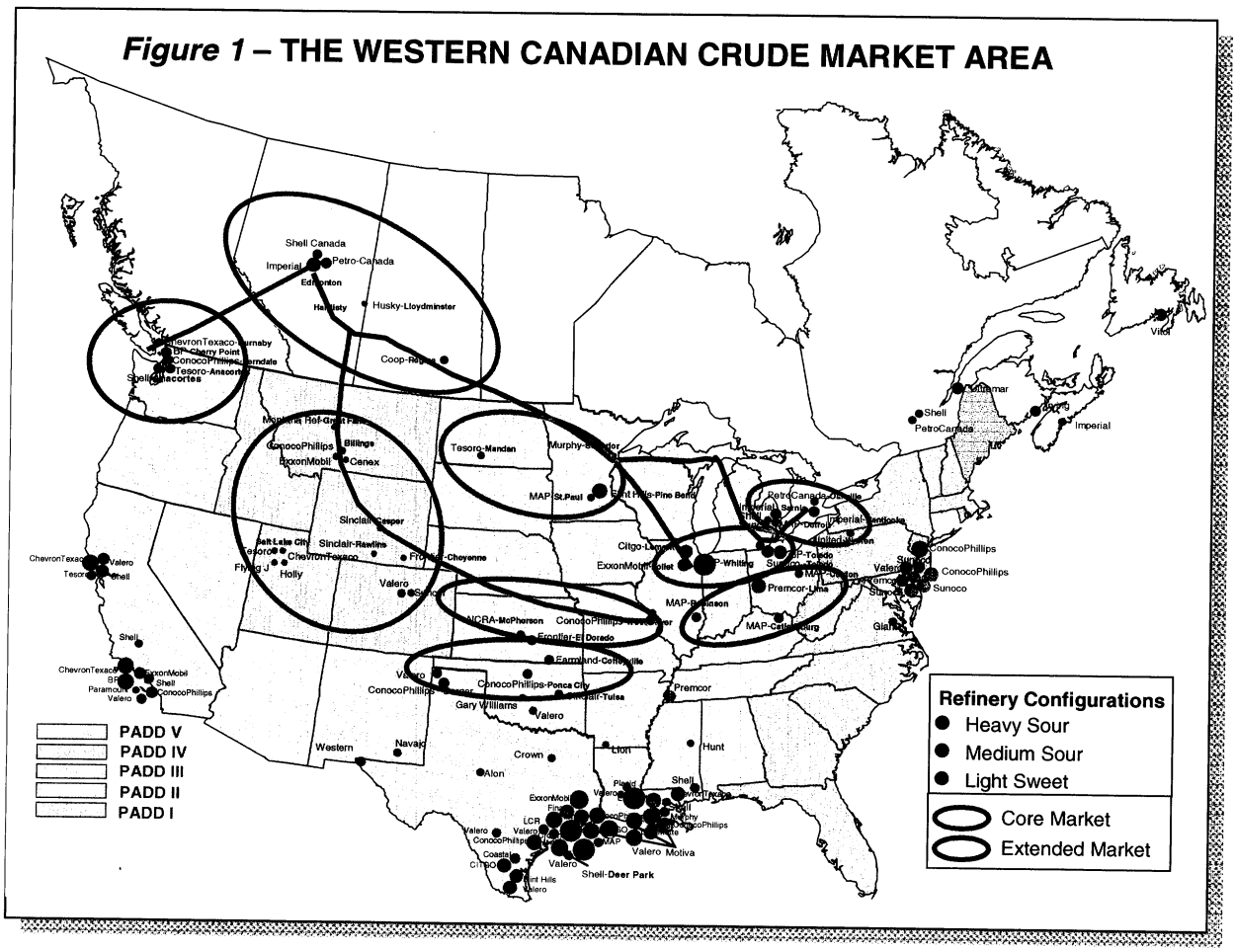
CHARACTERIZATION OF THE WESTERN CANADIAN CRUDE MARKET

The traditional Western Canadian crude market area encompasses an area that ranges from the Puget Sound area in the west, as far south as Oklahoma, and east to western Pennsylvania. Figure 1 displays a number of the attributes of this market area: regional submarkets, further divided into core and extended markets; relative refinery size (distinguished by diameter of the circles); and refinery configuration, which powerfully influences the type of crude (light sweet, heavy sour, etc.) preferred by the refiner. The core markets are those areas that have historically processed the great bulk of the crude produced in Western Canada.

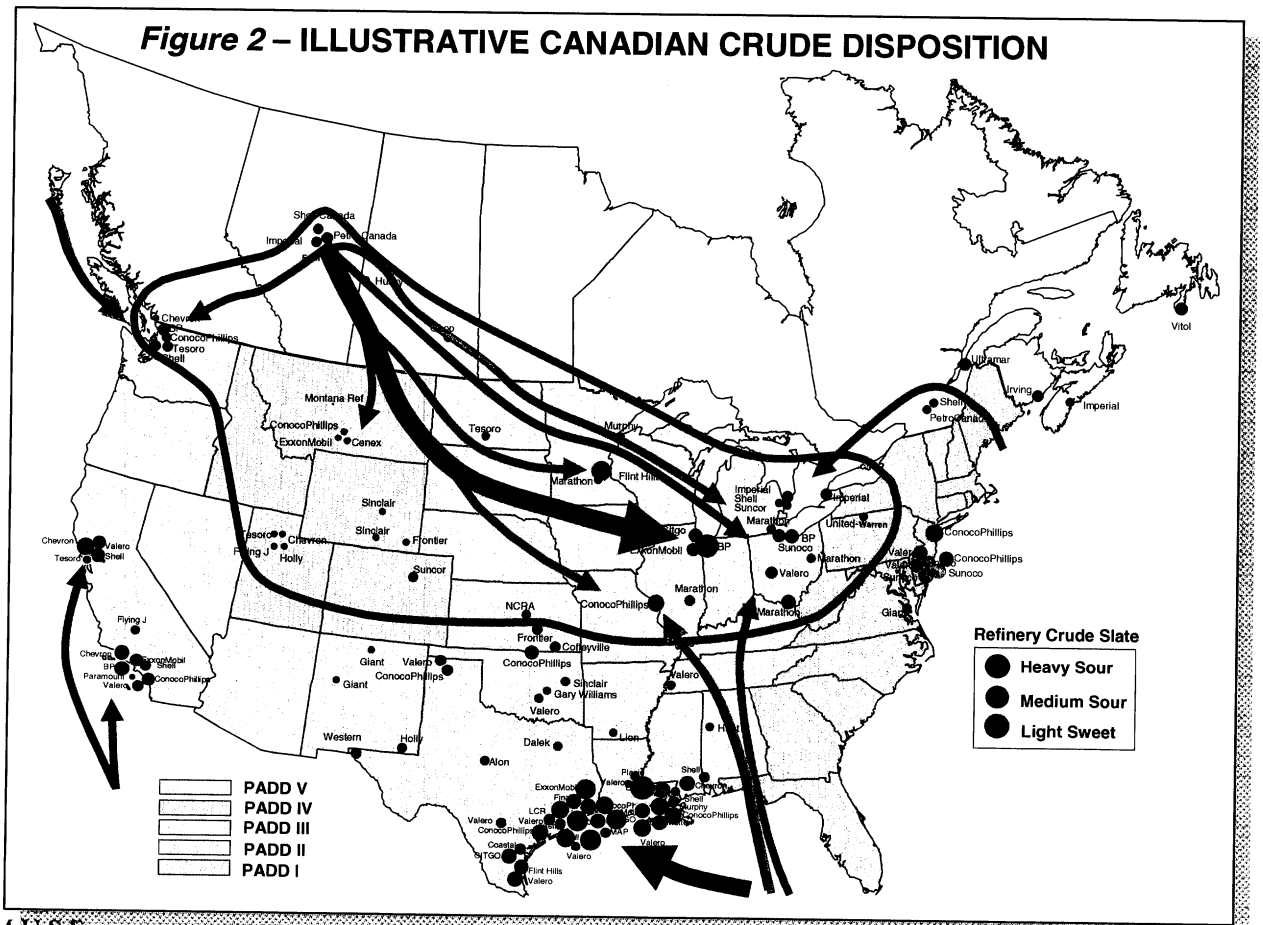
Figure 1 **– THE WESTERN CANADIAN CRUDE MARKET AREA**



The extended market areas are regions that Western Canadian crude producers are seeking to penetrate as production increases and their core markets reach saturation. Accordingly, if sufficient transportation capacity is available from Western Canada, it is these regions that will act as the price setting areas for Canadian crude in the future. The extended market area that the Southern Access Extension will initially target is generally those refineries located in Ohio, Kentucky, and southern Illinois. Longer term, the target market for crude shippers on the Southern Access Extension may well include the very large market located on the U.S. Gulf Coast.

Figure 2 provides a general overview of the current distribution of Western Canadian crude. Note the vital importance of the sizable Midwestern market to the Canadian crude producer, as approximately 45 percent of the total crude produced flows into the Midwest.

Figure 2 **– ILLUSTRATIVE CANADIAN CRUDE DISPOSITION**



WESTERN CANADIAN CRUDE SUPPLY FORECAST

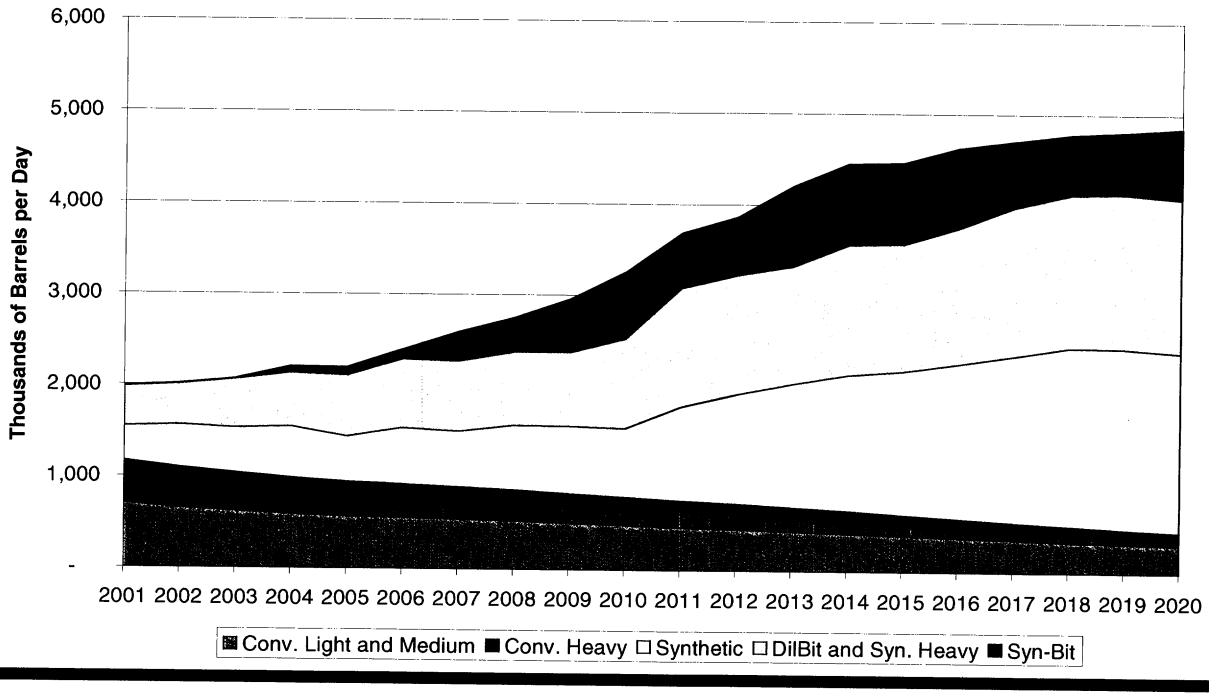
Western Canadian crude production exceeded 2.2 million b/d in 2005, and it is widely anticipated that production will continue to climb over the next decade. The Canadian Association of Petroleum Producers (CAPP) generates a widely used Western Canadian crude supply forecast. CAPP represents the upstream oil and gas industry in Canada, and its approximately 150-member-companies collectively produce more than 95 percent of Canada's natural gas and crude oil. CAPP periodically develops a crude production forecast for Western Canada to provide its members with information to evaluate the need for new pipeline capacity from Western Canada to various markets. CAPP's most recent forecast was publicly released in May 2006.[i] The forecast is based upon a combination of a survey of CAPP's member companies regarding their plans for Oil Sands production and an extrapolation of historical trends for conventional crude production.

Production from the Oil Sands is projected to grow at an annual 12 percent rate to reach some 3.5 million b/d by 2015. Total Western Canadian crude production will reach 4.4 million b/d, which is about a 100 percent increase from the 2005 volume. The total production of heavy crude is forecast to increase from today's total of roughly 1.1 million b/d to 2.5 million b/d by 2015.[ii]

Figure 3 illustrates CAPP's most recent forecast of the total supply of Western Canadian crude. CAPP's forecast presumes that a condensate import pipeline has been commissioned with initial imports of 150,000 b/d, growing to 200,000 b/d by 2020. There are at least two condensate import pipeline projects currently in the commercial development phase. Many of the very heavy crude grades produced in Western Canada require the use of a diluent, such as condensate, before they can be transported via pipeline. CAPP also has a crude supply forecast based upon the use of

synthetic crude as the bitumen diluent, rather than condensate. The total volumes in the two forecasts are substantially the same, as they differ only by the volume of imported condensate.

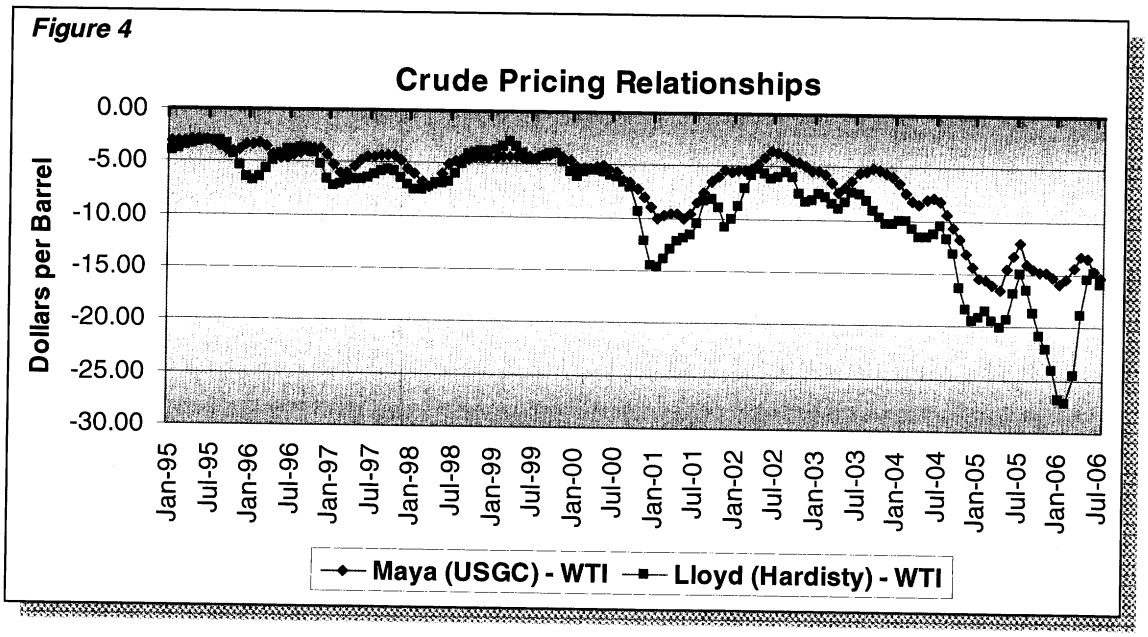
FIGURE 3
CAPP WESTERN CANADIAN CRUDE SUPPLY FORECAST



DEMAND FOR WESTERN CANADIAN CRUDE

Canadian crude, particularly the heavy grades, represents an economically attractive feedstock for Midwestern refiners. The increasing supply of Canadian heavy crude, and to a lesser extent Canadian synthetic crude, has applied downward pressure in recent years on Canadian crude pricing relative to similar grades from elsewhere. Figure 4 illustrates the pricing relationships for Lloydminster Blend, a Canadian heavy crude, versus Maya, the Mexican heavy crude.

Figure 4



Both pricing series are expressed as a differential to West Texas Intermediate (WTI) crude, a widely-traded light sweet crude, thus eliminating the effect that changes in the absolute crude price has upon the price of the two heavy grades. Lloydminster Blend, since about 2001, has frequently traded at a greater differential to WTI than does Maya, although in previous years their differential to WTI was relatively similar. The widening of the Lloydminster Blend differential is a reflection of the impact

that the greater supply of Canadian heavy crude has had on its pricing. Consequently, Midwestern refineries that can process Canadian heavy crude have found it to be more attractive in the last several years than the crude alternatives available from the U.S. Gulf Coast.

Future crude demand for Western Canadian crude also will be influenced by the extent to which refiners act to reconfigure their facilities to process additional Canadian crude, particularly the heavy sour grades. In almost all of the submarkets within the overall Canadian market area, there is little demand for heavy fuel oil and asphalt demand is finite. Growth prospects for heavy fuel oil and asphalt are low, and high transportation costs preclude refiners from shipping excess production of either to other regions of North America. Thus, since refiners in the Canadian market area cannot sell more heavy fuel oil and asphalt, they must convert the heavy fractions (frequently referred to as resid) of the crude barrel into light products within the refinery.[iii] As the refinery process units that convert resid are routinely operated at their maximum capacity, most refineries have a rather limited ability to further increase their runs of heavy crude, irrespective of the degree of attractiveness of the heavy crude pricing. Moreover, some refineries are not well equipped to process any significant volumes of heavy crude, as they lack the desulfurization capabilities required to accommodate the heavy crude grades. Essentially all of the heavy crude grades produced in Western Canada have a high sulfur content.

The marketing issues associated with Canadian synthetic crudes are somewhat less acute than is the case for the heavy sour grades. Almost all refineries can process some amount of synthetic crude, and the volume that they can process tends to be primarily driven more by the pricing of the synthetic grades, relative to other conventional crude grades available to the refiner, than by technical considerations. In addition, the synthetic crude producers have generally been improving the quality of

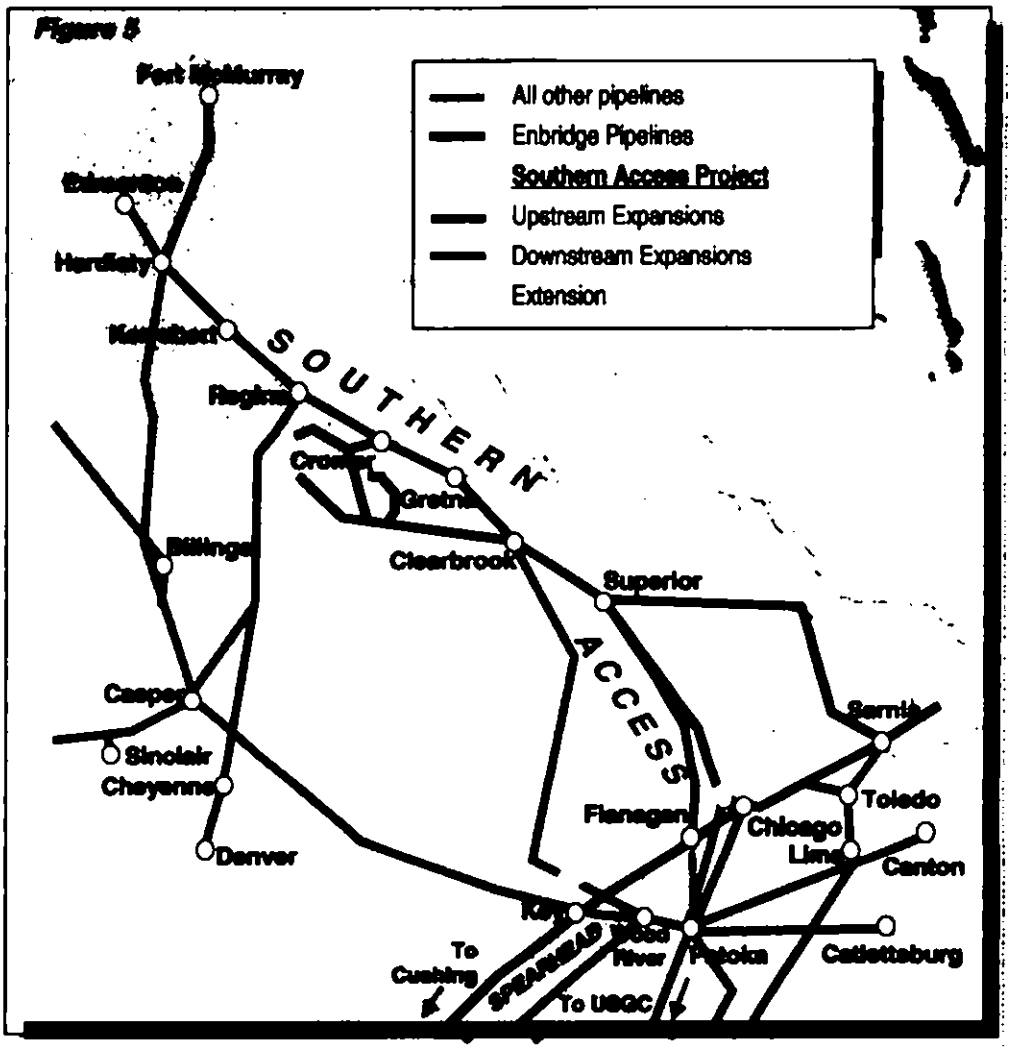
their synthetic crude grades so that refiners can process more synthetic crude before the technical limits on synthetic crude rates are reached.

Refiners are interested in upgrading their facilities to process more Western Canadian crude for several reasons: recognition that the supply of Western Canadian crude is increasing significantly and, therefore, will be available for the long term; attractive prices for many types of Canadian crude, particularly the heavier grades; improved security of supply and shorter delivery times; and, for some, a desire to integrate their Canadian upstream crude production business with their U.S. downstream refining business. The relative importance of these reasons varies among refiners but, in the aggregate, they are prompting refiners to propose an unprecedented number of upgrading projects for their Midwestern refineries. However, these upgrading projects are all predicated upon being able to receive Canadian crude, as only Canada offers a combination of supply availability and security, delivery time, crude cost, and upstream-downstream integration possibilities that makes these upgrading projects attractive. It is exceedingly unlikely that any sizable upgrading project in the Midwest would proceed absent transportation capacity which provides access to crude from Western Canada. The Southern Access Extension provides the Midwestern refineries with just such access.

A number of Midwestern refiners have announced that they are developing refinery upgrade projects – and these projects have a common theme – they are intended to increase the capability of the refineries to process Canadian crude. For example, Midwestern refiners such as BP, Marathon, Sunoco, Frontier, and ConocoPhillips have announced that they either have approved specific refinery upgrading plans or are in the process of commercial development of their plans. The individual refiner upgrading plans are further detailed in Attachment 1.

SOUTHERN ACCESS EXTENSION PROJECT OVERVIEW

The Southern Access Extension will originate at Flanagan, Illinois, which is the southern terminus of the Southern Access Mainline Expansion. The Mainline Expansion is a new 42-inch pipeline originating in Superior, Wisconsin that is part of a coordinated capacity expansion program of the Enbridge system between Alberta and the Midwest. The initial capacity of the Mainline Expansion is 400,000 b/d, and the pipeline can be incrementally expanded to 1,200,000 b/d at relatively low cost via the installation of additional pumping capacity.



The Southern Access Extension will provide up to an additional 400,000 b/d of crude transportation capacity into the Patoka Hub in southern Illinois by 2009. The Southern Access Extension can be further expanded to 800,000 b/d via the

construction of additional pumping capacity. From the Patoka Hub, crude can subsequently be transported: east to a number of refineries located in Ohio, Kentucky, and southern Illinois; south to the U.S. Gulf Coast; or west to the large refinery located at Wood River, Illinois.

EXPECTED SOUTHERN ACCESS EXTENSION UTILIZATION

To analytically assess the expected distribution of Western Canadian crude, Muse has constructed a distribution model of the Canadian market area. The key model inputs are the volume of Canadian and inland U.S. crude grades, refinery capacities, pipeline capacities and tariffs, and crude refining values. The overall market is broken up into a number of submarkets and individual refineries within each submarket are assigned to a refinery configuration class (light sweet cracking, heavy sour coking, etc.). Thus, within each submarket there may be as few as one refinery configuration or as many as four or five configurations. Pipeline capacities and tariffs for Canadian crudes and their crude competitors to each submarket are defined within the model. The model also seeks to optimize the distribution of Western Canadian crude by maximizing the aggregate crude value of all Western Canadian crude production, or, in other words, attempts to replicate the individual efforts of Canadian crude producers and U.S. refiners to maximize their profit.

An important component of the optimization technique is the determination of the value of Canadian crude grades to the refiners (the crude's refining value). Muse uses the AspenTech PIMS™ linear programming (LP) modeling system to determine the refining value of crudes. For purposes of this study, Muse developed 20 detailed LP models of different refinery configurations in the Midwest, California, Rockies, U.S. Gulf Coast, and Northeast Asia. These 20 LP models were then used to estimate the refining values of six grades of Canadian heavy sour crude and three Canadian synthetic grades over a range of throughput levels for the Canadian crudes. These nine grades reasonably cover the variety of Canadian crudes available to the marketplace. The refining value

is always assessed relative to the refiner's non-Canadian crude alternative, which typically is a waterborne foreign crude, that may be further transported inland via pipeline.

The understanding of the refining value, from the refiner's perspective, of Canadian crude is necessary to determine the optimal disposition of the Canadian crude. Absent the refiner's perspective on crude valuation, an optimization model could only distribute crude on the basis of minimizing total transportation cost (which mostly consists of pipeline tariffs). Refineries, even if in the same location, for a variety of technical reasons, can have quite different refining values for the same grade of crude. Accordingly, the optimal distribution of Western Canadian crude is as much a function of its value to individual refineries as it is of the total cost to transport it to the refineries. In summary, the optimization model mimics the efforts of the crude producers to seek out, and sell to, those refiners that see the greatest value for the particular grades of crude that the producer has for sale, and the attempts by the refiner to simultaneously obtain those particular grades of Canadian crude that best fit its refinery capabilities and product market attributes.

The key Crude Market Optimization Model outputs are the aggregate value of all crude grades (as well as individual grades), identification of available capacity in all crude pipelines (or the size of the incentive to expand a pipeline that is at capacity), and the volume of all crude grades assigned to each refinery configuration in each submarket. As the input variables can be easily changed, the optimization model provides the capability to analyze the market implications of: adding, or subtracting, crude pipeline capacity; changing the production volume of synthetic and bitumen blends; changing the production

volume of conventional inland crudes; and downstream developments, such as additional coker unit construction.

Table II shows the expected throughput of the Southern Access Extension starting with the first full year that the pipeline is in service. The throughput shown further assumes that the Mustang pipeline, which is an existing pipeline that essentially parallels the Southern Access Extension, is operated at its capacity of 96,000 b/d. To the extent that the Mustang pipeline is not operated at capacity, throughput on the Southern Access Extension will be correspondingly higher. The year-to-year variations in throughput are influenced by the volume and crude grade mix produced in Western Canada.

TABLE II
ESTIMATED SOUTHERN ACCESS EXTENSION THROUGHPUT
(Thousands of Barrels per Day)

	2010	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*
Throughput	158	204	176	315	409	400	446	479	519	533	567

SOUTHERN ACCESS EXTENSION BENEFITS

BENEFIT OF IMPROVED MARKETPLACE CRUDE DISTRIBUTION

Once the minimum crude export pipeline capacity is in place that is required to avoid shut-in crude production, there can be significant additional economic benefits that arise from additional pipeline capacity due to the improved distribution of Western Canadian crude. For example, if pipeline capacity to the Midwest is full, then the balance of the Western Canadian crude production must flow into the Rockies and the Pacific Northwest markets, even though the refiners in these areas may be reaching the upper limits on their capacity to process Canadian crude. In contrast, the Midwestern refiners may have considerable unused capacity to handle Canadian crude, but are unable to process more because of upstream pipeline constraints. In general, the value to the refiner of any specific grade of crude drops as the volume processed at an individual refinery is increased. This particularly tends to be the case for the Western Canadian synthetic and heavy sour crude grades, as their properties differ somewhat from that of the typical conventional crude grades for which most refineries have been designed.

The benefits of improved marketplace crude distribution arising from the Southern Access Extension are quantified in a multi-step process:

1. The Crude Market Optimization Model is run with Southern Access Extension capacity set to zero and the aggregate crude value is determined (the Base Case).

2. The Crude Market Optimization Model is rerun with the Southern Access Extension in operation, and the overall model aggregate crude value is determined (the Change Case).

3. For the Base Case years which require the operation of the Southern Access Extension to avoid crude shut-in, just enough Southern Access Extension capacity is provided to eliminate shut-in, so as to measure just the benefits of improved marketplace distribution, and not the benefit of preventing shut-in.

4. The aggregate crude value difference between the two Crude Market Optimization Model runs is calculated.

5. This exercise is repeated for each year of the forecast period (2010 to 2020).

The aggregate crude value provided by the Crude Market Optimization Model is essentially equivalent to the value of all Western Canadian crudes to the refiners, less the cost required to transport the crude from Western Canada to the refiners. Said differently, the aggregate crude value defines the total economic rent available between the refiners and the crude producers, and the split of the rent between the two will be a function of the commercial dynamics of the Canadian crude marketplace. Table III illustrates the difference in the aggregate crude value with and without the Southern Access Extension Project. This represents the value to the total oil value chain (crude producers and refiners combined) of improving the distribution of Western Canadian crude.

TABLE III
ESTIMATED CHANGE IN AGGREGATE CRUDE MARKET VALUE
(Millions of Dollars per Year)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Aggregate Crude Value	786	238	8	277	460	387	2,521	1,699	1,320	2,499	2,994

The impact of the Southern Access Extension varies from year to year. This is due to the timing of other pipeline projects, such as Gateway, that

may alleviate inefficiencies in marketplace distribution and the size and nature of crude supply increases in Western Canada. On a per-barrel basis, the benefit varies from close to zero in 2012 to slightly over $1.40/bbl in 2020. Since the volume of Western Canadian crude is enormous, the total economic benefits are also correspondingly large. A portion of the benefits also flow to U.S. crude producers, particularly heavy crude producers in the Rockies. Since heavy crude producers in the Rockies and Canada compete for the same refinery customers, a depressed Canadian crude price pulls down the heavy crude price in the Rockies.

An analysis of the model results indicates that more Canadian heavy sour crude is being forced into such markets as the Rockies and the Pacific Northwest than the local refiners would prefer to economically process. The construction of the Southern Access Extension enables the Canadian heavy sour crude to flow to the large U.S. refineries that are capable of processing heavy sour crude and, accordingly, realize higher values for the Canadian heavy sour crude than is the case for the refineries in the Rockies and the Pacific Northwest. The allocation, between the refiners and the crude producers, of the higher aggregate crude value is a function of the commercial dynamics of the marketplace.

IMPROVED CRUDE QUALITY

An additional benefit of the Southern Access Extension is the improved light crude quality that the Enbridge system will be able to provide upon completion of the project. During typical pipeline operations, a variety of crudes are transported in batches through the same pipeline, resulting in some mixing and, thus, contamination, at the interface of the individual crude batches. Mixing is an issue that all pipelines face, but its economic impact is more pronounced

when the pipeline transports crudes with widely dissimilar qualities. For instance, mixing in a pipeline that transports solely light crudes is less of a concern than in a pipeline transporting both light and heavy crudes due to the greater dissimilarity of the crudes' properties in the latter case. Any contamination between light and heavy crudes results in an upgrade for heavy crude while the light crude is downgraded. However, the economic implications of the mixing on the respective values of the heavy and light crudes are not equivalent. A complex coking refinery that processes heavy crude does not realize a substantial benefit from the upgraded heavy crude due to the refinery's extensive conversion and sulfur handling capabilities. On the other hand, refineries designed to process only light sweet crude are affected to a much greater degree by the mixing as these refineries are not equipped to accommodate the higher sulfur content (as well as a number of other contaminants) contained in the heavy crude.

Currently, the only southbound pipeline from Chicago to Patoka is the Mustang pipeline. As a result, any light crude transported on Mustang receives some contamination, thus negatively impacting the values of light crudes transported on the lines. The construction of the Southern Access Extension could potentially enable the Mustang pipeline to be primarily utilized for the transportation of light crude and, therefore, reduce the levels of contamination in the light crudes.

Muse has previously performed an extensive analysis of the impact on crude value resulting from improvements in light crude quality in pipelines. This analysis showed that light crudes typically incurred an approximate $1.00/bbl value degradation due to the introduction of heavier crudes from the mixing. The precise future distribution of light crude shipments between the Southern Access Extension and the Mustang pipeline cannot be predicted with

certainty. However, using a conservative assumption regarding shift of light crude shipments to Mustang, the economic benefit of the segregation of light crude supply can be quantified in a relatively straightforward manner. Table IV provides a summary of this expected benefit over the first six full years of operation of Southern Access Extension. The benefits can be expected to continue throughout the forecast period.

TABLE IV
ESTIMATED VALUE OF CRUDE QUALITY IMPROVEMENT
(Units as Noted)

	2010	*2011*	*2012*	*2013*	*2014*	*2015*
Light Sweet and Synthetic Crude Deliveries (Mb/d)						
Mustang Pipeline	25.0	25.0	25.0	25.0	25.0	25.0
Crude Price Improvement ($/bbl)	1.00	1.00	1.00	1.00	1.00	1.00
Annual Crude Value Improvement ($MM)	**9.1**	**9.1**	**9.1**	**9.1**	**9.1**	**9.1**

As illustrated in the table, the value of the improved light crude quality is material. Furthermore, these economic benefits will positively impact entities other than the pipeline and the respective refineries since improved crude quality will help to maximize refinery production and hence supply to consumers.

REDUCED TRANSIT TIME

The Southern Access Extension will reduce the transit time required to ship crude from Canada to the United States. The shipment of crude on Southern Access Extension acts to increase the throughput, and thus decrease the transit time, on the Enbridge mainline system upstream of the Chicago area (the origin point for the Southern Access Extension). Via the addition of the 400,000 b/d of pipeline capacity from Southern Access Extension,

pipeline flow rates can be improved throughout the Enbridge system. At a Southern Access Extension throughput of 200,000 b/d, the transit time to Chicago will be reduced by 3.3 days. An increase in Southern Access Extension throughput to 400,000 b/d will decrease the transit time by a further 1.6 days, for a total decrease of 4.9 days.

The transit time improvement not only increases operational efficiency, but provides financial benefits as well. The financial benefits can be calculated by considering the reduction in working capital. The Enbridge system transports crude not only to Chicago, but also to refiners in Minnesota and Wisconsin. Therefore, the working capital savings are determined for crude that is transported to Minnesota and Wisconsin in addition to crude that is transported to Chicago. Estimates for these volumes are available from Muse's Crude Market Optimization Model. The volumes are combined with a forecast of the delivered cost of Canadian heavy crude (Lloydminster Blend is used as the proxy) in these areas and the reduced transit times to yield a total working capital savings estimate. The Table V provides a summary of the calculations for the first six years of operation for the Southern Access Extension, and these benefits will continue throughout the life of the project.

TABLE V
ESTIMATED WORKING CAPITAL SAVINGS
(Units as Noted)

	2010	2011	2012	2013	2014	2015
Pipeline Volumes (Mb/d)						
Minnesota and Wisconsin	413	416	419	422	425	425
Chicago and Downstream	918	1,109	1,067	1,134	1,191	1,191
Heavy Crude Pricing ($/bbl)						
Minnesota and Wisconsin	39.50	40.22	42.24	42.71	42.73	45.11
Chicago and Downstream	39.82	40.55	42.58	43.05	43.08	45.47
Pipeline Transit Time Improvement (days)						
Minnesota and Wisconsin	2.6	3.3	2.9	4.2	5.0	4.9
Chicago and Downstream	2.6	3.3	2.9	4.2	5.0	4.9
Total Working Capital Improvement ($MM)						
Minnesota and Wisconsin	42.4	55.2	51.3	75.7	90.8	93.9
Chicago and Downstream	95.0	148.4	131.8	205.0	256.5	265.4
Total	**137.5**	**203.6**	**183.1**	**280.7**	**347.3**	**359.3**
Financed Working Capital Improvement ($MM)						
Minnesota and Wisconsin	3.0	3.9	3.6	5.3	6.4	6.6
Chicago and Downstream	6.7	10.4	9.2	14.4	18.0	18.6
Total	**9.6**	**14.3**	**12.8**	**19.7**	**24.3**	**25.2**

As illustrated in Table V, the annual savings from the improvement in working capital are quite substantial, ranging from $140 to $360 million. Assuming that the working capital requirements would be financed at a 7 percent interest rate, the reduced pipeline transit time provide a savings of $10 to $25 million per year. Due to the competitive nature of the industry, these savings will not exclusively accrue to the respective companies as they could benefit the communities that these companies serve as well, via lower product prices and increased spending in other areas.

ENDNOTES

[i] CAPP, *Canadian Crude Oil Production and Supply Forecast 2006-2020*, May 2006. This projection is based on CAPP's "Supply Scenario with Condensate Used as Diluent", which assumes that condensate is readily available for use as a bitumen diluent.

[ii] The values provided refer to the blended volume of heavy crude, as much of the Oil Sands crude is too heavy to be transported via pipeline and must be diluted with lighter grades of crude oil.

[iii] The primary means to convert resid into light products is via the use of a delayed coker, which is a refinery process unit that thermally cracks the resid into light liquid products and a solid material known as petroleum coke.