

**Potential Oil Production  
from the  
Coastal Plain  
of the  
Arctic National Wildlife Refuge:  
Updated Assessment**

**May 2000**

**Energy Information Administration  
Office of Oil and Gas  
U. S. Department of Energy  
Washington, DC 20585**

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# Preface

*Potential Oil Production from the Coastal Plain of the Arctic National Wildlife Refuge: Updated Assessment* is a product of the Energy Information Administration's (EIA) Reserves and Production Division. EIA, under various programs, has assessed foreign and domestic oil and gas resources, reserves, and production potential. As a policy-neutral agency, EIA's standard analysis of the potential of the Alaska North Slope (ANS) has focused on the areas without exploration and development restrictions.

EIA received a letter (dated March 10, 2000) from Senator Frank H. Murkowski as Chairman of the Senate Committee on Energy and Natural Resources requesting an EIA Service Report "with plausible scenarios for ANWR supply development consistent with the most recent U.S. Geological Survey resource assessments." This service report is prepared in response to the request of Senator Murkowski. It focuses on the ANWR coastal plain, a region currently restricted from exploration and development, and updates EIA's 1987 ANWR assessment.

Recognizing the value of this study, readers should be aware of the limitations of the projections. There are many underlying forces

of energy markets that cannot be known with certainty, such as the speed of technological development, the impact of variations in oil prices, changes in legislation, and impacts of the economy on supply and demand. The USGS resource estimates, on which the production estimates are based, have a sizeable range of uncertainty around them, of which readers should be aware. To allow timely completion of this study, simplifying assumptions were made which add to the uncertainty of the projections. For example, production schedules were postulated without specifying the effect of various levels of oil prices and technology advancements. Rapid technology growth can yield lower costs and faster development, with the reverse effect given slower technology growth. Oil price is a key factor in determining when production becomes economic.

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# Executive Summary

This Service Report, *Potential Oil Production from the Coastal Plain of the Arctic National Wildlife Refuge: Updated Assessment*, was prepared for the U.S. Senate Committee on Energy and Natural Resources at the request of Chairman Frank H. Murkowski in a letter dated March 10, 2000. The request asked the Energy Information Administration (EIA) to develop plausible scenarios for Arctic National Wildlife Refuge (ANWR) supply development consistent with the most recent U.S. Geological Survey (USGS) resource assessments.

This report contains EIA projections of future daily production rates using recent USGS resource estimates. The Coastal Plain study area includes 1.5 million acres in the ANWR 1002 Area, 92,000 acres of Native Inupiat lands and State of Alaska offshore lands out to the 3-mile limit which are expected to be explored and developed if and when ANWR is developed. **(Figure ES1)** About 26 percent of the technically recoverable oil resources are in the Native and State lands.

The Coastal Plain region, which comprises approximately 8 percent of the 19 million-acre

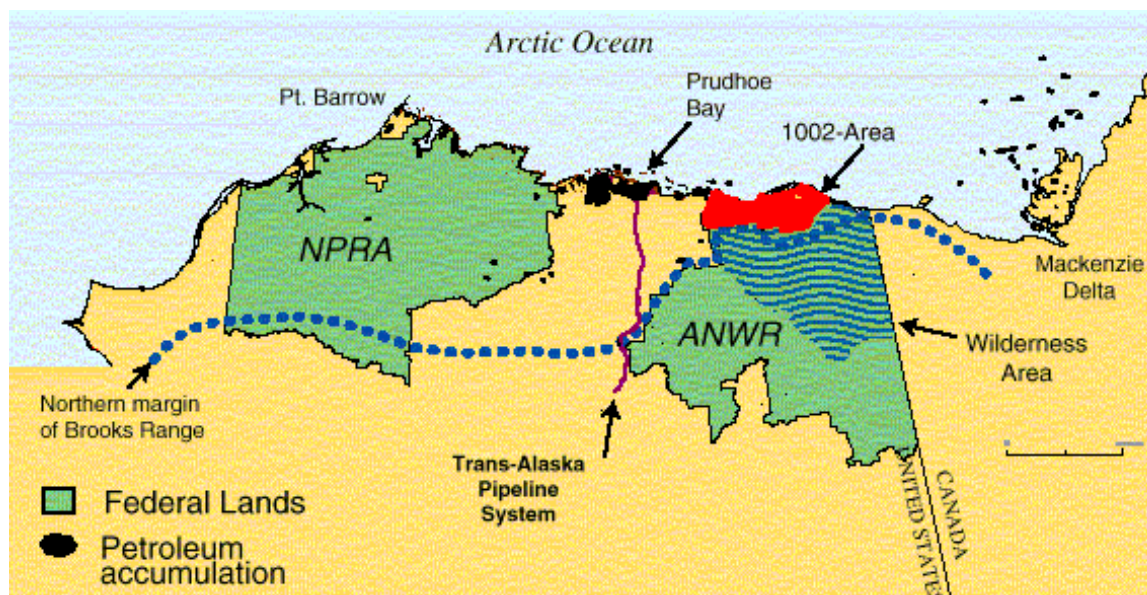
ANWR, is along the geologic trend that is productive in the Prudhoe Bay area, 60 miles west. This is the largest unexplored, potentially productive onshore basin in the United States. The 1002 area is now closed to exploration and development, although Native and State lands are open.

The USGS made the following estimates in 1998 of technically recoverable oil and natural gas liquids from the ANWR Coastal Plain:

- There is a 95 percent probability (a 19 in 20 chance) that at least 5.7 billion barrels of oil are recoverable.
- There is a 5 percent probability (a 1 in 20 chance) that at least 16 billion barrels of oil are recoverable.
- The mean (expected value) estimate is 10.3 billion barrels of recoverable oil.

By comparison, total 1998 U.S. proved reserves of crude oil were estimated to be 21 billion barrels and the 1993 estimate of undiscovered technically recoverable oil for the onshore lower 48 States (that would come from tens of thousands of small fields) was about 23 billion barrels.

**Figure ES1. Map of Northern Alaska**



Source: Edited from U.S. Geological Survey, "The Oil and Gas Resource Potential of the Arctic National Wildlife Refuge 1002 Area, Alaska," Open File Report 98-34, 1999.

EIA postulated yearly development rates of the resources without specifying the effect of various levels of oil prices and technology advances, and then projected daily production rates based on the USGS estimates, as follows:

- Low and high ANWR yearly development rates ranging from 250 to 800 million barrels per year are postulated for each of the three USGS estimates, forming 6 cases.
- Projected ANWR peak production rates range from 650,000 to 1.9 million barrels per day across the 6 cases.
- For the mean resource case (10.3 billion barrels technically recoverable), ANWR peak production rates range from 1.0 to 1.35 million barrels per day.
- Even with nearby production infrastructure, 7 to 12 years would be needed for lease sales, permitting and environmental reviews after approval for leasing. It is projected that initial ANWR production could occur around 2010 if leasing approval occurred within the next few years.
- The imported refiner acquisition cost in 2020 is projected in EIA's *Annual Energy Outlook 2000* reference case at \$22.04 (1998 dollars). At this price, the potential ANWR oil recovered would have a value between \$125 and \$350 billion (in 1998 dollars.)



# 1. Overview of the Arctic National Wildlife Refuge

## Background

The Arctic National Wildlife Refuge (ANWR) 1002 Area of the Alaska North Slope represents an area of 1.5 million acres. The ANWR Coastal Plain Area includes the 1002 Area, State of Alaska lands to the 3-mile limit from the coast line, and approximately 92,000 acres of Native Inupiat lands. The area is located between the Prudhoe Bay area of the Alaska North Slope (ANS) and the Mackenzie River Delta of Canada along the Beaufort Sea. The area contains the largest onshore, unexplored, potentially productive geologic basins in the United States. The 1002 Area is approximately 8 percent of the 19 million-acre ANWR.

The original Arctic National Wildlife Range of 8.9 million acres was created in 1960 by Public Law Order 2214. In 1980 the Alaska National Interest Lands Conservation Act (ANILCA) created 16 National Wildlife Refuges in Alaska. ANWR was enlarged to 19 million acres including the 8.9 million-acre wilderness area. Section 1002 of ANILCA deferred a decision on the management of oil and gas exploration and development of 1.5 million acres of potentially productive lands in the coastal plain of ANWR (which is why it is called the “1002 Area.”) Potential for oil and gas discovery is great because the area is an extension of the productive trends west of the area toward Prudhoe Bay and east toward the Canadian discoveries of the Mackenzie Delta. Congressional action would be required to open the land for exploration and development. In 1987 the Department of Interior recommended opening the area for oil and gas exploration and development. In 1995 the House and Senate approved ANWR 1002 Area development in the Budget Act that was vetoed by the President. Interest in the area has increased recently with the increase in crude oil prices, declining domestic production, and increasing imports.

The U.S. Geological Survey (USGS) updated in 1998 a petroleum assessment of the ANWR 1002 Area and the State and Native lands of the coastal

plain. Based on the new information from the USGS and increased interest in the potential for production from the area, this analysis is presented to show the range of potential production that can be expected from the development of the ANWR Coastal Plain.

## Geographic Setting

The 1002 Area of ANWR covers an area of 1.5 million acres between the Canning and Staines Rivers on the west, the Aichilik River to the east, the Beaufort Sea to the north, and the Brooks Range to the south. The Canning River western boundary is approximately 60 miles east of the Trans-Alaska Pipeline System (TAPS) and Prudhoe Bay. The 1002 Area extends approximately 100 miles from the Canning and Staines rivers (west boundary) to the Aichilik River east boundary. The area extends inland from the coast line of the Beaufort Sea from 16 to 34 miles to the foothills of the Brooks Range.

The Alaska native Inupiat have approximately 92,000 acres around the village of Kaktovik. These lands along with the State offshore lands to the 3-mile state boundary are included in this analysis. The study assumes that the resources of these lands also will be developed if and when the Federal lands of the 1002 Area are opened for development.<sup>1</sup>

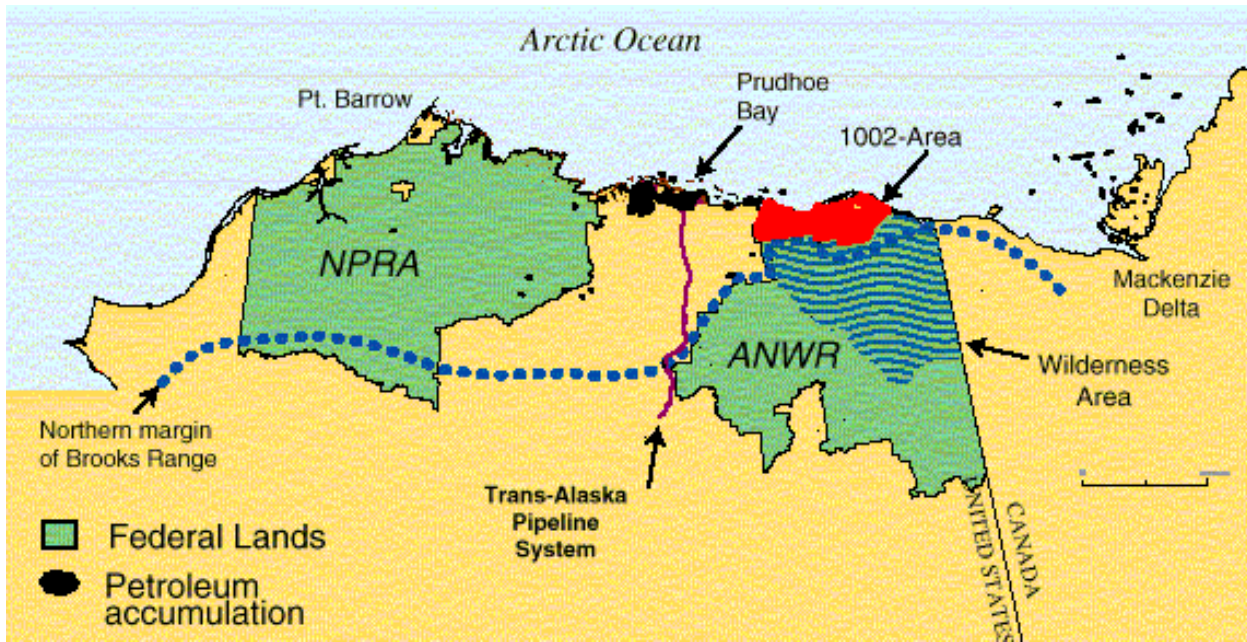
The map of **Figure 1** shows the location of the 19 million-acre ANWR along the eastern boundary of the state with Canada. The locations of the 8.9 million-acre Wilderness Area and the 1.5 million-acre 1002 Area are shown in ANWR. The 23 million-acre National Petroleum Reserve–Alaska (NPR-A) is shown to the west of ANWR. Parts of the northeast area of NPR-A were recently opened for exploration and development. Between ANWR and NPR-A are the areas that are currently producing, including Prudhoe Bay.

<sup>1</sup> Native and State lands are now open to exploration and development, but significant development has not occurred to date.

The path of the northern portion of the Trans-Alaska Pipeline (TAPS) is shown as it heads toward Valdez in southern Alaska. Also on the map are the Mackenzie River delta in Canada and

the trend of the Brooks Range across northern Alaska.

**Figure 1. Map of Northern Alaska and Northwestern Canada Showing the Locations of the National Petroleum Reserve-Alaska (NPR-A), Arctic National Wildlife Refuge (ANWR), 1002-Area, Current Productive Area, and Trans-Alaska Pipeline System (TAPS).**



Source: Edited from U.S. Geological Survey, "The Oil and Gas Resource Potential of the Arctic National Wildlife Refuge 1002 Area, Alaska," Open File Report 98-34, 1999.

## Geology

The description of the geology of the Coastal Plain is based on outcrops and geophysical data from seismic surveys of the area. The extrapolation of known geology and information from wells drilled offsetting the area provide additional confidence that potential oil and gas resources are located in the ANWR 1002 Area and the Coastal Plain. The stratigraphic section of **Figure 2** shows the source rocks and petroleum reservoir rocks of the area. The reservoirs that are productive in other areas of the ANS are indicated. The 10 plays (similar geologic settings) that were evaluated by the USGS are also included in the figure.

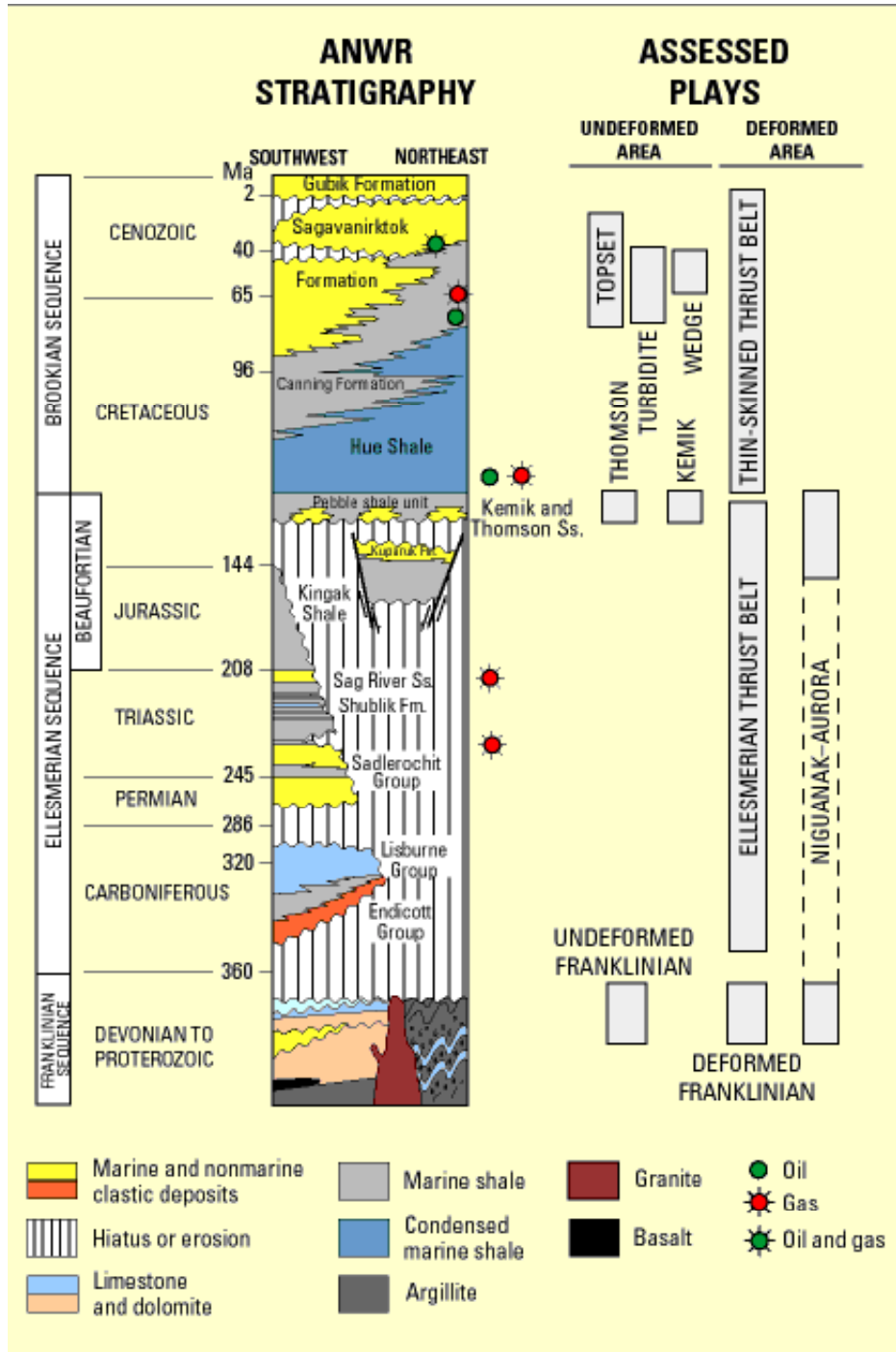
The following discussion of the sedimentary rocks in the area is from the *Arctic National Wildlife Refuge, Alaska, Coastal Plain Reservoir Assessment*, U.S. Department of the Interior, November 1986, p. 51.

“The area in and adjacent to the 1002 area is underlain by sedimentary rocks several tens of thousands of feet thick. These rocks range in age from Precambrian (greater than 570 million years old) to Quaternary (Bader and Bird, 1986). In northern

Alaska, rocks prospective for petroleum (oil and gas) are mostly Mississippian to Tertiary in age and overlie folded and truncated pre-Mississippian rocks. These rocks are divided into two sequences: the Ellesmerian sequence of Mississippian to Early Cretaceous age, and the Brookian sequence of Early Cretaceous and younger age. Deposition of the Ellesmerian sequence occurred when the land area was to the north and the seaway was to the south. During deposition of the Brookian sequence, the geography was reversed—the land area was to the south (the ancestral Brooks Range) and the seaway was to the north, much as it is today. The differentiation of these two sequences is important in understanding depositional history, and in projecting trends of reservoir rocks. Furthermore, properties of the Ellesmerian sandstones are generally better than those of the Brookian sequence.”

The unique combination of source rocks and reservoir traps is similar to the geologic combination of events that caused the productive reservoirs to the west including the Prudhoe Bay Field. Therefore, similar results are anticipated.

Figure 2. Stratigraphic Summary of Ages, Names and Rock Types in the ANWR 1002 and Coastal Plain Area of the Alaska North Slope. Potentially Productive Reservoirs and Plays Assessed by the USGS are Indicated.



Source: Edited from U.S. Geological Survey, "The Oil and Gas Resource Potential of the Arctic National Wildlife Refuge 1002 Area, Alaska," Open File Report 98-34, 1999.

## 2. Analysis Discussion

### Resource Assessment

The USGS most recent assessment of oil and gas resources of ANWR Coastal Plain (*The Oil and Gas Resource Potential of the Arctic National Wildlife Refuge 1002 Area, Alaska*, Open File Report 98-34, 1999) provided basic information used in this study. A prior assessment was completed in 1987 by the USGS. Information from recent offset drilling, offsetting discoveries, and new geologic and geophysical data were used to update the oil and gas resource potential.

An evaluation was made of each of 10 petroleum plays (similar geologic settings). For each play, USGS constructed statistical distributions of the number and size of potential accumulations based on a probabilistic range of geologic attributes. Minimum accumulation size was 500 million barrels. The resulting distributions were subjected to three risk parameters. Risk was assigned for the occurrence of adequate generation and migration of petroleum to meet the minimum size requirements, for the occurrence of reservoir rock to contain the minimum volume, and for the occurrence of a trapping mechanism to seal the petroleum in the reservoir. USGS analysts applied an appropriate recovery factor to the estimated oil in place that was calculated for each play to obtain an estimate

of technically recoverable petroleum resources. The combined recovery factor for the entire study area averages approximately 37 percent of the initial oil in place. It is likely that the actual recovery factor of potential large fields would exceed 37 percent, because the nearby giant Prudhoe Bay field recovery factor will exceed 50 percent.

The USGS results for the entire area are shown in **Table 1**, which lists the technically recoverable oil and initial oil in place for the ANWR 1002 Federal lands and for the entire Coastal Plain, including State and Native lands. The leasing of State and Native lands does not require Congressional action, but development is expected only if the Federal lands are available for utilization. That is why they are included in the analysis. About 26 percent of the technically recoverable resources are in the Native and State lands. The ANWR 1002 Area was also divided into a western undeformed area, north of the Marsh Creek anticline, and an eastern deformed area, between the Anticline and the Brooks Range in the USGS evaluation. More than 80 percent of the resources considered are contained in the undeformed area. The subdivision of resources between the undeformed and deformed portions is not considered in this report.

**Table 1. Estimates of Technically Recoverable and Oil in Place for the ANWR Coastal Plain and 1002 Area for 95 Percent, Mean, and 5 Percent Probability Levels**

<b>Part of Study Area</b>	<b>Volume of Oil, Millions of Barrels</b>		
	<b>95% Probability</b>	<b>Mean</b>	<b>5% Probability</b>
<b>ANWR 1002 Area</b>	4,254	7,668	11,799
<b>Oil in Place</b>	11,600	20,700	31,500
<b>Entire Coastal Plain Area</b>	5,724	10,322	15,955
<b>Oil in Place</b>	15,600	27,800	42,300

(Note: A 95% probability of recovery means that there are 19 chances out of 20 that this volume will be recovered; "mean" means there are 10 chances out of 20 that this volume will be recovered; and a 5% probability of recovery means there is 1 chance out of 20 that this volume will be recovered.)

Source: U.S. Geological Survey, "The Oil and Gas Resource Potential of the Arctic National Wildlife Refuge 1002 Area, Alaska," Open File Report 98-34, 1999.

## Method of Analysis

Potential production from the Coastal Plain of ANWR is based on the USGS estimates of technically recoverable oil. Production schedules are created for the statistical 95 percent probability, mean, and 5 percent probability of recovering the volumes. Production is scheduled for two development rates for each of the three probability estimates. The annual development rate is not associated with field size but is an amount attributed to the wells drilled each year. Several large fields may be discovered in a year but only a portion is scheduled for production. Actual development in early years may exceed development in later years but a constant rate of development is assumed in this study. **(Table 2)** Production schedules are presented for 6 scenarios. The range of potential is from 5.7 to 16.0 billion barrels of technically recoverable oil (the 95 percent to 5 percent probability range). A mid-case of 10.3 billion barrels is based on the

statistical mean of the estimates. Two development rates were chosen for each probability case to show the effect of accelerating development activities in the ANWR area. The development rates were chosen as volumes that could be developed within practical drilling and operational limits.

Production rates could be developed for different development rates, initial production rates, and decline rates. Technology improvements could change the recovery efficiency. The method of estimating the production schedule is a simplified approach that does not evaluate productivity, economic considerations or other factors that could affect development and production. The development rates are based on historical development in the area and engineering judgment based on the evaluation of performance and operational activities in the area.

**Table 2. Technically Recoverable Resources and Development Rates Associated with the Projected Production Cases for the ANWR Coastal Plain of the Alaska North Slope.**

<b>Statistical Estimate Cases</b>	<b>Technically Recoverable (BBbls)</b>	<b>Low Development Rate (MMBbls/yr)</b>	<b>High Development Rate (MMBbls/yr)</b>
95% Probability	5.7	250	400
Mean (Expected)	10.3	400	600
5% Probability	16.0	600	800

Source: Energy Information Administration, Reserves and Production Division. Technically recoverable barrels are from U.S. Geological Survey, "The Oil and Gas Resource Potential of the Arctic National Wildlife Refuge 1002 Area, Alaska," Open File Report 98-34, 1999.

A production schedule for each annual development volume is based on increasing production in the first 2 years to a peak production rate in the third year of approximately 10 percent of the development volume. Beginning in the fourth year, production is assumed to begin to decline at a 10 percent exponential rate. This decline continues until the total amount of expected recoverable oil is recovered. The annual production schedules are summed to obtain a total rate that recovers the estimated technically recoverable oil. Production schedules were postulated without specifying the effect of various levels of oil prices and technology advancements. That is, they are based on a simple engineering estimate. Rapid technology growth can yield lower costs and faster development, and vice versa.

An example of the method is presented for the 400 million barrel per year development of the 10.3 billion-barrel mean value case in **Table 3**. Increasing production in the first and second years is scheduled as 25,000 and 50,000 barrels per day, respectively. Peak production of 10

percent of the annual development rate, approximately 100,000 barrels per day, is scheduled in the third year of production. Beginning in the fourth year production declines at an exponential rate of 10 percent per year, ending after 40 years. This 40-year production schedule begins each year for 25 years, for a total productive life of 65 years. **Table 3** shows a portion of the full table constructed to schedule the rate of production. The total production for a given year is the sum of the individual production rates started that year and in previous years, as shown in the last column.

Seven to 12 years are estimated to be required from an approval to explore and develop to first production from the ANWR Area. This study uses 9 years to 2010 for the state of potential production. The time to first production could vary significantly based on time required for leasing after approval to develop is given. Environmental considerations and the possibility of drilling restrictions also could significantly affected projected schedules to reach first production.

**Table 3. Example of Production Schedule Projection for 10.3 Billion Barrels Developed at 400 Million Barrels per Year for the ANWR Coastal Plain**

Year	Producing Rate for Each Year of Development (Mbbbls/day)						Total
	1	2	3	4	-----	-----25	
1	25	--	--	--	-----	--	25
2	50	25	--	--	-----	--	75
3	100	50	25	--	-----	--	175
4	91	100	50	25	-----	--	266
5	82	91	100	50	-----	--	348
6	74	82	91	100	-----	--	422
-	-	-	-	-	-----	-	---
65	-	-	-	-	-----	2	2

Source: Energy Information Administration, Reserves and Production Division.

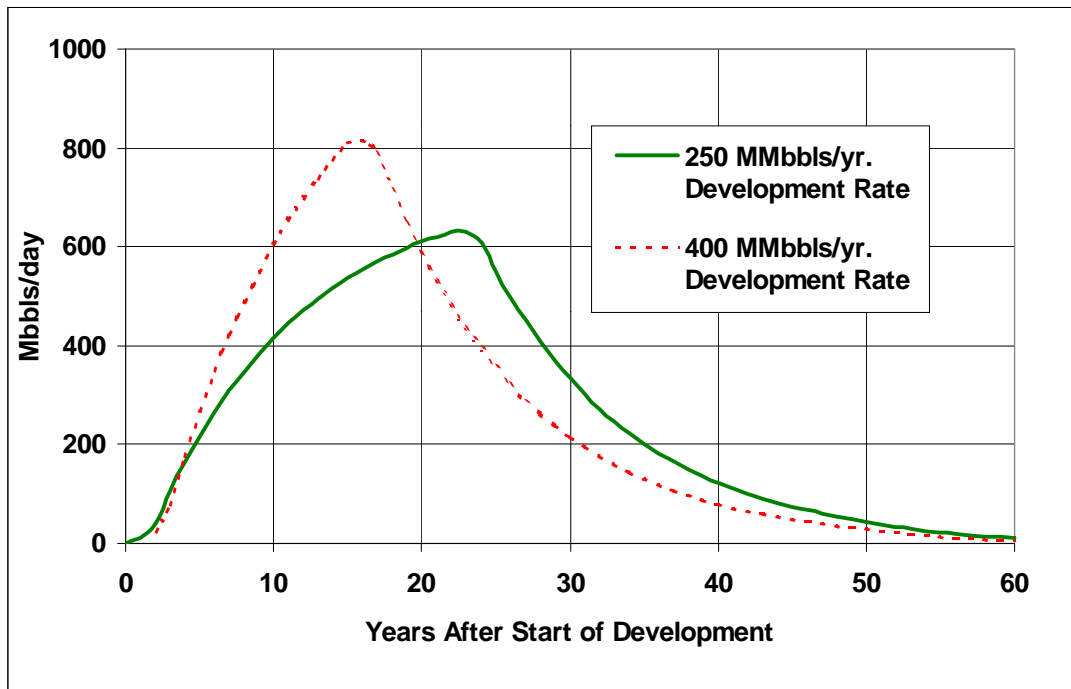
## ANWR Coastal Plain Assessment

The technique explained in the “Method of Analysis” section is applied to the USGS estimates of technically recoverable oil published in the USGS report, *The Oil and Gas Resource Potential of the 1002 Area, Arctic National Wildlife Refuge, Alaska,* Open File Report 98-34. Three estimates of technically recoverable resources are assessed at two development rates for each estimate. The resource estimates provide a range from a 95 percent probability, a mean, to a 5 percent probability of exceeding the technically recoverable volumes of 5.7, 10.3 and 16.0 billion barrels, respectively, from the ANWR Coastal Plain. The quantities of technically recoverable volumes for the same probability levels for the ANWR 1002 Area are 4.2, 7.7 and 11.8 billion barrels.

### 95 Percent Probability Case

The USGS estimates that there is a 95 percent probability (a 19 in 20 chance) that at least 5.7 billion barrels of oil may be technically recoverable from the ANWR Coastal Plain of the Alaska North Slope. The original oil in place corresponding to this recovery is at least 15.6 billion barrels. EIA scheduled daily production rates for postulated yearly development rates of 250 and 400 million barrels per year. The production rate peaks at 650,000 barrels per day for the development of 250 million barrels per year and at 800,000 barrels per day for the 400 million barrels per year development case. (Figure 3)

**Figure 3. Production Schedules at Two Development Rates for the 95 Percent Probability of Recovering 5.7 Billion Barrels of Technically Recoverable Oil from the ANWR Coastal Plain of Alaska.**



Source: Energy Information Administration, Reserves and Production Division. Based on USGS estimates of technically recoverable oil.

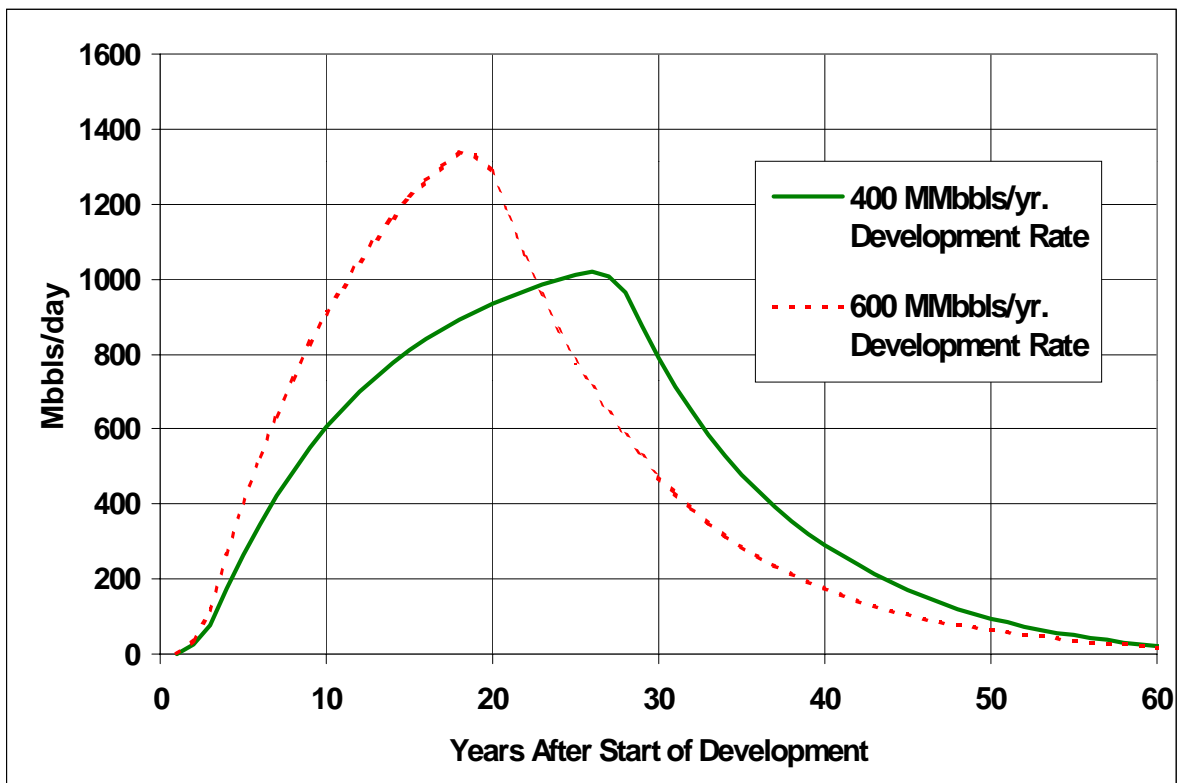


## Mean Case

The USGS estimates that the mean or expected value of the technically recoverable oil is 10.3 billion barrels from the ANWR Coastal Plain of the Alaska North Slope. The original oil in place corresponding to this recovery is 27.8 billion barrels. EIA scheduled production rates

are for postulated development rates of 400 and 600 million barrels per year. The production rate peaks at 1.0 million barrels per day for the development of 400 million barrels per year case and at 1.35 million barrels per day for the 600 million barrels per year development case. **(Figure 4)**

**Figure 4. Production Schedules at Two Development Rates for the Statistical Mean of Recovering 10.3 Billion Barrels of Technically Recoverable Oil from the ANWR Coastal Plain of Alaska.**



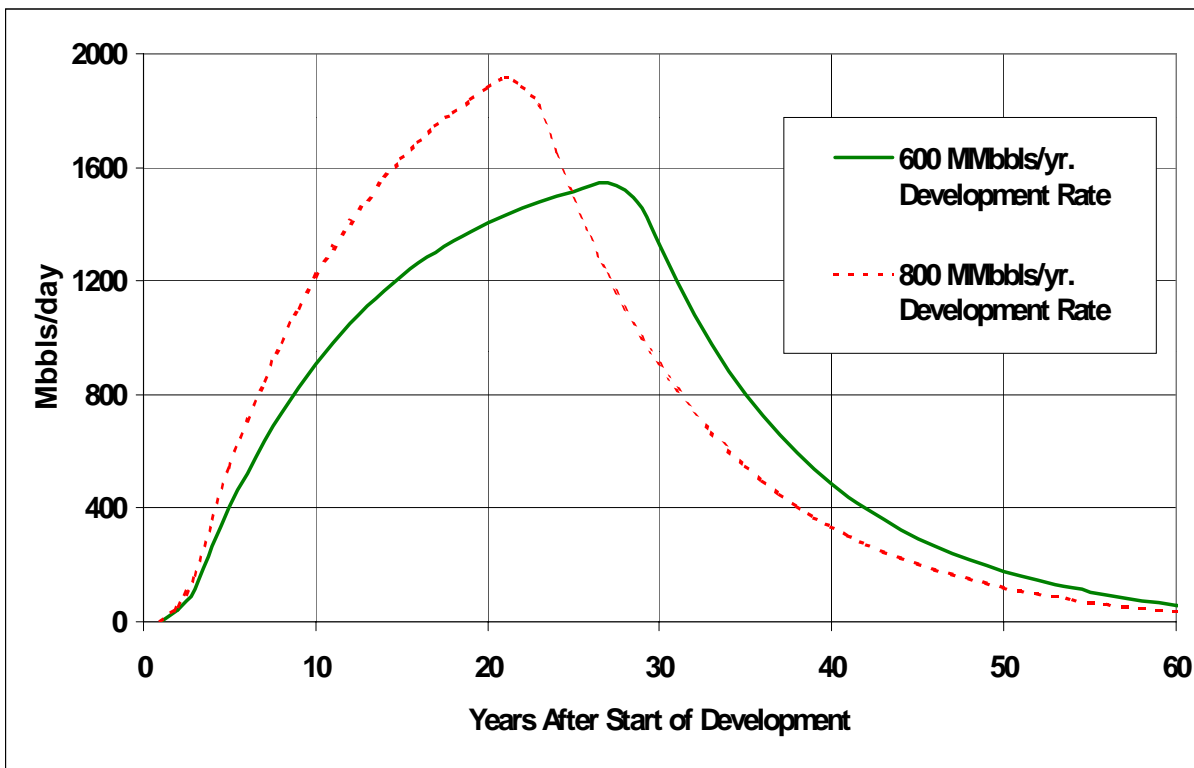
Source: Energy Information Administration, Reserves and Production Division. Based on USGS estimates of technically recoverable oil.

## 5 Percent Probability Case

The USGS estimates that there is a 5 percent probability (a 1 in 20 chance) that 16.0 billion barrels of oil, or more, may be technically recoverable from the ANWR Coastal Plain of the Alaska North Slope. The original oil in place corresponding to this recovery is at least 42.3 billion barrels.

EIA scheduled production rates for postulated development rates of 600 and 800 million barrels per year. The production rate peaks at 1.55 million barrels per day for the development of 600 million barrels per year case and at 1.90 million barrels per day for the 800 million barrels per year development case. (Figure 5)

**Figure 5. Production Schedules at Two Development Rates for the 5 Percent Probability of Recovering 16.0 Billion Barrels of Technically Recoverable Oil from the ANWR Coastal Plain of Alaska.**



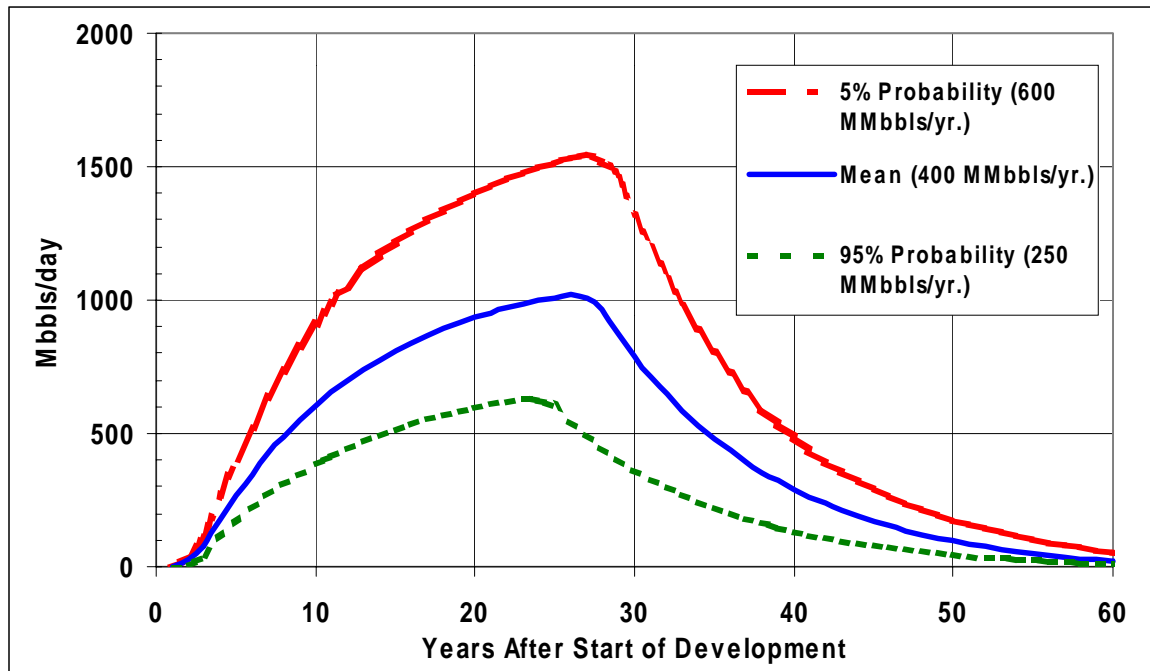
Source: Energy Information Administration, Reserves and Production Division. Based on USGS estimates of technically recoverable oil.

## Development Rate Summary

The production schedules for the low and high development rates are summarized in **Figures 6 and 7**. Many variables affect the rate of development and the production rates. The isolated location and harsh environment of the area limits the number of wells that can be drilled efficiently. Supply, demand and oil prices will also control the rate at which development occurs. Each of the charts shows the range of potential rates based on the probability ranges examined. Comparing the two charts shows how the production would respond to the rate of development. Production peaks around 20-30 years after the onset of development in all cases.

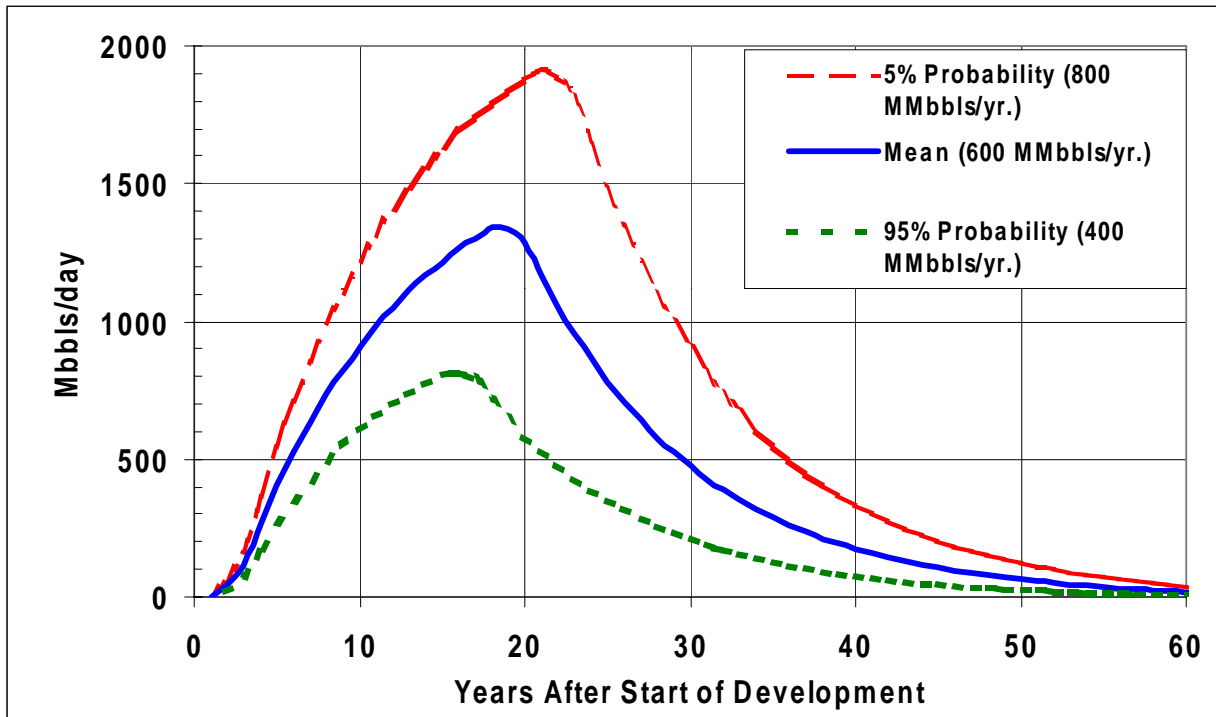
The analysis assumes that State and Native lands will be developed concurrently with the Federal lands. Significant variation in the development rates could be caused by oil price fluctuations and the use of infrastructure near the western boundary of ANWR Coastal Plain. With non-ANWR production rates expected to remain near the 1.0 million barrel per day rate over the next 10 years (EIA *Annual Energy Outlook 2000*) sufficient pipeline capacity exists to allow for the development of the ANWR Coastal Plain.

**Figure 6. Projected Production for the Low Development Rate of Technically Recoverable Oil Estimated at 5 Percent, Mean, and 95 Percent Probabilities for the ANWR Coastal Plain of the Alaska North Slope**



Source: Energy Information Administration, Reserves and Production Division. Based on USGS estimates of technically recoverable oil.

**Figure 7. Projected Production for the High Development Rate of Technically Recoverable Oil Estimated at 5 Percent, Mean, and 95 Percent Probabilities for the ANWR Coastal Plain of the Alaska North Slope.**



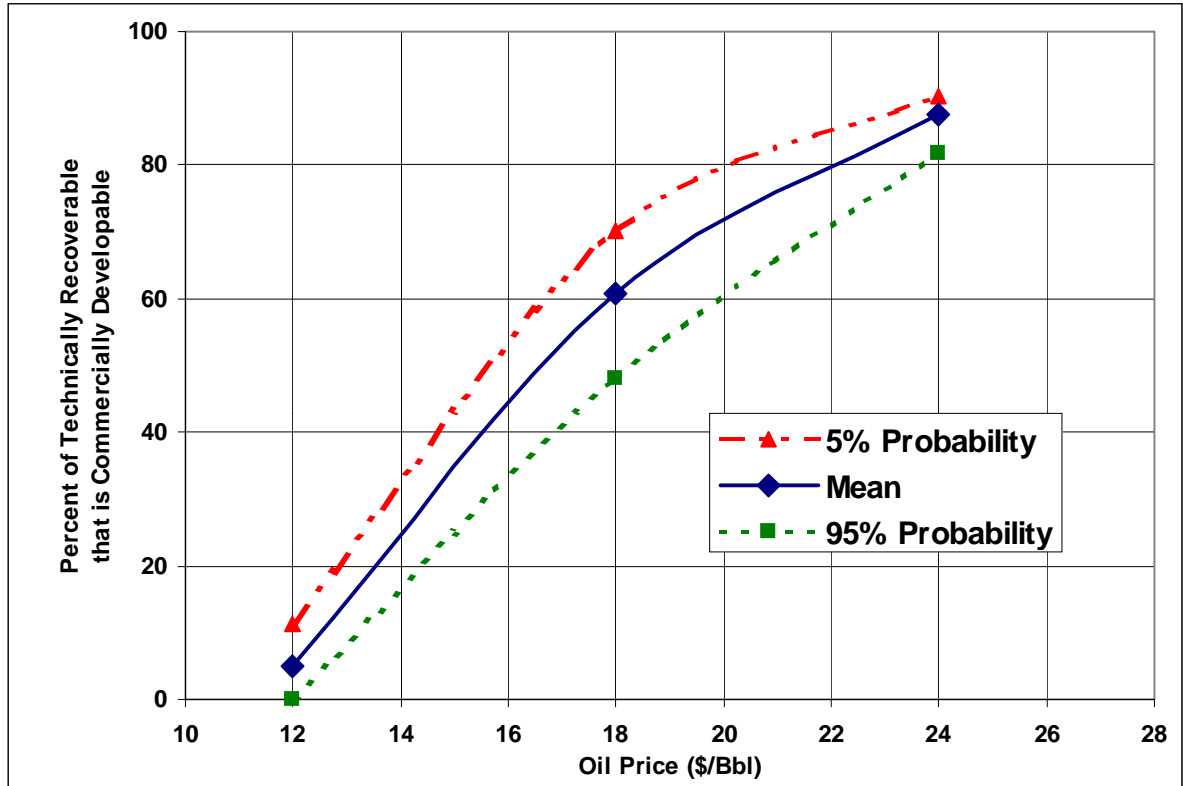
Source: Energy Information Administration, Reserves and Production Division. Based on USGS estimates of technically recoverable oil.

## Economic Impact

Economic analyses of the various scenarios of this report are not presented. An economic analysis of the ANWR 1002 Area (excluding Native and State lands) performed by the USGS is presented in *Economics of Undiscovered Oil in the 1002 Area of the Arctic National Wildlife Refuge*. That report, based on the USGS 1998 study of ANWR, presents broad economic parameters for finding, developing and producing oil at ANWR 1002 Area.

The commercially developable, technically recoverable resources associated with the three probability cases (5 percent, mean, 95 percent) that can be recovered at a given price are calculated based on a 12 percent rate of return. **Figure 8** shows percentages of the technically recoverable oil that can be commercially developed at given oil prices.

**Figure 8. Technically Recoverable and Commercially Developable Oil at 95 Percent, Mean, and 5 Percent Probabilities for Given Oil Prices as a Percentage of Technically Recoverable Oil for the ANWR 1002 Area of the Alaska North Slope.**



Source: United States Geological Survey, "Economics of Undiscovered Oil in the 1002 Area of the Arctic National Wildlife Refuge," 1998.

The USGS economic analysis of the ANWR 1002 Area calculates that once oil has been discovered, more than 80 percent of the technically recoverable oil is commercially developable at an oil price of \$25 per barrel. In general, it is assumed that production from Alaska (including ANWR) would reduce oil imports by an equal amount. The imported

refiner acquisition cost in 2020 is projected in EIA's *Annual Energy Outlook 2000* reference case to be \$22.04 (1998 dollars). At this price, the potential ANWR oil recovered would have a value between \$125 and \$350 billion (in 1998 dollars.)

### 3. Summary

The 1.5 million-acre coastal plain of the 19 million-acre Arctic National Wildlife Refuge is the largest unexplored, potentially productive geologic onshore basin in the United States. The primary area of the coastal plain is the 1002 Area of ANWR established when ANWR was created. A decision on permitting the exploration and development of the 1002 Area is up to Congress and has not been approved to date. Also included in the Coastal Plain are State lands to the 3-mile offshore limit and Native Inupiat land near the village of Kaktovik.

The USGS estimated:

- a 95 percent probability that at least 5.7 billion barrels of technically recoverable undiscovered oil are in the ANWR coastal plain,
- a 5 percent probability that at least 16 billion barrels of technically recoverable undiscovered oil are in the ANWR coastal plain, and
- a mean or expected value of 10.3 billion barrels of technically recoverable undiscovered oil in the ANWR coastal plain.

EIA postulates two development rates for each of the three USGS probability estimates without specifying the effect of various levels of oil prices and technology advancements, ranging from 250 to 800 million barrels developed per

year. EIA projects peak production rates from 600,000 to 1.9 million barrels per day over the six cases, with peak production estimated to occur 20 - 30 years after the onset of production.

Seven to 12 years are estimated to be required from an approval to explore and develop to first production from the ANWR Area. This study uses 9 years, to 2010. The time to first production could vary significantly based on time required for leasing after approval to develop is given. Environmental considerations and the possibility of drilling restrictions would directly impact the time interval to reach first production.

The USGS economic analysis of the ANWR 1002 Area calculates that once oil has been discovered, more than 80 percent of the technically recoverable oil is commercially developable at an oil price of \$25 per barrel. The imported refiner acquisition cost in 2020 is projected in EIA's *Annual Energy Outlook 2000* reference case at \$22.04 (1998 dollars). At this price, the potential ANWR oil recovered would have a value between \$125 and \$350 billion (in 1998 dollars.)

# Glossary

**ANILCA:** Alaska National Interest Lands Conservation Act

**ANS:** Alaskan North Slope

**ANWR:** Arctic National Wildlife Refuge

**BBbls:** billion barrels

**Bbls:** barrels

**Daily Petroleum Production Rate:** The amount of petroleum extracted per day from a well, group of wells, region, etc. (usually expressed in barrels per day)

**EIA:** Energy Information Administration

**MBbls:** thousand barrels

**MMBbls:** million barrels

**NPR-A:** National Petroleum Reserve-Alaska

**Petroleum Play:** A set of known or postulated petroleum accumulations sharing similar geologic, geographic, and temporal properties such as source rock, migration, pathway, timing, trapping mechanism, and hydrocarbon type

**TAPS:** Trans-Alaska Pipeline System

**Technically Recoverable Resources:** Resources in accumulations producible using current recovery technology but without reference to economic profitability generally conceived as existing in accumulations of sufficient size to be amenable to the application of existing recovery technology (usually expressed in barrels, for oil)

**USGS:** United States Geological Survey

**Yearly Petroleum Development Rate:** The amount of petroleum potentially made available through the drilling of wells and installation of infrastructure in a region in a year (usually expressed in barrels per year)

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