

**NON-CONFIDENTIAL**

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**Dover**  
**SAGD Progress Review**  
**Thermal Heavy Oil**

by  
**Devon Canada Corporation**  
*(Project Operator)*

March 9, 2004

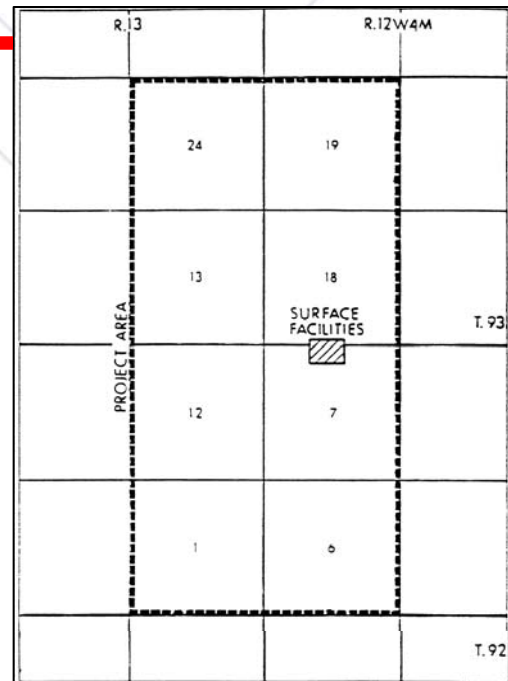
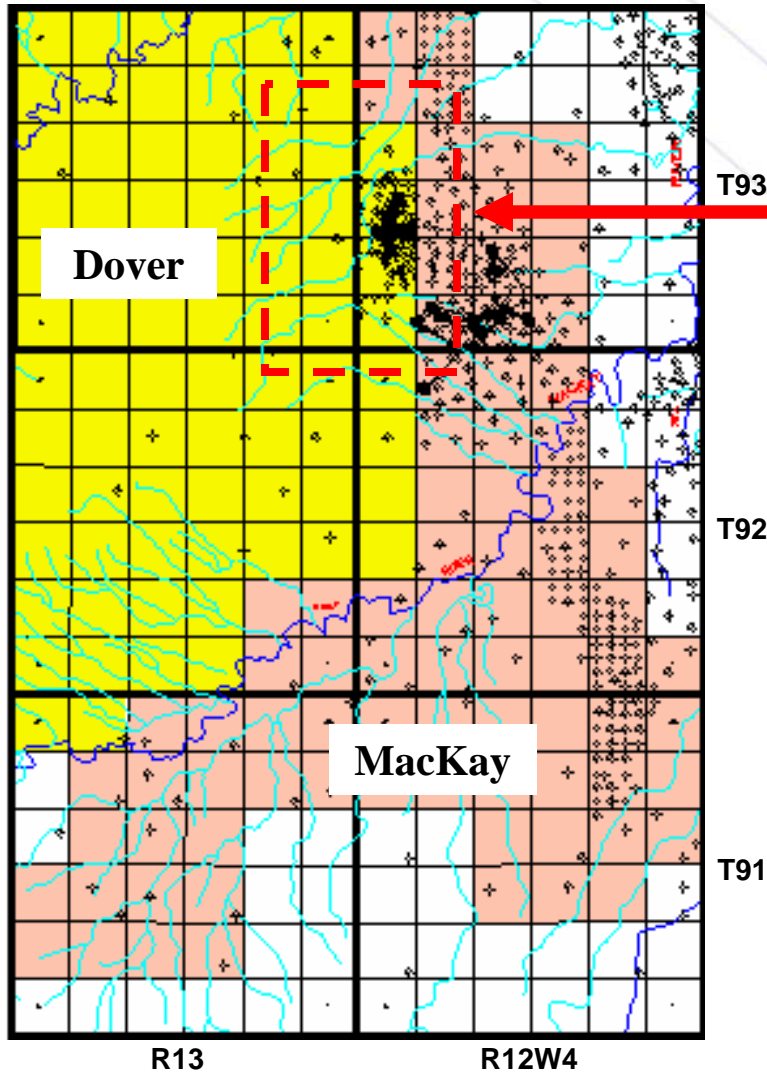
***AEUB Approval 9044, 9045, & 9139***

# Outline

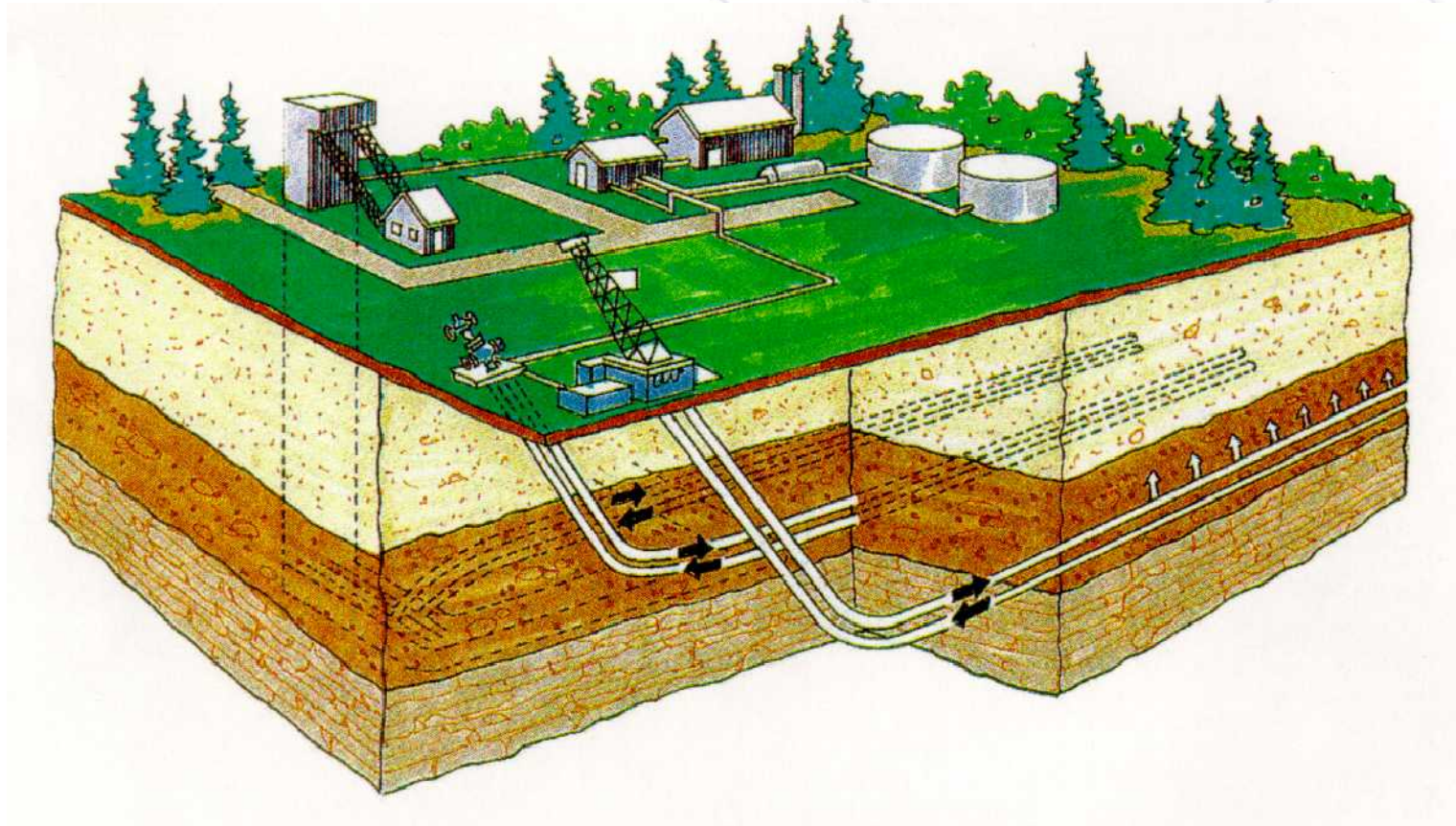
- **Introduction**
- SAGD Performance
- Facilities
- Regulatory
- Future Plans



# Dover Project Area



# Dover SAGD Project

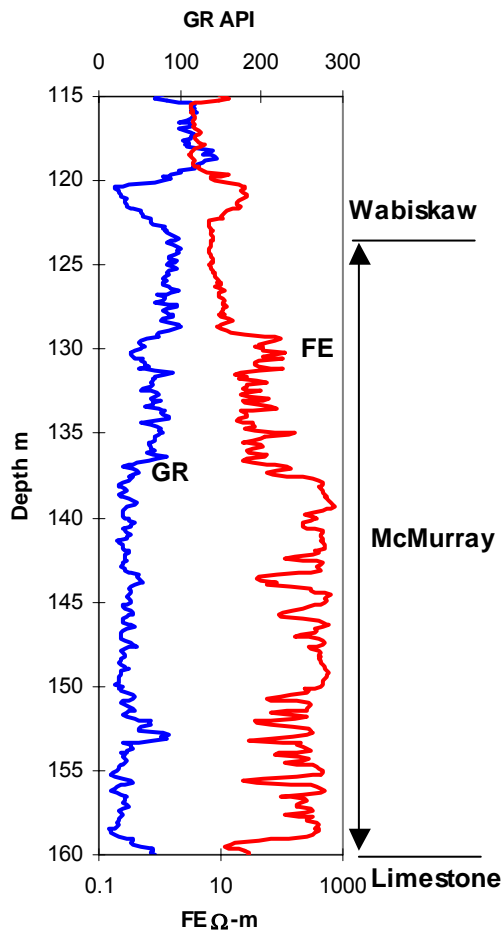


# Geology

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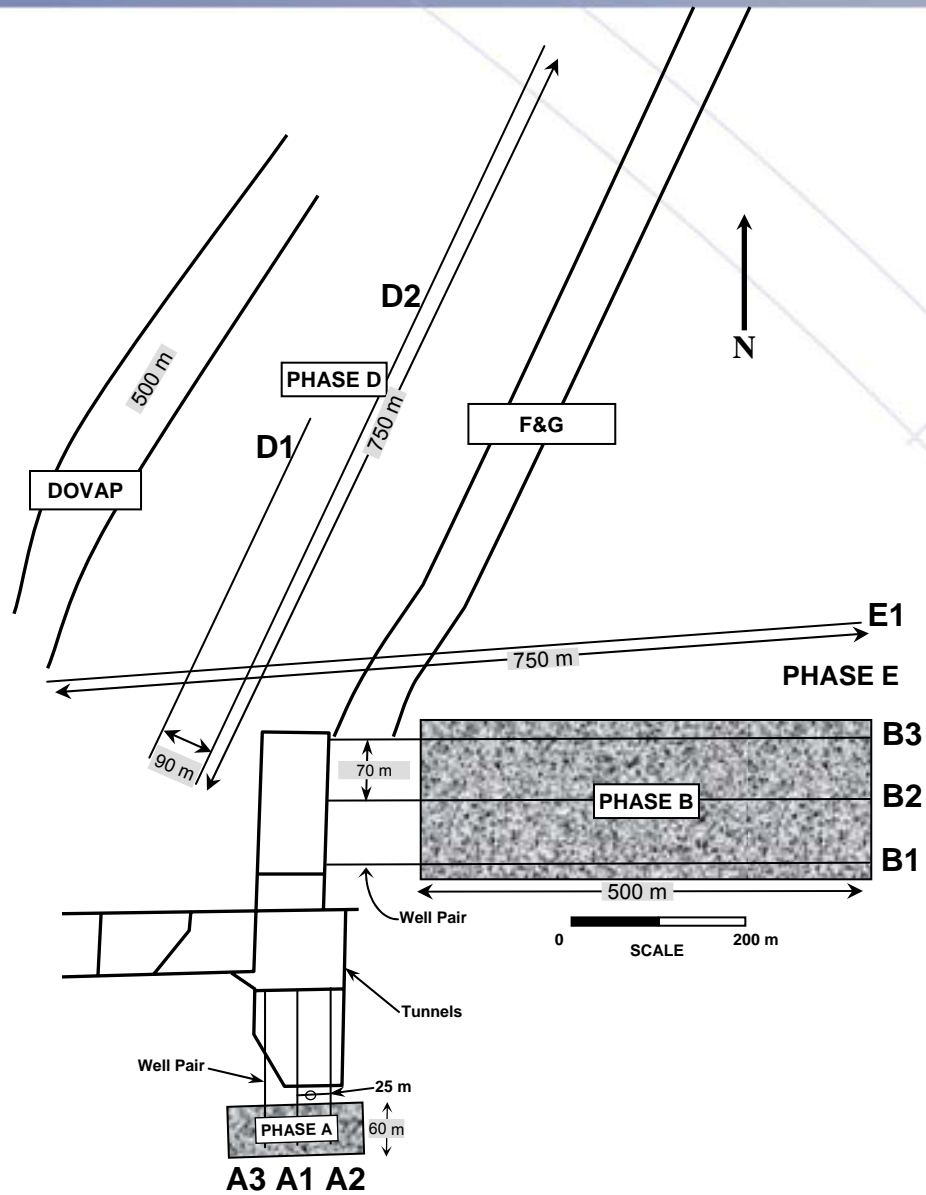
Typical Log of Good UTF Well



- North-South tidal channel sand deposit
- Channel width is about 500 to 800m
- Main target reservoir is the McMurray Formation
- Best quality at the base of reservoir (high porosity and  $S_o$ )
- Lower quality near the top of reservoir (bioturbated interbedded shales)
- No extensive bottom water and top gas/water



# Dover Project Well Layout



# Confidential Pilot Data



The following data will be held confidential until June 30, 2004 as per Approval 9045:

**Phase B** – 1986 to June 20, 2001

**Phase E** – 1997 to June 30, 2001

The following data will be held confidential until December 31, 2004 as per Approval 9044:

**Phase D** – 1996 to June 30, 1998

# Outline

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- Introduction
- **SAGD Performance**
- Facilities
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# Overview



- Phase B (3 SAGD pairs, drilled from underground) started in 1993.
- Started Phase D (2 surface-drilled SAGD pairs) in mid-1996. Added new facilities to handle the increased production.
- Started Phase E (1 surface-drilled SAGD pair) in late 1999.
- Produced Water Recycle (PWR) plant started up in 2000. Increased recycle rates have ultimately reduced available boiler feed water for steam generation.

## Overview (cont'd)

- DOVAP Vapex pilot started up in September 2003 (reported separately).
- Commenced operations in mid-November 2003 on Phases F and G (each one a surface-drilled SAGD pair)



# Dover Overall Performance

## 2003 Calendar Year

	Oil Produced (m <sup>3</sup> )	Water Produced (m <sup>3</sup> )	Steam Injected (m <sup>3</sup> cwe)	NCG Injected (e <sup>3</sup> m <sup>3</sup> )	Oil Cut (%)	SOR (m <sup>3</sup> /m <sup>3</sup> )
<b>Phase B</b>	26,644	58,951	30,902	131	31.1	1.16
<b>Phase D</b>	31,936	72,955	92,657	0	30.5	2.90
<b>Phase E</b>	29,951	63,379	77,409	182	32.1	2.58
<b>Phases F &amp; G</b>	98	1200	5430	0	7.6	55
<b>TOTAL</b>	<b>88,629</b>	<b>196,485</b>	<b>206,398</b>	<b>313</b>	<b>31.1</b>	<b>2.33</b>

# Dover Overall Performance

## Sample Original Oil In Place (OOIP) Calculation Dover Phase E OOIP



For the Dover OOIP calculation, the boundaries were determined by :

- 1) Geological Reservoir Boundaries, then;
- 2) Half the distance to the nearest well pair, then;
- 3) Half the distance to the location to which an additional well pair could safely be drilled. For unconfined well pairs, this distance will increase over time. It is Devon's position that in the case where the reservoir is relatively homogeneous, the temperature profile at the sides of the wells will match that at the heel. Where the steam quality is not consistent to the toe of the well, the temperature distribution may be somewhat less.

Boundaries of 50m were assigned for Phase E at the sides and the heel, constrained by the nearest or the nearest prospective well pair. A boundary of 10 m was applied to the toe of the well as it is likely that due to the length of the well (750m) and the size of the completion, 178 mm slotted liner with a 89 mm long tubing, that the steam quality to the toe is reduced.



# Dover Overall Performance

## Sample Original Oil In Place (OOIP) Calculation (Continued) Dover Phase E OOIP

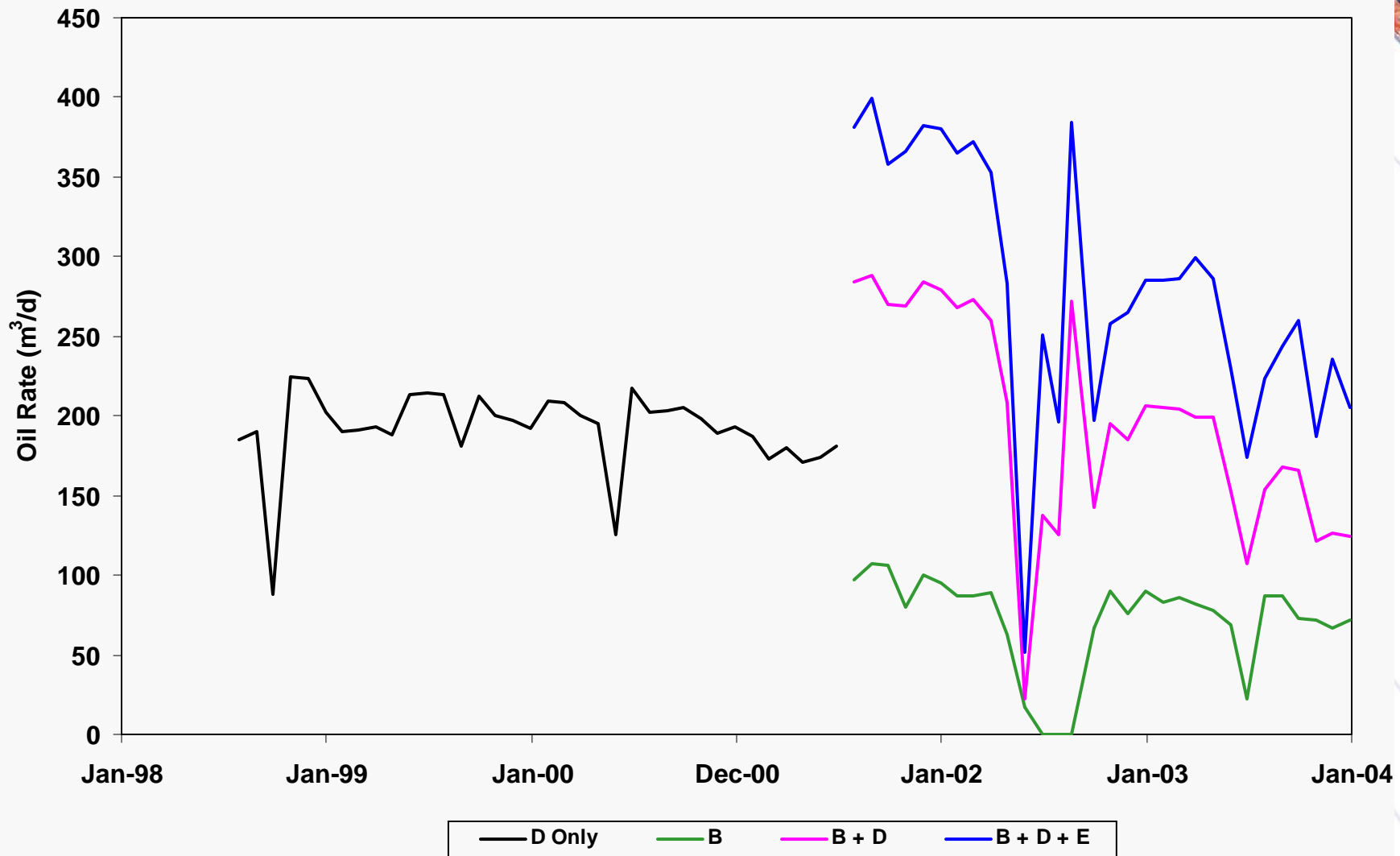
Total Phase E Area:		81 E3m <sup>2</sup>
Avg. Net Pay ETP1& ETP2	25.25 m	
Volume		2045 E3m <sup>3</sup>
Porosity		29%
Original Oil Saturation	85%	
Original Oil in Place		504.2 E3m <sup>3</sup>

This OOIP calculation remains unchanged from the data provided in the January 2003 Progress Review Report to the AEUB.

Interpretation of production from the IHS at Dover for Phases B, D, E, F & G has also remained unchanged from the data provided to the AEUB in 2003.

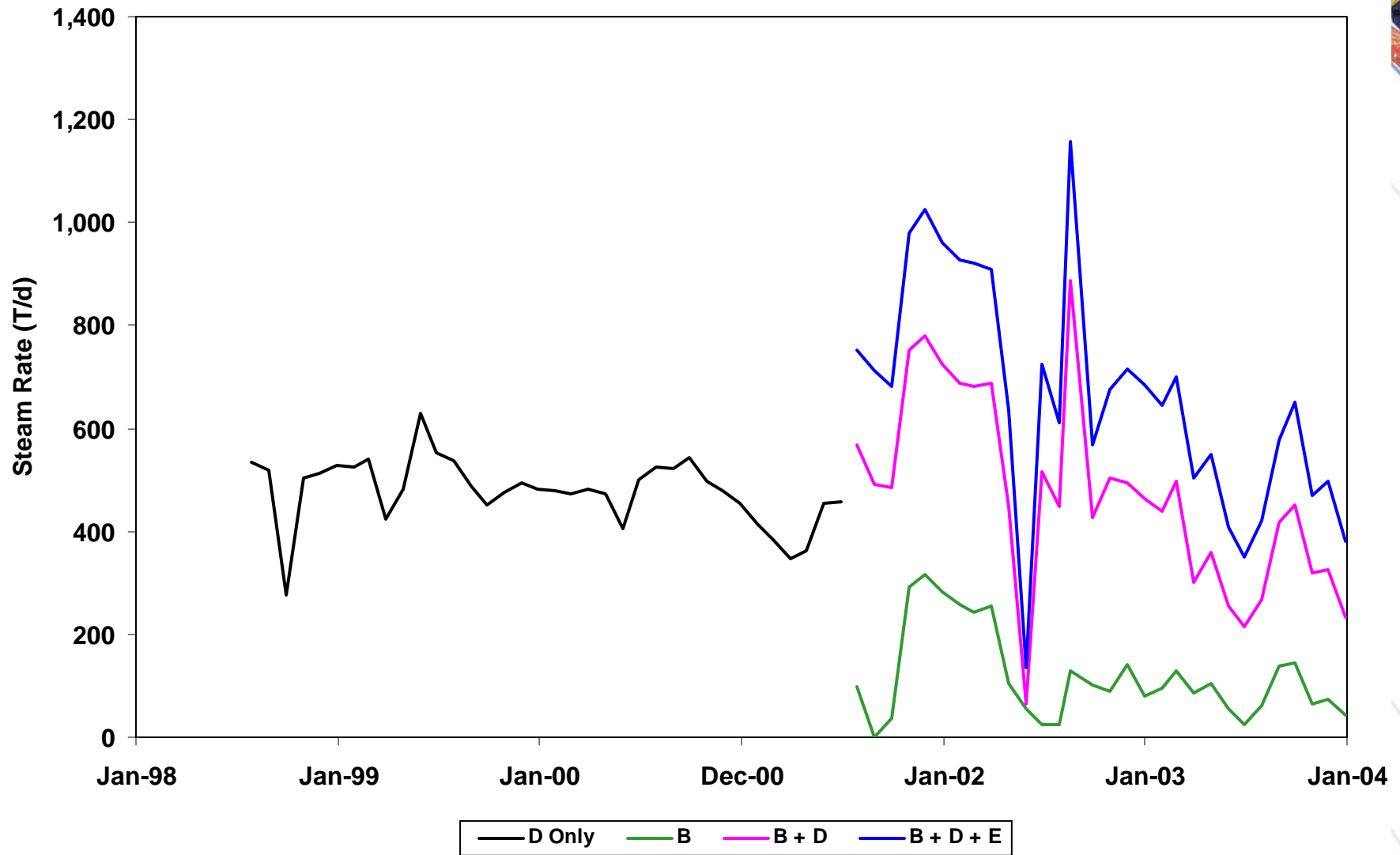


# Dover Site Production





# Dover Site Steam Injection



# Phase B Performance



- Late cycle performance has been better than anticipated due to:
  - bitumen recovery from the IHS zone
  - communication with Phase E steam chamber, early 2001
  - injection of non-condensable gas (NCG)
- Methane injection ceased in late Feb/03 due to high gas costs.

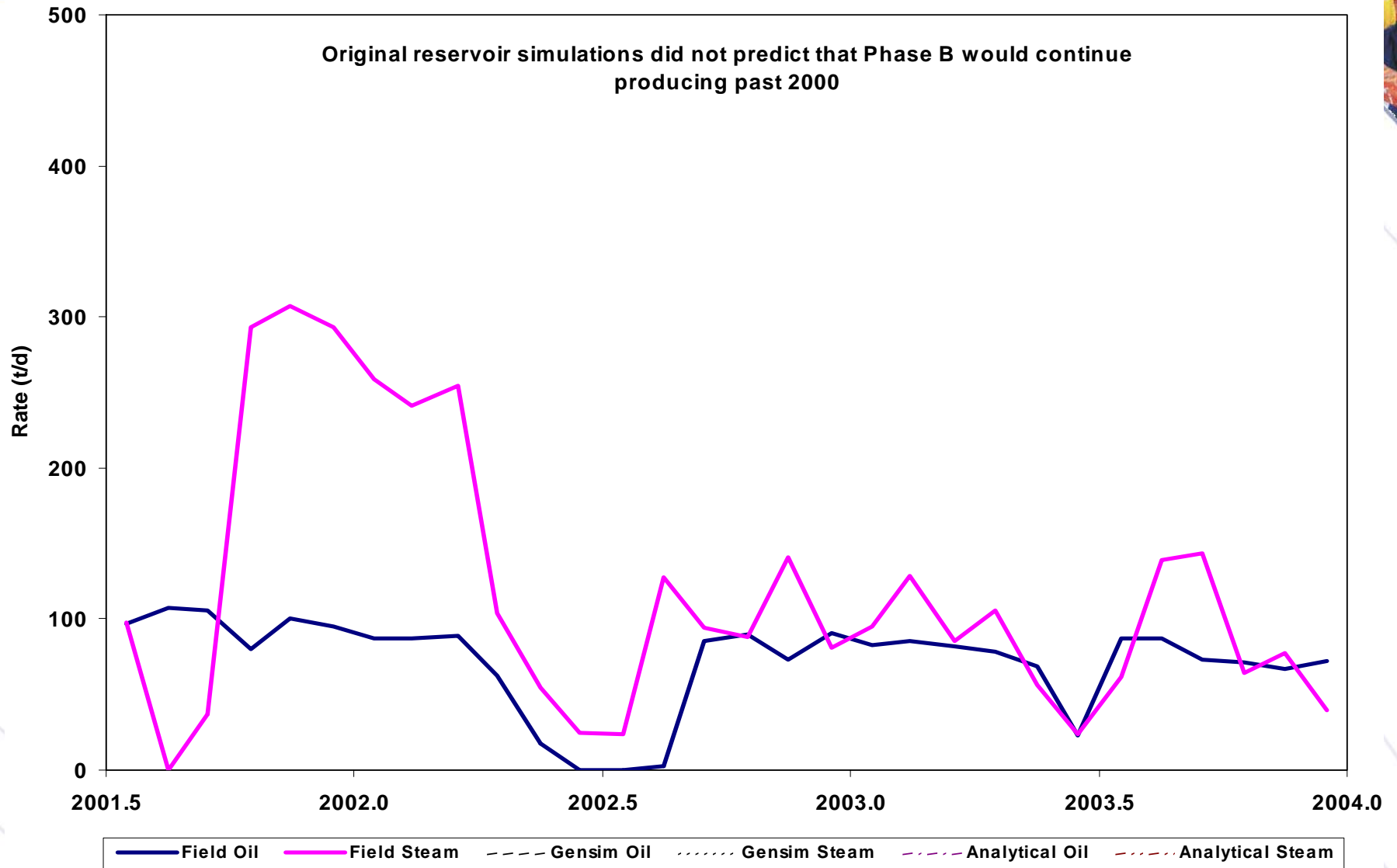
## Phase B Performance (cont'd)



- Current oil production of approximately 70 m<sup>3</sup>/d bitumen with SOR of 1.2. Target steam injection rates were not attained due to produced water recycle plant complications.
- Expect to shut-in Phase B production mid 2004. Periodic steam injection to maintain chamber pressure is anticipated.

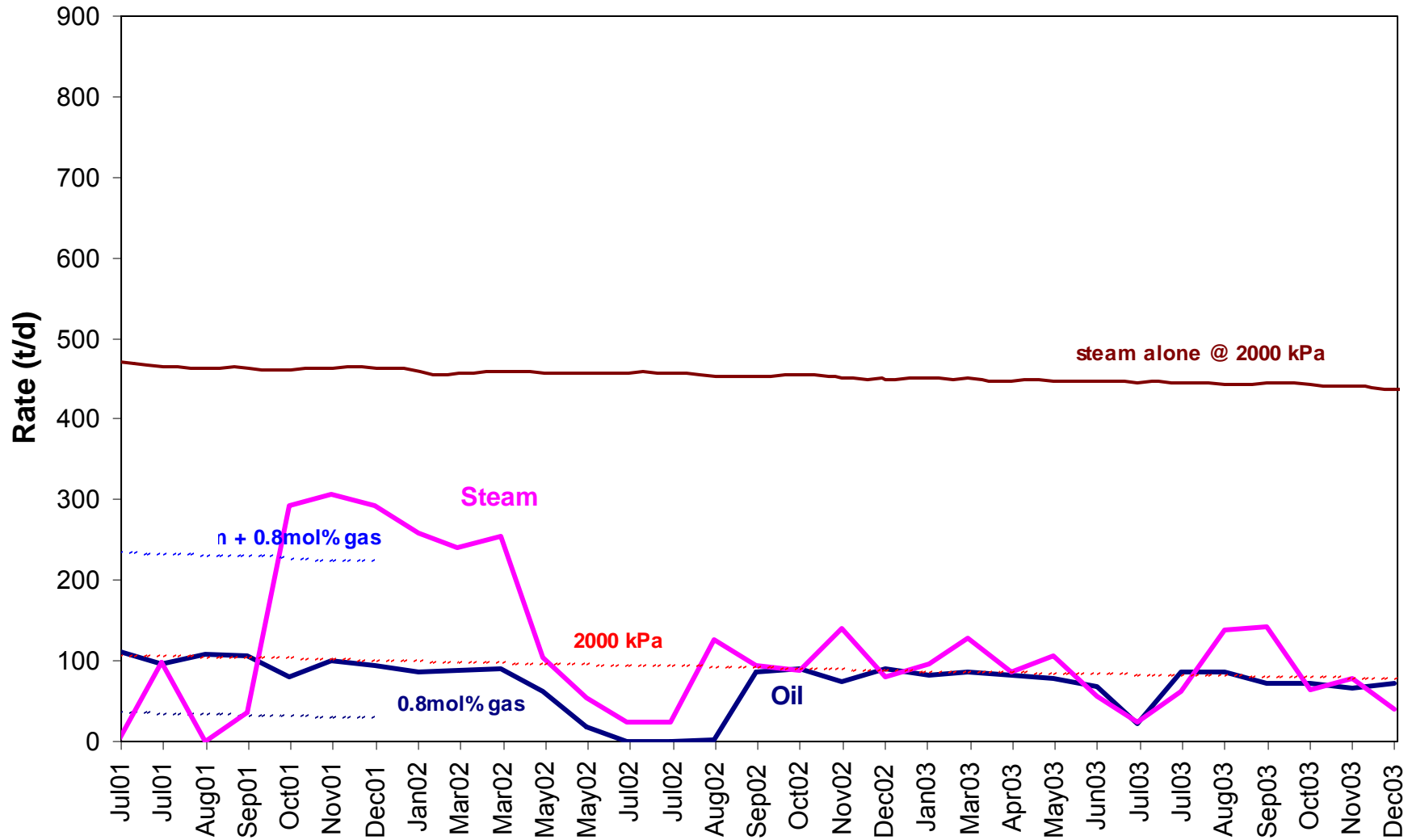


# Phase B Performance



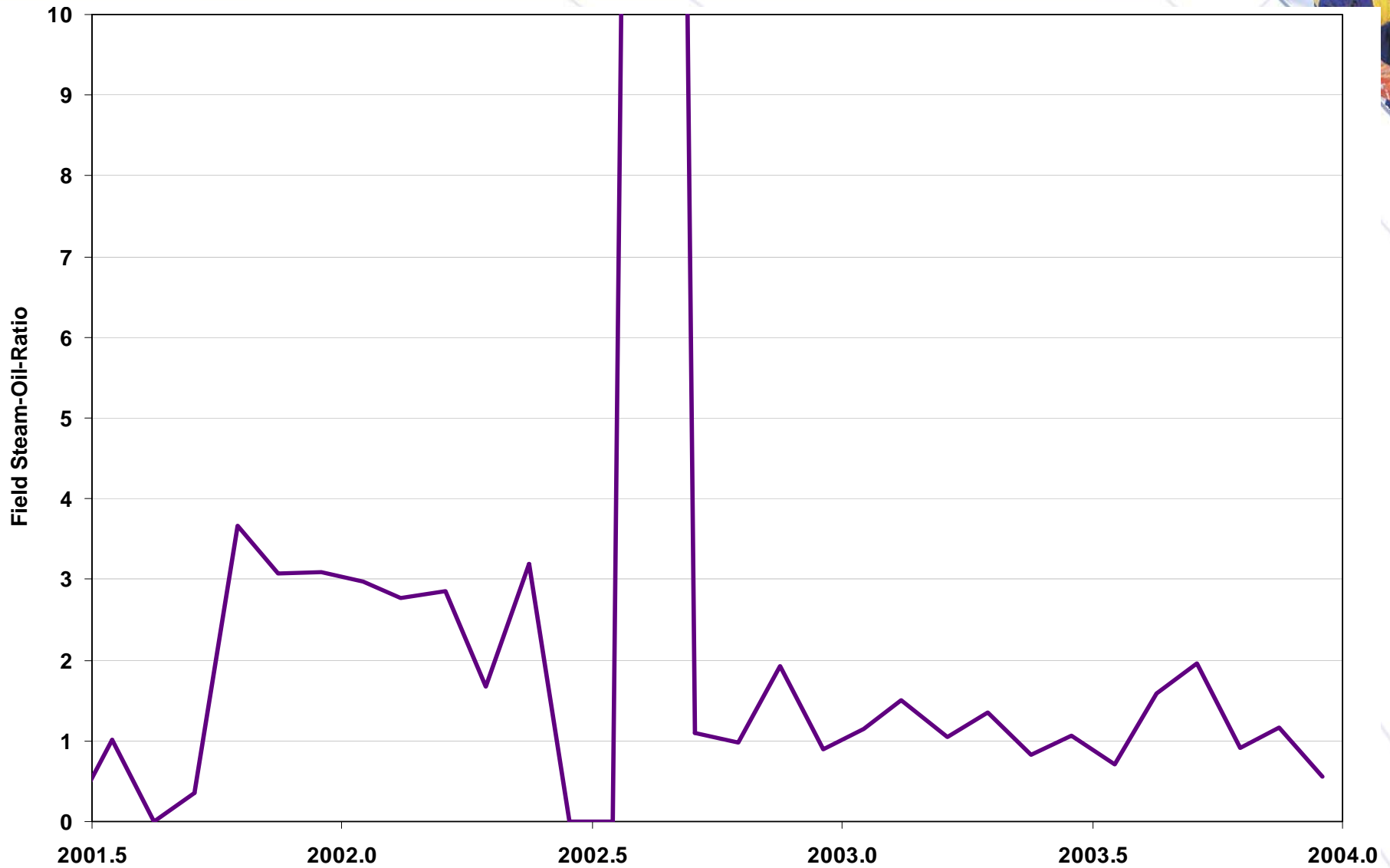
# Phase B Performance Forecast

for 0.8 mole % of gas injection with steam and steam alone cases





# Phase B Steam-Oil Ratio



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# Phase D Performance



- Overall Phase D performance is being hurt due to decreased steam chamber pressure.
- D1 performance per completed meter is significantly better than D2
  - larger liner diameter in D1
  - poorer pay quality at D2 toe, essentially unconfined well pair



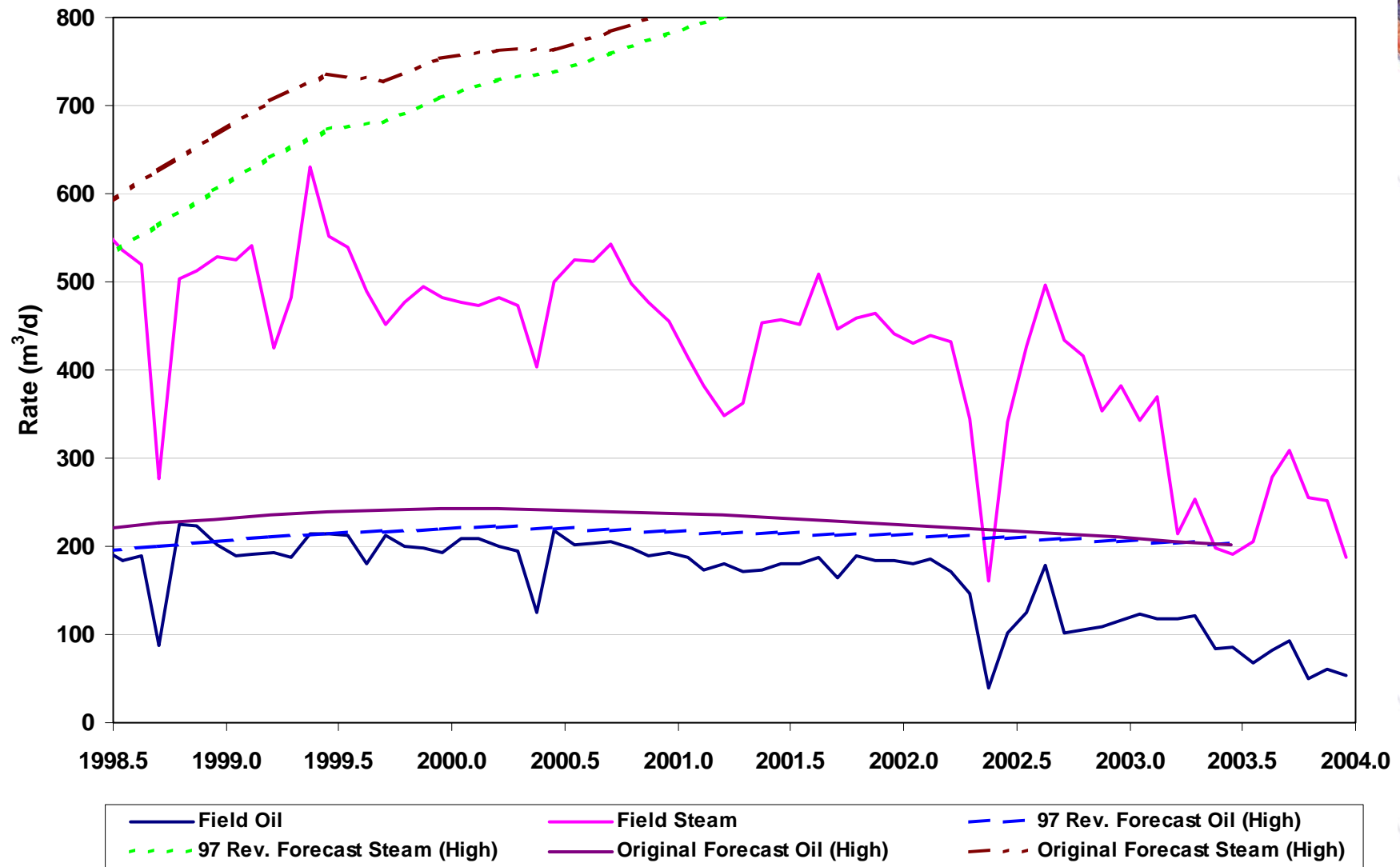
# Phase D Performance

	Liner Length (m)	Liner OD (mm)	Cum Oil* (m <sup>3</sup> )	Cum SOR	2003 Oil (m <sup>3</sup> /d)	2003 SOR
D1I	186	219				
D1P	293	219	140,440	2.58	46	3.0
D2I	748	178				
D2P	740	178	182,600	2.63	42	2.8

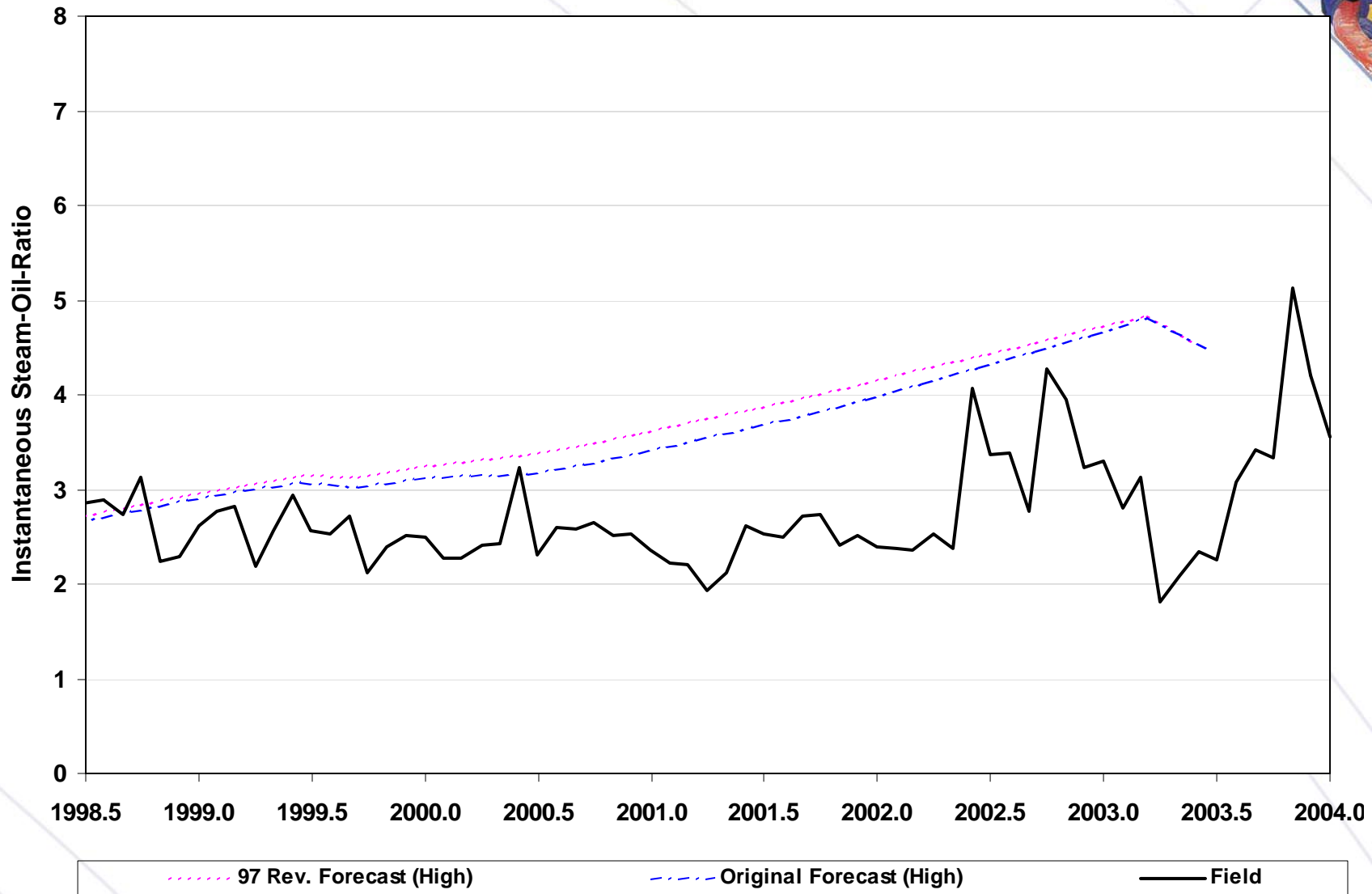
\* Cumulative as of July 1, 1998



# Phase D Performance



# Phase D Steam-Oil-Ratio



# Phase E Performance



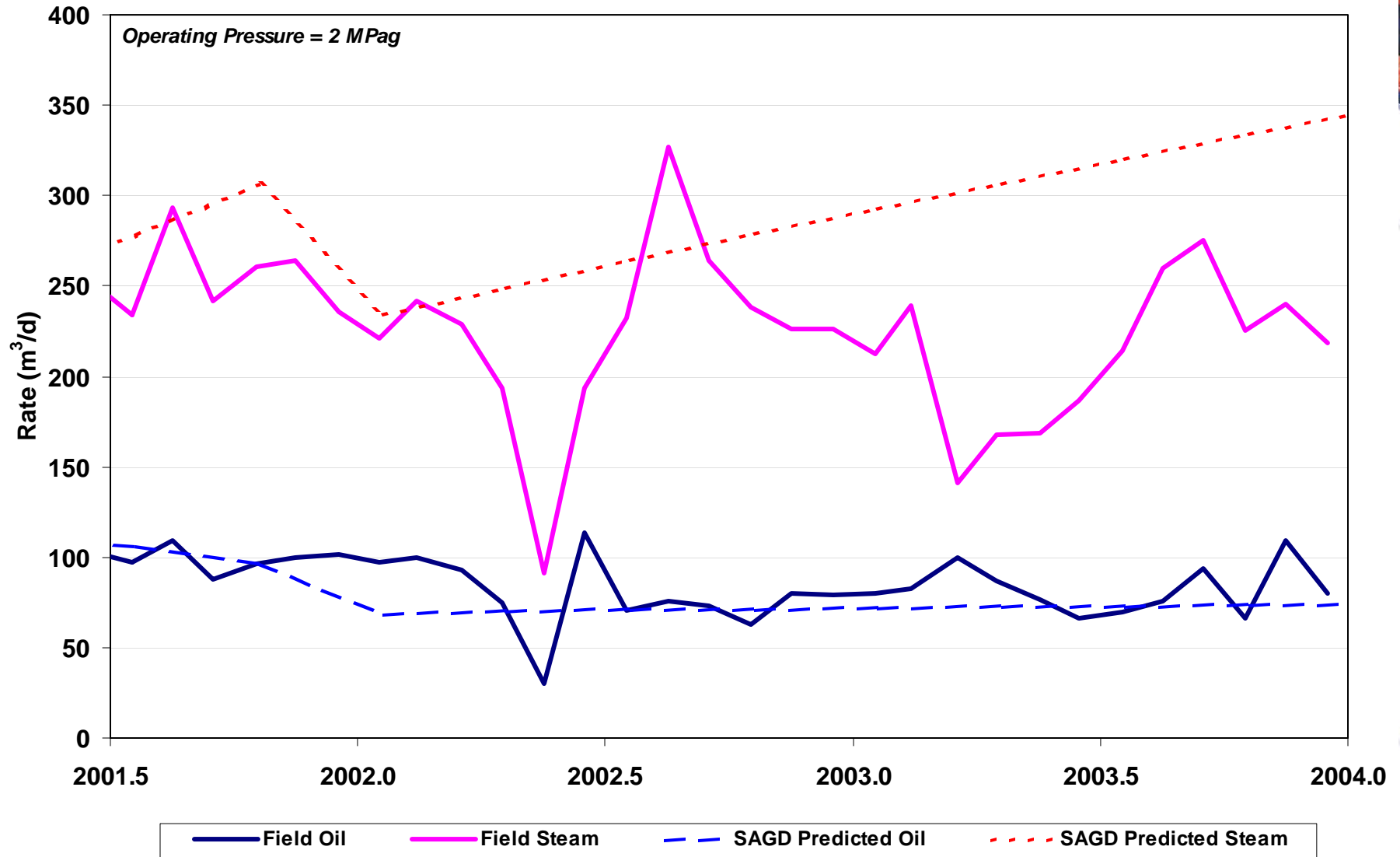
- Wells started up in 1999 with SAGP
  - Approximately 0.2 mole% methane injected
  - Performance enhanced in early life during vertical rise of steam chamber
- Oil production was flat in 2002 and 2003 at approximately 80 m<sup>3</sup>/d.
- Phase E and B steam chambers believed to be in communication since early 2001. SOR in 2003 was lower than target due to produced water recycle complications.

## Phase E Performance (cont'd)

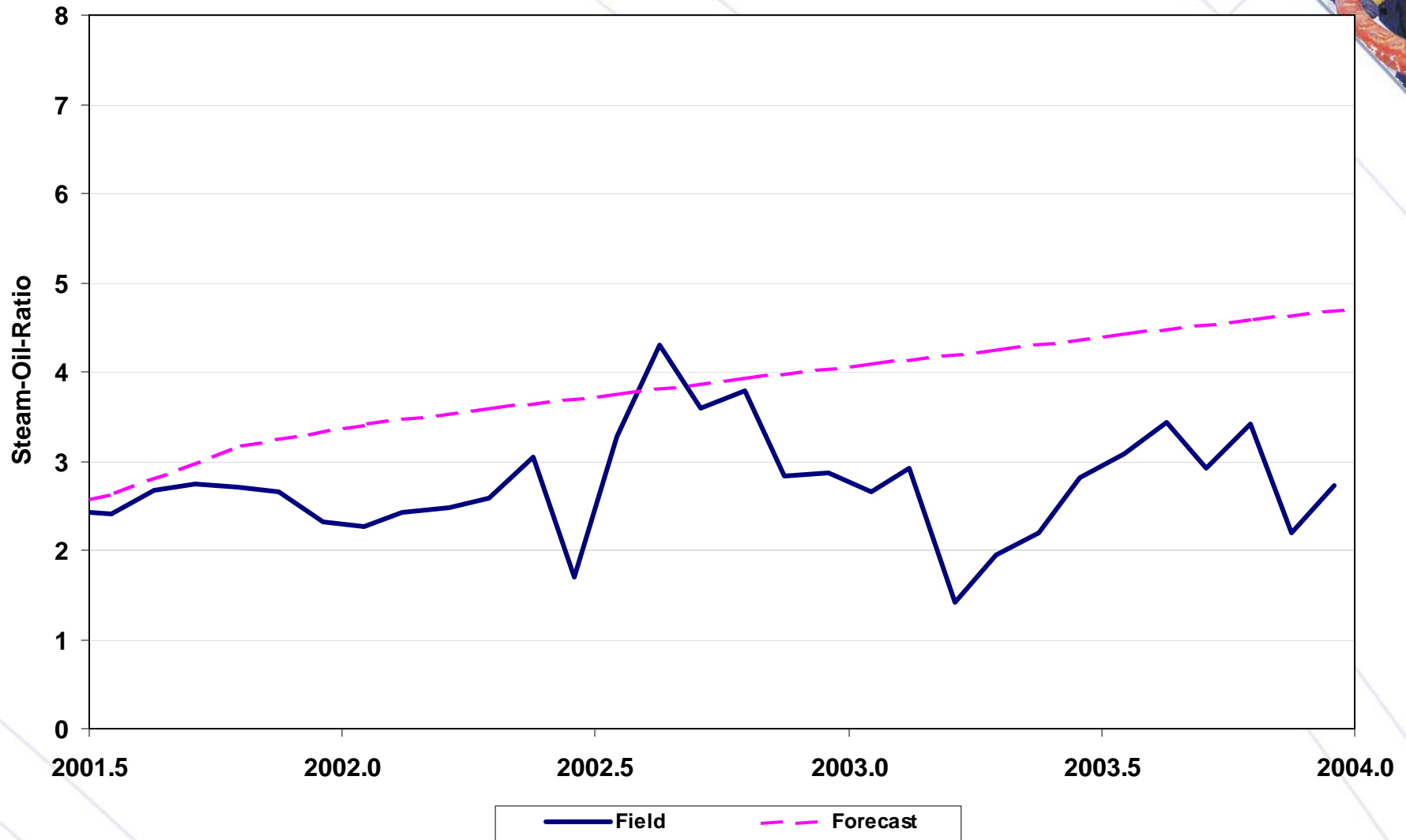


- Overall performance may be restricted by 178mm injection liner.
- Initially drilled proximal to Phase B in order to observe new chamber development next to a mature steam chamber. Overall recovery is expected to be negatively impacted.
- Lower steam chamber pressure does not appear to have severely impacted performance. Well may be benefiting from non-condensable gas injected into Phases E and B.

# Phase E Performance



# Phase E Steam-Oil-Ratio



## Phases F & G



- Each phase consists of a 750m horizontal well pair.
- Injectors completed with 219mm slotted liners.
- Producers completed with 178mm slotted liners.
- Performance with larger injection wells to be compared to E1 and D2 well pairs (750m horizontal wells with 178mm injection and production liners).
- Initial circulation commenced in November 2003.

# Outline

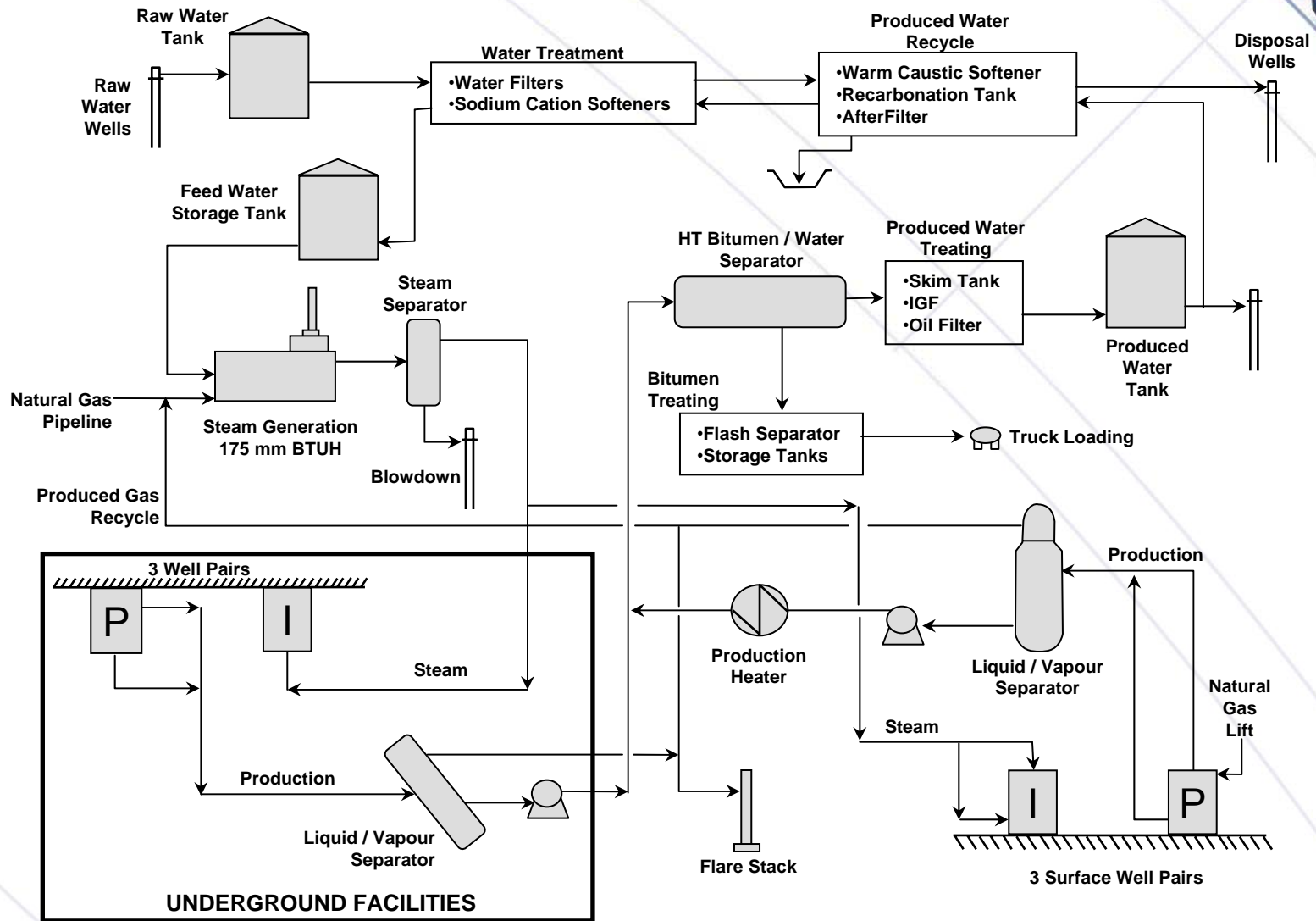
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- Introduction
- SAGD Performance
- **Facilities**
- Regulatory
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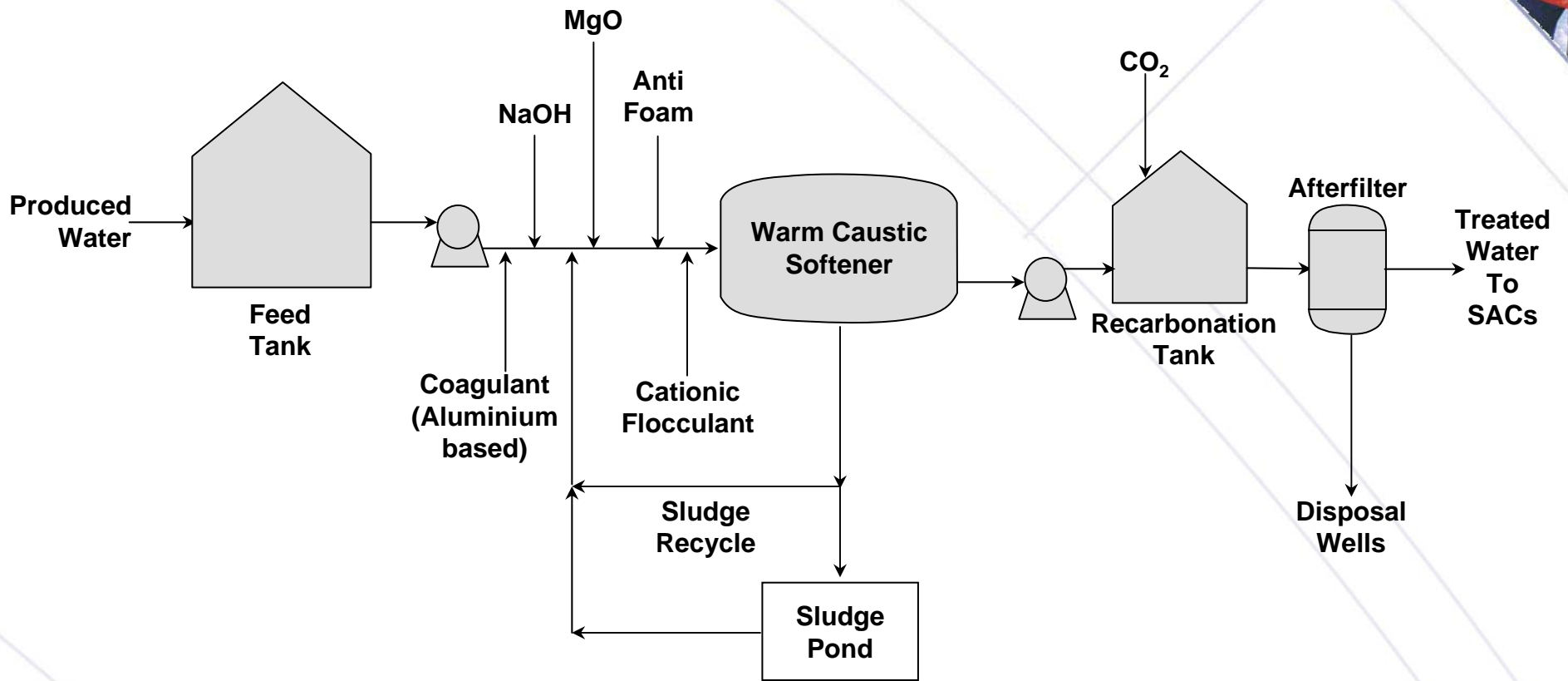


# Dover SAGD Process Schematic





# Dover PWR Process Schematic



# Facilities

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- Significant improvements in produced water recycle (PWR) rates through Warm Caustic Softener process in late 2002 and into 2003.
- All produced water is processed through PWR for silica removal and added filtration.
- Average water recycle rate in 2003 was 29% based on EUB formula:

$$\text{Recycle \%} = \frac{(\text{Steam Injected} - \text{Raw Water})}{\text{Produced Water}} \times 100$$

## Facilities (cont'd)

- Theoretical maximum with existing equipment is about 65%.
- Fresh water use has dropped by almost  $\frac{2}{3}$  from pre-PWR operations
- Increased produced water recycle volumes have caused a reduction in overall available boiler feed water due to incompatibility of recycled water and raw water when combined upstream at softeners.

## Facilities (cont'd)



- Recycle limited due to:
  - Inability to recycle blowdown water (high TDS)
  - High TDS fouling of SAC resin in boiler feed water conditioning
  - Insufficient disposal well capacity for regen water
- Experiments with anionic flocculants to increase performance in 2003 were unsuccessful.
- Re-carbonation of water to prevent SAC fouling in 2003 was unsuccessful. Discontinued in 2004.

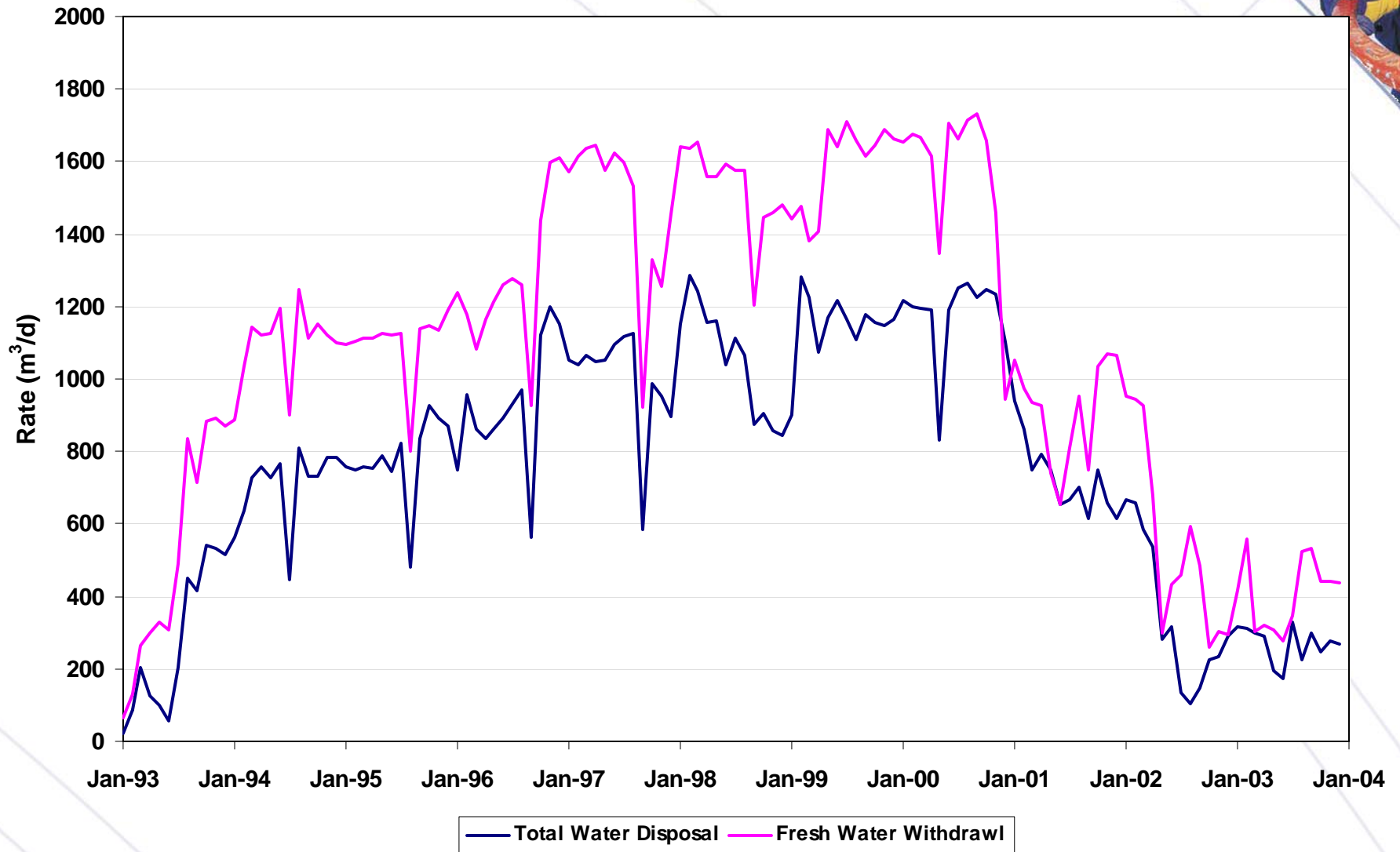


# Dover Source and Disposal Water

	<b>SOURCE Water (m<sup>3</sup>)</b>	<b>DISPOSAL Water (m<sup>3</sup>)</b>	<b><u>m<sup>3</sup> Source Water</u> m<sup>3</sup> Oil Produced</b>
<b>1999</b>	578,700	418,800	4.03
<b>2000</b>	574,000	449,500	3.72
<b>2001</b>	333,300	265,900	2.41
<b>2002</b>	200,800	126,200	2.07
<b>2003</b>	148,900	98,000	1.68

# Dover Water Disposal & Fresh Water Withdrawal

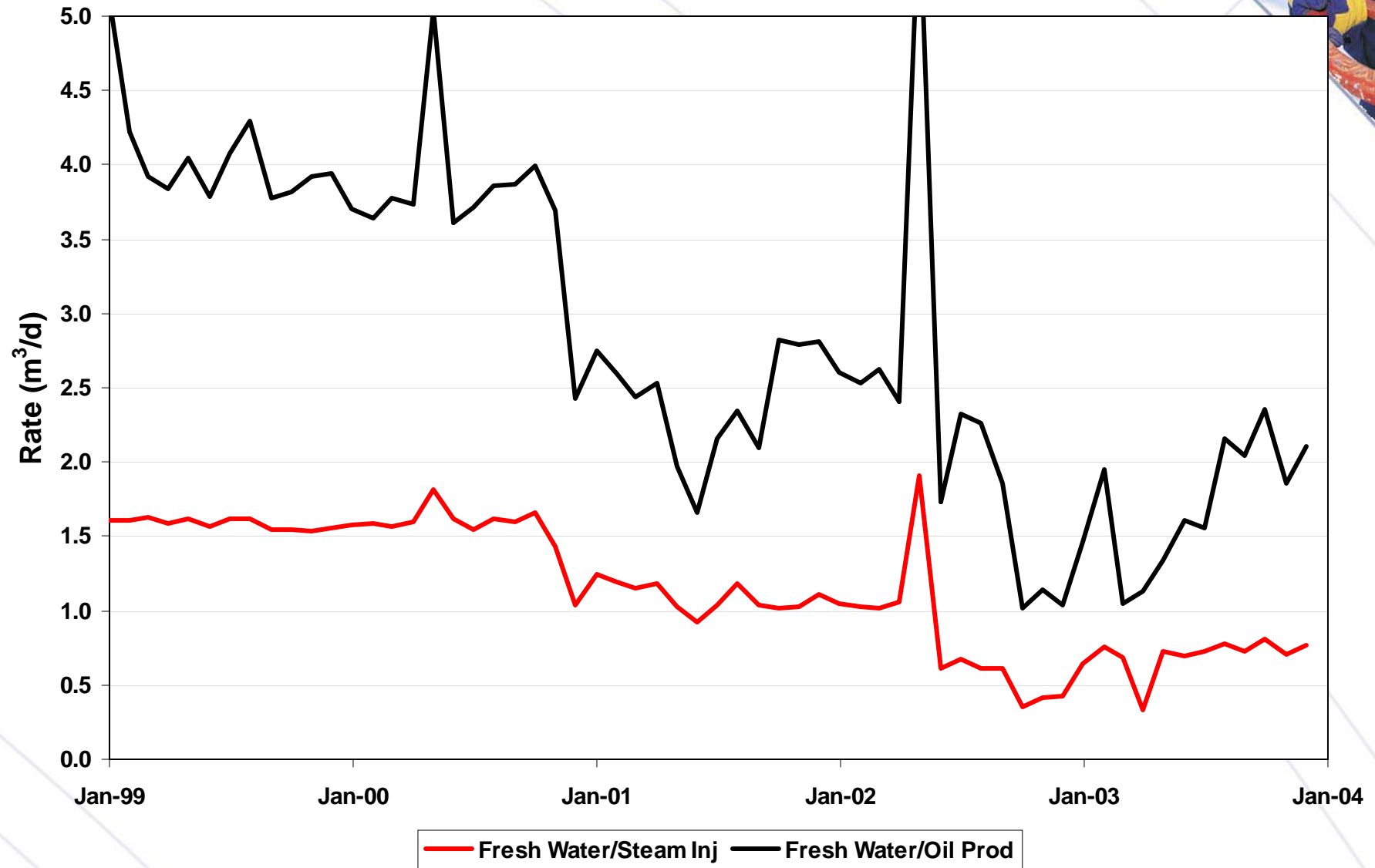
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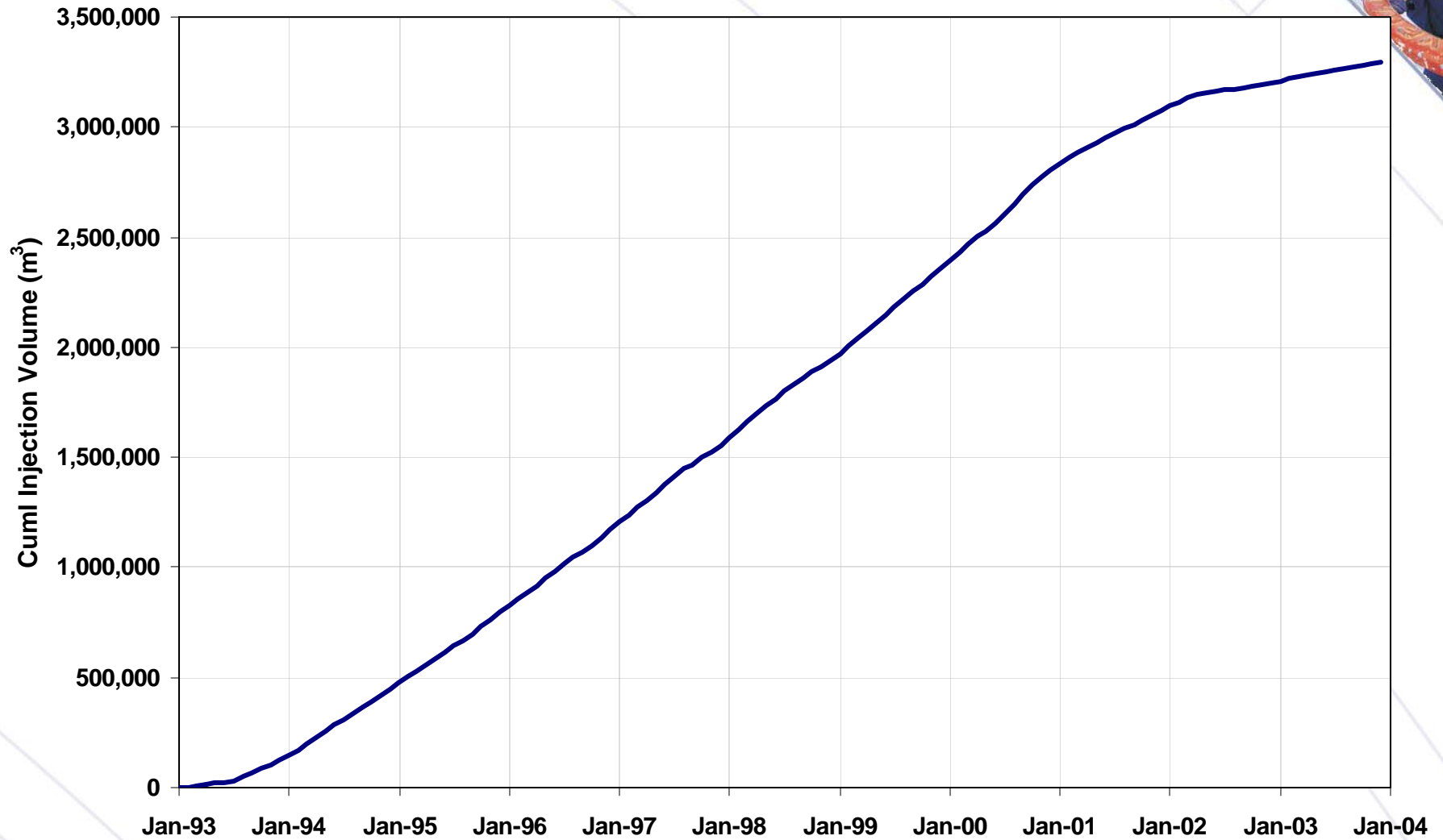


# Dover Fresh Water Use



# Cumulative Water Disposal into Wabiskaw

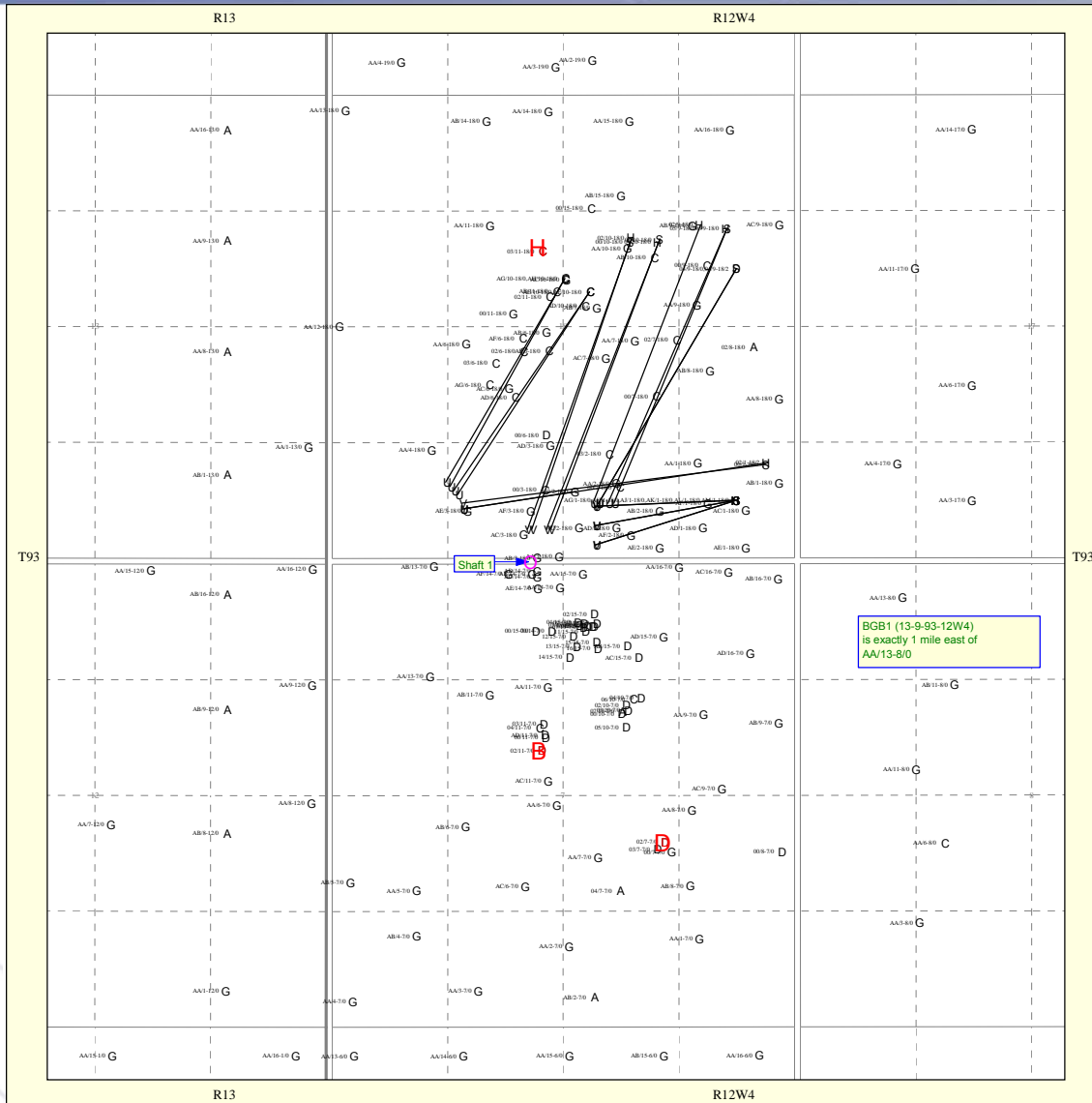
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# Wabiskaw Monitoring Program

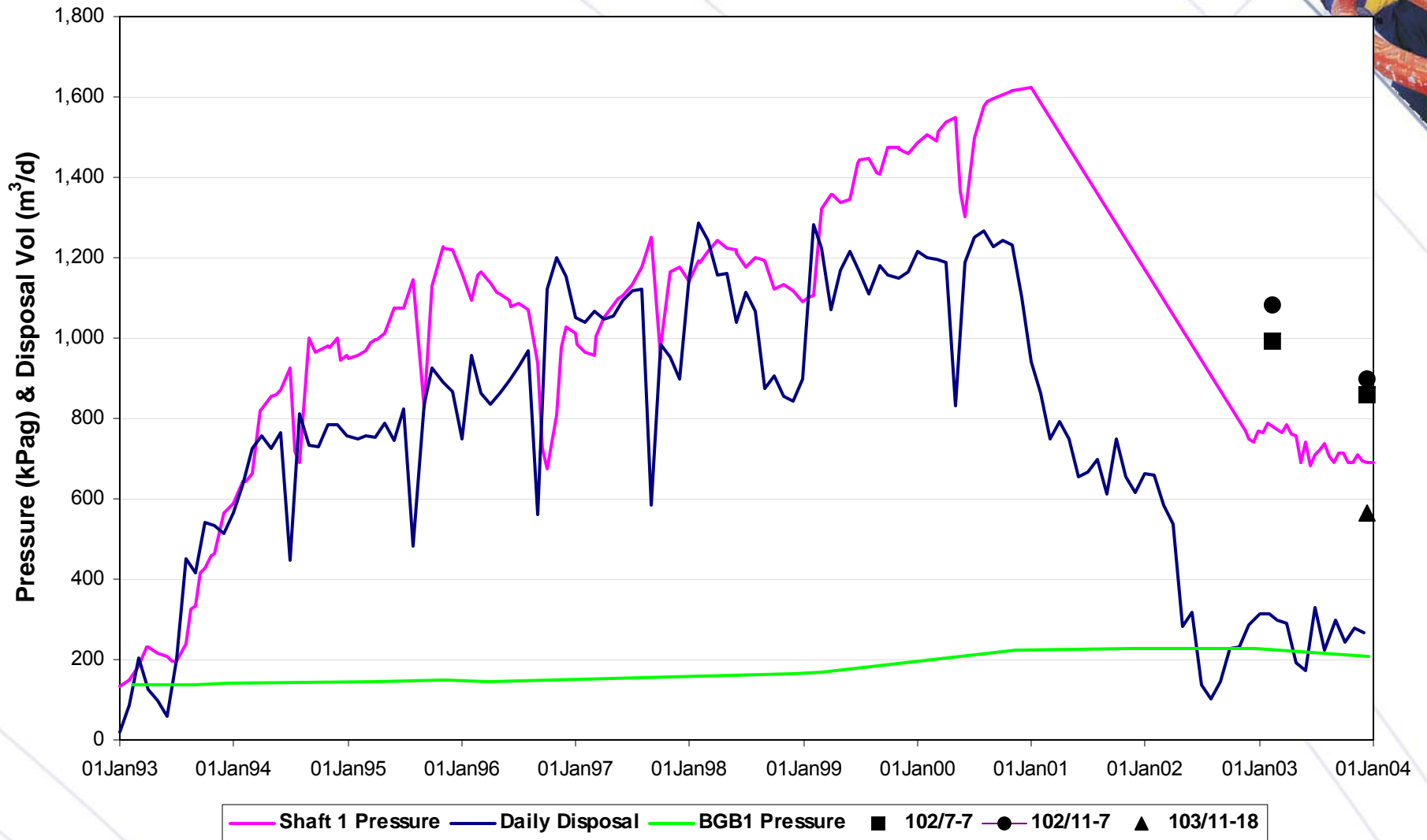
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# Wabiskaw Pressure & Disposal Volume

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# Outline

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- Introduction
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# Approvals




Approval	Expiry	Purpose
6809	31Dec1994	Construct Phase B
6809A	31Dec1997	Extend expiry to 31Jul99
6809B	31Dec1997	Add Phase D & facilities
6809C	31Dec1997	Add Phase E & PWR
6809D	31Dec1997	Inject NCG into Phase B
6809E	30Jun1998	Interim extension
6809F	30Jun2001	Continue piloting - rescinded
9044	30Jun2007	Commercial operating - experimental status removed
9044	30Jun2007	Add 3 SAGD well pairs (Phases F, G & H)
9045	30Jun2004	Confidential status of Phase B & E data to be removed 30Jun2004
9046	30Jun2005	Add 2 Vapex well pairs and facilities (DOVAP)

# Approvals

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Approval	Expiry	Purpose
6865	Rescinded	Water disposal into Wabiskaw
9139	30Jun2007	Water disposal into Wabiskaw, Wells WDW 22, 24 & 25 added in 2003
9139	Amendment sent, pending EUB response	Add one disposal well WDW 26

# Dover Regulatory Alberta Environment Reporting

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- Dover AEPEA Approval No. 705-01-00
- Dover AEPEA Approval No. 705-01-01
- Air Emissions Reports filed monthly
  - Licensed maximums never exceeded
- Annual reporting for:
  - Air emissions
  - Ground water monitoring – expanded in 2003 to include annual water sampling and pressure monitoring of the Wabiskaw
  - Industrial waste water and run-off

# Dover Regulatory

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- Devon Canada Corporation has, to the best of its knowledge, been compliant with all applicable regulations and approvals pertaining to the Dover SAGD Pilot in 2003.

# Outline

- Introduction
- SAGD Performance
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- **Future Plans**

## Dover Plans – Phase B



- Continue wind down of mature steam chamber
- Continue to monitor recovery in lower quality reservoir regions
- Continue to study impacts of NCG injection in SAGD behavior
- Probable termination of continuous production in mid 2004, followed by intermittent steam injection to maintain chamber pressure

## Dover Plans – Phases D&E

- Continue to study merging of existing steam chambers
- Continue to study impacts of NCG injection on SAGD behavior

# Dover Plans – Phases F&G

- Convert to SAGD production mode in early 2004
- Study performance of the larger injection liners relative to wells D2 and E1

## Dover Plans – Other



- Commence abandonment of Phases A & C observation wells and some suspended water disposal wells.
- Drill one additional water disposal well
- Install a separate water softening train for raw water to increase total available boiler feed water
- Optimize operation of the warm caustic softener
- No new well development planned in 2004

## Dover Plans – Other

- Temporary water diversion permit will expire on Dec. 31, 2004. New application to be submitted.