

**Brintnell Overview**

**Location**

**Geology**

**Waterflood Performance**

**Polymer Flood Performance**

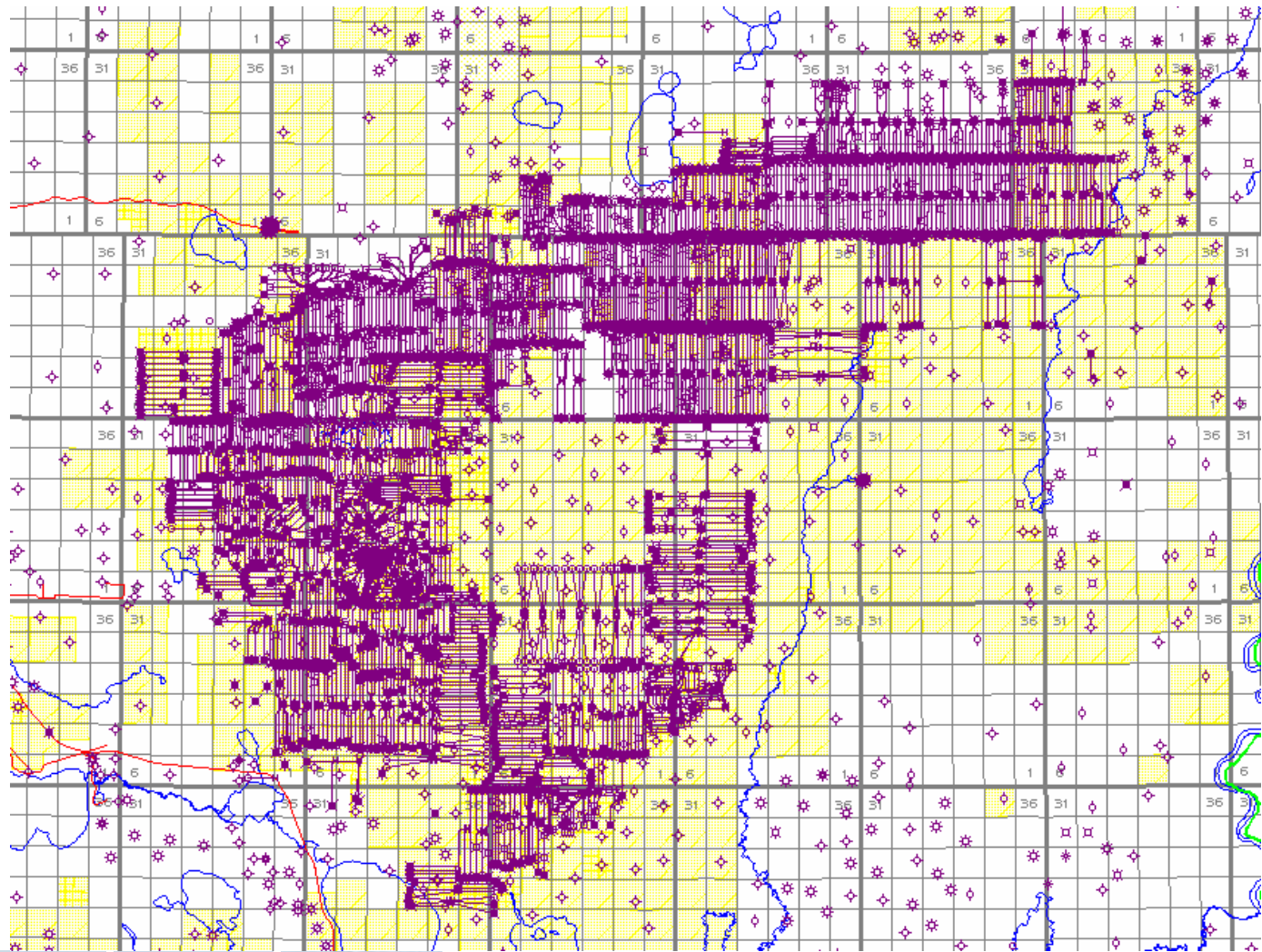
**Water Usage**

**Questions Questions Questions...**

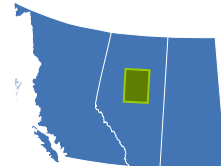
**Michael Moriarty P.Eng – Exploitation Engineer**

**Devin Lowe P.Eng – Exploitation Engineer**

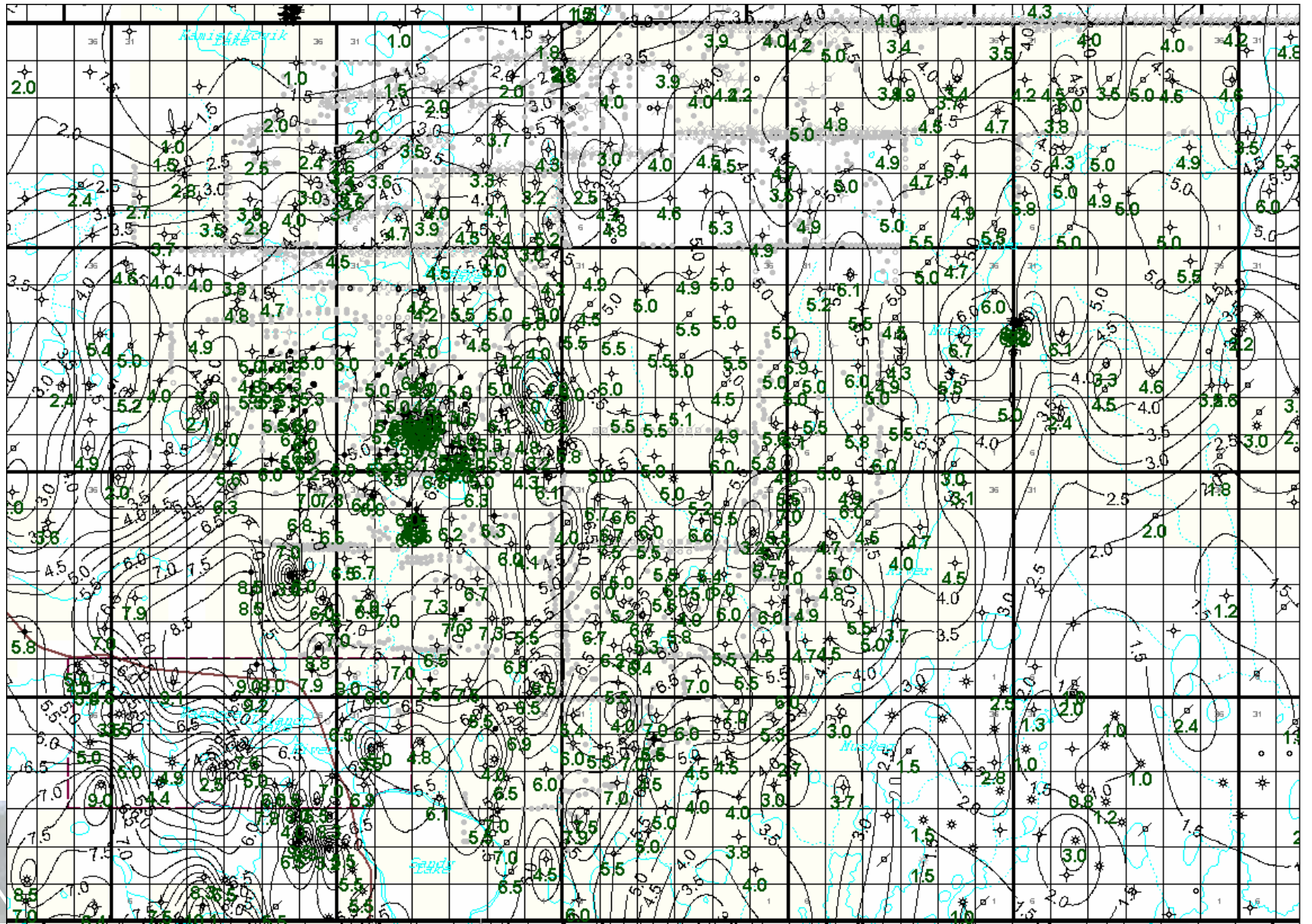
# Brintnell Field



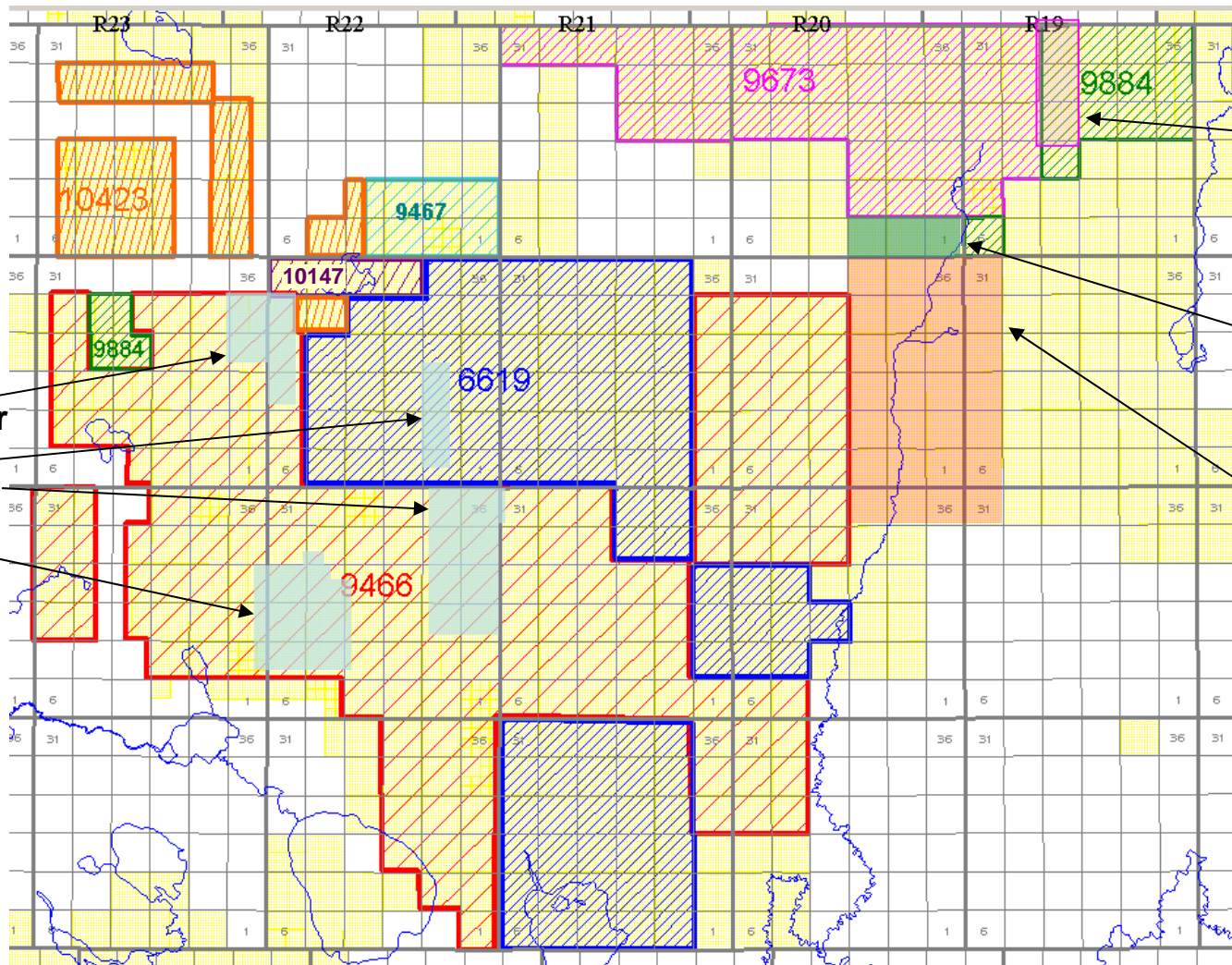
CNQ



# Net Pay Map



# Brintnell Field



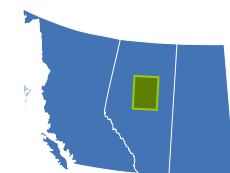
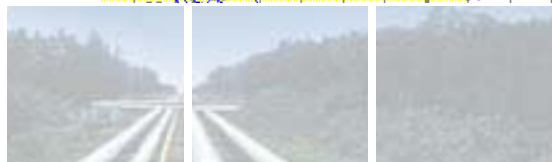
Application submitted for 9673 extension

Application submitted for 9884 extension

Application submitted for 9466 extension

Application submitted for 2007 Commercial Polymer Expansion

CNQ



- **Broad Overview**
  - **Shallow Marine Depositional Environment**
  - **Coarsening Upwards Sequence**
  - **Fine to medium grain size**
  - **Thickness varies from 4-7m**
  - **Porosity in the 30% range**
  - **Sw of 30-35%**

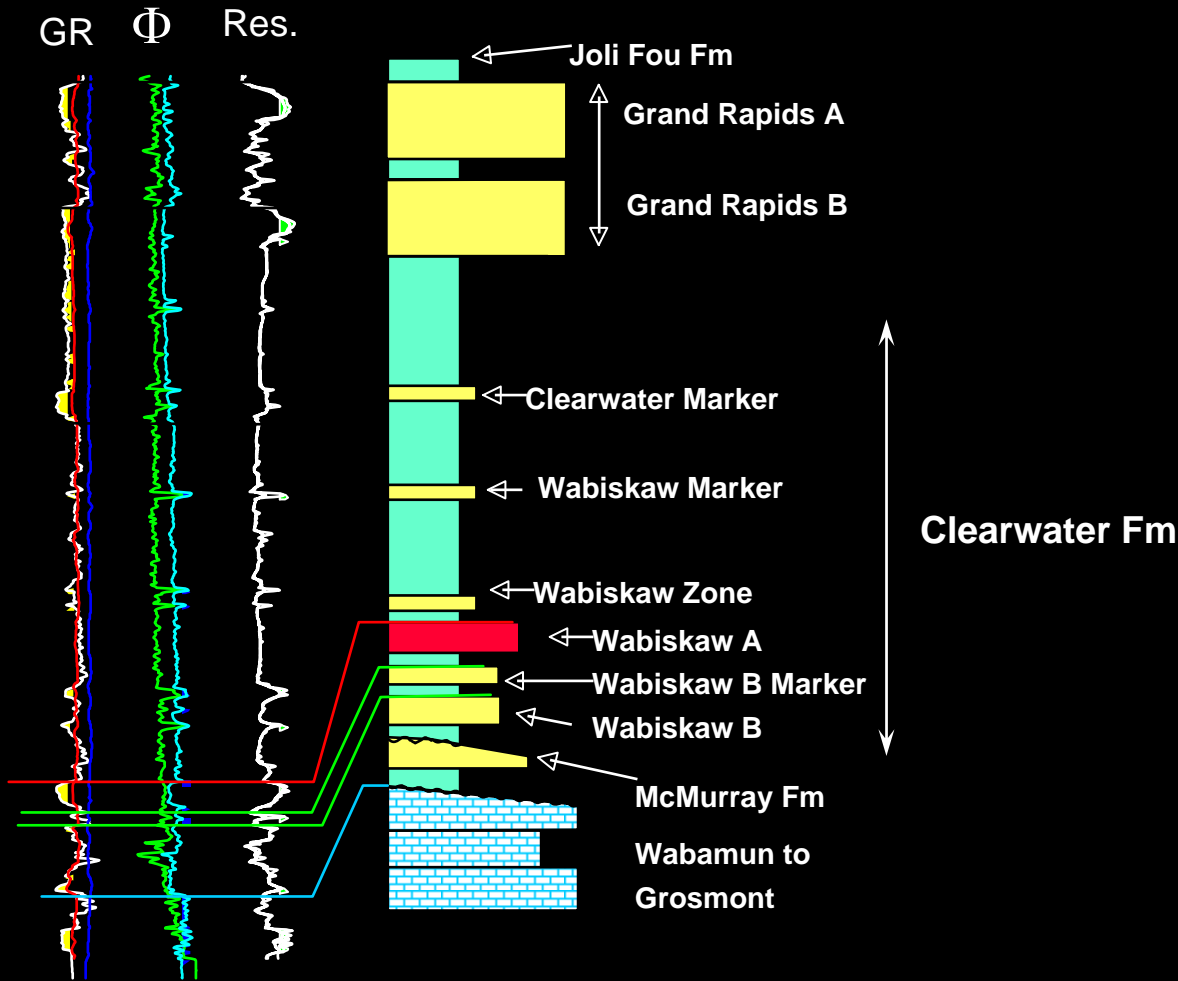


# Typical Stratigraphic Section



Typical Well Log

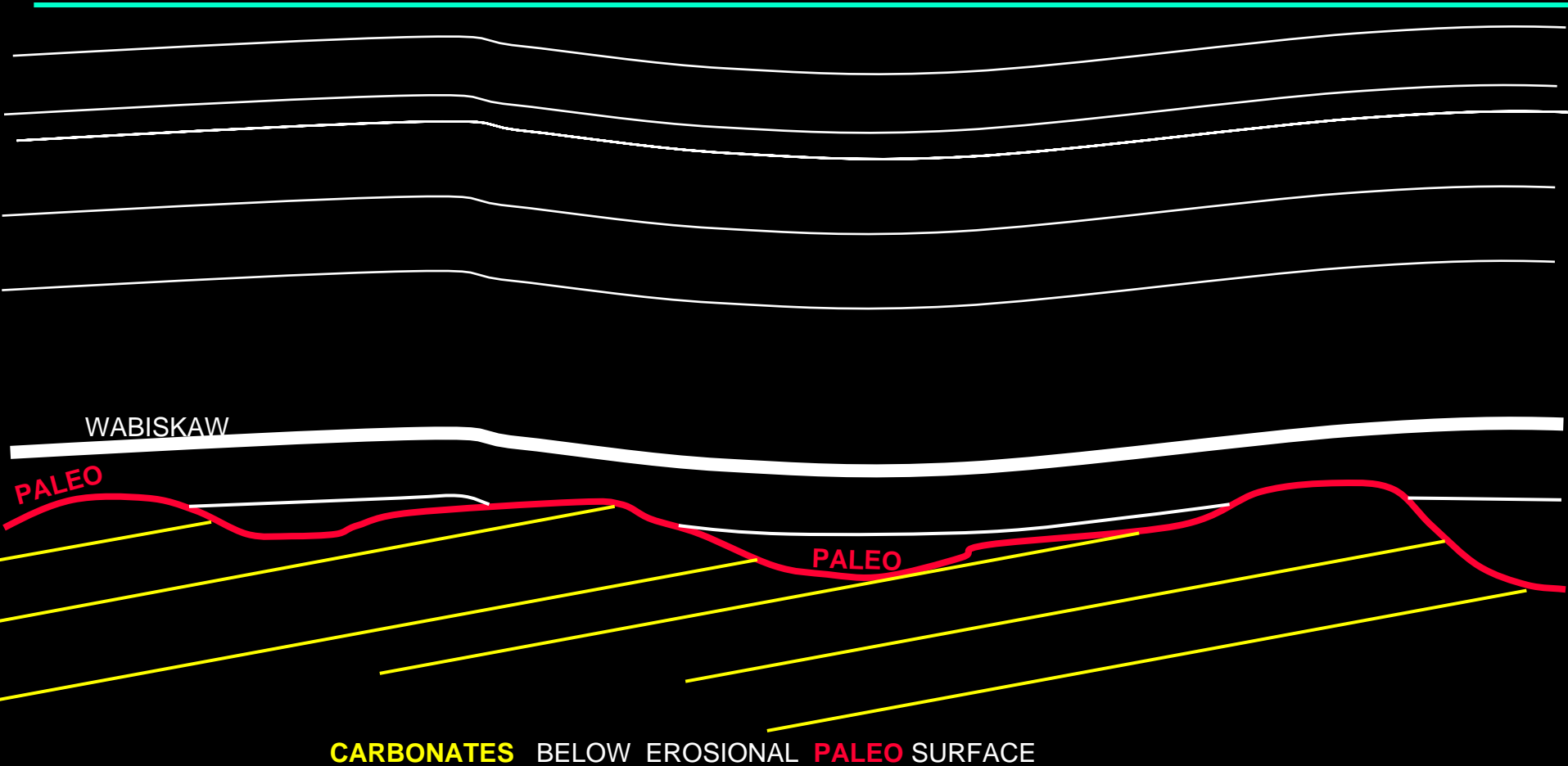
Stratigraphic Units



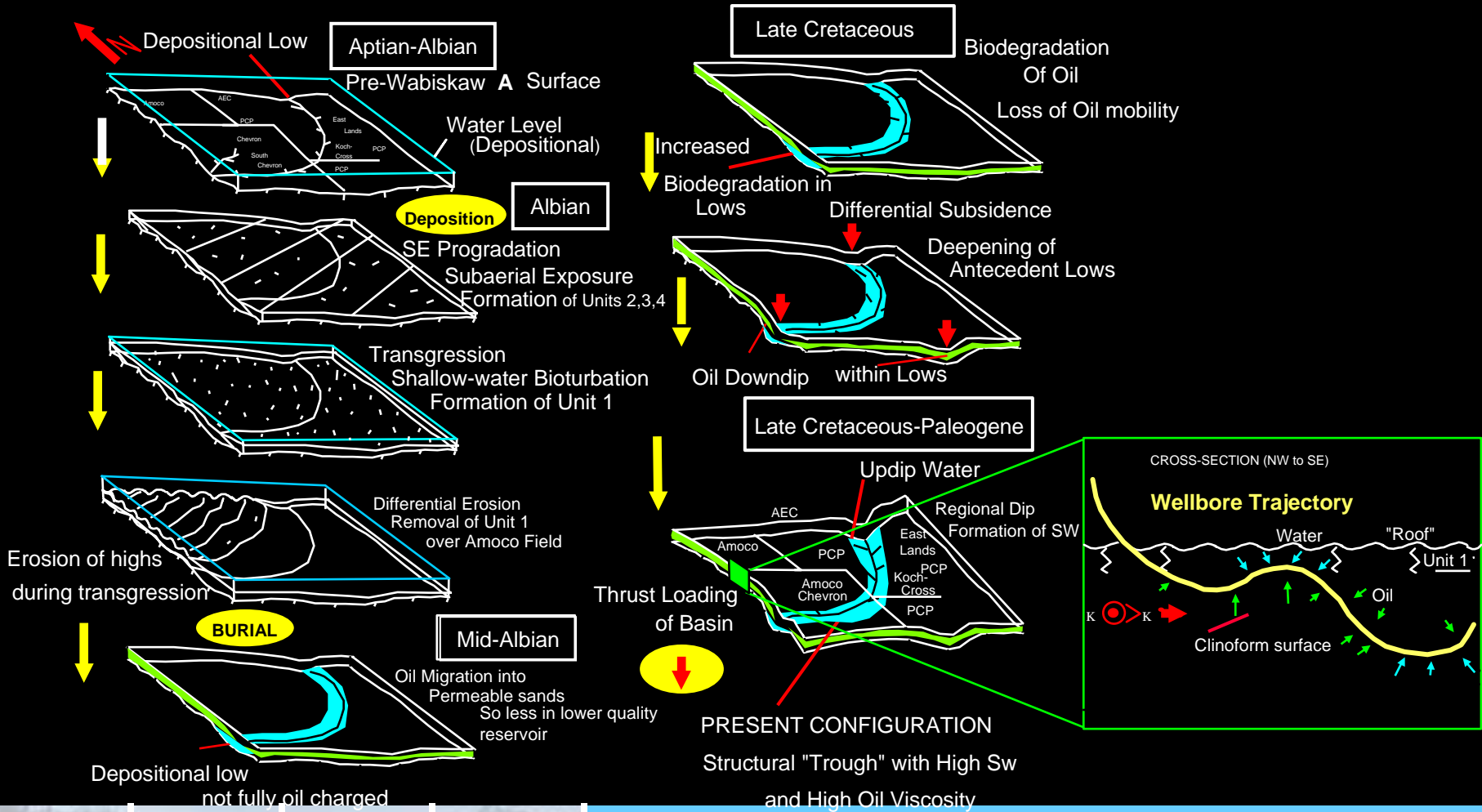
# Simplified Stratigraphic Model



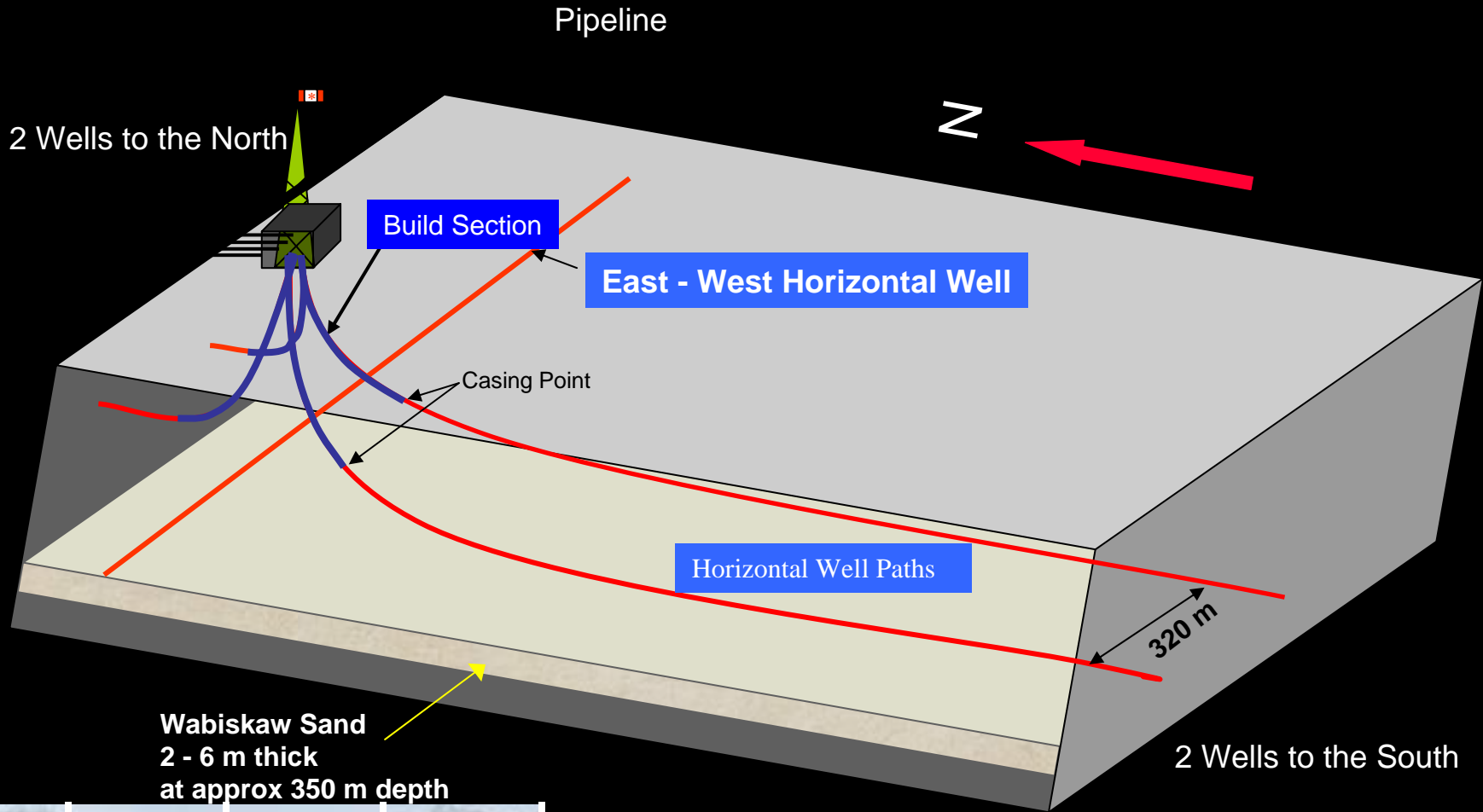
TOPO



# Depositional and Oil Migration Model Wabiskaw A



# Directional Wells

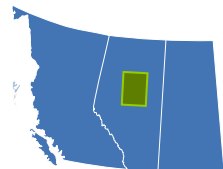


Wabiskaw Sand  
2 - 6 m thick  
at approx 350 m depth



## A Brief History

- **First waterflood commenced early 2003 in NorthHorseTail.**
- **Waterflood was expanded into North Brintnell in late 2003 and went commercial in early 2004.**
- **North Brintnell continues to expand with injector conversions ongoing in 2007 and plans to expand further in 2008**



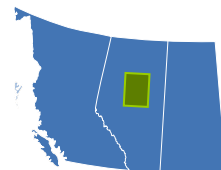
# Brintnell Waterfloods



## Compliance Issues

- CNRL is compliant with Regulatory Requirements
- CNRL is compliant with Approvals 9673 and 9467 Conditions including the G-51 requirement for a temperature log when the surface injection pressure reaches 2000 kPa. Temperature logs are being run and submitted as wellhead pressures reach 2000 kPa.
- CNRL is compliant with Gas Conservation guidelines.
- CNRL Field Staff and Contractors are respecting Landowner/Occupant concerns.

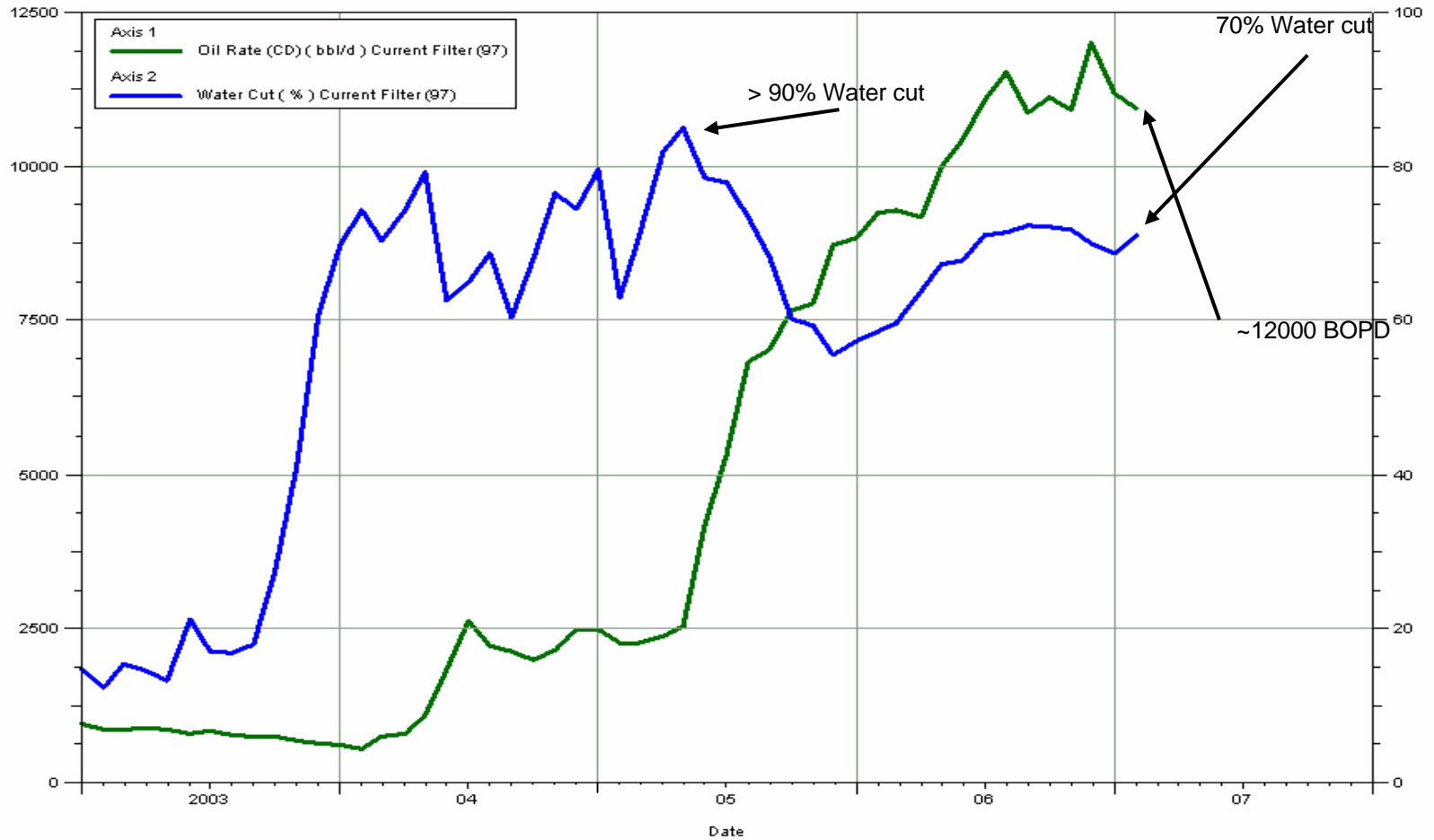
**All future expansion plans will be submitted according to EUB requirements and good reservoir practice is being vigilantly observed.**



# Waterflood Production



Brintnell CNRL Waterflood Production 2003 Forward



# NORTH HORSETAIL 9467



## Summary of Activities and Operations

Dec 2002 Submitted Application No. 1287680 for Enhanced Recovery by Water Injection

Jan-May 2003 12 Injection Well Conversions

Jan-Apr 2003 Drill and Complete 2 Grosmont Water Source Wells  
00/06-02-082-22W4, 03/14-11-082-22W4

Apr-May 2003 Submit G-51 Applications for 12 Water Injectors

May 2003 Additional Information Request for Application No. 1287680

Jun-03 Prelim approval received, Injection into 12 injectors commences

Jul 2003 Approval No. 9467 Issued; injection target 225 m<sup>3</sup>/day/well

Aug 2003 Increase Water Source Deliverability

Aug-03 First Flood response seen 3 months after injection commenced.

- increase in water production
- GOR on field decreases

Sep-Oct 2003 Increase Injection Target to 375 m<sup>3</sup>/day/well

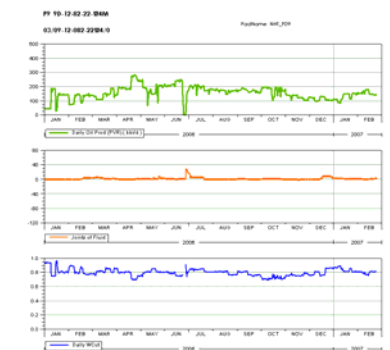
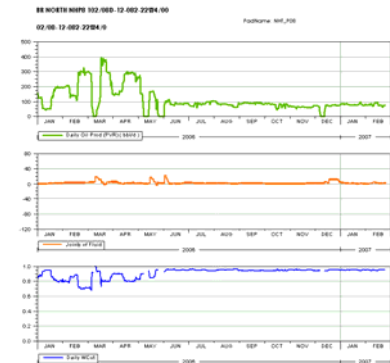
Oct 2003 Chemical Tracers Injected into 12 Water Injectors

Feb 2004 Stabilization of oil decline. From this point Oil production begins to increase

Apr 2004 Fill up stage on several patterns considered complete, pattern balancing begun

## Most Recent:

**(Fall 2006) Conformance treatment using 0.6% Alkali completed with no success observable**



## Scheme Performance

- Water injection rate started at 225 m<sup>3</sup>/day/well at 0 injection pressure
- Water Injection rates currently averaging 165 m<sup>3</sup>/day/well with surface injection pressure averaging 850 kPa; maximum allowable injection pressure is 3500 kPa
- Best overall response on west side of flood. Wells being optimized. Good response in northeast quadrant of flood. Wells being optimized. Southeast quadrant of flood experienced early breakthrough. Area closest to gas cap - potential pathway contributing to fingering. With controlled injection rates and balanced voidage replacement, southeast wells have begun producing oil.
- 2 Grosmont water source wells. Currently only one operating/required. Current injection rate 1730 m<sup>3</sup>/day.
- OOIP for Waterflood patterns: 68.9 mmstb (10.95 e6m<sup>3</sup>)
- Primary Recovery Factor: 6.5%
- Incremental Waterflood Recovery Factor: 7.5% to 10%

### Most Recent:

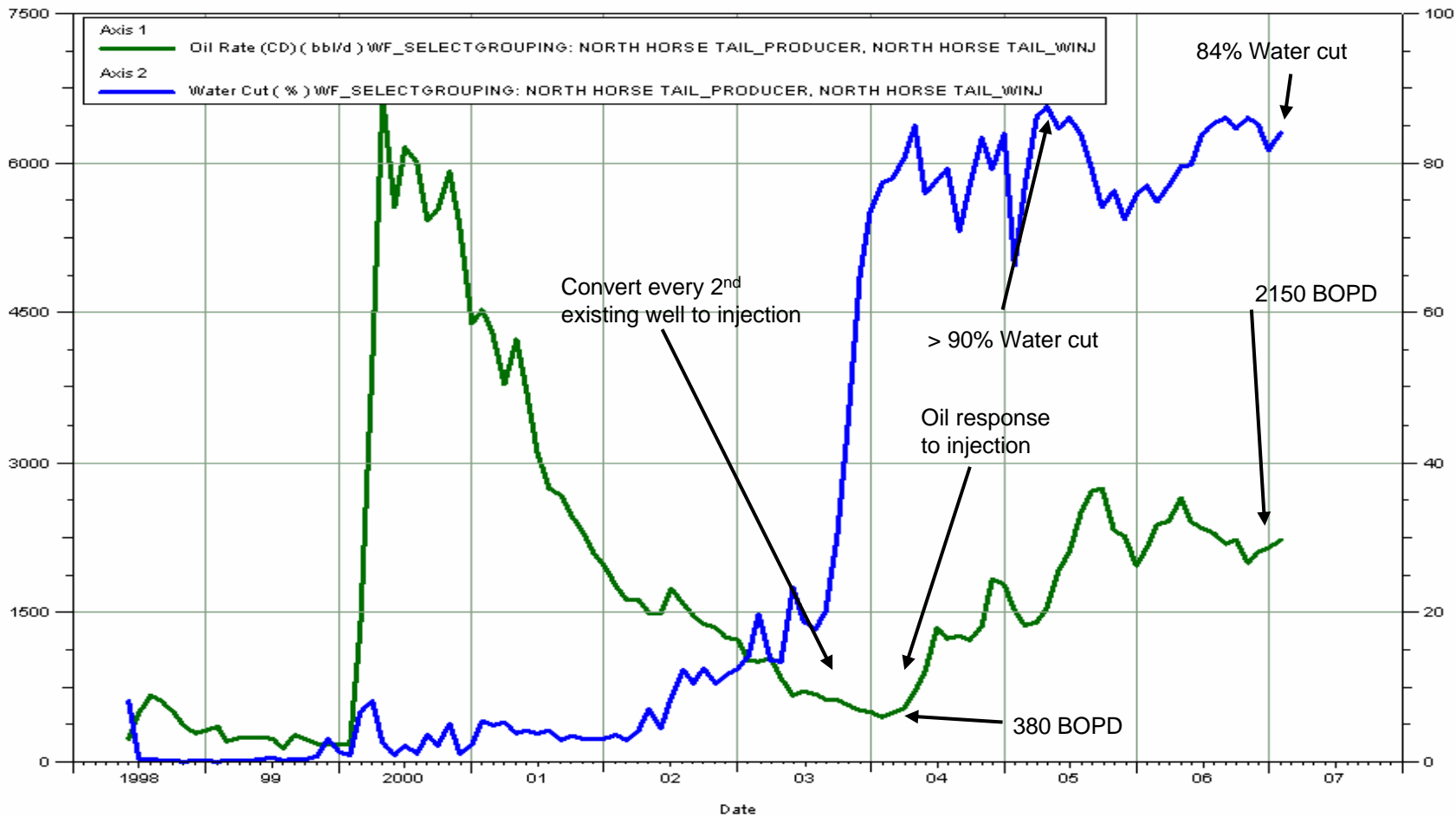
**2006/2007 has shown success in maintaining low production decline**



# NORTH HORSETAIL PRODUCTION



Brintnell CNRL North Horsetail Waterflood Production



# North Brintnell 9673



## Summary of Activities and Operations

July 2003 Submitted Application No. 1307897 for Enhanced Recovery by Water Injection into 16-31-82-19W4

Nov 13, 2003 Approval 9673 approved for injection into 16-31-82-19W4/0 (NBP31)

Jan 2004 Injection commences into 00/16-31-82-19W4/0  
Source well is F1/05-23-81-18W4

Jan 2004 Submitted application 1329772 to ammend approval 9673 and 7964 (primary) for Enhanced recovery by water injection into commercial area

- area includes 71 producing wells
- 84 infill wells to be drilled

Jan 2004 First 160 m infill wells drilled into pool

May 2004 Process of converting wells to injection commences

- several wells cleaned out with CTU
- 20 infill wells drilled, 4 each on Pads 6, 7, 8, 9 & 10 in 82-21W4
- Pad 20 in 82-20W4 drilled up with 4 producing wells
- five infill wells drilled with high gas rates on Pad 22, 23 and 25 in 82-20W4
- Infills ons pads 11, 12 & 13 were moved to 2005 drilling que
- two source wells drilled, one on Pad 6 and one on Pad 9

Jul 28, 2004 Commercial waterflood approval received

- spacing reduced to 150 m interwell distance
- G-51 approval received for wells converted to injection



# North Brintnell 9673

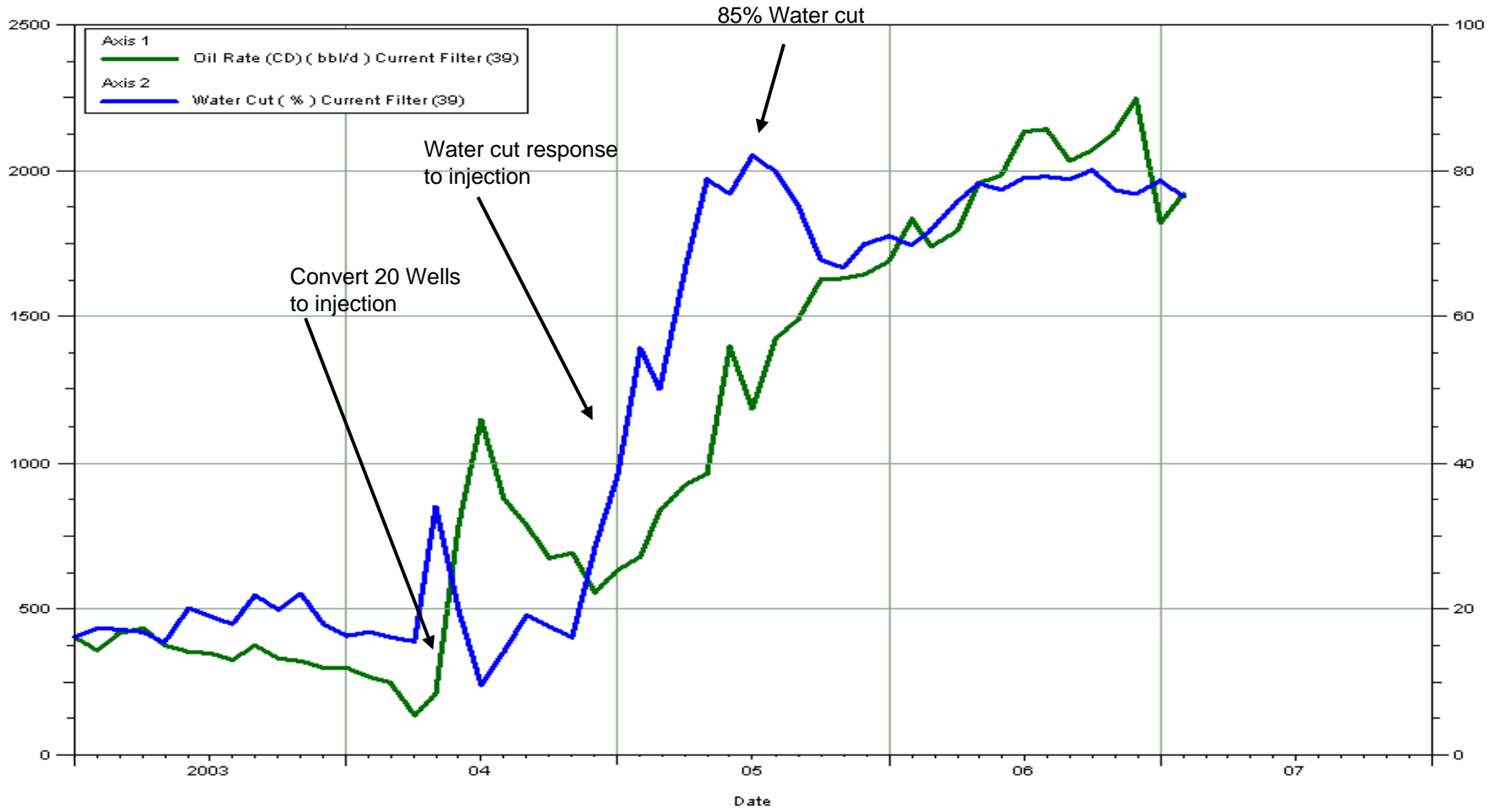


- Aug 2004 Injection begins on P6 through P10 total of 17 wells
- these pads all have infill wells drilled on 150 m spacing
  - Infill producers on production average of 3 months prior to injection starting
- Sept 2004 12 wells on Pads 11, 12 and 13 converted to injection
- pads have no infill locations drilled into them
  - injection commences P11-13
  - Last well on Pad 9 begins injection
- Oct 2004 Pressure sensor run into road well on Pad 13 8-26-82-21W4. Well is shut in. Tracer added to injection streams of 4 injectors (NBP8 16D-34-82-21W4, NBP10 16C-35-82-21W4, NBP11 14C-36-82-21W4, NBP12 15D-26-82-21W4)
- Nov 2004 Increased water cut on first well on Pad 8 02/1-22-82-21W4
- Sept 2005 Pads 6-10 majority of wells showing waterflood response as increased oil and water production. Oil rate at 250 m<sup>3</sup>/d up from minimum of 100 m<sup>3</sup>/d  
Pads 11, 12, 13 infill producers drilled April-June 2005.
- Fall 2005 Pads 14-17 downspaced and put on production with encouraging results
- 2006 Pads 18-22 Downspaced and put on production, 4 injector conversions to be undertaken in fall 2006. Pads 30 and 31 downspaced and put on production with encouraging results.

**2007 Plans include continuing injector conversions in line with our outstanding board applications**



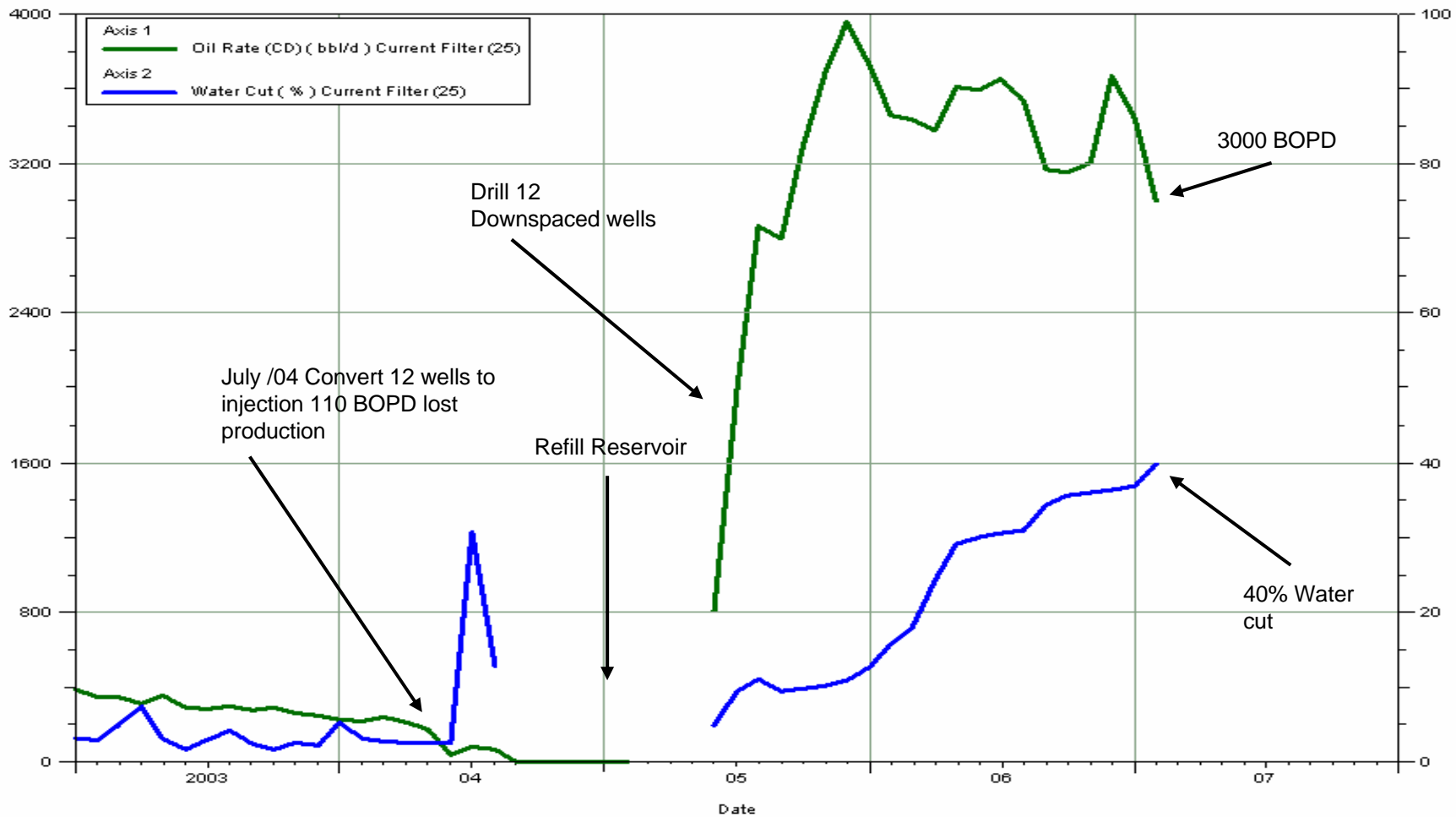
# NORTH BRINTNELL P6 – P10



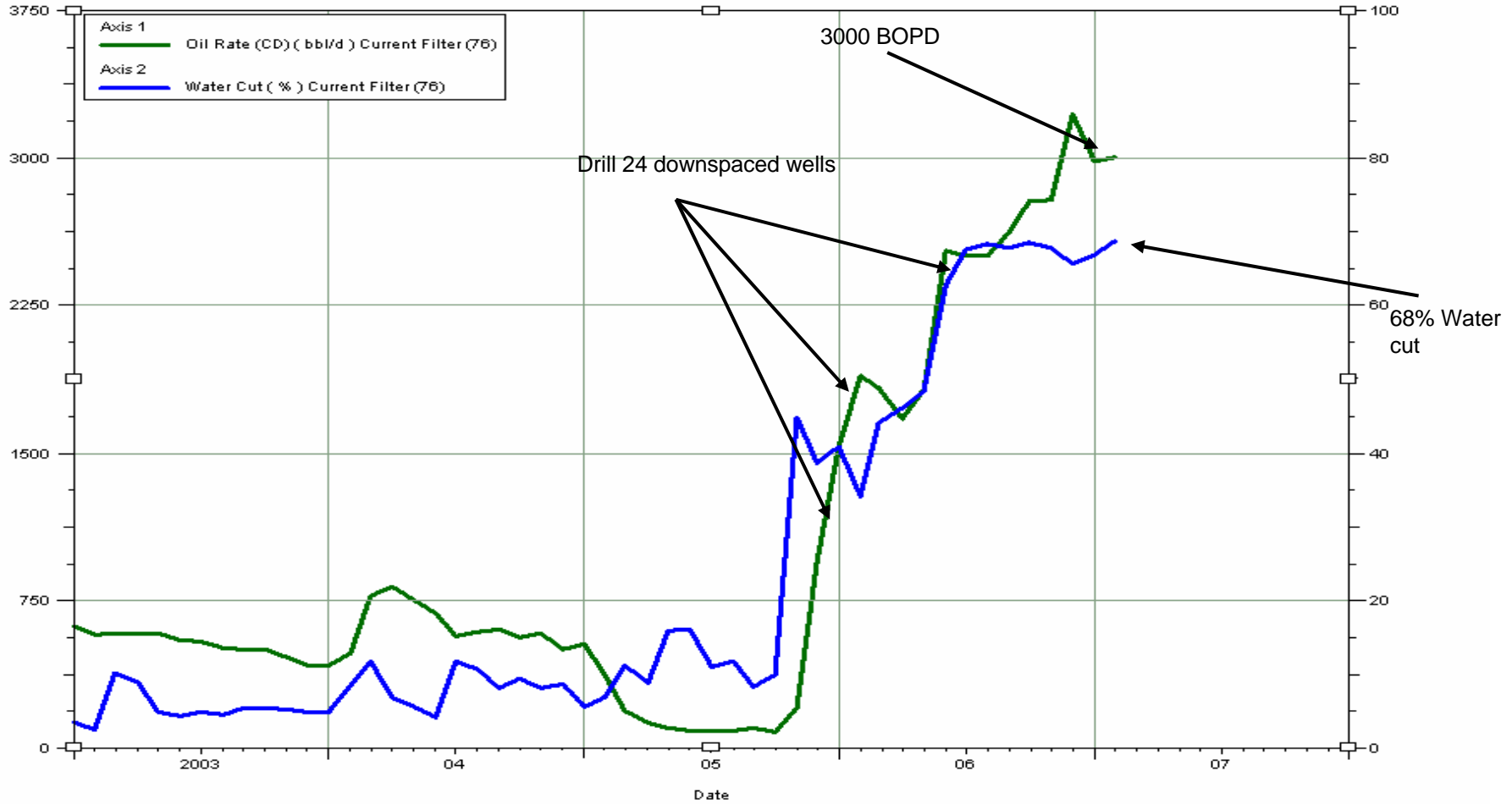
# NORTH BRINTNELL P11 – P13



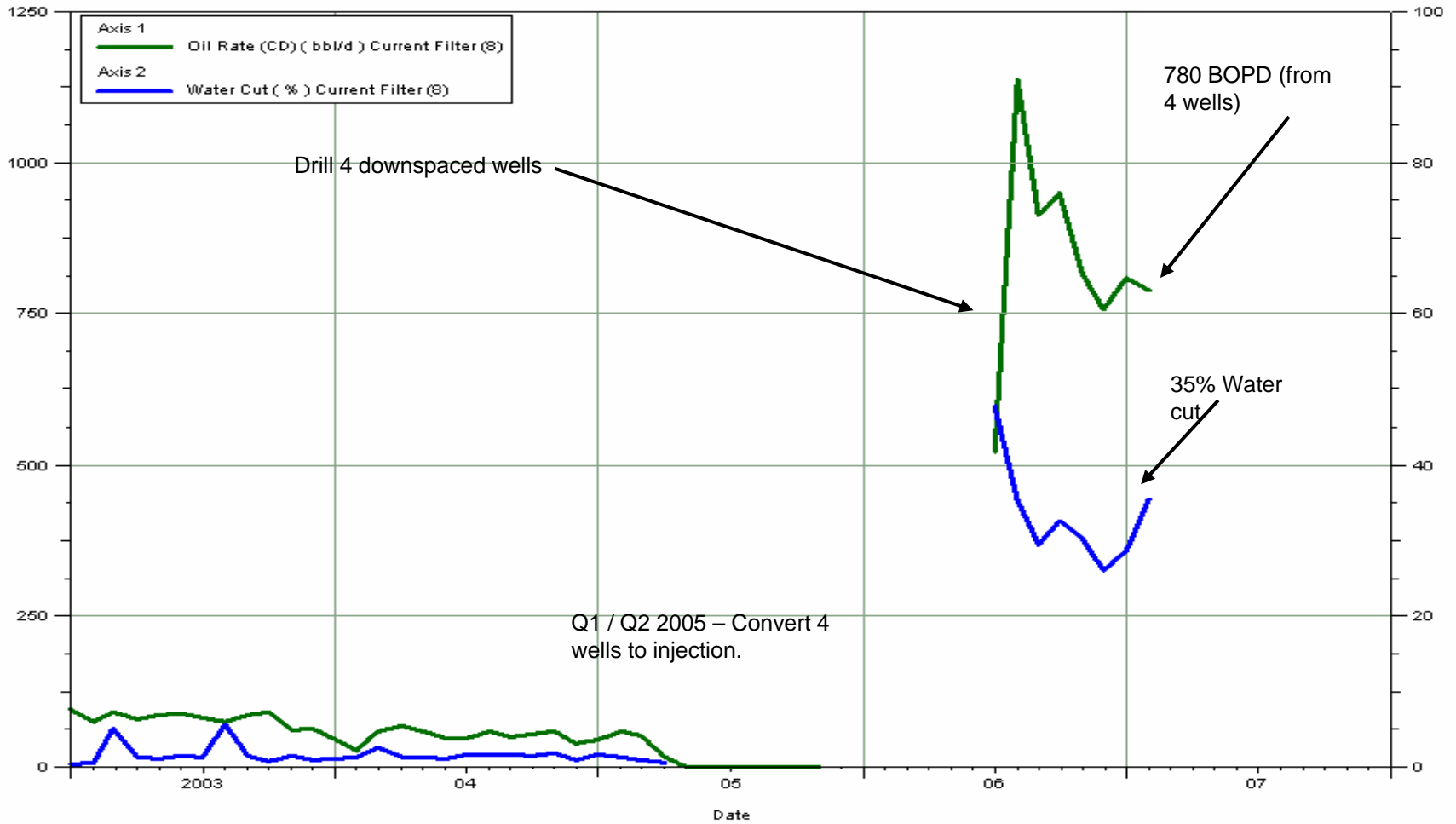
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# NORTH BRINTNELL P14 – P20

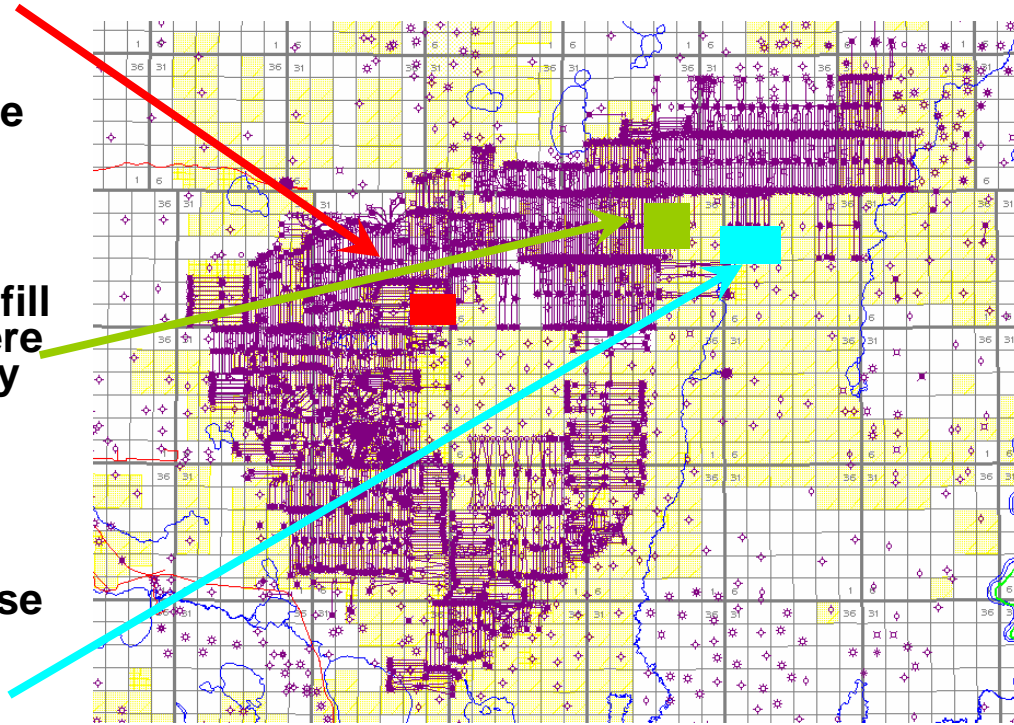


# NORTH BRINTNELL 30,31



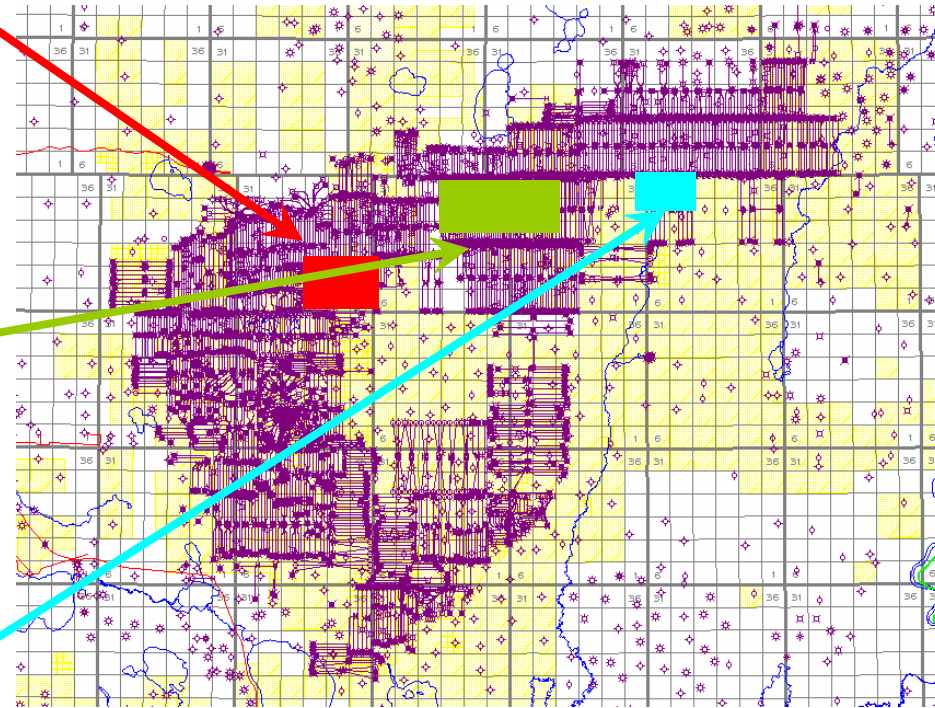
# Waterflood Challenges

- South East  $\frac{1}{4}$  of North HorseTail had a gas cap, high watercut wells in the area since injection commenced leads us to believe that water is short cutting through the depleted gas cap and bypassing oil pay. Controlled injection and balanced voidage are mitigating the difficulties.
- North Brintnell Pads 19-22 have shown resistance to building pressure during fill up period before downspaced wells were drilled, new wells have come on slightly lower than expected. Efforts are now being made to ensure all technical solutions are being considered.
- North Brintnell Pads 29-32 show promise but south wells on these pads show higher viscosity. The 2007 plan for this area is to pilot 4 patterns with downspaced drilling and injection to prove up heavier oil water flooding.

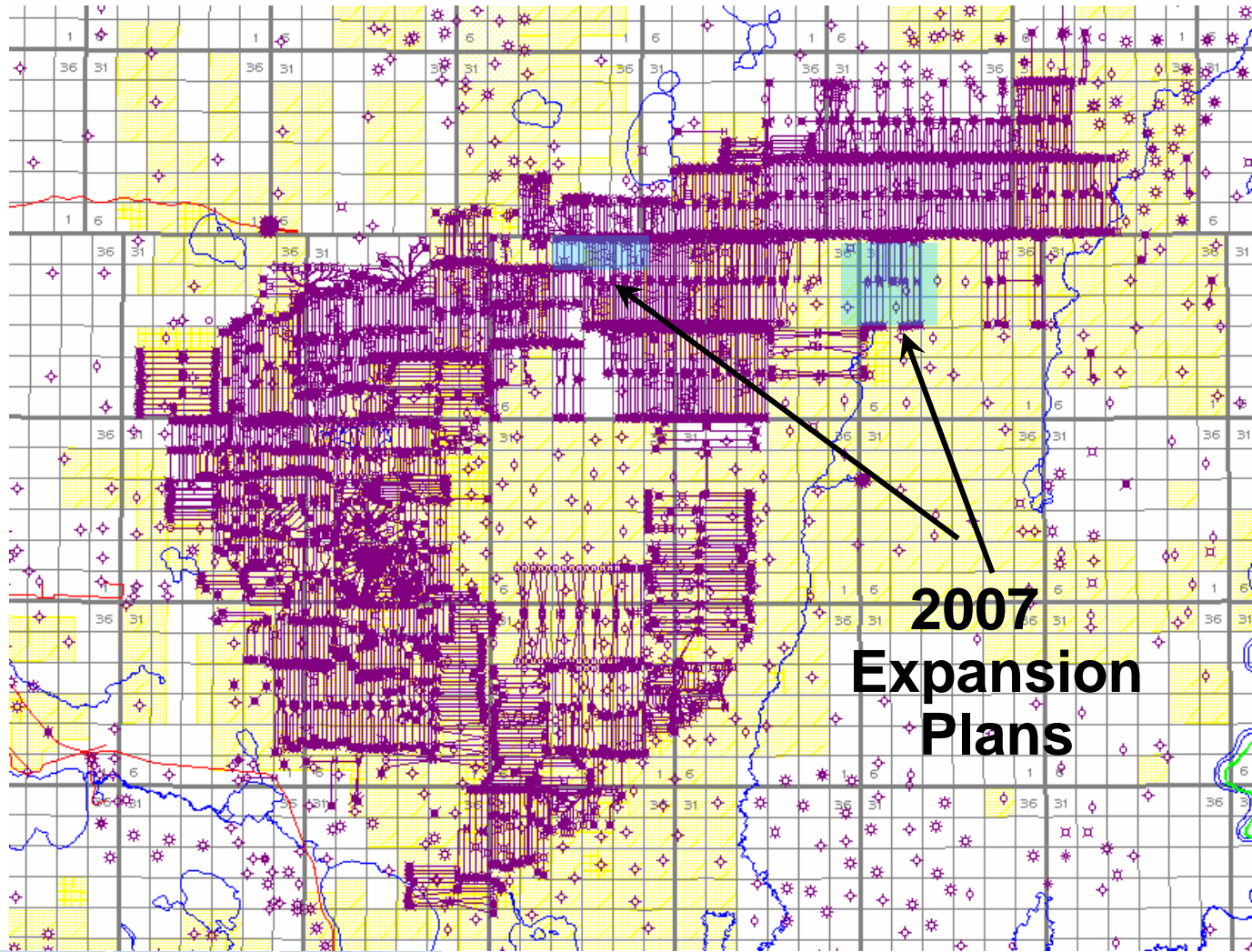


# Waterflood Successes

- North Horsetail still producing above expectations. Pattern balancing and voidage maintenance have restored water cut from all time high in the 95% range
- North Brintnell Pads 6-18 have responded favorably and continue to maintain reasonable watercuts. Emphasis on Pads 11-13 reveals an extremely low watercut for a heavy oil waterflood (40%).
- North Brintnell Pads 30 and 31 peaked at over 1000bbls/day combined and have recovered to a sub 50% watercut. Early indications are that these patterns will exceed expectations.



# Waterflood Expansion



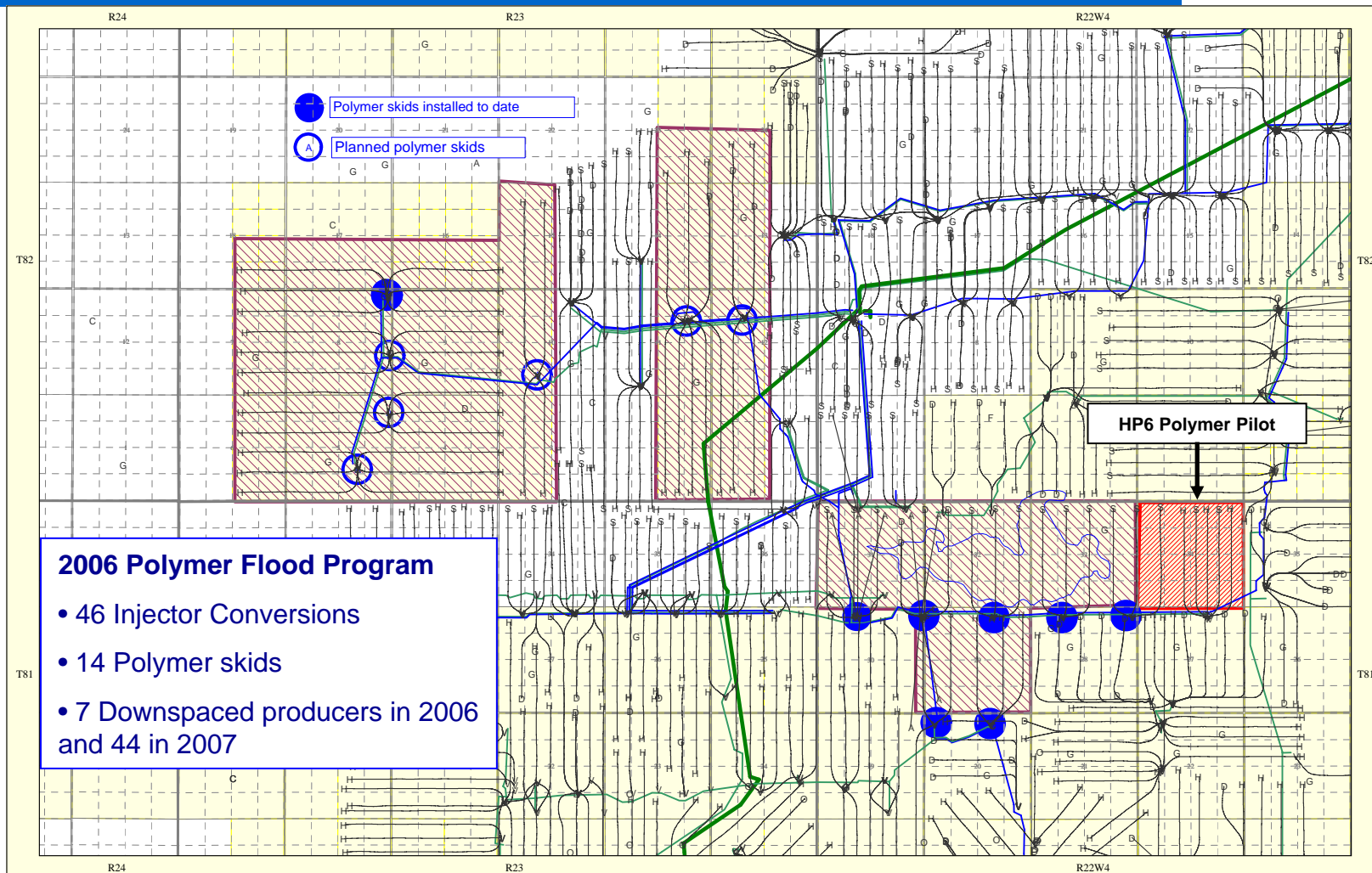
# Polymer – Like Water but Gooier...



## *Why Polymer?*

- **By raising the viscosity of the flood fluid we reduce the mobility of the injected fluid- mitigating viscous fingering**
- **By modifying the mobility ratio we extend the potential for enhanced recovery by flooding to heavier viscosity areas**
- **The polymer provides us with a new level of control by allowing us to vary the concentration and thereby the viscosity of the injected fluid to better respond to changing response at the production wells**
- **Production at lower watercuts helps control costs by reducing total fluid handled.**

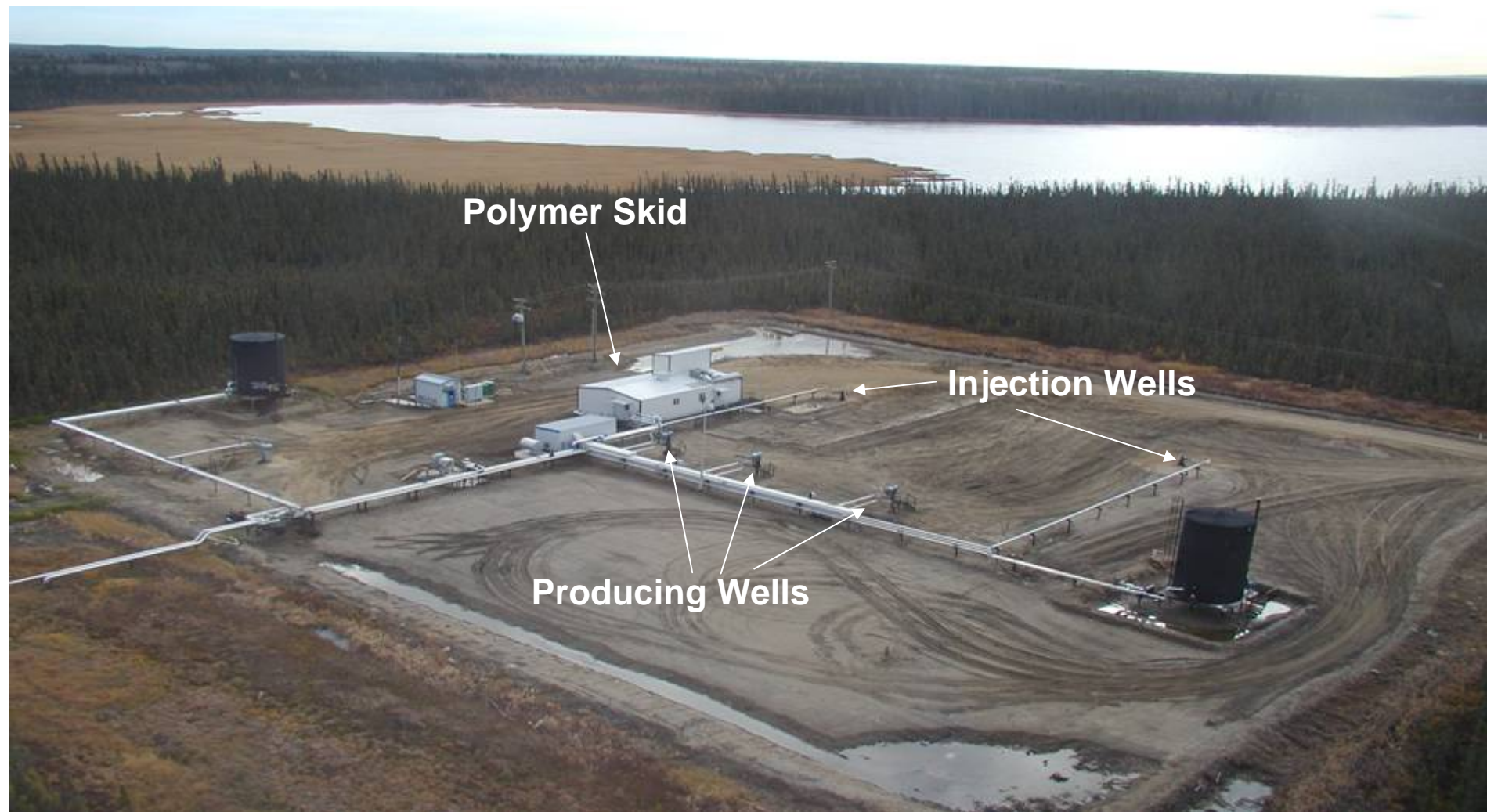
# 2006 COMMERCIAL POLYMER FLOOD PROGRAM



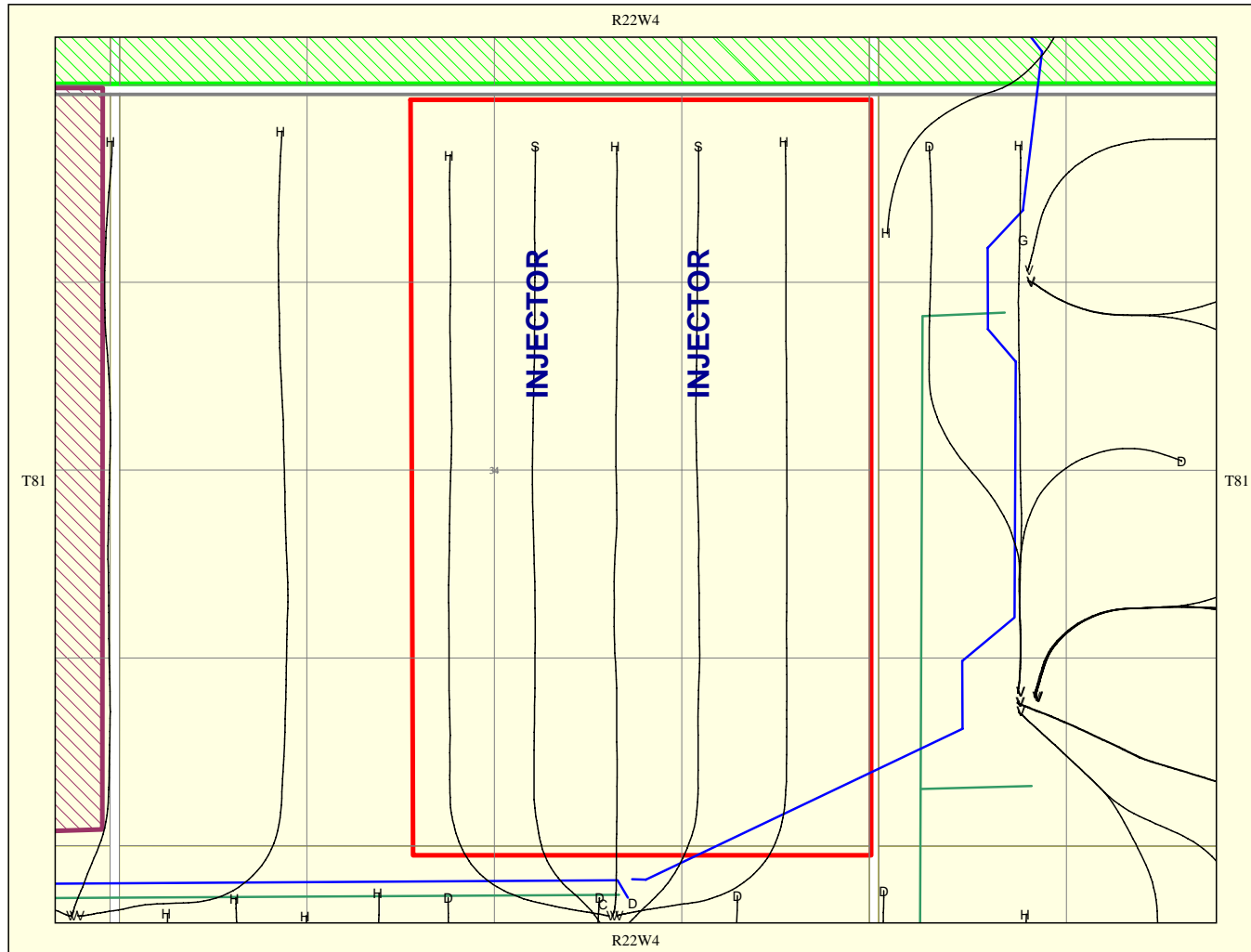
File: NHT POLYMER FLOOD Brnt Map fo Datum: NAD 27 Projection: Stereographic Center: NS6.07853 W113.47993 Created in ArcMap™, a product of ESRI



# HP6 POLYMER PILOT



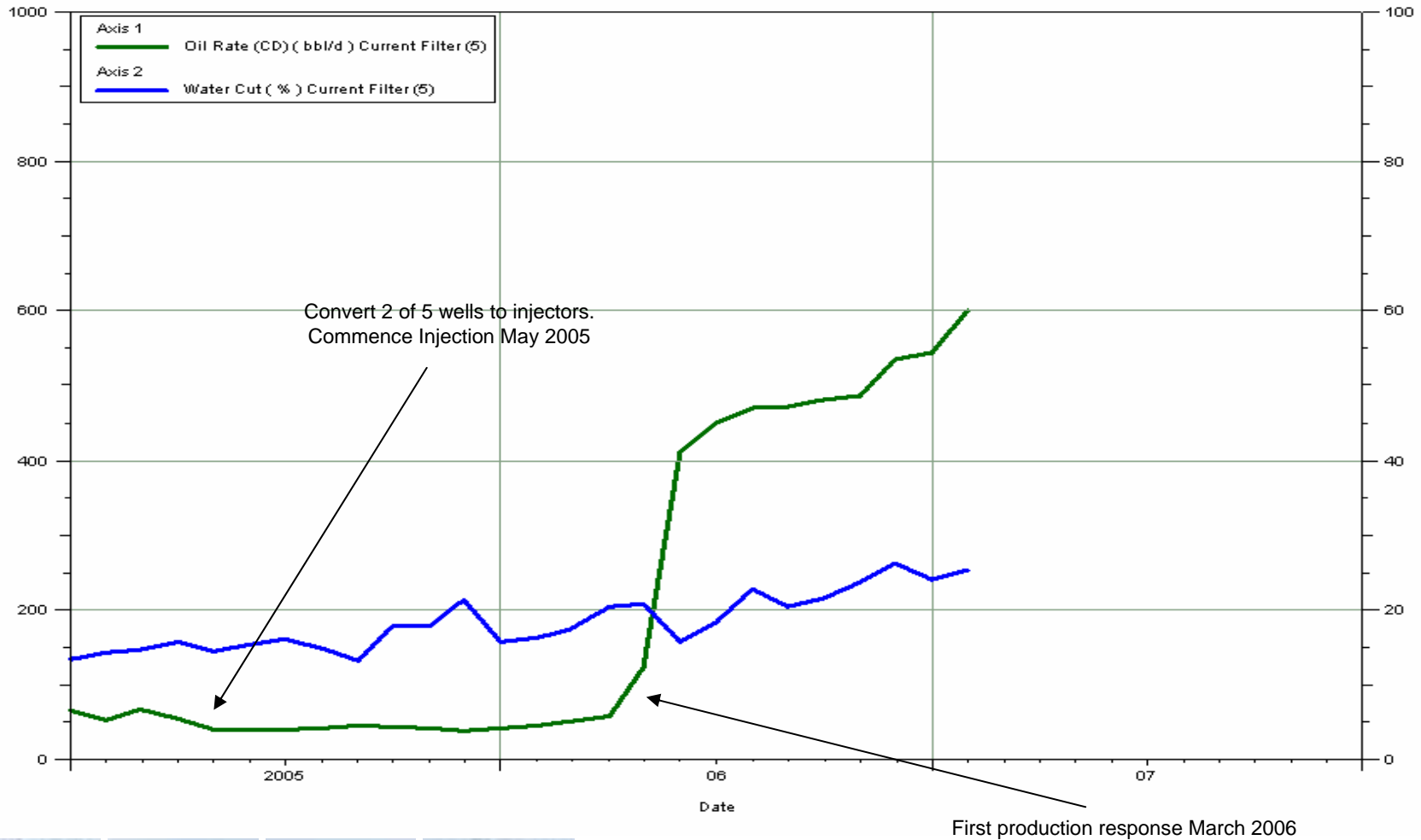
# HP6 POLYMER PILOT



File: Polymer Pilot for MSMM.MAP Datum: NAD 27 Projection: Stereographic Center: N56.06391 W113.35370 Created in AccuMap™, a product of IHS Energy



# HP6 POLYMER PILOT



# 2006 Polymer Flood Program



- **Infills were drilled on HTP1 and HTP2 (7 wells) in November 2006**
- **Rates have been as expected with little decline.**
- **HTP1 will be switched to fresh water only injection in Q2 to test effects of water after polymer**
- **Infills were completed on NHTP16 in early February 2007**
- **Preliminary results are encouraging with initial rates in expected range**
- **Continuing with infill drilling program throughout 2007**





# 2007 COMMERCIAL POLYMER FLOOD PROGRAM

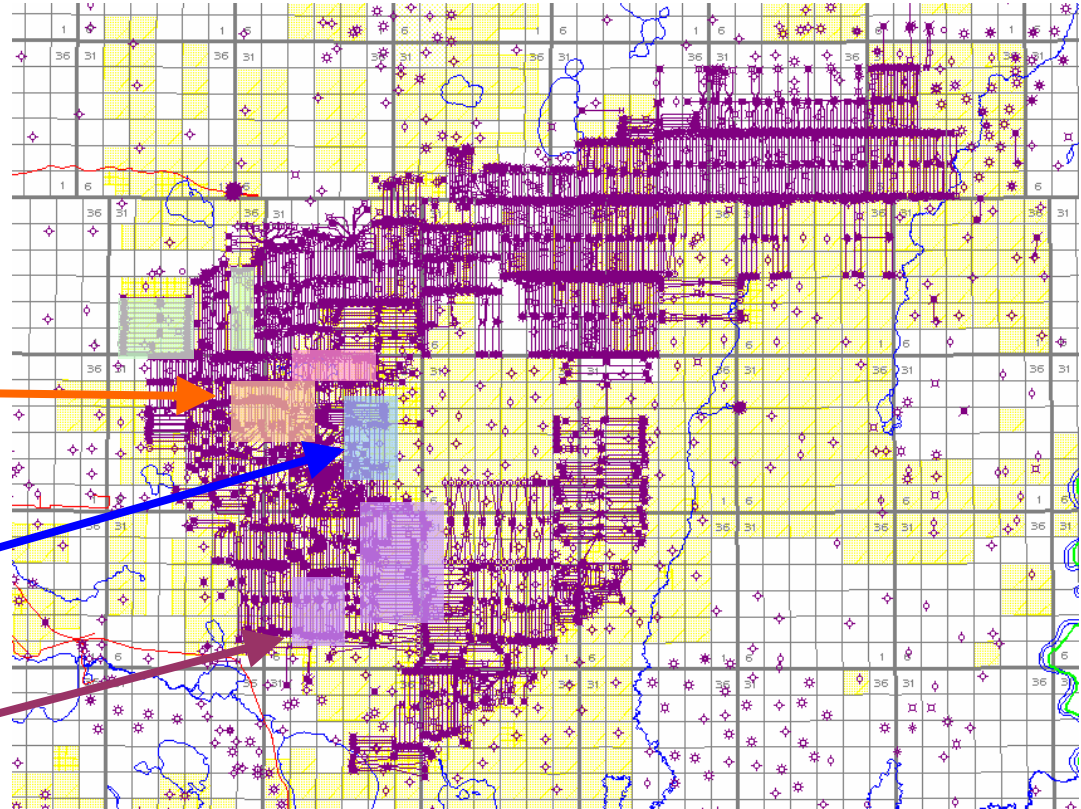


Trying to maximize learning's by exploring several keys opportunities:

Varied Well Geometries

Longer Horizontals

Higher Viscosity



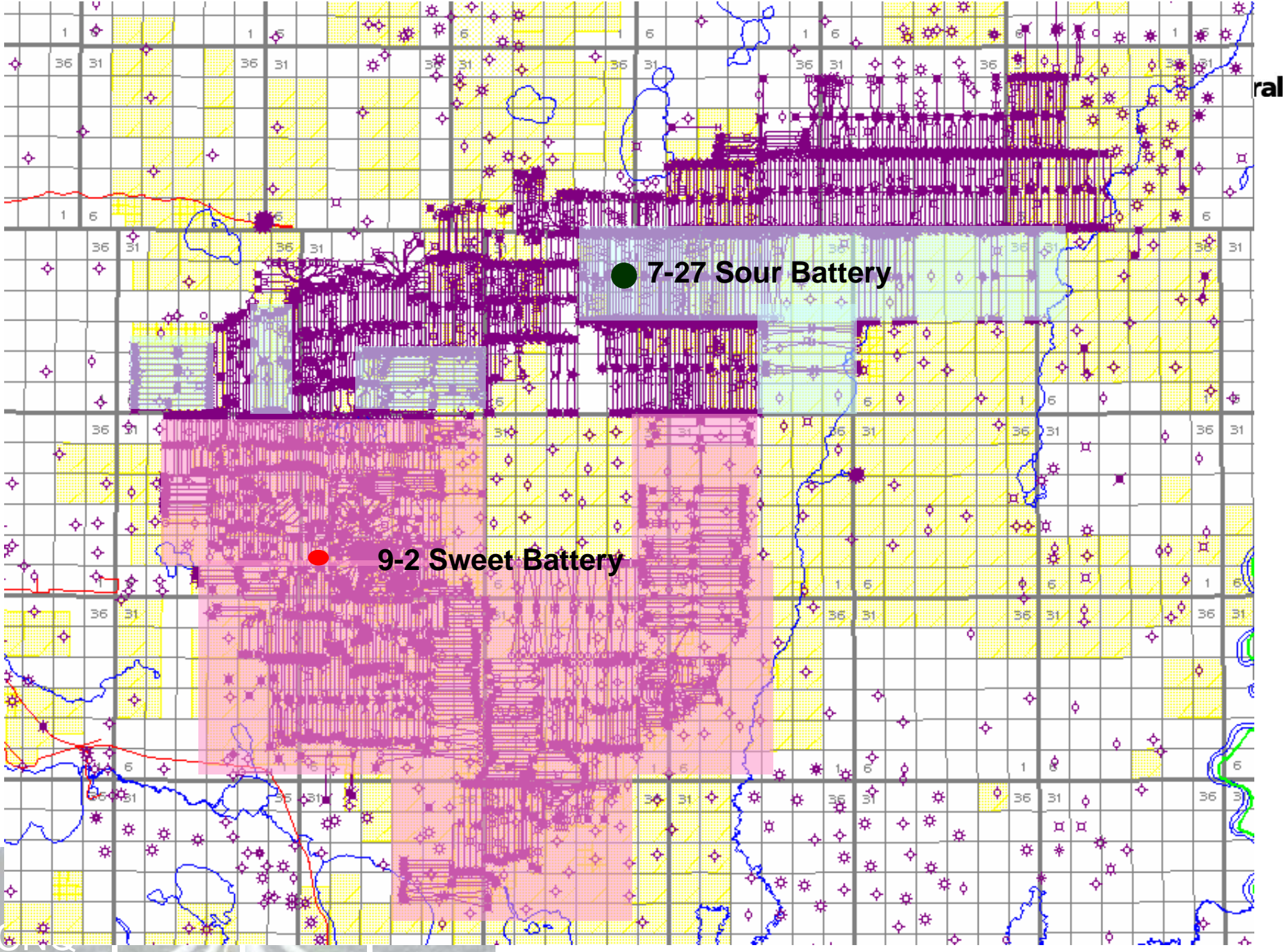
**2007 activity will be key in determining how polymer expands into the rest of the field**



## Current Situation:

- **All Waterfloods currently operating utilize source water from the Grosmont formation.**
- **The Grosmont is a sour water source with 0.01% H<sub>2</sub>S and upwards of 30,000 TDS.**
- **The 7-27 Battery which services North Brintnell is as a result of Grosmont flooding a sour battery.**
- **Making Polymer using current technology requires fresh, lower TDS water.**
  - **The polymer flood as it stands currently is fed by several fresh sources of water as approved by AENV.**

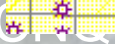




● 7-27 Sour Battery

● 9-2 Sweet Battery

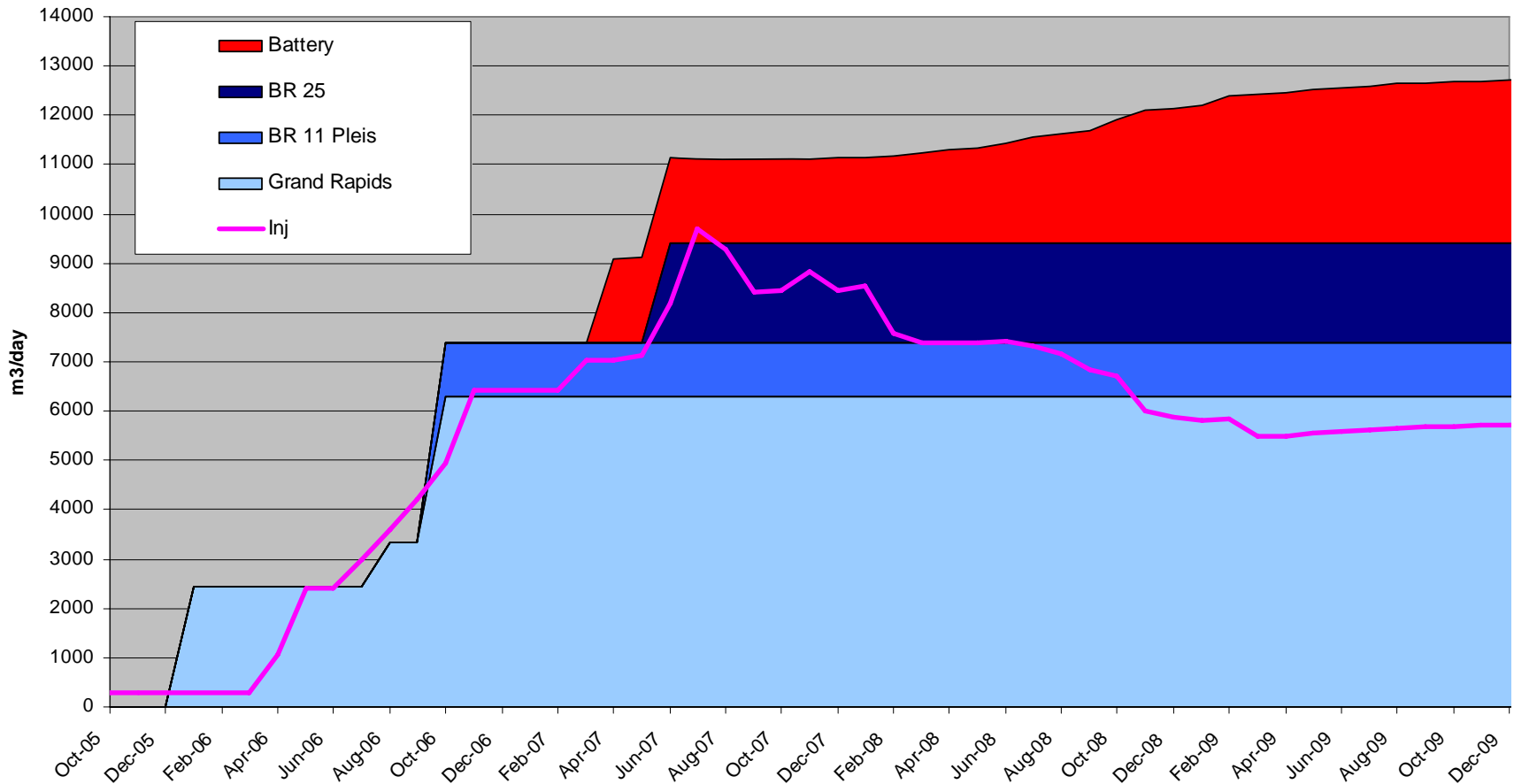
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# Water Usage – Current Polymer Flood Requirements + 2007 Forecast activities



Fresh Water Usage and Sources



## Going Forward:

- **Produced water from Township 79-81 can currently be recycled through the 9-2 (Sweet) battery and is a key component of CNRL's recycle plan.**
- **Areas where recycle is not viable due to the sour nature of the battery at 7-27 (Township 82) will not be committed to long term fresh water usage as there is currently no economically viable recycle option available.**



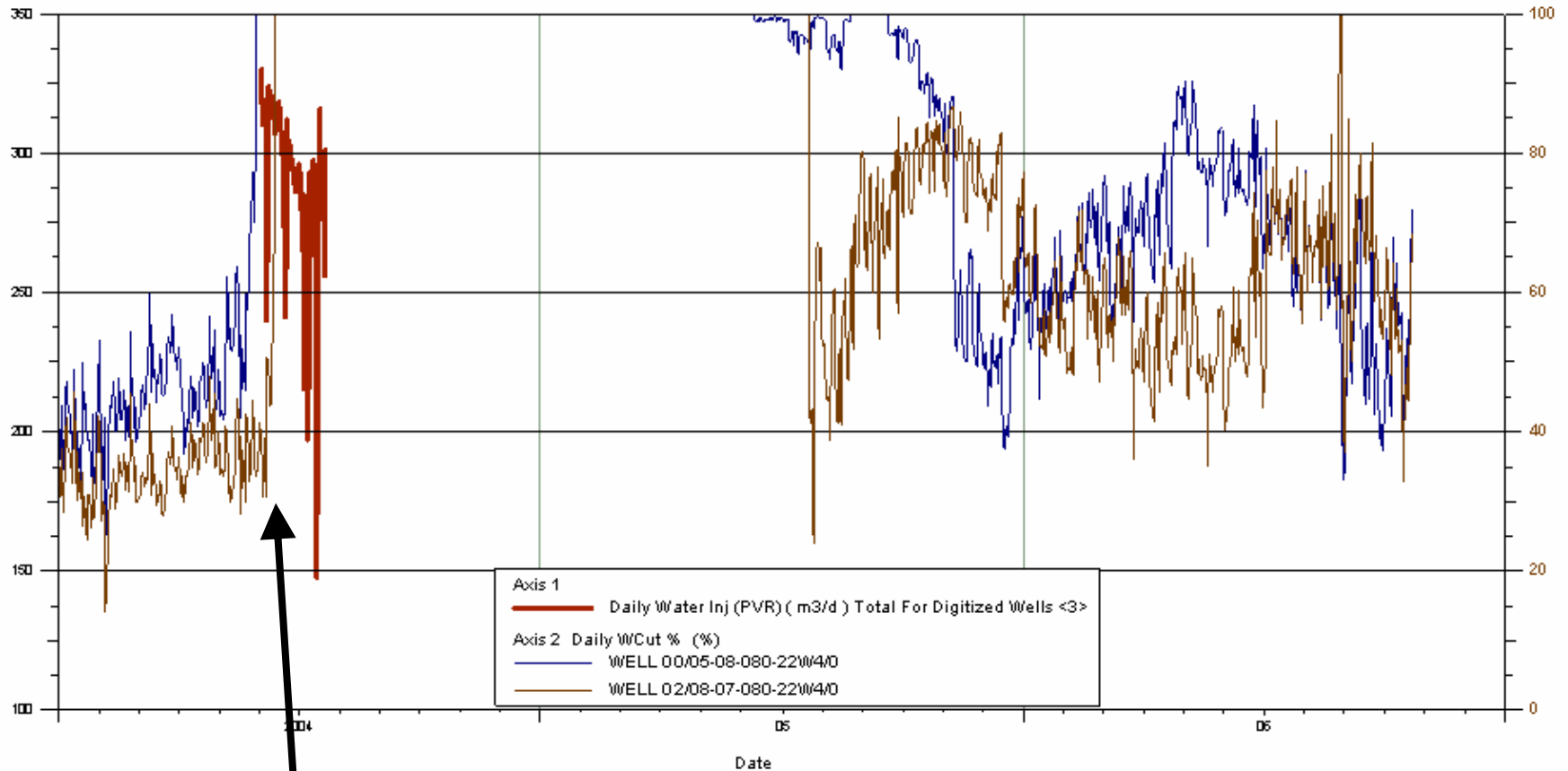
- **Fresh Water Injection Trial**

- Trial is complete on Brintnell Pad 11. No pressure response was observed.
- With a total of 26000m<sup>3</sup> Injected there was no observable pressure response recorded on the bottom hole recorders.
- With no pressure built by injection the fall off test conducted showed no results to imply any damage had occurred.
- The conclusion drawn is that fresh water injection is not detrimental to the formation and can be conducted with confidence that no clay swelling will occur to impede results.



# 9572 Approval

9572 Approval : Injection and Watercuts



- Injection corresponds to immediate water breakthrough at producers



- **This higher viscosity water injection test demonstrated quite dramatically that water injection in this area is not viable. The immediate watering out of the two offsetting producers is indicative of viscous fingering and injection was not attempted beyond the two months shown.**
- **Producers are now showing some recovery but still show high watercuts even after recovering more water than was injected.**
- **This area has been identified as a potential polymer injection site to mitigate the unfavorable mobility ratios.**
- **CNRL has applied to have this approval rescinded and blended into the polymer expansion.**

