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Testimony before the Senate Utilities Committee
January 30, 2007

Written Summary of Testimony

All material will be available as Kansas Geological Survey Open-File Report
Online at http://www.kgs.ku.edu/PRS/Info/webPubs.html (available by next week)

Chairperson Emler and Members of the Committee:

My name is Timothy R. Carr. I am Chief of the Energy Research Section of the Kansas Geological Survey, at the University of Kansas. I do not come as an advocate of any legislation before the committee, but to provide background on heavy and extra-heavy oil and bitumen (tar sands) production and resources on a world-wide and Kansas basis.

WHAT IS HEAVY OIL?

First I should define what is meant by these categories of crude oil. Crude oil is classified as light, medium or heavy, according to its measured API gravity[1].

- Light crude oil is defined as having API gravity higher than 31.1 °API
- Medium oil is defined as having API gravity between 22.3 °API and 31.1 °API
- Heavy oil is defined as having API gravity below 22.3 °API.
- Extra-Heavy or Bitumen ("Tar Sands") is defined as oil which will not flow at normal temperatures or without dilution. The API gravity is generally less than 10 °API, which means the crude has a density higher than water. Bitumen derived from the oil sands deposits in Alberta, Canada area has an API gravity of around 8 °API. It is 'upgraded' to an API gravity of 31 °API to 33 °API and the upgraded oil is known as synthetic oil. A similar process of upgrading is used on the Venezuelan extra-heavy crude prior to shipment.

The price of a barrel (which is 42 gallons or about 0.16 cubic meter) of oil is highly dependent on the location of its origin (e.g., "West Texas Intermediate, WTI", Kansas Common, or "Brent") and its relative weight and viscosity ("light", "intermediate", "heavy" or "extra heavy"). Refiners may also refer to it as "sweet," which means it contains relatively little sulfur, or as "sour," which means it contains substantial amounts of sulfur and requires more refining in order to meet the new more restrictive product specifications and environmental regulations (e.g., Ultra Low Sulfur Diesel). Each crude oil has unique molecular characteristics which are understood by the use of crude oil assay analysis in petroleum laboratories. All of these characteristics including geography affect the price of a particular crude oil.

[1] The American Petroleum Institute gravity, or ***API gravity***, is a measure of how heavy or light a petroleum liquid is compared to water. If its API gravity is greater than 10, it is lighter and floats on water; if less than 10, it is heavier and sinks. API gravity is thus a measure of the relative density of a petroleum liquid and the density of water, but it is used to compare the relative densities of petroleum liquids. For example, if one petroleum liquid floats on another and is therefore less dense, it has a greater API gravity. Although mathematically API gravity has no units (see the formula below), it is nevertheless referred to as being in "degrees". API gravity is graduated in degrees on a hydrometer instrument and was designed so that most values would fall between 10 and 70 API gravity degrees. Generally speaking higher API gravity degree oil values have a greater commercial value and lower degree values have lower commercial value. This rule only holds up to 45 degrees API gravity as beyond this value the molecular chains become shorter and less valuable to a refinery.

OIL RESOURCES VS. RESERVES

Extra-Heavy crude and bitumen usually occurs as deposits of oil sands, which consist of a mixture of crude bitumen (a semi-solid form of crude oil), silica sand, clay minerals, and water. "Tar Sands" are part of the hydrocarbon resource pyramid (Figures 1, 2). In an abstract way, the amount of oil or gas in the world can be viewed as a pyramid with a small amount of high quality resource that is cheap and easy to extract, and with increasing amounts of lower quality resource that are more difficult and expensive to extract. The upper part of the pyramid is well defined, as these resources are mostly known and are generally considered "conventional." The lower part of the pyramid is less well understood and the amount of petroleum in accumulations that are now largely uneconomic — such as hydrates or oil shale — is speculative.

Over time, the relative positions within the pyramid of the various accumulations of the world's oil and gas vary. The geological abundance of petroleum (prior to extraction) remains the same, but our perception of its economic viability changes for a variety of reasons. Hydrocarbon accumulations that were once thought to be only of scientific interest are transformed into "unconventional resources" and eventually become "conventional" as they rise higher in the pyramid. Over the last decade, Alberta oil sands have moved from the bottom of the pyramid. Similarly, a significant amount of U.S. and Kansas natural gas production now comes from coal and shale, sources once considered unconventional but now viewed as conventional. Resources may also fall in the pyramid. In 1860, Titusville was the oil resource at the top of the pyramid. In 1901, Spindletop was. Although they still produce, western Pennsylvania and eastern Texas are no longer near the top of the pyramid. At the beginning of the 20th century, the Middle East as an oil resource was viewed at the bottom of the pyramid.

Since Colonel Drake's well in 1859, we have produced in the lower 48 states approximately 183 billion barrels of oil. Adding proved reserves of 22 billion barrels provides a total of 205 billion barrels of produced or proven reserves (Figure 1, 2). However, this represents only a small fraction of our domestic resource pyramid. Whether we can and will produce this additional resource depends on price, technology and policy.

DISTRIBUTION OF NATURAL BITUMEN AND EXTRA-HEAVY OIL

Natural bitumen and extra-heavy oil are closely related types of petroleum, differing from each other, and from the petroleum from which they are derived, only to the degree by which they have been degraded. Chemically, bitumen is degraded to a greater extent than extra-heavy oil, so that it is not unlike the residuum from a refinery. This alteration, through bacterial attack and water washing, has resulted in severe loss of the light ends of the petroleum, notably the aromatic rings and paraffins, and subsequent relative enrichment of the heavy molecules, leading to increased density and viscosity. Of these molecules, the asphaltenes are very large and incorporate such non-hydrocarbons as nitrogen, sulphur, oxygen, and metals, in particular nickel and vanadium. The result of this chemistry is an array of problems beyond those encountered with conventional petroleum with respect to exploitation, transportation, storage, and refining. This, of course, is reflected in the increased cost of extraction and processing and the physical limitations on production capacity.

Although natural bitumen and extra-heavy oil are worldwide in occurrence, a single extraordinary deposit in each category is dominant. The Alberta, Canada natural bitumen deposits comprise at least 85% of the world total bitumen in place. Together, the Alberta (Athabasca) oil sand deposits cover about 141,000 km^2 of sparsely populated boreal forest and muskeg, an area approximately 2/3 the area of Kansas (Figure 3). The resource has been estimated to amount to about 1,700 to 2,500 billion barrels of bitumen in place.

Alberta estimates that the Athabasca deposits alone contain 5.6 billion cubic meters (35 billion barrels) of surface mineable bitumen and 15.6 billion cubic meters (98 billion barrels) of bitumen recoverable by in-situ methods. These estimates of Canada's oil reserves caused some astonishment when they were first published but are now largely accepted by the international community. This volume places Canadian proven oil reserves second in the world behind those of Saudi Arabia (Figure 4).

The method of calculating economically recoverable reserves that produced these estimates was adopted because conventional methods of accounting for reserves gave increasingly meaningless numbers. They made it appear that Alberta was running out of oil at a time when rapid increases in oil sands production were more than offsetting declines in conventional oil, and in fact most of Alberta's oil production is now non-conventional oil. Conventional estimates of oil reserves are really calculations of the geological risk of drilling for oil, but in the oil sands there is very little geological risk because they outcrop on the surface and are extremely easy to find. The only risk is economic risk of low oil prices and with the oil price increases of 2004-2006, the economic risk evaporated.

The Alberta estimates in some ways are extremely conservative, since they assume a recovery rate of around 20% of bitumen in place, whereas oil companies using the new steam assisted gravity drainage method (SAGD) of extracting bitumen report that they can recover over 60%. These much higher recovery rates probably mean that the ultimate production could be several times as high as government estimates.

At current rates of production, the Athabasca oil sands reserves would last over 400 years. However, they are unlikely to stay that way given the current supply shortage in the world. Assuming that Alberta quadrupled its production of oil, exporting most of it to the United States, the oil sands would last over 100 years. If production increased to the same level as Saudi Arabia, 10 million barrels per day, the life of the resource would be cut to a bit over 40 years.

Similarly, the extra-heavy crude oil deposit of the Orinoco Oil Belt, a part of the Eastern Venezuela basin, represents nearly 90% of the known extra-heavy oil in place. These two deposits, each located up-dip against a continental craton, represent about 3,600 billion barrels of oil in place, and represent the degraded remnant of petroleum deposits once totaling as much as 18,000 billion barrels. The Venezuelan Orinoco tar sands site may contain more oil sands than Athabasca. However, while the Orinoco deposits are less viscous and more easily produced using conventional techniques (the Venezuelan government prefers to call them "extra-heavy oil"), and are too deep to access by surface mining. Changes in government policies (ownership and taxation) have placed new investment and production efforts on hold.

Extra-heavy oil is recorded in 219 separate deposits; some of these are different reservoirs in a single field, some are producing, some are abandoned. The deposits are found in 30 countries and in 54 different geological basins.

Kansas has medium to heavy oil deposits within numerous sinuous reservoirs covering approximately 4000 km^2 scattered throughout a thirteen (13) county area of the Cherokee basin in southeast Kansas (Figure 5). While oil densities can vary widely in a single field, in general, oil densities from near the surface to approximately 1250 feet range from 10 ° to 25 °API. Deeper in the basin recorded density ranges upwards to 35 ° to 42 °API. Kansas heavy oil is relatively high quality heavy crude with 80% saturated and aromatic hydrocarbons and 20% non-hydrocarbon material. In comparison, Alberta tar samples consist of 50% hydrocarbons. Kansas heavy crude has lost both the light ends and the heavy normal paraffins as a result of waterwashing and biodegradation from aquifer recharge at the outcrop in Missouri and Arkansas. It has been estimated that the unrecovered resource in sandstone reservoirs thicker than 10 feet and at depths of less than 3,000 feet ranges from 350 to 750 million barrels (mmbo).

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HEAVY OIL AND BITUMEN PRODUCTION

Production in Alberta is up 61 percent over the past four years (Figure 6). This year, Alberta's oil sands are expected to produce 1.2 million barrels a day, roughly equal to the production of Texas. The recovery costs for oil from Alberta’s oil sands have fallen dramatically over the last 20 years and are estimated now about $8 per barrel. The numbers have not been lost on U.S. policymakers eager for a source of oil in a politically stable place. Canada is already the United States' largest source of foreign oil, providing 18 percent of its current supply and will probably grow to over 20% in the short term. In 2005, fully 10 percent of North America’s oil production came from Alberta’s oil sands. Production from 29 companies now operating in the three regions exceeds 1 million barrels per day, most of which is shipped to U.S. markets. Production is expected to triple -- to near 3 million barrels a day by 2015, making Canada the world's fifth largest crude oil producer.

The biggest bottleneck to increased Canadian imports is pipeline transportation. The lack of transport has depressed oil prices in the Northern Rockies and Northern Plains.

Canada’s and Alberta’s royalty and tax regime are attractive. The royalty regime consists of an initial 1% before project payout and 25% after recovery of project costs plus a designated return on capital. The royalties are paid based on the price of bitumen. Corporations are not taxed until after capital is recovered, so companies have an ever-increasing incentive to reinvest in growth. As a result of increased production and price, Alberta government revenues were $14.3 billion (Canadian) with an $8.7 billion surplus after annual increases in education spending (8.4%) and health spending (7.2%). These are significant inputs to a province with approximately the same population as Kansas (3.2 million compared to 2.7 million).

Kansas heavy oil is a much smaller scale than Alberta, Venezuela or even California. Also the divided mineral ownership and small operating leases have a negative effect on what are by necessity large capital projects. The tax structure (ad valorum) that imposes significant taxes on facilities would also have an affect.

IMPACT TO KANSAS

The planned Keystone Pipeline would transport through 1,830 miles of pipe approximately 435,000 barrels per day of crude oil from Alberta, Canada to markets in the U.S. (Figure 7). The pipeline would interconnect with other existing crude oil pipelines that could supply refinery markets in Kansas, Cushing, Okla., Wood River, Ill. and the U.S. Gulf Coast. It would have an affect on the supply of crude to Kansas refineries. Currently Kansas refineries process approximately 300,000 barrels of oil per day. Kansas produces approximately 90,000 barrels of oil per day. The difference is primarily imported oil brought up from the Gulf Coast. The natural disasters of the last few years (Katrina and Rita) and the political turmoil among U.S. suppliers suggest that Kansas should evaluate being tied to a single supply point for a significant portion of our liquid hydrocarbon requirements.

The increased use by Kansas refineries of imported heavy crude oil from Canada should help to stabilize oil prices. It may also encourage the increased production of Kansas heavy crude oil.

Thank you for your time and I hope this presentation provides some useful information.

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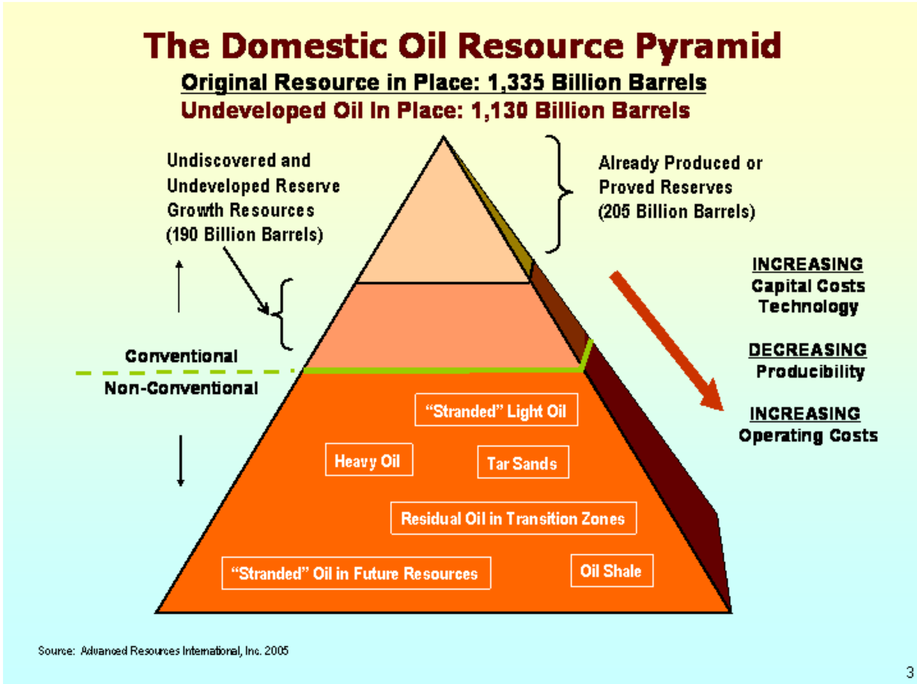

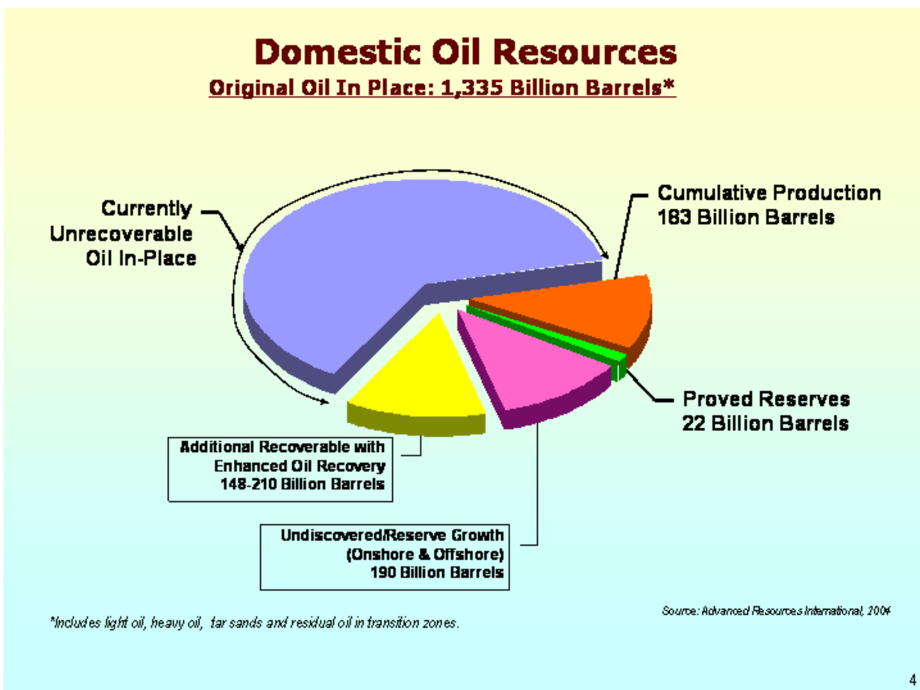

Figures 1, 2.-- Slides modified from data obtained from *Undeveloped Domestic Oil Resources: The Foundation for Increased Oil Production and a Viable Domestic Oil Industry*. Prepared for U.S. Department of Energy Office of Fossil Energy Office of Oil and Natural Gas by Advanced Resources International, February 2006. http://www.fossil.energy.gov/programs/oilgas/publications/eor_co2/Undeveloped_Oil_Document.pdf, and presentation entitled Opportunities for Increasing Revenues from State and Federal Lands: Pursuing the "Stranded Oil" Prize by David J. Beecy, Director, Future Oil and Gas Resources Office of Oil and Natural Gas/Office of Fossil Energy, U.S. Department of Energy, April 2005, www.fossil.energy.gov/programs/oilgas/publications/eor_co2/doe_eorco2_present.ppt

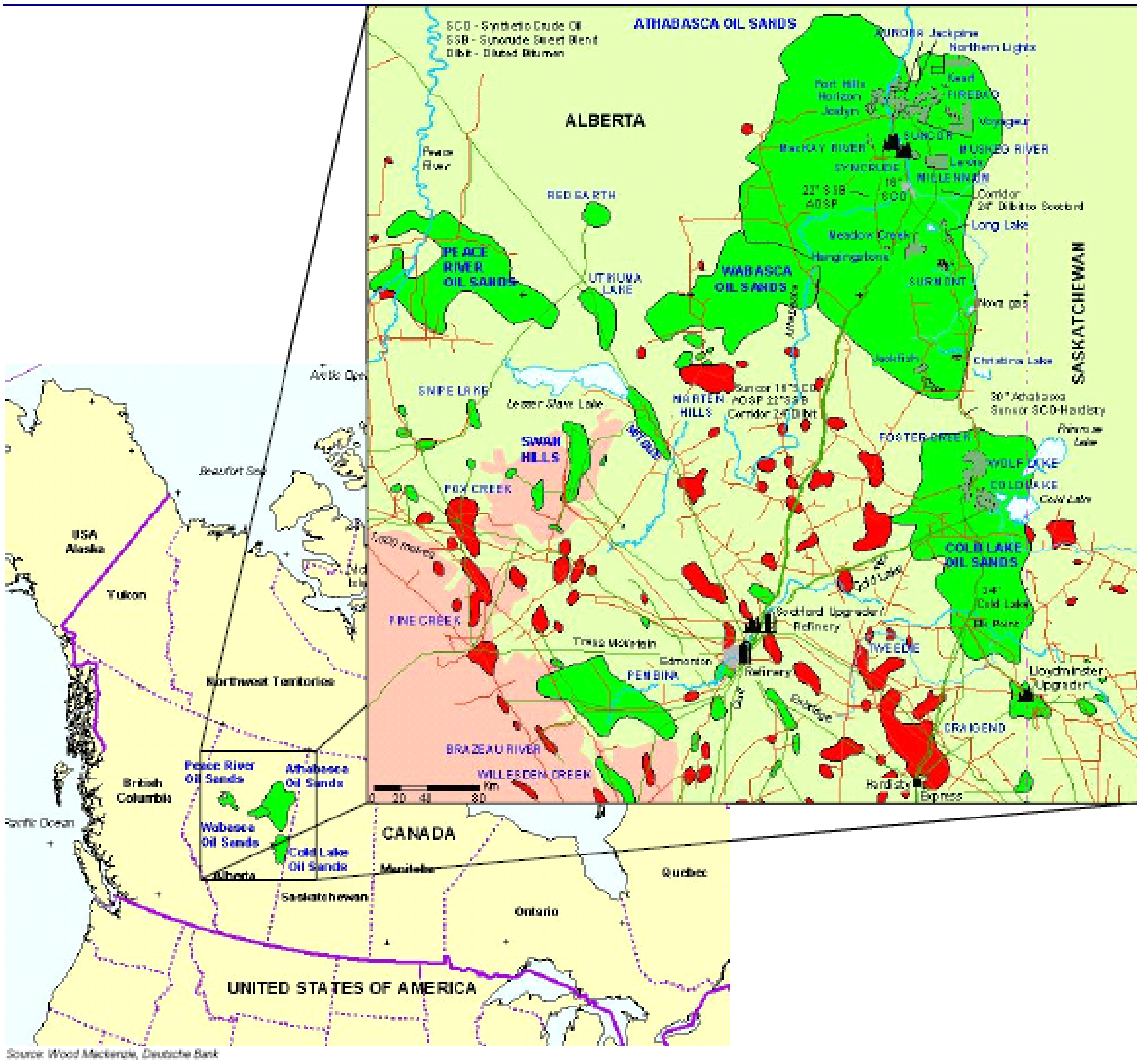

Figure 3.-- Area of Canadian Oil Sands plays.

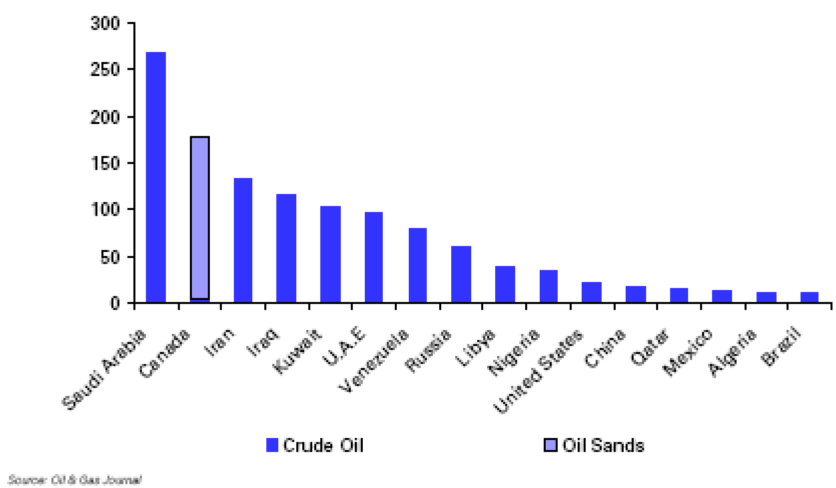

Figure 4.-- Estimated proved oil reserves in billions of barrels

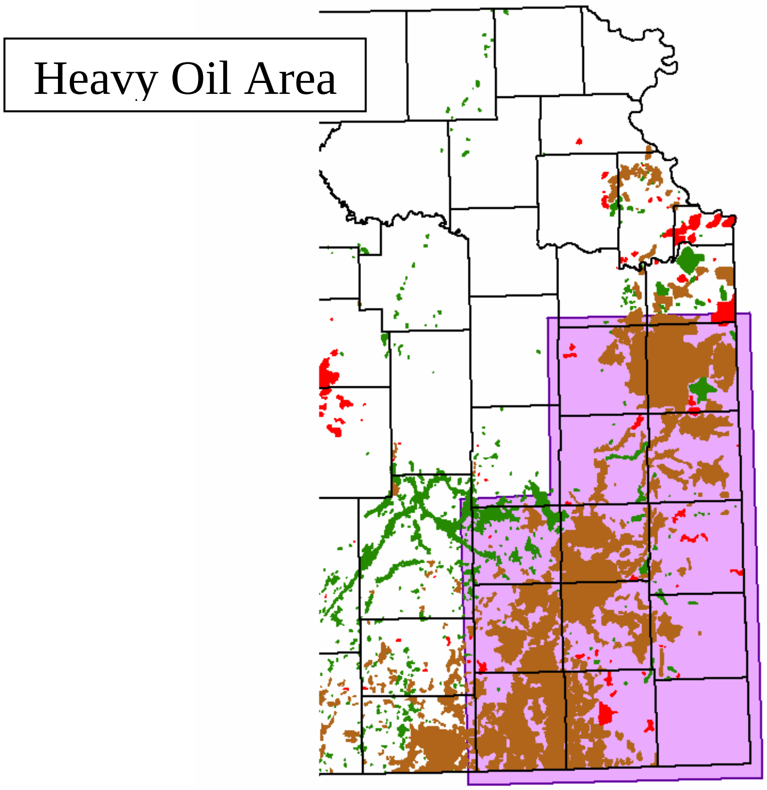

Figure 5.—Thirteen county area of southeast Kansas that contains heavy oils. Heavy oils continue into Missouri, Oklahoma and Arkansas.

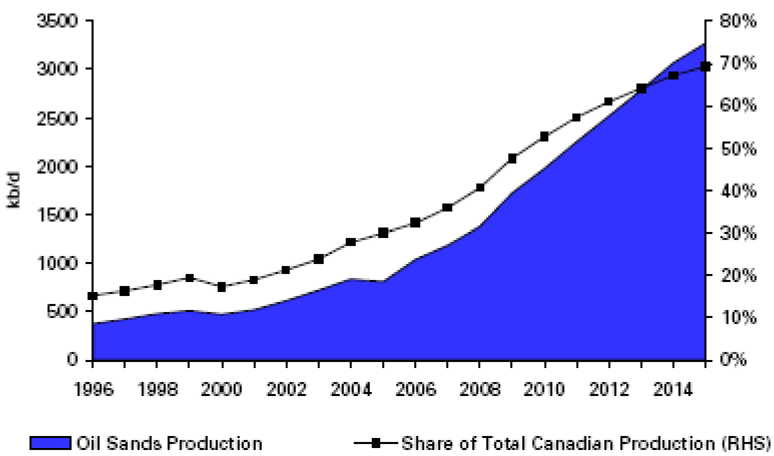

Figure 6.-- Canadian oil sands production and forecast in thousand barrels of oil per day.

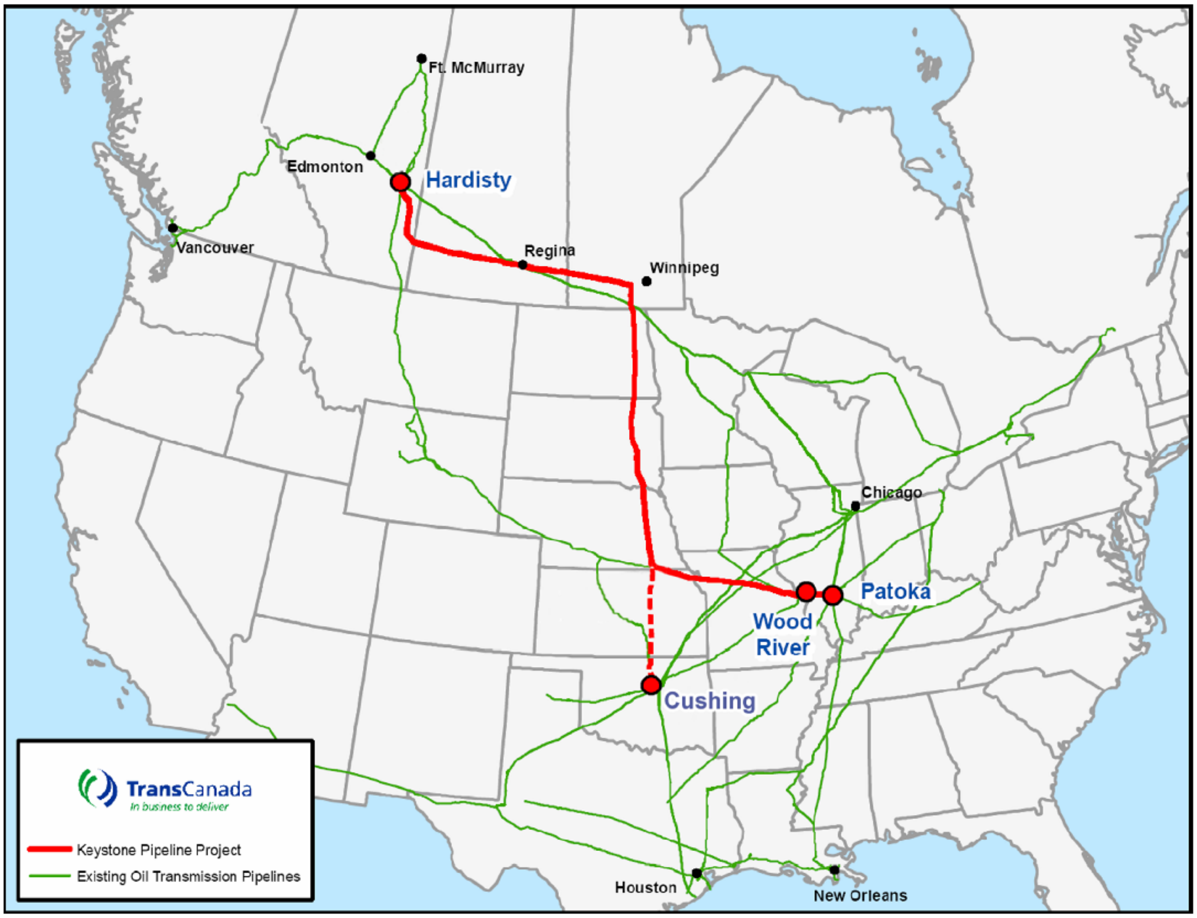

Figure 7.—Proposed route of keystone Pipeline project to increase the supply of Canadian heavy oil to the U.S.