

GAO

Briefing Report to Congressional Requesters

May 1987

OIL RESERVES

An Analysis of Oil Fill Alternatives



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Resources, Community, and
Economic Development Division

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May 21, 1987

The Honorable J. Bennett Johnston, Chairman
The Honorable James A. McClure,
Ranking Minority Member,
Committee on Energy and
Natural Resources
United States Senate

The Honorable Bill Bradley
United States Senate

The Honorable Don Nickles
United States Senate

This briefing report responds to your March 5, 1987, request that we provide an analysis of possible oil fill rate options for the Strategic Petroleum Reserve (SPR) and their annualized construction and petroleum acquisition costs. You expressed particular interest in (1) the Department of Energy's (DOE's) current construction and fill rate policy, (2) the maximum achievable fill rate for available storage capacities under current construction policy, (3) a fill rate of 100,000 barrels per day, and (4) other feasible fill rate options.

In summary, we found that

- DOE is planning to obligate about \$670 million in fiscal year 1987 to develop and manage the SPR, increase storage capacity to 581 million barrels, and fill the reserve at a 75,000-barrel-per-day rate;
- DOE is planning to stop developing additional storage capacity through its cavern leaching program after September 30, 1987, but expects to obligate about \$386 million in fiscal year 1988 for other facilities development, SPR management, and oil purchases at a reduced rate of 35,000 barrels per day;

- under DOE's planned leaching moratorium after September 30, 1987, the SPR will have about 47 million barrels of storage capacity available for fill in fiscal year 1988. Maximum oil deliveries averaging 146,000 barrels per day would fill the SPR to the 581-million-barrel level by the end of fiscal year 1988 at a cost of about \$884 million for oil;¹ and
- lower oil fill rates would increase the time needed to fill available capacity and would probably increase the total oil costs. A 100,000-barrel-per-day fill rate, for example, would reach the 581-million-barrel level in fiscal year 1989 at an estimated cost of nearly \$894 million. DOE's proposed 35,000-barrel-per-day fill rate would fill the available space in fiscal year 1991 at a total oil cost of over \$966 million.

We noted that if DOE continues with its proposed delayed leaching program and limits future oil fill to 35,000 barrels per day, a 750-million-barrel SPR could not be completed until 2004. If DOE continued developing cavern storage space after fiscal year 1987, however, several higher fill rate alternatives would be possible, with a 750-million-barrel inventory level reached much earlier. For example, filling available capacity as it is developed would complete the SPR in fiscal year 1992. A 75,000-barrel-per-day fill rate would complete the SPR in fiscal year 1995. Continued leaching to increase oil storage space would, however, add about \$22.4 million to DOE's proposed fiscal year 1988 budget and \$118 million during fiscal years 1989-92.

In addition to computing the amount of annual budget authority needed for DOE's proposed fill rate and for each of three oil fill alternatives under a continued leaching program, we also discounted their total costs to 1988 under three oil price forecasts. This comparison showed that under all assumed oil prices, it is generally less costly to the government to fill the SPR at the maximum rate--as fast as capacity is developed. Under the base case oil price forecast, for example, filling the SPR at the maximum rate

¹All costs are in current year dollars unless otherwise noted. Oil prices are based on Data Resources, Inc., Spring 1987, base case. Prices start at \$18.81 per barrel, including DOE's SPR-specific cost factor.

could cost about \$579 million less than filling at 35,000 barrels per day. Further, this alternative provides increased protection against import disruptions and increases the SPR maximum withdrawal capability at an earlier date.

In developing data for this report, we analyzed budget data, storage development schedules, and oil fill rates obtained from DOE officials in Washington, D.C., and New Orleans, Louisiana. We reviewed oil price and import forecasts obtained from the Office of Management and Budget, the Energy Information Administration, and Data Resources, Inc., for the fiscal year period 1988 through 2004.

On the basis of the above data, and using DOE's projected fiscal year 1988 to 1992 budget estimates as a base, we developed estimated costs for DOE's proposed fill rate and three oil fill alternatives. A complete description of our methodology is given in appendix I.

We discussed the accuracy and the reasonableness of the assumptions used in the report with responsible agency officials and have incorporated their views into the report where appropriate. As arranged with your offices, unless you publicly announce its contents earlier, we plan no further distribution of the report until 14 days from the date of this letter. At that time, we will send copies to the Secretary of Energy and interested congressional committees. We will also make copies available to others upon request.

Major contributors to this report are listed in appendix II.

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ABBREVIATIONS

CIP	Capital Improvement Project
DOE	Department of Energy
DRI	Data Resources, Inc.
EIA	Energy Information Administration
GAO	General Accounting Office
NPR	Naval Petroleum Reserve
OMB	Office of Management and Budget

SECTION 1
INTRODUCTION

=====

THE STRATEGIC PETROLEUM RESERVE

- WAS ESTABLISHED IN 1975,
- IS PLANNED FOR A 750-MILLION-BARREL INVENTORY,
- MUST BE FILLED AT AN AVERAGE 75,000 BARRELS PER DAY FOR DOE TO CONTINUE SALES FROM THE NAVAL PETROLEUM RESERVE,
- CURRENTLY CONTAINS 520 MILLION BARRELS OF OIL, AND
- IS CURRENTLY RECEIVING OIL FROM BOTH FOREIGN AND DOMESTIC SUPPLIERS.

SPR DEVELOPMENT AND STATUS

The Energy Policy and Conservation Act (Public Law 94-163, December 22, 1975), as amended, authorized the creation of a Strategic Petroleum Reserve (SPR) to store up to 1 billion barrels of oil for use in a supply disruption. To meet the goals of the act, the Department of Energy (DOE) established a three-phase plan to store 750 million barrels of oil with a 1989 completion date. While the timetable for achieving this oil inventory has continued to be extended, the original objective of a 750-million-barrel SPR has both congressional and administration support.

The SPR currently consists of six storage sites located in Louisiana and Texas. Two sites are full, three are in or nearing the final developmental stage, and one site is still under construction. Oil storage space is developed through a leaching process that entails pumping fresh water into salt deposits and removing the resultant brine solution. While the storage space is being created, crude oil can also be pumped into the cavern replacing the brine. As of March 31, 1987, the SPR sites contained 520 million barrels of oil.

The administration twice, 1985 and 1986, proposed a moratorium on storage development and oil fill, but the Congress rejected the proposals. The current fiscal year 1987 fill rate was established by the Omnibus Budget Reconciliation Act of 1986 (Public Law 99-509) which the President signed on October 21, 1986. The act requires DOE to fill the SPR during fiscal years 1987, 1988, and 1989 at the highest practicable fill rate achievable, subject to the availability of appropriated funds. The act also tied the sale of Naval Petroleum Reserve (NPR) oil to either having 750 million barrels of oil stored in the SPR or maintaining an average fill rate of 75,000 barrels per day.

DOE currently has two contracts for supplying oil to the SPR. On October 7, 1986, DOE awarded a contract to Transworld Oil U.S.A., for 3.65 million barrels of domestically produced oil. On November 7, 1986, DOE signed a sales agreement with Petroleos Mexicanos for about 23.7 million barrels of Mexican crude oil. The delivery period for the two contracts covers the period November 1, 1986, through November 30, 1987. DOE has no oil purchase agreements extending beyond that date.

SECTION 2

FISCAL YEAR 1987 PLANNED ACTIVITIES

Table 2.1: Status of Planned SPR Activities, February 29 to September 30, 1987

<u>SPR site</u>	<u>Beginning inventory</u>		<u>Ongoing operations</u>		<u>Ending inventory</u>	
	<u>Oil</u>	<u>Permanent capacity</u>	<u>Oil fill</u>	<u>Cavern development</u>	<u>Oil</u>	<u>Permanent capacity</u>
-----millions of barrels-----						
Bayou Choctaw	45.9	46.0	10.0	10.0	55.9	56.0
Bryan Mound	195.7	226.0	-	-	195.7	226.0
Sulphur Mines	25.9	26.0	-	-	25.9	26.0
Weeks Island	72.6	73.0	-	-	72.6	73.0
West Hackberry	174.1	181.5	9.8	18.5	183.9	200.0
Big Hill	-	-	-	-	-	-
Total	<u>514.2</u>	<u>552.5</u>	<u>19.8</u>	<u>28.5</u>	<u>534.0^a</u>	<u>581.0</u>

^aIncludes approximately 2.5 million barrels of oil in tanks and pipelines.

Source: DOE.

SPR CAPACITY DEVELOPMENT AND OIL FILL FOR FISCAL YEAR 1987

As shown in table 2.1, the SPR is scheduled to have 534 million barrels of oil in storage at the end of fiscal year 1987, and to have developed a permanent storage capacity of 581 million barrels--47 million barrels above the anticipated oil inventory level. DOE expects to obligate about \$670 million for oil purchases and for developing and managing the SPR during the fiscal year.

The expected inventory of 534 million barrels requires an average daily fill rate of 75,000 barrels. At the end of fiscal year 1986, the SPR petroleum account had an unobligated balance of about \$526 million. As of December 31, 1986, DOE had apportioned about \$429 million to this account for fiscal year 1987 to purchase 27.4 million barrels of oil--at an estimated average cost of \$15.14 per barrel. DOE plans to use the remaining \$97 million for additional oil purchases during the last quarter of fiscal year 1987, with delivery of 35,000 barrels per day occurring during the first quarter of fiscal year 1988 in support of its planned 35,000-barrel-per-day fill rate. However, if the current delivered price of oil to the SPR of about \$18 per barrel continues, the fiscal year 1987 apportionment may have to be increased by as much as \$50 million, thereby reducing the amount available for fiscal year 1988 oil purchases.

The 47 million barrels of available capacity includes 30 million barrels at Bryan Mound, which will be available as of October 1, 1987, following completion of the leaching project underway on Cavern 5. The remaining 17 million barrels result from the cavern development activities at West Hackberry.

SECTION 3

DOE'S FISCAL YEAR 1988 PROPOSED STORAGE DEVELOPMENT
AND OIL FILL PLAN AND POSSIBLE OIL FILL
ALTERNATIVES UNDER THE ADMINISTRATION'S PROPOSAL

Table 3.1: Administration Proposal for SPR Fiscal Year 1988

<u>SPR site</u>	<u>Beginning inventory</u>		<u>Annual operations</u>		<u>Ending inventory</u>	
	<u>Oil</u>	<u>Permanent capacity</u>	<u>Oil fill</u>	<u>Cavern development</u>	<u>Oil</u>	<u>Permanent capacity</u>
	-----millions of barrels-----					
Bayou Choctaw	55.9	56.0	-	-	55.9	56.0
Bryan Mound	195.7	226.0	12.8	-	208.5	226.0
Sulphur Mines	25.9	26.0	-	-	25.9	26.0
Weeks Island	72.6	73.0	-	-	72.6	73.0
West Hackberry	183.9	200.0	-	-	183.9	200.0
Big Hill	-	-	-	-	-	-
Total	<u>534.0</u>	<u>581.0</u>	<u>12.8</u>	<u>-</u>	<u>546.8</u>	<u>581.0</u>

Source: DOE.

PROPOSED SPR CAPACITY DEVELOPMENT AND OIL FILL
PLANS FOR FISCAL YEAR 1988

DOE's fiscal year 1988 SPR budget proposed net obligations of about \$386 million for oil purchases, facilities development, and management activities. However, DOE indicates that none of the funds are to be used to develop additional storage capacity after fiscal year 1987. The \$221 million planned for oil purchases is based on a fill rate of 35,000 barrels per day and an oil price of about \$17 per barrel. On the basis of DOE's budget, the available permanent storage capacity shown in table 3.1 would remain at 581 million barrels and the oil inventory would total 546.8 million barrels as of September 30, 1988.¹

The 581-million-barrel storage capacity is sufficient to sustain DOE's proposed 35,000-barrel-per-day fill rate through fiscal year 1990 and a large part of fiscal year 1991. The administration's announced intention to fill the SPR to a 750-million-barrel level, however, requires the resumption of cavern development at some future date. The administration has not yet stated when it will again propose funding for this activity.

In order to develop additional capacity to store oil beyond fiscal year 1991, leaching would have to be resumed in fiscal year 1989 at Bayou Choctaw and at West Hackberry in fiscal year 1991. Leaching at Big Hill would also have to be started in fiscal year 1991. Under this scenario, a 750-million-barrel SPR would be achieved in 2004.

¹DOE's proposed budget would, notwithstanding 42 U.S.C. 6240 (c) and (d), as amended by Public Law 99-509 (October 21, 1986), lower the fill rate requirements for the SPR to not less than 35,000 barrels per day and eliminate the requirements for a shut-in of the NPR if the fill rate is not maintained.

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DOE'S PROPOSED DELAY IN LEACHING ADDITIONAL STORAGE SPACE AND
REDUCED OIL FILL RATE WOULD

- LIKELY RESULT IN A HIGHER TOTAL COST FOR A COMPLETED SPR,
- LIMIT ITS FLEXIBILITY TO REACT TO CHANGING EVENTS, AND
- LIMIT ITS OPTIONS FOR CLOSING DOWN THE SULPHUR MINES
STORAGE SITE.

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IMPACTS OF DOE PROPOSAL

In addition to postponing the date at which the SPR would reach the desired total of 750 million barrels, the administration's approach would have several other consequences. For instance, a 35,000-barrel-per-day fill rate, while decreasing expenditures in the short run, would have the opposite effect over the long run if oil prices rise as forecasts indicate. (The costs of oil fill alternatives for a 581-million-barrel inventory are shown in table 3.2 and the costs for a 750-million-barrel inventory are discussed in section 5.) Furthermore, a moratorium on cavern development will limit future flexibility for increased oil purchases if they were thought advisable as a result of either changes in the international situation or relatively low oil prices.

The slowed development would also limit DOE's options for closing the Sulphur Mines site. Sulphur Mines is a small site (26 million barrels of oil) that has the additional disadvantages of being costly to operate on a per-barrel basis and having a limited drawdown rate of only 100,000 barrels per day. DOE has estimated that transferring the oil to one or more other locations and closing the site could save about \$90 million over a 20-year period. DOE also determined that the incremental storage costs at a larger site, such as West Hackberry, would be minimal. Transferring the oil would also enhance the SPR's overall drawdown capability. While DOE has plans to close the Sulphur Mines site, it does not expect to initiate such action prior to 1992-93. However, the site closure could extend into the next century if DOE's proposed 35,000-barrel-per-day fill rate and cavern development plan is authorized. The potential availability of excess storage capacity, if leaching were to continue after fiscal year 1987, offers the opportunity to move the oil stored at Sulphur Mines and close the site at an earlier date.

Table 3.2: Alternative Oil Fill Rates Under DOE's Proposed Leaching Moratorium

<u>Oil fill rate</u> (barrels per day)	<u>Date filled to</u> <u>581 million barrels</u> (fiscal year)	<u>Cost of</u> <u>oil</u> ^a (millions)
Maximum (146,000)	1988	\$884.1
100,000	1989	893.8
75,000	1989	902.3
35,000	1991	966.5

^aBased on Data Resources, Inc., (DRI) Spring 1987, base case price forecast.

FILL RATE ALTERNATIVES UNDER LEACHING MORATORIUM

DOE's proposed 35,000-barrel-per-day fill rate after fiscal year 1987 would not utilize all of the 47 million barrels of available storage capacity until fiscal year 1991. As shown in table 3.2, however, higher fill rates could be employed to reach the 581-million-barrel level at an earlier date. For example, the available storage capacity could be filled at an average rate of 146,000 barrels per day. At this rate, all available storage would be filled before the end of fiscal year 1988. This rate of fill would require the expenditure of an estimated \$884 million for oil purchases as compared with the \$221 million planned for by DOE in fiscal year 1988.

Filling at slower rates would require longer to fill up the available capacity and would reduce the expenditures for oil in any given year, but is likely to cost more in the long run. Because of the expected yearly increase in oil prices, delaying the completion of the oil fill beyond fiscal year 1988 has the potential for increasing the total cost of the required 47 million barrels of oil. Under our assumed oil price forecast,² the total cost of this oil at DOE's 35,000-barrel-per-day rate could be over \$82 million more than the oil would cost if the available capacity were filled at the maximum rate.

²Data Resources, Inc., Spring 1987, base case.

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A CONTINUED OIL FILL RATE OF 35,000 BARRELS PER DAY BEYOND FISCAL
YEAR 1991 WOULD REQUIRE THAT DOE

-- RESUME LEACHING OF CAVERN STORAGE AT BAYOU CHOCTAW IN
FISCAL YEAR 1989 AND AT WEST HACKBERRY IN 1991 AND

-- BEGIN LEACHING ACTIVITIES AT THE BIG HILL SITE IN FISCAL
YEAR 1991.

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LEACHING REQUIREMENTS TO CONTINUE FILLING
THE SPR AT 35,000 BARRELS PER DAY

As noted earlier, DOE's proposal to fill the SPR at a 35,000-barrel-per-day rate would use up all available storage space by fiscal year 1991. To continue filling the SPR at that rate until the full 750-million-barrel inventory is reached, DOE would be required to restart its leaching program prior to 1991. Based on leaching capabilities and capacity needs, DOE would have to resume leaching at the Bayou Choctaw site in fiscal year 1989. DOE estimates that it would take 5 years to complete leaching the remaining 16 million barrels of storage space currently planned to complete the Bayou Choctaw site and have it available for oil fill.

At the end of fiscal year 1987, about 19 million barrels of planned storage capacity will remain to be leached at West Hackberry. Because of the greater brine disposal capability at that site, DOE could complete the leaching in 1 year and, therefore, would not have to resume leaching until fiscal year 1991.

To provide adequate storage space for a 35,000-barrel-per-day fill rate and maintain about 10 million barrels of extra space for flexibility, DOE would also have to start leaching cavern space at the Big Hill site in fiscal year 1991. Whereas the Bayou Choctaw and West Hackberry sites would have to be leached at their maximum rates of 100,000 and 420,000 barrels per day, respectively, leaching at Big Hill could be limited to about 25 percent of its 1.4-million-barrel-per-day maximum capacity.

Under the above leaching and oil fill schedule, DOE would complete a 750-million-barrel SPR by 2004.

SECTION 4

ALTERNATIVE OIL FILL RATES

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ALTERNATIVES TO DOE'S PROPOSED OIL FILL RATE AND CAPACITY
DEVELOPMENT SCHEDULE ASSUME THAT

- LEACHING OF STORAGE CAVERN SPACE AT BAYOU CHOCTAW AND WEST
HACKBERRY SITES WILL CONTINUE AFTER FISCAL YEAR 1987 AND
- BIG HILL LEACHING WILL START IN OCTOBER 1987, OR POSSIBLY
OCTOBER 1988 FOR A 75,000-BARREL-PER-DAY FILL RATE.

DOE ESTIMATES THAT CONTINUED STORAGE CAPACITY DEVELOPMENT IN FISCAL
YEAR 1988 WOULD ADD ABOUT \$22.4 MILLION TO ITS PROPOSED BUDGET.

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PRE-CONDITIONS FOR ALTERNATIVE OIL FILL RATES AT THE SPR

The administration's past attempts to put a moratorium on SPR storage development have adversely affected DOE's ability to fill the SPR sites to the 750-million-barrel level by the fiscal year 1989 target date set in 1979.

As discussed in section 3, DOE's proposed budget for fiscal year 1988 anticipates halting the leaching activities at the sites after fiscal year 1987. A continuation of that policy would exhaust all available storage space by 1991 under DOE's proposed fill rate of 35,000 barrels per day, and the SPR would remain static at 581 million barrels of oil. Even under the resumption of leaching activities described previously, DOE's proposed fill rate would extend storage capacity development and oil fill into the next century and, in our opinion, limit the options for filling the SPR in the most efficient and cost-effective manner.

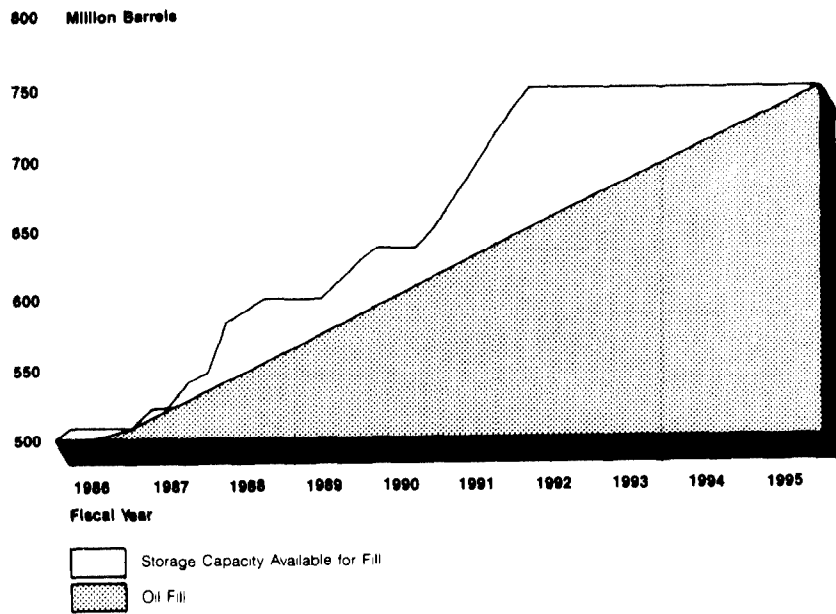
A change in policy and an increased level of funding, however, would allow DOE to choose among several alternatives--other than the one in its proposed budget--for filling the SPR. For example, DOE would need to continue leaching activities at the West Hackberry and Bayou Choctaw sites after fiscal year 1987 until all planned storage space is completed. The expected completion dates are fiscal year 1988 for West Hackberry and in fiscal year 1992 for Bayou Choctaw, if the caverns were leached at the maximum brine disposal rates.

DOE would also need to start the leaching process at the Big Hill site in early fiscal year 1988 instead of delaying it until fiscal year 1991 as would occur under DOE's proposal. Leaching at the site's maximum capacity would provide the greatest volume of storage capacity possible and allow a range of oil fill alternatives. An option to the early leaching at Big Hill, however, would be to delay the start of leaching at Big Hill until fiscal year 1989. Under this option, DOE would have less flexibility in selecting an appropriate oil fill rate.

DOE has estimated that implementing the full cavern leaching program described above would require adding about \$22.4 million to its fiscal year 1988 budget. This estimated cost includes \$4.5 million for West Hackberry, \$3.1 million for Bayou Choctaw, \$14.7 for Big Hill, and \$.2 million to cover management costs. (The Big Hill costs would be deferred until fiscal year 1989 if a less flexible oil fill program is acceptable). Total additional costs during fiscal years 1989 to 1992 to complete the SPR development to the full 750-million-barrel capacity are estimated to be about \$118 million. This amount includes over \$60 million to complete distribution enhancements needed to accommodate a full 4.5-million-barrel-per-day drawdown capability that will exist when the SPR is full.

DOE has proposed limiting the SPR oil fill rate to 35,000 barrels per day. We examined the possibility of filling the SPR at three alternative rates under the previously described assumption that DOE will continue cavern development after fiscal year 1987 until the full 750-million-barrel capacity is reached. The fill rates used are for new oil additions only. They do not consider the transfer of the 26 million barrels of oil at Sulphur Mines to the other sites. As we indicate in our discussion of each alternative, the timing of any such oil transfer will be dependent on the oil fill rate alternative.

Figure 4.1: SPR Storage Capacity Development and Oil Fill at 75,000 Barrels Per Day



Source: DOE.

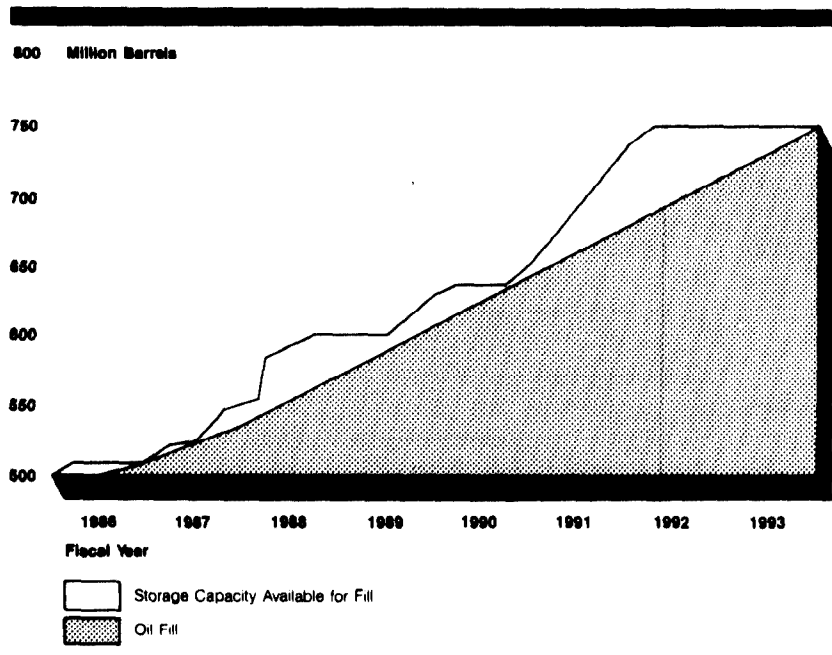
ALTERNATIVE I

Under current law, DOE is required to fill the SPR at an average rate of 75,000 barrels per day until the 750-million-barrel inventory level is reached or discontinue oil sales from the NPR. As shown in figure 4.1, sustaining this fill rate under our assumed leaching conditions is easily attainable. Under this alternative fill rate, a 750-million-barrel inventory would be achieved in fiscal year 1995 and NPR oil could continue to be sold. The transfer of oil from the Sulphur Mines site could also be advanced from fiscal year 1992 to fiscal year 1988. This would avoid spending about \$19 million in estimated operations costs during fiscal years 1989-92. Capital Improvement Projects (CIP) costs,³ currently budgeted for over \$8 million for the fiscal year period 1988 through 1991, could also be avoided.

This oil fill rate could also be sustained even if the leaching program at Big Hill were delayed until fiscal year 1989. However, if this decision were made, nearly all of the storage space developed by the continued leaching at the Bayou Choctaw and West Hackberry sites would be filled with oil in fiscal years 1990 and 1991. This would leave DOE with almost no flexibility for responding to changing conditions in the world oil situation. It would also require the continued use of the Sulphur Mines site until fiscal year 1992, with the attendant operations costs and possibly some CIP costs.

³Capital improvements are modifications to existing facilities to assure that mission objectives can continue to be met. Projects include upgrading fire protection, site security, emergency shutdown valves, and safety and systems reliability.

Figure 4.2: SPR Storage Capacity Development and Oil Fill at 100,000 Barrels Per Day

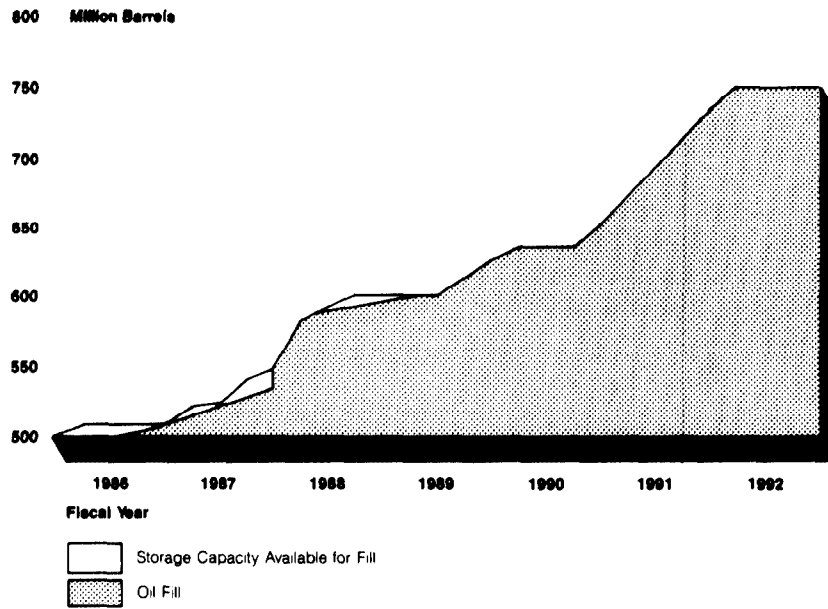


Source: DOE.

ALTERNATIVE II

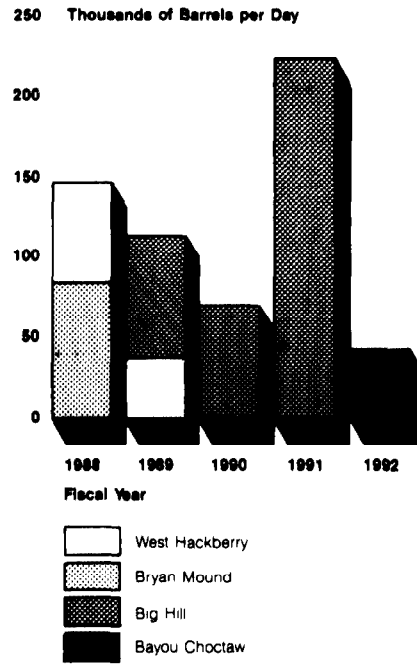
SPR oil fill at an average rate of 100,000 barrels per day is also possible. As shown in figure 4.2, this level of fill leaves a relatively large amount of available storage capacity unused except for a short period of time in fiscal year 1990. Under alternative II, the spare capacity would allow DOE to accelerate the abandonment of Sulphur Mines and begin transferring the oil at that site to the Big Hill storage site in fiscal year 1991, or 1 year earlier than is anticipated in DOE's current services or fiscal year 1989 restart plan. This acceleration would result in a reduction of about \$5 million in operations costs estimated for fiscal year 1992. The 100,000-barrel-per-day fill rate would allow DOE to achieve the full 750-million-barrel inventory by fiscal year 1993--2 years earlier than alternative I.

Figure 4.3: SPR Storage Capacity Development and Oil Fill at Available Capacity



Source: Prepared by GAO, using DOE data.

**Figure 4.4: Annualized Maximum Oil
Fill Rate Capability**



Source: DOE.

ALTERNATIVE III

A fill rate that is predicated on using all available storage capacity as it is developed rather than an average rate that is consistent over a period of years is also a possible alternative. As illustrated in figures 4.3 and 4.4, this alternative results in fill rates of 146,000 and 112,000 barrels per day in fiscal years 1988 and 1989, respectively; a reduced fill rate to 68,000 barrels per day in fiscal year 1990; and a relatively higher fill rate of 222,000 barrels per day in fiscal year 1991, with the final oil fill occurring late in fiscal year 1992. The increased fill rate potential after fiscal year 1990 results primarily from the availability of relatively large increments of storage capacity at Big Hill becoming available for oil fill.

Under alternative III, a 750-million-barrel inventory level would be achieved by the end of fiscal year 1992, when the last cavern is filled at Bayou Choctaw. However, because all available storage space will be filled with new oil until the Big Hill capacity becomes available, closing Sulphur Mines and transferring the oil will not be possible until fiscal year 1992. This means that DOE would have to continue incurring the nearly \$5 million annual cost for operating the site until that time. DOE would also have to assess the need to implement the proposed Capital Improvement Projects for the Sulphur Mines site. If these projects are determined to be necessary to maintain the site in a drawdown-ready condition, an additional \$8.4 million would have to be spent during fiscal years 1988 through 1991.

The alternative would be to use the available storage space for the Sulphur Mines oil. While this would avoid some of the costs required to maintain Sulphur Mines, it would also delay achieving the full 750-million-barrel oil inventory.

SECTION 5

ESTIMATED COSTS OF OIL FILL ALTERNATIVES

Table 5.1: Summary of Budget Authorities Needed for Selected SPR Oil Fill Alternatives

Oil Fill Rate	Fiscal Year																
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
----- (dollars in thousands) -----																	
35 MBO^a																	
Fac. & Mgt.	\$121,198	\$137,287	\$140,906	\$178,220	\$165,723	\$151,142	\$155,676	\$160,347	\$165,157	\$170,112	\$231,551	\$180,472	\$185,886	\$191,462	\$197,206	\$209,334	\$212,997
CIP	21,279	22,019	22,787	23,985	24,127	20,600	16,974	13,987	11,480	9,274	7,761	6,149	5,067	5,219	5,376	5,537	5,703
Oil ^b	<u>240,298</u>	<u>252,179</u>	<u>271,852</u>	<u>297,785</u>	<u>323,719</u>	<u>349,652</u>	<u>388,488</u>	<u>433,984</u>	<u>485,067</u>	<u>549,325</u>	<u>626,486</u>	<u>716,294</u>	<u>818,878</u>	<u>915,073</u>	<u>1,024,171</u>	<u>1,126,755</u>	<u>1,133,668</u>
Total	<u>\$382,735</u>	<u>\$411,485</u>	<u>\$435,545</u>	<u>\$499,590</u>	<u>\$513,569</u>	<u>\$521,394</u>	<u>\$561,139</u>	<u>\$607,917</u>	<u>\$661,704</u>	<u>\$728,711</u>	<u>\$865,798</u>	<u>\$902,915</u>	<u>\$1,009,831</u>	<u>\$1,111,754</u>	<u>\$1,226,753</u>	<u>\$1,341,625</u>	<u>\$1,352,368</u>
75 MBO^c																	
Fac. & Mgt.	\$128,914	\$165,044	\$201,759	\$188,018	\$160,985	\$142,081	\$143,530	\$147,836	\$136,885	\$140,786	\$145,009	\$149,360	\$153,840	\$158,456	\$163,209	\$168,106	\$173,149
CIP	21,279	22,019	22,787	23,985	24,127	20,600	16,974	13,987	11,480	9,274	7,761	6,149	5,067	5,219	5,376	5,537	5,703
Oil ^b	<u>514,924</u>	<u>540,382</u>	<u>582,540</u>	<u>638,111</u>	<u>693,882</u>	<u>749,254</u>	<u>832,474</u>	<u>827,287</u>	-	-	-	-	-	-	-	-	-
Total	<u>\$665,117</u>	<u>\$727,445</u>	<u>\$807,086</u>	<u>\$849,714</u>	<u>\$878,394</u>	<u>\$911,935</u>	<u>\$992,978</u>	<u>\$989,110</u>	<u>\$148,165</u>	<u>\$150,060</u>	<u>\$152,770</u>	<u>\$155,509</u>	<u>\$158,907</u>	<u>\$163,675</u>	<u>\$168,985</u>	<u>\$173,643</u>	<u>\$178,852</u>
100 MBO																	
Fac. & Mgt.	\$142,946	\$163,987	\$199,880	\$167,182	\$148,097	\$134,274	\$128,839	\$132,704	\$136,885	\$140,786	\$145,009	\$149,360	\$153,840	\$158,456	\$163,209	\$168,106	\$173,149
CIP	21,279	22,019	22,787	23,985	24,127	20,600	16,974	13,987	11,480	9,274	7,761	6,149	5,067	5,219	5,376	5,537	5,703
Oil ^b	<u>686,565</u>	<u>720,510</u>	<u>776,720</u>	<u>850,815</u>	<u>924,910</u>	<u>916,895</u>	-	-	-	-	-	-	-	-	-	-	-
Total	<u>\$850,790</u>	<u>\$906,116</u>	<u>\$999,187</u>	<u>\$1,041,982</u>	<u>\$1,097,134</u>	<u>\$1,071,768</u>	<u>\$145,813</u>	<u>\$146,691</u>	<u>\$148,165</u>	<u>\$150,060</u>	<u>\$152,770</u>	<u>\$155,509</u>	<u>\$158,907</u>	<u>\$163,675</u>	<u>\$168,985</u>	<u>\$173,643</u>	<u>\$178,852</u>
Max. Fill																	
Fac. & Mgt.	\$142,946	\$163,987	\$199,880	\$167,182	\$148,097	\$127,818	\$128,839	\$132,704	\$136,885	\$140,786	\$145,009	\$149,360	\$153,840	\$158,456	\$163,209	\$168,106	\$173,149
CIP	21,279	22,019	22,787	23,985	24,127	20,600	16,974	13,987	11,480	9,274	7,761	6,149	5,067	5,219	5,376	5,537	5,703
Oil ^b	<u>1,002,384</u>	<u>806,971</u>	<u>528,170</u>	<u>1,888,809</u>	<u>404,933</u>	-	-	-	-	-	-	-	-	-	-	-	-
Total	<u>\$1,166,609</u>	<u>\$992,577</u>	<u>\$750,637</u>	<u>\$2,079,576</u>	<u>\$577,157</u>	<u>\$148,418</u>	<u>\$145,813</u>	<u>\$146,691</u>	<u>\$148,165</u>	<u>\$150,060</u>	<u>\$152,770</u>	<u>\$155,509</u>	<u>\$158,907</u>	<u>\$163,675</u>	<u>\$168,985</u>	<u>\$173,643</u>	<u>\$178,852</u>

^aMBO—Thousand barrels per day

^bComputations were made using oil prices from Data Resources, Inc., Spring of 1987, base case. Amount shown assumes no carryover of prior year funds.

^cThis oil fill rate assumes Big Hill leaching starts in fiscal year 1989.

Source: Prepared by GAO using DOE budget data for fiscal years 1988-92.

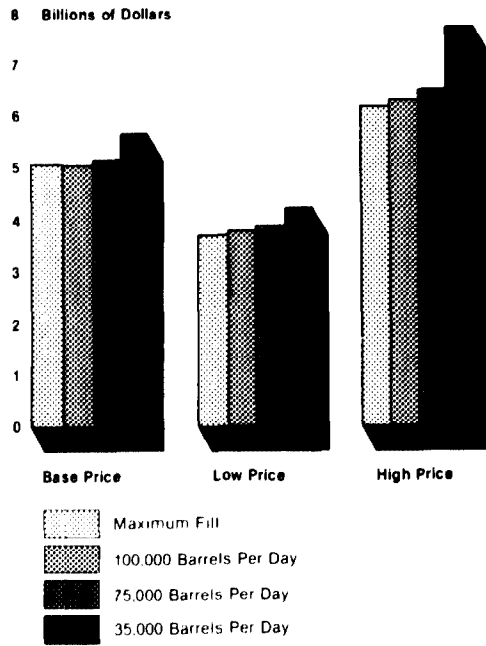
ESTIMATED ANNUAL COSTS OF OIL FILL ALTERNATIVES

Table 5.1 shows the estimated budget authority needed to develop and fill the SPR under DOE's proposed 35,000-barrel-per-day fill rate and three alternative oil fill possibilities. As would be expected, continued storage development in fiscal year 1988 and an accelerated oil fill require more funding than DOE's proposed moratorium on leaching activities after fiscal year 1987 and its slower fill rate. Over \$1 billion would be needed in fiscal year 1988 to develop capacity and fill at the maximum rate compared with DOE's estimate of about \$386 million in its budget proposal.

Budget authority estimates for facilities development and management and CIP for fiscal years 1988 through 1992 were obtained from DOE. We estimated costs for fiscal years 1993 through 2004 based on discussions with DOE officials as to the likely cost patterns in these "out" years under continued development, including oil fill, and with sites in full standby condition. Cost estimates include an assumed inflation rate of 3 percent. DOE has used this rate in other similar studies.

The annual oil costs were computed using DRI base-case estimates of oil refiners' acquisition costs and adding an SPR-specific cost factor for items such as higher costs for U.S. ship transportation in compliance with the Cargo Preference Act. DRI's costs were slightly higher in fiscal year 1988 than estimates provided in the Energy Information Administration's (EIA's) Annual Energy Outlook 1986 report. For fiscal years 1989 through 2000, however, DRI's cost estimates were consistently lower than EIA's estimates. DOE provided us with OMB's oil price forecasts for the fiscal year period 1988 through 1993. These prices were consistently lower than DRI's base case. We used DRI's forecasts as representing a middle-ground between the two agencies' forecasts.

Figure 5.1: Discounted Total Costs of SPR Oil Fill Alternatives Under Three Oil Price Scenarios, 1988-2004



DISCOUNTED TOTAL COST COMPARISON OF OIL FILL ALTERNATIVES

To provide a basis for comparing total project costs for each of the oil fill alternatives, we calculated the estimated annual costs that would be incurred for each alternative fill rate for fiscal years 1988 through 2004 using three different long-run oil price forecasts.⁴ We then discounted each of the 12 cost streams to 1988.⁵

With one exception, figure 5.1 shows that the slower DOE fills the SPR, the greater is the discounted cost of completing a 750-million-barrel reserve. The exception occurs in the base price scenario where the total discounted cost of the maximum fill alternative is estimated at \$5.1 billion whereas the cost of the 100,000-barrel-per-day alternative is about \$12 million less. This slightly lower cost results from a combination of the quantities of oil purchased in fiscal years 1989 through 1992 under each alternative, the annual percentage increase in oil prices, and the rate of interest used in discounting the costs.

The discounted total costs for the 35,000-barrel-per-day fill rate are consistently higher than the other oil fill alternatives under all three oil price scenarios. As illustrated in figure 5.1, the discounted total cost difference between the maximum fill and 35,000-barrel-per-day alternatives are about \$425 million under the low price forecast, about \$579 million under the base case forecast, and nearly \$1.5 billion under the high price forecast.

⁴Data Resources, Inc., Spring 1987. Forecasts have the following characteristics: The base case starts at \$17.61 per barrel in 1988 and increases at an average annual rate of 11.9 percent through 2004; the low price forecasts starts at \$10.20 per barrel and increases at 10.6 percent annually; and the high price forecasts starts at \$22.95 and increases at 11.5 percent annually to 2004.

⁵We used the U.S. Treasury's average rate for marketable interest-bearing debt of 8.749 percent as of February 28, 1987.

SECTION 6

BENEFITS OF OIL FILL RATE ALTERNATIVES

Table 6.1: Comparison of Benefits Resulting from Oil Fill Alternatives

Oil Fill Rate	Fiscal Year																		
	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	
35 MBD^a																			
Total inventory ^b	534,000	546,775	559,550	572,325	585,100	597,875	610,650	623,425	636,200	648,975	661,750	674,525	687,300	700,075	712,850	725,625	738,400	750,000	
Days of import coverage	99	100	94	88	86	84	81	79	78	76	75	74	73	72	71	70	69	68	
Maximum drawdown rate ^c	3.57	3.57	3.57	3.57	3.57	3.57	3.57	3.57	3.57	3.57	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
75 MBD																			
Total inventory ^b	534,000	561,375	588,750	616,125	643,500	670,875	698,250	725,625	750,000	750,000	750,000	750,000	750,000	750,000	750,000	750,000	750,000	750,000	750,000
Days of import coverage	99	103	99	95	94	94	93	92	91	88	85	82	79	77	74	72	70	68	
Maximum drawdown rate ^c	3.57	3.57	3.57	3.57	3.57	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
100 MBD																			
Total inventory ^b	534,000	570,500	607,000	643,500	680,000	716,500	750,000	750,000	750,000	750,000	750,000	750,000	750,000	750,000	750,000	750,000	750,000	750,000	750,000
Days of import coverage	99	104	102	100	100	100	100	95	91	88	85	82	79	77	74	72	70	68	
Maximum drawdown rate ^c	3.57	3.57	3.57	3.57	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Max. Fill																			
Total inventory ^b	534,000	587,290	628,170	652,990	734,020	750,000	750,000	750,000	750,000	750,000	750,000	750,000	750,000	750,000	750,000	750,000	750,000	750,000	750,000
Days of import coverage	99	107	106	101	108	105	100	95	91	88	85	82	79	77	74	72	70	68	
Maximum drawdown rate ^c	3.57	3.57	3.57	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	

^aMBD—thousand barrels per day

^bThousands of barrels

^cMillion barrels per day

BENEFITS VARY BY SPR SIZE

To show the benefits derived from the various oil fill rate alternatives, we used two measures of protection against an oil import disruption--the number of days of net oil import coverage and the rate at which oil can be withdrawn from the SPR. To assess the import coverage provided by each oil fill alternative, we used the 90-day criteria embodied in the International Energy Agency treaty. Under the 90-day criteria, DOE is allowed to add reserve oil stocks held by the private sector to the SPR inventory in computing the total days of coverage. However, because of the difficulty of quantifying the volume of private stocks that are held in excess of normal operating inventory and the questionable control the government might have over these excess stocks, we were unable to determine how much of the coverage might be provided from this source.

As illustrated in table 6.1, 90 days of coverage are provided through fiscal year 1995 for all alternative fill rates except DOE's proposed 35,000-barrel-per-day rate. Under this fill rate, 90 days of import coverage would only extend through fiscal year 1989. In calculating the coverage provided under the alternative fill rates, we used the net import estimates from EIA's February 1987 publication, Annual Energy Outlook 1986.

DOE's ability to withdraw large amounts of oil from the SPR and get it into the oil markets is expected to have a dampening effect on price increases that have resulted from past oil supply disruptions.⁶ This capability is also thought to limit oil producers' ability to raise oil prices even in the absence of a disruption. The SPR drawdown rate is a function of the oil inventory, and as shown in figure 6.1, the maximum design rate of 4.5 million barrels per day becomes possible as the 650-million-barrel inventory level is reached. This level is reached in fiscal year 1990 under the maximum fill alternative, but is not reached until fiscal year 1997 under the 35,000-barrel-per-day fill rate.

⁶See Oil Supply Disruptions: Their Price and Economic Effects (GAO/RCED-83-135, May 20, 1983), pp. 39, 40, and 41.

OBJECTIVES, SCOPE, AND METHODOLOGY

On March 5, 1987, the Chairman, the Ranking Minority Member, and Senators Bill Bradley and Don Nickles of the Senate Committee on Energy and Natural Resources, asked us to provide an analysis of possible oil fill options for the SPR. We were also asked to provide the annualized construction and petroleum acquisition costs for each option. The requesters expressed particular interest in DOE's current policy for developing and filling the SPR, the maximum fill rate achievable, and a 100,000-barrel-per-day fill rate. They left an analysis of other options to our discretion. Consequently, we added a 75,000-barrel-per-day fill rate option to our analysis.

Our analysis of the oil fill options included (1) a review of fiscal year 1987 actual development and oil fill activities, (2) a discussion of DOE's proposed plan for fiscal year 1988 and an analysis of possible fill rates under DOE's proposed leaching program, (3) three optional development and oil fill rates, (4) the estimated annual costs of the four options, (5) the discounted value of the total development, management, and oil costs for each option, and (6) the benefits derived from each option in terms of oil import coverage and drawdown rates. For cost comparison purposes, we used the 1988 to 2004 fiscal year period.

Data on DOE's plans for developing and filling the SPR in fiscal years 1987 and 1988 were obtained primarily from DOE documents. We obtained and reviewed documentation showing storage site capacities and oil fill plans through September 30, 1987, and the fiscal year 1988 proposed budget. We also reviewed documents obtained from both the SPR Program Office and the New Orleans, Louisiana, SPR Project Office related to fill rate options and development scenarios other than DOE's proposed schedule for fiscal year 1988. These documents included DOE's and OMB's cost estimates for various development options covering fiscal years 1988-1992.

Because DOE's budget estimates did not extend beyond fiscal year 1992, we developed our own cost estimates for each of the four options for the 1993-2004 fiscal year period. We used DOE's projected budget estimates for fiscal years 1988 to 1992 as a base and adjusted the costs for succeeding years based on DOE's estimates of the percentage decrease in facilities development and management costs as the SPR sites are completed, filled, and placed in standby condition. Capital Improvement Project costs were assumed to decline on an annual basis as the site modifications were completed. All of our cost estimates were adjusted for inflation by using a 3-percent annual inflation index. After we completed our analysis, we discussed its accuracy and reasonableness with cognizant DOE/SPR officials.

The annual volume of oil purchased under each option was costed using the base-case oil price forecasts obtained from DRI. We compared the DRI forecasts with the price forecasts prepared by the EIA for its Annual Energy Outlook 1986 report and OMB's forecasts through fiscal year 1993. DRI's prices tended to fit between the two government forecasts.

To compare the total cost of developing and filling the SPR to 750 million barrels under each option, we discounted the costs using the U.S. Treasury's average rate for marketable interest-bearing debt as our discount. As of February 28, 1987, this rate was 8.749 percent.

To assess the benefits of each option, we computed the number of days coverage of net petroleum imports that would be provided by the total oil inventory at the end of each fiscal year. EIA's net petroleum import projection for each calendar year from the Annual Energy Outlook 1986 report was divided into the SPR oil inventory expected at the end of each fiscal year. Combining calendar year and fiscal year data involves a 3-month time lag, but we do not believe it materially affects our analysis. Our assessment of benefits also noted the maximum drawdown rate of the SPR under each of the alternatives. We used DOE's schedule of drawdown rate changes in relation to inventory levels.

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