



**GEOLOGICAL SURVEY OF CANADA  
COMMISSION GEOLOGIQUE DU CANADA**

**Open File 2673**

**APPENDIX IN SUPPORT OF ECONOMIC ANALYSIS  
OF DEVONIAN PLAY GROUPS, CONTAINED IN  
"DEVONIAN GAS RESOURCES OF THE WESTERN  
CANADA SEDIMENTARY BASIN"**

**S.M. Dallaire  
R.R. Waghmare  
and  
R.F. Conn**

**Petroleum Resource Analysis Division  
Economic and Financial Analysis Branch  
Energy Sector  
Energy, Mines and Resources Canada**

**JULY 1993**



MEMORANDUM

NOTE DE SERVICE

TO  
A Dr. J. Franklin  
Chief Scientist  
Geological Survey of Canada

FROM  
DE J. Dixon

SUBJECT  
OBJET OPEN FILE 2673

SECURITY - CLASSIFICATION - DE SÉCURITÉ
OUR FILE — N / RÉFÉRENCE GS9680-9
YOUR FILE — V / RÉFÉRENCE
DATE May 28, 1993

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**O.F. 2673                    APPENDIX IN SUPPORT OF ECONOMIC ANALYSIS OF  
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**by S.M. Dallaire, R.R. Waghmare and R.F. Conn**

This report consists of 14 pages of text and tables. It is available from the Publications Office of the Geological Survey of Canada in Calgary at a cost of \$2.80 and it may be viewed at all Geological Survey of Canada libraries.

J. Dixon  
Scientific Editor, ISPG

JD/th

cc: Krista Lamer  
GID, Ottawa

## Description of Contents

This open file is a companion appendix to Geological Survey of Canada Bulletin 452, entitled "Devonian Gas Resources of the Western Canada Sedimentary Basin". It contains tables listing the reference case assumptions used in the economic analysis presented in Part II of the study.

The twenty-five mature exploration plays described in Part I were assigned to five groups in order to estimate costs. For each play group, two tables are provided. The first table lists, for each play in the group, the average geological characteristics, exploration success rates and likely development requirements used in the reference case for the economic analysis. Selected capital cost estimates, based on these assumptions, are also provided in the table. A second table shows the proportions of the resources expected to be found as non-associated gas and associated/solution gas, and as "sweet" and "sour" gas. The latter information was used to estimate the weighted average pool supply price for plays having both non-associated and solution gas and/or sweet and sour gas.

The data provided are *average* values for each play, based upon existing discoveries in each play at the time of analysis. Cost estimates reflect these average values, at 1990 cost levels. Characteristics of individual undiscovered pools and the required exploration and development costs can, therefore, vary significantly from these average values.

Exploration costs and field development costs are not applicable for those plays in which gas resources are found entirely as solution gas. N/A indicates which costs are not applicable.

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Table1  
**Input Data and Selected Cost Estimates (1990\$)**  
**Northwest Alberta - Devonian Plays**

<b>PLAY NAME:</b>	Keg River shelf basin - Shekille	Keg River shelf basin - Zama	Keg River shelf basin - Rainbow	Middle Devonian Clastics	Slave Point reef complexes - Cranberry
<b>DRILLING:</b>					
Gas Type:	Sour gas	Sweet gas	Sour gas	Sol.-Sweet gas	Sweet gas
Avg. Depth (metres):	1730	1400	1730	2100	1600
Costs (10**3 \$):					
(a) D&A Exp.	486.9	359.1	486.9	N/A	406.2
(b) D&C Exp.	789.8	582.1	789.8	N/A	656.6
(c) D&A Dev.	458.8	336.6	458.8	N/A	380.7
(d) D&C Dev.	739.0	540.6	739.0	N/A	609.9
Operating (10 <sup>3</sup> \$/well/mo.)	4.4	2.5	4.4	N/A	2.5
<b>PIPELINES:</b>					
Construction Support:	Remote	Remote	Remote	Muskeg	Muskeg
Unit Costs (10 <sup>3</sup> \$/dia-in-km)					
2"	39.3	30.9			
3"	33.0	25.9	33.0		21.1
4"			29.1	17.8	18.1
6"					16.3
8"					
<b>ROADS:</b>					
Construction Support:	Remote	Remote	Remote	Remote	Remote
Terrain:	Muskeg	Muskeg	Muskeg	Muskeg	Muskeg
Unit Costs (10 <sup>3</sup> \$/km):					
(a) Lease/field roads	52.0	52.0	52.0	N/A	52.0
(b) All-weather access	104.0	104.0	104.0	N/A	104.0
<b>WELLSITE EQUIPMENT:</b>					
Costs (10 <sup>3</sup> \$):					
(a) Alcohol injection					
(b) Dehydration					
(c) Line heaters	81 @0.12 Mm3/d	184 @0.11Mm3/d	81 @0.21 Mm3/d		81 @1.39Mm3/d
(d) Vapor Recovery				184 @ 0.14Mm3/d	
<b>COMPRESSION:</b>					
Construction Support:	Remote	Remote	Remote	Remote	Remote
Costs (10 <sup>3</sup> \$):	1331 @ 877 HP	1140 @ 854 HP	1905 @ 1542 HP	1161 @ 881 HP	@ HP
<b>GAS COMPOSITION:</b>					
N2	0.0177	0.0330	0.0178	0.1521	0.0323
H2S	0.0463	0.0000	0.0198	0.0000	0.0000
CO2	0.0521	0.0420	0.0467	0.0012	0.0288
C1	0.7638	0.8489	0.8082	0.6213	0.8338
C2	0.0667	0.0354	0.0537	0.0898	0.0551
C3	0.0284	0.0195	0.0256	0.0729	0.0256
i-C4	0.0045	0.0032	0.0047	0.0113	0.0039
n-C4	0.0095	0.0074	0.0099	0.0259	0.0086
i-C5	0.0000	0.0000	0.0000	0.0000	0.0000
n-C5	0.0064	0.0051	0.0069	0.0145	0.0054
C6's	0.0026	0.0027	0.0038	0.0055	0.0025
C7+	0.0020	0.0028	0.0029	0.0055	0.0040
<b>OTHER DATA:</b>					
Avg. well spacing (ha/well):	256	256	256	256	256
Avg. distance to existing gathering system (km)	10	10	10	10	10
Exploration success rate					
Technical:	1:2 (47%)	1:2 (66%)	1:1 (99.5%)	1:71 (1.4%)	1:10 (10%)
Economic:	1:2 (47%)	1:2 (66%)	1:1 (99.5%)	1:71 (1.4%)	1:42 (2.4%)
Development succ. rate:	0.95	0.95	0.95	0.95	0.95

Table 2  
**Percentage Weighting Factors for Reference Case  
 Northwest Alberta - Devonian Plays**

	Non-Associated Gas		Solution Gas	
	Sweet	Sour	Sweet	Sour
Keg River shelf basin - SHEKILIE play	26	34	11	29
Keg River shelf basin - ZAMA play	36	30	10	24
Keg River shelf basin - RAINBOW Play		18	17	65
MIDDLE DEVONIAN CLASTICS Play			100	
Slave Point reef complexes - CRANBERRY Play	100			

Table 3  
**Input Data and Selected Cost Estimates (1990\$)**  
**Peace River Region - Devonian Plays**

<b>PLAY NAME:</b>	Leduc Fringing reef - Worsley	Wabamun structural and stratigraphic - Parkland
<b>DRILLING:</b>		
Gas Type:	Sweet gas	Sour gas
Avg. Depth (metres):	2160	2400
Costs (10 <sup>3</sup> \$):		
(a) D&A Exp.	481.4	686.3
(b) D&C Exp.	700.9	966.7
(c) D&A Dev.	446.1	640.5
(d) D&C Dev.	645.1	898.1
Operating (10 <sup>3</sup> \$/well/mo.)	2.6	4.5
<b>PIPELINES:</b>		
Construction Support:	Local	Local
Unit Costs (10 <sup>3</sup> \$/dia-in-km)		
3"	19.7	
4"	17.7	19.1
<b>ROADS:</b>		
Construction Support:	Local	Local
Terrain:	Parkland	Parkland
Unit Costs (10 <sup>3</sup> \$/km):		
(a) Lease/field roads	20.0	20.0
(b) All-weather access road	40.0	40.0
<b>WELLSITE EQUIPMENT:</b>		
Costs (10 <sup>3</sup> \$):		
(a) Alcohol injection		
(b) Dehydration		
(c) Line heaters	81.0 @ 0.34 Mm <sup>3</sup> /d	81.0 @ 0.39 Mm <sup>3</sup> /d
<b>COMPRESSION:</b>		
Construction Support:	Local	Local
Costs (10 <sup>3</sup> \$):	2131 @ 2507 HP	2793 @ 2857 HP
<b>GAS COMPOSITION:</b>		
N <sub>2</sub>	0.0865	0.0496
H <sub>2</sub> S	0.0000	0.0623
CO <sub>2</sub>	0.0052	0.0317
C <sub>1</sub>	0.8263	0.7765
C <sub>2</sub>	0.0368	0.0344
C <sub>3</sub>	0.0202	0.0183
i-C <sub>4</sub>	0.0036	0.0041
n-C <sub>4</sub>	0.0069	0.0079
i-C <sub>5</sub>	0.0000	0.0000
n-C <sub>5</sub>	0.0049	0.0066
C <sub>6</sub> 's	0.0027	0.0034
C <sub>7</sub> +	0.0069	0.0052
<b>OTHER DATA:</b>		
Avg. well spacing (ha/well):	256	256
Avg. distance to existing gathering system (km)	5	5
Exploration success rate		
Technical:	1:14 (7.4%)	1:10 (10%)
Economic:	1:19 (5.2%)	1:18 (5.6%)
Development succ. rate:	0.95	0.95

**Table 4**  
**Percentage Weighting Factors for Reference Case**  
**Peace River Region - Devonian Plays**

	Non-Associated Gas		Solution Gas	
	Sweet	Sour	Sweet	Sour
Leduc Fringing reef - WORSLEY play	100			
Wabamun structural and stratigraphic - PARKLAND play	54	46		



Table 5

**Input Data and Selected Cost Estimates (1990\$)**  
**West Central Alberta - Devonian Plays**

<b>PLAY NAME:</b>	Swan Hills shelf margin - Kaybob South	Leduc/Nisku reef complexes - Windfall	Swan Hills isolated reef - Swan Hills	Nisku shelf margin - Brazeau River	Nisku isolated reef - Brazeau River	Bleu Ridge stratigraphic - Karr	Wabamun platform facies - Pine Creek
<b>DRILLING:</b>							
Gas Type:	Sour	Sour	Sol. sweet	Sour	Sour	Sour	Sour
Avg. Depth (metres):							
Costs (10 <sup>3</sup> \$):							
(a) D&A Exp.	2376.3	1879.4	N/A	1668.9	2376.3	1283.6	2207.7
(b) D&C Exp.	2953.0	2397.3	N/A	2162.6	2953.0	1729.6	2764.3
(c) D&A Dev.	2224.1	1759.7	N/A	1562.9	2224.1	1202.7	2066.5
(d) D&C Dev.	2756.4	2237.5	N/A	2018.3	2756.4	1613.9	2580.2
Operating (10 <sup>3</sup> \$/well/mo.)	5.2	5.0	N/A	4.9	5.2	4.8	5.1
<b>PIPELINES:</b>							
Construction Support:	Remote	Remote	Remote	Remote	Remote	Remote	Remote
Unit Costs (10 <sup>3</sup> \$/dia-in-km)							
2"							
3"	22.7	22.7	17.8	22.7	29.4	25.2	22.7
4"					25.2	22.7	
6"	19.5	19.5		19.5		19.5	19.5
<b>ROADS:</b>							
Construction Support:	Remote	Remote	Remote	Remote	Remote	Remote	Remote
Terrain:	Forest	Forest	Forest	Forest	Forest	Forest	Forest
Unit Costs (10 <sup>3</sup> \$/km):							
(a) Lease/field roads	39	39	N/A	39	39	39	39
(b) All-weather access	78	78	N/A	78	78	78	78
<b>WELLSITE EQUIPMENT:</b>							
Costs (10 <sup>3</sup> \$):							
(a) Alcohol injection							
(b) Dehydration							
(c) Line heaters	81.1 @ 0.75	81.2 @ 0.83	184.1 @ 0.23	81.1 @ 0.57	81.1 @ 0.13	81.1 @ 0.61	81.1 @ 0.49
(d) Vapor recovery							
<b>COMPRESSION:</b>							
Construction Support	Remote	Remote	Remote	Remote	Remote	Remote	Remote
Costs (10 <sup>3</sup> \$):	7392 @ 6050HP	8995 @ 7362HP	1579 @ 1439HP	5574 @ 4562HP	1359 @ 909HP	6605 @ 5406HP	4406 @ 3606HP



Table 6  
**Percentage Weighting Factors for Reference Case  
 West-Central Alberta - Devonian Plays**

	Non-Associated Gas		Solution Gas	
	Sweet	Sour	Sweet	Sour
Swan Hills shelf margin - KAYBOB SOUTH play		100		
Leduc/Nisku reef complexes - WINDFALL play		63		37
Swan Hills isolated reef - SWAN HILLS play			100	
Nisku shelf margin - BRAZEAU RIVER play		100		
Nisku isolated reef - BRAZEAU RIVER play		52	31	17
Blue Ridge stratigraphic - KARR play	25	75		
Wabamun platform facies - PINE CREEK play		100		



Table 8  
**Percentage Weighting Factors for Reference Case  
 Southwest Alberta - Devonian Plays**

	Non-Associated Gas		Solution Gas	
	Sweet	Sour	Sweet	Sour
Leduc isolated reef - WESTEROSE play		61		39
Leduc reef - NEVIS play				100
Nisku shelf drape - BASHAW TREND play				100
Upper Devonian subcrop - MARTEN HILLS play	100			
Wabamun platform facies - CROSSFIELD play		100		
Nisku shelf drape - RICINUS - MEADOWBROOK TREND play		22		78

Table 9  
**Input Data and Selected Cost Estimates (1990\$)**  
**Northeast British Columbia - Devonian Plays**

<b>PLAY NAME:</b>	Keg River isolated reef - Yoyo	Slave Point barrier reef - Clarke Lake	Keg River platform - July Lake	Slave Point platform - Adsett	Jean Marie biostrome - Helmet North
<b>DRILLING:</b>					
Gas Type:	Sour gas	Sour gas	Sour gas	Sour gas	Sweet gas
Avg. Depth (metres):	2250	2050	2050	2050	1260
Costs (10 <sup>3</sup> \$):					
(a) D&A Exp.	864.0	723.1	723.1	723.1	382.6
(b) D&C Exp.	1316.3	1133.6	1133.6	1133.6	617.8
(c) D&A Dev.	813.1	680.8	680.8	680.8	358.8
(d) D&C Dev.	1231.9	1060.9	1060.9	1060.9	573.8
Operating (10 <sup>3</sup> \$/well/mo.)	5.5	5.4	5.4	5.4	2.7
<b>PIPELINES:</b>					
Construction Support:	Remote	Remote	Remote	Muskeg	Remote
Unit Costs(10 <sup>3</sup> \$/dia-in-km)					
2"					33.5
3"					
4"	33.5	33.5	33.5	33.5	26.3
6"	28.1		28.1	28.1	
<b>ROADS:</b>					
Construction Support:	Remote	Remote	Remote	Remote	Remote
Terrain:	Muskeg	Muskeg	Muskeg	Muskeg	Muskeg
Unit Costs (10 <sup>3</sup> \$/km):					
(a) Lease/field roads	59.8	59.8	59.8	59.8	59.8
(b) All-weather access	119.6	119.6	119.6	119.6	119.6
<b>WELLSITE EQUIPMENT:</b>					
Costs (10 <sup>3</sup> \$):					
(a) Alcohol injection					
(b) Dehydration					
(c) Line heaters	93.4 @ 0.54 Mm3/d	93.4 @ 0.45 Mm3/d	93.4 @ 0.54 Mm3/d	93.3 @ 0.50 Mm3/d	211.6 @ 0.12 Mm3/d
<b>COMPRESSION:</b>					
Construction Support	Remote	Remote	Remote	Remote	Remote
Costs (10 <sup>3</sup> \$):	5594 @ 3981 HP	4625 @ 3291 HP	5594 @ 3981 HP	5223 @ 3717 HP	1165 @ 685 HP
<b>GAS COMPOSITION:</b>					
N2	0.0075	0.0177	0.0116	0.0088	0.0118
H2S	0.0102	0.0079	0.0106	0.0221	0.0000
CO2	0.1250	0.1069	0.0959	0.1056	0.0143
C1	0.8559	0.8659	0.8763	0.8604	0.9557
C2	0.0013	0.0014	0.0048	0.0031	0.0115
C3	0.0001	0.0002	0.0000	0.0000	0.0029
i-C4	0.0000	0.0000	0.0000	0.0000	0.0005
n-C4	0.0000	0.0000	0.0000	0.0000	0.0007
i-C5	0.0000	0.0000	0.0000	0.0000	0.0026
<b>OTHER DATA:</b>					
Avg.well spacing(ha/well):	1024	1024	1024	1024	1024
Avg. distance to existing gathering system (km)	10	5	10	25	25
Exploration success rate					
Technical:	1:3 (36%)	1:2 (47%)	1:3 (36%)	1:5 (19%)	1:10 (10%)
Economic:	1:3 (31%)	1:3 (30%)	1:6 (16%)	1:7 (14%)	1:59 (1.7%)
Development succ. rate:	0.90	0.90	0.90	0.90	0.90

Table 10  
**Percentage Weighting Factors for Reference Case  
 Northeast British Columbia - Devonian Plays**

	Non-Associated Gas		Solution Gas	
	Sweet	Sour	Sweet	Sour
Keg River isolated reef - YOYO play		100		
Slave Point barrier reef - CLARKE LAKE play		100		
Keg River platform - JULY LAKE play		100		
Slave Point platform - ADSETT play		100		
Jean-Marie biostrome - HELMET NORTH play	100			