



Petro-Canada MacKay River Performance Presentation Approval No. 8668

October 27, 2006

Agenda



Introduction

Plant Performance

Geology Overview

SAGD Performance

Regulatory Compliance

Future Plans

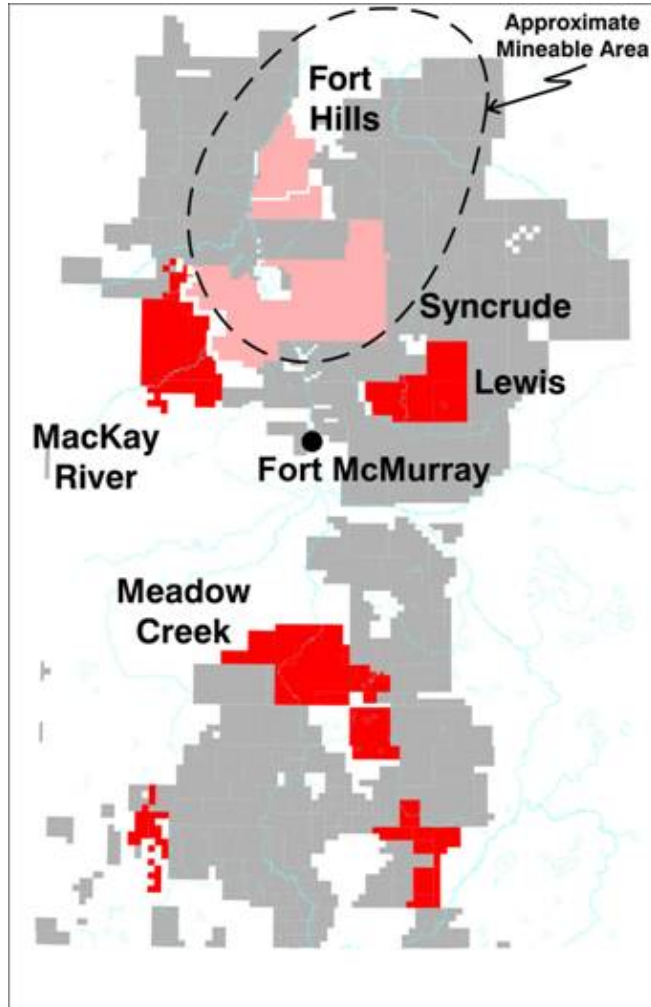


Introduction and Plant Performance

Nathan Kupsch
Asset Team Leader



Petro-Canada's land position



- Active in both *InSitu* and surface mining
 - WI Owner in Syncrude
 - Operator of Fort Hills
- Current *InSitu* operations at MacKay River and Dover
- Further opportunities at:
 - MacKay River / Dover
 - Lewis
 - Meadow Creek
 - Others

MacKay River



- **Petro - Canada's first operated SAGD facility**
- **Located 60 km NW of Ft. McMurray**
- **Adjacent to Petro Canada Dover (UTF / AOSTRA) project**
- **Target reservoir is the McMurray formation at a depth of 80 - 135 m from surface**
- **No extensive underlying water or gas over bitumen issues**
- **First steam September 2002**
- **First production November 2002**
- **Phase 2 (Pad 22) first steam January 2006**

Principle Development Area



Amended Principal Development Area (PDA) is portions of 11 Sections

Two amendments during 2005

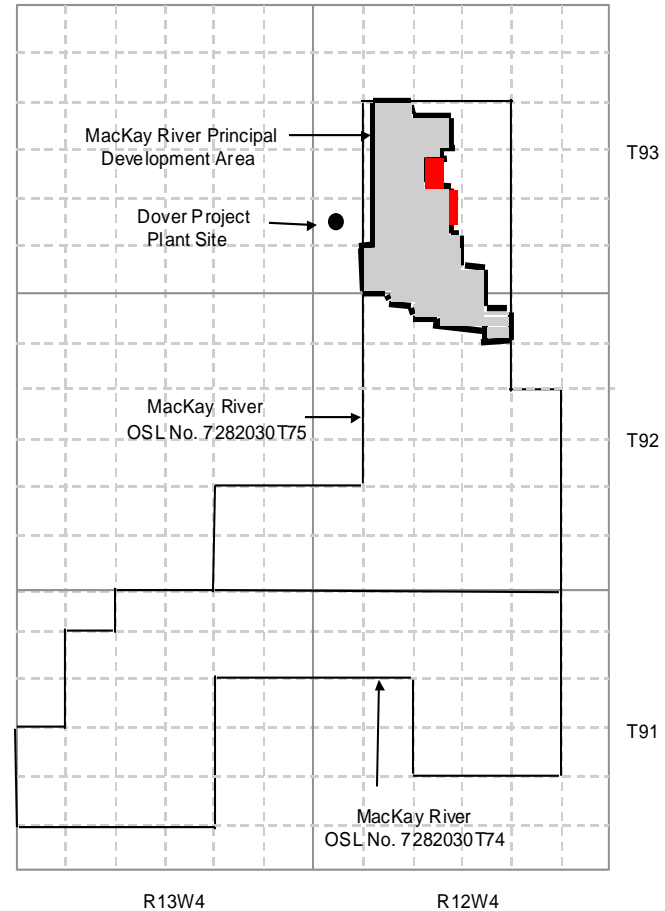
- **Section 16 Pilot area**
- **“E” Pattern toe extensions**

P90 OBIP: ~ 350 MM bbls (56 MM m³)

Rate: 33,000 bpd (5250 m³/d)

25 year field life:

- ~ 27 sub-surface patterns
- ~ 24 pads
- ~ 145 well pairs

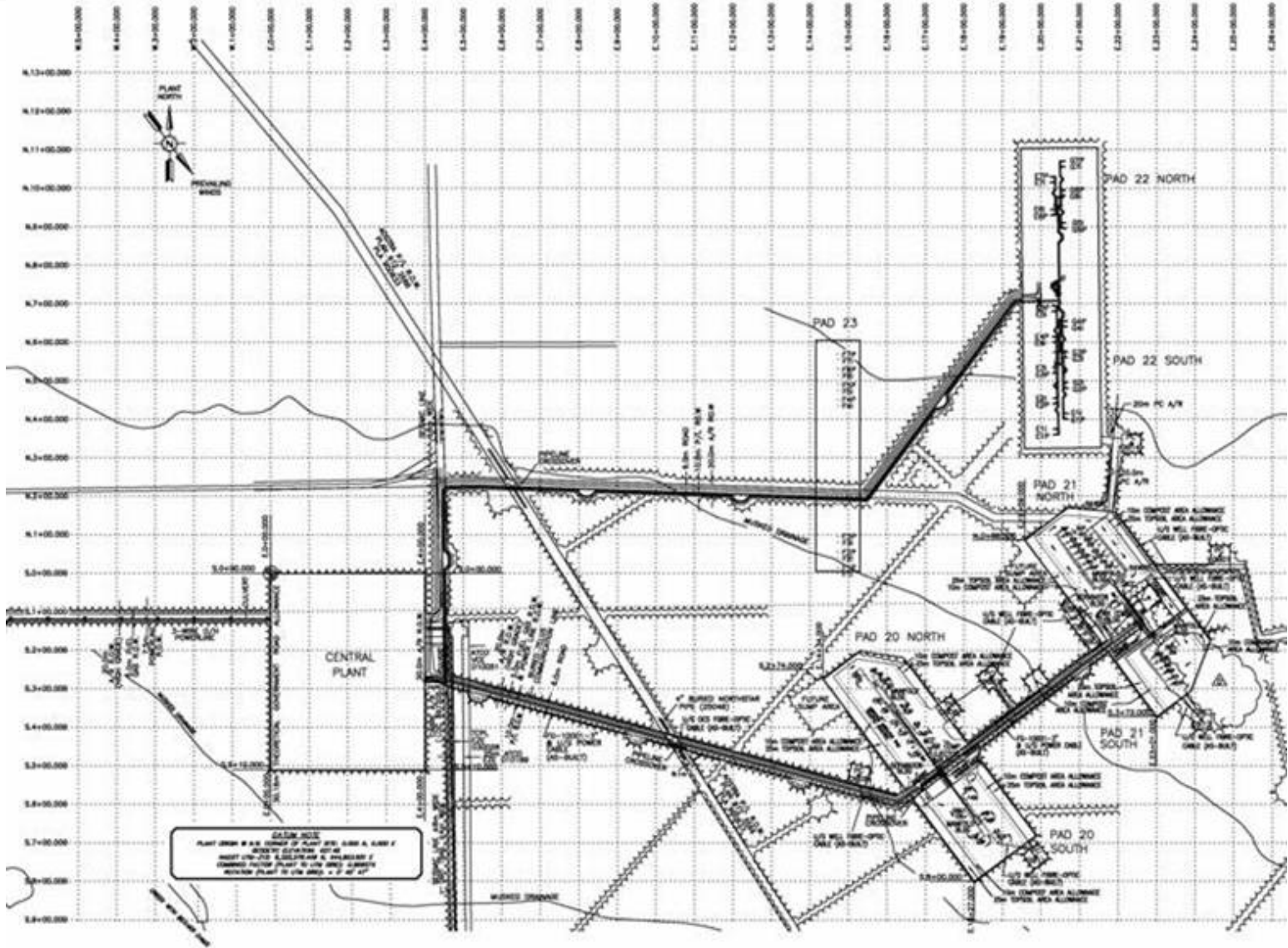


Original Project Design



- initial 25 well pairs in 2002, 16 additional in 2005/06
- 13 000 m³/d water treatment
- initial four 215 MM BTU/hr steam generators
- 9,500 t/day steam generation @ 80% quality
- zero liquid discharge system for water treatment
- High temperature/flash treating system for bitumen treating
- 16 000 m³ bitumen / 3200 m³ diluent tankage (3rd party)
- 50 km insulated bitumen export pipeline (3rd party)
- 165 MW co-gen (3rd party)

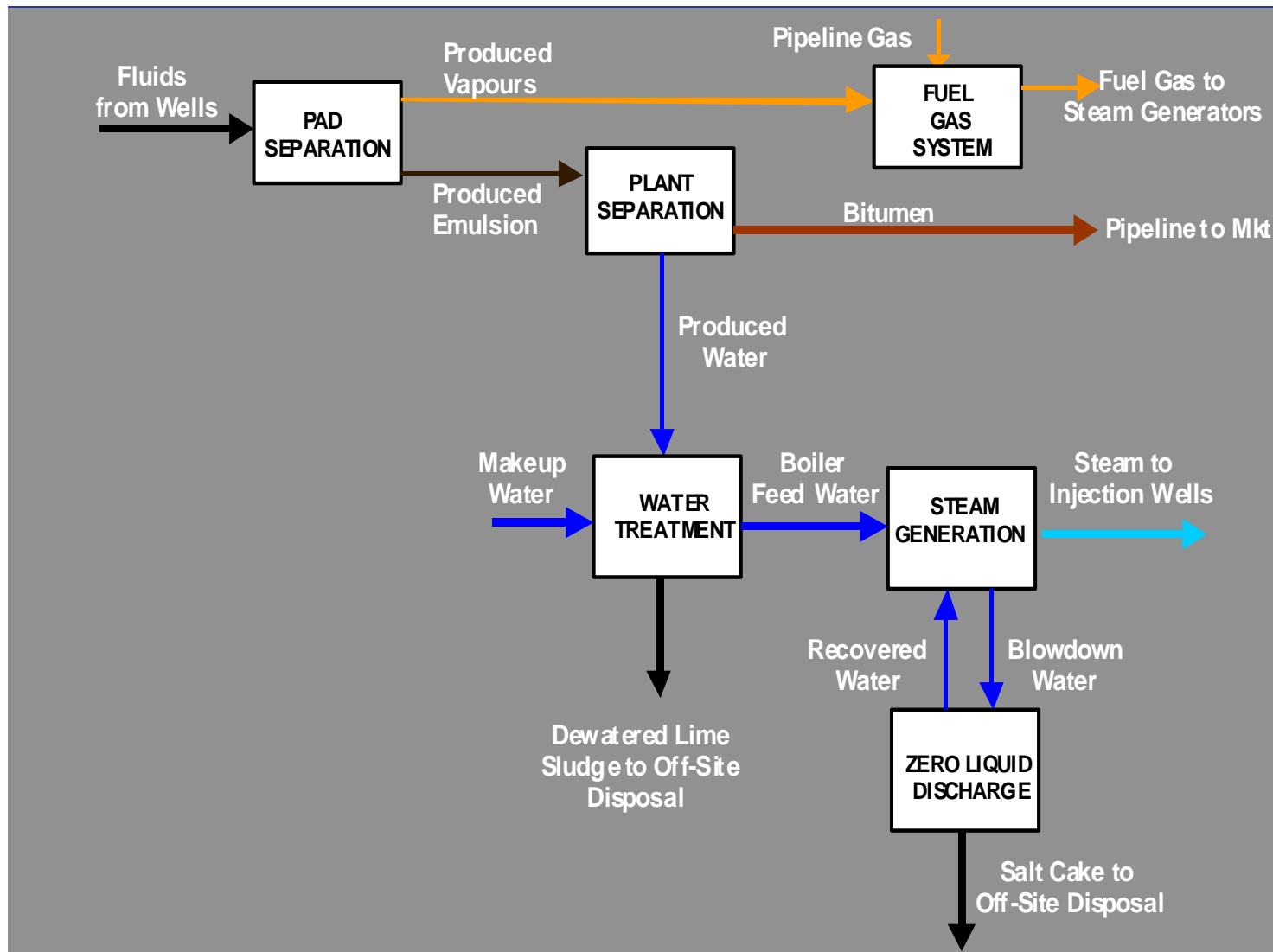
Site Plot Plan



MacKay River Plant



Simplified Process Flow



MacKay River Plant



New Equipment

- **Upgraded Zero Liquid Discharge system**
 - Ready for service early 2007
 - Includes additional evaporator and dryer systems
- **Additional bitumen cooler**
- **Upgraded steam separator system**

Major plant unavailability

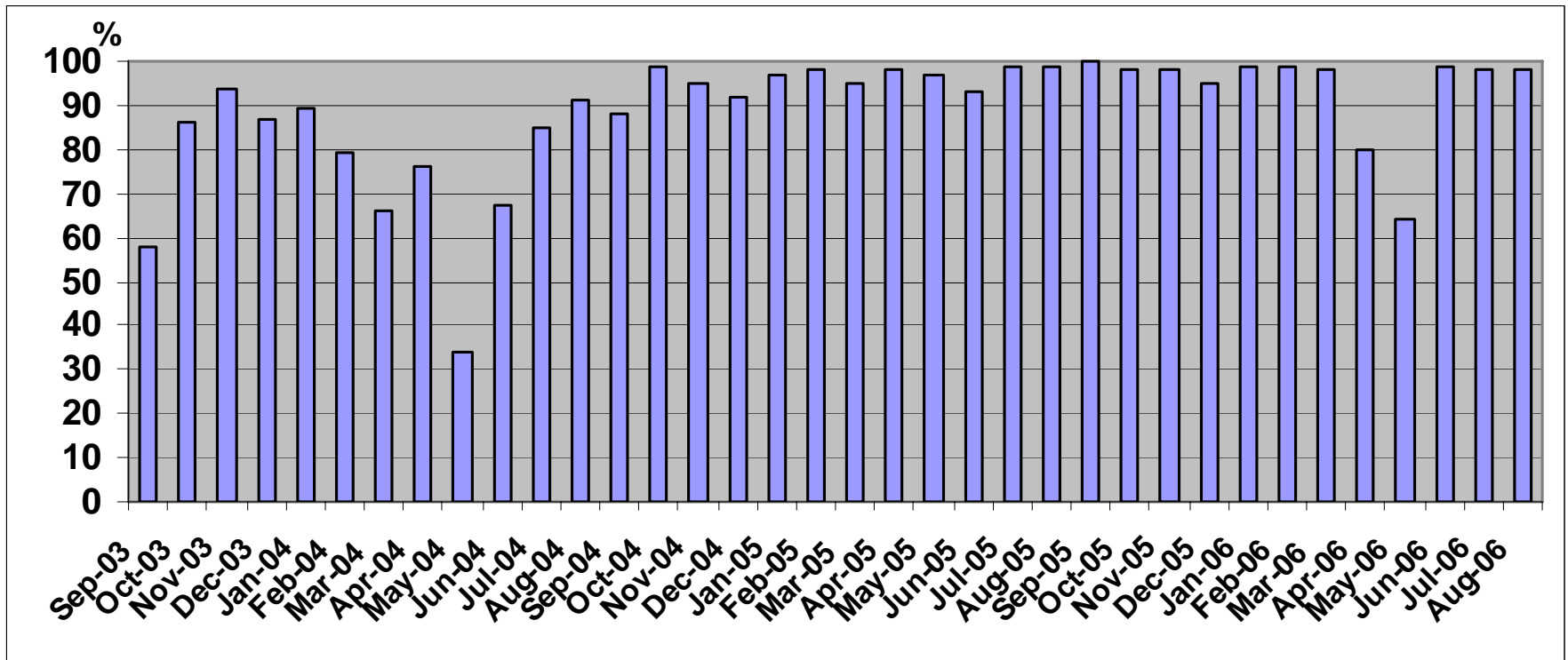
- **October 2005 – shut down one day for Substation maintenance**
- **Warm Lime Softener gearbox failure / cogen maintenance in April/May 2006 (12 days total)**

Reliability



The facility has continued to demonstrate high overall levels of reliability.

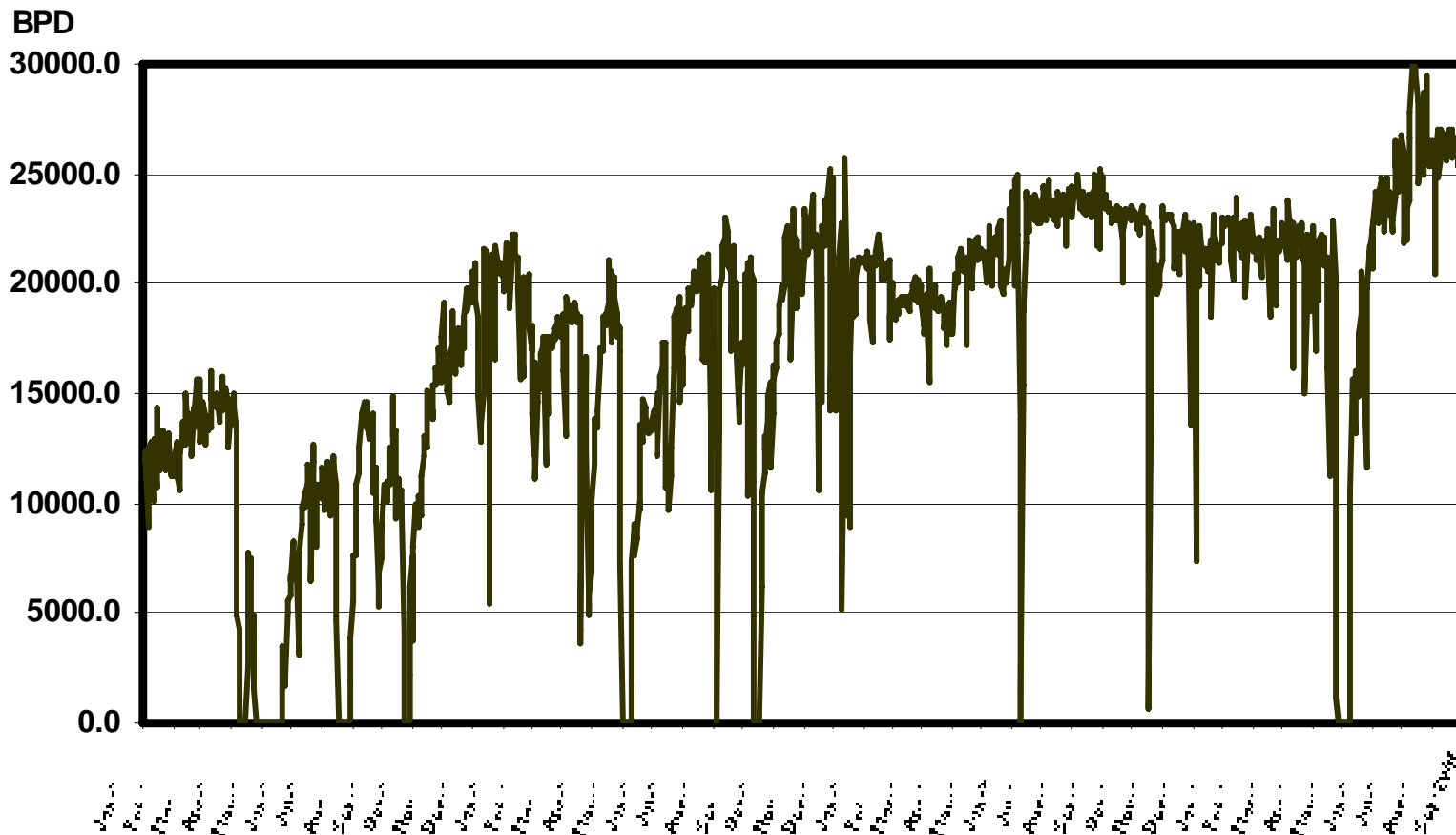
- Operations training and competency
- Engineered reliability controls



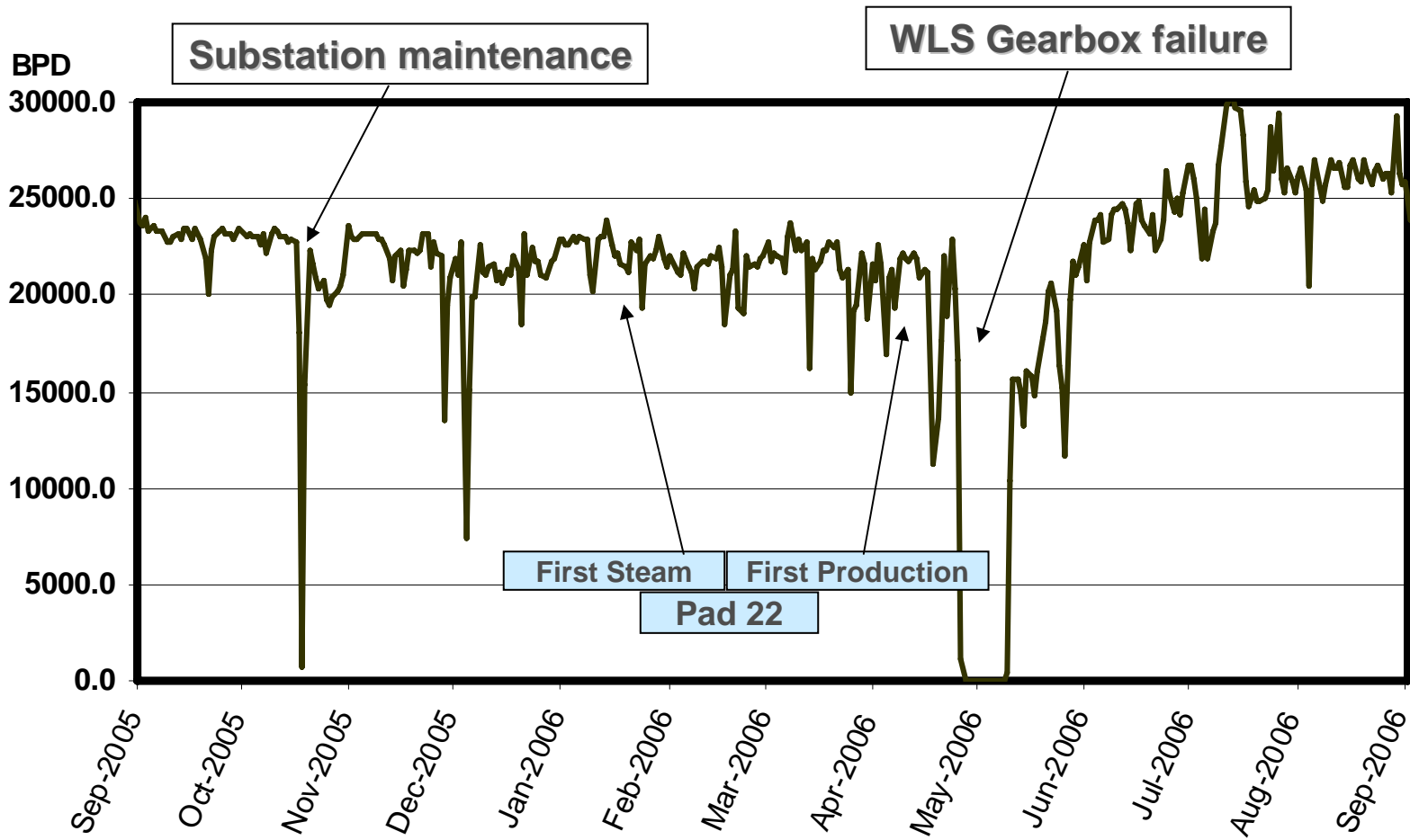
Field Production



MacKay River 2003 - 2006 Production



Bitumen sales





Geology

Todd Hagerman



Oil Sands Facies and Pay



Facies:

Defined by Vsh

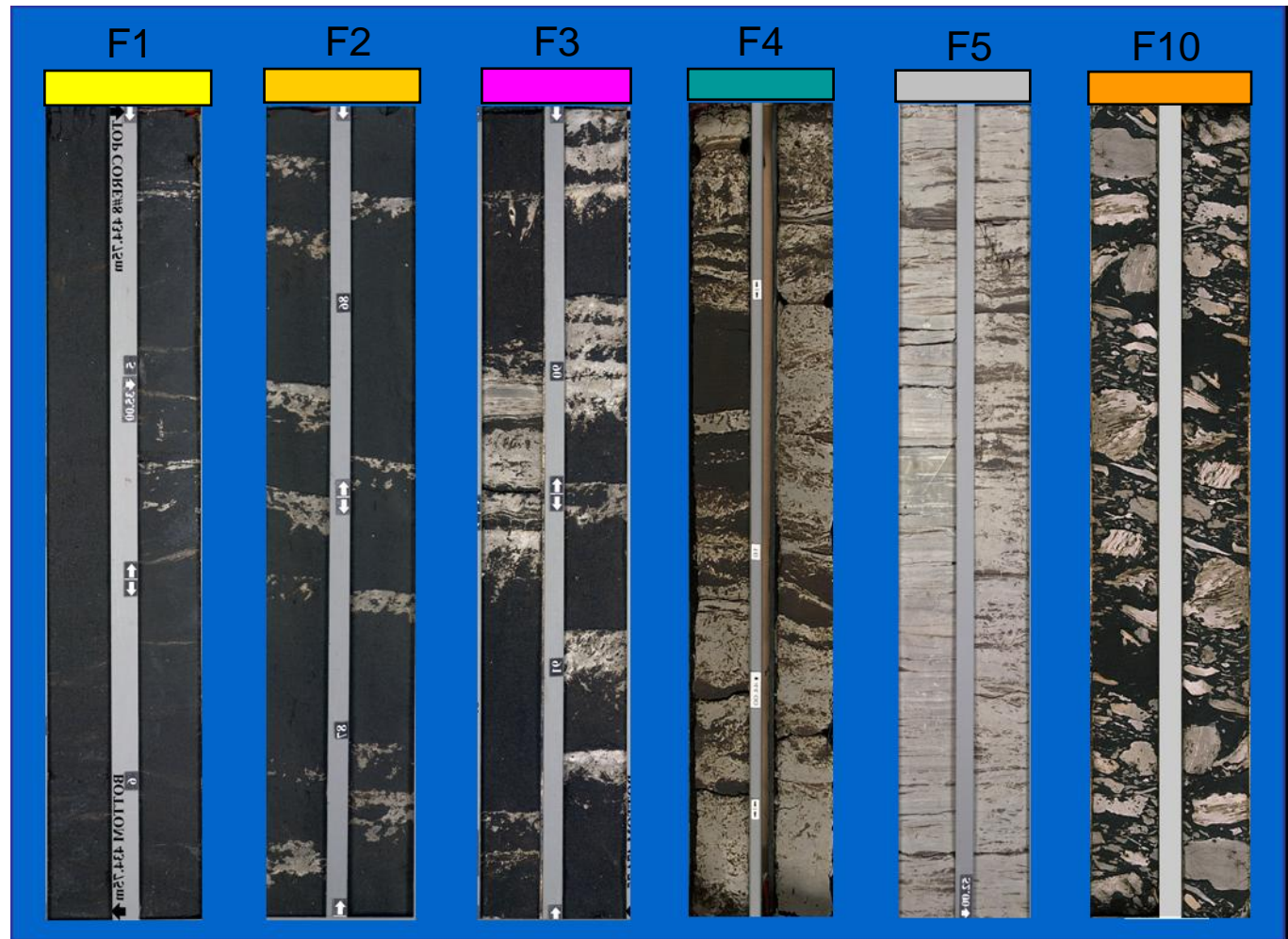
Cutoffs:

- F1 (Sandstone) = 0-5% Vsh
- F2 (Sandy IHS*) = 5-15% Vsh
- F3 (IHS*) = 15-30% Vsh
- F4 (Muddy IHS*) = 30-70% Vsh
- F5 (Mudstone) = 70-100% Vsh
- F10 (Breccia) = variable

* IHS = inclined, interbedded, sand and shale

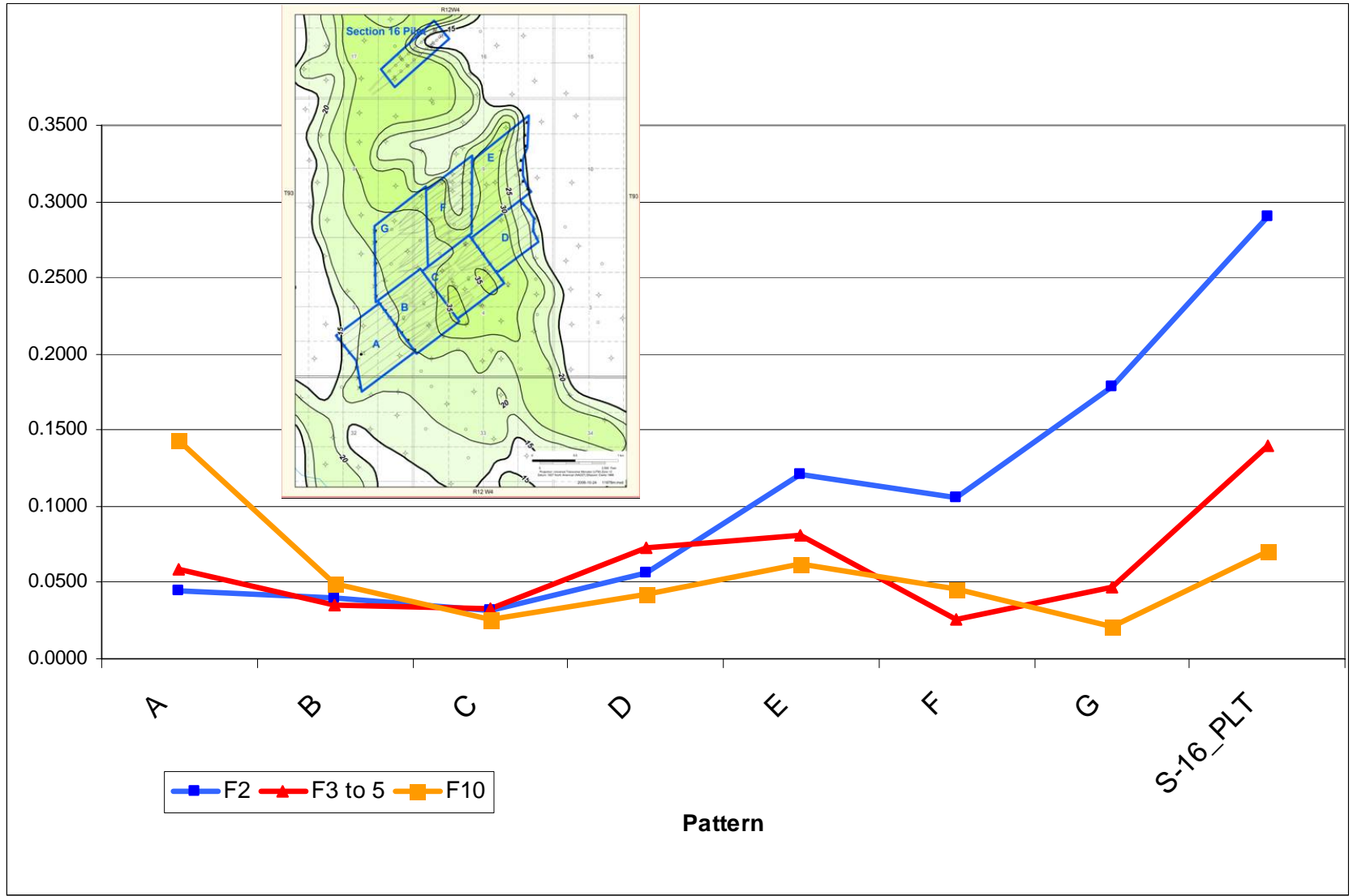
Pay:

- Includes Facies F1, F2, and F10
- Can include F3-F5, if < 2m thick
- Weight percent bitumen > 10%
- Generally > 30% Density Porosity
- > 15m for OBIP volumetrics



Modified From: Blair Mattison and Steve Hogan; Petro-Canada Reservoir Modeling Forum; St. John's, Apr. 27th -29th, 2004

Facies Proportions Excluding F1



Volumetrics



The 6 weight percent OBIP values provided span the Base of Cap Rock to Top of Devonian interval.

Petro-Canada does not regard the stated 6 weight percent cutoff OBIP to be representative of a currently commercial resource; economic recoveries have yet to be demonstrated from these low bitumen saturation intervals.

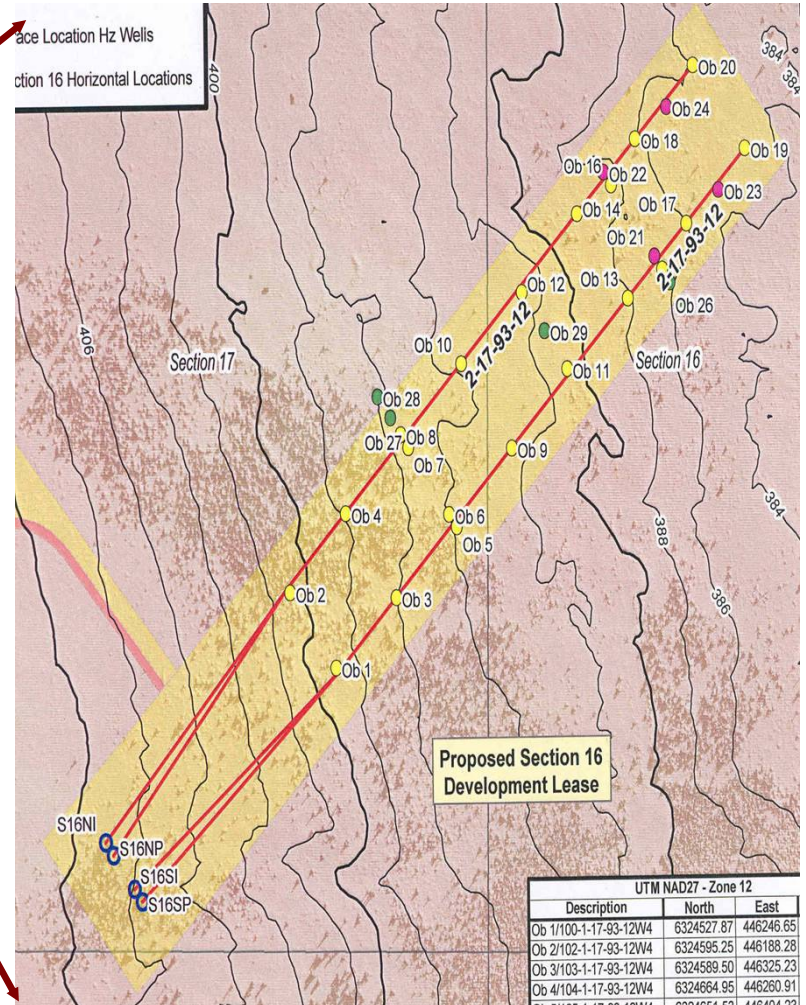
It should also be noted that due to the low bitumen saturation PC does not support using the same recovery factors used for our 10 weight percent volumetrics.

Volumetrics



OBIP of Developed Areas		
	PC P50	6%
Sub-surface Patterns	OBIP (MMbbls)	OBIP (MMbbls)
Phase 1		
A Pattern	13.0	17.3
B Pattern	22.5	23.7
C Pattern	27.4	28.3
D Pattern	16.2	21.5
Phase 2		
E Pattern	25.9	30.5
G Pattern	24.1	26.9
Phase 3		
F Pattern	23.2	26.4
Sub-Total	152.4	174.6
Section 16		
2 Well Pattern	8.0	~12.7

Section 16

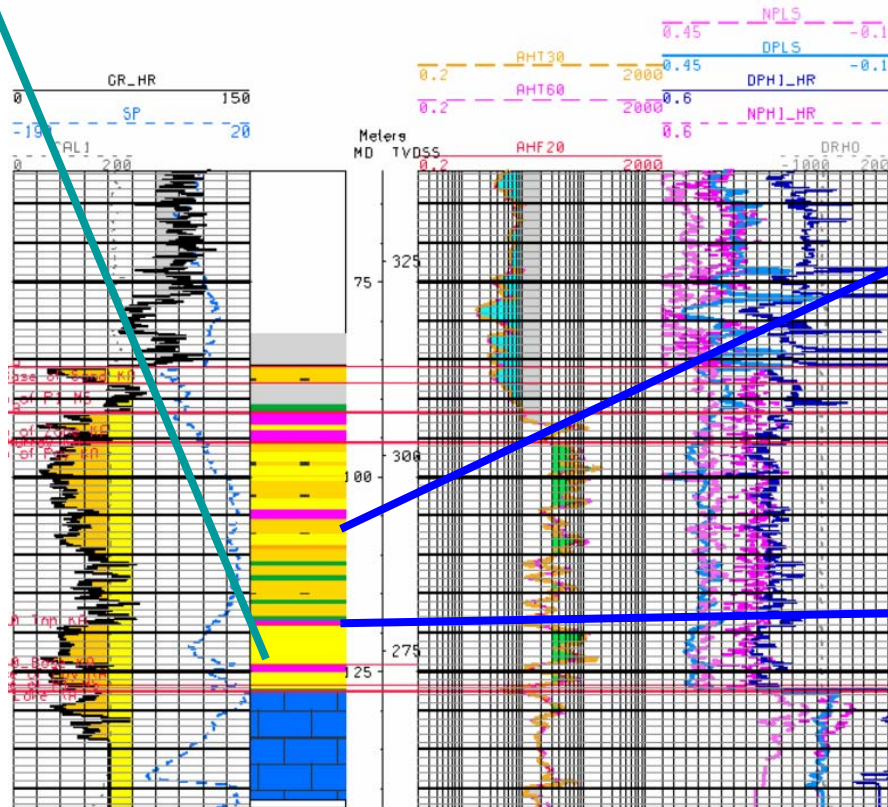


Section 16



OB 16-08

Faces 2 = I.H.S



Vsh <5%

5-15% 15-30% 30-70% >70%

Viscosity Property Variances

- No systematic study on vertical and horizontal bitumen viscosity variation has been done.
- Bitumen samples were taken at Pad 40 in February 2006.
- The viscosity of the sample bitumen is 2 ~ 3 times higher than that of the sale oil.
- May be due to bitumen viscosity variation with location.

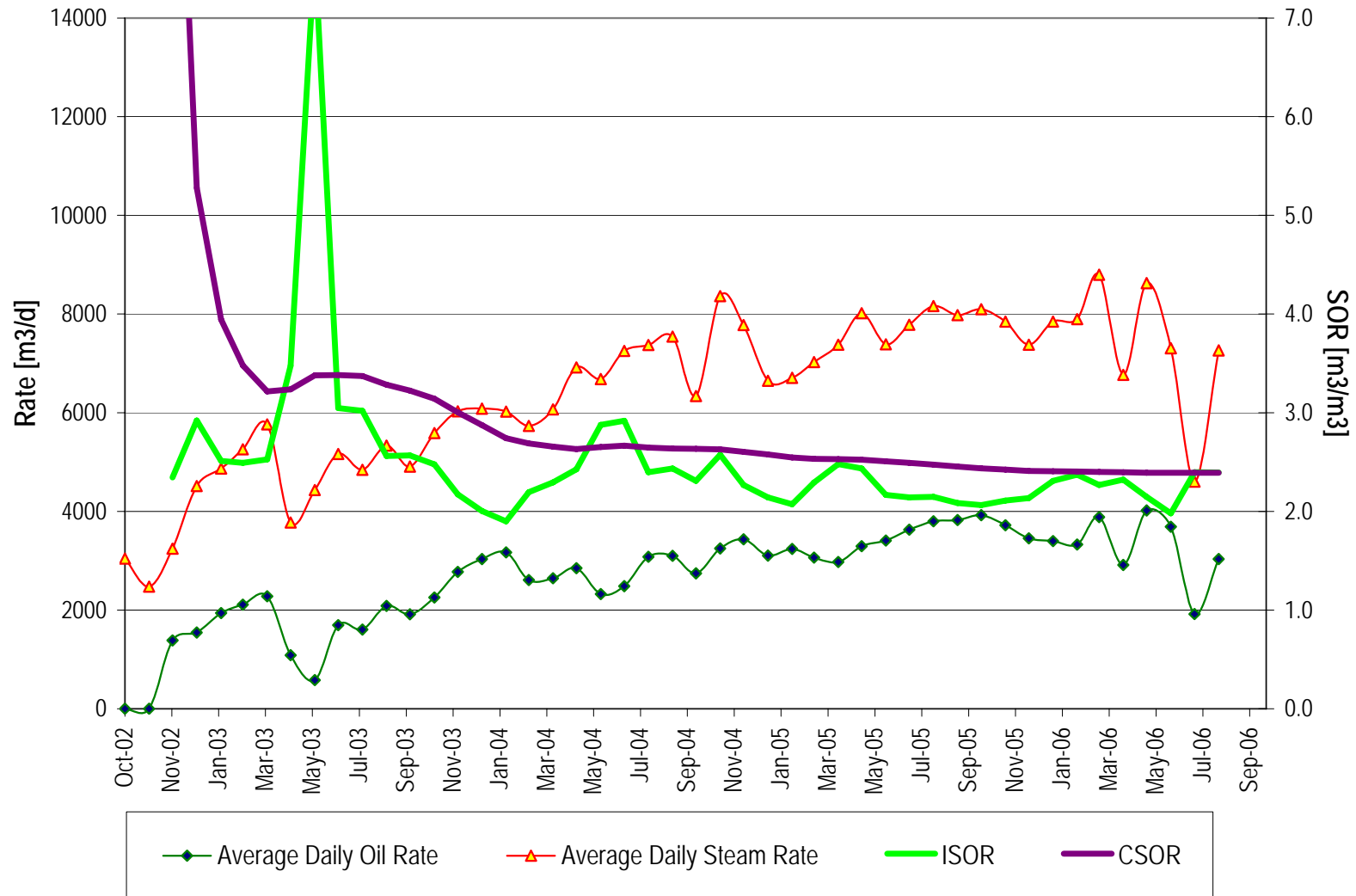


SAGD Performance

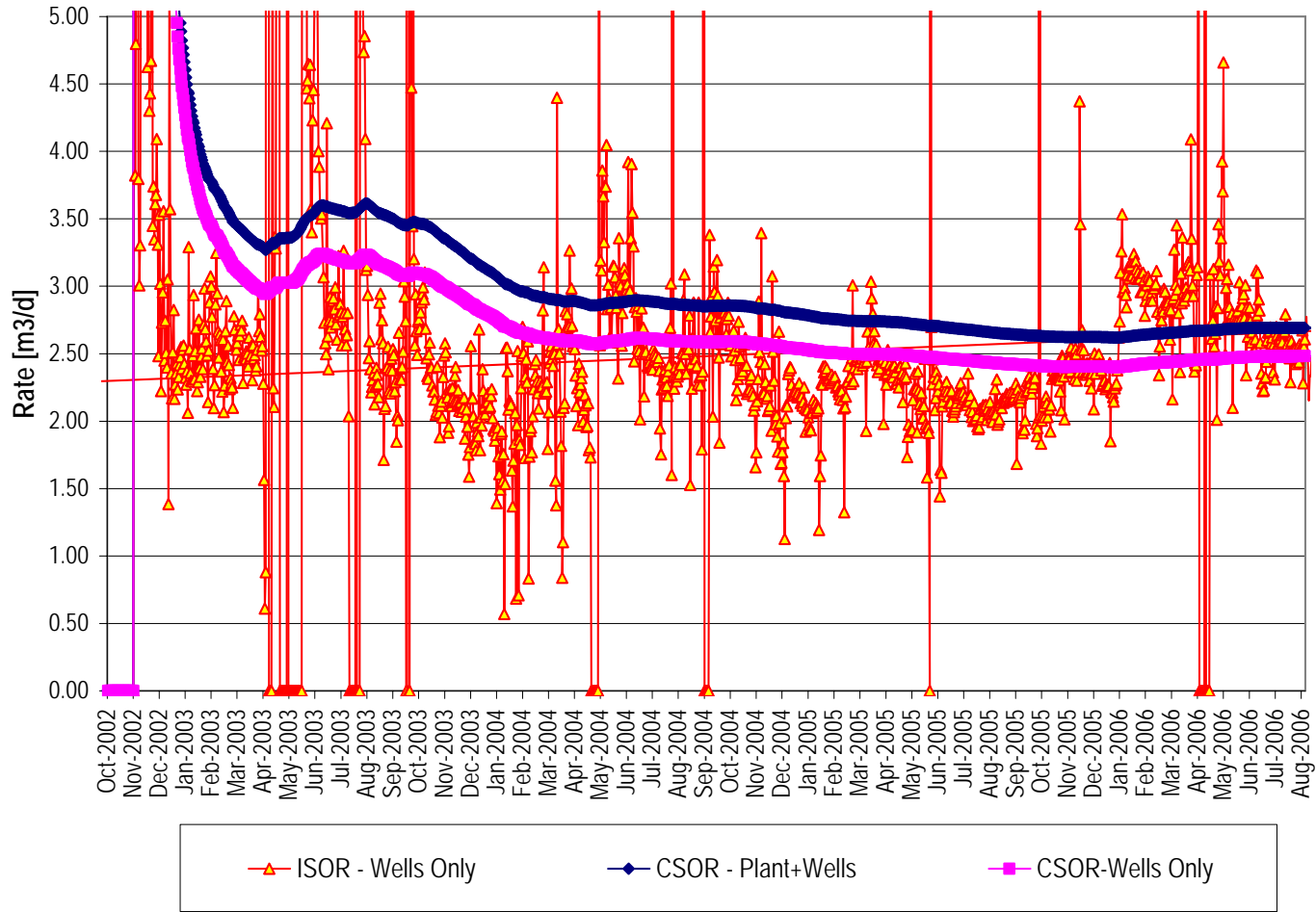
David Kennedy



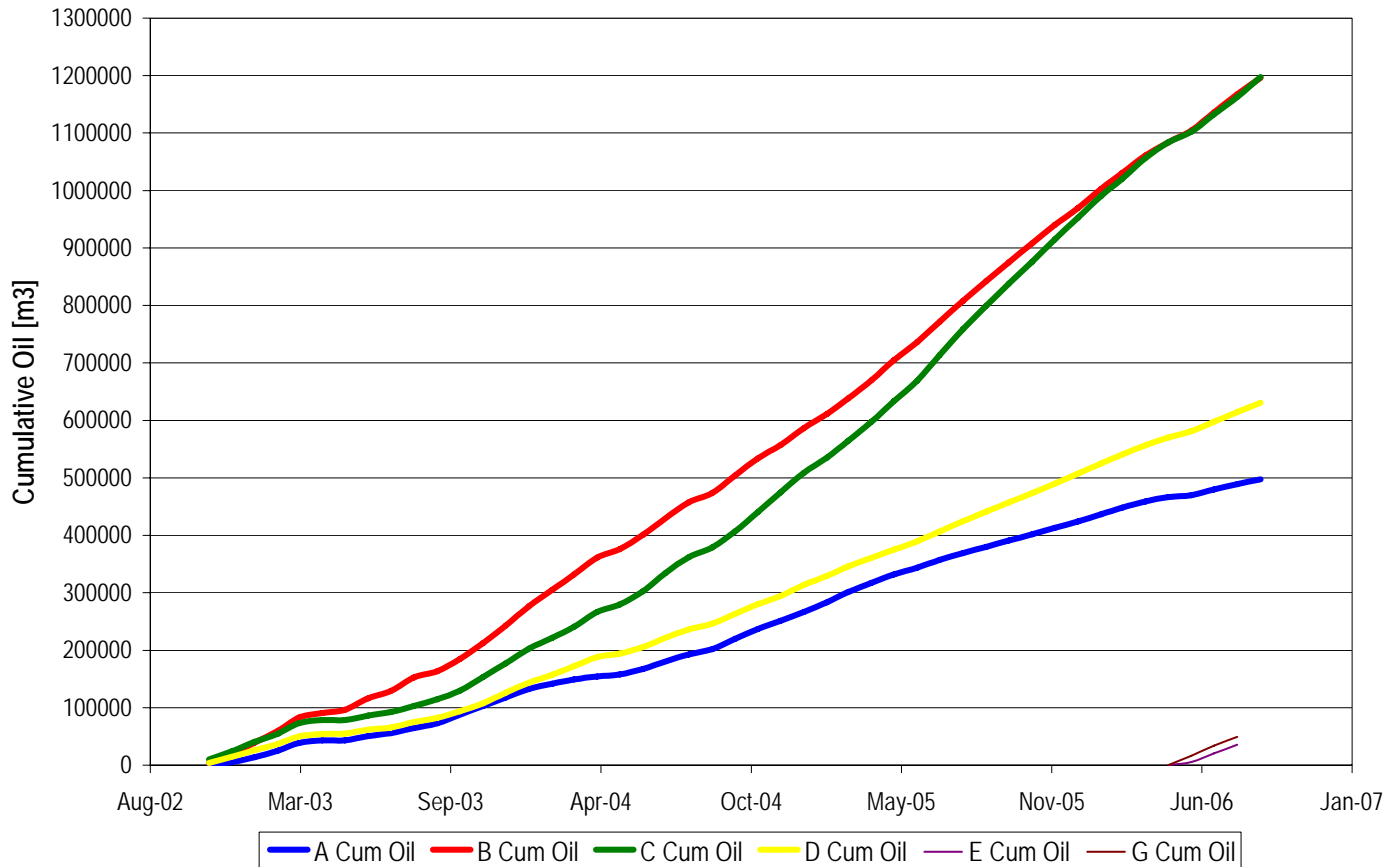
Performance to Date – Phase 1 only (Pad 20/21)



Full Field SOR's – Pads 20,21,22,40

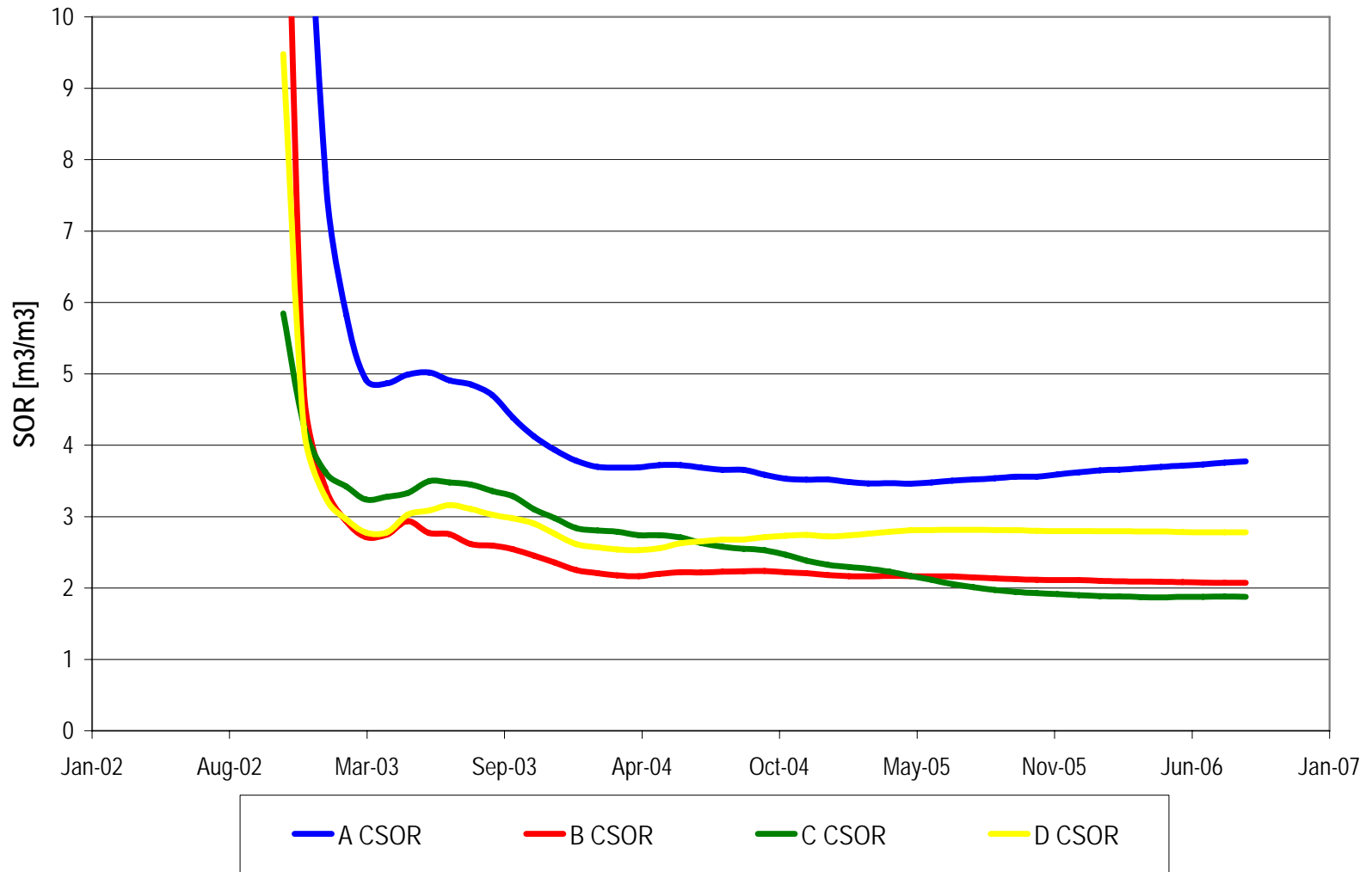


Bitumen Rates By Pattern

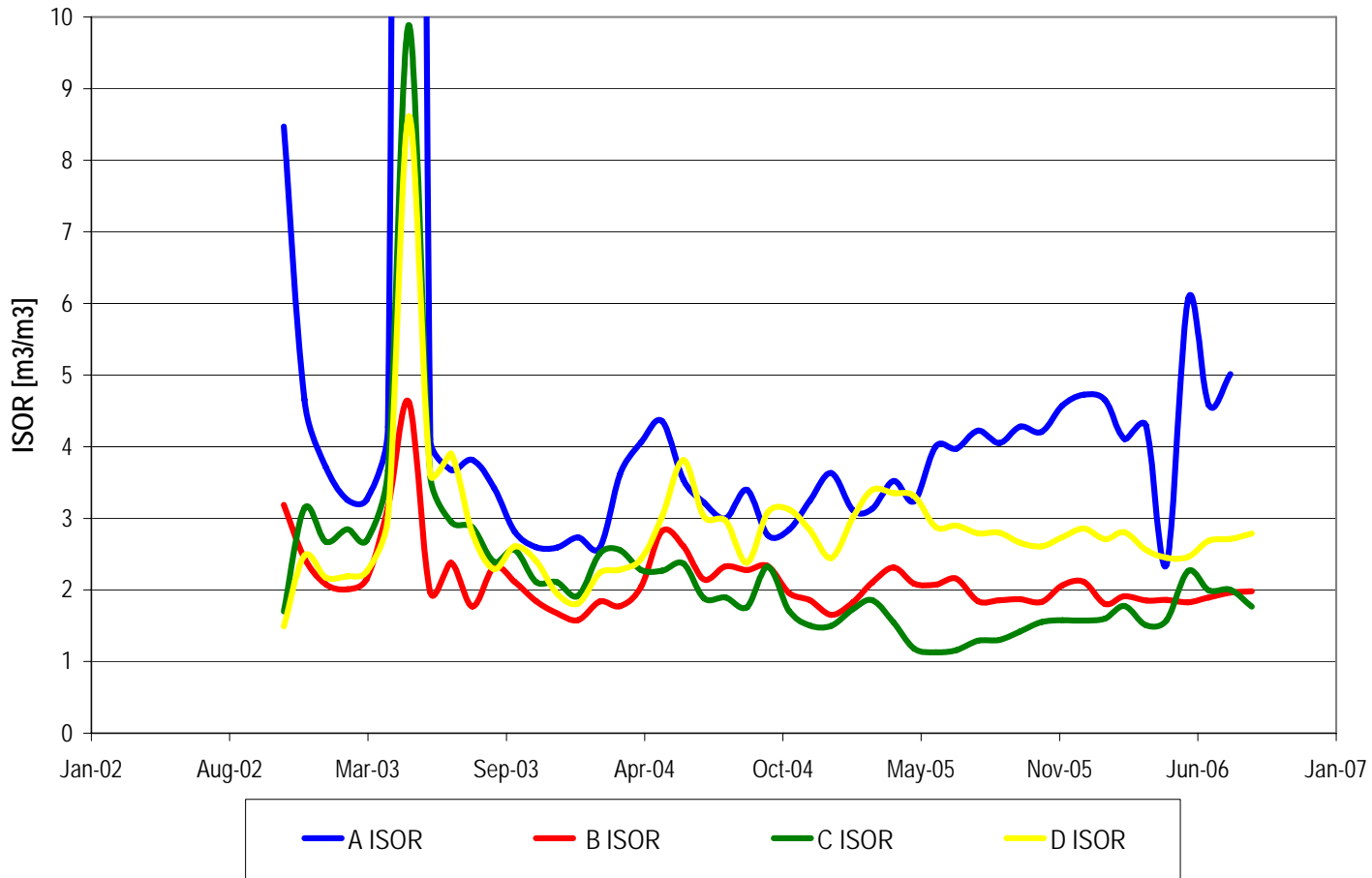


A: 7 wells
B: 7 wells
C: 6 wells
D: 5 wells
E: 7 wells
G: 7wells

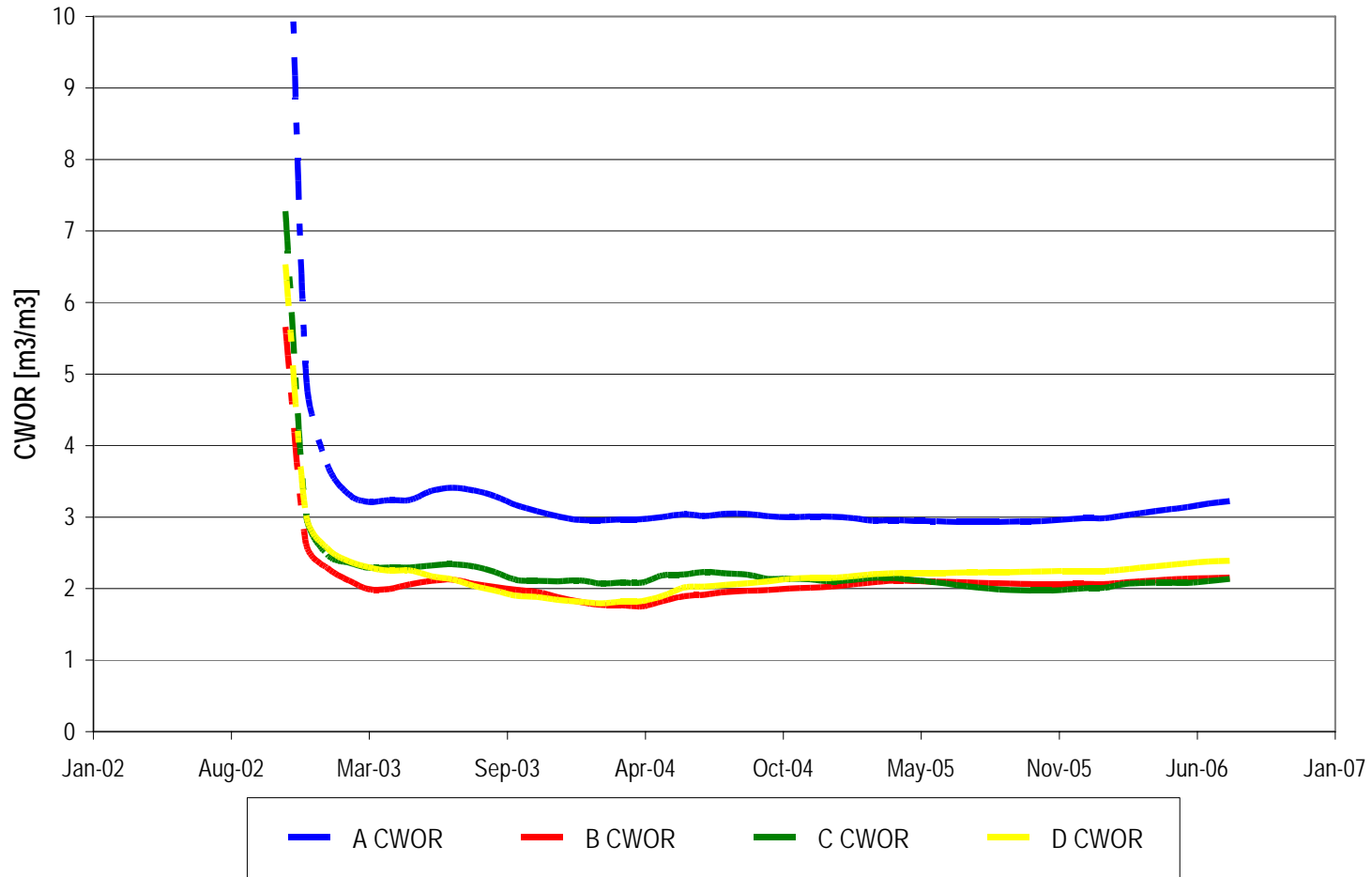
CSOR per Pattern



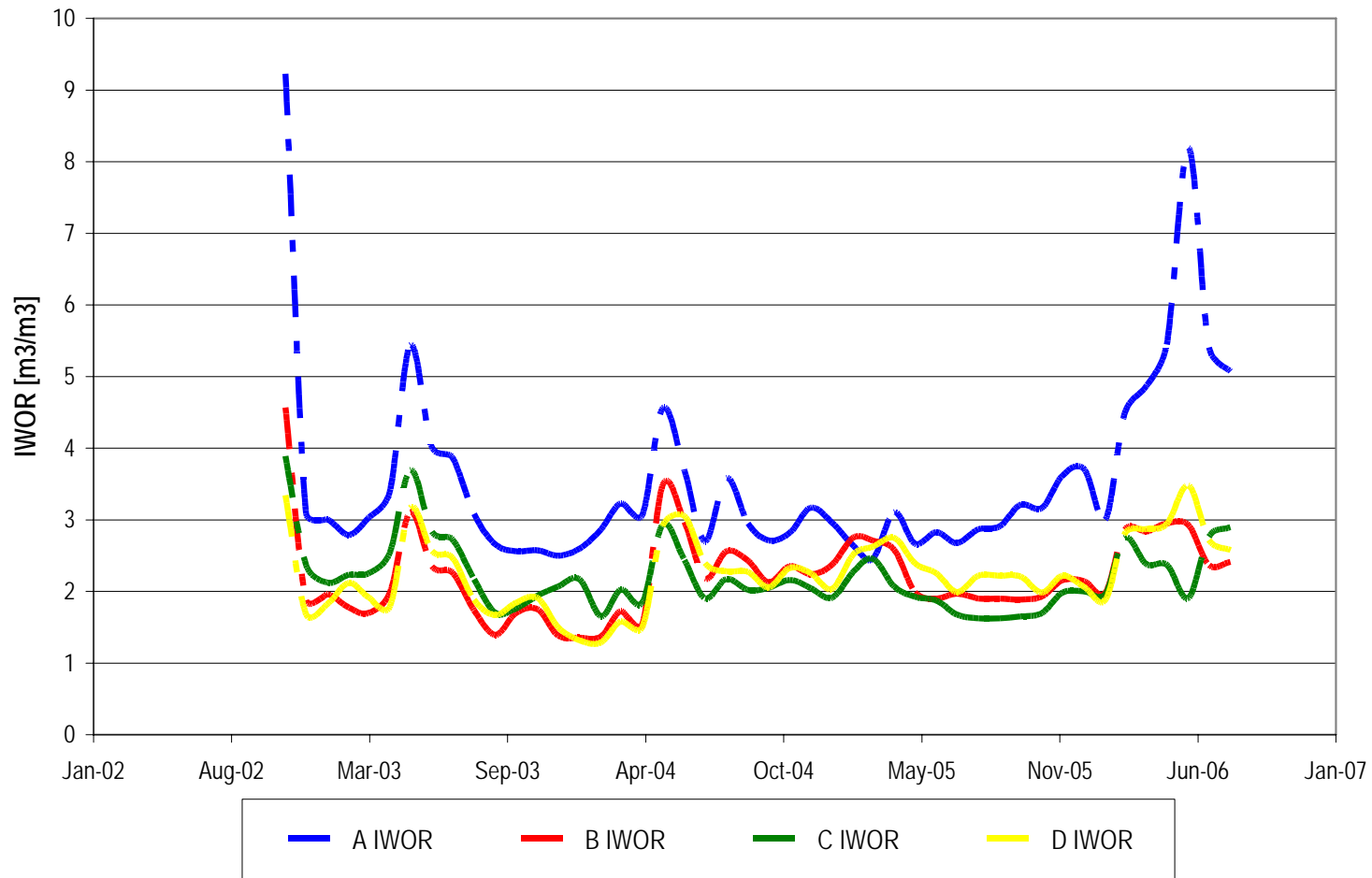
ISOR per Pattern



CWOR per Pattern



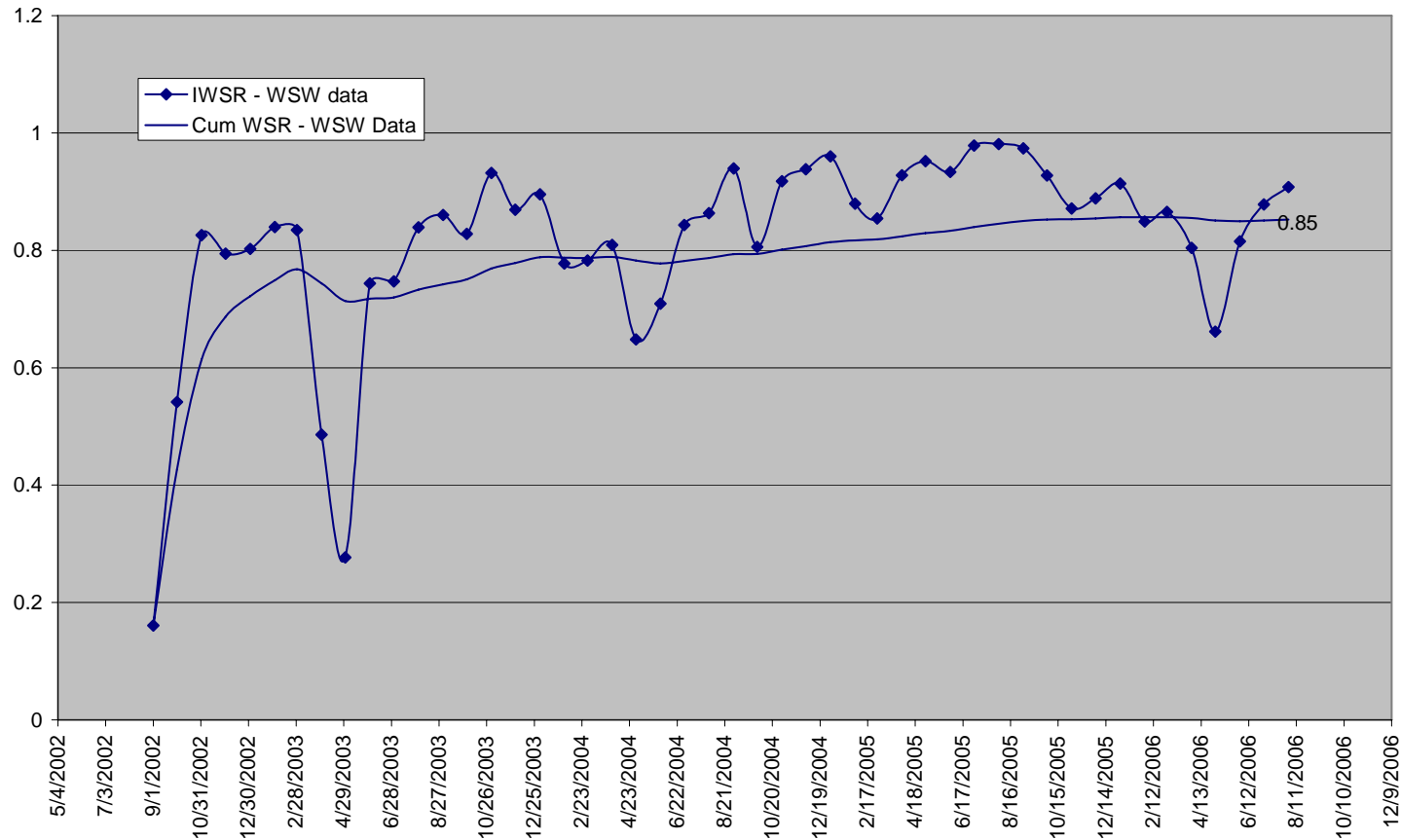
IWOR per Pattern



MackKay Water Balance – all Pads



Water Steam Ratios



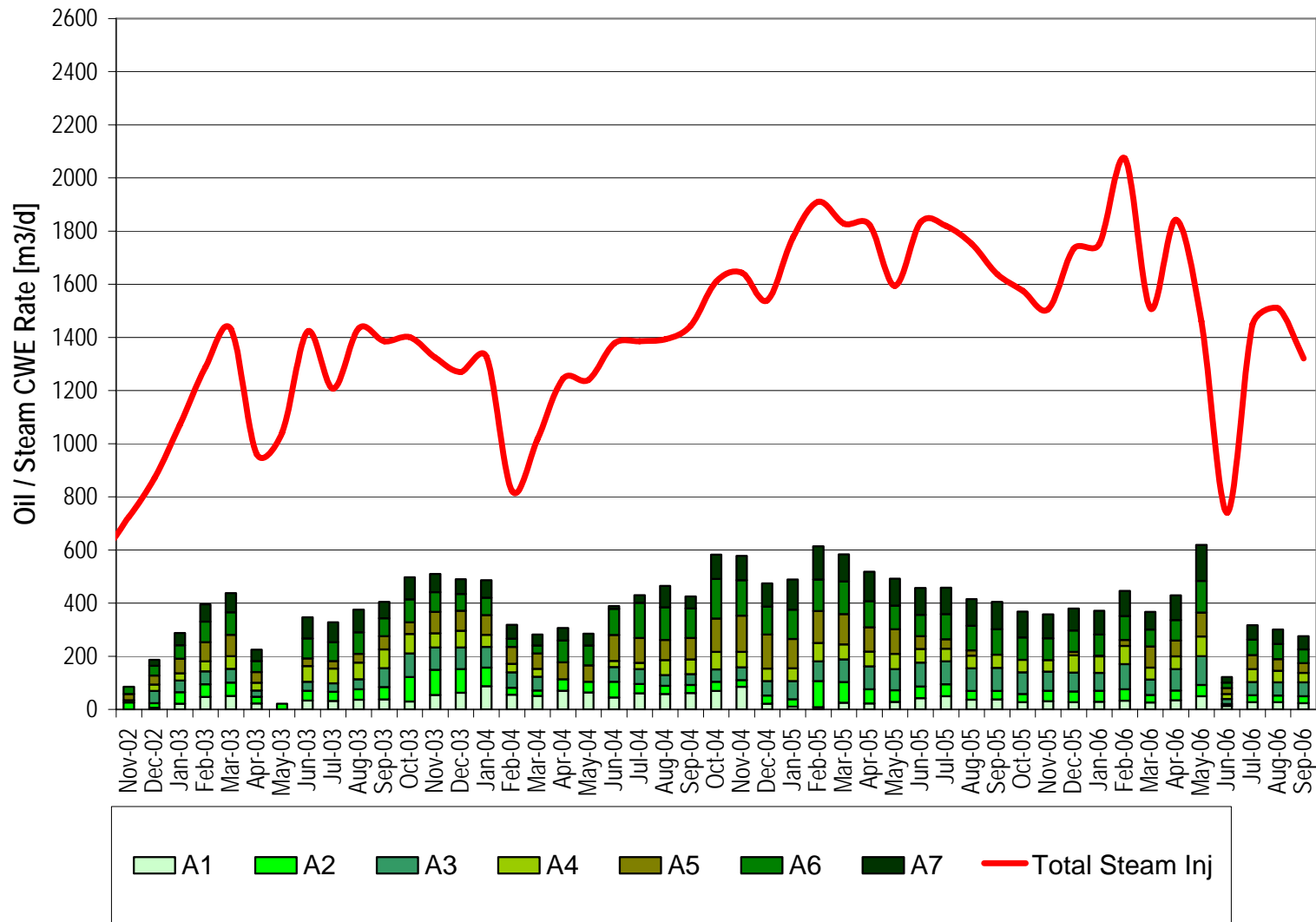
$$WSR = (\text{Steam Injected} - \text{Make-up Water}) / \text{Steam injected}$$

Performance Summary by Pattern



Cumulative Production to August 31, 2006					
	Cumulative Oil	Cumulative Water	Cumulative Steam Inj	Cumulative SOR	Cumulative WOR
	10^3m^3	10^3m^3	10^3m^3	m^3/m^3	m^3/m^3
Pattern A	490	1583	1842	3.8	3.2
Pattern B	1171	2522	2428	2.1	2.2
Pattern C	1169	2447	2199	1.9	2.1
Pattern D	790	1742	2196	2.8	2.2
Pattern E	36	49	121	3.4	1.4
Pattern G	49	83	126	2.6	1.7

A Pattern Performance



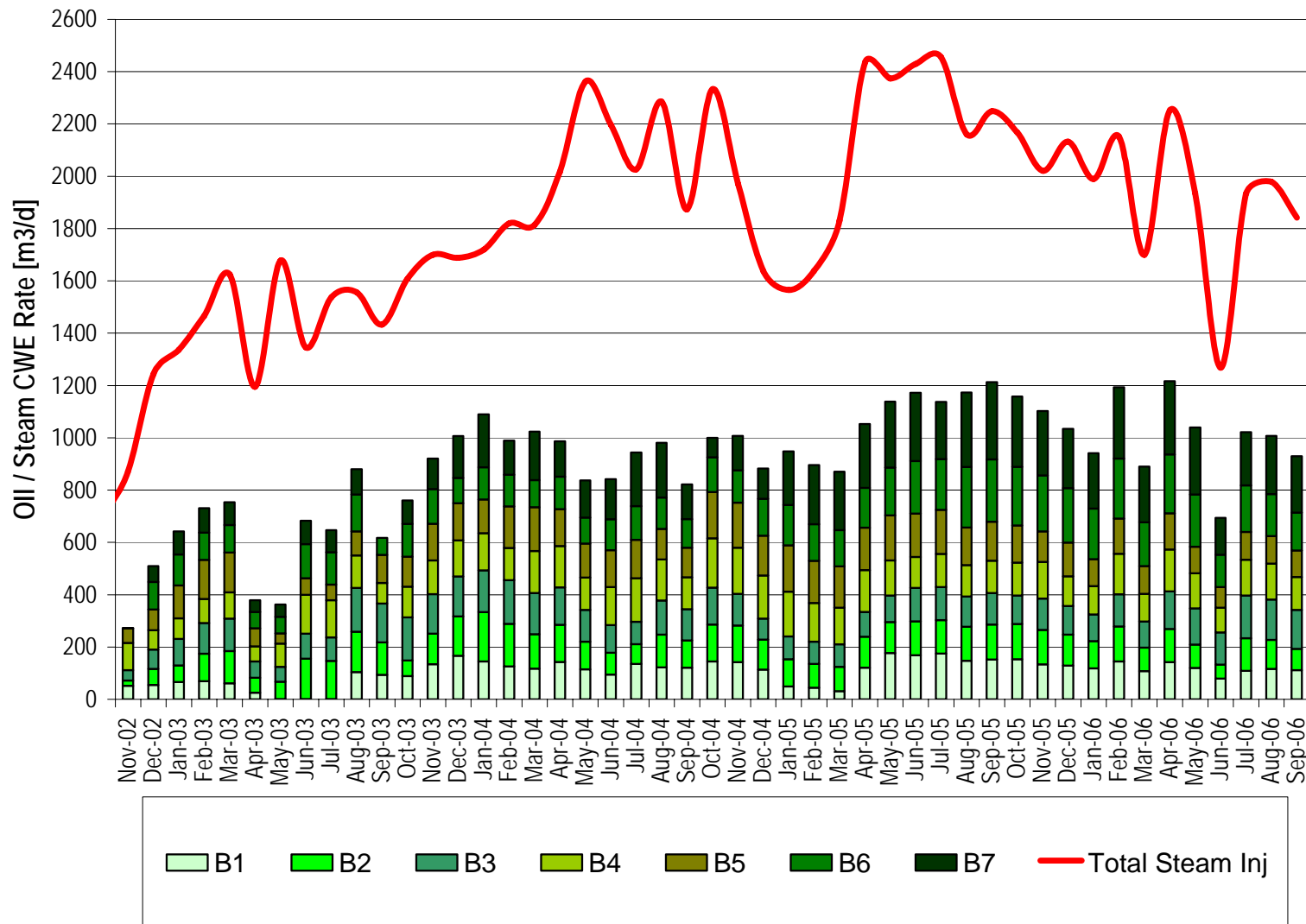
A pattern performance influenced by less favourable reservoir quality near channel edge, migration of steam to middle of channel

AA/02-05-093-12W4M



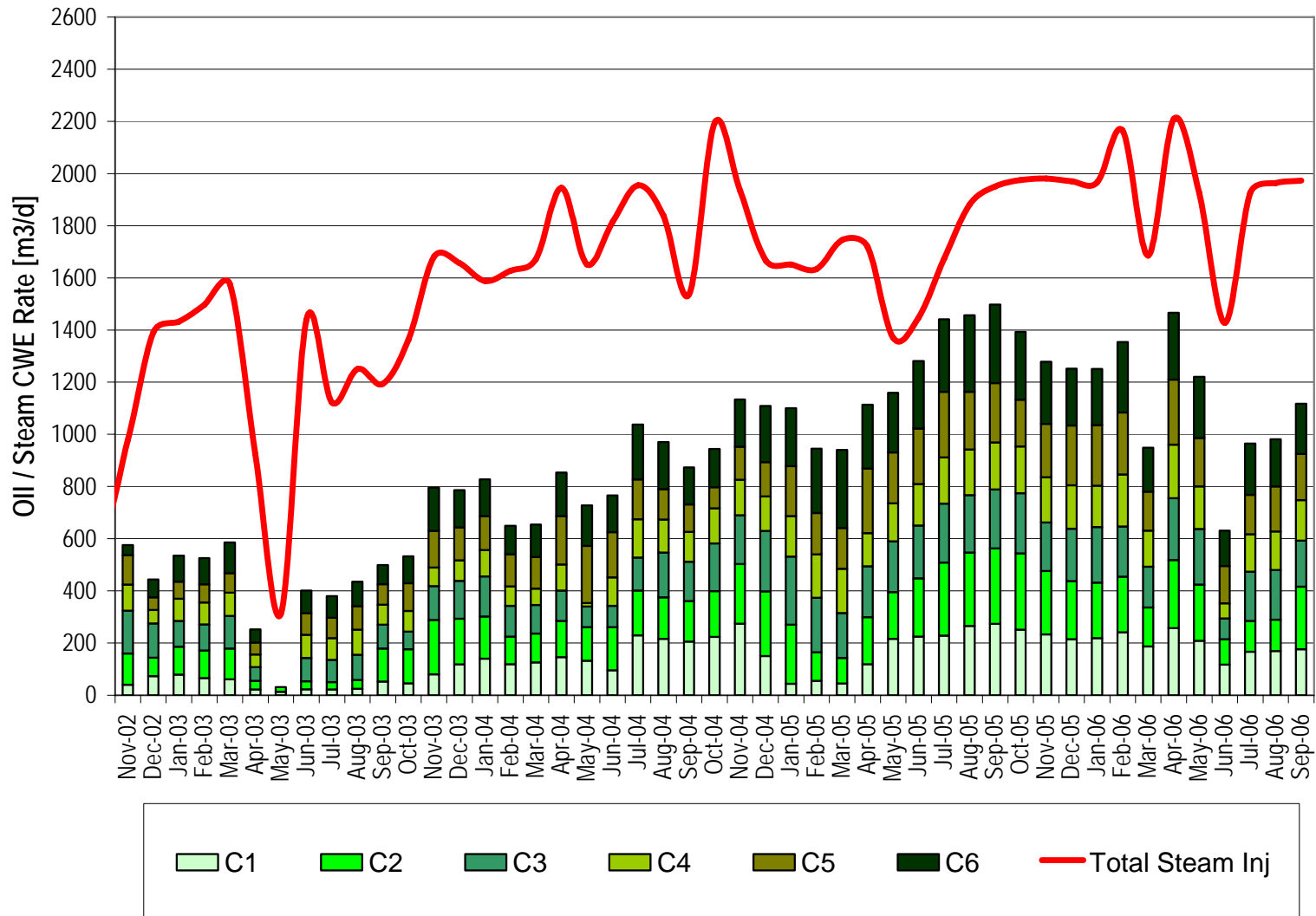
A pattern performance influenced by less favourable reservoir quality near channel edge.
Circles represent approximate injector, producer locations near edge of channel (toes of A wells)

B Pattern Performance



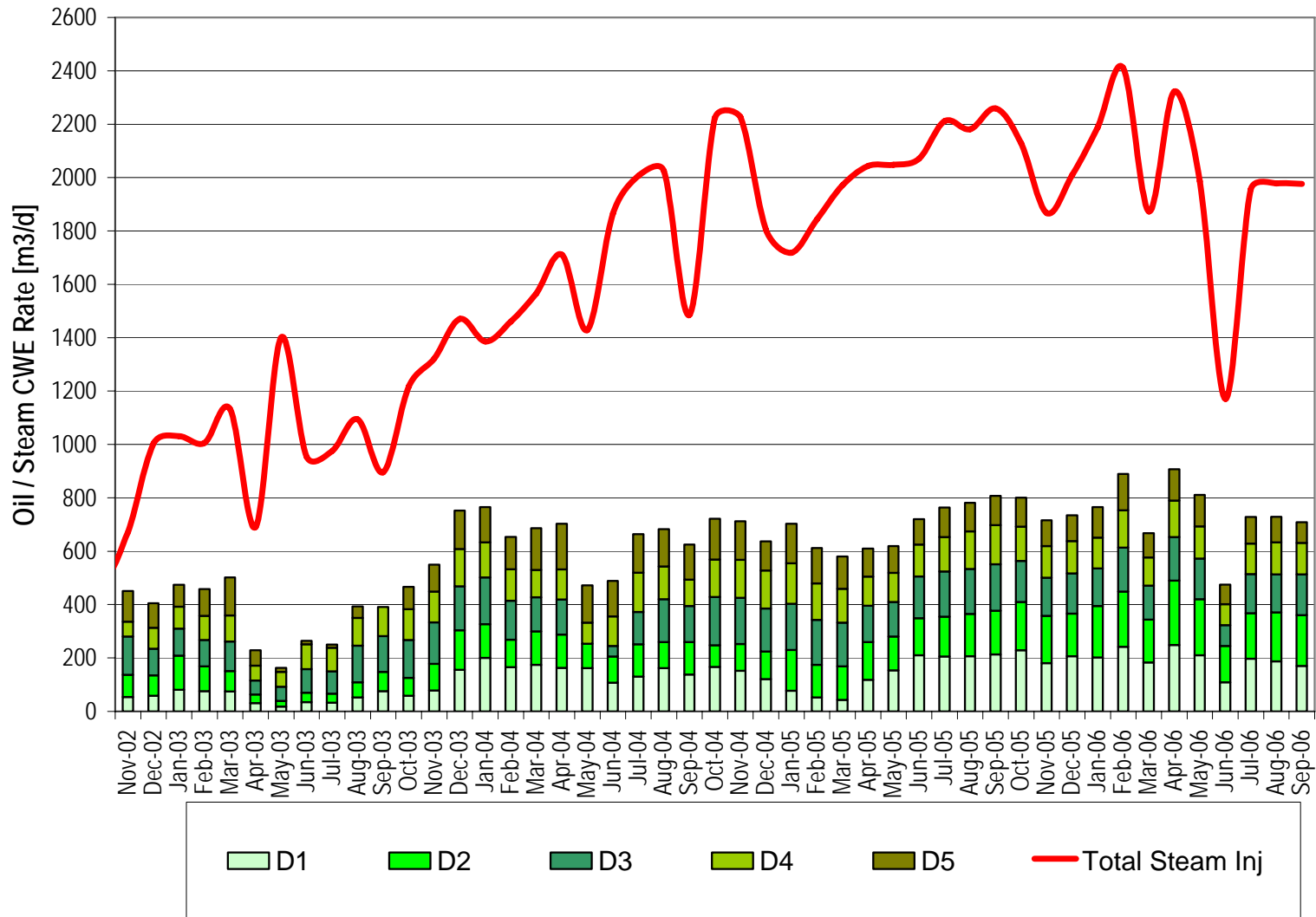
B pattern performance as expected, good rates, some steam migration from A pattern

C Pattern Performance



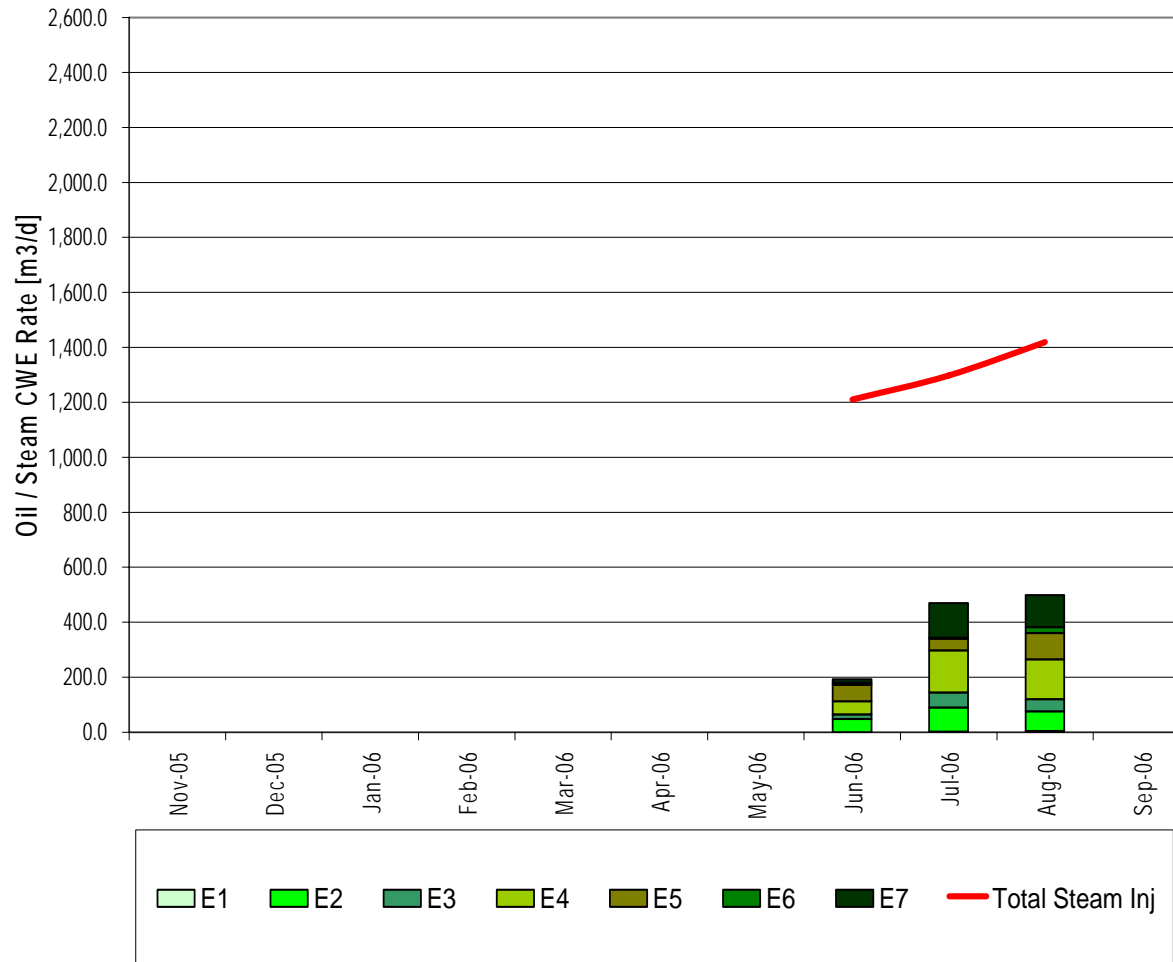
C pattern performance better than expected, great rates, some steam migration from other patterns

D Pattern Performance



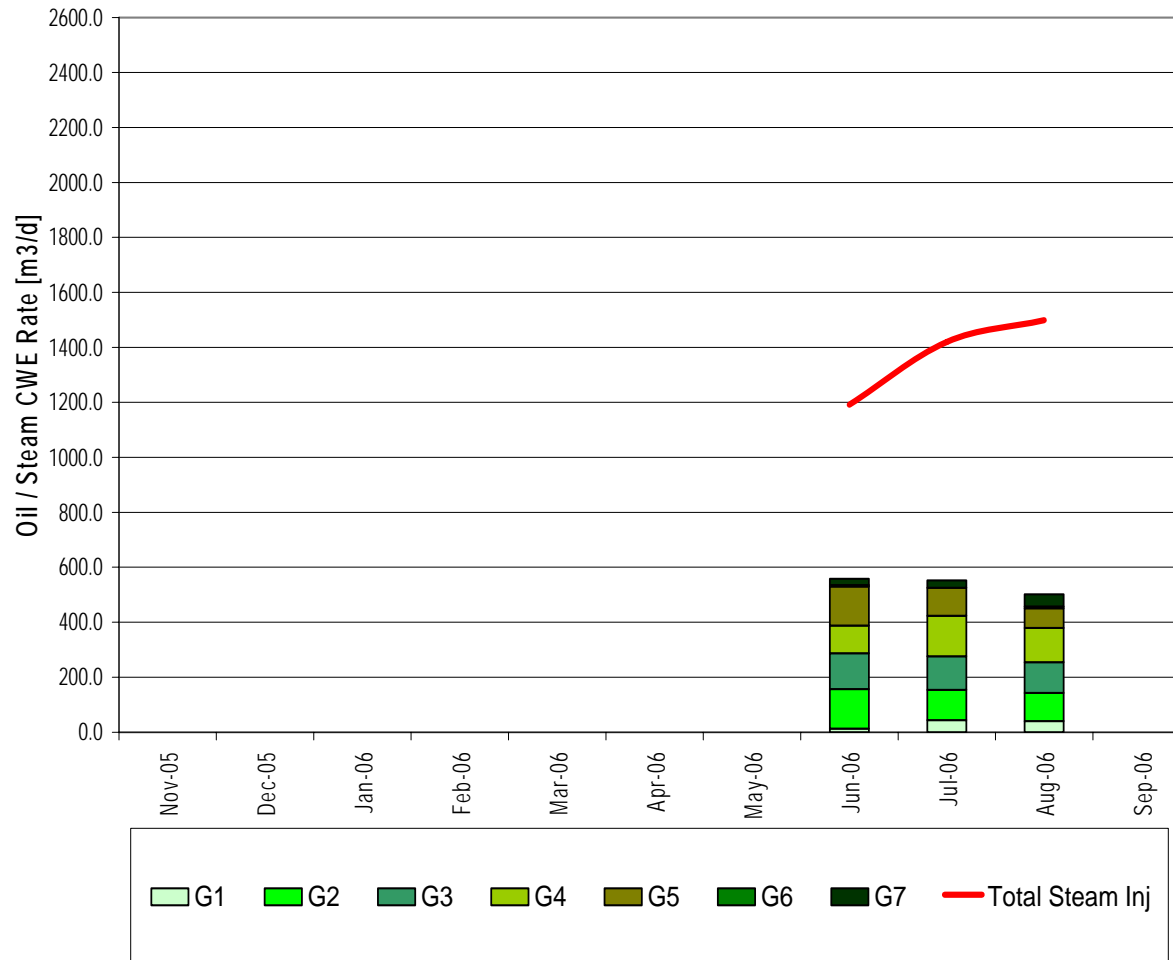
D pattern performance as expected, good rates, some steam migration to other patterns.

E Pattern Performance



Too early to draw conclusions about E pattern reservoir performance.

G Pattern Performance



Too early to draw conclusions about G pattern reservoir performance.

Current Recoveries



Recovery Factor to August 31,2006					
	P50 OBIP	Cum Oil	Cum Oil	Recovery	Predicted
	10^3m^3	10^3m^3	MMbbls	%	Recovery %
Pattern A	2073	490	3.08	24	65%
Pattern B	3578	1171	7.36	33	66%
Pattern C	4358	1169	7.36	27	67%
Pattern D	2581	790	4.97	31	64%
Pattern E	4118	36	0.23	1	60%
Pattern G	3832	49	0.31	1	59%
Section 16	1264	31	0.2	2	38%

OBIP calculated using 10% wt percent

Pad 22 Start-Up



	Day #
Early Start-Up (Steam to Toe then Choke Back to Maximize DHT)	~ 3 – 10
Stabilizing System, Conductive Heating	~ 10 – 25
Imposing Small Pressure Differential	~ 25
Semi-SAGD Tests – no injection into Producer	~ 60 – 70
Conversion to SAGD	70 +

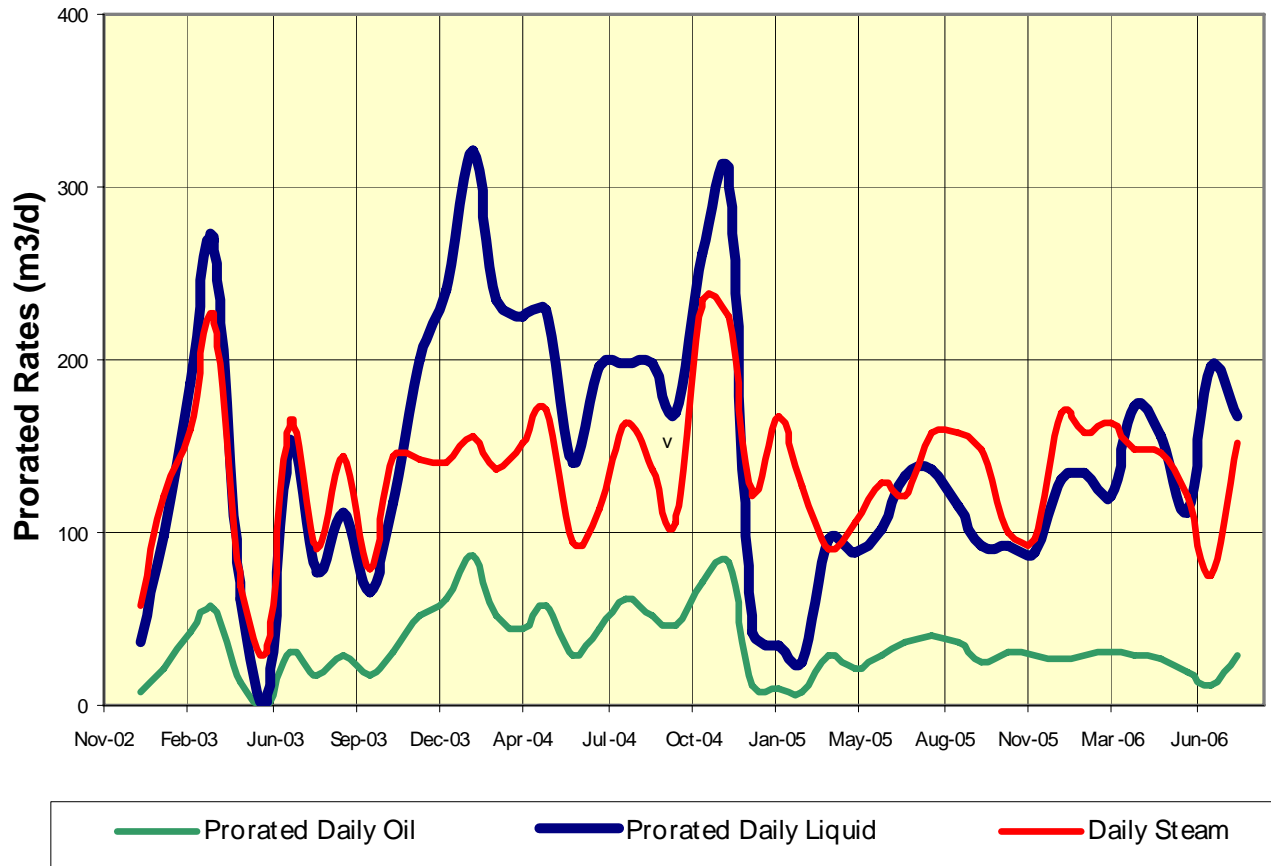
- Starting up wells largely dependent on
 - Steam availability, plant capability to handle water, vapor production
- Variability in circulation performance
- Operational interruptions extended warm-up for Pad 22

Refer to: SPE 86970



- **Extensive inter-well communication exists**
 - **Water mobility > zero**
 - **Select examples in first year (heel to heel wells)**
 - **Multiple examples in year 2,3**
 - **Most wells now communicating, some exceptions**
- **Steam migration to areas of better reservoir quality**
- **Operational interruptions can mask reservoir performance**
- **Heave observed – plan to re-survey**

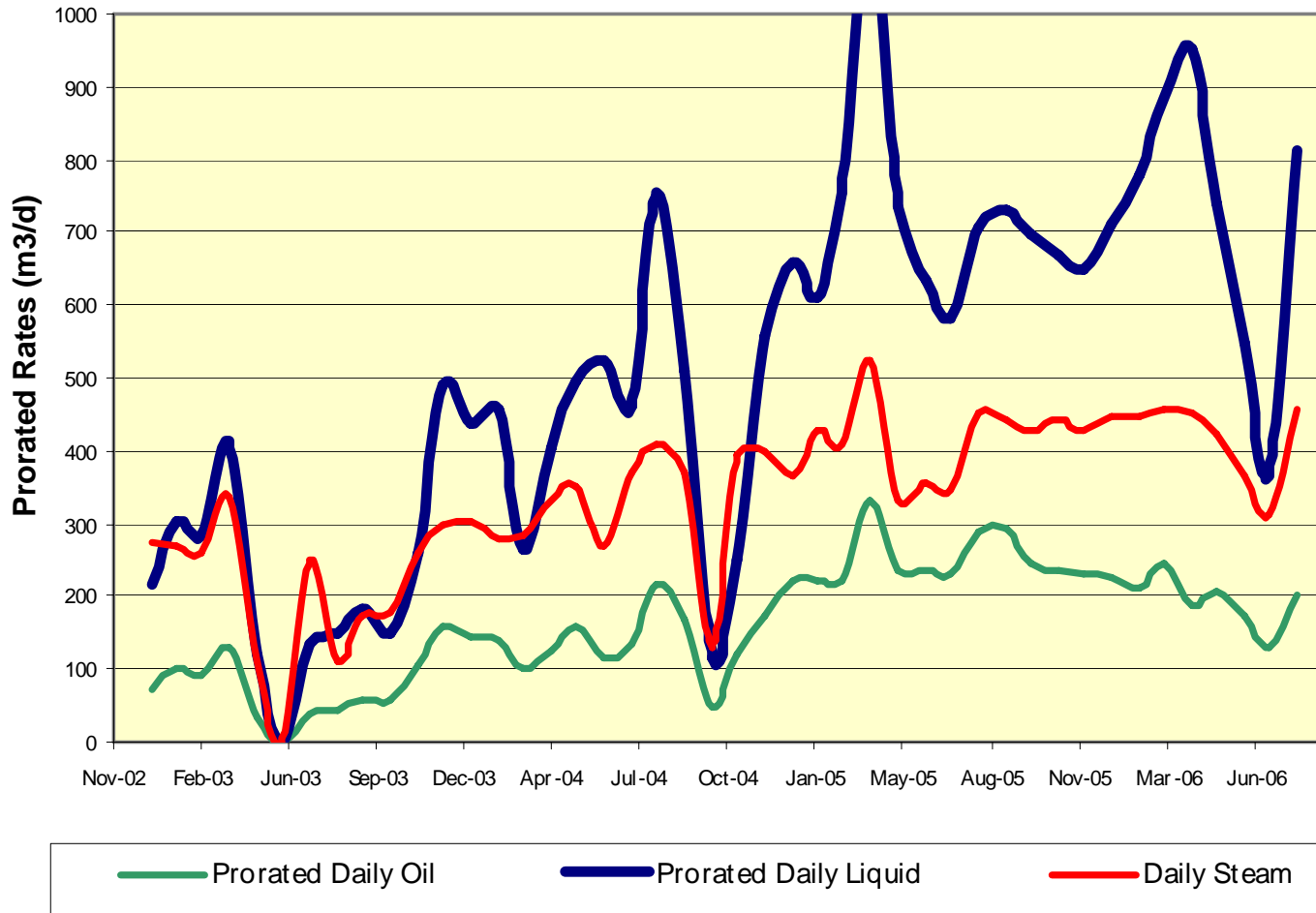
Individual Well Performance – A1



Cum oil ~0.3 MMbbls
CSOR ~4
CWOR ~3.2
CWSR ~0.79
CTFSR ~1.1
Steam Migration
Unbounded Edge

A1 well pair is one of the poorer MacKay wells

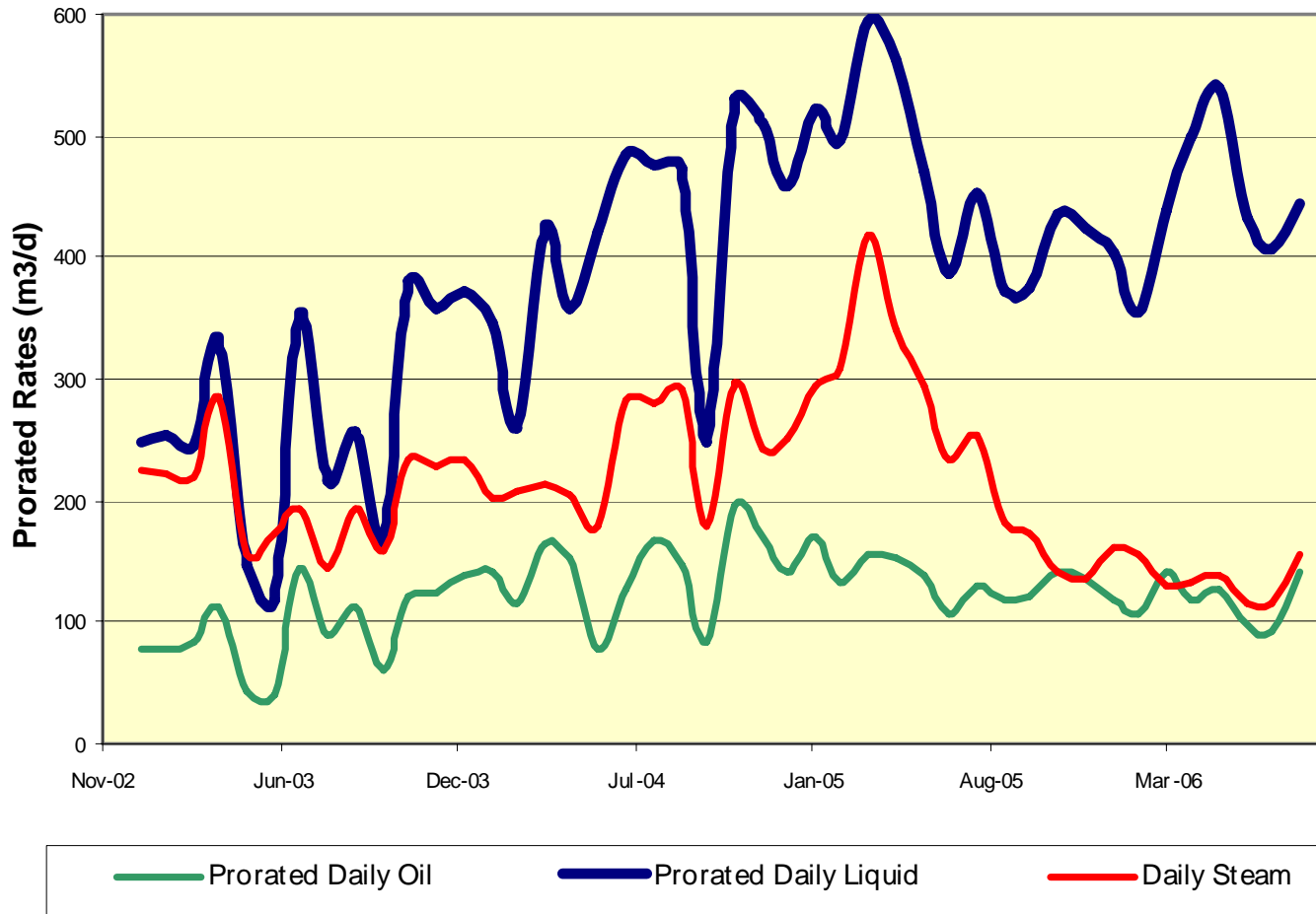
Individual Well Performance – C6



Cum oil ~1.4 MMbbls
CSOR ~2.1
CWOR ~2.1
CWSR ~1.02
CTFSR ~1.5
Unbounded Edge

C6 well pair is one of the better MacKay wells

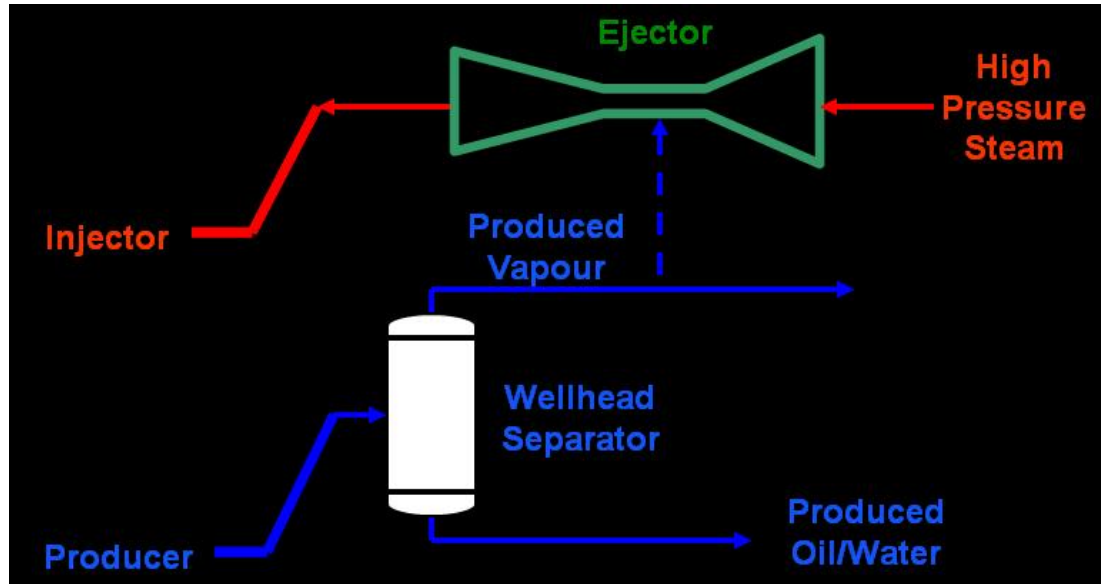
Individual Well Performance – B4



Cum oil ~ 1 MMbbls
CSOR ~1.75
CWOR ~2.2
CWSR ~1.25
CTFSR ~1.8
Fully Bounded

B4 well pair is relatively average MacKay well, located in the middle of the developed area, influenced by neighbouring wells at various times.

Ejector Operation



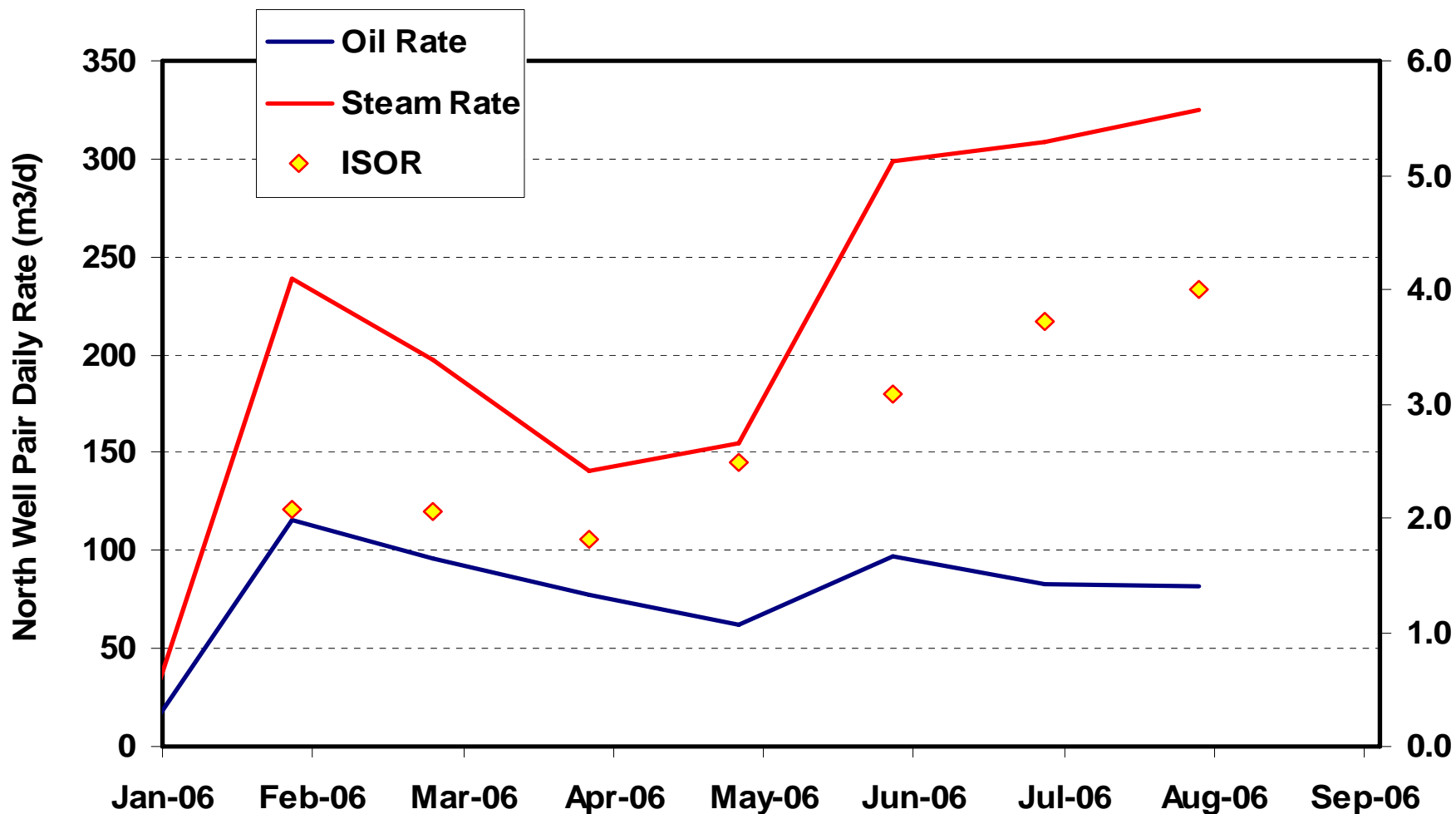
Petro-Canada proprietary technology

Produced vapour successfully re-injected

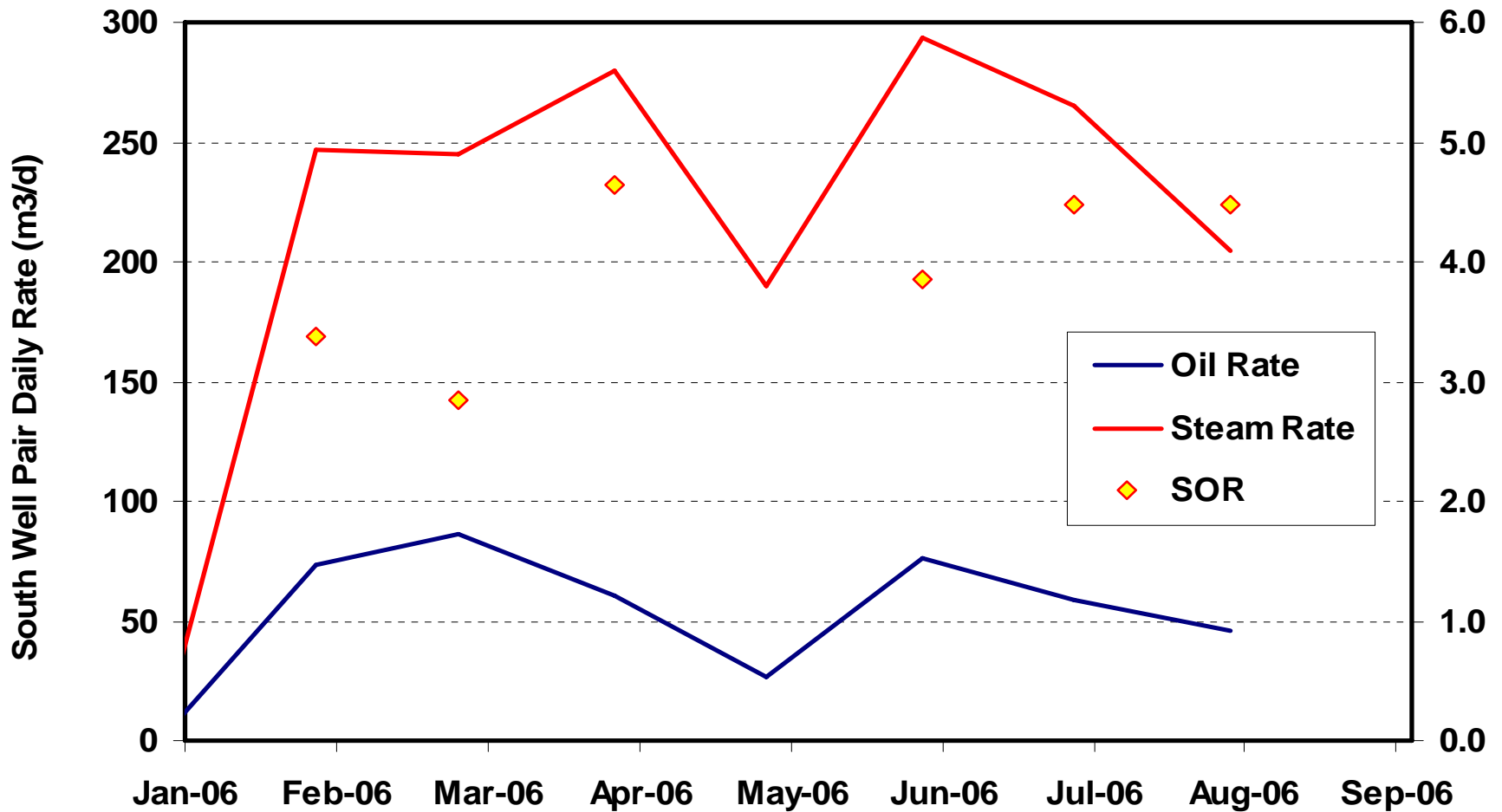
- Wells A1,2,3,4, C1,2,3,4

Evaluation underway, no conclusions at this point

Section 16 - North Well Pair Production Performance



Section 16 - South Well Pair Production Performance



Section 16 - Production Performance



- P50 OBIP is 1 265 e3m3 (7.96 MMbbls) based on $\geq 10\%$ weight BMFO (bulk mass fraction of oil). Recoverable bitumen is 491 e3m3 (3.09 MMbbls)
- Up to August 31, 2006, cumulative bitumen production was 31 358 m³ (197 331 bbl) and cumulative steam injection was 102 609 m³. Cumulative SOR is 3.2
- The recovery factor up to August 31 is approximately 2.5%

Future Work and Issues



- Investigate Non Condensable Gas injection effect
- Continue microseismic monitoring
- Consider low pressure SAGD with pump
- Evaluate steam chamber propagation through IHS



Steam Release Risk Mitigation

Nathan Kupsch
Asset Team Leader



Steam Release Risk Mitigation



Key Industry Risk Areas

1. Operating at inappropriate pressure
2. Breach in caprock due to geological factors
3. Well failure outside casing
4. Loss of control during drilling/workover operations
5. Delineation well abandonment procedures

Process for assessing Petro-Canada risk exposure

- Assess probability of potential industry scenarios that could result in a steam release and evaluate severity of occurrence
- Confirm Petro-Canada immediate reaction to event
- Evaluate mitigation taken to date by Petro-Canada and recommend if further steps are necessary

Steam Release Risk Mitigation



1. **Operating at inappropriate pressure**
 - Use shallowest depth, depth to base of caprock
 - Implement pattern specific operating pressures
2. **Breach in caprock due to geological factors**
 - Significant number of wells, caprock characterization work
3. **Well failure outside casing**
 - Premium connections, cementing practices
4. **Loss of control during drilling/workover operations**
 - Extra precautions, vertical wells
5. **Delineation well abandonment procedures**
 - Research old coreholes for potential remedial work

Steam Release Risk Mitigation



Summary

- **Appropriate mitigation steps have already been taken in most areas to address risk and a go forward plan developed for those remaining**
- **A steam release event, while remote, could have a severe effect from personal safety, environmental or financial viewpoints**
- **Some initiatives may lessen the probability of occurrence even further**
- **Further investigation or action will be done in a number of areas**

Steam Release Risk Mitigation



Action Plan

- Operating pressures should continue to be based on conservative parameters (frac gradient, depth to caprock, safety factor, etc.)
- Strict adherence must be enforced to these operating pressures
- All predecessor delineation wells within the active development area should be located if possible. Each should be evaluated for competence and addressed if necessary
- Low pressure (< hydrostatic) SAGD operation may be evaluated for the long term with respect to Total Loss Management and economic feasibility
- Participation in industry forums or JIPs should be encouraged
- Additional emergency response planning will be addressed if gaps exist
- Training and competency assessments are being completed to ensure vigilance and diligence in monitoring key risk indicators



Regulatory Compliance

Stephen Full
TLM Operations Team Leader



Regulatory Compliance



Petro-Canada is in compliance with all regulatory approvals, decisions, regulations and Conditions as described in Decision Report 2000-50; specifically pertaining to:

- **Plant and waste management facility location**
- **Ground level ozone and VOC monitoring**
- **Groundwater monitoring wells**
- **Surface water quality monitoring, and**
- **Participation in Regional Initiatives**

Waste Management



- **Waste management plan in effect at site since January, 2005**
- **Have a waste handling area which provides secondary containment**
 - **upgraded waste storage area expected in 2007 Maintenance program**
- **Waste Services contract signed June 20th/06**
 - **addresses hazardous, recycling, domestic and landfill**
- **Waste Tracker software used to track and submit manifests to EUB**

Release Management



7 EUB reportable releases within time period

- 1 release followed up by EUB inspector
 - March/06, Boiler feed-water into lined tank farm (80m³)
 - Satisfactory inspection received

Spill mitigation team initiated in 2005

- Highlighted repeat or high potential spill areas and developed forward plans
- Forward progress with maintenance capital items (e.g. spill boxes, permanent lines, etc).

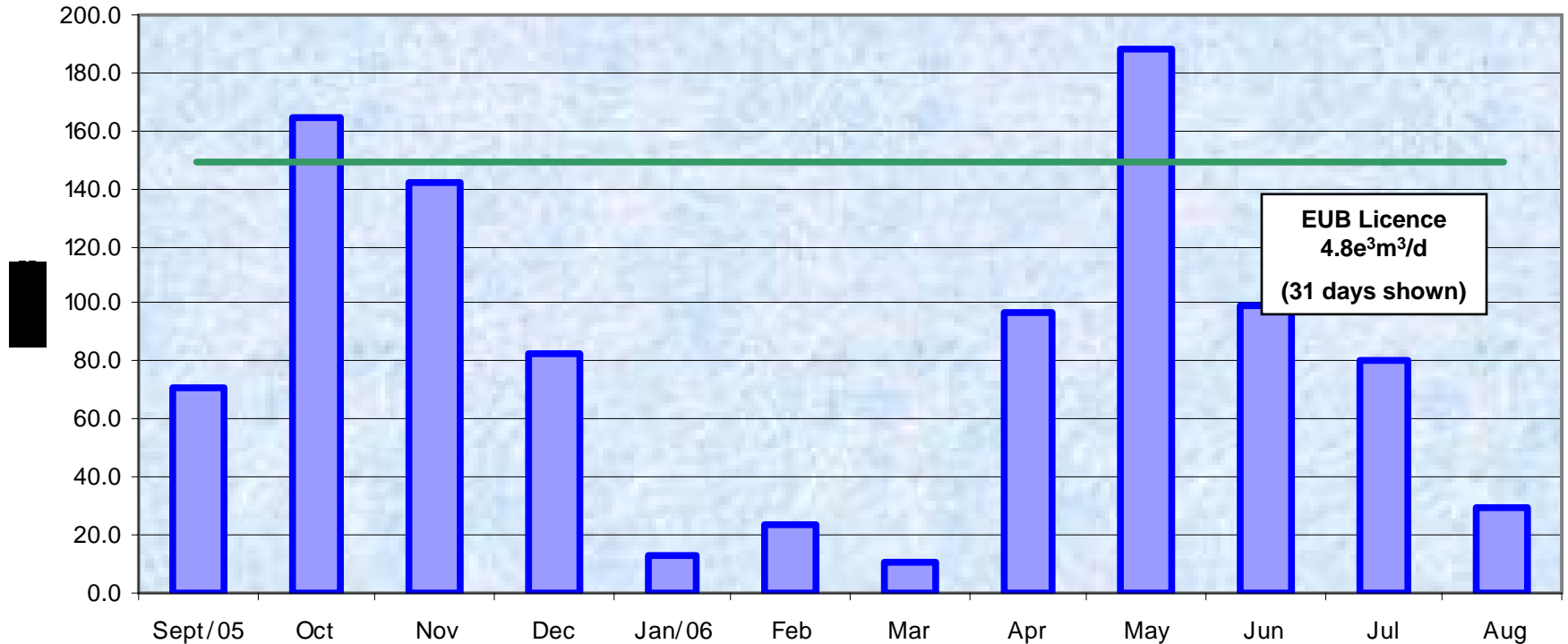
MacKay River Landfill

AEUB approval WM-072



- Volumes of solids to landfill (Sept 1/05 to Aug 31/06):
 - Lime: 7,263 m³
 - Salt: 9,753 m³
- Volumes of leachate to facility (Sept 1/05 to Aug 31/06):
 - Lime: 1,959m³ (on site lagoon)
 - Salt: 7,473m³ (on site lagoon)
- WM-072A approval received August 9th/06 for construction of Phase II landfill cells
 - Combined cells (salt & lime) instead of separate
 - Construction estimated to be complete November/06
- Two 'Unsatisfactory' landfill inspections (minor level 1) received
 - Jan/05 due to liquid carryover onto roadway from lugger truck
 - Jul/06 due to piling of waste in the cells to close to the liner edge
- Two salt cell liner damage events (Dec/05 & Jun/06) due to operator error

MacKay River Flared Gas



Flaring within limits for all months other than Oct/05 and May/06

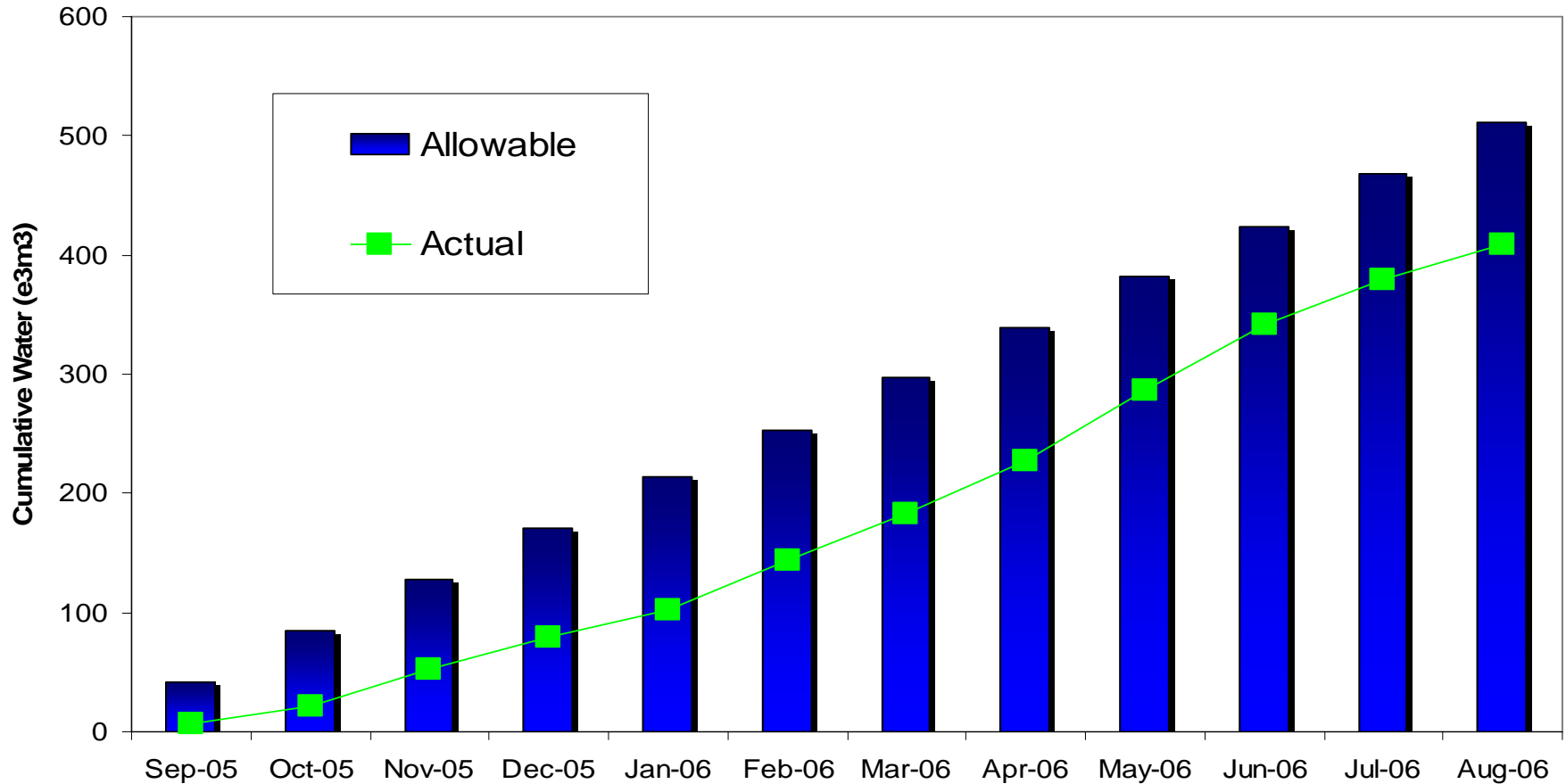
- Notification provided to EUB (verbal/written)
- Oct/05 a result of VRU troubleshooting
- May/06 a result of unplanned shut-down due to warm lime softener issue and VRU start-up
- Flare meters planned to be installed in 2007 maintenance capital program

Ground Water Monitoring



- **Ongoing groundwater monitoring (bi-annually), as per proposal submitted to AENV in November, 2000 and approved by AEPEA 48408-00-01.**
- **Fall/05 and Spring/06 field program completed within time frame**
- **To date, no groundwater contamination identified at facility or at the landfill**

Raw Water



- Regulatory allowable limit is $3.23e^3m^3/day$ ($511e^3m^3$ per year)

Surface Water Quality



- **Petro-Canada monitors surface water quality bi-annually, in spring and fall**
- **Petro-Canada also actively participates in the Regional Aquatics Monitoring Program (RAMP)**
- **Reports submitted to AENV by April 30th of each year**
- **To date, no significant findings from MacKay River**

Regional Initiatives



Petro-Canada is active in the following....

- CEMA SEWG
- CEMA NSMWG
- CEMA SWWG
- CEMA RWG
- CEMA CHR
- Area Y Spill Co-op
- CEMA TEK
- CEMA WL&F
- WBEA
- RAMP
- RIWG



Future Plans

Future Plans



- **Commissioning of Capacity Upgrade Project equipment**
 - **Late 2006 to early 2007**
- **Ramp up production rates closer to regulatory limit with Pad 22**
- **Begin facilities construction on Pad 23 early 2007**
 - **First steam planned for Q4, 2007**
- **Assess capital project to treat slop oil volumes**
- **Investigate application of lower pressure artificial lift**
- **Develop plan for Pad 24 exploitation**
- **Further testing on potential Keg River water disposal well**
- **Continue potential integration work with proposed MacKay River Expansion project**

Future Plans – MacKay River Expansion

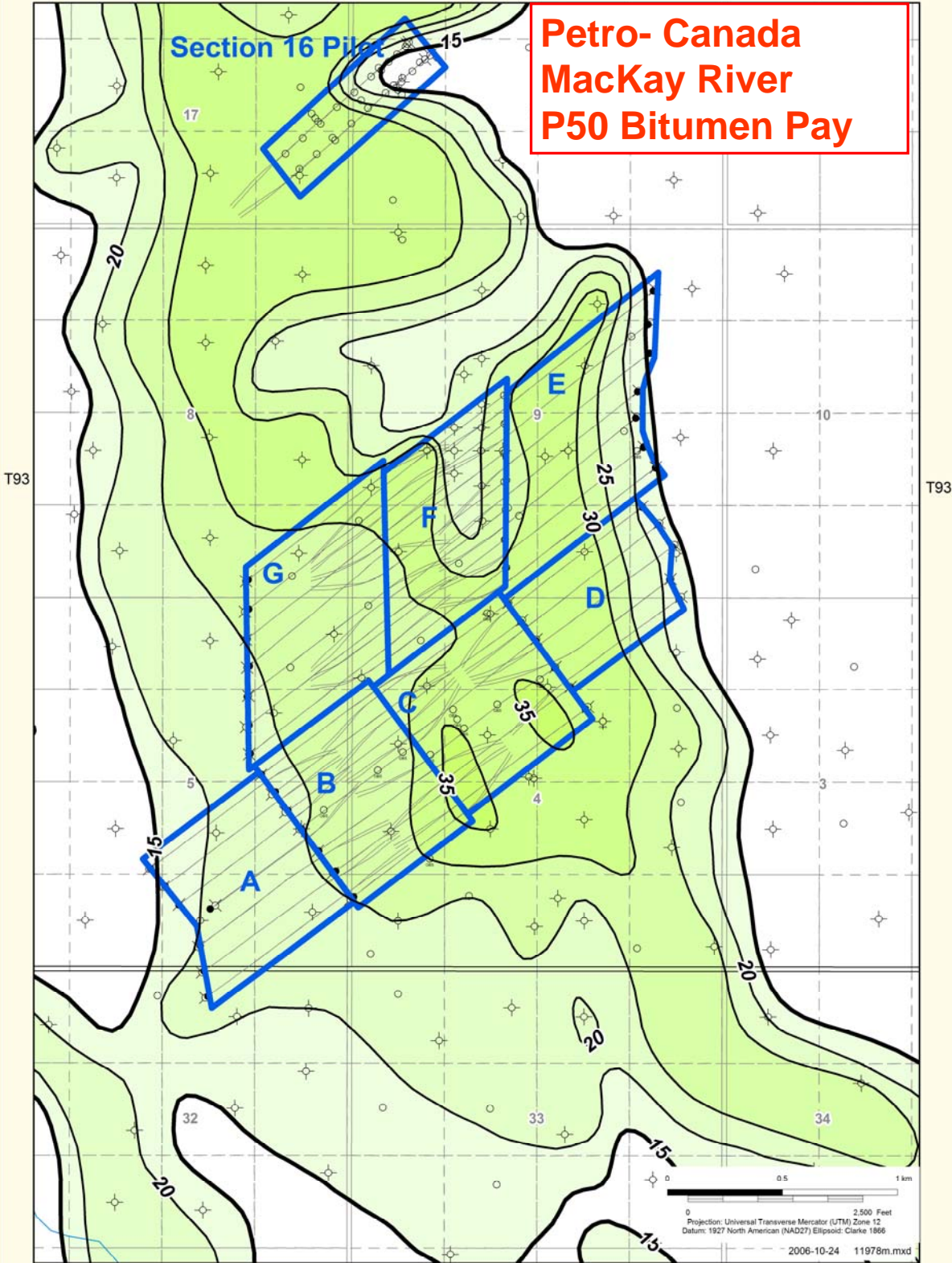


- **Commercial application filed November 2005; currently responding to AEUB and AENV Supplementary Information Requests**
- **Design Basis Memorandum complete and proceeding into Front End Engineering Design work**
- **Continued corehole exploration and delineation proceeding on MacKay River and Dover lands.**
- **Drilling observation wells planned for Q1 2007**
- **Pad construction planned for Q1 2007 with well pairs immediately north of MacKay River Pads 22 and 23 planned for Q2 2007; planning two super pads (14 well pair and 28 well pair) with longer well pair horizontal sections**
- **Subject to regulatory and internal approvals, first oil planned for 2010**

R12W4

Petro- Canada MacKay River P50 Bitumen Pay

Section 16 Pile



R12 W4