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MID- ATLANTIC REGIONAL STUDY

**AN ASSESSMENT OF THE ONSHORE
EFFECTS OF OFFSHORE OIL AND
GAS DEVELOPMENT**

EXECUTIVE SUMMARY

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

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OCTOBER 1975

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Executive Summary

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Note: The Executive Summary appears as Chapter 2
in the full report.

SUMMARY OF THE MID-ATLANTIC REGIONAL STUDY

SUMMARY OF FINDINGS

Offshore oil and gas exploration and production will require support which can be provided only by constructing and operating some oil and gas related industrial facilities onshore. The onshore effects of these operations on natural systems will be minor if environmentally suitable sites are selected.

Total Mid-Atlantic OCS-related employment opportunities are likely to be modest, numbering less than 0.2 percent of the persons employed there in 1970. Workers relocating to the region to fill some of these positions should number no more than two percent of the total regional population growth. Their demands for housing, land, and recreation are small in comparison to the demand created by population growth not related to the development program.

Economic benefits will accrue to the region from wages paid to workers, tax revenues, and capital investment of the oil, natural gas, and service industries. Tax revenues may defray costs associated with providing public services to the relocated workers.

BACKGROUND

Long-term increasing energy consumption, declining domestic petroleum production, and escalating prices for foreign crude have focused attention on the nation's undesirable dependence

on imported oil. In his call for a national commitment to Project Independence, the President underscored the need for energy self-sufficiency by mandating more comprehensive utilization of domestic supplies of crude oil and natural gas, the primary sources of the country's energy. Accelerated leasing of lands on the Outer Continental Shelf (OCS) of the United States for petroleum production has been proposed as the primary means to increase domestic supplies.

Offshore petroleum exploration and production may require support and result in certain effects onshore. The primary objective of the Mid-Atlantic Regional Study was to set forth and describe certain of the important effects which may result from an orderly and controlled OCS development program. For purposes of this study, the affected area is assumed to be all counties with direct ocean access and contiguous inland counties between about Cape Hatteras, North Carolina, and Long Island, New York. The area is shown on Figure 2-1.

The scope of the study is regional. The facilities and locations described are representative and were selected for illustration only. Therefore, this study is not intended to substitute for, and cannot be used in lieu of, site-specific assessments because the extent of onshore effects at specific sites depends heavily on the amount of recoverable oil and gas and its location on the OCS, both of which are unknown at the present time. In addition, although the study is rooted in the practical, operational experience of the petroleum industry, the development program outlined here is based on hypothetical assumptions concerning operations in a frontier area which may be confirmed only after lease sales occur and exploratory drilling commences.

MID-ATLANTIC REGIONAL STUDY

MID-ATLANTIC REGION

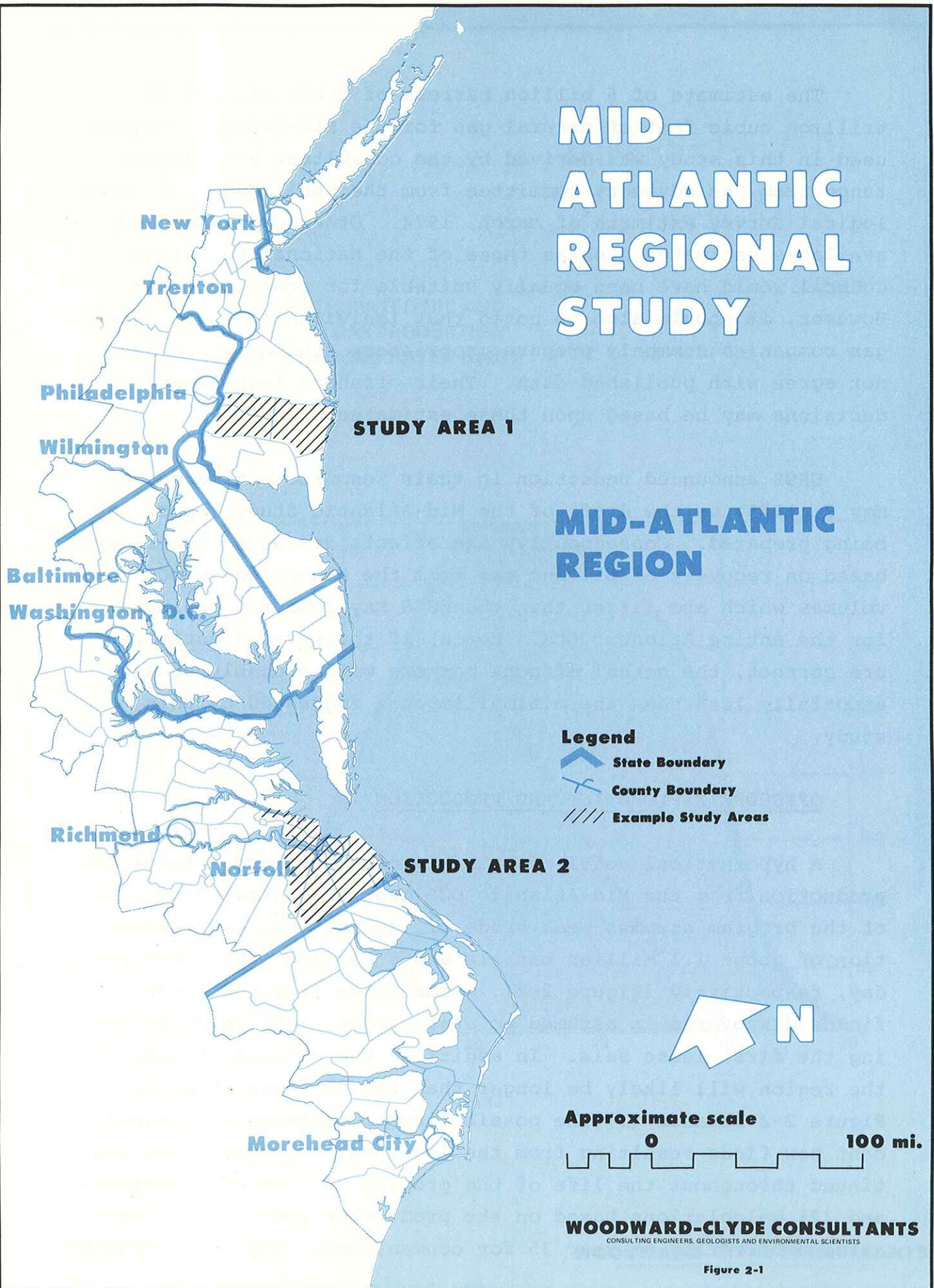


Figure 2-1

The estimate of 6 billion barrels of crude oil and 32 trillion cubic feet of natural gas for the Mid-Atlantic region used in this study was derived by the consultant with assistance from the advisory committee from the published U. S. Geological Survey estimate of March, 1974. Other published and available estimates such as those of the National Petroleum Council would have been equally suitable for study purposes. However, it should also be noted that individual oil and natural gas companies commonly prepare proprietary studies which may not agree with published data. Their offshore investment decisions may be based upon these estimates.

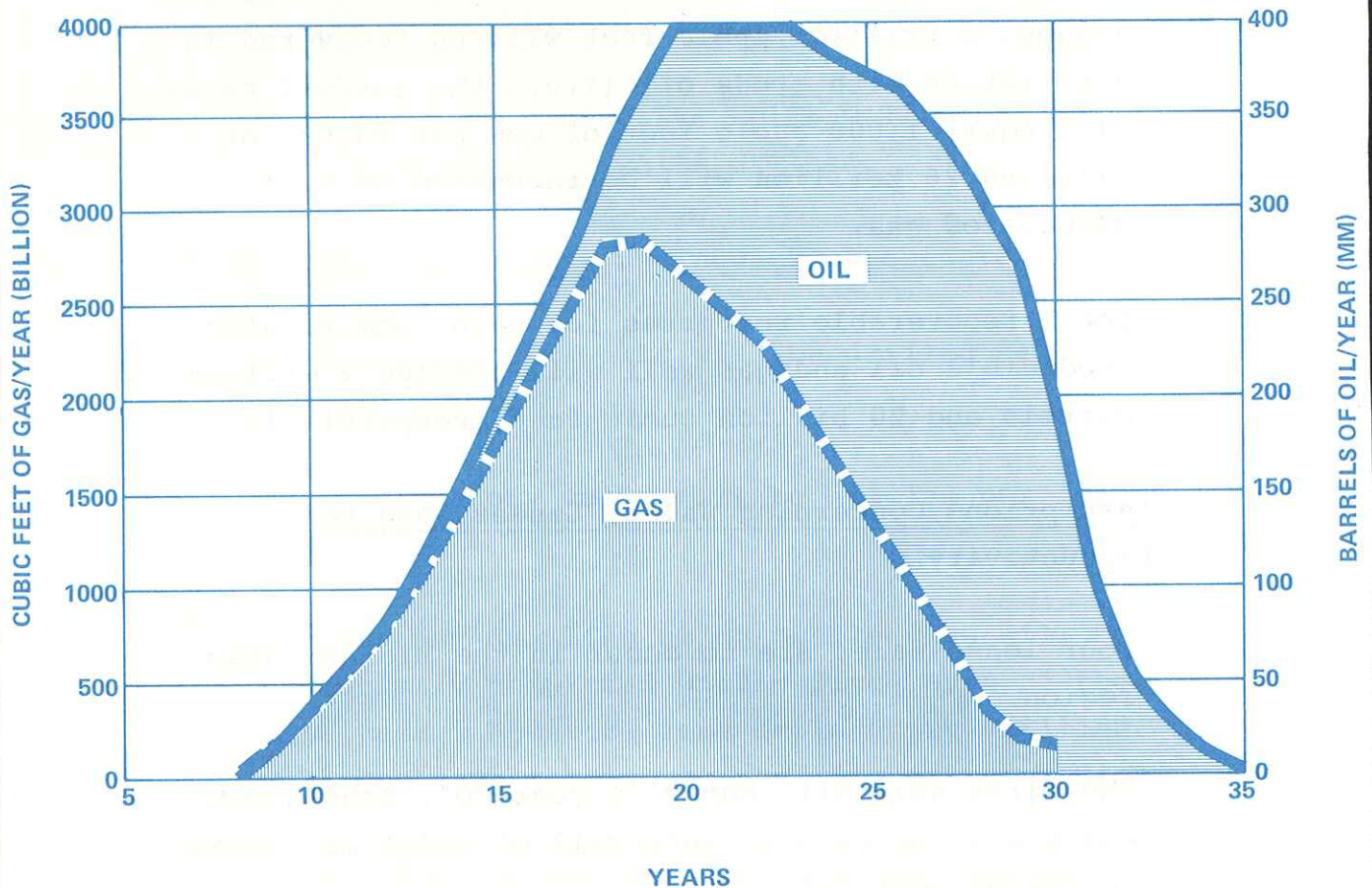
USGS announced reduction in their resource estimates on May 7, 1975, as the draft of the Mid-Atlantic Study report was being prepared. Consequently, the effects discussed herein are based on recovery of oil and gas from the Mid-Atlantic OCS in volumes which are larger than the USGS May resource estimate for the entire Atlantic OCS. Hence, if the revised estimates are correct, the actual effects onshore will probably be substantially less than the minimal impacts suggested by this study.

OFFSHORE EXPLORATION AND PRODUCTION

A hypothetical model of probable crude oil and natural gas production from the Mid-Atlantic OCS over the anticipated life of the program assumes peak crude oil and natural gas production of about 1.1 million barrels and 8 billion cubic feet per day, respectively (Figure 2-2). Production from the first fields discovered is assumed to start about eight years following the first lease sale. In addition, the productive life of the region will likely be longer than the 35 years shown in Figure 2-2 because (1) the possibility of isolated but significant new finds resulting from the low level of exploration continued throughout the life of the program has not been included, and (2) calculations based on the production model were terminated arbitrarily at year 35 for convenience. The small volumes

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ANTICIPATED OIL AND
GAS PRODUCTION
(GAS WELL & ASSOCIATED GAS)



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Figure 2-2

produced from initial finds after this time are insignificant in relation to production levels.

This production model was based upon 23 basic assumptions concerning reserve estimates, lease sales, lease productivity, industry procedures, and material availability. The assumptions are presented below.

Assumptions Concerning Resource Estimates

The total estimated recoverable resources in the Mid-Atlantic region are about 6 billion barrels of oil and 32 trillion cubic feet of gas. Of this gas volume, 6 trillion cubic feet will be recovered in association with crude oil (i.e., the gas/oil ratio will equal 1,000 cubic feet of gas per barrel of oil) and 26 trillion will be recovered as non-associated gas.

Total recoverable resources for each commercially producible oil and gas well will average 2 million barrels and 20 billion cubic feet, respectively.

Assumptions Concerning Sales, Leases, and Lease Productivity

Four lease sales are to occur in the Mid-Atlantic region.

The first sale will occur in year "0"; subsequent sales will be held at intervals of about 18 months following year "0".

The total number of tracts to be offered for sale in the Mid-Atlantic region is 424 (about 2.3 million acres). This total has been inferred from the results

of a series of sales in the Gulf of Mexico in which the average number of tracts per sale was 106 (see National Ocean Policy Study, 1974).

Of the total number of tracts offered for sale, 40 percent will be offered in Sale No. 1, and 20 percent will be offered in each of Sale Nos. 2-4.

The number of tracts leased per sale will average 56 percent over all sales, but 70 percent of tracts offered in Sale No. 1 will be leased.

The number of productive tracts will be 25 percent of the tracts leased.

The number of productive wells will be 80 percent of the development wells drilled.

Assumptions Concerning Industry Procedure

Four exploratory wells will be drilled per mobile rig per year.

Two exploratory wells will be drilled per leased tract.

Exploratory drilling using mobile rigs will be essentially completed within five years of the sale year. However, some exploratory drilling will continue throughout the life of the region.

A full year of exploratory drilling following the first sale will be required to obtain sufficient information to justify a decision to install the first platforms. The first platforms will be installed four years after this decision.

The number of fixed platforms required to develop each productive tract will be three.

Somewhat less than two (1.9) development rigs will be installed on each platform.

Eight development wells may be drilled by each platform rig each year.

The development drilling on each platform will be completed within two years.

Production will usually be delayed until development drilling is completed.

Twenty-four productive wells will be completed on each platform.

Assumptions Concerning Material Availability

Four mobile exploratory rigs can be made available and on location within 6 months of Sale No. 1.

Additional mobile rigs to a cumulative total of 15 will be available.

Platforms will be fabricated and installed to a maximum of 20 per year. About 75 percent will be constructed in the Mid-Atlantic region by the end of ten years.

Development rigs to a cumulative total of 80 will be available.

ONSHORE REQUIREMENTS

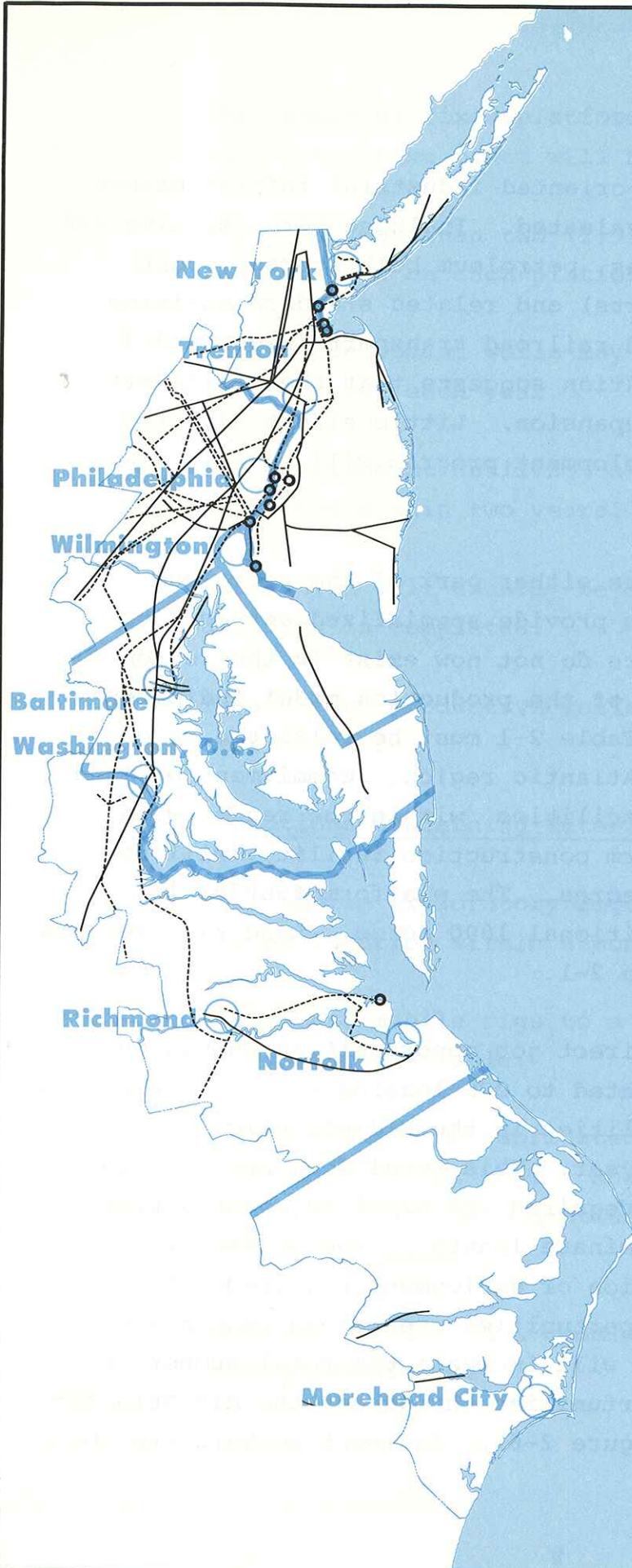
The existing petroleum-oriented industrial infrastructure in the region was broadly evaluated. Included were refining and related downstream industries, petroleum bulk storage, port facilities (including airports) and related standard maritime services, and air, road, and railroad transport (Figures 2-3, 2-4, and 2-5). This examination suggests that these elements need none or only minimal expansion. Little effect directly attributable to the OCS development program will be felt in these sectors.

Other elements which are either part of the petroleum production industry or which provide specialized services to oil and natural gas producers do not now exist in the region. Specifically, extrapolation of the production model indicates that the elements shown in Table 2-1 must be relocated to or constructed within the Mid-Atlantic region. Commitment of land for these onshore support facilities within the region, with the exception of the platform construction facility, will be slightly in excess of 1500 acres. The platform fabrication facility may require an additional 1000 acres. Land requirements are also summarized in Table 2-1.

Approximately 12,900 direct job opportunities should be available at facilities related to OCS leasing or in construction of onshore OCS-related facilities in the Mid-Atlantic region during the peak production year. This total does not include the work force that may be required for pipeline construction, since the currently indeterminate length of the necessary pipelines precludes estimation of employment requirements. Indirect and induced job opportunities created in response to the OCS development program will increase the total number of OCS-related employment opportunities throughout the Mid-Atlantic region to nearly 28,000 (Figure 2-6). Indirect workers are those

MID-ATLANTIC REGIONAL STUDY

OIL AND GAS PROCESSING



Legend

- Refineries
- Pipelines
 - Crude oil
 - - - Petroleum products
 - ... Natural gas



Approximate scale



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Figure 2-3

MID-ATLANTIC REGIONAL STUDY

PORTS

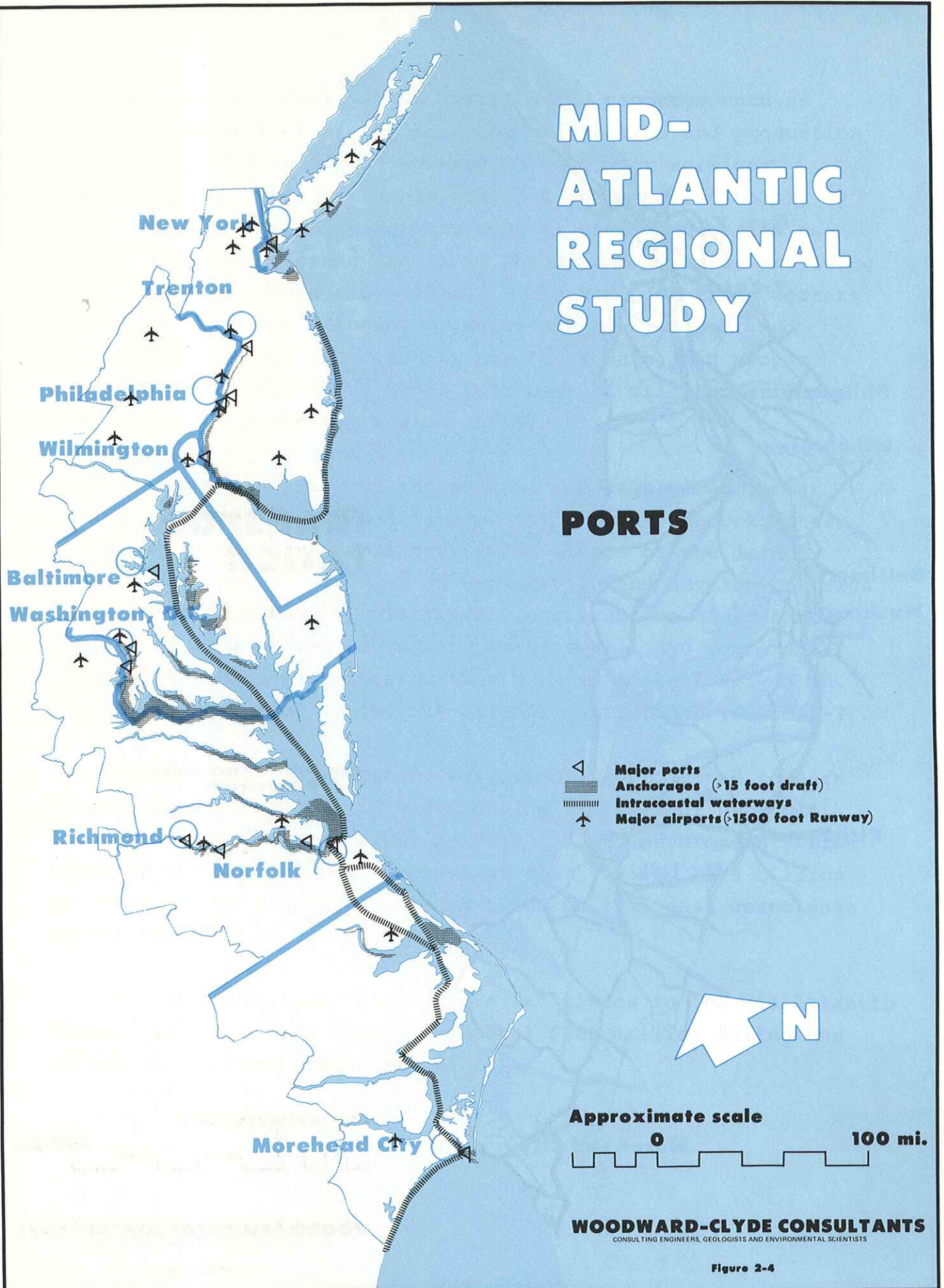
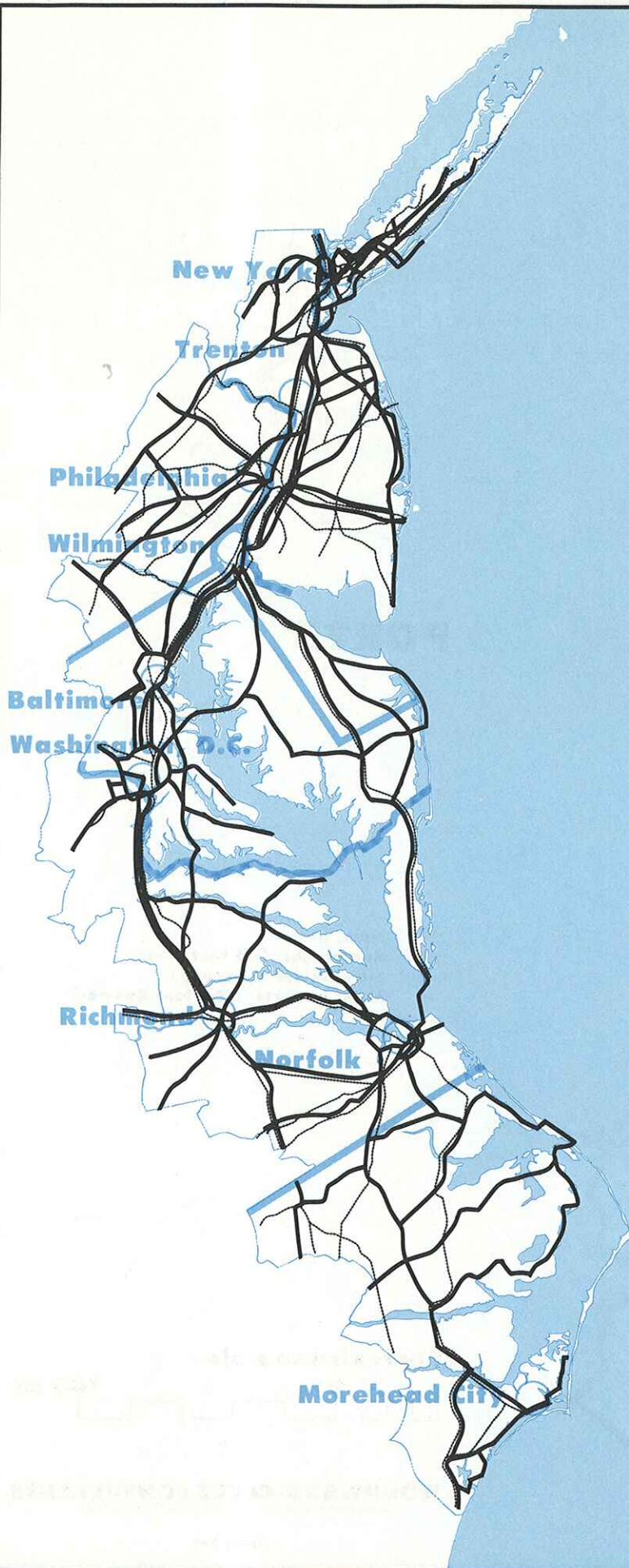


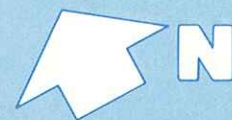
Figure 2-4

MID-ATLANTIC REGIONAL STUDY

TRANSPORTATION



— Major highway routes
- - - Major railroads



Approximate scale



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Figure 2-5

involved in manufacturing and distributing products such as paint and primary steel required for exploration and production activities. Unlike direct workers, products or services associated with indirect employment are not required solely by the oil and gas industry but are used by other industries as well. Induced employees are those whose jobs occur in providing common consumer goods and services. The need for these workers is generated by the spending of wages earned by direct and indirect employees. In order to put these data into proper perspective, it should be noted that over 12 million persons were employed within the region in 1970.

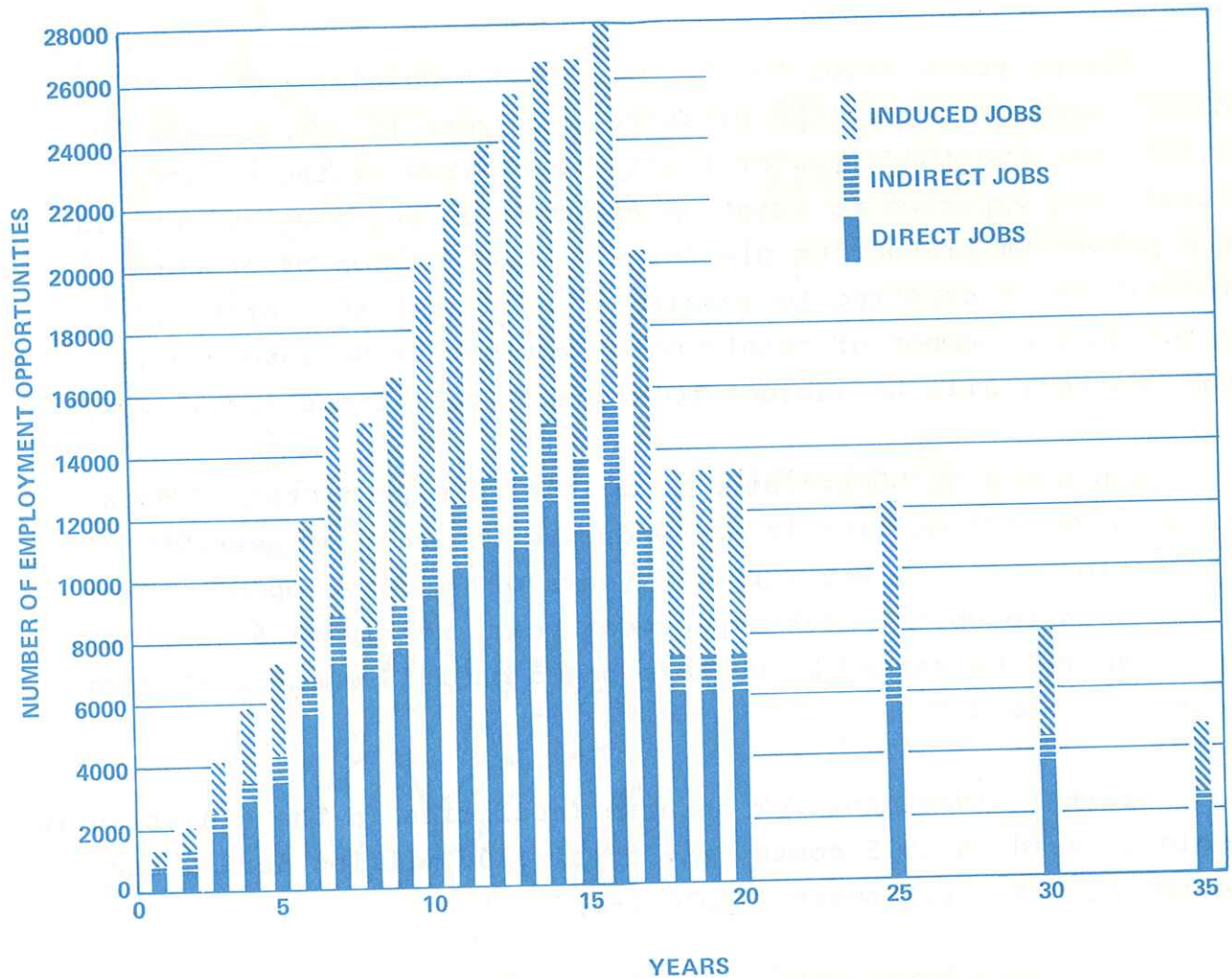
During years prior to the peak of OCS development, most direct employment will be offshore. By year 16, approximately 8,300 job opportunities, or nearly two-thirds of the direct total, are expected to exist on exploration and development rigs and petroleum production platforms. Construction of onshore facilities is expected to require as many as 1,400 workers, although the number of construction workers to be involved in any one year will be subject to sizeable variations (Table 2-2).

Employees at OCS-related facilities are projected to earn as much as \$177 million in wages during the year of peak OCS production. During the first 16 years of OCS development, from start-up through the peak employment year, nearly \$1.6 billion in wages may be earned by workers based on 1975 east coast wage levels (Table 2-3).

Capital investment for onshore facilities in the Mid-Atlantic region, based on 1975 costs, may total \$300 million during the period of OCS development (Table 2-1).

MID-ATLANTIC REGIONAL STUDY

OCS EMPLOYMENT OPPORTUNITIES



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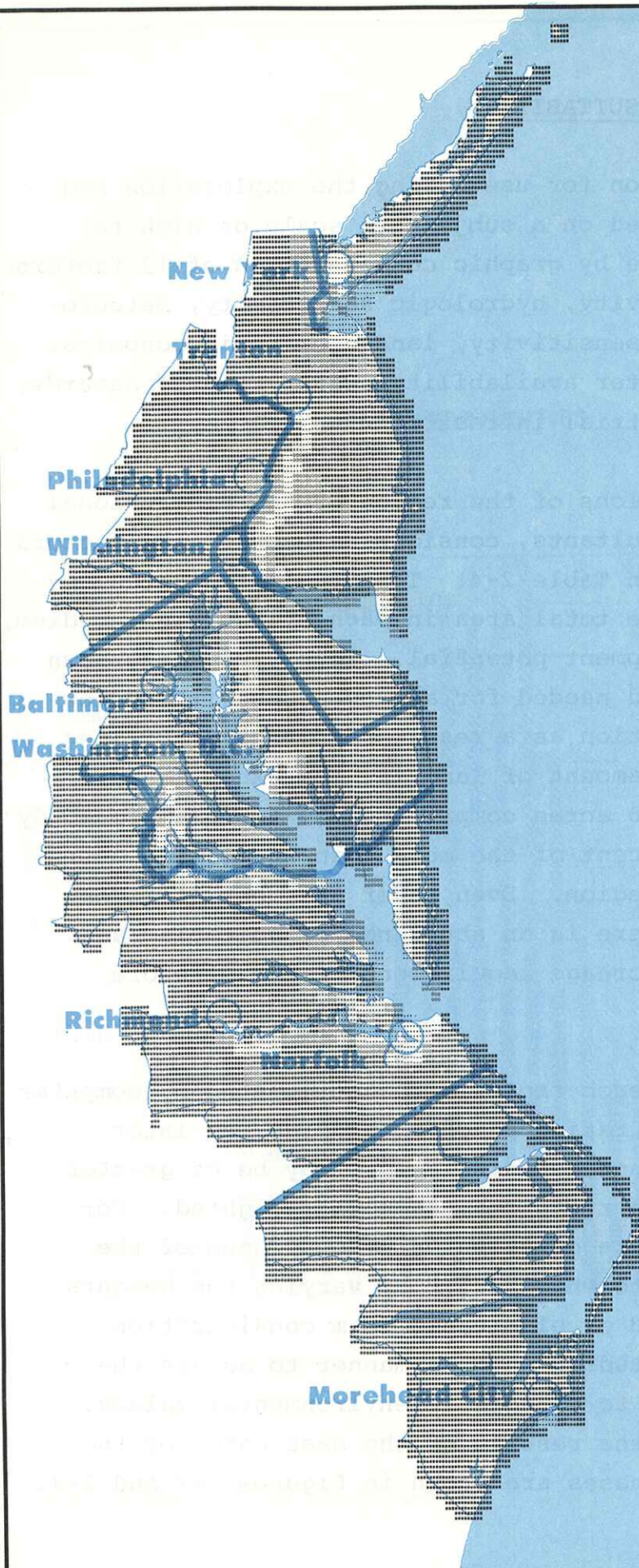
Figure 2-6

ASSESSMENT OF REGIONAL SUITABILITY

Suitability of the region for use during the exploration and production phases was assessed on a subjective scale of high to low. The assessment was made by graphic consideration of 12 factors including: ecologic sensitivity, hydrologic sensitivity, meteorologic sensitivity, geologic sensitivity, land use, socioeconomics, coastal zone legislation, water availability, water-related hazards, seismology, slope, and industrial infrastructure.

The broad scale evaluations of the region by the professional staff of Woodward-Clyde Consultants, considering each of the factors separately, are summarized in Table 2-4. This table indicates, by factor, the percentage of the total area in each of the high, medium, and low categories of development potential. This study has shown that the total amount of land needed for all purposes with the exception of pipeline construction as a result of offshore drilling is about 2,400 acres. This amount of land is, for example, only 0.14 percent of the 1,768,160 acres comprising the two example study areas. It is only 0.008 percent of the more than 30 million acres in the entire Mid-Atlantic region. Even under the most stringent environmental regulations there is an abundance of suitable land to accommodate the onshore acreage requirement of the offshore petroleum industry.

Individual ratings for each factor were accumulated by computer to give a composite regional rating which considered the interaction of all factors. Because certain factors may be of greater importance in relation to other factors, each was weighted. For the base case, the weights were distributed by consensus of the professional staff assigned to the study. By varying the weights, certain factors were stressed or eliminated from consideration. Five additional cases were studied in this manner to assess the sensitivity of the base case to changes in environmental values. Composite maps representing the results of the base case for the exploration and production phases are shown in Figures 2-7 and 2-8.



MID-ATLANTIC REGIONAL STUDY

COMPOSITE MAP

PHASE: EXPLORATORY 1

Legend

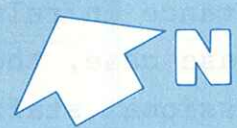
DEVELOPMENT POTENTIAL

High **Low**

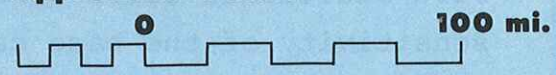
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Notes

1. See text for composite elements and weightings
2. Cell size: 16 square miles



Approximate scale



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Figure 2-7

MID-ATLANTIC REGIONAL STUDY

COMPOSITE MAP

PHASE: PRODUCTION 1

Legend

DEVELOPMENT POTENTIAL
High

Low

Notes

1. See text for composite elements and weightings
2. Cell size: 16 square miles



Approximate scale



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Figure 2-8



CONCLUSIONS REGARDING REGIONAL EFFECTS

The Mid-Atlantic states are now experiencing environmental problems. These problems may be increased by the onshore requirements of oil and gas exploration and production. However, the incremental addition to these problems generally appears small. The suitability assessment indicates that areas within the region are generally compatible with the demands to be imposed upon them during implementation of the development program. In contrast, the benefit to the national interest of significantly increasing domestic energy production appears large.

Detailed analyses of the implications of the data for overall onshore support requirements within the entire Mid-Atlantic region was judged to be inappropriate because the region is large and heterogeneous. Therefore, to illustrate the magnitude of anticipated effects on a local scale, reasonable proportions of the total program support requirement were allocated between two sub-regional study areas chosen by the staff as examples (Figure 2-1). Key effects were compared to existing or planned social, economic, and natural systems. The conclusions presented below for each study area are based on this analysis.

Although socioeconomic effects are discussed in detail, conclusions regarding effects on the natural environment are less detailed because definitive treatment requires site specificity (e.g., the environmental effects of a large industrial facility located in a coastal marsh differ significantly from those of an identical facility located in an abandoned agricultural tract or an industrial park). The scope of the study precluded this level of examination.

Study Area 1

Total OCS operations could create nearly 10,000 direct, indirect, and induced employment opportunities for residents of

this study area and generate over \$900 million in wages during the years prior to the peak of production. In addition, about 4,500 persons, including nearly 1,500 direct workers, may be eventually expected to relocate to the area. This relocation is equivalent to about two percent of the projected growth in area population between 1970 and 1990. Thus, the OCS-related demands for housing, land, and recreation are small in relation to the normal population growth which may be anticipated.

The relocated population may require about \$4 million in local government expenditures during the peak production year. Local tax revenues may be sufficient to defray these costs.

Demand for about 500 acres of land, even though small, may conflict with existing uses. In addition, future competition for land resulting from continuation of the present trend toward rapid urbanization within this study area may become evident. Facilities located on coastal sites (i.e., sites with ocean access) may impinge on ecologically fragile or highly productive biological systems and may accelerate coastal erosion problems. However, only one such site requiring about 40 acres is needed.

Should natural gas produced on the Mid-Atlantic OCS contain H_2S , emissions of SO_2 from a gas treatment plant in the western portion of the study area could cause secondary air quality standards to be exceeded. Ambient CO and NO_2 levels are also high in this area. However, such emissions can be controlled to conform with applicable U.S. Environmental Protection Agency and state air quality standards. No significant effects in the eastern portion of the study area are expected.

OCS related developments also have a potential for hydrologic and geologic effects, but these are highly site dependent. It

may be generally concluded, however, that water resources in the area are sufficient to support the development program. Other than a potential erosion problem which may be encountered at coastal sites, no significant effects related to the area's geology or seismology are indicated.

Study Area 2

OCS operations could create over 13,000 direct, indirect and induced employment opportunities for residents of this study area and generate \$1.3 billion in wages during the first 16 years of the operation period. Relocation to the study area may reach 5,400 persons. Of these, 1,800 will be directly employed. This relocation is also equivalent to about two percent of the anticipated population increase in the study area from 1970 to 1990. Thus, demand of these persons for housing, land, and recreation are also small in relation to demand created by anticipated population growth.

Local government expenditures for services required by the relocated population may total over \$3.3 million in the peak production year. OCS-related local tax revenues may be sufficient to defray most of these costs.

Potential effects on the natural environmental in Study Area 2 are similar to those summarized above for Study Area 1. Generally, severity of effect is site specific and is related to particular construction and operation procedures. Their potential magnitude is reduced almost in proportion to the quality and quantity of effort devoted to site selection, comprehensive facility planning, and adherence to environmental guidelines and regulations.

TABLE 2-1

LAND AND CAPITAL REQUIREMENTS OF OCS FACILITIES¹

Facility	Number ¹ of Units	Land (acres)		Total Onshore Capital Investment (1975 - million \$)	
		Unit	Total	Unit	Total
Exploratory Rigs	15	0	0.0	-	-
Service Support for Exploratory Rigs	1	39	39.0	5.2	5.2
Development Rigs	80	0	0.0	-	-
Service Support for Development Rigs	5.3	39	207.0	5.2	27.6
Operations Bases	5.5	50	275.0	2.8	15.4
Offices	5.5	1	5.5	-	-
Gas Plants	8	75	600.0	24.0	192.0
Pipeline Terminals (2 with Barge Facilities)	8	40	320.0	2.4	19.2
Platform Construction Facility ²	1	1,000	1,000.0	39.8	39.8 ²
Platforms	180	0	0.0	-	-
Total	-	-	2,446.5	-	299.2

¹ See Section 4.4 for derivation of number of units.² Derived from Urban Pathfinders, Inc. 1975. Brown and Root impact study. Baltimore, Md.

Source: Offshore Operators Committee. 1975. Unpublished data.

TABLE 2-2

PROJECTED TOTAL DIRECT EMPLOYMENT OPPORTUNITIES AT OCS FACILITIES, MID-ATLANTIC REGION

Year	Exploratory Rigs	Development Rigs	Support Services	Platforms	Pipeline Terminals	Gas Processing Plants	Office	Operations Base	Construction	Platform Construction Facility ¹	Total
1	339		174						120		633
2	339		174							380	893
3	678		174							1,040	1,892
4	1,356		226	64					120	1,035	2,685
5	1,356	520	365	160					120	1,034	3,320
6	1,356	1,300	539	320					1,190	1,094	5,465
7	1,695	2,080	644	480			42	136	1,400	1,088	7,300
8	1,695	2,600	713	720		68	42	136	120	1,168	6,987
9	1,356	3,250	835	960	34	68	42	136		1,257	7,576
10	1,356	3,900	922	1,280	34	68	42	136	620	1,355	9,306
11	1,130	4,550	922	1,600	51	102	63	204	670	1,500	10,332
12	904	5,200	1,027	1,920	51	102	80	258	500	1,500	11,151
13	565	5,200	992	2,240	68	136	109	354	1,170	1,500	11,838
14	565	5,200	992	2,560	85	170	134	435	1,170	1,500	12,334
15	226	5,200	957	2,880	102	204	164	530	1,100	1,500	12,367
16	226	5,200	957	2,880	119	238	189	612	1,170	1,500	12,933
17	226	2,600	487	2,880	136	272	218	707	670	1,500	9,521
18	226		174	2,880	136	272	231	748		1,500	6,113
19	226		174	2,880	136	272	231	748		1,500	6,167
20	226		174	2,880	136	272	231	748		1,500	6,167
25	226		174	2,560	136	204	202	653		1,500	5,655
30	226		174	1,216	68	136	92	299		1,500	3,711
35	226		174	64	34	68	42	136		1,500	2,244

¹ Assuming facility continues to operate after year 16, but platforms are exported to other areas.

Source: Woodward-Clyde Consultants calculations. 1975.

TABLE 2-3

PROJECTED WAGES TO BE PAID TO EMPLOYEES AT OCS FACILITIES,
MID-ATLANTIC REGION (Figures in thousands of dollars)

Year	Exploratory Rigs	Development Rigs	Support Services	Platforms	Pipeline Terminals	Gas Processing Plants	Office	Operations Base	Construction	Platform Construction Facility	Total
1	4,510		2,540						1,800		8,850
2	4,510		2,540							4,030	11,080
3	9,020		2,540							11,020	22,580
4	18,030		2,540							10,970	33,340
5	18,030	7,380	3,300	880					1,800	10,960	42,350
6	18,300	18,460	5,330	2,190					1,800	11,600	73,460
7	22,540	29,540	7,870	4,380			730		17,850	11,500	99,160
8	22,540	36,920	9,400	6,580			730	1,600	21,000	12,380	93,400
9	18,030	46,150	10,410	9,860	490	960	730	1,600	1,800	13,300	101,530
10	18,030	55,380	12,190	13,150	490	960	730	1,600	9,300	14,360	126,190
11	15,030	64,610	13,460	17,540	490	960	730	1,600	10,050	15,900	140,370
12	12,020	73,840	14,490	21,920	730	1,440	1,100	2,410	7,500	15,900	151,850
13	7,510	73,840	14,480	26,300	730	1,440	1,390	3,040	17,550	15,900	162,180
14	7,510	73,840	14,480	30,690	970	1,920	1,900	4,180	17,550	15,900	168,940
15	3,010	73,840	13,970	35,070	1,220	2,400	2,330	5,130	16,500	15,900	169,370
16	3,010	73,840	13,970	39,460	1,460	2,880	2,850	6,250	17,550	15,900	177,170
17	3,010	36,920	7,110	39,460	1,700	3,360	3,290	7,220	10,050	15,900	128,020
18	3,010		2,540	39,460	1,940	3,840	3,790	8,340		15,900	78,820
19	3,010		2,540	39,460	1,940	3,840	4,020	8,830		15,900	79,540
20	3,010		2,540	39,460	1,940	3,840	4,020	8,830		15,900	79,540
25	3,010		2,540	35,070	1,940	2,880	3,510	7,710		15,900	72,560
30	3,010		2,540	16,660	970	1,920	1,600	3,500		15,900	46,130
35	3,010		2,540	880	490	960	730	1,600		15,900	26,110

Source: Woodward-Clyde Consultants calculations. 1975.

TABLE 2-4
SUMMARY OF REGIONAL SUITABILITY

FACTOR	DEVELOPMENT POTENTIAL (Percent of Area)		
	HIGH	MEDIUM	LOW
Ecologic Sensitivity	35 ¹	21	44
Hydrologic Sensitivity	20	41	39
Meteorologic Sensitivity	21	20	59
Geologic Sensitivity	83	7	10
Land use			
Exploration	10	3	87
Production	4	73	23
Socio-Economic Index			
Exploration	27	59	14
Production	27	62	11
Coastal Zone Legislation	76	18	6
Water Availability	22	22	56
Water Related Hazards	68	7	25
Seismology	50	50	0
Slope	75	24	1
Industrial Infrastructure			
Exploration	2	8	90
Production	4	89	7

¹ 35 percent of the Mid-Atlantic region is considered highly suitable for development when tested against the criteria established for ecologic sensitivity.