

**In the Matter of Alberta Energy and Utilities Board
Proceeding No. 1347905, Bitumen Conservation Requirements
Athabasca, Wabiskaw-McMurray Phase 3 Final Hearing**

**Petro-Canada Response to Information Requests of Paramount Energy Operating Corp
(PEOC)**

1 Reference: Section 5.2.1 of the Petro-Canada Submission

- Request:**
1. Are there any surface pressure measurements available for the 11-33 after 2002 to supplement the subsurface gradient measurements?
 2. Provide gas pool pressure corresponding to the 10-26 piezometer readings.
 3. What is the estimated lateral extent of the 21-metre shale plug referenced on Page 39?
 4. Is the abrupt pressure drop of the piezometer installed at 319 m of well 09-24 in April-May 01 an artifact of the device or operations?

Response:

1. The 11-33 well is not a Petro-Canada well and, therefore, Petro-Canada does not have any surface pressure measurement data, after 2002, that is not on the public record.

Response: 2.

| Unique Well ID | Test Date | Run Depth (m GE) | Well-Head Pressure (kPaa) | Run Depth Pressure (kPaa) | Shut-in Hours (hrs) |
|-----------------------|------------|---------------------|------------------------------|------------------------------|------------------------|
| 100/14-15-081-07W4/00 | 1/14/1991 | 352.5 | 1775 | 1816 | 0 |
| | 1/22/1991 | 352.5 | 1762 | 1815 | 124.2 |
| | 1/22/1991 | 352.5 | 0 | 1811 | 118 |
| | 9/26/2000 | 354.3 | 553 | 567 | 3572.5 |
| | 3/17/2001 | 352.5 | 560 | 577 | 7708.2 |
| | 2/11/2002 | 0 | 560 | 562 | 15652.5 |
| | 2/1/2004 | 340.5 | 593 | 596 | 4 |
| 100/10-16-081-07W4/00 | 3/15/1990 | 385 | 1796 | 1846 | 110.1 |
| | 3/15/1990 | 385.2 | 1610 | 1846 | 109.1 |
| | 2/24/1999 | 380.5 | 393 | 569 | 101.4 |
| | 9/26/2000 | 383.2 | 500 | 520 | 3575.3 |
| | 3/17/2001 | 381.8 | 520 | 539 | 7709.2 |
| | 2/11/2002 | 382 | 528 | 548 | 15654 |
| 100/12-21-081-07W4/00 | 2/11/2002 | 391 | 528 | 552 | 15656.2 |
| 100/12-21-081-07W4/00 | 9/26/2000 | 391.2 | 513 | 534 | 11592.3 |
| | 2/13/2003 | 390 | 545 | 560 | 24456.3 |
| 100/11-22-081-07W4/00 | 2/24/1999 | 364.9 | 541 | 562 | 104.4 |
| 100/11-22-081-07W4/00 | 1/1/1991 | 363.7 | 1828 | 1853 | 0 |
| | 1/11/1991 | 376.3 | 0 | 1863 | 0 |
| | 3/17/2001 | 359.3 | 490 | 506 | 7707.3 |
| | 2/11/2002 | 355.3 | 507 | 525 | 15657.1 |
| | 2/13/2003 | 354.3 | 515 | 540 | 24456.7 |
| 100/10-23-081-07W4/00 | 12/29/1990 | 362 | 1586 | 1844 | 0 |
| | 1/5/1991 | 362 | 0 | 1841 | 117.1 |
| | 1/5/1991 | 362 | 0 | 1845 | 113.9 |
| | 2/24/1999 | 361.4 | 596 | 670 | 100.3 |
| | 9/29/2000 | 362.5 | 580 | 593 | 3652.3 |
| 100/07-27-081-07W4/00 | 2/25/1999 | 379.7 | 493 | 542 | 122.1 |
| 100/07-27-081-07W4/00 | 2/15/1991 | 381.2 | 1793 | 1851 | 0 |
| | 2/28/1991 | 381.2 | 1793 | 1848 | 254.4 |
| | 2/28/1991 | 381 | 0 | 1848 | 254.3 |
| | 9/28/2000 | 379 | 480 | 494 | 3621.5 |
| | 3/17/2001 | 377.7 | 490 | 507 | 7703.7 |

3. The 21-metre thick, abandoned channel, mudstone plug referenced on Page 39 occurs in the well 10-26-81-7W4, interval 367 metre to 388 metre. Petro-Canada's estimate of the lateral extent of an abandoned channel, mudstone plug ranges from 100 metres wide and long to about 250 metres wide by 1400 metres long.

The estimate takes into account work published by Flach and Mossop in 1985 that describes an expected 250 metre width of a 25-metre deep McMurray channel and an average meander radius of curvature to be about 700 metres.¹

The broad range in the estimated lateral extent of the abandoned channel, mudstone plug at the 10-26 well also takes into account the preservation potential in a meandering channel environment characterized by cut and fill relationships of subsequent McMurray channels in the Chard area. The Gregoire Lake Block One project area (section 27-85-8W4) has well density of 120 wells per quarter section. The dense well control demonstrated that abandoned channel mudstone plugs had low preservation potential in the McMurray channel environment with mudstone plug continuity less than 100 metres.²

At Chard, the small lateral extent of the 10-26 mud plug is corroborated by the absence of a mud plug at an equivalent level in released wells within sections adjacent to section 26, excepting section 27. In section 27, two adjacent wells penetrated a mudstone plug that may be common to both. The wells are 190 metres apart and demonstrate the rapid lateral change in mudstone plug thickness. The well 10-27-81-7W4 has a 16-metre thick mud plug. The well 7-27-81-7W4 has a 7-metre mud plug at the same stratigraphic interval, (see cross section, Tab 1). The rapid change in thickness demonstrates the high lateral variability in mudstone continuity at Chard.

The important observation at 10-26 is that, regardless of the preserved lateral extent of the abandoned channel mudstone plug, measurable pressure communication between the top of the McMurray and the bottom water occurs within a time scale comparable to production time. The communication is a direct indicator of the limited lateral extent of the mud plug at the well 10-26-81-7W4. This pressure drop results from a reservoir-induced effect.

4. Petro-Canada believes the piezometer is tracking a reservoir induced response.

- 2 **Reference:** “To summarize the literature, the tighter the mudstone, the more likely it is to fail under thermal stresses, and if there is permeability from bioturbation, the shales will typically leak in any event”, page 26, Section 4.2.3, Petro-Canada Submission.

¹ Depositional Environments of Lower Cretaceous McMurray Formation, Athabasca Oil Sands, Alberta. Peter D. Flach and Grant Mossop; in A.A.P.G. Bull. V.69, No. 8 (Aug. 1985).

² Intervention of Petro-Canada Oil and Gas, Surmont Application No. 960952, Part IV, March 8, 1999.

- Request:**
1. Does the Geomechanical literature address bioturbation aspects?
 2. Are there any physical laboratory measurements quantifying bioturbation induced permeability in the Chard area?

- Response:**
1. No. To clarify, the referenced sentence may be revised as follows: “To summarize the literature, the tighter the mudstone, the more likely it is to fail under thermal stresses. Also, if there is permeability from bioturbation, the shales will typically leak in any event”.
 2. In general, permeability measurements of oil sands address the sand rich portion of a potential reservoir. Only limited investigation of mudstone permeability has been undertaken. For example, Petro-Canada provided Exhibit number 1344, Chard-Leismer Hearing (Tab 2, with HYCAL analysis summary) which included mudstone vertical permeabilities ranging from .01 to 7.45 mD, some of which were bioturbated. Petro-Canada has no laboratory measurements specifically designed to address bioturbation induced permeability.

3 Reference: Section 4.2.1 Seal Capacity

- Request:**
1. Have Capillary Entry Pressure measurements been performed with samples from Chard wells?

- Response:**
1. No.