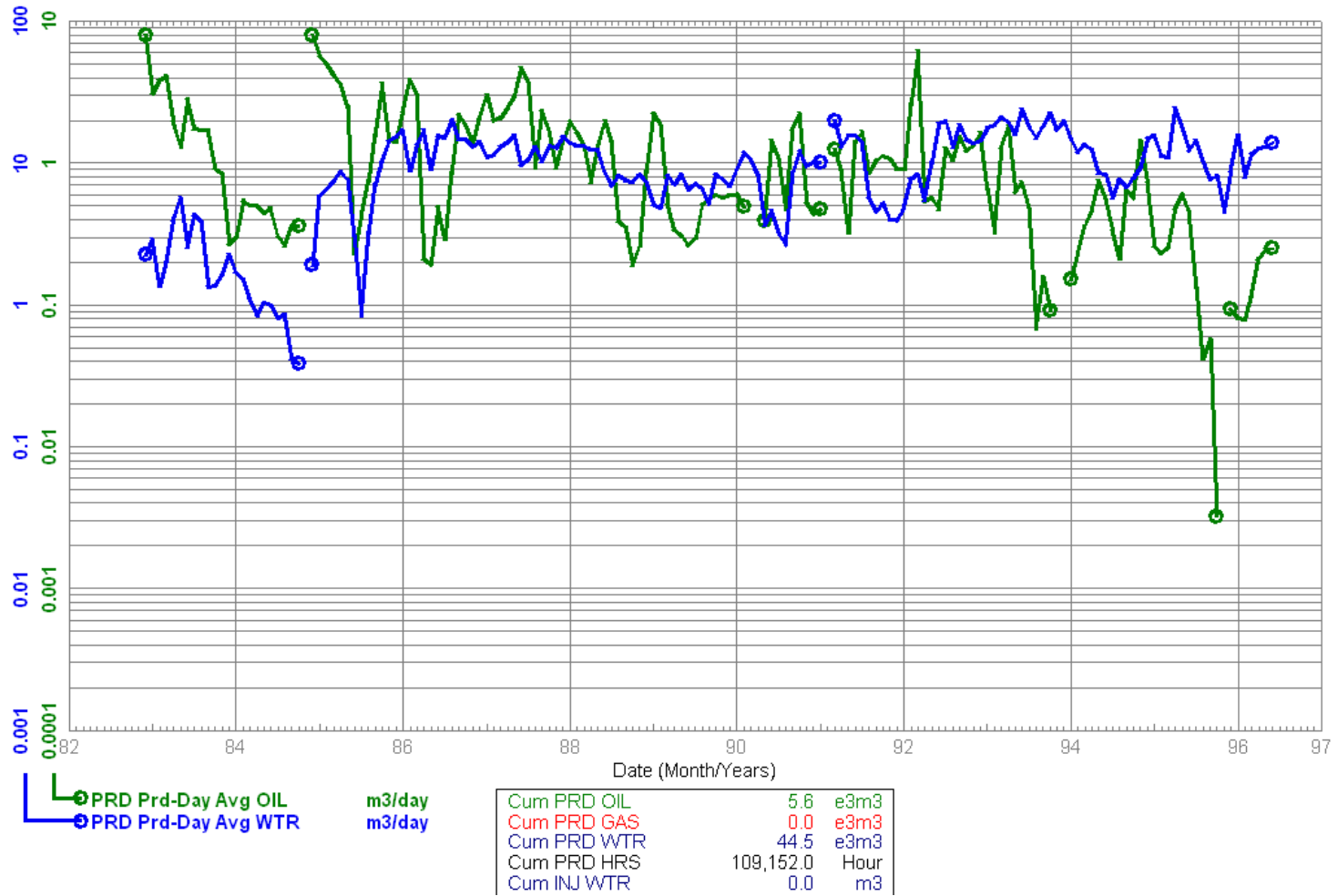
Field: WASKADA (03)  
 Pool: WASKADA MISSION CANYON 3A A (43A)  
 Unit: WASKADA UNIT NO. 12



Data As Of: 2012-10 (MB)  
 From: 1982-12  
 To: 1996-06

100/08-23-001-26W1/00  
 Waskada Unit No. 12  
 Abandoned Producer

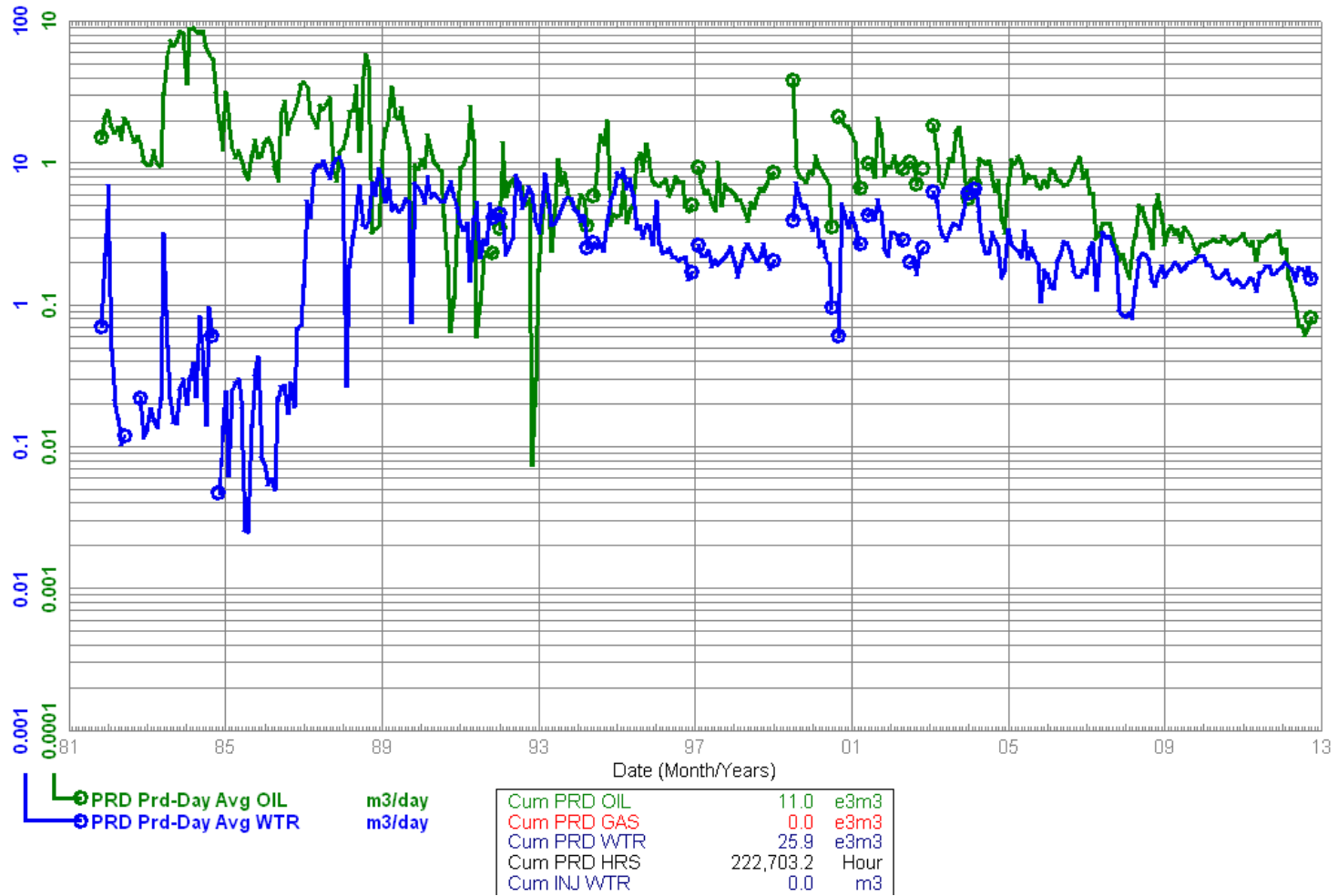
Field: WASKADA (03)  
 Pool: WASKADA MISSION CANYON 3A A (43A)  
 Unit: WASKADA UNIT NO. 12



Data As Of: 2012-10 (MB)  
 From: 1981-11  
 To: 2012-10

100/08-24-001-26W1/00  
 Waskada Unit No. 12 Prov.  
 Capable Of Oil Prod

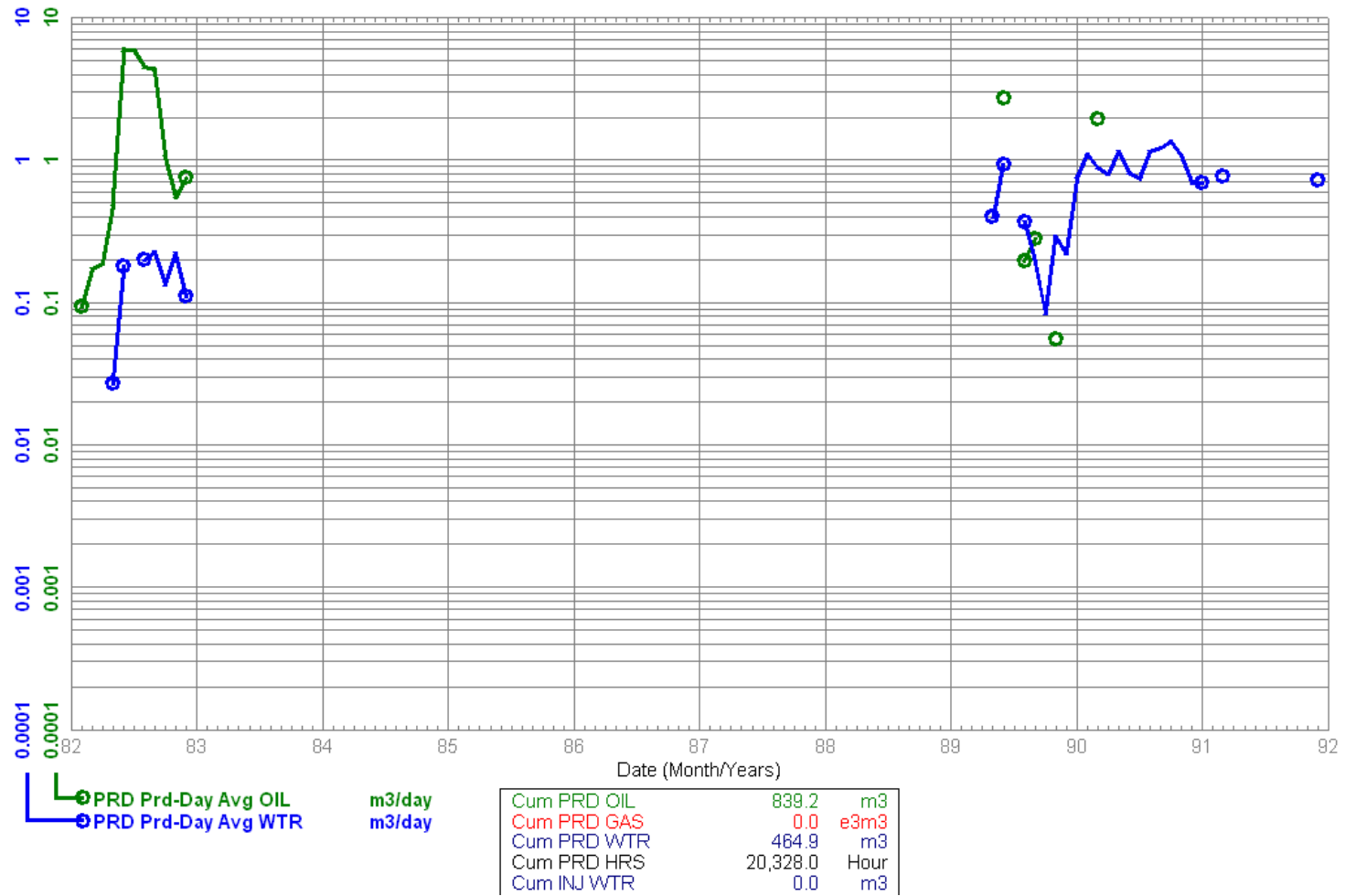
Field: WASKADA (03)  
 Pool: WASKADA MISSION CANYON 3A A (43A)  
 Unit: WASKADA UNIT NO. 12



Data As Of: 2012-10 (MB)  
From: 1982-02  
To: 1991-12

100/09-24-001-26W1/00  
Waskada LAm Unit No. 1  
Abandoned Producer

Field: WASKADA (03)  
Pool: WASKADA MISSION CANYON 3A A (43A)  
Unit: WASKADA UNIT NO. 12

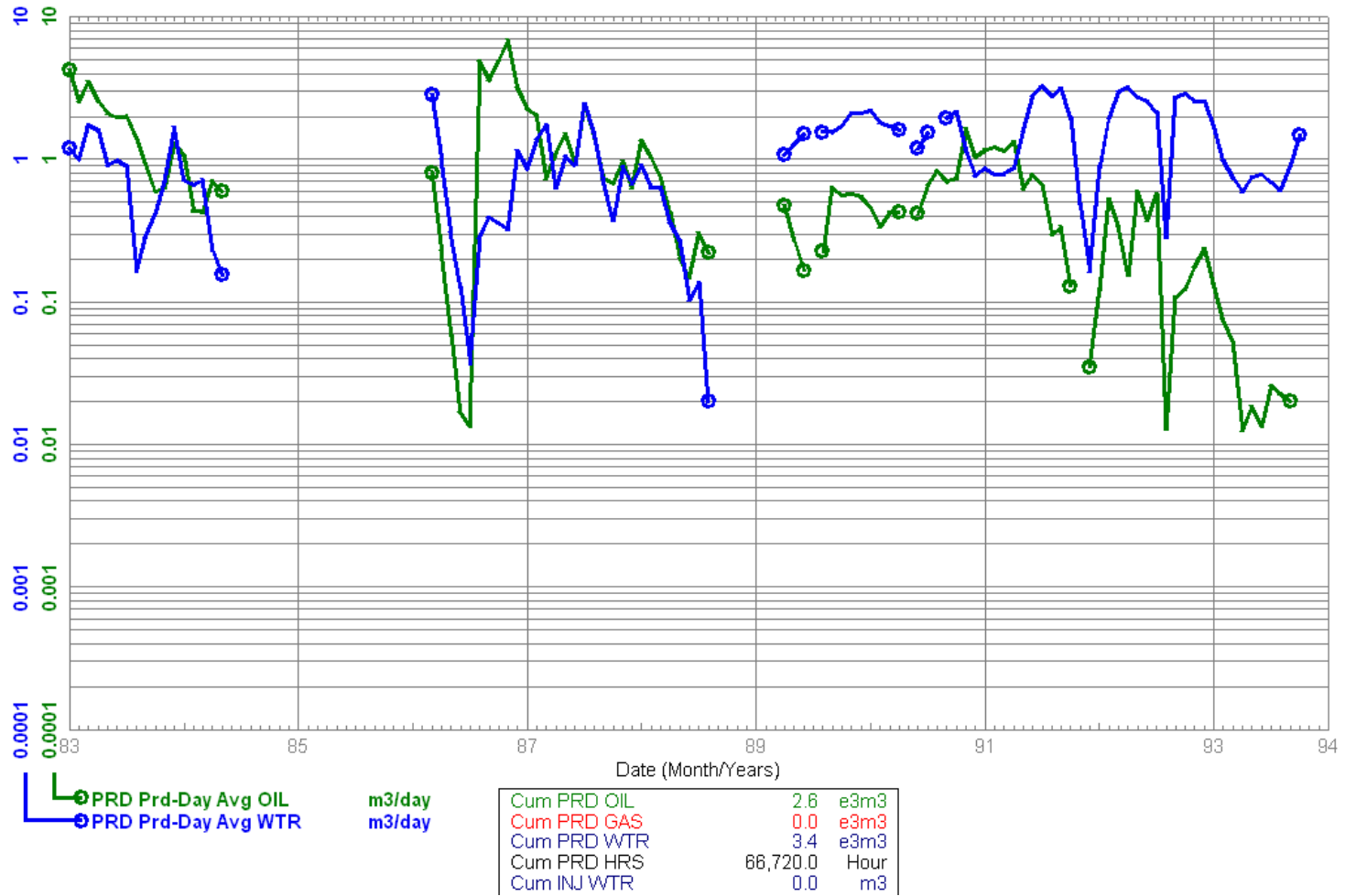




Data As Of: 2012-10 (MB)  
 From: 1983-01  
 To: 1993-10

100/10-23-001-26W1/00  
 Waskada Unit No. 12  
 Abandoned Producer

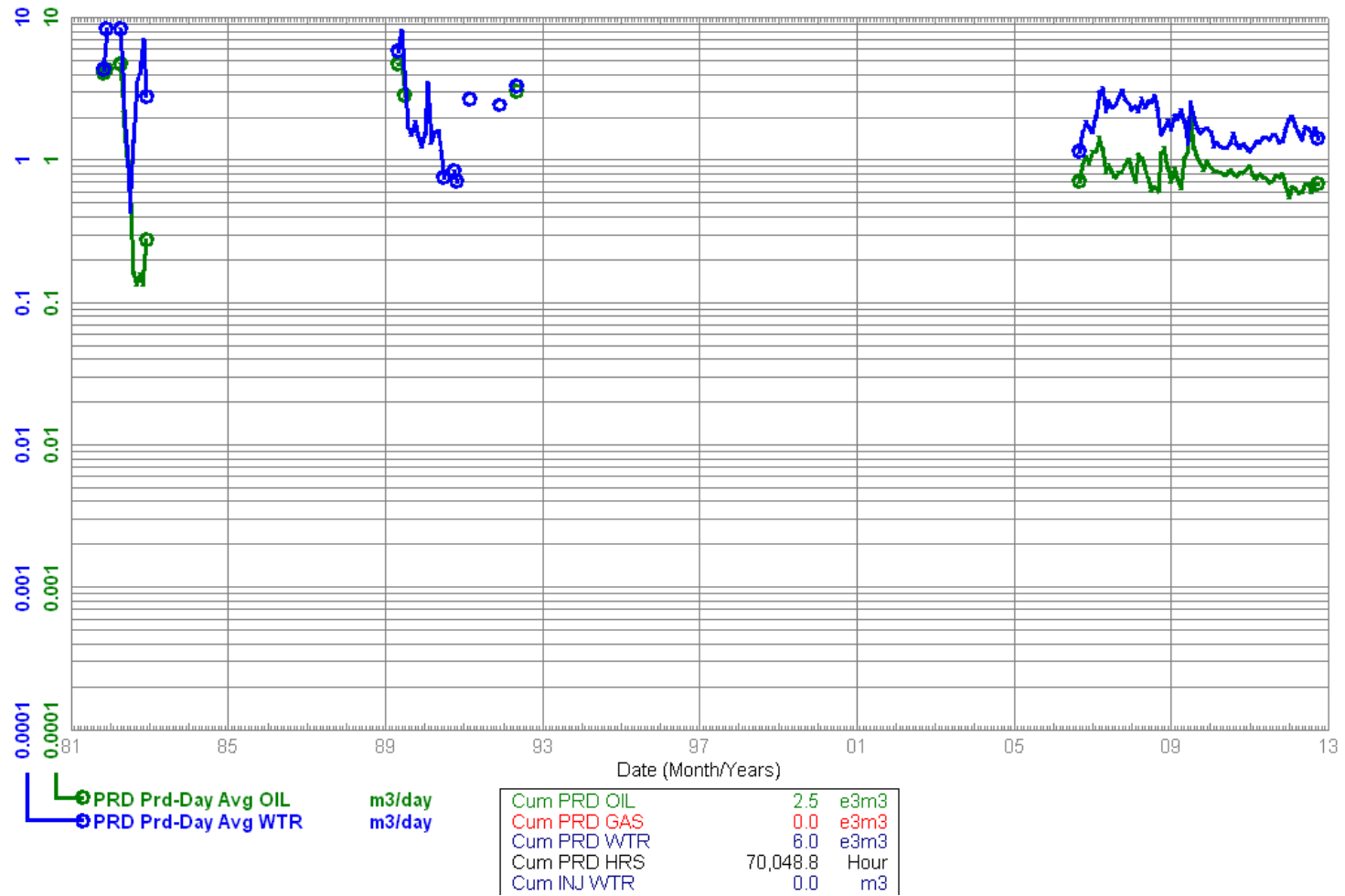
Field: WASKADA (03)  
 Pool: WASKADA MISSION CANYON 3A A (43A)  
 Unit: WASKADA UNIT NO. 12



Data As Of: 2012-10 (MB)  
From: 1981-11  
To: 2012-10

100/12-24-001-26W1/00  
Waskada Unit No. 12 COM  
Comingled

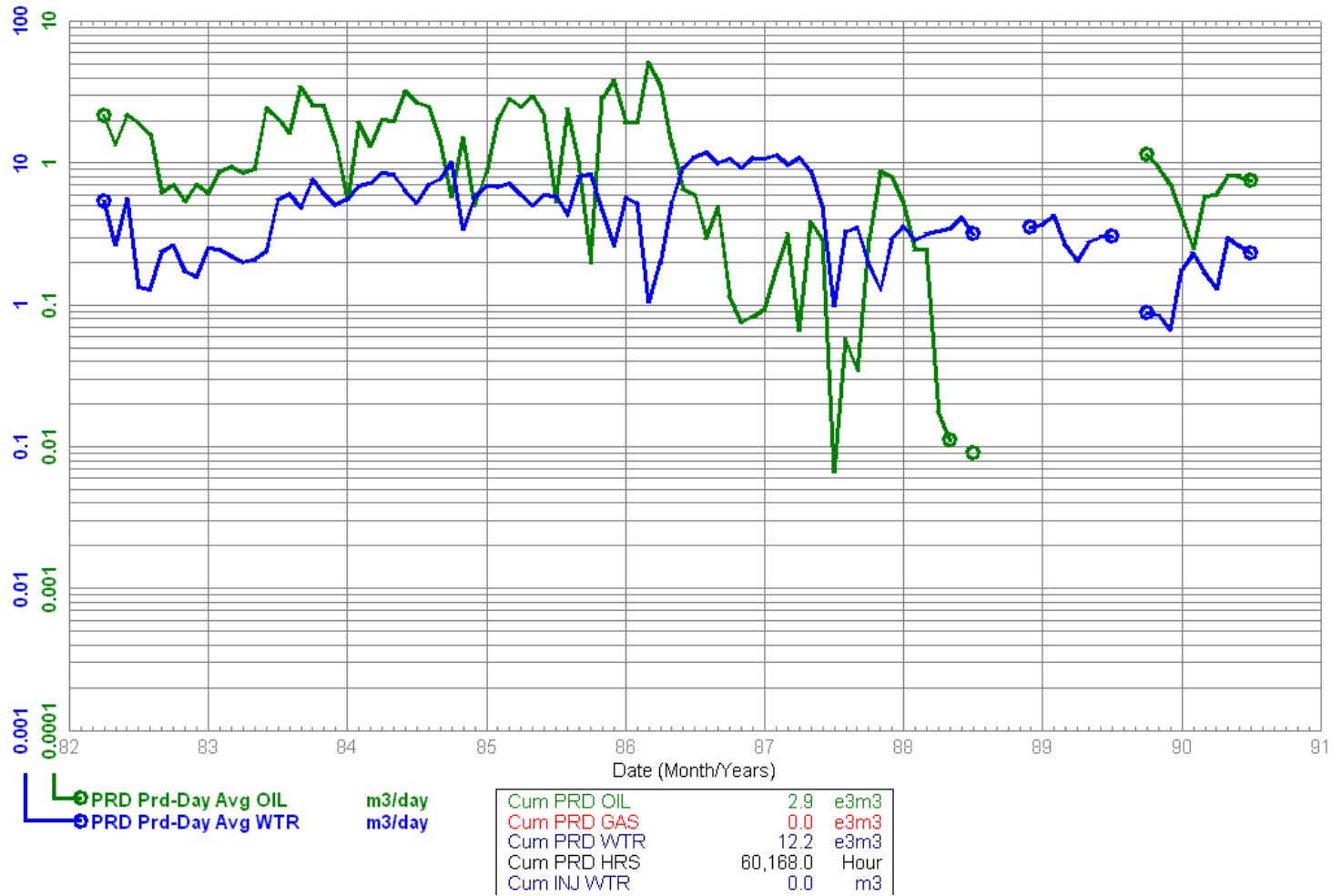
Field: WASKADA (03)  
Pool: WASKADA MISSION CANYON 3A A (43A)  
Unit: WASKADA UNIT NO. 12



Data As Of: 2012-10 (MB)  
 From: 1982-04  
 To: 1990-07

100/13-24-001-26W1/00  
 Waskada Unit No. 12  
 Abandoned Producer

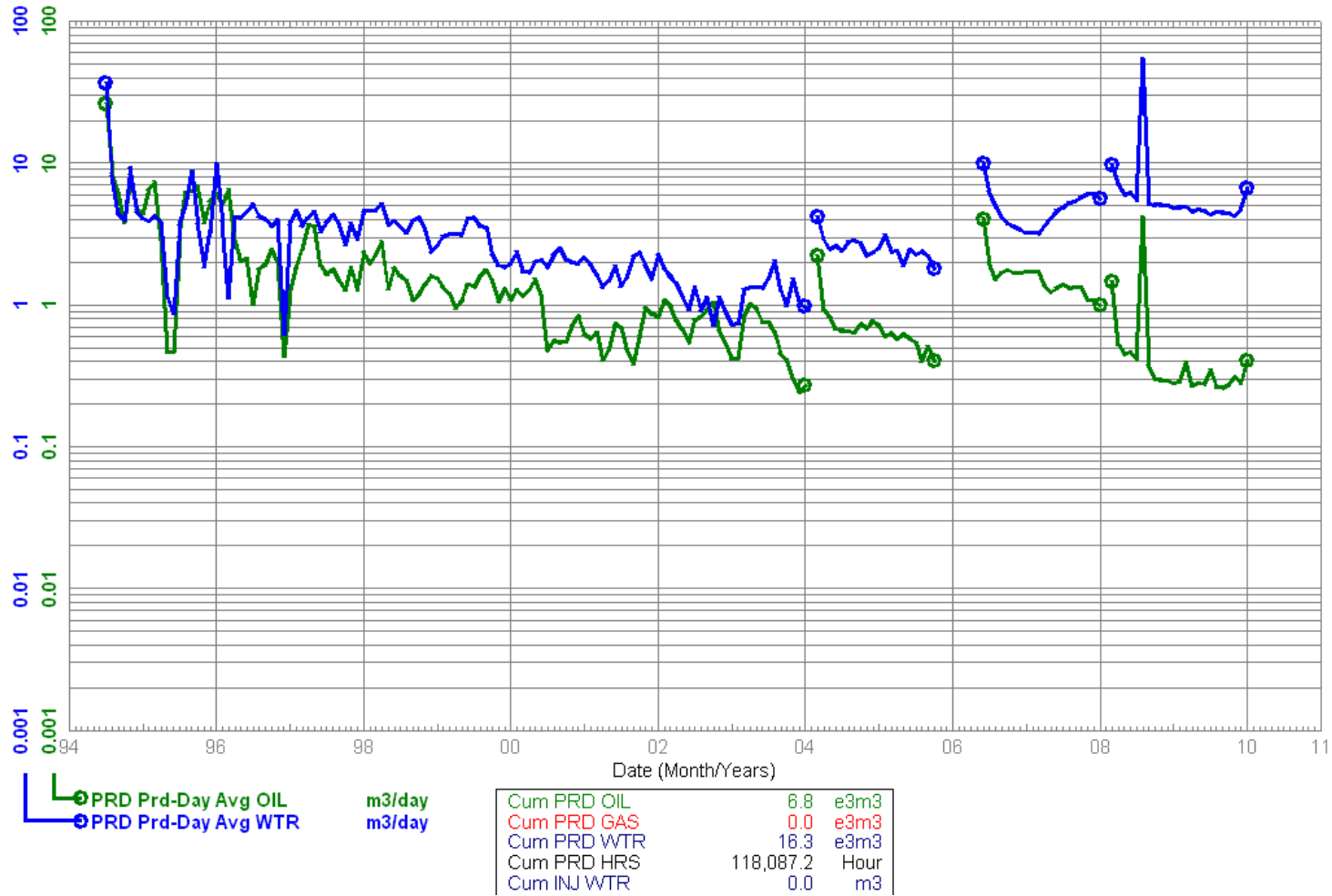
Field: WASKADA (03)  
 Pool: WASKADA MISSION CANYON 3A A (43A)  
 Unit: WASKADA UNIT NO. 12



Data As Of: 2012-10 (MB)  
From: 1994-07  
To: 2010-01

102/01-26-001-26W1/00  
Waskada LAm Unit No. 1 HZNTL  
Abandoned Producer

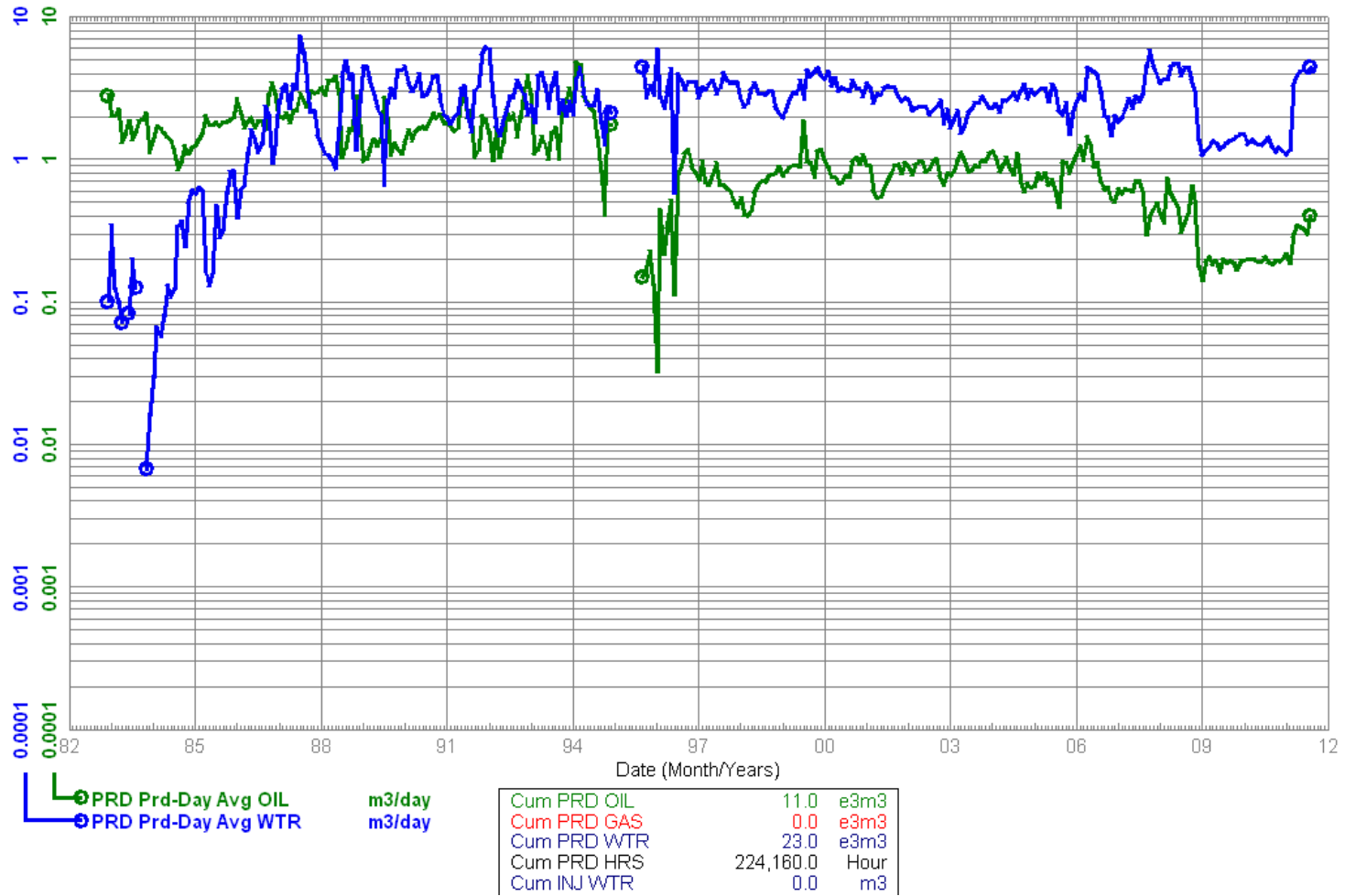
Field: WASKADA (03)  
Pool: WASKADA MISSION CANYON 3A A (43A)  
Unit: WASKADA UNIT NO. 12



Data As Of: 2012-10 (MB)  
 From: 1982-12  
 To: 2011-08

102/03-25-001-26W1/00  
 Waskada Unit No. 12  
 Capable Of Oil Prod

Field: WASKADA (03)  
 Pool: WASKADA MISSION CANYON 3A A (43A)  
 Unit: WASKADA UNIT NO. 12



Data As Of: 2012-10 (MB)  
From: 1984-04  
To: 1984-09

102/09-23-001-26W1/00  
Waskada Unit No. 12 WIVV  
Abandoned Water Inj Well

Field: WASKADA (03)  
Pool: WASKADA MISSION CANYON 3A A (43A)  
Unit: WASKADA UNIT NO. 12

